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DEVELOPING AN APPLICATION ON LAND USE PLANNING INFORMATION IN GIA RAI DISTRICT, BAC LIEU PROVINCE

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ABSTRACT

The research aims to develop WebGIS system and to apply on mobile device for land use (LU) maps as well as land use planning (LUP) maps in Gia Rai district, Bac Lieu province to support spatial data sharing on the internet environment. WebGIS was created base on HTML, CSS and JavaScript programming languages. In addition, an application (App.) on smarphone was applied using App Studio on ArcGIS software to be provided by ESRI. Spatial and attribute databases of land use and land use planning are stored on ArcGIS Online. The results were completed not only revision of maps and land parcels information but also land use planning maps in each commune in Gia Rai district, Bac Lieu province. Moreover, the web page were developed to provide spatial and attributes information of land use and land use planning which are interactive functions including displaying, searching by parcel numbers or by attributes, measurement, map printing, etc. can be accessed on the website of the Land Registration Office in Gia Rai district and on smartphone.

1. INTRODUCTION

The fourth industrial revolution (i.e., industry 4.0) is an inevitable demand in the current development which bases on the nine main pillars including big data analytics, autonomous robots, simulation, system integration, internet of things, cyber physical system, cloud computing, additive manufacturing and augmented reality. These foundations are the core achievements of the information technology (IT) [14]. Under the powerful development of the IT and internet connection, there is a demand of applying IT to quickly and timely address the work in the Vietnamese state agencies [7]. Online service advantages in the agencies help to reduce amount of work for the officers and save the customer's time while the work efficiency is also improved significantly.

In the context of economic development and population growth, the real estate market is quite vibrant and the land price tends to be increasing [2]. Thus, the resident increasingly demand to know land use and land use planning for their trading purposes. In fact, land information was only revealed in the Land Registration Office (LRO), thus it often wastes the time. Therefore, it is necessary to have an open land information system to the interested residents who could search land use, land use planning quickly, transparently and accurately. The system is designed as a WebGIS page which distributes the Geographic Information System (GIS) data via the World Wide Web (WWW) environment to perform and display the spatial data (Gillavry, 2000). The WebGIS could effectively supported the rural development, water, environment, tourism, land and building management [4], [8], [10], [11], [12].

Android is the most popular operating system on the mobile devices (e.g., smartphone) developed by Google cooperation on Linux platform [13]. The Android applications are created on open platform, multifunctional library and powerful developer community. These apps are delivered on Google Play Store with over 700,000 apps, that are friendly, easy to use, and highly customized products.

Therefore, the research was performed with the objectives of developing a WebGIS system to search data of the land use, land use planning information and creating the applications on Android mobile devices for interested users and the outdoor field survey purposes.

2. DATA AND METHODOLOGY

2.1 Study area

Gia Rai district is located in the west of Bac Lieu province and along the 1A national road. The town cover on an area of 35,466.81 hectares, it stretches from 9º00' to 9º38'09" North latitude, and from 105º14'15" to 105º51'54" East longitude. The Gia Rai district includes 2 towns (i.e., Gia Rai, Ho Phong) and 8 communes (i.e., Phong Thanh, Phong Thanh A, Phong Thanh Dong, Phong Thanh Dong A, Phong Thanh Tay, Phong Tan, Tan Thanh, and Tan Phong). The district borders to Hoa Binh district (Bac Lieu province) in the east, Ca Mau province in the west, and Dong Hai and Phuoc Long (Bac Lieu province) in the south and north, respectively (Figure 1) [1].

Gia Rai district is along the 1A highway approximately 30 kilometers which is as a main bridge to connect the two regional economy centers of Bac Lieu city and Ca Mau city. The district is an intersection among both waterways and main roads of the region. Moreover, Gia Rai district also belongs to the key zone of fishery and brackish aquaculture cultivation in the Ca Mau peninsula. Hence, the district has advantages to become a regional center of processing, trading and distributing brackish aquaculture products.

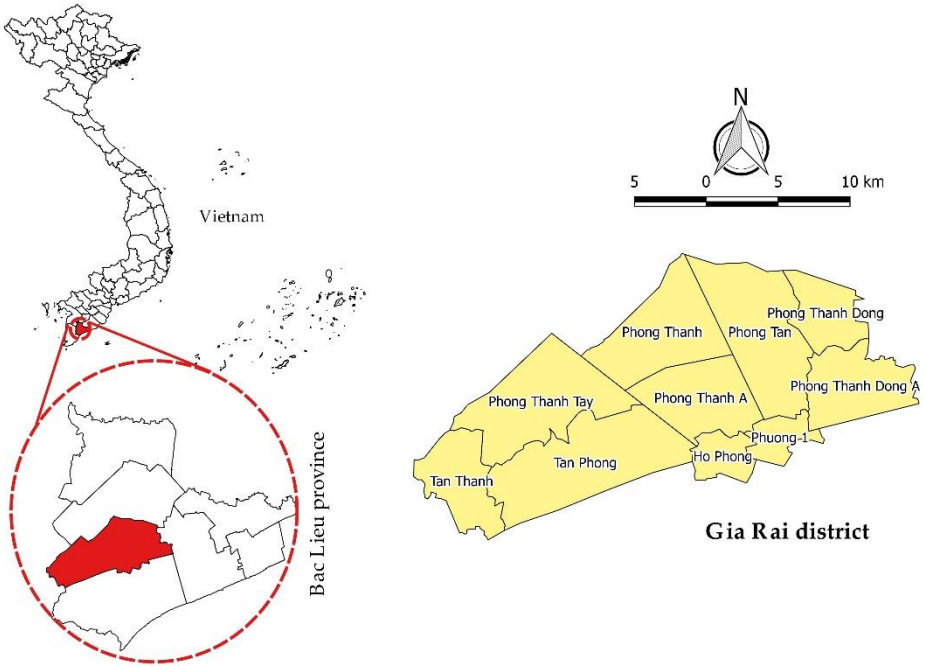


Figure 1. The study area of Gia Rai district, Bac Lieu province

2.2 Data used

The principal data in the research was the digital maps in scale of 1:25000 which were acquired in the Land registration office in Gia Rai town (Bac Lieu province) including: (1) Administrative map, (2) Land use map of Gia Rai district in 2010, (3) Land use planning map up to 2020 in Gia Rai town.

2.3 Methodology

2.3.1 Data conversion and manipulation

The collected digital maps in MicroStation format (*.dgn) were converted to MapInfo format (*.tab) for standard edition database and then converted to shapefile format (*.shp) for uploading data on ArcGIS online platform.

Firstly, the MicroStation format maps were transformed to MapInfo format maps by the Universal Translator tool on MapInfo. The outputs were defined the projection corresponding the Bac Lieu province (i.e., VN-2000, 105^{o} zone 3^{o}) by the extension tool of nGEOTOOLS. Then, the data was fixed the polygon errors, edited attribute table, and synthesized data to suit with database extraction.

Next, the MapInfo format data was again transformed to shapefile. The shapefile data then was mapped as following the Decision number 23/2007/QD-BTNMT of the Ministry of Natural Resources and Environment (MONRE) about symbols and colors for land use map in Vietnam (Table 1). The final maps of land use and land use planning were uploaded to online for storing and sharing database on the ArcGIS online platform.

Table 1. Color and land use/land use planning code

Nu.	Color & LU/LUP code	LU/ LUP	Nu.	Color & LU/LUP code	LU/ LUP
1	CAN	Army land	10	NTS	Aquaculture land
2	CLN	Perennial land	11	NVT	Coastal aquaculture
3	DGD	Educational land	12	ODT+LNK	Urban & perennial plants land
4	DGT	Transportation land	13	ONT	Rural residential land
5	DRA	Landfill land	14	ONT+CLN	Rural residential and perennial plants
6	DXH	Social service land	15	ONT+LNK	Rural residential and other perennial plants
7	HNK	Annual plants land	16	SKK	Industrial land
8	LUC	Rice land	17	SON	Rivers and canals
9	NTD	Cemetery land			

2.3.2 WebGIS design

Online map creation: The uploaded data was used to create maps, which could be online access on the internet environment. The steps to create the map consist of the following key steps: add layers> edit color, symbol and title> share map> create web interface> create map functions> create web application> complete and embed link into WebGIS page.

Website interface design: The website was designed by the programming languages of HTML and CSS. The WebGIS consists of 3 main components: (1) presentation section (i.e., banner, menu, link, etc.), (2) online database on ArcGIS online to access the parcel information, and (3) map application section. Firstly, the programmer designed web interface with menu and other web function. Then, the programmer embedded map links on the ArcGIS online to the website.

2.3.3 Mobile application design

The research created 2 isolated Apps of land use App and land use planning App, which provide the corresponding parcel information. Firstly, the map layers were added into the App Studio on ArcGIS online. Next, the Apps were designed the basic functions how to suitable on the mobile devices. Then, the Apps were run trial, corrected errors and completed the Apps.

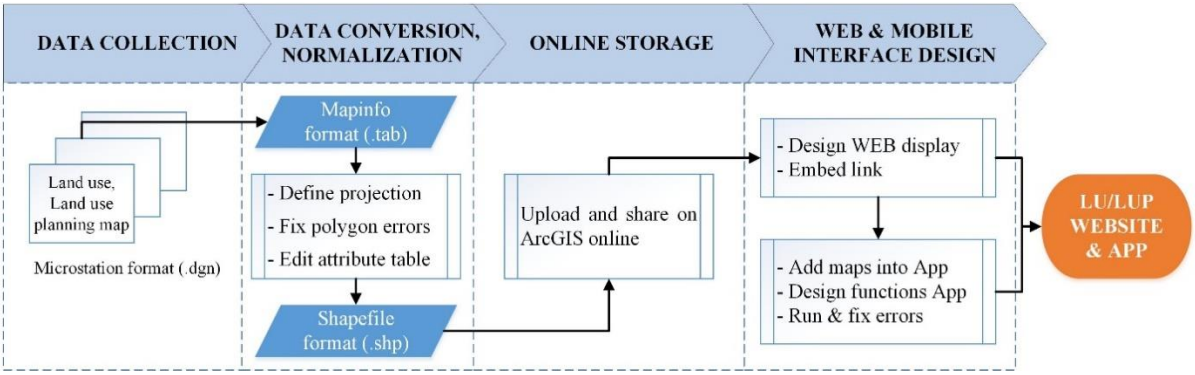


Figure 2. The flowchart steps on mobile application design

3. Results

3.1 Database

3.1.1 Spatial database

Land use map

There are 17 land use units in Gia Rai town which include the different land use purpose such as army land, perennial land, educational land, transportation land, landfill land, social service land, other annual plants land, rice cultivation land, cemetery land, aquaculture land, coastal aquaculture land, urban and other perennial plants land, rural residential land, rural residential and perennial plants, rural residential and other perennial plants, industrial land, rivers and canals.

In regarding to land use period, the principal rice cultivation areas included the communes of Phong Thanh Dong, Phong Thanh Dong A, Phuong 1 and Tan Phong. Besides, the district has advantages in brackish aquaculture, the aquaculture areas distributed in most of the communes. Tan Thanh commune is a core of the industrial zone expected to become a main area of aquaculture processing.

Land use planning map up to 2020

Generally, land use planning for 2020 in Gia Rai town has some following characteristics:

(1) Remaining the rice cultivation area in Phong Thanh Dong, Phong Thanh Dong A, Phong Tan and Phuong 1;
(2) Establishing the new administrative zone and commercial centers in the town;
(3) Increasing the area of land for culture - education, transportation, urban residential area, trade-services, medical land, public utility land across the district;
(4) Conversing other agriculture lands into brackish aquaculture purposes in most of the communes except Tan Thanh and Phong Thanh Dong A.

3.1.2 Attribute table

The properties table of the parcel designed including 6 data fields, which supply the parcel information such as parcel Identification (ID), owner name, address, land use purpose, area and color code of each land use type. The data type and width of each data field is shown in the table 2 below.

Table 2. Properties table structure of a parcel

Data field	Description	Type	Width
SHTHUA	Parcel ID	Character	8
HOTEN_CHUSD	Owner name	Character	50
DIACHI	Address	Character	50
LOAIDAT	Land use type	Character	10
DIENTICH	Area	Decimal	10, 2
Igds_color	Color code	Small Integer	

In terms of attribute table of land use planning map, which was designed in type of text with 10-character-width (Table 3). The field illustrates the planning information to orientate land use purposes in the district up to 2020, and notify the planning information to land owners.

Table 3. Properties table structure of a land use planning

Data field	Description	Type	Width
QuyHoach	Planning	Character	10

3.1.3 Map editor

The land use and land use planning maps were edited and assigned colors for each land use type. The colors were as the Decision number 23/2007/QĐ-BTNMT of the Ministry of Natural Resources and Environment (MONRE) about "Issue the symbols for land use status map and the land use planning map" corresponding to 17-land use purposes in the section 3.1.1 in Gia Rai district.

3.2 Land use and land use planning WebGIS

3.2.1 Homepage

Homepage is the first webpage when guests access the website, in the research's website the homepage consisted of 5 primary components such as banner, menu, map category, Google map, links, and extra components (e.g., footer, time and calendar) (figure 3).

Banner: Which is an image on the page header to show the website name and for decoration purpose.

Menu: The dynamical menus were a hierarchical structure, that were designed by programming language of HTML and CSS. A sub-menu was connected to a separated page, the corresponding link and page interface will be accessed when the sub-menu was selected.

Map category: There are 2 categories (i.e., land use maps, and land use planning maps), which support users to easily find a specific parcel information on the land use map, or the planning map through the buttons on the website. Each map shows one commune/town unit on an isolated page

Google map: The extensional utility helps guests to quickly access Google Map, the default location whenever the website be opened is Gia Rai district.

Link: The function links the website with other related website such as the Central portal, provincial portal. Besides, the function also helps to save time for searching additional information in other sectors.

Figure 3. The website homepage with component functions

3.2.2 Overview page

The overview page supplies the information about (1) general natural resources, (2) natural conditions, (3) natural resources, and (4) historical sites and landscapes. The detail information in each sub-category was shown below:

(1) General natural resources: to supply briefly about natural conditions;
(2) Natural conditions: administrative boundary, topography, climate, surface hydrological regime;
(3) Natural resources: Soil resources (soil groups such as saline soil, alkaline soil, alluvium soil), water resource;
(4) Historical sites and landscapes: Tourist features and development goals of tourism in the district.

3.2.3 Map category

Map category is a core part of the website, and it was link with "map category" in the overview page. The two categories (i.e., land use and planning) will be displayed in each separated commune/town map. The digital maps were accessed via available link which could be online accessed through the ArcGIS online platform.

Main functions

The map interface was designed with the main function buttons (figure 4), which support users to display the map, search the parcel information, export data, and print out the map in different paper sizes.

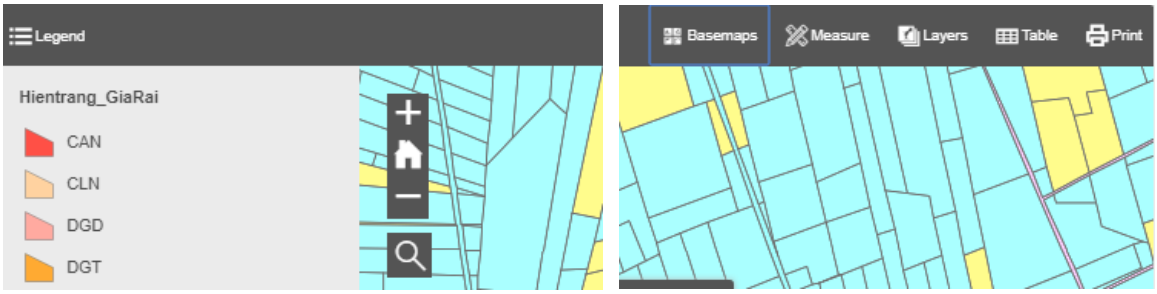


Figure 4. The map interface with multi-function buttons

The button group on the vertical axis of the map, which are the functions of zoom in , zoom out , Show default scale , and search the parcel information through the parcel ID
The button group on the horizontal axis of the map supplies the multi-functions as following below:

Basemaps The function provides numerous backgrounds, which the users could change during the map display. The base-map shows various support information such as topography, road, river, and administrative boundary. The base-map is a useful information channel for GIS users to reference the object location. The base-maps consist of Open Street Map (OSM), satellite, topographic map, stress map, ocean map, etc.

Measure The function supports the measurement methods of the object such as region area, distance between two points, and point coordinates.

Layers The function used to turn on, or turn off the map layer. On the land use planning map, the function is able to show land use map, land use planning map or both of them.

Table To display the map attribute table, the users could adjust the display mode to show or hide some information by using the + button and check on the interesting data fields (Figure 5).

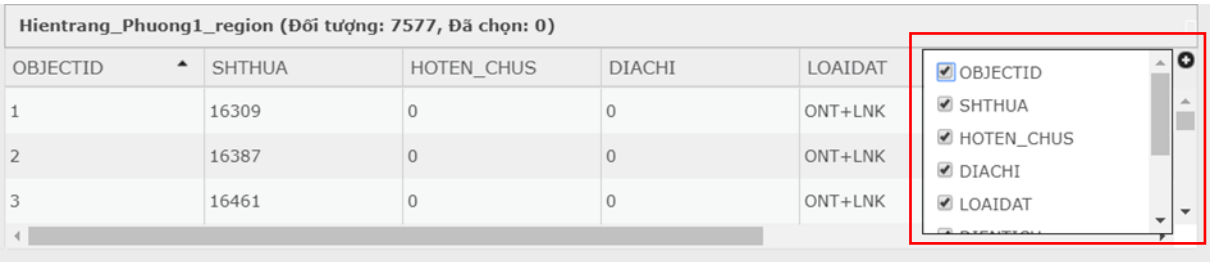


Figure 5. The optional display function on attribute table

Print To create print page for the current map under number of paper sizes. Besides, the users also add the map legend, map title into the print page.

Ability of retrieving parcel information

The website supports two different methods to extract the parcel information. A parcel information could be revealed when the users click left-mouse on it. A small query note will occur beside the selected parcel with detail information. Other way, the users also search a specific parcel by its ID, the website also moves to the selected parcel with its information note (Figure 3).

Figure 6. The clicked parcel information (a), the suggested parcel when using search ID parcel function

3.2.4 Subcategories

News: The news section provides the information in Gia Rai district with sub-menu corresponding to 4 sub-sections including social culture, political economy, urban management, and national security.

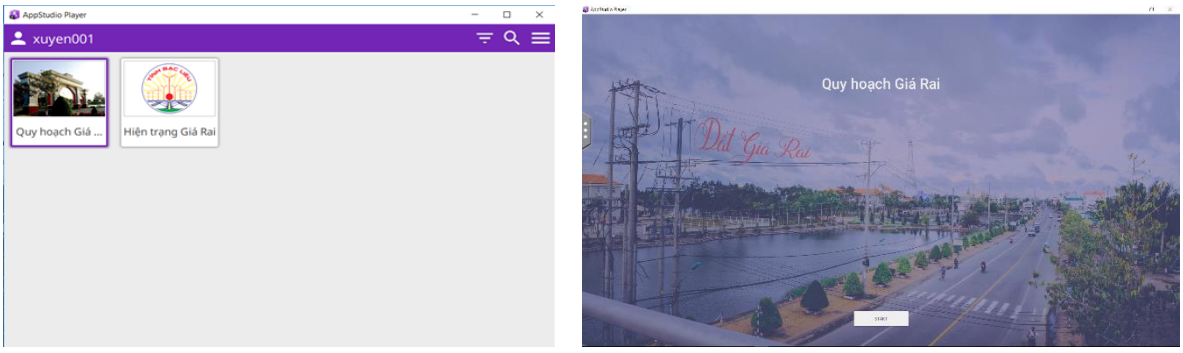
Documents: The webpage provides announcements, administrative documents, and legal documents.

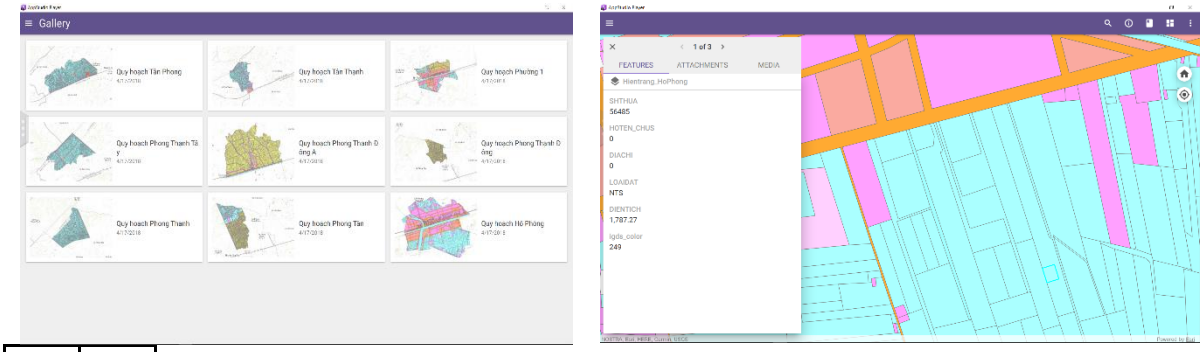
Contacts: The page stores contact information of related departments, and director of communes.

Sitemap: Which is a website's contents with a list of pages in the website.

3.3 Mobile device Application

The applications of land use, and land use planning were designed into two separated applications to optimize the Apps' interface and performance (Figure 7).





(a)	(b)
(c)	(d)

Figure 7. (a) Applications of land use and land use planning, (b) the display of planning App, (c) Map gallery, (d) the selected parcel information

When launching the App, the map gallery is opened to show the component maps in each commune. The map also supports interactive functions, the detail map function consists of tags such as INFO (i.e., display the layer name), LEGEND (i.e., show the key-map explanation), CONTENT (i.e., display the layers map of land use or planning map).

The users could extract the parcel information by the way of clicking on specific parcel on the App screen. Especially on the App version for smartphone, the App has the function of positioning , thus the users could extract the parcel information in their location of standing with only a smartphone with internet connection.

3.4 Application ability

Besides the basic features of a regular website such as general introduction of Gia Rai district, news, documents, contacts and related website links, the WebGIS provides land use, land use planning information in both attribute and spatial information. The spatial information also a real geographic location when the data was converted into the same projection reference, and compared to base map layer. The information is extracted in form of an animated map in each commune with the interactive functions. The function is parcel search using parcel-ID or attribute table, multi-scale zoom, measurement and print, that could be directly performed on the website interface. The WebGIS effectively performs on computer with mouse manipulations and external devices (e.g., printer), thus it could strongly support to experts, managers, and other interested people. On the other hand, the land use, land use planning Apps are more movable, because the users could install the applications on every Android device. The mobile version could be used by any people interested in land use, land use planning to be accessible everywhere with an internet connected smartphone. Through the GPS technique on the smartphone, the users also know their location compared to a specific parcel when they are performing a field survey. Thus, the management is able to be improved, because the heterogeneity between the legal land use state and the real land cover be revealed.

However, both the WebGIS and the applications should be improved to promote the applicability. The WebGIS should be added the administrative function and user decentralization. The administrator login to the website system to post news, update website data, and manage the suggestion box. Additionally, the attribute table of the parcel is too primitive, thus it should be completed by adding the detail information such as map number, land owner name, land origin, certificate number, document number, barcode, and certificate status. On the mobile applications, the google map functions should be developed support

the field survey purpose including direction, traveling time, nearest way suggestion, etc. Besides, the search function on the apps should be designed to quickly find a known parcel on the digital map.

4. CONCLUSIONS

The research created a planning portal website by WebGIS technique on non-charged storage platform of ArcGIS online, the website provides the basic contents and functions. The main content of the website is the map catalog with two map categories in commune level including the land use maps in 2010, and land use planning maps up to 2020. The website provides interactive functions on the map such as zoom in, zoom out, find, base map, measurement, layers, table, and print. Besides, the interactive website also allows the interested users to refer to a specific parcel information about its present land use and land use planning in 2020.

The two-application of land use App and land use planning App, which were also the research outcomes. The applications could operate on Android operating system of mobile devices. The applications also allow to access the online digital maps on ArcGIS online for displaying purpose. The main functions of the Apps consist of displaying map, changing base-map, extracting parcel information, legend map, and altering map layers. Especially, the users also know their location while checking a specific parcel through the positioning function on smartphone version, which is not available on the web version.

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