

A STUDY ON THE APPLICATION TO REGIONAL PLANNING IN REMOTE SENSING AND GIS TECHNOLOGY

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ABSTRACT

In this paper, the procedure of the regional planning of Wuchang County using aerial photographs and GIS technique are described. By interpreting and analysing the aerial photographs, the land resources of Wuchang County, such as arable land, water, forest, traffic and waste land, are investigated. Based on the sequential photographs and auxiliary data, the dynamic change of arable land, water surface and the expansion of Zhifang town and Jin kou town are analysed quantitatively and qualitatively. According to the factors of ecosystem, economy and environment, the suitable use of land resources are evaluated, such as the present situation and construction, and the suitable land for planting orange trees are analysed. The data base of land resources of Wuchang County has been established on micro-computer. The mathematic model of land, population and economy are established and the tendency of development are established.

The results show that a great deal of static and dynamic information can be extracted from airphotos and further processed by GIS and that they are very useful for the regional planning, management and decision-marking.

KEY WORDS: GIS application, Regional planning

INTRODUCTION

Land resources are the most valuable property that man has and relies and lives on, yet they might be destroyed by man's never-ending consuming. How to use and protect our resources rationally and reasonably. How to planning for a region has become a serious problem concerning all of us, as a result of the continues growth of world population and ever increasing demanding of our resources.

For resent years, with the development of the techniques in space and computer, remote sensing(R. S.) and geographical information system(GIS) techniques have become a pioneer in geological field. R. S. being a powerful tool in obtaining resources data, can get multi-time data quickly, on a large range and up to data whereas G.I.S. technology as an supplement, supply it with an advantageous method to analyse and deal with overlapping data of different kinds. In addition to the expert knowledge in geography, environment, planning and so on, the conglomeration of these techniques in multi--Sciences has formatted new merging field in science and technique and has showed a very promising perspective in our application to resource survey, development and region planning.

This paper describes the substances, method, techniques and examples of using R.S. and GIS to do regional development planning of Wuchang county.

LAND RESOURCES INVESTIGATION AND EVALUATION FOR REGION PLANNING

Wuchang County is situated in the Southern outskirts of Wuhan city. The area of the Wuchang County totals 2,100km or 25per Cent of the total land area of Wuhan city. In the past years, the area has experienced an exponential growth in its population and economy. The planning agencies of the area need detail information about resources and new technology in regional developing planning.

The data about quantity, quality and distribution of land resources are the important parameters for working out regional planning and formation of strate-

gic plans and policies. In order to meet the needs, we have investigated and analysed land resources of Wuchang County using color infrared airphotos at the Scale of 1:48,000 in 1988 and black-white airphotos at the Scale of 1:50,000 in 1956 and 1970, Such as cultivated land, the present use of water surface, land used for traffic, forests, waste land and so on. We have also detected the changes of cultivated land, water surface area and the historical process of expansion of Zhi Fang town and Jin Kow town in the area with the data of sequential airphotos combining other auxiliary data. The results of investigation make clear that the area of cultivated land was decreased form 1,627,342 mu in 1956 to 1,368,964 mu in 1988, but a great deal amount of population of Wuchang County has increased in the same time, so the area of cultivated land per capitation of Wuchang County decreased from 5.5 mu in 1956 to 2.7 mu in 1988. Also the area of water surface in Wuchang County was decreased from 817,400 mu in 1956 to 610,623 mu in 1988 and forest cover is only 25% so the agricultural ecological environment become bad more and more. According to this situation we have studied the models of the relation between land, population and economic and the Model about best structure of land use and suggest them how to protect land resource and control the growth of population in Wuchang County in future.

The long-term availability of agricultural land suitable for growing grain and oranges in Wuchang County has been studied to assist in planning for the future stability of economics in a rapidly developing area. The study has provided the suitable conditions of growing oranges. They are seven factors including temperature, soil, sunlight, elevation, weather condition in Wuchang County and slope. This study has shown that suitable land are currently available for growing oranges but suitable land for grain growing area must be protected.

MODELLING ANALYSIS TECHNIQUES WITH GIS

GIS, which handles spatial distributed data, supplies region planning with comprehensive analytical method. It not only succeeds in dealing with various spatial data by using computer, but also expends and

deepens various advanced mathematical method by GIS. So we can improve the work of region planning from information, technology and method, and cause region planning towards systematization, modelling and intellectualization.

Doing region planning with GIS, one of the keys is to form revealed mathematical models according to the regularity, stochastic process, indetermination and fuzzy of the studied object. The models should include analysis, forecasting, Comprehensive decision etc. The major models in this paper are as follows:

I. Evaluation Model (Land Suitability. Land productivity and orange suitability evaluation)
This is an improved method of common index sum and fuzzy comprehensive evaluation.

$$Y = V * b * t = \begin{pmatrix} V_{11} & V_{12} & \dots & V_{1m} \\ V_{21} & V_{22} & \dots & V_{2m} \\ \dots & \dots & \dots & \dots \\ V_{n1} & V_{n2} & \dots & V_{nm} \end{pmatrix} * (b_1, b_2, \dots, b_m)$$

$$= \begin{pmatrix} Y_1 \\ Y_2 \\ \dots \\ Y_n \end{pmatrix}$$

here:

(1) The sign V_{ij} denotes the marked value of index X_j in cell W_i ,

$$V_{ij} = \begin{cases} 0 & U_{ij} < C_{min} \text{ or } U_{ij} > C_{max} \\ C_j - U_{ij} & C_{min} \leq U_{ij} < C_{ma} \\ a & C_{ma} \leq U_{ij} \leq C_{max} \\ 1 & \end{cases}$$

a --parameter C_j --criterion Value
 U_{ij} --surveyed value C_{min}, C_{ma}, C_{max} --threshold
($i=1,2,\dots,n, j=1,2,\dots,m$)

(2) $b_i (i=1,2,\dots,m)$ denotes the weight of factor X_j
Rule to definite b_j is to make decision Value Y_i scatter and assume the square sum of b_j to be one
That is to say:

Lot sample variance

$$\sigma^2 = \frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2 \rightarrow \max$$

and

$$\sum_{j=1}^m b_j^2 = b^T b = 1$$

in which

$$\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$$

According to above, We can get b_j directly from original data v_{ij} . It's a development of expert making method.

(3) "0" denotes five operators-- $M(\wedge, \vee), M(\cdot, \vee), M(\wedge, \oplus), M(\cdot, \oplus)$ and $M(\cdot, +)$.

(4) $Y = Y_1, Y_2, \dots, Y_n * t$ denotes the decision results

II. Analysis and Forecasting Models

Using weighted regressive and relative analysis, relationship models among economics, land and population of agriculture in Wuchang County is formed and the future condition before 2000 was foreseen. Relationship between agricultural population and time t:

$$X_2(t) = 2.18145 + 0.087548t - 0.913566 \times 10^{-3}t^2 - 0.270692 \sin \frac{\pi}{20} t$$

($F=1562, S=0.0463, R=0.9964, cv=0.0122$)

Relationship between agricultural land and time t:

$$X_1(t) = 9.14099 + 0.0184341t - 0.146327 \times 10^{-2}t^2 + 0.238139 \times 10^{-5}t^3$$

($F=141095, S=0.1162, R=0.9621, CV=0.0136$)

Relationship among agricultural output value $Y(t)$, $X_1(t)$ and $X_2(t)$:

$$Y(t) = 0.308065 \times 10^{-3} - 0.875243 \times 10^{-2} X_1(t) + 0.6315 \times 10^{-2} X_2(t)$$

$$+ 5.66346 X_1^2(t) - 5.34761 X_1(t) X_2(t) - 2.09395 X_2^2(t)$$

($F=1203.1861, S=0.8232, R=0.9968, CV=0.0498$)

here:

$Y(t)$ --agricultural output value (10000000 yuan)

$X_1(t)$ --agricultural land area (100000 mu)

$X_2(t)$ --agricultural population (100000 person)

t --time(year) ($t=1,2,3,\dots$)

III. The model about Best Structure of landuse

Within agricultural land region by using Linear Program method, the best land use structural model in Wuchang County was set up, which accords to following rules:

a) The rule which combines the ecology benefit, economic benefit and social benefit;

b) Land suitability;

c) Agricultural land first;

d) The rule that land distributed according to elevation objective function:

$$\max z = -21.003X_{11} - 42.978X_{12} - 45.434X_{13} + 129.30X_{14} + 31.409X_{15} + 35.811X_{21} - 9.627X_{22} - 27.699X_{23} + 291.70X_{24} - 21.143X_{25} - 39.973X_{31} - 9.627X_{32} - 27.699X_{33} + 778.90X_{34} - 34.20X_{35}$$

s.t.

$$\textcircled{2} 0.0534 \sum_{i=1}^3 x_{i1} + 0.03896 \sum_{i=1}^3 x_{i2} + 0.05726 \sum_{i=1}^3 x_{i3} + 0.03 \sum_{i=1}^3 x_{i4}$$

$$+ 0.03107 \sum_{i=1}^3 x_{i5} \leq 10.1949$$

$$\textcircled{3} \sum_{i=1}^3 x_{i1} > 61.48$$

$$\sum_{i=1}^3 x_{i2} > 20.49$$

$$\sum_{i=1}^3 x_{i3} > 20.49$$

$$\sum_{i=1}^3 x_{i4} > 2.04$$

$$\sum_{i=1}^3 x_{i5} > 51.23$$

$$\textcircled{4} 94.73 \sum_{i=1}^3 x_{i1} + 55.60 \sum_{i=1}^3 x_{i2} + 88.72 \sum_{i=1}^3 x_{i3} + 812 \sum_{i=1}^3 x_{i4}$$

$$+ 65.69 \sum_{i=1}^3 x_{i5} > 37752.8$$

$$\textcircled{6} \sum_{i=1}^5 x_{i1} = 72$$

$$\sum_{i=1}^5 x_{i2} = 120$$

$$\sum_{i=1}^5 x_{i3} = 3.657$$

here:

z --agriculture output value which deducts labour force income (10 thousand yuan)

X_{ij} --planting j area under height i ; (10 thousand mu)

Through the best allocation, the value of output could increase 7572.71*10000 yuan.

Based on GIS, all these models were succeed in completing region planning in Wuchang County.

Land Resources Data Base System (LRDBS)

LRDBS is a system which the land resource data and related parameters are stored in and some analysis

functions are available. It's composed of micro-computer IBM-PC, data input and output devices, process and analysis software. User can input data, update data, retrieve data, check the system, recover, statistics and analyses easily with the system. The structure programming technique is used in the system design to facilitate the function expanding and program testing. Fig. 1 shows its configuration. The functions of the system as below.

- . Create data base: create files and input data;
- . Retrieve: query selected file according to the give condition to get the needed information;
- . Append: input new data to the selected file;
- . Delete: delete the records which satisfy the given condition from selected file;
- . Change: change the records which satisfy the given condition in selected file;

- . Copy: make the reserve disk;
- . Recover: recover the system to currently right status by using the reserve disk when the system is destroyed;
- . Check: Verify whether the system is correct;
- . Analyse: foresee and analyses models

CONCLUDING REMARKS

This achievement has been applied to the regional development planning of Wuchang County. It widens the fields of the employment of RS and GIS and make true the dream of application of advanced technique to region planning.

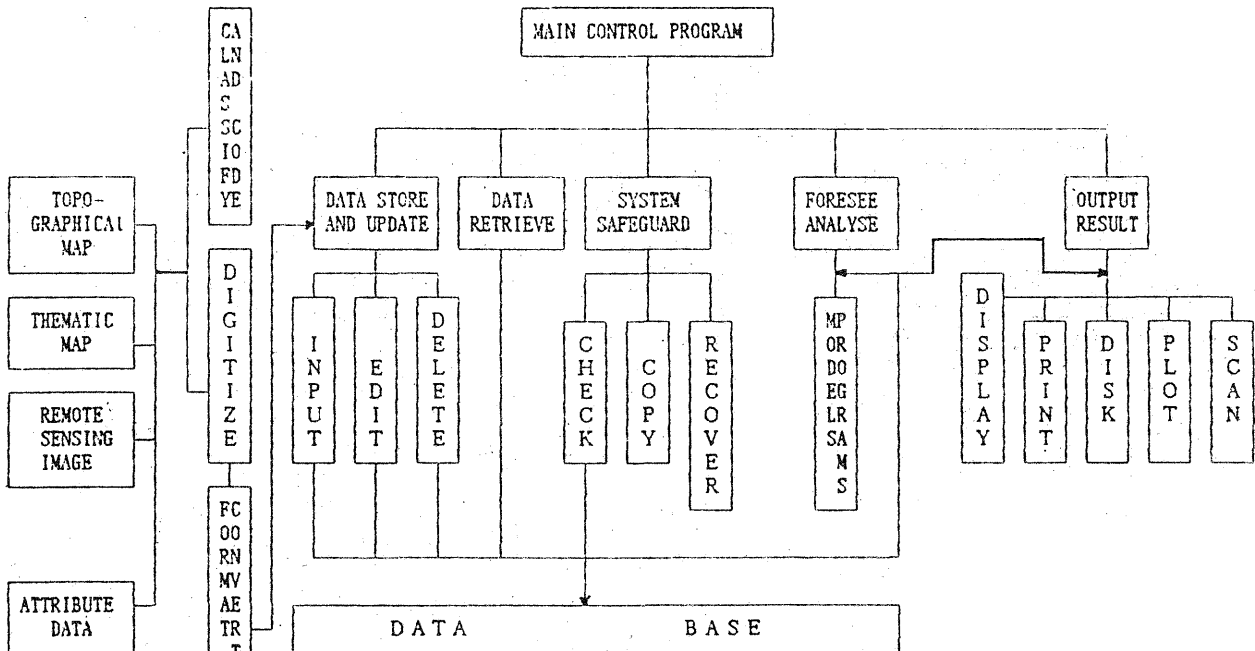


FIG. 1 The system configuration