

TURBOVEG, a comprehensive data base management system for vegetation data

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Abstract. The computer software package TURBOVEG (for Microsoft® Windows®) was developed in The Netherlands for the processing of phytosociological data. This package comprises an easy-to-use data base management system. The data bank to be managed can be divided into several data bases which may consist of up to 100 000 relevés each. The program provides methods for input, import, selection, and export of relevés. In 1994, TURBOVEG was accepted as the standard computer package for the European Vegetation Survey. Currently it has been installed in more than 25 countries throughout Europe and overseas.

Keywords: Computer program; European Vegetation Survey; Natura 2000; Phytosociology; Relevé.

Introduction

The task of producing a national vegetation classification for The Netherlands (Schaminée et al. 1995-1999) required the quantitative analysis and syntaxonomic synthesis of unusually large amounts of data. The computer package TURBOVEG (Hennekens 1995) was developed for storing, editing and selecting phytosociological relevés in virtually unlimited quantities.

This package has been extended, and in 1998 a version for all Microsoft® Windows® platforms was written. Currently, more than 350 000 relevés from The Netherlands have been stored in a data bank, managed at Alterra (Green World Institute, Wageningen). Each relevé is recorded on a national 1km ×1km grid system, and its provisional syntaxon code is determined. Before being added to the data bank, new relevés are compared to all existing relevés in order to prevent multiple inclusion of relevés.

Since 1992, the efforts of several national vegetation survey programs in Europe, including the Dutch program, have been united in the European Vegetation Survey, which aims at summarizing present phytosociological knowledge on a European scale (e.g. Mucina et al. 1993; Rodwell et al. 1995). One of the objectives of this survey is to bring together a selection

of standardized vegetation data in a computerized data bank. Such a data bank will provide information on the floristic composition and geographical distribution of plant communities, which will serve as a source for various applications. It will provide a scientific basis for a European vegetation classification and it will be possible to document the individual vegetation types (syntaxa) with phytosociological tables, based on original relevés. The long-established usage of the Braun-Blanquet approach throughout Europe will provide a sound basis for predicting and modelling environmental trends on a European scale. Therefore, the data base may contribute to international planning and management of ecological resources.

Within the European Union, the data base could be used for the implementation of the Directive on the conservation of natural habitats and of wild fauna and flora, and more specifically the establishment and management of the ecological network of protected areas 'Natura 2000' (Boillot et al. 1997). The classification of habitat types which will be protected by this network (listed in Annex I of the Directive), has been based on the hierarchical classification of European habitats developed by the CORINE Biotopes project in 1988. A thorough revision of the CORINE classification was published in 1991, which was two years later extended to the whole Palaearctic region (Devillers & Devillers-Terschuren 1993; see Romão 1996). A phytosociological interpretation of this classification is given by Rodwell et al. (1998). Finally, the data base could be used in conjunction with the Potential Vegetation Map of Europe, a project co-ordinated by the 'Bundesamt für Naturschutz' in Bonn, Germany (Anon. 2000).

During the third meeting of the European Vegetation Survey (Rome, March 1994), the Working Group Council proposed to use TURBOVEG as the standard computer package. Since then, TURBOVEG has been implemented in a number of institutes and universities outside The Netherlands, viz. Albania, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia,

Faroe Islands, Finland, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, Spain, Sweden, and the UK. Outside Europe, the package is in use in Burkina Faso, Israel, Namibia, South Africa, Thailand, the US, and other countries, for developing national phytosociological data bases. For most of these countries national species list are available for use in TURBOVEG.

General structure of the program

TURBOVEG is a data base management tool for vegetation data, running on all Microsoft® Windows® operating systems. The minimum system requirement is a 486-computer with 16 Mb RAM. Both single- and multi-user versions are available. The latter allows sharing data bases among multiple users in a local network. In TURBOVEG three functional units can be distinguished: data entry, data selection, and data export. Given the large amount of data collected within the framework of the national vegetation classification of The Netherlands, the total data bank is split into subsets (data bases). TURBOVEG can handle a practically unlimited number of data bases. Each data base may consist of up to ca. 100 000 relevés. Generally, a data base is a specific selection; it comprises, for example, the relevés of a single project, an author, a region, or a specific syntaxonomic unit.

Each data base is built up by three DBASE III+ compatible data base files, which are related by relevé numbers. One data base file includes the so-called header data (administrative data and environmental data as topography or soil type). A second data base file contains the species data, and a third data base file the remarks. To speed up the processing (e.g. selections), each data base is supported by a FOXPRO compatible index file.

TURBOVEG data bases enforce some obligatory format features, which are an important condition for exchanging data among data banks built up in different places. Important items such as 'date' or 'UTM grid code' for example, are included in this obligatory section of the data base structure. For her or his own specific needs, however, a user can easily extend the data base with a number of additional fields (columns).

Related to all the data bases is a set of manageable files (called pop-up lists or look-up tables) in which codes, as stored in the data bases, are translated into full descriptions. There are, for instance, translations for species numbers, author codes, project codes, codes linked to literature references, and codes for species cover-abundance. Some of the lists are standard, others are user-defined. The pop-up lists can be used whenever the user needs to know the meaning of a

specific code.

Another table that can be linked to all the data bases is an ecological data base. An ecological data base not only consists of ecological species data (e.g. Ellenberg indicator values), but may also include chorological, morphological, life history, and other kinds of data. In the case of ordinal data, mean indicator values can be calculated for each relevé in the database.

Data input, selection and export

To enter new data, two methods are available: input of separate relevés or tables 'by hand', and import of computerized data saved in Cornell condensed format (species data) and free formatted files (both species and environmental data).

For the selection of relevés from one or more data bases, several criteria can be used. These criteria can be defined on the basis of one or more header items and an unlimited number of species. Criteria can be combined with the operators 'and', 'or', 'and not' and 'part of'. In the latter case so-called wild cards can be used to search for a string of characters.

After a selection of relevés has been taken place several options are available. For each selected relevé, the header data and the species with their cover-abundance value can be displayed on the screen. When the locality of the relevés has been entered by means of the UTM co-ordinates a distribution map can be drawn. The full information of the selected relevés can be directed to a file (one relevé per page), and thereafter to a printer. An important option is the possibility of export to various file formats, allowing further analysis with other software tools. This includes TURBOVEG data bases (mainly for the purpose of relevé exchange between TURBOVEG users), MS ACCESS® database, Cornell condensed files of species and cover values (which can serve as input for a number of classification and ordination programs such as CANOCO, CEDIT, DECORANA, JUICE, MEGATAB, PC-ORD, TWINSPAN and VESPAN), MULVA input files, TAB and ESPRESSO input files, SYNTAX-5 input files, and tables with full species names, user-defined tables with header data and original cover codes in comma delimited format (which can easily be imported in a spreadsheet program like MS EXCEL®), Cornell condensed files of environmental data. In combination with the species file in Cornell condensed format the latter export file can be used to provide environmental data for constrained ordination methods as CCA or RDA as implemented in CANOCO.

Some general features and demonstration version

General features of TURBOVEG comprise 'renumbering data bases', 'floristic comparison of data bases', 'modifying database structures' and 'statistics'. Renumbering, for instance, is required whenever relevés in different data bases have the same relevé number. The floristic content of relevés can be compared numerically on the basis of the Jaccard index of similarity (Jongman et al. 1987). This option is especially useful to look for duplicated relevés in data bases. Furthermore, TURBOVEG allows for defining of different access levels for various users. This is especially useful in a network configuration.

Analyses of time series (permanent plots) is planned for a future version of TURBOVEG.

A demonstration version of TURBOVEG is available on the web. Visit <http://www.alterra.nl/onderzoek/producten/websites/turboveg/> to download an international or Dutch single-user version. Registered users can download the latest versions of the software, free of charge.

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Special Feature: The role of vegetation succession in ecosystem restoration

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