THE PEDAGOGICAL EXPERIENCE IN TEACHING CARTOGRAPHY AND GIS USING PUBLIC DATA AND SOFTWARE

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Abstract

This paper describes a GIS and Cartography learning/teaching experience performed during one semester to Environmental Engineering students at Paraná Federal University (UFPR). The main purpose is to present the fundamentals of cartography (basic and thematic) and its applications and importance to GIS effective understanding. In this particular pedagogic experience, free public data of the Brazilian territory, available from a governmental agency of cartography (the Brazilian Institute of Geography and Statistics – IBGE) and from a governmental agency of Remote Sensing (the National Institute for Spatial Research – INPE), were used to carry out practical exercises. Those institutions also provide free software (in the Geodesy, Cartography, GIS and Remote Sensing areas) which was tested as an option to the standard commercial ones. It is worth mentioning that the use of free public data and software is increasing among Brazilian education institutions (public and private) since the actual federal government changed its policy and initiated, in the last five years, a migration campaign towards the open source software in the public administration. It is also important to point out that the access of free public spatial data and free software are useful to build up ties among cartographic public institutions and educational centers as well as to bring out the discussion about country reality concerning the GIS spatial data sharing policy. It has to be considered that practical classes' preparation is much more complex than it was imagined in the beginning considering a larger variety of data formats and scales (especially with digitized or vectorized maps) available which, most of the time, are incompatible for overlaying or merging. As a result, it is an important issue to be taken on account by the educator because it's time consuming. One must bear in mind that data preparation (import, export and edition) and the adaptation of pre-existing free software tutorials according to the discipline requirements is essential to

properly follow teaching steps. The methodology applied was an adaptation of standard procedures that has taken into consideration that free software are in general more complex in terms of handling and, as well, demand a better conceptual basis from the students. As results, the referred pedagogical experience has shown that undergraduate students are capable of understanding the importance of free software dissemination as an element of digital inclusion and also that the availability of free public data represents an enormous contribution to the students' spatial and descriptive acquaintance to the nation's territory. This experience has permitted skills development of spatial data manipulation, storage, processing and analysis.

1. Introduction

Brazil's current federal administration policy, initiated in 2002, and is focused in the use of free software mainly in the public institutions. In order to achieve some improvement about this issue, federal government has instituted, in 2003, a committee (Brazilian Technical Committee to Implement Free Software) which has as priorities: the implementation of solutions, programs and services based on free open source software (FOSS); the gradual migration from proprietary systems; and the acquisition of hardware compatible with free platforms. The committee activities enclose the distribution of free software systems in a collaborative and spontaneous way and the strengthening of sharing actions between governmental organizations and society. (Presidência da República, 2003)

The Federal University of Paraná State (UFPR) as a public institution has been, since 2005, connected with the goals of the public state administration and has developed, in conjunction with local state agencies, strategies for the migration to free software. In 2007, the Students Association of UFPR has declared its intention to pursue a free software policy for the entire institution. Although these cases represent an evolution in the state administration politics, such experiences have not yet reached the graduation classes in a satisfactory measure. In the domain of cartography sciences, this reality has led to the development of new strategies for the teaching process.

2. Main Brazilian Institutions Involved with GIS Data and Software Distribution

There are many Brazilian institutions and organizations involved with the distribution of GIS free public data and free software. The most important ones are:

2.1. The Brazilian Institute of Geography and Statistics (IBGE)

IBGE can be compared to the US Census Bureau and its mission is to provide Brazilian officials with all the information and data necessary to understand what is going on in the country so that citizens can effectively exercise their citizenship (Costa, 2007).

In this manner, IBGE is the agency responsible for statistical, geographic, cartographic, geodetic and environmental information in Brazil. The Institute performs a national census every ten years and the statistics from these census are presented (made available for the public) in its website along with other data concerning the Brazilian territory: topographic mapping and mapping of territorial units (in the cartographic field); Brazilian geodetic system, Brazilian network for continuous GPS monitoring, permanent geodetic tide gauge network and geocentric reference system for the Americas (in the geodetic field); regional distribution, special areas (like border strip and coastal zone), atlases and cities influence areas (in the geographic field); and finally, publications about sustainable development indicators, environmental studies, fauna and flora, land use and hydrographic resources (in the environmental field). Also in the geodetic field some free software systems are made available by the Institute in order to attend to the data user needs.

2.2. The National Institute for Spatial Research (INPE)

INPE has as mission to promote and carry on studies, scientific researches, technological development, and human resources capacitation in the fields of Space and Atmosphere Sciences, Space Applications, Meteorology, and Space Engineering and Technology as well as in related domains, in accordance with the policies and guidelines set forth by the Science and Technology Ministry (MCT) (INPE, 2006).

Also INPE is an important agency concerning remote sensing and GIS data dissemination, its mission guidelines is to prepare and implement a plan to expand the divulgation efforts and the diffusion of scientific and technical knowledge for the popularization of space science and technology as well as for the promotion of the Brazilian social development (INPE, 2006).

One of the most significant achievements of INPE is the CBERS project which provides multispectral images of the world in different spatial resolutions with free distribution. The project has allowed enforcing a cartographic culture in Brazil by means of image interpretation and processing. Beyond CBERS images distribution, INPE maintain a satellite database of other remote sensing and environmental systems (LANDSAT, SPOT, ERS, RADARSAT; GOES, NOAA, TERRA, AQUA, MSG).

In the other hand, INPE also develop and distribute to the community free open source softwares in the following categories: state-of-the-art GIS, GIS classes and functions library, remote sensing image processing and web applications.

3. Using Free Public Data and Software in GIS Practical Lessons

In order to fulfill the proposed objectives for the discipline entitled "*GIS Applied to Environment Issues*", lectured to the Environmental Engineering students of Paraná Federal University, the significance of GIS and cartography are assessed in a sort of

workshop since these students have no experience related to the cartographic sciences. As a result, it is essential to select significant theoretical themes capable of giving them a general notion of basic cartography, GIS data collection, GIS fundamentals and basic remote sensing concepts.

The referred discipline is offered every semester and its content has to be fully worked in 90 hours (6 hours per week during 15 weeks). It is not an easy task to adjust theory and practical lessons. Thus, in order to optimize the time, it was proposed to each student a different portion of the Brazilian territory to be worked on (most of them were located at the south region of Brazil), concerning the data made available by IBGE (topographic maps at 1:50,000 scale).

At first, the students should have access to the IBGE homepage and explore its content in order to locate the desired data. It is important to notice that these data is made available by IBGE in a variety of formats, and so, at this time, the students had the opportunity to download the format data which they were acquainted with. The purpose of the proposed task was, in general lines: explore the referred webpage, download the proposed material (topographic maps), print the proposed material in a specific paper format (A1), and bring it to be worked on in class.

Basically, the studies carried on with the printed material were: topographic map reading and interpreting; coordinate (geographic and UTM) and altitude interpolation at points of interest; perimeter, area and volume determination; construction of topographic profiles at variable scales; slope calculation; and elaboration of hand made thematic maps (hypsometric; drainage and ridgelines; slope).

Thus, after an exhaustive work with the analogical data, the next study phase comprehended the access and download of free image data and software from the INPE homepage. In the same way, the students had to download the CBERS imagery that corresponded to each one of the topographic map areas proposed. The next step comprehended the registration and download of the requested software which was the SPRING version 4.3.3 (the newest version at that time).

According to Câmara et al. (1996), SPRING is a state-of-the-art GIS and remote sensing image processing system with an object-oriented data model which provides for the integration of raster and vector data representations in a single environment. It is being developed by INPE since 1992 and has required over 200 man/years of development, which includes extensive documentation, tutorials and examples (Câmara, 2008). SPRING versions are available for Windows and Linux and although it is freely available on the Internet, it is not open source software. Câmara (2008) also explains that to be open source software, SPRING project requires a major effort by INPE development team in terms of documentation and supporting fellow code developers, which exceeds the current Institute capacity.

SPRING has been chosen for this experience at UFPR not only because it is a free software which "provides a comprehensive set of functions, including tools for Satellite Image Processing, Digital Terrain Modeling, Spatial Analysis, Geostatistics, Spatial Statistics, Spatial Databases and Map Management" (Câmara, 2008), but for the reason that it is a national product that has been downloaded and tested by 'more than 80 thousand users from 60 countries' (Câmara, 2008).

For the referred learning experience, some tasks have been planned and should be fulfilled by the students until the end of the semester. Such tasks comprehended: the software download and installation (at the students personal computer); the software tutorials download (adapted to the discipline needs and made available by the educator through a specific Internet webpage); the data import, export and edition tutorials download (created and made available by the educator through the same Internet webpage); the tutorials execution, step by step, in order to achieve the expected software functions learning and the proposed spatial analysis results.

The practical classes were conducted with the purpose of clarifying the students' doubts with respect to the primary software functions; data import, export and edition functions; and spatial analysis functions. All the functions were handled having as basis the previous downloaded vector data and raster images. After the data import and edition, CBERS imagery was overlaid to vector data to perform the analysis functions and to ensure the close link between remote sensing, cartography and GIS. These tasks made possible the merging of theoretical and practical concepts (Figure 1).

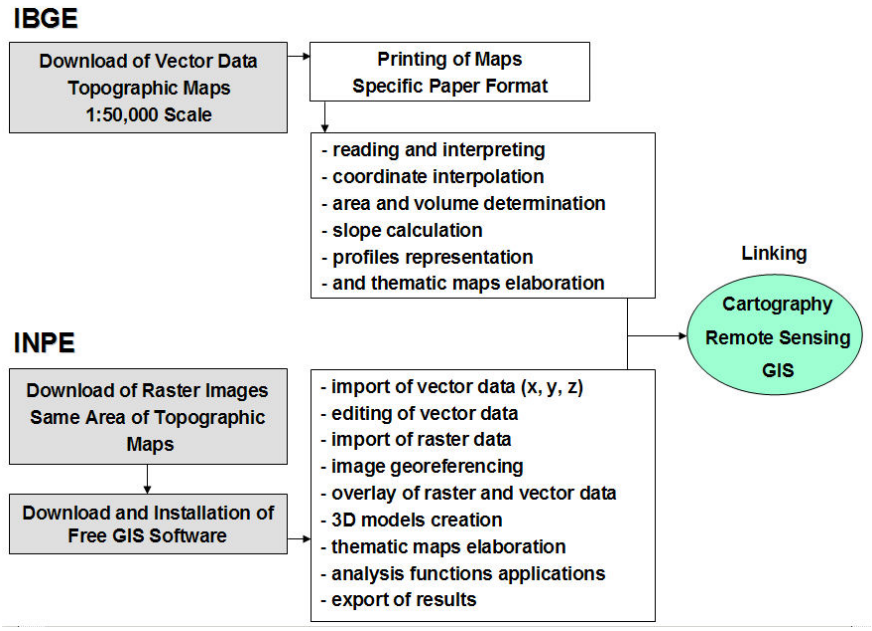

Figure 1. Diagram showing the sequence of tasks performed by the students and their achievements

To conclude the learning/teaching experience process, one final seminar was performed to exchange the experience among the students. The result of this final evaluation shows the importance of the cartographic science in the students' profession, once most of them enroll in the next semester to the discipline "*Environmental Zoning*", also focused on GIS analysis.

4. Results and Conclusions

Sharing the use of free public spatial data and free GIS software with the environmental engineering students of UFPR was quite an interesting experience because, surprisingly, these 7th academic term students have never had, during their graduation life, the opportunity of effectively working with topographic maps (analog or digital) and of extracting from them spatial information. This is an issue not so difficult to understand once the referred graduation course is focused in environmental modeling and has neglected the cartography concepts during its previous education.

Nevertheless, once the students have a very strong mathematical background, it is reasonably trouble-free to carry out basic cartography and remote sensing exercises. The bottle neck is performing a great deal of practical and sequential exercises in a short period of time.

The second and final phase of learning has presented the most significant difficulties for the students. These difficulties were basically related to the data edition and importation. The data edition has consumed a great amount of time once they were made available by IBGE with no logical consistency. In the other hand, the importation of data has required a specific vector format not available in the newer versions of the proprietary CAD system used.

It is important to mention that the access of free public spatial data and free software capable of dealing with these data demand from the educator other responsibilities. Practical classes preparation are much more complex once the data available are in a variety of formats and scales (mainly in the case of digitized or vectorized maps) and not always compatible with the software which is intended to be used. Thus, another issue for the educator may be the considerable preparation of data import, export and edition tutorials along with the adaptation of pre-existing free software tutorials according to the discipline needs.

After all, the referred experience has proved that graduation students are capable of understanding the importance of free software dissemination as an element of digital inclusion and also that the availability of free public data represents an enormous contribution to the students' spatial and descriptive knowledge of the nation's territory, which significantly increases their spatial analysis capability.

The experience of using SPRING as a learning tool for GIS technology in the environmental area has shown that it is important for the student to have the opportunity of working with other technologies than the proprietary ones and that national technology can be as good as any other.

The availability of national free public data and software is still a kind of knowledge not accessible to the majority of graduation students in Brazil. This knowledge, however, is capable of inciting the students to rely on their on capabilities of developing themes of study that are not fully contemplated by the graduation course's curriculum. And, most important, once the GIS user become familiar with free softwares and their functionalities, it can be expected that the personal and institutional software and data piracy in the country will diminish considerably.

Finally, the students have had an overall view of the cartographic sciences supporting GIS technology and the experience has proved to be valorous for the students by turning them into more demanding users and helping them to propagate the GIS culture among their equals.

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