APPLICATION OF WEB-GIS AND VGI FOR COMMUNITY RESOURCES INVENTORY

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Abstract: The objective of this study is mainly to integrate a WebGIS (web-based GIS) and VGI (Volunteered geographic information) in support of community resources inventory. The WebGIS provides simple interface for query and mapping service through the Internet, and VGI encourages more people to participate in the process of data collection and establishment of geospatial database. The research tries to establish a WebGIS platform for community resources management. The system offers some useful analysis tools for geospatial analysis and data management. Major achievements and methodologies used in the study include: (1) utilizing smart mobile device and GPS tracker for collecting spatial data about resources; (2) constructing a GIS geospatial database to integrate data from different sources and volunteered geographic information; (3) using Google Maps/Openlayers API and JavaScript to design a website that provides embedded digital maps in dynamic web pages. By integrating geospatial technologies, this study aims to promote more public participation in resources conservation of a local community.

1. INTRODUCTION

In Taiwan, many remote areas and rural communities are facing with the problems of population decrease, lack of labor and job opportunities, and low average income. Therefore, how to promote the community development in order to improve the livelihood of residents has become an important issue. On the other hand, with the rapid economic development and improvement of living standards, people tend to pay more attention to leisure and recreation, and thereby the tourism industry flourishes increasingly. As a result, many communities endeavor to develop ecotourism so as to fully utilize the natural, cultural and scenic resources, and at the same time minimize possible impacts to the ecological environment. Since Taiwan Forestry Bureau started the “Community Forestry Initiative” in 2002, hundreds of communities had participated in the program, and most of the communities focused on developing ecotourism (Chen and Lin, 2006).

With the rapid development of information technology in recent years, abundant information can be quickly accessed through the internet, including free electronic maps and satellite images such as Microsoft Bing Maps, Yahoo Maps, Google Maps, and Google Earth. With the help of computer networks and spatial information technologies, the visitors can know the resources of the community through the internet, and the community residents can participate in the planning process, which will be helpful for developing ecotourism of the community. Particularly, a well-designed website with rich content and dynamic graphics and maps are found to be effective media for promoting the communities (Seeker et al., 2002; Qiao et al., 2009). In order to reduce costs and increase efficiency, this study used open source software tools to develop a website management system for rural communities. The objective of the study were to integrate volunteered geographic information (VGI), collected by tourists and community residents using GPS logger and mobile devices, with the other maps and software tools to provide valuable information in support of community development.

2. MATERIALS AND METHODS

2.1 Study Site

The study site of this research is located in southern Taiwan. Da-Nei District, with a total area of 9200 ha, is a rural area under the jurisdiction of Tainan City. Chi-Shi community is part of Da-Nei with a population of less than 800 people. The community is situated among rolling hills, and the residents mostly are engaged in agricultural production. Figure 1 shows the location of the study site.

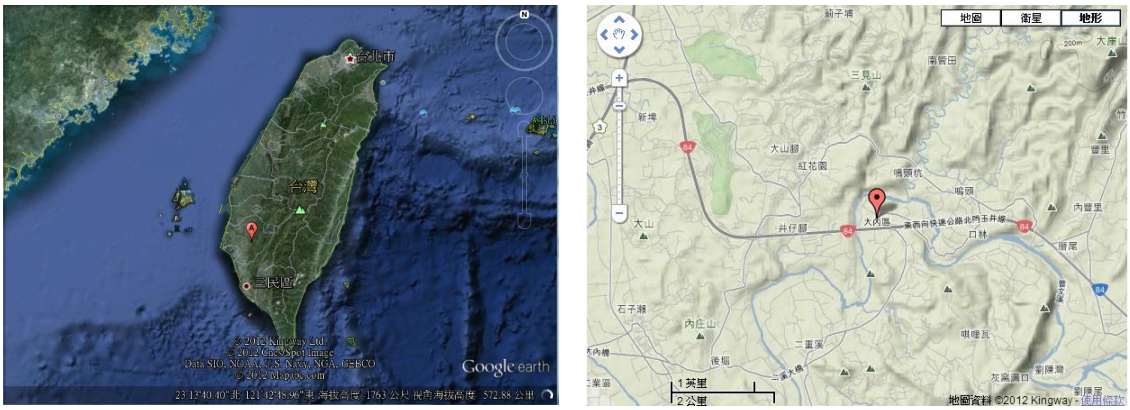


Figure 1. Location of the study site.

2.2 Data Collection

The study employed the VGI (volunteered geographic information) method to collect field data about various aspects of the community, including the distribution of natural resources, cultural highlights, scenic spots, fauna and flora, and trails. The community residents were equipped with a GPS logger and a digital camera for recording GPS coordinates and images as they traveled along the trails and points of interest. The GPS logger has a built-in memory capable of storing up to 250,000 waypoints recordings, and can be configured to record data at different sampling rate, which is convenient for different traveling methods (Figure 2). The GPS waypoints and digital photos were then matched by using a phototagger software to automatically produce a map showing where the pictures were taken on Google Maps. The software can also convert the data into standard Google Earth format for further processing or distribution of the field data (Figure 3). Besides the community residents, visitors can also share their traveling experiences by submitting waypoints and photos to the website established for this study. By incorporating the volunteered information contributed by community residents and visitors, we can build a database with relatively low costs and high efficiency.

Figure 2. The GPS logger used in the study.

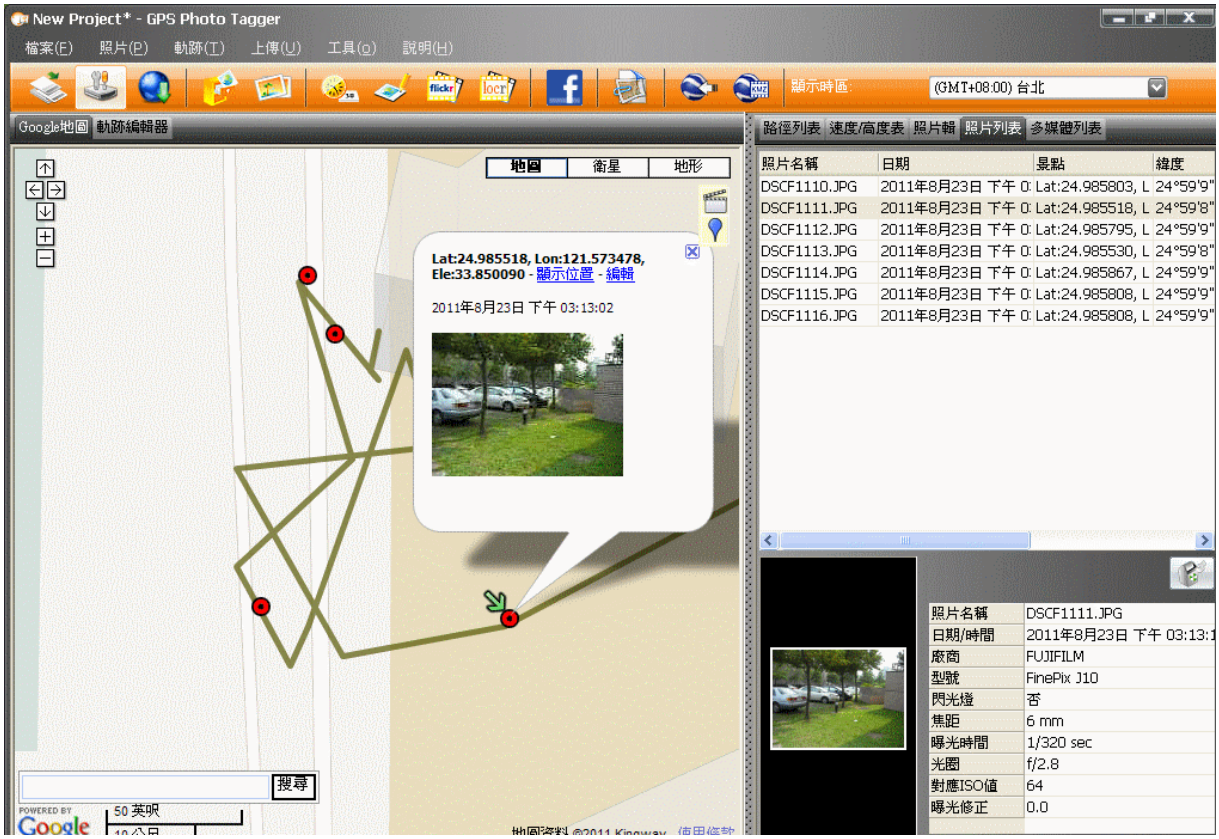


Figure 3. Automatic matching of waypoints and photos using phototagger software.

2.3 Building a Web-based GIS for Resources Management

GIS has been proven an effective tool for a variety of applications in wide range of disciplines. Particularly, GIS techniques are very useful for resource mapping and planning for applications on tourism and recreation, and forest conservation and natural resources management (Mbile et al., 2003; Tremblay, 2005). This research aims to develop a web-based GIS platform that can be used by communities for ecotourism planning. Considering the costs for developing and maintenance, we used open source software to develop tools for data processing, database management, querying, display, and analyses. Specifically, the software used in the study included QGIS (Quantum GIS), OpenLayers, PostgreSQL, PostGIS, and GeoDjango.

3. RESULTS

3.1 Community Resources Inventory

The Chi-Shi community has participated in the Community Forestry initiative for several years. Major income of the community residents are from selling agricultural produce such as papaya, guava, mango, and avocado. Besides the daily farming works, the community residents also help the Forestry Bureau by patrolling protection forests to prevent wildfire, dumping of industrial or domestic wastes and toxic chemical wastes, and illegal logging. In recent years, the community residents formed an organization to promote ecotourism hoping to preserve environmental resources as well as increasing economic benefits for the residents. The community organization had initiated numerous programs to investigate the resources of the community, including plants, animals, cultural heritage, and scenic landscape features. To raise public awareness of invasive alien species and their impacts to the environment, the community organization had held several activities and programs, from which many residents and young students learned the importance of environmental protection and measures to remove invasive alien species. By using GPS logger and smart mobile devices, while the residents only had little training, the data collection and manipulation procedure was simplified, and the quality of data was found quite acceptable. The field data were processed using a phototagger software to produce maps showing the distribution of various resources. The software uses Google Maps as the base map, and it provides utilities for editing data, adding descriptions, and converting data to Google Earth KMZ format (Figure 4).

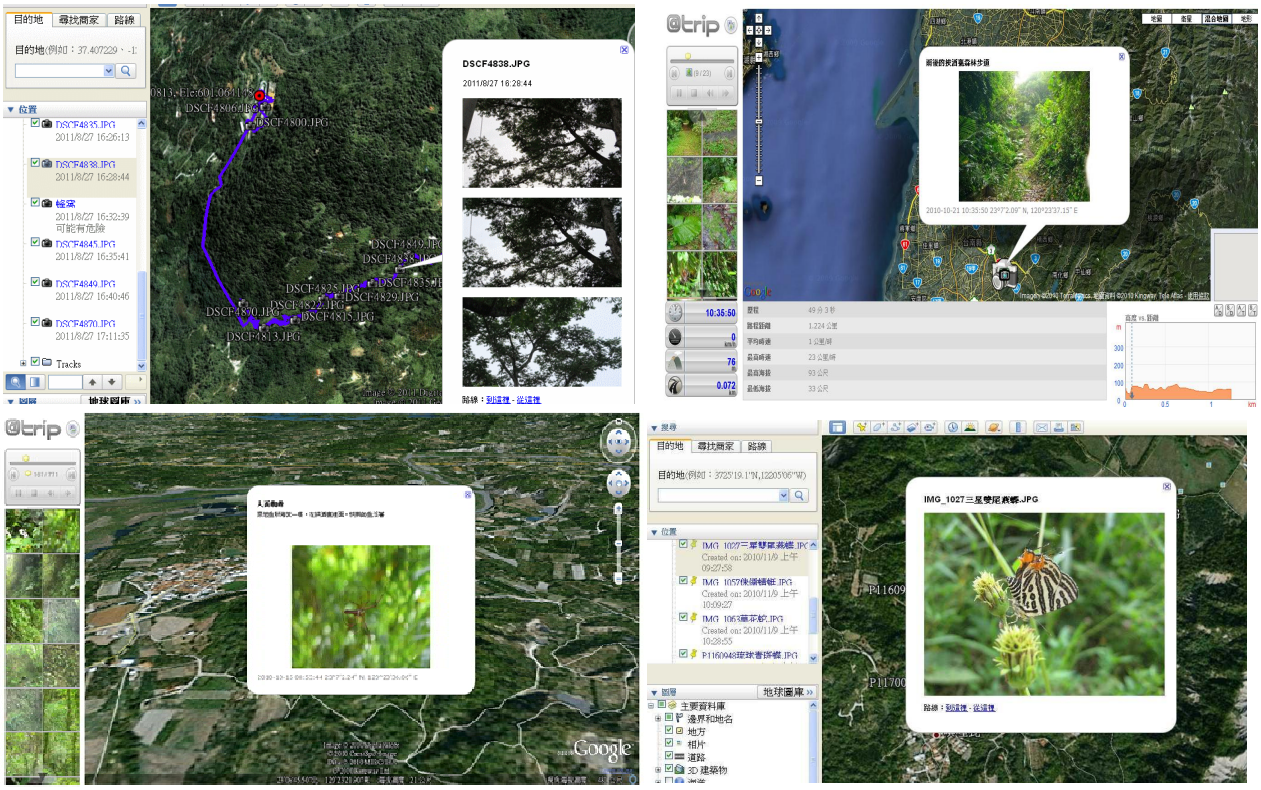


Figure 4. Results of community resources inventory using GPS logger and digital camera

3.2 Establishment of Spatial Database for Community Resources

QGIS (Quantum GIS) was used in this study for editing data, adding attribute data, overlay analysis, and producing various thematic maps. Unlike commercial GIS software such as ArcGIS and Mapinfo, QGIS is an open source software freely available for all purposes. We chose QGIS not only because of budget limitation, but also it provides many features, tools, and flexibility for customization and extending its capability for the purpose of this research. In addition to the field data of community resources, the study collected a variety of spatial data such as administration boundary maps, river and basin, roads, compartments and working circles of Forestry Bureau, protection forest, topographic maps, landuse maps, and orthoimages. All of the data comprise the geodatabase for the community, and the PostgreSQL software was used to store the database (Figure 5).

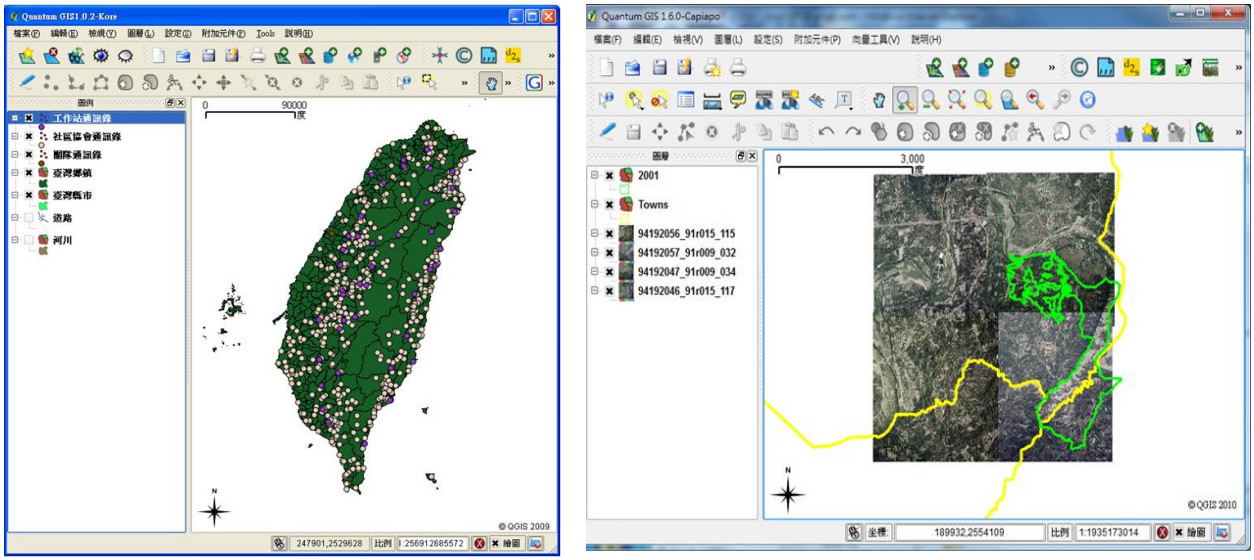


Figure 5. The distribution of communities participated in the Community Forestry Initiative, and the study site.

3.3 Establishment of the Web-based GIS platform

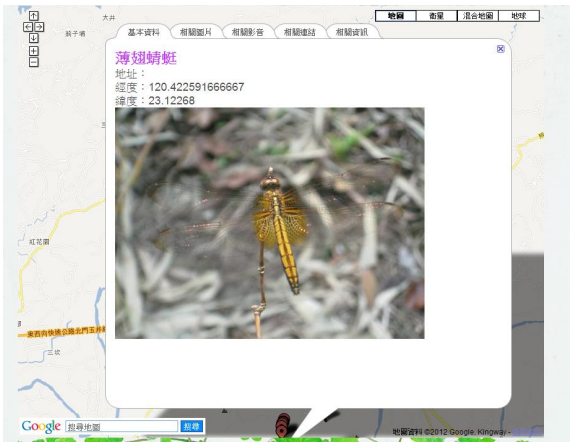
In view of the convenience and popularity of the Internet, this study hopes to convey useful information through web pages in order to promote ecotourism for the Chi-Shi community. Therefore, we built a website using the Django web framework along with Apache web server, and PostgreSQL database server. The website management system allows the administrator of the website to manage and publish web pages dynamically. Moreover, the JavaScript language and API (Application Programming Interface) of Google Maps and OpenLayers were used to incorporate dynamic maps into the web pages. The Google Maps and OpenLayers API provides a variety of tools for manipulating maps using regular web browsers such as Microsoft Internet Explorer, Google Chrome, and Firefox. In addition, the website provide searching tool so that users can inquire data more efficiently, and route planning tool by using the Google Maps API. Thereby the tourists can plan ahead before visiting the community. If the visitors want to share their traveling experiences, they can submit Google Earth KML (Keyhole Markup Language) files to the system through a web page. To avoid erroneous data and insure data quality, the system employs a double-checking mechanism to validate the data submitted by tourists.

Through the website, the community organization can publish web pages to introduce all kinds of resources and make announcements of special events and activities that may draw attention from tourists. The website also serves as a platform for exchanging ideas and opinions about important issues of the community development among the residents. In general, the website can incorporate volunteered geographic information contributed both from the community residents and tourists. It also facilitates public participation in community resources inventory, as well as planning and decision making on future development of the community. Besides, a section of the web pages introduce a range of cultural heritages, the process of growing various fruits, natural resources and unique landscape features, invasive alien species and natural conservation concepts, which are valuable for environmental education.

(a) the website of the community

(b) the web page shows information of cultural heritage

(c) the search tool for the resources of community



(d) the result of resource inquiry

Figure 6. The web-based GIS platform of the Chi-Shi community.

4. DISCUSSION

The GPS logger used in this study is very cost effective, however, it can only record coordinates of waypoints and lack of functionality for displaying measurements at the time of data collection. All the raw data have to be processed and manipulated after the field works are finished. Therefore, it is impossible to find if there are defects in the GPS device or poor data quality while working on the fields. On the other hand, smart mobile devices such as tablet PC, PDA (personal digital assistant), and smart phones are capable of showing maps and much more information about the field data. Nevertheless, the costs for procuring such devices and the complexity of using these devices in rural environment may cause more limitations than benefits for this type of application.

Currently most applications that employ embedded mapping techniques in web pages use JavaScript and Google Maps/Earth API to interact with the Google Maps/Earth server. The advantages of this method include fast response time, global coverage of the earth, free or low cost, and ease of use. However, the users of the free version of Google Maps/Earth are limited by accessible data volume, low image quality and update frequency in remote areas, availability of the other map layers, and lack of spatial analysis functionalities. This study demonstrates that open source software can be used to develop web-based GIS application systems that incorporate the Google Maps/Earth and OpenLayers. However, it requires more training and software programming skills in order to harness the power of these tools as compared to using off-the-shelf commercial software packages.

5. CONCLUSIONS & RECOMMENDATIONS

This study utilized open source software tools to develop a web-based GIS (WebGIS) platform for a rural community in Taiwan. The WebGIS in an integrating system and analysis tool for managing community resources inventory data collected by the residents of the community as well as tourists. It appears that VGI (Volunteered geographic information) is a valuable source for data collection, however, it is recommended to employ validation measures to avoid erroneous data and insure data quality.

The WebGIS is a useful tool for the community to draw more attentions from tourists. By providing convenient tools for query and mapping service through the Internet, the system encourages more people to participate in the process of data collection, thereby the geospatial database of the community resources can be established more thoroughly and efficiently. Additionally, the WebGIS can serve as a platform for exchanging ideas and opinions about important issues of the community development among the residents. Consequently, we conclude that a well-designed WebGIS can facilitate public participation in community resources inventory, as well as planning and decision making on future development of the community.

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