

ANALYSIS EFFECT OF THE LAND COVER CHANGE TO SOIL EROSION AS A KEY FOR LAND USE PLANNING

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ABSTRACT

To reduce erosion, land use planning is counted as one effective tool, especially in water sheet scale. The land cover changes everyday and in some case, it becomes a critical reason of soil erosion. The effect of land cover change to soil erosion has been mentioned. Commonly this effect is not used effectively in the land use planning in Viet Nam. The aims of this study are analysis this effect and build a model to use it in land use planning in a water sheet.

The land use planning can be split to 3 main tasks to answer the question: where (need to be changed), how (it could be changed) and what (is the reasonable way to change). However, the answer requires information integrated from many sources: natural condition and socio-economic condition. In the conception of reducing soil erosion based on the effect of land cover change, this study use a GIS modeling to answer each question and combine to get land use planning map. The land cover changed is detected by digital image processing of satellite image. The effect of land cover change to soil erosion is analyzed timely, spatially in GIS. Based on the effect, GIS spatial modeling is applied to answer each question of the land use planning. This method has applied to Tra Khuc watershed in central of Viet Nam.

1. PROBLEM STATEMENT

Sustainable land use is a problem which contents, according to many authors, several issues of different fields. It then needs to be considered under many aspects, at many levels and by using information from history to present (Mannaerts 1993). Soil environment is grand issue and the progresses making land degraded is differed. One of the factors that effects to the suitable land use is soil erosion and this effect ion has mentioned by several authors. In a conference organized by FAO at 1991 cover participants from 12 Asia countries, many reason of soil degraded were listed. In the list, the soil erosion is problem in the top of 11/12 countries.

Agreed with the conclusion that the soil erosion is most effective reason of soil degraded, this paper aims to analyze the relation of soil erosion with land cover change in order to point out the quantified information for land use planning. The land cover change was chosen in analysis relation with soil erosion because in a watershed it commonly is the most effective factor in changing soil erosion conditions.

The land use planning process requires not only the information come from relation of natural condition and natural process such as land cover change and soil erosion nut also the

information from analysis of socio-economic condition of the watershed. The complex of land use planning questions need to be solved by integrated information from differ field studies. According to H. Liniger and Schwilch, lack of information about the condition of land is one of important reasons make the soil degraded in mountainous area (Liniger and Schwilch 2002). However, this paper is limited in the finding information for land use planning based on analysis of natural conditions (here is land cover change) only.

Under the limitation of the study, the question of land use planning for sustainable land use becomes: how to use land use planning tools to affect to land cover (specify the items: location, time and intervention) to reduce the soil erosion and remove critical soil erosion in a watershed. Naturally, the purpose of the land use planning may change timely depends on the certain conditions. The geographical (spatial and temporal) approach has been used to answer the question. With the geographical approach, the spatial analysis of GIS takes very important role.

2. FROM LAND COVER CHANGE TO LAND USE PLANNING – SOIL EROSION APPROACH

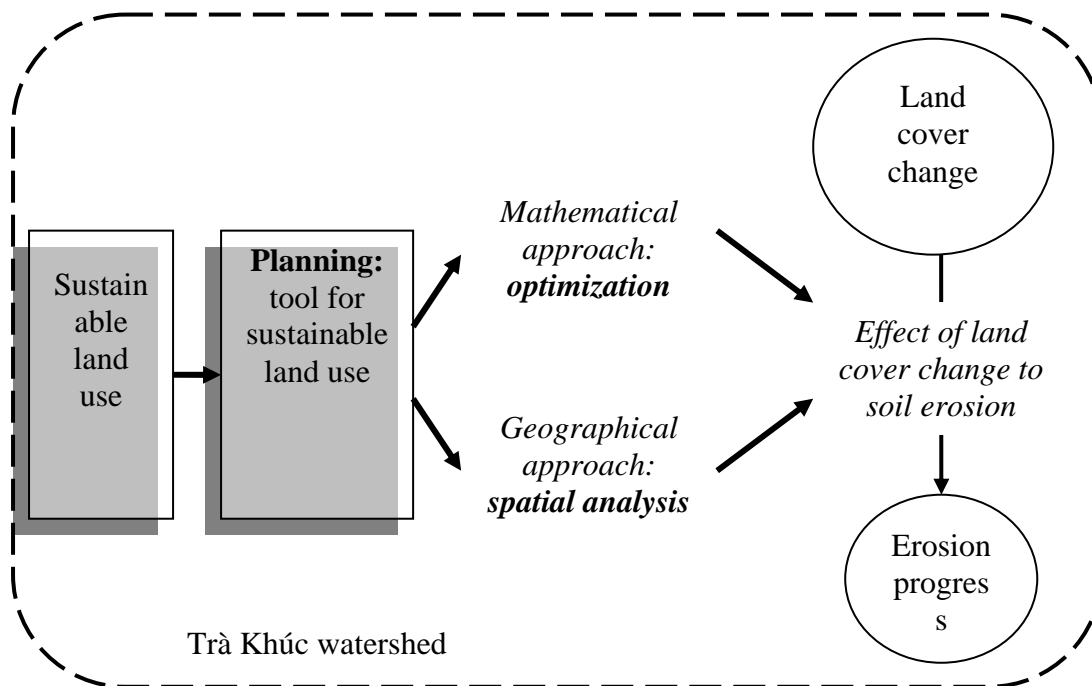


Figure 1. Effect of land cover change to soil erosion for land use planning and sustainable land use in Trà Khúc watershed

The figure 1 shows approach of the land use planning for sustainable land use by land cover change with soil erosion as a key point. In the figure 1, the contribution of information from remote sensing and GIS analysis to land use planning. Approach through the soil erosion, remote sensing data bring the land cover change spatially and timely.

Place the land resource of mountainous watershed such as Trà Khúc and base on the hypothesis that the main reason of land degraded is soil erosion, we can find that the solution of reduce soil erosion to remove all area of very critical soil erosion is land use planning. Naturally, be side land use planning there are many technical solution which can be applied to reduce the soil erosion. In the scale of watershed, all the technical solution can not be

applied for whole watershed and they should be a part of general solution – land use planning. In the factors listed in the USLE, the C factor (factor of vegetation cover) is only one which is human can change to reduce the soil erosion (Mannaerts 1993).

The percent of vegetation cover is higher, the soil erosion is lower (Mannaerts 1993). However, increase the vegetation cover in watershed should be the purpose of land use planning in order to protect soil resource out of erosion progress. Then, the question of the land use planning issue is “*how the land cover change to reduce soil erosion?*” and the answer can be found in analysis of the effect of land cover change to soil erosion

3. METHODOLOGY

3.1. Land cover change monitoring and soil erosion map

Land cover change information of Trà Khúc watershed has been collected from satellite images. Series of three Landsat TM image dated 1989, 1997 and 2001 has been processed digitally to get the picture of land cover change in the watershed.

Soil erosion map of the watershed has been created by applied USLE model. All the factors in USLE were mapped. The GIS is used for calculation factors map as well as potential and annual soil erosion map (Ouyang and Bartholic 2001)

3.2. Analysis of effect of land cover change to soil erosion.

In order to analyze the effect of land cover change to soil erosion spatially and timely, the soil erosion map of three dates (1989, 1997 and 2001) were overlaid to get the change in the soil erosion. With the supposing that all the erosion factors are not change except the land cover, the change of soil erosion is displayed the effect of the change of land cover. Accordingly, analysis the change of soil erosion under change of land cover can be used for pointing out the effect of the land cover change to soil erosion.

There are two ways of approaching the change of soil erosion analysis: absolute and relative value of soil loss. The absolute value shows the quantities difference of soil loss between two compared dates while the relative value show the quality (or percentage) of soil loss change. In this study, both ways of analyses were used based on the particular condition of soil erosion in each site. In sites where soil erosion change bigger than 20%, the absolute soil erosion will be analyzed and on the other hand, in sites where soil erosion change bigger than 50 T/ha.year, the relative soil erosion will be considered.

3.3. Application of effect of land cover to soil erosion for land use planning

All the information needed for land use planning can be summarized in answer of three questions: *What need to be done? Where? When?*. Answering these questions requires the information come from many study fields, especially the condition of the socio-economic and natural condition of the location.

As the purpose of land use planning is just for reducing soil erosion only, the answer of that three questions can be found by analysis the effect of land cover change to soil erosion as shown on the figure 2.

To answer the question: “Where need to be intervened?” the information of present condition of soil erosion were used: we should intervene to where the soil erosion is critical or high potential soil erosion. Where the high intervention and has bad land cover change (vegetation loss) should be the site need to be intervene as soon as possible – the answer of question “When need to be intervened”. Base the on present condition of land cover, the intervention method can be found to increase the vegetation cover. This is answer of the last question: “What need to be done?”

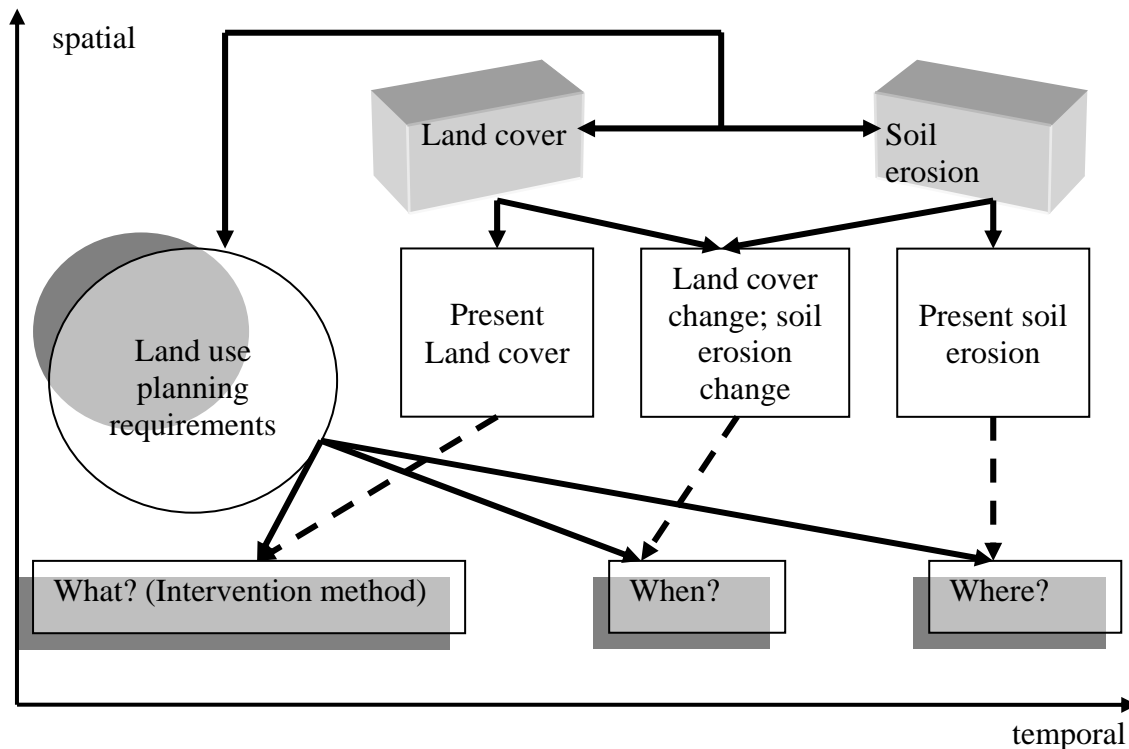


Figure 2. Application of effect of LC to soil erosion for land use planning

4. RESULT AND DISCUSSION

The effect of land cover change to soil erosion has analyzed spatially and timely from 1989 to 2001. The soil erosion change is shown on table 1 is result of effect of land cover change to soil erosion temporally. The figure 3 shows the result of analysis of effect of land cover change to soil erosion in pattern. This effect pattern is attached with a map shows effect of land cover change to soil erosion spatially.

Table 1. Soil erosion change of Trà Khúc watershed

Change type	1989-1997		1997-2001	
	Area (ha)	% of Area	Area (ha)	% of Area
Good reduce soil erosion	1088.73	0.33	2602.44	0.80
Reduce soil erosion	12073.5	3.68	24423.21	7.53
Increase soil erosion	16845.75	5.13	9920.34	3.06
Critical increase soil erosion	11926.62	3.63	6942.33	2.14
No change	286337.52	87.23	280412.01	86.47

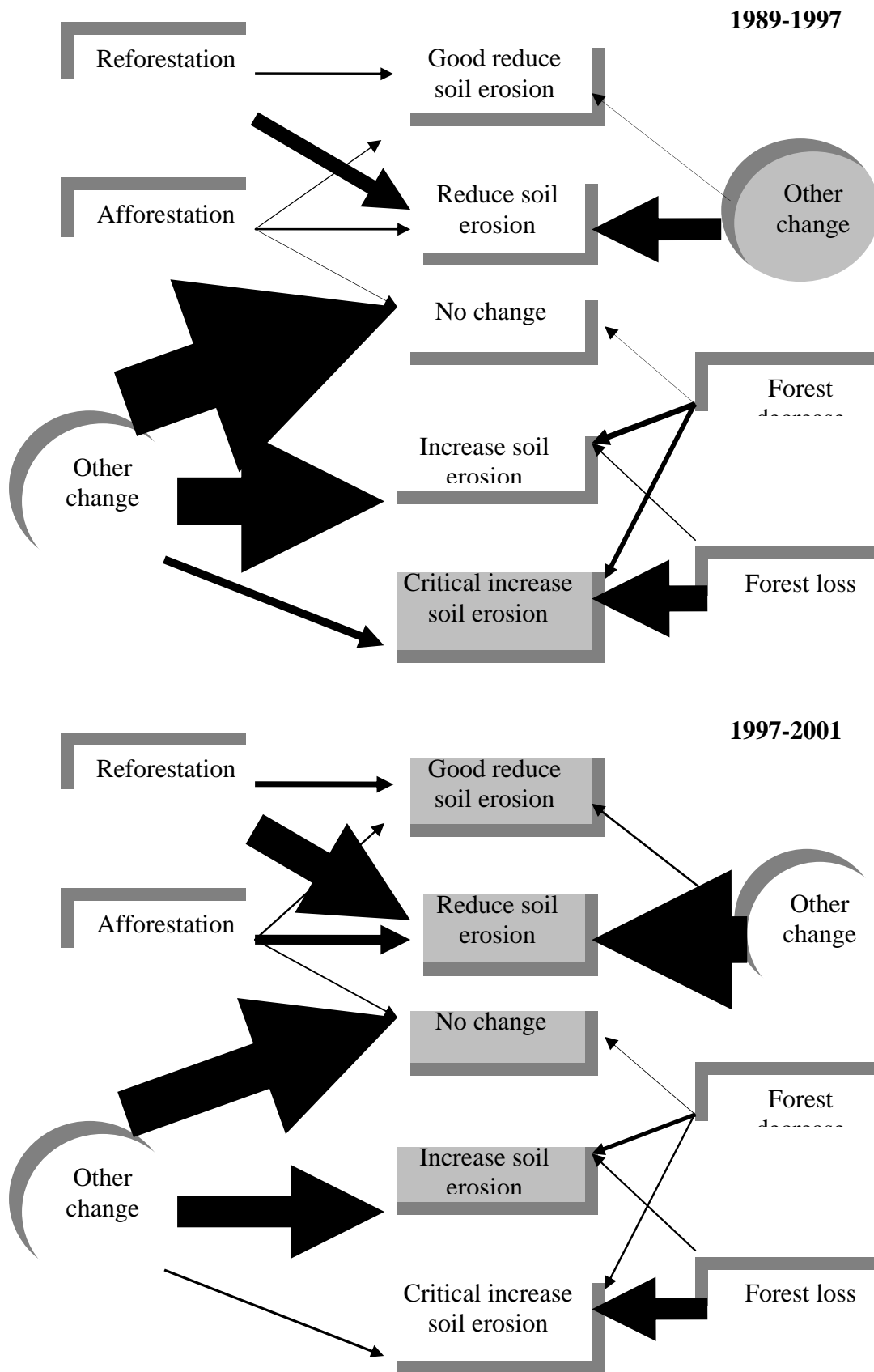


Figure 3: Effect of land cover change to soil erosion. Thicker arrow show more percentage of change (all change equal 100%)

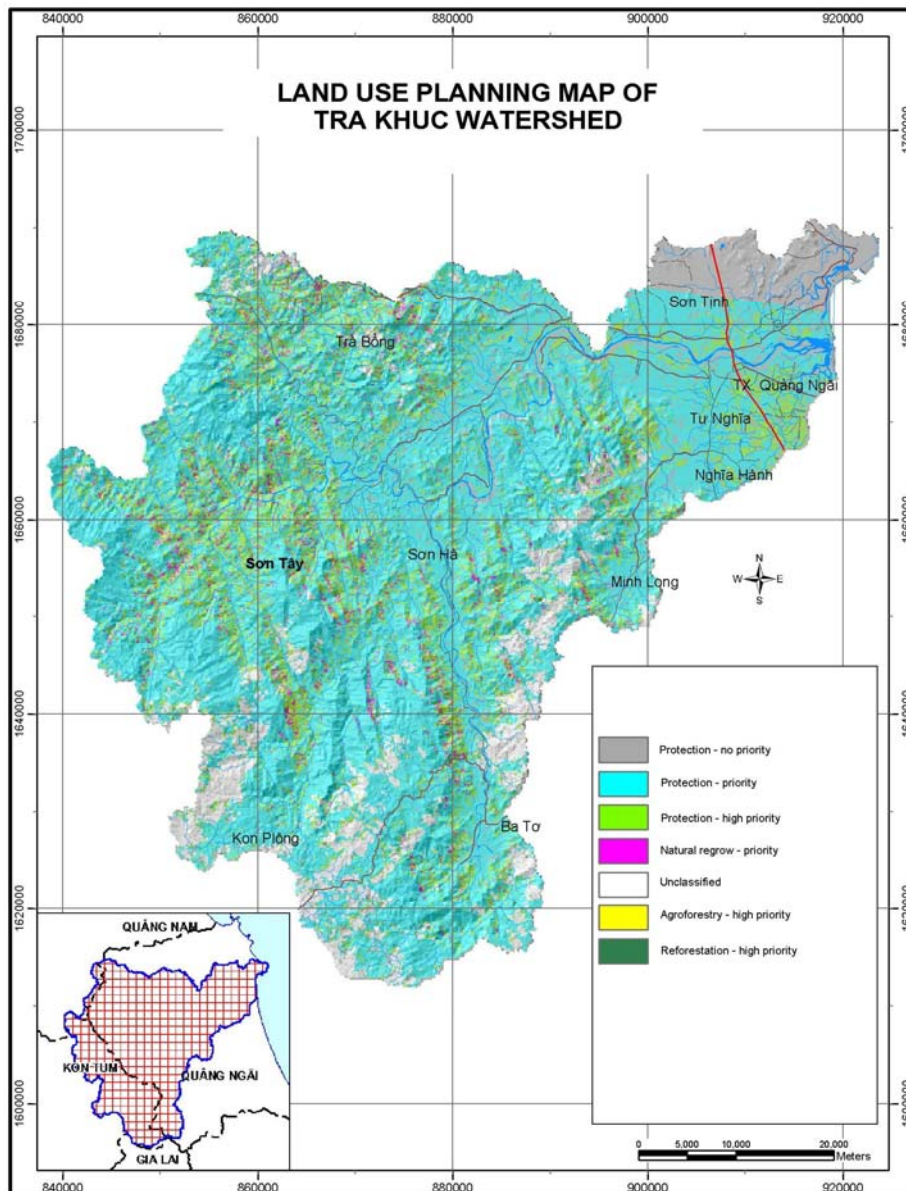


Figure 4. Land use planning map of Trà Khúc watershed

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In the watershed, the total area of protection is 88%. The high priority is in the West of the watershed where the potential soil erosion is high and the vegetation cover is losing.

The study shows the effect of the land cover change to soil erosion is directly and can be quantified for land use planning by GIS. It makes the building an information system for land use planning decision possible with GIS as a nuclear and remote sensing system as an input data system.