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Three Types of Spatial Function Zoning in Key Ecological Function Areas Based on Ecological and Economic Coordinated Development: A Case Study of Tacheng Basin, China

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Abstract: Three types of spatial function zoning is an effective measure for regional environmental protection and orderly development. For ecological and economic coordinated development, spatial function zones should be divided scientifically to clear its direction of development and protection. Therefore, based on ecological constraints, a beneficial discussion would be about the key ecological function areas adopting the concept of ecological protection restriction and supporting socioeconomic development for spatial function zoning. In this paper, the researchers, taking Tacheng Basin, Xinjiang of China as an example, choose township as basic research unit and set up an evaluation index system from three aspects, namely, ecological protection suitability, agricultural production suitability, and urban development suitability, which are analyzed by using spatial analysis functions and exclusive matrix method. The results showed that: 1) This paper formed a set of multilevel evaluation index systems for three types of spatial function zoning of the key ecological function areas based on a novel perspective by scientifically dividing Tacheng Basin into ecological space, agricultural space, and urban space, which realized the integration and scientific orientation for spatial function at the township scale. 2) Under the guidance of three types of spatial pattern, the functional orientation and suggestions of development and protection was clearly defined for ecological protection zones, ecological economic zones, agricultural production zones, and urban development zones. 3) A new idea of space governance is provided to promote the coordinated and sustainable development between ecology and economy, which can break the traditional mode of thinking about regional economic development, and offers a scientific basis and reference for macro decision-making.

Keywords: key ecological function areas; township scale; spatial function zoning; mutual exclusion matrix method; coordination of ecology and development; Tacheng Basin, China

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1 Introduction

The rapid development of society in China has caused problems, including heavy resource exploitation, contradiction in land use, and environmental degradation, that have become the main bottleneck blocking the full

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exertion of regional advantages and enhancement of competitiveness (European Commission, 2003; Tonts et al., 2012). Based on this background, Major Function-Oriented Zoning (MFOZ) has been proposed for coordinating regional conflict, solving the problem of resources and environment, and achieving sustainable development. This type of zoning can clearly iterate the direction of development and emphasis each type of functional zone, improve differentiation of regional development policies, and form an orderly pattern of development and protection (Lu et al., 1999; Chen et al., 2004; Shaw et al., 2005; Greater, 2011; Fan and Li, 2015). The theory of MFOZ has mainly originated from the spatial division of Western countries, the essence of which is to implement differentiation management according to the spatial difference of natural environment, economy, and society by region (Ma et al., 2010; Tang, 2011).

The studies on spatial division in Western countries focused on type and standard of regional division, governance, policies and systems, which mainly highlight the differences in regional space characteristics based on present situation of spatial development (Yang et al., 2002; Higgins, 2008; Mamat et al., 2017). The spatial types can be divided into compact areas, rural areas, residential areas, traffic corridors, and central areas (Brian, 2002; Enrico, 2004; Tian, 2014). Some researchers have considered establishing the specific spatial distribution and design scheme from the national, provincial, and municipal level for quality and guidance on the use of economic and social activities (Friedmann, 1998; Chen and Mao, 2012). With the development of theory and methods of spatial division, Gu (2003) divided Brazil into evacuation development areas, control inflation areas, active developing areas, undeveloped areas, and ecological protection areas, which makes great progress on aspects of spatial planning concept and regional division (Albrechts, 2003).

Research on ecological zoning was first put forward by Bailey. Robert et al. (2002) considered that the partitioned management of ecological areas in Alabama, United States (US), was based on the differences in plant species and environmental variables. Some scholars have focused, for example, on assessing the fragile ecosystem and carrying capacity of the ecological system (Farnworth and Golley, 1975; Petrosillo et al., 2006; John and Marco, 2011; Stephen et al., 2013). Carranza et al. (2014) studied a nature reserve in Brazil and observed the problem of mismatch of management evaluation and conservation results. Baral and Dhungana (2014) analyzed tourists' willingness to pay at a nature reserve in Nepal and suggested that the key to improving the effectiveness of biodiversity protection is continually maintaining region's financial supply. In general, the research on ecological zoning in Western countries is somewhat generalizable to China. China's scholars make progress when discussing the establishment of indicator system and the methods of regional division. At present, there are three methods for establishment of an indicator system. First, it is the '9 + 1' index system in practice in regional division of the national and provincial levels. Fan et al. (2010) and Wang et al. (2012) have established the comprehensive evaluation index of national spatial development and iterate two types of major functions: development and protection. The second method uses the carrying capacity of resources and environment, existing development density, and development potential as the first-level indicators to establish division index system. The third adopts methods including ecological footprint, potential-limit evaluation, and relative resources capacity to discuss the division of functional zones.

According to the literature from China and abroad, there is a dearth of research on three types of spatial functions zoning. First, regional function zoning at national and provincial levels can identify four types of functional zones and determine the differentiation among regional policies, which is suitable for macro-geographical unit (Jie et al., 2010; Zhang, 2012; Liu et al., 2017). However, because of the small amount of span space at county level with its obvious characteristics of regional internal fragmentation and homogenization, which make it more difficult to identify and divide regional functions at county level, the pertinence and effectiveness of regional policies has become weaker. Additionally, the key ecological function zone is a type of restricted development zone; its ecosystem is relatively fragile and sensitive, and the foundation of its economic development is weak. The contradiction between spatial development and ecological protection is the most serious and obvious to China's ecological security concerns. Therefore, studying the spatial function division of China in key ecological function areas by using townships as basic unit is more important and meaningful.

The purpose of this study is to clearly define the orientation of development and protection for different spatial zones at township scale by dividing different spatial function zones, offer a scientific basis and reference for macro decision-making, and finally promote the coordinated and sustainable development between ecology and economy. We use the special case of Tacheng Basin in China's Xinjiang Uygur Autonomous Region to elaborate these points. Because as the key ecological function areas in the restricted development zones of MFOZ, its ecosystem service function is particularly important but faces serious ecological crises because of the influence of natural environment and unordered development activities. Therefore, on the premise of ecological constraints of moderate development and construction, this paper divides the spatial function zones by setting multilevel evaluation index systems based on a novel perspective and proposes corresponding measurements which can coordinate the conflicts between ecological protection and economic development.

2 Materials and Methods

2.1 Study area

Tacheng Basin is located in the northwest of Xinjiang in China, and bounded on the northwest by Kazakhstan. Its geographical extent is 44°58′N to 47°14′N and 82°12′E to 85°20′E, which features a temperate, continental, arid climate and the second largest grassland in China: Kulusitai Grassland. This region includes one city and three counties: Tacheng city and the counties of Emin, Yumin, and Tuoli. The Basin's total land area is approximately 47 744 km^2. Over the past 15 years, Tacheng Basin has demonstrated a remarkably fast rate of growth. On the one hand, the Basin's total population has increased from 0.45 million in 2000 to 0.54 million in 2015, with the population growth rate of 1.22%. On the other hand, gross domestic product (GDP) of Tacheng Basin has increased from 2.78 billion yuan (RMB) in 2000 to 21.11 billion yuan in 2015, with per capita gross domestic product exceeding 150 000 yuan.

Tacheng Basin is the primary production base of food and animal products on the northern slope of Tianshan and Xinjiang. Although it is realizing rapid social and economic progress, the overall development of urbanization and industrialization remains at a low level. In recent years, influenced by natural environment and human factors, Tacheng Basin is facing severe ecological crises. There is disordered production activity in space, resulting in decreasing total ecological land and increasing pressure on urban ecological resources. These factors exacerbate the problems of low economic development and coordinated development in Tacheng Basin.

2.2 Data and processing

The basic data are presented as follows: the administrative division vector diagram of Tacheng Basin; the survey results of topographic condition (2015), an extraction from a digital elevation model (DEM) from a remote sensing image (90 m × 90 m) and related statistical data of water resource conditions, including water supply capacity and drainage density; the survey results of land-use type as indicators of ecological vulnerability (2015); the data from Land Use Overall Planning of one city and three counties (2010–2020); and the population data and herdsman per capita from the leading cadre handbook (2015) to analyze ecological pressures and the base of agricultural development for Tacheng Basin.

This paper processes all data on ArcGIS software platform because of the differences that exist among data sources and for spatial accuracy. In a quantitative evaluation, the data of land utilization are obtained by attribute query and calculations using ArcGIS. These data include national territorial area, cultivated area, forestland area, construction land area, area of land allowed for construction, and basic farmland preservation area. The altitude and gradient data are generated by sectional statistical analysis based on DEM, and the average of evaluation unit is used as the primitive value of the index. In addition, surface rolling of Tacheng Basin is calculated by grid neighbourhood computing tools for a DEM image approach. Other index data are processed through data registration.

2.3 Methods

2.3.1 Construction of evaluation index system

To fully reflect intra-region similar property and inter-region dissimilar property, this paper chooses townships for basic research unit. According to the concept of production-living-ecology spaces, considering the evaluation of ecological constraint function, this paper evaluates the suitability of development and construction function for unconstrained regions using the negative planning theory (Zhang, 2009). Moreover, in view of Tacheng Basin's areas of agricultural industry, the suitability of agricultural development will be evaluated separately, and industrial development and habitat environment will be used as the indictors of construction and development suitability for evaluation. Therefore, based on the ecological and agricultural development situation, an objective-level evaluation index system is constructed from three aspects: ecological protection suitability, agricultural production suitability, and urban development suitability. Considering the availability of data, this paper selects 21 three-level indictors as the index system of spatial function division. The detailed indicators are listed in Table 1.

2.3.2 Calculation of index weight

(1) Data standardization

The evaluation system of MFOZ includes positive and negative indexes, which have different meanings and opposite effects. To facilitate analysis and comparison, this paper creates the index of dimensionless positive change. The formula is as follows:

$$X_i = \frac{X - X_{\min}}{X_{\max} - X_{\min}} + 1 \quad (1)$$

$$X_i^* = \frac{X_{\max} - X}{X_{\max} - X_{\min}} + 1 \quad (2)$$

where X_i is the standardized value of positive indexes; X_i^* is the standardized value of negative indexes; i is the metrics for each row; X is the original index value; $X_{\min}$ is the minimum value of the original index; and $X_{\max}$ is the maximum value of the original index.

(2) Entropy weight and analytic hierarchy process

In the measure of a comprehensive index system, the entropy weight method is an objective weight determination that avoids the interference of subjective human factors and is widely used (Zhu, 2016a). This method of analytic hierarchy process calculates the weight of each element by ordering in single level and whole system of each evaluation index and judges the matrix consistencytest during the sorting operation to avoid one-sidedness. When the consistency ratio is less than

Table 1 Index system of spatial function division in Tacheng Basin, Xinjiang of China

Objective level	Factor level	Index level
Ecological protection suitability (E)	Terrain condition (E1)	Elevation (E11)
		Topographic relief (E12)
		Slope (E13)
	Water resources condition (E2)	Water supply capacity (E21)
		Drainage density (E22)
	Ecological vulnerability (E3)	Soil erosion (E31)
		Land desertification (E32)
		Proportion of forestland area (E33)
		Population density (E34)
	Ecological importance (E4)	The importance of water conservation (E41)
		The importance of biodiversity maintenance (E42)
Agricultural production suitability (A)	Agricultural development status (A1)	The per capita income of farmers and herdsmen (A11)
		Cultivated area (A12)
	The importance of agricultural Protection (A2)	Basic farmland protection area (A21)
	Agricultural policy orientation (A3)	The least cultivated areas (A31)
Urban development suitability (T)	Status quo of construction land (T1)	Traffic land (T11)
		Urban construction land (T12)
		Land of individual industrial and mining (T13)
	Development potential (T2)	The scale of planned urban industrial and mining land (T21)
		The proportion of planned industrial park (T22)
		New construction land for development (T23)

Note: The alpha code can be used to represent the name of the index in the paper

0.1, the consis tency check of the judgement matrix is acceptable; otherwise, the judgement matrix does not meet the consistency requirement and corresponding judgement matrix must be revised until the results are tested with consistency.

(3) Weighted average method

Based on the weighted value calculated by methods of entropy weight and analytic hierarchy process, this paper uses the weighted average method to calculate comprehensive weight value of each evaluation unit. Based on the related academic research (Mi et al., 2016), by consulting the relevant experts in ecology and regional economics, the weight of entropy method and analytic hierarchy process is, respectively, 0.4 and 0.6, using formula (3) to obtain the final weight of each index.

$$W = 0.4W_j \times 0.6W_{\mathrm{AHP}} \tag{3}$$

where W is the final weight of each indicator; j is the value of each column; W_j is the weight of the entropy method; W_{AHP} is the weight of the analytic hierarchy process.

2.3.3 *Method of comprehensive index weighting sum*

Comprehensive index is the index of objective level in that system (Yang, 2014), which is divided into the ecological suitability index and the suitable index of agricultural production and urban development in this paper. The formula is as follows:

$$EAT_j = \sum_{i=1}^{n} W \times X'_{ij} \tag{4}$$

where EAT_j is the exponent of ecological suitability, agricultural production suitability, and urban development suitability; i is the metrics for each row; j is the metrics of each column; W is the final weight of evaluation index; X'_{ij} is the standardized value of the index.

2.3.4 *Method of spatial function discrimination*

(1) Mutual exclusion matrix

The method is a model of regional division used in MFOZ (Zhu, 2016b). It performs a combination evaluation of the clustering results by establishing a three-dimensional Rubik's cube figure based on Cartesian coordinate system. The theory is that positive direction of the x-, y-, and z-axes in three-dimensional coordinates is ranked as low, medium and high based on the distance from the origin of the coordinates; additionally, according to 3 × 3 × 3 combination, it divides the entire coordinate area into 27 spatial units, each of which represent one type of combination (Fan et al., 2011). This paper defines the x-axis as ecological protection suitability, the y-axis as agricultural production suitability, and the z-axis as urban development suitability. The final spatial units are shown in the Table 2.

(2) Dominant factors correction and area proportion

To highlight ecological service function as the key ecological area, based on area proportion method and dominant factors correction method, this study uses spatial analysis tools to conduct the spatial overlay of relevant layers based on three types of spatial function orientation. The main layers include prohibit development areas, an average slope greater than 20°, the planned scope of an industrial park, and the rate of construction land in Tacheng City, Emin County, Yumin County, Tuoli County, *etc*. (Table 3). The determination of relevant threshold is based on the Technical Regulations in the Status of Land Use of China and the actual conditions of Tacheng Basin.

3 Results and Analyses

3.1 Evaluation of individual evaluation index

According to the designing index system, this paper

Table 2 Design of mutual exclusion matrix for function orientation in Tacheng Basin, Xinjiang of China

Function orientation	Mutual exclusion matrix unit
Ecological space	(High, Low, Low); (High, Low, Medium); (High, Low, High); (High, Medium, Low); (High, Medium, Medium); (High, Medium, High); (High, High, Low); (High, High, Medium); (High, High, High); (Medium, Low, Low); (Medium, Low, Medium); (Medium, Medium, Low); (Medium, Medium, Medium); (Low, Low, Low)
Agricultural space	(Medium, High, Low); (Medium, High, Medium); (Medium, High, High); (Low, Medium, Low); (Low, Medium, Medium); (Low, High, Low); (Low, High, Medium); (Low, High, High)
Urban space	(Medium, Low, High); (Medium, Medium, High); (Low, Low, Medium); (Low, Low, High); (Low, Medium, High)

Notes: The x-, y-, and z-axes is ecological protection suitability, agricultural production suitability, urban development suitability, respectively

Table 3 Identifying key factors of functional zones in Tacheng Basin, Xinjiang of China

Types of functional zones	Identifying key factors
Ecological protection zones	a. Forbidden development areas such as natural conservation areas, landscapes and famous scenery, national forest parks, glaciers and permanent snow areas.
	b. Slope that is greater than 20°.
	c. Headstream of the important rivers.
Ecological economic zones	a. Areas in the ecological space.
	b. Land-use type, mainly grass and meadow.
	c. Areas with high quality tourism resources that will become important developing industries.
Agricultural production zones	a. A slope less than 15°.
	b. Areas with concentrated distribution.
Urban development zones	a. Rate of construction land is greater than 5%.
	b. Areas close to a county or town or with planning industrial park for development.

Notes: Determination of relevant threshold is based on the Technical Regulations on the Status of Land Use in China and the Planning Technical Guidance of the Social and Economic Development in Cities and Counties

calculates the weight of each evaluation indicator based on entropy weight method and methods of analytic hierarchy process, obtains final weight by using the weighted average method (Table 4), and merges each category of indicators to calculate the comprehensive index of ecological protection suitability, agricultural production suitability, and urban development suitability using Formula (3). After an overlay analysis based on a GIS platform, to better depict the spatial distribution of function zoning, the paper uses cluster analysis to divide the comprehensive index into three categories: high, medium, and low. Of the levels, the high level is a better representation for the spatial function of ecological protection, agricultural production, and urban development. The evaluation results are shown in Figs. 1–3.

3.1.1 Evaluation of ecological protection suitability

Ecological protection suitability index of each evaluation unit is between 1.2326–1.8783. Higher values indicate

Table 4 Weight of each level evaluation index based on entropy weight method

Objective level	Factor level	Weight	Index level	W_j	W_{AHP}	W
Ecological protection suitability (E)	E1	0.2835	E11	0.1056	0.0695	0.0839
			E12	0.1060	0.0845	0.0931
			E13	0.1088	0.1049	0.1065
	E2	0.2144	E21	0.1102	0.1002	0.1042
			E22	0.1092	0.1107	0.1101
	E3	0.3312	E31	0.0237	0.0418	0.0346
			E32	0.1033	0.0559	0.0749
			E33	0.1077	0.1127	0.1107
			E34	0.1032	0.1162	0.1110
	E4	0.2510	E41	0.2113	0.1026	0.1461
			E42	0.1110	0.1009	0.1049
Agricultural production suitability (A)	A1	0.4312	A11	0.2222	0.1787	0.1961
			A12	0.2033	0.2562	0.2351
	A2	0.2454	A21	0.1807	0.2886	0.2454
	A3	0.2434	A31	0.1938	0.2764	0.2434
Urban development suitability (T)	T1	0.4116	T11	0.2209	0.0793	0.1359
			T12	0.1873	0.0889	0.1282
			T13	0.1363	0.1548	0.1474
	T2	0.5884	T21	0.1765	0.1370	0.1528
			T22	0.1004	0.3820	0.2694
			T23	0.1786	0.1580	0.1662

Notes: The alpha code can be used to represent the name of the index in the paper (the same parameters in Table 1). W is the final weight of each indicator; W_j is the weight of the entropy method; W_{AHP} is the weight of the analytic hierarchy process a larger space of ecological protection and greater importance of ecological protection; otherwise, the importance of ecological protection is relatively weak; however, the control proportion of important ecological space will not decrease because Tacheng Basin takes ecological protection as a priority principle. The evaluation units are divided into three categories. The value (1.2326–1.4065) is the first level (Low), the value (1.4065–1.5906) is the second level (Medium), and the value (1.5906–1.8783) is the third level (High) (Fig. 1).

In terms of ecological suitability index, Fig. 2 shows that high suitability areas take up the largest proportion in ecological system and are spatially concentrated in the south, north, and northeast of Tacheng Basin. The central parts of Kulusitai Grassland belong to the second-level suitability areas located in the west and southeast of Tacheng Basin. The low suitability areas are mainly in Tacheng City and Emin County, and others are in Halabula and Duolate Townships.

3.1.2 Evaluation of agricultural production suitability

Ecological protection suitability index of each evaluation unit is between 0.9200–1.7949. The higher values indicate a higher suitability of agricultural production development; otherwise, the lower values indicate a decrease in unsuitability. By using Natural Breaks (Jenks), the evaluation units are divided into three categories. The value (0.9200–1.0351) is the first level (Low), the value (1.0351–1.3175) is the second level (Medium), and the value (1.3175–1.7949) is the third level (High) (Fig. 2).

Fig. 2 demonstrates that agricultural suitability areas mostly focus on the Ta'er produce section and Yumin produce section, which are distributed in northwest of the basin, mainly including Abudula Township, Kelahabake Township, Yemenle Township, Qiaxia Township, Shanghu Town, Jieleagashi Township, Marelesu Township, and so on. Therefore, in terms of space, these areas display the feature of central aggregation. The distribution of the second-level suitability is scattered but closer to urban areas. In addition, the low suitability areas are spread over high altitude district in Tacheng Basin.

3.1.3 Evaluation of urban development suitability

Ecological protection suitability index of each evaluation unit is between 0.9999–1.4412. The higher values indicate a greater potential for urban development; otherwise, the lower values indicate less potential for urban development. The evaluation units are divided into three categories. The value (0.9200–1.0351) is the first level (Low), the value (1.0351–1.3175) is the second level (Medium), and the value (1.3175–1.7949) is the third level (High) (Fig. 3).

Tacheng Basin belongs to key ecological functional zones, and its sensitive ecological problems have become increasingly prominent. Therefore, most areas are

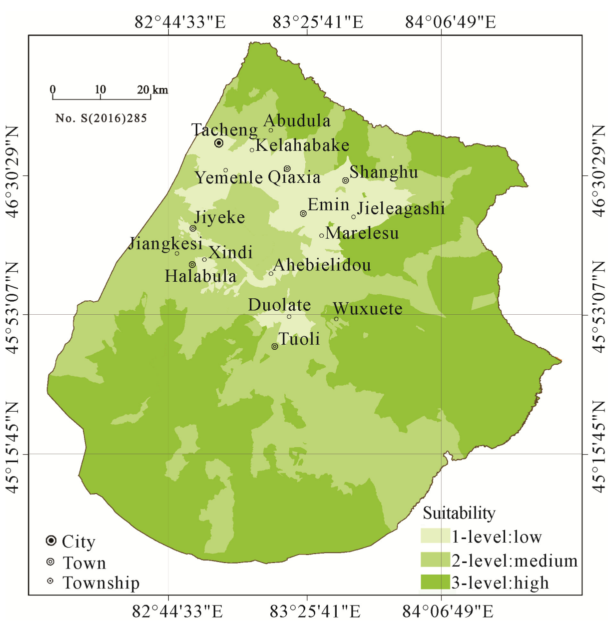

Fig. 1 Evaluation of ecological protection suitability in Tacheng Basin, Xinjiang of China

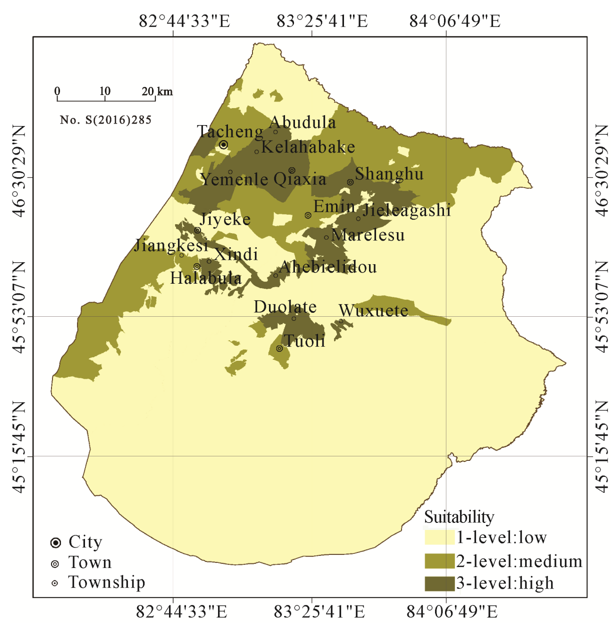

Fig. 2 Evaluation of agricultural production suitability in Tacheng Basin, Xinjiang of China

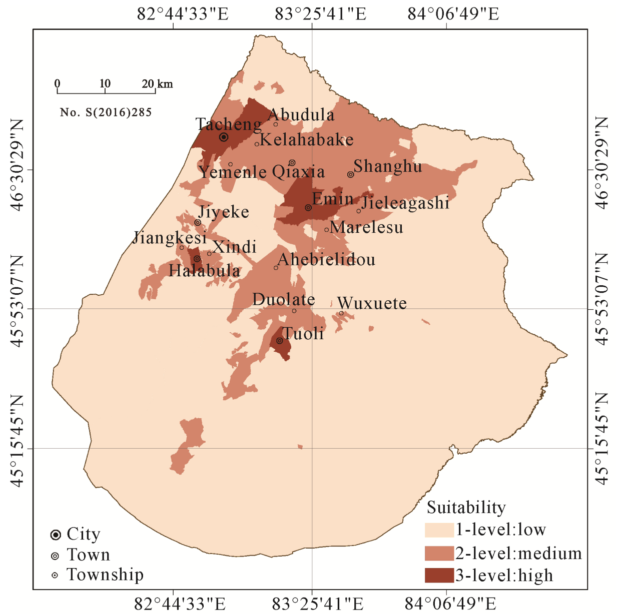

Fig. 3 Evaluation of urban development suitability in Tacheng Basin, Xinjiang of China

not suitable for overdevelopment. Fig. 4 shows that, spatially, in the south and east, the suitability of urban development is lower, and the ecological environment is very vulnerable. The higher areas of urban development suitability are only located in central city and townships closer to urban areas of Tacheng City, Emin County, Yumin County, and Tuoli County; in addition, others can be developed only under the premise of ecological protection.

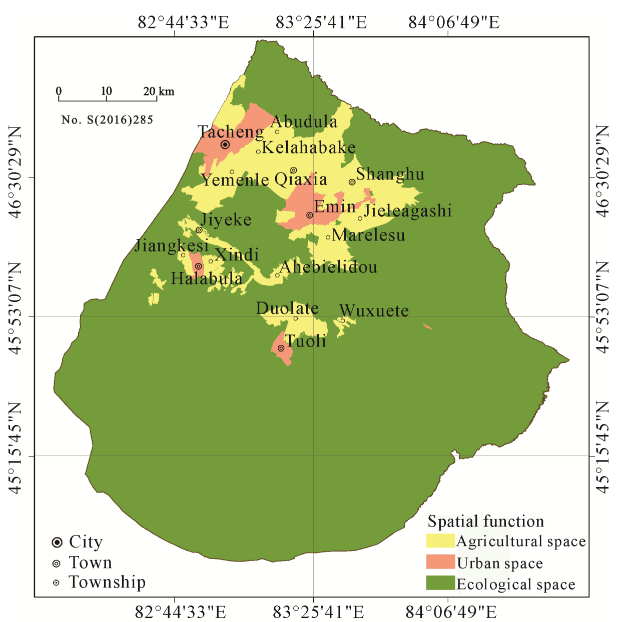

Fig. 4 Three types of spatial function in Tacheng Basin, Xinjiang of China

3.2 Evaluation of integrated spatial function

Supported by a basis database created through evaluation method of the comprehensive index, this paper constructs a mutual exclusion matrix of the suitability to determine function orientation for protection and development of each evaluation unit. There are 27 matrix units and each unit represents a combination-type trait of ecological suitability, agricultural production suitability, and urban development suitability. The design of mutual exclusion matrix is listed in Table 3. Dominated by ecological function, with the sequence of ecology, agriculture, and urban in the matrix, this paper recognizes the integrated suitability of every unit and creates a scientific division of three types of spatial function (Fig. 4).

The ecological space includes Taerbahatai Mountain, Qiwuerkayeer Mountain, Baerluke Mountain, Mayile Mountain, and the core area of Kulusitai Grassland, which covers 84.22% of Tacheng Basin and represents the largest area. The ecological space bears the functions of ecological service and ecological system maintenance and is suitable for ecological protection and ecological construction. Agricultural space includes the Ta'er produce section and Yumin produce section, accounting for 12.50% of Tacheng Basin. The agricultural space, including basic farmland, general farmland, towns, and villages, mainly undertakes the production of agricultural products and rural life. Urban space, covering approximately 2.83% of the Tacheng Basin, mainly includes the built areas, potential developed areas suitable for construction, and industrial development areas, which represent the central gathering places of population and industry, the important growth pole that supports economic development, and the core zones for improving the comprehensive strength and industrial competitiveness of Tacheng City, Emin County, Yumin County, and Tuoli County.

With the comprehensive analysis, the functional zone can be divided into four types: ecological protection zones, ecological economic zones, agricultural production zones, and urban development zones (Fig. 5).

4 Discussion

Based on a single index evaluation and the integrated spatial function, the proportion of three spaces is in sharp contrast: ecological space (including ecological

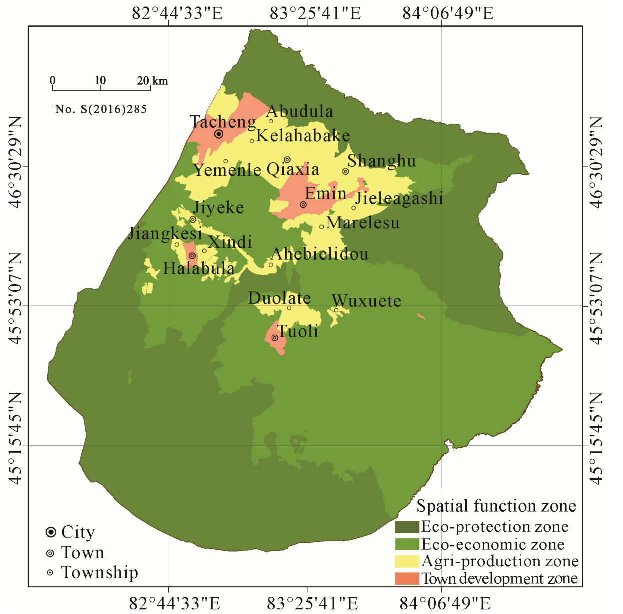

Fig. 5 Integrated spatial function zones in Tacheng Basin, Xinjiang of China

protection zones and ecological economic zones) accounts for 84.22%, agricultural space 12.50%, and urban space 2.83%. These results highlight the importance of ecological function in Tacheng Basin. The three types of space function zoning are the foundation of coordinated development in key ecological functional areas, and represent a comprehensive functional space with ecological space, agricultural space, and urban space, as well as a policy region which can reflect the function in space and the implementation of different space governances. Therefore, it can make the development direction of each function area clear, standardize the order of space development and ecological protection, and provide a new idea of space governance to solve problems of regional development.

4.1 Ecological function space

Ecological protection zones are mainly situated in high mountainous areas, including Taerbahatai Mountain, Qiwuerkayeer Mountain, Baerluke Mountain, and Mayile Mountain, and the functional zones cover 48.5% of Tacheng Basin, comprising the largest area. There are natural conservation areas, landscapes and famous scenery, national forest parks, and water source protected areas. The resource environment carrying capacity for ecological protection zones is relatively low and represents important function zones for ecological security and ecological restoration, mainly providing ecological products and ecological services. These conservation areas should strengthen ecological protection and restore ecosystem to improve the ability of ecosystem services.

Ecological economic zones are distributed in low mountain areas and townships of the core area in Kulusitai Grassland, covering 36.17% of Tacheng Basin. The biggest problem is the contradiction between development and protection, resulting in the grassland ecosystem being seriously damaged because factors that include overgrazing and excess reclamation. The areas with lower environmental bear capacity are mainly suitable for ecological animal husbandry and tourism, under the premise of protecting the ecological environment. In the future, strict ecological protection systems should be carried out, and the eco-overload population should be orderly transferred to protect eco-environment. Simultaneously, the zones should adopt measures that suit the conditions of Tacheng Basin, changing ecological advantages into developmental advantages.

Therefore, for ecological function space, the new economic growth must be based on ecological suitability and should adjust measures to local conditions in ecological development. Firstly, reduce population pressure in ecological area through ecological migration. Secondly, restore the ecological environment and ensure ecological security by prohibiting, for example, grazing, fencing, artificial management, and ecological protection engineering. Thirdly, limit farmland reclamation and implement the conversion of farmland to grassland and forest. Fourthly, improve supply capacity of ecological products and develop characteristic ecological industry based on the advantage of ecological resources. Lastly, implement innovative ecological compensation mechanisms that dispense compensation according to the region and its type, depending on the situation of Tacheng Basin and fully considering the differences in ecosystem services.

4.2 Agricultural function space

Agricultural function space has a relatively good agricultural production condition but also has some problems, including the lower level of agricultural development, poor infrastructure, and weak technical support ability. Consequently, we should increase investment in agricultural infrastructure construction and encourage agricultural leading enterprises, supported by examination and approval, and taxes and subsidies. We must transform the manner of agricultural development and develop modern agricultural facilites in Tacheng City, organic green agriculture in Emin County, and ecological agriculture in Tuoli County and Yumin County. Simultaneously, the measures for dual control of well-current should be adopted to control agricultural water use. The overloading population should be indirectly guided to a suitable development area of urban function space. Finally, we should engage in scientific planning and create a rational layout of rural residential land use by improving the rural infrastructure and optimizing the living environment.

4.3 Urban function space

Urban function space, as an important agglomeration zone of population and economy, can achieve spatial agglomeration of the socioeconomic resources; however, it is not only for urban development and contains, for example, extremely important ecological functions and basic farmland. To control urban development intensity, avoid spreading disorderly development, and protect the ecological environment of Tacheng Basin, the priorities should become planning ecological land and delimiting the biggest border of urban development; thus, we should increase the intensity of environmental regulation, conservation, and intensive use. At the same time, a characteristic industry should be developed in Tacheng Basin based on the resource advantages of four counties and cities, for instance, building a green food processing and distribution base for central Asia that relies on the 'green channel' of Timbuktu port. Additionally, the overload population in ecological and agricultural spaces should be guided in an orderly manner to gather in these areas.

5 Conclusions

This study sets up an evaluation index system for three types of space and constructed a scientific and reasonable pattern of ecological security, agricultural development, and urbanization to promote the construction of ecological civilization. The main conclusions of this research are as follows:

(1) This paper scientifically divides Tacheng Basin into ecological space, agricultural space, and urban space, forming a set of multilevel evaluation index systems for three types of spatial function zoning of the key ecological function areas based on a novel perspective. In the context of ecological constraints and protection, development and construction plans for urban space should firstly consider the demand of regional economic development and form the mechanism of collaborative propulsion between ecological protection and development suitability.

(2) Under the guidance of three types of spatial pattern, this study scientifically defines the direction of development and protection for ecological protection zones, ecological economic zones, agricultural production zones, and urban development zones. Comparing with the current situation of Tacheng Basin, excessive land reclamation and grazing and unreasonable farming practices are serious, making the ecological environment worsen and negatively influencing the economic development. Aiming at those contradictory problems, this paper proposes corresponding development measures, which can offer a scientific reference for macro decision-making.

(3) A new idea of space governance is provided to promote the coordinated and sustainable development between ecology and economy. The spatial function zoning in China can break the traditional mode of thinking about regional economic development, which clearly displays the functional orientation of development and protection. Including natural and human dimensions in research can help natural resource management become more integrated and balanced. Currently, there is a problematic contradiction between ecological protection and economic development, making it difficult for regional government to intuitively demonstrate the benefits by changing the development mode and developing the ecological economy.

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