Toward an Italian national vegetation database: VegItaly

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Abstract: VegItaly (http://www.vegitaly.it; GIVD ID EU-IT-001) is a web database designed to store, retrieve and analyse the vegetation data of Italy. Designed for both floristic and phytosociological data, it can handle any field plot according to the definition of "vegetation database" suggested by the Global Index of Vegetation-Plot Databases (GIVD) and the IAVS Ecoinformatics Working Group. VegItaly, supported by Società Italiana di Scienza della Vegetazione (formerly Società Italiana di Fitosociologia), is hosted by AnArchive (http://www.anarchive.it), a collaborative project aimed at archiving botanical data that involves several Italian universities coordinated by the University of Perugia. VegItaly's main aim is to contribute to data archiving and sharing in order to offer the possibility to manage large data sets for statistical analysis on a wide geographic scale.

Keywords: databank; ecoinformatics; phytosociological relevé; statistical analysis; vegetation plot.

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Introduction

Data represent the basis of any scientific research; in geobotany large data sets are particularly necessary when addressing large-scale research questions in biogeography and ecology of species and plant communities. It is well known that phytosociological syntaxa are vegetation models that can constantly be refined thanks to improved knowledge and analytical tools. In this sense, relevé databanks play a special role in monitoring and analyzing vegetation (Knollová et al. 2005, Cutko 2009). They are biodiversity inventories combined with associated environmental data, which represent a valuable tool not only for environmental science and practice, but also for nature conservation, when linked, for instance, to legistative instruments such as the 92/43/EEC Habitats Directive (Biondi et al. in press).

In the last decades, new national projects have rapidly established in Europe thanks to the initiatives of two working groups of the International Association for Vegetation Science (IAVS) – the working group on European Vegetation Survey (EVS) with its regular meetings mostly held in Rome since 1992 (Pignatti 1990, Mucina et al. 1993, Rodwell et al. 1995, 2002) and the relatively new working group on Ecoinformatics (http://www.bio.unc.edu/faculty/peet/vegdata/).

Nowadays a lot has been written on data requirements, sources, georeferencing, protocols and software, from the local to international level, e.g. within projects such as VegBank (http://www.vegbank.org), FloraWeb (http://floraweb.de/vegetation/vegetation.html), biodiversity of Cataluña (http://biodiver.bio.ub.es/biocat/homepage.html), TDWG (http://wiki.tdwg.org/Vegetation/), SynBioSys, TURBOVEG and many others (Brisse et al. 1995, Ewald 1995, Font & Ninot 1995, Neldner et al. 1995, Neave & Norton 1998, Bruelheide & Chytrý 2000, Mucina et al. 2000a, Ewald 2001, Hennekens & Schaminée 2001, Margules et al. 2002, Williams et al. 2002, Chytrý et al. 2002, 2003, Chytrý & Otýpková 2003, Schaminée et al. 2007, 2009, 2011 Dengler et al. 2011, Font et al. 2010).

What about Italy? According to the information provided in response to a questionnaire on vegetation-plot data in European countries and regions, Schaminée et al. (2009) reported for Italy a total amount of 150,000 plots (relevés). Two thirds of them were unpublished and only about 20,000 were captured electronically. This assessment probably underestimated the number of the vegetation plots available in Italy. Furthermore, the data considered as 'computerized' (captured) are part of private data banks, not available for the public, or they represent temporary data

sets stored in various data-sheet formats. In the same paper, the lack of an Italian data base was noted. In the light of this, the VegItaly project aims to inform the public about its existence and to serve as a reference point for the scientific community.

The VegItaly project: short history and main aims

VegItaly is a databank based on the open source project AnArchive for Botanical Data, a web geodatabase designed to store, retrieve and analyze herbarium, floristic and vegetation data (http://www.anarchive.it). Started in 2000 as a collaborative project, AnArchive has been supported and developed during the last 10 years by a team of researchers from the Universities of Perugia, Camerino and Siena (Panfili et al. 2004, Venanzoni et al. 2003, Venanzoni & Panfili 2010, Feoli et al 2011).

The project actually involves a dozen Italian universities collaborating in archiving botanical data. As such it represents a milestone in the Italian vegetation science and stands as a standard management system for botanical data at the national level (Feoli et al. 2011).

Mainly designed for herbarium specimens and flora data, step by step, the project enlarged its target to vegetation plots

and phytosociological data within the subproject VegItaly. The vegetation archive follows the GIVD standards (http://www.botanik.uni-greifswald.de/603.html?&L=1); the concept of vegetation plot concurs with that of Schaminée et al. (2009) and refers to "phytosociological relevés of the Braun-Blanquet type" (Mueller-Dombois & Ellenberg 1974, Westhoff & van der Maarel 1978, Dengler et al. 2008).

The main purpose of VegItaly is to contribute to archiving and sharing public botanical data, offering the scientists the possibility to process large data sets on a wide geographic scale, while protecting the data providers' property.

At the 46th Congress of the Italian Society for Vegetation Science, held in 2010 in Pavia, VegItaly was proposed as the standard to manage vegetation data at the national scale (Venanzoni & Panfili 2010). Figure 1 depicts the conceptual chart of the VegItaly project.

GIVD Database ID: EU-IT-001		Last update: 2012-07-09
VegItaly		
Scope: VegItaly, coordinated by the SISV, gets together the data collected by researchers resulting from the different approaches used in Vegetation Science. Currently the project is hosted in http://www.anarchive.it, a system dedicated to archiving botanical data (taxonomic data, herbaria specimens, flora and vegetation-plots). Based on the constant supervision of experts, VegItaly allows to cross floristic and vegetation data in order to facilitate the research in geobotany, synecology and syntaxonomy.		
Status: finished	**Period:** 1970-2012	
Database manager(s): Roberto Venanzoni (rvenanzo@unipg.it); Flavia Landucci (flavia.landucci@gmail.com); Edoardo Panfili (edoardo@aspix.it); Daniela Gigante (daniela.gigante@unipg.it)		
Owner: SISV (Società Italiana di Scienza della Vegetazione)		
Web address: http://www.vegitaly.it		
Availability: free online	**Online upload:** yes	**Online search:** yes
Database format(s): PostgreSQL	**Export format(s):** [NA]	
Publication: online-manual		
Plot type(s): normal plots	**Plot-size range:** 0.04-1001 m²	
Non-overlapping plots: 11,120	**Estimate of existing plots:** [NA]	**Completeness:** [NA]
Total plot observations: 11,120	**Number of sources:** [NA]	**Valid taxa:** 15,745
Countries: IT: 100.0%		
Forest: [NA] — **Non-forest:** [NA]		
Guilds: all vascular plants: 67%; bryophytes (terricolous or aquatic): 2%; algae (terricolous or aquatic): 1%		
Environmental data: [NA]		
Performance measure(s): [NA]		
Geographic localisation: [NA]		
Sampling periods: [NA]		
Information as of 2012-07-19; further details and future updates available from http://www.givd.info/ID/EU-IT-001		

Technical issues

The project VegItaly uses open-source software and is designed for institutions and individuals (both professionals and amateurs) to archive, retrieve and publish botanical data on the web or on a local network.

The web server application runs on Apache Tomcat[TM] servlet container and stores its data in PostgreSQL[TM]. Software such as Linnaeus (serving the management of taxonomic lists) and VegArchiver (filling data from registered users into personal or shared data bases) can be used as well. Both applications were written in Java to run on various platforms (Linux, Mac OS X, Windows). Access through the web is free for public data and by login of the owner for private ones. Any recent browser such as Firefox, Chrome, Internet Explorer and others can be used.

The geographic visualization is managed by an open source platform for publishing spatial data and interactive mapping applications on the web.

Database structure

The project includes two main interdependent sections and supports applications that focus on taxonomic lists and vegetation plots. These sections are:

Taxonomy: A taxonomic master list can be managed. Powerful tools are provided to handle complex taxonomic nomenclature, with synonymy, including *pro parte* cases and hybrids (Fig. 2). A hierarchical (and printable) master list is furnished as well. A national pool of experts constantly updates the Italian species list that forms the taxonomic core of the database. This list takes into account the official national flora and check-lists (Pignatti 1982, 2005, Conti et al. 2005), is updated on the basis of the most recent taxonomic papers, and follows as far as possible the guidelines of IPNI (International Plant Name Index; http://www.ipni.org/), PESI (Pan European Species-directories Infrastructure; http://www.eu-nomen.eu/pesi/), and BioCASe (Biological Collection Access Service for Europe; http://www.biocase.org/). The history of each species name is tracked by the system. The chain of synonymic names guarantees unequivocal names.

The **www.vegitaly.it** project:

START → DATA

- field or not published relevé
- published relevé

Description of project, subproject

- Plots (under development)
- Other methods (under development)
- Br.-Bl. method
  Br.-Bl. mod. Barckmann et al. (1964)
  Br.-Bl. mod. Pignatti & Mengarda (1962)

Bibliographic data:
Rel#, Tab#,
bibliographic reference

Syntaxonomical attribute

Master list of syntaxonomical literature (LISY)

Master list of italian sintaxa

Original classification:
chose syntaxa from
a master list: void/type
(olotype/lectotype/neotype)

Latest classification
(if different from original classification):
chose syntaxa from a master list
void/type (olotype/lectotype/neotype)

History of classification:
previous classifications
Tab. Rel, bibliographic reference
void/type (olotype/lecotype/neotype)

Habitat & geographic data:
surface (m²)
cover (%)
inclination (°)
exposition(°)
substratum
locality
municipality
country/region/state/nation
geographic coordinates
grids (UTM, CE)
further user's defined fields

e.g.: gps, Google Earth or
http://www.pcn.minambiente.it/PCN/

Floristic/structural data:
layer, 1 trees
height (m)
cover (%)
species 1, cover, sociability
species 2, cover, sociability
species 3, ...
    layer, 1.3 low trees
    height (m)
    cover (%)
    species 1, cover, sociability
    species 2, cover, sociability
    species 3, ...
layer, 2 shrubs
height (m)
cover (%)
species 1, cover, sociability
species 2, cover, sociability
species 3, ...
layer, 3 herbs
altezza (m),
cover (%)
species 1, cover, sociability
species 2, cover, sociability
species 3, ...

Standard number of layers
or user defined layer is supported

Cover values list

Sociability values list

Each layer may be
subdivided in sublayers

Master list of the italian vascular plants

Species data:
Taxonomy:
valid latin name
(with linked synonim)
Biogeography:
Chorologic type
Ecology:
Life form
Ecological ind.val.

Pignatti (mostly)

Landolt
Ellenberg
Pignatti

variant
subassociation
association
suballiance
alliance
suborder
order
subclass
class
superclass

Syntaxonomical rank:
Sp. charact. of...
Sp. differential of...
Sp. transgressive of...
Sp. guide of...
Companion

Syntaxonomical fidelity
weak
strong
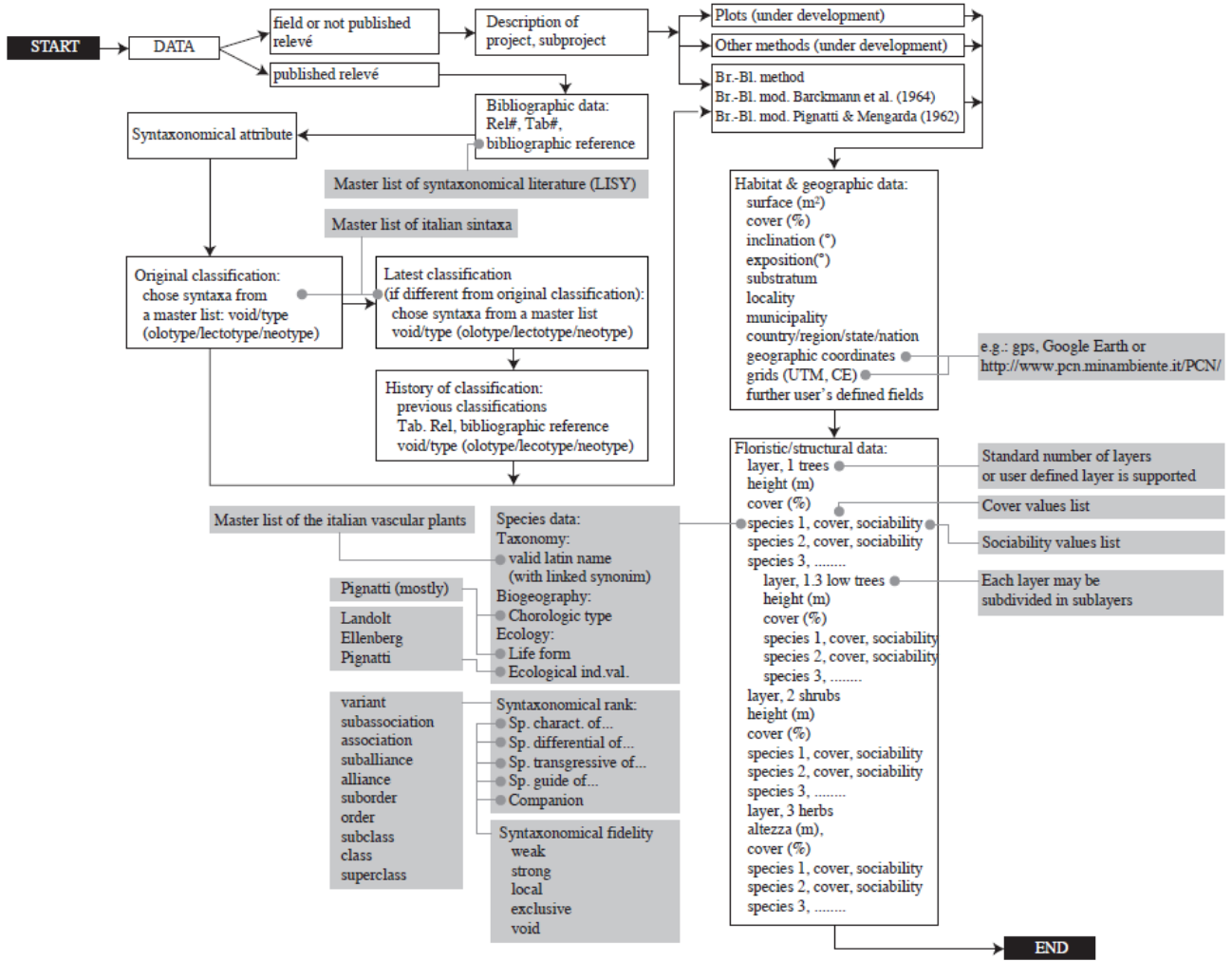local
exclusive
void

END

Fig. 1: Concept diagram representing the structure and metadata of the VegItaly database.

The check-lists which form the core of the system include the valid scientific name and synonyms for 23,140 native and 2,118 alien vascular plants, 4,181 bryophytes, 2,308 fungi and 64 algae (the lichen check list is under construction).

Vegetation: Phytosociological relevés and accompanying geographic, topographic, ecological and structural data (Mucina et al. 2000b) can be stored and managed by the system (see Fig. 1). Supported scales are: Braun-Blanquet cover abundance, including the subdivision proposed by Barkman et al. (1964) and Mucina et al. (2000b); Londo scale (1976); % projection cover values; ordinal transformation scale (van der Maarel 1979) and presence/absence. The results of the queries (by single species/localities/syntaxa/projects etc., or by a combination of them) are returned in html or text-file format, both as single relevés and tables, with tab-delimited fields that can be exported for further analysis or printed. The data can also be exported in a JUICE-compatible format (Tichý 2002, Tichý & Holt 2006) and other free or proprietary software such as TURBOVEG, VEGANA (http://biodiver.bio.ub.es/vegana/index.html), MatEdit (Feoli et al. 2011) and SYN-TAX (Podani 2007). Cluster analysis is also supported via web.

The **geographic data** are managed as well. When geo-referencing the data, WGS84 coordinate systems should be used; when importing data from other coordinate systems, suitable tools for the conversion are available.. Coordinates may be imported via Google Earth in degree or UTM format. If there are no exact coordinates, an element of the Central European Floristic Grid is assigned (Ehrendorfer & Hamann 1965, Niklfeld 1977).

Each relevé can be tracked according to the actual or any other past syntaxonomic classification. The List of Italian Syntaxonomic Literature (LISY) is assisting this tracking. LISY is a very important tool initiated in the 1990s by a cooperative work carried out by regional experts who collected and stored all citations of syntaxa and related bibliographic references published since 1909 for the Italian territory (Biondi et al. 1993, Bracco et al. 2007). At present LISY contains 3,381 scientific publications and 33,233 syntaxa, and it is being constantly updated (http://www.scienzadellavegetazione.it/sisv/lisy/index.jsp).

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

A: Bloom of *Klasea lycopifolia*, a species from the Annex II of the 92/43/EEC, very rare in the Region of Umbria and in Italy as a whole. Pastures and grasslands of the order Brometalia erecti Br.-Bl. 1936 represent an important part of the data set (Photo: R. Venanzoni).

B: Acidophilous *Quercus virgiliana* and *Erica scoparia* forests from Ferretto Plain close to Lake Trasimeno (Perugia, Italy). A large amount of relevés in the VegItaly database are from forests of Central Italy (Photo: R. Venanzoni).

C: Vegetation of the karstic plain "Pian Piccolo" of Castelluccio (Sibillini National Park), in the Apenninic Chain. The VegItaly database includes relevés from the alliances *Magnocaricion elatae* Koch 1926 and *Caricion davallianae* Klika 1934 (Photo: R. Venanzoni).
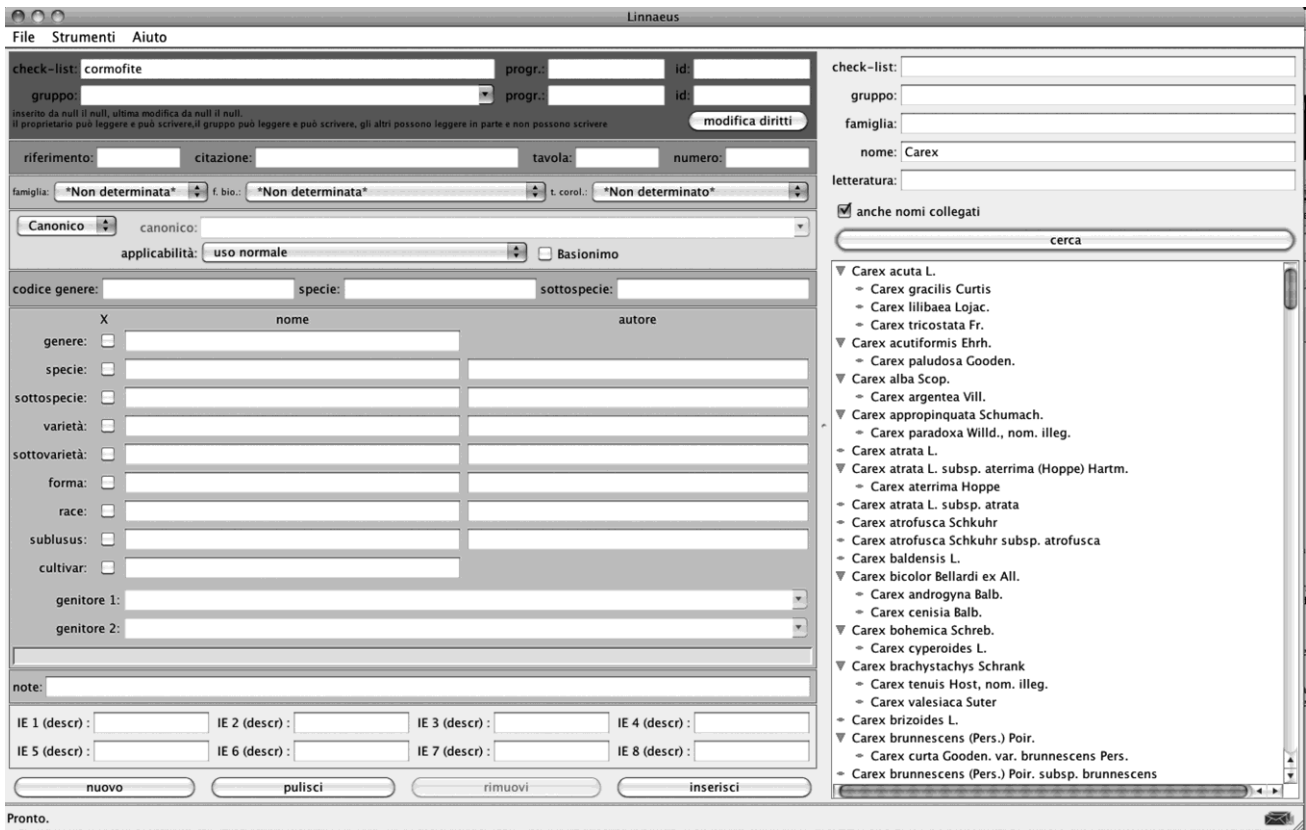
Fig. 2: Structure of the taxonomic list managed via Linnaeus application.

Partners of the project and state of the art

At present the project is supported by AnArchive users, nine Italian universities (Universities of Siena, Camerino, Genua, Ancona, Isernia, Florence, Trieste and Salento) coordinated by University of Perugia, as well as private and public partners (see more information at http://www.anarchive.it/anArchive/statistiche.jsp).

The project has been self-supported up to now and developed on a voluntary basis. In 2010 a panel of qualified users from several universities submitted a grant application to fund the implementation and further development of the Project, under the title "Formal ontology of the Italian vegetation system".

Scientists interested in supporting the project and using its results are encouraged to register and invited to cooperate in testing the system, providing comments, and developing the software.

Conclusions

Currently the database contains more than 104,000 entries, divided into different sections (floristic records, herbarium specimens and vegetation); the phytosociological database includes ca. 11,100 relevés, but the number is destined to rapidly increase as the average number of visited web pages and the services daily requested by users (mainly data changes and queries) are counting hundreds. Once the system is working at full capacity, a large amount of data will offer a solid support to vegetation scientists, biodiversity managers and other interested parties. The Plate shows some of the vegetation types represented in the database.

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