COLOR PHOTO MAPPING : THE LARGE SCALE BASE MAP OF THAILAND

By

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Abstract

The problems of illegal land holding in Thailand have increased drastically at present due to unclear boundaries of national forests and public properties. The most important problem is that illegal land holdings do not coincide with the land title maps. Large scale maps (1:4,000) are needed for use as base maps for data compilation and analysis. The unit of land parcel in Thailand is “rai” (625 rai = 1 hectare). To make it easy we use the scale 1:4,000 because 1 rai equals 1 gridcell of 4 square centimeter. This is the reason that Thailand applies the scale 1:4,000 for its base map.

During the year 2000, the Ministry of Agriculture and Cooperatives of Thailand had produced 1:25,000 photo maps from 1:25,000 aerial photographs in the project “Natural Resources and Property Management.” The cabinet then allowed the Ministry to produce 1:4,000 photo maps from the aerial photos at the scale 1:25,000. Although satellite imagery has been applied in many fields, it does not meet our requirements since we cannot use height. The other advantage of the aerial photos is that the cost of this application is only half the price of using other sources.

The project began with taking color aerial photographs of the whole country, with a flying height of 3,800 meters, then film scanning, conducting a ground control survey, extension of photo control points, DEM editing and mosaicking, producing 130,000 sheets at the scale of 1:4,000 and 3,300 orthophoto sheets at the scale of 1:25,000. The accuracy of the orthophotos is 1 meter horizontally and 2 meters vertically on flat terrain, while in mountainous areas it is 2 meters and 4 meters respectively.

No digital base map in the same standard for the whole country for use in GIS existed in Thailand. This had the disadvantage that every agency needed to produce their own from the topographic map at the scale 1:50,000 scale, using different equipment and methodology.

After completion of the project the base maps have been widely used among government agencies i.e. for field surveying, data retrieving and as base map in a GIS environment as well as for land titles. The most important application was to serve as the data base for solving the problem of illegal land holdings in Thailand.

Background
Rapid population growth in the recent past has led to land degradation and deforestation in attempts to clear land for cultivation, illegal logging for processing in the industry, for making charcoal and the collection of firewood. Moreover, road and dam construction has led to merciless cutting of trees without considering conservation of the land. In Thailand land conservation is the responsibility of the Ministry of Agriculture and Cooperatives which, as a planning agency, is also taking care of planning for sustainable land use, through which not only further degradation of land should be stopped, but also the already degraded areas would be gradually reclaimed.

The Thai Cabinet approved a mapping project for natural resources and property management on October 30 and November 7, 2000. It included inventing of agricultural data and natural resources of the whole country by application of color photographs to produce color orthophoto maps to be used for monitoring the present natural resources, and analyzing and classifying of present land use/land cover including property management. The unclear boundaries of national land reserve areas (i.e. forests, public and community land) led to difficulties for classification in situ.

This project on natural resources and property management of the Ministry of Agriculture and Cooperatives was divided into 2 phases: the production of color aerial photography and the production of orthophoto maps. The color aerial photography was conducted by the Royal Thai Survey Department (RTSD) and a Joint Venture Group (JVG). The production of the color orthophoto maps was performed by ESRI (Thailand).

The unit of land parcel in Thailand is the rai. One rai is equal to 1600 m²; therefore the map scale 1:4000 is expedient for measuring land areas. This is the reason why the map scale 1:4000 is used in Thailand.

Previously, in GIS environments in Thailand the fact that there was no uniform digital base map, produced to the same standard for the whole country, brought problems. Each agency had to make their own digital base map from the topographic map at the scale 1:50,000. Different equipments and methodologies caused many errors.

**Objective and Project Operation**

Therefore, it was the objective of this project to produce a large scale orthophoto map at the scales 1:4,000 and 1:25,000 covering the whole country according to the same specifications.

The operation of the mapping project on Natural Resources and Property Management of the Ministry of Agriculture and Cooperatives had been divided into 2 tasks namely Color Aerial photography and production of the orthophoto map.

The production of the color photographs at the scale 1:25,000 had been conducted by 2 agents, the Royal Thai Survey Department (RTSD) and the Joint Venture Group (JVG).
RTSD was responsible for conducting the aerial photography in the northeastern part of Thailand with a total area of approximately 171,289 square kilometers.

The Joint Venture Group (consisting of Thai Flying Service Co. Ltd, Kevron Aerial Survey PTY.Co., Finnmap FM. International OY and IGN France International) was assigned to conduct the aerial photography covering the northern, central and southern part of Thailand with a total area of 342,600 square kilometers (see figure 1).

Figure 1. The part of aerial photography performed by RTSD(at right) and the part performed by JVG.

Production of the Color Orthophoto Map

The production of the color orthophoto maps was performed by ESRI (Thailand) Co. Ltd. After taking the aerial photographs, color negatives were scanned at the resolution of 15 microns. Meanwhile, in a ground control survey, the establishment of a ground control network was conducted. Ground Control Points (GCP) were used as the reference points for locating photo control points (or photo controls). The photo controls obtained from the ground survey were used to get more photo controls in every photo in the process called aerial triangulation (AT). For the production of the orthophoto map,
topographic heights are required in order to eliminate the relief displacements in the aerial photography. A Digital Elevation Model or DEM was constructed and used for ortho-rectification. After that, orthophoto maps were produced. The orthophoto maps were mosaicked into large maps.

After that, they were cut into the required size of sheets at the specified map scale. Under the Mapping Project on Natural Resources and Property Management of the Ministry of Agriculture and Cooperatives there is a total of 130,000 sheets of color orthophoto maps at the scale of 1:4,000 and 3,300 sheets at the scale 1:25,000.

Products of the Project

The project resulted in several products that can be used afterwards:
1. Aerial photographs at the scale 1:25,000 (of which the negatives have been scanned at a resolution of 15 microns).
2. A DEM Digital Elevation Model with points for elevation measurement being random at the interval of 5 meters.
3. A contour map. The contour interval is 2 meters in flat areas and 5 meters in mountainous areas.
4. Ground Control Points. There are 2810 ground control points, spread all over the country and being adjusted at the same time.
5. A photo map at scale 1:4,000 in 130,000 sheets, being generalized subsequently to a map at the scale 1:25,000, in 3,300 sheets. The accuracy of the photo map is 1 meter horizontally and 2 meters vertically on the flat plain. In mountainous areas the accuracy is 2 meters horizontally and 4 meters vertically

Utilization

1. Use as base map

Because the photo map covers the whole country and because ground control networks were adjusted simultaneously, and the map itself was produced according to the same standard all over the country, it now became the new base map for the country. This map now can be used, for example:

1.1 To locate the exact administrative boundaries. Previously, these boundaries had been located on the topographic map at the scale 1:50,000. When it was transferred to the scale 1: 4,000 map, it caused a lot of errors, so it should be reallocated in order to fit to the environment of the scale 1: 4,000 map.
1.2 For town and country planning

Because of its large scale the base map can serve as a basis for town and country planning maps. As it is based on aerial photo imagery it is easy to recognize the locations depicted.
1.3 Utility and Housing

Again, the large scale and the easy recognition make the base map a proper tool for planning utilities like water and sewage pipes, electricity and cables up to the individual houses. Figure 5 shows an example.

Figure 5 Application of the base map for planning utilities and housing

1.4 Land Use Change detection
Figure 6 Application of the base map for land use change and detection

The comparison between the two images in figure 6, one from 1998 and the other from 2002 shows the rate of change and the nature of the change in this period.

1.5 To detect and protect National Land Encroachment
1.6 To indicate the area under jurisdiction of the Provincial Electricity Authority

Figure 8 Example of use of the base map for Jurisdiction Area Allocation for Provincial Electricity Authorities

The base map can also be used for showing the areas for which the provincial Electricity Authorities hold responsibility. This can be done as in figure 8, by showing the power lines and the transformer stations. This application is similar to that meant for utility and housing.

1.7 GIS for Public Health Care

In the base map in figure 9 a critical 100 meter radius around a bird flu infected farm has been drawn in. In combination with the smaller scale map on which the distribution of the chicken/poultry farms can be seen the threat to other farms can be assessed and the number of farms to be disinfected can be analysed.
Figure 9 Example for bird flue infected as distributed area
2. Locate the properties of the Ministry of Agriculture and Cooperatives

The Ministry of Agriculture and Cooperatives is responsible for many fields, forests and other tracts of land. These can be permanent forest areas, agricultural and cooperative land reform areas and cooperatives promotion settlement etc. On the base map 1:4,000 the land areas this Ministry is responsible for are registered, and it is possible, by comparing these land areas and the area under cultivation, as visible on the aerial photo imagery, to detect the infringements of private farmers on state land. Because of its high agricultural density farmers are tempted to also use state forests, deforested for illegal logging or even cultivate state land which results in illegal land holdings. Because of the production of the 1:4,000 base map the Ministry now for the first time can produce a database with information on the extent of these illegal holdings.

Conclusion

After the completion of the project, the photomap has been widely used all over the country. Especially local administration agencies use it for taxation purposes, and also use it for field collection, to solve the problems between private lands and public lands. Finally, it is very important that the various ministries and institutions that deal with land property, agriculture and highway construction now can all refer to the same cartographic data base for use in GIS, and so exchange their plans to one another, and better coordinate their plans.