Geoinformatics-based study on the regionalization of ecological function in the Chaohu Lake Basin, East China

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Abstract

Ecological function regionalization is a kind of geographic spatial division, which is based on the spatial differentiation of ecosystem functions. Based on an analysis of the primary features of the ecological environment of Chaohu Lake Basin in Anhui Province, the principles, bases, methodology and nomenclature of ecological function regionalization were determined. As the sub-valley is an independent geographical unit within the lake basin, its ecosystem sustains ecological integrity from the upstream through to the downstream. Therefore, ensuring the monitoring and management of the regional ecological environment in the sub-valley unit is of great importance to the conservation and ecological restoration of the regional ecosystem. Through extraction of land use information from remote sensing data, and sub-valley division from DEM analysis, this paper discusses the methodology of sub-valley ecological function regionalization in the research area based on the application of geoinformatics technology (e.g. RS and GIS technology). The ecological function regionalization of the Chaohu Lake Basin is then calculated, and the five ecological function regions and twelve sub-regions are subdivided. This study has an important practical relevance for the integrated management of the ecological environment of the Chaohu Lake Basin, and provides scientific grounds for the improved industrial distribution, ecological hazard prevention and reduction, environmental protection and construction planning in this area.

Keywords: RS and GIS, ecological function regionalization, ecological environment, Chaohu Lake Basin

1 Introduction

The ecological function regionalization is one of the most significant methods in conducting the geographical spatial division, which is based on regional environmental resources, the ecological sensitivity, and spatial differentiation of the ecological service functions [1, 2]. By using this method, the whole area can be divided into several different ecological function regions. Therefore, its purpose is to clarify ecological and environmental problems and fragile areas, and to provide scientific grounds for improved environmental protection and construction planning, ecological security, rational use of resources, and industrial distribution in the research area. Management information and resources can also be obtained more easily by decision-making departments [3]. This is the basis and premise of partition management in the regional ecological environment [4]. Therefore, ecological function regionalization plays an important role in the government management, ecological protection guidance, and standard ecological construction regulation.

The Chaohu Lake Basin is located in the central Jiang-Huai region of the Anhui Province (30°58′00″~32°06′00″N, 116°24′30″~118°00′00″E), which is adjacent to the fluvial plain along the Anhui section of the Yangtze River Valley in the southeast, and Huaihe River Basin in the northwest. It is bounded by Mt. Fucha, Huangshan, Fenghuang, Yinping, Yefu, Dabie, and the Jianghuai watershed. Administratively, it belongs to the Hefei City, the Shucheng County of Lu'an City, and the Yuexi County of Anqing City, with an area of 9131 km^2 [5]. This paper's research area is limited to the upstream of Chaohu sluice. The downstream river systems of the Chaohu sluice are not considered in this study.

2 Materials and Methods

Based on the theories of landscape ecology and the natural-social-economic composite system, the ecological function regionalization should be calculated in accordance with the following principles [1-10]: the principle of sustainable development, the principle of similarity and differentiation, the principle of comprehensiveness, the principle of holistic integrality, the principle of genealogy, and the principle of adjustability. There is a long history of human activity in the Chaohu Lake Basin. Therefore, along with the natural sub-area, social and economic factors should also be considered. Since ecological function regions are constantly changing, the ecological function regionalization should also consider time factors. Thus, historical factors require the adjustment of ecological

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function regions, so as to allow for changing situations in the ecological environments. Since the sub-valley is an independent geographical unit within the lake basin, its ecosystem sustains ecological integrity from the upstream through to downstream. Ensuring the monitoring and management of regional ecological environment in sub-valley unit is therefore of great importance to the ecological restoration and conservation of regional ecosystems [11, 12]. However, most sub-valleys cover multiple administrative or economic units, making it difficult to obtain the thematic information of ecological environments within each sub-valley. Therefore, based on the information extraction of land use from remote sensing data, and sub-valley division from DEM spatial analysis, thematic information extraction of the ecological environment within each sub-valley can be collected. The basic ecological features of the Chaohu Lake Basin and the ecological function regionalization of Anhui Province should also be clearly considered [4, 13]. The main premise of further division includes the climate-geographic features, ecosystem types, ecosystem service function types, and ecological environment problems within each sub-valley.

The data for this paper includes: 1:50,000 digital basic geographic data of the Chaohu Lake Basin, such as the data layer of river system, residential areas, railway networks, administrative divisions, and contour lines, etc.; digital data layers for regional resources and environment derived from vectorization of 1:250,000 soil type cartography, land type cartography, and land use cartography; 1:100,000 land use map interpreted from the Landsat TM images in January 11, 2009; and the above data layers tested and updated from the Landsat TM images (Figure 1).

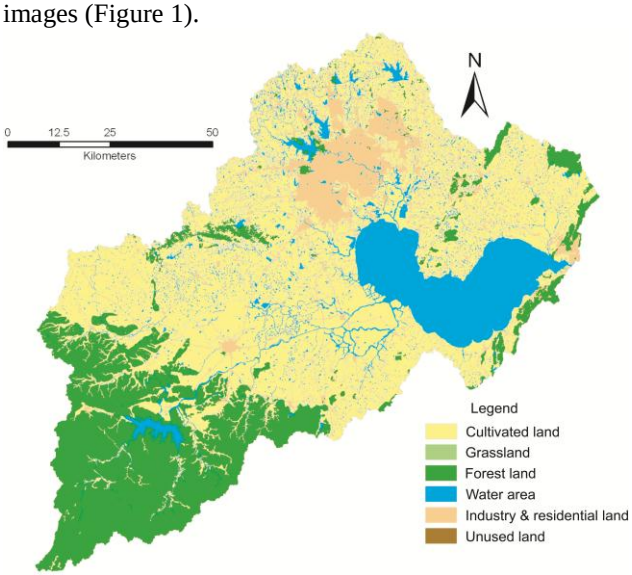

FIGURE 1 Land utilization map for the Chaohu Lake Basin

In the ArcGIS 9.2 software platform, existing vector data is edited and modified, in order to establish a unified coordinate system. Altimetric data is used for the TIN's construction, and then interpolated to generate DEM with 25 m resolution (Figure 2). Based on the above altimetric data and the DEM, sub-valleys are extracted and divided using the gully auto-extract method [14] in the research area. The major sub-valleys include the Hangbu-Fengle-Baishishan River valley, the Nanfei-Dianbu River valley, the Pai River valley, and the Zhegao River valley (Figure 3). There are other shorter gullies developing from lake-swamp plains surrounding the Chaohu Lake (Figure 3).

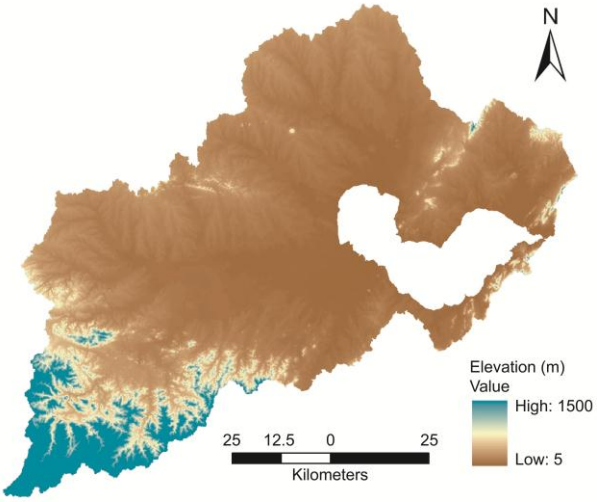

FIGURE 2 25 m grid DEM for the Chaohu Lake Basin

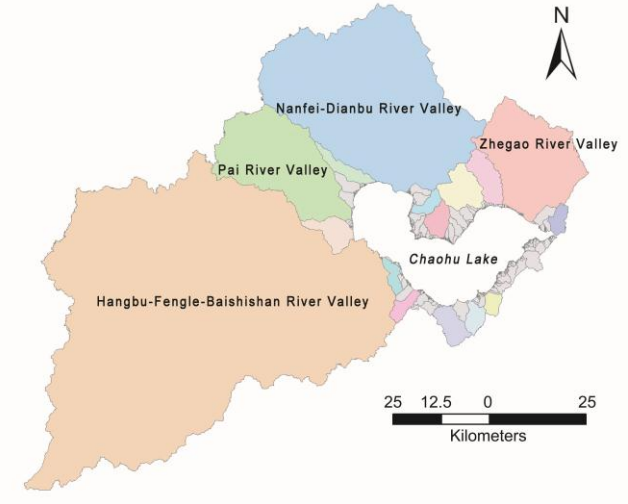

FIGURE 3 Sub-valley extraction for the study area based on DEM

The ecological function regionalization is performed using the superposition method on the basis of sub-valley division [15]. First, by using terrain information and DEM analysis, the regional gully system is extracted in an ArcGIS operating environment based on the D8 algorithm [16]. Sub-valleys are divided automatically, and then used as a main reference for the first-level division boundary. On this basis, first-level land use type's layer is overlaid. By using the multilayer superposition function of ArcGIS, resources and environmental elements are overlaid, and the administrative boundaries are separated. Most coincidence lines can be taken for boundaries. As for areas with fewer coincidence lines, key ecological elements are used for demarcation and necessary correction. Therefore, the second-level division

boundaries of the ecological function are determined. Finally, through the field investigations and confirmation, combined with the ecological function regionalization of Anhui [4], regionalization principles and rationality of the first-level and second-level ecological function regions are considered comprehensively. Necessary corrections are then processed, so as to determine the last schematic of ecological function regionalization within the whole basin. Detailed processes are shown in Figure 4.

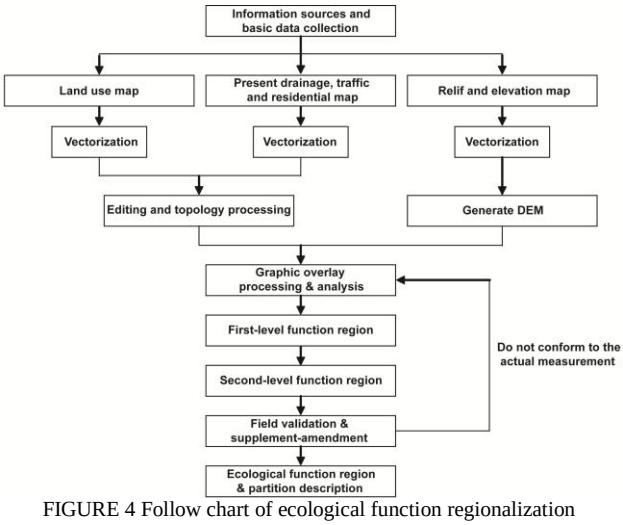

FIGURE 4 Follow chart of ecological function regionalization

The ecological function regionalization of the Chaohu Lake Basin can be divided into two levels. The dominant factor of the first-level ecological function region is the boundaries of the sub-valleys, reflecting the general pattern of ecological functions with each sub-valley as a unit. Its nomenclature can be expressed as *sub-valley name + ecological function region*. The dominant factor of the second-level ecological function region is the land use type. At the same time, characteristics of landform or climate, ecosystem type, and ecosystem service function should also be represented. The second-level ecological function region is the basic unit of ecological function type, reflecting the differentiation of ecological function within the first-level division zone. The nomenclature can be expressed as *place name + geomorphic feature or ecosystem type + ecological function feature + ecological function sub-region*.

3 Results and Discussion

In accordance with the above principles, the five ecological function regions and twelve sub-regions are subdivided in the Chaohu Lake Basin, as shown in Figure 5 and Table 1.

Through the ecological function regionalization of the Chaohu Lake Basin and its map compilation, the successful application of RS and GIS is fully demonstrated here. The advantages found [17, 18] in data collection and multilayer superstition are made full use of, so as to solve the difficult problem of ecological information extraction. This technique saves costs greatly and improves the accuracy and efficiency of graphics, realizing classic graphic principles excellently.

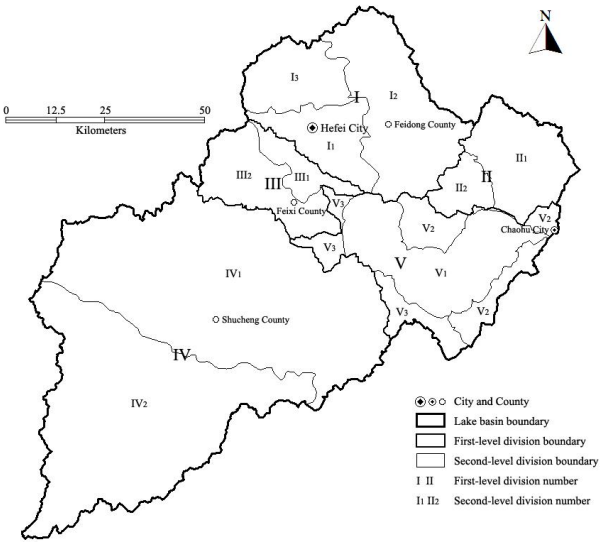

FIGURE 5 Ecological function regionalization of the study area

TABLE 1 Ecological function regions and their features in study area

First-level ecological function regions	Second-level ecological function sub-regions	Area (km^2)	Proportion (%)
I Nanfei-Dianbu River Valley	I_1 Hefei city and suburban agriculture	366	4.0
	I_2 Eastern hilly-plain agriculture	919	10.1
	I_3 Southern Jianghuai Watershed hilly agriculture and soil-water conservation	390	4.3
II Zhegao-Tongyang River Valley	II_1 Zhegao River Valley hilly and polder agriculture	530	5.8
	II_2 Tongyang River Valley hillock agriculture	178	1.9
III Pai River Valley	III_1 Northern town and suburban agriculture	158	1.7
	III_2 Southern hillock-plain irrigation farming and soil erosion control	478	5.2
IV Hangbu-Fengle-Baishishan River Valley	IV_1 Western Chaohu plain polder agriculture and nonpoint source pollution control	2664	29.2
	IV_2 Northern Mt. Dabie mid-lower mountain forest soil-water and biodiversity conservation	2138	23.4
V Chaohu Lake and lakeside	V_1 Chaohu Lake wetland flood water storage and agriculture	760	8.3
	V_2 Eastern lakeside hillock ground stone mining, collapse recovery and ecological conservation	329	3.6
	V_3 Western lakeside plain water channel wetland and polder agriculture	220	2.4

The ecological function regionalization result of the Chaohu Lake Basin indicates many vulnerable and key protection areas of the regional ecosystem, and has an important practical significance for the comprehensive

control of the basin's ecological environment, ecological hazard prevention and reduction, industrial distribution, environment protection, and the planning of construction in this area.

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