

BUILDING AN OPEN SOURCE WEBGIS FOR FOREST DYNAMICS PLOTS

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ABSTRACT: The objective of this study is to build a WebGIS for forest dynamics plots in Taiwan. Forest dynamics plots (FDPs) are characterized by large plot size and standardized procedure for field data collection. A total of 13 FDPs with areas larger than 1 hectare have been established in Taiwan, among them the 25-hectare Fushan site is the largest. Every tree within these plots were sampled, and the species name, location, height, and DBH were recorded. The census of tree samples in the FDPs is done every five years, which result in a huge tree database valuable for scientists of various disciplines. As a pilot study, this study utilized a combination of open source software, i.e., PrimaGIS, Plone, and Zope, to build a WebGIS (web-based geographic information system) for the Fushan FDP in Taiwan. The WebGIS provides easy

access for tree database and integration of various spatial and attribute data from different sources. In addition, by overlaying the tree data with satellite images, aerial photos, and a variety of thematic maps, the WebGIS can help the scientists address research problems on more solid scientific basis.

1. INTRODUCTION

The Center for Tropical Forest Science (CTFS) program of the Smithsonian Tropical Research Institute (STRI) consists of a network of large-scale Forest Dynamics Plots (FDP) including 18 sites in 15 countries. The CTFS program is unique because each plot uses a standardized sampling methodology, which allows scientists to directly compare data collected at different sites. Using data from the network of field sites, the scientists can understand the forest diversity and change in Asia, Africa, and Latin America (CTFS, 2006). In 1989, researchers from Tunghai University and STRI initiated a 3-ha Forest Dynamics Plot in Najenshan Nature Reserve, Taiwan. Since then, with the joint efforts of many researchers from different institutions, a total of 13 Forest Dynamics Plots were established in Taiwan (Fig 1). Among these plots, the Fushan Nature Reserve site is the largest with an area of 25 hectares (Sun, 2006; Hsieh, 2006).

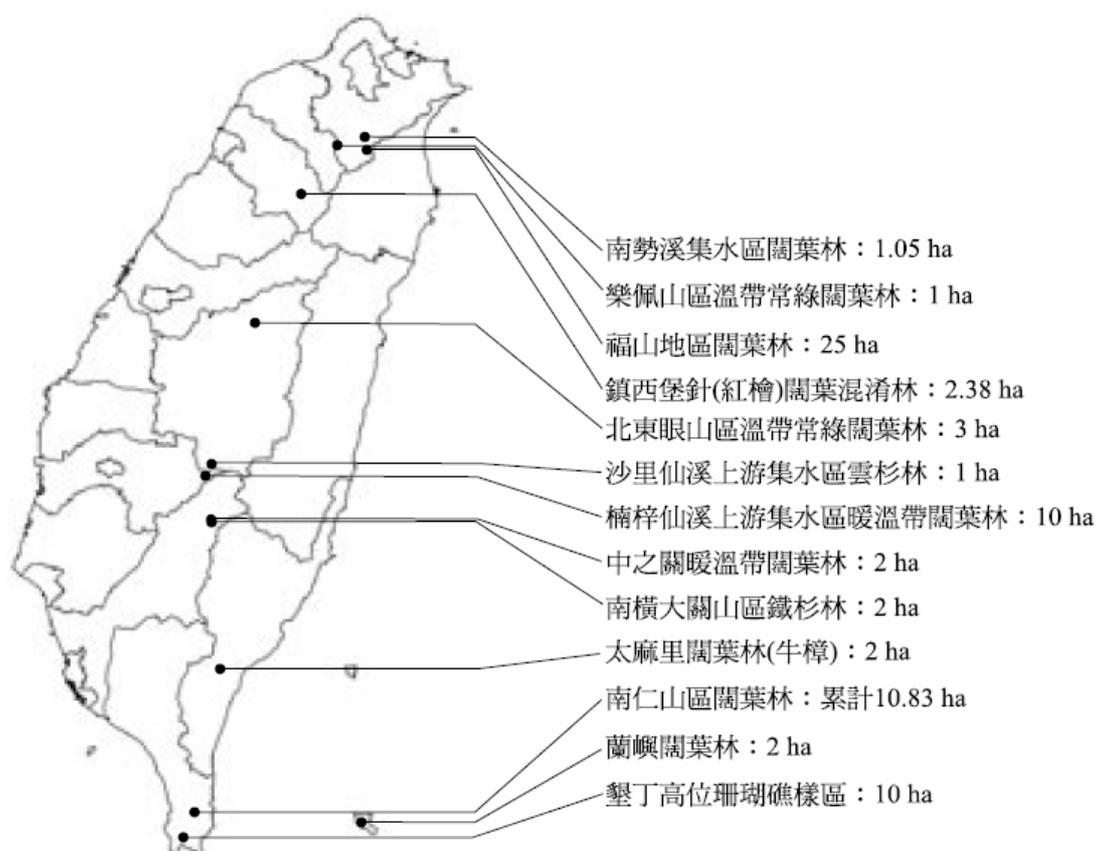


Fig 1. The Forest Dynamics Plots in Taiwan (Hsieh, 2006)

The data collected at different FDP sites form an invaluable database for forest related studies and regional forest management. Furthermore, the database provides ground truth data that are required for large-scale forest inventory using remote sensing data such as satellite imageries, aerial photographs, radar data, and LiDAR (**L**ight **D**etection **A**nd **R**anging) data. By integrating remote sensing data and field data collected from Forest Dynamics Plots with other geographical data such as topographic maps, soil maps, terrain data, and forest types, the scientists can address various problems from different perspectives at a broader scale. However, the field data must be registered to a coordinate system common to the other relevant data. To obtain a low-cost and robust system that can support the scientists of various disciplines, this research utilized open source software to establish a WebGIS (web-based geographic information system) for the FDP site in the Fu-shan Nature Reserve.

2. MATERIALS AND METHOD

2.1 Study area

The Fushan FDP was initiated in 2002. This site is located near the Fusan Experimental Forest, which is managed by the Taiwan Forestry Research Institute (TFRI). The experimental forest is located at 24°46'N, 121°43'E. Among all the FDPs in the CTFS global network, the Fushan FDP has the highest latitude. The elevation of the experimental forest ranges from 400 to 1,400 meters with a total area of 1,097 hectares. The annual mean temperature is 20°C, and the annual mean precipitation is 2,900 mm (TFRI, 2006).

2.2 Data

2.2.1 Vector data: Topographic maps and soil maps were obtained for the study area. These maps show soil characteristics and various topographic features of the study area, which include streams, roads, contours, and forest types.

2.2.2 Raster data: Digital orthophoto maps and satellite imageries were used to identify the land cover types within the study area. Digital elevation model (DEM) are useful for understanding the terrain relief of the study area. In addition, environmental factors such as aspect, slope, and curvature can also be derived from DEM.

2.2.3 Field data: During 2003-2004, the research team of the 25-hectare Fu-shan Nature Reserve FDP site completed the first census of the trees within the site. Based on a standard protocol followed by all the FDP sites of the CTFS program, every tree with DBH (diameter at breast height) larger than 1cm was measured and tagged. The species of each tree was identified, and the DBH and location of the tree was measured. A total of 114,508 trees was recorded,

which belong to 110 species. In addition, a total of 1,705 ground points within the FDP were sampled, and the elevations of these points were measured using a total station. These ground points were used to construct a TIN (triangulated irregular network) model and subsequently a 1-meter DEM (digital elevation model) were derived from the TIN model.

2.3 Methods

The main objective of this research is to establish a WebGIS for the FDPs in Taiwan. Although all the FDPs follow the same protocol to collect tree censuses, the field data are maintained by researchers from different universities or research institutes. Therefore, integration of the field data from different FDP sites are complicated because different software and database systems are used among the researchers. Another obstacle for data integration is lack of common coordinate system for all the field data.

In order to create a low-cost and easy access system that is available for all FDPs stie, this research used open source software to design all the software components. Major software used in this research include PrimaGIS, Plone, and Zope. All software run on Linux operating system installed on an IBM compatible personal computer.

3. RESULTS

PrimaGIS is a web mapping application for Plone, a content management system built on the Zope application server. In addition, several software are required to support the functionalities offered by PrimaGIS. Due to deep dependency in the software configuration, it is difficult to setup a functional system. This study follows a much easier procedure to install all the required software components, i.e., the 'PrimaGIS Buildout' method by Lautaportti (2007) and SEA_RLC (2007). Zope is an application server for building web portals (Latteier et al., 2002). It has a built-in object database and numerous tools which make it ideal for developing a system that can manage field data of the FDPs as well as web contents. Fig. 2 shows the management interface of Zope.

Plone is a content management framework providing website managers with easy access tools to maintain and publish web pages (McKay, 2004). PrimaGIS enables spatial content types to be managed within the Plone framework. Together they provide users with friendly interfaces and tools for publishing spatial data from different sources, including shapefiles, PostGIS, rasters, WMS, WFS (Hänninen, 2006). Fig. 3 depicts tree samples within the Fushan FDP, with selected species shown in light-blue color.



Fig. 2. Management interface of Zope

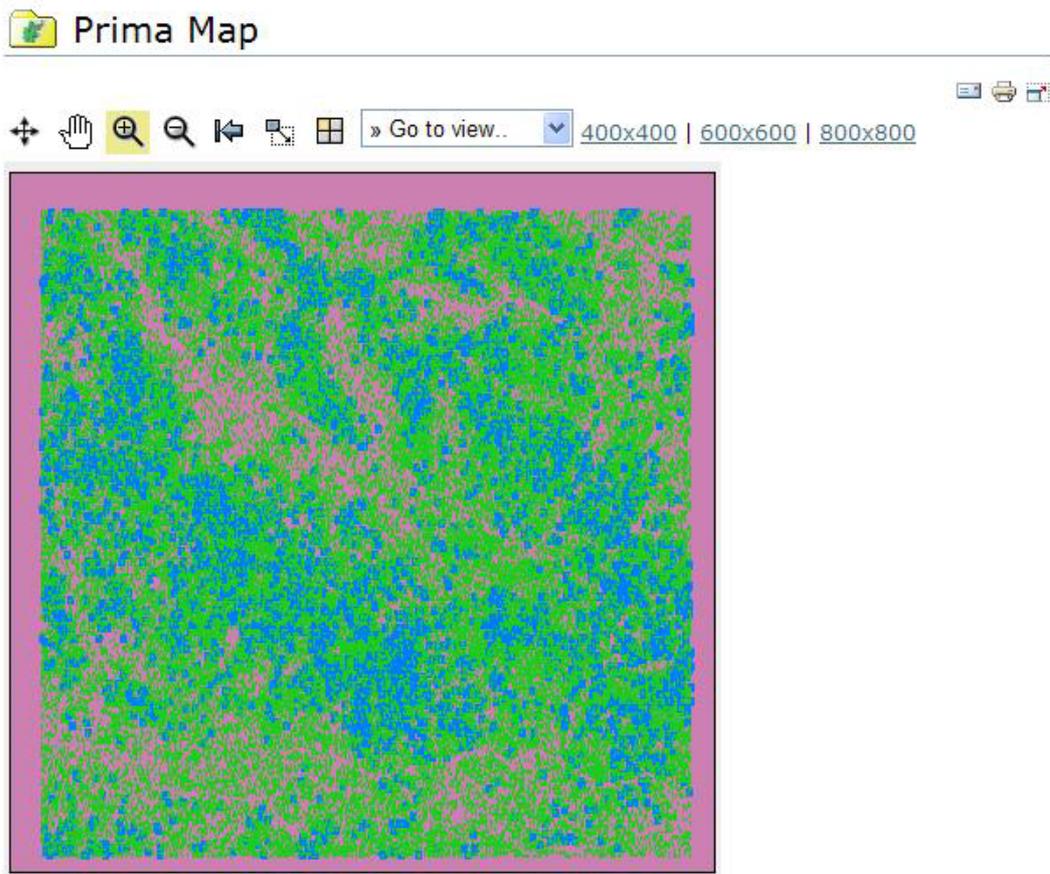


Fig. 3. The map of tree samples within the Fushan FDP, with selected species shown in light-blue color.

4. CONCLUSIONS

The PrimaGIS/Plone/Zope combination provides ease of use interface for publishing spatial contents through the internet, which is very convenient to establish a WebGIS for various applications. The results of this research show that it is feasible to create a low-cost WebGIS with minimal amount of efforts. With built-in object database and versatile application interface, the Zope system also allows users to develop sophisticated system to manage web contents, including spatial data and attribute data. In this pilot study of Fushan FDP site, the field data of FDP and various spatial data can all be integrated and managed by one system. Further research will focus on developing applications that can incorporate data of various sources from all the FDP sites in Taiwan.

5. ACKNOWLEDGEMENT

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