HABITALP

Annette Lotz (Ed.)

ALPINE HABITAT DIVERSITY

Project Report 2002 - 2006

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Alpine Space

Interreg III B

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Alpine Habitat Diversity
HABITALP

Project Report 2002 - 2006

EU Community Initiative INTERREG III B Alpine Space Programme

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HABITALP – a success story of alpine cooperation

The HABITALP project emerged from the cooperation within the Alpine Network of Protected Areas. Only two years after the foundation of this network in the year 1995 the working group "alpine habitats" was formed. In the frame of this working group the two main basic principals of the agreed alpine cooperation of protected areas were applied: the principals of co-responsibility and continuity of actions.

Co-responsibility in the sense that one or several protected areas take over the responsibility for specific issues or actions, care for their dissemination and provide the results to the common association of all protected areas. Disposing of many years of experience in the basic method of the project, this was the reason why the Nationalpark Berchtesgaden agreed to take over the duties of the lead partner. This implied the overall responsibility not only for the scientific but also for the administrative and financial implementation. In order to meet these obligations considerable additional out-of-official-budget contributions were provided to the project.

The continuity of actions as second basic principle of the Network cooperation means that there is no demand for short-term actions but that working programmes for several years, the regular exchange of experiences and methods and the set up of common "international" tools for all members of the Network are of high priority. The HABITALP project also allowed for the realization of this principle. The further development of initially "local" aerial image interpretation methods through the alpine cooperation lead to a restructuring and adaptation of the interpretation key which can now be applied in the total alpine area by all partners of the Network. The idea of alpine standardization and adaptation of methods and working tools received considerable progress. With the project's results a fundamental base was created for the vision of a transboundary coordinated protected area management.

The commonly developed methods, tools and results of the HABITALP project offer a great potential for future cooperation not only within the Alpine Network of Protected Areas but also with protected areas of other high mountain regions. An extension to more densely settled zones e.g. in the periphery of protected areas is possible as well.

Michael Vogel
Director Nationalpark Berchtesgaden

HABITALP – a new era for the monitoring and management of alpine habitats

After a period of four years the HABITALP project has now been terminated. Being of a high technical and scientific complexity this pilot project sets a new standard for the future monitoring of habitats and the resulting management measures. The INTERREG III B Alpine Space Programme offered the required frame to motivate 11 partners from five alpine countries to get involved into a highly demanding cooperation. The different and very concrete results like the interpretation key and the method of habitat cartography will be an important support for many protected areas and NATURA 2000 regions of the Alps for the fulfilment of their tasks.

Also within the Alpine Network of Protected Areas (ALPARC) the HABITALP project is of great importance as one of the ALPARC objectives is to develop new tools for the management of protected areas and to harmonize the applied methods. In this respect HABITALP was a pilot project and its results will now be of benefit to all interested protected areas in the Alpine Space. HABITALP enabled a first inventory of alpine landscapes and the definition of a common methodology in order to observe the future dynamic of these landscapes through a continuous monitoring.

HABITALP has pioneer character, not only because of its tangible results and the application of modern techniques but also and in particular because of the development of a common working culture in long-term questions of habitat management. In fact the project has raised many questions, which concern – beyond technical and scientific aspects – fundamental elements of protected area management. In this sense the implementation of an alpine coordinated management of protected areas has only just begun.

On behalf of all alpine protected areas ALPARC thanks the partners of this project and in particular the lead partner Nationalpark Berchtesgaden who guided this difficult project in a very competent and diplomatic way. It is due to all HABITALP partners that an essential progress was achieved in the field of habitat monitoring in the Alpine Space.

Guido Plassmann
Director Task Force Alpine Network of Protected Areas ALPARC
Permanent Secretariat of the Alpine Convention

HABITALP

Acknowledgement

After four years of transnational cooperation within a project community of more than 160 involved persons – composed by eleven official project partners and 34 subcontracted external experts in five alpine countries – as well as with the responsible authorities appointed by the European Union, the achievements to be acknowledged are numerous. We therefore cite individuals by name in the annex of this report and express at this point our general acknowledgements.

On behalf of the HABITALP lead partner we would like to thank

- the Alpine Network of Protected Areas which enabled the foundation of the project partnership and accompanied HABITALP for its entire duration with precious assistance and numerous communication, coordination, mediation and logistic services. As an officially recognized instrument of the Alpine Convention it will also offer the frame for future cooperation.
- the European Union for offering the funding frame within the INTERREG III B Alpine Space Programme and all involved authorities (Steering Committee, Managing and Paying Authority, Joint Technical Secretariat, National Contact Points and First Level Control bodies) for approving the project, for support in difficult phases and for finding practicable solutions during implementation.
- the national co-funding bodies for their financial commitment and the budget increase during the prolongation phase, in particular the Bavarian Ministry of Environment (Bayerisches Staatsministerium für Umwelt, Gesundheit und Verbraucherschutz) for granting the fundamental financial basis for the lead partner.
- the project partners' legally responsible persons, project managers and involved staff members as well as the leaders of the work packages and the regional coordinators for their contributions to all implementation levels.
- the numerous external experts for their great scientific and technical work, their flexibility and harmonic integration into the project community.
- the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz) for providing digital sections extracted from the bilingual publication of the aerial image interpretation key for Germany which served as cornerstone for the further development within the alpine frame of HABITALP.
- the whole project group for far more than 130 meetings with all resulting fruitful discussions and scientific enrichments, for their intercultural and interdisciplinary cooperation as well as for the constructive atmosphere, for preserving the common alpine spirit and the mutual tolerance, for uncountable out-of-official-budget actions, for numerous impressions of alpine tastes and landscapes and of course for the powerful HABITALP "germitfrenglish" whenever professional translators could not be offered.

Annette Lotz

Annette Lotz
Nationalpark Berchtesgaden

How to read this document

This project report presents the main results of the INTERREG III B project "Alpine Habitat Diversity – HABITALP" in a very concentrated form. As the full scope of project outcomes cannot be printed within the current financial constraints, further documentation is realized in the frame of several web presentations:

- http://www.habitalp.de
- http://www.habitalp.org
- http://maps.la.fh-weihenstephan.de:8080/habitalp

The publication is structured according to the project's work packages that are ranging from work package WP2 to WP12. The work package WP1 does not exist due to administrative reasons.

The chapter about the HABITALP mission gives an integrative overview on all project activities and explains the dependencies between the work packages. At the end of this report all achievements are summarized and analysed in the light of a common vision on alpine landscape management.

All work package chapters are prefaced by a summary in the project languages English, French, German and Italian in order to facilitate the communication of the main issues. However the majority of the text had to be realized in English. We recommend being aware that none of the authors is native speaker.

Most work package chapters represent the results that were commonly elaborated on the alpine project level and are thus valid for the entire project group.

As particular result the HABITALP project produced common alpine guidelines and recommendations that are designed to serve as basic instructions for repeated application and future transfer of the methods. Four major guidelines were defined as success indicators in the project application:

- Guidelines for the delimitation and interpretation of habitats
- Guidelines for the surveillance of habitats (surveillance rules)
- Guidelines of cooperation on landscape management

Being of particular importance for the follow-up actions emerging from the project, these four guidelines are subject to a separate illustration.

The guidelines for habitat delimitation and interpretation including the HABITALP interpretation key were produced in four languages. These alpine reference documents are too voluminous to be printed within the present constraints and can be found in digital format on the CD-ROM that is attached to this report.

This CD-ROM additionally stores the oral presentations held during the final conference on 14th and 15th September 2006 in Berchtesgaden.

Many local experiences have been made in the course of the project. In the frame of this publication we can only present selected experiences of two partner areas. Being of individual character they have to be clearly distinguished from the common alpine results. More local experiences are documented in the content management system that is accessible through http://www.habitalp.de

HABITALP integrates different local conditions, experiences and schools of thought into common alpine achievements. The authors of this report reflect this heterogeneity of the project group and present in addition to their "alpine" position also their individual personal opinions.

Title and work package overview

The following table gives an overview on the work package (WP) numbers and the official titles of the project's application form as essential reference for all project documents. WP numbers had to be changed in the course of the project due to a revision of the application form. For reasons of a more comprehensible structure short titles were introduced for this publication and are listed below with their corresponding work packages

Table 1: Title and work package (WP) overview

WP no. after request for change	**WP no. before request for change**	**Official title**	**Short title used in this publication**
All WP			The HABITALP Mission
WP1		not existing after request for change	
WP2	WP1	Transnational Project Management	Included in: The HABITALP Mission
WP3	WP1	Project Management	
WP4	WP9	Information and Publicity Activities	
WP5	WP2	Census and Orthorectification of Colour Infrared Aerial Photographs	Aerial Image Flights
WP6	WP3	Interpretation Key	Interpretation Method
WP7	WP4	Application of Harmonized Interpretation Key	Aerial Image Interpretation
WP8	WP5	Assigning and Surveillance of NATURA 2000 Habitats	NATURA 2000 & Monitoring (part 1 & 2)
WP9	WP6	Transnational Spatial Database	Transnational Spatial Database
WP10	WP7	Landscape Biodiversity	Landscape Diversity
WP11	WP8	Evaluation of Further Applications	Further Applications
WP12		Sustainable Setting of Project and Work Package Implementation	Included in: The HABITALP Mission
All WP			The HABITALP Vision

Abbreviations

CIR	colour infrared
EUNIS	European Nature Information System
HIK0, HIK1, HIK2	HABITALP Interpretation Key
LP	lead partner
PalHab	Palaearctic Habitat List
PP	project partner
WP	work package

Acronyms of partners

APB	Autonome Provinz Bozen Abteilung Natur und Landschaft, ITALY
ASTERS	Agir pour la Sauvegarde des Territoires et des Espèces Remarquables ou Sensibles (Réserves Naturelles de Haute-Savoie), FRANCE
CPNS	Consorzio del Parco Nazionale dello Stelvio/Konsortium für den Nationalpark Stilfser Joch, ITALY
NPB	Nationalpark Berchtesgaden, GERMANY
NPHT	Nationalparkrat Hohe Tauern, AUSTRIA
PNDB	Parco Nazionale Dolomiti Bellunesi, ITALY
PNÉcrins (= PNE)	Parc National des Écrins, FRANCE
PNGP	Parco Nazionale Gran Paradiso, ITALY
PNMA	Parco Naturale Mont Avic, ITALY
PNV	Parc National de la Vanoise, FRANCE
SNP	Parc Naziunal Svizzer, SWITZERLAND

Introduction

Characterised by a great diversity of natural and cultural landscape heritage the Alpine Space represents at the same time a homogenous biogeographical region that is subject to transnational policies like the Alpine Convention or the European Habitat Directive. The implementation of these policies requires a transboundary database of comparable and commonly used datasets with a spatial reference. Issues of landscape monitoring and success control of management measures can only be tackled by temporal data series of comparable quality. All this creates a strong need for the reproducibility of methods and commonly applied standards.

The protected areas of the Alpine Space are the preservation centres for many natural and semi-natural habitats and an important part of the European NATURA 2000 network. In an alpine context the preservation tasks for these habitats of different protection status require the integration of various national and local approaches on the basis of comparable landscape inventories.

HABITALP is embedded in the growing demand for practical applications that can support transboundary decision finding and pursues the vision of a common alpine landscape management. For the first time the alpine standardisation of methods is attempted for the creation and analysis of comparable landscape datasets in the protected areas of the Alpine Space.

Aerial images and the land cover data resulting from their professional evaluation (aerial image interpretation) describe the physiographic structure of the landscape. In protected areas this structural classification is of particular value as basic spatial reference because proprietary borders are of minor importance. Colour infrared images in comparison to real colour photos allow a more specific distinction of the vegetation types. The interpretation mosaic can serve as interdisciplinary link to datasets of other domains and allows cross-sectoral approaches.

This background initiated the project idea, which was born within the working group “Alpine Habitats” of the Alpine Network of Protected Areas. The initial methodology of colour infrared aerial image interpretation in an alpine environment has been established and refined in the Nationalpark Berchtesgaden since the 1980s. From 1999 to 2001 it was successfully pre-checked for transnational and reproducible application by the Hohe Tauern and Swiss National Parks and supported by the INTERREG II A funding programme.

Following the principles of co-responsibility of partners and continuity of actions promoted by the Alpine Network of Protected Areas, eleven of its members coming from five different countries of the Alpine Space founded the project partnership in 2002. Under the leadership of Nationalpark Berchtesgaden they committed themselves to enlarge the local methodology to an alpine scale and to create a transnational landscape database as fundament for the development of future transboundary strategies and the realization of coordinated measures. A long-term instrument should be provided which could serve for the transboundary implementation of the Alpine Convention and the Habitat Directive.

The project “Alpine Habitat Diversity – HABITALP” was approved in the first call of the INTERREG III B Alpine Space Programme and started in November 2002. It covered a duration of four years and a total budget of 2.100.000 € including 991.680 € of co-funding by European Regional Development Funds (ERDF).

Project Summary

HABITALP intended to create a long-term instrument that could equally serve local and transboundary protected area management. All work packages were thus dominated by the objectives of local integration and alpine standardization.

Common alpine methods for data capture and analysis were developed for eleven partner areas on the basis of colour infrared aerial images (http://www.habitalp.de).

The first step was to realize image flights and to produce orthophotos by the aid of harmonized technical specifications in three project languages. More than 7.000 km² localized in ten protected areas could be covered by aerial images. A subset of this surface was foreseen to undergo the interpretation process.

In the frame of professional image interpretations the distinguishable land cover types were delimited as polygons and described according to a list of coded habitat characteristics. The HABITALP interpretation key (HIK) as well as the guidelines for its application were elaborated in four languages and include all habitats that are occurring in the partner areas (http://www.habitalp.org). The common application of these alpine reference documents produced harmonized landscape datasets in ten partner areas. More than 4.000 km² were interpreted.

Following the particular interest of HABITALP in supporting protected area management with practical tools the project focused on three exemplary applications of the interpretation data:
Correspondence tables of HABITALP and NATURA 2000 habitat classifications were set up for nine partner areas. Refining of these correspondences by available ecological parameters was tested for one selected area. First maps showing the potential occurrence of selected NATURA 2000 habitats were derived.
Diversity modelling of interpretation data resulted in four numeric assessments of the landscape that were produced for eight partner areas according to a common alpine method. CORINE land cover and SRTM elevation data served to create a first surface covering (but less complex) alpine-wide model of landscape diversity.
The potential of HABITALP interpretation datasets for landscape monitoring was investigated by means of two interpretation layers of the Berchtesgaden area. Observed changes were analysed and common alpine surveillance rules derived.

Spatial datasets were integrated into a common transnational database that publicly visualizes HABITALP data by a mapserver application and web services (see http://maps.la.fh-weihenstephan.de:8080/habitalp). Methods and experiences are documented within a content management system, which can be accessed via http://www.habitalp.de.

Due to unforeseeable problems in the realization of image flights the full scope of scheduled tasks could not be fulfilled in all partner areas. Nevertheless HABITALP was a successful pilot project that produced within only four years of cooperation common alpine achievements of a heterogeneous project group. The alpine integrative dimension of all issues made the mission innovative and demanding and emphasizes the added value of the results.

HABITALP achieved a high degree of harmonization and the comparability of datasets. But we are only at the beginning of a common vision on alpine landscape management. Many questions have been brought up and further needs defined concerning methodological refining and increased standardization as well as with regard to transfer activities, database maintenance and further fields of application.

The HABITALP Mission

Local integration and alpine standardisation – fundaments of interdisciplinary exchange and common instruments within the Alpine Space

Annette Lotz, Diplom Geographin
studies of biogeography and physical geography in Saarbrücken, Germany, and Québec, Canada, working since 1996 in the Nationalpark Berchtesgaden, focus on GIS ecological modelling (habitats, species interrelations, priority areas of management measures), chamois monitoring, relational database structuring

Nationalpark Berchtesgaden

Summary

The HABITALP project group united 11 official partners belonging to the Alpine Network of Protected Areas and 34 subcontracted external experts who were interacting on three project levels for the implementation of 11 work packages. The official project language was English. The sophisticated project issues required an additional exchange in the native languages of the alpine partners.

The main objective was to develop a common alpine methodology for the census and analysis of landscape structure on the basis of colour infrared aerial images. The initial method locally established in Nationalpark Berchtesgaden was extended to comprise the variety of alpine habitats represented by ten other protected areas. With regard to the demands of practical protected area management further studies were carried through in the field of landscape monitoring, NATURA 2000 and landscape diversity. Spatial results were integrated into a transnational database. Methods and experiences are documented in a content management system. Both are publicly accessible via internet.

In the vision of a common alpine landscape management the highest possible degree of standardization and local integration should be achieved. This intention required from the very beginning a most intense interdisciplinary cooperation and the harmonization of all intermediate steps.

The main challenge of the HABITALP project was to achieve methodological development and subsequent application as well as initial data capture and advanced analysis within the same project phase in an alpine and multilingual environment. The complex project structure and the high number of more than 160 involved persons represented a particular challenge. Difficulties in the realization of the image flights as basis of all further steps resulted in overlapping implementation phases. Successful project termination under these conditions was only possible by an efficient and durable structure for management and coordination.

In conclusion it can be stated that HABITALP was a successful pilot project that tackled well-known issues in an innovative and ambitious alpine context. The results offer a great starting point for further transnational activities.

Résumé

Le projet HABITALP a réuni 11 partenaires officiels appartenant au Réseau Alpin des Espaces Protégés et 34 experts externes qui ont participé, à trois niveaux différents, à la réalisation de 11 work packages. La langue officielle du projet était l’anglais. En raison du caractère hautement technique des thèmes traités, une partie des travaux s’est déroulée dans les langues maternelles des partenaires de la région alpine.

Le principal objectif du projet est la mise au point d’une méthodologie commune à l’espace alpin pour le recensement et l’analyse des structures de paysages sur la base de photographies aériennes infrarouge couleur. La méthode initialement mise au point au Parc National de Berchtesgaden a été développée afin d’inclure la variété des habitats alpins des dix autres espaces protéges. Pour répondre aux exigences de la gestion pratique des espaces protégés d’autres études ont été menées dans le domaine de la surveillance de paysages, NATURA 2000 et de la diversité des paysages. Les résultats de ce monitorage spatial ont abouti à la création d’une base de données trans-nationale. Les méthodes et les expériences sont documentées à l’aide d’un système de gestion de contenus. Ce dernier, de même que la base de données, sont accessibles au public par l’internet.

En vue de la gestion commune du paysage alpin, l’harmonisation et l’intégration locale maximale sont des conditions incontournables. Depuis les premières phases, cette exigence a imposé une coopération interdisciplinaire intense et l’harmonisation des étapes intermédiaires.

Le principal défi du projet HABITALP était la mise au point d’une méthodologie et son application, la saisie initiale des données et leur analyse approfondie lors d’une même phase de projet et dans un environnement alpin multilingue. La structure complexe du projet et le nombre élevé (plus de 160) de personnes impliquées ont représenté un défi supplémentaire. Les difficultés rencontrées lors de la réalisation des survols – une étape indispensable pour la réalisation des étapes successives – ont causé un décalage des étapes de réalisation du projet. Dans ces conditions, le projet a pu être complété avec succès grâce à une structure stable et efficace de gestion et de coordination.

En conclusion, on peut affirmer que HABITALP est un projet pilote réussi, qui a traité des thèmes bien connus par une démarche ambitieuse dans un contexte innovant, représenté par l’espace alpin. Les résultats offrent un excellent point de départ pour la suite des activités transnationales.

Zusammenfassung

Die HABITALP Projektgruppe vereinigte 11 offizielle Partner aus dem Netzwerk Alpiner Schutzgebiete sowie 34 externe Vertragnehmer, die zur Umsetzung von 11 Arbeitspaketen auf drei Projektebenen beitrugen. Die offizielle Projektsprache war Englisch. Die anspruchsvollen Themen des Projekts erforderten einen zusätzlichen Austausch in den Muttersprachen der alpinen Partner.

Hauptziel war die Entwicklung einer alpenweiten Methode zur Erfassung und Analyse der Landschaftsstruktur mit Farbinfrarot-Luftbildern. Die ursprünglich im Nationalpark Berchtesgaden lokal etablierte Methode wurde erweitert, um der Lebensraumausstattung von zehn anderen alpinen Schutzgebieten gerecht zu werden. Im Hinblick auf die praktischen Anforderungen im Management von Schutzgebieten wurden weitere Studien zum Landschaftsmonitoring, zu NATURA 2000 und zur Diversität der Landschaft durchgeführt. Raumbezogene Ergebnisse wurden in einer transnationalen Datenbank integriert. Methoden und Erfahrungen sind in einem Content Management System dokumentiert. Beides ist über das Internet öffentlich zugänglich.

In der Vision eines gemeinsamen alpenweiten Landschaftsmanagements sollte ein möglichst hoher Grad an Standardisierung und lokaler Integration erreicht werden. Diese Absicht erforderte von Beginn an eine äußerst intensive interdisziplinäre Zusammenarbeit und die Harmonisierung aller Zwischenschritte.

Die größte Herausforderung von HABITALP war es, methodische Entwicklung und nachfolgende Anwendung, Erfassung der Rohdaten und hochentwickelte Analysen innerhalb derselben Laufzeit in einem alpenweiten und mehrsprachigen Umfeld zu erreichen. Die komplexe Projektstruktur und die hohe Anzahl von mehr als 160 beteiligten Personen stellten eine besondere Herausforderung dar. Schwierigkeiten bei der Realisierung der Bildflüge als Ausgangsbasis aller weiteren Arbeitsschritte verursachten mehrere sich überlappende Umsetzungsphasen. Der erfolgreiche Abschluss des Gesamtprojekts unter diesen Bedingungen war nur möglich mit Hilfe einer effizienten und dauerhaften Struktur für Management und Koordination.

Zusammenfassend lässt sich sagen, dass HABITALP ein erfolgreiches Pilotprojekt war, das bekannte Themen in einem innovativen und ehrgeizigen alpenweiten Kontext in Angriff genommen hat. Die Ergebnisse bieten eine großartige Ausgangsbasis für weitere transnationale Aktivitäten.

Riassunto

Il gruppo di progetto HABITALP ha riunito 11 partner ufficiali della Rete delle Aree Protette Alpine e 34 fornitori esterni che contribuivano, a tre livelli differenti, all'implementazione degli 11 Work Packages. La lingua ufficiale del progetto era l'inglese. In ragione delle tematiche particolarmente complesse del progetto, una parte dei lavori si è svolta nelle lingue madre dei partner alpini.

Il principale obiettivo del progetto era lo sviluppo di un metodo comune a livello alpino per il rilevamento e l'analisi della struttura paesaggistica, con fotografie aeree infrarosso a colore. Il metodo originariamente adottato localmente nel Parco Nazionale di Berchtesgaden è stato allargato in ragione della diversità degli habitat delle altre dieci aree protette alpine. Per rispondere alle esigenze pratiche nell'ambito della gestione delle aree protette sono stati effettuati altri studi sul monitoraggio dei paesaggi, su NATURA 2000 e sulla diversità paesaggistica. I risultati spaziali sono stati integrati in una banca dati transnazionale. I metodi e le esperienze sono documentati in un Content Management System. Entrambi sono accessibili al pubblico tramite Internet.

In vista della gestione comune dei paesaggi a livello alpino si trattava di raggiungere un elevato grado di standardizzazione e di integrazione locale. Quest'esigenza ha imposto fin dall'inizio una cooperazione interdisciplinare estremamente intensa e l'armonizzazione di tutti i passi intermedi.

La principale sfida di HABITALP è stata la messa a punto dello sviluppo metodologico e delle successive applicazioni, del rilevamento di dati iniziali e delle analisi avanzate nella stessa fase di progetto e in un ambiente alpino e plurilingue. La complessa struttura del progetto e l'elevato numero di più di 160 persone coinvolte hanno rappresentato una particolare sfida. Le difficoltà durante la realizzazione dei sorvoli, che rappresentavano la base di partenza per tutte le fasi di lavoro successive, hanno causato la sovrapposizione di diverse fasi del progetto. In queste condizioni, il progetto ha potuto essere completato con successo solo grazie ad una struttura di gestione e di coordinamento efficiente e permanente.

Riassumendo si può affermare che HABITALP è stato un progetto pilota di successo che ha affrontato alcune tematiche note in un contesto alpino innovativo ed ambizioso. I risultati offrono una straordinaria base di partenza per ulteriori attività transnazionali.

Background and objectives

“Alpine Habitat Diversity – HABITALP” is embedded in the growing demand for practical applications, which can support transboundary decision finding in the field of sustainable landscape management.
The idea was to serve this purpose by a commonly developed methodology for the capture and analysis of standardized landscape datasets in alpine protected areas on the basis of colour infrared aerial images.

Situation in the Alpine Space

The Alpine Space is characterized by a great diversity of natural and cultural heritage and represents at the same time a homogenous European biogeographyical region. It is subject to transnational policies like the Alpine Convention (Ständiges Sekretariat der Alpenkonvention, 2003) or the European Habitat Directive (European Commission, 1992).
Transboundary applications, which are appropriate to implement such policies, require comparable and commonly used datasets with an alpine spatial reference.
In order to tackle issues of monitoring and success control temporal data series of comparable quality must be available. As a consequence the reproducibility of the methodologies is indispensable and can be achieved through commonly applied standards.

Motivation of alpine protected areas

The protected areas of the Alpine Space are the preservation centres for many natural and semi-natural habitats and an important part of the European NATURA 2000 network. On an alpine scale the preservation tasks for these habitats of different protection status require the integration of various national and local approaches. This could be done on the basis of comparable landscape inventories.

Why aerial images?

Aerial images and the land cover data resulting from their evaluation (aerial image interpretation) describe the physiographic structure of the landscape. In protected areas this structural classification is of particular value as basic spatial reference because proprietary borders are of minor importance.

Aerial image interpretations are produced in a continuous and surface covering way which means that there are no “holes” without data. They describe the land cover types that can be distinguished as homogenous structural units on the images. The interpretation mosaic provides a basic data layer that can serve as interdisciplinary link to datasets of other domains.
Colour infrared (CIR) images in comparison to real colour photos allow a more specific distinction of the vegetation types. Regarding the detail of habitat description (legend classes) aerial image interpretations are ranging between more general satellite classifications (e.g. CORINE land cover) and more detailed phyto-sociological field maps (e.g. EUR 25). In contrast to currently available satellite images aerial photos allow a better three-dimensional view of the landscape and a good description of the vertical vegetation structure.
On an intermediate scale (“landscape level”) aerial images represent an efficient tool for the census of natural and semi-natural landscape structure, for the monitoring of its changes and for the spatial planning of appropriate preservation measures.

Growing of the project idea

Aerial image interpretation in an alpine environment is subject to specific challenges. Since the 1980s the Nationalpark Berchtesgaden has established and refined local methods that are suitable for high mountains. They emerged from an interpretation key (list of land cover types that are detectable on aerial images), which was initially issued for the land cover of Germany by the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz, 2002).
In accordance with the philosophy of the Alpine Network of Protected Areas, the wish came up to share these local experiences with other partners of the network, to harmonize locally existing tools and to develop a common alpine methodology. An INTERREG II A project (1999-2001) offered the chance to check the local Berchtesgaden methods successfully for transnational application in the Nationalpark Hohe Tauern and the Parc Naziunal Svizzer.
This background initiated the project idea, which was born within the working group “Alpine Habitats” of the Alpine Network of Protected Areas and first publicly expressed in September 2001 on the site

http://www.interreg.ch/alpinespace. In the year 2002 eleven protected areas of the Alpine Space committed themselves under the leadership of the Nationalpark Berchtesgaden to enlarge the local methodology to an alpine scale and to tackle the ambitious objective of producing standardized landscape datasets.

Funding frame

Thanks to the funding frame offered by the Alpine Space Programme of the Community Initiative INTERREG III B the interested project partners had the chance to compile the necessary financial means for the implementation of their idea. The partnership participated in the first call of the Alpine Space Programme and submitted its application for the project "Alpine Habitat Diversity – HABITALP" under Priority 3 "*wise management of nature, landscapes and cultural heritage, promotion of the environment and the prevention of natural disasters*" and Measure 2 "*good management and promotion of landscapes and cultural heritage*".

Objectives

In the vision of a common alpine landscape management a long-term instrument should be provided that could serve for the transboundary implementation of Alpine Convention and Habitat Directive. For future transnational applications the results should be documented in a publicly accessible database of comparable landscape data.
To this purpose the project had to start with data capture in all partner areas. This should be done by CIR aerial image flights and according to standardized technical specifications. The professional evaluation of these images required a common alpine method for the delimitation and interpretation of the visible landscape structures as well as a common coding system that encompasses all occurring alpine habitats. Beyond the methodological development the subsequent application in the frame of the aerial image interpretation process was also envisaged within the project. With regard to the demands of practical protected area management further studies were foreseen in the fields of landscape monitoring, NATURA 2000 and landscape diversity modelling. The potential for improvements and future applications should also be analysed.

Innovative approach

Basically the issues envisaged by the project are not unknown but become innovative and demanding once they are treated on an integrative alpine level that dares to harmonize local specifics. This attempt classifies the HABITALP approach as a pilot project in the field of alpine transboundary applications. The complexity of issues and the foreseeable need for adapted methods emphasize this project character.

Organisational and technical implementation

Pilot character and complex structure of the project were dominating the HABITALP implementation in many aspects. The objectives of local integration and alpine standardization accompanied all steps.

Project structure

Partnership

For the duration of four years the HABITALP project intensely united eleven protected areas (figure 1) located in five countries of the Alpine Space. The Nationalpark Berchtesgaden was charged with the leadership of the project and the overall responsibility.

Figure 1: Geographic distribution of HABITALP project partners (with official acronyms) in the perimeter of the Alpine Convention. Further information on the project partners can be found in the annex.

The majority of project partners including the lead partner come from EU member states: Austria (1), France (3), Germany (1), Italy (5). One partner is from Switzerland. All partners have been members of the Alpine Network of Protected Areas that was founded in 1995. Most project partners are national parks, but nature reserves and nature parks are represented as well.

The territories covered by the partner areas are ranging from about 57 km² (Parco Naturale Mont Avic) to more than 2.700 km² (Parc National des Écrins). This influences strongly the available resources.

All project partners dispose of public funds, although two of them have the status of private managing bodies.

Corresponding to the HABITALP project structure major results had to be achieved by external experts. In addition the project partners charged specifically skilled staff members for certain tasks. Consequently the entire HABITALP project community was much bigger than the approved partnership and comprised more than 160 individuals (see annex).

Geographic distances between the partner territories implied a great natural and cultural heterogeneity of the project group.

Work packages

HABITALP is composed by eleven work packages (WP) listed in the following with their short titles (more details are given in the annex):

- WP1 not existing in HABITALP
- WP2 transnational management
- WP3 local management
- WP4 information & publicity
- WP5 aerial image flights
- WP6 interpretation method
- WP7 aerial image interpretation
- WP8 NATURA 2000 & monitoring
- WP9 transnational spatial database
- WP10 landscape diversity
- WP11 further applications
- WP12 sustainable setting

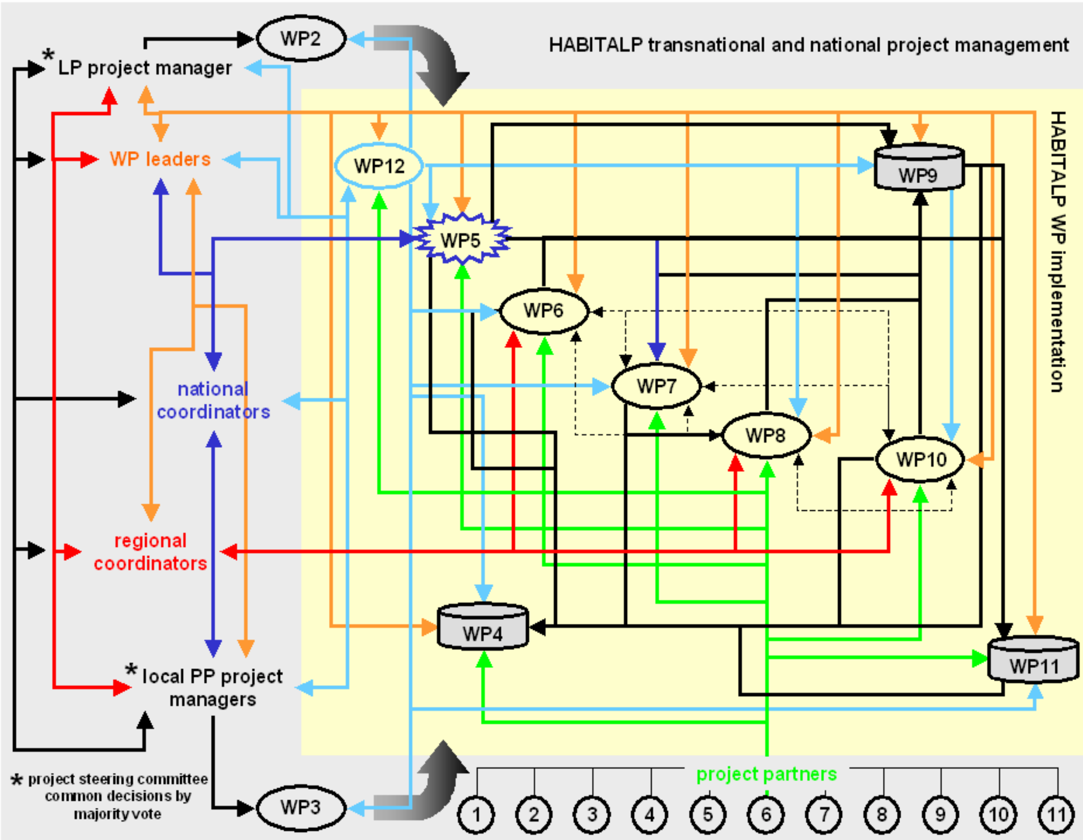

Figure 2: Interactions of parties and work packages (LP lead partner, PP project partner, WP work package)

Whereas two work packages are dedicated exclusively to transnational and local management (WP2 and WP3) the remaining nine WP are mainly technical (the term "technical WP" is used in the following to make a difference to "administrative WP" and includes equally all scientific and technical aspects).

Relationships between most technical work packages are hierarchical (WP5 to WP11) which means that each WP receives input from one ore more preceding ones (figure 2). All technical WP depend on the realization of flights in WP5. In some cases work packages are even interdependent i.e. certain results have a "backward" influence on the preceding work package (WP6 to WP10).

Similarly to the project management working constantly over the entire duration one technical WP was foreseen to contribute permanently to the sustainable setting of methods and results (WP12).

Three other technical WP should receive permanent input for public dissemination activities (WP4), for database construction (WP9) and for further applications (WP11).

The HABITALP philosophy was that all project partners contribute equally to all work packages. The ambitious objective to integrate local specifics and to harmonize methods on alpine level was characteristic for all work packages.

Budget

The total approved budget amounted to 2.100.000 €. The co-financing through ERDF (European Regional Development Funds) was 50 % for all partners of EU member states and comprised 991.680 €. The Swiss contribution was 116.640 € which is about 5,6 % of the total budget.

Corresponding to its role as promoter of the common European Spirit and the principle of co-responsibility of the Alpine Network of Protected Areas the lead partner took over a major part of the project budget. The part of the Nationalpark Berchtesgaden was 38 % whereas the ten other partners shared the remaining 62 %. On behalf of the entire project partnership the lead partner was thus enabled to finance not only the transnational project management but also most of the other common alpine experts.

The remaining common costs, which could not be taken over by the lead partner, were split into individual shares on the basis of the spatial extent of the protected areas that served as an indicator of available resources. This structure required the common transnational accounting of arising expenditures.

Due to the sophisticated scientific and technical contents of the project more than 75 % of the budget was foreseen for external experts. Several partners did not fully include their local costs into the budget plan. Considerable and unforeseen out-of-official-budget contributions occurred in addition.

Following the obligations of the application form the budget plan was structured for each of the eleven partners according to eleven work packages and seven cost categories, which implied manifold interrelations of the budget figures.

Responsibilities

Each project partner including the lead partner designated a legally responsible person and an executing project manager who were officially charged with project implementation. Beyond the administrative and financial duties (WP2 and WP3) this responsibility covered also the partner's contributions to the technical work packages (WP4 to WP12).

For each of the nine technical work packages one of the project partners was nominated as responsible leader of the alpine implementation. In five cases WP responsibility was at the charge of the lead partner in addition to its overall responsibility. Other WP leaders were CPNS, NPHT, PNV and SNP (details see annex).

The leader partner's duties implied the initiation of all administrative, financial, scientific and technical implementation activities in all WP, their coordination, alpine integration, supervision and adaptation in compliance with the application form.

Management and coordination

Taking into account the work package dependencies and the high number of involved persons it soon became obvious that the success of project implementation would essentially depend on efficient and durable structures for the management and for the scientific coordination.

To this purpose different levels of project implementation and additional coordinators were defined. Major emphasis was given to maximum vertical and horizontal exchange.

Implementation levels and interacting parties

Project implementation took place on three intricately related levels, which were defined as local – regional / national – alpine project levels (figure 2).

External experts supported all levels of implementation to different extents. The project partners worked primarily on the local level and contributed their results to the alpine level.

As many of the issues touched by the HABITALP project required different and sophisticated competences, all project managers needed specifically skilled staff or experts to cope with the manifold local duties (see annex).

Depending on the individual personal and financial resources external experts were engaged by the project partners to elaborate or to support the local contributions. This happened mainly for the fulfilment of scientific and technical tasks but sometimes also for administrative duties.

On the alpine level subcontracted external experts cared for the implementation of technical WP, harmonization and integration of local contributions into common alpine outputs. They worked under the guidance of the WP leaders and the lead partner who commonly realized WP fine planning and its permanent adjusting.

Although initially not foreseen intermediate levels of aggregation became necessary for some technical WP in order to handle the complexity of issues and to ensure efficient scientific coordination. Depending on the characteristics of the concerned work packages, national coordinators (France-Germany-Italy) were required for the tendering of aerial image flights (WP5) whereas regional coordinators (western-central-eastern alpine region) were nominated for the development of methods in the WP 6 + 8 + 10 (interpretation method, NATURA 2000 issues, landscape diversity). Coordinators aggregated local needs and supported their integration on alpine level (bottom up approach). In return they provided support and guidance in the implementation of alpine directives on the local level (top down approach). Both coordinative structures served thus as interface between local and alpine demands and enabled successful WP implementation.

Decision finding

Although the entire project community united numerous individuals, the decisive power was restricted to the core group of the partnership. The officially appointed project managers of all partner areas or their authorized representatives formed the project's steering committee.

Major decisions were supported by preparative documents of the lead partner and taken by majority vote within this steering committee.

Means of communication

Communication within the project group was realized primarily through email correspondence as an appropriate instrument to disseminate simultaneously huge amounts of information to many recipients.

As the size of the attached files constantly increased with progressing work, an ftp-server was set up and maintained by the Parc Naziunal Svizzer. This is only one example for the out-of-official-budget contributions cited above.

For the aerial images the data exchange even had to be organized through the physical transport of high capacity discs.

In the course of implementation the necessity of meetings became increasingly important.

Project conferences of all partners were mainly used to communicate the current status of implementation and to take management decisions on the further steps.

Essential progress of the technical work packages was achieved by workshops focusing primarily on the definition of technical specifications, assessment of tender applications, development of methods and harmonization of their application.

During the implementation phase eight conferences and more than 120 technical workshops were organized. All partner areas offered their hospitality at least once and cared for the logistic background. Due to the complexity of issues all meetings implied intense preparation by the presenting parties, qualified discussions by the participants and important resulting actions. All meetings offered the occasion to solve further problems in lateral discussions and unveiled repeatedly the importance of personal contact.

Languages

The official project language was English. All information determined for the entire project community was issued in this language.

However it soon became evident that English as language of exchange is not sufficient to communicate the technical and scientific issues of the HABITALP project. The terminology needed for the precise description of habitats or the tender specifications touches specific domains and is generally only known in the native languages of specialized experts. As genuine harmonization should be guaranteed, it became indispensable for the HABITALP project to elaborate common alpine reference documents in the languages of the partner areas. Furthermore technical exchange and methodological progress worked best when done in the native languages of the partners.

Even in less specific but highly complex administrative or emotional discussions the use of native languages was extremely useful to communicate clearly the different positions and common decisions.

Thanks to the assistance offered by the Alpine Network of Protected Areas and the high willingness of the project community to mobilize all available language skills, efficient structures could be provided for the multilingual and interdisciplinary communication.

Qualified professional translators were subcontracted and collaborated intensely with the respective experts to provide the alpine methodological reference documents in the project languages. In addition, part of the subcontracted scientists also issued themselves multilingual results. Six project conferences were supported by simultaneous oral translations of professionals. Numerous workshops were supported by the aid of single project members who provided their (non-professional) language skills to increase mutual understanding.

Role of the Alpine Network of Protected Areas

As commonly expressed by the project partners in the partnership agreements, the Alpine Network of Protected Areas (ALPARC) was of major importance for HABITALP.

It offered the institutional frame for the foundation and consolidation of the partnership and provided permanent assistance during the project implementation. In its function as an acknowledged instrument of the Alpine Convention the general ALPARC intention was the sustainable setting of the project idea and the achieved results in the sense of the European and Alpine Spirit. By manifold activities that were assigned to a specific work package (WP12) ALPARC fostered the sustainable vertical and horizontal exchange within and beyond the project community.

One field of activity was to support the communication in the native languages by coordinating oral and written translations, by providing the contacts to competent translators and by terminological research. ALPARC thus contributed essentially to the alpine harmonization of methods and procedures.

Apart from the linguistic assistance, ALPARC influenced considerably the positive evolution of the HABITALP communication culture by motivation of partners and mediation in delicate situations. Respecting the individual needs expressed either by the lead partner or by single project partners ALPARC thus supported the transnational integration. The pursued communication style enabled to recognize and balance cultural differences, to improve the mutual acceptance within the project group and to promote a constructive atmosphere.

Furthermore ALPARC provided its logistic structure for example for selected cartographic data or for the public dissemination through its own print and web media. Independently from the information and publicity activities within WP4, ALPARC helped thus to increase the circle of multiplying persons.

Information & publicity

Public relation work was foreseen to accompany the entire implementation phase and subject to a specific work package (WP4).

During the major part of project implementation the information and publicity (I&P) activities were mainly done through oral presentations, poster exhibitions, publications in conference volumes and representing activities of project partners in the frame of public external conferences. Publications in scientific media and press releases were also realized. Another rather important means of dissemination was the internal communication of the HABITALP progress to the staff members and associated persons of the partner areas through local activity reporting in oral and printed form.

These I&P activities were subject to individual motivation of the project partners, external experts and coordinators. In case they resulted in appropriate products, the latter were archived and publicly documented (downloadable pdf files).

Major I&P activities that integrate all partners and create common alpine products were realized in the termination phase of the project. A study on the individual needs and expectations of project partners concerning I&P activities was carried through and common alpine products were defined. In order to reach a broad range of target groups three printed publications were realized informing on different levels of detail:

- project folder (English)
- bilingual booklets (French-English, German-English, Italian-English)
- final report (English, summaries in French, German, Italian)

Apart from that I&P activities also occurred within other work packages and their results complement public dissemination. Major examples are:

- introducing multilingual project homepage (WP3) http://www.habitalp.de
- multilingual interpretation key and discussion forum (WP6) http://www.habitalp.org
- geographic visualization of landscape datasets through a mapserver application and web services (WP9) http://maps.la.fh-weihenstephan.de:8080/habitalp
- content management system (WP11) giving access to further project results, linked through http://www.habitalp.de

The culmination of I&P activities was the presentation of main results in the frame of a public project conference held on 14th–15th September 2006 in Berchtesgaden. Speeches are documented on the CD-Rom that is annexed to this project report.

Administrative implementation

Internal contracts and agreements

The contractual basis for the project implementation was built upon the partnership agreements between the lead partner and all other project partners and the subsidy contract between the Managing Authority of the Alpine Space Programme and the lead partner. In addition each project partner submitted a letter of financial commitment and its detailed local financial planning. The project's application was made an obligatory contractual compartment.

During the course of implementation further agreements among the project partners were issued for specific purposes e.g. for the optimisation of workflows (flights and interpretation), technical consulting, regional coordination, public data visualization.

External subcontracts

External experts were found through tendering and market researches. Ten tender procedures were carried through, most of them on international level. Many more exploratory contacts and negotiations were realized. 34 companies or freelance experts were subcontracted (see annex).

Flights and interpretations (WP5+7) were realized individually on the local levels of the project partners by the aid of common alpine specifications and reference documents.

All other technical WP were primarily realized by alpine experts and partly supported by regional coordinators and local experts. Apart from WP8 (NATURA 2000) and parts of WP4 (information and publicity) all alpine contracts were concluded by the lead partner. Regional contracts were established by the project partners according to common instructions issued by the lead partner.

Reporting obligations

All project expenditures had to be pre-financed by the project partners. The reimbursement of costs by the Alpine Space Programme was bound to a set of reporting obligations. About once a year the lead partner had to submit a progress report that integrated the local reports of the eleven project partners.

Each progress report consisted of three obligatory parts: activity report, financial report and information and publicity report. All expenditures listed in the financial report had to be certified with regard to their eligibility by authorized national "first level control" bodies. The sharing of common transnational expenditures had to be certified and accounted in a complex procedure.

During project implementation seven progress reports were submitted and more than 60 certifications issued. The time span from the occurrence of costs to the receipt of ERDF funds by the pre-financing project partner was up to 18 months, in one case even about 30 months.

Request for change

One of the fundamental decisions during project implementation was the request for change that became necessary because of two reasons: the initial financial structure of 2002 and the extreme weather conditions of the flight season 2003.

According to the application form the budget plan had to be assigned simultaneously to work packages and to cost categories. When the first financial plan was set up the project group was not aware that the coming implementation would demand the double splitting of actually occurring costs to these subunits. The interdependencies between the figures lead to the effect that the budget was fixed in the wrong table fields and could not be exploited. A complete restructuring of the budget was required.

Meanwhile the project implementation continued with the organisation of aerial image flights for the vegetation period 2003. Due the extremely dry summer of this year only parts of the flights could be realized. As the majority of partners was concerned and due to the hierarchical work package structure, the project's time schedule faced a considerable delay. The Managing Authority advised the lead partner to submit a request of change to obtain a prolongation of the project duration.

For the submission of this request most thorough preparations were required. First of all financial planning had to be done individually for each project partner who had to consider the three internal project levels, all obligatory subunits and future accounting modes, before the lead partner could start synthesis into the official table structure. Common alpine and regional costs had to be agreed by the project steering committee and local costs recalculated. The co-financing bodies had to approve increased financial commitments. The lead partner had to submit a new application form and a written justification for the request. The process from the decision for the request until its approval took about one year.

Technical implementation

All technical implementation phases were realized under the objective of alpine standardization and in the vision of a transboundary landscape management. A second dominating intention was the integration of local needs in order to create common tools that would be useful for local management purposes as well.

Both objectives required intense and interdisciplinary exchange as well as the transfer of know-how in different domains. Mainly through numerous workshops the project community produced common alpine results with integrative character and a high degree of harmonization.

Aerial image flights – WP5

Starting point of technical activities was the organisation of aerial image flights in all partner areas. Due to the required equipment all flights had to be subcontracted to external experts.

Austrian and Swiss project partners already disposed of aerial images in the required quality at the beginning of the project. Four tender procedures were realized for French, German and Italian partners. The nominated technical coordinators helped to harmonize specifications and to carry through tenders within aggregated national subgroups. The Italian tender had to be repeated on international level due to economic reasons. Assessment of tender applications and in some cases also the quality control of deliveries were realized by the WP leader together with other experts of the project group.

Because of unfavourable weather conditions the flights could not be realized as foreseen for all areas within the 2003 season. In order to ensure optimal visibility of habitats on the images, the flights had to be postponed to two subsequent years. The first postponement of flights was compensated by the extension of the project duration for one year (request for change). Effects of the second postponement were mitigated by the concession of all concerned parties to optimise workflows for the missing areas under the tightened time schedule (optimising agreement).

Finally the foreseen aerial image data packages could be provided for ten project partners and comprised analogous photos, digital scans and rectified geo-referenced orthophotos. The surface covered is more than 7.000 km². A subset of this surface was foreseen to undergo the interpretation process.

Interpretation method – WP6

In order to ensure a standardized evaluation of aerial images in all partner areas through professional image interpreters a common alpine methodology was required. An external expert experienced in the interpretation of the Berchtesgaden area (Landschaftsinformatikzentrum LIZ Fachhochschule Weihenstephan) was charged on alpine project level to develop the HABITALP interpretation key (HIK) and the instructions for its application (guidelines for delimitation and interpretation).

The process based on the habitat classification published for the land cover of Germany by the German Bundesamt für Naturschutz (2002), its successful adaptation to eastern alpine environments and first checks of transnational applicability in the Berchtesgaden, Hohe Tauern and Swiss national parks (HIK-0). In the frame of HABITALP an integration of all habitats occurring in the partner areas and an extension of the method to the alpine scale were achieved.

In the first step a simple enlargement from HIK-0 to HIK-1 and a general suitability check took place. In the second step a structural change in columns and codes from HIK-1 to HIK-2 became necessary because the original key version was not explicitly made for natural landscape structures of alpine environments (mosaic patterns) and not foreseen for modification to the extent required for HABITALP.

A transfer algorithm was developed to adapt HIK-0 and HIK-1 datasets to the progressing standard. Following partners served as test areas: NPHT for huge surface application of HIK-0, SNP for new HIK-2 structure, NPB for simultaneous application of HIK-0 and HIK-2 and test of transfer algorithm.

Common alpine development of the interpretation key and of its mode of application was achieved by expert discussions in the frame of numerous technical workshops and a web forum (http://www.habitalp.org).

In the beginning the methodological progress was based on “theoretic“ contributions derived from local habitat knowledge and then gradually refined by the practical input from the interpretation process.

Two training seminars and further coordinative workshops served to instruct the local interpreters in the application of the common method.

Locally available data was checked for potential support during the interpretation process.

Due to the different availability of aerial images in the partner areas the methodological development was realized within several subgroups and overlapping phases. One project partner is less intensely represented in the list of alpine habitats because of missing aerial images (PNDB).

Several draft versions of key and guidelines were issued in the course of the methodological progress. Multilingual editions were created in the three project languages. For the final versions of the alpine reference documents an English translation was realized in addition in order to facilitate transfer to other areas.

Aerial image interpretation – WP7

In the frame of this work package the aerial images (WP5) and the common alpine interpretation method (WP6) were applied for the delimitation and description of the visible landscape structures.

In the intention to harmonize the skills of the interpreters in charge technical recommendations were issued. Two partners found their local interpreters by tender procedures. The other partners either decided for internal staff or already had a specific person in mind (see annex).

Under the temporal constraints given through the availability of aerial images and the depending evolution of the interpretation key, the HABITALP methodology was adopted successfully in ten protected areas.

Only one partner could not participate in the interpretation process because of missing images (PNDB). Four of ten interpreting areas finished in time for the application of their datasets in the subsequent work packages of the project (APB, NPB, NPHT, PNE). Six other partners fully explored the project duration for the completion of their interpretation. Four of them submitted partial surfaces to further analysis (ASTERS, CPNS, PNV, SNP). The total interpreted surface covers more than 4.000 km².

Depending on different starting dates interpretation in the partner areas was an asynchronous process and lead to the application of different key (HIK-0-1-2) versions. Two partners (PNE, NPHT) were not able to adapt their running interpretation to the methodological progress because of the fixed budget frame for subcontracted external experts. Other partners could take the decision to follow the key evolution because their interpreters were permanent staff members or because out-of-official budget resources were invested. Three partners (PNGP, PNMA, PNV) expressed the need for a HIK-2 revision (HIK-3 issue), which could not be pursued under the constraints of the project. Several re-interpretation phases and the intense involvement of some interpreters in alpine methodological development retarded the local interpretations to different extents.

Interpretation datasets corresponding to different HIK versions (confer WP6 “Interpretation Method”) were adapted to the latest common agreed key status by a specific transfer algorithm.

For the Nationalpark Berchtesgaden interpretation results were delivered for two image generations dating from 1997 and 2003. They were foreseen to serve as basis for the subsequent studies in WP8 on the potential of HABITALP datasets for landscape monitoring and the development of surveillance rules.

Field controls of interpretation results (ground truth validation) were realized individually according to the local resources and requirements in the partner areas.

NATURA 2000 & monitoring – WP8

As explained in the beginning, HABITALP did not only tackle capture and evaluation of original data but also selected applications of the just achieved interpretation datasets. Two focus points were to investigate the potential that HABITALP offers for the surface covering monitoring of alpine landscapes in general as well as for the monitoring of selected habitats of European importance in particular. Both tasks were confided to alpine external subcontractors who were found through international tender procedures.

The NATURA 2000 (N2000) network encompasses protected habitat types of European importance that are cited in the Birds Directive (European Commission, 1979) and the Habitat Directive (European Commission, 1992). The Habitat Directive includes several annexes, which are referring either directly to habitats or to habitats of certain species. In a first attempt HABITALP considered only the habitat types listed in annex 1 of the Habitat Directive. Speaking of N2000 in the following thus concerns this subset of protected habitats.

Correspondence of HABITALP and NATURA 2000 classifications

This part of the study focused on the relationship of the HABITALP habitat classification to the N2000 typology and the contribution to the detection of N2000 habitats. The work was based on the definition of "theoretical" correspondences between both classifications and their practical validation in the field. The Palaearctic Habitat Classification (PalHab) as documented in the Interpretation Manual of European Union Habitats EUR25 (European Commission, 2003) was used as interface. An exemplary study by the means of a geographic information system (GIS) tested how additional environmental parameters could help to refine the previous correspondence.

In order to consider the complete habitat variety in all partner areas, local reference tables of occurring habitats were compiled by the project partners for different typologies (HABITALP - PalHab - N2000) and according to the guidelines issued by the alpine subcontractor (Bureau d'Études Biologiques). On alpine level these datasets were integrated into one common MS Access® database of relationship tables, which allows to query and to adjust local datasets for nine project partners. Common alpine instructions were issued to ensure harmonized field controls. They were carried through to different extents by the partner areas. One project partner made use of GIS modelling for local validation (NPHT). Validation results served to refine local correspondence and were integrated on alpine level.

The relationship between both habitat classifications is complex i.e. one HABITALP habitat can correspond to several N2000 habitats and vice versa. The refining GIS study (Centre Suisse de Cartographie de la Faune) could successfully reduce the number of possible relationships by taking into account the occurrence of N2000 habitats within certain ranges of altitude, slope, aspect etc. First maps of potential occurrence were derived for selected N2000 habitats.

Landscape monitoring and surveillance rules

This part of the work focused on the European demands for preserving the conservation status of single habitats as well as on the local needs of the project partners for the monitoring of their entire protected area.

By comparing the interpretations of two aerial image generations of the Nationalpark Berchtesgaden (1997 and 2003) within a transition matrix the changes having occurred within this time span and at this place were analysed. The changes observed and classified during the interpretation process were the basis of this work. Changes can occur in the delimitation as well as in the content of the polygons. Only genuine ecological changes were retained and explored for possible surveillance rules.

For a more long-term approach to the surveillance question the habitat types themselves were checked for their probability to evolve through natural dynamics (independently of the actually observed changes).

General rules for the surveillance of habitats derived from HABITALP interpretation data were set up. The contribution to the Habitat Directive as well as existing methodological limits and further potentials were analysed.

Landscape diversity – WP10

Issues of biological diversity are intensely discussed on international level (e.g. Bern Convention (Council of Europe, 1979), Bonn Convention (UNEP, 1979), Convention on Biological Diversity (UNEP, 1992), European Landscape Convention (Council of Europe, 2000) and formed the incentive to tackle this domain by giving a third example for the standardized practical application of HABITALP interpretation datasets. Two different subcontractors were charged with alpine implementation.

Biodiversity encompasses aspects of genetic, species and ecosystem diversity. HABITALP interpretation datasets can primarily serve for the analysis of habitat and landscape diversity and thus help to assess the diversity of ecosystems. Therefore the prefix “bio” in the original WP title (see annex) might be misleading.

Common alpine methods were developed on the basis of the interpretation layers created for the Nationalpark Berchtesgaden and then applied to all available datasets of the other partner areas. As the field of landscape diversity research is very wide, methodological development required an iterative process and repeated adjusting to find the most appropriate methods. Known classical diversity and modelling methods were adapted to meet the characteristic properties of the HABITALP data and the objective of practical applicability.

In a first approach the alpine expert in charge (Université Lausanne Institut d’Écologie) focused on landscape metrics. A huge range of parameters was checked for their suitability and a subset of parameters chosen. Experimental studies were made on the effects of cell size and moving window radius. Methods were mainly applied to the first column of HIK-0 (CIR1) representing the main habitat type. Intermediate results were validated and discussed with the Nationalpark Berchtesgaden as test area and a small group of partners and experts.

Like in all other work packages the know-how transfer within the project group represented a major concern. Therefore a common tool was developed (MapScape©) which can be used independently from the local GIS software and allows any project partner to calculate selected diversity indices for the local area (input data: Idrisi® raster file and dBase® IV table). Primarily designed for HIK-0 it can be widely used with HIK-2 as well.

The second alpine approach (e.m.u. projekte) concentrated on the practical application of the diversity models and the ecological interpretation of calculated diversity results. Priority was given to interdisciplinary discussions and exchange with the project partners and involved experts to find out about the needs in practical management. Focus points of diversity questions were extracted and checked if they could be pursued in the project.

Methodological development was based on HIK-2 and took into account the main habitat type as well as the degree of cover columns. The results of the first approach were considered. Intermediate results were presented to the project group and checked for further development in a commonly agreed alpine sense. Final landscape diversity models are a synthesis of three input factors:

- **abiotic relief diversity** derived from the digital elevation models
- **external habitat diversity** derived from the main habitat type of each interpreted polygon
- **internal habitat diversity** derived from the degree of cover within the interpreted polygons

Diversity modelling could be applied to eight interpretation datasets and resulted in four maps per partner area. In four cases only part of the foreseen surface was available due to the retarded interpretation process. One partner could not be considered because of missing aerial images. For two other partner areas interpretation did not cover sufficient surface to give reasonable results.

Special effort was dedicated to the validation of the diversity models. Extensive field controls took place in the Nationalpark Berchtesgaden. All project partners were guided to check their local models in a standardized way. The comments were integrated into the discussion of final results.

CORINE land cover and SRTM elevation data served to create a first surface covering (but less complex) alpine-wide model of landscape diversity.

Transnational spatial database – WP9

In the course of the HABITALP project a huge amount of data was produced. In the vision of future transnational applications all datasets should be integrated into one common database and made publicly accessible. Two subcontractors were charged with alpine implementation and worked in close cooperation.

Before the database could be set up high capacity hardware devices and suitable software had to be found. Server capacities are out-of-official-budget contributions of the alpine experts (Parc

Naziunal Svizzer and Landschafts-informatikzentrum FH Weihenstephan). A market research helped to determine the web and map server constellation that was most appropriate for HABITALP purposes. A license free solution was chosen.

The spatial database should integrate the complete geographic and tabular attribute data issued in the course of the project. For the alpine use of the geographic data a common reference and project system had to be defined. For all partner areas algorithms were developed to transform the local data into the alpine system.

The structure of the relational spatial database (Entity Relationship Model) progressed step by step according to the incoming datasets of the other WP. Database compartments are:

- orthophotos * (WP5)
- interpretation key (WP6)
- interpretation datasets (WP7)
- algorithm for the transformation of HIK-0 and HIK-1 datasets to the current HIK-2 version (WP6)
- correspondence tables (WP8) of HABITALP + N2000 classifications
- landscape diversity maps * (WP10)
- digital elevation models * (WP5+9)
- perimeters-summits-villages (WP9)
- metadata according to ISO 19115 CORE (WP9+11)

Raster files (see *) are included in the database but no part of the Entity Relationship Model.

Documentation of spatial datasets is done according to ISO 19115 CORE that was integrated as structural compartment into the database. In the frame of WP11 this structure was filled with descriptive metadata.

All project partners are represented with the datasets being available for their area at the closure date of the database. As interpretation continued in some areas, publicly visible results differ in some cases from the actual data available at the project's end.

Public visualization of the HABITALP data is given in a double way through:

- a mapserver application that can be accessed by current internet browsers (WebGIS)
- web services that can be accessed within a geographic information system (WMS-WFS standards)

All partners who contributed to the database signed agreements on the visualization of the HABITALP data that was achieved for their area. Due to the individual granting of rights the visualized data can differ from the actually produced data.

Further applications – WP11

In the intention to prepare the basis for further refining and continued application of the HABITALP method as well as for the transfer to other areas, a subcontractor was charged on alpine level with the evaluation of potential further applications. The company in charge was found by an international tender procedure.

In a first step this alpine subcontractor (E.C.O. Insitut für Ökologie) assessed the strengths and deficiencies of the HABITALP achievements concerning their practical benefit for protected area management. Possible future improvements in particular with regard to alpine standardization were extracted.

Local experiences of selected project partners in the integrative use of HABITALP interpretation data with datasets of other domains (creation of management plans, forest plans and vegetation maps, mapping of legally protected biotopes, habitat modelling) were collected. They were used to derive recommendations for the future data processing in those partner areas that do not have long-term experiences.

Apart from the geographic and attribute data that was integrated in the transnational spatial database of WP9 HABITALP produced a huge number of additional documents. For their long-term documentation and accessibility beyond the project end a content management system (CMS) was developed and filled with data.

Finally further fields of application, especially in transnational context and concerning the transfer to other areas, were checked. A list of proposals was elaborated that could be interesting to be pursued in the future.

Discussion and assessment

HABITALP was an ambitious project that tackled well-known issues in an alpine integrative context. A couple of difficulties have been overcome with success and important common alpine achievements emerged from a heterogeneous project group.

Administrative challenges

In the administrative point of view HABITALP experienced particular challenges because it was approved at an early stage of the INTERREG III B Alpine Space Programme (for more information on the programme see mid-term evaluation: Österreichisches Institut für Raumplanung, 2005).

Basic forms and procedures were still under development at the project start. In the course of the project this lead to a couple of adaptations.

Insufficient awareness of financial implementation procedures within the project group at the time of budget planning required complete financial restructuring. Continued financial implementation was only possible by the means of a request for change.

In general administrative obligations related to the receipt of co-funding were underestimated and quite a number of unforeseen duties aroused in addition. Many personal resources were consumed that were missing for the technical implementation.

Based on the strong commitment of the project group the successful administrative progress of the project was ensured. National Contact Points and First Level Control related bodies provided constructive and practical support.

Precious experiences were made that will help to improve set up and implementation of future projects. An increased mutual consideration of the requirements on programme level as well as on project level could lead to a better implementation performance.

Technical challenges

The main technical challenge was created by the fact that HABITALP dared to achieve methodological development and subsequent application as well as initial data capture and advanced analysis within the same project. Therefore the difficulties encountered in the realization of the image flights as basis of all further steps became especially important for the entire project implementation.

Arial image flights in alpine areas in the desired scale and spatial extent are particularly ambitious e.g. because of the altitudinal amplitude, strongly variable illumination conditions and short vegetation periods. The optimal time window is framed by minimum snow cover and maximum vegetation vitality. Within the HABITALP duration the number of potential flight days was reduced by the early dryness of the vegetation in 2003 (blurring normally visible habitat differences) and the high atmospheric humidity in 2004 (causing early daily cloud covers). One Italian partner had additional problems to obtain flight permissions due to military activities and finally could not get any images.

Such difficulties cannot be foreseen but become especially crucial the more areas have to be integrated within the same time frame. In this sense an approach seeming rather simple on the local level becomes an ambitious mission when tackled on the alpine level. HABITALP has thus achieved a great success for ten areas even though three flight seasons were needed instead of one.

As a consequence of flight delays not all work packages could be realized to the complete extent for all partner areas and the partnership was split into subgroups that had to realize asynchronously the same subsequent steps. This situation was extremely challenging for the project managers as well as for the subcontractors depending on the input of these results. Due to the strong project community the majority of objectives could still be achieved even under these difficult conditions.

With respect to the quality of the aerial images and the potential they offer for the following landscape analysis the decision for postponing flights to optimal conditions was justified. Inferior quality of original data cannot be compensated at a later time, not even by the most sophisticated analysis.

Assessment of achievements

Management and coordination

HABITALP could overcome the encountered challenges and achieved a good level of success in all work packages. Although not all partner areas contributed equally to all work packages, the majority of foreseen results could be obtained.

The achieved success confirms that the established management and coordination structures were suitable to cope with the heterogeneity of the project community and the complex interdependencies of work packages.

Linguistic and cultural differences as well as different levels of experience in many domains and different extents of personal involvement were compensated. Particular coordinative efforts could maintain the objectives of local integration and alpine standardization even within the project subgroups resulting from the flight delays.

Management and coordination proved thus to be durable enough to survive for four years and efficient enough to persist under retarded implementation phases. Improved performance could be obtained in future projects by more equal distribution of responsibilities (e.g. WP leaderships) and increased emphasis on certain aspects of the planning phase (e.g. provisions for possible deviations, pre-definition of potential experts, financial structure).

The long project duration offered the chance to create a strong partnership and implied at the same time the risk of premature decay. HABITALP took the chance and achieved a good consolidation of the project group.

A high level of intercultural tolerance and interdisciplinary communication developed thanks to highly motivated partners and the support of the Alpine Network of Protected Areas. The communication culture enabled the practise of an integrative and democratic decision finding. Although this philosophy produced very time consuming discussions, it lead to a good acceptance of the decisions and genuine alpine outputs. The project success is a common achievement of all contributing partners.

In the retrospective view the main project decisions were taken in the right way at the right time. Examples of particular importance are:

- financial restructuring (WP2+3)
- project prolongation for one year and optimising agreement (WP5)
- second tender procedure for flights in Italian partner areas (WP5)
- national coordination (WP5) and regional coordination (WP6+8+10)
- transition from HIK-1 to HIK-2 but stop for HIK-3 (WP6+7)
- continued research for alpine experts in several WP in spite of obstacles and advancing time schedule
- providing of server facilities by SNP and LIZ as out-of-official-budget contribution (WP2+3+9)

The list could be complemented with many entries. All of them worked as success factors at the crucial points of project implementation and helped to overcome difficult phases.

Alpine Network of Protected Areas

The Alpine Network of Protected Areas undoubtedly played a major role for the positive evolution of the communication culture and of the common Alpine Spirit within the project community. The integrating effect of ALPARC reaches far beyond the period of project management and is essential for the persistence of the partnership after project closure.

Information and publicity (I&P)

The implementation of I&P activities faced some obstacles because the WP concept had not been elaborated sufficiently enough in the application phase. The harmonization between partners and the decision for common I&P measures was thus difficult. The problems could be solved but are avoidable by a better planning. More important in this context was the technical character of project issues requiring a development effort before tangible results were obtained that could be used for I&P activities. Although (semi-) scientific circles could be addressed quite well within the project, the general public was difficult to access.

Intensified external dissemination has to follow after project closure based on the knowledge of definite results and potentials. Activities should foster further development of the HABITALP method and continued application. Appropriate printed products and web media are available. The preparation of selected results for a more general (non-) scientific and political public could be envisaged. ALPENCOM (http://www.alpencom.org) represents one current initiative of the Alpine Space Programme that is already making use of HABITALP data.

Aerial image flights

The main success of this WP is the comparability of aerial images that was achieved for ten partner areas and represents an essential condition for further transnational applications. Increased standardization of future image generations could be obtained by systematic quality controls regarding the respect of tender specifications (illumination, clouds, shadows, scale etc.)

HABITALP was also successful in the economic point of view: in one of the national tenders the prices offered were nearly eight times higher than the estimated costs. Within a second European tender the international competition made offers drop back to the expected price level.

One of the long-term achievements is the multilingual documentation of a common technical standard for flight conditions, aerial image and orthophoto production. The technical know-how available within the partnership was successfully transferred, not only through the common reference documents but also through practical support and advice during the assessment of tender applications and incoming deliveries. Both will guarantee for the reproducibility of the method for monitoring purposes.

Interpretation method

In spite of the retarded progress of key evolution HABITALP achieved a tremendous innovation on an alpine integrative scale. Together with the harmonized specifications for aerial images the interpretation method is the fundamental basis for producing comparable landscape datasets in alpine protected areas. The common alpine and integrative development leads to a high degree of acceptance and the public availability of multilingual reference documents ensures the reproducibility of the method for monitoring purposes as well as the transfer to other areas.

The structural change of the interpretation key from HIK-0/HIK-1 to HIK-2 in the course of its evolution was intensely discussed as it implied adaptations of the already running interpretations or transfer algorithms to achieve the comparability of the datasets. Although the interpretation was retarded in some areas by the impacts of this change (confer WP7), the decision is very forward-looking in the light of an alpine integrative process as well as with respect to extendibility and transferability of the HABITALP method.

The development of an algorithm to adapt the datasets of older key versions as well as the definition of desired HIK-3 modifications as voluntary complement to the agreed HIK-2 standard were indispensable decisions to achieve the alpine standardization of datasets within the project duration. The interrupted key development offers many possibilities for future activities (confer WP7).

Major progress of key evolution occurred through intense personal exchange in the beginning of 2004 and was encouraged by the activities of local interpreters who got engaged on a regional level. Their increasing importance as aggregating and disseminating scientific interface between the local and alpine level was recognized by the project's steering committee. The request for change in summer 2004 offered the occasion to nominate official regional coordinators and to dedicate an obligatory part of the revised budget to their expenditures.

One major success especially of this WP is the profound interdisciplinary exchange on habitat issues that was indispensable to reach the common alpine result. Without communication in the native languages of the partners and the translation of specific terminologies, the objective of common alpine reference documents would not have been possible (confer WP12). It is thanks to several highly motivated partners and the Alpine Network of Protected Areas that this communication could be realized.

Aerial image interpretation

Ten of eleven alpine protected areas successfully implemented the commonly developed HABITALP interpretation method. Although the spatial extent of application is different, this result is a considerable achievement.

The vocational training of local interpreters means a tremendous know-how transfer especially as very heterogeneous experiences and equipment had to be compensated. This results into the strengthening of local competences within public administrations or private companies. Appropriately skilled interpreters and common reference documents create ready-to-go-on conditions for future image generations.

A couple of issues could not be tackled to the desired extent and offer a huge field of further improvements: finishing key evolution, more training on the basis of a fixed key, analysis of interpretation data with respect to different applications of the same mapping instructions, stricter rules for these guidelines, systematic field controls. All could increase the quality of interpretations and the degree of standardization and lead to a sophisticated refining of the interpretation method.

NATURA 2000 & monitoring

The preservation of the favourable conservation status of N2000 habitats is a major and common concern of all European countries. The reporting obligations demand the repeated terrestrial census and assessment of these habitats. This implies enormous personal and financial resources. Common methods are missing for the census as well as for the assessment of the conservation status. Therefore there is a strong demand for efficient and reproducible methods that can also serve for comparisons in the transnational context.

HABITALP supported this demand by bringing together two completely different methods of habitat mapping: whereas the N2000 typology refers to phyto-sociological characteristics that are visible in the field, the HABITALP typology considers mainly structural characteristics that are visible on aerial images.

HABITALP interpretation data cannot replace phyto-sociological fieldwork but an intelligent combination of both approaches could serve to focus field and interpretation work on hot spots that are of particular relevance for N2000 issues.

The HABITALP concept is particularly useful for alpine regions that are difficult to access in the field and for huge surfaces. The most innovative aspect of this study however is not the attempt to look for N2000 from the air but to do it in a standardized way in all alpine partner areas.

The correspondence found between both habitat classifications in the first attempt is variable and in general rather coarse which is not astonishing in the light of the known difference in approaches. However the HABITALP attempt deserves to be pursued because the full range of possibilities could not be explored within the project (due to retarded interpretation and late alpine subcontracting).

The initial plan to use the results of this work package for the "backward" adaptation of the interpretation key and the mode of its application could not be realized. This could have focussed the interpretation process on selected features that are relevant for N2000 and concentrated field validation accordingly.

Relationship refining through GIS modelling of ecological parameters reduced the number of possible correspondences but could only be tested in a selected partner area. The degree of alpine standardization could be increased if this method was applied to all partner areas.

The spatial modelling of N2000 habitats could be especially helpful to estimate the area of their potential occurrence. It could be compared to the confirmed area of distribution and lead to differentiated assessments of the present N2000 network.

The repeated application of the HABITALP method creates temporal series of comparable interpretation datasets. Habitat changes that cause a visible structural difference in the aerial images can be detected and assessed. The observable changes do not show phyto-sociological details except for the degree of cover of certain vegetation compartments but unveil the general dynamics of the landscape e.g. the progress or retreat of forest and grassland.

The Nationalpark Berchtesgaden data gave a first impression on what can be expected within a time span of six years in a northern alpine region. This might be completely different for other HABITALP partners but could not be analysed within the project as no other partner area has subsequent interpretation generations yet.

The surveillance rules developed in the course of the project for the entire alpine region will become of essential value once the partner areas get involved in follow-up flight campaigns and represent thus a very innovative and forward-looking product.

Landscape diversity

Numerous aspects can be analysed in the field of landscape diversity. Each aspect can lead to highly sophisticated analysis. The main challenge was to focus on methods and parameters that are simple to understand for the decision makers in protected area management and enable at the same time a suitable assessment of landscape diversity.

The slow progress of interpretation made it difficult for the project partners to follow the methodological development of diversity applications. Vice versa the constant key evolution made it difficult for the alpine experts to understand what interpretation data would look like and to define methods in a way that takes into account the characteristic properties of the data.

With progressing key development it became more and more important to make use of the huge amount of habitat properties that can be mapped by the HABITALP method and to explore the full set of columns of the HIK-2 interpretation key.

The increasing familiarity with the properties of the interpretation layers lead to the finding that classical landscape metrics indices appeared too strongly influenced by the individual interpretation styles to produce comparable results. A method was thus needed that regards landscape as a whole and leads to more generalized results.

Thanks to the iterative proceeding and the open, communicative and inter-disciplinary style of discussions essential enrichments were received from the project community and the most appropriate focus points in the large field of possible approaches could be commonly agreed. A good general acceptance of the alpine methods was achieved. Similar to the development of the interpretation key this work is expressing the successful alpine integration of local needs and a profound cross-sectoral exchange. It contributes to the pilot character of the entire project.

Local model validation deserves more attention than it could receive within the project. Together with the "backward" adaptation of the interpretation key concerning certain diversity related focus points this could serve to refine the alpine diversity methods. The integration of spatial and polygon-related N2000 correspondence data could extend the present method.

The potential that interpretation data offers for the standardized derivation of landscape diversity and its practical application in the management of protected areas could be very well elaborated. Diversity results can support decision finding in the spatial planning of local management measures. At the same time they enable comparative studies between the partner areas and transnational assessments. These could promote transboundary strategies in the vision of a common management of natural and semi-natural landscape heritage. The applied methods are simple and can be adapted to specific purposes e.g. by focusing analysis on subsets of habitats of particular interest.

Transnational spatial database

HABITALP datasets can only be explored in future transboundary missions if project results are united within a common database. Public access to this data is needed to attract further users. WP9 achieved both and produced therefore very forward-looking project outputs.

The visualization of the geographic project results exceeds widely what can be communicated through descriptive data alone and gives an optical impression of the spatial character and extension of the HABITALP datasets.

The double public access to the transnational database is supposed to attract at the same time more general target groups (access through internet browsers) and more specific users (access through GIS).

The transnational database was the last step in the chain of subsequent implementation phases and subject to the retarded data input in a particular way. The processing of the final data packages accumulated at the end of the project and restricted the time for adaptations and improvements.

Therefore this WP implies still a great potential for further development in the field of cartographic visualization of spatial data, presentation of attribute data, web based database queries, surface analysis and spatial statistics as well as with regard to the design and functionality of the graphical user interface.

Transnational integration of spatial datasets, standardized description according to ISO 19115 CORE and public visualization form fundamental corner-stones for the future use of the HABITALP methods and results.

However this will only work when the database is maintained, updated and kept accessible on the long-term. Updating has become of immediate importance because in some areas interpretation continued after the date of “database closure”. It would be desirable to integrate completed interpretation surfaces once they are available as well as to update derived datasets like N2000 relationships and diversity models accordingly.

In general it can be said that this work package was very much ahead of its time. Whereas some partners still struggled to get their images, the transnational spatial database already thought of public and long-term dissemination of datasets that were not even available in some areas.

Within the project it was not possible to develop a common strategy for the database maintenance. Legal aspects of data use by third parties have been considered but must be elaborated in detail to present common conditions of use in a transnational context.

These activities are of crucial importance for the long-term persistence of the HABITALP vision and should be tackled after project closure. Database work requires the competence of specifically skilled experts. Follow-up actions should therefore include the research for sufficient financial means.

Further applications

The maintenance of the content management system (CMS) poses similar needs as explained above for the transnational database. This will become relevant with increasing availability of local and transnational experiences and applications and should therefore be included in the planning of follow-up actions.

Already in the application period the project group envisaged the potential that could emerge one day from the immense array of experiences and data gathered within HABITALP. The decision to foresee a specific work package for the self-critical assessment and the elaboration of long-term perspectives was thus very forward-looking.

The contributions of this work package should be explored after project closure and taken into consideration when planning and implementing new projects.

Conclusion

HABITALP opened a new dimension of transnational cooperation within the Alpine Space. Common alpine results emerged from the integration of local characteristics and represent a genuine community achievement of all involved partners and experts. Manifold difficulties were faced due to the pilot character and the complex structure of the project. But thanks to an adapted management and the motivation of the project group all problems were lead to an optimal compromise. The majority of goals could be achieved through a common effort. It is now the time to appreciate the benefits that were created and to open the minds for future activities.

In the human point of view the biggest benefit of HABITALP is to have established a constructive style of communication that works across all differences in culture, language and schools of thought. Project members have gained alpine competences that qualify them for future transboundary missions. The European intention of strengthening networks and local centres of competence has been fully achieved.

In the technical point of view the biggest benefit created is the attempt of alpine standardization in all project phases and the high level of achieved harmonization. The common method of aerial image interpretation and the comparable landscape datasets emerging from its application are the core results of the project that work as interface between harmonized initial data capture and advanced alpine applications. This represents the added value for the European Union and an important step towards the transboundary implementation of the Alpine Convention and the European Habitat Directive.

HABITALP was designed to serve for the practical application in protected area management. This objective was achieved on the local level of the participating areas as well as on an integrative alpine level. It was also the success factor of the project to promote an instrument that is equally useful for both purposes.

Three exemplary applications work as incentives to use HABITALP data not only as physiographic base layer but to explore further its inherent content.

Landscape diversity modelling for instance leads to think in dimensions that are detached from the interpreted polygons. It shows the importance of the interpretation layer as source data for derived questions and provides a cartographic basis for spatial decision finding and mediation of different stakeholders.

NATURA 2000 studies have brought together different schools of thought in the attempt of finding the optimal combination of methods.

Change analysis and surveillance rules deliver a precious enrichment that will show its value in the context of future image generations.

HABITALP wanted to create a long-term instrument and therefore put special emphasis on reproducibility and transferability. The transnational spatial database and the content management system ensure public visualization of the obtained datasets and access to reference documents and experiences. This is the basis for attracting further user groups and initiating new transboundary activities. The multilingual edition of several documents underlines the practical character of the results.

Based on the evaluation of further improvements and applications the follow-up actions were already in mind before the project was ending.

The Alpine Space Programme offered the funding frame for the HABITALP mission and enabled a tremendous scope of experiences that can only partly be communicated in this report. By granting a prolongation phase and a budget increase when the technical implementation was endangered, the EU authorities provided the means for successful project termination.

Outlook

HABITALP was a successful pilot project that produced common tools of local and alpine usefulness. Many aspects could not be treated exhaustively and provoked a lot of questions. An enormous potential resulted with regard to the refining of methods, increase of standardization, database maintenance and further fields of application. We are thus only at the beginning of a common vision on alpine landscape management. But thanks to HABITALP an essential fundament for the transboundary dimension of future protected area work was set.

On the local level HABITALP allows the protected areas to work with surface-covering layers of detailed landscape information. As a large know-how transfer has been realized and the local centres of competence have been well strengthened through vocational training, the project areas are enabled to repeat the methods independently.

For many project partners HABITALP datasets are innovative. Therefore local experiences must now be given some time to grow. The applications tested within the project and the evaluation of further applications offer some tangible examples. Increasing familiarity with the interpretation dataset and its applications will prove the usefulness on the local level.

Specific local applications and adaptations will surely develop. The speed of development will depend on the individual personal and financial resources as well as on the locally dominating environmental issues and discussions.

Although local applications might be quite different in the individual areas the basic interpretation datasets are widely standardized and offer a great potential for alpine applications.

Therefore transnational development should continue in a coordinated way and happen simultaneously to local activities.

Transboundary harmonization and comparability of datasets form the basis for visionary ideas. Some of them are illustrated in the concluding chapter of this project report.

The HABITALP approach is open to attract more users in the Alpine Space and even other high mountain areas. It is not necessarily limited to protected areas and can be extended to the adjacent peripheral zones.

Methodological development and documentation are so far advanced that further areas can adopt the method including also the project partner who could not realize flights within HABITALP. First transfer activities have already been launched within the project (adoption of colour infrared aerial image specifications and interpretation method in the Biosphärenreservat Val Müstair, Switzer-land and the Nationalpark Gesäuse, Austria).

HABITALP has set new standards but permanent practise and long-term development on alpine level require continued transnational activities.

The future of the HABITALP vision essentially depends on an integrating organization and the clear definition of responsibilities including an alpine leading body. The Alpine Network of Protected Areas could offer the institutional frame for the persistence of the partnership, the sustainable setting of the project's outcomes and the promotion of transfer activities. A permanent working group could be envisaged caring for coordinated methodological progress and database maintenance. A scenario for this is proposed in this report (see WP10 "Guidelines of cooperation on landscape management").

HABITALP

Beyond that sustainable pursuance of alpine activities can only take place if appropriate funding and sufficient personal resources are ensured. This is of particular importance as alpine objectives are no fixed compartment of local work and subject to an extraordinary personal motivation and financial commitment.

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Aerial Image Flights

Production of colour infrared aerial images in comparable quality as basis of harmonised transnational evaluation and analysis – WP 5

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Summary

The use of airborne colour infrared images (CIR) is well known in the field of surveying habitat structures. As the project HABITALP wanted to use this technology as well, the existence of CIR images was fundamental for the project. A major focus was given to build up harmonized specifications for the flight and images, including similar camera types (Leica RC 30 or Zeiss RMK TOP 30), the same film type (Kodak IR 2443) and similar image scales (1:10.000–1:17.000).

To optimize financial and administrative resources, three national groups were built to tender the flights in packages for the project partners in France, Italy and the NPB in Germany. NPHT and SNP decided to use already existing images for the project because they met the defined quality standard. While NPHT could start the project immediately with existing RGB orthoimages for delineation and original slides for interpretation, the SNP performed the aero triangulation and orthorectification – within the project.

For the French partners, Aeroscan s.a.r.l at Nancy (F) realized in total 251’000 ha flight area and 51’300 ha orthoimages. In Italy a consortium lead by AVT ZT GesmbH from Imst (A) realized 173’000 ha flight area and 97’100 ha orthoimages. Unfortunately the flights planned in Italy could not be realized completely. However the CPNS area could be covered at least for the most important parts. The remaining parts are not subject to EU financing. The flight for the PNDB was not possible either because of the bad weather conditions or the missing flight approval due to military flights in the same region and time. The missing images did make it impossible for PNDB to go on in the project. The NPB was realizing its tasks with the TERRA Bildmessflug GmbH & Co. Almost all delivered products had a high quality and were well useable for the further purposes of HABITALP. A minor impact did have a damage of some images in the PNGP, emerged through the film development.

The overall conclusion is positive, although the alpine trait of the areas did include many problems like weather conditions and topography evoking problems with shadows. The production of CIR images in comparable quality was a successful way to set up the fundament for a harmonized, detailed and cost effective habitat interpretation and landscape assessment in large and wide spread areas.

Résumé

Les photographies aériennes infrarouge couleur (CIR) sont un outil bien connu dans le domaine de la surveillance des structures d’habitat. Le projet HABITALP ayant décidé d’utiliser cette technologie, la possibilité de disposer de photographies infrarouge couleur était fondamentale pour le projet. Lors de la préparation des survols, une grande attention a été donnée à la mise en place de spécifications harmonisées concernant les survols et les photographies ainsi qu’à l’utilisation d’appareils semblables (Leica RC 30 ou Zeiss RMK TOP 30), de pellicules de même type (Kodak IR 2443) et d’échelles similaires (1:10.000–1: 17.000).

Pour optimiser les ressources financières et administratives lors de l’adjudication des survols, trois groupes ont été constitués selon les différentes nationalités: France, Italie et le NPB en Allemagne. Le NPHT et le SNP ont décidé d’utiliser des images déjà existantes, dont la qualité correspondait au standard établi. Alors que dès le début du projet le NPHT a réussi à utiliser les orthophotos RGB pour la délimitation et des diapositives originales pour l’interprétation, le SNP a réalisé l’aérotriangulation et l’orthorectification dans le cadre du projet.

Les partenaires français ont confié à Aeroscan s.a.r.l, Nancy (F), la prise des photographies aériennes sur une surface de 251’000 ha et d’orthophotos pour 51’300 ha. En Italie, les travaux ont été confiés à un consortium sous la direction de AVT ZT GesmbH de Imst (A). Les photos aériennes couvraient une surface de 173’000 ha, dont 97’100 orthophotos ont été tirées. Les survols programmés en Italie n’ont malheureusement pas pu être entièrement réalisés. Les survols dans le PNDB n’ont pas été possibles à cause des mauvaises conditions météorologiques. D’autre part, l’autorisation a été refusée en raison des exercices militaires prévus dans la région concernée. Ne pouvant disposer d’images aériennes, le PNDB a du renoncer au projet. Le NPB a confié la réalisation des survols, la scannérisation des images, l’aérotriangulation et les orthophotographies à TERRA Bildmessflug GmbH & Co. Dans la plupart des cas, l’excellente qualité des images a permis leur utilisation dans les étapes suivantes du projet HABITALP. Lors du développement des pellicules du PNGP, il s’est avéré que quelques images étaient endommagées, mais sans grand impact sur l’ensemble du projet.

La conclusion générale est positive, en dépit des caractéristiques du territoire alpin (conditions météorologiques et topographie provoquant des problèmes d’ombre). La production de photos CIR de qualité comparable est donc une solution efficace pour créer les bases d’une interprétation des habitats et d’un recensement du territoire harmonisés, détaillés et économiquement avantageux sur des territoires étendus et dispersés.

Zusammenfassung

Die Verwendung von farbinfraroten Luftbildern (CIR) ist im Bereich der Habitaterfassung sehr bekannt. Da das Projekt HABITALP diese Technologie ebenfalls verwenden wollte, war die Existenz der CIR-Bilder fundamental für das Projekt. Wichtig bei der Vorbereitung der Befliegungen waren einheitliche Spezifikationen für Flug und Bilder. Im Besonderen waren ähnliche Kameratypen (Leica RC 30 oder Zeiss RMK TOP 30), derselbe Filmtyp (Kodak IR 2443) und ähnliche Bildmaßstäbe (1:10.000–1:17.000) von Bedeutung.

Für die Ausschreibung wurden drei nationale Gruppen in Frankreich, Italien und den NPB in Deutschland gebildet, um die administrativen und finanziellen Ressourcen zu optimieren. NPHT und SNP entschieden sich, bereits existierende Luftbilder im Projekt einzusetzen, da diese dem definierten Qualitätsniveau entsprachen. Während der NPHT bereits mit Projektbeginn RGB-Bilder zur Delinierung und originale Diapositive zur Interpretation verwenden konnte, führte der SNP die Aerotriangulation und die Berechnung der Orthophotos im Rahmen des Projektes durch. Für die französischen Partner realisierte die Firma Aeroscan s.a.r.l in Nancy (F) Luftbilder auf einer Fläche von 251’000 ha und 51’300 ha Orthophots. In Italien wurden die Arbeiten von einem Konsortium unter der Leitung der AVT ZT GesmbH aus Imst (A) durchgeführt. Die Luftbilder umfassen eine Fläche von 173’000 ha, davon wurden 97’100 Orthophotos berechnet. Leider konnten in Italien nicht alle geplanten Flüge durchgeführt werden. Während im CPNS zumindest die wichtigsten Flächen beflogen werden konnten und die verbleibenden Bereiche nicht mehr der EU Finanzierung unterliegen, konnte eine Befliegung des PNDB wegen schlechter Wetterbedingungen oder fehlender Flugbewilligung aufgrund militärischer Übungsflüge in derselben Region zur selben Zeit nicht stattfinden. Das Fehlen der Bilder verunmöglichte die Weiterführung des Projektes im PNDB. Der NPB realisierte seinen Flug, das Scannen der Bilder, die Aerotriangulation und die Berechnung der Orthophotos mit der TERRA Bildmessflug GmbH & Co. Fast alle abgelieferten Produkte waren von hoher Qualität und für die weiteren Ziele des Projektes gut nutzbar. Einige Bilder aus dem PNGP wurden bei der Filmentwicklung beschädigt.

Insgesamt ist das Fazit positiv, obwohl die alpine Charakteristik des Gebietes einige Probleme wie die Wetterbedingungen oder topografisch bedingte Schatten auf den Bildern hervorbringt. Die Produktion der CIR-Luftbilder in vergleichbarer Qualität war ein erfolgreicher Weg, das Fundament für eine harmonisierte, detaillierte und kosteneffektive Habitatinterpretation und –Landschaftsbewertung in großen und weit verstreuten Gebieten aufzubauen.

Riassunto

L’uso delle fotografie aeree infrarosso colore (CIR) è ben noto nell’ambito dell’individuazione e della localizzazione degli habitat. Avendo optato per questa tecnologia anche nell’ambito del progetto HABITALP, la disponibilità delle immagini CIR era di particolare importanza per il progetto. A tal fine risultava fondamentale predisporre specifiche armonizzate per i voli e per le immagini, in particolare prevedendo macchine fotografiche simili (Leica RC 30 oppure o Zeiss RMK TOP 30), lo stesso tipo di pellicola (Kodak IR 2443) e scale simili per le immagini (1:10.000–1:17.000).

Per appaltare i lavori furono costituiti tre gruppi nazionali in Francia, Italia e il NPB in Germania, al fine di ottimizzare le risorse amministrative e finanziarie. I parchi NPHT ed SNP decisero di utilizzare le fotografie aeree già esistenti che corrispondevano agli standard di qualità richiesti. Mentre il NPHT riusciva fin dalle prime fasi del progetto ad utilizzare le foto RGB per la delimitazione e le diapositive originali per l’interpretazione, l’SNP effettuava l’aerotriangolazione e la creazione delle ortofoto nell’ambito del progetto. Per i partner francesi, la ditta Aeroscan s.a.r.l. di Nancy (F) realizzava le fotografie aeree su una superficie di 251’000 ha e le ortofoto per una superficie di 51’300 ha. In Italia i lavori furono affidati ad un consorzio diretto dalla AVT ZT GmbH di Imst (A). Le foto aeree comprendono una superficie di 173’000 ha, di cui furono prodotte 97’100 ortofoto. Purtroppo in Italia non fu possibile completare tutti i voli. Nel periodo in questione, i sorvoli nel PNDB non furono possibili a causa delle cattive condizioni meteo o della mancata autorizzazione, dovuta alle esercitazioni militari previste nella regione interessata. La mancanza delle foto rese impossibile il proseguimento del progetto da parte del PNDB. Il NPB realizzava i propri sorvoli, la scansione delle immagini, l'aerotriangolazione e il calcolo delle ortofoto con la TERRA Bildmessflug GmbH & Co. Quasi tutti i prodotti consegnati erano di ottima qualità e adatti all’uso successivo nell’ambito del progetto. Alcune delle immagini del PNGP furono danneggiate nel corso dello sviluppo della pellicola.

Il risultato complessivo è positivo, benché la caratteristica alpina del territorio produca alcuni problemi come le condizioni meteo o crei delle ombre di origine topografica sulle immagini. La produzione delle fotografie aeree CIR con una qualità comparabile si è rivelata la scelta giusta per creare le basi per un’interpretazione dell’habitat armonizzata, dettagliata ed efficace a livello di costi e per una valutazione del paesaggio in aree di grandi dimensioni ed ampiamente frammentate.

Introduction

Preliminary conditions

There are different ways to assess landscape diversity. A general distinction can be made by using remote sensing technology versus field mapping. In both cases the assessment of the diversity could either be made by collecting a randomized or stratified sample or by an area-wide mapping.

The decision for an area wide mapping for HABITALP is founded on the requirement for a fully measurable final result which avoids statistical extrapolation. Moreover, a further use in spatial analysis (e. g. wildlife studies) which needs a spatial intersection with other types of data needs this sort of geodata. It was therefore the purpose of the project to clearly define boundaries between the different habitat types. An area wide approach would also allow a quantitative measurement of habitat change in space and time.

Concluding, the use of infrared aerial images was the only possibility to assess the land use and habitat types and the project HABITALP was defining on two preliminary conditions.

- **Remote sensing based on colour infrared (CIR) images should be used.**
- **The investigated area should be mapped all over the available area of the images.**

The existence of aerial images was fundamental and generating the basis for the following steps of the project.

The decision to use CIR images is based on an investigation on different area wide parameters like vegetation land use or geology in the Berchtesgaden National Park (NPB) during the MaB 6 program (Kernerr et al. 1991). The use of aerial images in forestry and agriculture has a long tradition (Albertz 2001). The spectral reflection of plant leafs in the near infrared is highly depending on the structure and the water content of the vegetation. Therefore, CIR images are useful for a better differentiation in this field (Drobil 1978; BfN (Bundesamt für Naturschutz) / Federal Agency for Nature Conservation 2002). Moreover, the proposed approach did respect the special access restricts of the protected areas and minimized disturbance while a spatially and timely limited access is needed for ground truth instead of a full mapping. Moreover, a short field validation is adapted to the limited funds.

As the first approaches were heavily influenced by forestry management and vegetation purposes, the MaB 6 project and later as well an Interreg IIa project between the NPB, the Hohe Tauern National Park (NPHT) and the Swiss National Park (SNP) based their work on the same technology (Kias et al. 2001). The less optimal spectral characteristics of the CIR images in the immature soils had been neglected in these previous projects.

Objectives

The aim of the WP 5 was to deliver a set of congenerous aerial images for all partner areas. This basically simple aim was complicated by different legal and financial restrictions for flights in different countries which did not allow a tender procedure for all areas together. Moreover, some partners disposed of recently taken images and decided to spend the available budget for other tasks.

As well, a major aim was the knowledge transfer from those partner organisations with experience on conducting flights toward them without this experience.

Therefore, the objectives of this WP were the following:

- Define harmonized flight definitions for all flights
- Define common quality requirements based on the use of aerial images and the derived data within and beyond HABITALP.
- Support the inexperienced project partners during the task.
- Ensure the communication between the different national groups.
- Deliver congenerous aerial images and orthophotos for delineation and interpretation

Planned actions

In general, the WP was splitted in the following subtasks:

- Existing images in the involved areas should be listed and evaluated
- Aerial image flights were tendered and conducted.
- Subcontracted companies should execute the aerotriangulation and the calculation of the orthophotos.

- All results should be delivered to the specific partner and the transnational data base.

This work had to be done in different national groups to avoid legal and administrative problems.

Method and material

Method

Aerial photographs provide replicable and standardized methods for landscape surveillance (Hildebrandt 1996; Albertz 2001). An average scale of 1:10000 was established in the NPB during the MaB Programme. This covers the demand of the European Network NATURA 2000 for description and surveillance of natural habitats. Moreover it is widely accepted that CIR images allow a better differentiation of vegetation. Some partners had also experience with the existing keys describing landscape. Based on a key of the Federal Agency for Nature Conservation in Germany (BfN (Bundesamt für Naturschutz) / Federal Agency for Nature Conservation 2002), NPB and NPHT had applied an enhanced key during the previous Interreg II project (Kias, Demel et al. 2001). The SNP has developed in the same time period an interpretation key in a pilot project testing the usability of the CIR aerial images (Wortmann et al. 2000; Frei et al. 2003). PNE had also experience in describing the landscape on a systematic and area covering way although they did not interprete aerial images (Godron and Salomez 1995). All this earlier experiences were adopted in the HABITALP project and specified the input conditions for the images.

Common technical specifications

For the different tender procedures common technical specifications were proposed for the flight, the scanning of the analogue images, the orientation and aerotriangulation and the orthoimages.

The tenderer should use cameras which allow an adequate quality of the orthophotos (e. g. Zeiss RMK TOP 30 or Leica RC30) with a 300 mm objective. An FMC (Forward motion compensation and DGPS were mandatory as well as the use of a specific film type (Kodachrome III Infrared 1443). The use of a digital camera was discussed with some offerers and generally permitted. Finally, no tendering company was offering a flight with digital cameras due to the lack of experience in mountainous areas.

The average scale of the image should be 1:10000 (1:7000 – 1:13000 with an overlapping of the images of 60% in flight direction and 30% across the flight direction. The scale definition was mainly based on the requirements of the interpretation key (Demel and Hauenstein 2006a; Demel and Hauenstein 2006b). The flights had to be done between the 1st July and 31st August to avoid snow covered vegetation units. The sun inclination had to be over 40%. For the scanning we specified a geometric precision < 3 µm, the format should be TIFF (Tagged Image File Format) including date, source and image number in the header. For a local use, the data should be oriented in the local geodetic system. The pixel size of the orthophoto should be 15 – 20 cm and the average accuracy should not exceed 1m. Moreover, the quality control should follow international standards (JRC 2003).

More details on technical specifications procedures are available in the different national tender documents (HABITALP 2003a; HABITALP 2003b; HABITALP 2003c).

Existing images

An overview on existing images in all areas was done to identify usable data sets according to the requirements. This was done to identify the possibility to use existing images in the project and to reduce cost or shift financial resources within the project. For the further decisions it was important to get information about the date of the flight, the type of the images (RGB or IR) the scale and the status of the images (analogue or digital), the perimeter of the covered area and the legal status to define the usability of these images for the project.

The same questionnaire was compiling the status of existing digital elevation models (DEM). DEM are an important input in the process of calculating georeferenced orthophotos. Generating this spatial data base is as well a cost intensive task.

Table 2: Existing aerial images and DEM in the project partners areas. (*(= rectified aerial CIR photo) available)

Project partner	recent aerial images available	year(s) of census	data availability:	DEM available - resolution - date - data source	CIR ortho-image*	covered image area in km^2	scale
NPB	yes	1997	digital	YES - 10 m - 1997 - digitized from photogrammetric maps	YES	470	1:11.000 for 1400 m above sea level
		1990	analogue	NO	NO	470	1:10.000 for 1400 m above sealevel
		1980	analogue	NO	NO	470	1:10.000 for 1400 m above sealevel
ASTERS	yes	1998	Digital, but no originals available for stereoscopic view	YES - 20m but no full rights of use	YES	All the area	
APB	yes	1991	analogue	YES - 10m - 1999 - digitized from maps	NO	30	1:22.000 to 1:25.000
CPNS	yes	1991	analogue	yes - 10m - 1999 digitized from maps	NO	30	
		1991	analogue				
NPHT	yes	1998	Digital RGB only CIR analogue	YES - 25 m	NO	~ 2.000	1:16.000 for 2200 m above sea level
		1998	analogue	YES - 25 m	NO	~ 2.000	1:11.000 for 2200 m above sea level
		1998	analogue	YES - 25 m	NO	~ 2.000	1:11.000 for 2200 m above sea level
PNV	Yes	1996	analogue	YES - 50 m - 2002 - IGN	NO	about 550	aprox. 1:20.000 (ordered: 1:17.000)
PN Écrins	yes	1993	analogue	NO	NO	700	
PNMA	no						
PNDB	-						
PNGP	no						
SNP	yes	2000	digital	YES - 20 m with break lines, inside SNP YES - 25 m without break lines	NO (Yes for test area)	ca. 380	aprox. 1:10.000
		1988	analogue	NO	NO	ca. 170	aprox. 1.9.'000

Decisions and results

Evaluation of existing aerial images

The analysis of existing images showed, that some partners already had CIR aerial images on their disposal. In particular NPB had already a time series, which also was used in different projects to delineate habitat types. Recent and already scanned images had also the SNP (2000) and the NPHT from 1998 but only RGB images in digital format. The IR images were in analogue format. PNE tested the opportunity to use images from the Inventaire forestier national (IFN) in France, but decided after the evaluation to capture new images. The other partners had images older than from 1998 or did not get any information about existing IR images of the area. Therefore, the consortium decided to abandon from tendering new flights in the NPHT and the SNP instead to use the existing images. The SNP invested in calculating the orthoimages, NPHT was using the existing configuration, interpreting on analogue CIR images and delineating on the digital RGB orthoimages.

All the other partners had to get new images for the project.

Administrative operations

Flight tender submission

The basic aim to get comparable images in all partner areas could only be reached if one tender was done under the same premises. This was not possible due to administrative and practical reasons. The Italian partners argued that in Italy only local companies would have the right to fly. Therefore, the project consortium decided that three national groups should be established to conduct the tender procedure and the contracting with the flight companies. Therefore, HABITALP images would be done from three different companies in the three remaining countries to actually taking new pictures.

The French project partners were obliged to tender on European level. Under the leadership of the national coordinator PNE detailed technical and administrative documents were prepared. PNV decided to announce the flight over the total area of the park with an external additional financing. The responsible of PNV were convinced to get a benefit for the national park aims in getting images from the total area instead of only getting the part financed through the project. Therefore, not only 3570 ha were announced for flying scanning and orthoimage calculation, additionally 164300 ha flight was tendered. ASTERS was able to announce 27000 ha (more than 100% of the protected areas), PNE 24350, an equivalent of 9% of the total area protected. In March 2003 the bid was submitted.

The Italian partners prepared their tender documents as well until March 2003. CPNS decided to add like PNV additional financing to be able to fly the total park area instead of the minimum required for the HABITALP project.

In France, four offers were evaluated on the 6th May 2003. One bidder had to be excluded due to administrative reasons because the French partners wanted to separate the offers for each organisation. Finally, the evaluation commission recommended the legal responsible of the protected areas the AEROSCAN s.a.r.l. from Tomblaine (F). This recommendation was accepted by all organisations.

In Italy, two national offers were evaluated in April 2003. The result was deflating: The offers were almost 800% higher than expected in the budget and therefore unacceptable for all involved partners. With the experience in France, the lead partner and the WP-leader recommended to check again the accomplishment of an international bid. After a re-evaluation, this procedure was started in the end of June 2003. At this moment it was very difficult the reach a flight in the Italian areas in 2003. The evaluation of the European submission was done at the 1st August 2003. The recommendation of the evaluation commission was to accept an offer of an Austrian – German consortium (AVT ZT-GmbH and terra bildmessflug GmbH & Co). This offer differed substantly from the orginal technical guidelines in two points: The proposed mean flight scale was 1:13000 and the scanning resolution 12.5 µm. The bidder argued that this would be enough to reach the aims of the project and would distinctly reduce the costs. This offer was accepted by the Italian project partners.

Flight planning

In addition to all these tender procedures the flight plan had to be prepared. The final description of the perimeter was the first step. This had to be done by each project partner. Out of this total area the remaining parts for scanning and the orthoimages production had to be defined.

Next step was the detailed flight plan done by the bidders and the acceptance of the plan by the project partners. This control did include the coverage of the project perimeter, the flight height and the dependent scale, the distance between the flight lines, the number of images per flight line to estimate the overlap in flight direction and the control point design prepared by the flight companies.

The flight line design of the PNV (figure 3) shows the general approach for the flights: Normally the lines were going from East to West, but for some deep valley and high mountains additional lines had to be added to ensure the scale.

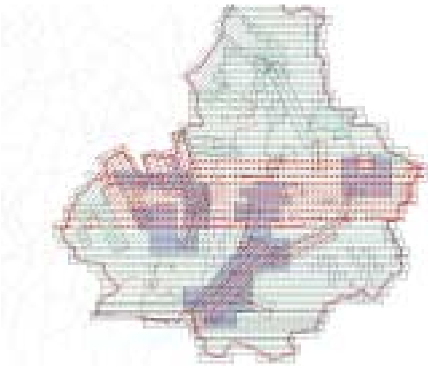

Figure 3: Flight line design of the PNV.

More details offered the Italian flight consortium, providing the PP with a print of the details for each flight line, including the altitude and the pre-calculated scale

NPGRANPA

Terra Bildmessflug GmbH & Co, Schumannstr. 21, D-71667 Marbach

DATE: 21/Jul/2004 TIME: 07:37

Project: AVTITALI
Area: NPGRANPA
Coordinate system: ITALY UTM
Camera Focal Length: 305.00 mm
Film Format: 230 x 230 mmý
Magnetic Variation: E 0.0ø
GAP Limit: +/- 200 m
Data Annotation #1: WGS84
Data Annotation #2: True Altitude [ft]

Line Parameter Listing :

LINE/SEG		ALTITUDE MSL [ft]	AGL [ft]	GL [ft]	FOTO SCALE	FORE LAP	BASE LENGTH [m]	DTK [ø]	TOTAL OF FOTOS	LINE LENGTH [km]
1	1	21507	13007	8500	1: 12999	62	1136	61	6	5.681
1	2	21507	13007	8500	1: 12999	62	1136	61	5	4.544
1	3	21507	13007	8500	1: 12999	62	1136	61	5	4.544
2	1	22007	13007	9000	1: 12999	62	1136	61	37	40.901
3	1	22007	13007	9000	1: 12999	62	1136	61	37	40.901
4	1	22007	13007	9000	1: 12999	62	1136	61	28	30.676
5	1	22007	13007	9000	1: 12999	62	1136	61	27	29.540
6	1	22007	13007	9000	1: 12999	62	1136	61	24	26.131
7	1	22007	13007	9000	1: 12999	62	1136	61	21	22.723
8	1	22007	13007	9000	1: 12999	62	1136	61	17	18.178
9	1	22007	13007	9000	1: 12999	62	1136	61	10	10.225
10	1	21207	13007	8200	1: 12999	62	1136	61	7	6.817
11	1	18907	13007	5900	1: 12999	62	1136	61	4	3.408
12	1	14808	13008	1799	1: 13000	62	1136	1	4	3.409
13	1	18308	13008	5299	1: 13000	62	1136	1	7	6.817
14	1	20208	13008	7199	1: 13000	62	1136	1	10	10.226
15	1	20208	13008	7199	1: 13000	62	1136	1	10	10.226
16	1	20508	13008	7499	1: 13000	62	1136	1	11	11.362
17	1	20508	13008	7499	1: 13000	62	1136	1	6	5.681
18	1	18307	13007	5299	1: 12999	62	1136	1	9	9.089
19	1	19507	13007	6499	1: 12999	62	1136	4	12	12.497
20	1	19508	13008	6499	1: 13000	62	1136	23	10	10.226
21	1	19507	13007	6499	1: 12999	62	1136	5	8	7.953
22	1	23007	13007	9999	1: 12999	80	598	337	9	4.784

Total number of lines/segments: 24
Total number of photos : 324

Total line length : 181.716 nm <==> 336.539 km

Estimated project time : 2 h 30 min (140 kts , 3 min per turn)

Terra Bildmessflug GmbH & Co, 71667 Marbach

Listing of PROJECT: AVTITALI AREA: NPGRANPA Page: 2

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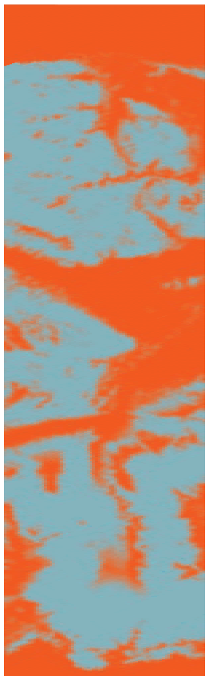
Seite 1

Figure 4: Details from the flight plan for the Gran Paradiso and Mont Avic area.

Flights 2003 and 2004

It was a preliminary goal of the project, to have comparable flights in the different parts of the Alps. One factor therefore is, to have the flights in the same time period, which was foreseen in the proposal. The reality was looking different. Using already existing images in the NPHT and the SNP was the first concession. These images were taken in August 1998 (NPHT) and in August 2000 (SNP). The second fact was the delay of placing this work. While some partners already had images in 2003 (NPB, ASTERS, PNE), the others did not even had a valid contract at this time. Moreover, the climatic extraordinary summer 2003 and hence the very dry vegetation was also a reason to postpone the flight to the following year (PNV and the Italian partners).

According to the technical specifications, the images should not have any clouds. This means in practice, that during the whole day of the flight, no clouds should appear. A maximum of 5% of the total area should be covered with clouds . This is very seldom the case in a mountainous region. Almost all days with high barometric pressure, cumulus clouds are appearing early in the afternoon. On these days, a flight was not possible as well. The dry summer 2003 was followed by a summer 2004, which had only very few days possible to fly in the different



regions. Therefore, in Italy only 29.5% of the total planned area could be flown. In France, the PNV had a similar problem. Only 40% of the total area could be flown, the remaining part had to be postponed again in the next summer. At least, 75% of all the planned orthophotos could be covered and the following steps of the interpretation were not compromised. ASTERS and PNV did not accept some parts of the images of the year 2004 due to shadow effects. Therefore, this part of the flights had to be redone in 2005 and 2006.

Optimising agreement

In Italy, the fact that only a part of the flight had been done by the end of the year put the project into serious problems. Moreover, that from the planned areas PNGP PNMA and PNDB did not have any pictures to work with. On a meeting in December 2004 between the LP, the WP leader, the flight company and representatives of the Italian partner, the further time plan was evaluated and tightened. This procedure was ending up in additional optimizing agreement signed by the involved partners (HABITALP 2005). In particular this agreement did include the new time plan and a weather forecast monitoring of the PP. The partners declared with their signature that they would do all needs possible to fulfil this time plan.

Table 3: Overview of the flights in the different areas of the project partner of HABITALP

	NPB	NPHT	APB	CPNS	SNP	PNMA	PNGP	PNV	ASTERS	PNE
Camera	Zeiss RMK TOP 30	Zeiss RMK Top 30/23	RMK TOP 30	RMK TOP 30	Leica RC 30	Zeiss RMK TOP 30	Zeiss RMK TOP 30	ZEISS LMK 2000	ZEISS LMK 2000	ZEISS LMK 2000
Lens focal length	305,084 mm	Topar A3 Objektiv	305 mm	305 mm	303 mm	305,083 mm	305,083 mm	304 mm	304 mm	304 mm
Film type	Kodak Aerochrome III Infrared 1443	Kodak Aerochrome II Infrared 2443	Kodak Aerochrome IR 1443	Kodak Aerochrome IR 1443	Kodak Aerochrome Infrared II 2443	Kodak Aerochrome III IR 1443	Kodak Aerochrome III IR 1443	Kodak Aerochrome III Infrared 1443	Kodak Aerochrome III Infrared 1443	Kodak Aerochrome III Infrared 1443
Resolution	63 l/mm	63 l/mm	63 l/mm	63 l/mm	Ca 63 l/mm	63 l/mm	63 l/mm	Ca 63 l/mm	Ca 63 l/mm	Ca 63 l/mm
Scan Resolution	12,5 µm		12.5 µm	12.5 µm	14 µm	12,5 µm	12,5 µm	14 µm	14 µm	14 µm
Medium scale	1:11'000	1:16.000	1:13'000	1:13'000	1:10'000	1:13'000	1:13'000	1:10'000	1:10'000	1:10'000
Planned overlap in flight direction	65%	60%	62%	60%	75%	60%	60%	75%	75%	75%
Planned overlap across the flight direction	40%	40%	30%	30%	ca. 35%	20%	20%	ca. 35%	ca. 35%	ca. 35%
Planned flight area (ha)	47000	260000	13800	110000	aprox. 37000	aprox. 7900	aprox. 40'000	aprox. 200000	aprox. 27000	aprox 24350
ha	47000	260000	13800	110000	37000	8900	40000	200000	27000	24350
Date of the flight	16.07.2003	9.08.1998 – 12.08.1998	18.09.2004	18.09.2004 3.7.2005 15.09.2005	24.08.2000	05.08.2005	05.08.2005	15. August 2004, 08. August 2005, 09. August 2005	11.08.2003	01.08.2003
Number of images	436	920	120		760	48	276	897 , 608 , 792	378	305
Flight company	TERRA Bildmessflug GmbH & Co, Marbach (D)	Hansa Luftbild, Münster;Photogrammetrie GmbH, München	TERRA Bildmessflug GmbH & Co, Marbach (D)	TERRA Bildmessflug GmbH & Co, Marbach (D)	L+T, Flugdienst / KSL	TERRA Bildmessflug GmbH & Co, Marbach (D)	TERRA Bildmessflug GmbH & Co, Marbach (D)	AEROSCAN sarl	AEROSCAN sarl	AEROSCAN sarl
Ortho image area (ha)	47000	260 000RGB	13700	35500	aprox. 36400	aprox. 7900	aprox. 40'000	aprox. 36 600	aprox. 27 000	aprox. 24350
Pixel ground resolution	20 cm	50 cm	15 cm	15 cm	20 cm	15 cm	15 cm	15 cm	15 cm	15 cm
Ortho image format	TIFF	TIFF	TIFF	TIFF	TIFF	TIFF	TIFF	TIFF	TIFF	TIFF

Flights 2005

The PNGP and the adjacent PNMA could were flown on the 5. August 2005. The HABITALP part of the CPNS could be finished on the 3.7.2005 and on the 15.9.2005. The late date of the second part of the flight in the Stelvio shows that again in 2005 only a few days with good weather conditions were available. In the PNDB an additional problem occurred: The area of the national park is a training area for military flights. In the few days with optimal weather conditions, the consortium did not get an authorisation to fly (30.9.2005 and 12.10.2005). Mid October 2005 the consortium decided to stop the flight campaign in the PNDB.

PNV could finish its missing parts early in August 2005.

Scanning and orthoimage production

The further procedure of delineation and interpretation demanded a scanning, the aerotriangulation and the calculation of the analogue images for the HABITALP interpretation areas. The development of the 5541 images was affected by a unfortunate exception: A film roll of the PNMA images was folded during the developing process.

Figure 5: Image of the PNMA with a fold through the image from the lower middle to the upper left.

For the following tasks this was not a severe problem, only the further use of the image for visualisation is affected (figure 5). The further scanning of the film rolls did not cause any problems.

With the Italian bidder consortium thescanning parameters were tested and evaluated (figure 7).

The consortium decided to scan with the parameters of the test series t1, even if visually the test 3 optically seems to be brighter. The reasons were that statistically t1 had 30 – 40% more different colours and the structures in bright areas are better visible. Small vegetation bodies on gravel ground can better be seen. Moreover, dark forest areas must be brightened during the interpretation anyway to get more details. For a digital photogrammetry as CPNS had planned for the interpretation, the test 1 therefore would allow more opportunities.

A radiometric correction of orthophotos should take care on visualisation effects and therefore brighten the images generally. The orthophoto production was done within the bidder companies. An exception was the SNP who focused in the production of this specific task (Imfeld and Haller 2004). The differential equalisation was realized on a resolution of 15 cm or 20 cm (NPB, SNP). The mosaics were adapted to a handy file size and the pixel resolution.

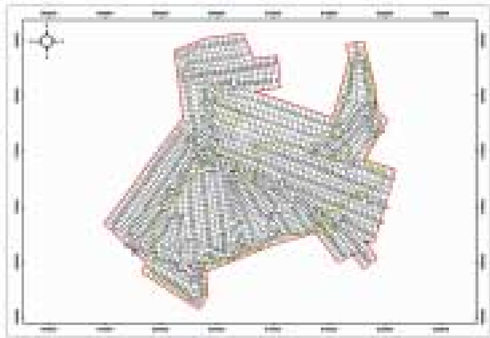


Figure 6: Orthophoto mosaic planning of the SNP

Quality control

An internal quality control of the images and the georeferencing of the aerial images was done and partly documented by the flight companies (Märker 2005; Märker 2006). External quality tests of the images in Italy were done by WP 5 leader SNP, Landschaftsinformatikzentrum Weihenstephan and Hauenstein Geoinformatik. An explicit positional accuracy control of the orthoimages was done by the SNP. The mean accuracy of independent control points was 0.59 m and therefore the guidelines of the technical specifications were reached (Thomson 2004).

Summary

WP 5 has succeeded to fly in 8 protected areas and a total surface of 768000 ha. This work was done with 3 different flight companies during 3 consecutive years. 5541 images were developed. A major part was scanned with a resolution of 12.5 µm respectively 14 µm in the French areas. 493000 ha (including the NPHT of 260000 ha) of orthophotos were calculated and delivered to the different PP. Therefore, more than 500 GB of orthoimages had to be distributed to the external control procedures and for the local interpretation work. They are moved again and merged into the trans-national spatial database.

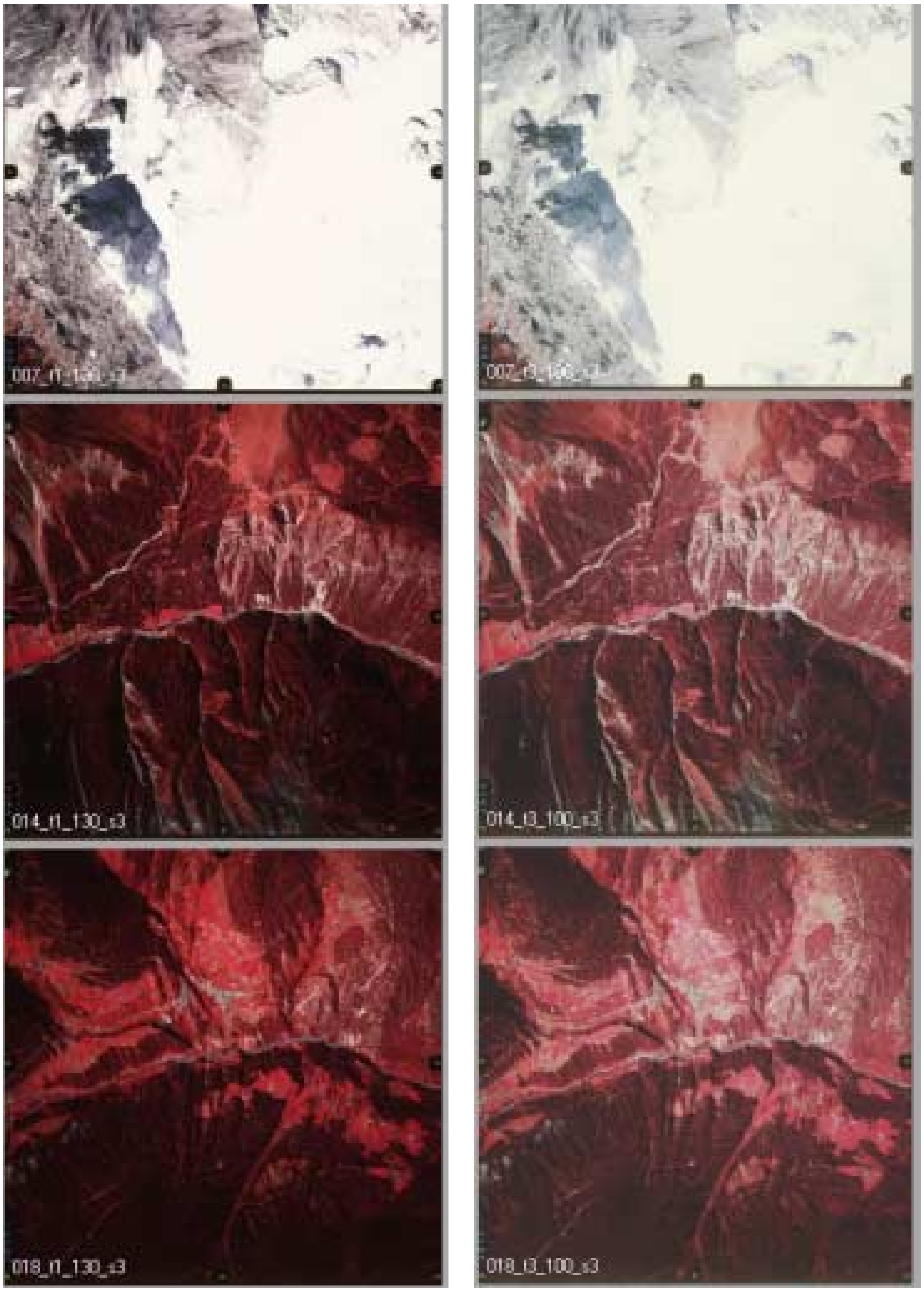


Figure 7: Different scan parameters (t1 left, t3 right) for the images of the CPNS

Discussion and assessment

As initially already mentioned, the timely delivery of the results of WP 5 was a fundamental must for the forthcoming of the project. Therefore, the project was using well established technologies mainly based on the experiences made in the NPB, NPHT and the SNP in previous years.

Taking analogue pictures from airplanes seemed to be the best way to avoid surprises and delays. Nevertheless, the timely delivery of the images was not possible in all cases. There are different reasons for this problems. The allowance of national preferences for tenders was a time consuming error of the consortium. While other partners could start their interpretation, the Italian PP had still no images available. The positive benefit of this error of the HABITALP consortium was afterwards the effort to announce the flights on the European level and break for the first time the local market and prizes in this field in Italy. Another benefit of aerial images, to be more independent on weather conditions than with satellite imagery, must be relativised as well. The dependency on climatic factors remains high and the difficult weather conditions in the Alps in relation to the needs for a perfect flight were the main factor for the delay of the flights. Nevertheless aerial image flight still has the advantage to be adjustable in agreement with the flight company in contrast to satellite images which have to be accepted with higher cloud cover percentage.

WP 5 was done mainly by external companies with specific knowledge. Nevertheless, for a trouble-free work flow it was necessary to explain these experts the specific needs of the project and the protected area or some technical prerequisites to the park managers, interpreters and other involved experts. An example illustrating this need might be the weather forecast. For the image flight it should not only be good weather, this good weather should also be forecasted and achieve the specific needs like sight distance and missing cumulus clouds in the afternoon. The monitoring of the weather by park staff therefore did demand these skills to be helpful. Therefore well instructed persons in the protected areas are indispensable to ensure a productive communication. Moreover, to guarantee a protected area internal quality check, well educated technical staff should be involved. This was not the case in certain managements.

Although the project was involving different flight companies and different flight dates, the images represent a good base to get harmonized and standardized data sets. Thanks to the technical specifications, every tender process based on the same guidelines and therefore guaranteed the highest possible comparability. The fact, that the flights are distributed within three consecutive years might be a negligible problem, as natural habitats to be derived do not change significantly during this time period.

The used method remains comparable for the future. HABITALP was using a known technology. Nevertheless to ensure a future comparison with new images, the specifications were developed with a look to the current state of the art and the future. This means the production of digital images for digital photogrammetry and the calculation of high resoluted images to get the highest details possible. Orthoimages can be used for future automatic interpretation work as well as for other purposes of the protected area.

As an example in this field might serve a virtual flight implemented in the visitor centre of the SNP (figure 8). It was derived from the orthophoto developed with the know ledge of the HABITALP project. The CIR images are of no disadvantage for this applications because they can be transferred to pseudo real colour.

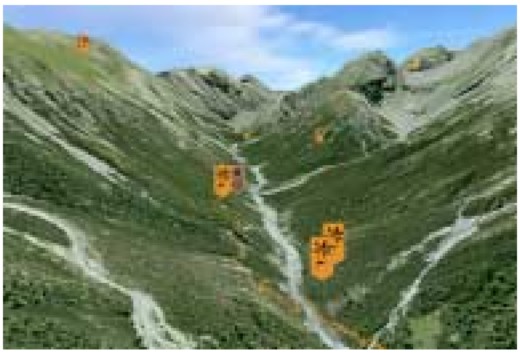


Figure 8: Screenshot of the virtual flight implemented in the visitor centre of the SNP

Examples from the PNMA showed a promising result (figure 9) and open different opportunities to use the data set in other projects of the park management.

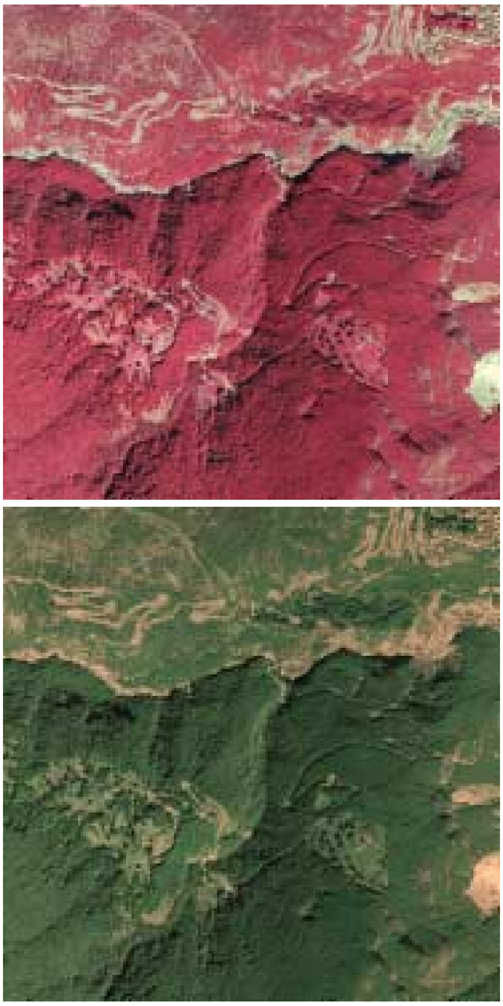


Figure 9: The example of the conversion of a CIR image (above) of the PNMA into a pseudo-RGB image (below).

Conclusion and outlook

WP 5 was the key to get comparable and harmonized data over the alpine wide distributed area. HABITALP used technology which defines the current state of the art for a practical approach. The use of a digital camera to get the images was not offered by any company. The risk seemed to high due to the lack of experience with this sensors in mountainous areas. A next generation will have to test the availability and experiences on new sensors again (see WP11), without neglecting historic prerequisites to make the different time generations comparable.

For the management of an area the aerial images themselves can serve for different applications as well. The images might be the base for landscape monitoring and environmental archives as well as for visualisation and public information.

In particular, the procedure - as exemplary demonstrated in the HABITALP project - sets the base for a harmonized assessment of the protected areas within the Alpine convention or the European Habitat Directive as well as an independent rating of habitat diversity. An adequate preparation of the involved persons in the protected areas is the mandatory premise. A future recapitulation in the same areas is highly recommended to get information about time series and a better view into change detection and disturbance processes in protected areas. Moreover, the procedure could be done in other regions of Europe to consolidate the knowledge on habitat diversity within the network of European's protected areas.

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HABITALP

Interpretation Method

Development of an alpine interpretation key and common mapping guidelines for the description and delimitation of land cover types – WP6

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Summary

A particularly important base for the planning and success control of protected area management are surface covering maps of land use, natural biotopes and structural units. Such maps have been produced and successfully applied at the Nationalpark Berchtesgaden since the beginning of the 80s by means of CIR aerial image interpretation. The need of transnational standards for the survey and preservation of protected habitats within the EU is increasing as stressed e.g. by the NATURA 2000 Habitat Directive.

In the mid of the 90s the cooperation of the National Parks Berchtesgaden, Hohe Tauern und the Swiss National Park brought up the request for the development of a common interpretation key in order to simplify the exchange of data and thus improve the cooperation. Within an INTERREG II A project a first version was set up that finally became the starting point for the project HABITALP. The objective was to enlarge the initial interpretation key to a total of eleven protected areas from the Alps.

A special challenge was the multilingualism of the project-group: It soon became obvious that English as language of exchange is not sufficient when specific terminologies are discussed. In order to facilitate the development of the interpretation key a multilingual version of the key was supplied at the beginning of the project and integrated as an internet discussion forum (www.habitalp.org). While all partners were enabled to make their contributions via internet, the revision of the interpretation key itself was done by an expert group consisting of representatives of all project regions. Another important aspect was the standardised application of the interpretation key: By the aid of multilingual guidelines for delimitation and interpretation and trainings of the interpreters the comparability of the interpretation results was assured as far as possible for all the partner areas. The integration of the interpreters in the key development process also gave the opportunity to profit from their experiences over the duration of the project.

By the end of this project the unique cross-language cooperation results in a common, multilingual interpretation key and common mapping guidelines for the interpretation of CIR aerial images from high mountain areas which are accessible also to a broad public via internet.

Résumé

La cartographie complète de l'utilisation du sol, des biotopes naturels et des typologies structurelles joue un rôle fondamental dans la planification et le monitorage de la gestion des espaces protégés. Depuis le début des années 80, ce type de carte basé sur l'interprétation des images aériennes couleur infrarouge a été produit et utilisé avec succès au Nationalpark de Berchtesgaden. L'existence de standards transnationaux facilitant l'étude et la conservation des habitas protégés est une priorité de plus en plus reconnue au sein des pays de l'Union Européenne, en particulier après l'entrée en vigueur de la Directive Habitats NATURA 2000.

Au milieu des années 90, dans le cadre de la coopération entre le NPB, le NPHT et le SNP le besoin est apparu de développer une clé d'interprétation commune pour simplifier les échanges de données et rendre la coopération plus efficace. Une première version a été élaborée dans le cadre du projet INTERREG II A qui a servi de point de départ pour le projet HABITALP. L'objectif du projet était d'élargir la clé d'interprétation initiale pour y inclure 11 espaces protégés de la région alpine.

Le nombre de langues représentées au sein du groupe de projet a constitué un défi supplémentaire: dès le début, il s'est avéré que l'anglais comme langue d'échange ne suffisait pas lors des discussions terminologiques spécifiques. Pour faciliter l'élaboration de la clé d'interprétation, la clé a été traduite en plusieurs langues dès le début du projet et un forum de discussion sur internet (www.habitalp.org) a permis de la mettre constamment à jour. Bien que tous les partenaires aient participé aux travaux grâce à internet, la révision de la clé d'interprétation à été confiée à un groupe d'experts formé par les représentants de toutes les régions du projet. Une grande importance a été donnée à l'application homogène de la clé d'interprétation : grâce au manuel multilingue de délimitation et d'interprétation et à la formation dispensée aux photo-interprètes, la comparabilité des résultats d'interprétation a été assurée - dans la mesure du possible - pour tous les espaces participant au projet. La participation des interprètes aux différentes phases de l'élaboration de la clé a permis de bénéficier de l'expérience accumulée tout au long du projet.

A' la conclusion du projet, l'exceptionnelle coopération a réussi à surmonter les obstacles représentés par les barrières linguistiques et a permis d'aboutir à une clé d'interprétation multilingue commune et à un manuel de délimitation et interprétation des photographies infrarouge couleur de haute montagne, également accessible au grand public sur internet.

Zusammenfassung

Eine besonders wichtige Grundlage für die Planung und Erfolgskontrolle im Schutzgebietsmanagement stellen flächendeckende Karten der Landnutzung bzw. Biotop- und Strukturtypen dar, wie sie im Nationalpark Berchtesgaden seit Anfang der 80er Jahre mittels Interpretation aus CIR-Luftbildern erstellt wurden und seitdem erfolgreich im Einsatz sind. Der Bedarf an länderübergreifenden Standards für die Erfassung und Erhaltung geschützter Lebensräume innerhalb der EU ist steigend, nicht zuletzt durch die Einführung der NATURA 2000 FFH Richtlinie.

Über die Zusammenarbeit der Nationalparks Berchtesgaden, Hohe Tauern und des Schweizerischen Nationalparks entstand schon Mitte der 90er Jahre der Wunsch, einen gemeinsamen Kartierschlüssel zu entwickeln, um durch den einfacheren Datenaustausch die Kooperation zu verbessern. In einem INTERREG II A Projekt wurde ein erster Prototyp erstellt, der zur Basis für das Projekt HABITALP wurde. Ziel war es, den ursprünglichen Kartierschlüssel für elf Schutzgebiete in den Alpen zu erweitern.

Eine besondere Herausforderung war die Mehrsprachigkeit der Projektgruppe: Bald früh wurde klar, dass die englische Sprache in der Diskussion von Fachbegriffen nicht ausreichend ist. Um die Arbeit am Kartierschlüssel zu vereinfachen, wurde deshalb eine mehrsprachige Version des Schlüssels bereitgestellt, die auch im Internet als Diskussionsplattform (www.habitalp.org) realisiert wurde. Während alle Partner über dieses Medium ihre Anregungen einbringen konnten, wurde die Überarbeitung des Kartierschlüssels selbst in einer Expertengruppe vorgenommen, die sich aus Vertretern aller Projektregionen zusammensetzte. Große Bedeutung kam der standardisierten Anwendung des Kartierschlüssels zu: Mit Hilfe ebenfalls mehrsprachiger Kartieranleitungen und Schulungen für die Luftbildinterpreten wurde sichergestellt, dass in allen Projektgebieten weitestgehend vergleichbar gearbeitet wurde. Durch die Einbindung der Luftbildinterpreten in die Weiterentwicklung des Kartierschlüssels konnten auch deren Erfahrungen über die Laufzeit des Projektes hinweg eingebracht werden.

Mit Ende dieses Projektes stehen damit als Ergebnis einer einzigartigen Zusammenarbeit über die Sprachgrenzen hinweg ein gemeinsamer, mehrsprachiger Kartierschlüssel sowie eine gemeinsame Anleitung für die Interpretation von CIR-Luftbildern aus dem Hochgebirge zur Verfügung, die über das Internet auch einer breiten Öffentlichkeit zugänglich sind.

Riassunto

La cartografia completa dell'uso del territorio, dei biotopi naturali e delle tipologie strutturali, realizzata nel Parco Nazionale di Berchtesgaden fin dagli inizi degli anni '80 tramite interpretazione delle fotografie aree CIR e da allora utilizzata con successo, rappresenta una base particolarmente importante per la pianificazione e il controllo di gestione delle aree protette. L'esigenza di standard transnazionali per il controllo e la conservazione degli habitat protetti all'interno dell'UE è sempre più sentita, in particolare dopo l'entrata in vigore della Direttiva NATURA 2000 FFH.

Verso la metà degli anni '90, nell'ambito della cooperazione fra i parchi nazionali di Berchtesgaden, degli Alti Tauri e della Svizzera, nacque l'esigenza di sviluppare una chiave di interpretazione comune per semplificare lo scambio di dati e di conseguenza migliorare la cooperazione. Nell'ambito di un progetto INTERREG II A venne creato un primo prototipo che rappresentò la base per il successivo progetto HABITALP. Obiettivo del progetto era estendere la chiave di interpretazione originaria ad un totale di undici aree protette alpine.

Una sfida particolare è rappresentata dal numero di lingue coinvolte nel gruppo di progetto; fin da subito divenne chiaro che la lingua inglese non avrebbe potuto essere sufficiente nell'ambito della discussione terminologica specifica. Per semplificare lo sviluppo della chiave di interpretazione, fin dall'inizio del progetto la chiave venne messa a disposizione in diverse lingue e venne creata una piattaforma di discussione in Internet (www.habitalp.org). Mentre tutti i partner avevano la possibilità di fornire il proprio contributo via internet, la revisione della chiave di interpretazione stessa venne effettuata da un gruppo di esperti composto da rappresentanti di tutte le regioni del progetto. Grande importanza fu attribuita anche all'applicazione standardizzata della chiave di interpretazione: con l'ausilio di una guida per la delimitazione e l'interpretazione, anch'essa plurilingue, e di un training degli interpreti, venne assicurata la comparabilità dei risultati dell'interpretazione in tutte le aree del progetto. Integrando gli interpreti nel processo di sviluppo della chiave si aveva l'opportunità di approfittare della loro esperienza accumulata nel corso del progetto.

Con la conclusione del progetto, l'eccezionale cooperazione ha brillantemente superato ogni ostacolo rappresentato delle barriere linguistiche, permettendo di realizzare una chiave di interpretazione plurilingue comune, nonché una guida comune per la delimitazione e l'interpretazione delle fotografie aeree CIR di alta montagna, disponibile anche al vasto pubblico attraverso internet.

Background and objectives

Area wide maps representing all habitat types play an important role for the management of protected areas as they provide basic information about the condition of a landscape.

But especially in high mountain areas the need for detailed data raises conflicts regarding the affordability:

As these areas typically are vast and hardly accessible, remote sensing – though being expensive too - remains the only affordable and thus recommended technique for inventory and surveillance (Rückriem and Roscher, 1999).

With transnational frameworks like Natura 2000 also the European Community emphasized the need of such data and of course standardized methods for the management of the Natura 2000 sites.

The INTERREG IIIb-project HABITALP is not a project specially designed for Natura 2000, but its results will be an important progress for standardised data acquisition at a very detailed level and help creating a transnational database of comparable landscape data.

Experiences in the National Park Berchtesgaden

In the National Park Berchtesgaden there is a long tradition in remote sensing, particularly the interpretation of aerial CIR images. Since the foundation in 1978 maps and data derived from CIR-images have been used successfully for projects like MAB 6 (Spandau and Siuda, 1985), the "Nationalparkplan" (StMLU, 2000) and numerous modelling projects (Lotz, 1997; Eberhardt et. al., 1997; Eberhardt, 1999).

From MAB 6 to INTERREG

Starting with an internal coding scheme for the image interpretation within the MAB 6-project (see table 4) in 1993 the administration of the National Park switched to the official "System for the Survey of Biotope and Land Use Types" (see table 5 in the next chapter) of the German Federal Agency for Nature Conservation ("BfN"; LANA, 1995 and BfN, 2002).

The main reason for this step was the optimisation of data exchange between the nature protection agencies in Germany.

Table 4: Land use and land cover types (extract) of the MAB 6-project "Ökosystemforschung Berchtesgaden" (Spandau and Siuda, 1985)

Code	RNTYP
1010	Glacier
1020	Rock face
1021	Rock face w. alpine grassland
1022	Rock face w. single groups of mountain pine
1023	Rock face w. single trees
1030	Scree
1031	Scree w. alpine grassland
1032	Scree w. single groups of mountain pine

On the other hand the intensive cooperation with other protected areas in the Alps like the National Park Hohe Tauern or the Swiss National Park brought up the vision of a common mapping system for protected areas in the Alps. From 1999 to 2001 these three parks gathered to carry out an INTERREG IIa project as a pilot study (Kias et. al., 2001) that provided a first version of such a mapping system.

The project HABITALP

The next step was the dissemination and adaptation of the results throughout the other alpine protected areas: In November 2002 eleven partners started the project HABITALP within the INTERREG IIIb Alpine Space Programme of the European Community. Besides the orientation towards the development of standards for data acquisition this project is also an attempt to leverage aerial image interpretation for the implementation and the reporting obligations derived from the Habitat Directive.

Objectives

The main objectives for work package 6 "Interpretation key" included

- the development of a common interpretation key and mapping guide for high mountain areas (based on the results of the proceeding INTERREG IIa project),
- the standardisation of the application of the key through the training of the interpreters and
- the compilation of the results into an internet platform as a contribution to the transnational database (cf. work package 9).

When the project started in November 2002 it was clear that there were some serious challenges concerning these goals: As some partners like National

Park Hohe Tauern already had images, the development and the application of the key were carried out at the same time. But the development of the key continued while the interpretation in National Park Hohe Tauern was already running. In order to preserve the compatibility of the datasets, a translation routine was programmed.

Another point was the tight time frame of the project that had to face the typical problems of flights in alpine areas: The later the partners get their images the later they can start to make their contributions to the key based on the experiences with their own images.

Also the different levels of experience of the project partners in remote sensing and GIS had to be compensated: For some of the partners HABITALP was the first project with intense use of these technologies.

Of course all these challenges had to be faced under the influence of another problem: The need of maximum linguistic analogy of terms and documents in the three project languages, i.e. accurate translations were regarded as a prerequisite for a standardised mapping system in this international context.

Organisational and technical implementation

The starting position and basic document for this work package was the interpretation key of 2001 – the result of the INTERREG IIa project that was already applied by National Park Berchtesgaden and provided for the National Park Hohe Tauern where the preparations for the tender procedure for the interpretation started even before HABITALP.

Preparations

This version of the key - an adaptation of the "BfN" coding scheme to high mountain areas - was later named HIK-0 (HABITALP Interpretation Key, version "0" (see table 5 and figure 10).

Characteristical for this very clear key was the principle of dominance as the main rule for the delimitation and coding: Polygons have to be mapped according to the dispersion of several types of objects, but the attribute tables were coded only with the dominating ones.

Another important feature of this key is the structure: Technically seen the information is stored in three columns with 4, 3 and 1 digits. In the first column (Cir1) habitat types are differentiated in 10 units according to a geographical classification of natural landscapes (e.g. waterbodies, forest, agriculture...). Each unit is hierarchically subdivided into several classes.

The next column holds informations on dominating species and the third one is intended for canopy or coverage.

The successful tender procedure in National Park Hohe Tauern has to be regarded as the first suitability check as the companies had to deliver test interpretations.

In order to accelerate the adoption of the key, translations were made available already for the first HABITALP project meeting in November 2002. Now having documents in their native language the project partners had the task to check for missing local requirements like species and habitat types or make contributions of additions and enhancements like new columns or definitions.

Table 5: The main mapping units from the "System for the Survey of Biotope and Land Use Types" (BfN, 1995) – the base of the HABITALP Interpretation Key.

Unit	Mapping unit of biotope / land use type
1000	Coastal areas
2000	Inland waterbodies
3000	Bogs, swamps
4000	Agricultural land; herbaceous perennial fields
5000	Skeletal soil sites, dwarf shrub heath, extreme sites
6000	Trees, copses, brush
7000	Forests
8000	Greatly modified, disturbed sites; supply and waste management areas
9000	Settlement, traffic, leisure and recreation

The steering of the development of the interpretation key and mapping guidelines was one of the main tasks of the alpine subcontractor, the Landscape Informatics Centre (LIZ) of the Weihenstephan University of Applied Sciences. Other main tasks included the training of the interpreters and the support of the project partners. In addition the results had to be documentated for further use in the transnational database.

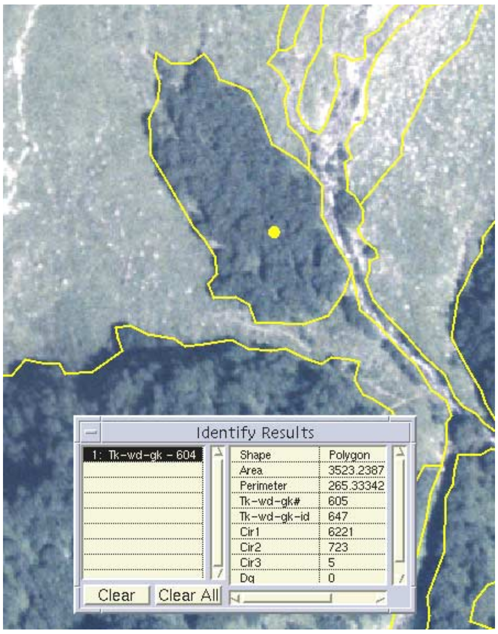

Figure 10: Example for a polygon of a HIK-0 dataset from the test region "Innergschlöss", Nationalpark Hohe Tauern. (Source: LIZ)

Cir1: 6221 = Shrub Stand, deciduous
Cir2: 723 = Alnus viridis (72.) Grass/ heath (3 accompanying)
Cir3: 5 = Closed stand, canopy cover > 90 %

The internet platform "habitalp.org"

To achieve these goals the implementation started with the development of an internet-based platform ("www.habitalp.org", see figure 11 below) as a discussion forum (in English) and platform for the further development of the key. This tool was ready for use in April 2003, i.e. at a very early stage of the project. Delivering a multilingual (French, German, Italian) synoptical version of the key this tool was intended to enable the integration of all project partners in a transparent way:

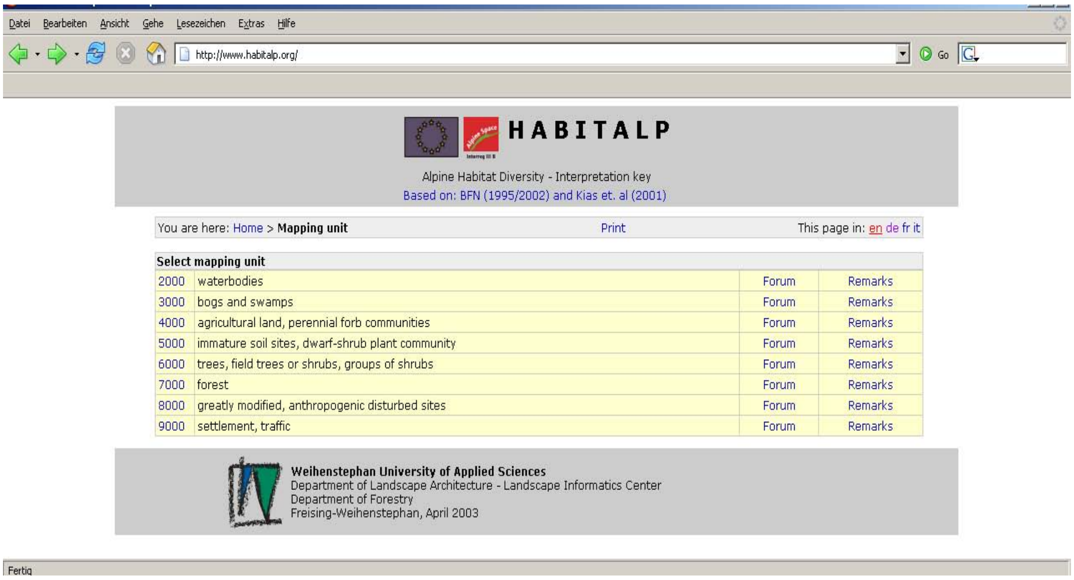

Figure 11: Screenshot of the first internet version of the HABITALP Interpretation Key. (LIZ)

All partners could get involved in the development and get informed of the current status. Additionally the cooperation with the Alpine Network led to a first published translation of the interpretation key and additional delimitation guidelines (ALPARC, 2003) which reflects the project status of summer 2003.

Key development and implementation

While the development of the key in the end was a result of the cooperation of all project partners, the technical implementation was done by an expert group on a regional level for efficient realisation of the required modifications and enhancements.

The group was established in January 2004 when the images of the first flight period were processed and these partners were preparing for the interpretation. Members of this group were

- Dr. Umberto Morra di Cella, responsible for the Western Alps,
- Dr. Pius Hauenstein, responsible for the Central Alps,
- Walter Demel, responsible for the Eastern Alps and as a technical responsible of the work package leader National Park Hohe Tauern,

- Helmut Franz,
  for the project leader National Park Berchtesgaden,
- Annette Lotz,
  for the project leader National Park Berchtesgaden.

The development itself began with an initial technical workshop with all project partners in Salzburg, June 2003: After a presentation of the current key HIK-0 the internet platform was opened for the further development of HIK-1. At the end of the year many contributions were made by the project partners – some directly via the internet platform habitalp.org and some indirectly via the support by the regional experts. But all contributions had been integrated into the discussion forum and were easily accessible for all project partners.

Preparations

After the phase of sampling, the technical implementation carried out by the regional experts group started in January 2004. In two workshops (Freising and Zurich) the suggestions of the project partners were integrated into the new version of the key (HIK-1, see table 6), which was the valid version for the first training of the interpreters held in Gap (March 2004). At that time the new version HIK-1 and additional training documents had already been translated into French by the expert group which was a great help to the participants.

Table 6: Example of the HIK-1 coding scheme for forests: The information is hierarchically stored in the four columns CIR1 – CIR4. The most important differences to HIK-0: The enlarged list for CIR1 and the new column CIR4. (LIZ)

Column	Code	Description
CIR1	74 15	1) Spread of deciduous/conifers: mixed forest (softwood dom.) 2) Stratification of the stages: old-growth stand
CIR2	4 . . . 1 . . . 1	3) Dominating species (cf. column CIR4): hardwood 4) Accompanying species: spruce 5) Underground: scree
CIR3	3	6) Canopy cover: sparse stand
CIR4	411	7) Dominating species (detailed list): Acer pseudo-platanus

First training of interpreters

The training was scheduled as a set of "lessons" according to the main units of the interpretation key. The training area was the test region "Innergschlöss" taken from the tender procedure in the National Park Hohe Tauern where a reference map was produced. All participants were provided with analogue CIR image pairs for stereoscopical viewing, a professional stereoscope was made available by the LIZ. After an introduction to the mapping unit the participants had to absolve the training interpretations on their own but were supported by the regional experts. Each lesson ended with an assessment of the results in a plenary session.

As a very important side effect of this training all participants became aware of the necessity of professional equipment (see figure 12 below): Depending on the quality of the equipment, the differences in quality between the interpretations were obvious to everybody. Fortunately some of the project partners without such stereoscopes were provided with redundant equipment transferred from agencies in Germany and Switzerland.

Figure 12: Professional GIS workstation with a high quality stereoscope (Wild APT1, LIZ)

The training ended with instructions and tips for the beginning interpretations in the partner areas Les Ecrins and ASTERS, especially a test period in a small region (about 10 km²) that should be checked in the next workshop in Lausanne (July 2004).

First experiences

During the following weeks and months the interpreters worked on their test regions and of course detected the pros and cons of the mapping system. Among lingual problems especially the activities in the Swiss National Park soon revealed some serious problems in the coding scheme, some of them caused by the extension of the key:

- ambiguity of the codes: the addition of many new types and species led to an overload of the scheme and stressed the interpreters in learning the scheme
- the compatibility to the original system of the BfN also was endangered by these extensions and on the other hand it was clear that there was not enough room for further extensions although most of the project partners not yet had fully contributed their local habitats
- the interpreters often had the dilemma in choosing the appropriate codes: As the BfN system is a coding scheme following the principle of dominance in many cases the non dominating objects and structures had to be omitted.

Proposal for a new version of the key

In order to find a solution for these problems a new draft scheme proposed by P. Hauenstein was elaborated and presented in the Lausanne meeting. This new system called HIK-2 (see below) consists of many new attributes which replace the variety of code combinations and simplify comprehension. Overall this system was especially designed to meet the requirements of the heterogeneous HABITALP partner areas and has a lot of improvements compared to the old one. At the same time it was retaining important characteristics of HIK-0:

- hierarchical structure (as before)
- compatible with the older versions, esp. with the system of the BfN
- widely self-explanatory attribute names and values with constant meaning across all columns
- separate "degree of cover" - attributes for objects (e.g. water, rock, grass ...), i.e. all habitat types can be mapped in detail for all these object types, not only the dominating ones
- scalable interpretation levels up to species (e.g. optional columns for trees, adaptable to local needs)
- easy to expand with additional columns for local use
- design improved for mapping (manifold legend possibilities)
- With regard to the vision of developing a sophisticated mapping system for alpine regions delivering widely standardised data, the project partners agreed in Lausanne to start a suitability check using HIK-2 in ASTERS and Switzerland. The results should be discussed in the following workshops and a final decision should be made by the end of 2004.

Table 7: Excerpt from the attributes list of the HIK-2. The complete documentation is available under www.habitalp.org.

Column	Description
HT*	Habitat Type
DC_WATER**	Water
DC_ROCK**	Rock
DC_SCREE**	Scree
DC_GH**	Grass, Herbaceous vegetation
DC_DS**	Dwarf shrubs, big perennial herbs, fern
DC_SHRUBS**	Shrubs
DC_TREES**	Trees
DC_SEALED**	Sealed area
DC_BUILDNG**	Building coverage
SP_HERB*	Species: Herbaceous vegetation ...
SP_SHRUBS*	Species: Shrubs
SP_TREES_D*	Species: Trees (deciduous)
SP_TREES_C*	Species: Trees (conifers)
AC1*	Additional Characteristics
AC2*	Additional Characteristics e.g. "Structure"
L_000***	Canopy of deciduous trees
C_000***	Canopy of conifers
L_100***	Canopy of beech
C_100***	Canopy of spruce
DQ*	Data quality
DQ_Anno****	Data quality annotation

Annotations:
* List of unique codes
** 5 classes of percentage
*** 10 classes of percentage
**** String column for comments
black obligatory
magenta recommended
green optional
(Demel and Hauenstein, 2006b)

Switch to HIK-2

In October 2004 the next technical workshop (Annecy) showed the first experiences with HIK-2 and the image interpreters came to the conclusion that a switch would be reasonable and help on the project HABITALP. In Bormio (November 2004) the project partners consequently decided to use HIK-2 as the official interpretation key for HABITALP.

Thereupon the finishing of the HIK-2 documents started, including a complete new version of the delimitation guidelines and once more comprehensive translational works to provide extensively harmonised multilingual documents. Additionally the maintenance and adaptation of the internet version of the key had to be completed in all three languages before the second group of image interpreters was scheduled for training in March 2005.

Translation tool "HIK-0/HIK-1 ↔ HIK-2"

When the project group decided to switch to the new HIK-2, interpretational works in Les Ecrins, Hohe Tauern and Berchtesgaden were already in progress. In order to keep the compatibility with the HIK-2 datasets, a translation tool was developed by Pius Hauenstein, that should transfer all data content from the older system into the new one as far as possible. Due to the more detailed mapping structure of HIK-2 this was not achievable in a one-to-one way for all values (e.g. canopy of trees) respectively habitat types: With additional and more coarse classification values for this data the existing information content could be fully preserved.

Second training of interpreters

This week-long training was held at the GIS laboratory of the LIZ in Freising (see figure 13 below) and completely based on computers and professional equipment for all participants.

Figure 13: Computer based training of the interpreters in Freising, March 2005. (LIZ)

At the end of the training in Freising there was also the agreement to start in the new regions with a test stage and an assessment during the next workshop (Bolzano, May 2005).

The last step in the development of the interpretation key was the meeting in Bolzano, when the suggestions for final modifications of HIK-2 were discussed.

Among other suggestions concerning details, a basic optimisation of the interpretation method was discussed. The idea was to extend the "degree of cover" attribute system from the species based approach (e.g. the column "DC_Trees") with a height based approach (e.g. new columns for vegetation with different height).

After an intensive discussion the group decided not to change the system as this would have meant too many modifications for the ongoing interpretations. But for future projects the suggested approach was regarded to be a promising way to a version HIK-3.

All in all the work on the interpretation key was a demanding exchange of experience by a unique cross-language cooperation: In contrast to purely scientific projects, HABITALP delivered results from methodological development and practical application spread over several languages and nations.

Discussion and assessment

After four years of work with partners from eleven protected areas in the Alps the experiences with aerial image interpretation as a method for data acquisition gave new impressions in many aspects.

Aerial image interpretation in general

Aerial image interpretation proved to be an established technique for data acquisition especially in vast or non-accessible regions. The often associated subjectiveness as a drawback is also typical for field inquiries, but remote sensing has the advantage of possible repetitions with the aerial images as a valuable and objective documentation of land cover at a given time.

The principle of homogeneous patches as a basic delimitation rule is an efficient method for the mapping of land cover and land use: While the recognition of objects in an aerial image differs from a terrestrial survey, the first experiences with biotop mapping in the National Park Hohe Tauern based on HABITALP datasets showed the great capabilities of this methodology. Especially in highly structured landscapes like mountain areas a mapping system is required which is able to handle the huge variety of elements and mosaic patterns of a landscape. The enhancements of the key during the HABITALP project focussed on these problems and led to a sustainable solution.

Obstacles are of course heterogeneous teams of interpreters that will always generate heterogeneous maps and language barriers that will complicate any process of standardisation and often annihilate any kind of time schedule.

Natura 2000 requirements

The Habitat Directive of Natura 2000 demands maps and reports on a very detailed level. But the desired level of detail is counterproductive in terms of producing comparable data within regions like the Alps: The more detailed the data has to be the more likely differences will occur caused by different producers.

Additionally, protected areas like those of the HABITALP project partners are typically completely Natura 2000 Sites and given the fact that field inventories are too expensive and in many cases too dangerous, the required surveillance obligations can only be fulfilled by means of remote sensing for the area-wide inventories or sampling methods for detailed investigations, e.g. zoological or phytosociological research (Lang, 2005). This means that not all requirements of Natura 2000 can be fulfilled by means of remote sensing, but aerial image interpretation will always be one of the most important methods of data acquisition in alpine regions.

The HABITALP approach

The core of the HABITALP approach is the use of CIR aerial image interpretation for the production of a basic map representing a inventory of land cover and land use. The possibility of producing data at the edge of the capabilities of aerial images is enabled by a sophisticated interpretation key and mapping guidelines in native language for all participants. Based on CIR images with a medium image scale of about 1:10000, professional equipment is considered to be an absolute prerequisite for producing high quality maps. Furthermore the interpreters have to have special skills in both landscape ecology and GIS, i.e. experienced professionals are strongly recommended.

To achieve this level of quality, the project partners were provided with recommendations and support for a successful tender procedure for the image interpretation.

The objective of standardisation was approached in several ways:

- integration of all project partners in the development of the key via internet and workshops
- multilingual workshops and trainings of the interpreters by training with real data and intense exchange of experience
- comprehensive translational works for the documents in all stages of the project

As a result the new HIK-2 contains many features that came from other activities of the different project partners:

- PNE: Mapping of landscape structures and spatial patterns (Godron and Salomez, 1995)
- SNP: Mapping of deadwood and disturbances
- NPB: Change detection (1997 - 2003)

These activities show the capability of the HIK-2 system in terms of being expandable without compromising the comparability of the data across the Alps.

Difficulties

Difficulties for this work package started with the problems of the tender procedures for the image flights: As these tasks were more complicated than estimated, they caused a delay in the project with several effects for the following work packages: The engagement of the project partners in the development of the key started later for those partners without images in the first two years.

Therefore the divergency of development and application within HABITALP was extreme: the first partners nearly finished their image interpretations while the last ones started. Another important point is the loss of time due to the time consuming translations which constrained also the development. Regarding the quality of the image interpretations the changes within some of the interpreter teams led also to heterogenity in the results and required additional efforts to achieve the comparability of the datasets. A possible solution to meet this challenge is to increase the number of workshops, so the necessary time for workshops and trainings must not be underestimated.

The coding scheme of the key itself was changed from a complex list of habitat types to an atomic system of many columns representing the occurrence of object. The additional efforts for collecting these objects were of course constrained by the financial capabilities of the project partners. However the graduation of the habitat types and data columns in "mandatory", "recommended" and "optional" ensured the comparability of the data.

While the loss of information caused by the principle of dominating objects was eliminated, the accurate botanical description of some habitat types (alluvial/floodplain forests) cannot be derived in a sufficient way. But as HABITALP was designed as project for generating a basic land use / land cover map with aerial images only, this refers back to the need of a comprehensive inventory system for any National Park.

Conclusion

The successful experiences of National Park Berchtesgaden led to the cooperation of eleven partners from the Austrian, French, German, Italian and Swiss Alps, setting the target to create a standardised system for deriving information from CIR aerial images as a basic dataset for the various management tasks in protected areas.

The HABITALP method

Aerial image interpretation has the reputation to be an established method for data acquisition but cannot fulfill all requirements and never will. Especially in alpine regions the HABITALP method is a good compromise between data quality and affordability.

This statement is reinforced by the evaluation of existing data within the HABITALP partner areas: No comparable datasets were found or at least few only for small parts.

In terms of the quality of such datasets this project showed the dependency on the experience of the interpreters: the more experienced the interpreters the faster they achieve good results. For this reason within HABITALP a key point was the standardisation of the interpreters skills with trainings and multilingual documents. At the end of this project widely comparable datasets in an unprecedented quality are available for further use in the alpine space.

The adoption of the HABITALP method by another protected area outside of the HABITALP group (Nationalpark Gesäuse, Austria) indicates that the efforts for this project - especially for the documentation - start to pay off.

Designed for map scales of 1:5000 as typical scales for management and planning, HABITALP data should become a basic tool for mapping, analysis and research in the project partner areas. Further cooperation of protected areas within the Alps should lead to further improvement of this mapping system and may generally help for the standardisation of such types of geodatasets.

Outlook

The project HABITALP distinguished itself by an intensive cooperation of eleven partners throughout the Alps bridging technical and lingual barriers in order to provide a sustainable solution for a surveillance and monitoring system. The applied interpretation key was designed for aerial CIR images with high resolutions but other remote sensing technologies will sooner or later provide new possibilities. In addition to the technical progress more exchange with other protected areas in alpine regions will help to consolidate this approach.

Human generated maps vs. image processing

Detailed maps, derived from high resolution aerial images and completely covering huge and hardly accessible regions, are always expensive when produced by human interpreters. Using computers and sophisticated image processing software to generate more or less automated datasets is considered to be the best alternative.

The latest achievements with software for automated image processing might help in producing more comparable results, but human interpreters still reach a better level of detail especially for area-wide maps: High resolution aerial images as used in HABITALP by no means automatically do improve the quality of computer generated maps. The additional information achieved by the superior resolution, in many cases is more an obstacle than an advantage for automated processing (Kias et al., 2001) while human perception normally benefits

Up to now the associative capabilities of human beings is still unmatched (Langanke et al., 2004) and current projects dealing with image processing often focus on single objects or single object classes (OBIA 2006).

Talking about the status quo of the automation of image processing in alpine areas, HABITALP has revealed an interesting result:

While the manual interpretations in this project were not an obligation for the companies, no company offered an automated or even semi-automated interpretation.

New technologies

Mobile computing

The production of even more detailed data and maps can only be achieved by field inquiries, but the adoption of mobile computing systems with GIS-functionalities like PDA's and full featured tablet PC's (figure 14 below) will facilitate and cheapen field surveillance: Any types of data can be created and validated directly on-site and errors caused by import or export can be avoided. The handling of the hardware and the software will become more user-friendly and by this means attract more scientists and researcher without having GIS skills but being commissioned to produce maps.

Figure 14: Ruggedized Tablet PC with GIS-software. (www.ili-gis.com)

Digital cameras

The next step concerning sensor technology will bring capable digital cameras aboard the aircrafts: With four spectral bands including the near infrared (NIR) these cameras will produce images with high resolutions and impressive radiometric and spatial accuracy (see figure 15). The biggest advantage of these systems will be the far better comparability between images as the notorious problems with the CIR film emulsion will be overcome.

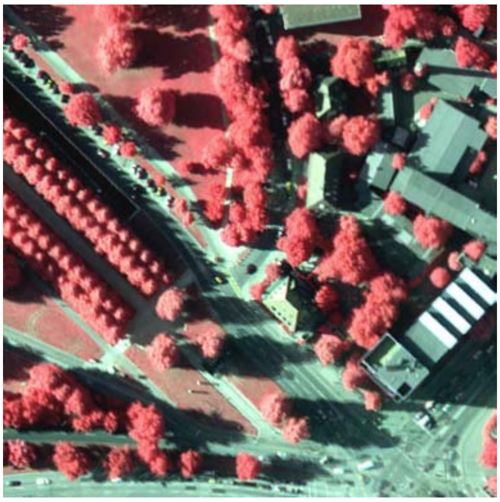

Figure 15: Aerial image (0,25m ground resolution) produced with an airborne scanning system (www.toposys.de)

Satellite imagery

Compared with airborne sensors, satellite-based sensors for decades were too coarse for producing very detailed maps. With Ikonos (4m multispectral / 1m panchromatic resolution) and Quickbird (2,4m multispectral / 0,6m panchromatic resolution, (see figure 16 below) this has changed. Images from these scanner systems almost meet the quality of those HABITALP images with smaller scales (~ 1:13000). While this might be tolerable, the difficulties in getting images at the appropriate time still are an issue: Especially in high mountain areas the satellite-based images often are partially covered by clouds that make an interpretation nearly impossible in these regions.

Figure 16: Color Infrared satellite image (0,6 m/ 2,4 m ground resolution; www.digitalglobe.com)

Laserscanning

Digital surface models (DSM) produced with airborne laser scanners will have one of the biggest impacts on the methods of image interpretation. Many references (Wiechert, 2005) show the strong potential of this new technology as it will deliver three dimensional data in unprecedented quality. The combination of these surface models with other data like high resolution images will provide many new ways of data analysis.

One of the most interesting aspects for researchers dealing with vegetation is the "first-pulse/last-pulse" effect (see figure 17 below) of the laser scanning technology: From the image interpreters point of view this data would be a perfect information for assigning height values to vegetation.

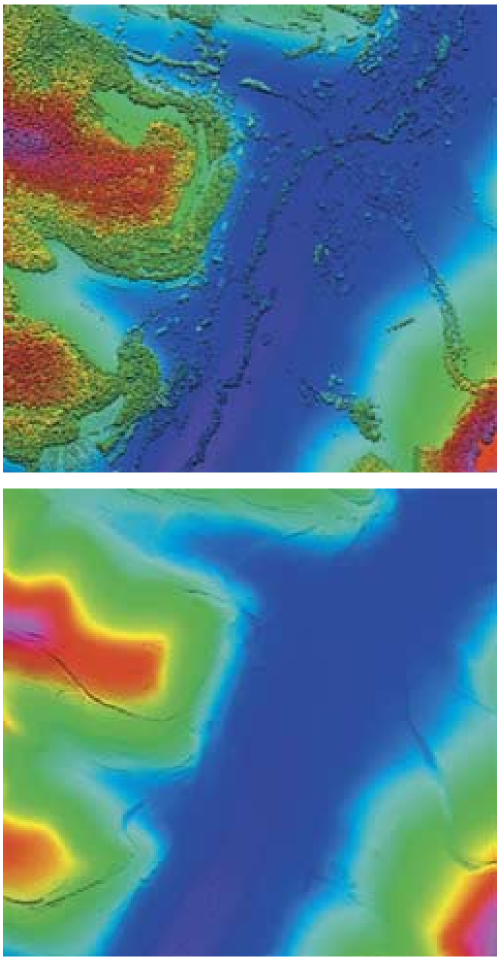

Figure 17: Upper image: Digital surface model (DSM) generated from "first-pulse" data with a point density of 1 pt/m². Lower image: Digital terrain model (DTM) of the same area, generated from "last-pulse" data. The fine grained structures of the DSM represent vegetation like shrubs and trees. (www.terra-digital.de)

Relating to HABITALP, laser scanning data may help to improve the mapping of three dimensional structures like forests with multiple stories. And - as this technology is independent from sunlight - of course some deficiencies in the data caused by shadows or clouds could be avoided.

Software

With respect to the development of software for automated data extraction it remains to be seen whether the available tools will mature where they can replace the human interpreters. Research in this field quickens it's pace noticeable: In 2006 the first international conference on "Object-Based Image Analysis" (OBIA; Lang, 2006) was held in Salzburg with more than 150 scientists from all over the world. With the special approach of using combinations of multiresolution data from different sensor types this technology will surely evolve quickly. The intensive research using data produced with laser scanners is a good indicator for this (Kressler and Steinnocher, 2006; Maier et al., 2006). An important input for mapping systems could be the automated detection of dispersion patterns, which may lead to a better description of the succession of a landscape.

New standards

On the other hand the development of new sensors and the improvement of the processing tools will sooner or later improve the capabilities of all image analysis methods and thus helping to generate more precise and comparable datasets. Projects funded by the European Community like SPIN (Spatial Indicators for Nature Conservation, Bock et al., 2003) describe the way for further applications in this field of research: By leveraging standardised indicators for landscape metrics and developing tools and workflows for standardised analysis on geometries representing geospatial information, an important progress towards practical standards was achieved. For the production of detailed base geometries in many cases human interpreters will remain the best "tool" either utilising a stereoscope for getting the most out of the images or a computer for automated data extraction or both.

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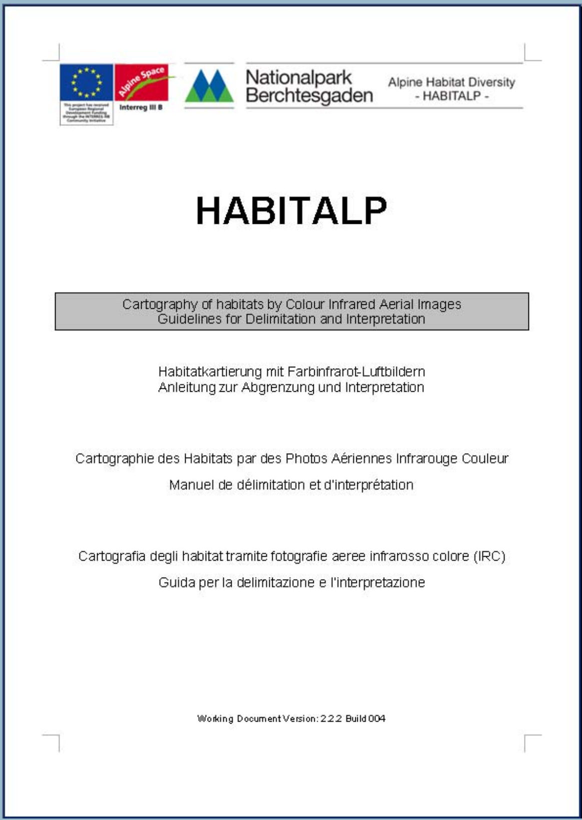
Guidelines for the delimitation and interpretation of habitats

Walter Demel

As a special output from this workpackage the multilingual interpretation key and guidelines for delimitation and interpretation are included as PDF-files on the enclosed CDROM.



Nationalpark Berchtesgaden

Alpine Habitat Diversity - HABITALP -

HABITALP

Cartography of habitats by Colour Infrared Aerial Images
Guidelines for Delimitation and Interpretation

Habitatkartierung mit Farbinfrarot-Luftbildern
Anleitung zur Abgrenzung und Interpretation

Cartographie des Habitats par des Photos Aériennes Infrarouge Couleur
Manuel de délimitation et d'interprétation

Cartografia degli habitat tramite fotografie aeree infrarosso colore (IRC)
Guida per la delimitazione e l'interpretazione

Working Document Version: 2.2.2 Build 004

The HABITALP guidelines for Delimitation and Interpretation (LIZ)

Especially the delimitation guidelines can be considered as a good starting point for getting familiar with the HABITALP mapping system, because this document delivers detailed descriptions of

- necessary equipment (stereoscopes, software ...),
- methodology, project organisation
- technical aspects of the interpretational work:
    - delimitation rules
    - digitizing rules
    - guidelines for data management

The interpretation key document contains detailed descriptions of the various database columns and additional informations concerning the interpretation of the specific habitat types. Sample images are not included in this document.

The complete interpretation key and the delimitation guidelines are available in English, French, German and Italian language and are also accessible via internet:

www.habitalp.org/doc/index.php

HABITALP

Aerial Image Interpretation

Application of the HABITALP interpretation method for the creation of comparable landscape inventories – WP7

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HAUENSTEIN GEOINFORMATIK

Summary

Within the framework of this work package, the mapping of habitats by aerial image interpretation was effected individually in the partner areas. For this purpose the interpretation key and the guidelines, developed in work package 6 (Interpretation Method), were utilised.

Preceding and centrally implemented training sessions in work package 6 served to introduce the aerial image interpreters to the mapping method and to achieve alpine wide comparable results by the apprehension of a uniform technical standard. 30 persons were trained to apply this mapping method and interpreted aerial images in the framework of this project.

As groundwork served the aerial images and orthophotos produced in work package 5 (Aerial Image Flight). The mapping was made by stereoscopic viewing of the aerial images and digitizing into a Geographic Information System. The results of this work package are databases with area delimitations and habitat descriptions corresponding to the common interpretation key.

The choice of the executing persons or company was made individually by each project partner. Regional coordinators were at their disposal during the key development and interpretation phase. In some cases these coordinators were contracted additionally for extended local support.

Caused by the unfavourable weather conditions for the flights, the project partners did not get their images in the same year. Hence they could start with the interpretation only asynchronously. Consequently the interpreters rarely were in the same working phase and the foreseen common discussion, exchange of experiences and of helping tools took place only limitedly. The whole mapped area covers approximately 4300 km2. This area was segmented during the delineation and interpretation into about 430'000 single polygons (habitats). Up to 20'000 different types effectively mapped can be counted.

With this mapping 10 protected areas in the Alps have obtained – at least partially – a surface covering habitat inventory in a spatial resolution, degree of detail und comparability which are unrivalled up to now. The corner stone for surface covering monitoring and transnational comparisons has been laid. Protected area management, research and the public relation section must scrutinize this inventory intensively to activate the value slumbering therein.

Résumé

Dans le cadre du ce work package, chaque espace protégé du projet a réalisé individuellement la cartographie des habitats par interprétation des images aériennes, en utilisant le manuel de délimitation et d'interprétation et la clé développés dans le work package 6 (Interpretation Method). Pour familiariser les interprètes des photos aériennes avec la méthode cartographique et obtenir de ce fait des résultats comparables pour toute la région alpine grâce à l'adoption d'un standard technique uniforme, des séances de formation ont été organisées avant et pendant le déroulement des travaux du work package 6. Dans le cadre du projet, 30 personnes ont été formées à l'application de cette méthode cartographique et à l'interprétation des images aériennes.

Les photos aériennes et les orthophotos prises lors du work package 5 (Aerial Image Flight) ont servi de base à la réalisation du travail. La cartographie a été réalisée par observation stéréoscopique des photos aériennes et numérisation dans un système d'information géographique. Ce travail a permis d'obtenir des bases de données avec délimitation des surfaces et une clé d'interprétation commune.Le choix des opérateurs ou de la société s'est fait à la discrétion de chaque partenaire du projet. Des coordinateurs régionaux ont encadré les équipes lors de la mise au point de la clé et des travaux cartographiques. Dans certains cas, ces coordinateurs ont été embauchés pour fournir un soutien supplémentaire au niveau local.

A' cause des mauvaises conditions météorologiques, tous les partenaires n'ont pas pu réaliser les photos la même année, la conséquence étant que l'interprétation n'a pas démarré simultanément. Puisque les interprètes se trouvaient à des stades d'avancement différents, la discussion commune, l'échange d'expériences et d'outils que l'on avait souhaité n'a été possible qu'en partie. La surface totale concernée par les travaux cartographiques couvre environ 4300 km2. Lors de la délimitation et de l'interprétation, cette surface a été segmentée en environ 430'000 polygones (habitats). On distingue environ 20'000 typologies effectivement cartographiées.

Grâce à cette opération, 10 espaces protégés des Alpes disposent – du moins en partie – d'un inventaire des habitats complet, avec une résolution spatiale, un degré de détail et de comparabilité jusqu'à présent inégalés. Ce projet a permis de jeter les fondations d'un monitorage diffus et d'une réflexion transnationale. Dans un avenir proche, un fort engagement au niveau de la gestion des espaces protégés, de la recherche et des relations publiques sera nécessaire pour exploiter pleinement le potentiel de cet inventaire.

Zusammenfassung

Im Rahmen dieses Arbeitspakets wurde individuell in den Partnergebieten die Kartierung der Lebensräume durch Luftbildinterpretation durchgeführt. Dazu kamen der in Arbeitspaket 6 (Interpretation Method) entwickelte Interpretationsschlüssel und die Kartieranleitung zur Anwendung. Die vorherigen, zentral durchgeführten Schulungen in Arbeitspaket 6 dienten dazu, die Luftbildinterpreten in die Kartiermethode einzuführen und durch das Erlernen eines einheitlichen technischen Standards eine alpenweite Vergleichbarkeit der Ergebnisse zu erreichen. Insgesamt wurden 30 Personen in der Anwendung dieser Kartiermethode geschult und haben im Rahmen dieses Projektes Luftbilder interpretiert. Als Arbeitsgrundlage dienten die im Arbeitspaket 5 (Aerial Image Flight) erstellten Luftbilder und Orthophotos. Die Kartierung erfolgte mittels stereoskopischer Betrachtung der Luftbilder und Digitalisierung in ein Geographisches Informationssystem. Das Ergebnis dieses Arbeitspaketes sind Datenbanken mit Flächenabgrenzungen und Habitat-beschreibungen entsprechend dem gemeinsamen Interpretationsschlüssel. Die Wahl der ausführenden Personen resp. Firma erfolgte individuell durch jeden Projektpartner. Während der Schlüsselentwicklung und der Kartierarbeiten standen regionale Koordinatoren zur Verfügung. Für weitergehende lokale Unterstützung wurden diesen Koordinatoren in einigen Fällen zusätzliche Aufträge erteilt.

Bedingt durch die ungünstigen Flugbedingungen haben die einzelnen Projektpartner die Luftbilder nicht im selben Jahr erhalten und konnten daher nur zeitversetzt mit der Interpretation beginnen. Da sich die Luftbildinterpreten dadurch kaum je in den gleichen Arbeitsphasen befanden, kamen die angestrebte, gemeinsame Diskussion, der Erfahrungsaustausch und der Austausch von Hilfsmitteln nur beschränkt zustande. Die gesamte kartierte Fläche umfasst rund 4300 km2. Diese Fläche wurde durch die Mosaikierung und Interpretation in ca. 400'000 Einzelpolygone (Habitate) zerlegt. Bis zu 20'000 effektiv kartierte Typen können gezählt werden. Mit dieser Kartierung haben 10 Schutzgebiete im Alpenraum - mindestens partiell - ein flächendeckendes Habitat-Inventar in einer bisher unerreichten räumlichen Auflösung, Detaillierung und Vergleichbarkeit erhalten. Der Grundstein für ein flächenhaftes Monitoring und internationale Vergleiche ist damit gelegt. Schutzgebiets-management, Forschung und Öffentlichkeitsarbeit werden sich in nächster Zeit intensiv mit diesem Inventar auseinandersetzen müssen, um den darin schlummernden Nutzen zu aktivieren.

Riassunto

Nell'ambito del work package la cartografia degli habitat tramite interpretazione delle fotografie aeree venne eseguita separatamente nelle aree dei singoli partner. A tal fine vennero utilizzate la chiave di interpretazione e la guida per la delimitazione e l'interpretazione, sviluppate nell'ambito del work package 6 (Interpretation Method). I corsi di formazione previsti in precedenza a livello centralizzato nell'ambito del work package 6 hanno permesso agli interpreti di apprendere il metodo cartografico e, grazie all'adozione di uno standard tecnico uniforme, avrebbero garantito risultati comparabili a livello alpino. La formazione sull'applicazione di questo metodo cartografico ha interessato un totale di 30 persone che, nell'ambito di questo progetto, erano incaricati dell'interpretazione delle fotografie aeree. La base del lavoro era rappresentata dalle fotografie aeree e dalle ortofoto create nell'ambito del work package 5 (Aerial Image Flight). Il lavoro cartografico prevedeva l'osservazione stereoscopica delle fotografie aeree e la digitalizzazione in un Sistema Informativo Geografico. Il risultato di questo work package è rappresentato da banche dati con delimitazioni di aree nonché descrizioni degli habitat secondo la comune chiave di interpretazione. La scelta degli operatori e delle aziende venne effettuata a propria discrezione dai singoli partner del progetto. Durante lo sviluppo della chiave e dei lavori cartografici vennero messi a disposizione coordinatori regionali. In alcuni casi questi coordinatori furono ingaggiati per fornire un supporto locale aggiuntivo.

A causa delle condizioni meteo sfavorevoli, i singoli partner non erano riusciti ad acquisire le fotografie aeree nello stesso anno, per cui non fu possibile partire contemporaneamente con l'interpretazione. A causa del diverso stato di avanzamento del lavoro dei singoli interpreti delle fotografie aeree, la discussione comune auspicata, lo scambio di esperienze e lo scambio di strumenti furono possibili solo in parte. La superficie complessivamente interessata dal lavoro cartografico comprende circa 4300 km2. Durante la delimitazione e l'interpretazione questa superficie è stata segmentata in circa 400.000 poligoni (habitat). Si contano fino a 20.000 tipologie effettivamente cartografate. Grazie a questa cartografia, 10 aree protette alpine dispongono almeno in parte di un inventario degli habitat completo, con una risoluzione spaziale, un grado di dettaglio ed una comparabilità finora mai raggiunti. Si sono così create le condizioni di base per un monitoraggio diffuso e per confronti internazionali. Nel prossimo futuro sarà necessario un forte impegno a livello di gestione delle aree protette, di ricerca e di pubbliche relazioni per valorizzare al massimo questo inventario.

Organisational and technical implementation

The work package 7 formed the framework for the processing and transaction of the aerial image interpretation. The aim of this work package was the standardized mapping and interpretation – methodically and qualitatively – in the areas that the project planning pinpointed.

The aerial images and orthophotos from the work package 5 and the interpretation key produced in work package 6 formed the basis. The individual project partners were responsible for the organization and placing of orders. The work package leader and the regional coordinators supported technically and administratively this process. Because the provision of the aerial images and orthophotos, the developments of the interpretation key and the training of the interpreters are very closely interrelated with the processing of the work package, the work package leader of the WP5 (Aerial Image Flights) and the alpine experts of WP6 (Interpretation Method) assisted the project partners in doing this work as well.

A great importance was attached to this cooperation and support, because administrative and technical aspects are very close interlinked and different project partners had no or only a few experiences in aerial image interpretation (see Optimizing Agreement in the chapter "Aerial Image Flights").

The choice and order of the firm or organisation for the aerial interpretation happened differently. Two project partners found their interpreters by tender procedures. Six partners placed the order directly, one park interpreted with its own staff. NPB gave the order to the same institute, with which they have been working together at this sphere already for a long time. Altogether 30 persons were introduced into the mapping method either in the official training courses or by internal training courses with the subcontractors (table 8; further details see appendix). The control of the working progresses and the quality took place with support via the regional coordinators and via the project responsible persons of the parks themselves.

Methods and infrastructure

The mapping instruction prescribes a high-quality stereoscope and a GIS (Geographic Information System). For administrative and financial reasons and considerations of the equipment and know how existing at the individual partners the idea of strictly unitizing the necessary infrastructure was abandoned in favour of recommendations. Therefore no generally work aiding could be developed and put to the interpreter's disposal (see table 9). While GI-Systems were available everywhere, some interpreters still had to be equipped at the start of the project with qualitatively sufficient stereoscopes. Because the preferential Stereoscope AVIOPRET APT1/2 is not produced any longer, used instruments (second hand devices) had to be obtained. There could be found enough instruments.

Optical stereoscopes are not produced anymore, because they are gradually replaced by digital instruments. Therefore and also to have a more precise and more reliable starting situation for later monitoring questions and to display at the

Table 8: Placing of order, number of interpreters and mapped area per park.
*) Estimation, at the time of printing the interpretation was not yet finalized.

Project Partner	Choice of Interpreters	No. of Interpreters	Total Area [km^2]
APB	Direct placing	2	117
ASTERS	Internal staff	1	270 *
CPNS	Direct placing	1	300
NPB	Former interpreter of 1997	3	467
NPHT	Tender Procedure	11	1836
PNE	Direct placing	7	228
PNGP	Direct placing	1	175 *
PNMA	Direct placing	1	40 *
PNV	Tender Procedure	4	366
SNP	Direct placing	3	364 *
Total of different persons		30	4163

Figure 18: Digital photogrammetry workstation: on the left screen the stereo image display can be viewed by the aid of special eyeglasses, on the right screen appears the mapping in the GIS. (Hauenstein/Jörimann)

same time 3D data, the Swiss National Park decided to work with a digital photogrammetric system, which is interlinked with a GIS (figure 18). The project partners of APB and CPNS decided to follow this procedure. The use of a digital photogrammetry system has the advantage, that at the beginning of the mapping work only the scanned aerial images ad the aerotriangulation have to be available. The orthophotos are not mandatory for the mapping process.

In the mountains the illumination conditions vary by the frequent changes of the exposition already on a small scale. Also the very variable densities of vegetation cause large differences of the light remission. This all together complicates the optimal film exposure. With digital photogrammetry systems the coloured representations can be changed due to the stereo viewing in real time. Therefore a better analysis of the picture content and a partial reduction of the cross fade effects are possible and more information can be retrieved in shadowy areas.

The transfer and import of the digital aerial images caused a not negligible amount of work because of the big file sizes of the data sets. However the effort for the production of digital copies and if necessary the transfer of data is smaller than the duplication of aerial photograph slides. Therefore it is easily possible, that several persons can work at the same time with digital aerial photographs or a distant person can make quality controls or remote support.

Interpretation key

As a result of the deferred flights and the equally deferred distribution of the necessary pictorial material (see chapter WP5), the start of the interpretations of the several partners took place time-shifted.

Substantial contributions to the further development of the interpretation key can be provided not until a certain experience with the application of the key. Hence the key had to be modified and enlarged over a longer time span.

Some partners, who started earlier with their interpretation couldn't assimilate the changes because of financial and temporal reasons. The additions and innovations in the key led mainly to a larger degree of details and completeness, additional habitat types and characteristics and a more systematic coding. The "backward compatibility" (i.e. the transferability of interpretation data in a more recent key version to a preceding key version) remained in principle preserved (see chapter WP6). As a result of the gradual expansion of the key from HIK-0 to HIK-2 the situation arose, that individual partner for financial reasons wanted to do without individual extensions. The elements of the key were arranged therefore into mandatory recommended and optional.

Table 9: Applied mapping method, used instruments and tools and for the interpretation required data.

Partner	Method	Devices	Tools	Data [GB]
APB	Photogrammetry	StereoAnalyst for ArcGIS	QA-Tool	170
ASTERS	Orthophoto	WILD APT2, MapInfo		20
CPNS	Photogrammetry	StereoAnalyst for ArcGIS	(QA-Tool)	670
NPB	Orthophoto	WILD APT2, ArcGIS		40
NPHT	Orthophoto	ZEISS, ArcView 3.2, ArcGIS	ecological check	200
PNE	Orthophoto	WILD APT2, MapInfo		20
PNGP	Orthophoto	WILD APT2, ArcGIS		30
PNMA	Orthophoto	WILD APT2, ArcGIS		10
PNV	Orthophoto	WILD APT1, WILD ST4, ArcView 3.3	Attribute Form	30
SNP	Photogrammetry	StereoAnalyst for ArcGIS	QA-Tool	700
				1890

Beyond that the formal structure of the key permits individual local extensions, which were not defined in the alpine framework of HABITALP. This scalability of the key into different levels was used by the partners (table 10).

From the methodical point of view the interpretations of the aerial photos from NPB and SNP have their own characteristics:

National Park Berchtesgaden

Before the HABITALP project was started, in the year 1997, NPB created a habitat map based on CIR-aerial images. The interpretation key HIK-0 was used. In the context with the tasks for the development of monitoring methods (see chapter: The HABITALP-project) this circumstance was used for the execution of a study on change detection. For surface covering mapping two methodical approaches for the detection of changes are possible:

a) Execution of a methodically identical however independent second mapping with subsequent analysis of the two generations by overlay of both data re-cords.

b) Update-mapping by complete examination of the borders and interpretations of the first inventory on the basis of the new aerial images.

The procedure b) was selected, because pseudo changes are reduced in this way to a minimum. With this proceeding only recognizable and quantifiable changes are captured again (figure 19). Otherwise the data of the first mapping is directly copied to the second mapping. Of course also interpretation errors of the first mapping are corrected. In a picture-to-picture-comparison relative differences are recognized above a smaller threshold value than it is normally needed for the change to a different class in the key. Therefore not only the interpretation for the second mapping was captured but also the smaller relative differences. Whenever qualitatively strong changes were recognized, further data was captured to describe the change process (avalanche, storm, erosion, forestry activities, building activities etc.).

The methodical advantages of b) can only be gained fully if similar aerial photograph material is available (photographic parameters, georefer-encing) and the interpretation is executed strictly with stereo viewing. These conditions could not be fulfilled for the pilot project NPB in all points. More details of the methodology are documented in the CMS which is ac-cessible through http://www.habitalp.de. Results of the analysis of the change detection data are contained in the chapter "NATURA 2000 & Monitoring (part 2)".

Swiss National Park

The analysis of disturbances is a current research topic in the SNP. Due to the forest history and the soon 100 years without any forestry, the forests in the SNP contain high rates of standing and lying dead wood. Synchronously with the actually HABITALP mapping it was tried to collect as much as possible informations about disturbances and dead wood. Therefore the interpretation key was extended by three columns:

Table 10: Used interpretation key, applied variations and options.
*) At the time of printing the details for the interpretation were not yet completely defined.

Partner	Base Key	Variations & Options
APB	HIK-2	All recommended columns, differentiation of 19 tree species in forests
ASTERS	HIK-2	Mandatory columns, + 3 columns for additional characteristics, + spatial structure within the polygons; Only differentiation of deciduous and coniferous trees in forests
CPNS	HIK-2	Mandatory columns, + dominant shrubs species, + 2 columns for additional characteristics, differentiation of 19 tree species in forests
NPB	HIK-1/HIK-2	Update of the inventory of 1997 with images of 2003, + spec. Change detection; conversion HIK-1 → HIK-2 (Details see text)
NPHT	HIK-0	{No options possible}
PNE	HIK-1	Spatial structure within the polygons
PNGP	HIK-2	*
PNMA	HIK-2	*
PNV	HIK-2	Mandatory columns, + 1 column for additional characteristics, dominant species for herbs, dwarf shrubs and shrubs, differentiation of 6 tree species in forests
SNP	HIK-2	All recommended columns, 11 Tree species, + 3 columns for additional characteristics; additional: disturbance indicators and dead trees

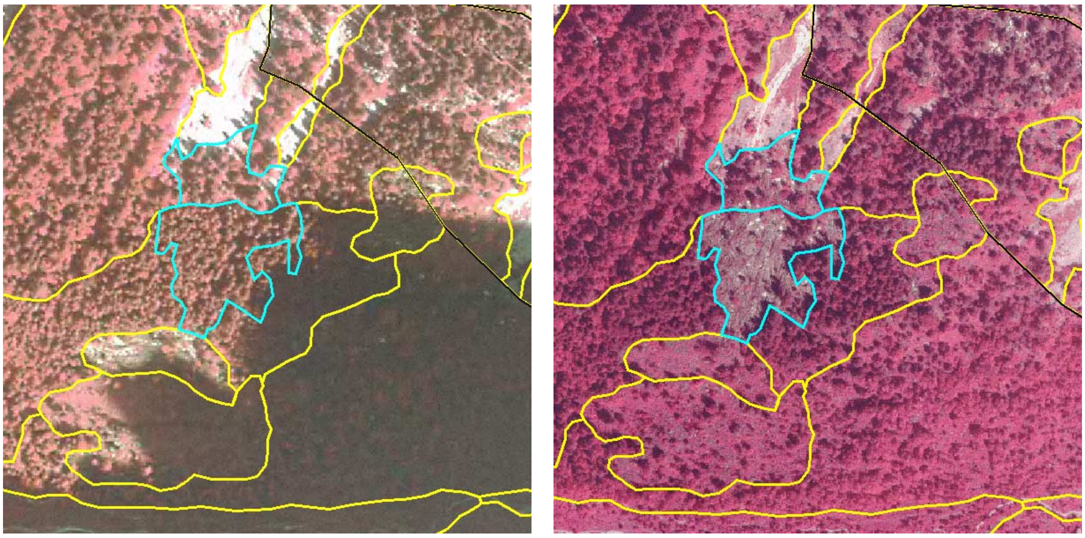


Figure 19: Comparison of two photograph generations (on the left side 1997, on the right side 2003), with identical delineations. The blue area is an update and was only defined on the basis of the new aerial photograph. (NPB/LIZ)

quota of standing dead wood, quota of lying dead wood and types of disturbance. Moreover the whole list of additional characteristics was respected. Because this list already contains a large number of disturbance indicators, the special column for disturbances contains only those additions and types, which cannot be integrated in the HABITALP-standard-column-set. In particular the dead wood of this extension has an influence on the tessellation. The dead wood is spatially very variable and there are many islands with dead wood.

Exemplary results of the mapping

The Habitat mappings show the most impressive results of the HABITALP project. They form the starting point for the monitoring analyses and for the subsequent projects. And they form a obvious means of labour. In the following a few examples and characteristics of the mapping are presented in order to give a descriptive impression of the information abundance, the spatial and thematic particulars and representability.

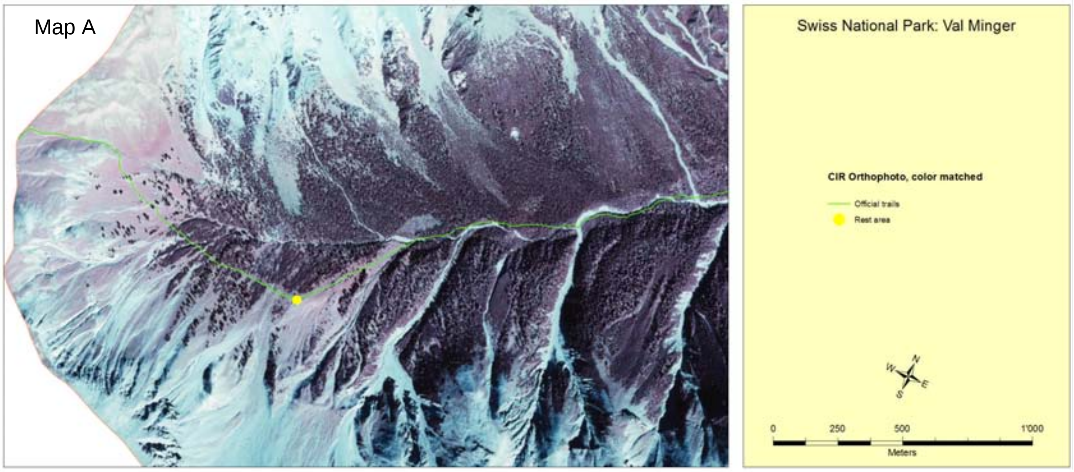
Swiss National Park, Val Minger

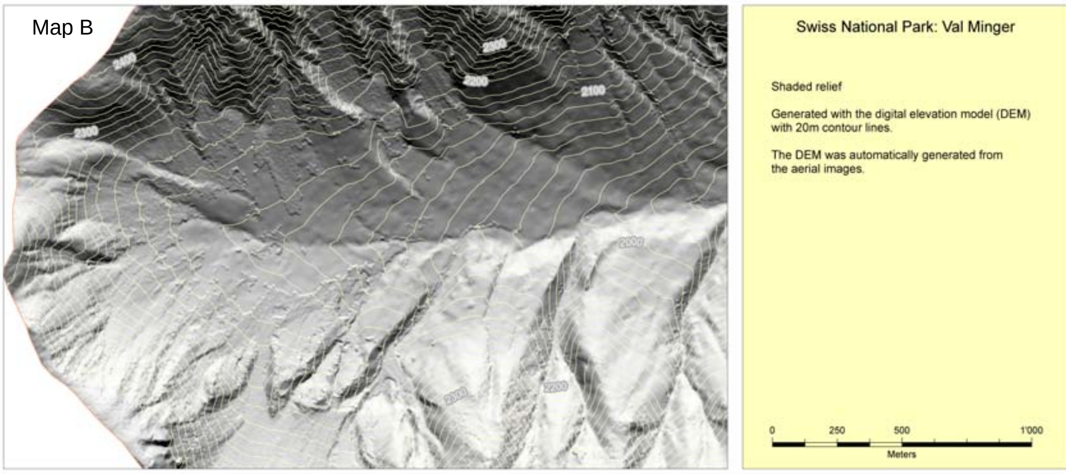
The Val Minger is a valley draining itself to northeast. It extends from 1650 m a.s.l. up to 2300 m a.s.l. and is flanked by high mountains up to 3000 m a.s.l. The u-shaped valley is characterized by a relief with high relief energy and active geomorphologic processes (figure 20). By this situation this valley evinces very distinctively the transition areas at the natural upper forest- and timberline, the vegetation border as well and a small-scale mosaic of different stages of succession, which is caused by the geomorphologic processes.

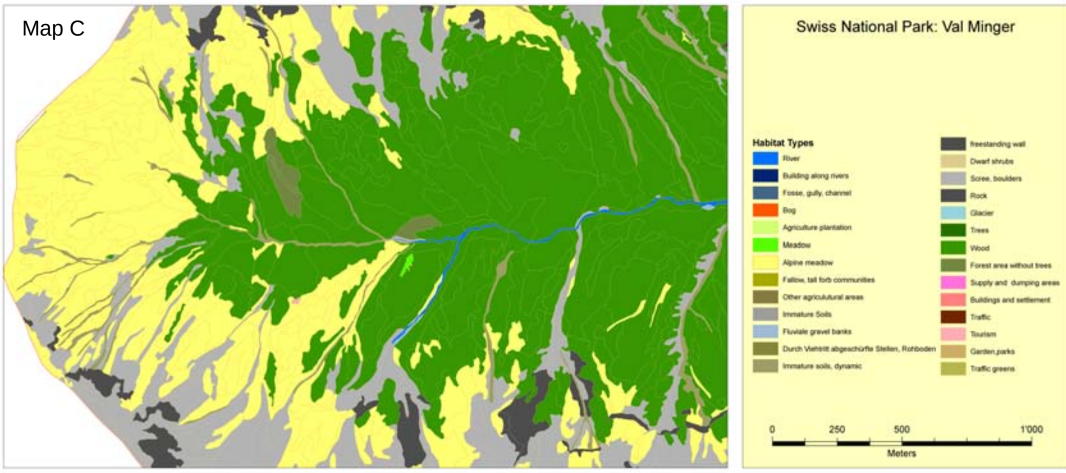
A selection of the abundance of the interpretation data is presented in six different illustrations. These are supplemented with the CIR orthophoto and the shaded relief.

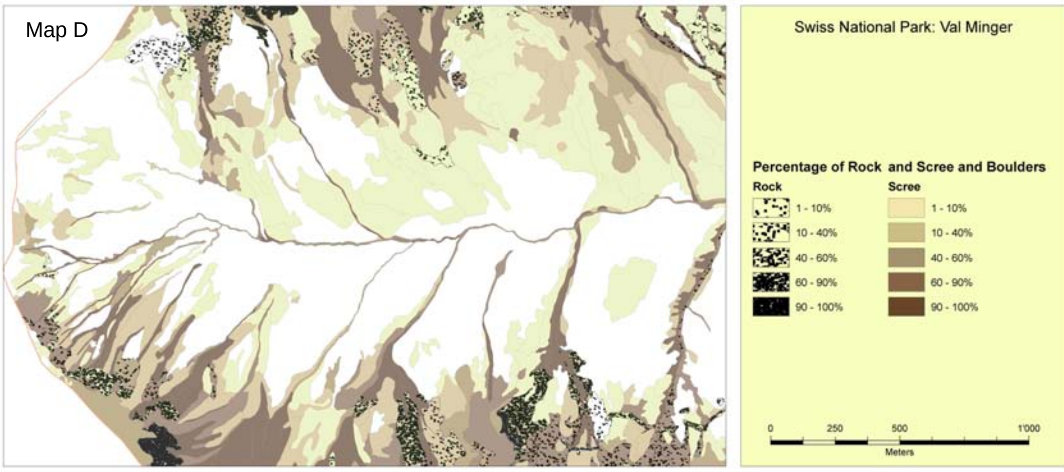
Map series next page:
Map A:
A colour-balanced Orthophoto derived from the CIR aerial images gives a generally understandable visual and intuitive impression. At the two-dimensional view you will see only one part of the informations, which are recognisable in the stereo view. For topic-referred and statistic evaluations the

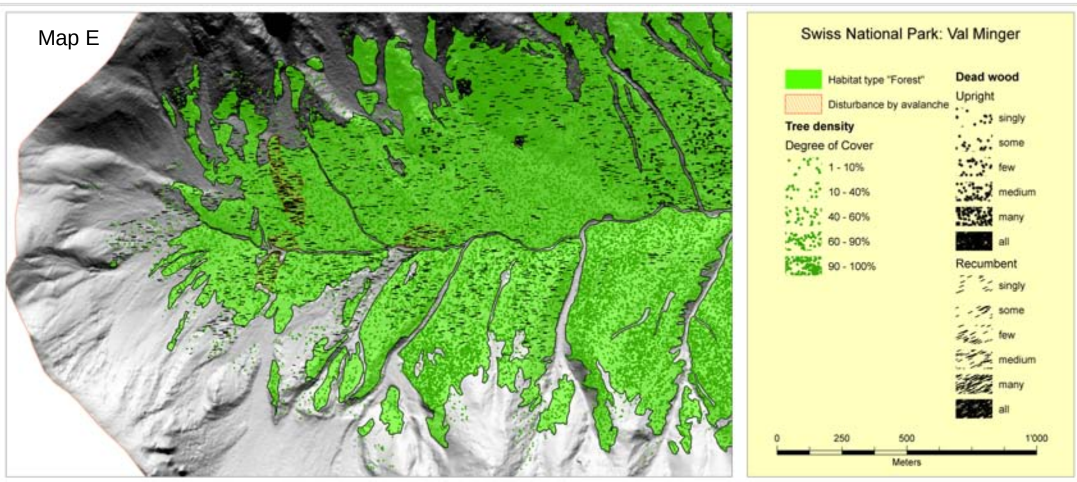
Figure 20: The rearward Val Minger. Position of the photographer: See Map D (Hauenstein)

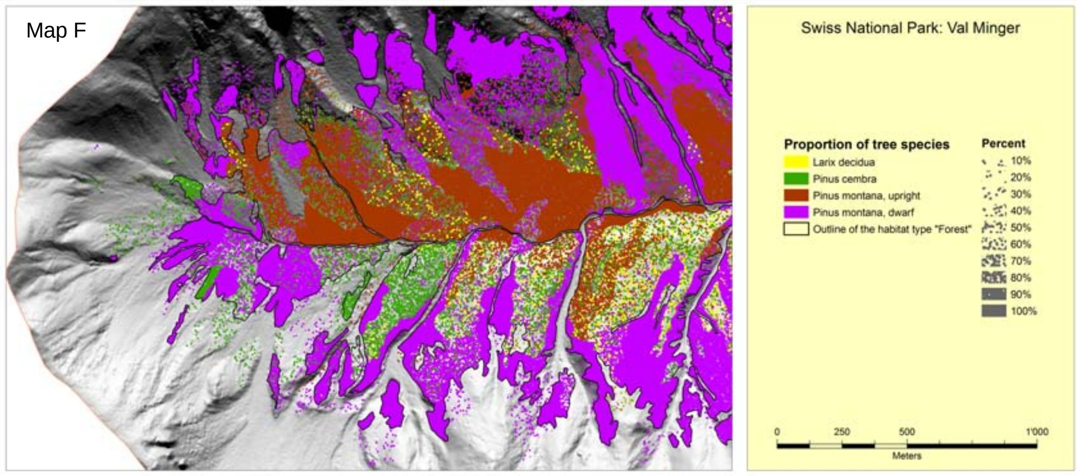

Map A
Swiss National Park: Val Minger
CIR Orthophoto, color matched
Official trails
Rest area
0 250 500 1'000
Meters

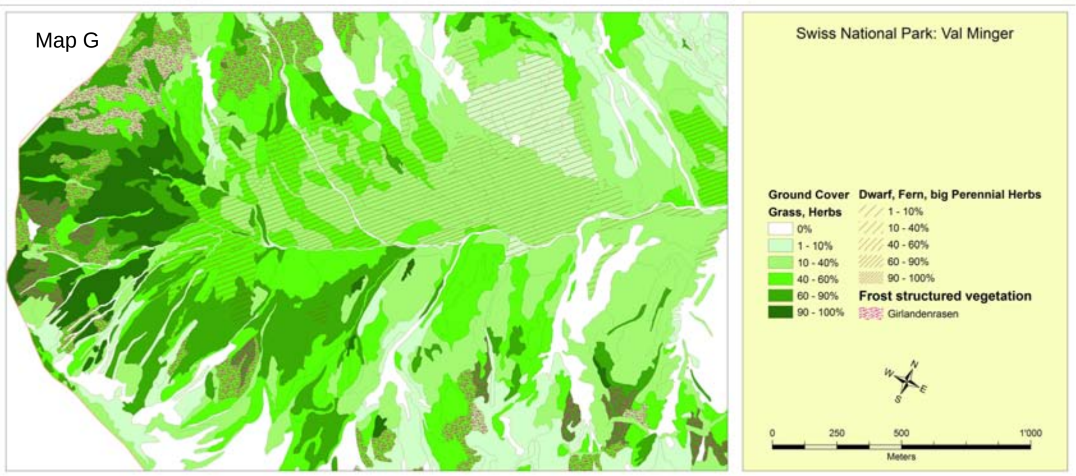

Map B
Swiss National Park: Val Minger
Shaded relief
Generated with the digital elevation model (DEM) with 20m contour lines.
The DEM was automatically generated from the aerial images.
0 250 500 1'000
Meters

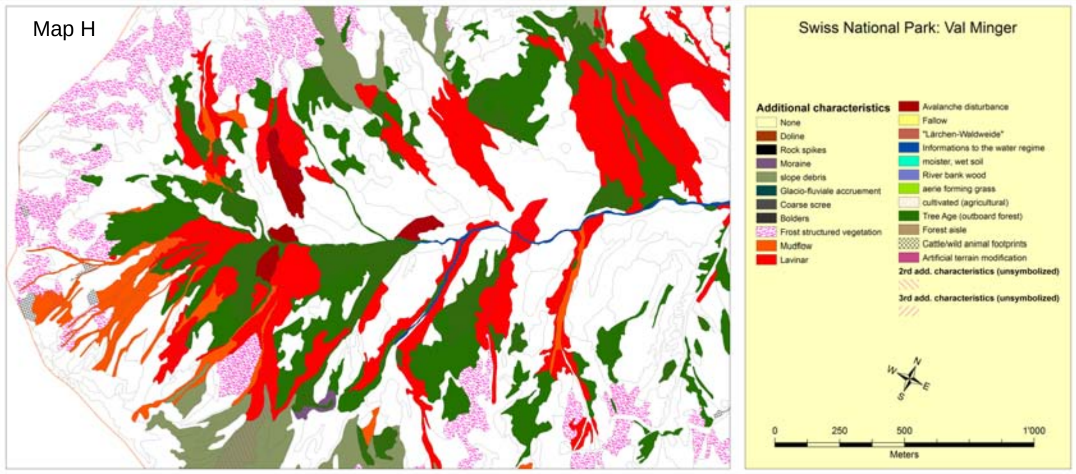

Map C
Swiss National Park: Val Minger
Habitat Types
River
Building along rivers
Fosse, gully, channel
Bog
Agriculture plantation
Meadow
Alpine meadow
Fallow, tall forb communities
Other agriculutural areas
Immature Soils
Fluviale gravel banks
Durch Viehtritt abgeschürfte Stellen, Rohboden
Immature soils, dynamic
freestanding wall
Dwarf shrubs
Scree, boulders
Rock
Glacier
Trees
Wood
Forest area without trees
Supply and dumping areas
Buildings and settlement
Traffic
Tourism
Garden,parks
Traffic greens
0 250 500 1'000
Meters


Map D
Swiss National Park: Val Minger
Percentage of Rock and Scree and Boulders
Rock
1 - 10%
10 - 40%
40 - 60%
60 - 90%
90 - 100%
Scree
1 - 10%
10 - 40%
40 - 60%
60 - 90%
90 - 100%
0 250 500 1'000
Meters


Map E
Swiss National Park: Val Minger
Habitat type "Forest"
Disturbance by avalanche
Tree density
Degree of Cover
1 - 10%
10 - 40%
40 - 60%
60 - 90%
90 - 100%
Dead wood
Upright
singly
some
few
medium
many
all
Recumbent
singly
some
few
medium
many
all
0
250
500
1'000
Meters


Map F
Swiss National Park: Val Minger
Proportion of tree species
Larix decidua
Pinus cembra
Pinus montana, upright
Pinus montana, dwarf
Outline of the habitat type "Forest"
Percent
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0
250
500
1'000
Meters


Map G
Swiss National Park: Val Minger
Ground Cover
Grass, Herbs
0%
1 - 10%
10 - 40%
40 - 60%
60 - 90%
90 - 100%
Dwarf, Fern, big Perennial Herbs
1 - 10%
10 - 40%
40 - 60%
60 - 90%
90 - 100%
Frost structured vegetation
Girlandenrasen
N
W
E
S
0
250
500
1'000
Meters


Map H
Swiss National Park: Val Minger
Additional characteristics
None
Doline
Rock spikes
Moraine
slope debris
Glacio-fluviale accruement
Coarse scree
Bolders
Frost structured vegetation
Mudflow
Lavinar
Avalanche disturbance
Fallow
"Lärchen-Waldweide"
Informations to the water regime
moister, wet soil
River bank wood
aerie forming grass
cultivated (agricultural)
Tree Age (outboard forest)
Forest aisle
Cattle/wild animal footprints
Artificial terrain modification
2rd add. characteristics (unsymbolized)
3rd add. characteristics (unsymbolized)
N
W
E
S
0
250
500
1'000
Meters

contents must first be categorized and quantified.
The orthophoto and the subsequent maps are clipped at the National Park Border. The Photo of figure 20 was taken from the rest area.

Map B:
To produce an orthophoto a digital elevation model (DEM) is necessary. The DEM was generated according to the method of autocorrelation with the CIR-Images. The DEM can be included in spatial and statistical analysis (see Chap. about WP 10). The shaded relief – calculated directly from the DEM – can be used to enhance the clearness of maps (see Map E, F).

Map C:
The most obvious representation of the image interpretation is a map with the habitat types. The whole interpretation key comprehends 251 habitat types (generalized hierarchical types omitted). For the Swiss National Park and its surrounding area 153 (= 60%) where used. An easy readable map should not comprise so many symbols. Therefore generalizations, groupings and/or elisions are indispensable. For every map an objective target must be formulated.

Map D:
With HIK-2 the degrees of cover of all layers (rock, scree, grass etc.) are captured consequently in the same manner for all habitat types. Therewith this semi quantitative information can be pictured for the whole area and without any habitat specific omissions. The quotas of rock, scree, grass and dwarf shrubs are complementary up to a certain degree. But in addition there is also the uncovered soil. These five elements can be found in many different combinations (compare with Map G).

Map E, F:
These two figures represent well the situation at the upper timberline, upper tree-line and beginning successional stages. The occurrence of trees outboard of the habitat type "Forest" is obvious. Particularly the occurrence of Pinus cembra on the left and lower left side of the forest border (see Map F) is an important landscape and ecology determinant factor (compare with figure 20). In Map E the amount of dead trees within and outboard the habitat type forest and is pictured. These two types are unevenly distributed. This knowledge is very important to monitor and understand the dynamic of the change of the tree and forest spreading.

The distribution of the tree species shows for example clearly the correlation of Pinus monatana dwarf ("Latsche") dominated areas with the upper timber line and the relief energy conditioned dynamic zones (mudflow, avalanches; compare w. Map H).

Map G:
Already on the orthophoto (Map E) a focal point of the covering with grass is visible near the upper end of the valley (left side in the figure). In the lower right part of the map the mosaic of the grass cover is eye-catching. These site differences are caused by the local relief and the local variation of the exposition of this general north exposed slope of the valley. Dwarf shrubs are present mainly on the left side of the valley. Frost structure soils and vegetation associations are very typical for the region of the Swiss National Park. Their presence is induced by the geology and the temperature regime around the freezing point during the periods without snow cover.

Map H:
HIK-2 allows the collection of several additional characteristics. These attributes comprise a wide range of miscellaneous themes. About 200 types have been defined. Because of this thematic variety it is not useful to picture all additional characteristics on one map. It is rather intended to use these attributes in combination with the other attributes. But on this map all additional characteristics where used, grouped and pictured to demonstrate the comprising amount of informations. Nevertheless the dynamic areas (mudflow, avalanche etc.) are recognizable quite well.

Statistics

Geometry

The granularity of the spatial data is the most important prevailing circumstance to be considered when spatial analyses are performed. The interpretation guidelines and key define for all habitat types the minimum area. That implies that the polygons should not be tinier. The maximum area is not defined. This is given by the list of habitats, degree of cover types and all the other attributes by the general rule "if anything changes, a new object (polygon) has to be created". But his rule is a little bit fuzzy and dependent on the style of the interpreter.

It's obvious, that naturally large objects like lakes, glaciers, rocky areas above the vegetation limit are comprised in the mapping as well. For logical reasons quantiles instead of averages should be used for a further discussion.

50% of all Polygons have an area between 0.22 and 1.20 ha. The median is 0.52 ha.

But there are some differences between the several parks (figure 21). Without in depth analyses it is not possible to quantify the causality of the different landscapes, methods (key, equipment) and interpreters. SNP and APB were interpreted by the same team and with the same equipment. In this case it can be assumed, that the difference in the granularity are induced by the landscape. Even though the granularity of all parks are in the same magnitude.

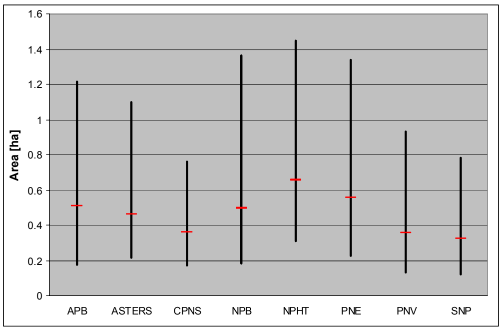


Figure 21: Median and 0.25% - 0.75% quantil of the polygon size per park (Preliminary results for ASTERS, CPNS, PNV, SNP).

Another unit to describe the granularity is the border length per area. It amounts 258 m/ha over all parks. Also this unit varies between the parks (figure 22). The border length per area is not only caused by the granularity of the mosaic. It is influenced from the curvature (intertwine of the habitats) and the slight or strong stretching of the borderline by the interpreter as well.

Both characteristics confirm a quite detaillied mapping and a just as well diverse landscape.

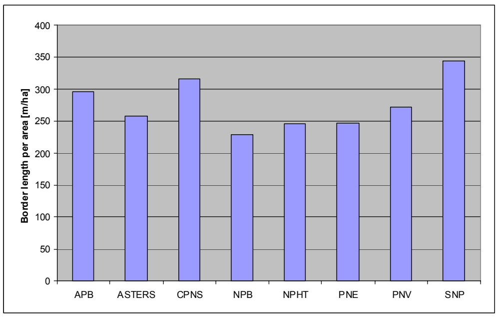


Figure 22: Border length per area for each park (Preliminary results for ASTERS, CPNS, PNV, SNP).

Interpretation

The interpretation key comprises 251 habitat types without hierarchical superior topics or 333 types all included. 9 columns for degree of cover each of them with 6 quantitative steps, up to 4 columns for dominant species, up to 3 columns for additional characteristics and several columns for percentage of tree species in forested areas each of them with 11 quantitative steps. Although some combinations are impossible because the attribute values exclude each other, there is a huge amount of possible combinations. But how many different habitats according to the key were really detected?

The answer depends on how many attributes will be taken into account (table 11). 91% of all in the interpretation key defined habitat types were used. Additionally considering the degrees of cover, 50 times more habitat peculiarities were found. Considerung additional attributes, like dominant species or addition characteristics, about 20'000 habitat peculiarities can be counted.

CPNS and SNP, located in a comparable subalpine – alpine region, have a similar number of habitat peculiarities of roughly 5500 (table 12). APB situated in submontane – montane regions has about the half. The less number of habitat peculiarities of NPB could probably be

Table 11: Number of captured habitat peculiarities over all parks, considering variable number of attributes. (Calculated with all data, but preliminary results for ASTERS, PNV, SNP; without incomplete HIK-1 to HIK-2 translations of NPB).

Attributes considered	No. of habitats
Habitat type	284
Habitat type, degrees of cover	14527
Habitat type, degrees of cover, additional Characteristics	25567
Habitat type, degrees of cover, additional Characteristics, dominant species	20531
Habitat type, degrees of cover, additional Characteristics, dominant species, percent deciduous/conifers	22314
All mandatory columns of HIK-2	11742

referred to partial ambiguity of the automatic HIK-1 to HIK-2 translation.

Despite this solely simplistic and tentative appraisal, it shows the potential of these data with regard to the biodiversity analyses. These approximately 20'000 habitats peculiarities open a wide field for data analyses but require a high sophisticated and ecology oriented approach and a pernickety check of the logical consistency as well.

Table 12: Number of habitat peculiarities per park, considering only the mandatory attribute of HIK-2 and complete records. PNE, NPHT do not have HIK-2 complete records.
*) Preliminary results

Park	Number
APB	2810
ASTERS	247 *
CPNS	6423
NPB	2040
PNGP	247 *
PNMA	128 *
PNV	3167
SNP	5558

Discussion and assessment

Every project partner who already had at their disposal or got new aerial images was able to apply the method in his territory. The advance and completing of the aerial image interpretation were mainly influenced by organisational aspects.

The HIK-2 interpretation key, developed during the lifespan of the project, was accepted generally positive even though its introduction caused many adjustments by the users. The flexibility of the key system was utilized. The key comprises still some deficiencies but evinces a potential for further development as well.

Generally the results of the image interpretations are commensurable. The granularities have a similar dimension. Up to a certain level the interpretations are comparable.

But the slightly varied application of the method, different equipment, differences of the aerial images and only a meagre alpine wide communication and exchange of the interpreters during their work endanger the comparability on a higher level.

Interpretation key

Despite the successful application of the interpretation key some critical notes to the actual concept must be made.

Hierarchic levels

The numerical hierarchical system for the main habitat type implies to the user, that these hierarchical levels represent similar ecological differentiations and hence the levels of this 4 digit code can be used to produce more or less generalized maps or analyses. It can easily be shown, that this assumption is wrong.

Structuring criteria of the habitat types

For the structuring of the of habitat types many different approaches and systematics were applied: topographical mapping, ecomorphology, agricultural and forestry exploitation, phytosociology, spatial planning, supply and waste management technologies, geomorphology. The main classes are very similar to a typical topographical map. Together with some map focused delineation rules (e.g. bridges have priority over all other types) not all requirements of a biodiversity focus landscape inventory are fulfilled.

Atomized or complex description of the habitats

The current system completes the description of the habitat after the primary habitat type with some additional "single parameter values". Also integrated with these parameters not all important habitats can be described sufficient to recover them in the data. Alluvial forests or larch pasturages (Lärchenwiesen, Lärchenwaldweide) are two examples, which are well recognisable on aerial image.

Groundcover

The groundcover comprising moss, grass, fern, herbs, perennials, dwarf shrubs and also shrubs and young growth has its importance particularly above the timber line. The species or species groups can be recognized in the aerial image only limited. But often with the colour, textural and structural informations can be implied on a phyto-sociological unit. The differentiation of grass and dwarf shrubs is often very difficult and many dwarf shrub heaths are formed by a typical mixture of species. With the current system it is not possible to collect adequately all visible informa-

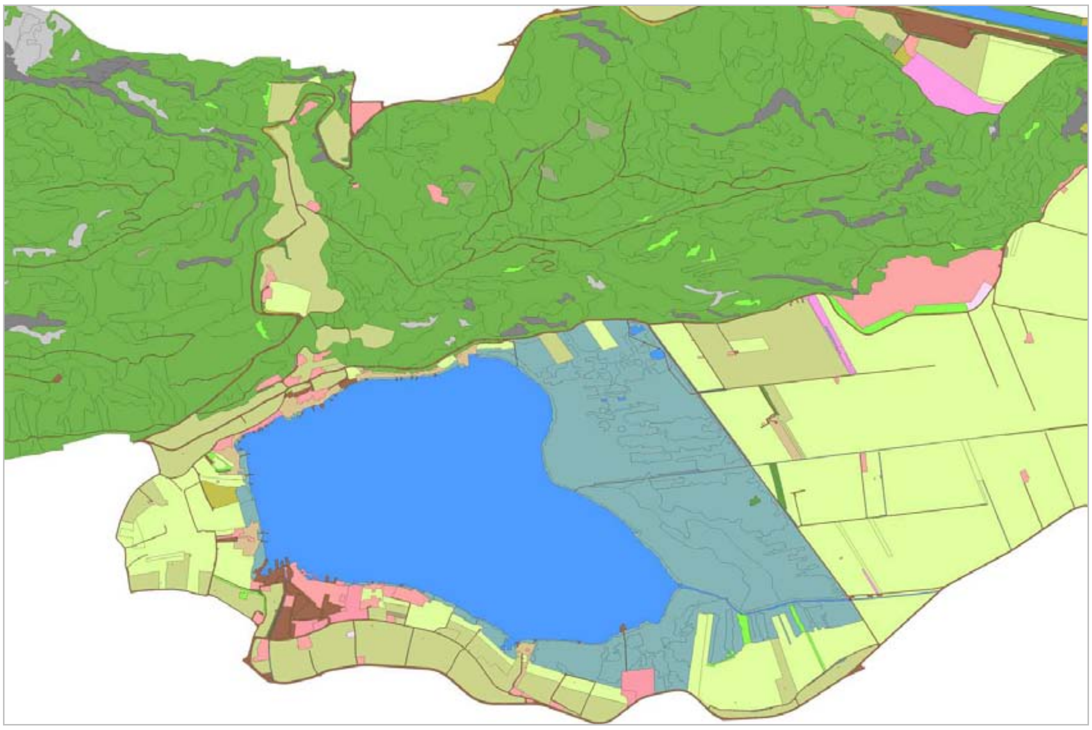


Figure 23: Kalterersee area, Autonome Provinz Bozen, It.

tions and to regard reduced reconcilability without conflicting the consistency.

Minimum size

With the HABITALP method only one area covering layer is mapped. To comply with the requirements of the cartography and to limit the costs, minimal area and minimal width were defined. Therefore important small-sized biotopes must be omitted. In the BfN-Key, which was used as base for the HIK-Keys (see chapter "Interpretation Method"), an approach is described for the mapping of small-sized elements with points and lines. With modern GI-System the simultaneous digitizing in several layers is not a technical problem. This optimized approach could lead to lower costs as well.

But at the end of this project the analysis of the data is still at its early stage. Before any changes to method will be made, the existing data should be analysed in depth, more experiences with the change detection method should be gained and the question "do we need more or less informations" must be answered.

Image interpretation

Calibration and verification

The "Guidelines for Delimitation and Interpretation" (see chapter "Interp-retation method") comprise only few statements about the field work for the calibration and verification. The effort utilized for this task varies between the parks from nearly nothing up to about 5% of all polygons. The influence on the data quality is unknown.

Quality management

Experiences of the interpretation process and with the transnational database point out again the importance of a systematic quality management system. Elements of this system are:

- Interpretation samples
- Independent field verification
- Logical checks of the coding
- Enhanced ecological checks on the basis of the DEM and other datasets.

These measures need some financial, personal and technical resources. The methods should also be standardized.

Outlook

With the application of the HABITALP method a first step for an alpine spanning landscape and habitat monitoring for protected areas was made. But after the HABITALP project many further steps are necessary.

Application of the results

The results of the interpretation should be transformed in a usable and for practitioners easy to handle form.

- Development of standardized legends an map.
- Development of standardized simple statistics.
- Development of standardized simple methods for the combination of the HABITALP-data with other data.

Methods

To achieve good results with aerial image interpretation a lot of experiences are necessary. Especially in regard of the future monitoring and change detection it is very important to foster sustainable the knowledge and experiences with this method.

- Institution of a “competence centre” for the HABITALP method and interpretation key.
- Further development of the monitoring and change detection methods.
- Optimizing the method currently under consideration of new technologies.
- Improving the scientific foundation of the HABITALP method.
- Development of tools.
- Conducting of training courses, workshops and support on demand

HABITALP

Local Interpretation Experiences

Aerial image interpretation in Hohe Tauern National Park

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Nationalpark Hohe Tauern

Summary

The Hohe Tauern National Park is the largest national park in Central Europe. It covers a surface area of 1,836 km² and extends over parts of the three federal states of Carinthia, Salzburg and Tyrol. The goal of the project "aerial interpretation for the Hohe Tauern National Park" was to develop and establish the first surface covering homogeneous GIS database for the entire area.

During this interpretation more than 1,500 different land surface types, visible on aerial images, were detected and evaluated according to the HABITALP interpretation key (HIK-0). This key was originally developed in 1995 for biotope and land use mapping at the German Bundesamt für Naturschutz Bonn – Bad Godesberg. In 2000/2001 the Hohe Tauern National Park adapted and modified this key for a pilot study in a high Alpine area and subsequently is now able to derive valuable information on the physiographic inventory as well as on the potential land use in the frame of the national park management.

The interpretation key within the HABITALP project developped during the project. The NPHT did not change the key immediately because of the huge surface. After termination of the interpretation an automated transfer algorithm was applied to obtain the data for comparative studies in the current HIK-2 version.

1,649 aerial infrared images and 432 true colour orthophotos dating from the pre-HABITALP aerial image flight of August 1998 served as a base for the interpretation. The extension areas in Carinthia (Zirknitz 2001, Obervellach 2005) were interpreted with the orthophotos from the Carinthian aerial image flight of 2003. The populated areas in the periphery of the park were not part of the interpretation. During the four year project more than 108,444 polygons were defined and interpreted.

Résumé

Le Parc National des Hohe Tauern est le plus grand parc national d'Europe centrale. Il s'étend sur une surface de 1.836 km² et touche les territoires de trois Länder autrichiens: la Carinthie, Salzburg et le Tyrol Oriental. Le projet "interprétation de photos aériennes du parc national des Hohe Tauern " avait pour but de créer une première base de données GIS homogène pour toute la région.

Dans le cadre de cette opération, plus de 1500 typologies de couverture du sol visibles sur les photos aériennes ont étés recensées et interprétées sur la base de la clé d'interprétation HABITALP (HIK-0), mise au point en 1995 par le Ministère Fédéral de l'Environnement allemand de Bonn – Bad Godesberg, dans le but de cartographier les biotopes et l'utilisation du sol. En 2001/2002, le Parc National des Hohe Tauern a adapté la clé dans le cadre d'un projet pilote portant sur un territoire alpin d'altitude. Aujourd'hui, elle fournit des informations précieuses sur l'inventaire physiographique et sur l'utilisation des sols dans le cadre de la gestion des espaces naturels de toute la région protégée.

Dans un premier temps, l'adaptation de la clé d'interprétation dans le cadre du projet HABITALP par l'intégration d'autres espaces protégés partenaires n'a pas été possible en raison des dimensions excessives des territoires concernés.

Lorsque l'interprétation fut terminée, un procédé de conversion informatique a permis d'obtenir les données nécessaires pour les études comparatives dans la version actuelle HIK-2.

L'interprétation a porté sur 1.649 photos aériennes infrarouge et 432 orthophotos en couleur réelle prises lors des survols sur toute la région réalisés en août 1998, avant le début du projet HABITALP. Les extensions en Carinthie (Zirknitz 2001, Obervellach 2005) ont été interprétées à l'aide d'orthophotos prises lors du survol réalisé en 2003. Les zones peuplées en bordure du parc n'ont pas été considérées lors de l'interprétation. Plus de 108.000 polygones ont été délimités et interprétés au cours des quatre années qu'a duré le projet.

Zusammenfassung

Das Projekt "Luftbildinterpretation des Nationalparks Hohe Tauern" hatte zum Ziel, erstmals für den größten Nationalpark Mitteleuropas mit einer Größe von 1.836 km² und einer Erstreckung über die drei Bundesländer Kärnten, Salzburg und Tirol, eine flächendeckend homogene GIS-Datenbasis für das gesamte Schutzgebiet zu erarbeiten.

Mit Hilfe der Differenzierung und Auswertung der mehr als 1.500 luftbildsichtbaren Oberflächenbedeckungstypen nach dem HABITALP Interpretationsschlüssel (HIK-0), welcher auf der Kartieranleitung des deutschen Bundesamtes für Naturschutz Bonn – Bad Godesberg für eine Biotoptypen- und Nutzungstypenkartierung von 1995 basiert und 2000/2001 im Rahmen einer Pilotstudie für den Nationalpark Hohe Tauern erstmals für die Anforderungen einer Hochgebirgsregion erweitert und modifiziert wurde, sind nunmehr wertvolle Kenntnisse über das naturräumliche Inventar sowie das Nutzungspotenzial für das Naturraummanagement des gesamten Großschutzgebietes ableitbar.

Die Fortentwicklung des Interpretationsschlüssels im Verlauf des HABITALP Projekts durch die Integration weiterer alpiner Partnergebiete konnte aufgrund der großen abzudeckenden Fläche zunächst nicht übernommen werden. Nach Abschluss der Interpretation wurde eine automatisierte Umrechnung auf die aktuelle Schlüsselversion HIK-2 vorgenommen.

Grundlage für die Interpretation waren 1.649 Color-Infrarot-Luftbilder und 432 Echtfarben-Orthofotos, die bereits vor HABITALP durch die Gesamtbefliegung des Nationalparks im August 1998 entstanden waren. Die Erweiterungsgebiete im Kärntner Anteil (Zirknitz: 2001 und Obervellach: 2005) wurden mittels Orthofotos aus der Kärntner Landesbefliegung von 2003 nachinterpretiert. Der Dauersiedlungsraum im Vorfeld des Schutzgebietes wurde nicht berücksichtigt. Insgesamt wurden mehr als 108.444 Polygone abgegrenzt und interpretiert.

Riassunto

Il progetto “Interpretazione delle fotografie aeree nel Parco Nazionale degli Alti Tauri” si proponeva di sviluppare ed implementare la prima banca dati GIS omogenea dell’intera area. Questo Parco Nazionale, con una superficie di 1.836 km2 il più vasto dell’Europa centrale, interessa i tre Länder austriaci Carinzia, Salisburgo e Tirolo Orientale.

Nel corso del progetto, più di 1.500 tipologie di copertura visibili sulle fotografie aeree sono state rilevate ed elaborate conformemente alla chiave di interpretazione HABITALP (HIK-0), sviluppata nel 1995 dal Bundesamt für Naturschutz Bonn – Bad Godesberg per una cartografia dei biotopi e dell’uso del territorio. Nel biennio 2001/2002, nell’ambito di uno studio pilota il Parco Nazionale degli Alti Tauri aveva ampliato e modificato questa chiave, adattandola ad una regione di alta montagna, ed ora è perciò in grado di fornire informazioni preziose sull’inventario fisiografico nonché sul potenziale uso del territorio nell’ambito della gestione degli spazi naturali dell’intera area protetta.

In una prima fase l’ulteriore evoluzione della chiave di interpretazione nell’ambito del progetto HABITALP tramite integrazione di altre aree partner alpine non è stata possibile per le dimensioni eccessive della superficie interessata. Al termine dell’interpretazione è stato applicato un algoritmo automatico di conversione per ottenere i dati per gli studi comparati nella versione corrente HIK-2 della chiave.

La base per l’interpretazione è rappresentata da 1.649 fotografie aeree infrarosso colore e da 432 ortofoto a colori reali acquisiti tramite i sorvoli aerofotogrammetrici dell’intera area nell’agosto 1998, prima del progetto HABITALP. Le aree di estensione in Carinzia (Zirknitz 2001 e Obervellach 2005) sono state interpretate successivamente sulla base delle ortofoto acquisite con i sorvoli di tutta la Carinzia nel 2003. Le aree con insediamenti permanenti nelle zone periferiche del Parco non sono state prese in considerazione. Nel corso dei quattro anni del progetto, complessivamente sono stati delimitati ed interpretati più di 108.000 poligoni.

Background and objectives

Stimulated by the many years of experience by the Berchtesgaden National Park (NPB) with surface covering data on biotope types and types of structures from CIR aerial image interpretation, and due to the lack of an Austria-wide standardised interpretation key, the NPHT decided in 1996 to also use the national system of the German Bundesamt für Naturschutz (Federal Office for Nature Protection) to develop a surface covering, homogenous GIS database for the entire reserve.

The foundation was to be a CIR flyover of all federal states, which was accomplished in 1998. The flyover was conducted using the same standards as in Berchtesgaden National Park (NPB), which was secured through close collaboration with the Centre for Landscape Informatics of the Weihenstephan Technical University under the leadership of Dr. Ulrich Kias.

In order to simplify the exchange of data and to improve the collaboration between the parks in the field of sanctuary research, the first prototype of a standardised interpretation key was developed as part of a joint Interreg IIa project by the three reserves NPB, NPHT, and SNP (Kias et al., 2001). It also served the interests of the high Alpine regions.

This prototype was renamed to HIK-0 (HABITALP Interpretation Key Version "0") during the course of further Alpine-wide development within the scope of the ensuing Interreg IIIb project 'HABITALP'. Meanwhile, it is available as HIK-2 in a thoroughly structurally revised form with expanded content, but still compatible to version HIK-0.

In NPHT, it was possible to start the interpretation considerably earlier than in the other project regions as a result of the CIR flyover that had already existed when the project began and which was suitable for the HABITALP standard. Consequently, NPHT continued its surface covering interpretation with HIK-0 with the consent of project management even when the completely new key HIK-2 started to emerge in the year 2004. Ultimately, a conversion routine was used to ensure that the HIK-0 data could also be provided for the NPHT in HIK-2 format for the subsequent comparison and Alpine-wide data analysis.

For NPHT, completion of its digital CIR aerial image interpretation meant the most important step so far for standardisation and homogenisation of the data situation for the natural area of the entire reserve.

After ten years of careful planning and execution covering an area of 1,836 km^2 of high mountains, there is now differentiation of all land surface types visible on aerial images according to pure CIR optical features, but also with the help of regional knowledge (vegetation, anthropogenic effects).

The vision of obtaining consistent datasets for the entire natural area and to be able to prove changes to it by monitoring the entire reserve has thus become within reach for the first time.

Organisational and technical implementation

Interpretation of the aerial images of NPHT was awarded to the bidder community ARGE "Interreg IIIb – HABITALP" (Ges.n.b.R) in an EU-wide invitation to bid. Members of ARGE were the Institute for Ecology and Environmental Planning, Klagenfurt (management: Dr. Gregory Egger), the company REVITAL ecoconsult, Lienz (management: DI Klaus Michor) and the Technical Office for Forestry, Feldkirchen (management: DI Dr. Eckart Senitza).

Due to the spatial separation of the three offices and the three-fold administration of the reserve as well as technical support from an external consultant (DI Walter Demel, Centre for Landscape Informatics, Weihenstephan Technical University), handling the project involved a great deal of collaboration and coordination effort.

The area of 1,836 km^2 to be mapped was divided up into six approximately equally sized mapping regions. After each section was mapped, content controlling workshops were held.

A complex system consisting of standardised assessment mechanisms, automated plausibility checks, regional knowledge, site visits, as well as very complex control processes from both quantitative and time perspectives were used to try to achieve the best possible results.

The basis were the 432 true colour orthophotos with ground resolution of 50 cm and the 1,649 colour infrared aerial images from the flyover in 1998 on one hand. On the other hand, there were true colour orthophotos for the NP extension areas in the province of Carinthia (Zirknitz and Obervellach) from the Carinthian flyover in 2003 with ground resolution of 40 cm. Both flyovers were conducted and financed outside the HABITALP project.

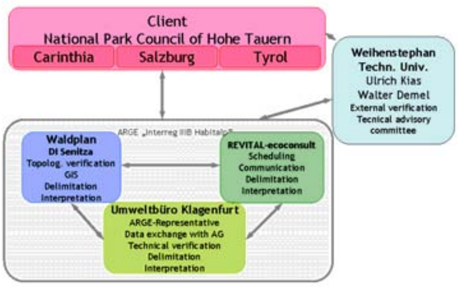

Figure 24: Project organisation, Hoffert (Ed., 2006)

Demarcation was done digitally on the screen. The content was taken from the colour infrared aerial images.

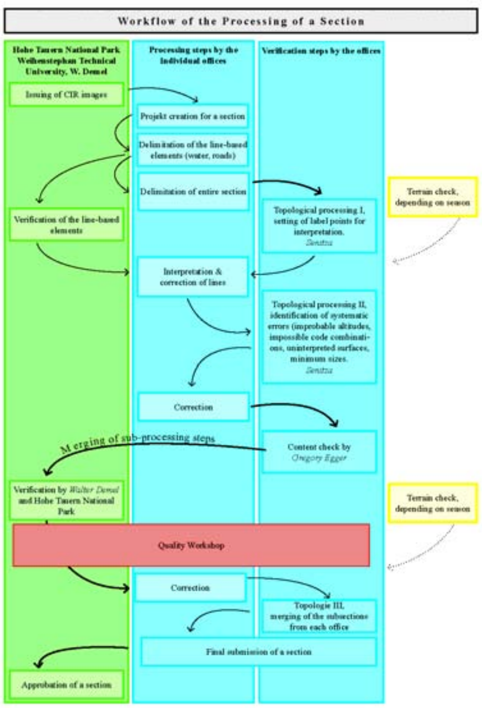

Figure 25: Workflow; Hoffert (Ed., 2006)

Interpretation

The following standards and work methods, among others, were developed for the interpretation (Hoffert et al., 2006, Appendix: Mapping key):

- Mapping scale: 1:2,500.
- Only polygons were mapped and no line or point features. For example, hiking trails were not charted; trails were only recorded in the ÖK 50 map up to the conventional symbol "cart path".
- Streams, gullies, buildings, and trails could be drawn over.
- Shadows, e.g. from trees and edges of forests, are to be interpreted based on other indication and assigned to the surrounding polygon.
- There is interference from failed images and other calculation errors at a few locations in the true colour orthophotos. Therefore, in the event of double images or unclear areas, more attention is to be paid to the contents of the CIR aerial images that are outstanding without exception.
- Depending on the CIR type, different minimum areas (100 m²/500 m²/1,000 m² as well as 3,000 m² for forest) and widths (3 m for waters) were defined. That way, areas that were mapped too small could be easily eliminated in subsequent error checking.
- Soft (up to 10 pixels – 5 m, e.g. tree and bush vegetation) and hard (2 pixels = 1 m, e.g. roads, paved trails and areas) borders must be differentiated.
- All anthropogenic structures (e.g. avalanche protectors, small power plants, bridges, lift supports for material cable cars, etc.) must be recorded as polygons without exception.

Quality management

Homogenous processing across the entire surface and correctness of the interpretation were important goals of the project. Various verification phases were used repeatedly and alternately between the interpreters and the control team (GIS employees of the three administrations and the external consultant):

- 1st step: check the delimitation of the lined elements (flowing water, trails)
- 2nd step: terrain verification (mainly used for verification of the interpreters, but also through previously mapped information from people knowing the region)
- 3rd step: check the interpretation
- 4th step: final check of the entire dataset
- 5th step: check of the topology

Automated checking mechanisms in GIS

- impossible altitude above sea-level of certain vegetation types

- typing errors by the interpreters
- shrubs above 2,400 m alt.
- pastures above 2,500 m alt.
- rocks and debris with trees or shrubs above 2,300 m alt.
- forest and shrubs above 2,200 m alt.
- pinus cembra dominating below 1,700 m alt.
- deciduous trees below 1,600 m alt.
- 3,300 (snow valleys) below 2,400 m alt.
- raised moss – generally impossible
- brick houses above 2,400 m alt.
- and a couple of other ones

Achieved results

After more than four years of processing time, the aerial image interpretation of the entire NPHT resulted in 108,444 polygons with 78 CIR1 types as well as more than 1,492 accounted for individual categories.

As a comparison: The only mapping that is even approximately comparable, which covers almost the entire surface (vegetation mapping by Schiechtl and Stern, 1985) resulted in just short of 15,000 polygons. This value alone clearly shows the significance of the interpretation compared to the former mapping of NPHT.

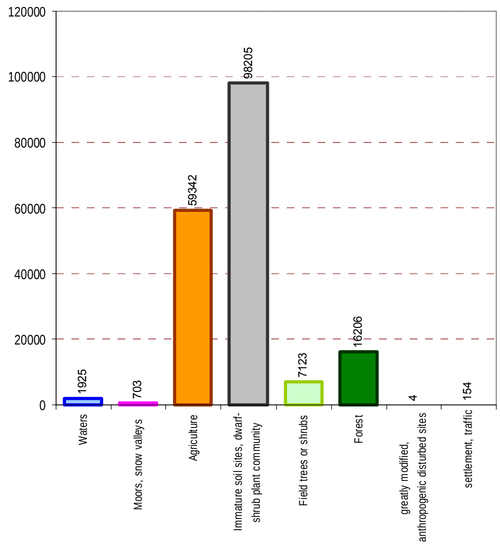

Figure 26: Achieved results (ha) in CIR1 categories, Hoffert (Ed., 2006)

Discussion and assessment

All in all, one can say that the temporarily work group, who was hired to perform the evidently very complex interpretation of the entire NPHT fulfilled their duties with regard to the schedule, organisation, quality assurance, accuracy, correctness, and documentation in the best possible way and completely satisfactorily.

Quality assurance

Altogether, as a result of the size of the region and the stipulated schedule, there were eight different persons working on the interpretation and digitalisation.

Accordingly the original quality requirement of dividing the interpreters specifically by habitat types and altitudinal belts in accordance with their respective experience and knowledge and not according to geographic regions had to be rejected right from the beginning as being organisationally impractical.

Field validation

It was also stipulated that the depth of interpretation was to be orientated around the most accurate coding given in the mapping guide. If this was not possible with aerial image interpretation, then the area was to be verified onsite. Only the shaded surfaces were excluded from this.

It was quickly noticed that it was not possible to meet this request for the 1,836 km^2 of high mountainous landscape with the specified schedule and financial framework. Site visits were de facto carried out only for verification of the interpreters but not to verify specific interpreted surfaces. To support the interpreters, national park wardens performed mapping in the field in advance.

If we had had more money and time at our disposal, we definitely would have had the chance to get better data – in the sense of it being 100% reliable, and more detailed – merely because of the possibility to perform much more field validation, not merely to verify the interpreters.

Accuracy

The ambitious goal was to not exceed an error rate of a maximum of 5% both for the geometry and location as well as for the factual data of all surfaces in the entire region (according to the number and size of surfaces).

Of the 108,444 polygons, 9,387 random samples were checked, which corresponds to just short of 9%. This 9% includes 196 still uncertain surfaces (= 2.08%), excluding the shaded areas. With this, it was possible to reach the targeted goal.

Table 13: Error statistics

Cat.	Description	No of Poly	Area
0	No further check necessary	107,048	1,808.18
1	Cir1 – type not sure (surface-type)	141	2.74
2	Cir2 – type not sure (species, category, characteristic)	39	1.03
3	Cir3 – type not sure (cover, canopy (?))	9	0.11
4	No description	3	0.02
5	Cir2/3 not sure	3	0.01
6	No description	1	0.01
7	Surface area shaded	1,160	23.85
8	Not assigned	0	0.00
9	Area was checked in the field	40	0.65
	Total	108,444	1,836.62

Further development HIK-0 >> HIK-2

HIK-0 was developed into HIK-2 during the scope of the project. It was thoroughly and structurally revised and the content was expanded.

However, compatibility of the two keys is provided by means of a conversion routine.

However the HIK-2 data can be completely converted into the HIK-0 format. But, due to less accurate details, the HIK-0 data can only be incompletely extrapolated into HIK-2 format.

The gaps are mainly in the degree of coverage, the additional characteristics, and the tree type percenttages in the forest. Especially for the tree type percentages, it is very dependent on what varieties of trees are found in the region. If the types occurring in HIK-0 can be completely covered, then there are smaller gaps.

In view of the multitude of additional characteristics that have to be taken into consideration with HIK-2, a more strongly differentiated mosaic would have to be expected also with significantly different geometry (incl. additional minimal surfaces and minimal widths).

Due to the fact that different mosaics result from different people even with the same key, this aspect can be considered to be negligible for the practical application of aerial image interpretation in NPHT.

As a vision, HABITALP considered the possibility that following this project, changes in Alpine reserves could be made more comparable in the future using standardised aerial image interpretation and that way, it would be possible to analyse them in a larger context.

Is NPHT adequately equipped with its HIK-0 data to that effect? How should NPHT ideally deal with data that in the future will be acquired from terrestrial mapping (e.g. biotope mapping, mapping of bogs) and which should successively improve the quality of aerial image interpretation in HIK-0 (or already in HIK-2)? Which of the involved reserves will even continue to use and further develop the HABITALP methods after completion of the project in order to keep the Alpine-wide vision within reach?

These questions are particularly relevant after completion of the project. How well the quality management will work for aerial image interpretation and consequently the associated analysis of natural areas as of this point in time will also be decisively dependent on the extent to which practical technical exchange of know-how can continue to be maintained between competent partners who are willing to act and have the same HABITALP vision and who are willing to set new goals.

Outlook

The mapping and interpretation presented here is considered to be the first surface covering vector dataset for the NPHT. It is effective as a quasi "habitat land register". As a result, besides the database (BioOffice) for the biodiversity of NPHT (processed at the national park institute at the 'Haus der Natur' in Salzburg), it will be established as a second standard for recording, managing, and analysing natural history and physiographic data.

Selectively localisable findings about the occurrence and distribution of species are documented in the biodiversity database. In contrast, the aerial image interpretation exclusively includes surface-related physiographic elements.

One of the most important challenges at this time is the reconciliation of terrestrial succession mappings such as mapping of the bogs and alluvial land across the surface of the entire NPHT as well as region-wide biotope mapping in Salzburg. The goal is to obtain long-term, consistent datasets for surface covering analyses of natural areas as well as monitoring of the reserve based on the GIS database of the aerial image interpretation.

With the help of trial runs with preliminary datasets from aerial image interpretation, the problem areas have been identified and regulated using a GIS mapping guide that is generally applicable to all future GIS-based projects that will follow.

As result of the different technical accesses between terrestrial mapping and pure GIS-based mapping, there was a central problem with many field mappers with taking over the lines from aerial image interpretation for the equivalent imagined lines. The conviction of being able to more accurately establish the delimitations through field observations than appeared to be possible by using aerial image interpretation was very difficult to resolve at the beginning. Only after making a comparison between the two results that were achieved independent of each other, was it possible to prove that this “apparent accuracy” was also not justifiable ecologically.

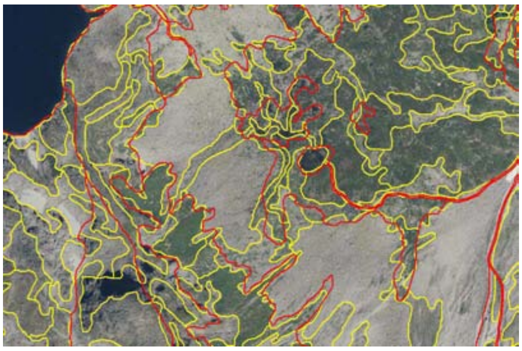

Figure 27: Overlay of biotope mapping and aerial image interpretation in Muhr (Salzburg) – not revised.

In contrast to the mapping scale of the aerial image interpretation of 1:2,500, the biotope mapping recorded its findings in a scale of 1:10,000. The ratio of mapped polygons was 1:3 to 1:7 depending on the natural area. Consequently, there were three to seven polygons from the aerial image interpretation on one polygon shown from biotope mapping. Usually, the biotope mapping combines multiple polygons from the aerial image interpretation into one type of biotope justified by the vegetation.

The following are examples of three of the conflict situations that have been identified and analysed so far:

1st case: Multiple polygons from the aerial image interpretation (AI) coincide with one polygon from biotope mapping (BM).

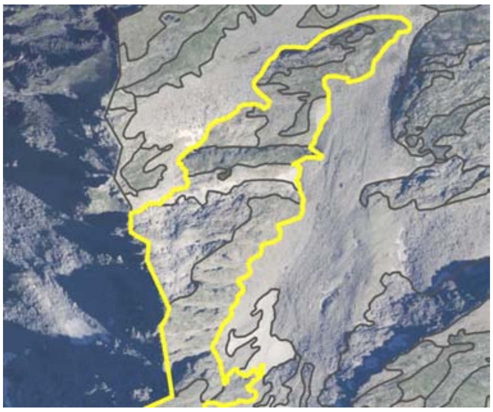

Figure 28: Case 1. Biotope mapping (in yellow) coincides with multiple polygons from aerial image interpretation (black).

2nd case: AI has different priorities than BM: in the AI, anthropogenic structures have priority over natural ones; in BM, it is the other way round.

Figure 29: Case 2. Aerial image interpretation shows the bridge.

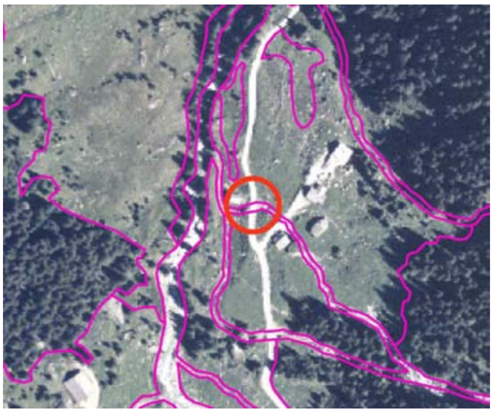

Figure 30: Case 2. In biotope mapping, the flowing water is more important than the bridge or road.

3rd case: During the site visit, biotope mapping finds content that is different from that which was possible to see in the AI. Furthermore, identified content is missing from the AI.

Figure 31: Case 3. The AI shows a river with two sandbanks (fluviatile deposits).

Figure 32: Case 3. The BM shows an additional arm of the river that could not be identified in the AI.

Figure 33: Case 3. In the "manually edited" AI – BM layer, the two sandbanks as well as the additional arm of the river are shown.

In the combined GIS layer (figure 33), the additionally mapped side arm of the river now has the content "river" from the BM as well as the content "sandbank" from the AI.

With this approach and with the help of clever version management, it should be possible to guarantee ongoing quality improvement of the base dataset of the aerial image interpretation in the long term with regard to the content as well as the geometry of the entire natural area of NPHT.

HABITALP

Local Interpretation Experiences

Reference list

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NATURA 2000 & Monitoring (Part 1)

Contribution of the HABITALP methodology to the detection of NATURA 2000 habitats – WP8-1

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Summary

The main objective of the HABITALP project is to develop and test a new method to map alpine habitats from high resolution aerial photographs through a common interpretation key (HABITALP Interpretation Key - HIK). A naturally emerging objective is to test whether the results of the HABITALP classification could be used to detect and monitor NATURA 2000 habitats (N2000). In order to address this issue, we explore three different questions: i) how can we translate HIK classes into N2000 units?; ii) how good is this translation when validated on independent datasets?; iii) can we use additional environmental information to improve this translation?

The first question is addressed by developing a relational database linking the HIK classes to the Palaearctic Habitat classification (PalHab), and then PalHab classes to N2000 units. This database relies on local filters that select the appropriate HIK, PalHab and N2000 units found in each partner area. The results show that most HIK classes correspond to several possible PalHab and NATURA 2000 units.

This multiple relationship is tested by comparing the result of HIK translations to field observations and existing N2000 maps. The results clearly show that HIK translation contains generally the correct N2000 habitat, but that it remains impossible to distinguish between several candidates, resulting in low probabilities of mapping the right N2000 unit.

These first results justify the next step of analysis that is to test whether the relationship can be improved by using additional environmental information. The distribution of each N2000 habitat is first described by coding in an expert table its potential range of altitude, slope, aspect, soil acidity and moisture together with the possible HIK classes. A second matrix describing the actual environmental characteristics of each mapped polygon then multiplies this first matrix. The final result is a matrix with mapped HIK polygons as rows and scores for each potential N2000 habitat in columns.

The proposed approach allows translating HIK polygons into a reduced number of N2000 units. However, the result obtained shows that habitat mapping from aerial photographs cannot replace field mapping of N2000 units. The suggested strategy is rather to detect the areas that have the highest potential to contain N2000 habitats and to plan efficient field campaigns on this basis.

Résumé

L'objectif prioritaire d'HABITALP est de mettre au point une méthode pour cartographier les habitats alpins à partir de photos aériennes à haute résolution en se basant sur une clé commune d'interprétation (HABITALP Interpretation Key HIK). Un second objectif consiste à tester si cette photo-interprétation peut être utilisée pour cartographier les habitats NATURA 2000 (N2000). Nous tentons ici de répondre à trois questions: i) comment peut-on traduire les classes HIK en habitats N2000 ?, ii) quelle est la valeur de cette traduction lorsqu'on l'évalue sur des jeux de données indépendants ?, iii) peut-on améliorer la traduction en utilisant des variables environnementales additionnelles ?

La première question est abordée en développant une base de données relationnelle qui lie les classes HIK à la classification paléarctique des habitats (PalHab), puis les classes PalHab aux unités NATURA 2000. Cette base de données utilise des filtres locaux des HIK, PalHab et N2000 propres à chaque région partenaire. Les résultats montrent que les classes HIK correspondent à plusieurs unités PalHab et N2000 possibles.

La deuxième question compare les résultats de la traduction des classes HIK en N2000, avec des données de terrain et des cartes N2000 existantes. Cette confrontation montre que la traduction HIK comprend généralement le bon habitat N2000, mais que la photo-interprétation ne permet pas de distinguer plusieurs candidats, résultant ainsi dans des probabilités faibles de cartographier le bon habitat N2000.

La troisième étape vise à améliorer la traduction entre HIK et N2000 en utilisant le contexte environnemental. La distribution supposée de chaque habitat N2000 est décrite dans un système expert incluant les gradients d'altitude, de pente, d'orientation, d'acidité et d'humidité du sol, ainsi que les relations possibles aux classes HIK. Cette première matrice est multipliée par une deuxième matrice décrivant la distribution environnementale de chaque polygone cartographié. Le résultat est une matrice qui fait correspondre à chaque unité HIK cartographiée un score pour les habitats N2000 possibles.

L'approche proposée permet de traduire les polygones HIK dans un nombre réduit d'unités N2000. Toutefois, la cartographie des habitats à partir des photos aériennes ne peut pas remplacer la cartographie terrestre des unités N2000. La stratégie proposée consiste à identifier les zones susceptibles d'abriter des habitats N2000 afin d'y effectuer des campagnes efficaces de terrain.

Zusammenfassung

Das Hauptziel des HABITALP-Projektes besteht darin, eine neue Methode zur Erfassung alpiner Lebensräume mit Hilfe von hochauflösenden Luftbildern und unter Verwendung eines gemeinsamen Interpretationsschlüssels (HABITALP Interpretation Key HIK) zu entwickeln und zu testen. Gleichzeitig soll geprüft werden, ob die Ergebnisse der HABITALP-Klassifikation für die Erfassung und Überwachung von NATURA 2000 Gebieten (N2000) verwendet werden können. Dazu müssen im Vorfeld folgende drei Fragen geklärt werden: i) Wie können die HIK-Klassen bestimmten N2000-Lebensraumtypen zugeordnet werden? ii) Wie zuverlässig ist diese Zuordnung, wenn man sie mit unabhängigen Datenreihen vergleicht? iii) Kann die Zuordnung durch die Einbeziehung zusätzlicher Umweltinformationen verbessert werden? Zur Untersuchung der ersten Frage wird eine entsprechende Datenbank erstellt, um die HIK-Klassen mit der Paläarktischen Habitat-Klassifikation (PalHab) und die PalHab-Klassen mit den N2000-Gebieten abzugleichen. Für die Zuordnung der in den jeweiligen Partnergebieten vorhandenen HIK-, PalHab- und N2000-Typen verwendet die Datenbank lokale Filter. Die Ergebnisse zeigen, dass die meisten HIK-Klassen mehreren möglichen PalHab- und N2000-Typen entsprechen. Zur Überprüfung der Zuverlässigkeit wird die Zuordnung der HIK-Klassen mit Feldbeobachtungen und bestehenden Natura 2000 Karten verglichen. Die Ergebnisse zeigen deutlich, dass die Zuordnung normalerweise das richtige Natura 2000 Habitat betrifft, aber dass es nicht möglich ist, zwischen verschiedenen Kandidaten zu unterscheiden, so dass die Wahrscheinlichkeit, dass das richtige Natura 2000 Habitat kartiert wird, eher gering ist. Diese ersten Ergebnisse rechtfertigen den nächsten Analyseschritt, bei dem überprüft werden soll, ob die Zuordnung durch die Einbeziehung zusätzlicher Umweltinformationen verbessert werden kann. Die Verteilung der einzelnen Natura 2000 Gebiete wird zunächst in Form einer Tabelle beschrieben, die Angaben über Höhe, Neigung, Beschaffenheit, Bodensäure und Feuchtigkeit sowie die möglichen HIK-Klassen enthält. Diese erste Matrix wird durch eine zweite Matrix mit den aktuellen Umweltmerkmalen jedes kartierten Polygons ergänzt. Das Endergebnis ist eine Matrix mit kartierten HIK-Polygonen, die jeweils einem möglichen Natura 2000 Gebiet zugeordnet werden.

Der vorgeschlagene Ansatz bietet die Möglichkeit, die HIK-Polygone auf eine begrenzte Anzahl von Natura 2000 Gebieten zu übertragen. Die Ergebnisse zeigen jedoch, dass die Kartierung von Lebensräumen auf Grund von Luftbildern die Feldkartierung von Natura 2000 Lebensräumen nicht ersetzen kann. Deshalb wird vorgeschlagen, jene Gebiete zu erfassen, die mit höchster Wahrscheinlichkeit Natura 2000 Lebensräume aufweisen, um dann auf dieser Basis effiziente Felduntersuchungen zu planen.

Riassunto

Il principale obiettivo di HABITALP è la creazione di un metodo cartografico rivolto agli habitat alpini basato su fotografie aeree ad alta risoluzione interpretate mediante l'uso di una chiave d'interpretazione comune (HABITALP Interpretation Key HIK). Il secondo obiettivo consiste nel verificare la possibilità di utilizzare la foto-interpretazione per realizzare una cartografia degli habitat NATURA 2000 (N2000). Il nostro lavoro si prefigge di rispondere a tre domande : i) come si possono tradurre le classi HIK in habitat N2000 ?, ii) quale valore ha questa interpretazione quando è applicata a serie di dati indipendenti?, iii) si può migliorare la traduzione utilizzando variabili ambientali addizionali? Alla prima domanda si risponde creando un database relazionale che colleghi le classi HIK alla classificazione paleartica degli habitat (PalHab), poi le classi PalHab alle unità NATURA 2000. Questo database utilizza filtri locali per la HIK, la PalHab e la N2000 di ogni regione partner. I risultati dimostrano che le classi HIK corrispondono a varie possibili unità PalHab e N2000. La seconda domanda riguarda il confronto fra i risultati della traduzione delle classi HIK in N2000, con i dati rilevati sul terreno e con le carte N2000 esistenti. Il confronto dimostra che la traduzione HIK comprende di norma il corretto habitat N2000, ma che la foto-interpretazione non permette di distinguere fra le diverse opzioni, con conseguente scarsa possibilità di cartografare il corretto habitat N2000. La terza tappa si propone di migliorare la traduzione della chiave HIK in N2000 utilizzando il contesto ambientale. La supposta traduzione di ogni habitat N2000 è descritta in un sistema esperto che include i gradienti di altitudine, di pendenza, di orientazione, di acidità e di umidità del suolo, come pure le possibili relazioni con le classi HIK. Questa prima matrice è moltiplicata per una seconda matrice che descrive la distribuzione ambientale di ogni poligono cartografato. Ne risulta una matrice che ad ogni unità HIK cartografata attribuisce un punteggio per le varie possibili opzioni N2000.

L'approccio proposto permette di tradurre i poligoni HIK in un numero ridotto di unità N2000. Tuttavia, la cartografia degli habitat a partire da foto aeree non può sostituire la cartografia terrestre delle unità N2000. La strategia proposta consiste nell'identificazione delle zone che potrebbero contenere habitat N2000 per svolgervi efficaci operazioni sul terreno.

Background and objectives

One aim of the HABITALP project is to develop a tool allowing the monitoring of NATURA 2000 habitats in the NATURA 2000 sites of the Alps with a standardized method based on aerial photographs. To achieve this goal, it was essential to establish the link between the results of the photo-interpretation and the habitat types defined by the CE Habitats Directive. This exercise required the development of a specific tool for translation.

Context

In the complex topography of the Alps, the census and the mandatory monitoring of NATURA 2000 sites constitute a particularly hard work because of access and location difficulties inherent to mountain topography. In this context, the help of photo-interpretation may allow an appreciable saving of time and a significant improvement of results reproducibility.

The HABITALP project, the photo-interpretation of which relies on documents of very high quality, covers a wide array of NATURA 2000 habitats occurring in the Alps. It constitutes therefore a good opportunity to develop a translation tool, and then to test it on concrete cases.

The Work Package No 8

A specific work package was planned from the very start of HABITALP project to define the correspondence with the classification system of NATURA 2000 and to explore the possible applications of the interpretation data within the framework of the follow-up of NATURA 2000 habitats.

The Work Package No 8 (WP8) has two parts. The first part (WP8-I) consists in converting HABITALP interpretation into NATURA 2000 system, then to test this translation in the field and to explore the improvement possibilities of the product. The second part (WP8-II) deals with the use of the interpretation data to monitor the evolution of NATURA 2000 habitats through time. This article treats only WP8-I.

More precisely, we focused on the following tasks:

- to define a general table of the correspondences between HABITALP units and NATURA 2000 habitats at the alpine level.
- to adapt the product to the local contexts and to prepare regional tables of correspondence
- to validate the results by control campaigns in the field.
- to analyse the possible improvements offered by the integration of additional environmental information.

Links with other work packages

WP8 is based on the information collected using HIK key (WP6, “Interpretation Method”) and depends closely on the quality of the results of WP7 “Aerial Image Interpretation”.

It produces an automatic translation of this data in NATURA 2000 system for each interpreted polygon, and in a differentiated way according to the study area.

In WP9 (“Transnational Spatial Database”), the tool allowing this translation is linked to the trans-national database, thus giving an outline of the potential distribution of NATURA 2000 habitats such as it can be deduced from HABITALP cartography.

Organisational and technical implementation

The adopted translation model is based on two variables of the HIK interpretation key and uses the Palaearctic Habitat classification (PalHab) as an intermediate link between HIK and NATURA 2000. The predictions of this model were tested through field validation and comparison with existing NATURA 2000 maps. These controls highlight the weak diagnostic capacity of HABITALP when taken alone. We explored then the improvement potential of additional ecological information.

Course of the study

This study, supervised by Véronique Plaige of the Parc National de la Vanoise (PNV), proceeded over a little more than one year, from June 2005 to September 2006. In addition to the authors, it implied several local experts, responsible for the control of the regional lists and field validation. The project committee was also mobilized on several occasions to discuss the methodological proposals and the intermediate results.

Development of the table of the correspondences

General references

The parameters of the interpretation key retained for the translation in NATURA 2000 system are the habitat types (parameter "CIR") and the dominant species (parameter "Species"). For these descriptors, the conversion of the data from the former key (HIK0) poses a few problems.

The other variables of the HIK2 key (« Degree of Cover », « AC1 », etc. ; see Demel & Hauenstein 2005) appeared to be not reliable or relevant enough to identify NATURA 2000 habitats; they were therefore not included in the translation model.

First, tests carried out in 2004 by NPB, NPHT and SNP showed that the direct translation of HABITALP into NATURA 2000 encounters difficulties when a HIK type covers also habitats not listed in the Directive Habitats (no FFH habitats). A more exhaustive reference frame was clearly needed.

The palaearctic system of classification of the habitats (PalHab; Devillers & al. 1996) was selected to solve this problem. This hierarchical classification includes all the habitats occurring in the Alps. It is an extension of the CORINE BIOTOPES system developed on behalf of the European Union and which served as a basis for the definition of the Natura 2000 habitats. The Interpretation manual of European Union Habitats EUR25 (European Commission 2003a) gives the PalHab codes of each NATURA 2000 habitat. The selected model is therefore:

HABITALP ⇨ PalHab ⇨N2000

Relational model

HABITALP → PalHab relations

For each CIR category, the list of the PalHab units likely to correspond to the definition of the type described by the HIK key and the HABITALP interpretation guide was established.

Generally, it gives a 1 to N relation. The coarser the HABITALP category is, the larger the N value becomes. For example, category 7000 ("forests", without precision) corresponds at the general level to 46 PalHab types and 22 different NATURA 2000 habitat types, whereas the 7100-L_100 category ("forest of pure deciduous trees dominated by the beech") corresponds to 5 PalHab types and 4 NATURA 2000 types.

It was admitted that the relationship between a category HABITALP and a PalHab unit applies uniformly to the whole alpine arc. The only regional variations are related to the geographical distribution of the PalHab units.

PalHab – NATURA 2000 relations

The Manual of interpretation EUR25 provides in theory valid codes of PalHab correspondence for the 25 members of the European Union countries. There is however a possibility for the national committees to adapt the definitions of NATURA 2000 habitats in a regional context. This possibility was used in France, Germany and Austria.

We took into account these particular cases by widening the definitions where necessary, except for very marginal habitats covering negligible surfaces.

In Switzerland, the NATURA 2000 network is replaced by the Emerald network. The list of the concerned habitats is given by the Resolution No 4 (1996) of the Standing Committee of the Bern Convention, whose codes correspond to the PalHab classification. As habitats from the Emerald list correspond largely to those of the Habitats Directive, it was decided not to treat Switzerland separately and to apply the European general model as well.

Regional versions

Each table of correspondence at the local or regional level can be regarded as a subset of the general database. The extraction is done by filtering the general table using the lists of habitats present in the study area.

HABITALP units

When the aerial photographs interpretation is achieved, the translation of HABITALP units can be limited to the CIR-Species combinations actually observed.

NATURA 2000 habitats

The national list of NATURA 2000 habitats occurring in the alpine biogeographic area (European Commission 2003b) was used for a first sorting. The lists supplied by each partner were then used as filters at a local level.

PalHab habitats

The lists of PalHab habitats of each study area are drawn up by the local experts. The database automatically extracts the units that are hierarchically related to the habitats of the provided list.

Structure of the database

The relational database WP8-DB was developed to produce the tables of correspondences automatically. It is implemented in MS Access®. It is a modular system, the elements of which can be modified separately.

The database mainstay consists of **elementary tables** of HABITALP units, PalHab types and NATURA 2000 habitats. These lists are defined at the alpine and national general level, as well as at the local level for each partner. They constitute the reference catalogues to be taken into account depending on the study area considered.

The elementary tables are interconnected by homologies and by two **relation tables**:

- Conversion of HABITALP units into PalHab units
- Conversion of PalHab units into NATURA 2000 Habitats

SQL requests extract automatically the tables of correspondences between HABITALP units, PalHab types and NATURA 2000 habitats, on the alpine scale and for each partner's area (table 14). Directly printable outputs are also provided by the database.

Table 14: Example of the correspondences of the unit 7100-L_001 (deciduous forest, undifferenciated deciduous tree) for the Parc National de la Vanoise (PNV)

PalHab		NATURA 2000	
41.1	Beech forest	-	-
41.1	Beech forest	9110	Luzulo-Fagetum beech forests
41.1	Beech forest	9130	Asperulo-Fagetum beech forests
41.1	Beech forest	9140	Medio-European subalpine beech woods with Acer and Rumex arifolius
41.1	Beech forest	9150	Medio-European limestone beech forests of the Cephalanthero-Fagion
41.11	Medio-European acidophilous beech forests	9110	Luzulo-Fagetum beech forests
41.13	Neutrophilous beech forest	9130	Asperulo-Fagetum beech forests
41.15	Middle European subalpine beech forest	9140	Medio-European subalpine beech woods with Acer and Rumex arifolius
41.16	Limestone beech forest	9150	Medio-European limestone beech forests of the Cephalanthero-Fagion
41.3	Ash wood		
41.4	Mixed ravine and slope forests	9180	Tilio-Acerion forests of slopes, screes and ravines
44.13	Middle European white willow forests	91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)
44.2	Montane grey alder galleries		
44.21	Montane grey alder galleries		

Validation of the correspondence model

The application of the correspondence model to real data of interpretation makes it possible to compare the results obtained with the actual distribution of NATURA 2000 habitats, documented by field controls or preexistent maps.

The validation process had to be adapted according to temporal constraints, the progress of the interpretation and the availabilities of each partner.

It was initially planned to collect one thousand field control points where the concordance between the observed habitat and the habitat predicted by the model had to be checked. These controls were supposed to be organized by the partners having carried out their interpretation during the vegetation season of 2005. Unfortunately, this program could only be partially accomplished. A complementary control based on the existing NATURA 2000 cartography was therefore proposed in October 2005. This second control consisted in overlaying the polygons of interpretation HABITALP with existing NATURA 2000 maps in certain sectors covered by both maps. (table 15 summarizes the treated data).

Table 15: Validation data and maps. The NPHT data was analyzed separately by local experts

PARK	Field control plots	N2000 Maps
NPB	260	-
PNE	-	Pétarel (2.4 km2) Lauzon (9.6 km2)
PNV	59	Tueda (5.3 km2)
NPHT	174	Inneres Pöllatal (31.7 km2)
ASTERS	89	-
APB	60	Kalterer See (3.1 km2), Castelfelder (1.5 km2), Trudnerhorn (64.1 km2)

Field validation

Methodology

The validation consists of specific controls following a standardized protocol in a representative set of sectors covered by the photo-interpretation and selected according to the principle of stratified sampling.

The field validation was accomplished by local experts: Dominique Lopez-Pinot (ASTERS), Véronique Plaige (PNV), Cesare Lasen (APB), Albert Lang (NPB) and Gregory Egger (NPHT).

On each point of validation, the photo-interpretation itself is controlled (are CIR and SPECIES correct?), then the occurring habitat is noted (PalHab type and if present NATURA 2000 habitat). Some local parameters (slope, altitude, aspect, geology) are also consigned for an ecological test.

The data analysis aims at comparing the predictions of the correspondence model with the effective observations in the field.

The analysis makes a distinction between the **"positive" matching** (a NATURA 2000 habitat type is predicted and its presence is confirmed on the field) and the **"negative" matching** (the model predicts the presence of a habitat not noted by the Directive Habitat, as observed on the field).

First, we make a **"global assessment"** by examining whether the habitat observed in the field is one of the possible habitats given by the regional table for the corresponding HIK type.

Then, we carry out a **"detailed assessment"** that seeks to identify which part of the possible cases represents the observed habitat (by simplification, all the "no-FFH" habitats are gathered in one single category). This statistic gives an indication of the degree of uncertainty of the prediction.

Results

Global assessment : The average rate of matching for the CIR units is 89 % (60 % positive matching + 29 % negative matching), which means that in most cases, at least one of the possible units given by the model corresponds to the field reality. The rate of total matching varies according to the type of CIR considered (figure 34).

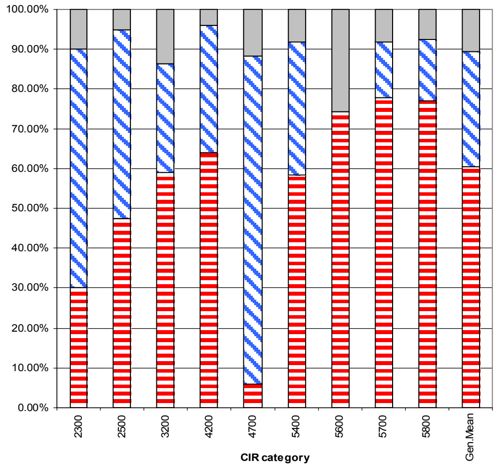

Figure 34: extract of the global evaluation by CIR units: Red horizontal hatches : observed NATURA 2000 habitat among the predicted habitats. Blue oblique hatches : no belonging to NATURA 2000; uniform grey: no fit at all.

Detailed assessment: Here, the rate of matching is definitely lower (figure 35), with a 20% average (10 % positive matching + 10 % negative matching). This difference is explained by the fact that the majority of CIR types overlap several habitats, which has the effect of weakening the possible correspondences. According to the type of habitat NATURA 2000 considered, the rate of matching varies between 0 % and 30 %.

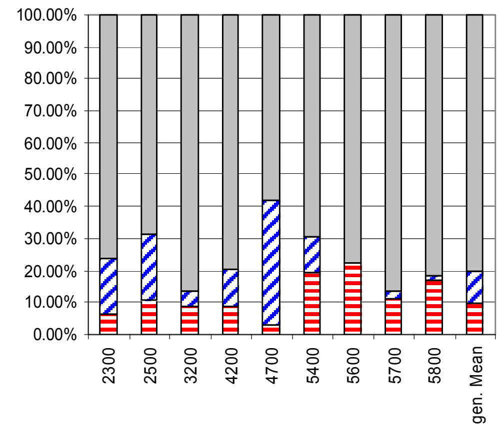

Figure 35: detailed evaluation by CIR units (extract). Red horizontal hatches : predicted habitat fits observed NATURA 2000. Blue oblique hatches : no FFH habitat as predicted; uniform grey: not matching.

Cartographic validation

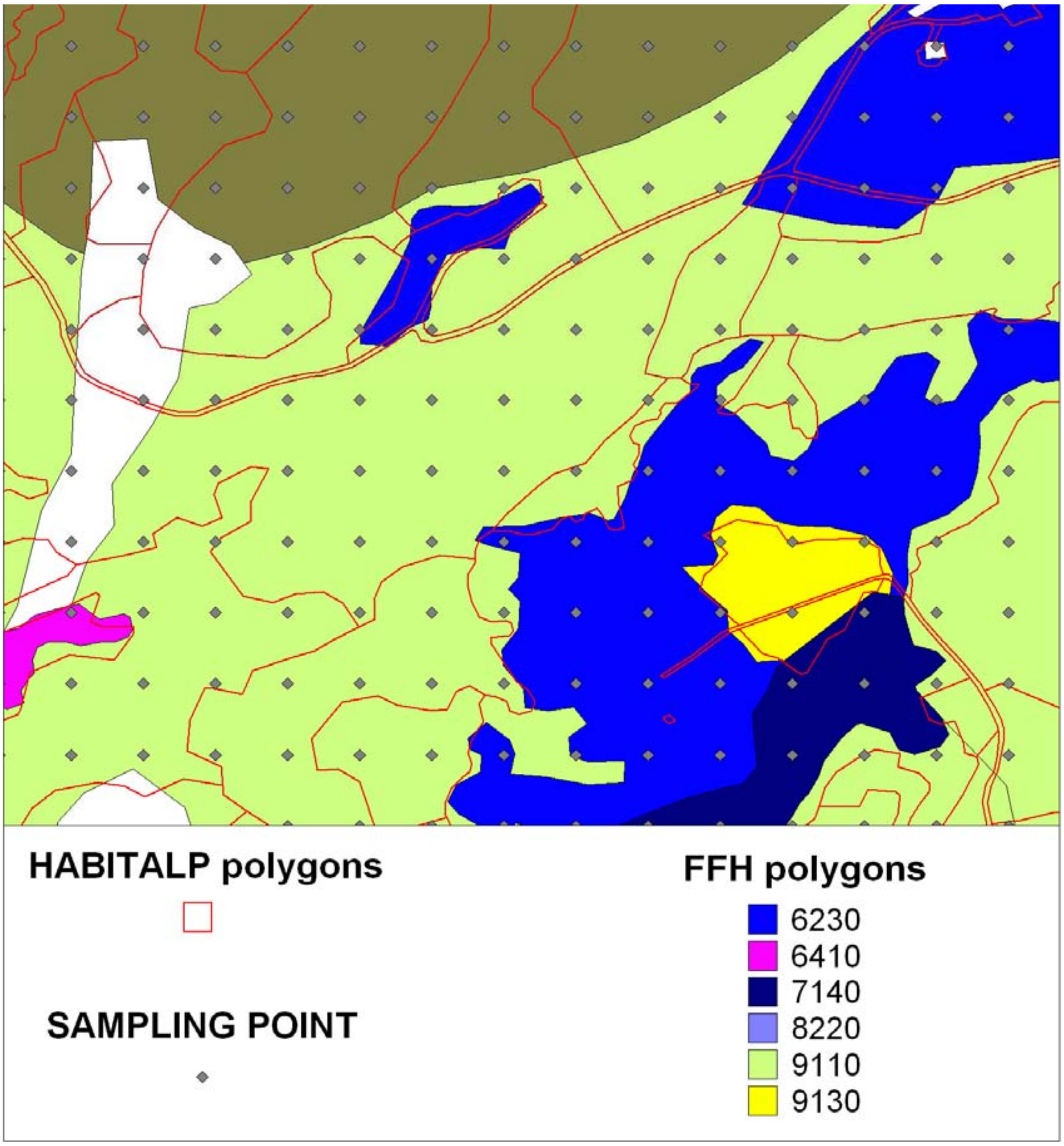

Figure 36: Extraction of the sampling grid (source : APB)

Methodology

The cartographic data resulting from HABITALP interpretation was superimposed on the available maps of NATURA 2000 habitats. A systematic sample of the overlapping zones was made using a grid of 50 m mesh (figure 36). For each point of the grid, CIR and NATURA 2000 codes were extracted from the underlying layers using MapInfo software.

On the whole, 28'950 points were extracted (APB: 22'302 points; PNE: 4' 659 points; PNV: 1'989 points).

Using the regional table of correspondences, the list of the possible habitats for each encountered HIK type was then extracted.

The matching statistics were calculated with the same model as for the field validation.

Results

Global assessment : for the CIR units, the average rate of global matching is 76 % (37 % positive + 39% negative matching). Important differences between CIR units are observed (figure 37). Certain types, like the aquatic biotopes (CIR 23xx, 25xx), cultivated fields (CIR 43xx, 44xx, 45xx), coniferous forests (CIR 76xx) and built surfaces (CIR 91xx, 93xx) are correctly identified. On the other hand, the diagnosis is clearly defective for the marshes (CIR 32xx, 33xx), rock surfaces (CIR 58xx) and forest clearings (CIR 77xx).

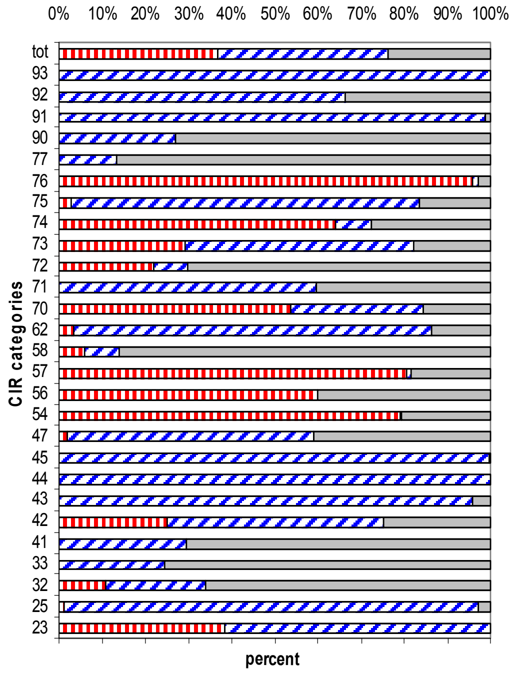

Figure 37: global evaluation by CIR units: Red vertical hatches : observed NATURA 2000 habitat among the predicted habitats. Blue oblique hatches : no belonging to NATURA 2000; uniform grey: no fit at all.

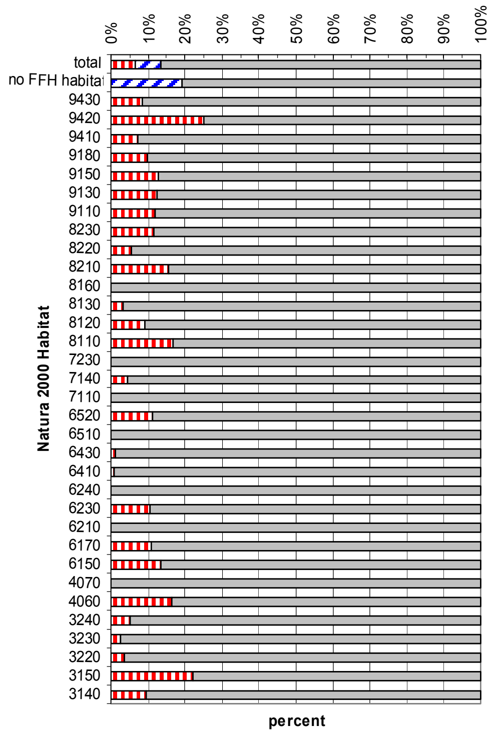

Figure 38: Detailed evaluation by NATURA 2000 habitat type. Red vertical hatches : predicted habitat fits observed NATURA 2000. Blue oblique hatches : no FFH habitat as predicted; uniform grey: no fit.

The global assessment for NATURA 2000 habitats is comparable. The matching is globally good for aquatic habitats (3000) and forests (9000). The situation worsens in the heaths (4000) and the screes (8000); it becomes definitely poor in the grasslands (6000) and the marshes (7000).

Detailed assessment : for the CIR types, the average rate of detailed matching falls to 13.5% (6.5 positive + 7.0 negative matching). The absence of NATURA 2000 habitats in the cultivated fields (CIR 43xx, 44xx, 45xx) and in the built areas (CIR 91xx, 93xx) is highlighted. On the other hand, NATURA 2000 habitats themselves are seldom identified (figure 38). The rate of positive matching exceptionally exceeds 20 %, whatever the CIR unit and NATURA 2000 habitat considered.

Integration of ecological factors

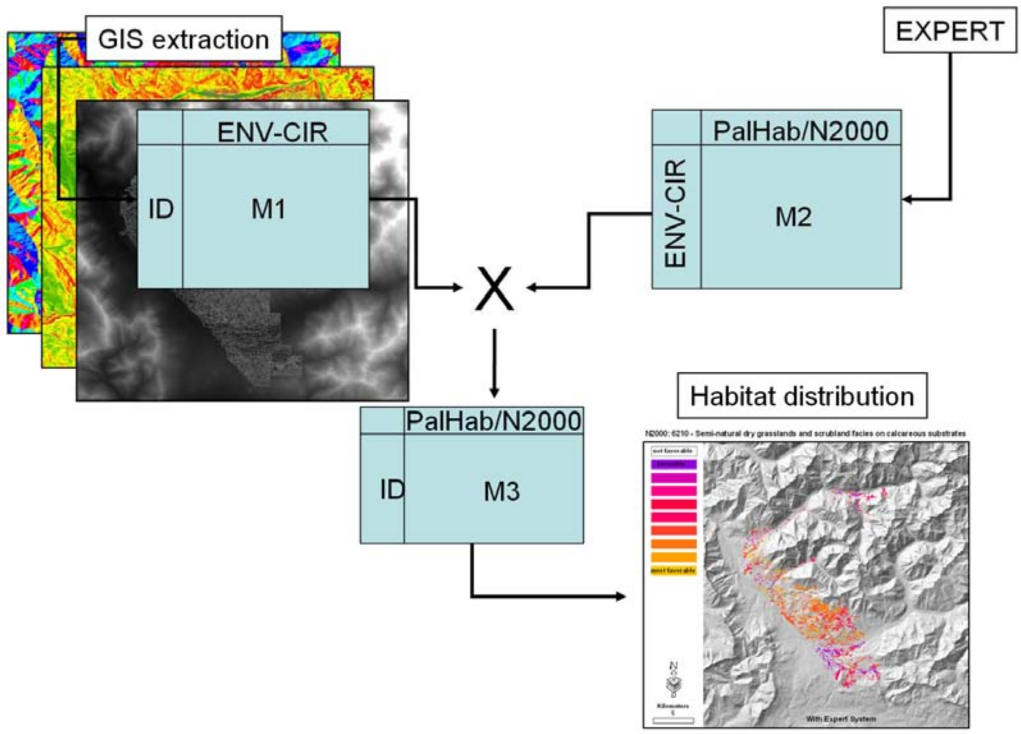

Figure 39: General approach to improve HIK types translation into PalHab/N2000 habitats using additional environmental information, expert knowledge and multiplication of matrices.

Methodological approach

The aim of the proposed approach is to use additional environmental information to improve the translation from photo-interpreted landforms (HIK) into habitats as defined in the palaearctic and/or Natura2000 classifications (PalHab/N2000). The general approach we explored is to exploit the expert knowledge on habitat distribution in one hand and to use matrix multiplication in the other hand. A first matrix (M1) is obtained by extracting the environmental information found underneath each photo-interpreted polygon in terms for instance of altitude, slope, aspect and geology. A second matrix (M2) is obtained by coding into a table the available expert knowledge on habitat distribution and possible translations between HIK and PalHab/N2000 habitats. The last step consists in multiplying these two matrices in order to obtain a final matrix (M3) containing scores for the potentiality of each PalHab/N2000 habitat within each HIK polygon (figure 39). The above mentioned approach is tested here on one part of the Parc National des Ecrins (PNE) in France. The photo-interpreted region represents a surface area of about 225 km2 and is delineated by 16’438 polygons.

Matrix M1 (nxp): Extracting ecological factors under each polygon

The first step consists in building the matrix (M1) describing the environment found underneath each photo-interpreted polygon. As one source of information is in vector format (HIK) and generally the other one is raster (altitude, slope, aspect, geology,…), the natural approach is to extract zonal statistics underneath each polygon and then to decide which statistic (e.g. mean, median, max, min, majority) to use for each environmental variable (figure 40). The obtained statistics are then distributed within selected classes of altitude, slope, aspect, geology, and attributed to one HIK type. The resulting matrix (nxp) has n rows, one for each photo interpreted polygon, and p columns, one for each class of environmental predictor, plus one for each possible HIK type.

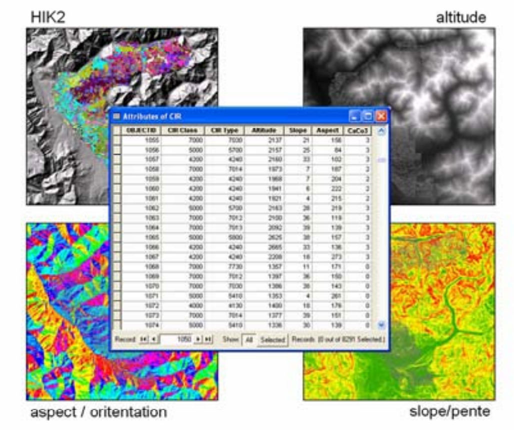

Figure 40: Median values for altitude and slope were extracted underneath each HIK polygon. Majority values where used for aspect and soil calcareous content.

Matrix M2 (pxm): Coding expert knowledge on habitat distribution

The second step was to gather expert knowledge on habitat distribution and to code it into a table in a standard way. In the restricted framework of this test, it was decided to start from the work presented by Raymond Delarze in his book on Natural Habitats of Switzerland (Delarze et al.,1998) in which most habitats are described and their distributions along the main gradients of altitude, soil acidity and humidity are sketched. In an ideal situation, expert knowledge should be coded directly by a local expert in each region. Each habitat needs to be coded into a table where environmental variables are split into the same classes as in M1 and the following coding system was used:

3: most favorable conditions
1: favorable conditions
0: plausible conditions
-100 : unfavorable conditions

The possible membership of one PalHab to a given HIK type was also coded based on the relationship between HIK and PalHab described in the database presented earlier.

The environmental distribution of each PalHab type is coded using a fuzzy logic that allows allocating points over several classes of a same gradient, avoiding therefore to make the hard choice of a single class (e.g. Castella and Speight, 1996).

The resulting matrix (pxm) has m columns, one for each possible PalHab habitat within a given region (here PNE), and p rows, one for each class of environmental predictor, plus several rows, one for each possible HIK type.

M1xM2 (nxm): Calculating habitats potentiality in each polygons

Once the first two matrices are ready, we multiply M1 by M2 in order to get a score of potentiality for each PalHab habitat within each HIK polygon (figure 39). The calculation within each cell of the resulting table is:

$Pot_{ij} = M1_{i1}*M2_{1j} + \quad + M1_{ip}*M2_{pj}$

Where: Pot_{ij} = potential for habitat j in polygon i, $M1_{i.}$ is the membership of polygon i to an environmental class, and $M2_{.j}$ is the likeliness of membership of an habitat j to an environmental class.

The matrix multiplication was carried out in the R open-source statistical package (www.r-project.org). The resulting table could then be exported back into the original GIS software and linked to the polygons ID in order to visualize a map of potential distribution for each predicted PalHab and N2000 habitats (figure 41).

Results obtained in test area

N2000: 6210 - Semi-natural dry grasslands and scrubland facies on calcareous substrates

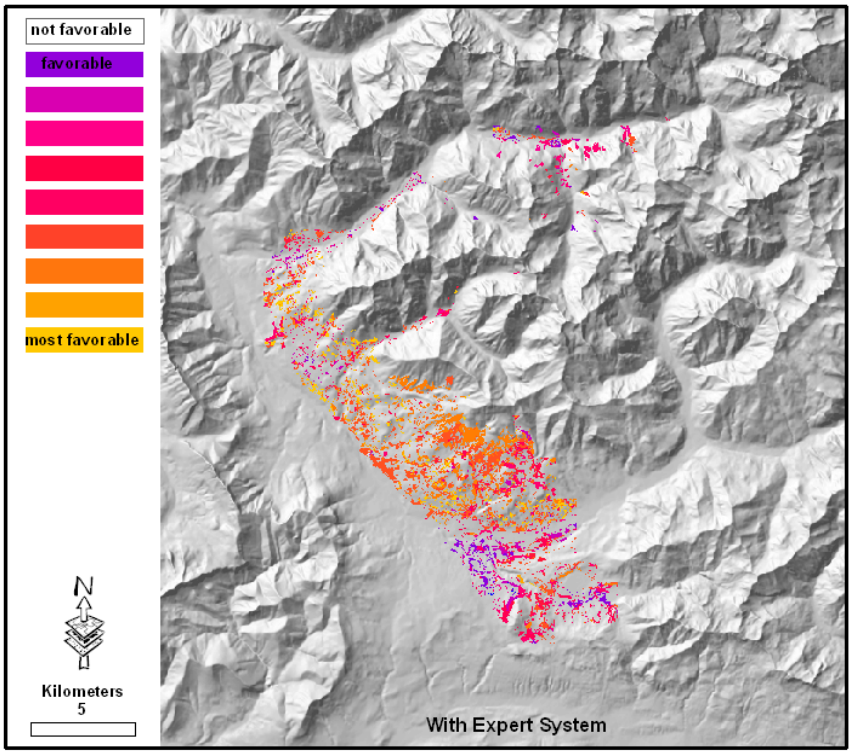

Figure 41: Example of a N2000 habitat type predicted with the expert system.

PalHab: 34.32 - Sub-Atlantic semidry calcareous grasslands

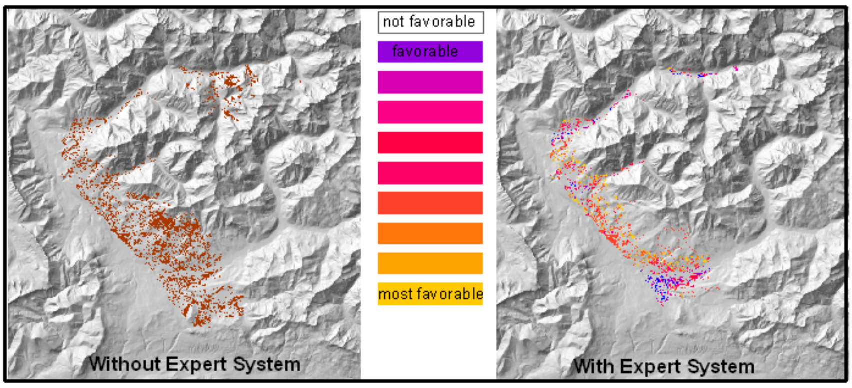

Figure 42: Comparison of predicted PalHab type distributions without and with the use of the expert system.

N2000: 6150 - Siliceous alpine and boreal grasslands

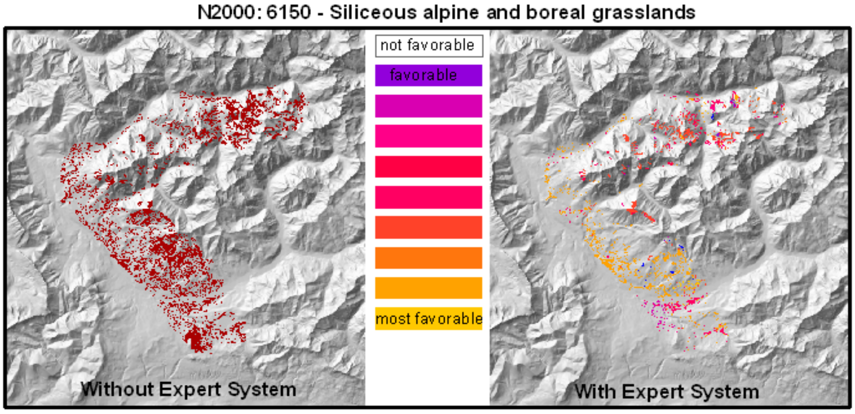

Figure 43: Comparison of predicted N2000 habitat distributions without and with the use of the expert system.

Relationship HABITALP to PalHab

We first present the cartographic result of the translation from HABITALP HIK polygons to PalHab habitats (figure 42). With the presented example we can show how the expert system allows reducing the predicted surface area while adding a scale of suitability from favourable to most favourable. Indeed, the total number of polygons suitable for the distribution of PalHab habitat (34.32) is n=4962 for a total area of 34 km2 without expert system, whereas it reduces to n=2751 and 17 km2 respectively with the expert system.

The reduction of the number of possible PalHab habitats polygons can be visualized with a simple comparison of the results obtained with or without the use of the expert system (figure 44). This figure shows clearly that the expert system reduces systematically the number of possible PalHab habitats potentially present in each polygon.

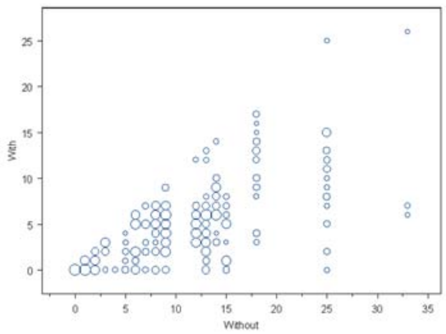

Figure 44: Relationship between the number of possible PalHab habitats found in one polygon with or without environment information. Smallest circles correspond to unique cases where largest circles correspond to up to 2700 polygons on a log transformed scale.

Relationship HABITALP (to PalHab) to NATURA 2000

The translation from HABITALP into NATURA 2000 presents very similar results as for PalHab habitats. For N2000 habitat 6150 (figure 44), the number of possible predicted polygons and their total surface area is drastically reduced from n=6058 to n=2874 and from 56km2 to 23km2.

Similarly, the number of possible N2000 habitats per polygon is also systematically reduced (figure 45). Indeed, the average number of N2000 potential habitats per polygon is 6.4 without expert system and 2.8 with the expert system.

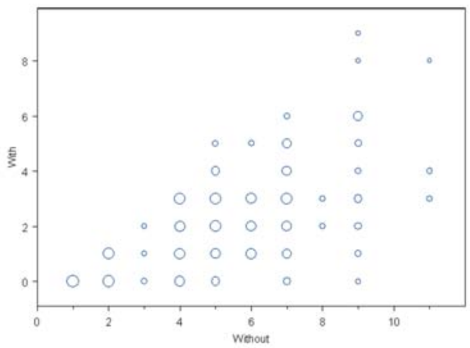

Figure 45. Relationship between the number of possible N2000 habitats found in one polygon with or without using environmental information. Smallest circles correspond to unique cases where largest circles correspond up to 3900 polygons on a log transformed scale.

Finally, the detailed number of predicted polygons per N2000 is presented in figure 46 together with the percentage of reduction obtained by the use of the expert system.

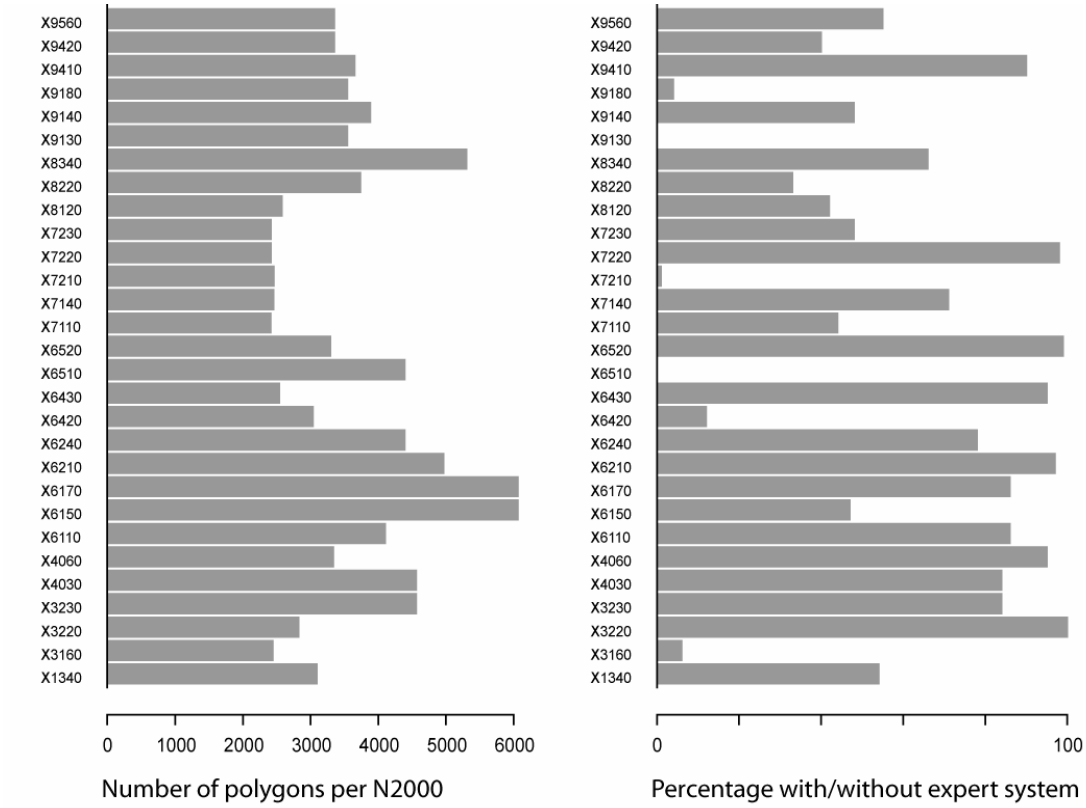

Figure 46. Detailed comparison of the number of predicted polygons per N2000. On the right: percentage of reduction of polygon number when using the expert system.

Discussion and assessment

In general, it proves to be impossible to recognize NATURA 2000 habitats using only the data of interpretation HABITALP without any additional information on the station. The analysis of some simple ecological parameters makes it possible to reduce uncertainty but does not exempt to envisage controls in the field.

Operational assessment

The field validations and the overlay with N2000 maps could not be carried out in all the parks partners of the project, but the checks achieved are sufficient to confirm the difficulty in affixing a single NATURA 2000 label to each HABITALP polygon. It is not rare that a HIK type corresponds to more than 10 different types of NATURA 2000 habitats, not to mention the “no-FFH” habitats.

It must be recognized that the uncertainties are still too large for a direct monitoring of NATURA 2000 habitats from aerial photographs. This is not surprising, because the HABITALP approach focuses on the description of structural parameters; in spite of the quality of the photographic documents on which it is based, the crucial elements necessary to the identification of NATURA 2000 units (in particular characteristic species) are seldom visible.

Several descriptors of HIK key, regardless of their relative precision (for example measurements of COVER) do not offer a great diagnostic capacity with respect to NATURA 2000. At best, they make it possible in some cases (extreme values) to exclude certain options, but they should be more useful for the follow-up of the evolution of the habitats than to their identification.

Another limitation of HABITALP data has to do with the practical difficulty to identify the dominant species on the aerial photographs. The general analysis carried out within the framework WP8-II by C. DENTANT and M. GODRON (unpublished) indicates that only dominant coniferous species are often identified (12 % of the polygons); dominant deciduous trees, bushes and herbaceous species are rarely identified (approximately 1 to 3 % of the polygons). In fact, many species appearing in the HIK key were not identified during the photo-interpretation. This reduces the possibility of recognizing certain habitats NATURA 2000, although this possibility exists theoretically.

In spite of these limitations, the systematic disentangling of HABITALP-NATURA 2000 relations made it possible to elaborate a general model of correspondences and highlighted the inherent constraints of n-m relationships.

Comparable approaches

A very similar task of monitoring NATURA 2000 habitats from remote sensing and ancillary data was assigned recently to the spatial indicator for nature conservation project (SPIN; Bock et al. 2005). The EUNIS classification key (EEA, 2003) was used as a starting point to be able to map NATURA 2000 from satellite images at different scales. At local scales, field data was used to improve the translation into NATURA 2000 habitats. This integrated approach could undoubtedly be also adopted for interpretation HABITALP.

Another example of m-n relationships comes from the LandsPot project (Maggini et al. in prep.) where Swiss natural habitats are mapped comparing the results from an expert system and from statistical modelling.

Filters

The general constraints of n-m relationships being recognized, the following stages of our work consisted in trying to reduce the indetermination of the relations.

In our case, the adopted solution consisted in reducing the number of possible choices by introducing additional sorting criteria. The different nature of the filters that we used has to be underlined.

Binary regional sorting

The correspondence tables are designed so as to filter the general table by removing all the elements absent of the considered study area. This binary logic (presence-absence) does not hold any account of the relative probability to meet a given habitat. Indeed, some habitats are rare and cover small surfaces, this scarcity being precisely the cause of their designation. For this reason, one should not hold account of the relative rareness of the habitats to exclude them from the list of possible correspondences.

It would however be interesting to introduce a weighting factor making it possible to underline the most plausible habitats. This however requires detailed information on the regional distribution of the habitats, which is not always available. Moreover, the probability of meeting a type of habitat varies strongly from one point to another, which seriously reduces the relevance of average regional values.

Probabilistic ecological sorting

The complementary sorting using ecological variables follows a different logic (fuzzy distribution model), implying the definition of more or less arbitrary thresholds to insulate the polygons whose score indicate sufficiently favourable conditions for a given type of habitat.

This makes the process more complex, but avoids the risk of a systematic underestimation of the rare habitats.

The original approach that was developed for the Habitalp project is inspired from species distribution modelling works (e.g. Lehmann et al. 2002), where here, statistical models are replaced by expert knowledge. The interest of the proposed method is that it allows to integrate expert knowledge on a large number of polygons using a single calculation that is based on the multiplication of matrices.

Cartographic complications

Heterogeneity of the HABITALP polygons

A noticeable rate of inadequacy between interpretation data and the CIR observed at the control spot was reported during field validation. This suggests that a certain number of interpretation polygons are internally heterogeneous, some consisting of mosaics of distinct formations. In a general way, a large proportion of mosaics and complex habitat mixtures characterize the alpine relief.

A solution to this problem could be brought by an adaptation of the HIK key. For example, composite codes can be proposed to describe mosaics (CIR a x CIR b). These mosaics could thus be identified and translated in NATURA 2000 system without risk of confusion with transition stages, which would still be identified by atypical values of degree of cover of main land cover types.

Scale of mapping

This point is of major importance for the recognition of the habitats fulfilling

NATURA 2000 criteria. The scale of the cartography determines the minimal size of the polygons and the level of necessary aggregation of information (suppression of the small objects, treatment of the mosaics, etc.) It influences the quality of the analysis resulting from the comparison of maps and affects the possibilities to transpose HIK polygons into NATURA 2000 habitats. The smaller the scale is, the better the possible correspondence might be.

Generalisation

The agreement of the results obtained by several analyses carried out in various areas, partly with different methods and by different actors, suggests that these results are relatively representative and applicable throughout the Alps.

While holding account of the regional and local characteristics, the proposed model can be applied in other parts of the Alps, provided minor adaptations. The adjustment is possible everywhere and requires a relatively modest investment: inventory of the present habitats types, digital elevation model (DEM) and digitized geological map.

The results appear either as potential distribution maps of habitats, or as lists of potential habitats for a given site. They return in both cases probabilities, on which one can seek to build a more precise and better documented representation of habitat distribution. This exercise was only outlined during the course of this study; if there is a life after HABITALP, this topic would undoubtedly deserve to be further developed.

In a broader perspective, it is probable that the approach developed for the translation into NATURA 2000 could apply to other hierarchically structured systems. The model of matrix multiplication used for the ecological analysis is easily transposable to other data sets in order to introduce expert knowledge in any cartographic translations.

Conclusion

The WP8-I study allowed to specify the possible contribution of HABITALP interpretation to the process of identification and cartography of NATURA 2000 habitats. It proves to be a powerful tool of pre-zoning and extrapolation, which brings an invaluable help when an exhaustive survey of the territory does not enter into consideration. The performance of this tool will be strongly reinforced if additional environmental data are available.

An evolutionary tool

The data base developed to translate the HABITALP units of interpretation into NATURA 2000 habitats offers various advantages:

- very broad frame of reference, including all the European habitats.
- single and universal conceptual model, the tables of regional relations being defined as subsets of the alpine general table.
- modular structure allowing to modify and correct separately each component of the system, while preserving the functionality of the whole
- great flexibility, allowing to extend the analysis by integrating additional environmental parameters or other filters according to available data.

Admittedly, the performances of this prototype are still far from giving whole satisfaction, for various reasons evoked in the preceding chapter; but it nevertheless helps to decipher a path throuhg the jungle of the multiple possible relationships and to identify the problematic units, requiring either verifications in the field or additional selection criteria.

Input of environmental variables

The integration of the ecological variables brings a great gain of precision at a reduced cost. As far as available numerical data cover uniformly the study area (DEM, geological data, etc.), their systematic use in the model is strongly recommended.

Possible improvements

We identified several ways to improve the translation from HIK to N2000:

- Improvement of the relationships between HIK > PalHab > N2000 per region.
- Addition of local weighting factors in the relationships between HIK > PalHab > N2000 to favor more probable correspondences.
- Improvement of expert system by a detailed examination made by a local botanist in each region.

- Addition of other environmental variables such as historical information on grazing or fire.
- Improvement of the coding system used to describe habitat environmental preferences.
- Calibration of the threshold value used to decide whether a habitat should be considered as present or not.
- Validation of the approach in other regions with different environmental contexts.

Practical value

Work package 8 has been defined from the beginning as a mean of establishing the link with the Habitat Directive and its lawful obligations. Through WP8 "NATURA 2000 & Monitoring" the HABITALP project can contribute in a significant manner to the rationalization of cartography of NATURA 2000 habitats. Even if it does not suffice alone to produce the map of the habitats, it provides useful information for a parsimonious and optimal use of the resources available for field work.

For very large NATURA 2000 sites and for mountainous regions with access difficulties, only parts of the whole area can generally be visited. In these situations, photo-interpretation remains the best way to delineate perimeters and to select objects to visit in priority, in order to check the translation and to get the basis for an extrapolation. The HABITALP methodology provides a standardized tool for such general surveys.

Outlook

The interest of HABITALP consists in its combined use with other tools. The challenge consists in optimizing the exploitation of information and its integration in a broader program implementing environmental data analysis and targeted controls in the field.

Use of environmental data

The next step of the integrated approach using HABITALP as a basis for assigning and monitoring NATURA 2000 habitats would be to generalize the use of additional environmental data to improve the diagnostic power of HABITALP. DEM data are ideal candidates, but other information, if appropriate maps exist, should not be ignored: flooding areas, soil maps, etc.

In parallel, the expert table must be adapted at the regional level and supplemented for each new discriminating parameter added to the model.

The result of this process could be potential maps of individual NATURA 2000 types, as well as "maps of uncertainty" (polygons labeled according to their number of possible different habitats).

Planning of field controls

In all the cases, a minimum of validation and calibration in the field is to be envisaged. In our opinion, it has no sense to oppose photo-interpretation and field survey as competing alternatives. On the contrary, these should be two obligatory and complementary facets of a single process.

Depending of the needs (study of a particular habitat or general inventory of the habitats), one of the above mentioned maps will be used as a basis to prepare the stratified sampling design of the field controls.

This will allow to draw up a list of polygons to be visited. The latter will be selected so as to get a representative image of the focused elements: potential habitats of particular stake, CIR units with large residual indetermination, etc. The implementation of adapted decision rules for an optimal sampling remains to be developed. It has to integrate manager's concerns, e.g. overweighting of areas submitted to rapid changes.

Update of the database

If it is used, the translation tool of HABITALP data will certainly undergo corrections, on general level as well as on regional level. It is desirable that the corrections are implemented in the common database elaborated within the framework of HABITALP Work Package 9 "Transnational Spatial Database". To perpetuate this structure and to formalize the flows of information between the central server and the regional partners are two important stakes for the future.

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HABITALP

NATURA 2000 & Monitoring (Part 2)

Landscape monitoring with HABITALP data and set-up of surveillance rules for alpine habitats – WP8-2

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EXPERTISE-CONSEIL EN ENVIRONNEMENT NATUREL

Summary

The objective of this study is to highlight HABITALP data potentialities for natural habitat surveillance, especially in NATURA 2000 context.

The first step of this work relies on a double analysis: to synthesize European Habitat Directive 92/43/EEC requirements as well as project partners' expectations about surveillance issues. Thus, the directive 92/43/EEC objectives are scanned and discussed. This preliminary study permits to focus on natural habitats' characteristics that must be studied to respond to NATURA 2000 surveillance aims. On the other hand, the consideration of the project partners' surveillance expectations should make this work package close to the prevailing needs in ecological management.

The second step of this work consists of analyzing what are the real possibilities of HABITALP data in order to monitor habitats. This has been carried out by scanning and checking frequencies of use for different data groups. This work permits to outline further analysis and to draw methodological limits. Afterwards, transitions between data of two aerial image generations (1997 and 2003) were studied in order to underline what can really be observed with HABITALP datasets. The transition matrix (data cross table of both interpretation datasets) shows different kinds of elements: natural transitions (e.g. vegetation dynamics), human-induced transitions (e.g. urbanisation) and artefacts (corrections and errors). A first set of surveillance rules is proposed. In a second time, a synchronic analysis is carried out to enhance "trends" of natural dynamics thanks to a single set of data: a hierarchy of different column combinations is set up in order to focus on which habitats may be more likely to evolve.

Eventually, expected elements (EU directive objectives) and real results (HABITALP data analysis) are synthesized and compared. General surveillance rules are deduced from them, as well as methodological limits. The conclusion provides a comparative assessment of the potentialities and the limits of the present work and the HABITALP method. It also gives propositions for further projects.

Résumé

L'objectif de cet atelier est de mettre en évidence les potentialités des données HABITALP dans le suivi des habitats naturels, et plus spécialement dans le contexte NATURA 2000.

La première étape de ce travail repose sur une double analyse : synthétiser les exigences de la directive habitat 92/43/CEE en même temps que les attentes des partenaires du projet sur la problématique du suivi. Ainsi, les objectifs de la directive 92/43/CEE ont été répertoriés et discutés. Cette étude préliminaire permet de mettre en évidence les caractéristiques des habitats naturels devant être analysés afin de répondre aux objectifs de surveillance NATURA 2000. En complément, la prise en compte des attentes des partenaires du projet relatives au suivi devrait permettre à cet atelier de répondre au mieux à des attentes de gestion.

La seconde étape de ce travail consiste à analyser les possibilités effectives des données HABITALP pour le suivi des habitats. Cela a été effectué en parcourant et vérifiant les fréquences d'utilisation des différents groupes de données. Ce travail permet de cadrer les analyses suivantes et d'esquisser les limites méthodologiques. Par la suite, les transitions entre les données issues de deux générations de photos aériennes (1997 et 2003) ont été étudiées afin de souligner ce qu'il est effectivement possible d'observer avec les jeux de données HABITALP. La matrice de transition (table de données croisées des deux couches d'interprétation) montre différents types d'éléments : transitions naturelles (exemple : dynamique de la végétation), transitions induites par l'homme (exemple : urbanisation) et artéfacts (corrections et erreurs). Un premier lot de règles de surveillance est proposé. Dans un deuxième temps, une analyse synchronique d'un seul lot de données est menée afin de mettre en valeur des «tendances» dynamiques : des combinaisons des différentes colonnes sont hiérarchisés afin de cerner quels habitats sont le plus susceptibles d'évoluer.

Au final, les éléments requis (objectifs de la directive européenne) et les résultats effectifs (analyse des données HABITALP) sont synthétisés et comparés. Des règles de surveillance générales en sont déduites, ainsi que les limites méthodologiques. La conclusion est une évaluation comparative des potentialités et des limites du présent travail et de la méthode HABITALP. Elle donne également des propositions pour des programmes futurs.

Zusammenfassung

Ziel dieser Studie ist es, das Potenzial der HABITALP-Daten für die Überwachung von natürlichen Lebensräumen insbesondere im Zusammenhang mit NATURA 2000 aufzuzeigen.

Der erste Arbeitsschritt basiert auf einer doppelten Analyse: einerseits die Forderungen der Habitat-Richtlinie 92/43/EWG und andererseits die Erwartungen der Projektpartner hinsichtlich der Überwachungsanforderungen zusammenzufassen. Zu diesem Zweck wurden die Zielsetzungen der Richtlinie 92/43/EWG erörtert und diskutiert. Im Rahmen dieser Vorstudie konnten die Eigenschaften der natürlichen Lebensräume ermittelt werden, die in Einklang mit den Überwachungszielen von NATURA 2000 zu untersuchen sind. Durch die Berücksichtigung der Erwartungen der Projektpartner in Bezug auf die Überwachungstätigkeit soll gleichzeitig sichergestellt werden, dass dieses Arbeitspaket den wesentlichen Anforderungen des Umweltmanagements gerecht wird.

Der zweite Arbeitsschritt beinhaltet eine Analyse der effektiven Verwendungsmöglichkeiten von HABITALP-Daten bei der Überwachung von Lebensräumen. Dabei wurde geprüft, wie häufig bestimmte Datengruppen verwendet werden. Diese Arbeit erlaubte es, den weiteren Analysebedarf festzulegen und die methodologischen Grenzen zu definieren. Anschließend wurden die Veränderungen zwischen den Daten aus zwei Generationen von Luftbildern (1997 und 2003) untersucht, um aufzuzeigen, welche Beobachtungen mit Hilfe der HABITALP-Datenreihen tatsächlich möglich sind. Die Veränderungsmatrix (Daten-Kreuztabelle beider Interpretationsdatenreihen) zeigt verschiedene Arten von Elementen: natürliche Veränderungen (z.B. Vegetationsdynamik); vom Menschen herbeigeführte Veränderungen (z.B. Urbanisierung) und Artefakte (Korrekturen und Fehler). Es wurde ein erster Katalog von Überwachungsregeln vorgeschlagen. Zu einem späteren Zeitpunkt wird eine synchronische Analyse durchgeführt, um die natürlichen Entwicklungstrends anhand einer einzelnen Datenreihe abzubilden. Durch verschiedene Spaltenkombinationen wird eine Hierarchie erstellt, die aufzeigt, in welchen Lebensräumen am ehesten Veränderungen zu erwarten sind.

Schließlich werden die zugrunde gelegten Elemente (Ziele der EU-Richtlinie) und die tatsächlichen Ergebnisse (HABITALP-Datenanalyse) zusammengefasst und verglichen. Daraus werden allgemeine Überwachungsregeln sowie methodologische Grenzen abgeleitet. Am Ende erfolgt eine vergleichende Bewertung der Möglichkeiten und Grenzen dieser Arbeit und der HABITALP-Methode. Diese liefert auch Vorschläge für zukünftige Projekte.

Riassunto

Il seminario ha l'obiettivo di evidenziare le potenzialità dei dati HABITALP per lo studio degli habitat naturali, in particolare nell'ambito di NATURA 2000.

La prima fase del lavoro si è concentrata su due obiettivi: riassumere i requisiti della direttiva habitat 92/43/CEE e definire le aspettative dei partner del progetto riguardo al seguito da dare ad HABITALP. Gli obiettivi della direttiva 92/43/CEE sono stati ripresi e discussi. Grazie a questo studio preliminare sono state evidenziate le caratteristiche degli habitat naturali da analizzare per soddisfare gli obiettivi di sorveglianza di NATURA 2000. Inoltre, nel discutere le aspettative dei partner del progetto riguardo alle applicazioni future di HABITALP sono emerse con particolare chiarezza nel corso del seminario le problematiche attinenti le aspettative in termini di efficacia gestionale.

La seconda fase verteva sull'analisi delle effettive possibilità offerte dai dati HABITALP per il monitoraggio degli habitat. L'analisi si è basata sulla valutazione della frequenza d'uso dei diversi gruppi di dati. Questo lavoro ha permesso di inquadrare le seguenti analisi e di delineare alcuni limiti metodologici. Successivamente sono state studiate le transizioni fra i dati risultanti da due generazioni di foto aeree (1997 e 2003), allo scopo di evidenziare ciò che effettivamente è possibile osservare grazie ai dati HABITALP. La matrice di transizione (tabelle di dati incrociati delle due serie di interpretazioni) mostra diversi tipi di elementi: transizioni naturali (ad esempio la dinamica della vegetazione), transizioni provocate dall'uomo (ad esempio l'urbanizzazione) e artefatti (correzioni ed errori). E' stata proposta una prima serie di regole di sorveglianza. In un secondo tempo viene svolta l'analisi sincrona di una sola serie di dati allo scopo di evidenziare le «tendenze» dinamiche: si classificano in ordine decrescente le combinazioni di diverse colonne al fine di individuare gli habitat con maggiori probabilità di evolversi nel tempo.

Infine gli elementi richiesti (obiettivi della direttiva europea) e i risultati effettivi (analisi dei dati HABITALP) sono stati riassunti e confrontati. Se ne traggono regole di sorveglianza generali e limiti metodologici. La conclusione è una valutazione comparata delle potenzialità e dei limiti del lavoro in oggetto, nonché della metodologia HABITALP. Il seminario ha ugualmente permesso di formulare alcune proposte su possibili programmi futuri.

Results

The complete illustration of results of the work package “NATURA 2000 & Monitoring (part 2) including the guidelines for the surveillance of habitats ("surveillance rules") are available in English and French in the content management system of the HABITALP project. Please see http://www.habitalp.de for access.

HABITALP

Landscape Diversity

Implementation of common alpine methods for landscape diversity modelling as an instrument for protected area management and future cooperation – WP10

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HABITALP

Landscape Diversity

Summary

On account of its physiographic and climatic characteristics, its cultural differences and its geographical position the alpine space shows a particularly high number of – partly endemic – species and unique ecosystems. Various forms of vegetation can be found close together. That is why this high mountain region plays such an important role regarding the conservation of biological diversity in Europe. The Alpine Convention integrates these circumstances and provides the basis for the indispensable cross-border cooperation. Being aware of this fact a separate work package is dedicated to the examination of landscape (bio)diversity within the HABITALP-project. The realized aerial image flights together with common guidelines for delimitation and interpretation and a common interpretation key, which were used to delimit habitats in the involved protected areas formed the basis for the analysis. Founded on the resulting digital interpretation datasets of the project partners, parameters and methods have been gathered to model landscape diversity within a Geographical Information System (GIS). The aim was to develop a tool for diversity assessment by making use of the comprising information of the interpretation key. The result should serve as one additional decisive factor for prior management areas.

The diversity of the relief and the habitats were chosen as parameters to derive landscape diversity and show the potential of the HABITALP-datasets. However, not the complex application of GIS procedures was the focus of attention but the intensive preoccupation with landscape diversity by the involved project managers. Specific diversity characteristics on the local level of the respective protected area were the starting point for the development of a common idea of the meaning of landscape diversity on the alpine level. All methodical steps have been discussed, validated and proved in terms of practical usefulness in close cooperation and open exchange together with the project managers of the partner areas. This procedure leads to an application-oriented process, which was aimed at the needs of the partner areas, as well as to the acceptance of the methods as a condition for future application of the results.

Résumé

En raison des caractéristiques physiographiques et climatiques, des différences culturelles et de sa position géographique, l'espace alpin offre une grande variété d'espèces - en partie endémiques – et des écosystèmes uniques. Des formes de végétation différentes sont regroupées sur une surface relativement petite. Voilà pourquoi cette région de haute montagne joue un rôle essentiel dans la conservation de la biodiversité en Europe. Dans cet esprit, la Convention Alpine offre le cadre pour l'indispensable coopération transfrontalière. Le projet HABITALP, prenant acte de ces circonstances, a prévu un work package précisément consacré à l'examen de la biodiversité du paysage. Les analyses sont basées sur les relevés aéro-photogrammetriques, sur le manuel de délimitation et d'interprétation et sur la clé d'interprétation – des outils communs permettant de délimiter les habitats dans les espaces protégés participant au projet. Sur le fondement des données de l'interprétation numérique des partenaires on a réuni les paramètres et les méthodes de modélisation de la diversité du paysage à entrer dans le Geographical Information System (GIS). L'objectif était de créer un outil d'évaluation de la diversité qui exploite la masse d'informations de la clé d'interprétation et devienne un instrument décisionnel supplémentaire dans certains domaines prioritaires de gestion.

La diversité du relief et des habitats a été choisie comme paramètre pour définir la diversité du paysage et mettre en évidence le potentiel des banques de données HABITALP. Toutefois, l'accent du projet n'était pas sur les procédures complexes du GIS, mais sur l'engagement profond des partenaires du projet en vue de préserver la diversité du paysage. Les caractéristiques spécifiques de la diversité au niveau régional dans les espaces protégés respectifs ont servi de point de départ pour aboutir à une vision commune de l'importance de la diversité paysagère au niveau alpin. Toutes les étapes méthodologiques des travaux ont été discutées, validées et testées, au niveau de leur utilité pratique, en collaboration étroite avec les managers des espaces partenaires. Cette procédure a permis d'adopter une démarche tenant compte des exigences des régions et orientée aux applications pratiques, mais aussi à l'acceptation des méthodes comme condition nécessaire pour permettre l'application future des résultats.

Zusammenfassung

Der Alpenraum weist aufgrund seiner naturräumlichen und klimatischen Eigenschaften, seiner kulturellen Unterschiede sowie seiner geografischen Lage eine besonders hohe Anzahl an – teilweise endemischen – Arten sowie einzigartigen Ökosystemen auf. Unterschiedlichste Vegetationsformen kommen dabei auf engem Raum nebeneinander vor. Hinsichtlich der Erhaltung der biologischen Vielfalt in Europa kommt diesem Hochgebirge daher eine besondere Bedeutung zu. Das „Übereinkommen zum Schutz der Alpen" („Alpenkonvention") integriert diesen Sachverhalt und liefert damit die Grundlage für die notwendige grenzüberschreitende Zusammenarbeit. In diesem Bewusstsein ist der Untersuchung der landschaftlichen (Bio)Diversität im Rahmen des HABITALP-Projekts ein eigenes Arbeitspaket gewidmet. Die Grundlage der Analysen bildeten die durchgeführten Luftbildbefliegungen sowie eine gemeinsame Kartieranleitung und ein gemeinsamer Interpretationsschlüssel, mit deren Hilfe in den beteiligten Schutzgebieten Lebensräume abgegrenzt wurden. Auf Basis der daraus resultierenden digitalen Interpretationsdatensätze der Projektpartner wurden Parameter und Methoden entwickelt, um die Landschaftsdiversität mit Verfahren eines Geografischen Informationssystems (GIS) zu modellieren. Ziel war es, ein Instrument zur Abschätzung der Diversität zur erarbeiten, welches die umfangreichen Informationen des Interpretationsschlüssels nutzt, um als eine zusätzliche Entscheidungsgrundlage für prioritäre Managementbereiche zu dienen.

Die Vielfalt des Reliefs und der Habitate wurden als Eingangsparameter ausgewählt, um die Vielfalt der Landschaft herzuleiten und damit das Potential der HABITALP-Datensätze aufzuzeigen. Jedoch stand nicht die komplexe Anwendung des GIS im Vordergrund sondern die intensive Auseinandersetzung der beteiligten Projektmanager mit der Thematik der landschaftlichen Diversität. Deren spezifische Ausprägung auf der regionalen Ebene des jeweiligen Schutzgebiets bildete den Ausgangspunkt für die Entwicklung einer gemeinsamen Vorstellung der Bedeutung der Landschaftsdiversität auf alpiner Ebene. Alle methodischen Schritte der Arbeiten wurden in enger Kooperation und offenem Dialog mit den Projektmanagern der Partnergebiete diskutiert, validiert und auf praktischen Nutzen überprüft. Diese Vorgehensweise führte sowohl zu einer an den Bedürfnissen der Regionen ausgerichteten, anwendungsorientierten Bearbeitung, als auch zur Akzeptanz der Methoden als Voraussetzung der zukünftigen Umsetzung der Ergebnisse.

Riassunto

Per le sue caratteristiche fisiografiche e climatiche, le sue differenze culturali e la sua posizione geografica, lo spazio alpino presenta un numero particolarmente elevato di specie – in parte endemiche – e di ecosistemi unici. Diverse forme vegetative possono essere individuate in spazi ristretti, vicine l'una all'altra. A questa regione di alta montagna spetta quindi una particolare importanza ai fini della conservazione della biodiversità in Europa. La Convenzione per la Protezione delle Alpi (Convenzione delle Alpi) integra queste circostanze e fornisce così la base per la necessaria cooperazione transfrontaliera. Con questa consapevolezza, il progetto HABITALP ha dedicato un apposito work package all'analisi della (bio)diversità paesaggistica. Le analisi sono basate sui voli aerofotogrammetrici, sulla guida per la delimitazione e l'interpretazione e sulla chiave di interpretazione comuni, che permettono di delimitare gli habitat nelle aree protette coinvolte nel progetto. Sulla base dei dati digitali di interpretazione che ne risultano per i vari partner, sono stati sviluppati parametri e metodi per modellare la diversità paesaggistica con le tecniche di un Sistema Informativo Geografico (GIS). L'obiettivo era quello di elaborare uno strumento per valutare la diversità, che utilizzasse le ampie informazioni della chiave di interpretazione e che fungesse da base decisionale aggiuntiva per alcune aree prioritarie di gestione.

La diversità dei rilievi e degli habitat è stata scelta come parametro per ricavare la diversità paesaggistica e quindi per mettere in evidenza il potenziale delle banche dati di HABITALP. L'attenzione tuttavia non era focalizzata sulla complessa applicazione del GIS, bensì sull'intenso trattamento della diversità paesaggistica a cura dei manager di progetto coinvolti. Le caratteristiche specifiche della diversità a livello regionale nella rispettiva area protetta rappresentavano un punto di partenza per lo sviluppo di un'idea comune dell'importanza della diversità paesaggistica a livello alpino. Tutti i passi metodologici dei lavori sono stati discussi in stretta cooperazione e in un dialogo aperto con i manager delle aree partner, validati e verificati in termini di utilità pratica. Questa procedura ha portato ad una gestione in funzione delle esigenze delle regioni ed orientata all'applicazione, ma anche all'accettazione dei metodi come presupposto per l'applicazione futura dei risultati.

Background and objectives

Treatment of the work package

During the duration of the HABITALP-project two different subcontractors worked on this work package:

- University of Lausanne (UNIL): October 2003 – April 2005 (19 months)
- e▪m▪u projekte: June 2005 – September 2006 (16 months)

Two interim reports (10/2003 to 04/2004; 05/2004 to 10/2004) and a final report of the University of Lausanne are available.

Thus, this final report only describes the work during the period from June 2005 to September 2006 when e▪m▪u projekte (Dipl.-Ing. (FH) Jochen GRAB) was in charge of the work package (although the contractual basis was given not before June 16th, 2005, this report also comprises the work of the subcontractor before this date, e.g. technical workshop in Bolzano, I on May 24th, 2005).

Even so, the report takes up results of UNIL selectively and describes how they were used.

The work package 10 – "Landscape Biodiversity" within HABITALP

As the following graph shows, the Work Package 10 is one of four application-oriented subjects within the HABITALP-project. An important issue is the need to develop integrated datasets throughout the continent (EEA, 2006). This demand of the European Environment Agency could be fulfilled by the HABITALP-project. It was the job of Work Package 10 to discover the potential and the practical use of the general methodology and the datasets of HABITALP for alpine landscape management.

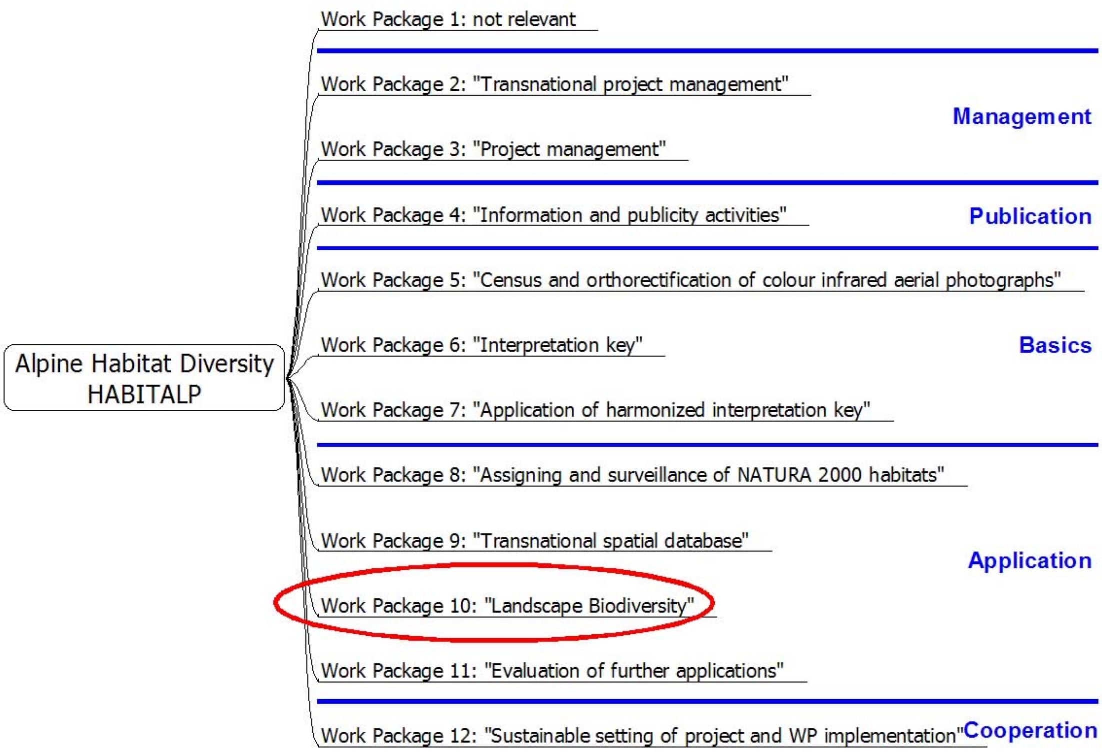


Figure 47: Structure of the HABITALP-project

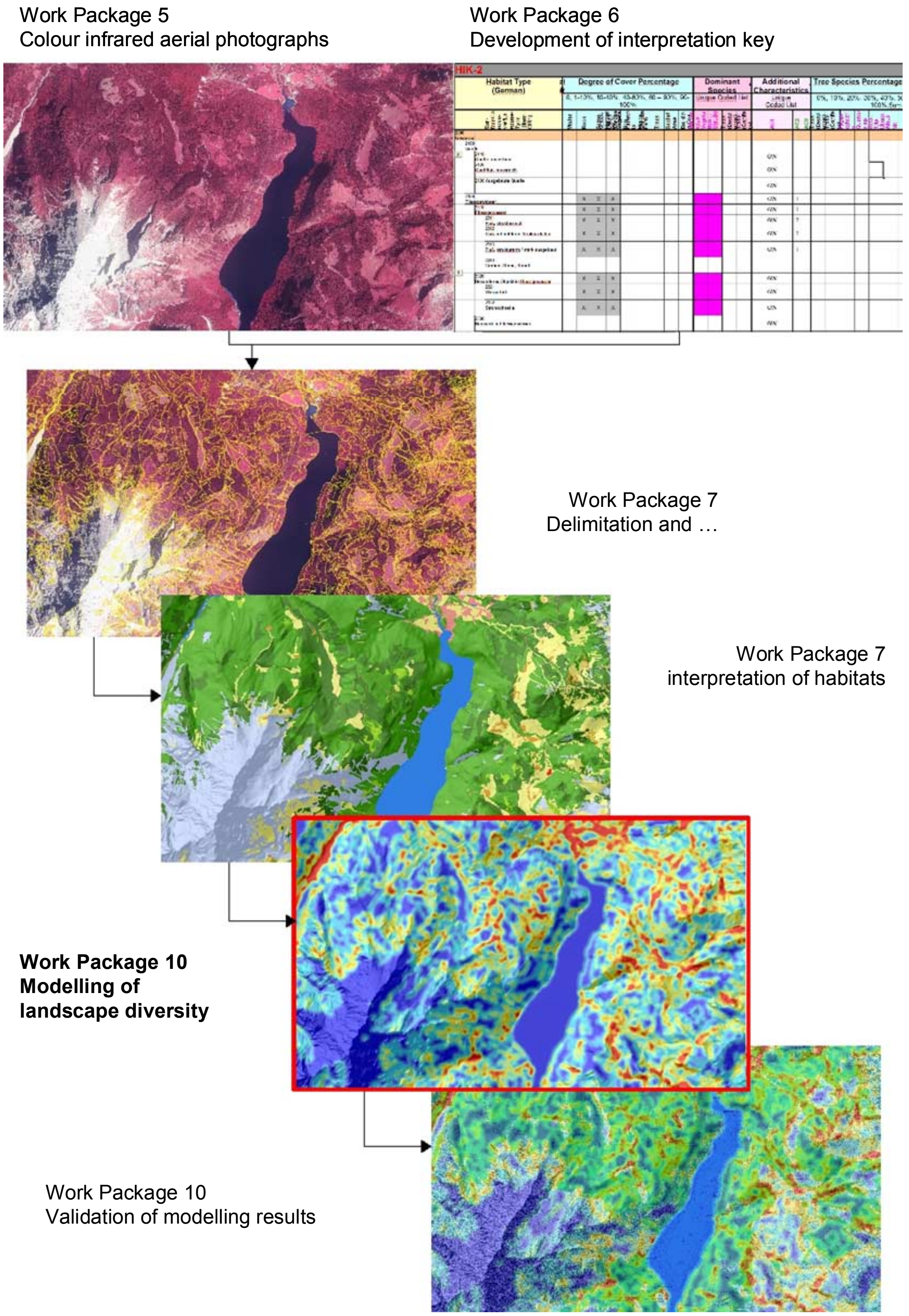


Figure 48: indicates the interplay of the different work packages.

Pilot character

The pioneer opportunities for analysing landscape diversity result from the pilot character of the work packages 5 (Aerial Image Flihgts), 6 (Interpretation Method) and 7 (Aerial Image Interpretation):

- Surface covering census of land cover types in the alpine space
- Digital orthophotographs of the partner areas
- Joint standardized interpretation key for alpine habitats detectible on colour infrared aerial photographs
- Common guidelines for delimitation and interpretation of habitats on CIR images combined with harmonized technical qualifications of the interpreters
- Multilingual documentation

These outcomes made landscape diversity analyses throughout the Alps feasible. They have been provided for all Project Partners with usable interpretation data.

The main objective of this Work Package was to develop methods and parameters to describe landscape diversity based on the HABITALP-interpretation data.

Analyses had to be realized from an application-oriented point of view.

In order to obtain these results a continual process of including the project partners and their needs into the development of the methods and analysis was absolutely essential. This leads to an increase of both, identification with and communication within the Work Package and thus to a great acceptance of the elaborated results. This formed the basis of an application-oriented work in general. According to this principle the work has been be aimed at.

By including the project group in the discussion process on different parameters, an improved and especially a common understanding of landscape diversity could be achieved. The realization of this milestone will serve to develop the vision of alpine landscape management in future, which was established during the HABITALP-project.

Interactions between alpine and regional/local level

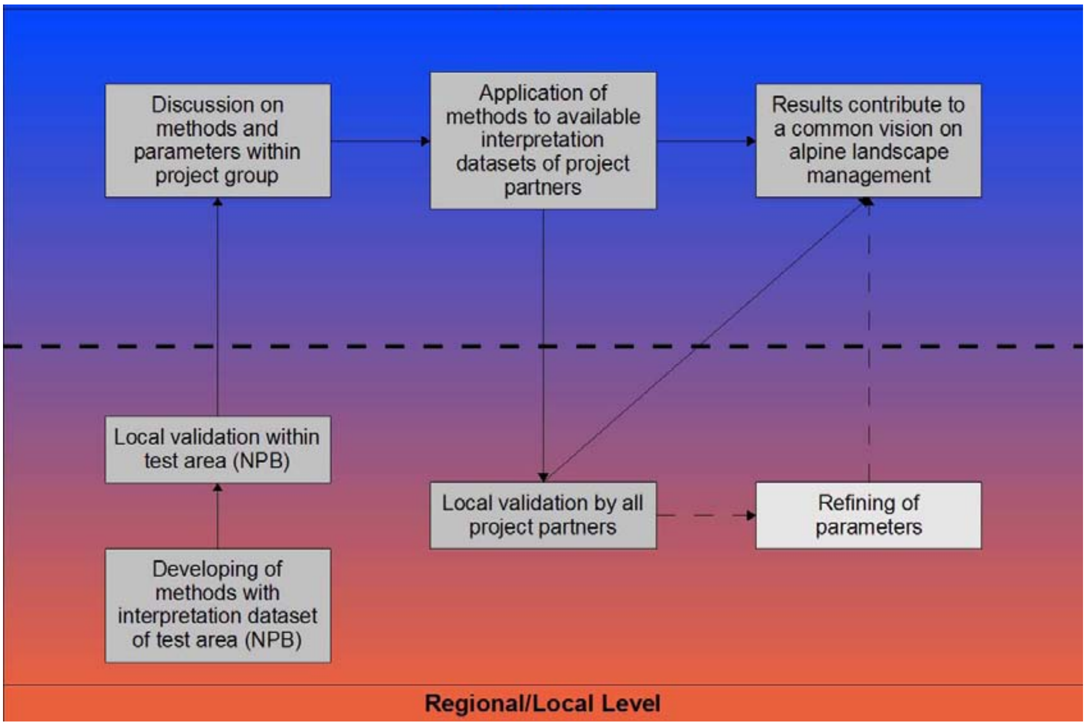


Figure 49: Reference of Work Package 10 to the alpine and regional/local level.

Organisational and technical implementation

General workflow

The most comprehensive objective of Work Package 10 was the cooperation on alpine landscape management. The strategy shown in figure 50 helped to achieve this aim.

Four technical workshops were held in the time between May 2005 and September 2006:

- Bolzano, I; May 24th, 2005
- Chambéry, F; July 12th, 2005
- Chur, CH; October 18th, 2005
- Zernez, CH; April 10th, 2006

The increasing numbers of participants attending the workshops indicate the great interest of the Project Managers in discussing and exploring the subject of landscape diversity in order to gather personal experience. But it also confirms the correctness and necessity of integrating the Project Partners in the process as much as possible. This is also one reason why the know-how of other already accomplished methods (e.g. software tools like IDEFIX of the SPIN project or Mapscape of UNIL) was used to accelerate or complement the Work Package implementation, but this process was not fully based on them.

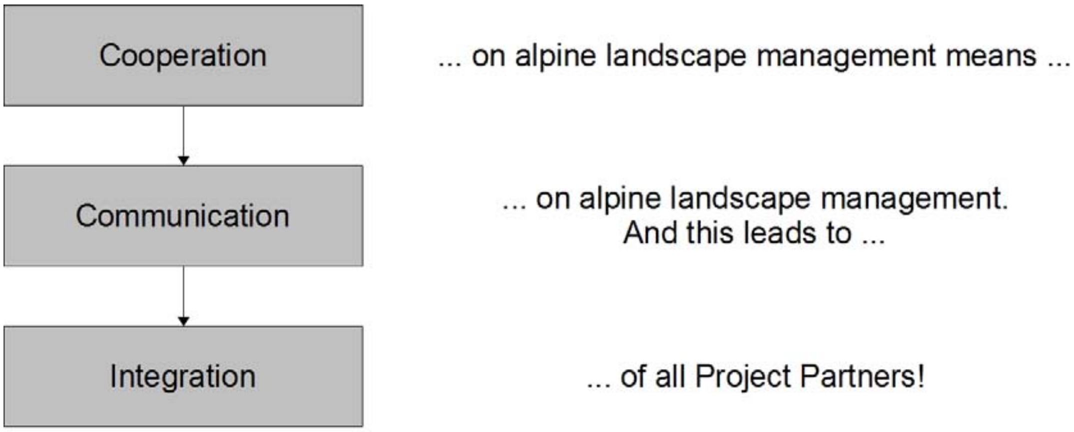


Figure 50: General strategy of Work Package implementation

In addition to the technical workshops, two project conferences took place in Aosta, I (November 16th-17th, 2005) and in Berchtesgaden, D (September 14th-15th, 2006), where the results of Work Package 10 were presented by the subcontractor.

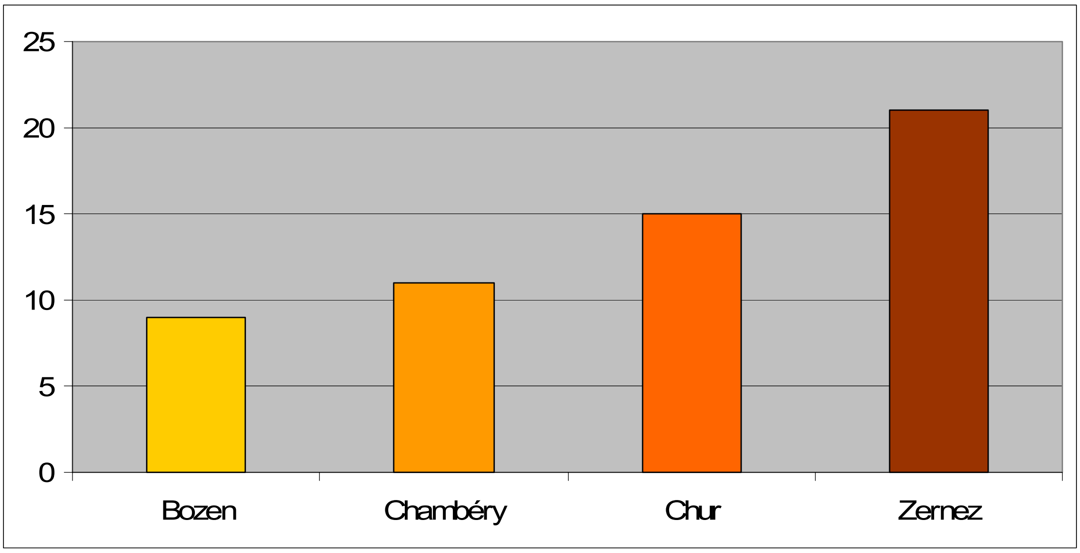


Figure 51: Number of participants attending the technical workshops

Methodological development

While the first project period from June to October 2005 has been determined by methodical development, the second part of the project focused on the selection of the most application-oriented solution to make landscape diversity visible on the basis of the interpretation data of the Project Partners. This selection has become necessary in order to identify one possible and – regarding the remaining project time – feasible solution out of the great number of different approaches. It was entirely due to the strong participation of the Project Partners during the discussions which made this important step possible and lead to intensive studies within the subject of landscape diversity.

The methodological development of the parameters describing landscape diversity is explained by summarizing the four technical workshops.

In order to accelerate the Work Package progress the first workshop was realized in May 2005 (Bolzano) in spite of incomplete contractual implementation. This workshop served to introduce the new subcontractor, but beyond that first methodical suggestions were presented, too.

Main subjects:

- Overview of the planned activities
- First methodical suggestions (with reference to UNIL results)
- Interlocking of habitat types

- Data quality: Comparability of results on the alpine level
- Description of the working methods

Discussion and results:

In the discussion questions arose concerning the potential of interlocking of habitat types and how to describe it. It was added that the digitizing accuracy plays a very important role within this subject. Many of the participants were interested in analysing the changes in the composition of landscape i.e. the potential of dynamic processes. A comparison between the protected areas with regard to their diversity should be possible. But also some fundamental questions dealing with how to find the suitable parameters and how to validate them later on came up.

Chambéry

Main subjects:

- Biodiversity: Possibilities of definition and determination
- Determination of landscape biodiversity
- Propositions of GIS-analysis to describe interlocking of habitat types
- First presentation of digital maps for NPB and PNE example data
- Connection between relief diversity and habitat diversity
- Validation of established parameters

Discussion and results:

The PowerPoint-presentation was interrupted several times by “live GIS-sessions” where the Project Partners had the possibility to get a real impression of the first results of analysis (habitat and relief diversity) by zooming in and out, showing different areas of interest and comparing the calculated diversity maps with the original interpretation data or other data like a hillshade model or a topographical map. This method invited the partners to really participate in the process. A great constructive discussion was the result.

After the presentation, the participants were asked for specific management questions and relevant habitat types which are of interest for the project partners and on which the further analysis should be based on to achieve application-oriented results. The main aspects of the very constructive discussion were qualitative approaches e.g. “which habitat types lead to high diversity and where?” or “which habitat types appear in which altitudinal zone?”.

Other contributions concerned dynamic or ecological processes and transition area development.

Chur

Main subjects:

- How can relief diversity be calculated by the parameters slope, aspect and curvature?
- Relief diversity + “External” habitat diversity = interim landscape diversity model
- Clarification of preparatory question: Areas of high/low diversity vs. important ecological areas vs. areas of large coherent habitats
- Explanation of “Internal” habitat diversity → towards the assessment of dynamic processes and transition areas
- Human influenced habitat types and their role within the assessment of habitat diversity
- Altitudinal zones and their impact on habitat diversity – quantitative and qualitative analysis
- Corridors (example of a specific application of HABITALP data)
- Comparison of protected areas and periphery concerning habitat diversity
- Time schedule for the remaining project duration

Discussion and results:

The workshop in Chur was the most comprising one regarding the topics of the presentation and the subjects of the following discussion. Basically the project partners agreed with the proposed method to describe landscape diversity by the parameters “Relief diversity“ (with slope, aspect and curvature), “External habitat diversity” (describing the spatial composition of habitat types regardless which habitat types are combined → quantitative approach) and “Internal habitat diversity” (analysing the diversity of the habitat type itself → qualitative approach).

During the meetings with the Landschaftsinformatikzentrum (FH Weihenstephan) the following topics could be answered (survey):

- Comparability of HIK 2-interpretations on the alpine level (different interpreters etc.)
- Delimitation of shaded polygons
- At which scale should HABITALP-data be used?
- Why do the interpreters not always use the greatest possible “depth”

(level of detail for habitat coding) during their interpretation although the interpretation key would provide more detailed habitat types?

Aosta (Project Conference)

The subcontractor had prepared a presentation for this project conference which could however not be presented for lack of time. The object was to inform all project partners (project managers and legal responsibles) of the present status of the Work Package. Within personal discussions, the subcontractor presented the "Interim" landscape diversity model (Relief diversity + "External" habitat diversity) to the Project Managers of NPHT, PNE and SNP. Useful remarks for the next steps of diversity modelling were the result.

Zernez

Main subjects:

- Assessment of landscape diversity and the results up to now
- Determination of the "Internal" habitat diversity
- Time schedule for the remaining project duration

Analysing landscape diversity

The landscape diversity analyses within Work Package 10 have been realized with ESRI ArcGIS 9.1 (ArcEditor). Thus, all technical expressions used in this report that are not explained separately come from this software package.
As developed during the workshops in Bozen, Chambéry, Chur and Zernez the methodology of deriving landscape diversity can be described by the following graph.

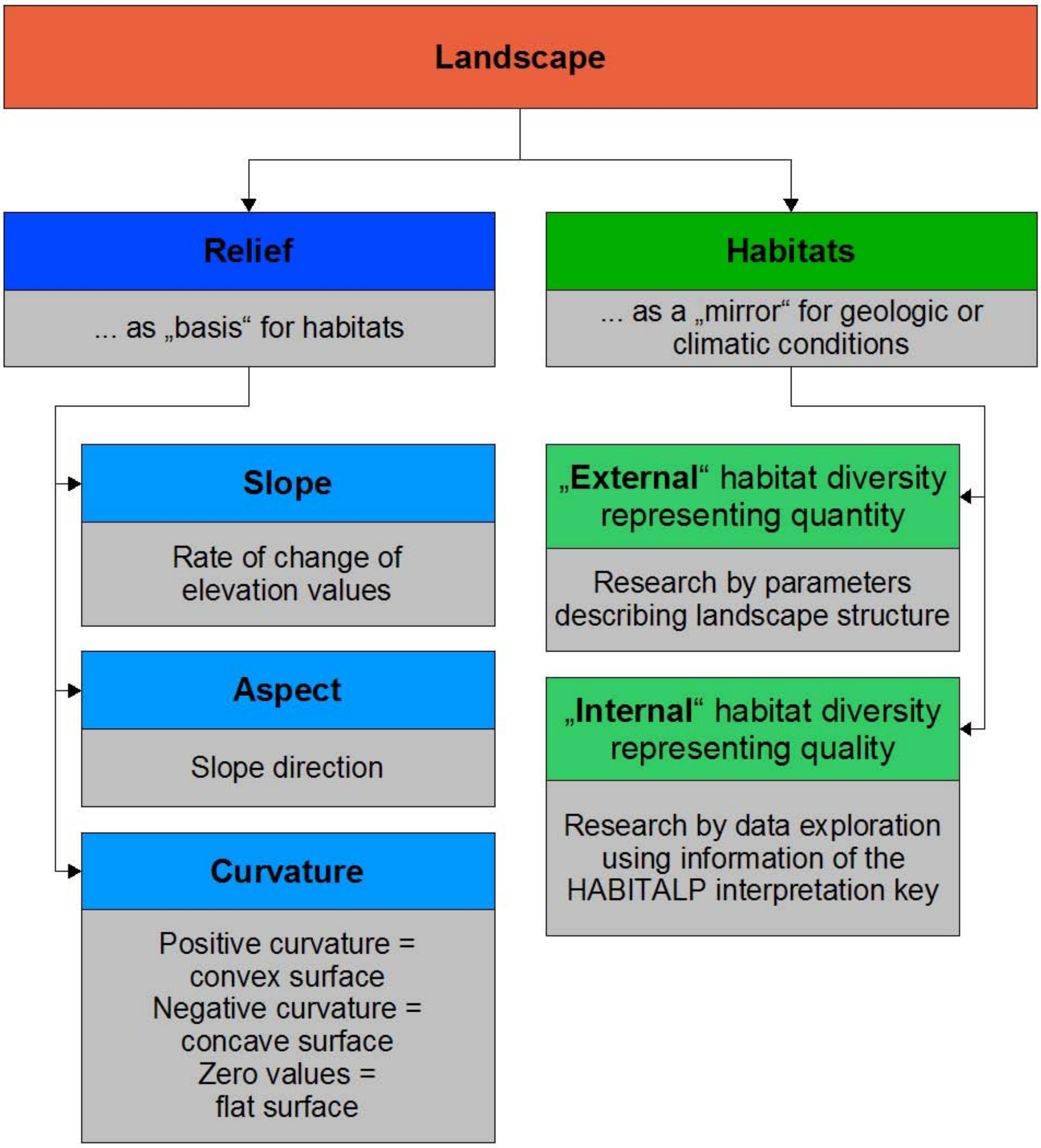


Figure 52: Parameters describing landscape diversity

The expressions of "External" and "Internal" habitat diversity are not conventional. Both of them have been developed by the subcontractor following the technical discussions of the workshops. They are explained separately in the next two chapters.

"External" habitat diversity

No. 1: Interpretation key
The Interpretation Key forms the starting point for the habitat diversity analyses. To derive "External" habitat diversity, the column, which contains the habitat type, is used.

No. 2: Attribute table in a Geographic Information System (GIS)
While determining the habitat types on the aerial images, the interpreter fills out a specific column in the attribute table, which contains the detected habitat types.

No. 3: Visualization of habitat types
The different habitat types detected by the interpreter can be displayed in a GIS.

No. 4: Calculation process
As a powerful tool, a GIS offers a wide range of possibilities to explore spatial data. Here, a statistical function (Focal Variety) is used to determine the number of unique values (i.e. habitat types) within a specified neighbourhood (see table 16).

No. 5: Model of "External" habitat diversity (same part of the map as number 3)
The result of the calculation process is a model, which presents new information about the original data (interpretation dataset). Red areas indicate high numbers of different cell values, i.e. existence of many different habitat types on a small area, i.e. a mosaic landcover. Blue areas show the opposite, i.e. areas with only one or few occurring habitat types, i.e. large coherent habitats.

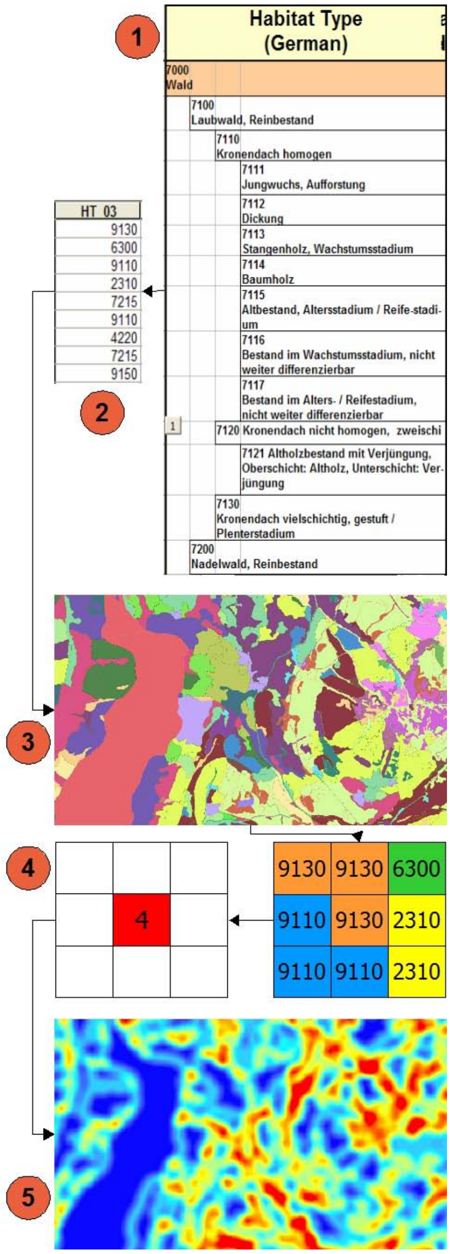


Figure 53: Assessment of "External" habitat diversity

The "External" habitat diversity is expressive regarding the degree of interlocking of habitats by applying a quantitative methodology.

“Internal” habitat diversity

No. 1: Interpretation key
The information of another part of the Interpretation Key (columns of Degree of Cover) is used to assess the “Internal” habitat diversity.

1

Degree of Cover Percentage								
0, 1-10%, 10-40%, 40-60%, 60 – 90%, 90-100%								
Water	Rock	Scree	Grass, Herbaceous Vegetation	Dwarf Shrubs, Perennial Herbs, Fern	Shrubs	Trees	Sealed Area	Building Cov.

2

DC WATER 0	DC ROCK 03	DC SCREE 0	DC GH 03	DC DS 03	DC SHRUBS	DC TREES 0	DC SEALED	DC BUILDNG
0	0	0	0	0	0	0	0	5
0	0	0	1	0	0	5	0	0
0	0	0	3	0	1	1	1	2
0	0	0	0	0	0	0	0	0
0	0	1	4	1	0	2	0	0
0	0	0	1	0	0	1	3	2
0	0	0	5	0	0	1	0	0
0	0	0	2	0	0	4	0	0
0	0	0	3	0	0	1	1	2

3

DC WATER 0	DC ROCK 01	DC SCREE 0	DC GH 01	DC DS 01	DC SHRUBS	DC TREES 0	DC SEALED	DC BUILDNG	SUM
0	0	0	0	0	0	0	0	1	1
0	0	0	1	0	0	1	0	0	2
0	0	0	1	0	1	1	1	1	5
0	0	0	0	0	0	0	0	0	0
0	0	1	1	1	0	1	0	0	4
0	0	0	1	0	0	1	1	1	4
0	0	0	1	0	0	1	0	0	2
0	0	0	1	0	0	1	0	0	2
0	0	0	1	0	0	1	1	1	4

No. 2: Attribute table in a GIS
Depending on the observed percentage of Degree of Cover within a habitat, the interpreter puts down these values into the attribute table by means of codes.

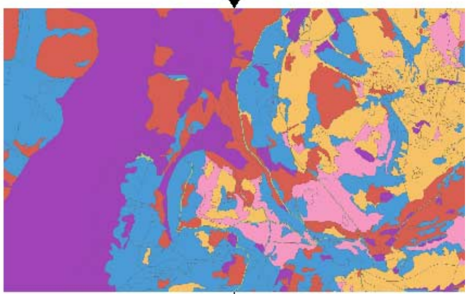
No. 3: Conversion and addition
All cells with values, i.e. with discovered additional structure within a habitat (e.g. rocks, trees, etc.) receive the value 1. All others remain 0. Negative values (e.g. shaded areas) are also changed to 0. After that, a new field is added to the table containing the addition of each row.

No. 4: Visualization
The additional structure (Degree of Cover) is displayed in a GIS.

No. 5: Calculation process
Another statistical function (Focal Sum) adds the values within a specified neighbourhood (Tab. 1).

No. 6: Model of “Internal” habitat diversity
Red areas show habitats with a high share of “internal” structure beyond what can be described by the column “Habitat Type”. Blue areas indicate uniform habitats.

4



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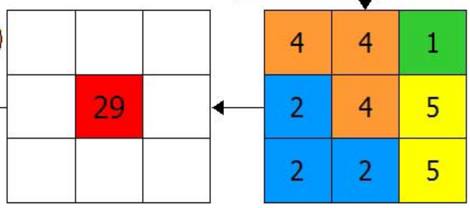

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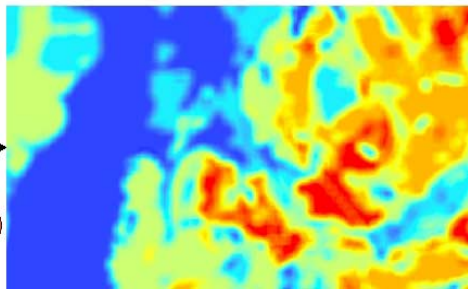


Figure 54: Assessment of “Internal” habitat diversity

The “**Internal**” habitat diversity represents an exemplary application of the Interpretation Key to describe habitat structure by a qualitative approach.

The “**Internal**” habitat diversity represents an exemplary application of the Interpretation Key to describe habitat structure by a qualitative approach.

Table 16: Resolution of raster data and resulting search radius

Project Partner	Resolution of raster data [metres]	Resulting search radius for Focal Statistics
APB	20	100
ASTERS	20	100
CPNS	10	50
NPB	10	50
NPHT	10	50
PNE	50	250
PNV	80	400
SNP	4	20

For the calculation of the Focal Statistics (Variety, Sum) in ArcGIS, it is necessary to set a specific search area (radius) in which the neighbourhood relations shall be assessed. This search radius was determined in reliance on the resolution of the Digital Elevation Model (DEM) of the Project Partners (to which the Interpretation Datasets (= vector data) were adapted while being converted to a raster). Small-sized search areas provide results that are hardly cognizable or interpretable. Search areas, which are too large, lead to unnecessary coarsened results. A comprise between these extremes has to be found to achieve well-balanced models.

From the experiences with the test dataset of Nationalpark Berchtesgaden the search radius was determined to be five times the size of the DEM-cellsize. In the course of several tests this appeared to be the most suitable solution and provided the best results.

This procedure as well as the methodology of deriving Relief Diversity, “External” and “Internal” Habitat Diversity was at first tested and validated in the Nationalpark Berchtesgaden, discussed in the workshops and then transferred to the other partner areas.

Bottleneck: resolution of the Digital Elevation Model (DEM)

To assess landscape diversity, raster-based analyses are indispensable. In order to achieve expressive results the quality of the basic datasets is the decisive factor. While the Interpretation Datasets can be converted to a raster with any resolution, the Digital Elevation Models (DEM) becomes the bottleneck for the quality of the outcomes. Figure 55 shows the range of DEM-resolution among the Project Partners. It is exactly the same part of the landscape!

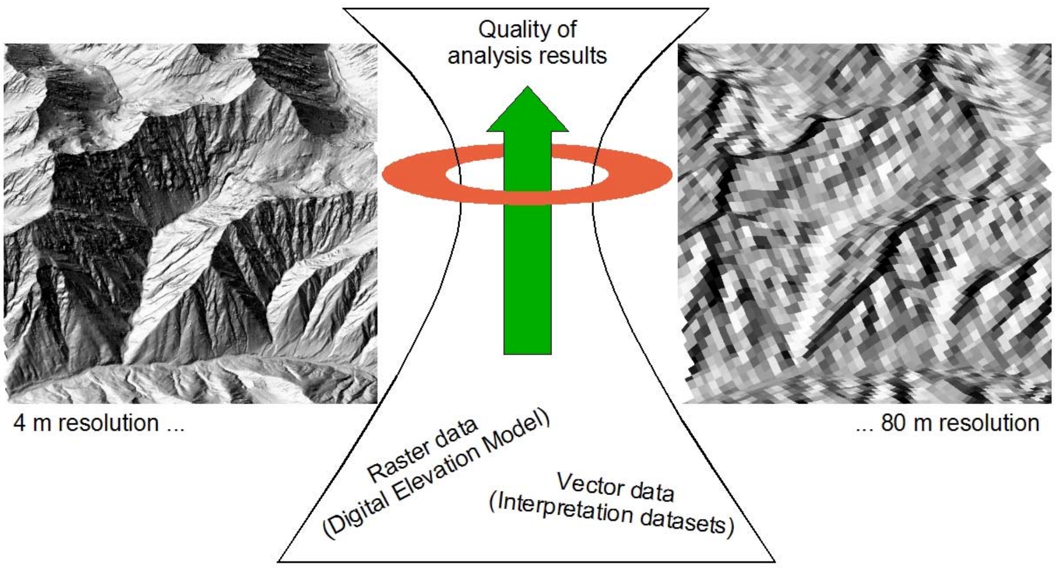


Figure 55: Raster resolution as bottleneck for the quality of analyses

Results of landscape diversity analyses for the alpine project partners

Table 17: Available interpretation data for landscape diversity analysis

Project Partners with interpretation data **usable** for landscape diversity analysis	Project Partners with interpretation data **not usable** for landscape diversity analysis	Project Partners without interpretation data
APB	PNGP	PNDB
ASTERS	PNMA	
CPNS		
NPB		
NPHT		
PNE		
PNV		
SNP		
→ WP 10-results **available**	→ WP 10-results **not available**	

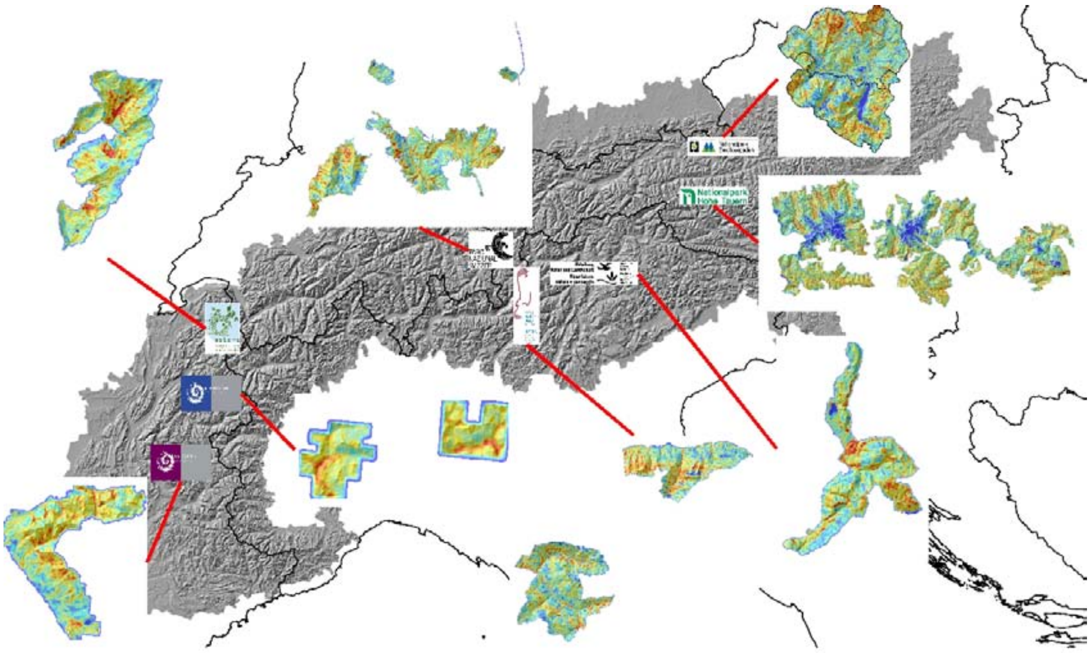


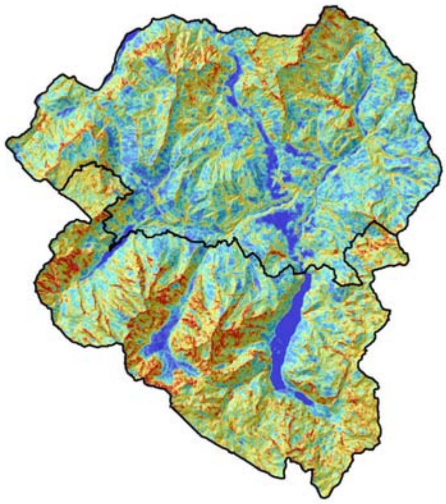
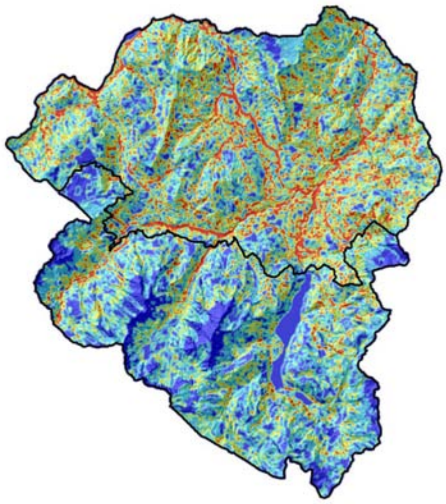
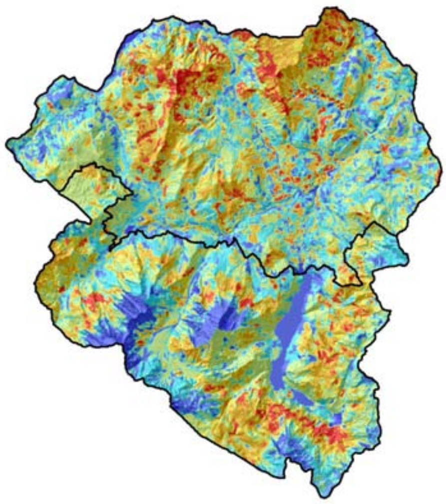
Figure 56: Calculated results of landscape diversity

Due to lack of space in this final report the results of landscape diversity analyses of each Project Partner can only be presented in an overall view.

On the next pages the interim parameters are explained by the example of Nationalpark Berchtesgaden.

Landscape Diversity

Explanations for the single parameters (example of Nationalpark Berchtesgaden (southern part) and its periphery)

Relief Diversity Red: ridges, deep valleys (clefts); steep walls with varying aspects Blue: valleys, plain	 Map A: Relief diversity in NPB
“External” habitat diversity Red: small-piece mosaic of different habitat types Blue: large coherent habitats (rocks, lakes, woods)	 Map B: “External” habitat diversity in NPB
“Internal” habitat diversity Red: area of interlocking of wood, alpine pasture and screes (between 1.300 an 1.600 m) Blue: large uniform habitats like lakes or rocks	 Map C: “Internal” habitat diversity in NPB

Landscape diversity (example of Nationalpark Berchtesgaden (southern part) and its periphery)

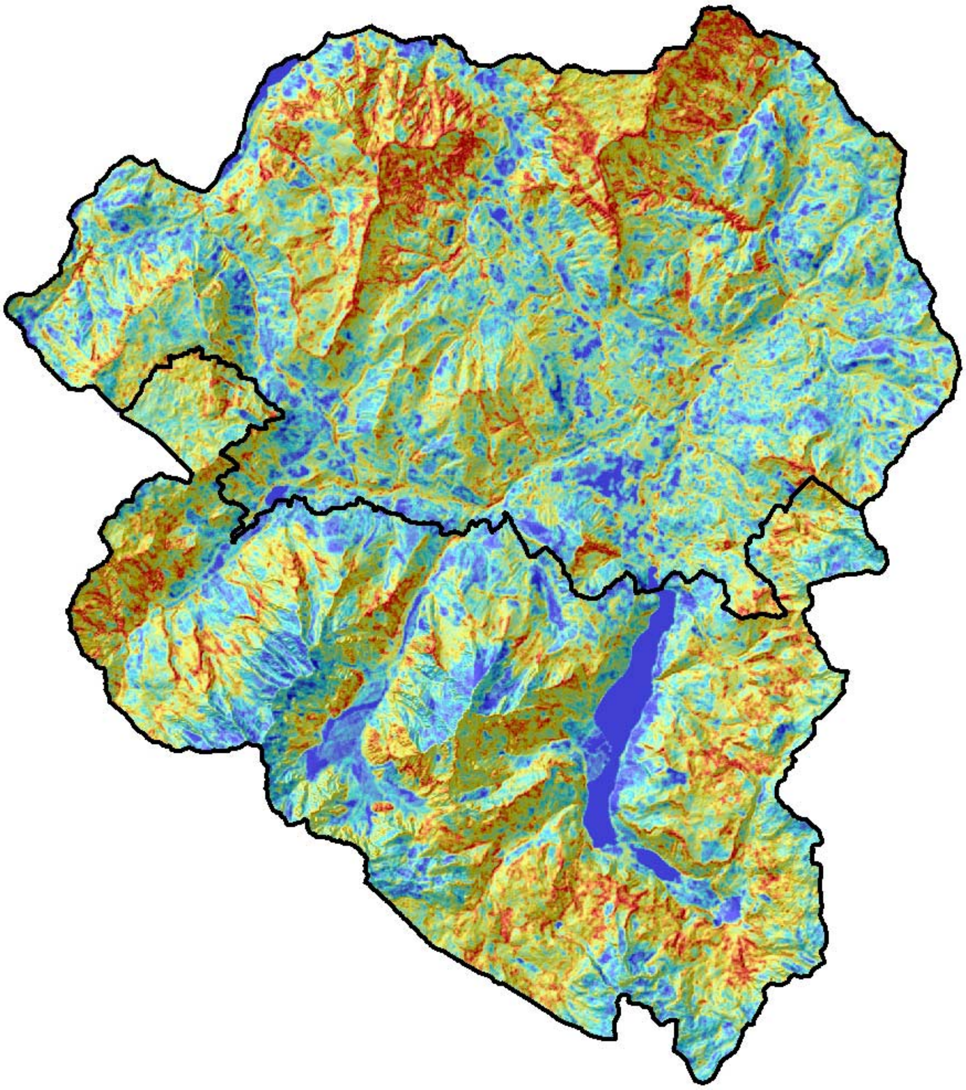


Figure 57: Landscape diversity model for NPB

Red: mosaic of ridges and canyons with varying aspects in combination with steep ascents in particular altitudinal zones
Blue: large uniform habitats

Coordinate system

Table 18: Transformation of coordinate systems

Project partner	Original coordinate system before transformation	Projected coordinate system after transformation
APB	PCS: ETRS_UTM_Zone_32N GCS_ETRS_1989	WGS_1984_ UTM_Zone_32N
ASTERS	PCS: NTF_France_II_degrees GCS_NTF	WGS_1984_ UTM_Zone_32N
CPNS	PCS: Monte_Mario_Italy_1 GCS_Monte_Mario	WGS_1984_ UTM_Zone_32N
NPB	PCS: DHDN_3_Degree_Gauss_Zone_4 GCS_Deutsche_Hauptdreiecksnetz	WGS_1984_ UTM_Zone_33N
NPHT	PCS: MGI_M31 *(shift: y: + 5.000.000)* GCS_MGI	WGS_1984_ UTM_Zone_33N
PNE	PCS: NTF_France_II_degrees GCS_NTF	WGS_1984_ UTM_Zone_32N
PNV	PCS: NTF_France_II_degrees GCS_NTF	WGS_1984_ UTM_Zone_32N
SNP	PCS: CH 1903 LV03 GCS_CH1903	WGS_1984_ UTM_Zone_32N

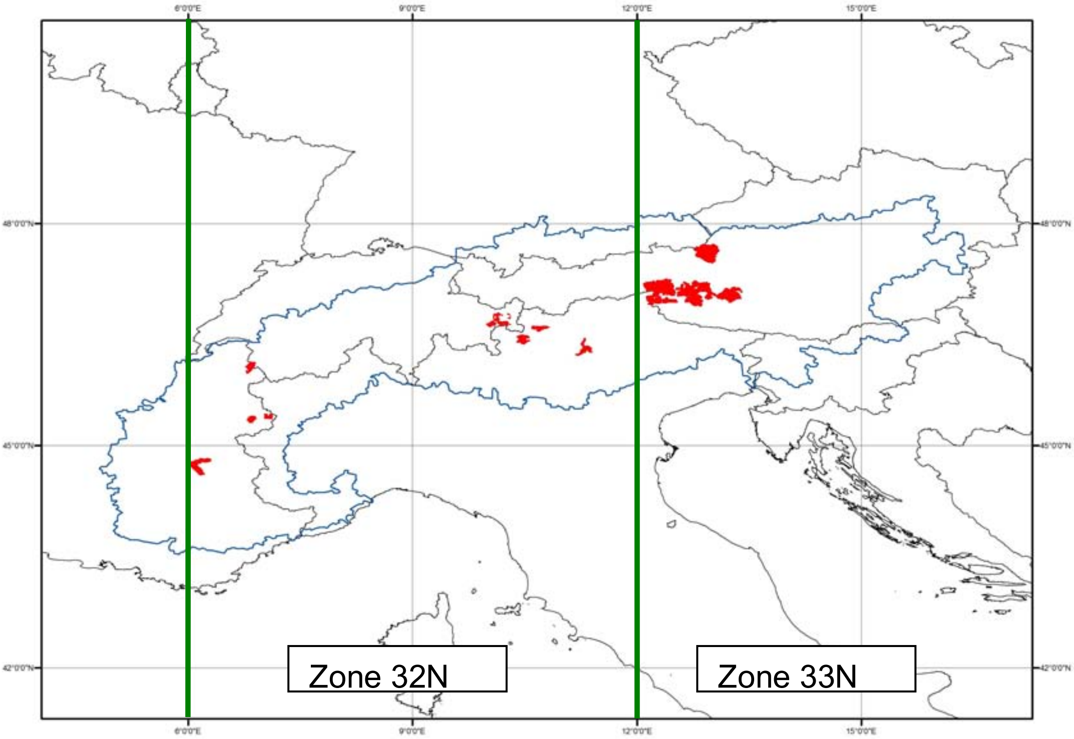


Figure 58: Location of project partners within the projected coordinate system WGS_1984_UTM_Zone_32N and Zone_33N.

The interpretation datasets of all project partners are available in the geographic coordinate system GCS_ETRS_1989. This is equivalent to GCS_WGS_1984. The digital elevation models were not available in one uniform coordinate system, but in the local ones used by the project partners for their areas. That is why they had to be transformed to GCS_WGS_1984 to be congruent with the interpretation datasets. In an additional step they were projected to the zones of the WGS_1984-System according to the location of the protected area.

Discussion and assessment

Validation by the project partners

Questionnaire

As a support for the Project Partners during the local validation process of the landscape diversity models, a short questionnaire was submitted by the subcontractor. Due to lack of time, it could only give a first assessment of the suitability of the applied methodology and serve to compare the validation between the Project Partners.

Contents of the questionnaire (summarized):

Sample points
Each Project Partner was asked to choose at least three sample points within his region and assess the four models concerning suitability. In addition to that it was of interest, which information could at this point serve to refine the models.

Questions on how the validation was realized

- By the knowledge of the area or experience of your own?
- By the knowledge of local experts?
- By maps containing additional information (topographical, geological, climate, vegetation maps)?
- By information from literature?

Conclusion
In a closing comment the Project Partners should assess the strength or weakness of the models and their applicability for local and alpine protected area management. The local ecological interpretation of the results is very important to get a realistic impression of the applicability and to carry out adjustments if necessary.

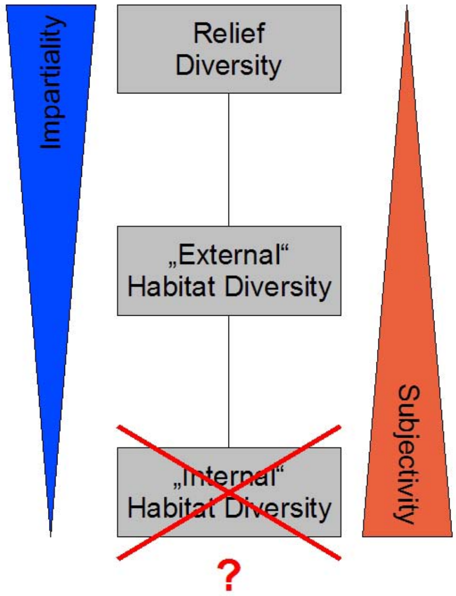


Figure 59: Parameters and impartiality/subjectivity

Assessment of the project partners

The following comments summarize the answers of the Project Partners.

- Should the calculation of landscape diversity only be based on the parameters “Relief Diversity” and “External Habitat Diversity”, because of too much subjectivity within the “Internal Habitat Diversity (e.g. interpretation style).
- In a first overall view the **model and local experts agree** in their determination of landscape diversity.
- Should **human influenced habitat** types (e.g. roads, buildings) be **excluded** from diversity analysis? (This question was discussed during the workshops many times, but could still not completely be answered.)
- Integration of **additional** information (e.g. intensity of grazing) could help to **improve** the model or adapt it to the specific needs/management demands of the protected area.
- At the present state the model can **form the basis** for landscape management strategies. It should be developed, refined and evaluated in future.
- It **shows the potential** of what is possible when using HABITALP-interpretation data.

The achieved results of Work Package 10 in comparison to the objectives of the application form

Objective: *Deriving the landscape biodiversity by modelling CIR interpretation data in the geographic information system and spatial database*.
Fulfilled.

Objective: *Common vision on alpine landscape management.*
Fulfilled, see "Guidelines of Cooperation on Landscape Management".

Main activity: *Modelling on one test area*.
Fulfilled.

Main activity: *Integration of new WP6(3) interpretation key.*
Fulfilled.

Main activity: *Integration of WP8(5) NATURA 2000 relationship.*
Could not be fulfilled, because no geographic data was available.

Main activity: *Transfer to all project areas.*
Fulfilled, as far as usable interpretation data was available.

Main activity: *Completion and integration into WP9(6) transnational database.*
Fulfilled.

Main activity: *Guidelines of cooperation on landscape management.*
Fulfilled.

Main activity: *Two-phased realization due to successive data input by WP7(4).*
Fulfilled.

Main activity: *Technical reports*
Fulfilled (two interim reports, one final report, the presentations and the minutes of the four technical workshops have been provided by the subcontractor).

Expected output/result: *Analysis methods of landscape diversity suitable for alpine transnational application.*
Fulfilled.

Expected output/result: *Analysis results achieved by the application of these methods to the available interpretation datasets.*
Fulfilled.

Expected output/result: *Visualization and mapping of the results.*
Fulfilled.

Expected output/result: *Comparative studies.*
Partly fulfilled, see presentation or minutes of the technical workshop in Chur. The beginnings of comparisons between altitudinal zones or protected area and periphery could be shown. Because of lack of time, only the potential applicability of HABITALP-interpretation data could be presented by the subcontractor.

Expected output/result: Evaluation of the potential applicability in questions of local landscape management.
Fulfilled. The applicability of the diversity results concerning local landscape management, management of protected areas or transnational landscape management have been one of the main topics during the technical workshops and in many personal discussions.

Expected output/result:
Recommendations for alpine transnational landscape management.
Fulfilled, see "Guidelines of Cooperation on Landscape Management".

Assessment:

Although there was only about one year left when the subcontractor joined the HABITALP-project, almost all of the expectations could be carried out. Reasons for deviations from the application form were because of a dynamic project development, which sometimes changed the initial situation or because of the strongly limited remaining project duration.

Transferability of applied methods

One important objective during the development of the landscape diversity parameters was the transferability of the methodology to other project areas. At best, it should be convenient to the entire Alpine Space or even to other mountain areas. To point out that the methodology is appropriate to do so, it was applied to the perimeter of the Alpine Convention. To this end the SRTM[1]-dataset with a resolution of 90 metres as elevation model and the CORINE[2] Land Cover dataset instead of the HABITALP-interpretation data were quoted to achieve an alpine wide model. Due to the different data structure of the HABITALP-interpretation data and CORINE Land Cover, it is not possible to calculate "Internal" Habitat Diversity. Thus, the calculation was restricted to the two

[1] Shuttle Radar Topographic Mission

[2] CORINE Land Cover 2000 (Switzerland from 1990)

parameters "Relief Diversity" and "External Habitat Diversity".

Figure 60 shows the "External" Habitat Diversity calculated with CORINE-data on the alpine level.

The dataset of Switzerland is not comparable to the other countries. It aggregates the classes of CORINE on Level 2 (other countries Level 3). That is why there is a different colour scheme.

On the top left there is a comparison between the analysis results of "External" Habitat Diversity using CORINE Land Cover data (left) and with HABITALP-interpretation data (right).

Although the map shows only one single parameter first ecological assessments are possible. For example, large coherent habitats (blue areas) are detectable that could potentially serve as habitats for big mammals or migrating species.

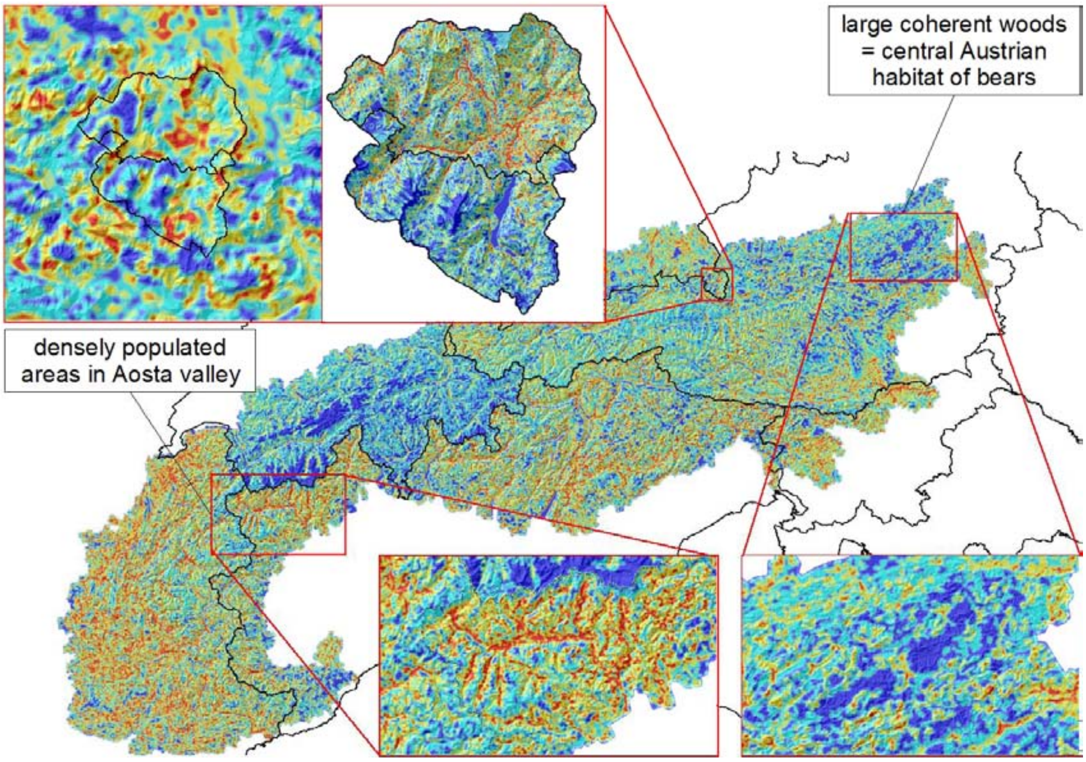


Figure 60: "External" Habitat Diversity calculated with CORINE Land Cover data

Conclusion

In summary it can be said that a common method of assessing landscape diversity within the HABITALP-project could be established considering the needs of the Project Partners as far as possible.

Most of the demands of the application form could be met within the term of the subcontractor, i.e. the last year of the project duration. The remaining time of the project was one limited reason, but some questions, parameters or methods also lead to greater discussions which could easily occupy another project. Thus it was extremely necessary to organise the work process very thoroughly to get a realistic view of what will be possible to do and what has to be put aside as contribution to further applications.

Added value and perspectives

Of course, HABITALP cannot provide direct information on biodiversity. Figure 61 indicates the components of biodiversity according to the Convention on Biological Diversity (CBD).

Following the discussions in the workshops another factor effects biodiversity, too: cultural diversity (Cortot).

But landscape diversity analysis and HABITALP interpretation data in general form the starting point for various studies to approach biodiversity.

Examples:

- Habitat suitability modelling
- Possibility of assessing the potential of species diversity
- Analysis on ecological corridors
- Possibility of comparative studies between protected areas
- Visualization of structures and combinations of habitats within the entire Alpine Space
- Transferability to regions outside protected areas and to other mountain areas

Especially the opportunity to get an overall view of the habitats throughout the Alpine Space represents a great chance to detect unique habitats. Within a single protected area they might be quite normal. Only when comparing them with the habitat structure of other areas they suddenly appear worth to be protected. This also means a raising of people's awareness to realize the Alpine Space as one connected, transboundary region and thus adjust the personal behaviour to this fact.

These circumstances form a powerful contribution of the HABITALP-project for the coordination of a transnational and interdisciplinary landscape management (see "Guidelines") as well as the realization of many international agreements (Alpine Convention, Convention on Biological Diversity, Bern Convention).

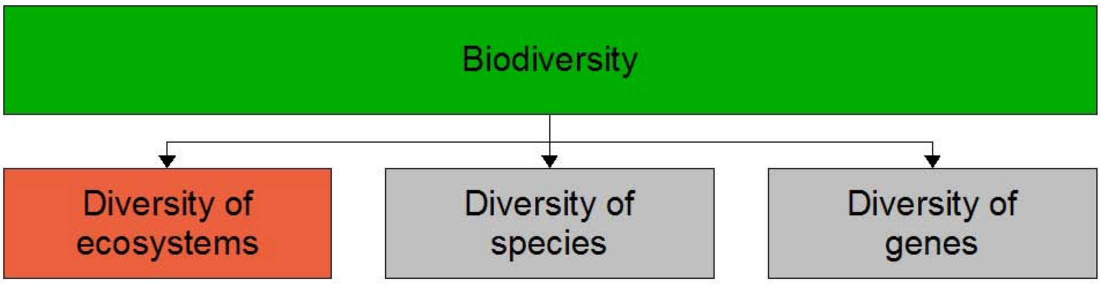


Figure 61: Components of biodiversity

Outlook

Encouragements of the HABITALP-project

Management of protected areas and biodiversity

In the present-day diversity research the attention is turned to highly diverse areas with a great variety of different units of vegetation or species. Areas including these components are considered to be of special interest concerning protection. The overall objective of reserve system design is to create a system of protected areas that conserves as much of a region's biodiversity as possible in the long term (Possingham et al., 2005). Protected areas in the Alpine Space are often emphasized as "Centres of biodiversity" and accordingly valuable. At the same time they have the principle of "allowing natural courses" in space and time. The analysis of the HABITALP-interpretation datasets could indicate a contradiction between these approaches and stimulates the reflection (Grab, 2006).

- How will the landscape/biodiversity of a protected area develop in future considering given up pastures, separation of forest and pastures, natural succession?
- Which forms of vegetation will prevail in the next decades?
- How did the landscape look like before the protected area was established (10, 100, 1.000 years ago)?
- How will the different forms of biodiversity develop in future? – considering the reduction of species diversity on account of an increasing (at once) and a decreasing level of utilization (within 5-20 years) (Bätzing, 2003)

Regarding the continually increasing human pressure on the available resources, an effective protected area system is the best hope for conserving viable, representative areas of natural ecosystems and their habitats and species. However, it must be understood that measurements of the number and extent of protected areas may only provide a superficial indication of the political commitment to conserving biodiversity (Chape et al., 2005). The degree to which biodiversity is represented within the existing network of protected areas is unknown (Rodrigues et al., 2004).

Most of today's habitat diversity is man-made and was only created since the spreading of human settlement. Natural habitat diversity is caused by storms, flooding, forest fire etc.

Figure 62: Towards the future development of the conservation of biodiversity

The interpretation of the diversity results (e.g. maps of "External" habitat diversity) raises the question, if the future expansion or establishment of protected areas – especially of those with a high status of conservation – should rather happen with reference to the protection of large coherent habitats and the observing of natural processes as the outstanding benefits of protected areas. Of course, this means also protection of biodiversity, but on another scale.

From this it follows that an increasing application of efficient tools for a sustainable development (and this is protection, too!) of the regions outside protected areas is necessary to incorporate the cultural diversity with all of its peculiarity.

HABITALP

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Guidelines of cooperation on landscape management

Jochen Grab

Figure 63 summarizes the experiences of the HABITALP-project and additionally presents recommendations for a common future landscape management.

Further explanations can be found on the following pages.

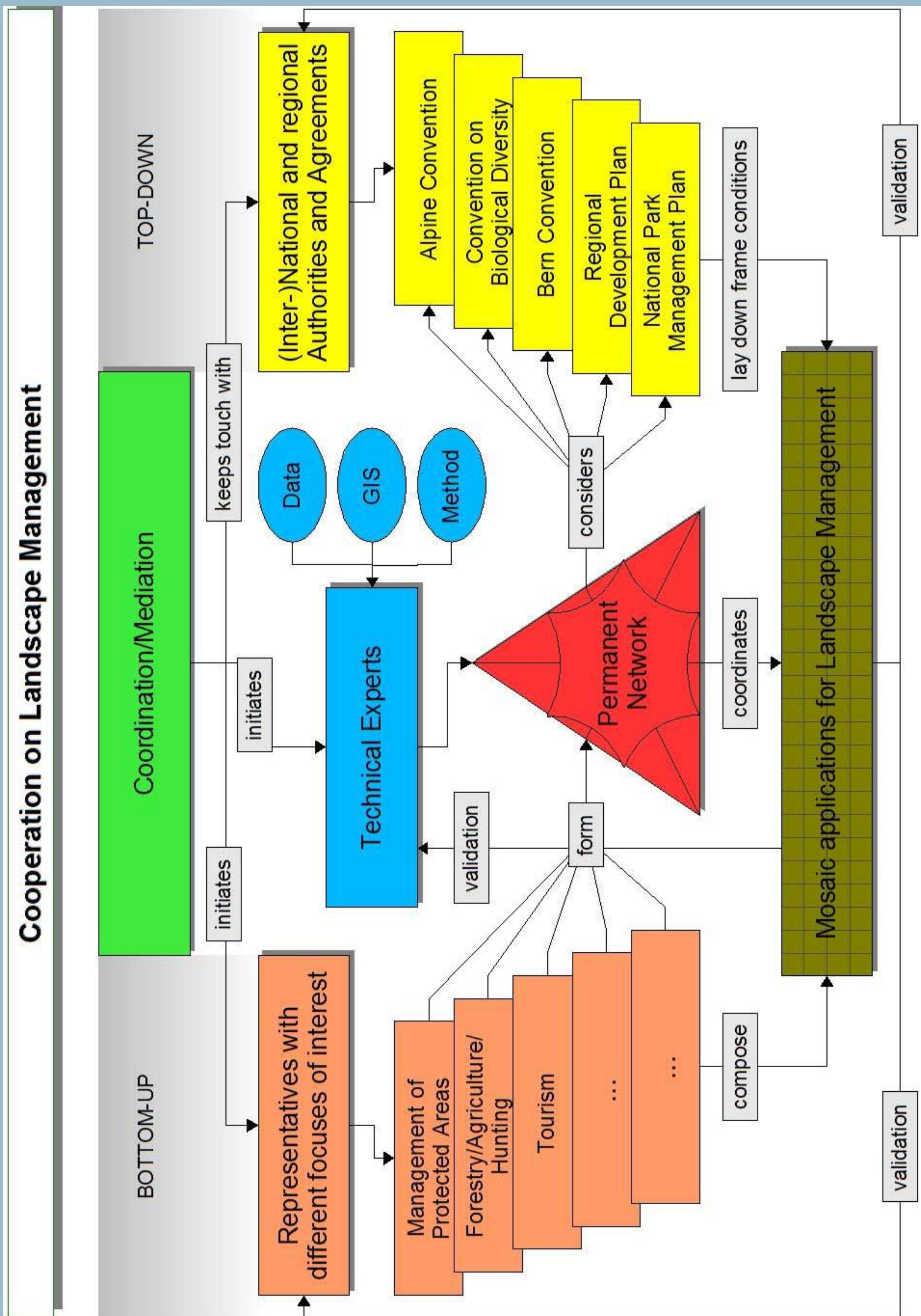
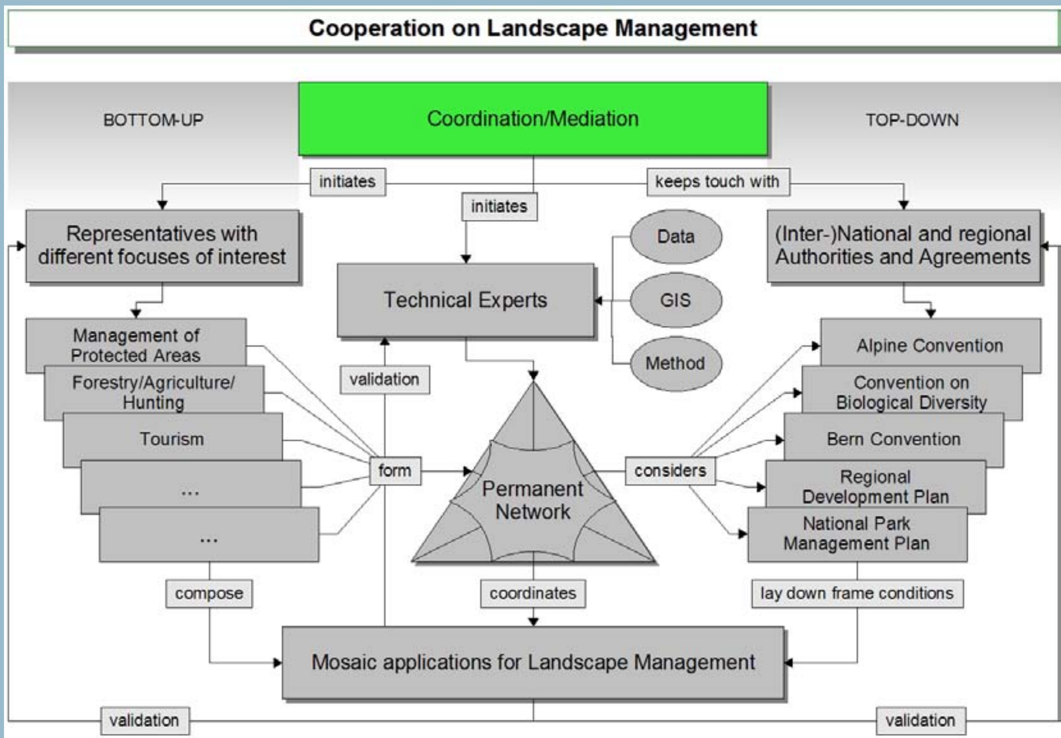
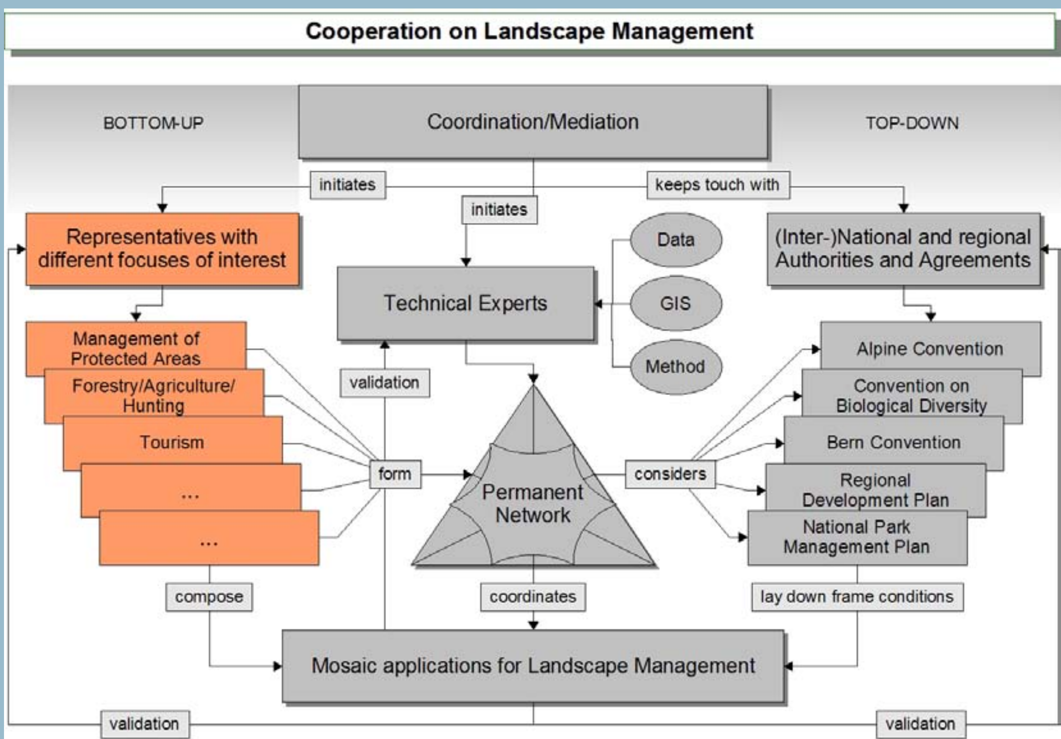


Figure 63: Cooperation on landscape management

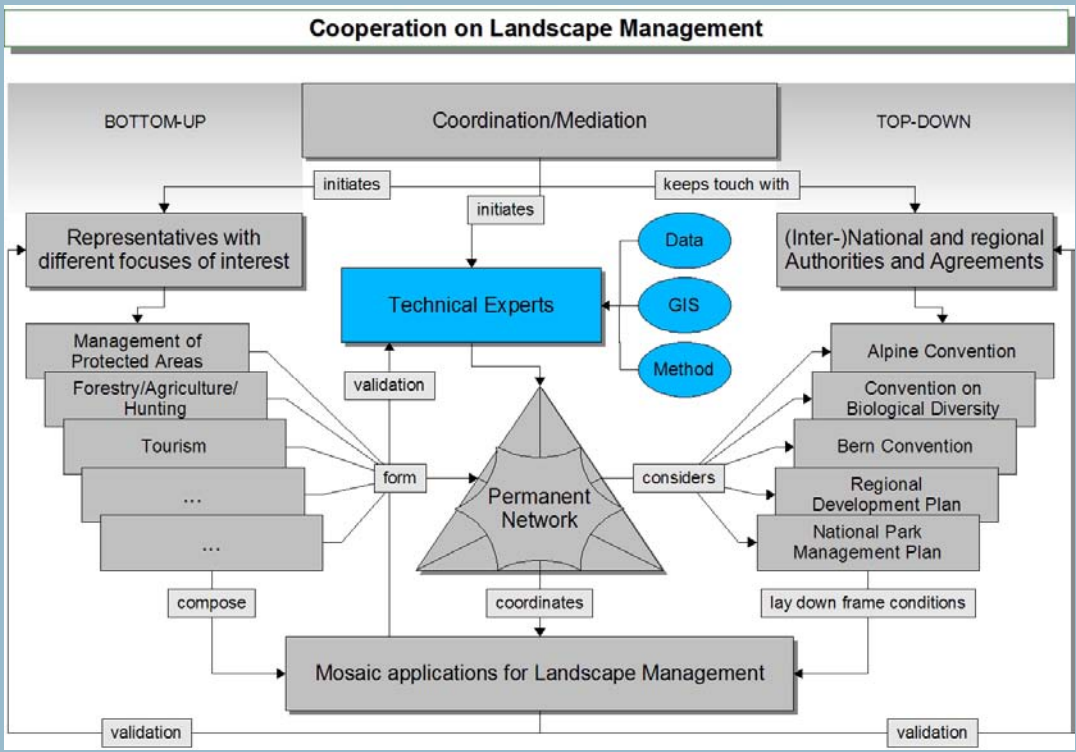
The process of an intensive cooperation on landscape management – of course – **has to be coordinated**. The responsible person or institution shall strive for well-balanced solutions among the partners. This requires special social and linguistic competence as well as a neutral position independent from own interests. The job is to initiate workshops including suitable people for the different demands and to be in contact with authorities on all hierarchical levels. The coordinator explicitly should not have overall responsibility, but every partner is responsible to contribute to the discussion in such a way that the aim of a common landscape management is always perceptible.



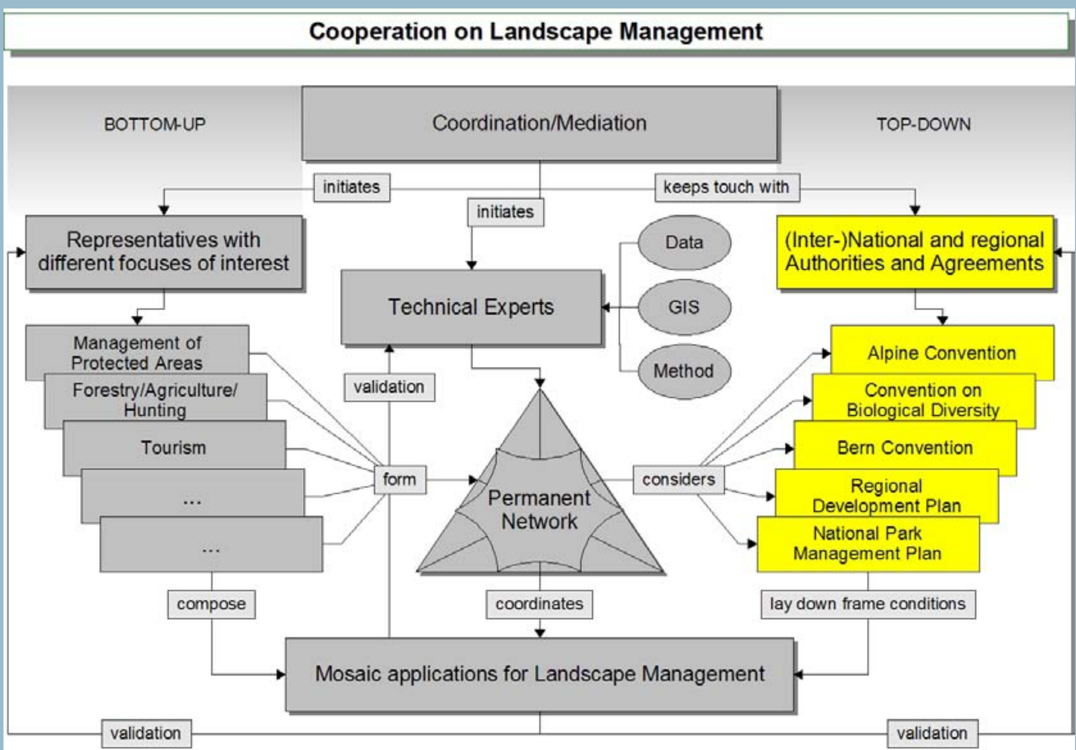
This leads to the group of **Representatives with** – at least initially – **different focuses of interest**. They fill the process with practical problems of the "real life" and ensure an application-oriented treatment of landscape management. With them the discussion will never end up in theoretical aspects. Thus they are very important for this kind of cooperation but at the same time form the greatest challenge for the coordinator in order to keep in mind the common aim.



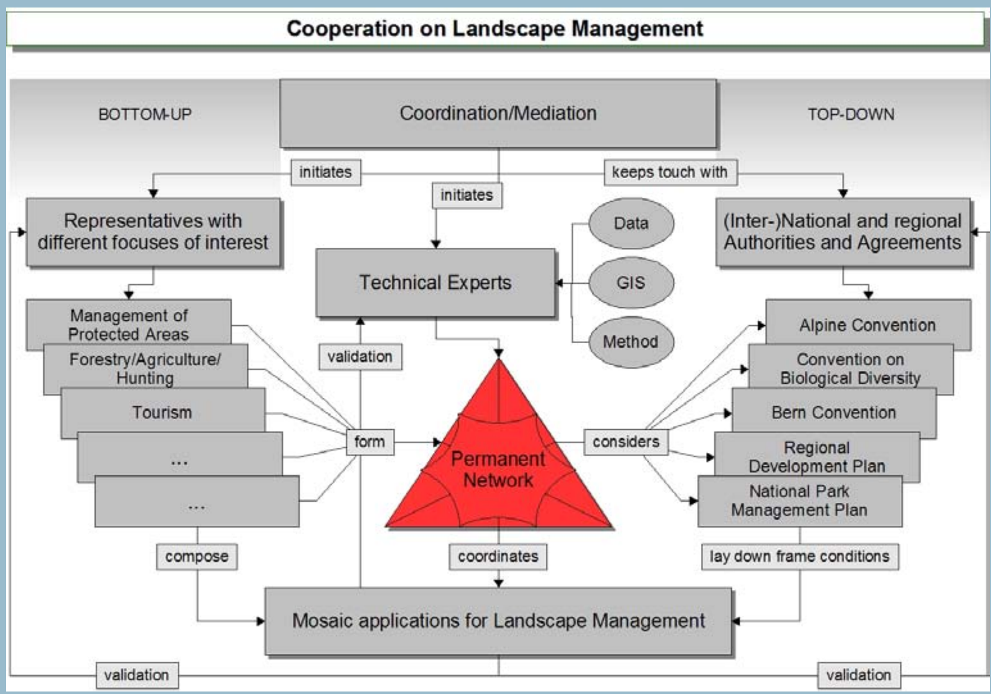
The contribution of the **Technical Experts** is their know-how. They have to choose the appropriate data (according to the scale the question is dealing with), methodology and tools (e.g. Geographic Information Systems) to transform the practical issues to maps and visualize the effects. By modelling they can transfer local aspects to a more extended area and detect the results of different strategies of landscape management beyond personal interests. New dependencies can be made visible by combining various data and serve for a better understanding of the processes within ecosystems.



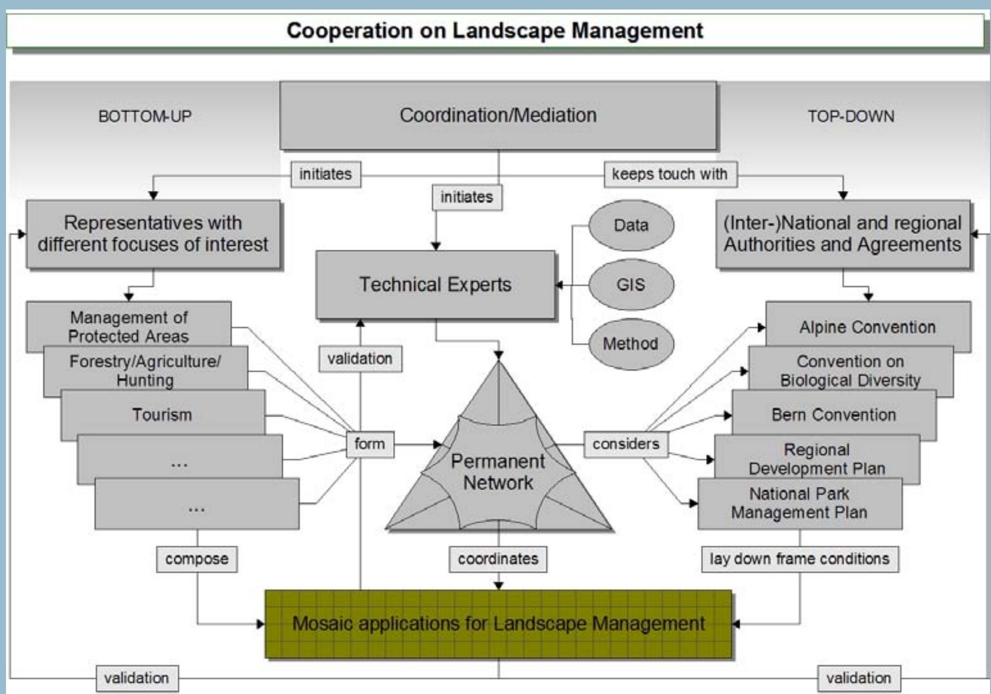
Authorities and agreements lay down the frame conditions for landscape management. On the one hand it is important that the entire process considers these conditions to implement the acquired knowledge and approaches. On the other hand the process can also stimulate policy-makers by practical solutions for demands of current interest. It is especially attractive for the political level because these progressive procedures are based on a broad acceptance.



A particular platform is needed to let this acceptance grow up. Thus, the core of the process is the **Permanent Network**. It consists of the coordinator, the representatives (e.g. of protected areas) and the technical experts. They form the permanent members. If necessary, additional experts from authorities or external experts may be invited to contribute to special questions by their competence and experience. The Permanent Network is a constructive place for exchanging opinions and feeling free to think in all directions.



The **application of landscape management** has to be oriented according to and embedded in a sustainable development. Sustainability always comprises a balanced interplay of ecological, economical and social demands. That is the reason why landscape management cannot serve only one purpose but has to consist of a **mosaic** of different ideas, solutions and answers. It is obvious that this requires people who are willing to look beyond their current area of responsibility and who are curious and open-minded enough to discover new associations. If we manage to achieve this, we have reached a real integrative approach, which is the condition to meet the responsibility towards subsequent generations.



HABITALP

Transnational Spatial Database

Development of a spatial data infrastructure and integration of HABITALP landscape data into a common alpine database – WP9

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PARC NAZIUNAL SVIZZER

Summary

In the course of the HABITALP project large amounts of spatial information were created for the participating protected areas. Therefore, on the one hand a Spatial Data Infrastructure (SDI) should be developed which harmonizes the datasets of the project partners and integrates them into a relational spatial database. On the other hand the further use of the spatial information should be permanently ensured and a know-how transfer within and beyond the project group should be realised. The Centre of Landscape Informatics at the Weihenstephan University of Applied Sciences and the Swiss National Park were assigned to accomplish these tasks.

In a first step the geometry of the vector data had to undergo a topological verification. Afterwards the datasets were projected from the local coordinate systems of the project partners into the common spatial reference system European Terrestrial Reference System 1989 (ETRS89) on the basis of documented parameters. The harmonized vector data could then be imported into a common database structure. To this purpose the open source PostgreSQL was chosen as database management system, which is able to integrate spatial data in an object-relational form with the extension PostGIS.

An essential part of the HABITALP database is the interpretation key (HIK) issued in work package 6 with the respective relationships to the interpretation data (work package 7). Furthermore the results of NATURA 2000 (work package 8) and landscape diversity studies (work package 10) were imported into the database. Another data package were the orthophotos (work package 5) which were inserted together with the digital elevation models. For better orientation selected topographic information was processed and included. Additionally metadata specification due to ISO 19115 were integrated.

For the presentation of the spatial data a market research on web-based geographical information systems was carried out. The mapserver application developed for HABITALP is based upon the open source programs Apache Webserver and UMN Mapserver. The supply of the spatial information based on the standards Web Map Service (WMS) and Web Feature Service (WFS) of the Open Geospatial Consortium (OGC) allows for the license free visualization of the spatial data beyond the HABITALP project duration. This makes it possible to address a huge number of potential users at long term.

Résumé

Le projet HABITALP a permis de produire une grande quantité d'informations spatiales concernant les espaces protégés partenaires. Il était donc nécessaire de développer une SDI (Spatial Data Infrastructure) dans le but d'harmoniser les données, en les intégrant dans une base de données relationnelle du territoire. Il fallait d'autre part assurer l'utilisation permanente des informations territoriales ainsi que promouvoir la diffusion du savoir technique au sein du groupe des partenaires et au delà. Ces tâches ont été confiées au Centre d'Informatique du Paysage de l'Université de Weihenstephan et au Parc National Suisse.

Dans un premier temps, il fallait soumettre à vérification topologique la géométrie des données vectorielles. Ensuite, les données ont été projetées du système de coordonnées locales des partenaires vers le «European Terrestrial Reference System 1989»(ETRS89) - système de référence terrestre commun - sur la base de paramètres documentés. Par la suite, les données vectorielles ainsi harmonisées on pu être importées dans une banque de données commune. Pour la gestion de la base de données on a choisi le système de gestion open source PostgreSQL, qui - à l'aide de l'extension PostGIS – peut intégrer les données spatiales dans un modèle relationnel corrélé à l'objet.

Un élément essentiel de la base de données HABITALP est la clé d'interprétation élaborée dans le work package 6 en référence aux données d'interprétation respectives (work package 7). Les résultats de NATURA 2000 (work package 8) et les études de la diversité du paysage (work package 10) ont été également importés dans la base de données. Un autre ensemble de données est constitué par les orthophotos (work package 5), intégrées avec les modèles d'élévation numérique. Pour une meilleure orientation, des informations topographiques sélectionnées ont été traitées et introduites. Des spécifications supplémentaires concernant les méta-données selon ISO 19115 ont également été introduites.

Pour la présentation des données spatiales on a effectué une enquête de marché sur les systèmes d'information géographiques basés sur le web. L'application mapserver développée pour HABITALP est basée sur les programmes open source Apache Webserver et UMN Mapserver. La visualisation gratuite des données spatiales est assurée au delà de la durée du projet HABITALP par la prédisposition des données spatiales basée sur le standard Web Map Service (WMS) et Web Feature Service (WFS) du Open Geospatial Consortium (OGC). Ceci permettra de s'adresser à un nombre potentiellement élevé d'usagers sur le long terme.

Zusammenfassung

Im Verlauf des HABITALP-Projektes entstanden sehr umfangreiche Mengen an räumlichen Informationen für die beteiligten Schutzgebiete. Deshalb sollte zum einen eine Geodaten-Infrastruktur (GDI) entwickelt werden, die die Daten der Projektpartner harmonisiert und in einer relationalen raumbezogenen Datenbank integriert. Zum anderen sollte die weitere Verwendung der Rauminformation dauerhaft gewährleistet und ein Know-how Transfer innerhalb und außerhalb der Projektgruppe durchgeführt werden. Mit der Durchführung wurden das Landschaftsinformatikzentrum der Fachhochschule Weihenstephan und der Schweizer Nationalpark beauftragt.

Im ersten Schritt musste die Geometrie der Vektordaten einer topologischen Überprüfung unterzogen werden. Anschließend wurden die Daten aus den lokalen Koordinatensystemen der Projektpartner in das gemeinsame räumliche Bezugssystem European Terrestrial Reference System 1989 (ETRS89) anhand dokumentierter Parameter projiziert. Die so harmonisierten Vektordaten konnten dann in eine einheitliche Datenbankstruktur importiert werden. Als Datenbank-Managementsystem wurde hierfür das quelloffene PostgreSQL gewählt, welches mit Hilfe der Erweiterung PostGIS Geodaten in objekt-relationaler Form integrieren kann.

Wesentlicher Bestandteil der HABITALP-Datenbank ist der Interpretationsschlüssel (HIK) aus Arbeitspaket 6 mit den jeweiligen Beziehungen zu den Interpretationsdaten (Arbeitspaket 7). Außerdem wurden die Ergebnisse der Studien zu NATURA 2000 (Arbeitspaket 8) und zur Landschaftsdiversität (Arbeitspaket 10) in die Datenbank übertragen. Ein weiteres Datenpaket stellen die Orthophotos (Arbeitspaket 5) dar, die zusammen mit den digitalen Höhenmodellen aufgenommen wurden. Zur besseren Orientierung wurden zudem ausgewählte topographische Informationen aufbereitet und eingefügt. Zusätzlich wurden noch Metadaten-Angaben nach ISO 19115 integriert.

Für die Präsentation der Geodaten wurde zunächst eine Marktrecherche über webbasierte Geographische Informationssysteme durchgeführt. Die entwickelte HABITALP-Mapserver Anwendung basiert auf den quelloffenen Programmen Apache Webserver und UMN Mapserver. Die Bereitstellung der räumlichen Informationen über die Standards Web Map Service (WMS) und Web Feature Service (WFS) des Open Geospatial Consortium (OGC) erlaubt die lizenzfreie Visualisierung der Geodaten über das HABITALP-Projektende hinaus. Dadurch kann auch langfristig ein großer Kreis potentieller Nutzer angesprochen werden.

Riassunto

Nel corso del progetto HABITALP è stata generata una grande quantità di informazioni spaziali per le aree protette coinvolte. Si trattava perciò da un lato di sviluppare un'infrastruttura di dati spaziali (SDI) che armonizzasse i dati dei partner, integrandoli in una banca dati relazionale del territorio. D'altro canto occorreva garantire l'utilizzo permanente dell'informazione territoriale e promuovere un trasferimento di know how dentro e fuori dal gruppo di progetto. Questi compiti sono stati affidati al Centro di Informatica Paesaggistica dell'Università di Weihenstephan e al Parco Nazionale Svizzero.

In una prima fase era necessario sottoporre ad una verifica topologica la geometria dei dati vettoriali. In seguito i dati sono stati proiettati dal sistema di coordinate locale dei partner nel sistema di riferimento terrestre comune (European Terrestrial Reference System 1989 - ETRS89), utilizzando i parametri documentati. Successivamente è stato possibile importare i dati vettoriali così armonizzati in una banca dati comune. Per la gestione del database è stato scelto il sistema di gestione open source PostgreSQL, in grado di integrare i dati spaziali in un modello relazionale ad oggetti con l'ausilio dell'estensione PostGIS.

Una parte essenziale della banca dati HABITALP è la chiave di interpretazione (HIK) prodotta nell'ambito del work package 6 e rapportata ai rispettivi dati di interpretazione (work package 7). Nel database sono stati importati anche i risultati degli studi su NATURA 2000 (work package 8) e sulla diversità paesaggistica (work package 10). Un altro pacchetto di dati è quello relativo alle ortofoto (work package 5), inserite insieme ai modelli altimetrici digitali. Per il migliore orientamento sono state elaborate ed inserite le informazioni topografiche selezionate. Infine sono state integrate anche le specifiche dei metadati secondo la ISO 19115.

Per la presentazione dei geodati è stata effettuata una ricerca di mercato sui sistemi informativi geografici basati sul web. L'applicazione mapserver sviluppata per HABITALP è basata sui programmi open source Apache Webserver e UMN Mapserver. La predisposizione delle informazioni spaziali tramite gli standard Web Map Service (WMS) e Web Feature Service (WFS) dell'Open Geospatial Consortium (OGC) permette la visualizzazione libera e senza licenza dei dati spaziali anche aldilà della durata del progetto HABITALP. Ciò permetterà il coinvolgimento a lungo termine di un gran numero di potenziali utenti.

Background and objectives

The enormous amount of spatial data resulting from the various work packages during the HABITALP project demands an intelligent data management. The major objective of the WP 9 was to provide public accessibility of the resulting standardized landscape datasets through a common transnational spatial database. Therefore the implementation of a Spatial Data Infrastructure (SDI) was scheduled. GSDI (2004) describes the term "Spatial Data Infrastructure" as "often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. A SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general". The main components of a SDI are:

- Network,
- Spatial data,
- WebGIS,
- Web Services,
- Standards and
- Metadata.

Several objectives had to accomplish for the implementation of the HABITALP SDI. One fundamental target was the integration of the geographical datasets of all 11 project partners in one common coordinate reference system. Therefore the local and the common projection parameters as well as the transformation scripts had to be documented. The spatial datasets resulting from the various research activities during the HABITALP project had to be processed and validated. This step includes the following datasets:

- Orthophotos (WP 5)
- Interpretation key (WP6)
- Interpretation datasets (WP7)
- Algorithm for the transformation of HIK-0 and HIK-1 datasets to the current HIK-2 version (WP6)
- Correspondence tables (WP8) of HABITALP + NATURA 2000 classifications
- Landscape diversity maps (WP10)
- Digital elevation models (WP5+9)
- Base data layers (perimeters, summits, villages) (WP9)
- Metadata according to ISO 19115 core (WP9+11)

After the validation the datasets had to be integrated into a joint database structure. The database was foreseen as the starting point for the knowledge and know-how transfer of the HABITALP results. For this transfer a WebGIS and Web Services had to be implemented. Finally, the datasets had to be analysed and documented according to standardized documentation guidelines.

The HABITALP steering committee assigned the Centre of Landscape Informatics at Weihenstephan University of Applied Sciences and the Department of Spatial Information System of the Swiss National Park for the accom-plishment of these tasks.

Organisational and technical implementation

Coordinate reference system

A common coordinate reference system (CRS) had to be identified and all local CRSs of the project partners had to be documented. Furthermore the transformation method and their computation parameters for the geodatasets from the local to the common reference system had to be specified.

For the definitions of the terms on the topic of CRSs and projections see Daly (2001). Furthermore the standard ISO 19111:2003 "Geographic information - Spatial referencing by coordinates" of the International Organisation of Standard-ization (2004) defines a conceptual schema for the description of geographic reference systems.

Harmonized GIS projection parameters

The "European Terrestrial Reference System 1989" (ETRS89) is a pan-European CRS and has been chosen as the common CRS of the HABITALP database. It is a geocentric cartesian coordinate reference system, which defines three-dimensional coordinates (X, Y, Z). The ellipsoid identifier of ETRS89 is GRS80, which is - from the geometric point of view - identical with the WGS84 ellipsoid. The centre of the ellipsoid is the origin for three axes: the X-axis shows to the intersection point of equator and the prime meridian of Greenwich, the Y-axis shows to the intersection point of equator and the meridian 90° eastwards from Greenwich and the Z-axis shows to the geographic North Pole (Flacke and Kraus 2003).

For the two-dimensional cartographic visualisation of the spatial data over the extent of the Alps, several projections are suitable. Especially the "Lambert Azimuthal Equal Area" projection is very convenient for thematic maps. Further specifications are documented by Eurographics (2005).

Transformation scripts

The 11 project partners use seven different local coordinate reference systems (Röder et al. 2006b).

Table 19: HABITALP project partner and local coordinate reference systems

Project partner	Local Coordinate Reference System
NPB (D)	DHDN Zone 4
ASTERS (F)	NTF France II
APB (I)	ETRS89/UTM 32N
CPNS (I)	ETRS89/UTM 32N
NPHT (A)	MGI/M31
PNV (F)	NTF France II
PNE (F)	NTF France II
PNMA (I)	ED50/UTM 32N
PNDB (I)	Monte Mario (Rome) / Italy zone 1
PNGP (I)	ED50/UTM 32N
SNP (CH)	CH1903 / LV03

Depending on the specific local reference system different transformation methods are used to convert the geodata to the common reference system ETRS89:

- "geocentric translation" with 3 parameters or
- "position vector" with 7 parameters.

All resulting geodatasets in the ETRS89 reference system possessing a good congruence relating to the local coordinate reference system (EPSG 2006).

Technical appliance of transformations

The technical realisation of the coordinate transformation is done with the aid of the cartographic projections library PROJ.4 (PROJ4, 2003), which is based on a database of the "Surveying and Positioning Committee" of the "International Association of Oil & Gas Producers" (OGP). This database (EPSG, 2006) comprises the specifications for all important CRSs as well as their transformation parameters. With the designation of the so called EPSG-Codes, the respective CRS of a geodataset will be defined. The transformation of the geodata with the PROJ.4 library will be accomplished automatically ("on-the-fly") by the designation of the desired CRS as display reference system. The computation of new geodatasets in a specific target CRS (e.g. ETRS89) was done with ESRI ArcGIS 9.1. This desktop geographical information system also uses the EPSG database as a source for the reference system specifications and for their transformations. Further instructions on the topic of CRSs and transformation relating to the HABITALP project are documented in a separate technical report (Röder et al. 2006b).

Central data processing and integration of interpretation results

Previous to the analysis and visualization of common landscape datasets, they had to undergo a processing and topological validation step. For a smooth data exchange between the project partners and the experts, a FTP server was implemented. The version used for the final report includes all data delivered by the June 30th 2006.

Orthophotos

A further step in the development of the HABITALP database was the processing of raster data. The original digital colour infrared orthophotos had a ground resolution of about 15 to 20 centimetres. In total, the HABITALP orthophotos as original datasets cover nearly 5600 km² and need more than 500 GB hard disc space. For the Swiss and the Berchtesgaden National Park several orthophotos series exist for the same area. More orthophotos have been produced but could not be integrated anymore due to temporal constraints.

Table 20: Covering area and ground resolution of the original orthophotos of the HABITALP project partner

Partner	**Original Ground Resolution (m)**	**Covered Area (km²)**
SNP - CIR	0,2	504
SNP - RGB	0,2	694
PNV	0,2	475
ASTERS	0,15	238
PNE	0,15	303
NPHT	0,5	2.690
NPB - 97	1,0	655
NPB - 03	0,2	652
APB	0,15	234
CPNS	0,15	498
Total		**6.943**

For a faster visualisation via internet the raster data had been resampled to a ground resolution of 1 m (resample factor 5 for 0,2 m original ground resolution) or 1,05 m (resample factor 7 for 0,15 m original ground resolution) and several overview images were sampled for each participating protected area. This compromise was made due to the opposed requirements of high rendering performance, less hard disc space consumption and as high as possible display resolution of the orthophotos (Röder et al. 2006a). The resampled orthophotos need only a small part of the original hard disc space.

Table 21: Disk space consumption and ground resolution of the resampled orthophotos of the HABITALP project partner

Partner	**Resampled ground resolution (m)**	**Disk Space GB**
SNP - CIR	1,0	2,0
SNP - RGB	1,0	2,7
PNV	1,0	2,0
ASTERS	1,05	0,9
PNE	1,05	1,1
NPHT	1,0	11
NPB - 97	1,0	2,5
NPB - 03	1,0	2,6
APB	1,05	0,9
CPNS	1,05	1,9

The availability of orthophotos for the project partners is listed in chapter "WP5 Census and Orthorectification of Colour Infrared Aerial Photographs".

All photos were delivered in the local CRS of the respective project partner. With the PROJ.4 library it would have been possible to transform the orthophotos into any other reference system. But the big amount of raster data would make this step very time consuming. Therefore the CRSs of the orthophotos were not changed. The visualization of the geodata throughout the WebGIS application of each partner is done in the local coordinate system. Thus the vector data were transformed "on-the-fly" from the ETRS89 system of the HABITALP database towards the specific local reference system. The display of the orthophotos is carried out by the usage of raster catalogues, which are integrated in the HABITALP database.

Digital Elevation Model

For visualization purposes the digital elevation models (DEM) were defined as a base data layer for the WebGIS application. Therefore the hillshade of the DEM was calculated. The visualisation was done with the transparent hillshade layer above the coloured elevation dataset. The outcome of this step is a very good impression on the terrain morphology.

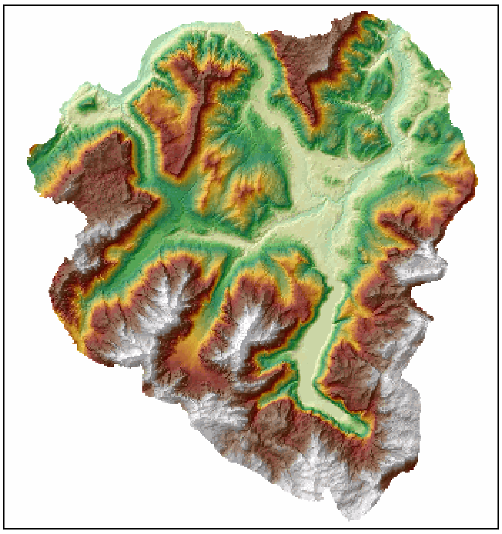

Figure 64: Coloured DEM of Berchtesgaden National Park

If the project partners had no DEM or did not have the rights for internet publication of the DEM, the elevation data from the NASA Shuttle Radar Topographic Mission (SRTM) were used. These data are currently distributed free of charge by the United States Geological Survey (USGS). The SRTM data are available as 3 arc second (approx. 90m resolution) DEMs. The vertical error of the DEMs is reported to be less than 16m (CGIAR-CSI, 2006). The horizontal errors of the original SRTM data were adjusted by the Consortium for Spatial Information (CSI) from the Consultative Group on International Agricultural Research (CGIAR) with an interpolation method.

Landscape diversity maps (WP10)

The landscape diversity maps are delivered in ESRI ArcInfo Grid format. Due to limitations of the UMN Mapserver, the datasets were transformed into Erdas IMG format with 16 Bit integer data type. Four different diversity assessments were calculated (see chapter WP10 "Landscape Biodiversity"):

- External Habitat Diversity,
- Internal Habitat Diversity,
- Relief Diversity and
- Landscape Diversity.

The visualisation of the diversity maps is done with the classification of the value range in equal intervals. The intervals are set according to the relative value ranges of each project partner and of each diversity raster.

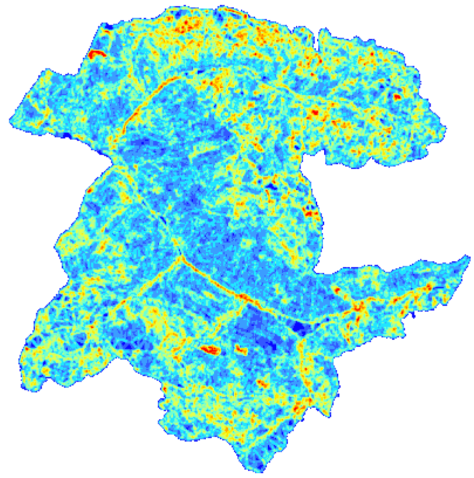

Figure 65: Visualisation of a landscape diversity map (CPNS)

Vector datasets

The processing of vector datasets starts with the transformation from the local to the common reference system based on the documented methods (Röder et al. 2006b).

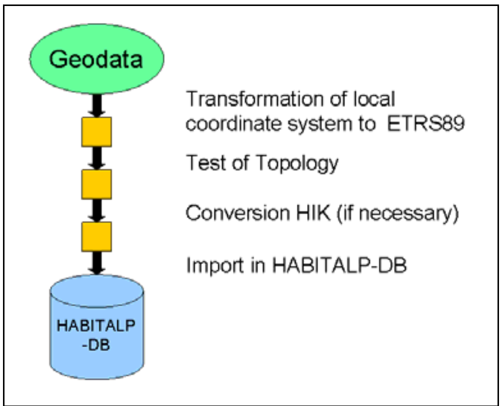

Figure 66: Workflow for vector datasets

Next the geometry of the geodatasets was tested regarding to their topological properties. This was done using a Personal Geodatabase and ESRI ArcGIS 9.1. The topology rules used for this validation were:

- "must not have gaps" and
- "must not have overlaps".

If the interpretation data were collected with version 0 or 1 of the HABITALP Interpretation Key (HIK), the datasets were transferred to HIK-2. The algorithm for the transformation of HIK-0 and HIK-1 datasets to the current HIK-2 version is described in chapter WP6 "Interpretation Key". The last step in processing the vector data is the import into the HABITALP database. Therefore the geodata had to be converted towards the ESRI Shape file format if necessary.

Joint database structure

The main focus of the WP 9 was the development of a joint database structure. This structure should integrate the results of the other HABITALP work packages. Therefore a conceptual schema in terms of an entity relationship model (ERM) had to be developed.

Entity relationship model

The ERM for the HABITALP database is composed of different components. Figure 67 shows the main components of the ERM in a schema. Raster data like the orthophoto and diversity grids are stored as files and can therefore not be integrated in the ERM.

HABITALP interpretation key (WP 6)

The HIK-2 in version 2.2.2 is an essential part of the schema. As the result of WP 6, the HIK-2 is the interface between the results of WP 7 and WP 8. The main advantage of HIK-2 in comparison to the former interpretation key like HIK-0 or HIK-1, which were used for earlier habitat mapping in PNE, NPHT and NPB, is the object-relational structure. This structure was replicated according to Demel and Hauenstein (2006b).

Interpretation data (WP 7)

The application of HIK-2 was done during WP 7. After the delimitation of the habitats, their attributes were stored in a specific table structure, which was defined by Demel and Hauenstein (2006a). This table structure was integrated into the HABITALP database with an additional column for the polygon geometry. Each entry in these tables represents one habitat polygon.
The relationships between the interpretation data and HIK-2 are also part of the ERM.

Correspondence to NATURA 2000 (WP 8)

The WP 8 database contains tables and relationships for the assignment of the habitat interpretation types according to HIK-2 to the Natura2000 habitats. These items were transferred into the HABITALP database.

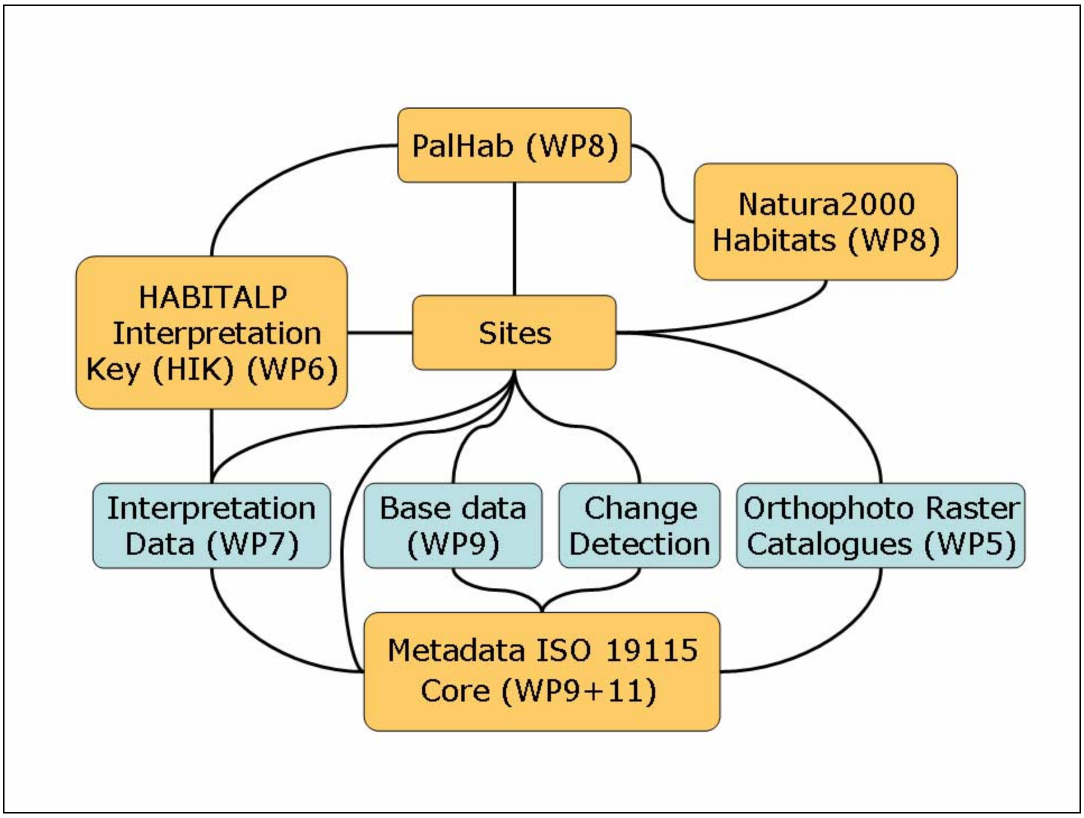

Figure 67: Schema of the HABITALP Entity Relationship Model (spatial entities are blue coloured)

Ortho photo raster catalogues (WP 5)

For the available orthophotos raster catalogues were built in the local CRS of the respective partner. This catalogues were imported into the HABITALP database. They contain the physical address to the digital images and could therefore be used for the visualisation with the WebGIS application.

Base data layers

For a better orientation in the WebGIS application some topographic features like the summits and villages in the surrounding of the specific partner were collected and integrated into the HABITALP database. Moreover the boundaries of the project partners and the perimeter of the interpretation area were also integrated into the database.

ISO 19115:2003 – Metadata

Finally, the model holds the table structure for the management of metadata for all spatial datasets according to the core of ISO 19115:2003 (International Organization of Standardization, 2006). A conceptual schema of this standard is provided by the technical committee 211 of ISO (ISO/TC 211, 2006). Thereby the metadata standard serves as documentation guidelines for the geodata documentation.

Implementation of ERM

The implementation of the entity relationship model was done with the database management system PostgreSQL. The source code of this object-relational database management system (ORDBMS) is published under the BSD License. The beginning of the PostgreSQL development was the POSTGRES project at the University of California in Berkeley in 1986 (Eisentraut, 2003). One fundamental property of the used PostgreSQL version 7.4.7 is the support of the major features of SQL:2003 (PostgreSQL, 2006).

For the integration of the spatial data the database extension PostGIS was used, allowing the storage of geometry types according to the OpenGIS Simple Feature Specification for SQL (Ryden 1999).

A detailed description of the implementation of the HABITALP database was documented in Röder and Kias (2006c).

Knowledge and know-how transfer

Another main objective of WP 9 was the presentation and accessibility of the HABITALP results to the public. Based on the realised joint database structure, several different options for the knowledge and know-how transfer are realised.

WebGIS

A web based geographical information system (WebGIS) is a presentation of geodata by internet connection. A web browser acts as client, while the datasets and the functionality of the WebGIS are provided by a web server. The first step towards a WebGIS was a market survey on such software products. Due to the limited project funding of the HABITALP project, the license cost was a main appraisal criterion. Therefore an open source and cost-free application for the presentation of the spatial data via internet was preferred. Finally, this application was developed based on the UMN MapServer (MapServer, 2006), using the Common Gateway Interface (CGI) on top of a web server. It passes user requests and delivers rendered images back to the client. The HABITALP MapServer application was generated by a Perl middleware, controlling the appearance of the desktop with HTML-Template and CSS. The application acts as a web-based information system and as a graphical user interface to the spatial data, containing the demanding GIS functions like zooming, paning and querying (Röder et al., 2006a). The HABITALP MapServer application (LIZ, 2006) is an adaptation of the Digital REgional Atlas Munich (DREAM) of the Department of Health and Environment of the City of Munich (RGU, 2006).

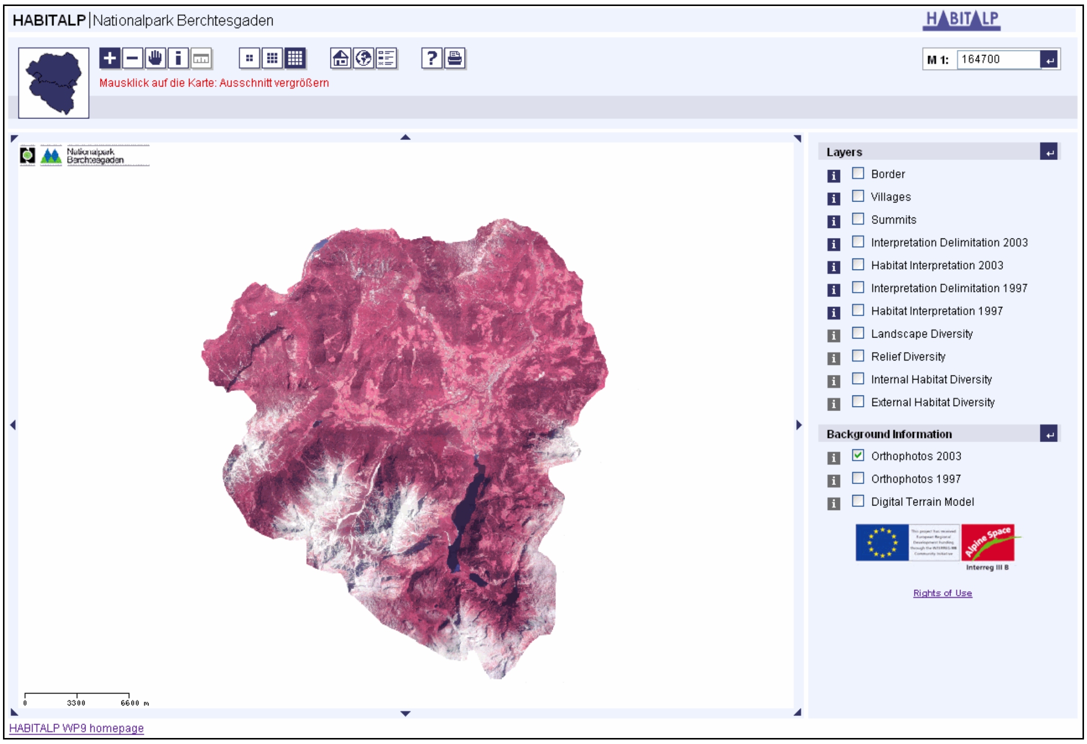

Figure 68: HABITALP MapServer application

Web Services

A Web Service is a software function, which can be accessed over a network by standardized protocols. To ensure a platform and software independent usability of the spatial data, the access method was defined by using the Web Map Service (WMS) (de La Beaujardière 2004) and Web Feature Service (WFS) (Vretanos 2005) standards from the Open Geospatial Consortium (OGC). The access to the web services happens over TCP/IP (Transmission Control Protocol/ Internet Protocol) and HTTP (Hypertext Transfer Protocol). The preparation of the spatial data depends on the specific client request and is done by the server. The client query is received by the web server (e. g. Apache WebServer). For preparing the spatial data the web server refers the query to the Mapserver, which reads the original datasets in dependence of the requested information. In case of a WMS request, the Mapserver renders and returns a new image in PNG format. In case of a WFS request, it returns the geometry encoded in GML (Geographic Markup Language).

These access methods allow any software supporting these standards to act as a client, which offers the maximum possible flexibility to the users (Röder et al., 2006a).

Database connection

The database access with SQL is based on a TCP/IP connection. After a successful authentication it is possible to access the database as client. The attributes, stored in the HABITALP database, can be accessed by the standardized interface method ODBC (Open DataBase Connectivity). With this method it is possible to import the database entries into any office program. Furthermore the direct client connection is implemented in several open source desktop GIS programs (QGIS, UDIG). For some commercial programs like ESRI ArcGIS a software extension exists. The purpose of such a direct connection between desktop GIS and a spatial database compared to an ODBC connection is the usage of spatial and attribute data at the same time.

Documentation guidelines and data documentation

The guidelines for the documentation of the spatial data, captured during the HABITALP project, orientate on the ISO 19115 standard (International Organization of Standardization, 2006). This standard contains originally over 400 specifications. Integrated in the ERM of the HABITALP database is the ISO 19115 core, which is a selection of 20 specifications. The documentation of the spatial data is done in WP 11 together with the metadata documentation for all datasets and documents originated during the HABITALP project.

Surface analysis of existing landcover types

Four project partners could deliver final versions of the interpretation data at the due date 30th June 2006. From six partners only a preliminary stadium of the aerial image interpretation was available. Considering these different states of completion of habitat interpretation a detailed statistical analysis was postponed due to the preliminary character of the data.
The WebGIS solution shows also a simple visualisation of the interpretation data as an interactive way of landcover mapping. With the free access to the geodata by web services or database connection, further mapping and analysis can be done by interested users on their own.

Discussion and assessment

Projection and transformation

The transformation "on-the-fly" from the common CRS ETRS89 to the local CRSs combined with the visualization of the local orthophotos shows a good congruence of the two datasets. The documented transformation methods and parameters as well as the practical implementation with the PROJ.4 library and the EPSG database proved to be very reliable and fast.

Quality control of the interpretation data

The processing of the interpretation data includes a validation of the geometry. The interpretation datasets, including four final and six preliminary datasets, were checked. The results were reported to the respective project partners and to the lead partner. The errors were no limitations for visualisation and further analyses because they were of negligible dimension.

Integration of results

The integration of the HABITALP results was without any problems. Updated versions of the preliminary interpretation results and further orthophoto series can easily be imported.

HABITALP database

Compared to other existing databases the HABITALP database does compile not only the metadata or the references to available datasets. The database comprises spatial data which means that the geographical part allows for digital maps and the descriptive part for attribute tables.

One fundamental property of the HABITALP database is its spatial and temporal extensibility. The ERM of the database would allow the integration of further protected areas as well as the import of interpretation data, collected with newer or older aerial images.

The outstanding purpose of the integrated alpine landscape datasets is their high degree of standardisation which guarantees a high comparability. This can be used during spatial analysis with the functions provided by PostGIS.

HABITALP MapServer application

The developed HABITALP MapServer application, delivering the usual GIS functions, shows an extraordinary performance in processing and delivering of the spatial data. The display and analysis of the orthophotos and the habitat interpretation can be done in a reasonably fast way through the Internet on any computer of a manager of a protected area. The use of any specific software is obsolete. The open source license of the used software guarantees the long-term supply and service of the realised know-how transfer methods over the end of the HABITALP project duration. At the same time, this Spatial Data Infrastructure (SDI) could be taken over by any project partner without any license fees.

Conclusion and outlook

The landscape datasets obtained in the course of the HABITALP project and their accessibility through the SDI creates a considerable potential for the international coordination of further applications and preservation activities in the Alpine Space.

The described application of OGC standards provides an interoperable usability of HABITALP spatial datasets to the project partners and to third parties. Furthermore, the Web Services may be a valuable connection to other European programmes in the field of spatial information like INSPIRE (Commission of the European Communities 2004), Natura 2000, analysis of landscapes in general or projects of the Alpine Network of Protected Areas (ALPARC) like ALPENCOM. Further development steps could be the integration of other standards of the OGC e. g. Catalogue Service (CS) or Web Terrain Service (WTS). A CS would offer the possibility for searching spatial data on the basis of their metadata. The WTS enables the visualization of 3D-Views in standard web browsers. Both can support the distribution and popularity of the HABITALP results to a broader audience.

Due to the usage of open source software no further license costs will occur beyond the end of the HABITALP project duration (Röder et al., 2006a). For the permanent maintenance and the ongoing development of the SDI it is necessary to transfer the infrastructure to a superior institution and to find appropriate finance tools.

After a possible integration of the final interpretation results, further surface analyses and statistics can be generated.

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HABITALP

Further Applications

Technical review on the HABITALP methodology and outlook on further development – WP11

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JOANNEUM RESEARCH

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Summary

One focus point of this work package is the identification of strengths, deficiencies and potentials of the HABITALP methodology and the resulting datasets with respect to surveillance obligations and practical benefits in protected area management. Furthermore the contribution of HABITALP on local, regional and transnational application levels is differentiated and compared to other existing methods. The user-friendliness of the developed tools is checked. Objective of all assessments is to identify the possibilities for the improvement of data quality, comparability, transferability and user-friendliness.

In a further step the methods and results of the HABITALP project are analysed with regard to possible fields of future applications. Particular attention will be paid to possible transboundary applications in the frame of international conventions and policies and to the transfer to further areas of the Alpine Space and other high mountain regions.

Concerning the integration of HABITALP interpretation data with data of other domains local case studies were carried through by some project partners. The thematic focus was given to the creation of management plans, forest plans and vegetation maps, the mapping of legally protected biotopes and habitat modelling. The analysis of these results serves the elaboration of recommendations for the future integrative treatment of HABITALP and other data.

Work package 11 comprises the question of accessibility and availability of the HABITALP results. In addition to the transnational database and the descriptive website of the project a content management system (CMS) is developed which documents further data and experiences. Its structure enables future users to access more comprehensively the HABITALP results and is the fundament for possible later updating. Finally the possibilities are checked for the integration of HABITALP data into existing geospatial data centres.

Résumé

Une des priorités de ce work package était de cerner les points de force et de faiblesse ainsi que le potentiel d'utilisation de la méthodologie HABITALP- et des données qu'elle a produit – dans le cadre des responsabilités de monitorage et d'évaluer les avantages pratiques qu'elle offre au niveau de la gestion d'un espace protégé. L'apport de la méthode HABITALP à la gestion des espaces protégés est analysé au niveau local, régional et transnational et comparé aux autres modèles existants. La convivialité de l'outil développé a été testée. L'objectif de cette évaluation est d'explorer les possibilités d'améliorer la qualité, la comparabilité, la transférabilité et la convivialité des données.

Dans l'étape suivante, les méthodes et les résultats du projet HABITALP ont été analysés pour identifier les possibles domaines d'application futurs. Une attention particulière a été donnée à leur utilisation dans le cadre des conventions et des politiques internationales, mais aussi à leur possible transfert à d'autres régions de l'espace Alpin et de haute montagne.

Quelques partenaires ont mené des recherches locales en vue d'intégrer les données d'interprétation HABITALP aux données d'autres secteurs spécifiques. Dans ce contexte, l'accent a été mis sur l'élaboration de plans de gestion, plans forestiers, cartes de végétation, cartographie de biotopes et sur la modélisation des habitats. L'analyse des ces résultats servira de base à l'élaboration de recommandations concernant le traitement futur des données HABITALP.

Le work package 11 a également traité le thème de l'accessibilité et de la disponibilité des resultants HABITALP. En plus de la banque transnationale de données et du site web illustrant le projet, un système de gestion du contenu (CMS) est mis au point dans le but de documenter d'autres données et expériences. Sa structure permettra aux utlisateurs futurs un accès facilité aux résultats HABITALP et prévoit la possibilité d'actualiser les données. Enfin, nous avons envisagé la possibilité d'intégrer les données HABITALP au sein des centres de données géospatiales existants.

Zusammenfassung

Ein Schwerpunkt dieses Arbeitspakets ist die Identifizierung von Stärken, Schwächen und Potenzialen der HABITALP-Methode und der aus ihr hervorgehenden Datensätze im Hinblick auf die Erfüllung von Monitoringverpflichtungen und auf ihren praktischen Nutzen. Der Beitrag der HABITALP-Methode zum Schutzgebietsmanagement wird auf lokaler, regionaler und transnationaler Ebene analysiert und mit anderen bekannten Methoden verglichen. Die Benutzerfreundlichkeit der entwickelten Werkzeuge wird überprüft. Ziel dieser Bewertungen ist es, Möglichkeiten aufzuzeigen, mit denen die Datenqualität, die internationale Vergleichbarkeit der Daten und die Übertragbarkeit und Benutzerfreundlichkeit der Methode weiter verbessert werden können.

In einem weiteren Arbeitsschritt werden Methoden und Ergebnisse des HABITALP-Projekts hinsichtlich ihrer Einsatzmöglichkeiten in weiteren Anwendungsfeldern untersucht. Besonderes Augenmerk wird dabei auf ihre Verwendung im Rahmen internationaler Konventionen und Richtlinien sowie bei Projekten in anderen Hochgebirgsregionen gelegt.

Zur Verknüpfung der HABITALP-Interpretationsdaten mit Datensätzen anderer Fachgebiete wurden von einigen Projektpartnern lokale Studien durchgeführt. Thematische Schwerpunkte dieser Arbeiten waren die integrative Anwendung bei der Erstellung von Managementplänen, Forstplänen, Vegetationskarten, Biotopkartierungen und Habitatmodellierungen. Die Analyse dieser Ergebnisse bildet die Basis für Empfehlungen zum künftigen Umgang mit HABITALP.

Das Arbeitspaket 11 befasst sich auch mit Zugänglichkeit und Verfügbarkeit der HABITALP-Ergebnisse. Zusätzlich zu einer transnationalen Datenbank und einer beschreibenden Website des Projekts wird ein Content Management System (CMS) entwickelt, in dem weitere Daten und Erfahrungen dokumentiert werden können. Seine Strukturierung erlaubt künftigen Nutzern einen besseren Zugriff auf die HABITALP-Ergebnisse und schafft die Basis für eine mögliche spätere Aktualisierung. Schließlich wird untersucht, wie die HABITALP-Daten in existierende Geodatenzentren integriert werden können.

Riassunto

Un punto focale di questo work package è l'identificazione dei punti di forza, di debolezza e dei potenziali del metodo HABITALP con i relativi dati, in relazione all'adempimento degli obblighi di monitoraggio ed ai benefici pratici nella gestione delle aree protette. Il contributo del metodo HABITALP alla gestione delle aree protette viene analizzato a livello locale, regionale e transnazionale e confrontato con altri metodi noti. Viene verificata la facilità d'uso degli strumenti sviluppati. Queste valutazioni hanno lo scopo di delineare le possibilità di migliorare ulteriormente la qualità dei dati, la comparabilità internazionale dei dati, la trasferibilità e la facilità d'uso del metodo.

In una fase successiva i metodi e i risultati del progetto HABITALP vengono analizzati in relazioni alle possibili applicazioni future in altri campi. Particolare attenzione viene rivolta al loro utilizzo nell'ambito delle convenzioni e politiche internazionali, ma anche nei progetti di altre regioni di alta montagna.

Alcuni dei partner hanno svolto ricerce locali per integrare i dati di interpretazione HABITALP con i dati di altri settori specifici. Questi lavori erano focalizzati sui temi dell'applicazione integrativa in fase di creazione di piani di gestione, piani forestali, carte della vegetazione, cartografia dei biotopi e modellazione degli habitat. L'analisi di questi risultati rappresenta la base per raccomandazioni sul trattamento futuro dei dati HABITALP.

Il work package 11 si è occupato anche dell'accessibilità e della disponibilità dei risultati HABITALP. Oltre alla banca dati transnazionale e ad un sito web descrittivo del progetto verrà sviluppato un Content Management System (CMS) che consentirà di documentare altri dati ed esperienze. La sua strutturazione permetterà agli utenti futuri un accesso migliore ai risultati HABITALP e crea la base per un possibile aggiornamento futuro. Infine viene esamintata la possibilià di integrare i dati HABITALP nei centri di dati geospaziali esistenti.

Background and objectives

The work package includes the analysis and evaluation of the HABITALP methodology with respect to its application. Main focus is on the assessment of the potentials of the methodology as well as on its user-friendliness in terms of practical application.

Another part of the work package consists of the set-up of a digital knowledge based framework including a web-application in order to structure the large amount of data resulting from all HABITALP work packages and to make them available to users.

The aggregation of experiences derived from the pilot projects serves as a major source of information and will provide the basis for evaluation and identification of further improvement potential.

Structure of results

In the first section a review on the applied methods and technologies sorted by the thematic work packages can be found.

The second section deals with the integration of the HABITALP data into the management of protected areas. This includes the evaluation of the needs of surface covering habitat information within the different development-phases of a protected area.

How HABITALP data can be applied to solve special tasks in protected area management and which further application seem to be meaningful is illustrated in the third section.

The final section tries to point out the needs of a successful future development of the HABITALP methodology.

Organisational and technical implementation

This work package was commissioned in February 2006 by the lead partner and was carried out by a team of subcontractors:

- E.C.O. Institute for Ecology, Klagenfurt (A)
- Hauenstein GeoInformatik, Tamins (CH)
- Landschaftsinformatikzentrum Weihenstephan, Freising (D)
- Joanneum Research, Graz (A)
- BIOGIS Consulting, Salzburg (A)

The team was formed by experts who have been new to the HABITALP team (E.C.O., Joanneum Research, BIOGIS) and experts who have been involved into the HABITALP project from the very beginning. Through this combination a perspective from an outside position could be provided as well as the experience of “insiders” (although the insider knowledge was not available for all WP to the same extent).

When this work package started in the final phase of the HAPITALP project, it depended on the results and experiences from all other work packages. At this point we want to express our acknowledgements to all partners within the HABITALP-project for providing information materials, data and personal experience.

This review is based on the available results of the different work packages and on the presentations held at the technical workshop in Zernez (CH, April 10th, 2006) and the final conference in Berchtes-gaden (D, September 14th–15th, 2006). An internal workshop on 29th June 2006 was held in Salzburg, where Pius Hauenstein, Arno Röder, Walter Demel and Ulrich Kias presented their review to the following work packages to the subcontractors of E.C.O., Joanneum Research and BIOGIS Consult:

- aerial image flight
- interpretation key
- aerial image interpretation
- transnational database

Furthermore the concept of the knowledgebase-CMS was presented by Paul Schreilechner at this workshop.

All available documents have been screened. Beside of the final papers presented in this report, technical reports, interim reports, workshop presentations and workshop minutes are available. These additional documents are only referenced in the review, when their information is not already content of this project report. So the list of used documents does not comprise all available documents, but those, used for the discussion in the review.

Further Applications

Discussion and assessment

Strengths, deficiencies and possible improvements of the HABITALP methodology

Project management (local, transnational, organisational)

Managing an interdisciplinary project with 11 partners in 5 countries is an enormous challenge, especially with a dense working programme and a high level of expected results presented in the HABITALP project.

A detailed review and critical analysis of the work packages dealing with the organisational structure of the project has already been provided by Annette Lotz (see chapter: "The HABITALP Mission"). So at this point only a general summary should be presented.

The review is based on personal discussion with the lead partner and further members of the project community. Further on the (final-) reports of the lead partner have been analysed.

Strengths

- Strong position of the lead partner
- Democratic decision structure
- Good communication design
- High availability of results

The central and **strong position of the lead partner** was essential for the realisation of the project. Without this clear position it would not be possible, to manage 11 Partners in five countries through such a comprehensive and challenging project.

An important advantage of Berchtesgaden National Park as lead partner was its own detailed experience within the subject of aerial image interpretation.

Within the project team decisions were found in a **democratic** manner. This was important for the acceptance of decisions by all partners and allowed that most partners realized the intense work programme.

Another important factor for implementing the work packages in a successful way was the **good communication design**. It was a good decision to use simultaneous translation at the project conferences. Through this advantage, every partner was able to express his thoughts in his own language. This is very helpful to overcome cultural borders and concentrate on the technical contents of the project. The essential papers (interpretation key, guidelines of delimitation and interpretation) have been published in all three languages of the project partners and additionally in English. It turned out, that the project partners and subcontractors speaking three to four different languages provided substantial contribution to this multilingual communication.

The translation services provided by and mediated through the Alpine Network of Protected Areas therefore was of great importance.

Throughout the concept, that all partners had to participate in all work packages, all partners had to solve similar problems and tasks. This led to an intensive discussion process between partners and external experts and to a good participation on internal workshops. Eight project conferences and more than 120(!) technical workshops indicate the enormous contribution to transnational experience exchange.

The decision to always select different locations for the meetings in all five participating countries promoted the cultural exchange beside the technical one.

The importance of making all **results accessible to a large user group** has been recognised from the very beginning. The FTP-Server made it possible to exchange huge amounts of information between the partners and subcontractors. The project homepage, several publications, the online interpretation key-platform and the transnational spatial database make the results available for an immense group of potential users.

Deficiencies

- Underestimation of workload
- Too dense time schedule
- Rare consequences for insufficient/late results by partners
- Democratic decision structure

The **amount of workload for the lead partner was underestimated**. Only one full-time academic worker for scientific leadership, administration, coordination, communication and strategic development was definitely insufficient for a project of this size although supported by a non-academic assistant. Additionally, the contract for the project leader did not cover the project enlargement phase, which led to some periods of unclear project proceeding.

The time schedule was quite optimistic and resulted to a dense working programme not only at the end of the project period. Because each work package was built up on the results of the previous one, it was very hard to stay within the time table for all partners.

Also the workload of the project partners was underestimated. The partners are employed by the local protected area managements. The projected activities within HABITALP had to be done additionally to the usual working programme. Hence many of the project partners had a significant lack of time resources too.

Although the democratic decision structure between the project partners was very important for an over all acceptance of the programme, sometimes decisions from top-down in a hierarchical manner could have made it easier to stick on to the tough time schedule. In the process of decision finding, compromises had to be found – this led sometimes to a decrease of quality level between the best possible and the agreed solution.

The partners were employed by local organisations and their remuneration did not essentially depend on project financing. Therefore they were economically independent from the lead Partner except for the flight and interpretation budget. Their cooperation was only based on good will. There have been no adequate consequences for insufficient or late results.

Possible improvements

More personal resources for the lead partner are required, i.e. at least two full-time workers with scientific background. At least one person is necessary for administrative tasks (budgeting, EU-reporting). It is strongly recommended, to redesign the tasks for EU-reporting and budgeting on the European level, to reduce the large overhead costs within such projects.

While the scientific manager should accompany the project from the prephase (project development) at least until the end, the employment of the administrative manager should exceed the official end for several months to be able to finish all administrative tasks.

The function of the scientific manager may be accompanied by an advisory board.

Determining the end of the work packages three to four months before the overall deadline of the project would have made it easier to gather all results and increase quality of publications.

Image acquisition

The acquisition of images provided the basis for all further work packages. The qualities of the images, reasonable costs and delivery in time have been the challenging points.

The review is based on the tender specifications, the final report of the work package in this publication and the internal workshop on 29th June in Salzburg.

Strengths

- Good tender specifications
- Improved competition reduced costs
- Homogenous image quality
- Quality controls possible by the shared knowledge within the project group

Based on the experience of previous projects good tender specifications for image flights, scanning and ortho-rectification have been provided by the work package leader and sub contractors. This enabled transnational competition.

The flight tender submission on the European level improved competition between flight-companies and helped to reduce overall costs of the image acquisition.

Throughout the clear definition of quality standards the resulting images fulfilled the criteria's of the image interpretation and provided similar image quality for all partners, where flights have been possible. The resulting images are of high value for the management on a local and regional level.

Deficiencies

- Delay of flights

Economical problems during the tender submission and the short time of optimal flight conditions have been under-estimated. Therefore the time schedule was exceeded which delayed all following work packages.

Possible improvements

Aerial images are a very important requirement for many management and research tasks in protected areas. The use of analogue aerial images is very well developed and has reached its technical limits.

But new imaging technologies have been developed and will partly replace analogue image technology in future.

Future development

1. Sensor Technology

Aside from the traditional CIR images, new sensors are available, that can be used for the mapping and monitoring of Alpine habitats. Regarding optical sensors, these new systems comprise very high resolution (VHR) satellites and digital airborne camera systems. Furthermore, laserscanning is an active remote sensing system that can complement the optical systems. VHR satellite data can be defined as data with a geometric resolution of 1 m and less. Currently available systems with this specification are Quickbird (61 cm) and Ikonos (1 m). As an example for digital camera data, UltracamD data is analysed. A comparison of the two groups of new optical sensors (VHR satellite and digital camera) to the traditional CIR imagery regarding resolution, availability, clouds, technical specifications etc. is given in table 22.

Ad 1) The geometric resolution for airborne images basically depends on the flying altitude and focal lengths, while it is fixed for satellite data. That gives more flexibility for the airborne systems. Nowadays, the highest resolution of civil satellites is 61 cm in the panchromatic band, in the near future it will be 41 cm (GEOEYE1). The last generation of digital cameras (UltracamX) can map up to a ground sampling distance of 3 cm, which is also possible at a low flight height with traditional film cameras (depending on forward motion compensation, exposure time).

Table 22: Comparison of sensors
* for digital frame camera data (not valid for line scanners like ADS40). See discussion below.

		CIR image	Digital camera data	VHR satellite data
1	Geometric resolution	Depending on flight height/focal length/ forward motion compensation (typical geometric resolution 10 to 50 cm		> 61 cm
2	Radio-metric resolution	8 bit	12 bit	11 bit
3	Spectral resolution	3 ms bands only (R, G, NIR)	Panchromatic band plus four ms bands (R, G, B, NIR). Sensitivity of pan band is sensor dependent!	
4	Data availability, Clouds	High, thin clouds might not avoid acquisition.		High, thin clouds are proble-matic.
5	Flexibility	Depending on the flight company		Smaller time slot
6	Geometric properties	Central perspective * stereo intersection, digital data up to 90 % forward overlap		Line Scanner Image. Homo-ge-neous geome-tric pro-perties
7	Spectral properties	Illumination effects, spectral instability		Robust spectral con-ditions

Ad 2) Traditional CIR images are generally scanned to 8 bit. 10 bit per band instead of the currently delivered 8 bit per band would be possible. Higher radiometric resolution of the digital systems improves the differentiability of classes for digital classification. Additionally, the better radiometric resolution gives the possibility to extract information from shadows and therefore map also those areas (illustrated in figure 69).

Within the HABITALP project, "contrast spreading" was also done within the digital stereoscopic interpretation process. This led to better visibility in shaded or very bright areas of the image. The results were better, when the original image was scanned more darkly, than it would have been done for analogue interpretation. It should be tested, if darker original images (shorter exposure time of the film) can further increase the usability of "contrast spreading").

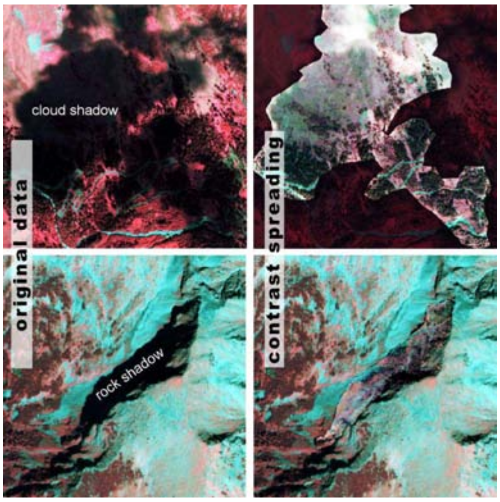

Figure 69: Mapping shaded areas in Quickbird image based on contrast spreading

Ad 3) The spectral sensitivity of the distinct bands of digital camera data as well as of VHR satellite data varies depending on the sensor. For Quickbird, the panchromatic band covers the whole spectral range of the multispectral bands, while exemplarily the UltracamD panchromatic band covers the visible spectral range only. Depending on the application, this can be of importance for pan-sharpening algorithms. Pan-sharpening is very important for all digital data, as mostly only one panchromatic band is acquired with high geometric resolution, while the multispectral bands are acquired with an about three to four times fewer ground sampling distance. Pan-sharpening means the group of methods that are able to merge the high resolution pan with the lower resolution multispectral bands.

Multispectral data with additional spectral information, e.g. Spot5 which includes also the short wave infrared spectrum, can be used as additional information source; however, the segmentation requires very high resolution data. The exclusive use of these medium spatial resolution image data (5 to 10 m spatial resolution) is not sufficient for habitat mapping according to the HABITALP interpretation key.

A further group of sensors are hyperspectral sensors (e.g. DAIS, Chris/Proba), which have a very high spectral resolution (e.g. more than 50 spectral bands). Methods for information extraction from these data in the alpine area however are in the research status and are currently not feasible for large area operational mapping because of high data acquisition and processing costs. Main methodological problems can be seen in the proper calibration/ atmospheric correction (specifically, availability of appropriate regionalised meteorological data for atmospheric correction). One advantage and at the same time disadvantage of new sensors might be their still rapidly progressing development. Based on the changes in development, it is difficult to guarantee full comparability between today's and future data sets.

Ad 4) The basic limitations regarding clouds and other weather conditions are valid for all optical sensors. High, thin clouds can be less problematic to airborne data capture, if there is still enough radiation for imaging.

Ad 5) As the satellite crosses the area of interest at a certain time of the day, there is not as much flexibility as by using an airplane.

Ad 6) Both analogous and digital frame cameras show central perspective, which provides a stable stereo condition. Some digital cameras offer the possibility of a very high overlap, i. e. > 90 % forward overlap. This provides more than two images available for stereo intersection and thus offers new possibilities of stereo mapping (see section "Interpretation and Classification"). On the other hand, the central perspective is disturbing, when mapping forest borders (leaning trees) or for the mosaicking of orthophotos.

Airborne linescanner data (e.g. ADS40) reduce this effect along, but not across flight direction. Very high resolution satellite sensors show a high altitude compared to a small ground coverage (smaller field of view) which result in less distortions compared to aerial images. The degree of distortion depends on the focal lengths of the aerial camera and the viewing angle of the satellite sensor. Stereo interpretation using such VHR satellite images is possible, however this data is very cost intensive and not as detailed as aerial stereo images.

Ad 7) The spectral properties of the sensors are of key importance for digital classification of the image data. Whereas satellite images are radiometrically calibrated, the radiometry of the scanned CIR images can vary locally depend on the viewing geometry and also on front- and backlight effects. Local adjustment on the other hand may be wanted if the imagery is only interpreted visually, e.g. for optimised image contrast.

The complementary use of Laserscanner data:

As pointed out throughout the report, 3D information is an important information source for habitat mapping. Aside from the 3D information derived from optical data by stereo interpretation or automated stereo mapping (digital surface models, DSMs), also laserscanning can deliver accurate 3D information. The substantial advantage of laserscanning is, that Digital Terrain Models (DTMs) can be obtained even under dense vegetation. Based on such a DTM combined with a DSM, accurate vegetation height maps can be derived. Typical spatial resolutions of these models are in the range of one to several meters. New "full waveform" laserscanner technology allows mapping not only first (DSM) and last pulses (DTM), but also the intermediate reflections. However, this is still in the field of ongoing research, no detailed studies or results about the usability of this kind of data for habitat monitoring are yet available.

Interpretation key

The development of the interpretation key was based on results of former projects of NPB, NPHT and SNP. Within the HABITALP project it was developed further on to meet the needs of the 11 project partners.

The review is based on the "Guidelines for Delimitation and Interpretation", the final report of the work package in this publication, the Habitat code list from the transnational spatial database (interpretation key), the interpretation datasets of eight project partners and the internal workshop on 29th June in Salzburg.

Strengths

- Common alpine methodology for 11 partner areas
- Comparability on local, regional and transnational level
- Comprehensive compilation of habitats for 10 alpine regions
- Good guidelines for application of the key
- Multilingual results
- Online available (incl. discussion forum)

During the application of the HABITALP Interpretation Key (HIK), in 10 different areas, the content has been widely enlarged and the structure considerably improved.

With more than 300 habitat-types the key is very comprehensive. The application in different parts of the Alps has revealed the key as rather complete and usable on a regional but also on the transnational level.

The application of the key is described in detail in the "Guidelines for Delimitation and Interpretation". This guideline is one of the main results.

The main results, the interpretation key and the guidelines are available in English, French, German and Italian. Except for Slovenia, it is available in the native language of all Alpine countries. This will make the future application of the HABITALP methodology much more likely.

The internet platform for the interpretation key is not only available for a huge number of users, it provides also the transportation of information in both directions. On the one side the internet user can derive a detailed description of the key attributes with examples and on the other side he can upload his comments to the discussion forum and share his experience with other users. This can improve the further development a lot.

The structure of the key has improved during the project period. Many inconsistencies of the former BfN-key (BfN 2002) have been solved. The key has a hierarchical structure with obligatory (core), recommended and optional attributes. The structure is open and can be adapted to the special needs of a user.

A translation tool is available to transform interpretation of old versions (HIK0, HIK1) to the new version (HIK2).

Deficiencies

- Different key-versions within the project
- Uneven number of habitat-codes within the different main types
- no specific integration of requirements for NATURA 2000 and landscape diversity issues

The current HIK2 is the result of a long development. The reasons of some deficiencies are caused in the "multi-purpose" functionality of the key. It is hard to develop a unique key, providing best usability to very different applications. The parallel development of the interpretation key and the application of the key during the same project period led to difficulties in the comparability of the results.

The original interpretation datasets are available in HIK0, HIK1 and HIK2. Although a transformation tool is available, not all columns can be automatically filled because the information content of HIK-2 is more comprising than HIK-0 and HIK-1.

The subdivisions of the different formations (waterbodies, forests, bogs & swamps) seem to be heterogeneous in the number of levels (see table 23).

The main categories "greatly modified, anthropogenic disturbed sites" and "settlement, traffic" are divided into 104 subtypes (32 % of all subtypes) but representing only 7,4 % of all polygons or 1,3 % of the total area.

This will have no negative effect on the interpretation itself, but needs proper adaption or aggregation of the habitat types for further applications. E.g. for the calculation of landscape diversity this can lead to a systematic imbalance if not considered appropriately.

This uneven distribution of subdivisions is also very obvious by comparing the total area of each habitat type within the final interpretation dataset (4.300 km², eight partner areas, almost 240.000 polygons. Within this dataset only three habitat types (out of 320 possible) cover 58 % of the total area (Codes 4240, 5700 and 5800). The 10 most frequent habitat types cover already 78 % of the area and 90 % of the total interpreted area can be described with only 25 habitat types.

Of course, this comparison does not include the additional attributes of each habitat which would give a more detailed impression, but it shows up, that the interpretation key is not very detailed for the most common land cover types.

A major deficiency is the low direct compatibility with habitat types of the EC Habitat directive (NATURA 2000 habitats) as revealed in the work package "NATURA 2000 & monitoring".

Within this application on the HABITALP interpretation dataset it was shown, that optional attributes can make the development of analysing tools very difficult. To match HABITALP habitat types to NATURA 2000 some optional attributes, especially the proportion of tree species in forests, are of major importance. But not all interpreters made use of these optional attributes.

Some habitats can be either classified by the land cover type or by land use, which would lead to different habitat codes. For example, a pasture used as game reserve could be coded 9314 (game reserve, game park) or 4220 (grassland with medium moistness). This makes it sometimes easier for the interpreter, but makes analysing difficult.

Possible improvements

The user-friendliness and applicability of the HIK2 has been widely proved through the interpretation of more than 4.300 km². But the following work packages "NATURA 2000 & monitoring" and "landscape diversity" showed up, that the actual HIK2 key still has potential of improvement.

Table 23: Number of different habitat types (HT-codes) for each main category and percentage of polygons and area this main category represents in the interpretation dataset of 8 partners (ca. 4,300 km²)

	Main category	Number of habitat types	% habitat types	Interpretation dataset	
				% polygons	% area
2	waterbodies	38	12 %	3 %	1 %
3	bogs and swamps	14	4 %	1 %	0 %
4	agricultural land, perennial forb communities	44	14 %	38 %	31 %
5	immature soil sites, dwarf-shrub plant community	30	9 %	34 %	45 %
6	trees, field trees or shrubs, groups of shrubs	9	3 %	1 %	0 %
7	forest	81	25 %	16 %	20 %
8	greatly modified, anthropogenic disturbed sites	30	9 %	0 %	0 %
9	settlement, traffic	74	23 %	7 %	1 %
	Sum	320	100 %	100 %	100 %

To meet the requirements for the calculation of landscape diversity, the diversification of habitat types should be checked. Unevenly distributed subtypes within the main categories of the interpretation key (HT column) could lead to different diversity values, which might not correspond with reality.

The matching of HABITALP habitat types and NATURA 2000 habitat types is of common interest for all European protected areas. Only 78 out of 218 NATURA 2000 habitat types were expected in the Alpine region (table provided by Delarze and available through the transnational spatial database). Based on the experience made within the HABITALP project these 78 types should be checked, whether or not they can be accessed by aerial images. Those types, which can be determined by aerial images, should be directly integrated into the HIK-code. For the others the adaptation of existing HABITALP types may bring better chances for spatial prediction of NATURA 2000 habitats and will help to reduce the amount of field work for exact determination.

Separate attributes for land use could improve the key. I.e. the forest types could be reduced to six main types (defined by the amount of coniferous and deciduous trees), when the different development stages (which are the same for all six types) are coded in a separate attribute. It has to be figured out, how the type of land cover (e.g. vegetation type), land use and structure can be coded, so that further analysing of the results is possible in an optimal way. Redundant information (e.g. cover of tree species coded in the habitat type and in separate attribute columns) should be avoided.

After a final revision of the interpretation key, the development of the key should be stopped for some years to establish it as a standard. Continuous development would lead to numerous versions and affect comparability between different areas.

To maintain the interpretation key an organisation is needed, that is in charge for the future development. Special rules have to be developed to regulate the extension of the key. These rules should to define, when a new Habitat type has to be added or an existing one has to be adopted. Further more, the expansion of additional attributes has to be regulated and coding has to be guaranteed to be unique.

Aerial Image Interpretation

Interpreting the aerial images was the central and most time consuming task within the HABITALP project. During the interpretation of about 4.300 km² in 10 different regions with 30 different persons a lot of experience has been revealed.
The review is based on the final report of the work package in this publication, the technical report “Field Validation Nationalpark Berchtesgaden” within the work package “NATURA 2000 & Monitoring”, provided by Lang (2005), the interpretation datasets of eight project partners and the internal workshop on 29th June in Salzburg.

Strengths

- Application on about 4.300km²
- Trainings for interpreters led to comparable results
- Different techniques of interpretation tested
- Common alpine methodology

The interpretation method has been proved to be applicable to large alpine regions.

The guidelines and trainings have been effective, so the result was a relatively homogenous dataset. Average polygon size and boarder length are quite similar in different regions and worked out by different interpreters. Further investigations will reveal, if the differences are caused by the landscape or by interpreters.

Different techniques (analogue stereoscopic and digital photogrammetric) have been tested and a step to future development was made.

Tools for quality checks have been developed to guarantee high data integrity.

Deficiencies

- Changes in interpretation key led to slightly different results
- Missing or rare documented quality control

Little information about the data quality of the interpretation results is available. Systematic field validations have only been applied in five of ten interpreted partner areas within the work package “NATURA 2000 & Monitoring” and the results are not documented in full extent. The only detailed field validation report has been provided for the Berchtesgaden National Park by Lang (2005) in the context of NATURA 2000 relationship validation. This evaluation is based on a stratified sampling with 260 plots. Only on 140 plots (54 %) the habitat type of the interpretation was the same as the habitat type observed in the field. This low rate may be caused by the sampling design and the special evaluation method used in the NATURA 2000 validation and may not be representative for the overall interpretation quality.

There can be three levels of field work distinguished, to ensure quality:

- Training: First step for the interpreters to gather experience of the landscape, they are working with. What is expected to be seen on the images of that region?
- Calibration: Field-check during the interpretation to guarantee homogeneous interpretation and to find a common interpretation level between different interpreters in the same area.
- Evaluation: A systematic test of the interpretation results to reveal the precision and data quality of the final dataset.

The topics training and calibration are touched in the "Guidelines for Delimitation and Interpretation" (Demel & Hauenstein 2006). But the guidelines for evaluation are still missing. There should be a systematic evaluation approach, defining the number of sampling points per area/polygons and a field check to reveal the quality of the attributes and the spatial delimitation of the polygon.

Through the development of the interpretation key during the project, not all attributes are fully comparable between older and newer key-versions.

Possible improvements

In addition to the comprehensive interpretation key and the "Guidelines for Delimitation and Interpretation" (Demel & Hauenstein 2006) a proper quality control must be provided. This has been done in some, but not in all partner areas. A systematic field validation is required to document the quality of the results. In most cases the field validation has been done, but the results are not documented.

The interpretation process could be improved by ready-to-use GIS-tools for delineation and attribution. Unfortunately numerous different GIS-systems are used in protected areas. Therefore it seems very unlikely, to develop extensions that are easy to install for all GIS-systems. But even though the tools themselves are not ready now, the logical constraints to guarantee data integrity and semantic correctness could be defined. These rules should be integrated into the description of the interpretation key or into the guidelines of delimitation and interpretation.

During the HABITALP project several database queries and test routines have been coded. It would help further users if these control codes were documented and made publicly available.

Future development

New technologies may change the interpretation process in the near future:

1. Interpretation and classification

New digital image data sets can significantly improve the quality of the interpretation results, while still applying the current technology of visual interpretation. One improvement is the better radiometry, which also allows interpreting shaded areas. Another improvement of digital camera data compared with the CIR imagery is less grain. Smaller structures can be identified and more details can be recognized. A detailed comparison is given in Perko (2006). For the differentiation of land cover classes, more spatial details (less grain) as well as the improved radiometric characteristics can enhance the interpretation possibilities.

Figure 70: left: image from analog camera, right: same area mapped with UltracamD (from Perko, 2006)

2. Automatic interpretation without stereo mapping

As the radiometry of VHR satellite data is stable and illumination effects are minimized, land cover classes show the same spectral characteristics throughout the scene. This is the basis for automatic procedures like image classification. One method is to classify the clearly separable - land cover classes like snow, ice, forest, non-vegetated areas etc. automatically and only do the further differentiation manually. In the following, as an example, the derivation of the alpine forest border line is shown. Tests have shown that based on Quickbird image data, a majority of the forest border line can be derived automatically based on the use of texture features (see figure 71, from Granica et. al., 2006).

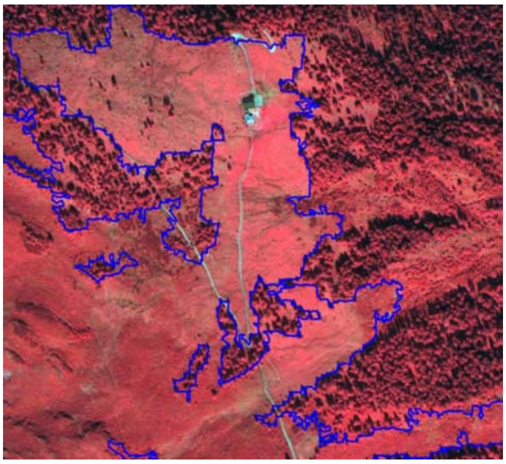

Figure 71: Blue line: automatically calculated upper forest boundary based on a Quickbird image. Test site: Landeck area, Tyrol, Austria.

A further option to improve the results of the interpretation is to calculate percentages in areas of mixed land cover classes. Examples are the mixtures of dwarf shrubs & grass or of alder & dwarf mountain pine above the alpine timber line. As these mixtures are often very patchy and closely interlocked, the percentages are difficult to estimate visually. When using radiometrically consistent data, the percentages can be calculated automatically and therefore improve the quality and help being consistent.

Finally, segmentation can be performed in order to pre-segment the image and only afterwards start interpreting. This can save a considerable amount of time, as only part of the digitising work needs to be done.

A study in the scope of the GEOLAND project (EU project: IP geoland FP6-2002-SPACE1) showed, that there were only marginal differences in texture between monoscopic Quickbird data and monoscopic aerial images using the HIK0 interpretation key at a scale of 1:2.500. Based on the geometric resolution, only very small objects like cutting trails could better be extracted from aerial CIR images. Generally, the precision of the results is lower, when working without stereo interpretation. Stereoscopic methods (both visual stereoscopic interpretation as well as automated stereo matching) improve determination of forest species, tree heights and densities or heath rate.

3. Derivation of 3D information

The DTM and the vegetation height are important information sources for all kind of habitat mapping. A DTM from laserscanning gives detailed information about the terrain characteristics. They can be important themselves (example: rock glaciers) or can give indirect information about the land cover (for example in sinks other plant species occur than on slopes). The vegetation height can be derived by subtracting the DTM from the DSM. Based on this vegetation height information, better differentiation between classes with similar spectral properties, but different heights (for example between dwarf-shrubs and herbaceous perennial fields) can be achieved. Within the forest, the differentiation of canopy coverage or density classes is often difficult, when using only optical data, as the viewing angle strongly influences the estimations. This problem can be solved by using vegetation height models in addition to the optical images. As already mentioned, the DSM can be derived from laserscanning data, but it can optionally also be calculated from optical stereo data (airborne or spaceborne). One of the main advantages of digital camera data compared to traditional aerial images is the new possibility in calculating a detailed DSM (Ofner et. al., 2005). Digital cameras are able to map with a very high forward overlap (more than 90 %). The same point on the ground is visible in five instead of the standard two images. The multiple projection rays of this system are depicted in figure 72 for a forest gap. This vertical structure can be mapped by using the images 2, 3 and 4, while the point would not be visible from the projection rays of standard image acquisition with 60 % overlap (dashed lines, image 1 and 5). Based on this multiple stereo intersection, a much more detailed DSM can be derived, which – together with an accurate DTM – allows to calculate an accurate vegetation height model.

The derived vegetation surface models can be integrated in the automatic classification process. This has been performed on forest research projects, but not operationally to habitat interpretation tasks. It can be expected, that in future, the obtainable accuracy using such methods will be close to the quality of stereo-interpretation.

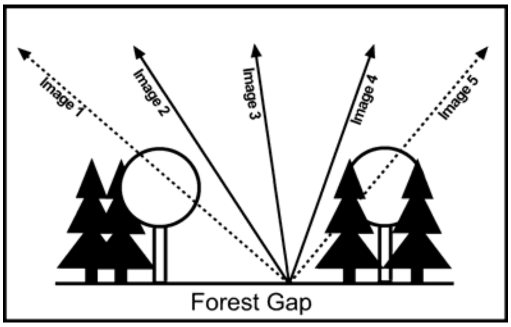

Figure 72: Mapping a forest gap: intersection rays from standard overlap (dashed lines, no calculation of the coordinate possible) and from 90 % overlap (all lines, calculation possible).

4. Improved field work

Based on the already mentioned possibilities of pre-segmentation and classification, necessary field work can be facilitated. Field work is still very costly and therefore, a tool to maximize efficiency can save a lot of money. Based on the pre-segmentation and/or classification, the expert can use a small, handheld computer (PDA) or a tablet PC in the field. On this mobile device, the data base (image) as well as the pre-segmented polygons and the corresponding attribute data (classes) are stored. The device is also equipped with a GPS antenna, which makes orientation easy. The segments and/or attributes can be adapted directly on the PDA and thus, additional copying of field records is avoided. Methods are in the research status and maturity of hardware/software is expected in the middle-term.

5. Updating maps

Based on appropriate data and already existing interpretation results, automated monitoring of land cover changes, which result in significant changes of the reflectance between the image acquisition dates, can be performed. The methodology is based on “change detection” methods. There are two basic approaches. Statistical approaches are comparing and detecting differences in multi-temporal input images. This is possible, if the images are generally (radiometry, acquisition time, sensor) comparable (Gallaun et al., 2001). On the other hand, there are knowledge-based approaches using the interpretation result and comparing it to the new image. If the expectations (pixel/segment values) in terms of spectral and/or height information are not met, the segment is marked as “changed”. Subsequently, changed segments can be compared to the properties of unchanged segments of different classes and assigned to the most suitable class. This procedure is less sensitive to differences in image acquisition and sensor characteristics, as the expected values can be adjusted according to the image data. In this context, the change detection is not fully-automatic, but a semi-automatic method.

NATURA 2000 & monitoring

The efficient management and monitoring of sites of European interest, expressed in the NATURA 2000 network is a difficult task. How the HABITALP methodology can help to solve this task was checked in this work package.

The review is based on the final report of the work package “NATURA 2000 and monitoring part 1” in this publication, the technical workshop in Zernez, the presentation of the final conference 14th–15th September in Berchtesgaden, link tables for HABITALP <> PALHAB <> NATURA 2000 within the transnational spatial database. The final report on work package “NATURA 2000 and monitoring part 2, Landscape Monitoring with HABITALP Data” was not available at the time of review. So the review is mainly focused on “NATURA 2000 and monitoring part 1, Contribution of the HABITALP methodology to the detection of NATURA 2000”, the “Methodological Notice For The Field Validation“ (working paper Delarze 2005) and the presentations in Chur and Zernez.

Strengths

- Comprehensive link table HABITALP <> PALHAB <> NATURA 2000
- Possible link to the EUNIS catalogue through PALHAB
- Standardized integrative trans-boundary approach

A comprehensive catalogue was developed, to link the HABITALP habitat types to the NATURA 2000 habitat types. This catalogue was set up as a database that can be adapted according to further validation results. Within the catalogue different spatial levels can be distinguished: Transnational Alpine level, level of countries and local level of partner areas.

The catalogue uses the classification system of PALHAB (Devillers & Devillers-Terschuren 1996) to translate between HABITALP and NATURA 2000.

Through the PALHAB code, a link to the EUNIS-catalogue (European Nature Information System (EUNIS), see http://eunis.eea.europa.eu) could be made.

The tables of the database are well structured, documented and can be easily adapted by the project partners.

Deficiencies

- Low rate of prediction of NATURA 2000 habitat types
- Additional uncertainty through PALHAB layer between HABITALP and NATURA 2000
- High effort to build up localised expert systems

The PALHAB classification is used in the Interpretation Manual of European Union Habitats – Version EUR 25 (European Commission 2003) served as common descriptive reference for phyto-sociological habitat types. PALHAB was used to assign not only the NATURA 2000 habitat types, but also the other habitat types. The PALHAB catalogue describes 5976 habitat types that have to be matched to 218 NATURA 2000 habitat types of the annex 1 of the Habitat Directive. The relation between PALHAB and NATURA 2000 is either 1:1 or n:1 or n:m (many to many) and brings further uncertainty in the transformation process. A direct translation between HABITALP HIK2 and NATURA 2000 could have been more easily verified. Further on, without PALHAB interrelation it would be easier to recognise possible modifications to HIK2 that are needed to make translation more effective.

Although the refining GIS study dealing with the integration of environmental variables (see chapter "NATURA 2000 & Monitoring (part 1)" in this report) has improved the results of the correspondence tool, the effort to develop special localised expert systems as described seems to be quite high compared to the results.

The NATURA 2000 sites are part of a legislative system. Therefore an exact localisation and qualitative assessment of the NATURA 2000 habitat types is indispensable when proving the impact of a certain project.

If the NATURA 2000 habitat type cannot be determined by the aerial image, it has to be determined in the field. The predetermination of possible NATURA 2000 habitat types can reduce the amount of field work, especially in the task of delimitation of the habitats, but cannot replace the validation in the field.

Possible improvements

Better results may be provided when the interpretation key is better adapted to the NATURA 2000 habitat types (see above).

From our point of view, the HABITALP methodology has its advantages not in the prediction or determination of NATURA 2000 sites, but in an appropriate delimitation of the habitats and providing a proper monitoring system to detect changes on (field-) determined NATURA 2000 habitats. In some cases the HABITALP polygons have to be modified (see Bauch & Seitlinger "Local Interpretation Experience" in this report with their experiences with terrestrial biotope mapping and Dentant & Godron 2006).

The old Palaearctic Habitat catalogue is mainly replaced by the EUNIS habitat catalogue. The EUNIS catalogue is the current development emerging of the Corine Biotope programme and the PalHab list. It is strongly recommended to establish a good link between the HABITALP and the EUNIS catalogue to provide comparability on European level.

Once the habitats have been classified, many disturbances and changes can be detected by means of remote sensing.

Landscape diversity

Landscape diversity is one part of Biodiversity and needs special methods and tools to be measured. While in species diversity the definition of the single units of measurement are well defined (number of plant or animal species within a certain area) the units of landscape diversity are hard to define. The definition of a landscape unit has to be done and the question, at which scale the classification should be provided, has to be figured out.

The review is based on the final report of the work package part 1 (Le Lay & Guisan 2005) and part 2 (provided by Grab in this publication), the minutes of the workshop in Chambéry (2005) the technical workshop in Zernez and the presentation of the final conference 14th–15th September in Berchtesgaden.

Strengths

- Clear overall concept
- Flexible and scaleable method

- Good discussion process with integration of all partners
- Results for Partner areas and whole alpine region
- Common alpine methodology

J. Grab provided a clear concept how to assess landscape diversity. The theoretical concept based on the combination of relief-, external- and internal-diversity is logical and distinct.

He integrated all partners in this development process. The combination of theoretical concepts and the translation into viewable maps have been obviously an essential factor of success for this discussion process.

It comes up with results that are easily reproducible and understandable even to non-experts.

The concept is flexible and scalable to different tasks and scales. This was shown by the application of the method on the regional level of the HABITALP partners and on the transnational alpine level by generating landscape diversity maps for the whole Alpine biogeographic region (based on SRTM digital elevation model and CORINE land cover data).

Deficiencies

- Different grain size/analysing cell size among partner areas
- Uneven definition of landscape units

The first part of the work package provided by the University of Lausanne is a very detailed discussion about the importance of scale or grain size. The team tried to find out the proper size of the cell size, that should be chosen for diversity measurement. Unfortunately, it did not come up with a distinct solution which might have been a consequence of missing interpretation data of other partners than NPB and the missing definition of a specific application.

J. Grab found a solution that is in a first step independent of a specific application by taking five times the cell size of the digital elevation model (DEM). This is a good solution to calculate relief diversity algorithms on the DEM, but led to different classification scales within the different partner areas, ranging from 20 to 400 meters.

These differences in scale will lead to different results of relief diversity, depending on the available DEM.

Beside the question of scale, the question of how to define different landscape units is still insufficiently solved. This is a quite difficult task and need a broad scientific discussion, depending on the specific fields of envisaged application.

For the calculation of landscape diversity within the HABITALP project the interpretation data was used. To calculate the "external" habitat diversity, the classification of the habitat type according to the interpretation key has been used. Each habitat code was treated as a "landscape-unit". The more different landscape units within a certain search radius can be found, the higher the value of external habitat diversity becomes.

As Pius Hauenstein has pointed out in his chapter ("Application of the harmonised interpretation key"), the hierarchical habitat-units are not of the same "ecolog-ical differentiation".

There is no rule that defines how similar or different two habitat types on the same hierarchical level of the key have to be. Therefore the finer the differences between habitat types are, the more divers the landscape will be classified. As pointed out in the discussion of the interpretation key above, it seems that the habitat types are not evenly distributed within the key. Within the anthropogenic dominated habitat groups "greatly modified, anthropogenic disturbed sites" and "settlement, traffic" more than 100 habitat types can be found, while the natural habitat groups "bogs and swamps" and "immature soil sites, dwarf-shrub plant community" contain together only 44 habitat types.

Possible improvements

In the question of scale a unique solution for the size of the classification unit should be found for common alpine purposes. One solution could be, to generalise all DEM to the same resolution and calculate relief diversity on that coarser level. This would increase comparability but reduce spatial accuracy. Therefore applications on local level should work with the smallest possible cell size unless a coarser analysis is sufficient.

The question of cell or grain size is very important to be discussed, especially, if comparable results for the whole alpine region should be found (see i.e. Turner et al. 1989).

Once the grain (= cell) size has been fixed, the question of the landscape units has to be reviewed. This may lead to a discussion of the hierarchical structure of the interpretation key. It has to be checked, if the units on the same hierarchical level have the same impact on landscape.

For example, is the difference between “areas for gas supply” (code 8340) and “areas for oil supply” (code 8350) comparable to the difference between “moist and wet grassland” (code 4230) and “montane – subalpine – alpine sward, meadows and pastures” (code 4240).

These examples show habitat types on hierarchical level 3 within the HIK2 interpretation key. Not all habitats on level 3 are divided to subtypes on level 4. If a habitat type is divided into subtypes, it will lead to higher diversity in regions where these subtypes are classified separately than in regions, where the general habitat type has been used for classification.

This is just a minor problem and can be solved on a separate table with as special “landscape-diversity-classification” with each HIK2-code in a row and a separate column with a relate to a aggregated landscape-unit, which mainly can be based on HIK2-level 3 items.

Beside the technical approach, a detailed discussion in the value of landscape diversity, as also encouraged by J. Grab, has to be done. Does “low diversity” always mean “low nature conservation value”? How the landscape diversity values should be interpreted from the view of a protected area manager? Is there a relate between Landscape diversity and biodiversity on the species or genetic level?

The results of the HABITALP landscape diversity work package gives an immense input to that discussion, because it provides for the first time diversity data produced with the same method for large areas from different parts of the alpine region.

Transnational spatial database

Sharing the results and making them available for other users to promote further development is the main idea of the “open source” concept in software development. The transnational database presents all digital maps produced during the HABITALP project on the World Wide Web. Everyone, having access to the Web has the possibility to view all results in detail and to get an impression of scale and quality.

The review is based on the final report of the work package “Transnational Spatial Database” in this publication, the transnational spatial database itself and the internal workshop on 29th June in Salzburg.

Strengths

- High availability of spatial results on the internet
- Low licence costs
- High performance
- Uniform platform for all spatial data

Traditionally, spatial data was presented in analogue maps. This has the disadvantage that detailed maps need large scale paper sheets, which are hardly to handle and expensive. Because of the high costs, mostly these detailed maps are only available in low numbers of pieces. Digital maps are much easier to copy and distribute.

Digital maps on a web map service, as it was done in the transnational spatial database have furthermore the advantage that the user can combine different layers of his interest and he can choose exactly the location he/she wants to view.

This is possible with a simple web browser without any GIS-expert know-ledge or GIS-software.

This is a big break through in making spatial data available for a large user group.

By choosing open source software additionally licence costs have been saved and the technology, which has been developed by the project team, is also available for other protected areas at low costs.

To present the data of all partner areas on a uniform platform made it necessary, to transform it into the same geographic projection and data formats. This will make data transfer and data exchange much easier.

Deficiencies

- Metadata still incomplete
- Unclear legal status of data usage

The collection of Metadata information on the presented datasets started very late in the project. Maybe not all information is available at this moment. Thanks to a special user interface, the continuous update of metadata information is possible.

The problem of the data rights is still of high importance. Limited rights on data access reduce the availability for other users. This is a general problem and is not specific for the HABITALP project.

Within the HABITALP project, different levels of usage are distinguished:

- Rights for viewing data
- Rights for download and use data

At the moment, only the rights to view are granted for the transnational spatial database. For further use, the data can be derived from the data owner (in most cases the local project partner). The contact persons are specified in the metadata information.

Possible improvements

The questions of viewing and querying all the different attribute data are still unsolved. Further technical development is needed to provide special forms to enable queries or to choose individual symbols for different attributes.

The data rights of the authors within a project that is co financed by the EU have to be regulated on a European level.

Rules have to be set up, how the data may be used further on and how the authors have to be referenced. This has be done on the transnational spatial database for the HABITALP data. A more general "rights of use" may be generated out of this definition (see "contacts" on the transnational spatial database)

Maybe the GNU public licence used in open source software development can give some ideas how these questions can be handled.

The transnational spatial database can now be integrated into existing geospatial data centres, so the valuable data could be easily found on the internet (e.g. on the European Geo-portal: http://eu-geoportal.jrc.it/gos).

Figure 73: List of "fields of activity" within each development phase of protected area. The graphs on the right side indicate the importance of full area covering spatial habitat data, as provided by the HABITALP interpretation datasets.

Further applications

To look for further applications, all fields of activities within the life cycle of a protected area have been checked. This concept of different phases in the development of a protected area and the list of fields of activity within each phase was the outcome of the INTERREG III B Cadses project IPAM (Integrated Protected Area Management, Jungmeier et al. 2005, www.ipam.info).

Figure 73 lists the 4 development phases of a protected area and the fields of activity, which are characteristic for each phase. The graphs on the right side indicate the importance of having spatial data on land cover for the whole protected area.

It can be demonstrated that in the Pre-Phase and in the Basic-Planning Phase spatial data in that detail, as it is provided by the HABITALP interpretation dataset, is of minor importance.

But in the phases of detailed planning and implementation, good information on the land cover and habitat types is needed to find a good zoning concept and to set up management plans, which take care of the spatial distribution of protected animals, plants or habitat types.

The earlier a universal data layer exists, the better other data layers can be integrated to build up a consistent spatial data model.

This is of high importance, because in the phase of implementation a lot of data capturing in the field (due to impact assessment or research programmes) is gathered. A huge amount of this data has spatial information. If the work of delineation of habitats is done once, this geometric basis can be used in multiple projects as a template. This basic-polygon network has only to be adapted to the special needs of each task. Beside of the amount of work for delineation and digitising that can be saved, the resulting datasets have the same basic spatial structure. Borderlines of different GIS-datasets have exactly the same geometry, when they deal with the same content. The delineations of forest edges, lakes, roads etc. are needed in almost all spatial datasets. If they are digitised again an again from the scratch, there will always be over- and under laps when intersecting the different layers. This could be avoided, by once preparing a data layer of high quality, which can be used in all follow up projects and tasks.

Modern GIS-technologies make it possible, to create relates between different GIS-layers. If one layer is changed, these changes have effects on related GIS-layers. This means, if the forest edge has changed, it has to be adapted only once in the appropriate GIS-layer and all related layers will be updated as well. The HABITALP interpretation dataset could build the basis for other management GIS-layers like the forest management plan or a NATURA 2000 management plan. If the interpretation dataset is updated through a new image census, these changes can automatically be updated in the GIS-layers based on and related with the HABITALP dataset.

This can make data updating much easier.

To avoid troubles with different versions it is very important, to separate the interpretation data set and follow up thematic maps.

Figure 74 shows a schema how the HABITALP dataset can build a basic layer for a management GIS. Based on the first HABITALP interpretation dataset, a management GIS-layer (Ma-GIS1) can be built up. Further on, other thematic mappings, also those that do not cover the entire protected area, can be integrated. The HABITALP interpretation data provides at least the basic geometry of parts of the new layer. Unique ID-numbers in the MA-GIS-layer enables the link to the related basic GIS layers (in our example the HABITALP dataset from the year 2003 and the forest mapping). The HABITALP dataset can provide basic delineation for the forest mapping. Some polygons may need to be divided; others need to be merged.

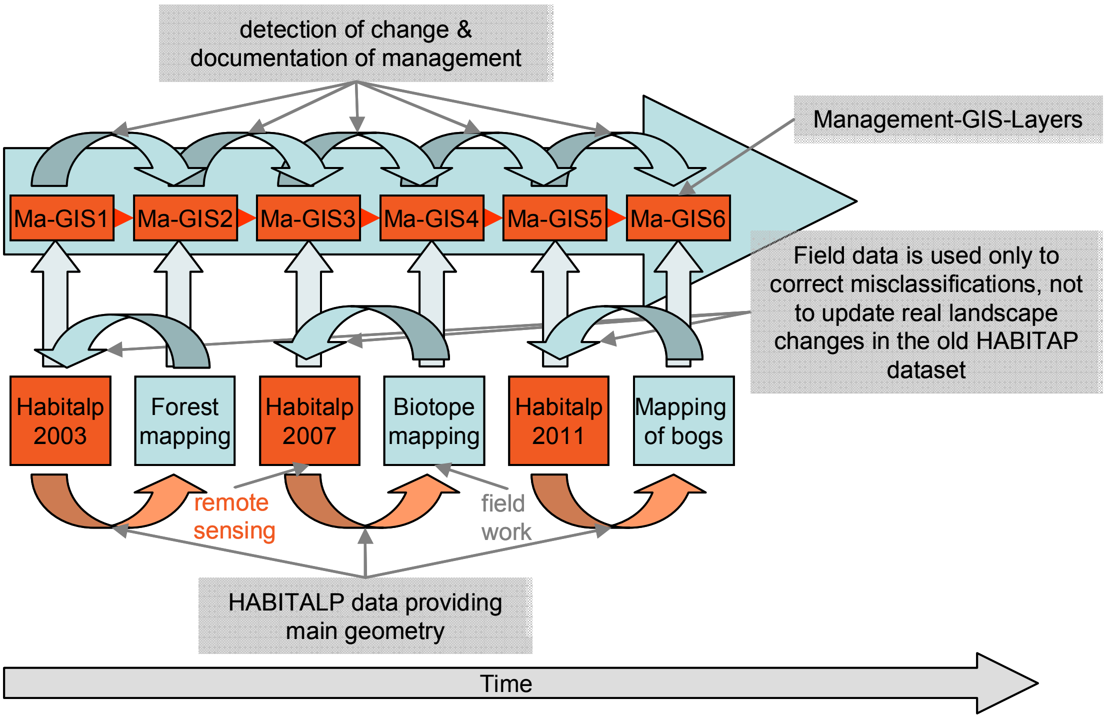

Figure 74: Integration of the HABITALP interpretation datasets into a protected area management GIS-infrastructure. Each square symbols a distinct GIS-layer. The big arrows are showing the transfer of attribute data and/or geometric information on polygons.

During the field work done for derived thematic maps (e.g. the forest mapping), some misclassifications in the HABITALP data 2003 may be detected (e.g. because of shaded regions on the aerial image). These misclassifications should be updated in the HABITALP dataset of 2003. But changes, that have taken place in the meanwhile, should not be corrected in the data set of 2003, because otherwise it would be impossible to generate proper time series and change analysis.

To keep track on these changes a new census should be done on the whole area. In our example new aerial images from the year 2007 will be interpreted and a new HABITALP interpretation dataset has been generated. As Hauenstein pointed out in his chapter "Application of the harmonised interpretation key" it is a good solution to overlay the old interpretation dataset from the year 2003 with the new images of 2007. The interpreter checks each polygon for visible changes. Through the better quality of newer aerial images, some misclassifications in the old interpretation dataset may be detected. Misclassifications should be corrected in the old dataset so they are not interpreted as changes.

If changes have occurred, it is useful to classify the origin of these changes (anthropogen or natural impact like forest management or avalanche etc.)

Through the chronological integration of all GIS-layers into one management GIS-layer a time series will be generated. These series documents different stages of landscape at different dates and the development can be analysed.

It is of uppermost importance that a precise base geometry is chosen for such a time series, and only qualified changes are integrated into the dataset. If every new interpretation is done without using the geometry of the old dataset, minor differences in the delineation will emerge on boarders of objects which are still the same, but which are not digitised exactly with the same polygon vertices. Intersecting the old and the new dataset will lead to thousands of very small "sliver" polygons, which are unwanted. Under these circumstances change detection is very difficult, because it is not easy to find out, if the different interpretation of a small polygon is the result of different interpretation or digitising mode or if changes in the landscape occurred.

Detailed aspects of methodology and results of the change detection with HABITALP data in Berchtesgaden National Park is provided by Kias et al. 2006 (available within the HABITALP knowledgebase-CMS on www.habitalp.de).

Other experiences on further application on the HABITALP interpretation datasets have been provided during the project period.

In these pilot studies it has been tested, if and how the data can be used for protected area management. The following "milestones" have been reached:

- HABITALP interpretation data provide basic polygon geometry for terrestrial biotope-mapping
- HABITALP interpretation data provide basic polygon geometry for forest development plan
- HABITALP interpretation data provide basic polygon geometry and modelling data for vegetation map
- HABITALP interpretation data provide basic polygon geometry for management plan and its compartments
- HABITALP interpretation data provide base data for modelling habitat quality and potential distribution of species

The experiences within these studies have been compiled in "milestone" reports (available within the HABITALP knowledgebase-CMS on www.habitalp.de).

As shown in figure 73 the HABITALP datasets can provide huge benefit in the following fields of activity:

- Detailed Planning:
- Ecosystem-based Management Plans
- Implementation
- Evaluating Management Effectiveness
- Impact Assessment and Limitation
- Research Setting and Monitoring
- Information, Interpretation and Education

In the following section, each of the selected fields of activity is shortly described and some examples for HABITALP dataset applications are listed:

Ecosystem-based management plans

Dynamic management planning is fundamental to achieving conservation objectives. It applies to sites, habitats and species and indicates how the protected area should be used, developed and managed. Many organisations have developed their own frameworks for management planning. A comprehensive management plan, however, consists of two core issues divided into several sub-categories: evaluation (e.g. legislative and regional/national background, resource inventories and management effectiveness) and planning (e.g. objectives, measures, budget outlines and surroundings). Typically, management plans for protected areas fit into a framework of legislation, policies and plans (regional and broad-scale land management, subsidiary plans, etc).

HABITALP data applications:
The location of conservation objects is crucial for successful management. This includes a proper zoning of different levels of protection within a protected area. The HABITALP interpretation dataset can provide the size and location of conservation objects either directly through the interpretation attributes or through modelling tools or additional field work. For the management plan the HABITALP dataset can provide:

- Full surface covering habitat map
- Habitat-polygon layers as basis for deriving further GIS-datasets
- Basic map for planning of spatial management actions
- Input layer for modelling species distribution

Evaluating management effectiveness

The establishment of protected areas and protected area systems is a public task that is competing with other interests for public budgets. Proving success and effectiveness is, and will become even more, an important issue. However, as well as purely economic features, many "soft indicators" have to be taken into account. Although no general benchmarking system has been developed, there are nevertheless many different approaches in this field. Evaluating effectiveness should be seen as a comprehensive approach including the whole cycle of establishing a protected area, evaluating the whole range from site-based actions to broad political and policy reviews. The key elements encompass legislation, management objectives, boundaries, management planning, local support, personnel, infrastructure, finance, information feedback and potential threats.

HABITALP data applications:
The HABITALP interpretation dataset, based on aerial images of different census years, can give a proper overview on landscape changes. Especially the human impact on the protected area and its objects of conservation can be evaluated:

- Repeated census and documentation of change of land cover
- Review on the areas covered by protected or endangered habitat types. Analysis, if the objects of conservation increased or decreased.
- Success control of applied management measures

Impact assessment and limitation

Generally speaking, protected areas exist to prevent inappropriate projects and forms of land use which might harm nature (or culture). Depending on the category and legislation, technical projects, changes in land use or changes to the infrastructure must be approved by a public authority. In this procedure, impact assessment plays an important role when evaluating the effects on the protected area. The conflict between public and private interests tends to be emotional: transparent procedures, clear regulations and reproducible assessments are therefore required.

HABITALP data applications:
Many human impacts on nature are visible on aerial images. Especially changes in land use lead to new habitat types or to the change of spatial distribution. This can be directly accessed through tools of change detection based on the HABITALP interpretation data.

- Documentation of direct human impact (e.g. new settlements, increasing farming or foresting activity)
- Documentation of indirect human impact (e.g. upward moving of vegetation belts, loss of glaciers through global warming)

Research setting and monitoring

Most research concerning protected areas is funded by different sources, executed by various institutions and distributed to a wide variety of interest groups. Apart from self-generated research, the protected area has little influence upon these activities. A comprehensive research and monitoring system is an appropriate means of attracting and steering research activities. In addition to any (potential) ethical guidelines, clear targets, contents and contexts can be provided. A balanced composition of commissioned research and “stimulated” external research activities may create enormous synergies. A clear strategy will also simplify the question of acquiring additional financing. Basic research (e.g. on regional resources) provides an overview of the region’s environment. Detailed studies can, for example, investigate regional inventories or a protected area's management topics. Participation in national or international research programmes facilitates a crucial comprehensive approach. Finally, monitoring is based upon long-term considerations and involves making observations with sufficient precision to determine whether a required condition is being met. Monitoring therefore includes both research-related and evaluation-related components.

HABITALP data applications:
Research in protected areas often needs spatial data. In order to make results of different research projects comparable, it is of high importance, when they are related to the same spatial units. Therefore a basic habitat polygon network supports optimised sampling design and spatial intersection of different research programmes. The high spatial precision of the HABITALP data makes it very valuable for further investigation and analysis:

- Pre-selection of sampling points for research (stratified sampling reduce costs)
- Analysing the interaction between habitat-types and occurrence of natural disasters (mudflow, avalanche)
- Documentation of habitat-change caused by climatic changes (do habitats “climb” higher?)
- Analysing the dynamic of natural forest stands (gap-analysis)

Information, interpretation and education

With few exceptions protected areas have the task of educating and raising public awareness regarding nature, ecology, sustainability and related issues. Information, Interpretation and Education are aiming at making the protected area's assets, values and outstanding features available to the public on a broad scale. Education is characterised by the structured provision of information (e.g. through academies, seminars, schools, etc.) and aims at people whose primary objective is to learn about their natural and cultural heritage.

HABITALP data applications:
Beyond enjoying the beauty of landscape visitors should be provided with information on the different sites of the protected area. Through the HABITALP dataset information on the habitat type can be provided for each part of the protected area. The dynamic of landscape is a process that is often only visible in the time interval of years. The comparison of aerial images and interpretation results of different times can help to make these changes visible to the visitor. New technical developments like GPS and handheld computers make this information accessible in the field.

- Providing visitor information focused on their specific location
- Background layer for superposition of visitor adapted information (points of interest)
- Providing maps of landscape development due repeated HABITALP interpretation census.

Conclusion

Within the project period 2002–2006 a huge amount of results has been provided and valuable experience has been exchanged between different parts of the Alpine Region.

Beside the huge amount of written documents, a lot of knowledge and experience is existing in the minds of the project group. This knowledge could be used further on, if the network will continue. It would be a good decision, to develop tools to make this implicit knowledge available to the team and further users. This could be one of the further applications.

Despite of all difficulties, aerial images of high quality are now available for 10 partner areas. They are an important snapshot of alpine landscape development and can be used for several applications, also beside the HABITALP project.

The HABITALP interpretation datasets are covering ten protected areas and an area of more than 4.300 km².

These datasets, based on a uniform methodology, provide a new management tool for protected areas.

Managing parts of landscapes requires spatial reference units. The public administration utilises the system of parcels; the forest managers use their forest management plan with its management units. For protected area management, the HABITALP interpretation dataset can provide a reasonable basic network of spatial units. The boarders of the units are based on ecological habitat units and are therefore optimised for nature conservation tasks.

A unique framework of spatial units is very essential for all further thematic maps, to guarantee spatial data integrity and to avoid geometric artefacts when combining different thematic layers.

This basic polygon layer should be provided in an early stage of the development of a protected area, to ensure GIS-data integrity from the very beginning.

The concerted development of the methodology within all HABITALP project partners can be seen as an example for interdisciplinary and international cooperation. Common alpine results are now available. Especially the interpretation datasets and landscape diversity maps, all based on the same methodology are from high value for the practical work in the protected areas. Networks of experts and people, who are applying the results, have been built up. This was only possible through a good communication concept and continuous translation of work papers, results and discussions in the native languages of the participants.

The workload of all project partners was on the limit, but the results reimburse the efforts multiple times.

It is of high importance, to continue this promising way and to engage other protected areas, not only in the alpine region but also from the other mountainous regions of Europe, to use the experience for their purposes. The methodology is the result of a scientific development and has the advantage, that it has been tested for practical use on thousands of square kilometres.

The scientific community is invited, to make use of the impressive and comprehensive datasets, based on one unique methodology and spread over a large part of the Alps to provide further analysis and reveal new knowledge on this important biogeographical region of Europe.

Some difficulties but also chances have arisen, because of the combination of base data production and immediate application of analysis methods within the same project. A revision period, taking into account the analysis experiences of the NATURA 2000 and the landscape diversity application, could have been helpful to adapt the interpretation key and the resulting interpretation data before the final application of analysis methods to the complete interpreted surface. Through this adjustment in the development of the interpretation key and the application of further analysis, many deficiencies, which now become obvious, may have been avoided. But this two-phased project design is not realistic within one INTERREG project. On one side, all partners would need the affirmation of the budget for both project parts; on the other side the project management must have the possibility to adjust the method, budget and results during the project period, which is not possible in the current design of the INTERREG programme.

Now, that the final results are available, the scientific community has got a big input for analysing this harmonised dataset to reveal new knowledge on the alpine landscapes and ecosystems and for new ideas on further improvement of the methodology.

Technical conclusions for future development

For future applications, analogue CIR images will mainly be replaced by digital image data, because of improved radiometric characteristics of the digital data, automatisation of parts of the work-flow and additional spectral information (True-Colour as well as CIR). It can be assumed, that for mapping according to the detailed HABITALP interpretation key, digital frame camera data with central perspective image geometry will be used in the next years. As the established workflows do not have to be changed significantly, the interpretation method will thus persist even if image input is developing.

In the mid-term, currently developed automatic image interpretation techniques will be mature and will contribute significantly to the automation of the interpretation process. A change of the work-flow and specific know-how in image processing is necessary in this case. Because of stable radiometric characteristics of satellite image data, it is expected, that in the mid-term, satellite image data will replace the airborne digital frame cameras to some extent.

Concerning field work, appropriate hardware and software will be used (handhelds equipped with GPS). This should also facilitate sampling approaches, where the remote sensing derived information is combined with field data.

For monitoring land cover changes and for updating the land cover maps, a period of 5 to 10 years is often suitable. Once an area is mapped according to the HABITALP interpretation key and a proper delimitation is available, it is expected, that very high resolution satellite image data may be used instead of further aerial image generations for automatic change detection methods combined with field surveys. In selected areas this could be a very cost effective way to monitor specific areas.

Currently, laserscanning is performed for many regions (e.g. Bavaria, South Tirol, Vorarlberg) as basis for various application fields. Because of cost reasons it cannot be expected that laserscanning will be performed exclusively for operational habitat mapping. However, for regions with already available laserscanning data from other projects, improved information for habitat characterisation will be derived from this data source (e.g. detailed forest parameters).

If translation of HABITALP habitat types to NATURA 2000 habitat types should be significantly improved, the HIK2 interpretation key needs adaptation and the mapping instructions need a particular focus.

Outlook

Within the HABITALP project a huge amount of data has been collected and analysed. Methods and results have been discussed intensely between protected area managers and scientists on transnational level.

Almost all partners have acquired their CIR images and have done their first interpretation. This data is now available thanks to the transnational spatial database and first analyses have been carried out.

Now the integration of the data into practical management starts out.

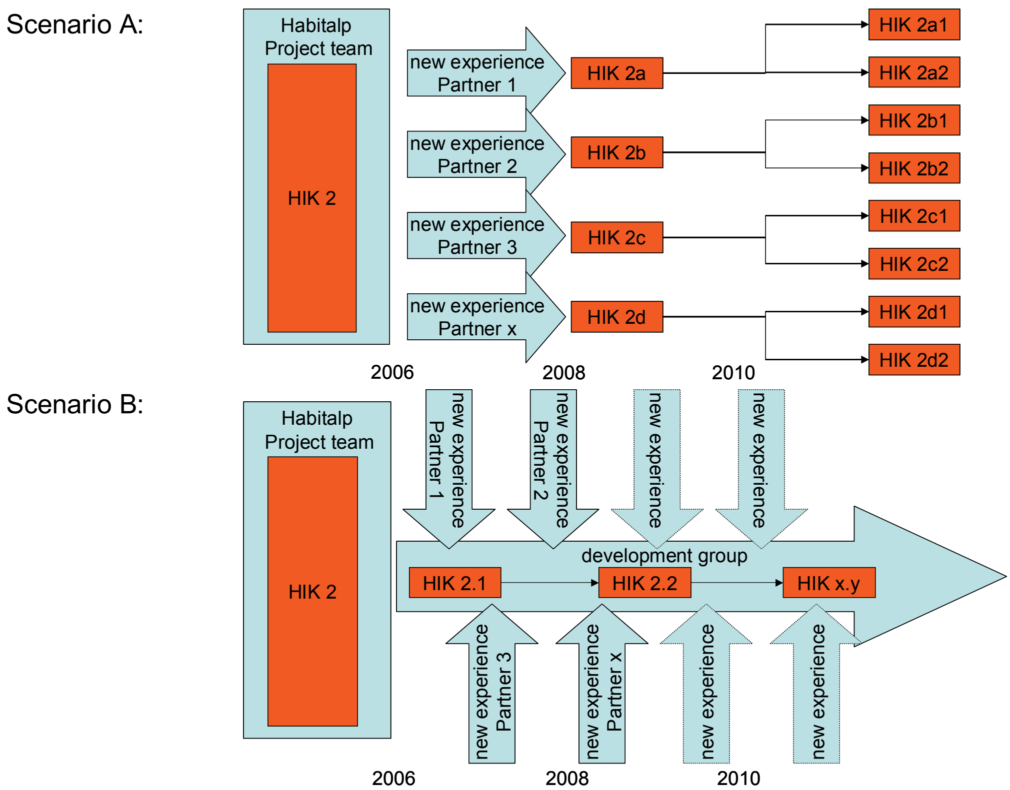

Figure 75: Comparison of two possible developments without (Scenario A) and with (Scenario B) ongoing HABITALP development group, that is in charge of maintaining and updating methodology and tools.

The more often the interpretation dataset can be used for different management questions, the earlier the "return of investment" will come. Now every partner is able to experience, how the results can be used in practical work.

New questions arise:

- Is the spatial resolution high enough to provide the basic geometry for other surveys?
- Are the attributes of each habitat useful for ecological modelling?
- Are there too many attributes, which are nice to have but not really required?

After the HABITALP project has finished in the year 2006, application of the methodology will continue. Modifications will be necessary, new experience will be gathered, but without an ongoing project team, the documentation and exchange between the users will decrease. Changes may occur to the interpretation key after some years of development. The application of the key in other protected areas will lead to the coding of new habitat types and maybe to structural modification. It is just a question of time that the methodology differs so much and the results can not be compared anymore. Tools, which have been developed by one user, are not available for another one, because of incompatible interpretation keys. The need of an organisation being in charge of the further development of the HABITALP methodology is obvious and is also pointed out by Hauenstein in this report (end of chapter "Aerial Image Interpretation").

This organisation should be able to provide the following tasks:

- Integration of new habitats into a unique catalogue
- platform for development of tools & methods
- documentation of user experience (feed back)

Only an organised development team will be able to promote the method and reduce parallel development.

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HABITALP

Local Application Experiences

Which questions, which tools? The role of HABITALP in the manager's tool case of Les Écrins National Park

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Les Ecrins

Summary

What is the place of the HABITALP tool in the range of existing tools ? Our objective is give to the protected area managers some usable tools in order to answer to the mains questions.

The work we made during the year 2005 uses 3 concepts : the system theory (von Bertalanffy), the levels of organisation and the observation level theory (Auger) and the scale and the hierarchy theories (Allen and Starr).

Quality and validity analysis of the data used in alpine protected areas evokes 3 types of questions :

- characterization (inventory of the existing)
- dynamic (follow up)
- prospective (monitoring).

We define 4 observations levels :

- protected area or region
- operational geographic unit
- landscape pixel or physiognomic unit
- habitat, ecosystem, community

and attribute to each the tools to obtain the data as well as the corresponding analysis and communication tools.

For example for a question like : “what is the habitat quality ?” the tools to obtain the data are aerial photos of “high resolution” (type HABITALP) and the analysis is made by photo interpretation. But we can also use the orthoplan IGN or ICONOS satellite views. This reflection is completed by an inventory of tools and their technical characteristics.

In conclusion we encourage the protected area manager to ask themselves some apparently simple questions before using tools for spatial data capture.

For us the high resolution colour infrared aerial photo (type HABITALP) is a specific tool with some limits and qualities... If all the phases to obtain the tool can be managed and if it’s possible to obtain a very fine spatial delimitation based on the physiognomic character.

It’s clear that you cannot replace the fine scaled terrestrial cartography of certain habitats nor the field knowledge. The main advantage of the HABITALP tool is to create a layer of homogenous spatial units which provide data on the land cover without being obliged to detailed field work. A simple checking can be enough. The application of this common tool in protected areas enables at the same time comparisons and shared know-how. The efficiency of this tool is around 100 km² coverage which corresponds well to the surfaces of high heritage value.

Résumé

Au début du programme, l’équipe des Ecrins s’est interrogée sur la place de l’outil HABITALP dans le panel des outils existants. Notre objectif est de donner aux gestionnaires quelques outils utilisables pour répondre aux questions principales.

Le travail réalisé durant l’année 2005 utilise 3 concepts : la théorie des systèmes (von Bertalanffy), les niveaux d’organisation et la théorie des niveaux d’observation (Auger) et les théories des échelles et des hiérarchies (Allen et Starr).

L’analyse de la qualité et de la validité des données utilisées dans les aires protégées alpines posent 3 types de questions :

- caractérisation (inventaire des rencontres)
- dynamique (suivi)
- prospective (monitoring).

Nous définissons 4 niveaux d’observations :

- aire protégée ou région
- unité géographique
- grain de paysage ou unité physionomique
- habitat, écosystème, communauté

et attribuons à chacun un outil pour obtenir des données, l'outil d'analyses correspondant, voire de communication correspondants.

Par exemple pour une question du type « quelle est la qualité des habitats ? », les outils pour acquérir des données est la photo « haute définition » (type HABITALP) et l'analyse se fait par photo interprétation. Mais nous pouvons aussi utiliser l'orthoplan IGN ou les vues satellites ICONOS. La réflexion est complétée par l'inventaire des outils avec leurs caractéristiques techniques.

En conclusion, nous encourageons les gestionnaires d'aires protégées à se poser de simples questions – en apparence – avant d'utiliser des outils d'appréhension de l'espace.

Pour nous, la photo infra-rouge couleur de haute définition (ou type HABITALP) est un outil spécifique avec ses limites et ses qualités… Si on est capable de gérer toutes les phases pour obtenir l'outil et si l'on peut obtenir une délimitation spatiale fine basée sur les caractères physionomiques.

Il est clair que l'on ne peut pas remplacer la cartographie terrestre à fine échelle de certains habitats ni la connaissance nécessaire du terrain. L'avantage d'un outil comme HABITALP est de pouvoir créer une couche d'unités spatiales homogènes, pouvant fournir des données d'occupation du sol sans être obligé à un travail de terrain très fin. Un simple contrôle peut être suffisant. L'utilisation de cet outil commun aux espaces protégés est à même de fournir des comparaisons et des savoirs-faire communs. L'efficience de l'outil correspond à une couverture d'environ 100 km² et correspond bien à des surfaces de haute valeur patrimoniale.

Zusammenfassung

Welchen Stellenwert hat das HABITALP-Tool im Rahmen der bestehenden Instrumente? Unser Ziel ist es, den Verwaltern von Schutzgebieten nützliche Instrumente zur Klärung der wichtigsten Fragen zur Verfügung zu stellen.

Die im Jahr 2005 durchgeführte Arbeit beruht auf 3 Konzepten: der Systemtheorie (von Bertalanffy), den Organisationsebenen und der Theorie der Beobachtungsebenen (Auger) sowie der Skalen- und Hierarchietheorie (Allen und Starr).

Die Qualitäts- und Zuverlässigkeitsanalyse der in alpinen Schutzgebieten verwendeten Daten ist mit drei Arten von Fragen verbunden:

- Charakterisierung (Bestandsaufnahme)
- Dynamik (Entwicklung)
- Perspektive (Überwachung).

Wir definieren 4 Beobachtungsebenen :

- Schutzgebiet oder Region
- Operationelle geographische Einheit
- Landschaftspixel oder physiognomische Einheit
- Habitat, Ökosystem, Gemeinschaft

und ordnen jeder Ebene die Instrumente für die Datenerhebung sowie die entsprechenden Analyse- und Kommunikationsinstrumente zu.

Für die Frage nach der Lebensraumqualität zum Beispiel dienen als Instrument der Datenerhebung hochauflösende Luftbilder (Typ HABITALP) und die Analyse erfolgt mittels Bildinterpretation. Wir können aber auch den IGN-Orthoplan oder ICONOS-Satellitenbilder verwenden. Diese Überlegung wird durch ein Inventar der Instrumente und ihrer technischen Eigenschaften ergänzt.

Und schließlich ermutigen wir die Verwalter von Schutzgebieten, sich selbst einige – dem Anschein nach – einfache Fragen zu stellen, bevor sie die Instrumente für die räumliche Datenerfassung verwenden.

Für uns stellt das hochauflösende Farbinfrarot-Luftbild (Typ HABITALP) ein spezifisches Instrument mit gewissen Grenzen und Qualitäten dar…. Wenn es gelingt, alle Entwicklungsphasen des Instruments zu bewerkstelligen und eine sehr genaue räumliche Abgrenzung auf Grund von physiognomischen Merkmalen vorzunehmen.

Es ist klar, dass man weder Landkarten im kleinen Maßstab noch Gebietskenntnisse ersetzen kann. Der Hauptvorteil des HABITALP-Instruments liegt darin, dass ein Layer von

homogenen räumlichen Einheiten gebildet werden kann, die ohne die Notwendigkeit einer detaillierten Feldarbeit Daten über die Landnutzung liefern. Eine einfache Kontrolle ist ausreichend. Die Verwendung dieses gemeinsamen Instruments in Schutzgebieten ermöglicht gleichzeitig Vergleiche sowie den Austausch von Know-how. Die Effizienz dieses Instruments entspricht einer Abdeckung von 100 km² und eignet sich somit gut für ökologisch und landschaftlich hochwertige Flächen.

Riassunto

All'inizio del programma, il nostro team si è chiesto quale posto andava assegnato ad HABITALP nella gamma di strumenti già esistenti. Il nostro obiettivo è quello di fornire agli amministratori strumenti idonei a soddisfare le loro principali esigenze.

Il lavoro realizzato nel corso del 2005 si è basato su tre concetti: la teoria dei sistemi (von Bertalanffy), i livelli di organizzazione e la teoria dei livelli di osservazione (Auger) e le teorie delle scale e delle gerarchie (Allen e Starr).

L'analisi della qualità e della validità dei dati utilizzati nelle aree protette alpine solleva tre ordini di quesiti:

- la caratterizzazione (inventario delle presenze riscontrate)
- la dinamica (follow up)
- lo studio prospettico (monitoraggio).

Abbiamo definito 4 livelli di osservazione:

- area protetta o regione
- unità geografica
- grano del paesaggio o unità fisionomica
- habitat, ecosistema, comunità

e a ciascuno abbiamo attribuito strumenti per la raccolta dei dati, nonché i corrispondenti strumenti di analisi o di comunicazione.

Per esempio, di fronte a una domanda del tipo «quale è la qualità degli habitat?», lo strumento per acquisire i dati è la foto ad «alta definizione» (tipo HABITALP) e l'analisi avviene tramite foto-interpretazione. Ma si può utilizzare anche l'ortopiano IGN o le immagini satellitari ICONOS. La riflessione è stata completata formulando un elenco degli strumenti, con relative caratteristiche tecniche.

In conclusione, incoraggiamo gli amministratori di aree protette a porsi domande apparentemente semplici prima di utilizzare strumenti per la conoscenza del territorio.

Secondo il nostro parere, la fotografia infrarosso colore ad alta definizione (o tipo HABITALP) è uno strumento particolare che presenta specifici limiti e qualità… A condizione di essere in grado di gestire tutte le fasi del processo e di ottenere una delimitazione spaziale sottile basata sulle caratteristiche fisionomiche.

E' evidente che non può sostituire la cartografia terrestre su scala ridotta di alcuni habitat né la necessaria conoscenza del territorio. Il vantaggio di uno strumento come HABITALP è di creare un livello omogeneo di unità spaziali in grado di fornire dati sull'uso del territorio senza essere costretti a un lavoro estremamente minuzioso sul campo. Può bastare una semplice verifica. L'uso di questo comune strumento da parte delle aree protette può fornire elementi di confronto e una metodologia comune. L'ottimale efficienza di questo strumento corrisponde a una copertura di circa 100 km² per superfici ad alto valore patrimoniale.

Introduction

During the setting up of the Habitalp programme, the partners of Parc National des Écrins have felt the need to complete their reflections with a specific work aiming at:

- placing the tool elaborated by Berchtesgaden (at the origin of the Habitalp project) in a set of mainly spatial tools (aerial photographs, satellite views)
- reminding that, to every question asked, corresponds a set of tools adapted to the geographical, technical and cultural context in which the manager or scientist asks the question.

The aim is to provide protected area managers with a synthesis of the available tools for answering precise questions.

A consideration including the managers' and the scientists' approaches has aimed at being as wide as possible. Spatial concepts and tools have been emphasised. The objective is to find the right tool, in order to obtain an adequate answer. Here are examples of typical questions, with which managers may be confronted:

- Where are the Lady's Slippers (*Cypripedium calceolus*) located?
- What is the surface of larch forest in the park?
- What is the trend concerning bocage landscape?
- Where are the zones that deserve highest attention?

These are only four significant examples of a list that could be much longer…

Behind the apparently trivial title "which questions, what tools", it is necessary, in the first place, to give a precise definition of the concepts needed to address this issue.

A list of the main questions for each level of observation will then be compiled, in the light of which some tools will be proposed.

Finally, the main spatial tools will be described, giving details on the constraints of each tool from the technical, material and human points of view.

The reflection is based on 3 concepts:

- the systems theory (Von Bertalanffy, 1968; Frontier & Pichod-Viale, 1991)
- the notions of levels of organisation and observation (Auger et al., 1992)
- the notions of scale and hierarchy (Allen & Starr, 1982)

Levels of observation: a fundamental stage

In a protected area such as a National Park, we mainly use 5 levels of observation.

Table 24: the different levels of observation

Level of observation	Examples
Country, massif, protected area	The National Park
Operational Geographical Unit (OGU)	A valley, a N2000 site…
Physical unit, landscape feature	A slope, a mountain pasture…
Community, ecosystem or habitat	Snow-beds
Population	Reine des Alpes (*Eryngium alpinum*) du Fournel

Table 25: relations between level of observation and processes

Level of observation	Potentially involved factors and processes
Global	Economy, climate, evolution of repartition, speciation,
Country, massif, natural areas	Local policies, invasive species
Operational Geographical Unit (OGU)	Aquifer mechanisms, species flow (large fauna), soil, vegetation stages, global exposure
Physionomic unit, landscape pixel	Interactions between habitats , erosion - accumulation Uses (agricultural rotations
Habitat, Community, ecosystem	Microclimate, meso-topography, interactions between species
Population	Numbers, movements, gene flow
Individuals	Physiology, anatomy, behaviour

Adequate data: which quality and validity?

In parallel, the data is collected in protected areas, by 3 possible methods (ecological survey, inventory, monitoring). Each of these methods yields a specific load of information. This information has a certain validity in time and space that must be taken into account. Therefore, depending on the main question, an analysis of the existing data is necessary. If insufficient in quantity or quality, the setting up of a specific data-collecting protocol is required.

A typology of questions to refine the reflection

The issues examined in this synthesis are of 3 types:

HABITALP

- characterisation: these issues are usually of a descriptive nature
- dynamics: these issues are comparative (monitoring), analytical, as well as phenomenological
- forecasting: all the questions concerning models and mechanism scenarios fall into this category.

The manager's tool case for assessing space

To solve the manager's questions, a wide array of tools exists. We will only examine space-oriented tools.

For each level of observation, only a limited number of tools is pertinent (table 26).

Table 26: relations between level of observation and tools

Tool	Global	OGU	Physical unit	Ecosystem
High-resolution IRC aerial photography (type Habitalp)			x	x
IRC Aerial photography (type IFN)			x	x
Real-colour aerial photography (type IGN)		x	x	
Very high resolution satellite		x	x	
Low resolution satellite	x			
Topographic backgrounds (1/25000)		x		
Topographic backgrounds (1/50000 - 100000)	x			
MNT 50m	x	x	x	
MNT 10m				x

Description of data-generating tools

These descriptive slips aim at presenting different data-generating tools, in a summarised way.

In order to obtain and analyse the data, it is necessary to go through more or less complex procedures ranging from simple orderings to calls for tender, from geo-referencing to the writing of specifications for detailed aerial browsing… Hence, the main actions are listed in the part "data generation".

The metadata chapter allows, using 15 parameters, to evaluate the technical limits to every tool.

It is necessary to include in the technical characteristics, the material and human needs required to obtain the data (third part). The manager's choice will be guided by the analysis of these 3 factors.

Finally, the fourth part deals with the material and human means required for the analysis. We have intentionally separated them from the means required for the acquisition, because the tasks can be achieved by different persons or structures.

(Example of a slip see next page, other slips : see table 26).

SLIP N° 1

HIGH RESOLUTION AERIAL PHOTOGRAPHY (TYPE HABITALP)

DATA GENERATION
→ Creation of specifications for the type of photography and procedures → Call for tender for the realisation → Process monitoring → Data collecting

METADATA	
1. Properties	Backer
2. Acquisition	Analogical
3. Type	Slides
4. Quality	4/5: very good
5. Resolution	15 cm (scanned and ortho-rectified image)
6. Periodicity	Undefined
7. Geo-referencing	Must be financed
8. Surface per unit	Can be modulated (currently provided by 1 km²)
9. Flight plan	Controllable by the backer
10. Date and time of flight	Partly controllable
11. Availability	Low (6 to 12 months)
12. Storage constraint	Very high (> 40 G. memory)
13. Stereoscopy	Yes
14. Feasibility	Small surface (< 100 km²)
15. By-products	Maps; picture analyses

MATERIAL AND HUMAN MEANS REQUIRED FOR THE AQCUISITION		
1. Material means	PC with high backing storage capacity and large random access memory (for reading files). Visualisation software.	
2. Human means	**Geomatician**	
3. Minimal cost of acquisition	Without geo-referencing:	With geo-referencing:

MATERIAL AND HUMAN MEANS REQUIRED FOR THE ANALYSIS	Interpretation	Processing
1. Material means	✓ Slide stereoscope ✓ GIS software ✓ Powerful computer	✓ GIS and image processing software ✓ Powerful computer
2. Human means	• *Photo-interpret* (spatial segmentation) • *Geomatician* (organisation of the results)	• *Thematician* (brings forward a question depending on the field concerned) • *Image processing engineer* (picture analysis) • *Geomatician* (organisation of the results)

To conclude…

There are no "wrong tools", neither are there "bad questions". Only the choice of an inadequate working tool for a given question, or the inappropriate formulation of an expectation with regards to a limited tool, are methodological or technical deadlocks.

As a consequence, every study potentially needing spatial data must be analysed through a precise list of considerations:

- what theme is to be analysed (vegetation, trails, glaciers, etc.)?
- what is the main question associated with this theme (deforestation, wood monitoring, impact of trails, glacier fluctuations, etc.)?
- are spatial tools required?
- if they are, which ones are appropriate? What are their limits (technical and analytical)? And finally, which is the necessary document (most precise and/or cheapest) that answers my question?
- which processes will be needed for acquisition and analysis?
- what results, given the choice made, can be expected?
- are these results useful for answering the question initially defined?

Many studies involving remote detection and photo-interpretation have been launched and carried out with great scientific soundness and methodological precision. However, many results have not been judged satisfactory, because the answer provided did not really reflect the underlying expectations of the project. Indeed, a question like "at what speed do Rhododendron heaths spread" actually requires many preliminary precautions – which have seldom been considered – such as defining the pertinent level of observation, the necessary level of precision, the time scale on which the study is to be carried out… In short, many elements needed to define the scope of study, that cannot be overlooked, considering past experience.

To conclude temporarily, Habitalp proposes a specific tool, with its qualities and limits. This tool will not answer all the managers' question, and will not spare them the reflection and complementary studies.

Its main advantages lie within the creation of a very precise spatial segmentation, based mainly on the physical characteristics of the vegetation. The addition of structural data will allow a quite complete description of each delineated unit. The result is a map describing the state of land use, enriched with information concerning dynamic trends.

The limits of this document are linked with its qualities: the aim being spatial segmentation, there are no inventories of floristic communities and ecological data allowing to distinguish the habitats (in the European sense – "Corine Biotope") covered. Thus, this document could at most provide elements for a pre-cartography of habitats, which would need to be completed by a cartography and by field inventories (systematic or sampling).

In 2006, it seems obvious that there are no tools able to provide answers for all the questions a manager raises. There are also very few data-generating tools adapted for different levels of organisation.

This is the reason why a policy of differential data acquisition (corresponding to the different levels of observation) is recommended.

HABITALP

The HABITALP Vision

Perspectives for a common alpine landscape management

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Nationalpark Berchtesgaden

HABITALP – a common vision for the Alpine Space?

HABITALP project implementation was accompanied by the idea of setting the fundament for a transboundary and sustainable landscape management within the Alpine Space.

This chapter summarizes the project achievements and analyses them in the light of this vision.

Innovative core results

The core results of the HABITALP project are represented by the common alpine interpretation method (multilingual interpretation key and guidelines for delimitation and interpretation of habitats) and the interpreted datasets of ten protected areas of the Alpine Space (confer WP6 and WP7).

Although aerial image interpretation is not an unknown field, these two achievements represent a real innovation because of their alpine dimension and mean thus an enormous added value for the Alpine Space as well as for the European Union.

Within only four years of intense cooperation a tremendous methodological progress took place and motivated a heterogeneous project group to adopt standardized methods.

This was only possible because of the integrative proceeding, the respect of local requirements and the willingness of the partners to create a common result. The success factor was to promote a common alpine tool that is at the same time of local usefulness. Thanks to all members of the project community the European Idea could be put into practise through very tangible products.

The transnational competences and the profound networking that were achieved through HABITALP are the fundamental basis for the future improvement and development of these core results.

Transboundary approach

HABITALP interpretation datasets describe the physiographic structure of the landscape and offer spatial reference units that are independent from administrative delimitations.

As nature does not respect any political frontiers a transboundary classification of the space is needed. HABITALP can do so on a very detailed level of habitat description (see WP7) as shown in the adjacent project areas of Parc National de la Vanoise (France) and Parco Nazionale Gran Paradiso (Italy) or Parco Nazionale dello Stelvio (Italy) and Parc Naziunal Svizzer (Switzerland).

The existence of standardized interpretation datasets enables comparisons between the landscapes of the Alpine Space and reveals the alpine uniqueness of protected areas like for example the traditional hedgerow landscape ("bocage") in Parc National des Écrins (France) or the huge stands of upright *Pinus montana* ("Spirkenwälder") in Parc Naziunal Svizzer.

By the aid of the HABITALP database the importance of protected areas becomes thus evident not only in the national but also in the transnational alpine context. This will help to assess the Alpine Space as an entire biogeographical region and enable coordinated spatial development of alpine protected areas.

Alpine applications

Modelling of landscape properties on the basis of HABITALP interpretation data can support such transboundary deliberations. One exemplary attempt was made within the project in the field of landscape diversity.

Diversity models generalize the interpreted polygons to a certain extent in order to visualize the inherent information on the diversity of the landscape that is often not directly recognizable when looking at the original interpretation data. The results distinguish between areas of high and low diversity but also unveil where the landscape is composed by huge coherent habitats and where it has a mosaic composition of small habitats (confer WP10).

Manifold variations of these analysis methods according to the prevailing questions can be imagined. The assessments can support different management strategies and focus them on the preservation of desired landscape structures and the species preferring such structures.

The common alpine application of such methods creates a powerful source of spatial information for transnational assessments and strategies. Developed in the frame of diversity modelling (confer WP10) the guidelines of cooperation on landscape management give an idea of how this knowledge pool might be nourished and applied in the sense of the HABITALP vision.

Sustainable transnational landscape management

The sustainability of landscape management is only possible if the effects of applied measures are controllable and adjustable. This requires monitoring and assessment of the landscape structures by reproducible methods.

HABITALP offers a common alpine tool for the fine-scaled spatial census of the landscape (1:5.000 mapping scale) and the detection of its changes (confer WP "NATURA 2000 & Monitoring (part 2)"). Repeated application of the HABITALP method will create temporal series of comparable interpretation datasets.

As HABITALP does not select specific habitats, landscape changes can be observed in a surface covering way and in comparison to their surroundings. The observed natural evolutions and man-made modifications can be assessed with regard to desired or undesired effects. Depending on the results of this assessment, the spatial planning of management measures is possible. Subsequent image and interpretation generations will enable the success control of the applied measures and the adjusting of future actions.

It is the alpine standardization of methods offered by HABITALP that widens these possibilities to a transnational dimension and builds the fundamental basis for the transboundary coordination of such measures.

The repetition interval of image flights will depend on the local landscape dynamics and the financial resources. In any case HABITALP has set the starting point for the gathering of long-term experiences in habitat surveillance.

Alpine tools

Although interpretation method and emerging datasets represent the core results of HABITALP they would not have been possible if the initial data capture by aerial image flights was not equally subject to common alpine specifications.

Aerial image technologies evolve constantly (confer WP5 and WP6) and specifications will have to follow the technical progress. Improvements in satellite imagery will have to be considered. But in the foreseeable future aerial images will remain a highly suitable tool for the fine-scaled and efficient census of the land cover types. The principal HABITALP approach is thus far looking and future oriented.

Local landscape datasets are of no value for transnational applications unless they are unified and made publicly accessible in a common database. Europe needs data and it must be shown to Europe that these data exists.

With today's technical means immense amounts of data can be produced. The main challenge is to archive and update the data in a standardized way that is easily understandable for future users and to ensure long-term accessibility.

HABITALP goes beyond archiving and tackles web visualization, which surely makes data more attractive (see WP9 and WP11). But web technologies will refine in future and HABITALP will have to keep pace with the development in order to remain a database of long-term attractiveness. The alpine dimension of database maintenance is very challenging. It will require many future activities ranging from legal aspects to update rhythms and from structural extensions to improved cartography.

Alpine and European policies

HABITALP focuses on protected areas but not exclusively on natural habitats that are free of any human influence. Semi-natural habitats of European importance emerging from traditional extensive forms of land use are embedded in the transition and peripheral zones of protected areas. As these habitats are equally integrated in the HABITALP method (confer WP6 and WP7), questions of an integrated spatial development of natural and cultural landscape heritage can be approached.

Effects of abandoned or maintained traditional land use as well as of undisturbed national dynamics or risk protection measures can be studied on landscape level and considered for management decisions. Preservation conflicts emerging from recreational use, economic interests and natural hazards can be tackled on the basis of HABITALP interpretation data.

In particular because of its cross-sectoral character HABITALP is thus in compliance with the long-term intentions expressed by the European Union in terms of integrated management approaches and strategies for the promotion of natural and cultural landscape heritage. HABITALP meets the aims of the Alpine Convention and the needs expressed in different protocols (nature protection, spatial planning, alpine pastures, alpine forests, recreation).

European policies do not need short-term actions. If the HABITALP vision is continued a major fundamental pillar of European policies is supported on the long term.

What about the space in between protected areas?

Surface-covering census of the Alpine Space by aerial image interpretation is not feasible at the moment due to economical reasons. Technological progress might change this in the future but presently land cover data in the accuracy of the HABITALP habitat description can only focus on limited surfaces (up to 1.800 km² per area achieved within the project).

However, the positioning of protected areas with regard to their non-protected surroundings could be tackled by exploring the freely available CORINE land cover data. Derived from satellite images CORINE data is much coarser than HABITALP data (max. 44 habitat classes in the most detailed version in comparison to several hundred main habitat types in HIK-2). But due to its spatial extension it could help to assess on an alpine scale the protected areas of today and even imagine the protected areas of tomorrow.

A first landscape diversity model derived from CORINE land cover and SRTM elevation data is very promising (confer WP10). Bridging the gap between protected and non-protected areas with satellite landscape data can give hints on the questions if protected areas were defined in the right places and in which places additional protection might be required. It could help to extract possible ecological corridors between protected areas and make these zones subject to more precise aerial image interpretations.

Ecological corridors could be envisaged that will link similar habitats of different protected areas and enable species migration and genetic exchange.

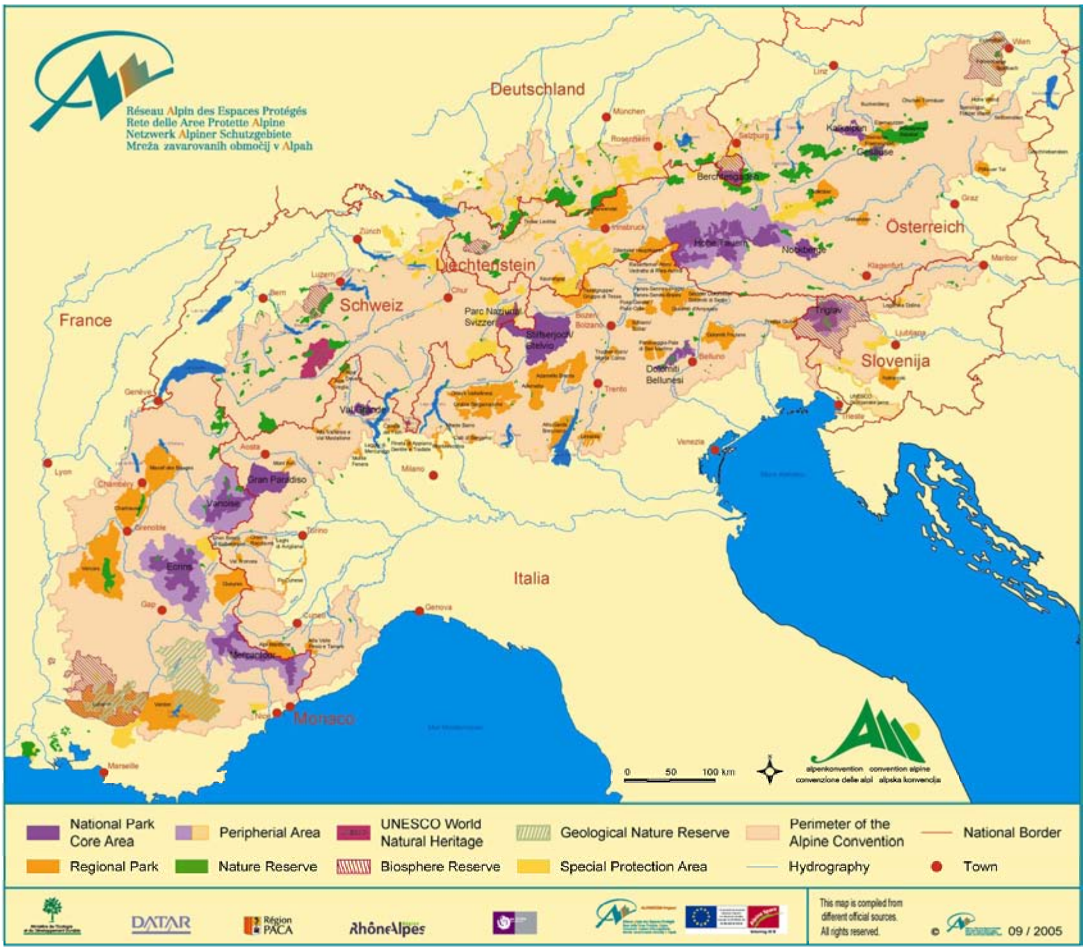

Figure 76: Alpine Protected Areas > 100 ha (ALPARC)

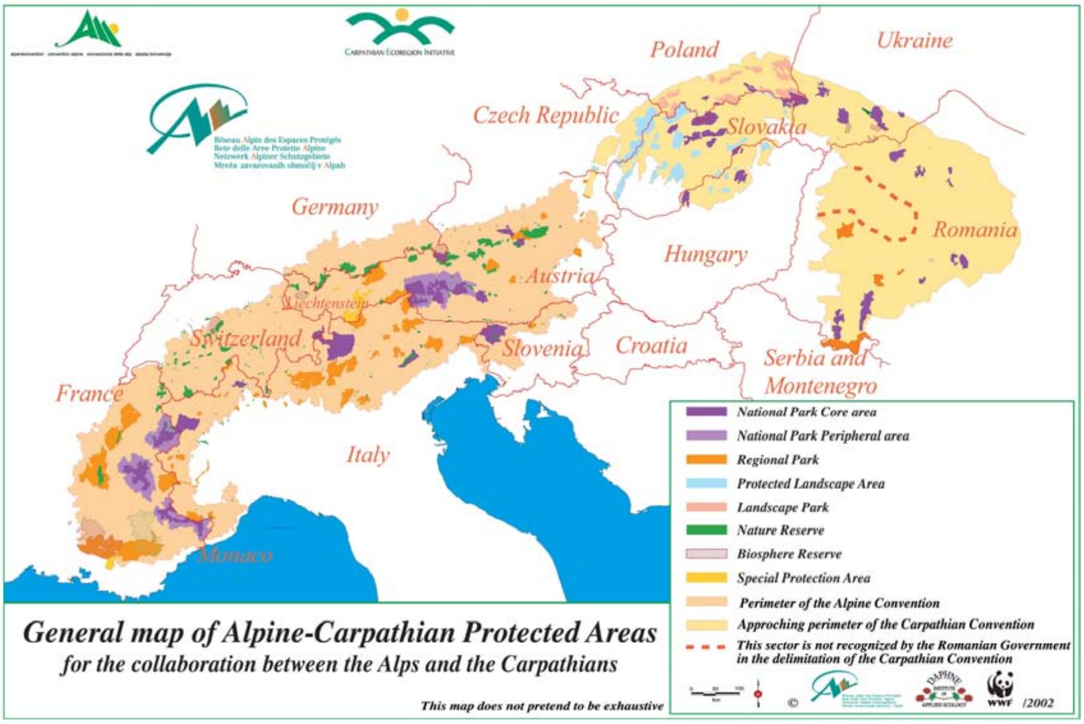

Figure 77: Alpine-Carpathian Protected Areas (ALPARC)

Transferability and ecological networks

The more alpine protected areas adopt the HABITALP methodology the more possibilities will arise for an integrative spatial development within the Alpine Space.

The Alpine Network of Protected Areas (figure 76) unites about 350 areas of more than 1 km² size. In this regard the eleven HABITALP project areas represent only a very small subset. But the attempt of alpine standardization is unique and the common methodology is the basis to make use of the transfer potential offered within this network.

The availability of multilingual reference documents is of great benefit for the initialisation of methodological transfers either within the Alpine Space or to other European mountain chains like the Carpathians or the Pyrenees.

English reference documents can serve as interface before a translation into the specific national terms is effected. This national translation however will be necessary to ensure that all users have the same understanding of the method.

Based on these common instruments the definition of a pan-European ecological network (figure 77) becomes imaginable.

NATURA 2000 – an ecological network

The protected areas of the Alpine Space are important parts of the NATURA 2000 network (see figure 78). They are often registered as entities within NATURA 2000 even if single habitats do not correspond to specific habitat types listed e.g. in the Habitat Directive. Therefore the investigated correspondence between HABITALP and NATURA 2000 habitat typologies is “only” one compartment (see WP8-1) of a more general approach that can be offered by surface covering aerial image interpretation data.

NATURA 2000 remains an issue of major importance, especially as transnational approaches for its coordinated implementation are missing.

HABITALP cannot replace phyto-sociological fieldwork but it could be the incentive to refine the first alpine attempt of identifying NATURA 2000 areas on general level and to define beneath this common umbrella more precise but internationally coordinated local steps.

NATURA 2000 working groups could be envisaged that integrate in an alpine context the information derived from aerial images and the information derived from field knowledge to combine a powerful instrument that can meet reporting obligations on the conservational status.

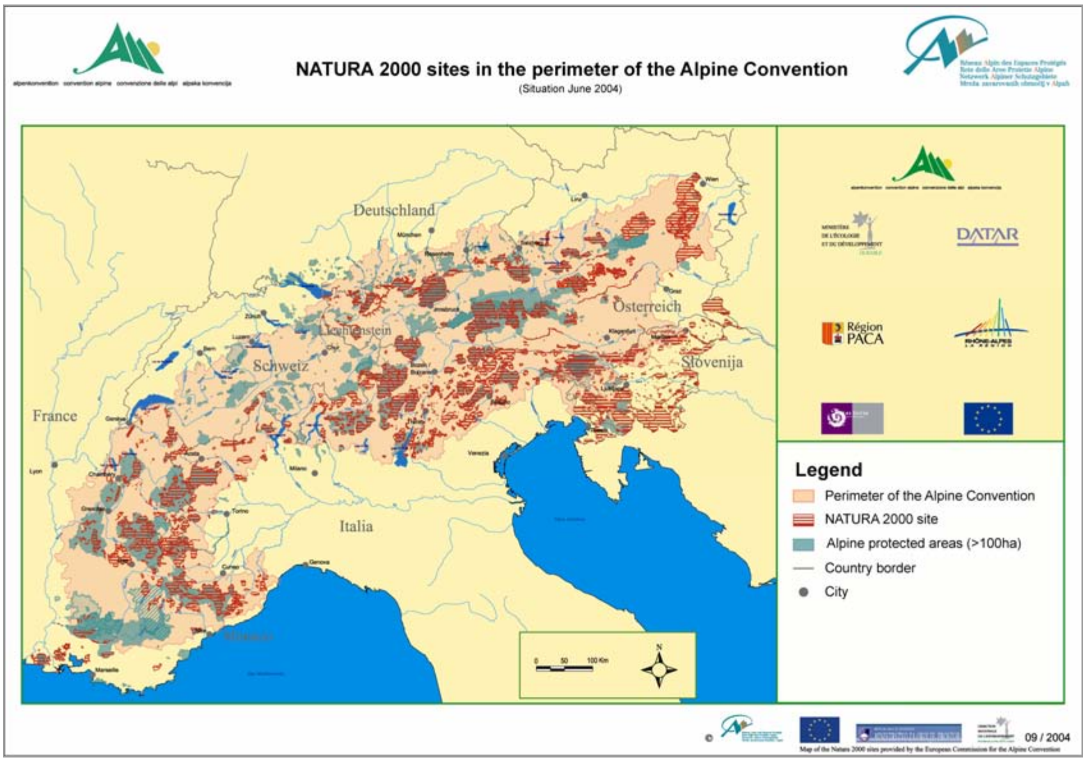

Figure 78: NATURA 2000 sites within the perimeter of the Alpine Convention (ALPARC)

From pilot mission to permanent practise

Many questions have been brought up and further needs defined. The potential created is very promising. We are thus only at the beginning of a common vision and HABITALP has placed the cornerstone for the construction of a durable and long-term transnational building.

Follow-up actions should comprise initiatives to put HABITALP to permanent practise in the partner areas and to increase the awareness beyond the administrations of protected areas.

More stakeholders should be involved like different land users, political authorities, research institutions and environmental organisations (confer WP10 guidelines of cooperation on landscape management).

Especially political authorities could make HABITALP an instrument of politically acknowledged importance for example in the frame of the long-term working programme of the Alpine Convention.

Public promotion work as well as further refining of the core results, maintenance of the database and development of transnational applications require an integrating organization and the alpine responsibility of a leading body.

The Alpine Network of Protected Areas could offer the institutional frame to maintain the high motivation of the partners and to support the sustainable setting of the project’s outcomes (confer WP12). Different responsibilities have to be defined.

Financing tools of high administrative efficiency are strongly required. The obligations related to the receipt of funds should not overcharge the available personal resources.

Alpine objectives are still no natural compartment of protected area work and subject to a high extraordinary motivation, which affects the budget that is available for local purposes.

Sustainable pursuance of alpine work can thus only take place if appropriate funding and sufficient personal resources are ensured.

List of work packages, project partners, involved staff and external experts

Work packages (WP)

WP no. after request for change	WP no. before request for change	Official title	Short title used in this publication	WP leader
WP1		not existing after request for change		
WP2	WP1	Transnational Project Management	Included in: The HABITALP Mission	Lead Partner Nationalpark Berchtesgaden
WP3	WP1	Project Management		All other Project Partners
WP4	WP9	Information and Publicity Activities		Consorzio del Parco Nazionale dello Stelvio
WP5	WP2	Census and Orthorectification of Colour Infrared Aerial Photographs	Aerial Image Flights	Parc Naziunal Svizzer
WP6	WP3	Interpretation Key	Interpretation Method	Nationalpark HoheTauern
WP7	WP4	Application of Harmonized Interpretation Key	Aerial Image Interpretation	Nationalpark Berchtesgaden
WP8	WP5	Assigning and Surveillance of NATURA 2000 Habitats	NATURA 2000 & monitoring	Parc National de la Vanoise
WP9	WP6	Transnational Spatial Database	Transnational Spatial Database	Nationalpark Berchtesgaden
WP10	WP7	Landscape Biodiversity	Landscape Diversity	Nationalpark Berchtesgaden
WP11	WP8	Evaluation of Further Applications	Further Applications	Nationalpark Berchtesgaden
WP12		Sustainable Setting of Project and Work Package Implementation	Included in: The HABITALP Mission	Nationalpark Berchtesgaden

EU Lead Partner

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EU Project Partners

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Central Alps WP6 + WP8 + WP10	APB CPNS PNDB SNP	Pius Hauenstein	Hauenstein GeoInformatik Waidagurt 6 CH – 7015 Tamins Phone: +41-81641-2585 Mail: pius.hauenstein@alumni.ethz.ch
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Eastern Alps WP8 + WP10	NPB NPHT	Jochen Grab	e.m.u projekte Lindenstraße 61 D – 83451 Piding Phone: +49-8651-767-365 Mobil: +49-178-4863-997 Mail: j.grab@emu-projekte.de Web: http://www.emu-projekte.de

Subcontracted alpine experts

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