4th Workshop

Vegetation databanks and GIS applications

The 4th workshop on vegetation databanks in Germany will take place

from March 16th to 18th, 2005
at the Institute of Geobotany at the Martin-Luther-University Halle-Wittenberg.

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80 participants from Germany, the United States, the Netherlands, Switzerland, Austria and the Czech Republic gathered in Halle to discuss recent advances in vegetation databanking. While the three previous workshops had the aim to present recent developments in linking vegetation databases to biodiversity research (Göttingen 2002), to plant trait databases (Regensburg 2003) and to nature conservation research (Freising 2004), this workshop explored the link to Geographical Information Systems (GIS). The development of GIS techniques has advanced so tremendously over the last years that many new applications useful to vegetation science have emerged. Under the title “Vegetation databanks and GIS applications” the workshops was designed to give a state-of-the-art report of the intersection between the two disciplines.

The workshop programme was loosely organised into three topics that reflect the need to provide a platform for reporting on the ongoing progress in software development, an opportunity to point out basic research ideas how to link the different scales of vegetation plots to landscape units and a forum for presenting successful GIS applications.

Wednesday, 16.3.2005
Lubomir Tichy (Masaryk University, Brno) taught an introductory course to the use of the computer program JUICE.

Meeting of the FlorKart-user group (active users of floristic mapping data of Germany)
16 participants gave reported on their activities in analysing FlorKart data, which are accessible online for members of the group. To become a member one must register in the forum system of Floraweb.

Program
Please click on titles to see abstracts and pdf-files of slides!

Thursday, 17.3.2005
Welcome notes by Jörg Ewald, Helge Bruelheide
1st session: Conceptual issues
Walter Berendsohn (Berlin): Creating, editing, and maintaining "Taxonomic Backbone" databases.
2nd session: Technical reports on software solutions linking vegetation databases to GIS.
Rudolf May (Bonn): FloraMap: An online GIS-tool.
Martin Kleikamp (Bergisch Gladbach): A vegetation data exchange standard
Jörg Ewald (Weihenstephan): Tuexenia feeds VegetWeb - an initiative to make new vegetation data accessible
Cord Peppler-Lisbach (Oldenburg): Predicting spatial distribution and biodiversity patterns of Nardetalia species by equilibrium models
3rd session: Linking plot and landscape scale
Stephan Hennekens (Key note speaker, Wageningen, The Netherlands): GIS application in SynBioSys Netherland and SynBioSys Europe.
Jens Wahr & Volker Mosbrugger (Tübingen): Biodiversity patterns and environmental correlates: Modelling floristic species on a regional scale using vegetation-databases and GIS.
Erik Welk (Halle): GIS-based analyses of global distribution data - Phytochorology today
Hagen Fischer (Röttenbach): From plot to landscape with Arnica montana
Stefan Binner, Jörg Ewald & Steffen Rogg (Weihenstephan): Ecological interpretation of geological maps based on the databank of Bavarian mountain forests.
Petr Petřík & Helge Bruelheide (Průhonice & Halle): The transferability of species groups and their ecological interpretation across scales.
Swantje Löbel & Jürgen Dengler (Uppsala, Lüneburg): The influences of landscape structure on the phytodiversity of dry grasslands on Öland (Sweden) – what can be learned from linking phytosociological plot data with GIS informations.
Heike Beismann (Düsseldorf): VDI-Guidelines and standardisation in the field of biodiversity.
Evening: Meeting of persons interested in establishing a VDI group on standardizing biodiversity research (initiated by Heike Beismann).

Friday, 18.3.2005
4th session: Case studies of using GIS to explore large vegetation databases
Ingolf Kühn (Halle): Geographic Use R Information - Visualisation, analyses and information retrieval of spatially referenced assemblages using a free non-GIS software.
Sebastian Schmidtlein (Bayreuth): Imaging spectroscopy for mapping Ellenberg indicator values and floristic gradients at the stand level.
Florian Jansen (Greifswald): Die Floristische Datenbank Mecklenburg-Vorpommerns geht online.
Henrik von Wehrden & Karsten Wesche (Halle): Phytosociological data as ground truth for vegetation mapping in Southern Mongolia.
Christopher Traiser & Volker Mosbrugger (Tübingen): Verarbeitung von Paläofloren in der Datenbank PANGAEA und deren Einbindung in GIS.
Boucníková Eva, Kučera Tomáš & Guth Jiří (České Budějovice & Prague): GIS analysis of Natura 2000 habitat mapping in the Czech Republic.
Heike Culmsee (Göttingen): Sampling and data base design for a sacred natural site—landscape context analysis in Morocco using ArcGIS 9.0 linked to the Spatial Pattern Analysis Program for Categorical Maps (FRAGSTATS).
Ralf Moshammer (Weihenstephan): Analysis of tree species diversity in Bavarian forests.
based on inventory data.
Jörg Ewald (Weihenstephan): Concluding remarks

Posters
Johannes Peterseil (Wien): Objektorientierte Abbildung von Information mit MORIS.
Sebastian Hoechstetter (Tübingen): Ökologischer Ausgleich in den Alpen - Auswirkungen des Agrarumweltprogrammes auf die Biodiversität im Kanton Graubünden
Peter Strobl (Salzburg): Die weitere Vernetzung von BIS und GIS
Zaboj Hrazsky (Ceske Budejovice): Potential distribution modeling of the invasive tree Acer negundo in the Czech Republic
Abstracts

VDI-Guidelines and standardisation in the field of biodiversity
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The Commission on Air Pollution Prevention of VDI and DIN (Kommission Reinhaltung der Luft im VDI und DIN, KRdL) carries out the tasks in the field of air pollution control according to § 1 of the Federal Ambient Pollution Control Act. The KRdL sets the state of the art of science and technique in volunteer self-responsibility and together with all parties concerned (authorities, science and industry). The results of this work are laid down in VDI-guidelines and technical standards (DIN, CEN, ISO). The guidelines and standards elaborated by the KRdL are implemented into legislation and the activities of the executive. Furthermore, they are implemented into European and international standardization work.

A number of VDI-Guidelines are already published by the KRdL about the use of different bioindicators to assess the effect of air pollution on plants (VDI 3957). These methods measure directly the effect of air pollution on plants, in contrast to common methods, which measure e.g. the concentration of toxic substances in the air. The advantage is firstly, that a measure of the effect is given and secondly that the effect of a mixture of different substances can be tested together with their interactions.

In the field of biodiversity influenced by air pollutants a VDI-Guideline for the mapping of lichens already exists (VDI 3957/13) and another about the value of moss diversity as bioindicator is just about to be published (VDI 3957/12). The diversity of plant species is dealt with in a VDI-Guideline (VDI 4330/9, in discussion) that shall feed into a monitoring of the effect of genetically modified plants on the environment.

Further activities within the KRdL could have biodiversity as focus point. Possible aims could be the effects of air pollution (ozone, nitrogen, dust etc.), global change and change of land use on biodiversity at different levels.

Creating, editing, and maintaining "Taxonomic Backbone" databases
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Concept-oriented taxonomic databases have been one of the main foci of research at the Biodiversity Informatics Department of the BGBM over the past decade. Building on the model developed for the International Organisation for Plant Information (IOPI), the "Berlin Model" was devised and implemented for several projects, among them the IOPI Global Plant Checklist, the Euro+Med PlantBase, the Med-Checklist (Compositae), the AlgaTerra information system on terrestrial and limnic Micro Algae, the Dendroflora of El Salvador (NSC), and, last not least, the German checklists for vascular plants and mosses (s.l.). The presentation will focus on the collaborative and distributed mechanisms for the elaboration and updating of these taxonomic databases, which represent the taxonomic backbones for wider and applied information systems. Examples are presented for the import process of monographic treatments (IOPI), collaborative in-house editing (NSC), consensus checklist editing (Euro+Med revision process) and the possibility of maintenance by means of a WWW remote editor (MoReTax).

How to generate distribution maps for the plant communities of Mecklenburg-Vorpommern
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We used floristic grid data (vascular plants, bryophytes, lichens, stoneworts) stored in a FLOREIN 5.0 database in combination with the location data of the classified vegetation relevés to illustrate the distribution of syntaxa. Three different types of grid maps were generated: (1) maps of single character taxa, being useful only for syntaxa closely associated with one plant species; (2) maps of the locations where the communities were found, and (3) synoptic maps (both for associations and superior
syntaxa) that combine the real evidences of the respective community with a representation of its potential distribution range. The latter is derived by the superimposition of distribution data of the diagnostic species.

None of these three types of maps actually represents the real and actual occurrences of a certain syntaxon, but they can give an adequate idea of its distribution pattern. However, the picture of the maps may overestimate or underestimate the actual distribution due to varying quality of floristic data, number, frequency and constancy of diagnostic species and recent vegetation changes. The maps of the potential distribution ranges are based on the coherence between flora and vegetation, which is high, but not total. If a plant community has only few diagnostic species, these have low constancy values or were under recorded in the floristic data base, maps of the potential distribution ranges did not give useful results. Syntaxa without diagnostic species ('central syntaxa') were not presentable in this manner at all. A next step to improve the maps of the potential distribution ranges will be the weighting of the different species included.

Comparing the distribution patterns of syntaxa with climatic and geological GIS-information available in LINFOS M-V, we found a decreasing correlation from more natural to anthropogenic vegetation types.

**Ecological interpretation of geological maps based on the databank of Bavarian mountain forests**

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Management planning in extensive protected areas of the European NATURA 2000 network requires a GIS-model of site quality and potential natural vegetation (pnv) for the Bavarian Alps. In an ongoing research project we use the phytosociological databank BERGWALD to calibrate the vegetation model in conjunction with a digital terrain model and geological maps, which will serve as predictors. Our contribution reports on the assignment of geological map units to nutrient levels as one important criterion in the delimitation of pnv units.

Regional vegetation classification distinguishes 4 nutrient levels reflecting soil pH, carbonate content and base saturation. Based on frequency distributions (histograms) of Ellenberg’s R-indicator value for soil reaction in those 2,107 plots in the databank BERGWALD, that have previously been assigned to nutrient levels through phytosociological classification, we developed discriminant functions allowing us to assign all 4,903 plots to nutrient levels based on R-histograms. In the GIS we intersected nutrient levels of 1,241 georeferenced plots with geological units and tested the significance of associations using a χ² test. This will form one crucial basis for mapping potential nutrient levels for the entire region of the Bavarian Alps.

**GIS analysis of Natura 2000 habitat mapping in the Czech Republic**

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The mapping of natural habitats for the establishment of Natura 2000 network finished in the Czech Republic last year. On the basis of the field habitat mapping a large and a valuable database about a spatial distribution and a quality of natural areas was established in the Czech Republic. There were mapped 157 biotopes on a scale 1:10 000. In GIS language this means that we have obtained a large database which contains over 1 500 000 polygons (segments) and for each segment there are 21 describing attributes. The central administration office of the national Natura 2000 GIS database is in the Agency for Nature Conservation and Landscape Protection in Prague.

We prepare some new applications as pilot projects based on the biotopes database and GIS layers: (1) GIS evaluation of representativeness of biotopes protected by the small sized nature reserves network; (2) Red Data Book of biotopes of the Czech Republic as a tool for complementary species-habitat conservation, management and monitoring; (3) Estimating above-ground grasslands carbon
Fluxes in the Czech Republic with application of CORINE-land cover and biotopes mapping (project CzechCarbo); (4) The habitat monitoring plan based on the stratified sampling design.

Florengebiete Schleswig-Holsteins: GIS-gestützte Auswertung einer arealkundlichen Datenbank
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Sampling and data base design for a sacred natural site—landscape context analysis in Morocco using ArcGIS 9.0 linked to the Spatial Pattern Analysis Program for Categorical Maps (FRAGSTATS)
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In Morocco, sacred natural sites are small areas protected for religious reasons. By the example of the Tangier Peninsula, the hypothesis will be tested whether the occurrence of sacred natural sites is linked to certain physiotopes. Physiotopes are here understood as landscape units bearing more or less uniform abiotic conditions, i.e. relief situation, geological substrate, soil properties, bioclimatic conditions, and carrying the same potential natural vegetation.

Using ArcGIS 9.0 linked to the Spatial Pattern Analysis Program for Categorical Maps (FRAGSTATS), landscape pattern defined by several abiotic factors (relief situation, geology, altitude, bioclima) are tested for correlation to sacred site distribution. The work is still in process.

Tuexenia feeds VegetWeb - an initiative to make new vegetation data accessible
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Central European phytosociology has a long tradition of publishing primary data in the form of vegetation tables. As a consequence, journals like Tuexenia are important archives for biodiversity research and applied vegetation science. However, the high effort involved in compiling data for meta-analyses inhibits broader use. Digital databanks with individual plots permit rapid searching, filtering, compilation and synthetic analysis of data from heterogeneous sources. In particular, data structures taking account of concept taxonomy reduce the effort of matching synonyms. VegetWeb, an online databank offered by Germany's Federal Agency for Nature Conservation under the floraweb portal, contains > 7.000 forest plots and is designed to become the common data pool of German phytosociologists. Data will partly be contributed from regional digitisation projects. In addition, new plots published in vegetation tables in Tuexenia will be transferred to VegetWeb. Tables submitted by the authors with a minimum of accessory information will be prepared for import into VegetWeb. It is expected that ready accessibility will improve the reception of publications and stimulate phytosociological research.

From plot to landscape with Arnica montana
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Arnica montana is an endangered but widely used medicinal plant. The species is red listed in central Europe, its typical habitat type, species rich Nardus stricta grassland, is listed in the EU-FFH directive. But large populations of the species are maintained in the Apuseni Mountains in western Rumania. In this area agriculture is practiced like in Central Europe 100 years ago. This is the reason why large populations of the species still exist in this region.

The ambition of a research project of the university of Freiburg (www.proiect-apuseni.org) was to identify the potential for a sustainable development of this region. Romania is about to become a member of the EU and in consequence the farmers will profit from EU grants, apply more nutrient and intensify the agriculture to improve their economic status. This process threatens the habitats of Arnica and other rare species. On the other hand the use of Arnica flower heads can contribute to the income of the local community and thus awaken the interest to conserve their habitats and populations. Currently a project of WWF-UK aims on the establishment of a cooperative that shall organize the collection of Arnica flower heads, improve the quality to increase the economic benefits and supervise the sustainability of these activities.

From Proiect Apuseni a huge amount of data is available to support this goal: traditional vegetation relevés, terrestrial mapping, information from satellite data and GIS derived data like the simulated solar radiation input. Based on this information we set up a model to simulate the potential distribution of Arnica. A Bayes model according to Fischer (1994) was applied. The results from the simulations reveal that beyond the still large amounts of Arnica habitats there are even more potential fields were Arnica habitats could be developed if an appropriate management regime would be applied.

But not only Arnica can be used for medicinal applications. The database with vegetation relevés was linked to a database of medicinal plants. This revealed that half of the plants found in the area can be used as medicinal plant. Together with a vegetations classification vegetation types that are rich in medicinal plants could be identified. Linking this information with vegetation maps in GIS we projected this plot derived information on the landscape scale.

GIS applications in SynBioSys
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In the Dutch version of SynBioSys, GIS is widely used for presentation and analyses of spatial data. Four examples of GIS applications will be demonstrated.

The first example is a simple application showing the distribution of plant communities in the Netherlands. Clickable dots open up the background information.

In the second example, GIS is used to find information on flora, vegetation, and landscape of a selected area. Also the internet database with metadata of the Dutch Vegetation Database holding more than 400,000 records can be examined in this way.

The compilation of predictive distribution maps of plant communities is shown in the third example. By using various databases (distribution of flora, vegetation and landscape) and a detailed soil map several maps can generated which can be combined into one predictive map. The last example focuses on Natura2000 sites where GIS is used to monitor changes in the distribution of the Natura2000 habitat types and changes in the environment (using Ellenberg indicator values).

See also SynBioSys Europe website.

Potential distribution modeling of the invasive tree *Acer negundo* in the Czech Republic
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Information about *Acer negundo* distribution was investigated using recently collected data from national mapping, from national phytosociological database and observed in two last seasons. Topological (elevation, slope, aspect and their combination), climatic (mean annual temperature, mean annual sum of precipitation), geographic (roads, rivers, towns, railways) and thematic (potential vegetation, geology, land cover) GIS layers were used as predictors of boxelder naturalization sites.

Several models based on logistic regression (GLM, GAM) were fitted and prediction of potential naturalization sites was performed. 6 different models were built to compare more approaches different in model type and in complexity. The predictors and types of model selection as well as prediction in different scales were discussed.

Die Floristische Datenbank Mecklenburg-Vorpommerns geht Online
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Alte Daten in neue Systeme? Rückwirkende Georeferenzierung, ein Überblick

Um die Daten in Geoinformationssysteme einbinden zu können, ist eine Georeferenzierung dieser ortsbezogenen Informationen notwendig. Die Ortsangaben werden hierfür in geografische Koordinaten, sofern noch nicht vorliegend, transferiert und damit für raumbezogene Biodiversitätsanalysen auswertbar gemacht. Informationen aus historischen Datenbeständen können dann zum Beispiel mit aktuellen Erhebungen abgeglichen werden.

Einige Arbeitsgruppen haben Methoden zur Georeferenzierung entwickelt, wie z.B. MaPSTDi georeferencing protocol (University of Colorado), MANIS Georeferencing Calculator (University of California at Berkeley), INRAM (University of New Mexico) GEOLocate (Tulane University), Biogeomancer (University of Kansas), ArcView Georeferencing Extension (California Academy of Sciences). Eine Georeferenzierung geht in der Regel eine Klassifikation der vorliegenden heterogenen Ortsangaben voraus. Die Klassifikationen folgen Genauigkeitskriterien, die auf Orts-, Richtungs-, Ausdehnungs- und Entfernungsangaben, Maßeinheiten sowie Koordinaten Bezug nehmen. Anschließend können Koordinaten mit Hilfe manueller, computerunterstützt-manueller sowie vollautomatischer Methoden ermittelt werden. Jede dieser Methoden hat Vor- und Nachteile. Alle Vorgehensweisen zielen darauf, einen möglichst hohen Grad an Genauigkeit der Ortsangaben unter Berücksichtigung der Effizienz zu erreichen.


Der Vortrag soll einen Überblick geben über die verschiedenen Methoden und ihre Einsatzmöglichkeiten.

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An exchange standard for vegetation data (ESVeg)
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Most XML import/export formats represent a direct reflection of the underlying database structure. The idea of the XML schema ESVeg (http://www.floraweb.de/vegetweb/VegetWeb.xsd) was to create a common data exchange standard with a maximum information content, thus allowing an exchange between different vegetation software tools or manual transformations by implementing only a single import/export module. The logical format had to be independent from the physical data model. This was achieved by replacing technical IDs with globally unique codes. The data elements have been reviewed during three annual workshops in Germany, and much of the pioneer works from the VegBank and MoreTax projects have been included. The main features of ESVeg are the support of taxon concepts and interpretations, a freely definable vertical vegetation structure and cover indices. One of the aims was an easy import of existing data from spreadsheets and local databases. To achieve this, some XML entities are copies of the structure of the corresponding relational tables, but others are denormalized summaries of several tables. The structure is similar to the CSV files of VegBranch, only with using XML. During the import into VegetWeb - the current national vegetation database in Germany - all compatible data are transformed back to the complex relational data model.

Instead of an ordinary hierarchical representation, ESVeg uses a meta structure with entities linked by key codes. This consumes much less storage space, allows quick validation and easy corrections of spelling mistakes. Most of the codes are abbreviated in such a way, that, for example, the references or plot information have to be imported only once. The import in the current VegetWeb version also recognizes these primary codes and prevents double import while allowing additional inserts of corrected data.

ESVeg has the capability to serve as a basis for an international vegetation data exchange standard. As a first step, the identifiers should be translated into English and missing attributes of VegBank and TurboVeg will have to be included.
Geographic Use R Information - Visualisation, analyses and information retrieval of spatially referenced assemblages using a free non-GIS software
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The use of Geographic Information Systems (GIS) in analysing and visualising spatially referenced data became virtually indispensable during the last decades. However, not for all kinds of visualisation or analyses is it indeed necessary to use a GIS and it might be more appropriate for users who have no experience in GIS to use some familiar software, when applicable. Using a sample from our current work, I will present the distribution of the functional diversity (Mason et al. 2003) of ploidy levels of vascular plants in Germany. This functional diversity per grid cell is linked with environmental parameters for subsequent analyses. Using the freely available statistical environment ‘R’ (www.r-project.org), it is possible to simulate some basic GIS applications, such as visualising distribution patterns, interactive selection of certain grid cells by mouse click, retrieval information on the background data (e.g. functional diversity, environmental covariates), do statistical analyses with these data or retrieve the results of past analyses (e.g. residuals of spatially autoregressive models), extract the underlying species pool for the used data and connect to a referential database (such as BioFlor, Klotz et al. 2002) to retrieve selected traits associated with theses species.


The influences of landscape structure on the phytodiversity of dry grasslands on Öland (Sweden) – what can be learned from linking phytosociological plot data with GIS informations
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Our aim was to analyse the relative importance of local environmental conditions, landscape structure and biotic interactions for the species richness of vascular plants, bryophytes and lichens in dry grasslands on the Swedish island Öland.
We sampled the full range of dry grassland types in 4 m² plots (n = 452) and recorded species lists (vascular plants, bryophytes, lichens), structural data and site conditions for each relevé. Patch sizes and different measures of isolation were calculated by use of GPS position data and a GIS-based vegetation map. For statistical analyses, we used GLMMs after accounting for spatial autocorrelations. Different environmental variables explained the diversity of vascular plants, bryophytes and lichens. Overall, the effects of the local abiotic environment, particularly of soil pH, were strong compared to those of landscape structure. Vascular plant species density showed a unimodal response to soil pH, whereas bryophyte and lichen species densities linearly increased with increasing alkalinity.
The size and isolation degree of dry grassland patches where sample plots were located significantly affected bryophyte and lichen species densities, but we did not observe any effects in vascular plants. Still, spatial structuring in vascular plant diversity was significant, and thus may indicate that the historical rather than present landscape structure is important. Our data suggest that dispersal limitation in bryophytes and lichens confined to dry grasslands is more common than often assumed. After eliminating effects of the abiotic environment, we observed negative relationships between bryophyte and lichen species densities and the cover of vascular plants. In contrast, the cover and diversity of bryophytes and lichens showed positive effects on vascular plant diversity. Thus, interactions between vascular plants and cryptogams may be rather asymmetric. Positive effects of bryophyte and lichen cover on vascular plant species richness further indicate that cryptogams have an important ecological function in dry grassland ecosystems.
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Standortsanalyse und Biomassevorrat der Bodenvegetation in Wäldern des NP Harz. Ein Beispiel für die Auswertung von Vegetationsaufnahmen mit Hilfe von Access®-basierten Auswertungsprogrammen (Fridolino, PhytoCalc)
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Standorte Analyse and Biomasse Vorrat der Bodenvegetation in Wäldern des Nationalpark Harz.
Ein Beispiel für die Auswertung von Vegetationsaufnahmen mit Hilfe von Access®-basierten Auswertungsprogrammen (Fridolino, PhytoCalc)

FloraMap: an online GIS-tool
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FloraMap is a special GIS tool within the FloraWeb website. It is based on a java applet developed by the working group SPADE (spatial decision support) at http://www.ais.fhg.de/SPADE/index.html. FloraMap gives the user a wide spectrum of functionalities based on a series of cartographic images at different mapping scales. The applet is driven by javascript functions, which provide the data it uses for visualizations as javascript variables. General visualization parameters are set in properties files, allowing to tailor the underlying geodata to specific needs (e.g. what cartographic images will be displayed at which scale, etc.). In the FloraMap context, the applet is controlled by three frames. Two of them are visible and contain elements of the user interface (GUI), the third is invisible and contains a database interface to the distribution data of the german vascular plants flora and to a geothesaurus. One of the GUI frames allow querying for plant names or geoobject names. The location of plant records or geoobject are shown, when a single name is selected. By selecting groups of species, the database query produces numbers of records per grid cell, and the applet allows for various methods of classifications of these statistical data. The second GUI frame allows to enter field observation/recording data with geographical references provided by the applet, either as coordinates of a location or as a single or a series of grid cells defining an observation area. The recording data are stored in the database and merged with the data of the floristic survey. External websites can use a transfer page to feed FloraMap with species list. The lists can be composed of names or codes to be obtained from the german standard list of vascular plants. Read more about FloraMap (in german) at http://www.floraweb.de/news/news.html.

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Spatial accuracy in the vegetation databases of the Austrian Alps
Vegetation relevés - each being the description of a concrete phytocoenosis - contain floristic information, spatial information (locality), information on site conditions (altitude, aspect, slope, geology, soil etc.), and temporal information (sampling date). In connection with a Geographical Information System (GIS), these data provide a powerful tool for spatial analysis on the community and landscape level as well as for case studies on ecological theories. Therefore, a project has been started to build up a GIS-based vegetation databank of the Austrian Alps. This project is part of the Alpine research program of the Austrian Academy of Science. The current application provides tools for interacting between a Microsoft Access 2000 database and ESRI's ArcInfo8.3 resp. ArcView 3.3. Currently, the database contains 22,428 relevés including site parameters. A high proportion of these are located spatially in a GIS-System which means more than 8,657 single spatial units. Vegetation relevés can be approximated as point data, at least in a broader spatial context, thus localization should reflect this point nature. The database contains 1,534 relevés localized by GPS (spatial accuracy 30m), 4,874 relevés which are assigned to a fixed raster (spatial accuracy approximately 100 - 200m) and 2,249 relevés, mainly literature data, which were only assigned to broader polygons (from 3,000 m² up to more than 10,000 ha).

Spatial accuracy seriously affects analysis potential. Analyses depending on presence/absence (like distribution modelling) need point data. Increasing assignment area means decreasing localization accuracy and therefore multiplies noise in any spatial explicit environmental data, which might be assigned to the respective relevés. The problem of low spatial accuracy is particularly severe for vegetation data from literature with imprecise or only rough information about sampling area and location. Thus, we strongly recommend the use of GPS for data sampling as it multiplies the possibilities for further analysis.

Analysis of tree species diversity in Bavarian forests based on inventory data
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What do we know about tree species diversity in European commercial forests and its spatial implications? A lot of explorations supplied information about tree species diversity on small-sized areas not more than a few hectares. Mostly next step approaching forest diversity is the landscape level. Here we only record forest communities, but we have no more detail information. We have a large gap between these two scales.

Based on inventory data from the Bavarian State Forest Service methods were developed to analyse tree species diversity from single plot up to landscape level. The inventory database contains raster sampling information over 0.75 mio. hectares state forest distributed over the whole Federal State of Bavaria. First inventories were performed in the 1970's with a ten years repetition.

The presentation shows preliminary results of the project “Analysis and monitoring of tree species and structural diversity in Bavaria’s state forests based on forest inventory data”. The presented analyses based on information out of more than 158,000 inventory plots. The project is supported by the Bavaria State Forest Service and conducted in cooperation by Chair of Forest Yield Science, TU München and Department of Forestry (Botany and Vegetation Ecology), FH Weihenstephan. The presented analyses based on information out of more than 158,000 inventory plots.

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Die Anwendung Empirischer Nullmodelle bei der Auswertung Raster-basierter Verbreitungsdaten
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Bei floristischen Kartierungen stellt sich, ebenso wie bei der Analyse von klassischen Vegetationsaufnahmen, die Frage, welche Arten gemeinsame oder abweichende Verbreitungen aufweisen. Floristische Muster entsprechender Artengruppen liefern neben der Beschreibung der Vegetation eines Gebietes Ansätze für Korrelation- und Kausalanalysen und können als presence-absence oder quantitative GIS-Layer verwendet werden. Bei der Suche nach floristischen Mustern in umfangreichen Datensätzen werden oft multivariate Verfahren eingesetzt, welche die Ähnlichkeiten s.l. in der Verbreitung der Arten analysieren (similarities s.str., distances, correlations, ...). Irrtumswahrscheinlichkeiten dafür, dass diese Ähnlichkeiten von einer rein zufälligen Verteilung abweichen, werden bisher kaum verwendet. Empirische Nullmodelle liefern eine Möglichkeit solche
Irrtumswahrscheinlichkeiten zu berechnen. Im Gegensatz zu klassischer Statistik, die von unabhängigen Beobachtungen ausgeht, bieten Empirischen Nullmodellen die Möglichkeit, räumliche Autokorrelation bei Analysen zu berücksichtigen.

Im Vortrag wird zunächst der Ansatz Empirischer Nullmodelle für die Analyse Raster-basierter Verbreitungsdaten vorgestellt. Neben Vor- und Nachteilen publizierter Methoden wird ein neues, allgemein anwendbares Verfahren erläutert und durch Beispiele veranschaulicht. Die Beispiele basieren auf der floristischen Kartierung der Stadt Zürich (E. Landolt; 1-km-Raster; 122 km²; rd. 1700 Arten) sowie auf Daten zur Bodennutzung (GIS Stadt Zürich). Räumlich scharf abgegrenzte wie auch diffuse Verbreitungsmuster lassen sich dabei sowohl auf einzelne Pflanzengesellschaften (z.B. Magerrasen) wie auch Gesellschaftskomplexe unterschiedlicher Ausdehnung (z.B. Verlandungskomplexe, urbanophile Arten) zurückführen.

VegBank and SEEK: North American initiatives in ecoinformatics.
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Community ecology is undergoing a dramatic transformation made possible by the emergence of ecoinformatics. For the first time we have simultaneous access to detailed, spatially extensive information about places, databases of attributes of taxa including phylogeny and geographic distribution, and archives with thousands of plots representing records of taxon co-occurrence and importance. The intersection of these data types should allow ecologists to resolve broad-scale patterns and processes while simultaneously acknowledging that local community structure depends on contingencies of place and history. However, discovery and merging of large quantities of distributed and heterogeneous data poses technical and scientific challenges. For ecoinformatics to realize its potential, ecologists need to develop and conform to standard data structures, metadata standards, exchange formats, and data registration and archiving practices. I describe two North American projects that share these goals: VegBank and SEEK.

VegBank is the public, online vegetation plot archive of the Ecological Society of America's Panel on Vegetation Classification. VegBank consists of three linked databases that contain (1) plot records, (2) vegetation types including all those recognized in the U.S. National Vegetation Classification, and (3) plant taxa including those recognized by USDA plus other plant taxa in plot records. As part of the VegBank project we have developed a general data model for co-occurrence records to facilitate archiving, recovery, and sharing of vegetation data. Because taxonomic standards for both organisms and communities vary with time, place, and investigator, we employ taxon concepts (name-reference couplets) to allow for semantic mediation of taxa where one name can apply to multiple taxa and a single taxon can have multiple names. Vegetation records, community types and plant taxa may be submitted to VegBank and may be subsequently searched, viewed, annotated, revised, interpreted, downloaded, and cited. The VegBank plot archive is a component of the information infrastructure being built by the ESA Vegetation Panel to support a comprehensive vegetation classification for North America, but also will be available for numerous forms of ecoinformatics research. Plot data used in the classification enterprise will be submitted to VegBank for documentation and future reanalysis. Proposals for changes in the National Vegetation Classification will be prepared, submitted, and processed using a web-based peer review and publication system.

The Science Environment for Ecological Knowledge (SEEK) is a five-year initiative designed to create a cyberinfrastructure for ecological, environmental, and biodiversity research. SEEK participants are building an integrated data grid (EcoGrid) for accessing a wide variety of ecological and biodiversity data and analytical tools (Kepler) for efficiently utilizing these data stores to advance ecological and biodiversity science. An intelligent middleware system (SMS) will facilitate integration and synthesis of data and models within these systems. Datasets registered on the EcoGrid will be marked up using Ecological Markup Language (EML). A subgroup of SEEK is working to develop standards and tools for treating taxonomic entities within a concept framework similar to that used in the VegBank and IOPi models.

Predicting spatial distribution and biodiversity patterns of Nardetalia species by equilibrium models
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This contribution aims to show how vegetation databases can be used to calibrate equilibrium models for a spatially explicit prediction of species distribution. The analysis is based upon a dataset of 280 relevés, including soil and management variables. Additionally, climatic variables were taken from maps.

Logistic regression models were fitted for 138 species. These models are used to forecast the distribution pattern of Nardetalia species in northwestern Germany. The models combine predictors of different scale levels, i.e. local soil and management parameters as well as large scale climatic variables. By this, maps of predicted distribution can be generated for different local conditions. Apart from an explicit prediction of species composition for a given geographical position, predictions of large scale biodiversity patterns can be made.

The presented approach could be useful in nature conservation, for instance to predict potential species pools as well as target species compositions. It may also be an interesting tool for generating hypothesis in order to detect important drivers of distribution and biodiversity patterns.

Object oriented representation of information with MORIS using Ontologies
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A lot of data exist about the environmental conditions on different levels. These data are held by different institutions and stored under various database systems. The data format and storage systems differ widely between the institutions and program standards. One of the major challenges facing ecologists today is the problem of obtaining sufficient amount of information pertaining to widespread ecological phenomena. As ecology is a very wide field, many different types of data must be made available to allow the discovery of various relations between the multiple factors involved in ecological phenomena and for the development of models. For integrated ecosystem research reaching from plot scale to landscape and regional scale, the availability of spatial explicit information especially in historical terms is crucial. A common language and syntax for data representation is needed to ensure data exchange within the scientific community, but also to provide information about the environment for the wider public. Ontologies, as being an explicit specification of a conceptualization, play a crucial role. An ontology is the attempt to formulate an exhaustive and rigorous conceptual schema within a given domain - a typically hierarchical data structure containing all the relevant entities and their relationships and rules (theorems, regulations) within that domain. The term ontology is derived from the much older usage of the term in philosophy, where it means the study of being or existence as well as the basic categories thereof.

MORIS as object relational information system tries to incorporate these requirements. Originally, MORIS (Monitoring and Research Information System) was designed to depict all data derived from the ecosystem-monitoring activities of the UN-ECE Programme (Integrated Monitoring of Air Pollution Effects on Ecosystems) in Austria. An appropriate data information system was considered a fundamental tool to identify cause-effect relationships and trends, and to develop and validate models in the course of long term ecosystem monitoring. The basic concept of MORIS is putting strong emphasis on providing not only sheer values but also information on the methodological and spatial design used in gathering these data (primary metainformation). As object oriented analysis and design methods were applied, the main elements of MORIS are objects (spatial objects, media, taxons), properties (variables, parameters) and methods (sequentially combined to methodological designs). The abstract property is concretised by a methodological design towards a defined parameter. Using the concept of ontology all objects and properties can be typified and hierarchically classified and related to each other. Any kind of relation between instances of classes can be defined. Several years of experience in implementing the domain ontology by the use of MORIS has lead to a basic set of conceptual elements and strategies tackling inter alia the challenges of representing and linking reference lists (taxonomic lists), of the application of a backbone ecosystem model throughout the system and developing a practicable set of object classes. Parameters and the mentioned object-object-combinations or single objects are forming “datapoints” which finally can be given values. Moreover all central tables of the basic modules offer links to modules administrating secondary metainformation such as actors, archive and projects.

The work on the domain ontology for integrated ecosystem research is embedded in Austrian (Data integration) and European (ALTER-Net) activities to setup a core ontology and information network for biodiversity and ecosystem research.
The transferability of species groups and their ecological interpretation across scales

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The main questions to be investigated are as follows: (a) can vegetation datasets be used to predict the results of floristic mapping and vice versa, and (b) how do the species groups relate to the driving forces at different scales. Three different datasets were sampled at Jested Ridge (Czechia), a floristic datasets on a 0.5 km² grid, another one on a 0.13 km² grid, and a vegetation dataset at the plot scale (1-900 m²). In each dataset, species groups were produced by the Cocktail algorithm. Species groups formed in this way were characterized by a maximized joint occurrence in the dataset. As a measure of fidelity to the species group the $\Phi$ coefficient was used. A sample was assigned to a species group if it fulfilled the condition of having a statistically derived minimum number of species of this species group. In a second step, species groups formed in one dataset, i.e. at particular scale, were applied crosswise to the two other datasets, i.e. to other scales. Correlation between GIS-variables and species distribution at each scale was carried out in multivariate analysis. The species groups that were common to all datasets (across all scales) represented the main ecological gradients of the area. Groups derived from broader scale data had generally a lower correspondence when applied to fine-scale data than groups derived from finer scale and applied to broader scale. Both the species pattern and the species groups were scale-dependent. The most important variables in the multivariate analysis for the spatial distribution of species were the size of forest area, whilst most variability of data was explained on the fine-scale. A possible application is to predict the potential occurrence of missing species in areas with incomplete floristic or vegetation surveys.

Imaging spectroscopy for mapping Ellenberg indicator values and floristic gradients at the stand level

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Vegetation science provides a bundle of methods for the detection of organismic vegetation patterns that is largely neglected in remote sensing. A deliberate combination of those methods with techniques of imaging spectroscopy may open up new applications and enhance the quality of mapping products. Two examples may help to assess the prospects.

The first study comprises an attempt to map gradual transitions between plant species assemblages in Upper Bavarian hay meadows (Schmidtlein & Sassin, 2004). Image segmentation can present misleading or even erroneous results if applied to continuous spatial changes in vegetation. Even methods that allow for multiple class memberships of pixels presuppose the existence of ideal types of species assemblages that constitute mixtures and; an assumption that does not fit the case of continuas where any section of a gradient is as pure and as any other section like in modulations of grassland species composition. In our study, maps of floristic gradients have been derived by extrapolating axes of an unconstrained ordination of a species by plot data matrix. The extrapolation was based on partial least squares (PLS) regression analyses of ordination scores with reflectance data.

The second example comprises an soil map of a montane pasture in the Berchtesgaden National Park (Northern Alps). The map depicts averaged plant indicator values (Ellenberg/ et al., 1991). Where regional lists of plant indicator values exist, they enjoy great popularity in management and conservation. Up to now, indicator-based estimates of growth conditions were mostly plot-related since maps of averaged indicator values demanded extensive sampling. The study comprises an example for the efficient use of airborne hyperspectral imagery to extrapolate plot data and to produce indicator maps. The technique provides fast access to spatially contiguous and explicit information about soil conditions as indicated by plants. Both studies showed that imaging spectroscopy can efficiently make use of advanced methods in vegetation science. However, the relations between canopy reflectance and ordination scores or indicator values are affected by local conditions and short-term temporal modulations. Thus, predictions are hardly transferable to new areas without new calibration. Model calibration will remain an integral part of this kind of investigations.

Die weitere Vernetzung von BIS und GIS
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Verarbeitung von Paläofloren in der Datenbank PANGAEA und deren Einbindung in GIS
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Neben den zahlreichen rezenten Vegetationsdatenbanken, die zur Zeit im Aufbau begriffen sind, soll dieser Beitrag einen Einblick in die Verarbeitung fossiler Vegetationsdaten anhand des Informationssystems „Pangaea“ geben. Die Datenbank des Informationssystems Pangaea (www.pangaea.de) ist darauf ausgerichtet ein konsistentes geowissenschaftliches Datenformat (Datensatztitel, Datensatzautoren, Referenzen, Parameter) langfristig zu archivieren, allgemein verfügbar zu machen und vor allem als neues wissenschaftliches Werkzeug zur Auswertung von Daten zu dienen.


Aufgrund der sehr weit gefassten Aufgaben und den damit verbundenen Anforderungen an das Informationssystem Pangaea, können komplexe Abfrage- und Darstellungsmöglichkeiten der Paläovegetationsdaten nur durch einen erheblichen Programmieraufwand in GIS eingebunden.
werden. Andere bestehende Datenbanken, die re zente Vegetationsdaten beinhalten, haben unter Umständen vergleichbare Datenstrukturen und somit auch ähnliche Anforderungen bei der Verarbeitung der Daten in GIS. Im Hinblick auf den Datenaustausch zwischen verschiedenen Vegetationsdatenbanken sowie deren benutzerfreundliche Anwendung in GIS wirft dies die Frage nach der Machbarkeit einer (annähernd) „standardisierten“ Datenstruktur für Vegetationsdatenbanken auf.

Biodiversity patterns and environmental correlates: Modelling floristic species richness on a regional scale using vegetation-databases and GIS
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The present study aims to determine biodiversity patterns of vascular plants (species richness) on a regional scale (SW-Germany; Baden-Württemberg) and their correlates with different environmental variables.

To correlate floristic and environmental data, large inventory datasets and digitally available factor maps have been implemented and processed in GIS. Floristic data rely on the “Flora of Baden-Württemberg” (Sebald et al. 1990-92; 1996-89) consisting of a regional floristic mapping scheme with a spatial resolution of 5.5*6 km. These data are stored in the regional database FLOREIN, maintained at the State Museum of Natural History Stuttgart (Staatliches Museum für Naturkunde Stuttgart, SMNS, see http://www.naturkundemuseum-bw.de/) and in the database on German Flora (FLORKART, see http://www.floraweb.de), maintained at the Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN). A total of 931 grids cells covering about 30,000 km² are analysed using the FLORKART-database.

Spatial patterns of biodiversity of all species and selected species groups (native, alien, red-list) are connected with abiotic and anthropogenic environmental factors (climate, geology, soils, land-use, etc.) and then statistically analysed. Out of 200 environmental parameters processed in GIS a set of 25 independent parameters were extracted. Multiple linear regression is applied to establish transfer-functions explaining the relationship between environmental correlates and the biodiversity patterns of the selected species groups.

The results suggest that multiple linear models may explain about 40% of the variability in the total number of all plants, and up to 60% of the variability in the total species-number of specific plant-groups (e.g. alien-species). Geology seems to be the most important factor for native plant species richness. For alien species richness parameters like temperature, geology and landuse have influence on the pattern of pre-1500 aliens while landuse (settlement area, population density) and temperature seem to be the most important parameters for post-1500 aliens.


GIS-based analyses of global distribution data - Phytochorology today
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Drawing on the relationship between climate and large scale plant distribution pattern, we estimated naturalization potential for locally recorded alien and casual plant species of the German flora. GIS was used to georeference and digitize the distribution data, but subsequent modelling was performed using automated database queries in order to save computing efforts. The results are reported as a web presentation that is directly generated from database outputs.

Phytosociological data as ground truth for vegetation mapping in Southern Mongolia.
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Spatially explicit information on the distribution of habitats and vegetation types is a key requirement.
for resource management. Mongolia has designated some of the world's largest nature reserves in the last years, but protected areas are often in remote semi-desert regions with limited baseline data available. Here, we present a recent study on remote-sensing based vegetation mapping in the driest reserve in Mongolia, the Great Gobi special protected area situated in the deserts and semi-deserts of the Transaltay Gobi.

Field-work followed a Braun-Blanquet approach with deliberate selection of study sites; sampling was guided by visual interpretation of unsupervised classifications from Landsat satellite data. Relevés were classified by phytosociological table work following the general framework provided by Hilbig (1995, 2000). This classification was compared to the Russian classification scheme based on dominant species, to cluster analysis, and to a COCKTAIL classification (Bruelheide 2000). Indirect and direct gradient analysis techniques (standard DCA and CCA) were used to infer ecological relationships among relevés and species; secondary data for the ordination included climatic data from a public domain climate model, digital elevation data and remote sensing information in addition to survey data gathered during fieldwork.

Phytosociologically classified plots served as ground checks for a supervised classification of Landsat 7 data in order to create a vegetation map. Prior to classification, plots had to be manually enlarged as relevés were not large enough for the employed classification algorithm. Isoclass unsupervised classifications of the raster data were the first approach to identify homogenous areas within the Landsat scenes. As vegetation cover in the study area is mostly below 20% several NDVI transformations were tested to assess primary productivity and vegetation cover. However, tasseled cap transformations proved to be a better tool for individual enlargement of the plot data.

Enlarged plots were finally implemented into a maximum likelihood classification, results of which were smoothed using a nearest neighbour 7x7 pixel mean filter. Classification accuracy was assessed by cross-validation with an independent data set. The final map was implemented in a GIS and compared to maps produced with the same methods for the neighbouring Great Gobi B strictly protected area and the Gobi Gurvan Saikhan national park.


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