

Environmental Assessment of Land Use Planning Based on Remote-sensing Technique and Geographic Information System in ZouCheng County

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Abstract—Since Land Use Planning's (LUP) implement will have impact on local ecological environment, the environmental assessment of LUP (LUPEA) is essential. This article explored the feasibility and method of LUPEA based on the environmental sensitive analysis study under the support of remote-sensing (RS) technique and Geographic Information System (GIS) and had assessed the ZouCheng County Land Use Overall Planning Environmental Impact using the method above.

Firstly, after the analysis of the local environment status in quo, the environmental individual factors of ZouCheng County were determined, which included soil erosion, biodiversity, water quality, land subsidence and drain basin pollution. Secondly, the drainage area, elevation hierarchical map and slope distributing map were extracted with the aids of SRTM3 data. After that, we constructed the contaminant burdening indices including chemical oxygen demand (COD) and waste water on the basis of local drainage area to measure drain basin pollution individual factors. Thirdly, the vegetation feature and land use/cover information were also extracted using Landsat TM image based on the supervised classification and man-machine interaction interpretation method. Fourthly, with groundwater, nature reserve, coal mining caving in risk thematic information and other data including extracted information above, the Environmental Assessment Database System was set up in GIS environment. After the overall evaluation of environment status, the comprehensive assessment map of ZouCheng county environment was acquired and was overlapped by the land use overall planning map subsequently.

With the analysis of the environmental assessment and land use overall planning data, several conclusions were drawn as follows:

(1) High sensitive areas are mostly located on the big slope and areas and mountains apt to lose water and soil; moderate ones, on groundwater resources, large contribution water body, nature reserve and coal mining caving in risk area; and low ones, on natural or manmade woods and relatively severe polluted basins.

(2) Burdening contaminant of local drainage area is an important factor in industrial distribution layout.

(3) Land use overall planning scheme of ZouCheng County was feasible in environment respect in first approximation.

(4) It is of great significance to assess the LUP using RS and GIS Technology.

Keywords—environmental sensitive analysis; Land Use Planning Environmental Assessment (LUPEA); Geographic Information System (GIS); Remote Sensing (RS) technique

I. INTRODUCTION

As an important integral allocation and arrangement of land use, land use overall planning would have profound impact on local environment. Land Use Overall Planning Environmental Assessment (LUPEA) is mostly resolved with the traditional project Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) methods. It is of great significance to analyze current environment in the process of Land Use Planning Environmental Assessment (LUPEA), while environmental sensitivity zoning theory could be used for the preliminary Environmental Assessment of Land Use Planning. Environmental sensitivity zoning theory research has been persisted for several years. For example, value of environmental sensitivity area and environmental sensitivity of biology were probed into by Garrod G D, Willis K G. and Alastair cameron, robert J. Johnston, Jim McAdam[1, 2]. Ignacio Lozano explored the Storminess and environmentally sensitive Atlantic coastal areas of the European union on the view of climate[3], and Stephanie Abakerli assessed the impact development and conservation policies in environmentally sensitive regions in Brazil[4]. In China, many scholars have studied the environmental sensitivity zoning theory and methods in various aspects likewise [5, 6, 7]. In spite of the popularity of studies in this domain, there is a relative lack of LUPEA based on current environment assessment using environmentally sensitivity zoning theory under the support of the Remote Sense(RS) and Geographic Information System(GIS) technology. We think that the research of environmental sensitivity is a foundation to understand and remodel nature, and a guidance of land use, regional development planning and ecological environment protection.

This paper discussed the feasibility of LUPEA based on the method and clew above with ZouCheng county's data in mesoscale. Thematic information including terrain, drainage basin, and landscape of ZouCheng County was extracted from remote sensing images, which were inducted to

LUPEA Spatial Information Database with present land use information, land use planning information and other thematic information. Later LUPEA of ZouCheng County was processed on the basis of LUPEA Spatial Information Database.

II. SURVEY AND BASIC DATA SOURCE OF ZOUCHENG COUNTY

ZouCheng, a county located in the south of Shandong province in China, has five kinds of terrain: low mountains, breck, campagna, depression and water plane, whose geology belongs to North China platform type with sedimentary deposit of 2450m. The maximum altitude is 648.7m and minimum 35m, average 77.8m. The dominating water system includes about 40 rivers such as SiHe River and BaiMa River, most of which belong to seasonality intermittent stream flow. The number of soil category in ZouCheng is 4 and soil local type 48. ZouCheng County also has kinds of underground resources including coal, dolomite, crouan, and so on.

To accomplish the research we gathered TM image in 2002 and SRTM3 image and other thematic information data of ZouCheng. TM and ETM images shot with American Landsat satellite series have 30m ground resolution, Each scape corresponding area of 185km×185km. In 2000, "Endeavor" space shuttle got remote sense images using INSAR technique, and the image were subsequently disposed into DEM named SRTM with 90m ground resolution. Other thematic information data of ZouCheng mainly comprises underground resources, geologic environment and nature and human landscape thematic information data.

III. DETERMINATION OF PRINCIPAL ENVIRONMENTAL LIMITING FACTORS IN ZOUCHENG COUNTY

Principal environmental limiting factors including soil erosion factor, biodiversity and water quality were extracted after the environmental survey and environmental overall evaluation. In addition, as a significant coal mining county, there is some land subside areas caused by coal mining in ZouCheng, which is an important limiting factors as well. We define it as land destruction factor in this paper. As a polluted industrial city, the wastewater and chemical oxygen demand (COD) discharge capacity is quite large, so contamination bleed to river, namely drain basin pollution factor is an important limiting factor too.

Soil erosion factor has osculated relationship with landscape vegetation cover and terrain intelligence, so we can use terrain and landscape vegetation cover to evaluate its significance. As there is little significance to measure the biodiversity indices accurately due to the unbearable giant force and financial consumption, to assess land use planning environmental impact in mesoscale, the rank and distribution of nature reserve may be feasible options to measure

biodiversity indices value. Water quality and hydrology indices could be measured based on the surface and ground water function and service coverage, and land subside indices based on the destruction caused by coal mining, and drain basin pollution indices based on contaminant burdening value using local drainage area.

Each individual indices rank and valuation was determined on the expert's synthetic decision and correlative national standard after the process above listed in table 1. The reference of rank and valuation is current environmental quality and characteristics of ZouCheng. The nature reserve reflecting biodiversity indices, for example, were defined as follows because of lacking national level nature reserve, Provincial nature reserve were evaluated as 3, municipality as 2, county as 1, and non as 0.

TABLE I. CLASSIFICATION AND VALUATION OF ENVIRONMENTAL SENSITIVITY INDIVIDUAL FACTORS

Individual Index	Intensity level				
	<i>Non or least lightly</i>	<i>Gentleness</i>	<i>Moderate</i>	<i>Gravity</i>	<i>Most gravity</i>
Soil erosion factor	0	1	2	3	4
Biodiversity indices	0	1	2	3	4
Water quality and hydrology indices	0	1	2	3	4
Land subside indices	0	1	2	3	4
drain basin pollution indices	0	1	2	3	4

IV. INDIVIDUAL FACTORS THEMATIC INFORMATION ACQUISITION

A. Remote Sensing Information Extraction

In this research the correlative thematic information were extracted from TM image and SRTM3 image on the ERDAS imagine software platform.

1) *Data preprocessing*: Data preprocessing mainly contains image geometric correction, projective transformation, framing cutting, splice process, and so on [8]. As the range of ZouCheng crossover 35 and 36 TM images, it is essential to cut and splice TM images. In the process of framing *cutting* and splice Histogram matching was used to eliminate aberration between 35 and 36 TM images. All the correlative thematic information were transformed into the same projection system as GCS_WGS_1984 and inducted into GIS spatial information system after geometric correction process.

2) *Elevation grading and slope extracting*: In this process, elevation grading and slope information were extracted from DEM data as SRTM3 image. The criterion of slope extracting is on the elevation and slope influence to agricultural production and legibility of factors. We classify slope into four grades: 0-7° ,7-15° ,15-25° , >25° , and elevation into 60m spans.

3) *Vegetation and land utilization/cover information extractin*: To extract vegetation and land utilization/cover

information, the following steps were employed: (1) selecting training sample from training field delimited with field investigation and auxiliary data based on ancient land use information, interpretation key and geographical object spectral diagnostics. The determination of training sample is on characteristics of images, land type size and quantity, and the number of each kind of training sample is no less than 10. (2) Building adequate classification templates with process of edition and evaluation. (3) Generating preliminary land utilization/cover classification map using supervised classification and man-machine interaction interpretation method. (4) Generating final land utilization/cover classification map using cluster analysis, removing analysis to eliminate insignificant small plots and to label classification mistaking pixel.

4) *Drainage basin extracting: Contaminant discharging into water body can result in the aggravation of environment burdening capability; thereby it is essential to consider the impact of Contaminant discharging into water in the procession of land use layout. To assess the burdening contaminant of drainage area indices value we extracted the local drainage basin from DEM and constructed the COD and wastewater burdening indices using the technological processes below:*

a) *Direction of flow extracting:* It is very convenient to parametrizing the drainage area using DEM remote sense images to get the information of water system and sub-drainage area [9]. For each grid, direction of flow is defined as direction that stream flows away the grid. Local direction of flow can be extracted from SRTM3 DEM images of ZouCheng County with support of hydrologic analysis module of ArcGIS software.

b) *Depression stuffing:* Depression area is the place of ridiculous direction of flow, which can be judged with direction of flow and be stuffed, thus the non-depression DEM is acquired.

c) *River network extracting:* Firstly, each grid direction of flow was calculated with non-depression DEM images. Then, the accumulative confluence was calculated. After the accumulative confluence value attaining certain amount, it is possible to get surface flow, and then the river network was extracted.

d) *Drainage basin extracting:* The location of analyzing windows brim water outlets were firstly dug out and the location of upstream grid flowing into water outlets subsequently. The upstream grid is known as drainage basin.

B. Drainage area contaminant burdening indices value measurement

Using the drainage basin map extracted above, COD and wastewater burdening amount were calculated according to zero dimension model of pollutant dispersion using drainage basin extracted from SRTM3 images, and were inputted into space lattice database of ZouCheng then. Finally, we got the

contaminant burdening distribution map based on drainage basin.

The contaminant discharge is an important factor that needs taking into account in the future land use layout. Additionally, the diffusion of contaminant discharge is out of ZouCheng County, which is a witness to external impact of land use environment.

C. Process and entry of other thematic individual factors

We also collected other thematic individual factors including groundwater, nature reserve, and coal mining caving in risk thematic information to analyze the environmental sensitivity of ZouCheng County. It is necessary to take Map digitization and Geometric correction process because the form of thematic information above is mostly physical maps. The scanning of maps was essential firstly, while projection definition secondly. To reduce the scanning error in GIS environment, Image Registration Geometric correction was adopted. Vectorization is the last step in this course.

D. Environmental sensitive zoning of ZouCheng County

After the entry of other thematic individual factors, weight assignment of each individual factors were determined based on Analytic Hierarchy Process (AHP) and reference of relevant experts. With the working procedures the weight of each individual factor was measured in table 2.

TABLE II. WEIGHTS OF ENVIRONMENTAL SENSITIVITY INDIVIDUAL FACTORS THEMATIC MAP

environmental sensitivity individual factors	Weights
elevation	0.15
slope distributing	0.25
Surface water system and groundwater head site distribution	0.15
Coal mining carving and nature reserve distribution	0.15
vegetation feature and land utilization /cover information	0.1
wastewater burdening	0.1
COD burdening	0.1

With the analysis of major environmental factors distribution and correlations between each other, we got the environmental sensitive zoning map of ZouCheng county in the ARCGIS platform with Superposition analysis method.

From the map in figure 1, we can get the information that the high brittleness areas are mostly located on the big slope and areas and mountains apt to lose water and soil; while moderate ones, on groundwater resources, large contribution water body, nature reserve and coal mining caving in risk area; and low ones, on nature or manmade woods and relatively severe polluted basins.

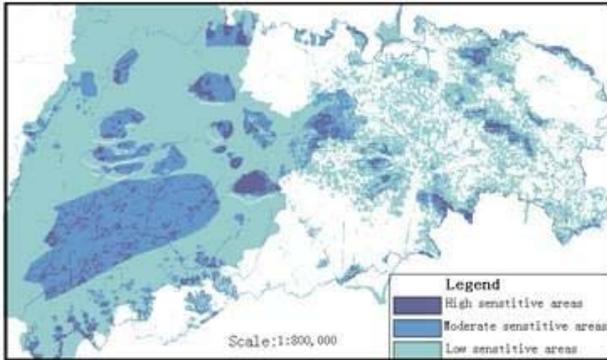


Figure 1. Environmental Sensitive Zoning Map of ZouCheng County.

V. ENVIRONMENTAL PRELIMINARY ASSESSMENT OF LAND USE PLANNING

Rationality of Land Use Planning layout could be appraised by means of overlapping Land Use Planning layout map on Environmental Sensitive Zoning Map showing in figure 2. It could be concluded that environmental adverse land use layout was mostly distributed in the low or non brittleness area, nevertheless land used for traffic was unavoidably in moderate brittleness area. Therefore, the Land Use Planning layouts tally with Environmental Sensitive analysis conclusions by and large.

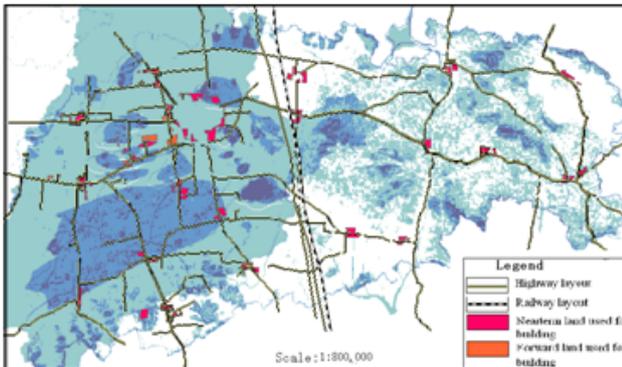


Figure 2. Land Use Planning preliminary assessment based on Environmental Sensitive Zoning.

VI. CONCLUSIONS

For all that, with the adverse impact on environment, the Land Use Planning layout was in great request of adjustment

to fit the Environmental Sensitive analysis conclusions in ZouCheng County. Specifically, in moderate brittleness area the land used for building layout requires pertinent palliation measures to reduce the adverse impact on environment and the contaminative industrial projects is forbidden to layout in the high sensitive area, Nevertheless, some land used for traffic is needed.

It is of great significance that the environmental assessment of LUP (LUPEA) was achieved based on the environmental sensitive analysis method. Furthermore, with the aids of remote-sensing (RS) technique and Geographic Information System (GIS) technologies, the LUPEA could be prosecuted intuitively and conveniently, which is the prevailing trend in geosciences research as well.

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