

# WEB GIS SOLUTION FOR SHARING DATA AMONG ADMINISTRATION AGENCIES IN THE MEKONG DELTA REGION

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## ABSTRACT

*GIS is very necessary for integrating data among administration agencies in the urban management, monitoring changes in natural conditions, natural resources, natural disasters that aims to achieve sustainable development in the Mekong Delta region. However, biggest difficulty is the lack of data, not frequent update with different formats and coordinates. Research orientation and development of Mekong Delta Geographic Information System (MGIS) aims to provide fully integrated information to 13 provinces and city. This paper demonstrates the suitable Web GIS solutions for sharing base map with different scale among administration agencies that aims to ensure the efficiency of development appropriate thematic maps of Mekong Delta region from multiple sources. Web GIS applications for urban management are introduced to allow specified users to edit data, update or share datasets online.*

**Key words:** base map, sharing data, thematic map, Mekong Delta region, MGIS, Web-GIS

## 1. INTRODUCTION

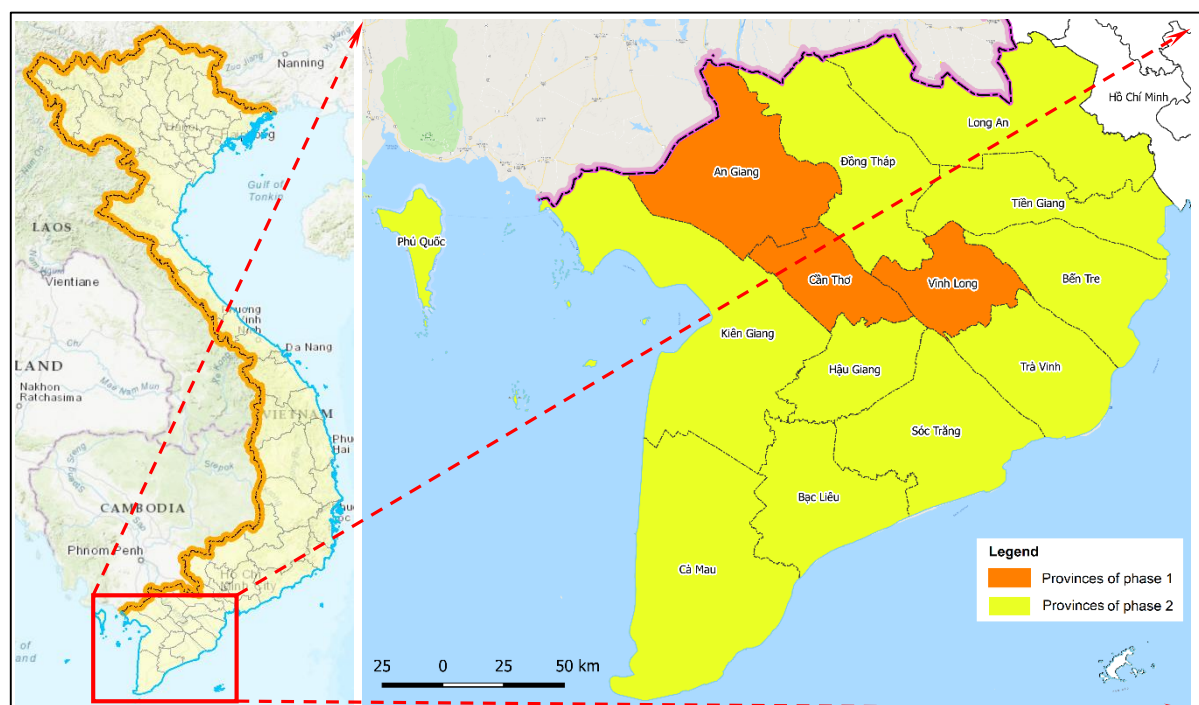
Geographic Information Systems (GIS) are a powerful set of tools for collecting, storing and analysing spatial data in administration agencies of Viet Nam. Many agencies have deployed GIS as a tool to modernize their management and to strengthen their administrative machinery. Since 2000s, some provinces has been undertaking projects on specific purposes, related to the applications on the integrity of remote sensing and GIS technologies. However, due to the spontaneity of agencies in deploying GIS technology, it turns up some problems: duplication in data collection effort among organizations, different geographic data themes for an area, and difficulties in sharing information among organizations because of both mechanisms of management and technology.

In recent years, Web GIS has been widely applied in mapping and sharing data that aims to create valuable solutions for the sustainable development in the Mekong Delta region. Adnan, *et al.* (2010) have demonstrated that an important part of every web-based GIS application is its mapping or visualization technology, which makes it possible to show data in the form of maps. Odil Kurbanov (2015) has discussed how to provide a way to allow the staff of law enforcement agencies easily manage the data using open source web GIS platform enabling users to access, visualize and interact with the data online within a web browser. This paper introduces a Web GIS solution has been applied to establishing “The Mekong Delta Geographic Information Systems - MGIS” that can be used as a tool for planning socio-

economic development, natural resources and environmental management at different levels in the region. The proposed method shows that MGIS database management system is established based on the technical conditions of each province so that ensures the efficiency of investment in providing data from a variety of sources. The choice of an appropriate database management model in the development a web-based GIS plays an important role in sharing and updating data synchronization. The Web GIS applications must be created by the user interfaces that provide online tools that allow specified users to display in the form of thematic maps, to edit data and to create solutions for sharing data among administration of the 12 provinces and a city in order to meet the requirements of supporting local leadership in decisions maker in planning and sustainable development in the Mekong Delta region.

## 2. STUDY AREA

The Mekong Delta comprises The Mekong Delta region with total land area about 39,000 km<sup>2</sup> comprises a city of Can Tho and 12 provinces of Tien Giang, Long An, Ben Tre, Vinh Long, An Giang, Dong Thap, Tra Vinh, Hau Giang, Soc Trang, Kien Giang, Bac Lieu and Ca Mau. This region plays an important role to the sustainable socio-economic development of Viet Nam. However, Mekong Delta is a region having very high risk of inundation. If sea-level rises 100 cm, approximately 38.9% of Mekong River Delta would be at risk of flooding (MONRE, 2016). Therefore, Vietnamese Government try to undertake comprehensive and coordinated land planning based on the state of the environment and natural resources and future development needs. GIS thus plays the most important role in Viet Nam's land planning and management. The main MGIS project goal is to design and implement comprehensive information system tools which support regional and provincial government agencies in the Mekong Delta in their planning processes to develop the region and adapt to climate change in the context of sustainable development. MGIS has been divided into two phases in Figure 1.



**Figure 1. Location of Can Tho, Vinh Long and An Giang in Mekong Delta region**

In the first project phase (2015-2017) a prototypical Geographic Information System was developed and implemented and a centralized database was created for sharing and updating data synchronization based on Web GIS applications: i) to establish an suitable model to provide information for planning and development of regional socio-economic; ii) to build an appropriate database management system in sharing and updating data synchronization, in order to create Web GIS applications; iii) to provide general solutions for Can Tho, Vinh Long and An Giang in building GIS database in order to develop MGIS to easily connect databases with the remaining 10 provinces.

### 3. WEB GIS SOLUTION FOR SHARING DATA

#### 3.1 Model of database management system

MGIS database management system must be established so that can provide exact data when is required from a variety of sources. The Web GIS applications will be created mainly for sharing and updating data synchronization and providing online tools that allow specified users to display in the form of thematic maps, to edit data and to create solutions for mapping and monitoring the natural resources changes in order to support management. Base map (topographic maps) thematic maps (cadastral maps, land use maps,...) and Remote sensing data are available can be used in different situations. A mix scale approach involving the integration of data is applied. All data are conducted in changing the data format and projection (Datum: VN2000). Choosing an appropriate database management model has a major impact upon the performance of the Web GIS applications. It is important that the database perform efficiently in response to different user requests.

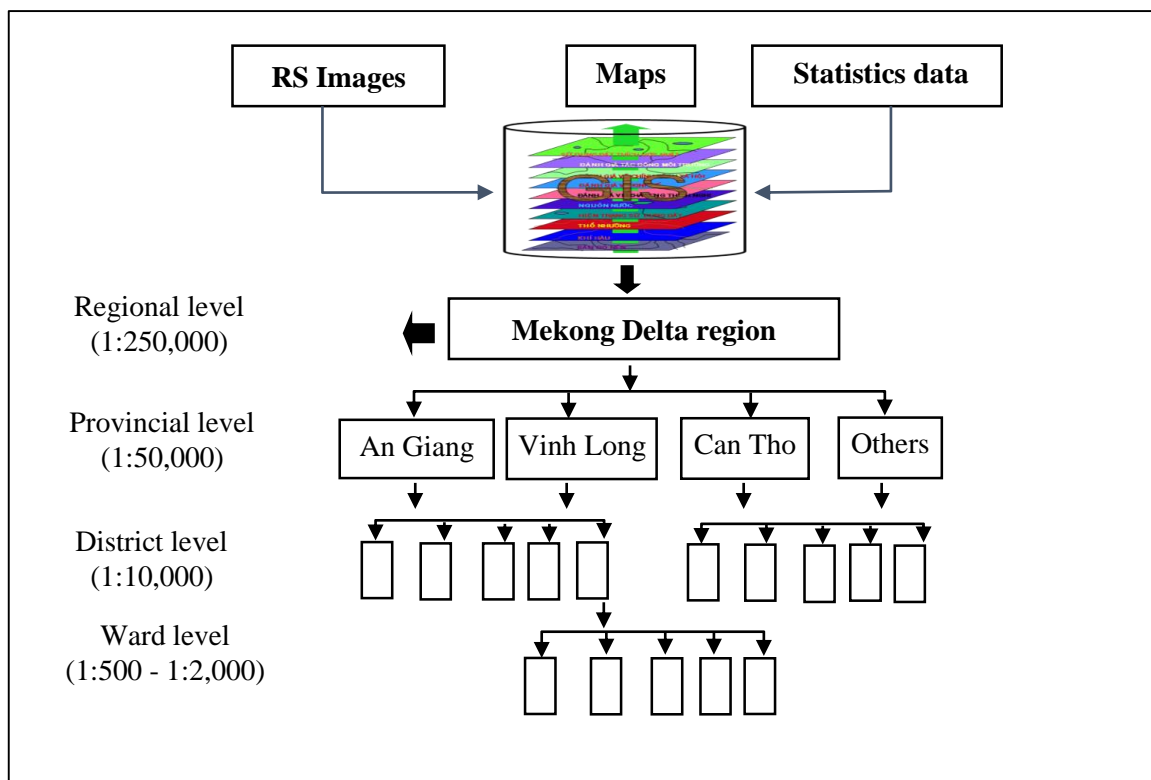
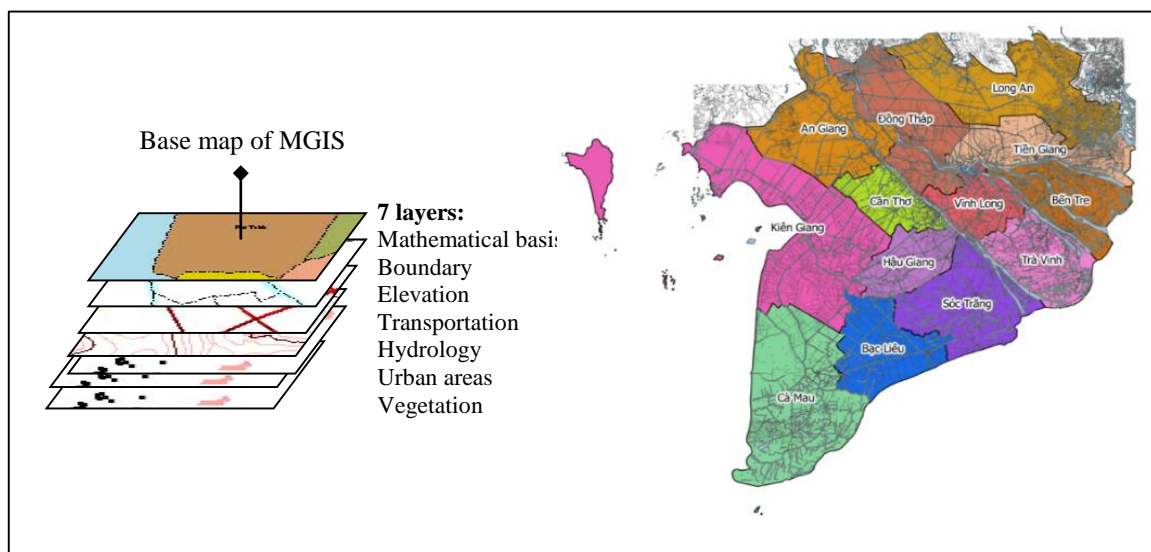


Figure 2. Database management model of MGIS

Base map of Mekong Delta region has been generated from topographic map at 1:250,000 scale includes 7 basic layers in Figure 3. It serves as general base information to made thematic map at regional level. Topographic map of each province at 1:50,000 scale is also used to generate base map at the provincial level, that have been shared as geospatial data services. This solution prevents duplicate data and allows multiple users to access the same data at the same time via an intranet and/or the internet in a safe and high secure manner.

Thematic maps have been established from the previous projects such as Vegetation, transportation and hydrology networks, land use change, river bank change,... as well as remote sensing data includes all image of the fact of floods and salinity intrusion. The thematic database is established to provide data layers that create useful information for supporting local leadership in decisions maker in planning and sustainable development in the Mekong Delta region.



**Figure 3. Model of base map and topography map at 1: 250,000 of Mekong Delta region**

### 3.2 Web GIS solution for MGIS

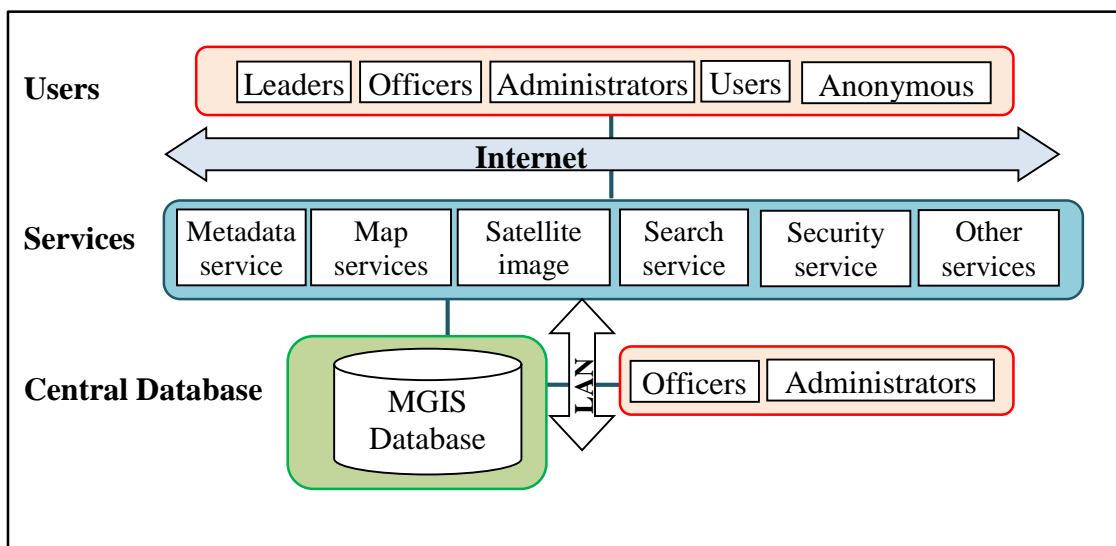
Web GIS solution for MGIS was designed and developed based on the open source software applications in Table 1 that aim to reduce the operation costs of MGIS.

**Table 1. Open source software applications used.**

<b>Software Application</b>	<b>Version</b>	<b>Function</b>
PostgreSQL 9.5	10.1	Object relational database
PostGIS	2.4.1	Spatial database extension
Geoserver	2.12.1	Share geospatial data
OpenLayers APIs libraries	4.3.2	Development of geographic user interface
.NET Core/ASP.NET Core	2.1	Framework for building Internet-connected applications

The .NET Core and ASP.NET Core framework were used for server side programming, that are fully open source and available on Windows, Mac, and Linux, and can be used in device, cloud, and embedded/IoT scenarios. All data were stored in a PostgreSQL database which is an open source object-relational database management system and PostgreSQL can store geospatial data with PostGIS geospatial extensions. Map services were created using GeoServer, which is an open source platform for publishing geospatial data and interactive mapping applications. The client web-based geographic application as the user interface, was developed using OpenLayers APIs library which was originally based on the Prototype JavaScript Framework.

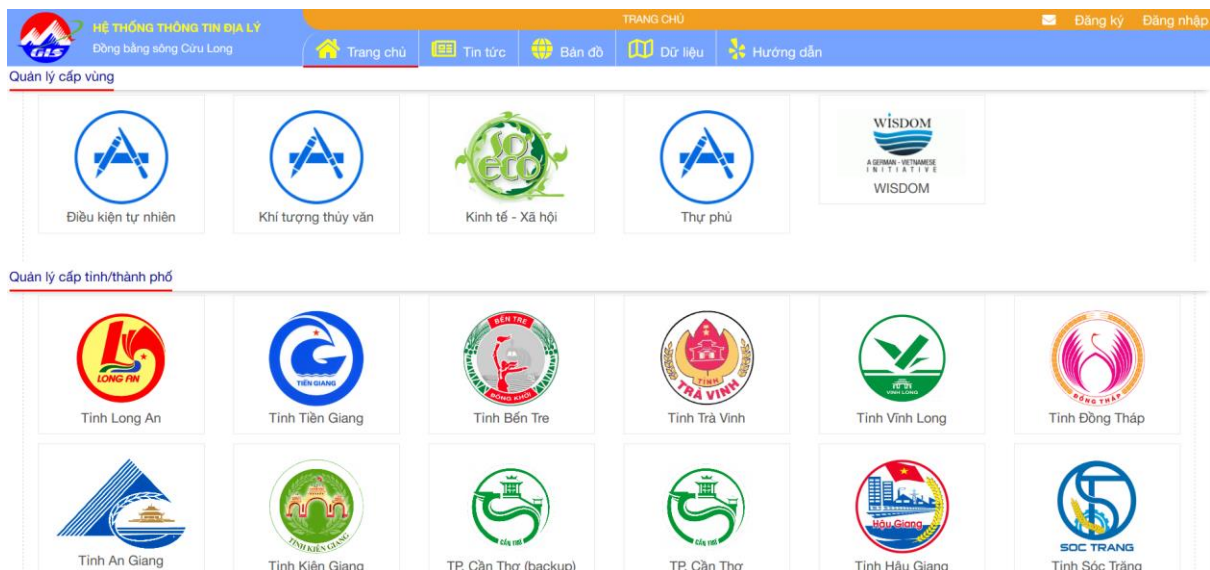
Application model of Web GIS based on 3-tier architecture as shown in Figure 4 to serve different user requests indicates the response time of the database management system of MGIS for natural resources management. The user interface is on the 1<sup>st</sup> tier that data and maps can be presented on a web browser (website: <https://mgis.vn>) without the need for any additional software. All web-based GIS applications lie on the 2<sup>nd</sup> tier implements the functionality of MGIS with an application framework that can be used to build other applications such as user management, menu systems. MGIS database lies on the 3<sup>rd</sup> tier and is managed by PostgreSQL software that users can download or upload data to contribute content of MGIS database. GeoServer is used for dealing with spatial and attribute data available inside of MGIS database and provides service in connecting to database of other provinces that content can be requested to open other layers outside of MGIS through Web Feature Service (WFS) standard, or the Web Map Service (WMS) protocols.



**Figure 4. Application Model of Web GIS for MGIS**

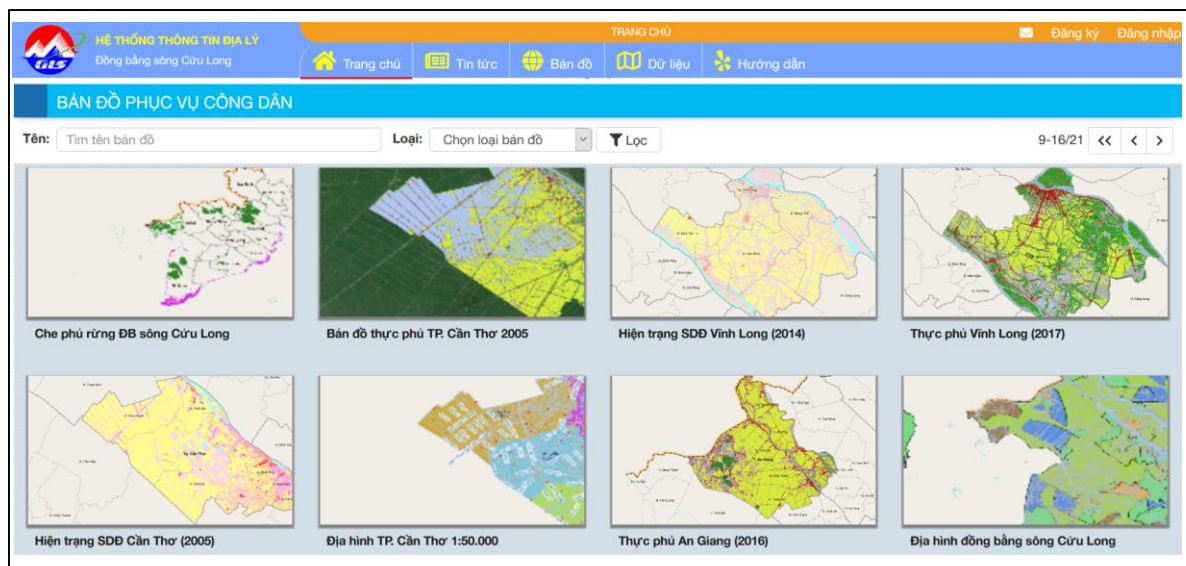
### 3.3 Web GIS for sharing data of MGIS

Database of the MGIS includes various data sources and satellite images to support for monitoring of changes in natural resources, environmental and socio-economic. Sharing of regional data allows multiple users to use the same data at the same time via the internet in a safe and can bring more value on understanding the regional level situation. Web GIS applications is a good opportunity for 12 provinces and a city to share data for managing and supporting the sustainable development in Mekong Delta region.



**Figure 5. Home page of MGIS at <https://mgis.vn>.**

Web GIS demonstrated an efficient solution for visualization of a very large amount of thematic data of MGIS. The online mapping applications are developed that is mainly composed of data handling tools for analyzing the trend and displaying spatial distribution of thematic maps such as vegetation, transportation and hydrology networks, land use change, river bank change,...



**Figure 6. Web GIS enabling users to visualize and interact with thematic data**

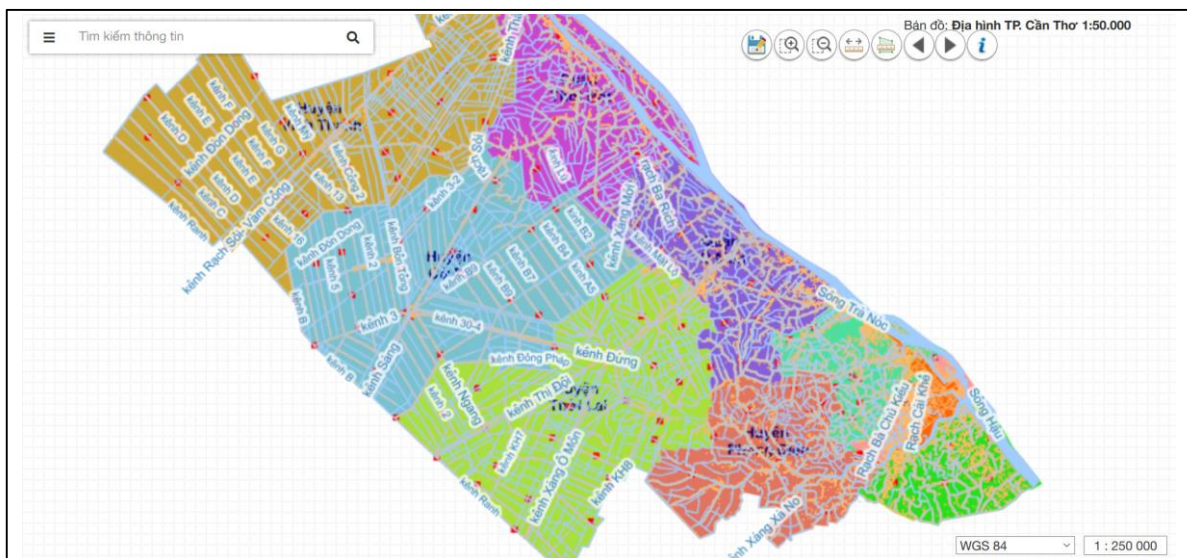
MGIS allows multiple users and integrate information as management requirements at the macro level, in order to serve the leadership and managers of the Government. Web GIS has a function for sharing data among administration agencies to open up a new way of developing GIS applications whereby the GIS server produces the thematic maps and then specialists of administration agencies can add some more information to it. This can assist the researchers and operational analysts to undertake further analysis regarding natural resources management that aims to achieve sustainable development in the Mekong Delta region. In order to share data in MGIS database, a user accesses the server with a Web browser and acquires an HTML form necessary for sending a geospatial data request. Next, the user clicks

the responding link in Figure 7 and sends parameters to the server. Web GIS applications are executed based on the analysis results and the requests are transferred to relative services.

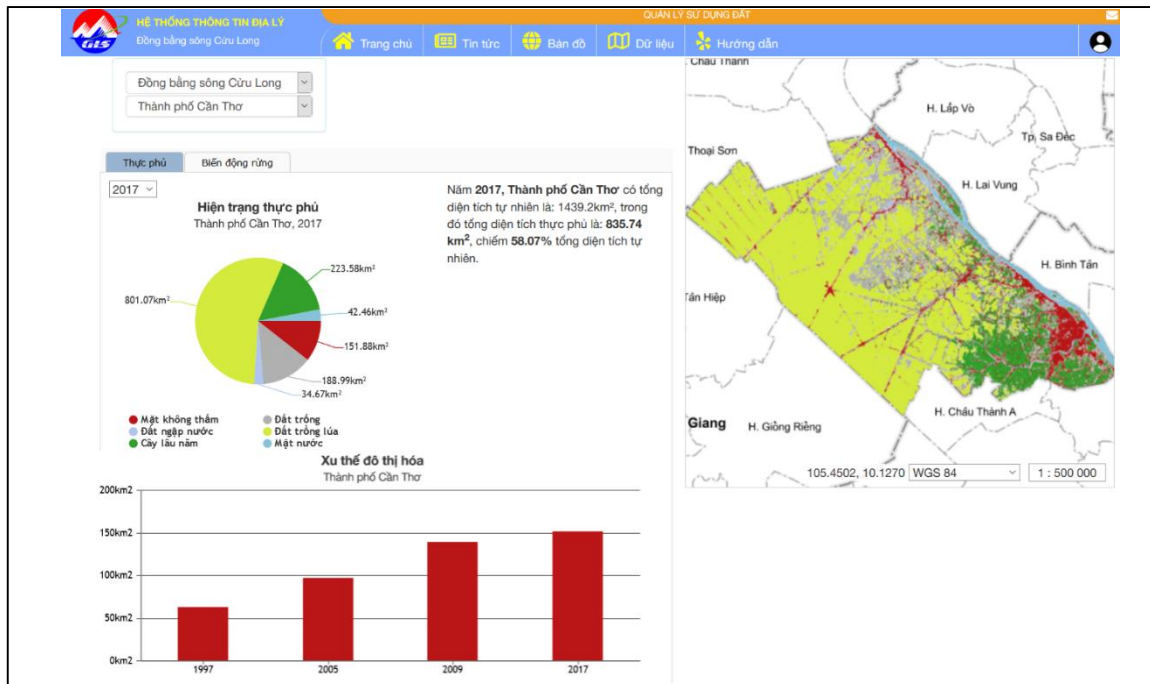
Công cụ	Họ và tên	Cơ quan	Đã chia sẻ?
1	Trương Quốc phương	Sở Giao thông Vận tải	Chưa
2	Lâm Phúc Nhân	Sở Nông nghiệp và Phát triển Nông thôn	Chưa
3	Nguyen Trong Luat	Văn phòng đăng ký đất đai - Sở TNMT	Chưa
4	Dương Phạm Trọng Khoa	Sở Khoa học và Công nghệ	Chưa
5	Trần Phong Nhà	Công ty Cấp thoát nước	Chưa
6	Vu Cong Doan	Sở Tài nguyên và Môi trường	Chưa
7	Lê Quốc Hải	Sở Xây dựng	Chưa
8	Trịnh Hữu Phúc	Công ty Cấp thoát nước	Chưa

**Figure 7. Web GIS for sharing data among administration agencies**

Web GIS applications is a good opportunity for 13 provinces to share data for managing and supporting the sustainable development in Mekong Delta region. Figure 8 shows the base map of Can Tho City that is shared for establishing land cover thematic maps in the period from the year 1997 to 2017 and Web GIS is used for analyzing the trend of land cover change and urbanization of Can Tho City in Figure 9.



**Figure 8. Topography map at 1: 50,000 scale of Can Tho City**



**Figure 9. Land cover change and urbanization of Can Tho City**

#### 4. CONCLUSIONS

MGIS is divided into two phases in order to develop GIS synchronization and computerize the state management for to support for policy making that aims to achieve sustainable development in the Mekong Delta region. MGIS plays the important role in this region for thematic mapping and monitoring of changes in environment and natural resources. This paper provide the suitable Web GIS solution for sharing database of MGIS among administration agencies with framework that can be used to build other applications that aims to achieve sustainable development in the Mekong Delta region. The proposed solution with standards of technology concerned with the actual development of the MGIS's applications that can apply efficiently for a case study in monitoring and analyzing the trend of land cover change. Database of MGIS can be shared and presented within a web browser, without the need for any additional software, to provide information quickly for state management that ensures the efficiency of investment. This solution can bring more value on understanding the regional level situation and develop GIS synchronization from multiple different databases and agencies of 13 provinces in the Mekong Delta region.

#### ACKNOWLEDGEMENTS

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