Application of GIS on Soil and Water Conservation Plan for Small Watershed

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Abstract: By GIS, the various natural factors and social and economic factors of the plan area can be expressed different coverages that are in the same geodetic coordinate system. By qualitative and quantitative overlaying analysis of these relational coverages, many middle results and positive results can be yielded. The jobs of Area measuring and statistic are easy. The work efficiency and the reliability of programming data will improve greatly.

Keywords: GIS, soil and water conservation plan, spatial analysis

Introduction

The applications of ecosystem economics and system engineering combined with development plan of local national economy for carrying on subarea of water and soil conservation, land resources evaluation, constructions target argumentation, total layout and constructions contents plan, investment budget estimation and benefit analysis according to the local nature condition with social and economic basis, which are the main contents of water and soil conservation plan. In the past, the works of water and soil conservation plan are done mainly by handcraft tasks, such as land resources investigation of land plan. The adoptions of traditional survey method, drawings and calculations of area, which bring not only much work, but also the bigger error margin. It is not easy to carry out related spatial analysis of land resources, water and light resources, and other nature and social economy conditions. In recent years, during the woks of water and soil plan, the biggest work efficiency brought by computer and GIS is noticed more and more [1], especially the examples of soil erosion survey, evaluations and applications [2—5]. However, during the work of water and soil conservation plan in small watershed, the application of GIS just now begin [6]. Some plan sections just make use of the calculator to complete the mission of cartography, the spatial information management of GIS and the application of spatial analysis are far and far not enough. So, aims of this paper will do some discuss taking an example for water and soil conservation plan in Huangshui watershed.

1   Basic conditions of the reserch region

The research region is located in branch range of Qi lianshan-south foot of Daban Mountain, the north of Huangshui watershed (the stair branch in the upper reaches of Yellow River), including the Beichuan River and Sha Tangchuan watershed. Which involves Datong County in Qinghai province totally and regions of Huzhu, Huangzhong and Xining county partly, and occupying the area of 4,477km^2. The planned area has complicated landform, which have many mountainous and hills, the proportion of river valley plain is small; The topography is high in the northwest, and low in the southeast, the highest altitude is over 4,600 m and the lowest is less 2,200 m.The yearly average temperature becomes lower gradually from southeast to northwest in accordance with the altitude highness, which is between 4℃— –2℃ mostly. According to the weather subarea of Yellow River, the north central area with south area belongs to two climatic zones. Namely, the north central part belong to half wetness area in the upper reach area of a plateau weather, and south area belong to half dry weather in Q.G. N. area of medium temperate zone. The average yearly precipitation is 500 mm, much of them concentrated in the summer from June to

Augusts. The water and soil conservation plan of this has representative meanings for water and soil conservation and ecosystem environment construction in the upper reach of Yellow river.

2 Gis analysis and total layout of water and soil conservation

Each factor of nature condition with society and economy basis is independent, as well as related and influenced mutually. Only by analyzing and definite their relations and their influences on soil erosion, can we find out projects of the more science and economic measures to control water and soil loss. First, obtain the first-hand data by investigating field. Secondly, for convenience of make overlaying analysis, these inquired data will be put into the atlas of having earth coordinate, and one of them will be used as a coverage. Thirdly, carry on overlaying analysis of nature factor and social and economic factor (coverage), analyze the relation of each nature factor and water and soil loss, find out the dominate and subordinate factor of influencing soil erosion and potential of land resources producing. Furthermore, provide the layout of soil and water conservation about the research area on the basis of macro-analysis (seen in Fig. 1).
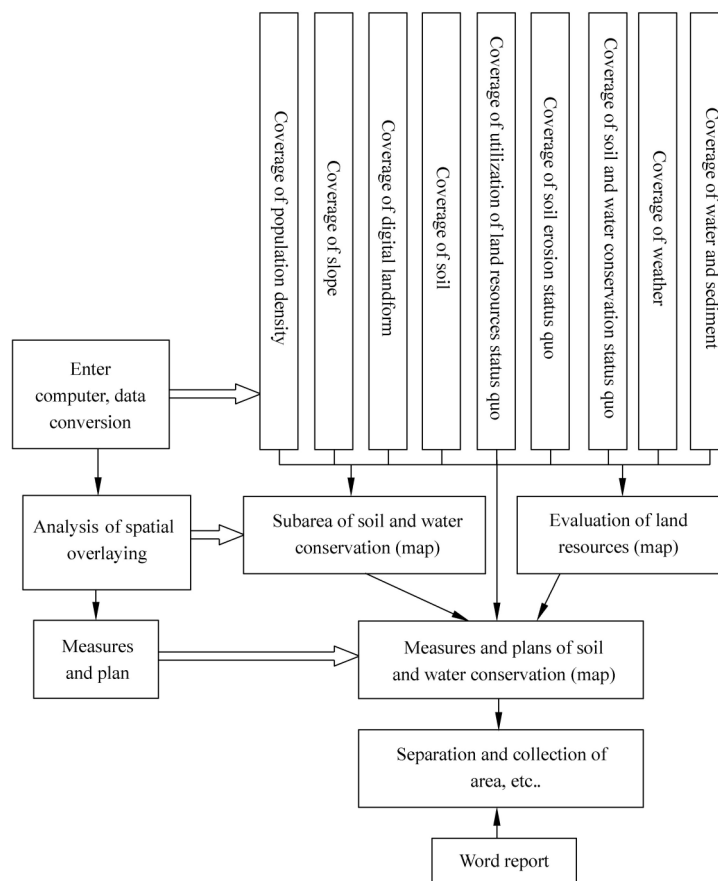
Fig.1   Sketch map of soil and water conservation plan in watershed based on GIS

3 Land resources evaluation based on gis

Evaluation of Land resources is a premise of exerting the potential of land resource producing fully, using land reasonably and preventing water and soil loss, and a basis of utilization and plan of land resources as well as soil and water conservation plan. Now, GIS technology has been introduced into evaluation of land resources and program of utilizing soil [7,8]. According to technique demand of **general rule of comprehensive harness and layout on soil and water conservation** in this paper, the factors

system of land resources is established. Furthermore, on the basis of the relation of each factors and soil erosion, each factor is quantified reasonably (seen in Table 1). In the GIS database, the data *Vi* (*i* means the coverage No.) express each value. Then, make use of spatial analysis function of GIS, and overlay the related coverage and build new coverage and polygon, and increase the data value in the new coverage, thus the following equation is made,

$$Value = \sum_{i=1}^{n} V_i F_i$$

In the above equation, Value means the overall of each new coverage after the map is overlayed, Vi mean value of the i factor in new polygon, Fi mean power of the i factor in the new polygon. According to the new diagram, land grade is formed , and Land grade map from computer automatically.

Finally, according to the nature grade characteristic of different land and its present utilization condition, and the combination of reasonable analysis of agriculture and forestry section, reasonable analysis of the research area is presented and provides the basis of carrying on various soil and water measures.

Tables 1   Factors of land resources evaluation and their values

Factor	Grade and value (G means Grade, Vmeans value)											
	G	V	G	V	G	V	G	V	G	V	G	V
	1		2		3		4		5		6	
Altitude (m)	<3,100	5	3,100—4,000	3	>4,000	1						
Slope (°)	<5	6	5—15	4	15—25	3	25—35	2	>35	1		
Erosion degree	tiny	6	light	4	medium	3	strong	2	strongest	1		
Soil depth	deepest	6	deeper	5	deep	4	thinner	3	thin	2	thinnest	1
Soil texture	Light and medium soil	6	Medium and weight soil	5	Weight soil and coarse sand	3	efflorescence	1				
Irrigation condition	have	6	none	0								

4   Layout and plan of water and soil conservations measures using gis

Soil moisture, light and heat condition, soil condition and soil erosion etc. are distinct in different regions or different geography areas, adaptations of land resources are different, too. Good combinations of soil conservation measure must consider the spatial differences of environment factor, and can make sure superior combination mode. In this paper, overlay the altitude of the planed area, slope, soil, vegetation, present condition of land utilization, water and soil conservation, and land evaluation etc., analyze different vegetation growth under different environment condition and different production effect and soil conservation function of different utilization of land resources. By comparing them, the layout scheme of basic farm and different forestry and herbage is confirmed, and the project of harness gully is ascertained according to the status of soil loss and landform in different region.

The request of soil and water conservation plan is that the area of various measures must be quantified. According to the coincident principle of water and soil conservation and ecosystem environment development plan, predict the demand of basic farmland according to the increase of

population in programming periods, grain demand, and grain production with each unit of area, etc. Under the condition of self-supporting satisfying fully, according to present condition of farmland, make sure of areas of various basic farmland and quitting farming. In the middle of land resources of quitting farming, some are planted for proper wood, some for proper grass. Measures of forestry and grass are laid in appropriate soil unit, and form plan map according to the layout project of various areas

5 Conclusions

The natural factors and social and economic factors concerned with the plan area can be expressed by different coverage, which are in the same geodetic coordinate system. Furthermore, GIS can overlay basic elements in order to represent special map and enhance the spatial performance ability of plan data. The jobs of Area measuring and statistic using GIS software, which can improve work efficiency and increase the reliability of programming data. Special analysis function provided by GIS, which can evaluate land resources, carry on subarea of water and soil loss and lay out water and soil conservation measure. Moreover, the application of GIS will boost the science quality and objectivity of soil and water conservation plan.

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