Revista Internacional de Ciencia y Tecnología de la Información Geográfica
International Review of Geographical Information Science and Technology

*Gonçalves Seco, L., Cordero Souto, M., Crecente Maseda, R. y Miranda Barrós, D. (2005):"Evaluation for GRASS (5.0.3) using the common GIS functionalities", GeoFocus (Informes y comentarios), nº 5 , p. 43-50. ISSN: 1578-5157*

# EVALUATION OF GRASS (5.0.3) USING THE COMMON GIS FUNCTIONALITIES

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RESUMEN

Este informe presenta el resultado de una evaluación al programa SIG GRASS. La evaluación fue realizada a través de la implementación del proyecto "Implementación de información cartográfica dos Montes Vecinales de Mano Común de la comarca de Os Ancares (Galicia). Se analizó la herramienta en cuanto a capacidad, facilidad, funcionalidad y tiempos de ejecución. Los resultados han revelado que GRASS muestra una gran capacidad de análisis y manipulación de datos, cubre bastantes áreas de aplicación en proyectos SIG. Sin embargo, hemos verificado que tiene un entorno gráfico incompleto, que causa pérdidas de tiempo en el desempeño de algunas funciones tales como las salidas gráficas.

Palabras clave: SIG, Software libre, GRASS

ABSTRACT

This paper presents the evaluation results of GRASS GIS software. The evaluation was carried out through the project 'Implementation of cartographic information for Communal Forests in the region of Os Ancares', by analyzing the tool in terms of capability, functionality, ease of use and execution time. The results reveal that GRASS shows high capability to analyze and manipulate data, and covers many application areas in GIS projects. However, it shows an incomplete and scarcely intuitive graphical interface, which causes slow performance of many options such as layout map.

Key words: GIS, free software, GRASS

Recibido: 2 / 02 / 2005
Aceptada versión definitiva: 10 / 06 / 2005

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## 1. Introduction

Free software and proprietary software (Stallman 2003) have the same aims concerning the creation of solutions that use Information Technologies (IT) for process automation. However, both types of software have different philosophies in regard to software development and commercialization.

Because proprietary software is more widely used than free software, many organizations do not consider this option (Halloran and Scherlis 2002) before resorting to other criteria to implement a project. Free software (DiBona; Ockman, and Stone 1999) has gradually gained ground in European economy (Greve 2003). Moreover, free software has provided good alternative solutions to proprietary software, as in the case of Linux versus the operating system Microsoft Windows. With regard to GIS, free software currently offers quality alternatives (Wagner 2005), which may become a competitive added value due to its inherent characteristics.

Given the increasing relevance of the free philosophy, this study presents a free tool that has prevailed in the development of GIS software. Born in 1982, GRASS (Geographical Resources Analysis Support System) is the oldest free and costless GIS software that is active. It has played an important role in the progresses made in the Geospatial model, both in education and in the scientific community (Neteler and Mitasova 2002). Moreover, it has played an important role in the field of business, for the creation of solutions to solve spatial problems.

## 2. Objectives

The global aim of this paper is to carry out an evaluative analysis of functionalities common to almost every GIS software, by studying the three-tiers of the classic GIS software architecture. This study aims to conduct an evaluative analysis of the variables mentioned below by developing the project "Implementation of cartographic information for Communal Forests in the region of Os Ancares" using GRASS 5.0.3. The analyzed variables are:

2.1. Capability;
2.2. Ease of use;
2.3. Functionality;
2.4. Time of project implementation;

## 3. Materials and methods

Information about Communal Forests (CFs) in Ancares was obtained from the cartographic material of the CFs in the province of Lugo supplied by the Department of Forestry of the Province of Lugo. This material was developed in 1977 and 1978 by the Spanish National Institute for the Conservation of Nature (ICONA) by using aerial photographs of the area, scale 1:20,000. This material included a 1:25,000 map at municipal level of all the CFs in the municipality, in paper form. The size of the material supplied was A0. In addition, 1:5000 cartography provided by the Galician government *Xunta de Galicia* was used in the georeferencing process. Such cartography

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was developed by the Department of Urban Planning of the Galician Ministry of Territorial Policy, Public Works and Accommodation ('*Consellería de Política Territorial, Obras Públicas e Vivenda, Dirección Xeral de Urbanismo'*), and was georeferenced and made available in Microstation digital format (DGN) by the Land, Underground and Biodiversity Laboratory (LUB).

The execution of the project was divided into 6 phases (according to the methodology in Figure 1). Each phase was assigned scores of 0 to 1. The following features were analyzed:

### 3.1. Capability

This variable is defined as the assessment of the availability of the tools required to perform a given operation, and of the potentialities of the software in the analyzed phase of the project;

### 3.2. Ease of use

Connected with the Graphical User Interface (GUI), this variable aims to assess the speed and ease of use of the tool supplied by the software in each phase of the project;

### 3.3. Functionality

The analysis of this variable assesses whether the results obtained in each phase of the project correspond to the expected results.

### 3.4. Time of project implementation

The execution times were computed in all the stages of the project, implemented for the region of Ancares (Table 1). The learning phase required to develop the project was not computed. Therefore, the analysis of the times was carried out from the moment the user was sufficiently skilled to use the software.

#### 3.4.1. GIS Project Implementation for the three variables of the comparative analysis

*A) Importing cartography to GIS software*

The aim of this phase was to import the non-georeferenced maps (CFs) and the georeferenced maps (1:5000 maps of the province of Lugo) to GRASS.

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*B) Georeferencing*

Establish point correspondences between the non-georeferenced maps (CFs) and the georeferenced maps (1:5000 maps of the province of Lugo). In GRASS, vector point selection involved selecting points using the keyboard, and raster point selection involved selecting points using the mouse. Therefore, we decided to convert DGN (Microstation CAD Drawing File) to raster because it was faster and easier. The georeferencing process was performed with the two images placed beside each other.

*C) Digitizing*

Design the CFs based on the georeferenced image, to apply geometry correction functions in order to verify errors, and to associate geometric data with a label that identified them in a single manner, by using vector design tools.

*D) Database connection*

With a view to storing the most detailed information about each forest, a database that would match the corresponding label was built. In GRASS, alphanumeric data and geometric data are stored in different locations. Therefore, the data structure and the database had to be created in *PostgreSQL*, and connected to geometric data through GRASS.

*E) Spatial Analysis*

A spatial analysis of the area covered by CFs in a municipality in the region of Ancares was carried out. The analyzed forests belonged to that municipality, but their boundaries went beyond the limits of the municipality. Due to ease of use, raster tools were used to implement the project (with r.mapcalc command). Nevertheless, implementation of the project with the vector model could have been performed by using the commands *v.cutter*, *v.patch*, *v.extrat*., and *v.report*.

*F) Layout map*

In this study, the printout of a query is presented. The mentioned printout shows the classified communal forests that belong to the municipality of *Baralla*. The potentialities of the command *ps.map* were analyzed because the use of the mentioned command is the only possibility to print directly from the tool.

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**4. Results and discussion**

4.1. Capability

With regard to capability, the following conclusions were reached (see Table 2):

a) It was verified that GRASS includes the tools required to import data. Generally, GRASS shows with gdal library (Heesch, 2004) a great capability to import and export data.

b) With regard to the georeferencing method, GRASS does not offer any alternative to the georeferencing method used.

c) GRASS includes good edit tools for the digitizing process.

d) GRASS allows access to *PostgreSQL*, but does not display many 'manipulating' tools.

e) GRASS includes vector analysis tools, and displays quite powerful tools for *raster* analysis (Neteler and Mitasova 2004), which include statistic generation, local operations, neighborhood operations, area operations, extended neighborhood operations, decision-making, generation of elevation models (erosion, hydrology, fires, landscape ecology), etc. In addition, GRASS is capable of analyzing satellite images (color composition, atmospheric correction, geometric correction), etc.

f) In GRASS, *Layout map* must be alternated with software that visualizes *PostScript* files.

In short, a great potential of GRASS was verified in terms of capability to import and export data, and in terms of the large number of spatial analysis tools by application area, and by data model (vector, *raster*).

4.2. Ease of use

a) In GRASS, the DGN import process has to be carried out as many times as files have to be imported. A less experienced user must create a *script* to automatize such process.

b) The georeferencing process is fast and easy. However, many zoom operations are needed because the two images are placed beside each other and cannot be overlaid.

c) Using GRASS, the design process is intuitive and demands few operations.

d) Because in GRASS the GIS project is not directly connected to the database, the whole process of data integration and manipulation is not easy.

e) GRASS does not have a graphical interface for every analysis command. However, the results can be easily obtained with a few steps.

f) In GRASS, the generation of maps is difficult due to the total lack of a graphical interface.

GRASS shows a different working philosophy. GRASS is a command-oriented *ArcInfo* type application, whose functionality is sometimes poor. For example, the process to import DGN with the command *v.in.dgn* becomes a complicated operation due to the fact that only one file can be imported at a time. With regard to layout, printing the first map in GRASS is a time-consuming task because the lack of a graphical interface affects the time required to create a sample model. We consider this aspect as the less positive aspect of the tool (Table 2).

### 4.3. Functionality

All the results obtained (Table 2) correspond to our expectations.

### 4.4. Time of project implementation

Table 3 shows the data obtained from measuring execution times. The difficulty of identifying data related to CFs on the cartographic material must be taken into consideration. The number of lines made it difficult to recognize the boundaries of each forest, and 30% of the execution time was spent in this task. Moreover, the digitizing process and the database connection process required the consultation of the documentation and books enclosed with the cartographic material, which contained information about the forests.

As shown in Table 4, the phase that took longest was the digitizing process. In this particular case, time depended on the expertise of the user to minimize the digitizing error as far as possible.

The estimated total costs per time of implementing this project for the region of *Ancares* could be easily calculated depending of the methodology used. In this case, the main advantage of using GRASS should be the zero cost of GIS software per hour.

From a global perspective, and according to the analyzed data, Table 4 shows the most positive aspects and the least positive aspects of GRASS. Currently, GRASS unstable versions 5.3 and 5.7 (GRASS Development Team 2005) correct some of the problems that have been mentioned. For example, the mentioned versions include a graphical interface for layout map, more functionalities in the digitizing process and improvements in the DBMS, which includes the *MySQL* database.

## 5. Conclusions

The main conclusion drawn from this study is that GRASS can cover a large number of knowledge areas in GIS projects because it works with raster and vector formats, and because it offers many tools for spatial analysis. Moreover, GRASS is a free, open source tool that enables the user to explore, alter, adapt, or just consult the algorithms, which makes the tool rather flexible. However, an improved GUI can reduce the time of implementation.

We have verified that our initial interest in the issue of free software was completely justified because it agrees with specific concerns that many companies and research organizations must face at present.

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## References

DiBona, Ch., Ockman, S. and Stone, M. (1999): *Open sources. Voices from the open source revolution*. O'Reilly, 1º ed.
Halloran, T. J. and Scherlis, W. L. (2002): *High quality and open source software practices. Meeting challenges and surviving success. 2nd Workshop on Open Source Software Engineering*, ICSE 24; Orlando, USA. .
GRASS Development Team. GRASS 5.7 Development [Web Page]. 2004; Accessed 2004 Aug 18. Available at: http://grass.itc.it/grass57/index.html.
Greve, G. C. F. (2003): *Free software in Europe*. Public Service Review - European Union. 2003 Nov 2; 5th Edition.
Heesch, D. V. (1997): *GDAL* [Web Page]. Accessed 2004. Available at: http://remotesensing.org/gdal/.
Neteler, M. and Mitasova, H. (2002): *Open Source GIS: A GRASS GIS Approach*. Kluwer Academic Publishers, 1 ed.
Stallman, R.: *The GNU Project* [Web Page]. Accessed 2004 Aug 15. Available at: http://www.gnu.org/gnu/thegnuproject.html.
Wagner, J.-O. (1999). *FreeGIS* [Web Page].; Accessed 2004 Jan 8. Available at: http://freegis.org.

## TABLES

**Table 1. Characteristics of the municipalities in Ancares**

| Municipality | No of Forests | Area (ha) |
|---|---|---|
| Nogales | 71 | 6137 |
| Navia | 100 | 17742 |
| Becerreá | 151 | 9016 |
| Pedrafita | 49 | 5906 |
| Cervantes | 107 | 19069 |
| Baralla | 47 | 5704 |

**Table 2. Evaluation results – Capability, Easy of use and Functionality in the 6 phases**

| Project phases | Capability | Ease of use | Functionality |
|---|---|---|---|
| a) Importing | 1 | 0.6 | 1 |
| b) Georeferencing | 1 | 0.8 | 1 |
| c) Digitizing | 0.6 | 0.8 | 1 |
| d) Database connection | 0.6 | 0.6 | 1 |
| e) Spatial analysis | 1 | 0.8 | 1 |
| f) Layout map | 0.6 | 0.6 | 1 |

**Table 3. Data obtained from measuring execution times**

| Phases of the Project | Nogales | Navia | Baralla | Becerreá | Pedrafita |
|---|---|---|---|---|---|
| a) Importing | 0.3 | 0.4 | 0.15 | 0.17 | 0.2 |
| b) Georeferencing | 1 | 0.5 | 1 | 1.3 | 1.15 |
| c) Digitizing | 9 | 30 | 10 | 16 | 22 |
| d) Database | 3 | 6 | 4 | 6 | 6 |
| e) Spatial analysis | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| f) Layout map | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Total hours | 14 | 37 | 16 | 24 | 30 |

**Table 4. General evaluation**

| | Most positive | Least positive |
|---|---|---|
| **GRASS 5.0.3** | 1. Capability to import and export data<br>2. Many spatial analysis tools<br>*3. Open Source*, which allows access to all the algorithms<br>4. Free | 1. Rather incomplete and scarcely intuitive graphical interface, which causes slow performance of many options such as layout map<br>2. Few options for database manipulation |

## FIGURES

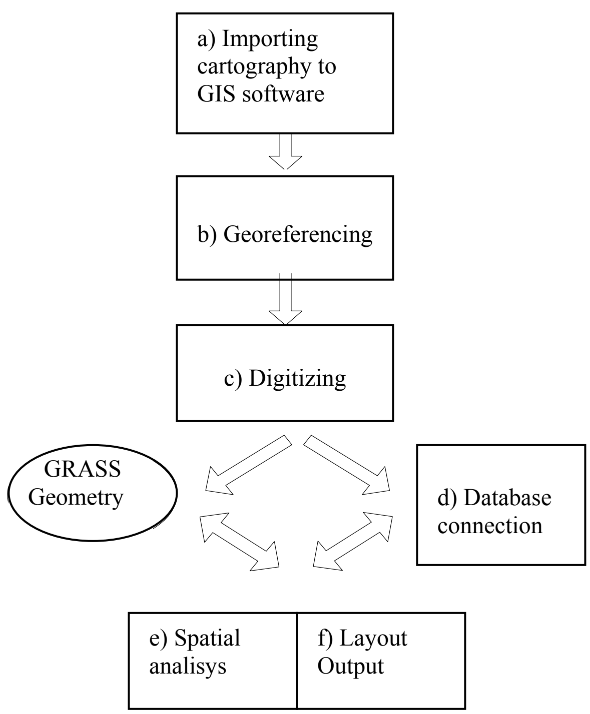


**Figure 1. Methodology used to implement the project in GRASS 5.0.3**