Developing Internet-GIS for Environmental Management in Mekong Delta (Vietnam)

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Abstract

The objective of this paper is to introduce the Internet-GIS approach, analyse the needs and demand of the project and generate a complete Internet-GIS application based on UMN Map Server and kvwmap for flood control and socio-economic development in Mekong Delta area of Vietnam. This paper reviews and discusses the current development of Internet-GIS as well as its future, suggested Map Server and kvwmap for the development of Internet-GIS application for environmental management. The application has been developed in PHP and Java Script and databases have been created and managed by MySQL and PostgreSQL. An Internet-GIS application has been created with different functions such as: basic functions, navigation functions, layer functions, editor functions, query functions, digitizing functions, print functions, import/export functions, data management and work flow functions, collaborative work functions, advanced analysis functions, etc. The application can switch between 3 languages: English, German and Vietnamese. The authors have created a complete Internet-GIS application including geospatial database which is divided into 5 groups: Topography, Digital Elevation Model (DEM), Land use; Hydrology system; and Remote sensing data.

Keywords:

Geographical Information System, Internet-GIS, Web GIS, Mekong Delta, Vietnam

1.   Introduction

The Mekong River starts from the Tibetan highland plateau and runs through China, Myanmar, Laos, Cambodia and South Vietnam and flows out into the South China Sea. The deposition of its 9 mouths, tributaries and tentacles formed a vast delta. The Mekong Delta is one of a part of that delta and locates in southwestern Vietnam. It encompasses 13 provinces: Long An, Dong Thap, An Giang, Kien Giang, Ca Mau, Soc Trang, Bac Lieu, Can Tho, Vinh Long, Tra Vinh, Ben Tre, Tien Giang and Hau Giang and accounts for 5% of total downstream area of Mekong River (of about 39,000 km²) that plays an important function to the sustainable socio-economic development of the country. Today, the region is one of Vietnam's highest producers of rice crops, vegetables and fruits.

From a technical point of view are there enough techniques to provide geospatial information about resources and environmental issues in that region as well as in other parts of the world over the Internet, see

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Korduan, P. Zehner, M.L. (2008). A common problem especially in developing countries is the availability of appropriate geospatial data.

The Remote Sensing Center of Vietnam, under the Ministry of Natural Resources & Environment, is responsible for collecting that data. The data are originally in common GIS data formats, such as ESRI Shape Files and GeoTIFF, so they can be used in common GIS Software like ArcGIS. In this project, data should be provided for a wide range of applications and analyses. Users should have access through a standard internet browser. Therefore an Internet-GIS solution is used.

Fig. 1: Vietnam and Mekong River

There exist many different Internet-GIS solutions. For a developing country such as Vietnam it is advantageous to use open source software, so we decide to use UMN-MapServer based technology. The Remote Sensing Center and Research Center for Environmental Monitoring and Modeling, Hanoi university of Science (Vietnam National University, Hanoi) have cooperated with the University of Rostock (Germany) in developing such an Internet-GIS. The Institute for Management of Rural Areas, Rostock University, has many years of experiences in development of Internet based geospatial solutions and was also involved in international projects. Staff members of this Institute actively develop the Internet-GIS solution for municipalities kvwmap , which is used in different districts in Germany. We describe in this article how kvwmap is used to provide the Mekong Delta geospatial data, how the system is managed and how the multilinguality is adopted, see section 3.7.

2. Theoretical and technical issues

The Internet-GIS for this project is implemented with the software kvwmap. kvwmap is an Internet-GIS development framework based on Open Source Software. The core of this software is a PHP script, which

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provides the client, including maps and thematic information as well as connections to databases holding information about user settings and the geodata.

Maps are produced by the UMN-MapServer. With this, all GIS data formats supported by the GDAL and OGR data access libraries are readable. The data used for user authentication and authorisation, map configuration settings and access log are stored in a MySQL database. The vector data of the Mekong Delta project are integrated as ESRI shape files and stored in a PostgreSQL database with spatial extension PostGIS (these vector data can be editable through the kvwmap editor). This application runs in common web browsers such as Internet Explorer or FireFox. To support vector graphics, kvwmap uses Scalable Vector Graphics (SVG), meaning that some browsers require an additional Plug-In.

3. Developing Internet-GIS for flood control and socio-economic development in Mekong Delta

3.1 Motivation and project introduction

The Mekong Delta is often covered by seasonal flooding. In the rainy season, all the rivers flood. Flooding in the Mekong Delta is "well-known". Recent examples of large floods (1961, 1966, 1978, 1984 and 1991, 1995, 1996) have seen hundreds of thousands of hectares of crops destroyed. The losses from water disasters in the Mekong Delta are large. Every year, many people die, and the damage to property costs millions of dollars (Dang Quang Tinh 2004). In order to control and prevent loss of people and property from floods in the Mekong Delta and follow the policy of the Vietnamese Government "Live along with flood", the Vietnam Remote Sensing Center has been appointed to be the host agency of the project "Establishing database of hydro-topographic information system for flood control and socio-economic development in Mekong Delta" since 2004.

The main objective of the project is building a Multi-purpose Base Topography-Hydrology Information System for Mekong Delta (MBISM) for monitoring, controlling and warning of floods as well as proposing flood preventive measures annually. It can be used as a tool for planning socio-economic development, natural resources and environmental management including land used, territory management and administrative management at different levels in the region. The detailed objectives are: (i) creating a MBISM including main layers with are capable of solving problems of flood prevention, supporting socio-economic development of the region; (ii) creating a database management system to storage, update, achieve data for prevention and warning of flood as well as provide exact data when is required.

The products of the project includes topographical maps at a scale of 1:5000 in Vietnam National projection VN – 2000 (contains 5 layers: hydrology, transportation system, residential area, land cover and administrative boundary); DEM with precision of 0.10 m for typical and important objects such as dykes, irrigation systems, transportation system, etc., 0.20 m for floodable areas and 0.40 m for other areas; Land use thematic maps; Hydrology system; Remote sensing data system for correcting the base maps and monitoring the changing of environment and natural resources before and after the flood. The MBISM should be a Dynamic GIS, a spatiotemporal model, a decision support system for flood prevention and can be integrated with other database systems at a national level as well as at the regional level. Outcomes of this project also include a software system that not only allows users to operate this database system effectively in the traditional way (query, collect, create new data as well as distribute products of the project) but also allows multiple users to use the same data at the same time via an intranet and/or the internet in a safe and high secure manner. It is a good opportunity for us to apply Internet-GIS technology for managing such a database, the outcome of using Internet-GIS will make a great contribution to flood control and socio-economic development in Mekong Delta.

In the first phase, the Internet-GIS application was created mainly for viewing the collected data of the project. Some basic functions of an Internet-GIS application (zoom, pan, search, measure, etc.), Layer Manager, Task Manager, User Manager, Print, etc have also introduced. Beside, generic layer editor has also been introduced to allow specified users to edit data, add new or delete datasets online that meets the requirements of the project.

The next phase will establish a completed database for storage, update, achieve all data have been collected, provide tools of a fully work-out Internet-GIS, it will be capable of being developed and extended to meets all demands of the users in the future, being used as a decision support system to help user to make decision for online management of natural resources and environment (e-government).

3.2 Development of Internet-GIS application for environmental management in Mekong Delta area

The application is cross-platform and runs on a Windows operating system as well as UNIX-based Systems such as Linux. The following free software is used in the application:

- UMN Map Server for Windows: internet Map Server (www.maptools.org)
- KVWMAP: configuration tools and client application (www.kvwmap.de)
- PostgreSQL: PostGIS Geodatabase (www.postgresql.org)
- MySQL: user data (www.mysql.com)
- phpMyadmin (www.sourceforge.net)
- PDFClass (http://www.ros.co.nz/pdf)
- Image Magick (www.imagemagick.org)
- GhostScript (www.sourceforge.net)

The pre-defined MySQL database was changed and 41 tables were created. For security reasons, a password is required to prevent illegal access to the database. The development of the database was done by importing from existing ArcGIS and MicroStation databases. In the following section we describe some functions implemented with kvwmap.

The Thematic group includes: vegetation (land cover), transportation, population, boundary, and contour layers. The Topography group includes: topography, Mekong Delta and World Map layers. The Hydrology system group includes all hydrological system of the area. The Remote sensing data includes all aerial image of the study area. The Digital elevation model includes DEM and Hillshade layers.

The data of geospatial database such as surveying data, topographical, geographical and meteorological data are used as inputs of mathematical models (MIKE and HERAS) for forecasting flood. The application will use spatial analyst functions to analyze the outputs and produce integrated maps, flooded maps and flood warning maps that help decision maker to control and prevent flood, support social-economical development process of the reagion. The information on flood generated by this web-based application is divided into administrative and public groups. The administrative information, directly support for Ministry of Natural Resources & Environment to control and prevention flood. The public information provide information for public, especially for local communities.

3.3 Digital User Rights Management

The system can be used by multiple users at the same time. This is inherent in the client-server architecture, with communication via the HTTP protocol. A user can use the system in a specific role, see Figure 2. Login and Role selection. After client authentication the user must choose a task in which they will work and the system then provides the specific interface for this role. User, role and task have appropriate

properties in the data model, allowing relevant permissions to be assigned, e.g. a data administrator must have more permission, than a common user.

   The application was developed originally for municipal administrative tasks with spatial context. This recognises the fact that an official may have different tasks, and needs predefined sets of spatial data for each task. Additionally, a person may work in more than one position. The interface properties for a user are task-independent (e.g. screen size), whereas the properties related to the task are strong for all user in this task. (e.g. which data is presented to them). Multiple users may carry out the same role in the same position but have personalised interfaces. In this research 3 tasks have been created for Administration, Mekong Delta and Kien Giang province, one of the provinces of Mekong Delta.
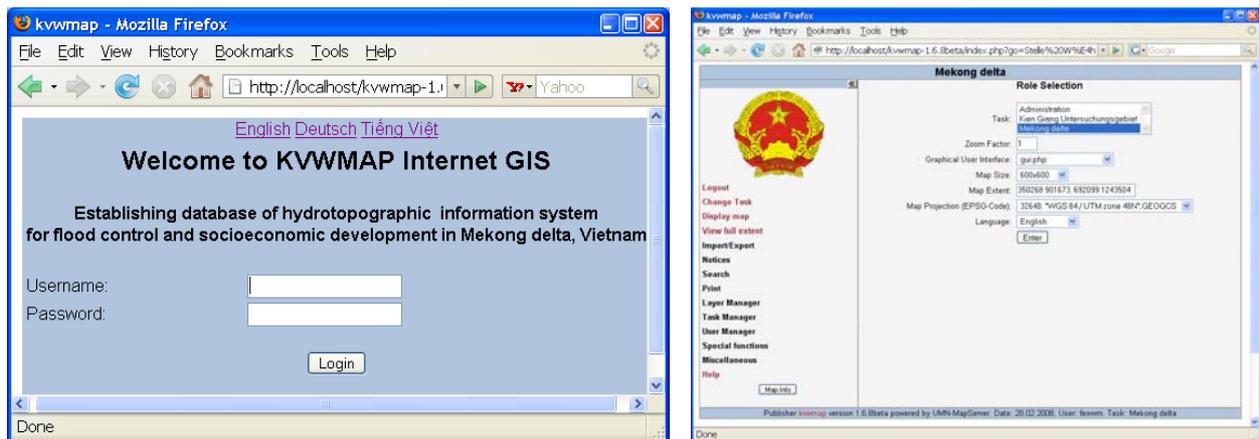
Fig. 2: Login and Role selection

3.4 Graphical User Interface

The graphical user interface GUI is divided in four parts. In the header section a title describes the current selected task. In the footer section the user name, role, publisher and copyright information are located. The middle section shows a menu bar on the left side and a main section. The menus leads to different use cases in this program, such as administration, full extent, role selection, login, comments, printing, export and others. The menus are collapsible. The main section is in most cases filled by the map and a legend. The mapping area includes buttons for the user interaction functionality such as zoom, pan, search and measure. In this main section also thematic information are presented (if search functions was used) or forms for data manipulation and input are loaded. The layer switcher bar right beside the map shows which layers are currently visualized, see Figure 3. The layers are grouped together in thematic categories. The classes of vector based layers are described with a legend. This legend, used also as layer switcher, can be switched off and the groups are collapsible. The map projection used is UTM zone 48 north. With the selection of the role the projection can be changed. Also the size of the map and the language can be selected by the user.
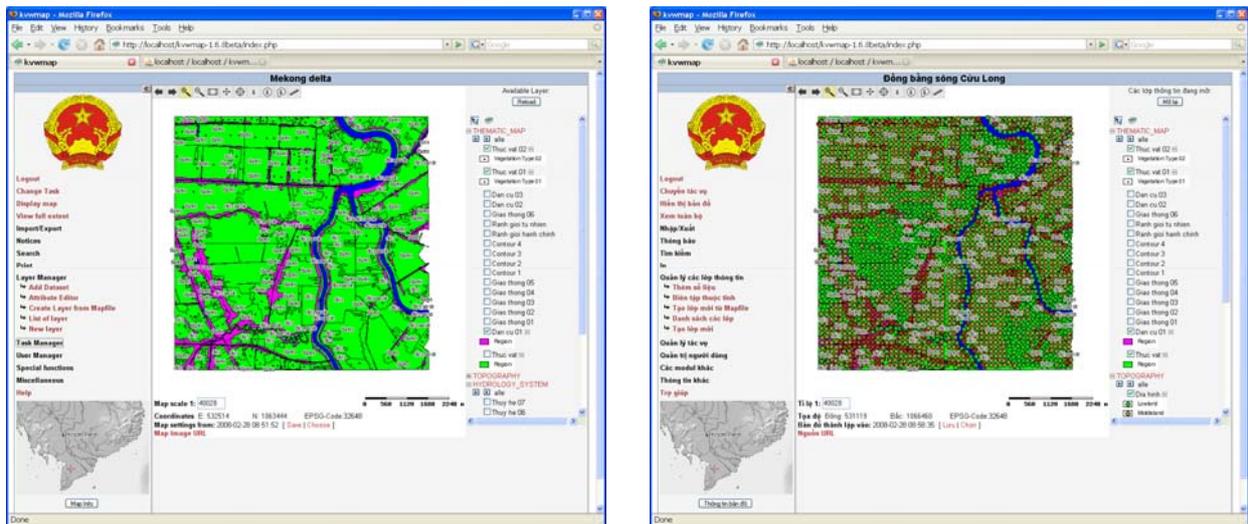
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Fig. 3: Turn on/off layers

3.5 Administration

Due to all map and user settings being stored in a database, all settings can be changed with an internet based database client. Some frequently used management functions such as adding a new user or data layer, copy a task and assign new menus or change permissions to single attributes are integrated in the GUI of kvwmap. Some single settings must be done direct in the database. The application is under permanent development.
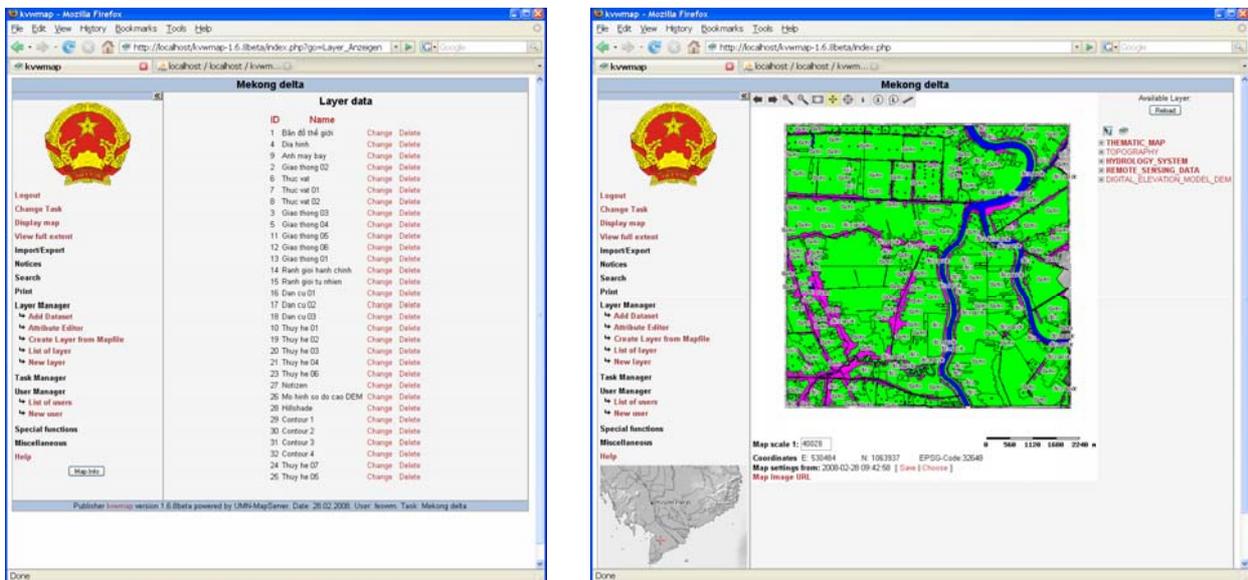

Fig. 4: Layers and Layer groups

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Additional management functions are currently being integrated in the GUI of kvwmap. We have used Layer Manager to create the Internet-GIS database of hydro-topography in Mekong Delta which were divided in to 5 layer groups, i.e. Thematic maps, Topography, Hydrology system, Remote sensing data and Digital elevation model, see Figure 4, create and change task by using Task editor in Task Manager, see Figure 5.

Kvwmap also can be used to collect metadata compatible to the ISO Standard 19119. Therewith each layer can be provided as an OGC conform Web Map Service (WMS). The application enables the user to search for data in a spatial, temporal and thematic context.
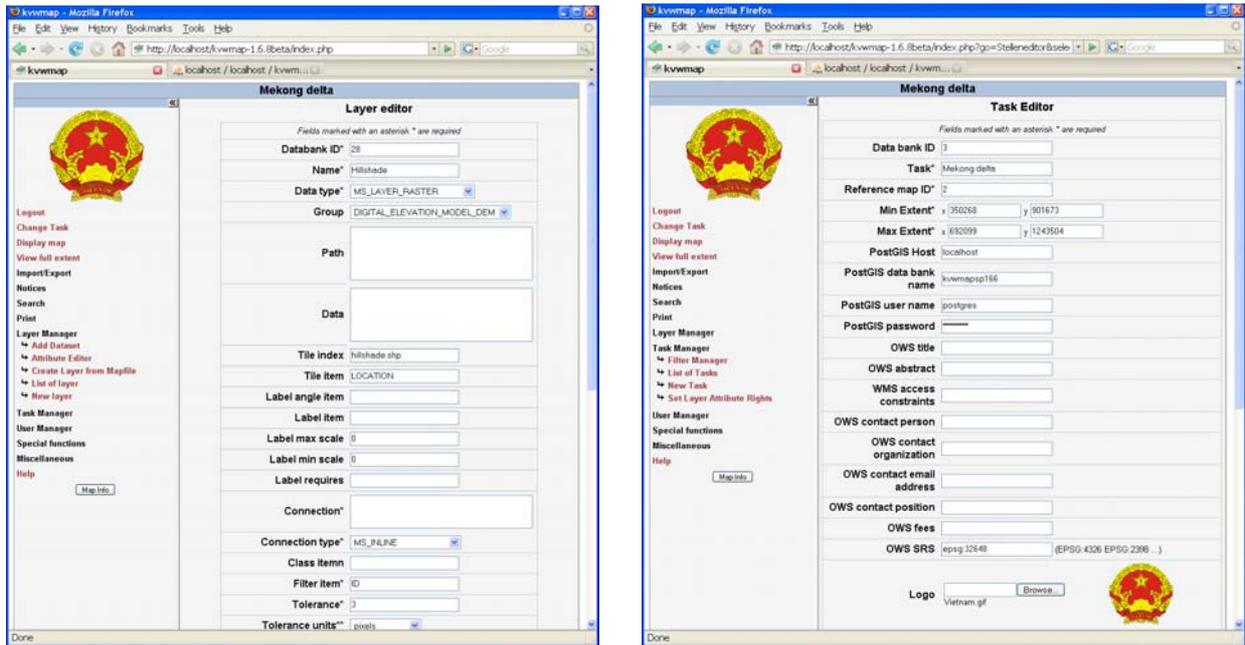

Fig. 5: Layer editor and Task editor

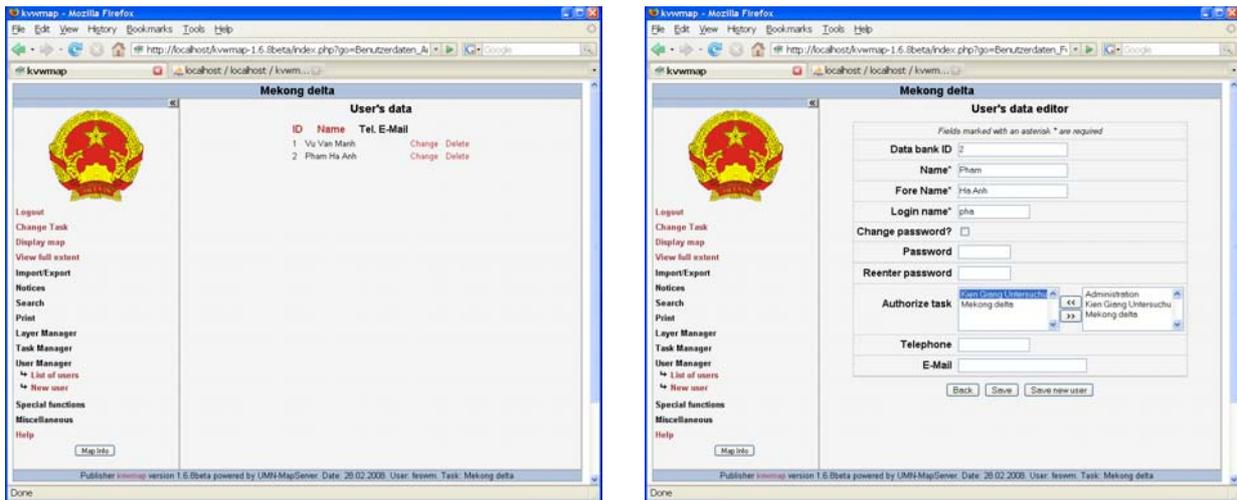We have used User Manager to create users and assign task to these users.

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Fig. 6: User editor

3.6 Generic Layer Editor

A good opportunity to change data, not only display it, is the generic layer editor of kvwmap. It enables a user to change data, add new datasets or delete them. If the administrator sets the appropriate permissions, each user can participate to keep the data actual and to add their own datasets. The editor is generic. It means, that the layer set must only be defined once in the layer definition table, the attribute types and permissions must be set and the forms for editing and search are created automatically by the application, see Figure 7.
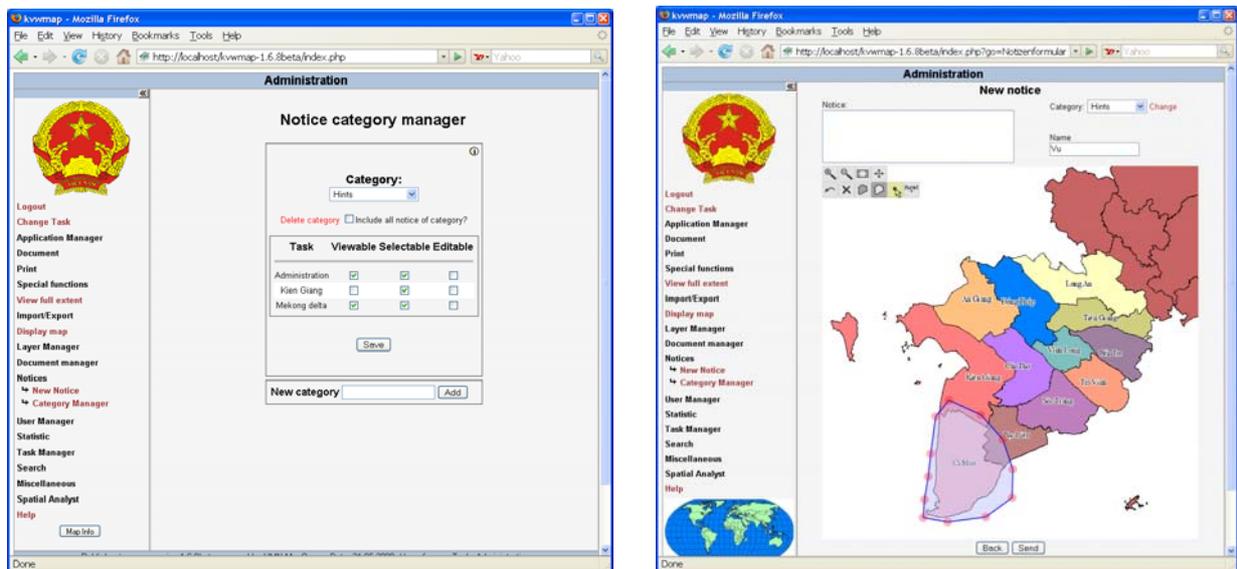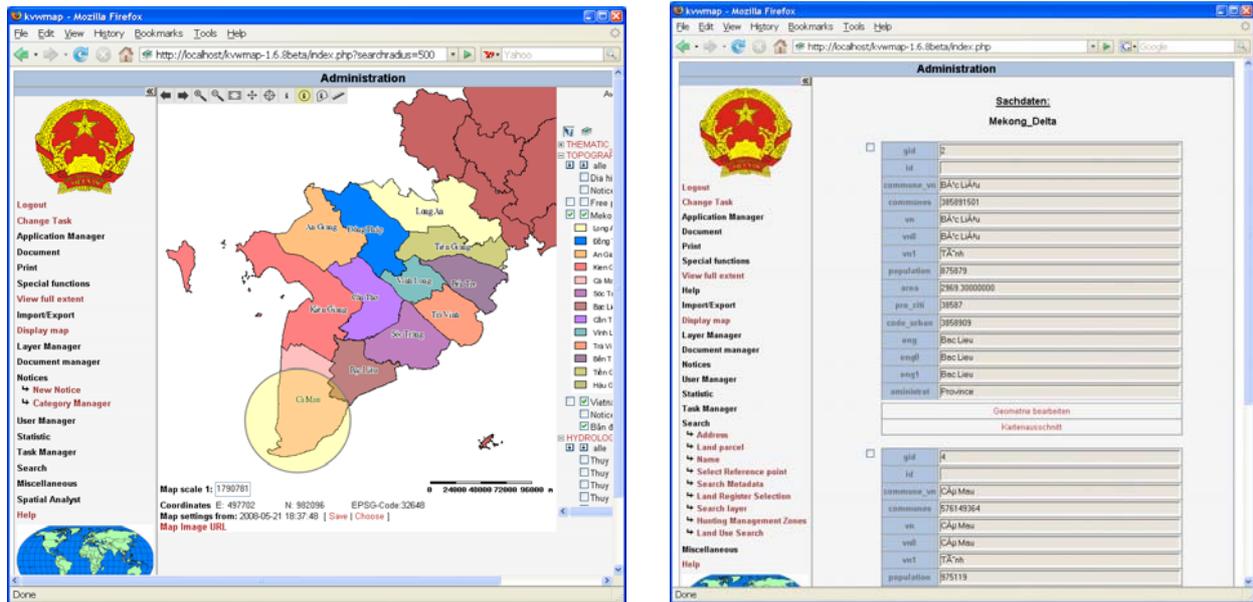

Fig. 7: Create new notice

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Fig. 8: Querying information of the Geo-data

3.7 Multilinguality

Currently three languages are implemented for the graphical user interface. The GUI consists of different snippets. The text phrases in these snippets are represented by variables. The values of the variables are assigned in language files. For each language one file is assigned to the snippet. Depending of which language is selected the appropriate language file is used to assign the values of the text variables. This allows the user to switch between English, German and Vietnamese. Text, which is loaded from the user database, such as task names and menus are stored in different language columns of the tables.

4.   Summary

In this paper, we have reviewed and discussed some theoretical and technical issues on Internet-GIS for environmental management. Thereby we have created an Internet-GIS application for flood control and socio-economic development in Mekong Delta area.

   As an example of applications, this Internet-GIS application will be used and further developed by Vietnam Remote Sensing Center, the Ministry of Natural Resources & Environment of Vietnam, host agency of the project "Establishing database of hydro-topographic information system for flood control and socio-economic development in Mekong Delta".
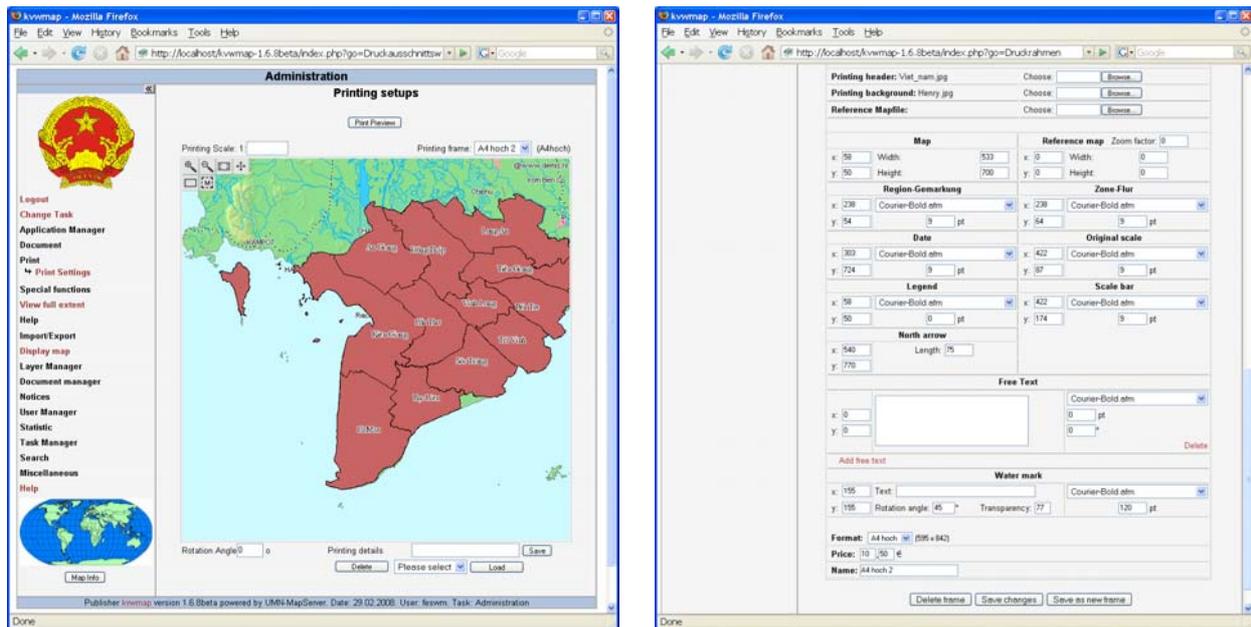
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Fig. 9: Print and Print frame setting

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