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A new method for comprehensive division of mountainous area: taking Huaihua City as an example

作者: HU Bao-qing et al.

Abstract: This paper summarizes principles and measures of comprehensive division of mountainous areas, as well as clarifies meaning, structure, function and path established for the map and file information visibility system (MFIVS). And then, taking Huaihua City of Hunan Province as an example, and based on the MFIVS means, concrete attempts on regionalization are carried out. The result is relatively objective and accurate, which illuminates that the method is a comprehensive one with the characteristics of concision, applicability and effectiveness.

A new method for comprehensive division of mountainous area: taking Huaihua City as an example HU Bao-qing1, REN Dong-ming2, ZHANG Hong-en1, LIAO Chi-mei3 (1. Changsha Institute of Geotectonics, CAS, Changsha 410013, China; 2. Department of Resource and Environmental Sciences, Beijing Normal University, Beijing 100875, China; 3. Department of Geography, Guangxi Normal College, Nanning 530001, China) 1 Introduction As human society has entered the 21st century, knowledge-based economy and "Digital Earth" project are paid much attention to. Studies on regional sustainable development come into the manipulating stage. Thus, traditional division needs to be reconsidered[1]. In new era, division work should be both in conformity with rationality of eco-environment, and be beneficial to socio-economic development, i.e., eco-economic comprehensive division should be taken into account[2,3]. As a particular natural landscape, mountainous area has three-dimensional space comprising of obvious undulating ground surface and steep slopes, whose salient characteristic is instability and sensitivity of mountain environment as well as diversity of habitat[4]. This results in abundant resources but fragile ecosystem of mountainous area. Mountain system is designated as human-mountain system formed by mutual restriction of resources-environment against human socio-economic activities in the special area like mountain, confronted with economic-environmental double-plight (see Figure 1). Thus, mountainous sustainable development must firstly divide mountain system comprehensively, clarify regional characteristics and questions about exploitation and utilization of apiece sub-region, and provide a scientific basis for sustainable development plan carried through for strategic thinking of developing regional economy. Taking the mountainous area-Huaihua City as an example, and in line of the principles and methods of mountainous comprehensive division, the paper probes into division process by relying on the advanced measure-map and file information visibility system (MFIVS). Figure 1 Framework of map and file information visualization system 2 Principles and methods of comprehensive division Partition process of comprehensive division is similar to that of other natural divisions, which comprises of ascertaining principles of division, setting up moderate grading system, adopting corresponding division means, choosing appropriate division index and partitioning procession. On the theoretical basis of regional differentiation law and mountain system theory, mountainous comprehensive division includes the principles of relative consistency (of eco-environment and territorial resources, socio-economy, and regional comprehensive development direction, i.e., comprehensive evaluation of PRED system), limitation period, integrating macro regional structure with regional types, and regional conjugation[2,5,6]. Now that high-grade units of comprehensive division lie in differentiating and understanding large regional discrepancy, top-down deductive approach ought to be adopted in division process, while the low-grades are the integration of ecology and economy, aiming to serve regional sustainable development, so the bottom-up approach should be adopted. Anyway, only integrating top-down and bottom-up approach is adopted, could comprehensive division become comparatively perfect. Dissimilar division methods select different index systems. The former adopts integrate qualitative index, while the latter takes quantitative index or index system of comprehensive division, whose division mean

s includes system clustering analysis, gray constellation clustering analysis and fuzzy comprehensive evaluation. 3 S tructure and function of map and file information visibility system Map and file information visibility system may re serve the convenient retrieval and pick-up of tradition database, as well as lay out digital inherent meanings of geo graphic space. It is made up of geographic information system (GIS)[7] and information visibility system (IVS)[8], s o it makes information mapificative and data visible through its functions including digital map, database administra tion and spatial data associated disposal. Huaihua map and file retrieval information system should come true by empl oying the MFIVS method. In object county or city order, Huaihua MFIVS is established by utilizing computer, GIS and d atabase technique. Maps, data and literatures are systematically arranged, classified and synthesized, which include degenerated condition, natural hazards, spatial resources, agricultural natural resources, mineral resources, touris m resources, water resources, regional economic energy, economic development capability, regional restructuring optim ization, population and quality of living environment, social stability and medical ensurance etc. within this area. The corresponding database, file bank, picture pool, map bank and model system are set up so as to provide geographi c inquisition, regional finished-map and data analysis in support of the studies on eco-economic comprehensive evalua tion, geographical synthetic division and sustainable development planning (Figure 2). Figure 2 Frame map of comprehe nsive evaluation information system makeup 4 Comprehensive division of Huaihua City 4.1 Area survey of Huaihua City H uaihua City, situated in southwestern Hunan Province, borders Guizhou on the west, Guangxi on the south, Loudi Prefec ture, Yiyang city, Changde city, Shaoyang city, Xiangxi Autonomous Prefecture, Zhangjiajie city of this province on t he east and north. In ancient times it used to be called as "gateway to Yunnan and Guizhou" and "strategic passage t o Hubei". Nowadays, Huaihua City is crossed by Zhuzhou-Guiyang and Zhicheng-Liuzhou railways as well as by 320 and 20 7 national roads, a "double cross" running through downtown, even 12 counties (cities) of the entire city. Now Chongq ing-Huaihua Railway is under construction. Huaihua City lies in the junction part between the central-eastern China a nd greater southwestern China, the only way from central-eastern China and the greater southwestern China, which occu pies a strategic location to develop China´s west. The whole city covers an area of 27.6 thousand km2, with a populat ion of 4.76 million (1999a) (Figure 3). Huaihua lies in the transitional zone between the eastern margin of the Yunna n-Guizhou Plateau and Hunan-Guangxi hilly and basin area, featured by continuous, criss-crossed mountains, ridges an d peaks, gullies and ravines, the relief is very complicated. The Wuling Mts. passes through the western part of the city by north in N-S arch, the Xuefeng Mts. is entrenched in the eastern part, south prominency, and within them the Ruanshui River and its tributaries wander in, forming a long narrow SW-NE oriented "two apexes nipping a ridge" relie f. In the long oblique-shaping area, the widely distributed hilly counties account for over 80% of the city´s area. S ub-tropical climate with obvious mountainous features predominates, precipitation is sufficient with little intra-ann ual changes but great daily change, and uneven spatial-temporal distribution, so drought and flood happen frequentl y. Rivers and streams densely cover over the city, density of waterways network amounts to 0.64 km/km2. Runoff amoun t is great, with a total amount of 22.4 billion m3/a, and relative height difference reaches to 1900 m, so water reso urces are rich. Thanks to the intricate geological conditions and various soil parent materials, soil types vary. The rein, slate and shate are extensively distributed, accounting for 65%. Developing on the basis of it, yellow earth i s distributed vastly, with enriched mineral nutrient and wide arability. Subject to lasting-infection of soil and cli mate, vegetation and habitat have distinct delamination structure. 4.2 Index system of eco-economic comprehensive eva luation In the bottom-up approach, comprehensive division ought to differentiate section types by utilizing quantitat ive index, namely, comprehensive evaluation index system. 4.2.1 Setup principles of index system of comprehensive eva luation In the process of mountainous eco-economic comprehensive evaluation, the index system should be designed in t he following principles: integrating resources-environment with socio-economy, combining spatial span with temporal l imitation, uniting systematicness with dynamicness, linking integration with concision and holding relative integrit y of district division[9,10]. 4.2.2 Index system frame of comprehensive evaluation In the viewpoint of systematism, a nd according to the above-mentioned index designation principles, the index system of mountainous comprehensive evalu ation includes five grades[9, 11] (see Figure 2), that is, A grade (degree of regional human-land sustainable develop ment, DRSD), B grade (degree of sub-system eco-economic coordination, DEEC), C grade (sub-system yearly evaluation), D grade (second sub-system yearly evaluation) and E grade (factor yearly evaluation). Among them, C grade comprises o f four aspects, i.e., C1 degree of eco-environment frailty (DEEF), C2 Degree of territorial resources dominance (DTR S), C3 degree of economic development (DED) and C4 Degree of social progress (DSP). D1={E1 ~E3}={relief degree of lan d surface, aridity, forest cover ratio}; D2={E4~E6}={bio-diversity, water and soil erosion ratio, soil erosion modulu s}; D3={E7, E8}={geological disaster, climate-stricken ratio}; D4={E9~E11}={attractive degree, communicative degree, latent degree}; D5={E12~E16}={annual gross solar radiation, ?10oC active accumulative temperature, water resource, la

nd resource, dominant population}; D6={E17, E18}={mineral types, reserves-grade}; D7={E19~E21}={scene source value, scene spot density, tourism conditions}; D8={E22~E23}={runoff, drop}; D9={E24~E28}={economic density, gross tertiary industrial product ratio, breed-plant ratio, multiple cropping index, land reclamation and cultivation ratio}; D10={E29~E33}={GNP annual improvement factor, GAP annual improvement factor, farm products processing transferring ratio, agriculture all-around commodities ratio, output value profits Tax Ratio}; D11={E34~E38}={fixed assets Investment ratio, per capita deposit, informationalization investment ratio, science and technology contribution ratio, economic export- oriented degree}; D12={E39~E41}={urbanization level, urban-rural income ratio, labor transferring ratio}; D13={E42~E47}={population I.Q, poverty-stricken population ratio, per capita net income of farmer, road density, ten-thousand-person-equal telephone set, three waste discharge index}; D14= {E48~E52}={per capita cultivated land, per capita grain, per capita fresh water resource, per ten-thousand capita doctor, rural social guarantee cover ratio}. 4.3 Confirming method of index weight Conforming index weight of comprehensive evaluation is an issue of highly importance but abnormal troublesome. On the basis of the degree of contributing to system, this ascertains the weight of all level indices by adopting meliorated 3-grade IAHP and experience estimating means. Table 1 The weight values of evaluation index system 4.4 Comprehensive evaluation methods 4.4.1 Undimensionification model of single index data-effect function Among the index system of eco-economic comprehensive evaluation in mountainous area, descending-distributing function is adopted in whichever elements have the much stronger negative-effect to human-mountain system, the greater the value is, for instance, water and soil erosion ratio etc.; reversely, increasingly distributing function is taken in which factors positive-effect to human-mountain system, for example, forest cover ratio. Whose effect function model stands for Ei´ =(Eimax-Ei)/(Eimax-Eimin) (Ei´ as negative-effect) or Ei´ =(Ei - Eimin)/(Eimax-Eimin) (Ei´ as positive-effect.), respectively. 4.4.2 Calculation models of clustering index and clustering analysis—evaluation method function There are numerous kinds of comprehensive evaluation methods nowadays. In the mountainous eco-economic comprehensive evaluation, composite indices are used for three kinds comprehensive evaluation including gray clustering analysis, constellation clustering analysis and fuzzy integrate judge, whose evaluation results validate one other, in order that the outcome of comprehensive evaluation is more precise and impersonal. Calculation models of three kinds of evaluation method and composite index values see Table 2[9,10,12,13]. 4.5 Results of clustering analysis Operated by calculating models of compound indices and three kinds of analyses of eco-economic comprehensive evaluation in mountainous area, the results are shown in Table 3. Figures 4-7 are deduced to draw by utilizing Excel etc. software. Therein, evaluation map of system clustering factors reflects excellent or inferior of compound index values of various evaluated counties. Hereby, two grades and three sub-kinds may be divided into in the system clustering map required. In the constellation-clustering map of Huaihua eco-economic comprehensive evaluation, the different points classified approximately into two kinds. In line of fuzzy comprehensive evaluation, scopes of sub-kind comprehensive values are >0.6, 0.6-0.4 and <0.4, respectively. Three kinds evaluation methods are utilized to class and corroborate one another, whose results are general consistent. Thanks to various matters, e.g. weight values of indices and insufficient source material etc., however, there exist some differences. Table 2 Calculating model of clustering indices and analyses of eco-economic comprehensive evaluation in mountainous area Table 3 Results of clustering indices and analyses of ecological-economic comprehensive evaluation in Huaihua City 4.6 Comprehensive division of top-down approach Comprehensive division of top-down approach introduces synthetic qualitative indices. Hereon, latitude location and traffic situation are mainly selected as consult indication of division. Latitude location of Yuanlin County is the highest and without railway passage, Tongdao, Jingzhou, Huitong, Hongjiang District and Hongjiang city are located in the southeastern part, whose latitude locations are lower, having only Zhicheng-Liuzhou Railway and 207 national road pass through. Otherwise, the rest are all in the central section, as well as Zhuzhou-Guiyang and Zhicheng-Liuzhou railways, 320 and 207 national roads run across appearing in "double-cross" intersection. 4.7 Huaihua comprehensive division Synthesizing the results of two bottom-up and top-down approaches including four kinds of methods, and according to the principles of regional conjugation and holding relative integrality of administration borderlines, Huaihua City is divided comprehensively into two grades, comprising of two regions and three sub-regions, whose names are as the following: A central low-hilly and basin integrated economic sub-region, Table 4 Huaihua comprehensive division system 4 Conclusions Map and file information visibility system is an applicative integration software grouped for the studies on eco-economic comprehensive evaluation, geographical synthetic division and sustainable development planning etc., which has the features of concision and advantages, mainly adopts Excel and Mapinfo etc. For study target of intricate levels and strong integration, especially the area of low-level research, this may after all be accepted as a quantitative study method-containing scientific and convenient qualities, and can make up, modify and transact data expediently and in time. References

关键词： comprehensive division; regional system of mountainous area; map and file information visibility system (MFIVS); comprehensive evaluation of PRED system; Huaihu