On Comprehensive Regional Division of Agricultural Ecological Economic Resources System Based on GIS

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Abstract

The paper conducts a systematic research on the relative theories, techniques and methods of agricultural ecological economic regional division with model testing of GIS technology and the building of agricultural ecological economic index system and its index quantitative models in a progressive and ever-deepening manner, based on ecological economic theories and grid technology and guided by the systematic thinking, to form a quantitative method system for agricultural ecological economic regional division system. The paper takes Zezhou County, Shanxi Province as the research object, using the models and technological methods to calculate and analyze the agricultural ecological economic regional division system indexes of Zezhou County, based on which the agricultural ecological economic system of Zezhou County is made into 6 agricultural ecological economic regions of 4 categories. The comparison is carried out between the theoretical system and the actual local planning to prove such two are almost the same which further proves the credibility of such theory and techniques.

Keywords: GIS, agricultural ecology, regional division, division index

1. INTRODUCTION

As is known to all, with the overview of the world economic development, the environment and resources are playing a more and more important role in the social and economic development, and at the same time, the modern social and economic development are closely connected to the ecological environment. To keep abreast of the times, it is necessary to fully introduce the advanced economic division and ecological division, to greatly coordinate the developments of ecology, environment, society and economy. At present, there are huge limits on the actual economic and ecological since China at the moment in this area are still dominated with old-fashioned methods and theories, especially in the area of comprehensive management of the national land resources, reasonable industrial layout and the treatment of exacerbating environmental pollution during the urban development, which hinder the urbanization and industrialization (Ayalew and Yamagishi, 2005). Therefore, it needs to put forward an improved comprehensive regional division theory and methods, in particular, to go along with the resource environment and social and economic development, to help the regional economic development and form the reasonable planning.

It is no doubt that the different artificial ecological systems have distinctive regional differences. In other words, each region is subject to its distinctive ecological structure and functions. And it is the same with the different human approaches in exploiting different regions and the activity intensity. The ecological economic regional division should combine with the compound regional and ecological economic system structures and it should carry out the reasonable and targeted improved development and utilization of the natural space and resources (Silva et al., 2013). It is necessary to comply with the regional features, to divide the ecological economic zones and to improve the integrity of the regional ecology, while creating the social wealth and coordinating the healthy development among the regional society, nature and economy, improving the sustainable development by giving full play to the advantages to the compound ecological system.

The current research methods mainly focus on the qualitative and quantitative ones. Generally speaking, such methods lack accuracy and thus is contained within the administrative zones planning framework, lagging greatly behind the actual being of the ecological economic system (Niggol et al., 2009). To some extent, the insufficiency of the old-fashioned ecological economic regional division research method calls for a further
deepening analysis which would make breakthroughs in administrative areas and hence improve the accuracy of the quantitative ecological economics in a wholesome manner.

2. BASIC THEORIES OF ECOLOGICAL ECONOMIC REGIONAL DIVISION

2.1 Theory of ecological economics

There are several schools regarding from different scholars. First, the study subject of ecological economics is ecological economic system, namely the relation between human beings and natural ecology. Second, ecological economics, as a marginal subject, has fully converged with many subjects and disciplines (Neamatollahi et al., 2012). Third, two research focuses includes some certain quantitative assessment and sustainable development. Compared with the old-fashioned economics, ecological economics tends to emphasize more on coupling between ecology and economic system, which stresses not only on the main goal of social and economic development, but also on the highly efficient recycling of all material energies, reasonable resource allocation and on-going optimizing the whole ecological economic system, namely improving the systematic efficiency fully (Lin et al., 2013). The ecological economics focuses more on the economics which fully considerate the interactions between the social and economic rules and natural ecological rules, and it also stresses on the unification of ecological and economic reproduction, the unification of ecological and economic structures, the unification of the ecological functions and economic functions, and the coordination of ecological economic system development, to improve the coupling, coordination and integration of the system, building a solid foundation for the sustainable ecological development. Therefore, the ecological economics, in essence, embodies the very concept of the coordination of the sustainable ecological economic development.

![Figure 1: Ecological economic system model](image)

2.2 Theory of restoration ecology

Davis and Slobodkin (2004) believed in the one or multi value landscape and practice, namely the ecological restoration. The restoration ecology deems the aesthetics entertainment, species ecological habitat and bio-diversity and the like as the restoration objectives. At the same times, it rejects taking landscape conversion as the ecological restoration, for instance, the forest converting into the cities is irreversible. The landscape conversion should be involved in the properties of the ecological restoration (Olayide et al., 2013). At present, most restoration ecologists point out that it needs to combine with carrying function of the materials in some certain basin scale, and the water flow, two of which interconnect and interact with all landscape elements and ecological system. It can restore land ecological system of the water catchment areas or take restoring the water system as the basis for the improvement of the whole basin ecological environment. By comparison, the ecological management of basin scale proves to be more effective and rational (Barbosa et al., 2009).

3. ECOLOGICAL ECONOMIC REGIONAL DIVISION MODEL RESEARCH

3.1 Ecological economic regional division index system framework

The ecological economic regional division system needs to make all indexes. In studying ecological economic system, three aspects need to be considered. First, the general trend and the development stage of the social and economic development. Second, the influence of the regional development on the ecological system (Samet, 1991). Third, all factors influencing on the regional development, including natural disaster, environment capacity and resources talents and the like. A full coordination of these three factors, an all around improvement
of regional development, will form the following three modules. First, the development stages of the social and economic development, mainly studying the zone position, population, economic development level and the like (Benz et al., 2004). Second, the ecological system protection level, mainly studying the ecological system service functions and the system fragility. Third, the resource environment bearing capacity, mainly the environment capacity, land resource, terrestrial disasters and the like. A comprehensive study of all the basic indexes will further create the new indexes for every principle level.

3.2 Ecological economic regional division model

There are four layers of ecological economic regional division index system, namely target layer as the first, module layer as the second, principle layer as the third, and basic index layer as the last. In other words, the corresponding model to be constructed has to go along with such index system in quantitative ecological economic system (Mirkena et al., 2015). In addition, constructing models needs to consider the following principles, such as corresponding to the actual needs of the grid calculation, breaking the limits of the administrative areas, enriching the model numerical value, getting close to the ecological economic development rules, and giving full play to graduality, differentiability and continuity of the numerical value (See Figure 2).

4. APPLICATION OF AGRICULTURAL ECOLOGICAL ECONOMIC REGIONAL DIVISION MODEL

4.1 Overview of research region

Zezhou County, located in the southeastern part of Shanxi Province in China, boasts of 2023 square kilometers, adjoining Linchuan County on the east and Gaoping City on the north, adjacent to Qinshui County, Yangcheng County, Bo’ai County, Xiuwu County. As in Figure 3, it spans from longitude 112˚32’ to 113˚14’ east and latitude 35˚12’ to 35˚42’ north, with a total area of 2023 square kilometers.

4.2 Geographical analysis

There are mountains from all sides in Zezhou County, which is high in the east and low in the south. The peak standard height of the southeastern area hits at around 1000, named Taihang Mountains, with overlaying steep peaks, while the river valley at the Danhe River departure along the southeast boarder is only 290 meters. The middle terrains remain relatively low and flat, and the ground standard height of Jincheng basin ranges from 690 to 790 meters, with small basins, such as Bagong, Nancun, from the north to the south. Xiacun County boasts of the main peak of Wushen Mountains of 1346.6 high above sea level.
4.3 Data collection and preparation

(1) Remote Sensing Image Processing and Interpreting

Remote sensing image can acquire original image data which could display a 3-D version landscape projected from a 2-D resource, namely restoring the scrambled images including Geometric deformation radiation volume and shape distortion and the like. That's why it is necessary to pre-process the images to interpret the remote sensing images, namely the digitalized processing of the remote sensing images. The research forms the remote sensing images by fitting into the coordinates of the mapping projecting based on the correction of geometrics and radiation and the like. In such case, it needs more processing, such as the accurate correction of geometrics, editing images and strengthening image radiation and optical spectrum and the like.

(2) Strengthening Remote Sensing Images

The luminance levels and the resolution ratios of the outline and borderline would be easily affected without the strengthening processing, which will increase the difficulty in the direct explanation and categorization. The strengthened multi optical spectrum images can improve the image quality and effect while highlighting the information. There are several steps to strengthen the images in practice, such as Color synthesis, linear stretch, filter processing, and spatial transformation which can be further divided into other fine methods (Wheatley et al., 2005).

5. ECOLOGICAL ECONOMIC REGIONAL DIVISION SCHEMES AND RESULT ANALYSIS

5.1 Regional division scheme

Agricultural ecological economic regional division indexes fully consider the resource environment bearing capacity, ecological system protection efforts, social economic development and the like. In short, it forms a quantitative ecological economic regional division. A higher EEI value promises higher tapping value. A careful study of all values of EEI can determine the optimization of development zones, key development zones and prohibited limit zones and the like. It is also combined with the unique geographical features, regional development characteristics and corresponding planning (See Table 1) of six ecological economic regions. Figure 4 shows the result of ecological economic regional division of Zezhou County.

Table 1 Ecological economic regional division scheme of Zezhou

<table>
<thead>
<tr>
<th>Ecological economic zone type</th>
<th>Partition number</th>
<th>Partition named</th>
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<tbody>
<tr>
<td>Prohibited development zone</td>
<td>IA</td>
<td>Prohibited development zone</td>
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<tr>
<td>Limit development zone</td>
<td>IIA</td>
<td>Peripheral limit development zone</td>
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<td>Optimization of development zone</td>
<td>IIIA</td>
<td>Back to optimize development zone</td>
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The key development zone

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<th>The key development zone</th>
<th>IVA</th>
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<td>IVB</td>
<td>Understand key development zone</td>
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**Figure 4** Ecological economic regional division map

### 5.2 Regional division results analysis

Six agricultural ecological economic regions of Zezhou County mainly fall into four types. At the same time, it further proves the rationality and accuracy of the regional division results by investigating the ecological, economic and social aspects of each ecological economic region.

1. **Agricultural Prohibited Development Zone in Zezhou County**

   This zone is mainly divided into two parts of core zone and buffer zone, both located in the south of Zezhou County. The forest coverage rate here reaches at 45%, with winding rivers crossing each other against the lush forest. Danhe River and Qinhe River are the main rivers flowing from the north to the south. There are 223 kinds of species of wild animals, including one order, two families and three species of amphibians; three orders, seven families and eighteen species of reptiles; ten orders, 41 families and 166 species of birds; seven orders, one family and 36 species of mammals. 23 wild lives live here under national key protection, including leopard and musk deer as the first class national protect animals, 21 second class key protect wild animals and 12 provincial level key protect wild animals. In summary, the rich natural resources in the region plays an important role in promoting ecological balance, hence there is necessity of exploiting the core zone to improve the regional environment quality full dimensionally. Therefore, it is necessary to divide the region into the prohibited development zone.

2. **Limit Development zone near Zezhou Macaque Natural Conservation**

   The region is located in the northeast of Zezhou Macaque Natural Conservation, including Nanling Country, Lizhai Country and the lab areas in the conservation. The region enjoys high plantation coverage rate with good natural environment. In addition, Danhe River and Qinhe River also flow across such region. Lizhai is with the most beautiful natural sceneries of all. In general, the region is not suitable for attracting and concentrating population and industries. It should emphasize on its ecological functions and practice limit development suited to the local conditions.

3. **Optimization Development Zone in North of Zezhou County**

   The region is in the north of Zezhou County, including Bagong Town, Daiyang Town, Beiyicheng Town and the west of Gaodu Town and the like. As the most economically developed region of Zezhou County, it is with mature chemical industry, construction material, casting, refining, and coal businesses. Bagong Industrial Park is with poor forest coverage rate and flowing water quality though Danhe River and Gonghe River flow across the
region. Its ecological system is vulnerable with less or even negative atmosphere remaining environment bearing capacity. In general, such elements all indicate that the region has reached its biggest development density, which is overly high industrialization. The shattering environment bearing capacity during development calls for emergent need to optimize the regional ecological environment quality by transforming the traditional growth mode characterized by industry and reducing environmental pressure in a precise fashion.

(4) Optimization Development Zone in South of Zezhou County

The region is located in the south of Zezhou County, including Daji Town, Benlichuan County, the north parts of Nancun County and the like. The regions boasts of many industrial enterprises, with casting, refining, coal and construction materials and the like. The water shortage is due to no main river flowing across the region. In addition, the atmosphere remaining environment bearing capacity ecological system function, and forest coverage rate and others are in relatively poor conditions, which results in the shattering environment bearing capacity during over development, which creates the need to rapidly upgrade the technologies, expand the industrial chains, reduce pollutant emissions, and at the same time, reduce energy loss per unit of products and increase the product added value. In summary, it needs to optimize environment education in an all-around way, and such region is divided as the optimization development zone.

(5) Key Development Zone along Changhe River

The region is located in Changhe River basin in the west of the County, including Xiacun Town, Dadonggou Town, Chuangdi Country and Zhoucun Town. The region enjoys relatively developed economy, especially in the rich limestone, iron and coal and the like. The region has all sorts of industries of mechanical repairing and parts, transportation, refining, coal mining, without any official scales and systems regrettably. The region is surrounded by Changhe River with poor plantation coverage rate. Those areas not surrounded by Changhe River enjoy high plantation coverage rate. At present, the region has rich resources and relatively good environment, with uniquely rich coal resource. Thus it is necessary to quicken the development with protection, especially focusing on the infrastructure construction, actively building sound investment environment, quickening the construction of all the businesses concentration, expanding the development of correlating industries, enhancing the development of city concentration and industrialization, and promoting attracting population and industries in an all-around way to boost the economic development. Thus this region can be divided as the key development zone.

(6) Key Development Zone in East of Zezhou County

The region is located in the east of Zezhou County, including the west of Gaodu Town and the north of Jincun Town. Currently the region is rather economically developed. There are all sorts of construction materials, coal mine, refining and other enterprises, without an integration of the productive force regrettably, let alone a complete industrial chain. Compared to other regions, the region here enjoys average plantation coverage rate, environment being and development level. In addition, there is room for further development due to the relatively rich resource, and relatively high atmospheric environment bearing capacity. The regional geographic advantages and good soil are particularly conducive to promoting modern industries. The home region near Jingcheng City area can quicken the pace of urban development by giving full play to the radiation of Jingcheng City area. It needs to rationally promote the warehouse logistics, property industry, entertainment and leisure business and the like to actively transfer the city businesses and population; to develop the coal chemical industry by giving full play to the rich coal resource, actively expanding the industrial chains, suited to the local conditions. Thus it is necessary to divide the region as the key development zone.

6. CONCLUSION

The paper employs all grid technologies, especially RS and GIS. It fully embodies the graduality and continuity of agricultural ecological economic development by fitting in the grid space, calculating all levels of models of ecological economic regional division, namely not subject to the administrative regional division. At the same time, taking Zezhou County as the breakthrough, the empirical study calculates and analyzes the agricultural ecological economic regional division indexes of the agricultural ecological economic regional division of Zezhou County by combining corresponding technological methods and models. There are six ecological economic zones, namely Agricultural Prohibited Development Zone in Zezhou County, Limit Development zone near Zezhou Macaque Natural Conservation, Optimization Development Zone in North of Zezhou County,
Optimization Development Zone in South of Zezhou County, Key Development Zone along Changhe River, and Key Development Zone in East of Zezhou County and the like. In the end, it finds that the theoretical regional division methods suits the local conditions which further proves the feasibility and rationality of the constructed agricultural ecological economic regional division models and methods by the comparisons of the field investigations and regional division results.

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