Long Database Report

VLAVEDAT – the vegetation database of Flanders (northern Belgium)

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Abstract: Vegetation research based on plot sampling has been carried out in Flanders for more than one hundred years. The history of the Flemish vegetation database (VLAVEDAT; GIVD ID EU-BE-001), which consists of relevés from Flanders (northern part of Belgium), is drawn up. The emergence of VLAVEDAT is situated in a project (1999–2002) of framing a typology of the Flemish nature based on vegetation. Currently, 40,660 relevés are computerized and stored in the VLAVEDAT central database (TURBOVEG) and its close satellite databases together. This paper reviews basic statistical figures on the VLAVEDAT central database. In particular, spatial and ecological distribution of the compiled relevés are illustrated and discussed. As it is the case in many vegetation databases, also VLAVEDAT appears to be biased towards sites and vegetation types of special interest. Within the categories of vegetation types with nature value, the proportion of relevés is well correlated with the area of the habitats they represent in Flanders. Most of the relevés were recorded in permanent grasslands, coastal dunes and marshes. Forests are underrepresented, since these are part of another database that has not yet been incorporated in VLAVEDAT. The spatial distribution of relevés is not uniform among ecoregions of Flanders. To exemplify, when related to their respective land area, the proportion of relevés is very high in the Dunes region, the Valley of the Meuse region and in the Polders regions; in contrast the proportion is lower in the three other ecoregions. VLAVEDAT is currently hosted and managed at the Research Institute for Nature and Forest (INBO), a scientific institute of the Flemish Government. Relevés in the VLAVEDAT central database are available upon request according to specific agreement, for the purpose of various projects, and non-commercial use by the scientific community in Flanders and abroad.

Keywords: Europe; Global Index of Vegetation-Plot Databases (GIVD); land cover; nature value; phytosociology; plot sampling; relevé; survey; TURBOVEG; vegetation type.

Abbrevations: INBO = Research Institute for Nature and Forest.

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Introduction

Over the last decades, advances in computer technology have facilitated the development of many large electronic vegetation-plot databases (Mucina & van der Maarel 1989, Bekker et al. 2007, Haveman & Janssen 2008, Schaminée et al. 2009). In this respect, the program TURBOVEG (Schaminée & Hennekens 1995, Hennekens & Schaminée 2001) is recommended as the standard computer package for storing, editing and selecting relevés. According to estimates of a recent survey of vegetation databases in Europe (Schaminée et al. 2009), approximately 4,300,000 vegetation plots exist in 35 European countries (but only a part of them is digitized).

Here we review the history and reasons for compilation of the vegetation databases of Belgium. We analyze the VLAVEDAT database, which consists of relevés from Flanders (northern part of Belgium), according to bibliographic sources, spatial and ecological distribution. Because of data availability and for other practical reasons, figures and numbers refer only to the VLAVEDAT central database (26,180 relevés) and thus do not include information neither from the satellite databases nor from the forest database (unless stated otherwise).

Methods

Phytosociological data prior to VLAVEDAT

Vegetation research and particularly phytosociological research based on plot sampling has been carried out in Belgium for more than one hundred years. A first preliminary and incomplete national overview of the vegetation associations in Belgium was published in 1942 (Louis & Lebrun 1942), followed by a completely revised edition in 1949 (Lebrun et al. 1949). This syntaxonomical overview of the plant communities of Belgium remains as the last phytosociological synthesis at national level. During the same period, a comprehensive systematic survey of the Belgian land cover was initiated (Vanden Berghen 1949). The vegetation survey was implemented by the Centre for Phytosociological Mapping (Faculty of Agriculture, University of Gembloux). Unfortunately, at the beginning of the 1980s this detailed and time consuming vegetation mapping project stopped and remained unfinished. The legacy data of this vegetation survey provide more than 19,000 filing cards (pers. comm. H. Claessens), constituting the core of an analogue, preliminary and now frozen phytosociological database. Nowadays, the archives are deposited at the *Unité de*

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Gestion des Ressources forestières et des Milieux naturels of Gembloux Agro-Bio Tech (University of Liège). Modern computerization of these archives is slowly continuing, being separately performed in the northern and southern parts of the country. Since the end of the 1990s, the relevés recorded in Flanders have been partially computerized with TURBOVEG and stored in VLAVEDAT (Vandenbussche & Hoffmann 2001).

VLAVEDAT		
Scope: All available phytosociological relevés (mainly vascular plants but also non vascular plants) of open and woody vegetations, from validated sources, principally collected in Flanders (northern Belgium) but also in closed neighbouring regions, with known geographical localisation, with plot size preferably 1-2500 m², with recorded abundance and/or cover estimation (for each species and vegetation layers).		
Status: ongoing capture	**Period:** 1927-2003	
Database manager(s): Gisèle Weyembergh (gisele.weyembergh@inbo.be); Desiré Paelinckx (desire.paelinckx@inbo.be)		
Owner: Research Institute for Nature and Forest (INBO)		
Web address: http://www.inbo.be		
Availability: according to a specific agreement	**Online upload:** no	**Online search:** no
Database format(s): TURBOVEG	**Export format(s):** TURBOVEG, Excel, plain text file	
Publication: Vandenbussche V., Hoffmann M. (2001): De Vlaamse Vegetatie Databank (VLAVEDAT): eerste aanzet tot een overzicht van natuurtypen en plantengemeenschappen in Vlaanderen (The Flemish Vegetation Databank (VLAVEDAT): first step towards realizing a classification of nature types and a review of plants communities in Flanders [in Dutch with English summary]. – Stratiotes 22: 36–44.		
Plot type(s): normal plots	**Plot-size range:** 0.1-10000 m²	
Non-overlapping plots: 26,180	**Estimate of existing plots:** 55,000	**Completeness:** 48%
Total plot observations: 26,180	**Number of sources:** 295	**Valid taxa:** 2,122
Countries: BE: 98.1%; FR: 1.4%; NL: 0.5%		
Forest: 3% — **Non-forest:** aquatic: 3%; semi-aquatic: 13%; arctic-alpine: 0%; natural: 0%; semi-natural: 56%; anthropogenic: 2%		
Guilds: all vascular plants: 100%; bryophytes (terricolous or aquatic): 31%; lichens (terricolous or aquatic): 5%; algae (terricolous or aquatic): 2%; non-terricolous taxa (epiphytic, saxicolous, lignicolous): 4%		
Environmental data: altitude: 1%; slope aspect: 12%; slope inclination: 7%; surface cover other than plants (open soil, litter, bare rock etc.): 14%; soil pH: 7%; other soil attributes: 1%; land use categories: 77%		
Performance measure(s): cover: 100%		
Geographic localisation: point coordinates less precise than GPS, up to 1 km: 6%; small grid (not coarser than 10 km): 94%; political units or only on a coarser scale (>10 km): 100%		
Sampling periods: 1920-1929: 0.3%; 1930-1939: 0.2%; 1940-1949: 0.9%; 1950-1959: 3.2%; 1960-1969: 1.2%; 1970-1979: 11.7%; 1980-1989: 30.7%; 1990-1999: 36.7%; 2000-2009: 8.1%		
Information as of 2012-07-17; further details and future updates available from http://www.givd.info/ID/EU-BE-001		

How VLAVEDAT started

The Flemish central vegetation database was launched in 1999. It was set up and initially designed for the project "Towards a system of the Flemish Nature Types" (1999–2002). The project, as commissioned by the Nature Agency of the Flemish Government, consisted in framing a first typology of the nature types occurring in Flanders. For this purpose, the description of the best direct perceptible characteristics of nature, the observed vegetation and therefore the plant community, was chosen as the basic unit. In this context it was necessary to centralize and digitalize all available phytosociological relevés. The project was carried out by the University of Ghent. Vegetation data collected in Flanders originating from a large quantity of published and unpublished sources and from the archives of the above mentioned former phytosociological database were computerized using TURBOVEG (Hennekens 1995) and added to VLAVEDAT (Vandenbussche & Hoffmann 2001). Because the flora of Northern Belgium is very similar to the Dutch flora and due to immediate availability, the Dutch species list (higher plants and cryptogams) based on van der Meijden (1996) as provided by S. Hennekens was used since the beginning of the project. Synonyms were preserved.

VLAVEDAT is currently hosted and managed at the Research Institute for Nature and Forest, a scientific institute of the Flemish Government in Belgium that is focused on biodiversity research and monitoring, with the aim to underpin and improve nature policy.

Results

First results of the project

At the end of the "Flemish Nature Types" project in 2002, VLAVEDAT counted more than 25,000 relevés from 130 authors (plus anonymous sources) from 1,675 sites (nature areas, administrative entities). As they originated from various sources and were initially sampled to serve different purposes, the original relevés in VLAVEDAT are very heterogeneous. Neither the geographical, nor the syntaxonomical distribution of the plots was uniform over Flanders. As a first output of VLAVEDAT, the resulting provisional typology of the Flemish Nature Types contains nine reports (all in Dutch, deposited at the library of the INBO), one explaining the methodology (Vandenbussche 2002) and eight describing the different biotopes groups: marshes (Vandenbussche et al. 2002), pioneer vegetation (De Fré & Hoffmann 2004a), grasslands (Zwaenepoel et al. 2002), heathland and inland dunes (Vandenbussche et al. 2002b), tall herb fringe communities (Zwaenepoel 2004), scrubs (De Fré & Hoffmann 2004b), coastal dunes (Vandenbussche et al. 2002c), mudflats and salt marshes (Vandenbussche et al. 2002d).

VLAVEDAT in 2010: facts and figures

From 2003 the database input has continued, depending on the dynamics of other feeding projects carried out at the INBO

and associated partners. These have mostly mean studies related to specific topics, e.g. typology of running and standing waters, typology and management of grasslands, ecohydrologically sensitive vegetation and/or studies at regional level (e.g. along the Coast, Scheldt, Meuse and in the Campine region). Currently almost 40,660 relevés are computerized and stored in VLAVEDAT or closely related satellite databases, all hosted and managed at INBO. On the one hand, the VLAVEDAT central database contains 26,180 relevés which are available to a large extent (according to specific agreement) upon request for the purpose of various projects, and non-commercial use by the scientific community in Flanders and abroad. On the other hand, the satellite databases around VLAVEDAT totalize together 14,480 relevés and are not yet available for external use.

Besides these, in order to make a typology of the Flemish forests (2003–2007) as ordered by the Forest Agency of the Flemish Government, a separate forest database has been created (Cornelis et al. 2007). Currently this forest database contains 13,925 relevés (TURBOVEG) and integrates amongst others the Flemish Forest Inventory and other records more specifically designed for forestry purposes. The forest database is currently hosted and managed at the Nature and Forests Agency and is partially and on special demand possibly available for external users (pers. comm. B. Roelandt and J. Cornelis).

Bibliographic sources

About 14% of the bibliographic references of the central database belong to the category "published papers or monographs": most were published in *Dumortiera* (floristic journal devoted to the flora of Belgium), in the *Belgian Journal of Botany* (formerly *Bulletin of the Royal Botanical Society of Belgium*) and in *Dodonaea* (journal of the Royal Society of Natural Sciences, Ghent). Another 27% of the sources consist of "grey literature": 9% are scientific studies and reports, most of them carried out or ordered by the former Nature Agency and/or the INBO and 18% are Bachelor, Master or PhD theses in botanical sciences. Field notebooks mostly of experienced botanists account for 49% of the sources. The close cooperation between INBO and researchers of the Universities of Ghent and Antwerp and of the National Botanical Garden explains the particularly high proportion of these two categories. Digitalized archives of the former phytosociological databank (excerpts) account for 10%. The digitalizing process is not yet finished.

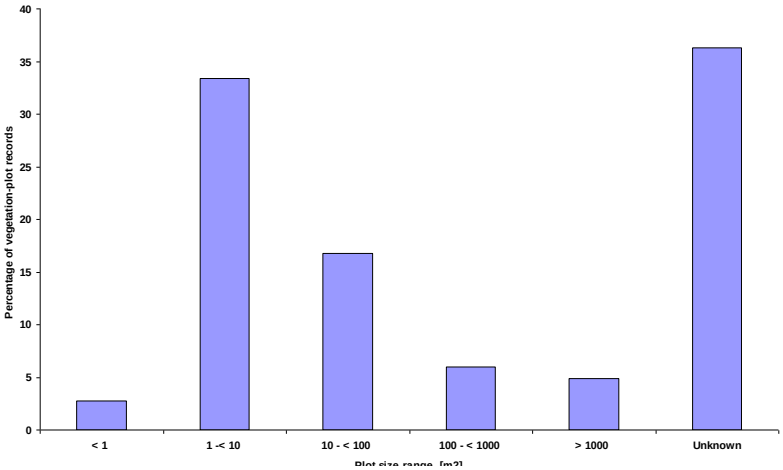

Fig. 1: Plot size distribution of the relevés included in the VLAVEDAT central database.

Age of the relevés

The oldest relevés in the central database were recorded by Maurice Hocquette at the coast in 1927 (Hocquette 1927). They are approximately contemporaneous with the oldest ones in the databases of other European countries (1920s according to Rodwell 1995, Chytry & Rafajova 2003, Šibíková et al. 2009). In total, only 1.4% of the relevés were completed before 1950, 7.8% between 1950 and 1975 and 8.1% after 2000. The large majority (75.9%) was recorded between 1975 and 2000.

The very low proportion of relevés from before the 1950s is due to less intensive sampling in earlier times and to their low accessibility. Indeed, as it can logically be expected, many older samples are probably no more available to us (lost notebooks or notebooks of whose existence we are unaware). Additionally, we assume that in earlier times the aim of making vegetation relevés was purely intended for phytosociological reasons in order to classify vegetation syntaxonomically (e.g. Lebrun et al. 1949), while in more recent times the majority of relevés were made for regional or local vegetation description, vegetation mapping, and not merely for phytosociological reasons.

Characteristics of the relevés

The plot sizes in the database ranges from 0.01 m^2 to 10,000 m^2. The size of the majority of relevés range between 1 and 100 m^2. For a considerable number of relevés, plot size was not available (see Fig. 1).

Woody plants and vascular herbaceous plants (if present) were recorded in all relevés. Terricolous bryophytes were recorded in nearly one third of them. By contrast records of terricolous lichens (5%), non-terricolous non-vascular plants (4%) and algae (2%) were rarely included. For almost all relevés (99.94%) the used performance measure was cover, a small minority only includes absence/presence data.

The most frequently recorded plot-based environmental variables were slope aspect (12%) and slope inclination (7%). Altitude is given for only 1% (in Flanders altitude ranges only from 0 to 270 m a.s.l., and is hardly ever considered to be a vegetation determinant). Soil attributes as litter or open soil are available for 14% of the relevés and the pH for 7% (from which 2/3 are permanent grasslands and 1/5 are heathlands and fens).

Geographical distribution

The location on a 4 km × 4 km grid is given by the authors (or has been *a posteriori* determined from verbal descriptions) for 94% of the relevés of the central database. As shown on the map (Fig. 2), the geographical distribution of the relevés is not uniform over the ecoregions in Flanders. The proportion of grid cells containing relevés, the proportion of relevés and similarly the plot density (see Table 1) are extremely high in the Dunes region, very high in the Valley of the Meuse region and in the Polders region. Grid cells with

many relevés are often concentrated in those grid cells where nature reserves are situated. They are located along the river IJzer and Scheldt and scattered on the plateau of the Campine region. Regions outside these areas are far less represented in VLAVEDAT. Conspicuous gaps are open in the Campine, in the Sandy and sandy-loamy region. The rather poor geographical representativeness of the VLAVEDAT central database reflects the way in which this vegetation database was fed: data is mainly gathered from casual regional projects and thematic research which are mainly carried out in areas harbouring high nature values.

Table 1: The proportional area of ecoregions in Flanders and the estimated proportion of relevés and plot density (ranges calculated as the amount of relevés in grids having their centre in / intersecting the ecoregion by GIS overlay) per ecoregion.

Ecoregions	Area	Estimated proportion of relevés	Estimated plot density per km^2
Dunes	0.7%	12–17%	29.9–42.7
Polders	8.1%	18–27%	4.3–6.4
Sandy and sandy-loamy	32.2%	20–30%	1.2–1.8
Loamy	27.8%	22–24%	1.5–1.7
Campine	30.5%	19–32%	1.2–2.0
Valley of the Meuse	0.6%	around 2%	5.2–5.7

Table 2: Land cover classes and vegetation types (all categories): covered area in Flanders and amount of relevés in the VLAVEDAT central database (the land cover classes and vegetation types and their area are derived from the Biological Valuation Map of Flanders; De Saeger et al. 2010).

Land cover and vegetation types	Indicative area	Amount of relevés
Urbanised land	25%	0.1%
Agricultural land	48%	0.3%
Forests and scrubs	11%	4%
Tall herbaceous	<1%	6%
Lakes and ponds (plus tidal and brackish water)	<1%	7%
Heathlands and fens	1%	8%
Marshes	<1%	14%
Coastal dunes	<1%	16%
Permanent grasslands	13%	44%

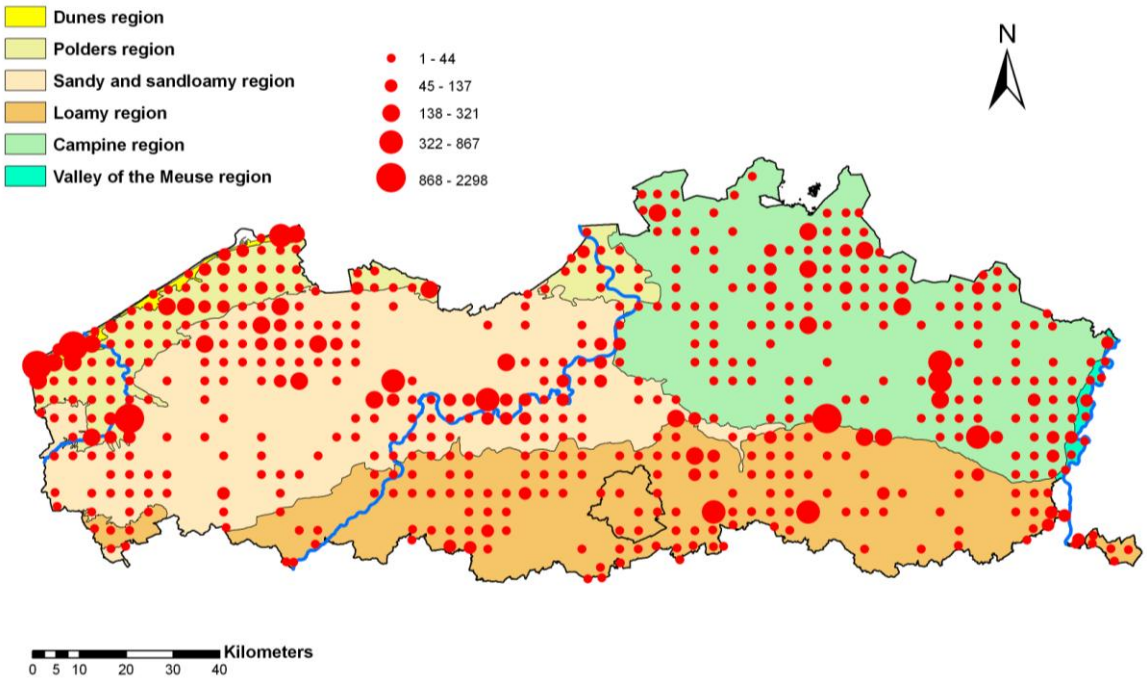

Fig. 2: Geographical distribution of relevés in the VLAVEDAT central database (grid cells 4 km × 4 km). Rivers are, from west to east, IJzer, Scheldt and Meuse.

Representativeness for the Flemish land cover and vegetation types

For 77% of the relevés a coarse indication about land cover class/vegetation type (De Blust et al. 1994, De Saeger et al. 2010) is mentioned by the author or has been *a posteriori* assigned (from verbal description of the habitat field). The number of relevés by land cover class/vegetation type is not proportional to the covered area in Flanders (see Table 2). For example, the categories with very low nature value such as intensive agricultural and urbanized areas (together more than 70% of Flanders) are undersampled (together less than 1% of all relevés recorded in VLAVEDAT). In contrast, the land cover classes/vegetation types with higher nature values are overrepresented. Such an oversampling of habitats that are attractive to the researchers (e.g. those containing rare species or high species richness) in the databases is a widespread phenomenon and not limited to Flanders (Chytrý & Rafajový 2003, Knollový 2005). In the VLAVEDAT central database, this is especially the case for coastal dunes, marshes, heathlands, lakes, ponds and permanent grasslands.

If we exclude the urbanized and agricultural lands as shown in Figure 3, the distribution of the relevés is better and reasonably representative for their area in Flanders. The conspicuous oversampling of coastal dune vegetations reflects the special nature policy, aiming at the conservation and the restoration of the coastal dunes with an associated important fine-scaled vegetation survey. Additionally, vegetation research at Ghent University has always been strongly focused on the coastal dunes, with significantly less emphasis on forest and other biotopes.

Due to the growing attention in conservation of species-rich permanent grasslands and with the special 'fertilizers action plan', grasslands are recently the subject of intensive field investigations on their typology, ecology and management. This is one of the reasons why the sampling effort is very high on these vegetation types. As a consequence their representation is high in the database and in accordance with their large area.

The VLAVEDAT central database is poor in forest relevés (but the above mentioned forest database contains currently almost 14,000 forest relevés).

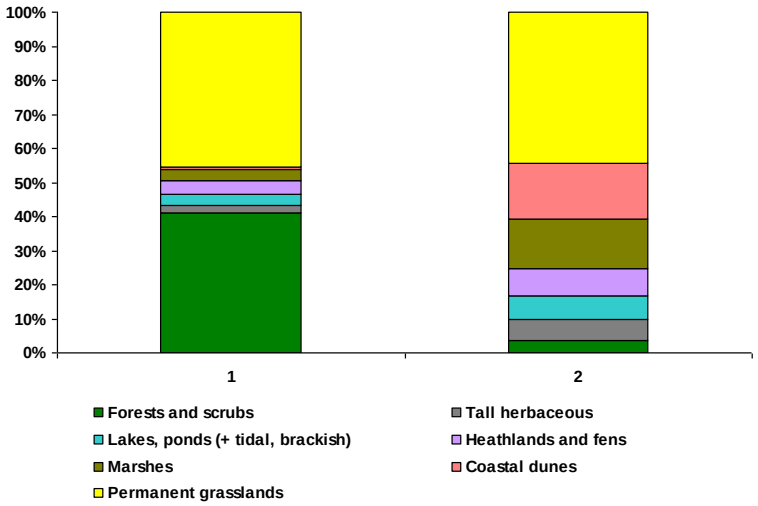

Fig. 3: Vegetation types with higher nature value: proportional area in Flanders (1) and proportion of relevés in the VLAVEDAT central database (2).

An output in floristics

Intrinsically, relevés and consequently vegetation databases are treasuries of floristic information. This is especially the case in VLAVEDAT with 94% of the relevés, providing an accurate location of the 'species-locality' records, and basic data to draw the spatial distribution of plants. In the *Atlas of the flora of Flanders and the Brussels Capital Region* (Van Landuyt et al. 2005), VLAVEDAT was the third most important source of information (totaling 9% of all records) after the traditional floristic lists (55%) and regional atlases and maps (13%).

Discussion

Conclusions and future perspectives

With 40,660 relevés computerized and stored in the VLAVEDAT central Database and its close satellite databases together, Flanders has a plot density of 2.99 per square kilometre. According to the recent compilation (Dengler et al. 2011) of the metadata on electronic vegetation databases, Flanders belongs to the countries/regions with the highest plot density.

Our analyses show that the relevés compiled in VLAVEDAT are rather heterogeneous. As is undoubtedly the case in many vegetation databases, they are biased towards sites and land cover classes/vegetation types of special nature interest. Because unevenly distributed data strongly affects phytosociological classification (Knollová et al. 2005), and most certainly phytosociologically driven vegetation mapping, and also analysis of long-term changes in plant communities (Haveman & Janssen 2008), the original dataset of VLAVEDAT as such is not optimal for any of these purposes. For phytosociological classification, according to Knollová et al. (2005) and for mapping, stratified resampling (using geographical and different habitat stratifications) could improve the representativeness of the datasets. In spite of this, because some areas or habitats are undersampled or missing in the initial database, removing redundancy due to oversampling of some areas or habitats will not automatically provide a fully representative dataset. Only additional field sampling can remedy the lack of data from some areas or habitats (Knollová et al. 2005).

In the future, the central database of VLAVEDAT should be enlarged by integrating the satellite databases. It is also highly advisable, if possible, to incorporate the forest database and the still not introduced older relevés dating from the 1950s. Overlapping content (identical relevés) should be detected. Quality control and, if necessary, correction of the entered header data and species data have a high priority. Because taxonomical problems can arise in particular when combining different databases (different taxonomic concepts of many species, subspecies or aggregate species) and because inconsistent use or application of plant names compromises the usefulness of the databases (Jansen & Dengler 2010), specific attention has to be paid when unifying taxonomic concepts in the compiled data sets.

Plate: Vegetation types featured by the vegetation-plot database GIVD EU-BE-001.

A: Coastal dunes systems: shifting dune with *Ammophila arenaria*, dune grassland, dune scrub at Ter Yde (Photo: Y. Adam).

B: Inland marshes, reedbeds with *Phragmites australis* at Het Vinne (Photo: Y. Adam).

C: Species-rich permanent grasslands with *Cardamine pratensis* at Merkembroeken (Photo: Y. Adam).

The expected growth of the database with existing and new data could change its above described restrictive applicability. For building an optimally structured vegetation database, however, a gap analysis leading to an appropriate sampling scheme should be completed, taking into account the aims of future applications. For instance, in order to complete and synthesize the typology of the Flemish Nature types, we should examine further if some important areas or land cover classes/vegetation types are still undersampled or not. If this is the case, then only additional field sampling could remedy the lack of data from some areas or land cover classes/vegetation types. Digitalizing missing relevés from literature and other analogue sources of (already existing) relevés as in the archives of the old phytosociological databank is not the actual first priority. However it could also contribute to a selective (in of the sense of filling the gaps) enlargement of the database.

As we have shown, concerns in nature policy can strongly influence research projects (topic and area) and the related sampling effort, as it is the case for the dune vegetation and the permanent grasslands. At the European level, the Habitats Directive also constitutes an important issue for the vegetation databases. Indeed, member states have to assess the conservation status of the Natura 2000 habitats and it seems that vegetation-plot data are useful to define the (favourable) conservation status of habitat types (Rodwell et al. 2002, Schaminée et al. 2009). For the implementation of the assessments every six years, monitoring schemes for Natura 2000 and vegetation sampling are to be set up. Consequently, related Natura 2000 vegetation datasets will soon increase.

Acknowlegdements

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References

Bekker, R.M., van der Maarel, E., Bruelheide, H., Woods, K. (2007): Long-term datasets: From descriptive to predictive data using ecoinformatics: Introduction. – Journal of Vegetation Science **18**: 458–462. CrossRef

Chytry, M., Rafajova, M. (2003): Czech National Phytosociological Database: basic statistics of the available vegetation plot-data. – Preslia **75**: 1–15.

Cornelis, J., Hermy, M., De Keersmaeker, L., Vandekerkhove, K. (2007): Bosplantengemeenschappen in Vlaanderen: een typologie van bossen op basis van de kruidachtige vegetatie (Forest plant communities in Flanders: forest typology based on the herbaceous layer) [in Dutch]. – Brussels: Research Institute for Nature and Forest.

De Blust, G., Paelinckx, D., Kuijken, E. (1994): Up-to-date information on nature quality for environmental management in Flanders. – In: Klijn, F. [Ed.]: Ecosystem classification for environmental management: 223–249. Dordrecht: Kluwer.

De Fré, B., Hoffmann, M. (2004a): Systematiek van natuurtypen voor Vlaanderen: Pioniersmilieus (System of the nature types in Flanders: pioneer vegetations) [in Dutch]. – Brussels: Research Institute for Nature and Forest.

De Fré, B., Hoffmann, M. (2004b): Systematiek van natuurtypen voor Vlaanderen: Struwelen en mantels (System of the nature types in Flanders: scrubs) [in Dutch]. – Brussels: Research Institute for Nature and Forest.

De Saeger, S., Ameeuw, G., Berten, B., Bosch, H., Brichau, I., De Knijf, G., Demolder, H., Erens, G., Guelinckx, R., Oosterlynck, P., Rombouts, K., Scheldeman, K., T'jollyn, F., Van Hove, M., Van Ormelingen, J., Vriens, L., Zwaenepoel, A., Van Dam, G., Verheirstraete,n M., Wils, C., Paelinckx, D. (2010): Biologische Waarderingskaart versie 2.2 (Biological valuation map version 2.2) [in Dutch]. – Brussels: Institute for Nature and Forest.

Dengler, J., Jansen, F., Glöckler, F., Peet, R.K., De Cáceres, M., Chytrý, M., Ewald, J., Oldeland, J., Finckh, M., Lopez-Gonzalez, G., Mucina, L., Rodwell, J.S., Schaminée, J.H.J., Spencer, N. (2011): The Global Index of Vegetation-Plot Databases (GIVD): a new resource for vegetation science. – Journal of Vegetation Science **22**: 582–597. CrossRef

Haveman, R., Janssen, J.A.M. (2008): The analysis of long-term changes in plant communities using large databases: the effect of stratified resampling. – Journal of Vegetation Science **19**: 355–362. CrossRef

Hennekens, S.M. (1995): TURBO(VEG). Software package for input, processing and presentation of phytosociological data. User's guide. – Wageningen: Instituut voor Bos en Natuur.

Hennekens, S.M., Schaminée, J.H.J. (2001): TURBOVEG, a comprehensive data base management system for vegetation data. – Journal of Vegetation Science **12**: 589–591. CrossRef

Hocquette, M. (1927): Etude sur la végétation et la flore du littoral de la Mer du Nord de Nieuport à Sangatte. – Archives de Botanique **1(4)**: 1–179.

Knollová, I., Chytrý, M., Tichý, L., Hájek, O. (2005): Stratified resampling of phytosociological databases: some strategies for obtaining more representative data sets for classification studies. – Journal of Vegetation Science **16**: 479–486.

Jansen F, Dengler J. (2010): Plant names in vegetation databases – a neglected source of bias. – Journal of Vegetation Science **21**: 1179 –1186. CrossRef

Lebrun, J., Noirfalise, A., Heinemann, P., Vanden Berghen, C. (1949): Les associations végétales de Belgique. – Bulletin de la Société Royale de Botanique de Belgique **82**: 105–207.

Louis, J., Lebrun, J. (1942): Premier aperçu sur les groupements végétaux en Belgique. – Bulletin de l'Institut agronomique et des Stations de Recherches de Gembloux. Belgique. **11**: 1–86.

Mucina, L., van der Maarel, E. (1989): Twenty years of numerical syntaxonomy. – Vegetatio **81**: 1–15. CrossRef

Rodwell, J.S. (1995): The European Vegetation Survey questionnaire: an overview of phytosociological data, vegetation survey programmes and databases in Europe. – Annali di Botanica **53**: 87–98.

Rodwell, J.S., Schaminée, J.H.J., Mucina, L., Pignatti, S., Dring, J., Moss, D. (2002): The diversity of European vegetation – An overview of phytosociological alliances and their relationships to EUNIS habitats. – Rapport EC-LNV **2002/054**: 1–168. Wageningen: National Reference Centre for Agriculture, Nature and Fisheries.

Schaminée, J.H.J., Hennekens, S.M. (1995): Update of the installation of Turboveg in Europe. – Annali di Botanica **53**: 159–161.

Schaminée, J.H.J., Hennekens, S.M., Chytrý, M., Rodwell, J.S. (2009): Vegetation-plot data and databases in Europe: an overview. – Preslia **81**: 173–185.

Šibíková, I., Šíbík, J., Jarolímek, I., Kliment, J. (2009): Current knowledge and phytosociological data on the high-altitude vegetation in the Western Car-

pathians – a review. – Biologia **64**: 215–224.
van der Meijden, R. (1996): Heukels' flora van Nederland (Heukels' Flora of the Netherlands) 22nd ed. – Groningen: Wolters-Noordhoff.
Van Landuyt, W., Hoste, I., Vanhecke, L., Van den Bremt, P., Vercruysse, W., De Beer, D. (2006): Atlas van de Flora van Vlaanderen en het Brussels Gewest (Atlas of the flora of Flanders and the Brussels Capital Region). – Brussels: Instituut voor Natuur- en Bosonderzoek, Nationale Plantentuin van België.
Vanden Berghen, C. (1949): La carte des groupements végétaux de Belgique. (Vegetation map of Belgium) – Les Naturalistes Belges **30(4)**: 71–73.
Vandenbussche, V., Hoffmann, M. (2001): De Vlaamse Vegetatie Databank (VLAVEDAT): eerste aanzet tot een overzicht van natuurtypen en plantengemeenschappen in Vlaanderen (The Flemish Vegetation Database (VLAVEDAT): first step towards a classification of nature types and a review of plants communities in Flanders [in Dutch, with English summary]. – Stratiotes **22**: 36–44.
Vandenbussche, V. (2002): Systematiek van natuurtypen voor de biotopen heide, moeras, duin, slik en schor: deel 1 : inleiding. (System of the nature types in Flanders: heathland, marshes, dunes, mudflats and salt marshes: first part: introduction) [in Dutch]. – Brussels: Research Institute for Nature and Forest.
Vandenbussche, V., T'Jollyn, F., Zwaenepoel, A., Vanhecke, L., Hoffmann, M. (2002a): Systematiek van natuurtypen voor Vlaanderen: Moerassen. (System of the nature types in Flanders: marshes) [in Dutch]. – Brussels: Institute for Nature and Forest.
Vandenbussche, V., T'Jollyn, F., Zwaenepoel, A., De Blust, G., Hoffmann, M. (2002b): Systematiek van natuurtypen voor Vlaanderen: Heide en landduinen (System of the nature types in Flanders: heathland and inland dunes) [in Dutch]. – Brussels: Research Institute for Nature and Forest.
Vandenbussche, V., T'Jollyn, F., Leten, M., Hoffmann, M. (2002c): Systematiek van natuurtypen voor Vlaanderen: Kustduinen (System of the nature types in Flanders: coastal dunes) [in Dutch]. – Brussels: Research Institute for Nature and Forest.
Vandenbussche, V., T'Jollyn, F., Zwaenepoel, A., Van Den Balck, E., Hoffmann, M. (2002d): Systematiek van natuurtypen voor Vlaanderen: Slik en schor (System of the nature types in Flanders: mudflats and salt marshes) [in Dutch]. – Brussels: Research Institute for Nature and Forest.
Zwaenepoel, A., T'Jollyn, F., Vandenbussche, V., Hoffmann, M (2002). Systematiek van natuurtypen voor Vlaanderen: Graslanden (System of the nature types in Flanders: grasslands) [in Dutch]. – Brussels: Research Institute for Nature and Forest.
Zwaenepoel, A. (2004). Systematiek van natuurtypen voor Vlaanderen: Ruigten en zomen. (System of the nature types in Flanders: tall herb fringe communities) [in Dutch]. – Brussels: Research Institute for Nature and Forest.

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