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Analysis of the Spatial Differentiation and Development Optimization of Towns' Livable Quality in Aksu, China

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Abstract: With the proposal of the United Nations Sustainable Development Goals (SDGs), how to effectively improve the quality of human settlements has become a hot spot. Governments and scholars around the world pay attention to reasonable improvement of livability, which is conducive to improving the happiness level of residents and is closely related to human well-being. Due to the lack of rural statistical data in Xinjiang, this study established a new comprehensive evaluation system, which selected 21 indicators from the natural and humanistic aspects. The results show that the overall ecological security of Aksu prefecture is good, and Kuche city has the best humanistic livability performance. In terms of the livable quality of towns, Kuche Urban Area performs best. The towns with excellent and good livable quality are concentrated, but their spatial connections are weak. Based on the analysis and survey results, we put forward zoning optimization suggestions for the livable quality in Aksu prefecture. The results of this study would provide directional guidance for the improvement of livable quality in Aksu prefecture. At the same time, we expect that it can provide a methodological supplement for the relevant evaluation in other similar regions.

Keywords: township livable quality; spatial differentiation; development optimization; Aksu prefecture

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1. Introduction

The concept of human settlement was first proposed by Doxiadis in the 1950s and founded the science of human settlements [1,2]. Doxiadis believes that human settlement should be a whole in space, and Geddes also believes that urban planning cannot ignore the development of rural areas [3]. The United Nations "Vancouver Declaration" first put forward the concept of "human settlements", including social, material, spiritual, cultural elements, etc., covering cities and towns [4]. In the 1990s, Chinese scholar Liangyong Wu proposed the science of human settlements, covering social, economic, ecological, cultural, technological, and other aspects, and formed a scientific system of human settlements based on Chinese experience [5]. The 16th Annual Session of Global Forum on Human Settlement pointed out that building green, healthy, and resilient cities is conducive to promoting global economic development, progress, and prosperity [6]. The construction of sustainable cities is of great significance to improve the service level of human settlements and better benefit mankind. With the advancement of urbanization and industrialization, the rapid development of many developing countries has led to a series of urban and rural problems, such as air pollution, traffic congestion, insufficient public facilities, and uneven urban–rural development [7]. The emergence of these problems will continue to affect the happiness index of residents in urban and rural areas, and even become an incentive for crime. Research has shown that livable quality is highly correlated with personal well-being [8]. Livable quality has gradually become a topic of great concern to governments, scholars, and residents around the world.

In urban development in developed areas, the rapid expansion of cities and the increase of residents' demand for consumption and services have brought pressure and challenges to the sustainable development of society and the environment [9]. In developing areas, the living standards of residents often do no keep up with the pace of economic development. The rapid development has neglected the coordination between economic growth and livability and deviated from the people-centered development themes [10,11]. For human beings, the environment—whether it is the economic, social, or ecological environment—is an essential factor that intuitively affects the livable quality [12]. Adhering to the people-centered development philosophy, satisfying the people's yearning for a better life, and realizing the all-round development of people are the fundamental goals of upholding and improving the socialist system with Chinese characteristics and advancing the modernization of the country's governance system and governance capacity [13]. The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China mentioned the development goals that the urban and rural livable environment could significantly improve, and the people's livelihood could reach a new level. The livable quality is an indicator to measure the living standards of people in a particular region, and it can also reflect the ability of a region to transform from economic level to living standard. Whether in urban or rural areas, studying the current status and optimization strategies of livable quality is of great significance to its all-round high-quality development and the improvement of people's living security ability [14].

Scholars around the world have widely discussed the research on livable quality. Disciplines include economics and management, architecture and planning, geography, etc. [15–17]. The research areas concentrate mostly in the regions with relatively developed economies and society, and the research scales are almost above the county level [18–21]. The research methods are mainly divided into three categories. The first category is to build an evaluation system based on economic, social, and other statistical data to evaluate the livable quality of the study area [22,23]. The second category is to build a comprehensive index of livable quality and then make a weighted analysis of regional livable quality with the help of rasterized natural and humanistic data [24,25]. The last category is to carry out statistics and analysis on the satisfaction with the livable quality in questionnaires [26,27]. Previous studies on the livable quality are only based on either statistical survey data or raster image data. However, this study combines these two kinds of data, and thus avoids the trade-off problems caused by using only one of them. There will be no defects in the research due to incomplete selection of indicators or excessive subjectivity. Therefore, our research adopts the method of equal weight superposition of raster data and statistical data to study the livable quality.

As an organic part of geography, human settlements science also follows the laws and theories of geography and carries out human settlements research from a geographical perspective, which has gradually become an important academic trend in the field of human settlements science. The livable quality is affected by many factors, which can be roughly divided into ecological environment factors and livable conditions factors [16]. The minimum cumulative resistance model can represent the spatial distribution of ecological levels [28,29]. This paper uses raster data to evaluate the safety level of the ecological environment in Aksu prefecture through the minimum cumulative resistance model, to characterize the natural livable quality. In addition, we evaluated the humanistic livable quality of society, economy, culture, education, etc. using the TOPSIS model. This study aims to: (1) quantitatively measure the overall ecological environment quality and humanistic livable level in Aksu area; (2) According to the overall measurement results, assign natural livability and humanistic livability according to townships, and obtain the livable quality and their spatial connection levels of townships; (3) Combined with the analysis results, this paper puts forward some suggestions on the optimal development of townships' livable quality in Aksu prefecture. The research on livable quality is conducive to providing data and theoretical support for the livable construction of cities and towns, promoting the sustainable development of urban and rural society, and is of great significance to improve residents' life satisfaction and happiness.

2. Materials and Methods

2.1. Study Area

Aksu prefecture (including Alaer city, collectively referred to as Aksu prefecture in this paper) is located in northwest China and the middle of Xinjiang Uygur Autonomous Region, with an attitude of 945~7435 m. It belongs to a typical temperate continental climate, with dryness, little rainfall, large evaporation, and abundant natural resources. In 2020, the regional GDP was CNY 131.505 billion, and the total population was 3.124 million, with industry and agriculture as the leading industries. The economic development of Aksu prefecture is at a medium level. Still, the level of basic public services such as education, medical care, and transportation is poor, and the internal distribution is uneven. The geographical position of Aksu prefecture is shown in Figure 1.

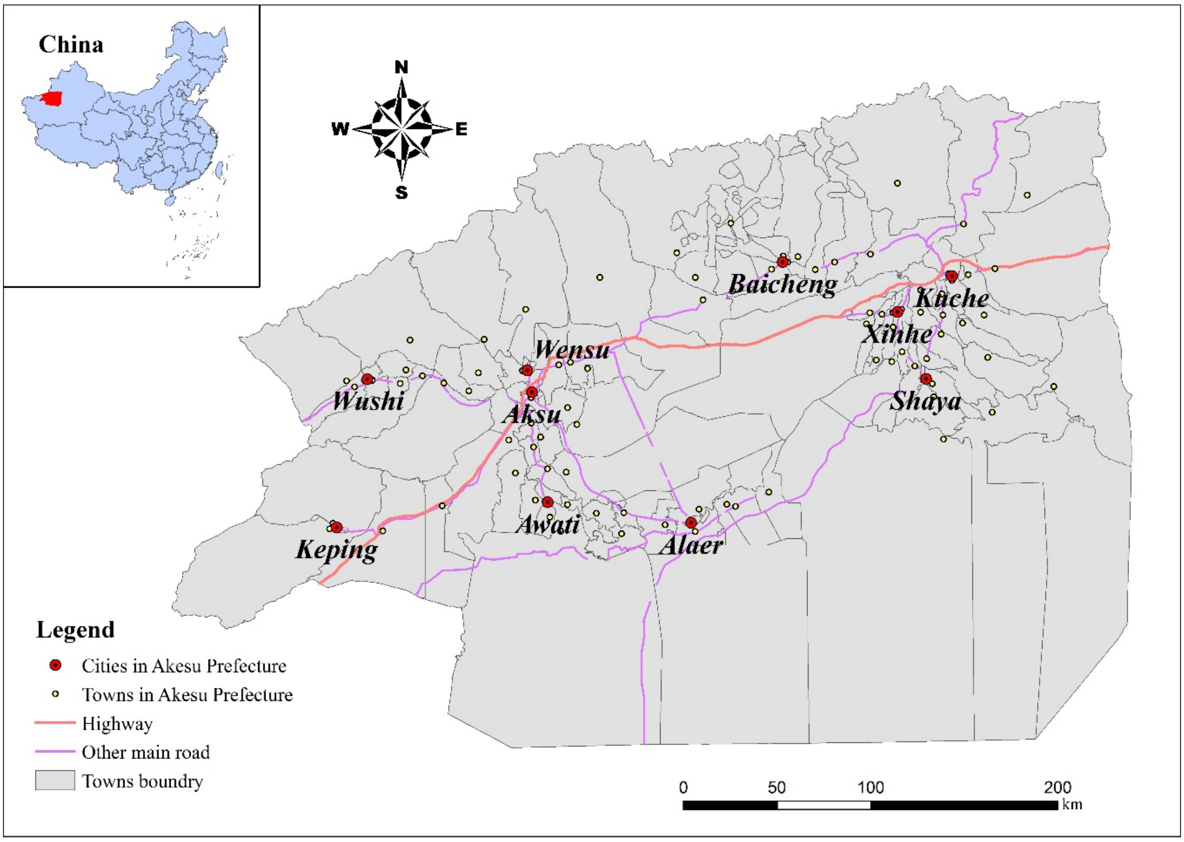

Figure 1. The geographical position of Aksu prefecture in China.

2.2. Data Sources

The elevation data and slope data of the Aksu prefecture with a resolution of 90 m are derived from the Geospatial Data Cloud (www.gscloud.cn) [30]. The normalized difference vegetation index (NDVI), soil erosion, main road, administrative division, and land use data are from the Data Center for Resources and Environmental Sciences of the Chinese Academy of Sciences (www.resdc.cn) [31]. The data of ecological reserves come from Aksu prefecture natural resources bureau. Other relevant statistical data come from "Aksu Prefecture Statistical Yearbook (2019)", "Xinjiang Production and Construction Corps Statistical Yearbook (2019)", "Alar City Statistical Yearbook (2019)", and "China County Statistical Yearbook (2019)".

2.3. Index System Construction and Methodology

2.3.1. The Construction of Index System

(1) Index system of natural livable quality

Referring to previous studies [32,33], the ecological reserve in Aksu prefecture was selected as the ecological source. The elevation, slope, NDVI, soil erosion degree, annual precipitation, days of floating dust, number of earthquakes (≥3.0), and distance from the main road were selected as resistance factors in combination with local conditions. Each resistance factor is divided into five grades, and the resistance coefficient is assigned to each grade. The classification of these factors is based on previous studies on ecological security and MCR model [29,34], combined with the classification results of the natural discontinuity method in ArcGIS 10.2. (Environmental Systems Research Institute, Inc., Redlands, CA, USA) The weight of each factor is determined by the entropy method. The evaluation index system of the natural livable quality constructed in this paper is shown in Table 1.

Table 1. The evaluation index system of natural livable quality in Aksu prefecture.

Resistance Factor	Unit	Index Type	Grade of Resistance Coefficient					Weight/%
			10	20	30	40	50	
Elevation	km	+	[0, 1.4)	[1.4, 2.1)	[2.1, 3.0)	[3.0, 4.0)	[4.0, ∞)	14.61
Slope	(°)	+	[0, 5)	[5, 10)	[10, 20)	[20, 30)	[30, ∞)	14.14
NDVI	/	−	[0.8, ∞)	[0.5, 0.8)	[0.25, 0.5)	[0.1, 0.25)	[0, 0.1)	10.65
Soil erosion degree	/	+	micro	mild	moderate	serious	severe	12.33
Annual precipitation	mm	−	[137, ∞)	[113, 137)	[89, 113)	[65, 89)	[41, 65)	11.60
Days of floating dust	days/year	+	[0, 31)	[31, 40)	[40, 50)	[50, 60)	[60, ∞)	12.54
Number of earthquakes (≥3.0)	times/year	+	[0, 1)	[1, 4)	[4, 13)	[13, 15)	[15, ∞)	13.58
Distance from main road	km	−	[15, ∞)	[8, 15)	[5, 8)	[2, 5)	[0, 2)	10.55

(2) Index system of humanistic livable quality

This paper selects 11 indicators from five aspects of economic development, culture and education, transportation, public infrastructure, health, and medical security to construct the index system to evaluate the overall humanistic livable quality of the counties and cities in Aksu prefecture. The evaluation index system of the humanistic livable quality constructed in this paper is shown in Table 2.

Table 2. The evaluation index system of humanistic livable quality in Aksu prefecture.

The Subsystem	Indicators	Unit	Index Type	Weight/%
Economic development	Per capita GDP	Yuan	+	9.77
	Per capita annual income	Yuan	+	7.74
Culture and education	Student-teacher ratio	Student/teacher	−	8.82
	Number of literary and artistic institutions	Institution	+	8.47
Transportation	Car ownership	Car	+	10.21
	Urban road length	km	+	9.92
Public infrastructure	Rate of television	%	+	7.02
	Green area	hm^2	+	10.03
	Length of water supply and drainage pipes	km	+	9.55
Health and medical security	Number of people with basic medical insurance	People	+	9.38
	Number of beds in medical institutions	Bed	+	9.09

2.3.2. Determination of Weight

There are many methods to determine the weight, including principal component analysis, entropy method, analytic hierarchy process, and so on [35–37]. After analyzing the degree of correlation between previous studies and this study, and comparing the above three methods, it was found that the entropy method is the most suitable method for the data of this study.

To standardize the indicators and eliminate the influence of dimensions, this paper selects the range standardization method [38,39]. The specific methods are as follows:

Positive indicators:

$$x'_{ij} = \frac{x_{ij} - min(x_{1j},\ x_{2j},\ \ldots,\ x_{nj})}{max(x_{1j},\ x_{2j},\ \ldots,\ x_{nj}) - min(x_{1j},\ x_{2j},\ \ldots,\ x_{nj})} \tag{1}$$

Negative indicators:

$$x'_{ij} = \frac{max(x_{1j},\ x_{2j},\ \ldots,\ x_{nj}) - x_{ij}}{max(x_{1j},\ x_{2j},\ \ldots,\ x_{nj}) - min(x_{1j},\ x_{2j},\ \ldots,\ x_{nj})} \tag{2}$$

where x'_{ij} is the jth index value of the ith area (i = 1, 2, . . . , n; j = 1, 2, . . . , m).

The index contribution of the jth index value to the ith area:

$$p_{ij} = \frac{x_{ij}}{\sum_i^n x_{ij}} \tag{3}$$

Entropy calculation:

$$e_j = -\frac{1}{\ln n}\sum_{i=1}^{n} p_{ij}\ln(p_{ij}), e_j \geq 0 \tag{4}$$

Difference coefficient calculation:

$$g_j = 1 - e_j \tag{5}$$

Weight calculation:

$$w_j = \frac{g_j}{\sum_j^m g_j}, j = 1, 2, \ldots, m \tag{6}$$

2.3.3. Minimum Cumulative Resistance Model (MCR)

The minimum cumulative resistance model is the model that calculates the cost of the movement from the "source" to the destination [40,41], where the ecological cost distance is used to measure the natural livable quality. The formula is as follows:

$$R_{MC} = f_{min}\sum_{j=n}^{i=m}(D_{ij}R_i) \tag{7}$$

where R_{MC} is the minimum cumulative resistance value from source j to a point in space; D_{ij} refers to the spatial distance from source j to landscape unit i. R_i is the resistance coefficient of the landscape unit i to the particle movement.

2.3.4. TOPSIS Model

The TOPSIS model is used to calculate the proximity of each evaluation unit to the ideal point, that is, the relative proximity. The larger the relative proximity, the closer the evaluation unit is to the ideal level [42,43]. The formula is as follows:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(R_{ij} - R_i^+)^2},\ d_i^- = \sqrt{\sum_{j=1}^{n}(R_{ij} - R_i^-)^2} \tag{8}$$

$$C_j = \frac{d_i^-}{d_i^+ + d_i^-} \tag{9}$$

where d_i^+, d_i^- are the distances between each evaluation unit and the positive or negative ideal solutions and C_j is the relative proximity. The relative proximity C_j is in the range of [0, 1]; the larger the C_j, the closer the jth evaluation unit is to the ideal level, and the higher the suitability of the evaluation unit.

2.3.5. Gravity Model

The gravity model is used to measure the impact of cities on the livable quality of towns, and the visual expression of the spatial radiation of livable quality can be obtained [44,45]. The formula is as follows:

$$I_{ij} = G\frac{M_i M_j}{r^b} \tag{10}$$

where the empirical coefficient G takes 1, M_i and M_j as the ith and jth gravitational units. The friction coefficient b is taken as 2, which is more in line with the actual situation and consistent with Newton's universal gravitation model.

3. Results Analysis

3.1. Overall Analysis of Prefecture

3.1.1. Natural Livable Quality

We used the cost distance tool of ArcGIS 10.2 to obtain four types of zones of natural livable quality in Aksu prefecture. From the overall level, the natural livable quality of Aksu prefecture is good. There are only small areas of poor level zones in the west and southeast, and the zones of the excellent livable quality mainly distributed in the north and central South of the prefecture. The zones of fair level are distributed around the poor zones closely, and the good zones are distributed around the fair zones closely. The good and fair zones serve as buffer transition zones for the excellent and poor zones. The four zones show a distribution trend of surrounding and alternating evolution in space (Figure 2).

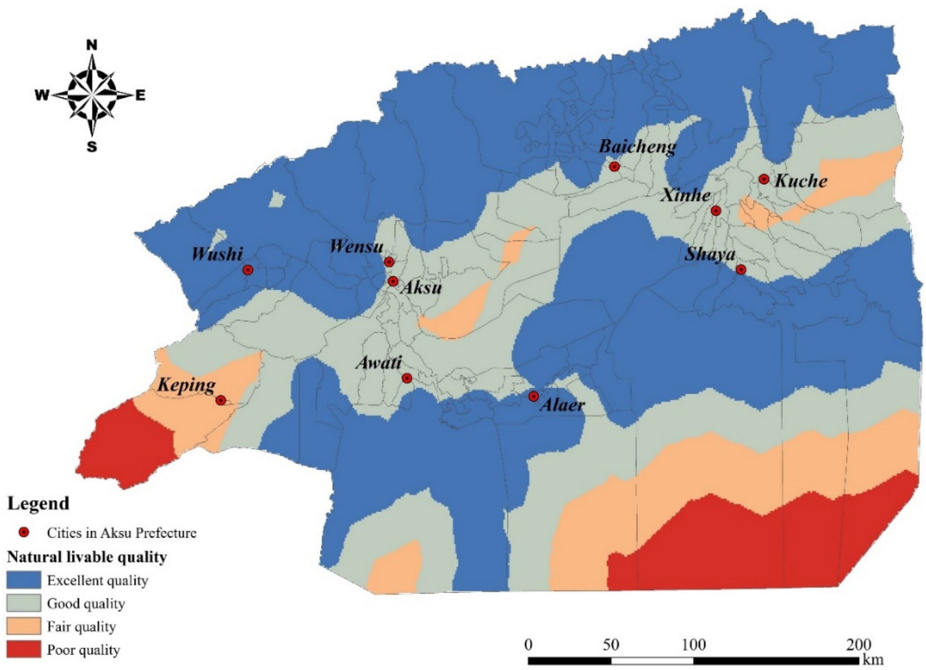

Figure 2. Spatial distribution of natural livable quality in Aksu prefecture.

3.1.2. Humanistic Livable Quality

Through the calculation of TOPSIS model, the relative proximity results of urban humanistic livable quality in Aksu prefecture are obtained. In order to correspond to the natural livable quality level, by referring to previous studies [46,47], we adopted the method of equal division to divide the level of human livability into four grades: poor (0, 0.25), fair (0.25, 0.5), good (0.5, 0.75), and excellent (0.75, 1) (Figure 3).

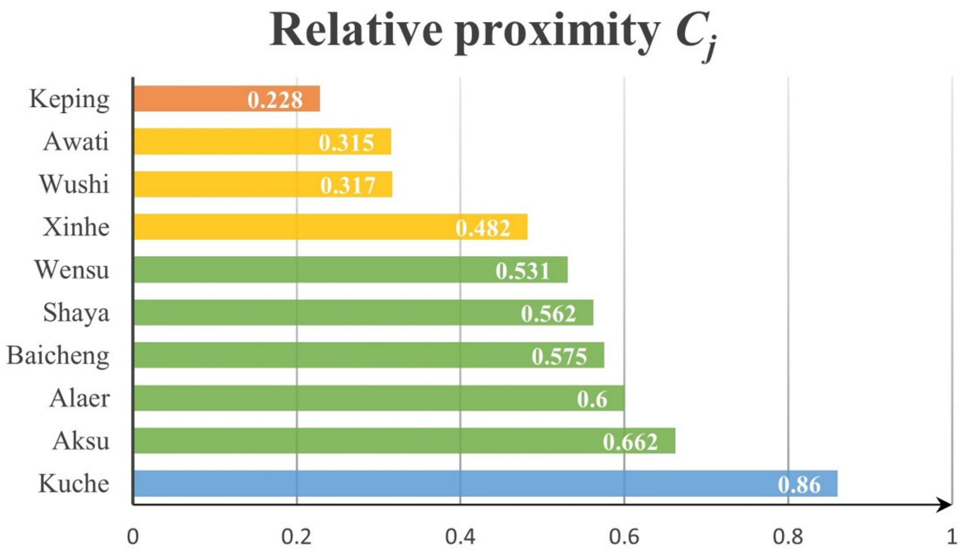

Figure 3. The humanistic livable quality of cities in Aksu prefecture.

Overall, Kuche has the highest relative proximity and is the only city in Aksu prefecture with an excellent humanistic livable quality, with a score much higher than other cities. The cities of good level include Aksu, Alaer, and another three cities; the cities of fair level include Xinhe, Wushi, and Awati; and the city of poor level is Keping. There is a large gap between the cities of poor and fair livable quality and the cities of excellent and good livable quality. The differences in the humanistic livable quality among the cities in Aksu prefecture are significant. The urban development level in the southwest of the prefecture is low due to the poor natural resource conditions. The economic foundation is weak, and the supporting facilities in various aspects are not perfect. While the central region relies on good natural resources and policy conditions, the economic and social development is relatively good. Kuche, the city with the best humanistic livable quality, uses its advantages in location, transportation, and resources to focus on the development of secondary and tertiary industries. It has a solid economic foundation and vigorously improves the supporting level of public infrastructure. It was recognized as a national health county in 2018 and selected as one of the top 100 counties in western China in 2019.

3.2. Analysis of Townships

3.2.1. Natural Livable Quality of Townships

The ecological cost distance of townships is obtained by using the vector boundary of each township to cut the ecological cost distance of the prefecture, and the mean value of the ecological cost distance of each township is calculated (Table 3). The ecological cost distance is used to measure the natural livable quality, and the smaller the former, the better the latter. In terms of scores, the natural livable quality of Laohutai township is the best, followed by Yakra Town, and Gaizlik Town of Keping county is the worst. From the perspective of spatial differentiation (Figure 4), the towns with the excellent and good natural livable quality are concentrated and contiguous, located in the oasis area. The towns with fair and poor natural livable qualities are mixed, and the natural livable quality of northern towns is better than that of southern towns. The main reason is that the southern part of the prefecture is close to the Taklimakan Desert, and the ecological environment is poor.

Table 3. The ecological cost distance of townships in Aksu prefecture.

Town	Ecological Cost Distance	Ranking		Town	Ecological Cost Distance	Ranking
Laohutai Town	0.136	1		Gulawati Town	9.623	91
Yakra Town	0.531	2		Bixibag Town	10.018	92
Yimum Town	0.535	3		Yuerqi Town	10.391	93
Autobash Town	0.673	4		allahag town	10.539	94
Wushi Urban Area	0.835	5		Gulebag Town	10.826	95
Tumusuke Town	0.919	6	……	Qiman Town	11.278	96
Jinyang Town	1	7		Gaizikumu Town	11.584	97
Tagrak Town	1.02	8		Tarim Town	12.714	98
Chagrak Town	1.02	9		Keping Urban Area	13.372	99
Arg Town	1.024	10		Gaizlik Town	22.257	100

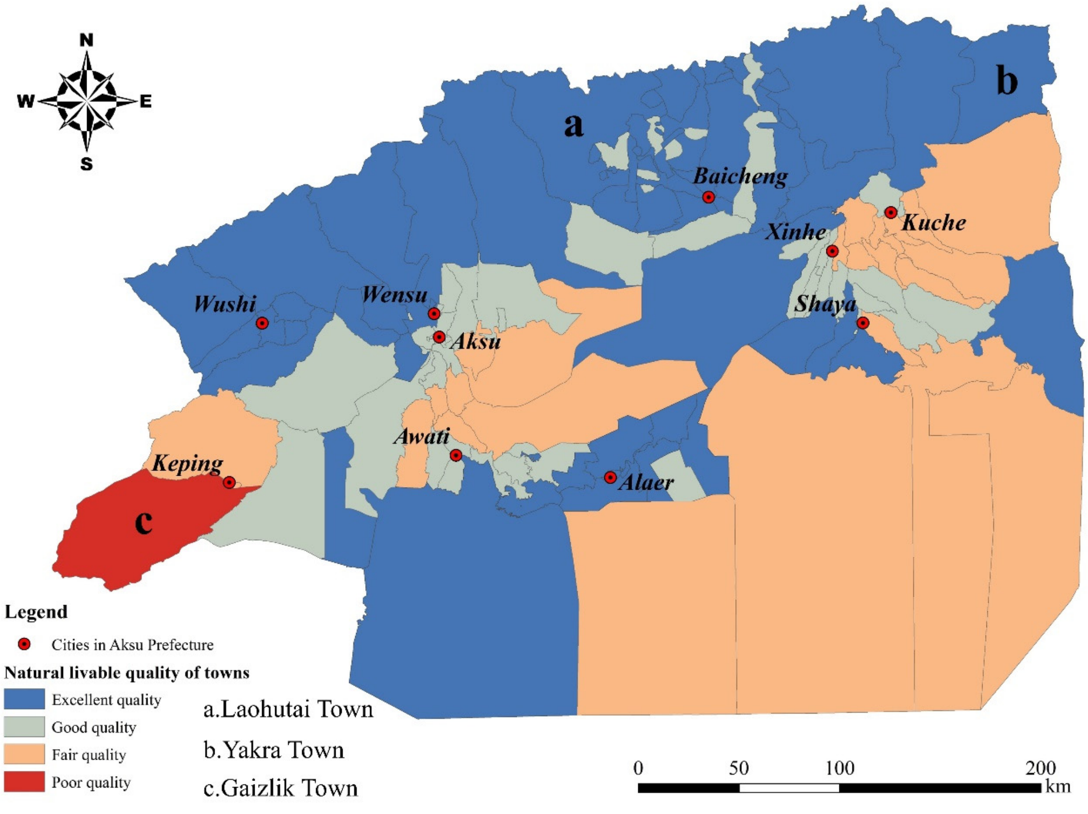

Figure 4. Natural livable quality of towns in Aksu prefecture.

3.2.2. Humanistic Livable Quality of Townships

The distribution of construction land in Aksu prefecture is greatly affected by the distribution of oases, and the productive and livable scope of residents is severely restricted by construction land. The area of construction land, in a way, can reflect the productive and livable standards of a township. Therefore, the humanistic livable quality is calculated according to the proportion of the construction land area of each township in the city where it is located (Table 4). The humanistic livable quality of Kuche Urban Area is the best, followed by Wuzun Town, and there is a large gap with the subsequent towns. Since there are many high-altitude mountains in the administrative area, and the distribution of land types is mostly bare land, Yakra Town has the worst level of humanistic livability.

Table 4. The humanistic livable quality of townships in Aksu prefecture.

Town	Value	Ranking		Town	Value	Ranking
Kuche Urban Area	0.946	1		Gaizikumu Town	0.021	91
Wuzun Town	0.860	2		Bageturgeluc Town	0.018	92
Aksu Urban Area	0.728	3		Yamansu Town	0.009	93
Ayikule Town	0.662	4		Autobash Town	0.008	94
Alaer Urban Area	0.660	5		Gaizlik Town	0.007	95
Baicheng Urban Area	0.633	6	……	Yuerqi Town	0.005	96
Shaya Urban Area	0.618	7		Tamuturgeluc Town	0.002	97
Yaha town	0.612	8		Wigan Town	0.002	98
Chang'an Town	0.600	9		Gongtsingtuan Town	0.002	99
Wensu Urban Area	0.584	10		Yakra Town	0.001	100

From the perspective of spatial differentiation (Figure 5), the towns with poor humanistic livable quality are the most widely distributed. The towns with excellent quality are only two in Kuche Urban Area and Wuzun Town. The towns with excellent and good quality are mainly distributed in the central-western and central-eastern regions of Aksu prefecture. The distribution range overlaps with the two oasis plains in the prefecture. The humanistic livable quality of southern Xinjiang, especially Aksu prefecture, is greatly restricted by natural ecological and environmental factors.

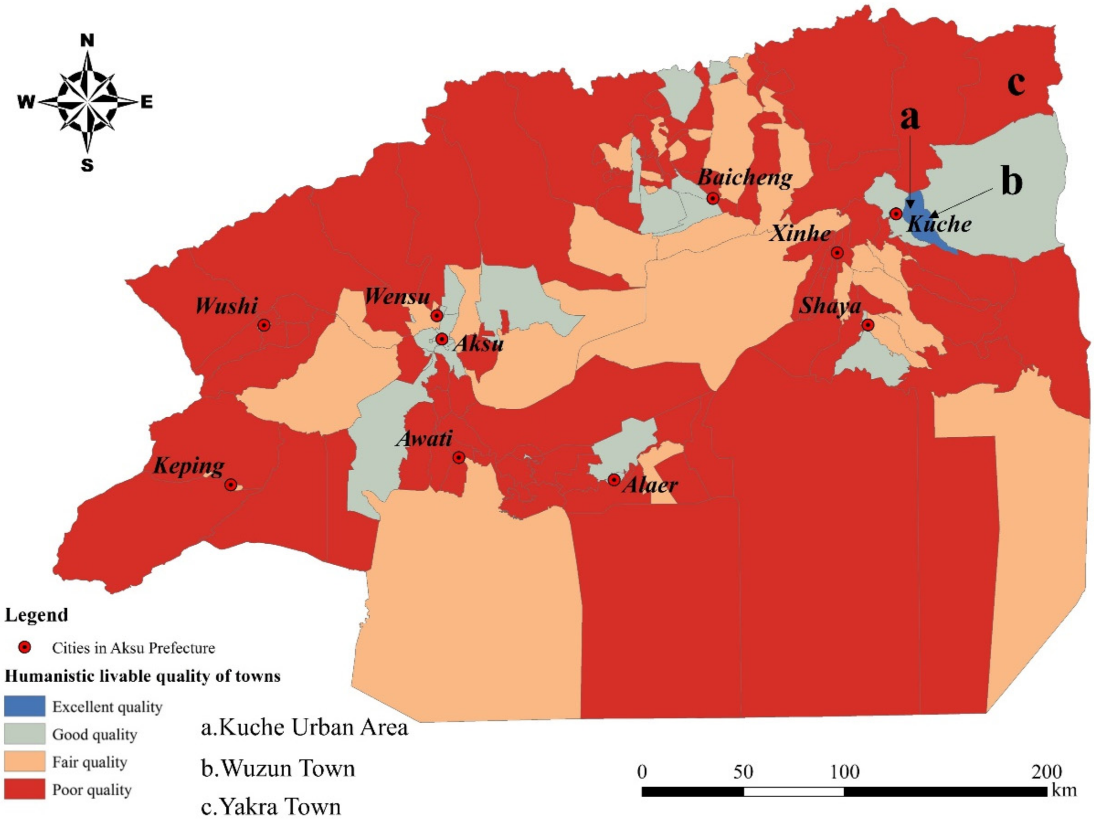

Figure 5. Humanistic livable quality of towns in Aksu prefecture.

3.2.3. Livable Quality

The natural livability level (ecological cost distance) of towns is reversely normalized and superimposed with the humanistic livability level in equal proportions to obtain the township's livable quality results. Concerning the classification of humanistic livability, the towns in Aksu prefecture are divided into four categories: excellent, good, poor, and fair (Figure 6). Due to the different policies, backgrounds, and development potentials of urban areas and towns, this paper analyzed the livable quality of urban areas and towns separately (Table 5). In terms of urban areas ranking, Kuche urban area performs best, Baicheng urban area takes second place, and Keping urban area performs worst. From the perspective of towns, Gaizlik Town performed the worst, Wuzun Town performed the best, and even scored more than Baicheng Urban Area. From the perspective of the spatial distribution pattern, the towns with excellent and good livable quality are concentrated and contiguous, and the towns with fair and poor livable quality are mainly located in the southeastern, western, and central parts of the prefecture.

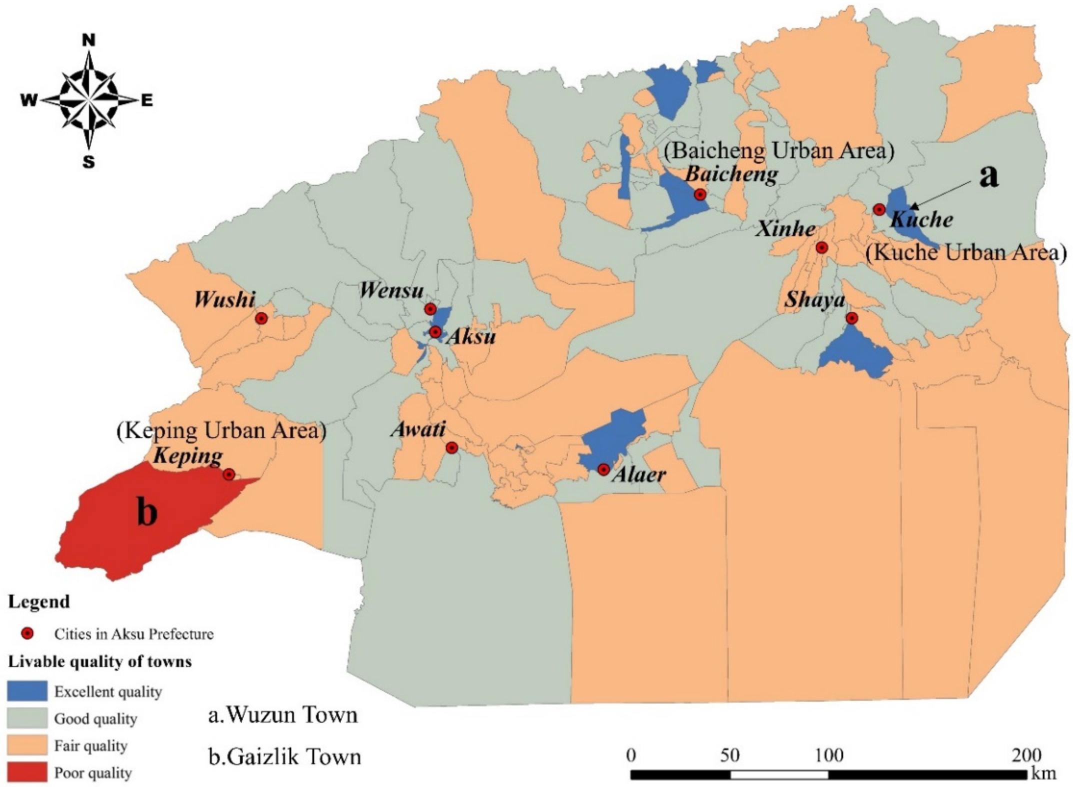

Figure 6. Livable quality of towns in Aksu prefecture.

Table 5. The livable quality of Urban Areas and towns in Aksu prefecture.

Urban Area	Value	Ranking	Town	Value	Ranking
Kuche Urban Area	0.946	1	Wuzun Town	0.784	1
Baicheng Urban Area	0.782	2	Mijik Town	0.773	2
Alaer Urban Area	0.781	3	Toyburghledi Town	0.771	3
Akesu Urban Area	0.763	4	Chang'an Town	0.763	4
Shaya Urban Area	0.722	5	Ayikule Town	0.741	5
Wensu Urban Area	0.704	6		……	
Wushi Urban Area	0.668	7	Yuerqi Town	0.270	87
Xinhe Urban Area	0.617	8	Tarim Town	0.262	88
Awati Urban Area	0.552	9	Gaizikumu Town	0.252	89
Keping Urban Area	0.333	10	Gaizlik Town	0.003	90

4. Discussion

4.1. Interactive Analysis of Research Results and Field Investigation

After the previous analysis and field research, it is found that the overall quality of human settlements in the Aksu prefecture is average, and the regional development is extremely uneven. The severe ecological environment will hinder economic and social development, exert pressure on industrial and agricultural development, and reduce the investment desire of external industries [48,49]. The gradually deteriorating ecological environment and backward economic level have caused significant restrictions on human living and production activities in Aksu prefecture. In the past, the enterprises that did not meet the emission standards were eliminated, which also impacted short-term economic development. Due to the backward economy, Aksu prefecture does not have enough ability to improve the development of livable quality. The level of essential public services is relatively poor, and the widening gap between the rich and the poor makes the differentiation of livable quality in the prefecture serious [50].

We also discovered an interesting phenomenon. Generally speaking, the best quality of living in an area should be the central administrative area, but the best livable quality in Aksu prefecture is Kuche Urban Area, not Aksu Urban Area. Based on research and data analysis, we found that the overall economic development of Aksu Urban Area is better, but the per capita GDP and per capita annual income are not as good as Kuche Urban Area. In addition, basic education indicators such as student-teacher ratio are also better in Kuche Urban Area. Kuche Urban Area is far away from the administrative center of Aksu prefecture in space, and has a better degree of self-reliance. Therefore, the livable quality of Kuche Urban Area is in the first place in Aksu prefecture.

4.2. Spatial Connection Strength of Livable Quality among Towns

The actual survey found that all cities in Aksu prefecture are only attractive to their own townships, and residents' life and production activities hardly consider other nearby cities. This will lead to the better development of towns with excellent and good livable quality and a greater gap with other towns. However, some studies have shown that if a region wants to develop steadily, it must coordinate the overall situation and cannot allow the development gap to expand [51,52]. We consider the four urban areas of Kuche, Aksu, Alaer, and Baicheng as development poles, and analyze their gravitational attraction to surrounding townships, so as to provide a reference for the balanced improvement of the overall livable quality in Aksu prefecture.

According to the results of the calculation of the townships' livable quality, the spatial gravitational radiation distribution between the development poles and each township is obtained (Figure 7) [53,54]. From the perspective of development poles, the radiation effect in Kuche Urban Area is the strongest, and that in Alaer Urban Area is the weakest. Due to the lack of self-development and the limitation of spatial distance, the radiation effect of the development poles of livable quality in Aksu prefecture only stays near itself. The radiation effect intensity is not enough, the level varies greatly, and the connection degree of other towns is even worse. The spatial analysis results of livable quality are basically consistent with the survey, indicating that there is indeed a problem of insufficient spatial connection of the livable quality in Aksu prefecture.

4.3. Improvement and Optimization Suggestions

Based on the previous analysis and with reference to the "Land Spatial Planning of Aksu Prefecture (2020–2035)" [55], this study defines four promotion zones: Ecological Conservation Zone, Ecological Restoration Zone, Humanistic Livable Cooperation Zone and Humanistic Livable Optimization Zone (Figure 8). The previous part of the natural livability analysis found that the ecological security of the northern Aksu prefecture is excellent, and at the same time, it is less disturbed by human activities. Therefore, the northern Aksu prefecture is designated as the Ecological Conservation Zone. In this zone, attention should be paid to water and soil conservation to prevent water and soil loss and protect the basis for the survival of vegetation. According to the previous investigation, in recent years, the ice and snow melt water has increased in the northern mountainous area of Aksu region, and debris flow disasters have occurred frequently. The local government should also do a good job in governance and protection to protect the personal safety of the township residents in front of the mountain. The Ecological Restoration Zone is located in the south of Aksu prefecture and has poor natural livability, mainly due to the large area distribution of the desert. Affected by the Taklimakan Desert, the towns in the southern Aksu prefecture are influenced by sand and dust all year round, and the living standards of the residents have been seriously impaired. In this zone, windbreak and sand fixation should be done, the original vegetation should be protected, and the ecological maintenance function should be restored by planting drought-tolerant plants such as Haloxylon ammodendron.

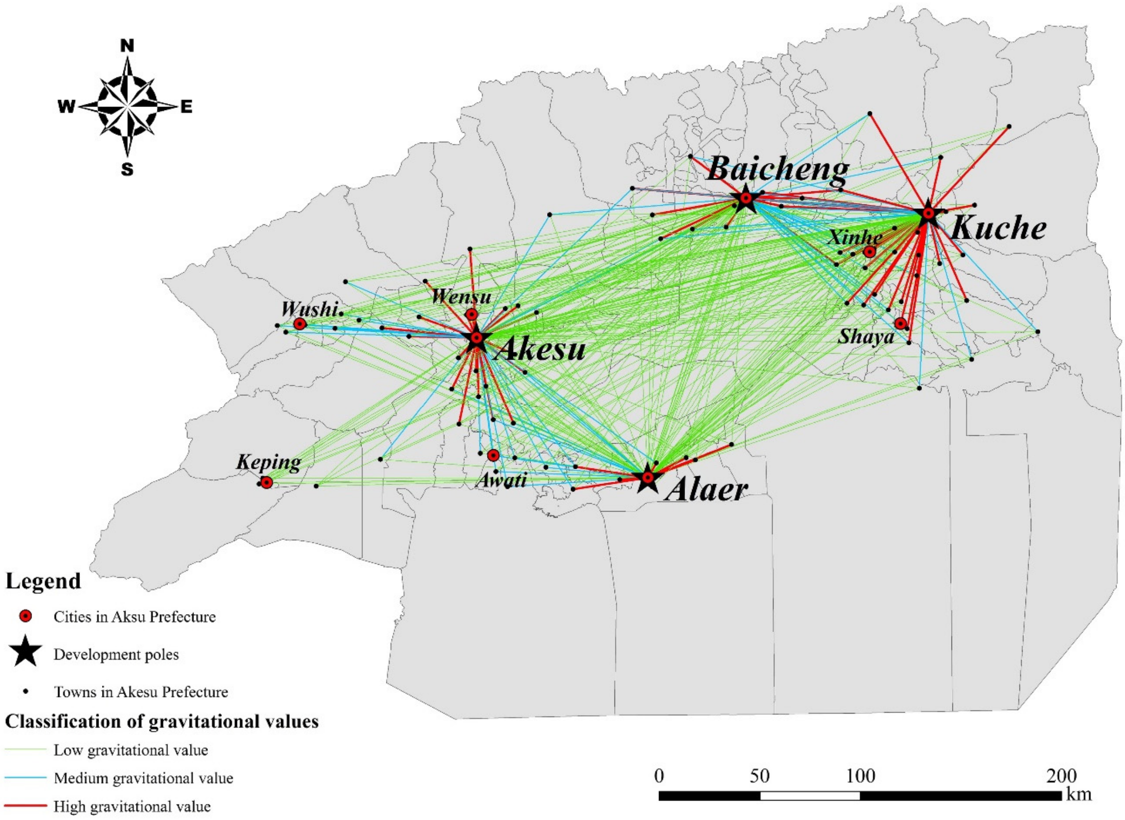

Figure 7. Gravitational radiation effect of development poles.

Humanistic Livable Cooperation Zone and Humanistic Livable Optimization Zone are delineated based on the location of the two oases in the Aksu prefecture and the characteristics of livable quality. The main role of Humanistic Livable Cooperation Zone is to promote the balanced improvement of the livable quality through the radiation effect of the Aksu and Alar development poles on other towns. In this zone, there are two counties, Wushi and Keping, where the development of livable quality is relatively backward. Their own development power is insufficient, and they need the assistance of external power to develop. First of all, the radiation effect of development poles on other towns should be strengthened, especially the centrality of Aksu Urban Area in the zone. In addition, in the process of strengthening the development poles, attention should be paid to the balanced distribution of resources to prevent the imbalance in the development of livable quality in towns. Humanistic Livable Optimization Zone is located in the oasis area in the eastern part of Aksu prefecture. Due to its far distance from the administrative center of prefecture, it needs stronger self-development motivation. Townships in this zone should focus on the layout of advantageous industries, introduce emerging industries while giving full play to the advantages of traditional brands, and improve the industrial layout system. In addition, the townships in the zone are relatively concentrated in space, and it is possible to consider the joint establishment of industrial parks of different types and levels to give full play to the leading role of the development poles.

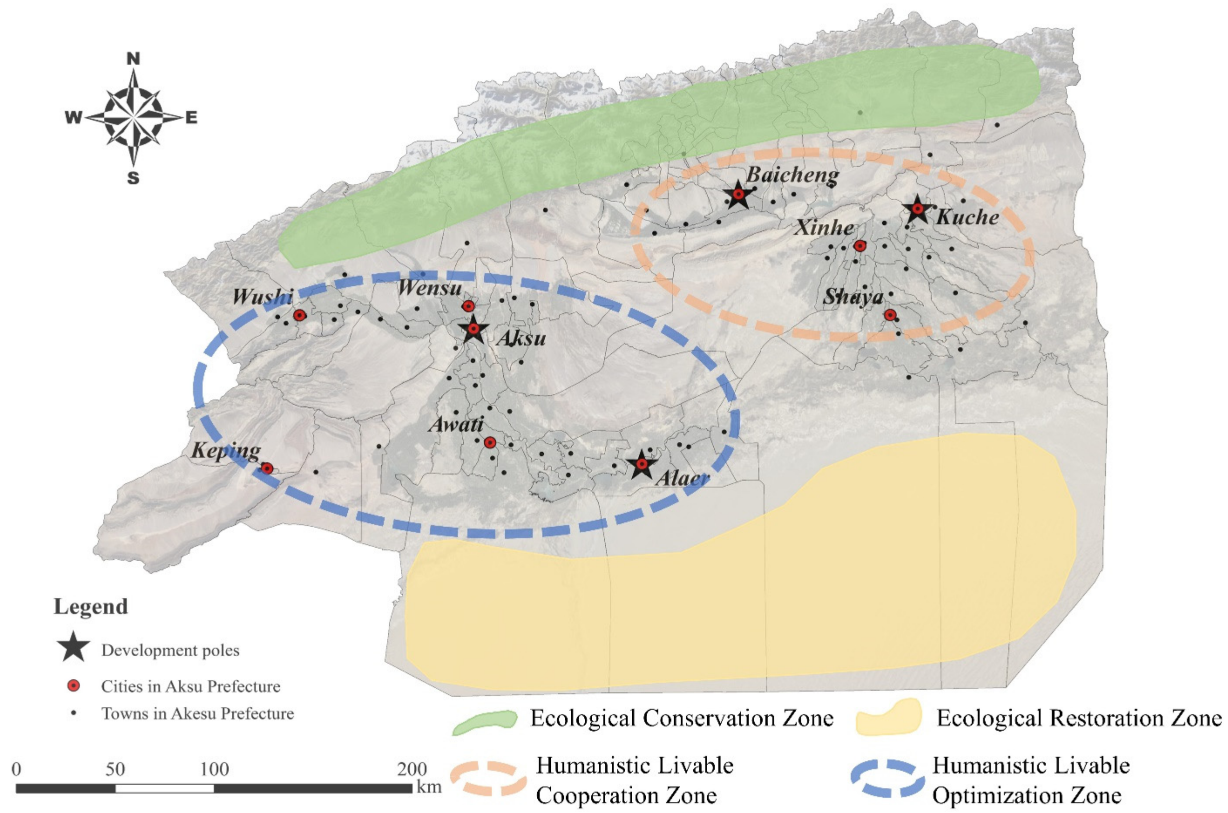

Figure 8. Optimization scheme of livable quality.

5. Conclusions

This study proposed a comprehensive assessment framework based on natural and humanistic suitability to measure the livable quality of townships in Aksu prefecture. By means of spatial analysis and econometric analysis, combined with field research, this paper revealed the spatial distribution and relationship of townships' livable quality from two aspects. This study can provide a reference for the evaluation and optimization of livable quality in arid oasis areas. The main conclusions are as follows: (1) At the regional level, the ecological security pattern in Aksu prefecture is good, with only a small area of ecologically fragile areas in the west and southeast. In terms of humanistic livability, Kuche City performed the best, and Keping County performed the worst. (2) From the township level, Laohutai Town has the best natural livability level, and Kuche Urban Area has the best performance of humanistic livability. The urban area with the best livable quality performance is Kucha Urban Area, and the township with the best performance is Wuzun Town. In terms of spatial distribution pattern, townships with excellent and good livable quality are concentrated and contiguously distributed. However, the spatial connection between the four urban areas with excellent livable quality and other townships is weak, and the radiation range is small. (3) Based on the measurement results and research analysis, this study defines four promotion zones: Ecological Conservation Zone, Ecological Restoration Zone, Humanistic Livable Cooperation Zone, and Humanistic Livable Optimization Zone. According to the zoning, we put forward some optimization suggestions, in order to provide reference for the improvement of the livable quality of Aksu prefecture.

Previous studies on the quality of rural livability in Xinjiang were few, and most of them were analyzed in the form of questionnaires. Because of the lack of statistical data at the township level in Xinjiang, there are not enough data to directly support the research. Moreover, the townships in Xinjiang are sparsely distributed and spaced far apart. Using the form of questionnaires would consume a large amount of manpower and time.

Therefore, this paper proposed a new research framework: studying the livable quality at the city level, and then using the proportion of building land area to obtain the quality of livability at the township level. This study can provide a paradigm reference for other similar areas where data are scarce. In addition, although this study obtained the spatial distribution and relationship of the livable quality of townships in Aksu prefecture, the temporal evolution characteristics were not involved. In future research, we will focus on the characteristic changes on the time scale to provide a more accurate basis for the sustainable development of urban and rural livable quality.

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