FOSS-BASED GIS TRAINING TOOLS FOR THE FIELD OF URBAN PLANNING EDUCATION

Kei SAITO

Department of Landscape Architecture, University Technology Malaysia

Michihiko SHINOZAKI

Department of Architecture and Environment, Shibaura Institute of Technology

ABSTRACT

We have engaged in research and developing a GIS training tools in the field of urban planning for undergraduate education using FOSS (Free/Open-Source Software). GIS training materials mainly consist of several spatial data and converter, and are provided with sample data and instruction of coursework as one set for weekly practical training. These materials have been utilized for actual undergraduate GIS training course since 2006. We've obtained some feedback about GIS environment improvement using FOSS and training materials from students. These results show some satisfactory / unsatisfactory points from the aspect of providing training environment. Currently we have been working improvement to existing tools following the findings from the response.

1. INTRODUCTION

Recently, there's been an increase of advanced technological development and new application service of geographic spatial information. Also, these new type geographic service has been increase public recognition as well as expert. In Japan, to develop basic infrastructural data and advanced methods for spatial data acquisition are making steady progress. Further advancement leading to our real life is hoped in future. In this evolving field of spatial information technology, FOSS(Free/Open Source Software) is one of the important keyword. In this evolving field of spatial information technology, FOSS(Free/Open Source Software) is one of the important keyword. FOSS application include features such as anyone can use free of charge and customize source code as usage directly. It is considered that these FOSS's merits are suited for use especially in universities in terms of the software initial/maintenance, escaping vendor lock and so on.

2. PURPOSE OF THIS STUDY

With these background, our group has engaged in research and developing a GIS training tools in the field of urban planning for undergraduate education in college using FOSS since 2005. Before now, firstly, we compared the functions of open-source GIS software and commercial GIS software, and then verify the substitutability by using open-source GIS software. As a next step, we've organized the current situation of spatial digital data distribution that are generally available free of charge or affordable price. Based on these basic findings, these training materials have been utilized for actual undergraduate GIS training course since 2006. We introduce our effort to develop the series of training tools for urban planning fields through this paper.

3. Comparison major function of GIS

3.1 What is "GRASS-GIS"?

GRASS-GIS (Geographic Resources Analysis Support System) was originally developed by U.S. Army Construction Engineering Research Laboratories (USA-CERL) for land management in military facilities in the 1980s. GRASS can handle the raster and vector format map and widely applicable to analyze the geographical issue as statistics, environment, terrain analysis and assessment of natural disaster. The stable latest version is GRASS 6.2.3. This software is running under regardless of plat home as Linux, MS-Windows and MacOS (Figure 1).

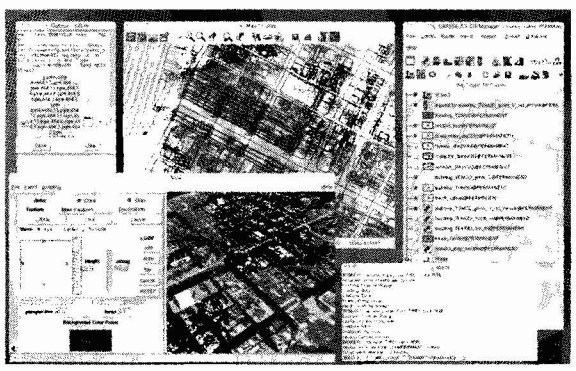


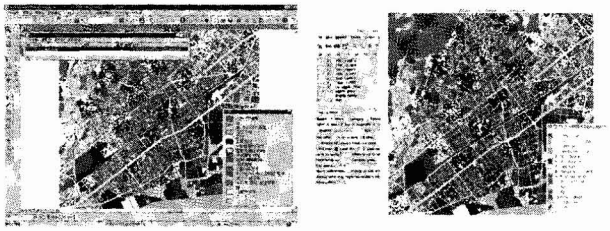
Fig. 1 GRASS Desktop

3.2 Comparison GIS functions follow the actual training topics

In this section, we consider the possibility of replacement of commercial GIS software by Open-source GIS software from functional standpoint especially treatment of several format data and spatial analysis. As a sample for comparison, we use the data that was treated in training program for undergraduate students. The Department of Architecture and Environmental Systems, Shibaura Institute of Technology is using ArcGIS 9.2and MicroStation/Geographics.

Vector and Raster map data Overlay

Fig.3 shows the screenshot of map overlay training using two different format data formats -Vector map (Black Line in the fig.2.1(a), (b)) and Raster map- using MicroStation GeoGraphics. As shown in Fig. 4, it was demonstrated that it was possible to reproduce the same work satisfactorily under the GRASS environment. GRASS' features include high compatibility between various formats and resolutions of data in the same database. Moreover, it has well developed import and export functions.



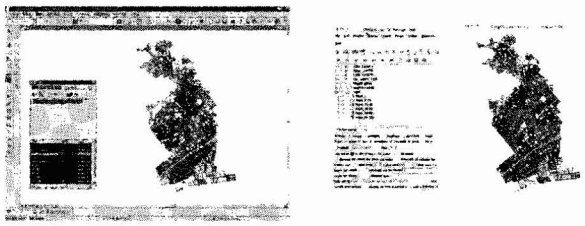
(a) Microstation (b) GRASS

Fig. 2.1 Data Overlay

We converted to the ASCII format the digital data in the proprietary software, such as a digital map and land use mesh map. We then developed approaches to facilitate the conversion of those ASCII data into GRASS binary formats with a customized import command macro.

Construction and Management of Attribute Data and Data Analysis

Figure Figure2.2 (a) shows the screenshot of data search and classification training using attribute databases. Attribute data derived from an investigation of the 1995 Kobe earthquake in Japan were originally stored in DBMS (Microsoft Access2003. As shown in Figure 2.2 (b), it checked that it was possible to reproduce the same work satisfactorily under the GRASS environment.

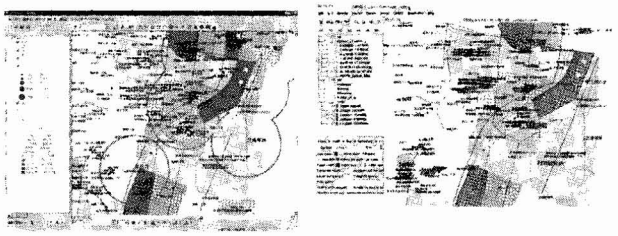


(a) Microstation (b) GRASS

Fig. 2.2 Database Manegement

Geo-Spatial Analysis Function (ex. Generating Buffer)

Next, Figure 2.3 (a) shows a screenshot of data analysis training such as calculation of buffering centering on a station point data. Figure 2.3 (b) confirms that it was possible to reproduce the same work satisfactorily under the GRASS environment. GRASS is equipped with substantial geographical analysis functionality. It is possible to easily execute buffering on the raster data treated here, and also of combination and display of multiple output layers of raster and vector data.



(a) ArcGIS (b) GRASS

Fig. 2.3 Spatial Analysis (Buffering)

3.3 Possibility of substituting open-source GIS for commercial GIS

As explained using the previous examples, we confirmed that GRASS is equipped with sufficient functionality to reproduce the processes and results of work in the training exercises noted here. The GRASS's functionality and operational characteristics are summarized in Table 1 through comparison with the general commercial GIS software's functionality and operational features. In comparing the functionality of the commercial GIS and GRASS, we can safely say that there is no effective difference with respect to the tested procedures. In the case of university GIS education/training, it is considered practical to replace all such materials with open-source GIS software.

Table 1. Comparison of Functionality and Operability

Function and Operate in Commercial GIS Software	Replacement by GRASS
Various Data Input / Output, Data Convert	+++
Display of Legend Symbol, Create Histogram	++
Vector Map Data Handling	+++
Raster Map Data Handling and Calculation	+++
Linkages between Figure and Attribute Data	+++
Spatial Analysis Functions	+++
User Interface, Operationality	++
Presentation use	+

+++ : Sufficient, ++ :Possible, + :Bit difficult

4. Development of Training Materials

With these backgrounds and findings, we introduce the development of GIS training tools mainly using GRASS.

4.1 Study on the training topics

Basically, GRASS is application running under the UNIX environment. Therefore, a beginning student may feel the difficulty of getting used of the operability and interface. Students get to learn the UNIX basic command operation in the first two weeks. After that, they tackle the series topics such as creating base map, basic analysis and creating report. The concrete schedule and topics of the training course as follows.

- Topic1 (2weeks): Training of UNIX Operation
- Topic2 (1week): Training of CUI-based GRASS operation using existing tutorial data
- Topic3 (2weeks): Training of GUI-based GRASS operation using existing tutorial data:
- Topic4 (2weeks): Creating Base Map (Geo-reference, Tracing a data on raster map)
- Topic5 (2weeks): Training of Spatial Analysis (Visualization of Basic information, Calculation of Accessibility and density of public facilities, etc)
- Topic6 (2weeks): Creating the final report

4.2 Several Spatial Data in the Tools

The specification of several spatial data we've prepared for training course is as follows.

Vector Map:

-Store[1], Station[1], School[1], Hospital[1] (point)

-Road[2], River[2] (1/2,500, Polyline)

-Landuse[3], Statistical Data[3] (1/2,500, Polygon)

Raster Map:

-Zoning Map[3], 50mDEM[2], Busstop[1] (Image)

[1] Original data

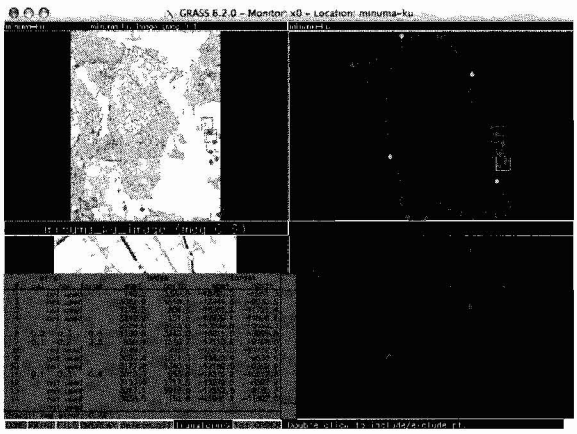
[2] Provided by GSI (Geographical Survey Institute)

[3] Provided by Saitama City Office

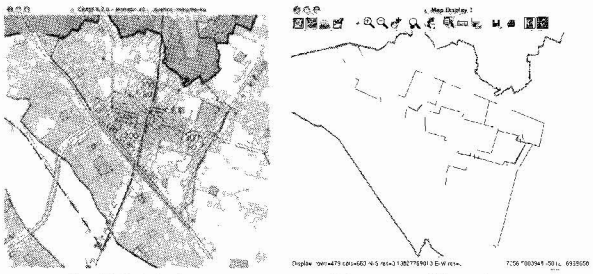
4.3 Development of the training materials

Spatial data acquisition and creation

This topic is to create the base map for spatial analysis in the next topic. Specifically, to download other necessary spatial data based on the already distributed data as a sample, and to rectify the scanned paper-based map data and trace on it for importing the GIS. (Fig. 3.1)



(a) Rectification of Raster Map

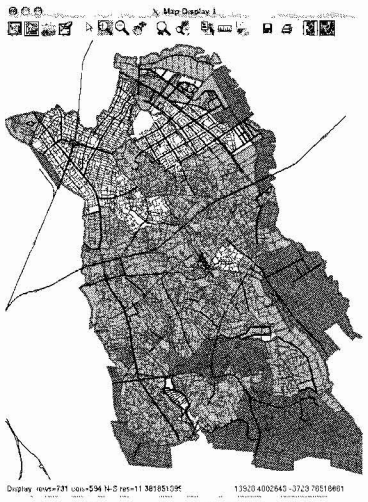


(b) Digitizing (c) Data Cleaning

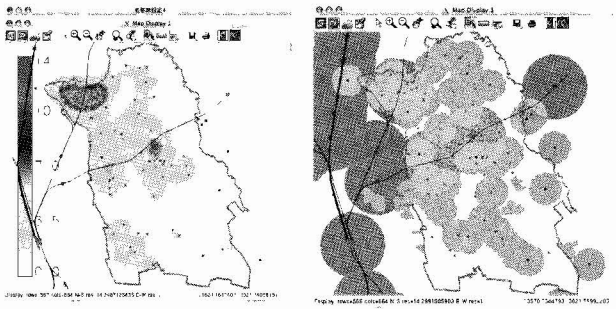
Fig. 3.1 Base Map Creation

Spatial analysis

Next topic is to actually execute some analysis command based on the developed base map and distributed statistics data in the target region. And also to learn about how to calculate the basic indices such as BCR (Building Cover Ratio), road ratio and so on, and to compute the location density and coverage region of public facilities such as hospitals, elementally school and green park, finally how to represent the result on the map. (Fig. 3.2)



(a) District Road Ratio Map



(b) Facility Density (c) Facility Placement

Fig. 3.2 Spatial Analysis

Creation of a report

Final topic is to create the assessment of the living environmental map and to organize a final report with a combination of the methods for upgrading of spatial data and spatial analysis learned in the previous weeks. In this case, students are required to make a choice and to combine effective two or more indices that can be reflect the current situation of the target region. Figure 3.3 shows sample of the final report from a student.

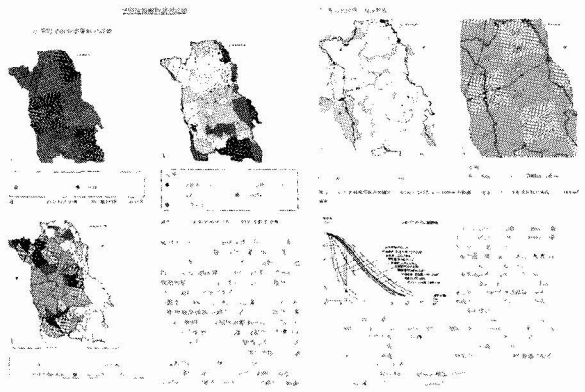


Fig. 3.3 Final Report

Two lecturers and one teaching assistant manage his training course, and the number of annual average of students taking this course is about 20.
Figure 3.4 shows the training room and individual work environment.

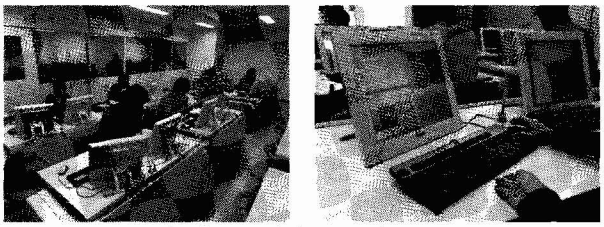


Fig. 3.4 Training Environment

4.4 Training application and response

After final class, we've carried out a course evaluation that is type of free-answer question about development of training environment and actual training contents. As a result, in terms of using GRASS and Linux environment, we obtained a kind of favorable answer from 15/18 students. On the other hand, there were some improvement points such as an increase of distributed sample data size, a shortage of machine specification relation to training contents. In this relation, we've considered how to cope with that as a future works. 1. To prepare the flash memory type storage for each student as a backup media, because basically there is a data storage limitation on the university environment. 2. To consider how to use the same GIS training contents using other common PC on campus.

5. CONCLUSION

This paper describes the development of GIS training environment and actual application for urban planning field in the undergraduate school using mainly FOSS. As a result, we obtained some merits/demerits as follows.

- We have verified the substitutability of training materials at university from commercial GIS to open-source software, on the basis of a functional comparison between commercial GIS and GRASS.
- Most students were able to proceed the GIS training without delay same like other application by preparing the procedure documents in the details.
- In order to solve a problem of increasing data file size, it is necessary to reduce the each spatial data size or to scale down a training target area before distribution, or to prepare the individual storage to keep own data.
- It's desirable to develop and provide the training environment and contents anywhere at any time without being restricted working on common use PC.

In addition, if we consider the use of this GIS training materials and environment in other country or other organizations, it is thought that the application use is possible by considering the following points.

- To develop a converter follow original data format vary from country to country.
- To set the way of data download and upload follow the number of students taking course and network environment.
- To set the way of data download and upload according to the number of students taking course and network environment appropriately.

Currently, we've engaged the on-demand based GIS training environment using relatively large capacity storage media such as DVD or USB flash memory including GIS environment and LinuxOS. It is expected that students can use training materials anytime at anywhere and without limitation of data storage problem.

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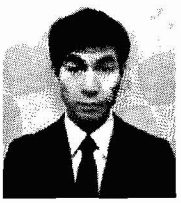

Kei SAITO received the B.E. (1998), M.E. (2000), and Ph.D (2003) degrees in regional environment systems from Shibaura Institute of Technology. He is a senior lecturer, Department of Landscape Architecture, University Technology Malaysia from Dec. 2008. His current interests include urban landscape analysis and GIS/Computer application.

Michihiko SHINOZAKI received the B.E. (1984), M.E. (1987), and Ph.D (1990) degrees in urban planning from the University of Tokyo. He is a Professor, Department of Architecture and Environment Systems, Shibaura Institute of Technology.