GEO-INFORMATICS TECHNOLOGY FOR AGRICULTURAL DEVELOPMENT IN THAILAND

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Abstract: Agriculture is the important sector of Thai economy since it accounts for 70% of the employment in the whole national man power. However, agriculture of Thailand is still facing the issue of low income and low productivity. Advanced cultivation technology, agronomic research and environmental impact assessment are necessary to support the sustainable agricultural development in Thailand. Geo-informatics technology allows for obtaining those data; therefore, the objectives of this project are to apply the geo-informatics technology to agricultural practice and to develop an agricultural web map service “GIS AGRO”.

In this study, the agricultural areas were extracted from high spatial resolution satellite images using visual interpretation. By integrating with other data, including land use, soil suitability, irrigated zone, meteorological data, land parcel and household, and cash crop cultivation calendar, the GIS AGRO will provide information for five subsystems which are crop monitoring system, pest and plant diseases monitoring system, agricultural technology transfer system, weather forecast system, and productivity estimation system. The research will provide valuable information related to agriculture for central government, local agricultural organization, and developed farmers aiming towards the sustainable agriculture in Thailand.

INTRODUCTION

Agriculture is the important sector of Thai economy as it represents one of the major exports of Thailand and ranks among major agricultural exporters of the world. The main products are rice, rubber, cassava, sugar, and fishery products. However, agriculture of Thailand is still facing the issue of low income and low productivity. The current status and long term trend of Thai agriculture show that advanced cultivation technology, agronomic research and environmental impact assessment are essential to support the sustainable agricultural development in Thailand. Geo-informatics technology, namely, Geographic Information System (GIS), Remote Sensing (RS), and Global Positioning System (GPS) allows us to obtain these data.

Geo-Informatics and Space Technology Development Agency (Public Organization): GISTDA, as one of the principal Thai agencies responsible for geo-informatics technology, realizes the importance to help solve Thai agriculture problems. The rapid advancement of Remote Sensing and Earth Observation Satellite technologies are producing various satellite sensors, especially high spatial resolution sensor. Furthermore, the ability to update the data rapidly with satellite images has brought about useful technologies for many applications, especially in mapping land-use and land cover, soils and forestry mapping, city planning, archaeological investigations, military observation, land cover changes, deforestation, vegetation dynamics, water quality dynamics, and agricultural management.

In view of the characteristics of geo-informatics technology mentioned above, GISTDA has applied this technology for agricultural application and has developed geo-informatics service system to support the central government, local agricultural organization, and farmers aiming for the agriculture development in Thailand.

OBJECTIVE

1. To apply the geo-informatics technology to agricultural practice.
2. To develop an agriculture web map service.

METHODS AND EQUATION

This project has two main components one of which is to apply the geo-informatics technology to agricultural practice and the other is to develop an agriculture web map service "GIS AGRO". Therefore, methodologies of this project are divided into four stages: image preparation and processing, image classification, agricultural geo-spatial database design and realization, and web map service "GIS AGRO" development.

1. Image preparation and processing.
The raw high resolution satellite images with 0.5-2 meters spatial resolution including THAICHOTE, IKONOS, QUICKBIRD, GEOEYE, and WORLDVIEW were collected and processed to the ortho satellite images. They were used as the base data of the project.

Table 1: The main base data of the project.

Satellite image	**Spatial resolution** (m)	**Image processing**	**Image type**
THAICHOTE	2	Ortho Rectified Image	Pansharpening
IKONOS	1	Ortho Rectified Image	Pansharpening
QUICKBIRD	0.61	Ortho Rectified Image	Pansharpening
GEOEYE	0.5	Ortho Rectified Image	Pansharpening
WORLDVIEW	0.5	Ortho Rectified Image	Pansharpening

2. Image interpretation and classification.
Agricultural areas were classified from the base data comprising high resolution satellite images, using visual interpretation and manual digitizing. The accuracy of result classification was assessed by ground truth information from field survey. The experiment steps are shown in Figure 1.

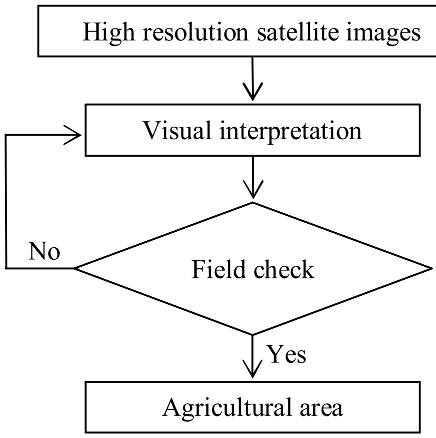

Figure 1: Image classification flow chat.

3. Agricultural geo-spatial database design and realization.
Agricultural geo-spatial database was designed to be the main database which would support web map service "GIS AGRO". Several agricultural data were collected from many sources and imported into database. Agricultural area was classified from satellite image by means of image to be inputted into the spatial database. The information of attribute data of agriculture area such as farmer's name and his picture, farmer's national identification number, crop area, land parcel identification number, starting date of crop growing, water source, predicted date of harvest, planting acreage, and predicted crop production was stored in document form by agricultural local agencies. It was them imported into database which could be analyzed and connected to geographic information system (GIS).

Moreover, other data which is related to agriculture, including administrative boundary, transportation, land use, soil suitability, slope and aspect, flood plain, irrigated zone, meteorological data, land parcel and household, and cash crop cultivated calendar were collected and imported to agricultural geo-spatial database on the same projection and coordinate system.

4. Web map service “GIS AGRO” development.
Web map service for agricultural management “GIS AGRO” will be developed from agricultural geo-spatial database. The complete system of GIS AGRO will provide information for five subsystems which are crop monitoring system, pest and plant diseases monitoring system, agricultural technology transfer system, weather forecast system, and productivity estimation system.

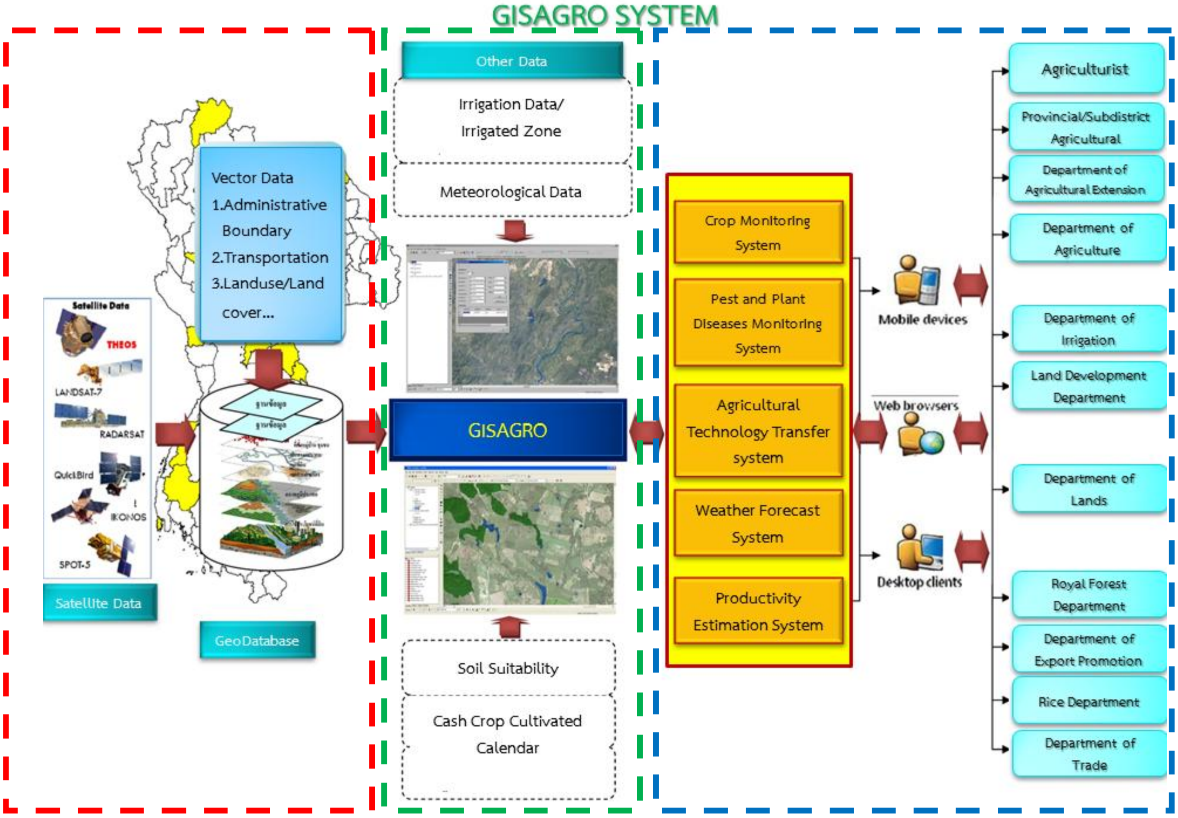

Figure 2: The overall GIS AGRO system, the first phase (red border), the second phase (green border), and the third phase (blue border).

In this paper, the first phase of the project (2012), will be presented consisting of image preparation and processing, image interpretation and classification, and agricultural geo-spatial database design and realization.

The second phase involving the web map service “GIS AGRO” will be developed from the first phase in 2012 and the last phase to produce the complete system will be concluded later to provide agricultural information to several users.

RESULTS

1. Image interpretation and classification.
The agricultural areas were not difficult to extract and interpret by visual interpretation and manual digitizing from pansharpening of high resolution satellite images. The delineation of agricultural boundaries was much clearer. Orchards or perennials such as mango, orange, longan, tamarind, and pararubber were easily identifiable, where rows of trees are clearly defined. (Figure 3)

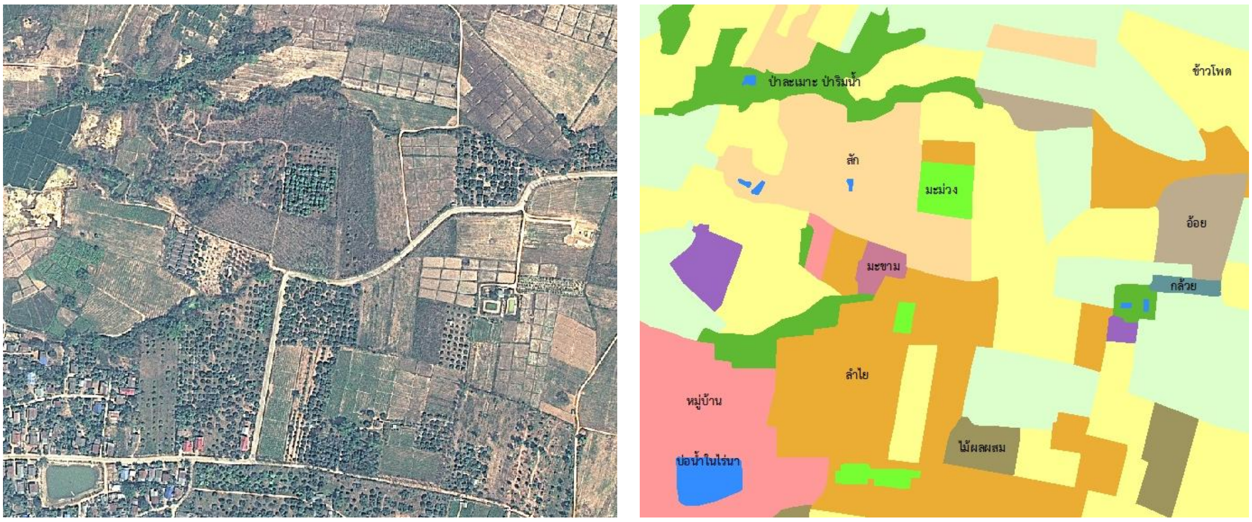

Figure 3: High resolution satellite image from WORLDVIEW-2 and agricultural area classification result.

2. Agricultural geo-spatial database design and producing.

The information of agricultural area that was stored in document form was connected to Geographic Information System (GIS). Such details include farmer's name and his picture, farmer's national identification number, crop area, land parcel identification number, starting date of crop growing, water source, predicted date of harvest, planting acreage, and predicted crop production. The attribute data structure is shown in Table 2 and Table 3.

Table 2: The information of agricultural area.

Colum	Data Type	Description
GID	Serial	Internal sequence number
GEOM	Geometry	2D MULTIPOLYGON
area_sqkm	Double	Calculate area in sq km
acc2_fk	Integer	Reserved
aac3_fk	Integer	Province code
aac4_fk	Integer	Amphoe code
aac5_fk	Integer	Tambon code
landuse_fk	Integer	Landuse code
species_fk	Integer	Crop species code
soil_group_fk	Varchar	Soil group code
proper_use	Boolean	Proper use vs soil suitability
water_fk	Integer	Water source code
farmer_ssn_fk	Integer	Farmer's national identification number
land_prn_fk	Integer	Land parcel registration number
grow_begin	Date	Starting date of crop growing
grow_end	Date	Predicted date of harvest
crop_count	Integer	Planting acreage
crop_yield	Double	Predicted crop production
yield_unit	Varchar	Unit of crop production

Table 3: The information of ownership.

Column	Data Type	Description
farmer _ssn_pk	Integer	Farmer's national identification number
title_th	Varchar	Title in Thai
name_th	Varchar	Name in Thai
surname_th	Varchar	Family in Thai
title_en	Varchar	Title in English
name_en	Varchar	Name in English
surname_en	Varchar	Family in English

Column	Data Type	Description
sex	Smallint	Sex
birth_date	Date	Birth date
nationality_fk	Ingeter	Country code showing nationality
addr_hrn_fk	Ingeter	Address house registration number
phone	Varchar	Mobile or telephone number
email	Varchar	Email address

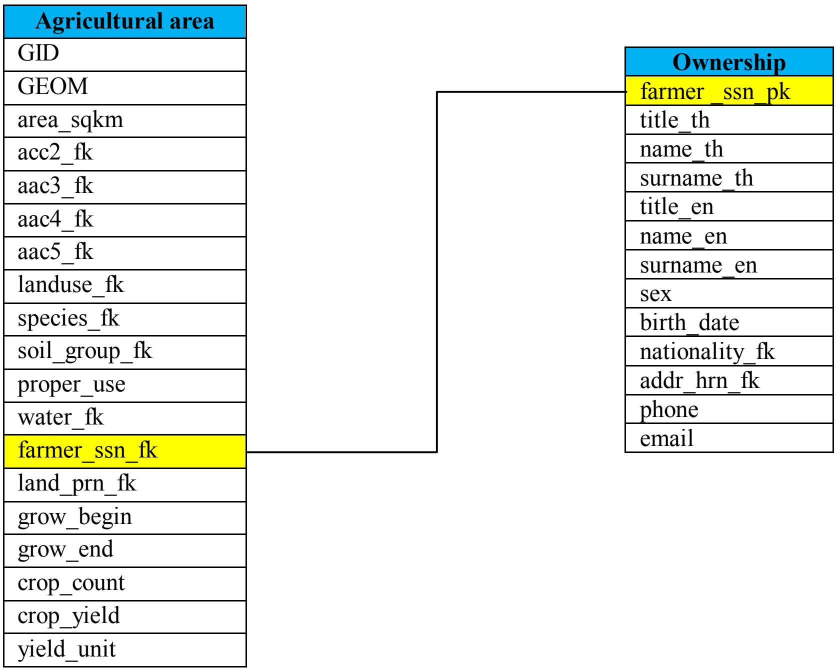

Figure 4: The structure and relationship of agricultural area and ownership.

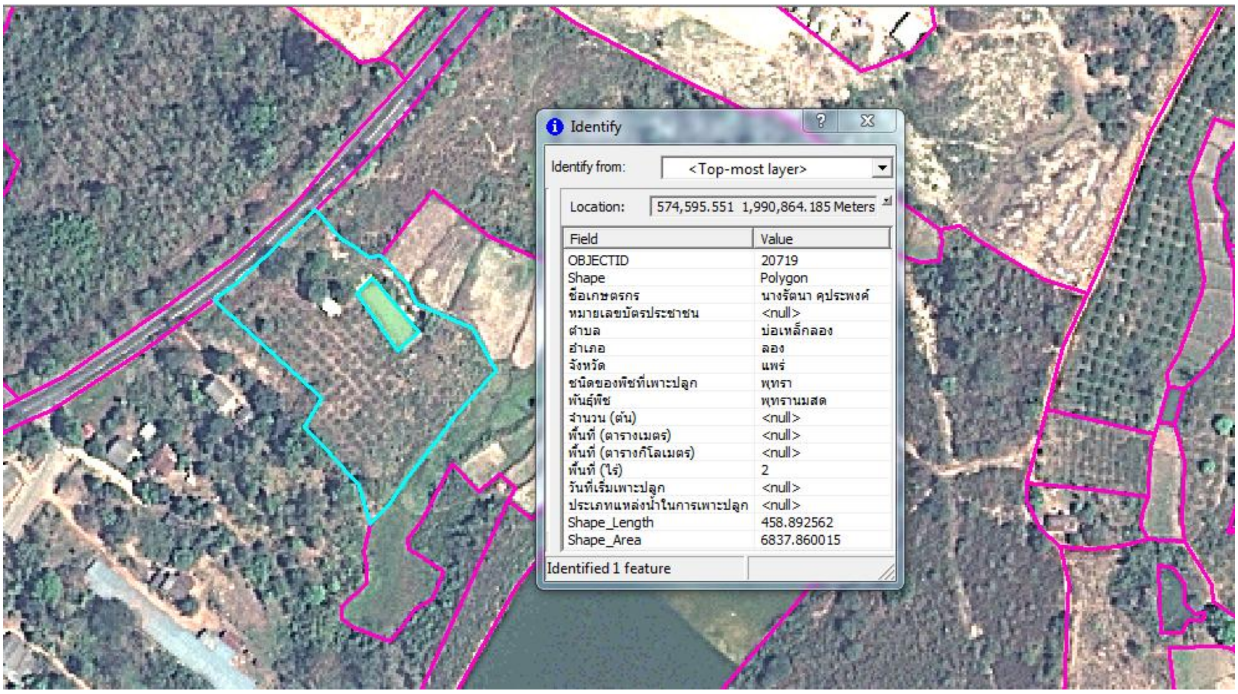

Figure 4: The information or attribute data of agricultural area on map

DISCUSSION

For image classification stage, availability of feature extraction and interpretation from high resolution pansharpened imagery by means of visual interpretation techniques and manual digitization was evaluated. Most features were easily extracted and interpreted. The vegetation boundaries of paddy field and orchard were clearly visible for manual digitization. The main difficulty of feature extraction and interpretation was field crop type classification such as sugar cane, cassava, corn, rice, and bean because the texture was similar. The ground truth information helps to confirm some of the ambiguous features identified from the imagery.

Several data from many sources were collected and imported to agricultural geo-spatial database. The main problem was not to overlay the data as they were produced from different base data and different coordinate systems. Geo-spatial database produced from same base data such as ortho satellite image is the best solution for this problem.

CONCLUSIONS & RECOMMENDATIONS

Applying the geo-informatics technology for agriculture development would be useful for agricultural management and monitoring of crops, quality control management for agricultural products, and planning of cultivation. It can provide valuable information related to agriculture for sustainable agriculture in Thailand. The online application for GIS services for agriculture management should be developed and widely used at all levels: the national level, regional level, provincial level, district level, and local agencies. The up-to-date data from satellite imagery and ground truth collection are the most important for the system. Therefore, the local agencies are not only the important users but also the essential supporters of the system to update the up-to-date data or information from ground truth to database.

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