

Application GIS on environmental zoning and management (Case study in Sontay, Hanoi, Vietnam)

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Key words: GIS, suitable analysis, environmental zoning and management

SUMMARY

Environmental zoning and management as arrange a region into different zones and proposal to sustainable utilization of natural resources and protection environment according to their environmental functions, natural and socio-economical condition, and trend of sustainable development in the region.

This article presented principles for environmental zoning. And It was also described the process and a data set for zoning processing in the study area. Sontay were divided into 4 zones, they are urban and cultural and historical tourism development; development eco-tourism and breeding farms; Building factories, and cultivation; and Rural area; they are including total 19 sub-zones. And the resolutions of environmental management and rational use resources were proposal based on characteristics of the arranged zones, the strategic development and the economical master planning development in the study area.

The result is illustrated for application of GIS as power tool on environmental zoning and management.

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1. INTRODUCTION

Environmental protected planning is zoning natural and environmental conditions according to their functions for the trend of the economical development and human life, also it has to protect and manage environmental quantity and suggest suitable use of the natural resources. Environmental zoning (EZ) is the first of the environmental protected planning. Its aim is balance the relationship between environment – socio-economic in a region, to assume responsibility for socio-economical development suitable with the capacity of the natural conditions, protect environmental quality and increase the standard quality of life.

Each kind of the planning has difference criteria for zoning. Such as, criteria of the forestry zoning are based on degree of cover of leaf canopy, biodiversity, value of tree, aim of use, etc. Land-use planning is based on land units and land use suitability. EZ is based on interrelationship between natural resources, environment and human in one specific geographical area.

The task of EZ is defined and zoning it into different zones which are different characteristics. Their characteristics must be particular on ecosystem and sensitivity. These characteristics are basis of the functional zoning and environmental protect planning. Each kind of zone is also represented for each type of aim of human development activities; protect environment and rational use of the natural resources. They are individuals and have close boundary and distributed full fill in the whole area, and not repeat in the geographical spatial.

The EZ has 10 criteria, they are following:

- Zone unit system: depend on the scale and characteristic of the area, zone unit system can be ranked.
- Boundary: each unit has close boundary. They are defined by the splitting of natural, socio-economical and environmental conditions. Boundaries aren't necessary overlay administrative boundaries in the area. In some special cases, the boundary of the unit can be fit with the borderline of the administrative manage, such as industrial or urban zones.
- Shape of zone
- Area of each zones and units
- Characteristics of zones and units
- The particular or dominant characteristics
- Relative homogeneous in each zone
- Ecological characteristics of each zone
- Environmental functions
- Aim of use

The principles of the EZ are following:

- The land-use and resource use must be rational in all zones, sub-zone and units
- Protection and re-habitation of the ecosystem
- To take unforeseen circumstances into consideration if possible

Sontay is a big town and belong to Hanoi; it is lying down in the high area. The main road No.21 and N.32 are connected Sontay to Hanoi, and other provinces. The climate is monsoon tropical area. Average rainfall is 183.9 mm. The average temperature is 22.3°C. The humidity is 84%. The Sontay topology and landscape is rather high and nice. The geological and geomorphologic conditions are diversified. The main soil types are alluvial soil and yellow red soil in the clay stone. Particular, the Bavi National Park has the diversity of the fauna and fauna.

2. METHODOLOGY AND METHODS

2.1 Ecological approach

EZ is based on analysis and evaluation the inter-relationship between natural and socio-economical factors. They are always parallel exit and reciprocal influence. These effects create the particular characteristics of each area. The human activities, including cultivate and industrial development, are changing the original characteristics of the ecosystem, even creating new ecosystems, such as, bare hills, urban systems. So, these inter-relationships is cause of splitting zones, sub-zones and units, they have particular ecosystems, specifically functions and products. These of particular characteristics of the each zone are based for rational natural use, developing economic and protecting environment in the strategies and planning.

2.2 Suitable analysis

The suitable analysis can be defined the suitability of the specific human activities in the area. The analysis processes are based on principle sustainable development, current natural and socio-economical conditions and the trend of economical development. Suitable analysis is first applying on land units for the cultivated activities. Now, this method is encroaching on many fields and human activities, and developed trend.

In case of EZ, suitable analysis is assesses suitability of the development activities of socio-economical development planning. The output of this process is determined the geographical site with the degree of suitable of the status natural, socio-economical conditions and environmental quality for special human activities. In other way, this process is the first step of the EZ, to determine and classify the degree of the capacity of the environmental factors and their changing when human activities are happened in an area. These are a science fundament to design rational measures for management resources and protect environment quality from human activities.

The aims of the human activities in the master of socio-economical development in Sontay, period 2015-2020, are expand urban areas, open new central politic and culture zone, develop tourism and conserve landscape activities, plant vegetation and flower. The process of suitable analysis is described in fig.1. (1) Based on the socio-economical planning to define aims and trends of development economical, special the main human activities; (2) Suitable analysis and create suitable maps (3) assessment of the suitability of human activities to the environmental condition based on suitable maps.

2.3 Geographical Information System (GIS)

GIS as useful tools for establish database, spatial and tabular analysis. Its can be encode character data and integrated difference kind of data in the spatial analysis. It can be described output into map with definition of the geographical position of all the objectives.

2.3.1 Establishing GIS database for EZ

The database for EZ is include 4 groups of the information, those are natural, socio-economical, environmental quality and trend of socio-economical development (including master, industrial, agriculture, forestry, aquaculture development plans etc.) and aim of the protect environment and natural resources. For example the database of EZ of Sontay is described detail in the table 1.

2.3.2 Multi-criteria spatial analysis for EZ

This method is integrated multi-criteria analysis with spatial analysis tools in GIS. The process is showed in fig. 2, it is described in following steps:

Step 1: Definition the aims of the assessing process and the main human development activities

- Defining achieve objectives or aims based on the trend of socio-economical development. These aims are created suitable maps; they are defined degree of the suitability of the natural resources, socio-economical conditions and environment for human development activities from the plans. As in the Master Development planning In Sontay, Urban settlement/ built up area will be expanded, industrial small area will be built, near the rural settlement with the good soil quality will be planted vegetation and flower, developed breeding and aquaculture farms in the suitable area, and protecting Bavi National Park and landscapes.

Step 2: Establishing the criteria for suitable analysis

- Finding the criteria and draw up them in the levels of the branch of tree
- Assessing role or effect of these criteria in each branch of tree
- Building the pare-wise matrix to calculate the weight of each criteria
- Assessing the value of the stable of these weight

The groups of the criterias and their weights for each activity are described in table 2. Each of the activities will be collected some of the effected criterias.

Table 2. Criterias were collected for assessing their suitability for human activities

	Topography (elevation, slop, and direction	Geology and geomorpholog y (stratum, foundation stone, risks, faults, vulnerability, etc.)	Hydrologic -al system (density, lakes and distance)	Soil (type, quality, erosion)	Land use and land cover	Environ mental qualities	Infrastruct- ure (road, hotel, restaurant, hospital, etc.	Cultural condition (pagoda, festivals, vestiges, etc.
Urban settlement	x	x	x	x	x	x	x	x
Build up area for industry	x	x	x	x	x	x	x	x
Tourism development	x	x	x			x	x	x
Agriculture	x		x	x	x	x	x	x

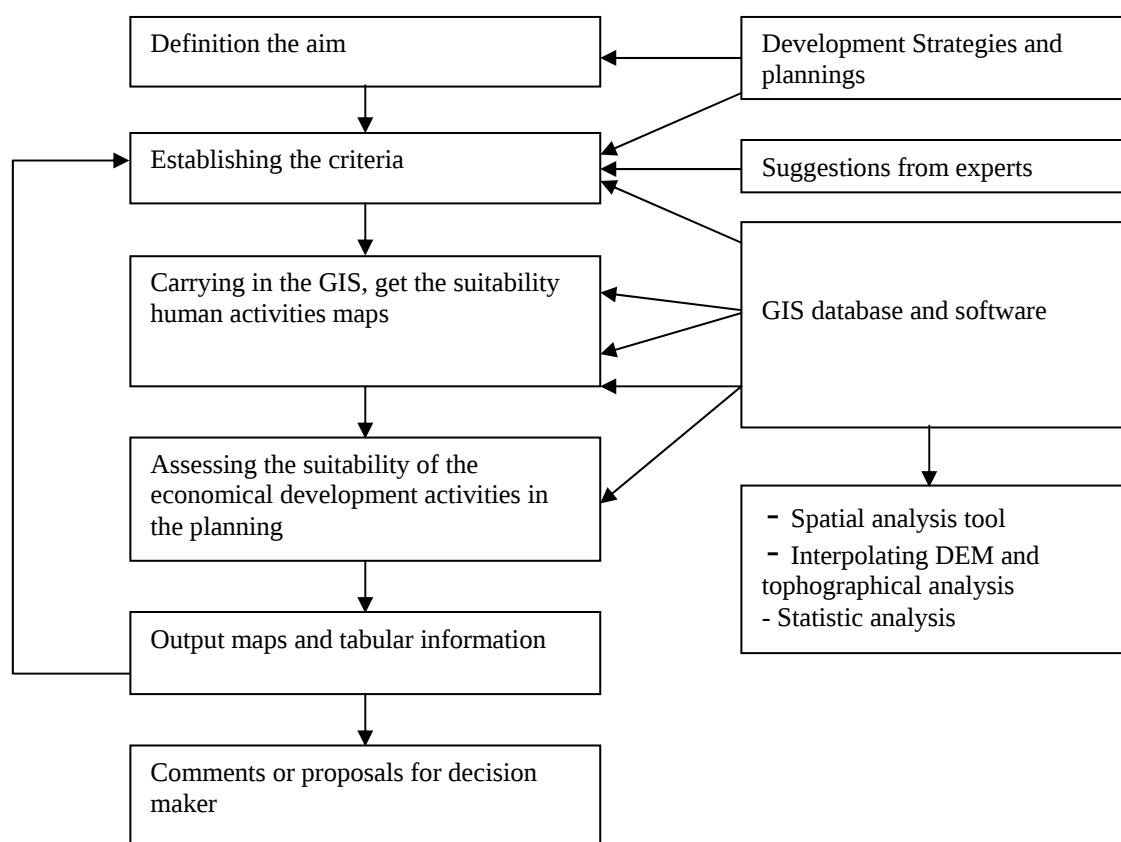


Fig.1. Steps of multi-criteria spatial analysis of the EZ

Step 3: Carrying in the GIS

- Building the process in GIS software
- Defining the spatial analysis tool for each criteria, objectives and aims
- Building the carrying out process (automatically in GIS software if possible)
- Carrying out in the GIS software

The figure 2 is a example of the suitable assessing and carrying out in the GIS software

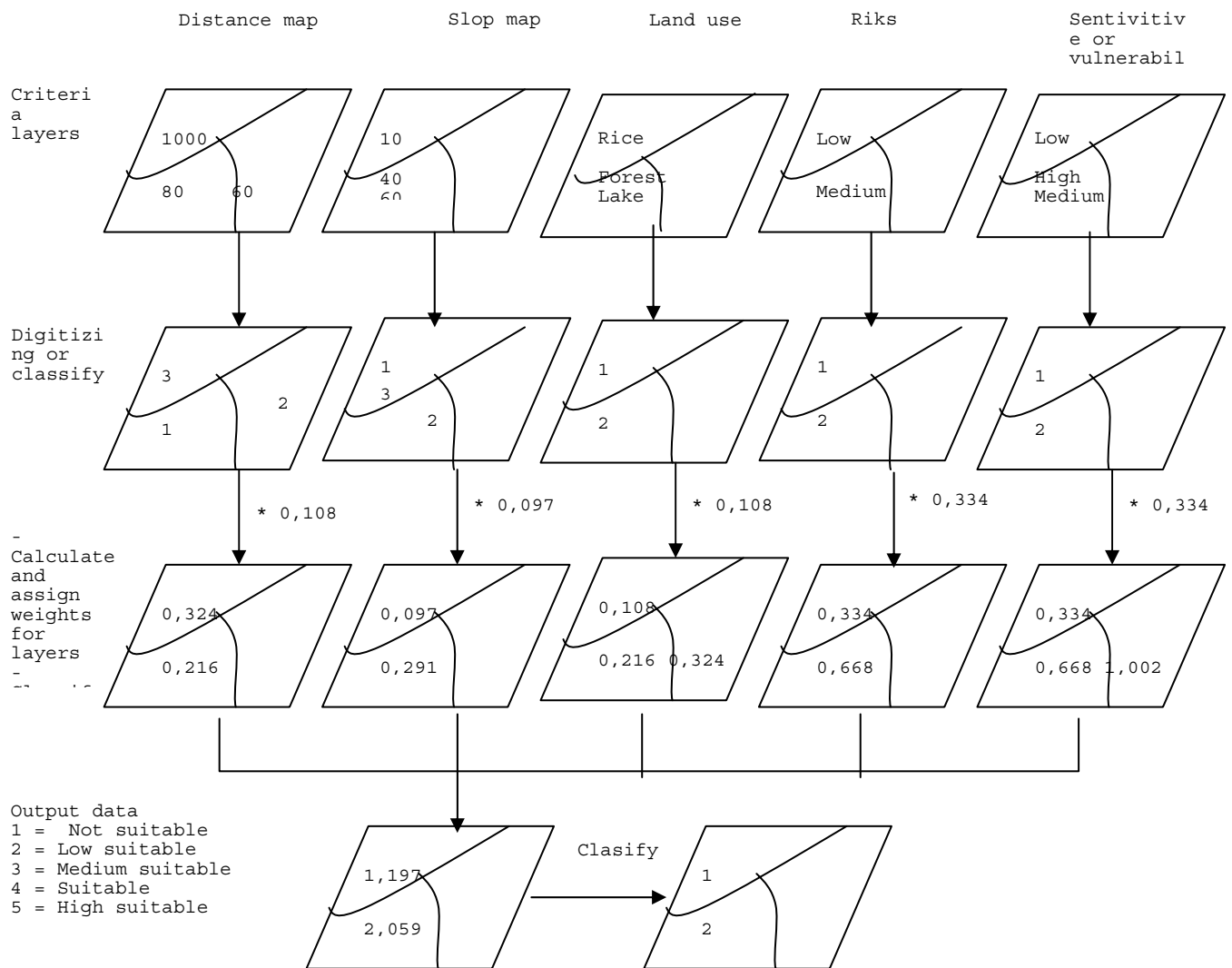


Fig. 2: Example of the suitable assessment in GIS software

Step 4: Output and evaluation

- Evaluation the spatial output and tabular output
- Evaluation error
- If the outputs aren't logical for the study area, the process has to come back to examine step 2

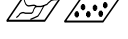
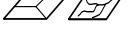
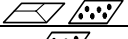
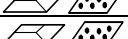
Step 5: Final output

- Map and tabular
- Recommendation

2.4 Environmental zoning

Based on suitable maps, economical plans and assessing suitable and perdition human activities and environmental quality in the area, environmental zones can be defined by using GIS software.

Table 1: Database for the EZ of the Sontay

Data groups	Data format	Data layers
1. Natural data		Geology (stratum, fauts, etc.)
		Geological and geomophological risk (earthquake, landslide, land subsidence, etc.)
		Mineral
		Topographical data (elevation contourline, point of the top of the moutain, DEM, Slop, direction, etc.)
		Geomophological zone with characticistics
		Hydrological system (river network system and its characteristics, river density, catchment, flood and underground water.
		Soil (soil types and composition)
		Weather and climate
		Flora and fauna (ecological system, particular concentrated on the sensitive areas and threaten species)
2. Socio-economical data		Administrative data (boundaries)
		Central administrative points
		Population characteristics: population, population density, family characters, birth rate, death rate, unemployment rate, income, education level, etc.
		Status landuse
		Transport system
		Culture resources: historical sites, cultural sites, religion, etc.
		Industrial distribution and their characteristics
		Other infrastructures
3. Environmental quality		Distribution of the current and potential environmental polluted points
		Stutas and preditiong of the water quality
		Stutas and preditiong of the air quality
		Stutas and preditiong of the soil quality
4. Trend of economical development		Master ecomical development planning
		Urban areas development planning
		Industrial development planning
		Toursim development planning
		Agricultural development planning
5. Suitable maps		Developed urban suitable area
		Developed industrial suitable area
		Developed tourism suitable aera
		Developed agricultural suitable area
Note :  raster  point  polyline  polygon		

3. OUTPUT AND DISCUSSION

3.1 Suitable maps

The output of the suitable analysis are include suitable maps for building urban settlement, built up area for setting up industrial factories, tourism development, and agricultural activities. All the suitable maps showed 5 levels (degree) of the suitable for each kind of the human development activities in Sontay. And they are described and showing in the geographical position in maps (fig 3). Total 5700 ha of the area (approximate about 48% of the area) is suitable for urban development, they are distributed in whole area, except in the big lakes and mountain areas (fig 3a). Total of 4900ha of the area (approximate about 41% of the area) is suitable for developed industrial zone (fig 3b). They are rather concentrated in the Northeastern and Southwest of Sontay. Total of 4800 ha of the area (holding about 48% of the total area) is suitable for tourism development. The map (fig 3c) showed the tourism suitable areas are distributed in whole Sontay, and concentrated in the big lakes (Dongmo and Xuankhanh). Total of 4300 ha of the area is suitable for culturing and breeding. They are distributed in the Northwest and the Central of Sontay, in the good soil quality, lakes, mountain and hill areas (fig 3d).

3.2 Assessment suitability of the economical development activities on the natural and socio-economical condition

In the limited of this research, the assessment economical activities on natural resources and socio-economical current is based on information from suitable maps by overlaying to finding conflict areas.

In the master development planning:

- Urban settlement will be expand to the Northern Centre, open new urban in the Northern-west that are near in Xuankhanh, Xuanson (near the Xuankhanh lake), and in the Southern-east that is Codong, and long some of main roads. Comparing developed urban areas in the master planning with the urban suitable area map showed that 55% of the developed area will be lie down in the suitable areas. And only 10.6% of the rest of the new urban areas are be in the un-suitable and low suitable. Other part is belong to the medium suitable
- Industrial zones and factories will be buit in Thanhmy- Xuanson, Phuthinh and Sondong, Duonglam and Trungsontram. The statistic showed that about of 400ha of the planed industrial area (aprox. 60%) is suitable. And only about of 4.7% of the planed industrial areas are in the un-suitable and low suitable. Other part is belong to the medium suitable
- Total of 1800ha of the planed tourism area (about 80%) is suitable for developing tourism activities. And only 1.1% of the rest of the planed tourism area is un-suitable. Other part is belong to the medium suitable
- Total of 4300ha of the planed agricultural area (about 37%) is suitable for planting or breeding. And the total of un-suitable or low suitable areas for agricultural activities is reach 39.8% of the planed agricultural area. Other part is belong to the medium suitable

Application the suitable analysis by using GIS in the assessment impact of the human activities can be showed in both exactly suitable geographical position and statistic the area of the suitable areas or un-suitable. That is the right require information of the environmental zoning process and proposal solutions for protecting environment for economical development planning.

3.3 Environmental zones map and proposal environmental management plants in the each environmental zones

Environmental zones are established from the information of the outputs of the assessing suitability, economical development planning and status and the perdition of environmental quality (the fig 4 is a map of the EZ in Sontay). Sontay area can be divided into 4 EZs, they are following:

- Urban and cultural tourism development zone. This zone can be divided into 9 sub-zones. They are including old urban; Ancient Duonglam village; Ancient citadel tourism; Political center; Service area; New urban settlement along road No.21; New urban settlement Sondong; New urban settlement Codong; New urban settlement Kimson.
- Eco-tourism and breeding development zone. This zone can be divided into 3 sub-zones. They are Dongmo and cultural village tourism area; Dongmo lake tourism; Xuankhanh lake tourism;
- Industrial and planting vegetation and flower development zone. This zone can be defined into 2 sub-zones. They are Tea farm and Thanhmy – Xuanson industrial area. And
- Rural intermix industrial area can be divided into 5 sub-zones. The rural settlement and plating area are intermix with Industrial Duonglam; Thanhmy; Xuanson and Sondong areas; and the Garbage disposal Xuanson area;

Based on the characteristics of each zones and sub-zones, the strategies and solutions for protecting environment and resources were built. And examples of some of the priorities of the environmental management are following:

- In Urban and cultural tourism development zone: in the old urban is required the solution for environmental sanitation, especial the sewage system has to rebuilt. The Ancien Duonglam village really needs an enough of the buffer zone to protect village with the current exploit building material activities and new factories will be built. The canal around the Ancient citadel tourism are required filtering.
- In Eco-tourism and breeding development zone, the monitoring water quality must be first priority activity. And the suitable land use is also required.
- In Industrial and planting vegetation and flower development zone must be control the industrial pollution
- In Rural intermix industrial area has to setup the buffer area between factories and rural settlements, the industrial pollution is also need to be control

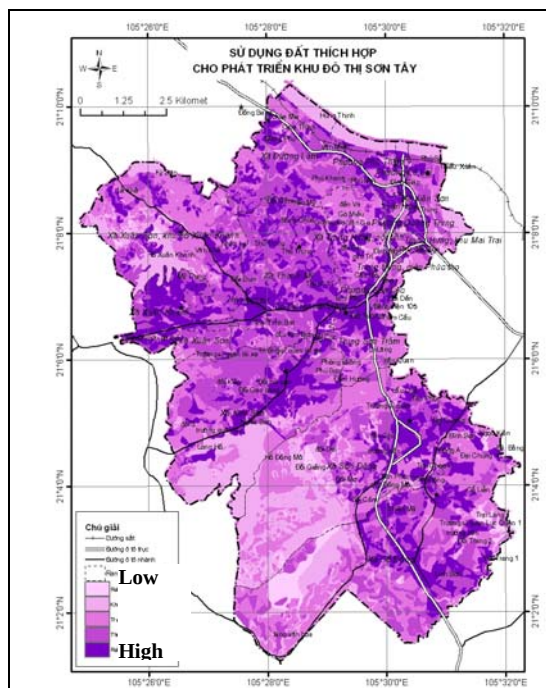


Fig 3a. Urban developed suitable area

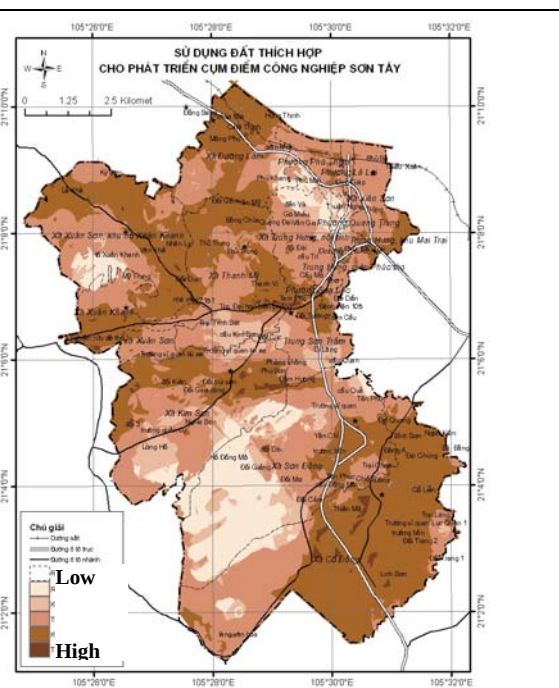


Fig 3b. Industrial developed suitable area

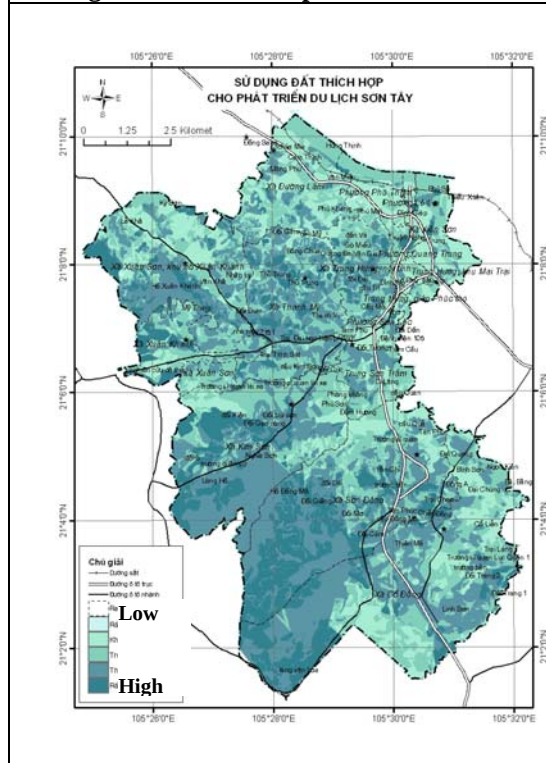


Fig 3c. Tourism developed suitable area

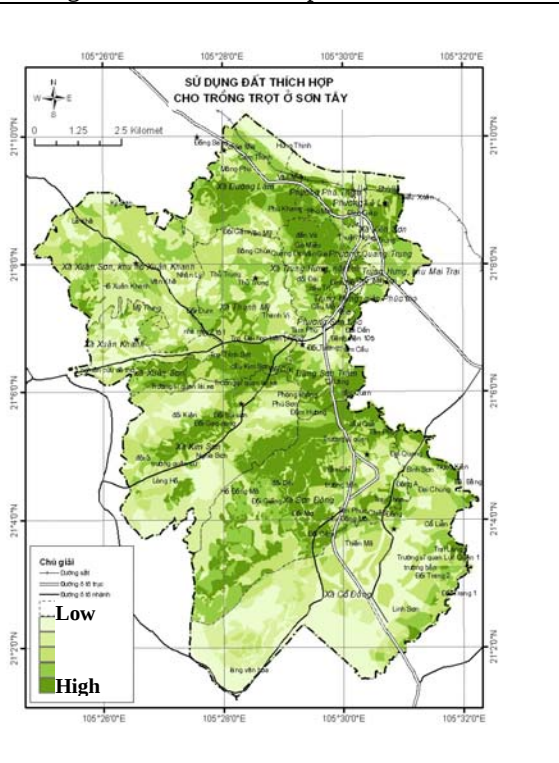


Fig 3d. Agricultural developed suitable area

**PHÂN VÙNG QUẢN LÝ MÔI TRƯỜNG SƠN TÂY THEO QUY HOẠCH PHÁT TRIỂN
KINH TẾ XÃ HỘI ĐẾN 2015, ĐỊNH HƯỚNG TỚI 2020**

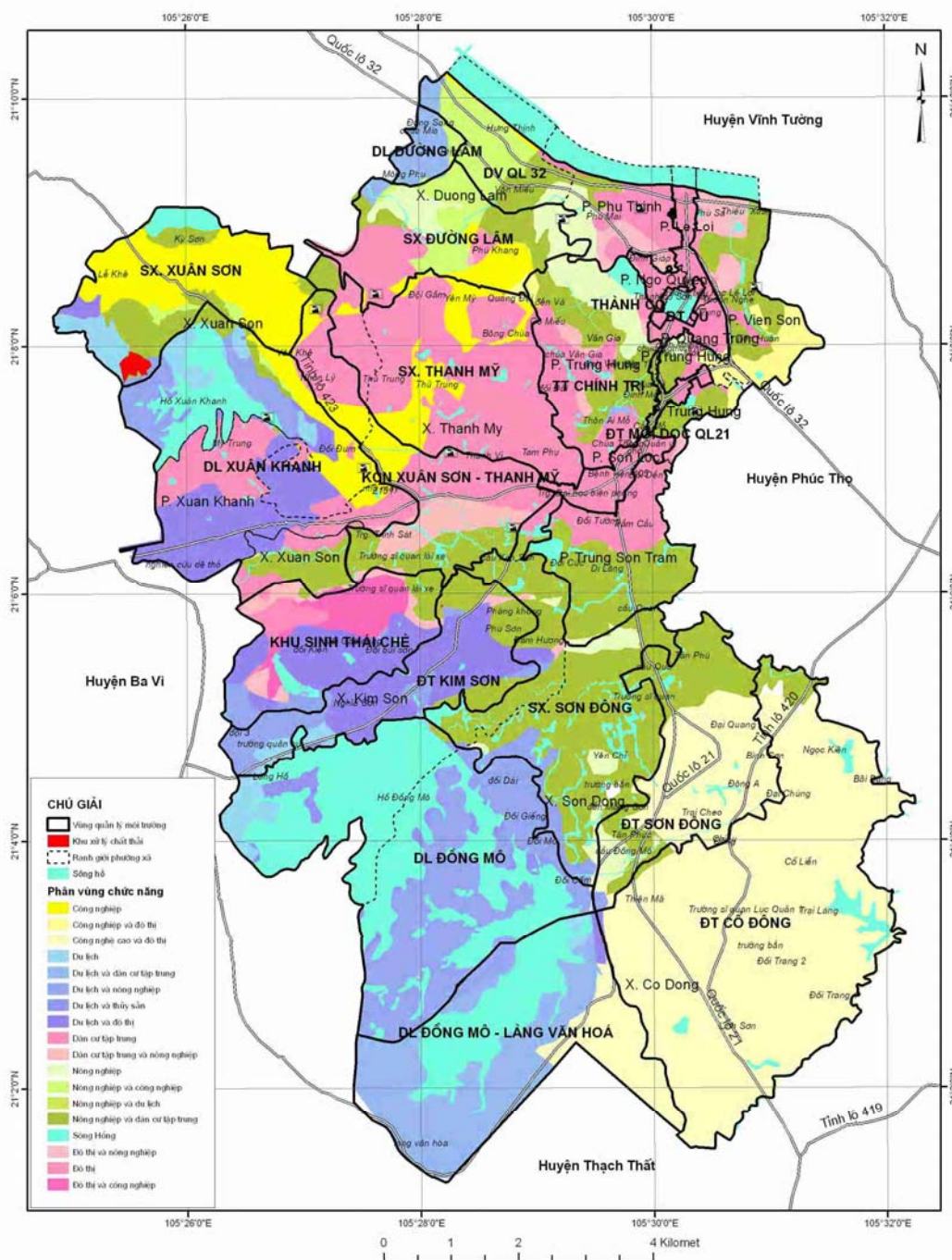


Fig 4. Environmental management zones in Sontay

4. CONCLUSION AND RECOMENDATION

The ecological approach and suitable analysis are rational methodology and method for EZ, including zoning process and proposal environmental management in each zone. EZ should be using GIS as tool for establishing database and spatial analysis, include integrated data or multi- criteria spatial analysis, and using expert experiences.

GIS database need to describe enough information of the study area. They can be divided into 5 groups, include current natural and socio-economical condition, development planning and environmental quality, and suitable maps.

The suitable analysis should be followed five steps. Especial, criteria collected process is the importance. This part is required reference expert experiences. The criterion is high affected to the suitable maps and EZ of the study area. Based on suitable maps, return to compare and assess the suitability of the human activities with the suitable maps. This information is keyed for zoning process and get EZ map, also proposal environmental management in EZ.

Sontay can be divided into 4 EZs, they are Urban and cultural tourism development, Eco-tourism and breeding development, Industrial and planting vegetation and flower development, and Rural inter-mix industrial area. The solution of the environmental management can be built based on their characteristics.

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BIOGRAPHICAL NOTES

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