
Development of the Decision Support System for Land Use Planning by Geo information Technology

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Introduction

Among the problems in land management in Thailand, there are the number of authorized agencies, laws relating to the determination of land use zones and multiple land use measures as well as. many cabinet resolutions. In practice, many problems occur i.e. the land boundaries are not clear and the dispute between public sectors, public and private sectors and between people. In addition to the problem of management, there are also significant problems with inappropriate land use involving the area condition and soil quality. The benefits of land use are not fully realized. The theoretically inappropriate land use causes soil degradation.

This research aims to develop a decision support system for planning sustainable land use. The study analyzes the essential factors for setting up the Geographic Information System (GIS) database and its web allowing users to the database for analyzing the potential of the land. The analytical model was generated from local, legal, academic and administrative data to support the user's decision by offering the alternative uses. The developed tool will enable the application of GIS technology to sustainable land use planning for solving land management problem more effectively.

According to the survey and mapping in BE 2553-2556, the land use in Thailand is mostly in agriculture of 174.31 million Rai, accounting for 54.36% of the country's total area, followed with the use for community and building of 16.52 million Rai (5.15%), miscellaneous area of 11.63 million Rai (3.63%) and water sources of 8.98 million Rai (2.80%).

Office of Policy and Planning, Environment and Natural Resources (BE 2557) refers to the definition of land use from multiple sources. For example, FAO (1989) states that land use planning is the systematic assessment of land potential for the most economically and socially suitable land use as well as public needs. Stamp (1967) states that land use planning is an important tool in balancing the satisfaction of local groups to meet the 6 needs of food production, housing, industry, recreation, transport and stability. Shaller *et al.* (1968) emphasizes the importance of land use planning. While land is the limited basis of the natural environment, the constantly growing population needs land for at least 6 purposes: farming, pasture, forest, towns and roads, industry, specific activities such as parks, wildlife sanctuaries, national security, water reservoirs, mines, dirt-stone, cemeteries, golf courses, etc. Where never-ending demand meets limited natural resources, the utilization plan of land and related is needed. Harle (1994) states the 5 main objectives of land use planning are to create a better living and working environment in both urban and rural areas, to conserve nature as heritage for next generations, to ensure economic stability in land use, to ensure proper use of land and either natural or man-made resources and to reduce the conflict between land users. Vogt (1948) linked land use planning to environmental principles with their carrying capacity of each type of land under the environmental restrictions for the maximum output of any activities and the environmental impact when the use is exceeded.

Department of Land Development (2000) has developed a manual for soil suitability for economic crops in Thailand. From the on-site study according to Soil Taxonomy, the soil classification is based on their physical and chemical characteristics including some conditions affecting on the crop's growth or yield. Soil Taxonomy is well-structured and easily transferred system to reduce the time and expense of studying. The soil suitability for economic crops are classified, evaluated and translated into simplified information of the suitability for planting, the constraints affecting the growth and/or impact of crop productivity and severity. This information is a baseline for addressing and solving these constraints to obtain the reduced investment costs with worthy returns.

The recorded data of physical and chemical properties as well as some environmental conditions from on-site survey was classified for economic crops in Thailand, based on the principles of Soil Taxonomy classification. The soil suitability for crops can be divided into 4 groups i.e. rice, field crops, fruit plants and permanent pastures. The appropriate 5-class stratification consists of 1) Very Well Suited Soil, 2) Well Suited Soil, 3) Moderately Suited Soil, 4) Poorly Suited Soil and 5) Unsuitable Soil.

Techniques in System Development

The decision support system for sustainable land use planning was developed with a database and a set of instructions to work via the Internet. The database of the relevant GIS data layers consists of information layers related to land use, management and planning in terms of characteristic features, utilizations, laws and regulations. The data collection includes the case study of land use planning analysis in Chonburi. The researcher developed the area analyzing tool with the capacity of Geoprocessing Service of ArcGIS for Server installed on the server of the database where the central system's total Relation Database was stored. It is accessible via the developed application-installed server. It also provides the system's Web and RSS Services. Users can access via the link URL <http://www.slup-chon.org/> or temporary URL <http://119.59.123.116/SlupChon/> on a Web Browser. However, the application of decision support systems develops the 3 analysis conditions: (1) the case analysis of land use constraints and conditions; (2) the case of sustainably appropriate land use guideline and (3) case analysis to determine the optimum decision support for land use.

The system development applies geographic information, covering both fixed parameters and variables, to support the most appropriate selection and planning of land use with maximum yields and benefits according to characteristics of soil resources, properties and environment of the area including its sustainability. It also includes the relevant laws and regulations, such as conservation area, legal requirements of city planning, building control, environment as well as policies and plans for local development. The management approaches and academic tools involving sustainable conservation and utilization of the area such as appropriate measures for watersheds, conservation and rehabilitation measures, measures to manage cropping and so on. All data were collected and prepared for geographic information database designed using geo-information technology. GIS web was developed for the users' access to the database via internet. The concept of research and development process is shown in Figure 1.

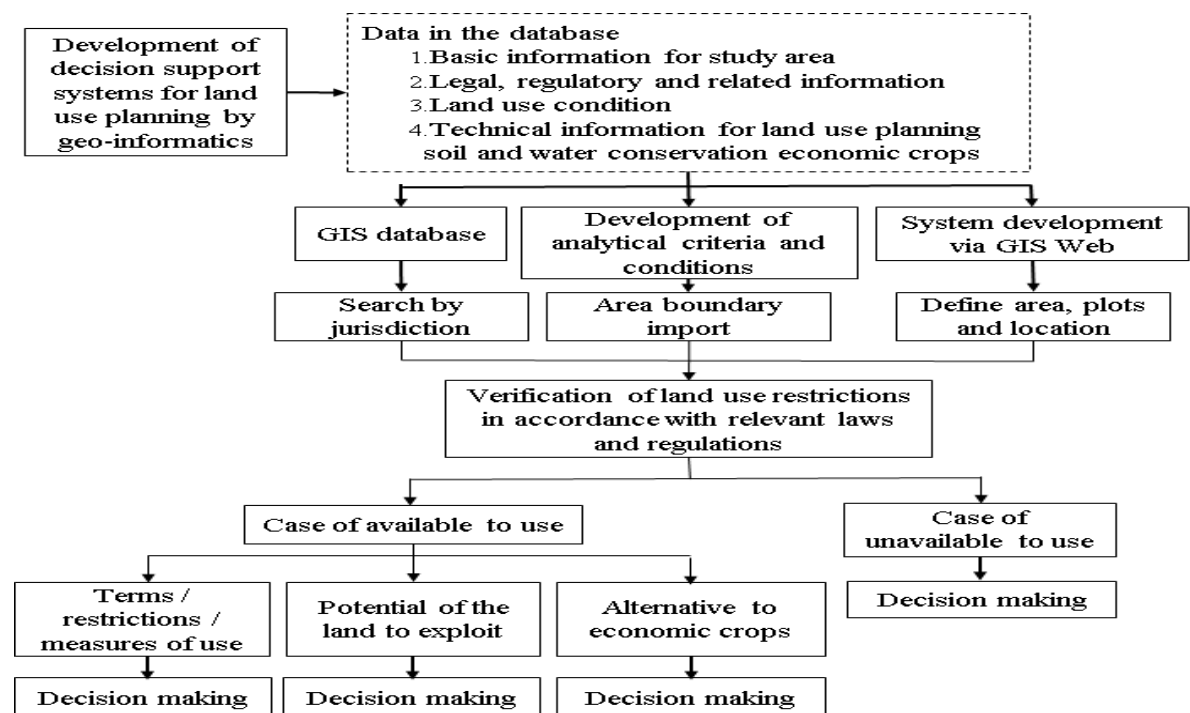


Figure 1 Conceptual framework for research and development
Geo-informatics

In this study developed a databases of information both from geospatial databases and reports academic papers. The conditions for analysis were determined for an alternative approach of decision support in land use planning. The data layers prepared for the geographic information databases in this research are shown in Table 1.

Table 1 GIS data layers in the system development

No.	Data Layers	Source / Source Data
1. Data Group of Basic Information for Reference		
1	Administrative regions	Royal Thai Survey Department; Department of Provincial Administration
2	Office of provinces and districts	Royal Thai Survey Department; Department of Provincial Administration
3	Transport routes	Royal Thai Survey Department
4	Water sources and routes	Royal Thai Survey Department
5	Location of villages and communities	Royal Thai Survey Department
6	Key reference locations	Royal Thai Survey Department and related agencies' databases
7	Altitude and elevation indicator	Royal Thai Survey Department
2. Data Group of Basic Information for Analytical Factors		
8	Soil group mapping information	Land Development Department
9	Soil series mapping information	Land Development Department
10	Land use survey mapping information	Land Development Department
11	Forest conservation mapping information	Department of National Parks, Wildlife and Plant Conservation
12	National reserved forest mapping information	Royal Forest Department
13	Slope mapping information	Applied from Royal Thai Survey Department's elevation map
14	Mapping information of land reform area for agriculture	Office of Land Reform for Agriculture
3. Data Group to Define Analytical Conditions		
15	City planning	Department of Public Works and Town Planning
16	Building control zone	Department of Public Works and Town Planning; Local administration
17	Land use measures based on watershed classification	Office of Natural Resources and Environmental Policy and Planning
18	Demand for crops in planting	Land Development Department
19	Suitability of soil for cultivation of economic crops	Land Development Department
20	Techniques and methods for soil and water conservation	Land Development Department
21	Environmental protection area and measures	Office of Natural Resources and Environmental Policy and Planning

Analysis of data supporting land use planning**1. The analysis of constraints and conditions of land use**

The required factors for the data layers were determined with the studies and analysis for GIS. The analysis approach is to import the data of the user's Area of Interest (AOI) either by locating, assigning or defining the area to check with the conservation area, restrictions or regulations to find the utilization limitations. The characteristics of the area can be extracted and viewed as illustrated in Figure 2.

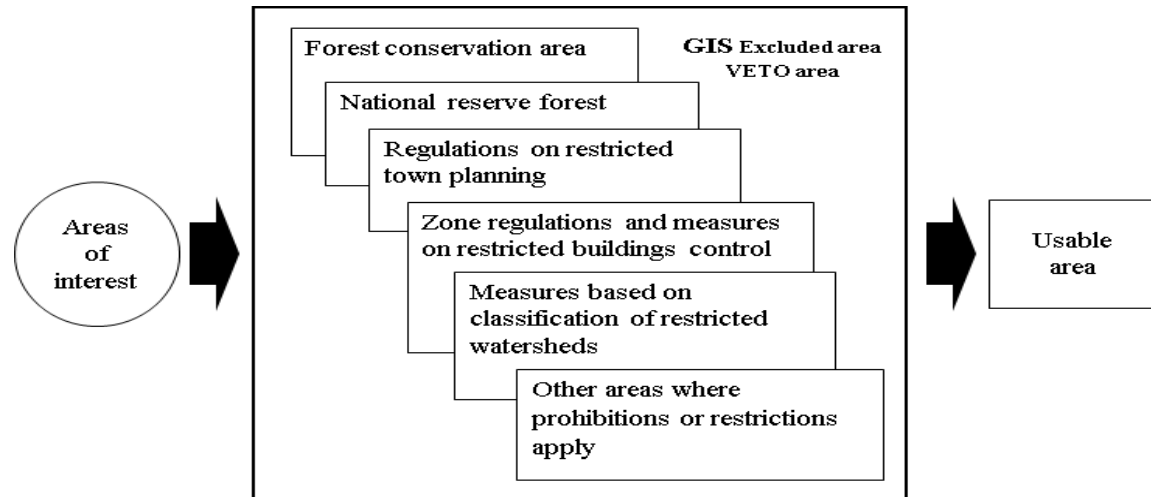


Figure 2 Concept of data management for the analysis of constraints and conditions of land use.

2. A guideline of land use and appropriate conservation for sustainability

Data of the available area that users can use to plan and decide on appropriate land use and to conserve soil and land for sustainable use were studied and analyzed. In spite of the availability, the conditions may be set for either land use or activity. The concept of analysis is illustrated in Figure 3.

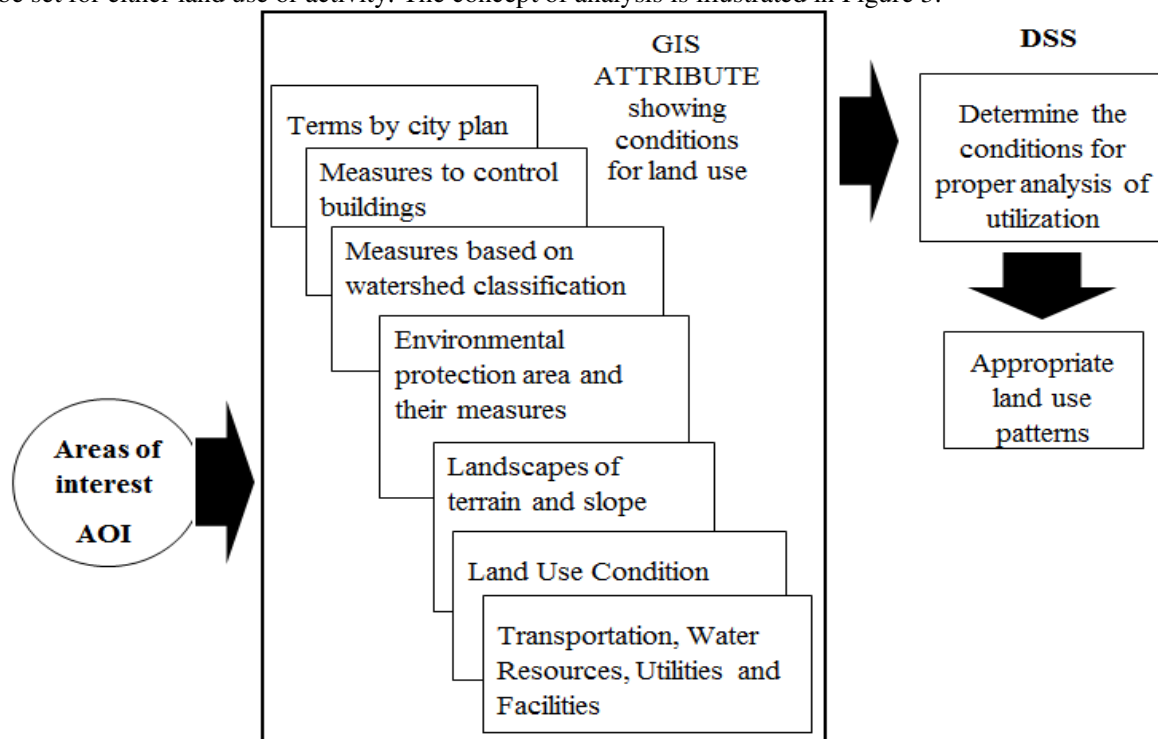


Figure 3 Concepts of data layer management of land use and appropriate conservation for sustainable utilization

3. An analysis as the decision support guideline for land use with maximum benefits

Soil features and properties, cultivation, average yield of main economic crops, together with the needs of crops, information on plantation and soil suitability for the crops including techniques and methods for soil and water conservation were studied and analyzed to determine the decision support guideline for land use with maximum benefits.

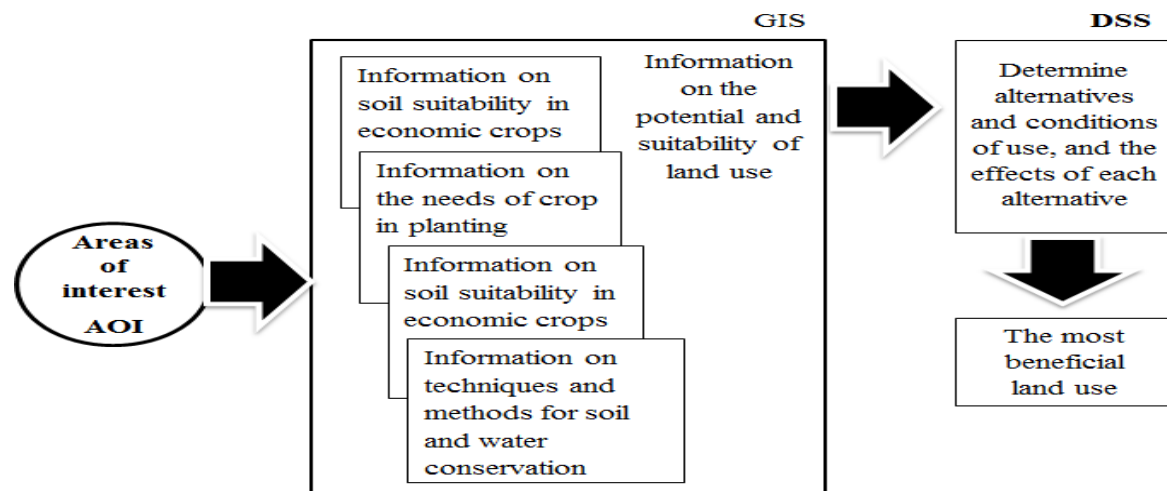


Figure 4 Concept for data layer management when analyzing to determine the decision support guideline for land use with maximum benefits

Instruction of the system

To access the system, visit <http://www.slup-chon.org/> or the temporary URL at <http://119.59.123.116/SlupChon/>. The online map of Chonburi province will be visualized including its interesting locations and information. There are tools for finding places in the selected area, asking for an inquiry, measuring distance, calculating area and evaluating the suitability for cultivation in the area of interest.

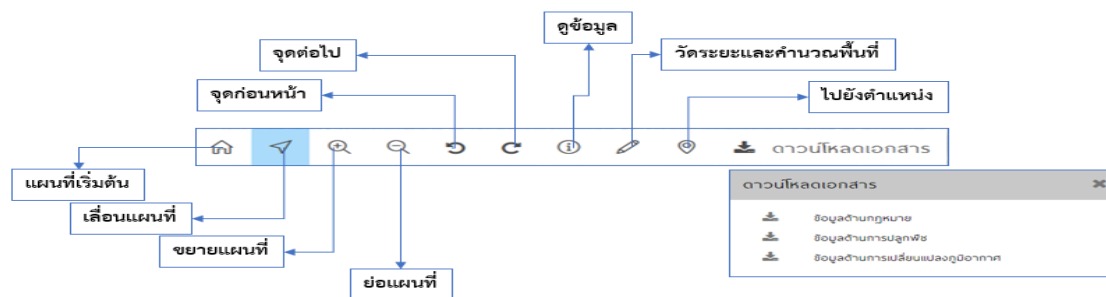


Figure 5 Basic menu of the system

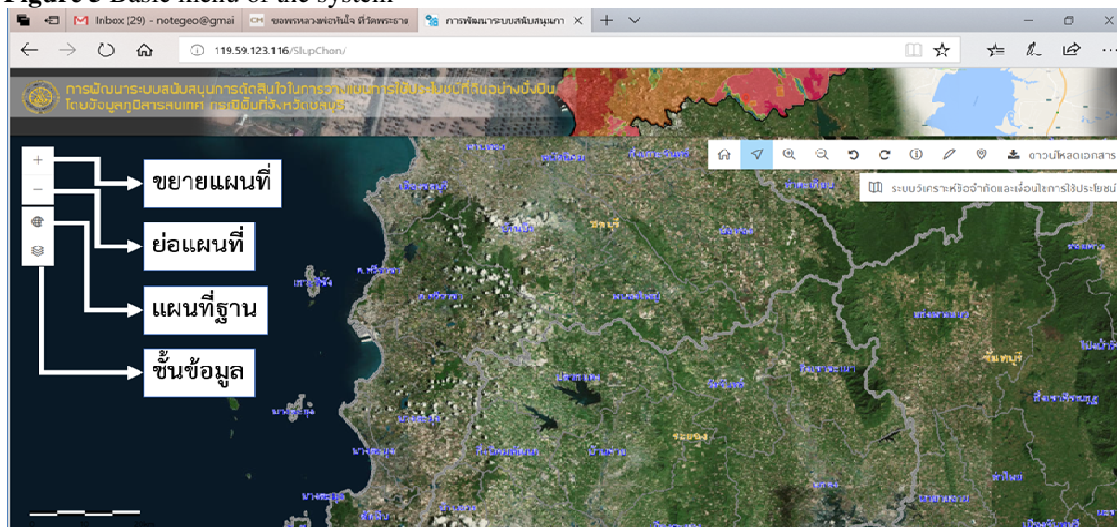


Figure 6 GIS system's web menu. Users not need any geographic information basis

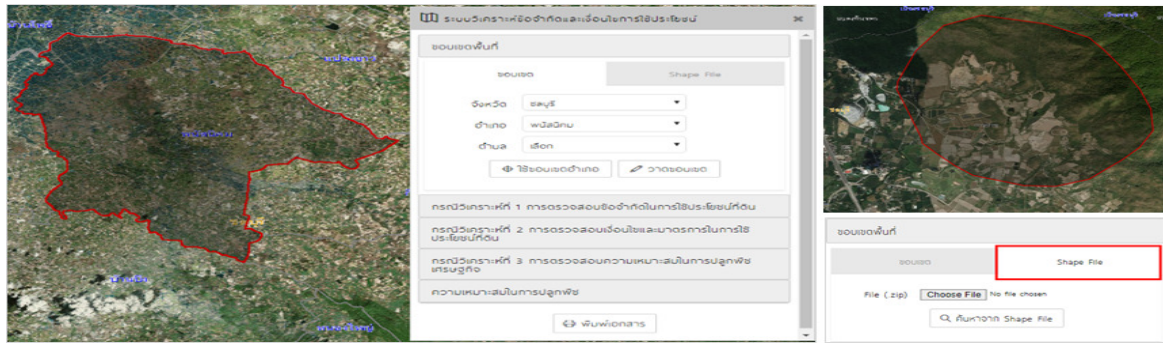


Figure 7 A function to set the area of interest. This can be done by either selecting the district, drawing on the screen or importing an .shp file.



Figure 8 An analysis function of 3 cases after scoping down to the chosen area. Every data layer in the area of interest is shown.

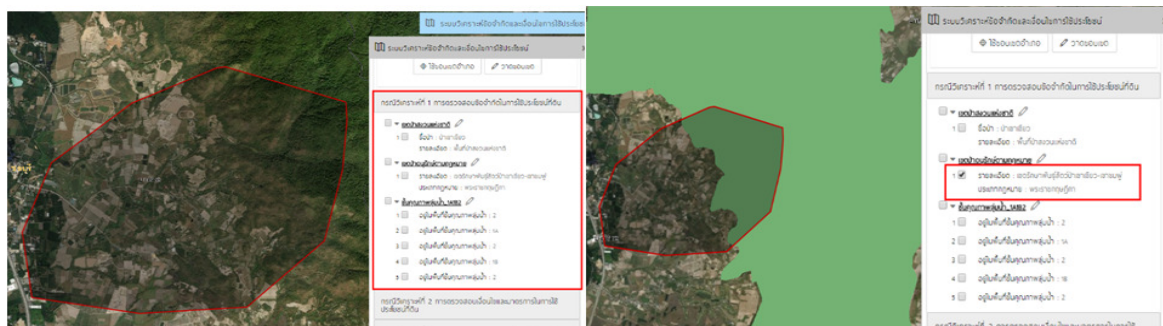


Figure 9 A display of analyzed constraints and conditions in land use

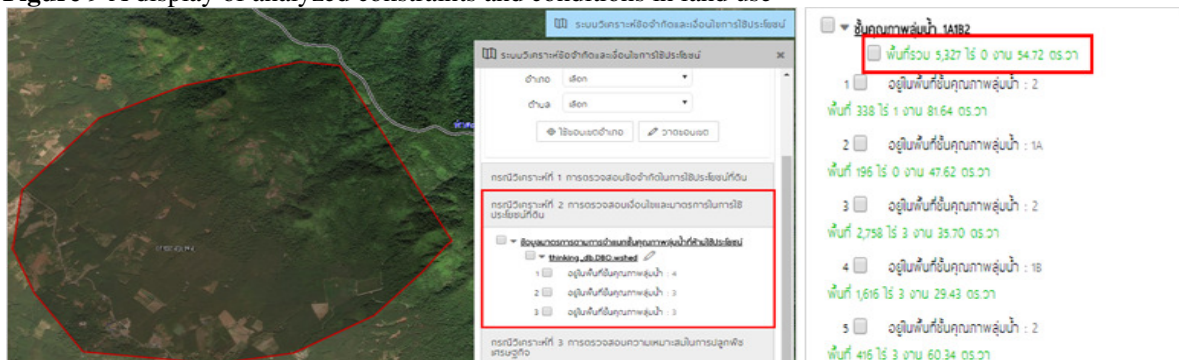


Figure 10 A display of the guideline of land use and appropriate conservation for sustainable utilization

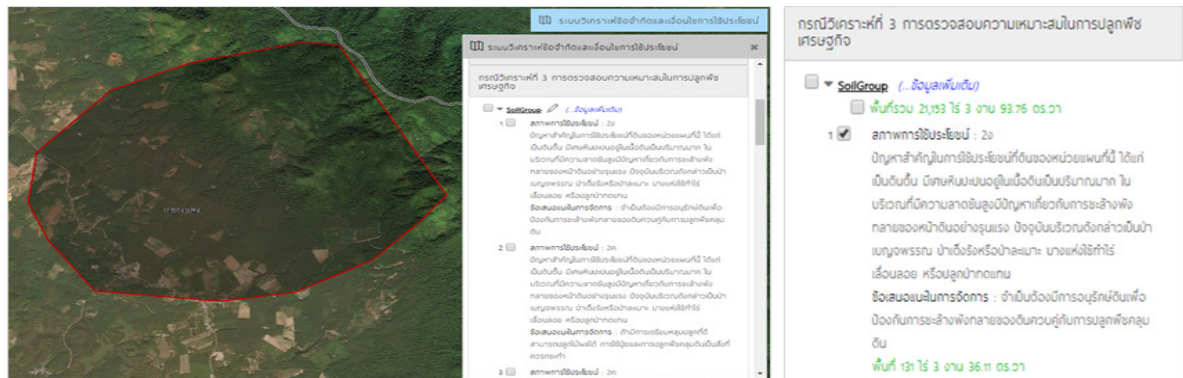


Figure 11 A display of analyzed decision support for land use with maximum benefits

Advantages and benefits of the development

There are advantages and benefits of the development of the system: (1) It is the database system of relevant regulations with overlying layers of data and measures. Users can find the information quickly, easily and interpret correctly. User can check the specification of the area of interest whether there are any implemented law or regulation, regulatory measures and how to treat each issue. This makes it more comprehensive; (2) The system design, which analyzes data of each plot and enables the users set their own area of interest, is user friendly and gives the accurate and precise information of each plot; (3) The GIS web system development reduces the need to travel to agencies to verify the land requirements which consumes less time; (4) The system supports decision making in planning and utilization processes both with regulations and land potential.

Developmental approach to research extension

As the results of this research, geoinformatics technology can be used in land use planning in terms of laws and regulations. The developed GIS web system simplifies the data access for the users who do not have geo-informational skills. Therefore, the system is useful for land searching, the use planning and decision making. For further development of the system's concept of this system, the data of relevant agencies should be integrated and accessed online. The concept will be extended to maximize the benefits of land use planning and the conservation of land and soil resources for sustainable use.

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