# Better defined biotopes

A precise knowledge of biotopes is useful to preserve their stability, often under threat from human pressure. It is also a decision-making aid for managers responsible under the Natura 2000 network's Habitat directive to help preserve the European Union's biological diversity. To perfect and refine biotope identification and thus classification, exploratory research combined hyperspectral data with precise measurements of interacting chemical, physical and biological processes. In the interests of preserving fragile environments, other projects have included hyperspectral data in research on humidity gradients and their effect on plant associations.

ECOMALT
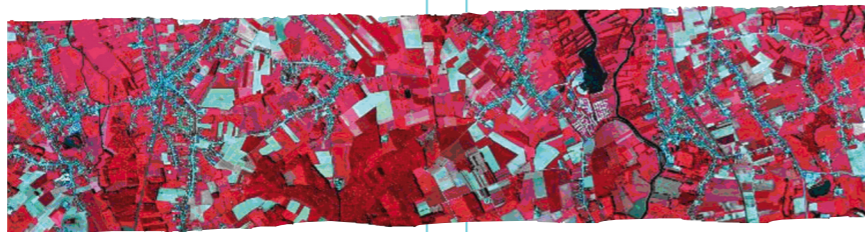
Classifying ecotopes

In densely populated and industrialised Flanders, environmental management is a task made difficult by the intense pressure on the remaining natural areas. A valuable tool for land management and environmental monitoring is the Biological Valuation Map (BVM). Drawn up by the regional body INBO (Instituut voor Natuur- en Bosonderzoek / Institute for Nature and Woodland Research), this map records all the biotopes in Flanders.

The ECOMALT project looked at the possibility of using the fine spectral resolution of hyperspectral data supplied by the HyMap sensor to better identify different ecotopes, particularly in the Dender valley. An image processing chain using machine learning algorithms was designed to provide a classification of ecotopes that meets the criteria of high precision, stability performance, high repeatability and interpretability, and persistence to signal noise. The project showed the importance of the short wavelength infrared (SWIR) and drew up a classification chart for the BVM map based on 16 classes with tree and grassland categories. It also confirmed the superiority of the hyperspectral approach compared to the multispectral approach. A new avenue of research will be concerned with the testing of the robustness of the methods with the aim of using hyperspectral data for the change detection that is needed for updating the BVM map.

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HYPERKART

Mapping coastal vegetation

Dune observation on the Belgian coast is an inherent part of the European Integrated Coastal Management Programme. The active surveillance of coastal plant cover has a twofold interest for federal and regional officials: an ecological interest to ensure the preservation of these habitats with a high biological value, and a functional interest in the knowledge that dunes are the very important advance guard of protection for the land and agglomerations located in the hinterland, sometimes below sea level. Some plant species play a key role in resisting erosion and stabilising the coastline.

Integrating a large number of ground reference and hyperspectral data from the AISA-Eagle sensor, the project identified with great precision about 20 vegetation classes for marram dunes, moss dunes, grasslands, scrubland, wooded areas and 4 "non-vegetation" classes. The mapping software developed was delivered to the Flemish Government (Afdeling Kust, IVA Maritieme Dienstverlening en Kust, Vlaams Ministerie van Mobiliteit en Openbare Werken) accompanied by an instruction manual. The administrations concerned are thus in a position to produce detailed maps on the basis of hyperspectral data and thereby evaluate the stability of the foredunes and map the ecological diversity of the coastal dunes.

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HISMAC

Tools for managing salt marshes

Concentrating on the nature reserve on the island of Schiermonnikoog, in the Netherlands, the project sought to map the vegetation of the fragile salt marsh ecosystems. The type, spread and changes of the vegetation as well as their biophysical and biochemical characteristics are all useful tools for the decision-makers. The project improved data processing algorithms in the interest of a better exploitation of the data recorded by the AIS hyperspectral instrument. At an initial stage, the research determined the most appropriate classification strategies (including artificial neural networks). At a subsequent stage, different dimensional reduction approaches (genetic algorithms in particular) were applied to different classifiers. Because of its added value, an object-oriented classification approach, consisting of segmenting the hyper-spectral datacubes into object images with clear limits and extracting from them the object signatures, was used to determine significant categories of vegetation types.

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MOISGRAD

Moisture gradients and ecological indicators

Identifying and describing underground hydrological systems is particularly important for managing and developing ecological resources in river basins. At the ground surface, these systems appear as either infiltration zones that remain relatively dry or discharge zones that are more humid due to upward groundwater seepage. The project sought the best way of analysing the hyperspectral CASI and SASI data for the determination of the moisture gradients of the Doode Bemde nature reserve in the Dyle Valley. This site has been the subject of in-depth research over recent years, providing numerous field measurements and the results of simulations. The site also has the advantages of showing a certain hydrochemical uniformity, relatively constant moisture gradients and a variation in vegetation over a short distance that is linked to underground hydrological movements. It proved possible to establish correlations between the hyperspectral measurements and the field data for soil moisture on one hand and between ground moisture and the depth of the groundwater table on the other. These results enabled to map the humid and dry zones as well as the plant species that indicate moisture gradients (phreatophytes).

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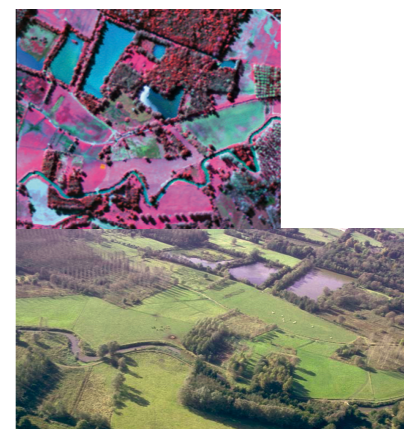
HYECO + HYECO 4

A contribution to eco-hydrological models

On the basis of data obtained by the CASI, ATM, HyMap and AHS sensors, the project investigated how imaging spectroscopy (IS) could enrich and refine hydro-ecological models. These models are based on detailed spatial data concerning vegetation types and parameters such as water availability (moisture gradients, groundwater depth) and evapotranspiration. Recent advances in remote sensing have shown that IS can be used to extract relevant biochemical and biophysical variables for estimating the real state of vegetation, such as Leaf Area Index (LAI), Net Primary Production (NPP) and Plant Functional Type (PFT). On this basis, the multidisciplinary scientific teams who conducted their research at specific sites in Belgium and the Netherlands showed that, when integrated into ecological process models, spatially explicit variables derived from IS can be very useful in compiling an inventory of ecosystems and forecasting their development. The methodological progress achieved by this project helped improve the analysis tools and thus contributed to a better understanding of the eco-hydrological functioning of the sites observed.

Follow-up of HYECO, **HYECO 4** resulted in a classification of vegetation types, an analysis of moisture gradients, the determination of the LAI for conifer stands, the establishment of promising correlations between NPP and biomass obtained through IS on one hand and by an ecological model on the other, and finally in the use of radiative transfer models to produce plant species maps.

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