UTILIZATION OF LAND AND LAND USE INFORMATION SYSTEM ON SOILS DERIVED FROM WEATHERED BASALT FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT IN CENTRAL HIGHLANDS OF VIETNAM

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ABSTRACT

The Central Highlands of Vietnam has characterized by popular distribution of soils originated from weathered basalt, which occupied 1,455,200 ha. Thank to high fertility these soils are considered suitable for many crops, especially such cash crops like coffee, rubber, pepper.... Recently extensive planting some crops, such as coffee, tea, fruit-tree ... and expanse of cultivated land of migrant farmers have made deforestation gone out of control, irregular floods.... Long drought, lowered water level brings adverse effect on crop yield. To meet appropriate and economic agricultural planning on basalt soils at Central Highlands the Land and land use information system was established.

Land and land use information system on basalt soils at Central Highlands based on GIS is specifically designed for generating readily accessible and transferable information on physical land resources in both map and tabular formats which are used for agricultural resource management and development planning. This information system includes information on soil, land use and other pertinent socioeconomic of agricultural production data.

1. INTRODUCTION

The Central Highlands including 4 provinces lies in the western central region. In Vietnam there are 2,396,800 ha of soils generated from weathered basalts, in which more than 60 % distributed at the Central Highlands.

Soils originated from weathered basalts are considered precious with the most magnificent soil depth and fertility among soil associations derived from basic and neutral magma. Hence, these soils are suitable for numerous crops, especially cash crops like coffee, rubber, pepper....

However, recently extensively planting some crops, namely coffee, tea, fruit-tree ... and expanses of cultivated land for foods of many migrant farmers have resulted to deforestation, both natural and planted forest, gone out of control, vegetation cover evidently reduced,

floods frequently and frightfully occurred.... Long drought, lowered water-level have made thousands ha of yield loss coffee plantation cut down, and bring adverse impacts on productivity of other irrigated crops. Both excessive and unsound fertilizer utilization by rich house holders or putting down fewer fertilizer by the poor not enough to recover soil nutrients that have caused critically soil degradation.

Now there have been plenty of fundamental investigations carried out on soils, land use, most of which are stored, managed with manual, single and not systematic approach. Therefore, to look up or update data have been much more difficult.

The qualitatively and quantitatively land resources inventories by utilization types and impact assessments are oriented forward suitable land use lay out on basalt soils for agricultural activities in the Central Highlands, that bring into play the advantages and overcome the shortcomings in building development strategies, giving guidance in production and initiating technology solutions guaranteed for economically effective and sustainable land use. So, to establish the information system on land resources and employment conditions of these resources becomes the urgent and realistic requirements which are concentrated in applications of information technology for land resources systematism, management and inventory, that assist evaluating land resources dynamics over different periods of time, and to promote abilities to set land use in accordance with the regional socioeconomic development demands. At the same time this system enables to put forward measures mitigating implicit hazards perhaps caused by exploiting land resources excessively.

The land and land use on basalt soils information system founded and maintained at RSGAC (Remote Sensing and GIS Applications Centre) under NIAPP (National Institute of Agricultural planning and Projections) is a bio-physical resource base on land, soil, climate, hydrology, land suitability. It constitutes the foundation for agricultural planning database. The system can generate readily accessible and transferable information on physical land resources in computerized map or tabular formats.

The technology being used to establish the land and land use information system includes ESRI GIS software, for instance ArcInfo, ArcView GIS, combining with EXCEL, ACCESS and DBASE; as well as web publishing tools.

2. SCOPE AND OBJECTIVES OF THE STUDY

2.1 Scope

The study was aimed at lands resulted in basalt weathering and the major land utilization types existing on these kinds of lands at the Central Highlands, Vietnam.

2.2 Objectives

The comprehensive objectives cover two areas, namely:

- Moving towards region-wide land use planning and management of basalt soil resources for agriculture at the Central Highlands;

- Providing a valuable tool for gaining access to, and sharing information and data among resource management agencies, and others that might need it. In order to make the best decisions about the management and uses of basalt soils and other natural resources, the responsible people need to have access to all the relevant information that is available, no matter which agency has collected or holds that information.

The more specific objectives of the study are to:

- Establish an integrated GIS based centred in land and land use on basalt soils information system for the Central Highlands divided in three levels: regional, provincial and district.
- Design an appropriate database structure to soundly managing and exploiting basalt soil resources for setting agricultural production.
- Utilize the land and land use information system for agricultural planning in the Central Highlands.

3. SYSTEM DESIGN

Land and land use information system focused on basalt soils must be unified, centred and based on GIS aimed at the sensible basalt soil resources management and exploitation in order to serve agricultural production at the Central Highlands.

The system contains two main components:

1) Spatial database (or GIS database) includes the data in map format;
2) Non-spatial database consists of the tabular data relating to land use situation and effectiveness on basalt soils.

This information system is arranged on three levels, such as regional, provincial and district.

(See Figure 1)

3.1 GIS database

A GIS database has been constructed to allow for a spatial analysis and modeling capability. This approach involves creation of a multi-layer GIS database in which each component layer is allowed to change. The GIS database includes many thematic layers in professional ESRI GIS formats (ArcInfo, ArcView), namely:

- ⇨ Topobase,
- ⇨ Soils,
- ⇨ Agro-ecology,
- ⇨ Agro-climate,
- ⇨ Land use,
- ⇨ Land resource utilization,
- ⇨ Proposed land use.

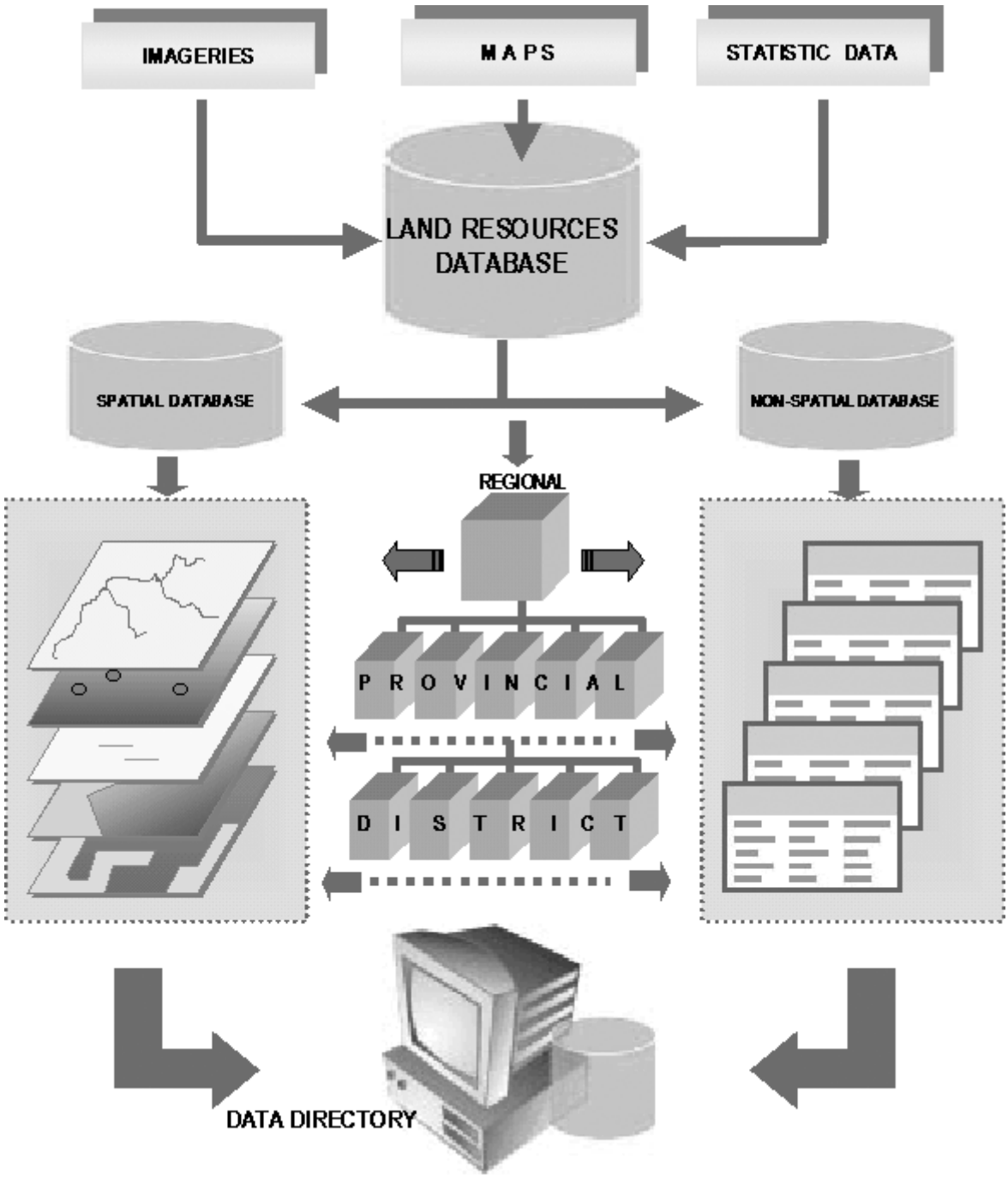

Figure 1. Conceptual structure of the land and land use information system

Paper maps and remote sensing imageries are served as the vector and raster data sources, respectively, for geographic data.

3.2 Non-spatial database

In order to meet the needs of basalt soil resources management and utilization non-spatial database consists the following data types:

⇨ Soil type area by admistrative divisions, agro-ecological subzones, soil slope, soil depth,
⇨ Land use type area by admistrative divisions, agro-ecological subzones,
⇨ Land resource use, area and productivity of major crop,
⇨ Economic effects of land utilization on each soil type,
⇨ Physical and chemical characteristics by soil types.

These data types have been organized in tables, namely:

- Basalt soil resources,
- Basalt soil utilizations,
- Land use effectiveness,
- Unused lands of basalt soils.

The non-spatial database is categorized as static and dynamic data. The static category includes look-up tables, like administrative division names, crop types.... The dynamic category consists of the remaining (not look-up) tables characterized by data in time series.

4. SOME RESULTS IN UTILIZATION OF LAND AND LAND USE INFORMATION SYSTEM

4.1 The basalt soil resources inventory

The basalt soil resources inventory application allows for the classification and mapping of soil characteristics from the information system, which contains several attributes describing physical soil characteristics. Since basalt soil inventory attribute data has a many-to-one relationship to soil mapping units, the data must first be summarized by the mapping unit and resulting mix of soil resource inventory characteristics classified for mapping purposes.

4.2 Basalt soil resources data directory

A basalt soil resources data directory has been built for use by researchers and decision makers in land and agricultural resources management as well as agricultural development planning. The basalt soil resources data directory is a valuable tool for information sharing, so this is vital to successful land resources management and utilization.

4.3 Land use planning assistance

The study developed a comprehensive database on the present agricultural land use on basalt soils by agro-ecological zones and soil type, which can be used for present and potential land use and crop production planning.

5. CONCLUSIONS

5.1 Today the lands originated from weathered basalts have been almost in use, of which more than 70 % are in sensible way. Coffee, rubber, tea, water rice, pepper, fruit tree plantations are the most effective land utilization types.

5.2 GIS based Land and land use information system focused on basalt soils has been initially established, which aimed at the sensible basalt soil resources management and exploitation in order to serve agricultural production at the Central Highlands. The system contains two main components, namely spatial database (or GIS database) and non-spatial database that are arranged on three levels, such as regional, provincial and district.

5.3 Cropping pattern suitability, land productivity assessment, land resources management for sustaining agricultural development etc. are important applications in future.

6. REFERENCES

Antoine, J., 1991. *GIS Application in Land Resource Appraisal, planning and management. A suggestion for developing AEZ database into GIS-based Land Information System*.

Dai, D. D., Dzung, B. T. N., Thanh, N., Hung, B. V. and Xuan, N. T., 2001. *Sustainable land use of the Central Highlands basalt soils. Establish the land and land use information system*. Unpublished report, NIAPP, Hanoi, Vietnam.

Kassam, A. H., Van Venthuisen, H. T., Fisher, G. W., and Shah, M. M., 1989. *Assessment of population supporting capacity for development planning in Kenya.* Report 1: Resource database and land productivity. FAO/IIASA.

Soil and Fertilizer Institute, 2000. *Soil and fertilizer information system of China.* China.