HABITALP

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HABITALP

HABITALP

Further Applications

Technical review on the HABITALP methodology and outlook on further development – WP11

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Further Applications

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 Berchtesgaden (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.

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”).

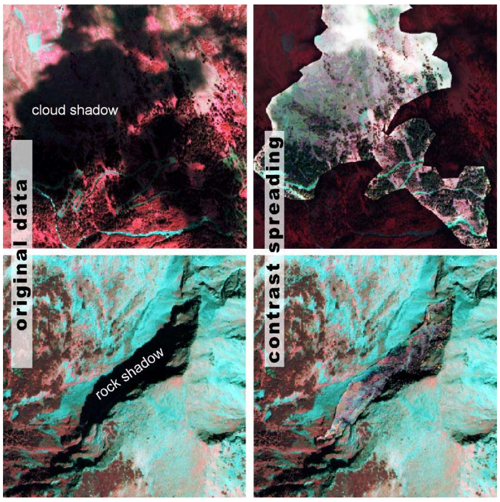

Figure 69: Mapping shaded areas in Quickbird image based on contrast spreading

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

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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	Interpretation dataset % 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).

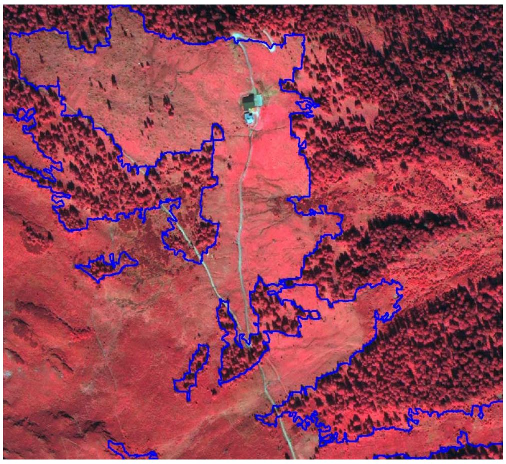

Figure 71: Blue line: automatically calculated upper forest boundary based on a Quickbird image. Test site: Landeck area, Tyrol, Austria.

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.

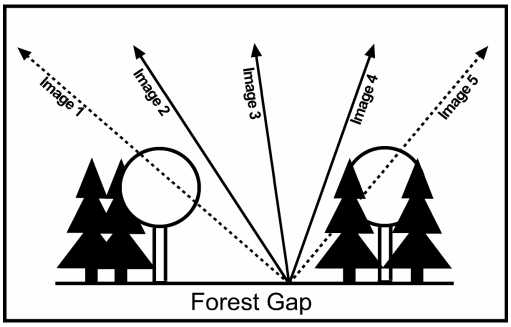

Figure 72: Mapping a forest gap: intersection rays from standard overlap (dashed lines, no calculation of the coordinate possible) and from 90 % overlap (all lines, calculation possible).

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 14^{th}–15^{th} 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 "ecological 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 knowledge 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.

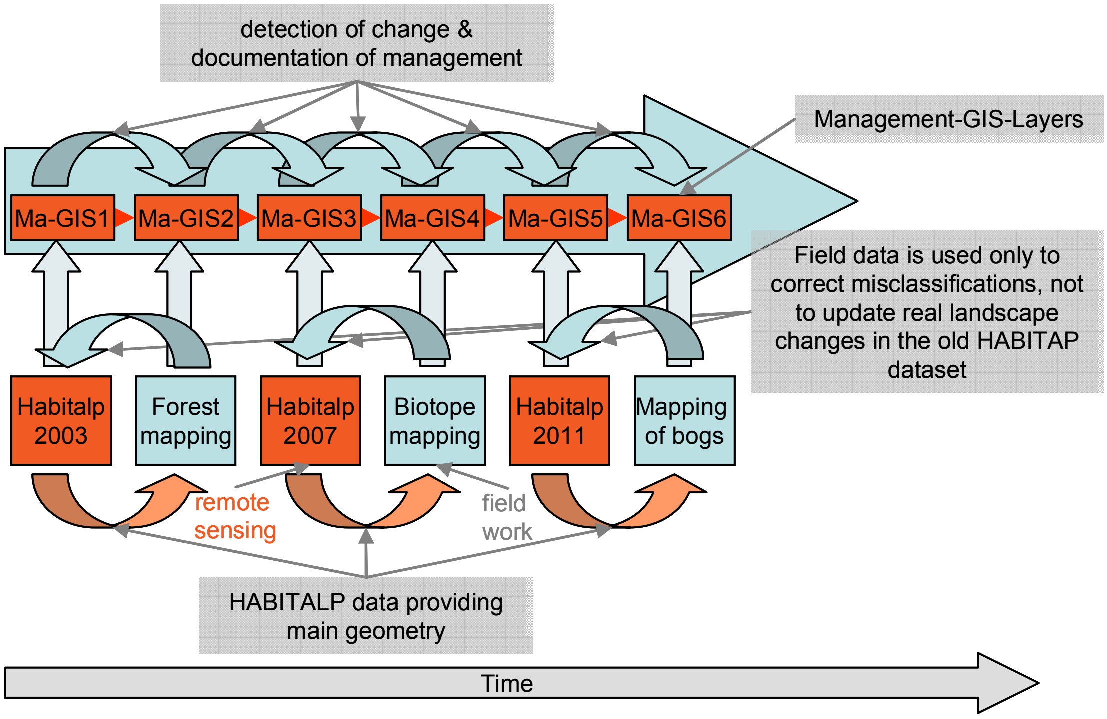

Figure 74: Integration of the HABITALP interpretation datasets into a protected area management GIS-infrastructure. Each square symbols a distinct GIS-layer. The big arrows are showing the transfer of attribute data and/or geometric information on polygons.

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.

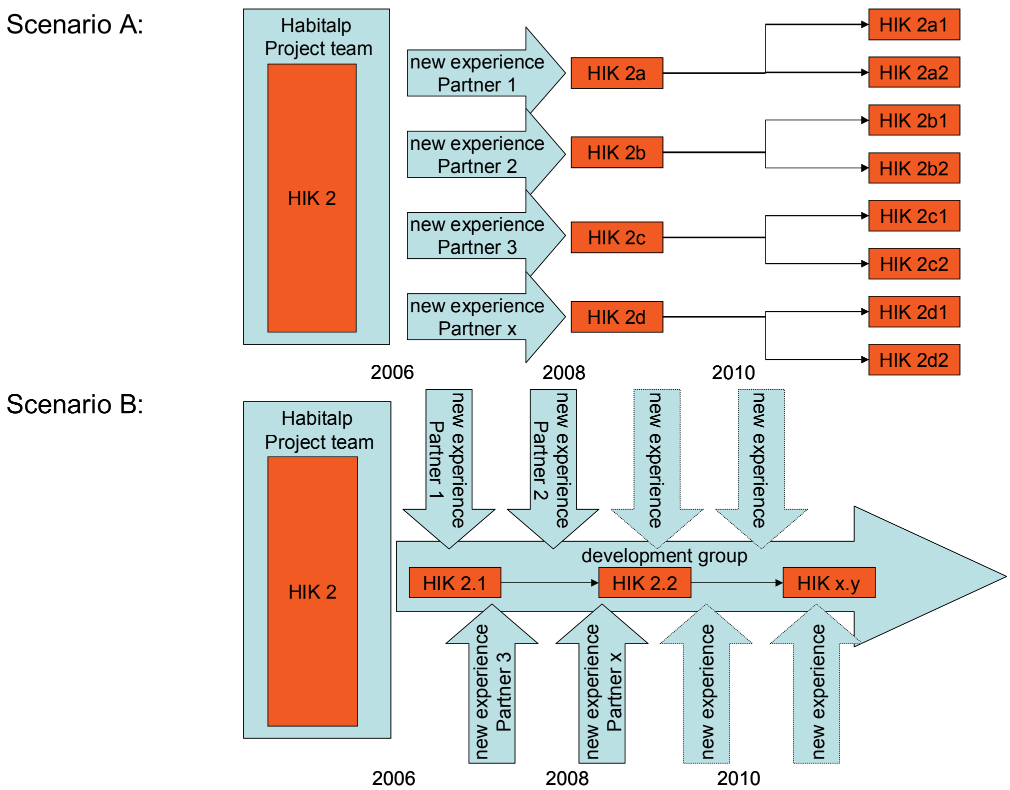

Figure 75: Comparison of two possible developments without (Scenario A) and with (Scenario B) ongoing HABITALP development group, that is in charge of maintaining and updating methodology and tools.

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.

Reference list

BfN (Bundesamt für Naturschutz) / Federal Agency for Nature Conservation (Ed.), 2002. Systematik der Biotoptypen- und Nutzungstypenkartierung (Kartieranleitung) / A System for Survey of Biotope and Land Use Types (Survey Guide) (überarbeitete zweisprachige Ausgabe / updated bilingual edition). Schriftenreihe für Landschaftspflege und Naturschutz, Bonn, Heft 73, 169 S. (deutscher Teil), 166 p. (english part)

Demel, W. & P. Hauenstein, 2006. Cartography of habitats by Colour Infrared Aerial Images – Guidelines for Delimitation and Interpretation, Freising-Weihenstephan, URL: http://www.habitalp.org/doc/index.php (last date accessed: 1.10.2006)

Dentant, C. & Godron, M., 2006: Landscape Monitoring with HABITALP Data and Set-up of Surveillance Rules for Alpine Habitats. Final technical Report of the HABITALP WP8. 78 p.

Devillers, P. & Devillers-Terschuren, J., 1996: A classification of Palaearctic habitats. Council of Europe Publishing, Nature and Environment 78: 194pp.

European Commission, 2003: Interpretation Manual of European Union Habitats. Version EUR 25. Europäische Kommission, Generaldirektion XI.

Gallaun H., Schardt, M., Granica, K., Flaschberger, G., 2001. Monitoring von Schutzwäldern mit Satelliten-Fernerkundung. VGI – Österreichische Zeitschrift für Vermessung & Geoinformation, Heft 2001/3

Granica, K., Hirschmugl, M., Proske, H., Wallner, H., Wurm, M. & Schardt, M., 2006. The Derivation of Indicators for Landslide Detection Using Very High Resolution (VHR) Satellite Imagery . Proceedings of HMRSC conference, Graz, 14.-15. September 2006, in press.

Jungmeier, M., Kirchmeir, H., Kühmaier, M., Velik, I. & Wagner, J., 2005. The IPAM-Toolbox: An Expert System for Integrative Planning and Managing of Protected Areas. Conference Volume 3rd Symposion of the Hohe Tauern National Park for Research in Protected Areas, 15.-16-17. September, Eigenverlag, Kaprun, pp 83-89.

Kias, U., Demel, W., Krüger, B. & Schweiss, I., 2006. Konzept für die Luftbildinterpretation "HABITALP" im Biosphärenreservat Berchtes-gaden – Dokumentation zur Kartierung 2003, Kartierung der luftbildsichtbaren Änderungen 1997–2003 (Change Detection) und zur Umstellung des Kartierschlüssels von HIK-0 auf HIK-2. Project report of the HABITALP WP6. LIZ Weihenstephan.

Lang, A., 2005. Field Validation Nationalpark Berchtesgaden (Workpackage 8) -Final Report of the HABITALP WP8, December 2005. 16 p.

Le Lay, G. & Guisan, A., 2005. Landscape biodiversity - Final report of the HABITALP subproject WP7. November 2004 – April 2005. University of Lausanne; Department of Ecology and Evolution - Laboratory for Conservation Biology.

Ofner, M., Hirschmugl, M., Raggam, H. &. Schardt, M., 2006. 3D stereo mapping by means of UltracamD data . Proceedings of International Workshop "3D Remote Sensing for Forestry", BOKU, Vienna, 14.-16. February 2006, unpaginated online publication.

Perko, R., 2006. Image Quality: Digital Pansharpening Versus Full Color Film. White Papers at VEXCEL Homepage, URL: http://www.vexcel.com/downloads/photogram/ultracam/whitepapers/Perko-Pansharpen-PEARS-Manu.pdf (last date accessed: 06 September 2006).

Turner, M.G., O'Neill, R.V., Gardner, R.H. & Milne B.T. 1989: Effects of changing spatial scale on the analysis of landscape pattern. Journal of Landscape Ecology, Volume 3, Numbers 3-4 / December, 1989, pp 153-162