Botanica SERBICA 33 (2): 131-136 (2009)

Original Scientific Paper

A Web-Enabled Interactive Application for the Development of a Knowledge Base on Greek Flora

Maria Konstantinou*, Ioannis Paliokas, Valasia Iakovoglou, Sofia Sarikou, Grigorios Chatziphilippidis and Nikolaos Eleftheriadis

Kavala Institute of Technology, Faculty of Agriculture, Department of Landscape Architecture, Drama, Greece

ABSTRACT: This paper describes a web services application based on a Flora database. A relational database model is used to deliver information access services mainly to students, as well as educators and researchers of Landscape Architecture. The contents of the database are related to the vascular species of the Flora of Greece which could be used as ornamentals. Authorized users of the web services can also contribute to the content enrichment of the database. The aim of the project is the contribution to the evaluation of Greek flora and taking advantage of available knowledge base in education of Landscape Architecture. The embedded communication tools like forums can be used for delivering didactic activities based on the project method. The database structure, the way of use and the effectiveness of its use are briefly explained.

Key words: Flora Database, Web Services, Landscape Architecture, Ornamental Plants, Greece.

Received 06 October 2009 Revision accepted 28 November 2009

UDK 582.4/.9:004.6(495)

INTRODUCTION

The development of Landscape Architecture projects requires the designers and researchers to have access to Flora knowledge bases related to specific study areas. During the past, library search has been required along with multiple media storage like CD's, books, magazines, textbooks and other hard copies. The lack of full access to complete data sets about plant species affected the quality of projects in a negative way. Today, free access to rich and reliable flora databases can speed up the concept planning process of Landscape Architecture projects.

In this fashion, the main target of our team was to develop and maintain a well documented knowledge base about vascular species of the Greek flora, which could be used as ornamentals. It can be useful not only for students but also for researchers, educators, planters and the wider public. The knowledge base is currently accessible throughout the Intranet of our department and it provides free and open access to well documented botanical and ecological data. A basic set of web services includes access to flora knowledge base, user profile management, forums and search engine capabilities based on text queries logical operators (AND, OR, NOT). Furthermore, it provides dynamic search results on popular web browsers and it is designed for people with low to moderate technical abilities. Finally, the described system is multi-platform and easily transferable due to common and widely used web protocols.

Landscape Architecture and Flora Databases. Landscape Architecture deals with the needs of modern societies, which can be described by the provision of pleasant surroundings for active work and play, passive relaxation and the quality of life improvement in urban landscapes. Nature, with its enormous variety of landscapes and plant forms, often works as a source of inspiration for the landscape architect in encountering current problems of urban environment.

Greece, due to its dissected topography and geographic position in relation to its limited area, is a country with a very rich flora and a great variety of habitats. Greece occupies the southern part of the Balkan Peninsula within the Mediterranean area. According to Flora Hellenica

*correspondence: mkonst@teikav.edu.gr

(Strid & Kit Tan 1997, 2002) the number of wild-growing vascular plants in the territory of Greece is currently estimated to c. 5700.

Based on the above, it is expected that the floristic and habitat richness of the Greek nature should be represented to public and private places like gardens, parks, etc. Instead of that, the extent use of foreign or exotic species, which are mainly imported from abroad, is observed very often in Greek urban landscapes (Tsakaldimi 2003). The authors are against this practice and support the use of native plant species as ornamentals.

Furthermore, there is an increasing interest in the use of databases in a number of disciplines in the field of Botany, such as Systematics, Ecology, Geobotany (Moraczewski *et al.* 1995; Berendsohn *et al.* 1997; Navarette *et al.* 2000; Fertalj *et al.* 2000; Gachet *et al.* 2005). Landscape Architecture is a scientific field where botanical, ecological and horticultural data are combined. As Eckbo refers "even an aesthetic discussion of plants as used in landscape design must be based on plant science: botany, ecology, horticulture, genetics" (Eckbo 2002).

There are numerous Flora databases over the Internet offering free access to reliable information about species found in all over the world. BIOPOP, a database about flora of Germany (Poschlod *et al.* 2003) and BASECO based on French Flora (Gachet *et al.* 2005) are only a few examples. Most of them are suitable for educational use just like in the project of Quinnell *et al.* (2008). Others have given priority to the richness of their content, like the rich database of Ding under the name 'Seed Plants of China-SPCH' (Ding 2002). Taking advantage of the available information of these databases is a one-way road for landscape architects. Wacha & Ultrick imply that 'the informational value in offering website access to our natural areas for aesthetic and environmental reasons seems self-evident' (Wacha & Ultrick 2001). But every web portal has its own unique technical and scientific characteristics. Working on such a diverse information space like the Internet (with different file structures and followed ontologies) makes the study of flora planning in a uniform way a difficult task.

MATERIALS AND METHODS

System Architecture. The web application described in here is structured in separate layers (Figure 1). The user interface is delivered by common web browsers as shown at the top of the schema. The application layer is divided into two sublayers: the Presentation and Logic. In the Presentation sublayer, the search engine input forms automatically translate the user selections into SQL queries which are forwarded to the database system. Forum and User Profiles are easily accessible through the main menu (Fig. 2).

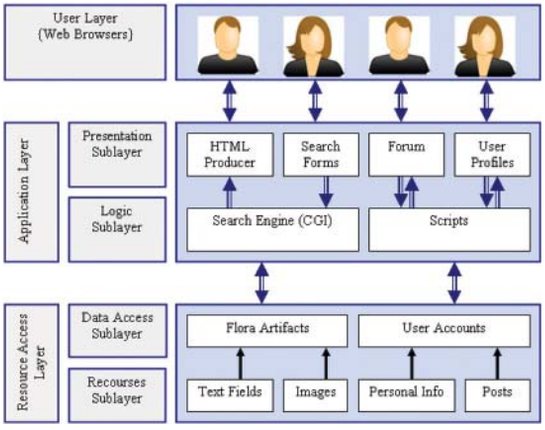

Fig. 1 System Architecture of the web application.

Fig. 2 Screenshot of the welcome page.

The Common Gateway Interface (CGI) protocol was used for script writing. CGI programming has been widely used for creating dynamic generated pages on the Web. The underlying programming language was Pascal as used in Borland Delphi 6.0, a powerful Rapid Development Kit. Script development in compiling languages produces executable files (in exe or dll format) as outcome for server side programming. This solution has certain advantages like language independence and simple programming interface. The only disadvantage of using CGI is related to slow server responses in case of high traffic. Currently the system is working on the Landscape Architecture department's intranet without facing important response delays. In future, when web services will be available on the Internet, all scripts can be easily translated into FastCGI protocol for better performance.

Database structure. The underlying database driver used in this project was Microsoft Access 'Jet.OLEDB.4.0' to connect with GreekFlora.mdb database. Among other reasons that this driver and file format was chosen was the

Tab. 1. Plant traits and their ranges/values.

A/A	Field Name	Range/Values
1	Code number	{Autonumber key)
2	Scientific name	Textual
3	Synonyms	Textual
4	Common name	Textual
5	Family	Textual
6	Plant group	Gymnospermae, Angiospermae, All
7	Leaf phenology	Evergreen, Deciduous, Semi-evergreen
8	Growth form	Tree, Shrub, Herb, Climber
9	Crown	Conical, Pyramidal, Globose, Elliptical, Ovoid, Obovoid, Columnar, Umbrella-like, Irregular, Pendent, Compact, Broad, Much-branched, Erect
10	Plant height (m)	Arithmetic (maximum value of the height of the tree or shrub/flowering stems in perennial herbs. For ranges of values see "Plant description-Comments"
11	Leaf description	Textual
12	Leaf colour	Textual Color Code
13	Flower colour	Textual Color Code
14	Colour of male cone	Textual Color Code
15	Colour of female cone	Textual Color Code
16	Flowering period	January-December
17	Fruit	Follicle, Capsule, Siliqua, Silicula, Legume, Lomentum, Achene, Nut, Single samara, Double samara, Caryopsis, Drupe, Berry, Pome, Schizocarp, Syncarp
18	Highest dimension of fruit (mm)	Arithmetic
19	Highest dimension of mature female cone (mm)	Arithmetic
20	Fruit colour	Textual Color Code
21	Colour of mature female cone	Textual Color Code
22	Fruiting period	January-December
23	Growth rate	High, Moderate, Slow
24	Light requirements	Sun, Half-sun, Shade
25	Humidity requirements	High, Moderate, Low
26	Nutrient requirements	High, Moderate, Low
27	Frost tolerance	High, Moderate, Low
28	Wind tolerance	High, Moderate, Low
29	Air pollution tolerance	High, Moderate, Low
30	Tolerant of pruning	Yes, No
31	Uses	Textual (how species are used as ornamentals)
32	Plant description-Comments	Long Textual (additional morphological information, distribution in Europe & Greece)
33	Photos	habit, bark, inflorescence, infructescense
34	PostedBy	Source profile information

fact that our colleagues working on content enrichment were feeling more comfortable with this database type based on their previous experience. After web applications were developed and tested, content enrichment by users is now possible through the web interface. The table containing the flora species information is organized into 34 fields. Most of them are Text/Numeric as shown in Table 1. The field names and list values were carefully selected based on landscape architects' professional and educational needs. The followed process of table design deals with some simplifications in comparison with what botanists would expect from such a system.

The total number of 34 table fields can be divided into three major clusters: A) Fields from 1 to 6 consider name forming (Taxa codification), B) fields from 7 to 23 & 31-32 are descriptive about the species and C) fields 24-30 consider treatment of species (see Tab. 1). An additional field containing the pictorial information (photos) was also imported. The second cluster of table fields is more analyzed into 'morphology' (growth form, plant height, leaf description, leaf colour, flower colour etc.), 'phenology' (period of flowering, period of fruiting) and 'ecology' (light requirements, humidity requirements, nutrient requirements, frost tolerance, wind tolerance, etc.). For all the plant traits, the species described are supposed to be mature, i.e. reproductive.

This field categorization in clusters is the result of an extensive and long experimentation with plant traits based on our target audience characteristics and the international literature research. Another currently hidden field about plant distribution is also available for future use. Currently all information about distribution of plant species are included in the 'Plant description-Comments'.

Selected species. The database content deals with the wild-growing vascular plants of Greece. At the time this paper was under development, information about 216 species and subspecies was available. This first group of plant species was selected based on aesthetic criteria. Among them, 23 are Gymnosperms and 193 are Angiosperms. The current group of species represents 48 families and 113 genera. Forty nine (49) are perennial herbs, 70 trees, 93 shrubs and 6 climbers. The lowest level that can be defined in the database is subspecies. In most cases a total number of 4 photos are shown for each species (habit, bark, inflorescence, infructescense).

Important data sources were Flora Hellenica (Strid & Kit Tan 1997, 2002), Flora Europaea (Tutin *et al.* 1968-1980; 1993), European Garden Flora (Walters *et al.* 1984-1986, 1989; Cullen *et al.* 1995, 1997, 2000) and Arabatzis (1998, 2001). In cases that some plant traits were not fully described or certain characteristics were not clearly defined in these series, relevant information was obtained from other sources (Burnie 1995; Brickell 1996; Lancaster 2001; Lord 2003) or "expert advice" from the working group. The followed nomenclature is in line with Flora Hellenica (Strid & Kit Tan 1997, 2002) and Flora Europaea (Tutin *et al.* 1968-1980, 1993).

DISCUSSION

Creating a web application for Greece and South Balkan Peninsula flora can be very useful for education and research. The authors expect that giving emphasis on native species will elect the floristic richness of Greece and the surrounding Balkan countries. The system described above was designed mainly for landscape architects, but also for botanists, ecologists, gardeners, industry practitioners. Also, it can be used as an educational encyclopaedia for Landscape Architecture students who can take advantage of the available information in the selection and arrangement of species in their plant designs. In overall, some of the advantages of the system are:

- Decrease the library search effort in cases the research material is stored in diverse and multiple media like CD's, books, magazines, textbooks and other hard copies.
- Delivery of free and open access to well documented botanical, ecological and horticultural data.
- Extensive search engine capabilities.
- Dynamic search results on popular web browsers.
- Easily used by people with low technical abilities.
- Multi-platform and easily transferable due to common and widely used Server-Client communication protocols.

In our future plans, the currently hidden field about the distribution of plant species will be used for map visualization purposes in the next version of the web application. In our future plans, information about territorial expansion of species will be available on a separate layer of a spatial data visualization system (GIS extension).

Acknowledgements – The presented paper was supported by the research program "A Web-Enabled Interactive Application for the Development of Knowledge Base on Greek Flora", funded by the Research Funds Office of the Kavala Institute of Technology.

The authors would like to express their gratitude to Mr. Vidakis Konstantinos for shearing with the team part of his original photos collection related to the selected species.

REFERENCES

Arabatzis TH. 1998. Shrubs and Trees in Greece I. Oikologiki Kinisi Dramas, Technological Educational Institute of Kavala, Drama (in Greek).

Arabatzis TH. 2001. Shrubs and Trees in Greece II. Oikologiki Kinisi Dramas, Technological Educational Institute of Kavala, Drama (in Greek).

Berendsohn WG, Greilhuber J, Anagnostopoulos A, Bedini G, Jakupovic J, Nimis PL & Valdés B. 1997. A copmprhensive data model for karyological databases. *Pl. Syst. Evol.* **205**: 85-98.

Brickell C. 1996. RHS A-Z Encyclopedia of Garden Plants 1-2. Dorling Kindersley, London.

Burnie D. 1995. Wild flowers of the Mediterranean. Dorling Kindersley, London.

Cullen J, Alexander JCM., Brady A, Brickell CD, Green PS, Heywood VH, Jörgensen PM, Jury SL, Knees SG, Leslie AC, Matthews VA, Robson NKB, Walters SM, Wijnands DO & Yeo PF. 1995. European Garden Flora IV. Cambridge University Press, Cambridge.

Cullen J, Alexander JCM, Brickell CD, Edmondson JR, Green PS, Heywood VH, Jörgensen PM, Jury SL, Knees SG, Matthews VA, Maxwell HS, Miller DM, Nelson E., Robson NKB, Walters SM, & Yeo PF. 1997. European Garden Flora V. Cambridge University Press, Cambridge.

Cullen J, Alexander JCM, Brickell CD, Edmondson JR, Green PS, Heywood VH, Jörgensen PM, Jury SL, Knees SG, Maxwell HS, Miller DM, Robson NKB, Walters SM, & Yeo PF. 2000. European Garden Flora VI. Cambridge University Press, Cambridge.

Ding T. 2002. The botany database: Seed Plants of China (SPCH), and its applications. *Geoscience and Remote Sensing Symposium* **4:** 2432-2434.

Eckbo G. 2002. Landscape for living. Hennessey + Ingalls, Santa Monica.

Fertalj K, Nikolic T, Helman T, Mornar V, & Kalpic D. 2000. Flora Croatica Database Application, Mathematics and Computers in Modern Science, New York, USA: World Scientific and Engineering Society Press: 175-182.

Flora Europaea, Cambridge University Press. 2001. Also available online by the Royal Botanic Garden Edinburgh at: http://rbg-web2.rbge.org.uk/FE/fe.html.

Gachet S, Véla E & Tatoni T. 2005. BASECO: a floristic and ecological database of Mediterranean French flora. *Biodivers. Conserv.* **14(4):** 1023–1034.

Lancaster R. 2001, Perfect plant-Perfect Place. Dorling Kindersley, London.

Lord T. 2003. Flora. The Gardener's Bible 1-2. Cassel, London.

Moraczewski I, Zembowicz R & Zytkow JM. 1995. Geobotanical Database Exploration. AAAI Technical Report SS-95-03.

Navarette D, Dávila R & Sánchez A. 2000. A Specific Domain Translator Application in a Floristic Digital Library. In Cairo O., Sucar LE & Cantu FJ (eds.): MICAI 2000, LNAI 1793, pp. 436-442.

Poschlod P, Kleyer M, Jackel AK, Dannemann A & Tackenberg O. 2003. BIOPOP - A database of plant traits and internet application for nature conservation. *Folia Geobot.* **38(3):** 263-271.

Quinnell R, Henwood M, Hanfling S & Brownlee R. 2008. eBot: a collaborative learning object repository for Australian flora. In Symposium Proceedings: Visualisation and Concept Development, UniServe Science, The University of Sydney: 86–90.

Strid A & Tan K. 1997. Flora Hellenica. Vol. 1. Koeltz Scientific Books, Koenigstein.

Strid, A & Tan K. 2002. Flora Hellenica. Vol. 2. Gantner Verlag, Ruggell.

Tsakaldimi MN. 2003. The importance of the right plant species selection for the urban green space. Proc. Conference "Plant species selection for afforestation, reforestation and improvement of rural and natural landscapes", Technological Educational Institute of Kavala, Department of Forestry, Drama (in greek).

Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, Valentine DH, Walters SM & Webb DA. 1993. Flora Europaea 1 (2nd edition), Cambridge.

Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters, SM & Webb DA. 1968-1980. Flora Europaea 2-5. Cambridge.

Wacha RS & Ulrick K. 2001. Electronic Guide to Wildflowers: Maintaining an Online Database for Natural Areas. *Proceedings of the 17th N.A. Prairie Conference*: 228-234.

Walters SM, Alexander JCM, Brady A, Brickell CD, Cullen J, Green PS, Heywood VH, Matthews VA, Robson NKB, Yeo PF & Knees SG. 1989. The European Garden Flora. III. Cambridge University Press.

Walters SM, Brady A, Brickell CD, Cullen J, Green PS, Lewis J, Matthews VA, Webb DA, Yeo PF & Alexander JCM, 1984-1986. The European Garden Flora. I-II**.** Cambridge University Press, Cambridge.

REZIME

Web interaktivna aplikacija za razvoj baze podataka o grčkoj flori

Maria Konstantinou, Ioannis Paliokas, Valasia Iakovoglou, Sofia Sarikou, Grigorios Chatziphilippidis, Nikolaos Eleftheriadis

Ovaj rad opisuje aplikacije na web-u u bazi podataka Flora. Model vezanih baza podataka je korišćen da bi se dobile informacije pristupom servisima od strane korisnika različitog profila. Sadržaj baze podataka odnosi se na vaskularne biljke Flore Grčke koje mogu biti korišđene kao ukrasne biljke. Autorizovani korisnici web servisa mogu da obogačuju bazu. Cilj projekta je prilog evaluaciji flore Grčke uzimajući u obzir dostupna znanja iz pejzažne arhitekture u obrazovanju. Alatke kao što su forumi mogu da se koriste za didaktičke aktivnosti u zavisnosti od projektnog metoda. Struktura baze podataka, način i efekat korišćenja su objašnjeni.

Ključne reči: Flora baza podataka, Web servisi, pejzažna arhitektura, ukrasne biljke, Grčka.