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Remote Sensing in Protected Areas: Practical Experiences in Charting Natura 2000-Habitats, Detecting Changes in Landscape and Monitoring

Two case studies in the Gesäuse National Park

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Summary

Remote sensing, especially aerial interpretation is a main research tool for the monitoring and conservation management of Protected Areas, and in particular for National Parks. Vegetation modeling via HABITALP aerial interpretation (Lotz 2006) was carried out with two main inputs: A "Forest site investigation" and the query of site conditions from a Digital Elevation Model (DEM).

Practical experience often reveals both the limits and potential of remote sensing. In many cases remote sensing never displaces terrestrial investigations; when it comes to area-wide tasks the full range of possibilities that remote sensing provides has not yet been employed.

Keywords

Remote sensing, habitat types, woodland communities, forest stand types, DEM, geology, GIS, modelling, monitoring, morphology, dynamics in landscape

Starting Position

Managers of protected areas are often confronted with a limited financial budget and work force for the monitoring of their resources. Thus, inexpensive repeatable monitoring protocols of extreme importance. Remote sensing is rapidly becoming the preferred methodology to fulfill this need. There is no doubt that additional field investigations and monitoring of habitats and their biotic communities are the key element to successful management of protected areas.

Sufficient quality and cost-effectiveness are especially important for the management of large Natura 2000 regions. We draw on our experiences in the Gesäuse National Park, Ötztaler Alpen Natura 2000 area, Hohe Tauern National Park and Puez-Geisler among others to discuss the limits and scopes of remote sensing in such protected areas.

Investigation and Methods

The investigation area is the Gesäuse National Park in the Northern Calcareous Alps in the Styrian province of Austria. The vertical-extension reaches from 600 up to 2370 m a. s. l. The area is characterized by a high frequence of dynamic natural processes such as avalanches, floods and windthrows. Approximately 50 % of the area is covered by woodland, nearly 15% by shrubs, 5% mountainous-subalpine pastures and alpine grassland and around 30% by rocks and their associated vegetation.

The results of a "forest site investigation" (150 relevés with 87 soil profiles and chemical analyses of 21 different soil profiles), the HABITALP interpretation and the DEM were combined to create queries in the GIS (ESRI, ArcGIS Map, Spatial Analyst).

The morphological investigations are implemented by remote sensing, interpretation of laser-scans and the comparison of two generations of areal photos (1954 and 2004) combined with field work.

Objectives

Forest Site Investigations and Vegetation Modelling

Especially the forests and mountainous pastures ("Almen") have not yet been managed according to our conservation goals. Unmanaged pastures would become reforested and thus loose their open landscape character along with its associated faunal and floral diversity. Therefore these habitats are in the management zone of the national park. To optimize grazing for conservation

purposes management plans are worked out for each "Alm". The basis for the inventory of different habitats on these pastures was an area-wide aerial image interpretation (HOFFERT & ANFANG 2006). This interpretation following methods of an INTERREG Alpine Space project called HABITALP and served as well as a main base for different follow-up projects, like simulation of bark beetle risk zones (SCHOPF et al. 2008) and especially the modeling of the current dispersion of different woodland communities in the National Park Gesäuse (EGGER & HASSLER 2007). The results of this project guided us to attempt the combination of two different methods, the "Forest site investigation" (CARLI 2008) and the modeling of woodland vegetation depending on site conditions like geology (soil), exposition, declination and sea level (ZIMMERMANN 2008).

Morphology and Dynamics in Landscape

Through these efforts, both high standards and a considerable amount of information concerning the habitats and biotope-types in protected areas has been gathered. Nonetheless, studies on landforms or morphometric parameters are lacking, even though this information can be very advantageous:

Habitat modelling needs parameters like slope-gradient, exposition, landforms, surface structure, and surface lithology to compliment investigations of the vegetation layer.

When we talk about protected areas and national parks, land use, landforms and the face of the landscape are basic layers of a macrochore database

Charting morphology offers the possibility of charting landscape dynamics. Developments resulting from natural hazards or changes in the vegetation cover and forest-based-sector can not only be documented but also observed and analysed.

Therefore the Gesäuse National Park GmbH and REVITAL GmbH are devising a mapping method, where morphometric parameters as well as landscape monitoring aspects are included. At the moment a test area was charted with following parameters:

declination

exposition

morphological landform

morphological process which actually is responsible for the morphological dynamic

substrate (generalized)

Landscape dynamics – causation

Landscape dynamics – dimension (qualitative)

The challenge is, as usual, executing a low-cost area-wide investigation.

Results

Forest Site Investigations and Vegetation Modelling

Data from 335 woodland relevés were statistically evaluated. This analysis showed up with average values (sea level, exposition, declination and geology) for the different stand types. For each natural forest association we now had corresponding ecological factors and a typical tree species composition. From now on it was possible to have a classification of the forest stand types and to create queries on the HABITALP interpretation (% of tree species coverage), the DEM (Digital Elevation Model), and the geological map of the Gesäuse. Some of the forest associations had to be merged while others had to be mapped in the field. Nevertheless the result was a map of the current vegetation (scale 1:25.000) of a large territory without carrying out area-wide field work.

Morphology and Dynamics in Landscape

The test area (Langgriesgraben, 1.024 ha) was divided into 1917 polygons. One of most valuable results of this effort was that it will be possible to accurately chart the entire Gesäuse National Park with reasonable project costs. Conclusions like "which part of the National Park has got the most dynamic landscape or is affected by natural hazards", "where are seldom landforms", "where do we have a high variety of landscape", "where do we have a highly dynamic landscape in combination with National Park infrastructure", can be answered. Additionally it is possible to model any kind of habitat more accurately – provided that a laser-scan model is available.

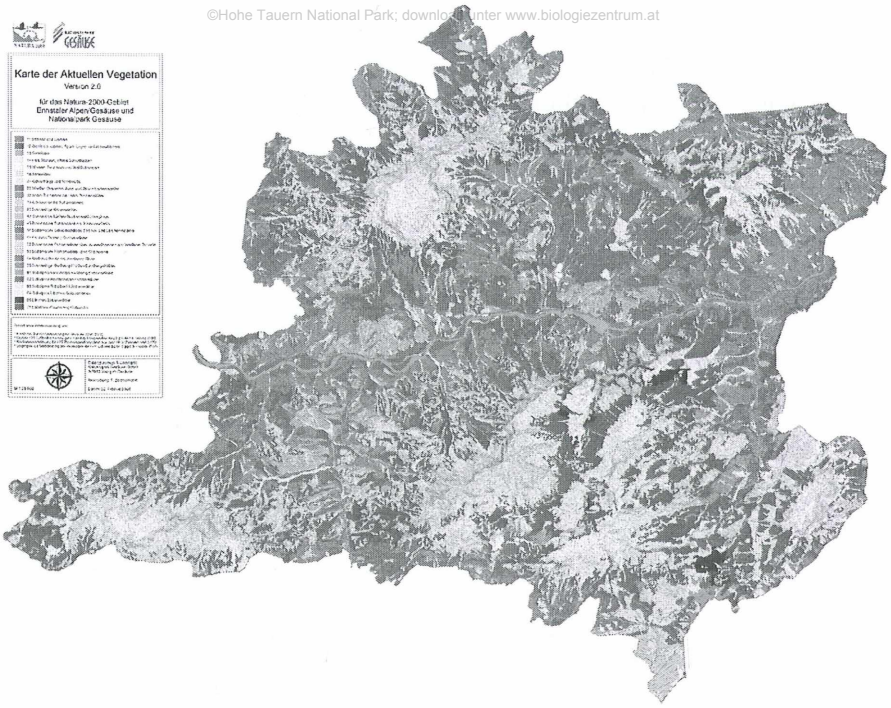

Figure 1: Map of the current vegetation in Gesäuse National Park
(Source: Nationalpark Gesäuse, 2008)

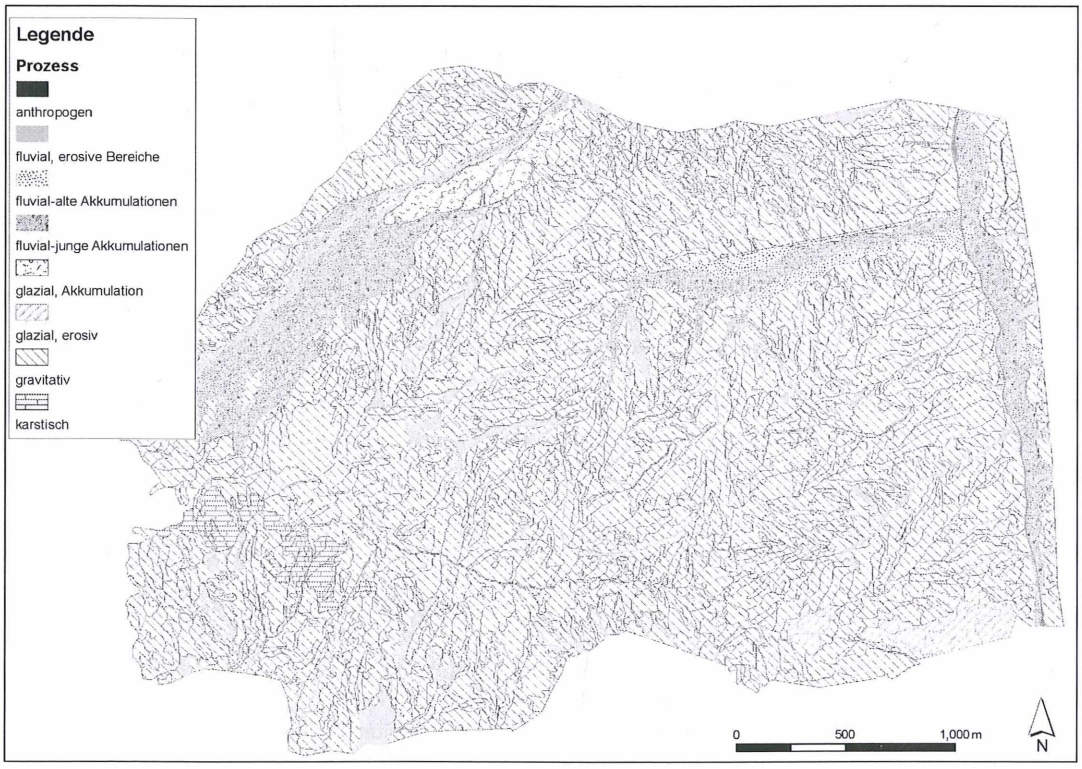

Figure 2: Predominant morphological processes in the test area (Langgriesgraben)
in the Gesäuse National Park (draft). Source: Hoffert, 2009 (in prep.)

Outlook

The different ecological factors provide for a great variety of stand types in the National Park. From riverine forests (Salicetum albae) along the river Enns to larch-stone pine woodland (Rhodothamno-Laricetum and Rhododendro hirsuti-Pinetum cembrae). In history the main type, (spruce-fir-) beech forest on limestone (Helleboro nigri-Fagetum, Adenostylo glabrae-Fagetum, Saxifrago rotundifoliae-Fagetum) had in many cases changed to spruce forest. Currently we work on maps of the FFH habitat types and the "Potential Natural Vegetation" in the National Park

Gesäuse to see where we have the most need for forest management in the near future (ZIMMERMANN & KREINER, in prep.).

Concerning morphological surveys the next step will be to elaborate guidelines for delimitation and interpretation. In combination with other datasets (HABITALP, Geology) another target is to look forward, what kind of queries are possible and which analysis can be done.

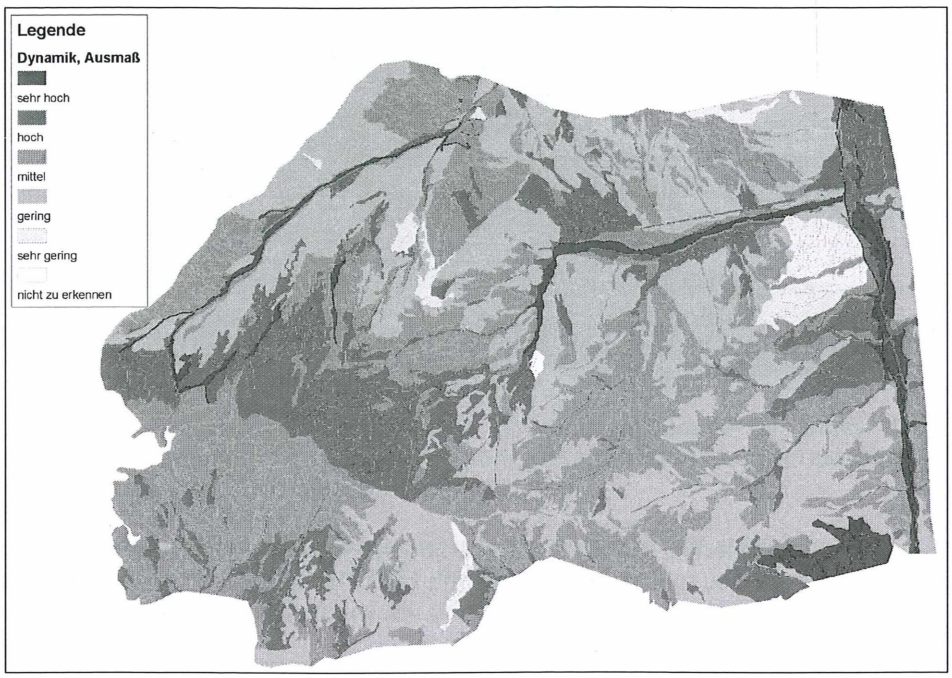

Figure 3: Landscape dynamics - dimension in the test area (Langgriesgraben) in the Gesäuse National Park (draft). The charting of dynamics is a result of the comparison of aerial photos from 1954 and 2004 and interpretation of morphological structure in consideration of the vegetation cover and forestry activities. Source: Hoffert, 2009 (in prep.).

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