

GIS DATABASE DEVELOPMENT FOR CHANGE DETECTION OF EGAT RESERVOIR AREA: TRESPASS AREA CASE STUDY

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ABSTRACT

For over years, areas around EGAT reservoirs have confronted invasions from the neighborhoods. The trespassed areas have been used for agriculture and accommodation which leads to complaints and compensations when the water level reached its maximum height and flooded area. Therefore, Electricity Generating Authority of Thailand (EGAT) has been designed and developed GIS database in order to support planning, problem solving, and decision making in the management of the invasions. The database contains orthophotos as a base map which overlaid with high resolution satellite images for change detection by visualization method, combines with maximum high water level vectors. The maximum high water level boundaries, that were collected directly from field by 3rd order direct leveling method, was used as a trespass reference datum. This paper demonstrates database design and development in change detection of Bhumibol reservoir trespass area, in Tak province, as a case study.

1. INTRODUCTION

The areas around EGAT (Electricity Generating Authority of Thailand) reservoirs have confronted invasions from the neighborhoods. The trespassed areas have been used for agriculture and accommodation which leads to complaints and compensations when the water level reached its maximum height and flooded the area. From the situation, there were legal issue between EGAT and severance that lives nearby, EGAT's field staffs in dam site area have been faced this problem without any proper geological information in hand. Therefore, the meeting of land use controlling and trespass area problem solving committee, the assembly consigned to Survey Department providing Geo-information System in order to monitoring the trespass area around seven EGAT reservoirs as follows; Bhumibol Dam, Ratchaprapa Dam, Sirikit Dam, Sirindhorn Dam, Srinagarind Dam, Ubolratana Dam and Vajiralongkorn Dam by using the Aerial Photograph from the Land Development Department with 1:25,000 scale maps, which were taken in 2002-2005, as base maps. In objective to serve operation planning, problem solving, and decision making. This study is advantageous in updating and accessing the data faster through world wild web network. In addition, this research will be used as an EGAT standard to support the other six in seven EGAT reservoirs invasion projects and will be the pilot system for any other invasion or related problem in departments of EGAT.

2. STUDY AREA

Sirinart Manasaknon (2012), the Bhumibol Dam's webpage administrator, gave some information on the webpage as follow, Bhumibol dam (formerly known as the Yanhi Dam) is the largest concrete arch dam in Thailand on the Ping River, a tributary of the Chao Phraya River, in Amphoe Sam Ngao district of Tak province, Thailand. It is located about 480 kilometers (298 miles) north of Bangkok. It is the first dam in Thailand that was constructed in 1958 and was finished in 1964. It was built for the purposes of water storage, hydroelectric power production, flood control, fisheries and saltwater intrusion management. The dam was named after King Bhumibol Adulyadej. As it is the largest dam, so it was boundary with severance's residents which leads to large number of invasion issues. Also, this area has been chosen as an pilot project due to completeness of its input data for analytical process in Figure 1 is shown the study area constitute with Bhumibol reservoir and its associated area, which consists of Bhumibol reservoir area, and the trespass area around the reservoir. The study area was placed in Amphoe Chomtong district, Amphoe Doi Tao district and Amphoe Hot district in Chiangmai province of Thailand



Figure 1 the study area

3. DATA AND METHODOLOGY

Data

The database contains orthophotos as a base map which compared with high resolution satellite images for change detection by visualization method, combines with maximum high water level vectors. The maximum high water level boundaries, that were collected directly from field by 3rd order direct leveling method, was used as a trespass reference datum.

The data of this study compose of raster data layer and vector data layer as follows;

1. raster data layer

Raster layers consist of two types of image to be used as the base map in order to see changes that happen over years. The type of image that were used as follow;

- 1) Orthophoto (2002) from Ministry of Agriculture and Cooperatives



Figure 2 Orthophoto (2002)

- 2) High resolution satellite image;
 - World view I (2008-2009)
 - Quick Bird (2006)



Figure 3 high resolution satellite image [Worldview 2008]

2. vector data layer

General vector data on base map

- 1) Base map: Street, Water way, Administrative district



Figure 4 Base map

2) Hydrological data from Hydrology and Water Management Center, Royal Irrigation Department Thailand

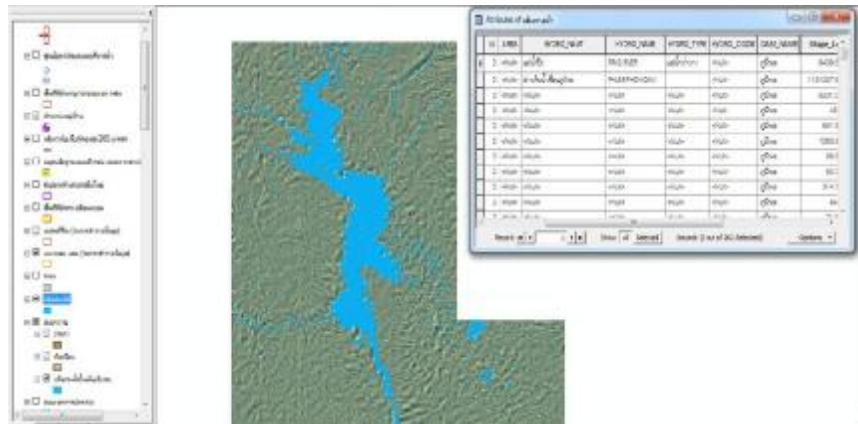


Figure 5 Hydrological data

3) Meteorological data from meteorological monitor and caution bureau, Thai Meteorological Department

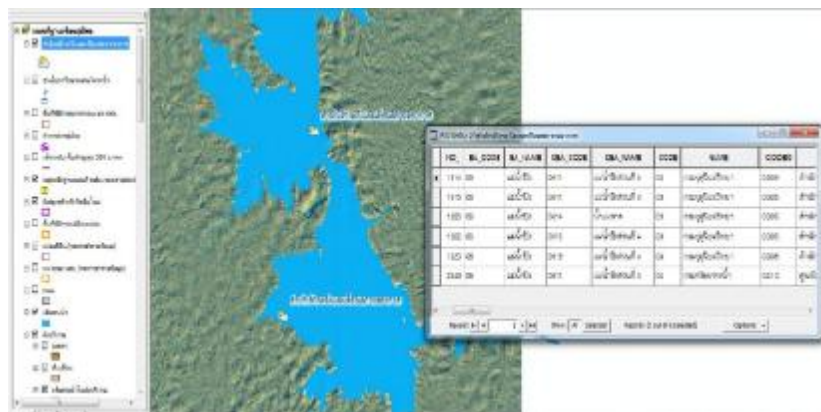


Figure 6 - Meteorological data

4) Land Parcel

Vector from image processing and analysis methods

1) High water level vector

High water level vector shows us the boundary of dam when the water hit it's the highest level. If severances' residents were placed below this 260 MSL of elevation, it will be concluded as invasion. There are 3 ways to get the vector as follow;

- a. Contour line at 260 MSL, which was digitized from 1:25,000 Topographic Map of Royal Thai Survey Department
- b. DEM which was generated from 2002 orthophoto
- c. Contour line at 260 MSL from 3rd order direct field surveying within purposed area (for recheck the area that was suspected as the trespass area)

2) New constructed infrastructures

The new constructed infrastructures are the evidence for invasion. Other than so, it can be used for damage evaluating issues that were caused by water level.

Methodology

Data preparation

- *Digitizing (from GIS Cookbook for LGUS)*
Digitizing refers to the capture of data from analogue maps into digital format. This study is used analogue map as 1:25,000 Topographic Map of Royal Thai Survey Department to conduct vector of 260 MSL level.
- *DEM Generating*
Peucker, Fowler, Little and Mark (1978) found that Digital Elevation Model, the data that contain elevation of the terrain over a specific area, which is derived by Triangulated Irregular Network (TIN). TIN is conceived of as a primary data structure which contains within it a secondary data structure in which the essential phenomena and feature of the terrain are represented and named as integrated, holistic objective. Different disciplines may regard different aspects of the terrain as the "essential phenomena" of the surface
- *3rd order direct field survey*
method of measuring directly with a graduated staff the difference in elevation between two or more points.

Database

- Relational Data Base Management System

Database is a collection of stored operational data used by application system of a particular enterprise. In this study used “relational approach to data is based on the realization that files that obey certain constraints may be considered as mathematical relations, and hence that elementary relation theory may be brought to bear on various practical problems of dealing with data in such files.” (Date, 1977)

4. STUDY METHOD

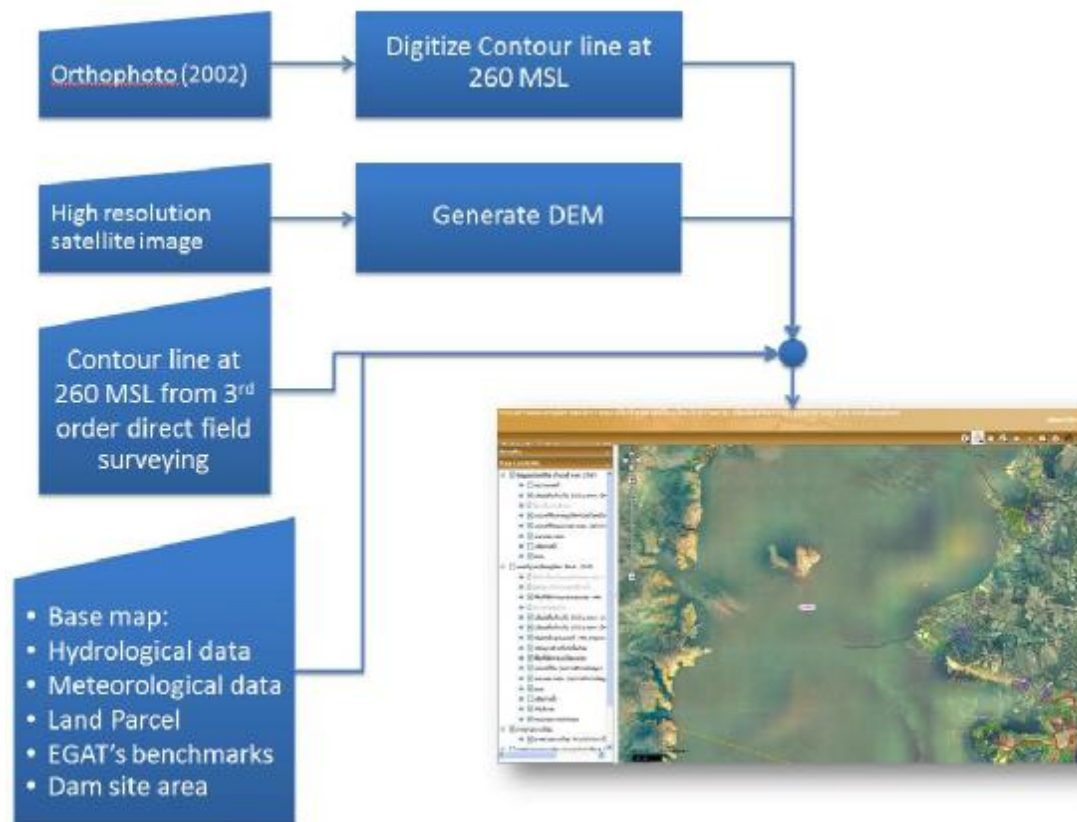


Figure 10 - process flow chart

From the flow chart (Figure 10), the study process starts with vector creation by three types from orthophoto after it has been through the rectification and interpretation process. These vectors are used for visualize the change detection that occur in area. Also, by using 3 isolated boundaries vector for visualizing can confirm accuracy and reliability in different sub-area. The contour line at 260 MSL was digitized from 1:25,000 Topographic Map of Royal Thai Survey Department, DEM was generated from 2002 orthophoto, and contour line at 260 MSL from 3rd order direct field surveying within purposed area. For the new structured buildings were digitized by high resolution

These three types of vector will be structured in high water level class of vector display with other general vector data on base map, which are orthophoto (2002) from Ministry of Agriculture and Cooperatives, High resolution satellite image (World view I (2008-2009) and Quick Bird (2006)).

There vector and raster are put into database as were designed the fields in tables below;

Table 1 CONTOUR260 data contains vector of dam;s boundary at 260 MSL

Field	Description	Type (Format)	Length (Bytes)
DAM_NAME	Name of Dam	Text	2
CONTOUR	Level of Contour	Text	3
TAMBON	Name of Tambon	Text	50
AMPHOE	Name of Amphoe	Text	50
PROVINCE	Name of Province	Text	50
REMARK	Any Remark	Text	50

Table 2 AREACHANGE table contains fields specifying both the type and origin of the data.

Field	Description	Type (Format)	Length (Bytes)
DAM_NAME	Name of Dam	Text	2
TAMBON	Name of Tambon	Text	50
AMPHOE	Name of Amphoe	Text	50
PROVINCE	Name of Province	Text	50
AREA_RAI	Area of Change area in Rai scale	Integer	4
AREA_NGAN	Area of Change area in Ngan scale	Integer	1
AREA_WAH	Area of Change area in Wah scale	Integer	2
LANDUSE	Specified how the change area change to use for any activity	Text	30
REMARK	Any Remark	Text	50

Table 3 RESPASSBUILDING table stores information pertaining to the new building in trespass area data.

Field	Description	Type (Format)	Length (Bytes)
DAM_NAME	Name of Dam	Text	2
TAMBON	Name of Tambon	Text	50
AMPHOE	Name of Amphoe	Text	50
PROVINCE	Name of Province	Text	50
TYPE	Type of Building	Text	30
REMARK	Any Remark	Text	50

There are some tools were used for preparing vectors, for example, Erdas and ArcMap 10, in process of rectification, interpretation, digitization, and DEM generation.

After got all layers prepared into database structure, it was used to connect to webpage for easier accessibility. On webpage, it displays vector and raster data which can swipe to detect changes.

5. RESULT

The study method above leads to webpage as a communication channel for staff to access the information directly in order to plan, solve problem and make decision in field. Components on the webpage consist of base map, layer vectors and swipe tool to present different of the area in years as shown in picture below (Figure 11).

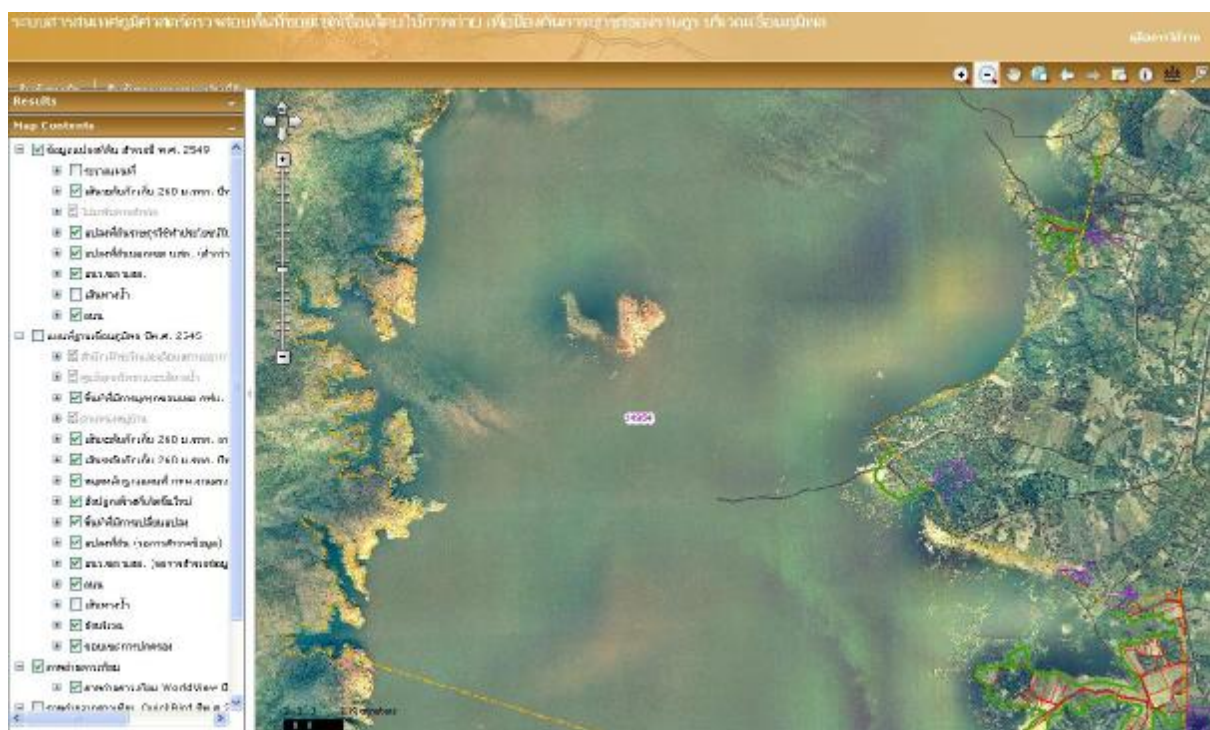


Figure 11 - web site available on EGAT's intranet, provides reservoir and trespass area information

6. CONCLUSION AND DISCUSSION

From gathering all basic data and form into layers to develop into database and present on webpage can serve EGAT's field staff to have all the information for operating in hand at all required time to manage issue in reservoir in trespass area. In this study discussed in two aspects. One is data preparation and another is database.

For data preparation aspect, the study is used analogue map as 1:25,000 Topographic Map of Royal Thai Survey Department to conduct vector of 260 MSL level which according to GIS Cookbook for LGUS (year), Digitizing refers to the capture of data from analogue maps into digital format. Moreover, DEM which was generated from 2002 orthophoto followed in DEM generating theory of Peucker et al. (1978) which found that Digital

Elevation Model, the data that contain elevation of the terrain over a specific area, which is derived by Triangulated Irregular Network (TIN). TIN is conceived of as a primary data structure which contains within it a secondary data structure in which the essential phenomena and feature of the terrain are represented and named as integrated, holistic objective. Different disciplines may regard different aspects of the terrain as the “essential phenomena” of the surface. In addition, this study contained field survey which followed in 3rd order direct field survey standard of Bossler (1984) who promulgated FGCC standard.

For database aspect, this study designed the database by Relational Data Base Management System principle followed in Date (1977) who said that Database is a collection of stored operational data used by application system of a particular enterprise. In this study used “relational approach to data is based on the realization that files that obey certain constraints may be considered as mathematical relations, and hence that elementary relation theory may be brought to bear on various practical problems of dealing with data in such files.”

Entirely, the study in Bhumibol Dam is used as the pilot project for EGAT’s invasion monitoring and other related purposes of work.

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