

# DEVELOPMENT OF A VALLEY MANAGEMENT SYSTEM FOR GIS AND REMOTE SENSING EDUCATION

Mu-Lin WU, Deng-Ching WONG, Yu-Ming WANG

Department of Information Management  
87-1 Nansh Li, Madou, Tainan 721, Taiwan  
E-mail: mulinwu@yahoo.com.tw

**ABSTRACT** ... College GIS and remote sensing education usually consists of commercial software packages implementations in the classroom. Computer programming is quite important when college graduates work in private or public sectors relevant with GIS and remote sensing implementations. The objective of this paper was to develop a valley management system which implements GIS and remote sensing as the key components for education. The Valley Authority is entitled with water resource protection for sustainable drinking water supply of the second largest city in Taiwan. The test area consists of three different government agencies, Forest Service, EPA, and Water Resource Agency. Materials were provided by the Valley Authority in ArcGIS file format. MapObjects have made the GIS development process much easier. Remote sensing with image manipulation functions were provided by computer programming with Visual Basic.NET and Visual C#.NET. Attributes inquiry are performed by these two computer languages as well. ArcGIS and ArcPad are also used for simple GIS manipulations of the test area. Comparison between DIY and commercial GIS can be made by college students. Functions provided by the developed valley management system depending on how many map layers have been used and what types of MapObjects components have been used. Computer programming experience is not essential but can be helpful for a college student. The whole process is a step-by-step sequence which college students can modify to depict their capability in GIS and remote sensing. The development process has gone through one semester, three hours every week in 18 weeks. College students enrolled in this class entitled with GIS showed remarkable progresses both in GIS and remote sensing.

**KEY WORDS:** GIS, Remote Sensing Education, ArcGIS , MapObjects, Visual Basic.NET, Visual C#.NET.

## 1. INTRODUCTION

### 1.1 GIS and Remote Sensing Education

GIS and remote sensing are two different courses in college education. However, GIS course with some remote sensing ingredients would be better than a single course only. Professor Chang wrote two chapters entitled with raster data and raster data analysis in his book, introduction to GIS, which consists of 16 chapters (Chang, 2002). It is one example that remote sensing takes about 12.5% in typical GIS textbook. High resolution satellites are available in the open markets such that remote sensing implementations with GIS are more popular and reasonable. Some departments have GIS but there is no remote sensing available for college students. They provide digital image processing instead. It seems reasonable to make some more remote sensing ingredients into a GIS course.

### 1.2 Development of a Valley Management System

GIS and remote sensing are good for solving problems encountered in watershed management. A valley management system based on GIS and remote sensing usually consists of some brand-name commercial software packages. In Taiwan, ArcGIS is popular both in private and public sectors. It is reasonable to implement ArcGIS for teaching in college education. All materials provided by the valley authority are in ArcGIS format. It is easy to implement ArcGIS and ArcPAD for GIS software implementations. In the mean time, MapObjects are good for computer programming training in terms of Visual BASIC.NET and Visual C#.NET. It is good for college students to obtain more skillful experience in GIS and remote sensing

training when they have to develop their own valley management systems.

### 1.3 Objective

The objective of this paper was to develop a valley management system which implements GIS and remote sensing as the key components for college education.

## 2. MATERIALS AND METHOD

The test site is located in southern Taiwan which covers one major watershed in four counties (Figure 1). A task-oriented government agency was established several years ago. The valley authority is entitled for water resource protection in order to sustainable supply of drinking water for people living in the second largest city in Taiwan.

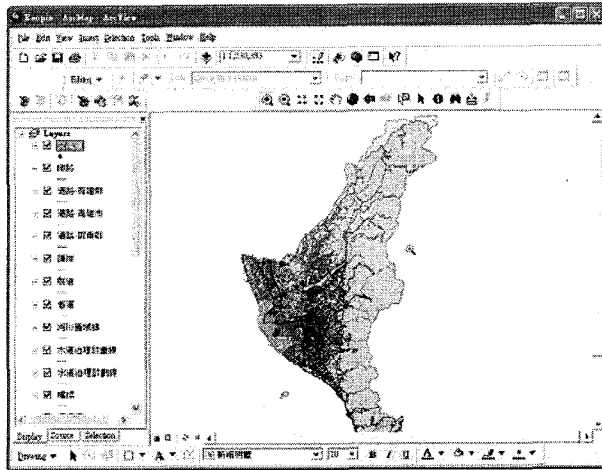


Figure 1. The test area at southern Taiwan shown in 25 layers.

All materials were provided by the valley authority in ArcGIS file format. There are 25 GIS map layers consisting of road, river, county, township, bridge, and watershed. Attributes relevant with trouble spots to be monitoring and patrol routes are also ready for further analysis.

## 2.1 Software

**2.1.1 GIS Software:** ArcGIS 9.1 was used for typical GIS implementations for development of a valley management system. ArcPAD was used for PDA and personal computers GIS implementations. MapObjects 2.3 was used for Visual BASIC.NET and Visual C#.NET computer programming. College students can accomplish their jobs not only with brand-name GIS software but also by their own programming skills.

**2.1.2 Image Information Software:** Remote sensing techniques were implemented in a very simple fashion. Image retrieval, display, and its image attributes inquiry are the basic image information functions provided by a home-made image information system. BASIC components provided by ER Mapper were used in this regard. Image file formats are converted into ECW using free programs provided by ER Mapper (ER Mapper, 2006). Image header is needed for further manipulations to make coordinates information for overlay operations with other map layers. The working procedure to develop an image information system has been performed and published in IGARSS 2006 in Denver (Wu et al. 2006). This paper just followed the same procedure and changed digital images that cover the test area.

**2.1.3 Database Manipulations:** Attributes inquiry and database manipulations are typical MIS operations. Visual BASIC.NET and Visual C#.NET were used for database manipulations. Attributes inquiry, adding record information to an existing database, and deleting any single record can be done in different programs or in the same program.

**2.1.4 Statistical Charts and Table Generation:** TeeChart for PDA is good for automatically generate statistical charts (Steema Software, 2006). Visual C#.NET can be used in this regard. Automatic table generation is good for paper work in management of water resource protection. It can be done by Visual BASIC programming by working with Word objects or Excel objects. (Siler and Spotts, 1998.)

## 2.2 Hardware

Hardware consists of personal computers, PDA, and GPS devices. ArcGIS is used in personal computers and ArcPAD is good for personal computers and PDA. A GPS device can be used with PDA when ArcPAD was ready for use. In this case, a valley management system can be categorized as a mobile GIS.

## 2.3 Database

Database consists of map layers, images, and attributes. Database management can be implemented in Access or Microsoft SQL server. This paper only implements Access for simplicity purpose.

## 2.4 Method

**2.4.1 GIS Software Implementation:** GIS software implementation using ArcGIS and ArcPAD is quite straight forward. Map layers were added or deleted from the menu. GIS functions provided by the commercial software can be arranged to solve a given task such as field patrol to monitor illegal land use and water pollution. Digital images such as satellite, aerial photos, and orthophoto maps can be displayed as background information in ECW file format, both in ArcGIS and ArcPAD.

**2.4.2 MapObjects:** MapObjects is used for computer programming in order to develop one's own small GIS modules for a given task in valley management for water resource protection. MapObjects provides several different computer language versions. This paper used Visual Basic.NET and Visual C#.NET. A step by step working procedure has to be given to overcome programming barrier that a college student may has to face in the computer laboratory.

## 3. RESULTS AND DISCUSSIONS

A valley management system consists of software, hardware, and database. Hardware can be personal computers and PDA. A GPS device can be used for field operations. Digital camera is useful in field patrol for evidence collection. Digital images taking in the open field is good for drafting management prescriptions of water resource protection.

### 3.1 ArcGIS and ArcPAD

Figure 1 shows 25 map layers in a valley management system using ArcGIS 9.1. Figure 2 indicates the same 25 map layers using ArcPAD 7. ArcPAD provides a try version which can work 20 minutes only. A try version is good for college teaching purpose. Every student can have their own ArcPAD copy both in the classroom and their private home.

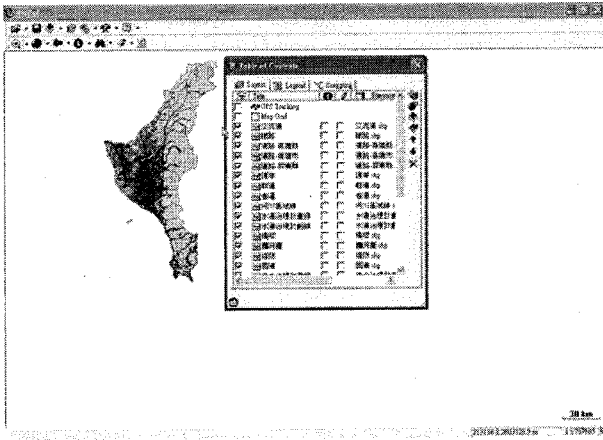


Figure 2. 25 map layers shown in ArcPAD ready for field operations.

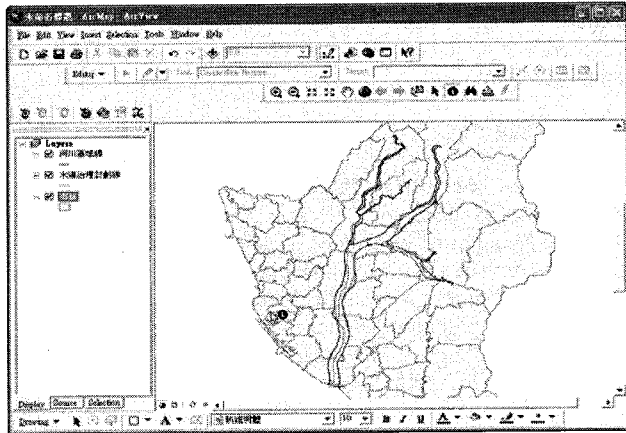


Figure 3. River boundary for water resource protection enforcement.

### 3.2 MapObjects

Figure 4 indicates that AXMAP has been used to display all layers in ArcGIS file format. Taiwan can be the largest background information and several map layers can be added such as township, river, road, bridge and so on. Figures 4 to 6 are three jobs performed by college students enrolled in this class. Figures 4 and 5 used Visual Basic.NET and figure 6 used Visual C#.NET.

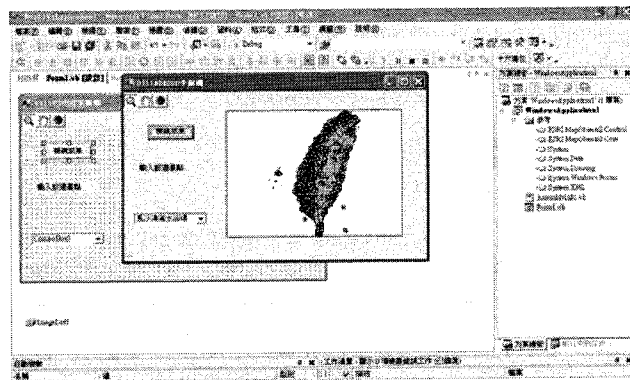


Figure 4. Taiwan and several other map layers were manipulated with zoom, pan, extent functions using Visual Basic.NET.



Figure 5. A small GIS module using Visual Basic.NET.

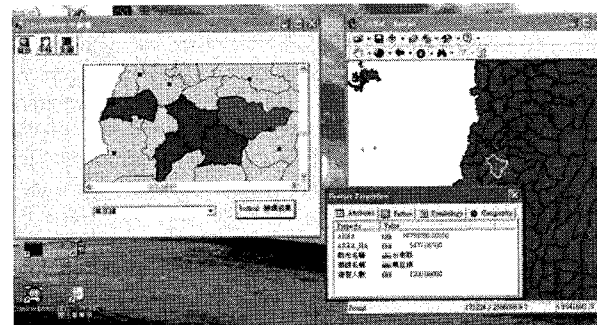


Figure 6. A thematic map indicates township information using Visual C#.NET (left chart) and the same township inquiry in ArcPAD (right chart).

### 3.3 Statistical Charts

Figure 7 is a job done by a college student using TeeChart for .NET in PDA. Visual C#.NET was used (Steema Software, 2006).

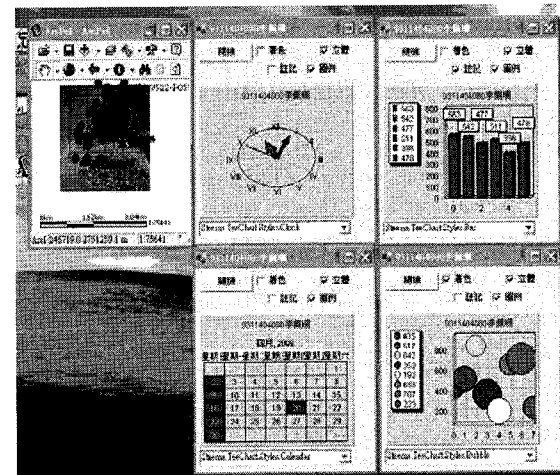


Figure 7. TeeChart to generate statistical charts using Visual C#.NET for PDA.

### 3.4 Discussions

To develop a valley management system using ArcGIS and ArcPAD is not difficult when materials were ready and their format is for ArcGIS. Management prescriptions have to be identified such that a valley management system can be implemented right away. Know-how is quite important in water resource protection especially for daily operations. It consists of water resource management, GIS, and remote sensing. Computer programming training using MapObjects, Teechart for .NET, Visual Basic.NET, and Visual C#.NET would increase productivity of a college student.

The whole process has taken 3 credits in 18 weeks. That means 3 hours every week in 18 weeks for a single semester. Visual Basic.NET and Visual C#.NET are not easy to work with, especially, when one has to work with MapObjects. A step-by-step working procedure was given with Microsoft Word and PowerPoint made it easier for college students enrolled in the class. Every student can modify the working procedure to make some different GIS modules to solve different types of problems encountered in water resource protection.

## 4. CONCLUSION

GIS and remote sensing education in college can be taught separately or simultaneously. This paper indicates how to develop a valley management system for water resource protection. Comparison between DIY and commercial GIS can be made by college students. Functions provided by the developed valley management system depending on how many map layers have been used and what types of MapObjects components have been used. Computer programming experience is not essential but can be helpful for a college student. The whole process is a step-by-step sequence which college students can modify to depict their capability in GIS and remote sensing. The development process has gone through one semester, three hours every week in 18 weeks. College students enrolled in this class entitled with GIS showed remarkable progresses both in GIS and remote sensing.

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