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Evaluating the Suitability of Human Settlements Using Big Data and GIS in Jieyang City, China

BY

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Abstract

This study aims to reveal the spatial pattern of the suitability of the human settlement environment in Jieyang City. The method applies big data of resource elements such as land cover, meteorology, hydrology, and economy, combined with Geographic Information System (GIS) technology, for analyzing the overall distribution of suitability by combining the Human Settlement Environment Index (HEI) of different areas, an evaluation model, location conditions, socio-economic development, and other relevant data. The results show that the whole study region belongs to suitable, but the regional spatial difference is real. The value of the natural index of the human settlement environment is between 24.49 and 72.63. The distribution of suitability is mainly related to ground cover exponential, hydrological suitability, climate suitability, and social and economic factors.

Keywords: Geographical Information System (GIS), Suitability of human settlements, Human Settlements Environment Index (HEI), Big Data, Normalized Difference Vegetation Index (NDVI)

1. INTRODUCTION

The human settlement environment refers to the natural space and social activity complex that affects human survival and development, including five systems of nature, humans, society, residence, and support, and five levels of global, regional, urban, community, and architecture (Feng et al., 2008). The environment is a critical component of human survival and development. In recent years, due to the pressure of rapid population growth, the ecological environment has deteriorated, and the demand for resources and other issues, the study of the suitability of human settlements is urgent and significant (Wang, 2017).

At the end of the 19th century, the rapid development of industry led to the deterioration of urban ecology, and the change in the residential environment became more constraining for the urban population. In this case, E. Howard's "Garden City" provides an ideal model. The primary schools of study include urban planning, human settlements, geography, and ecology (Chen, 2011), with a wide range of research scales and scopes. According to domestic and foreign literature on human settlements, we can notice that foreign research on human settlements includes cities, urban communities, urban fringe areas, villages, particular areas, etc. (Shang and Yang, 2017).

The suitability of human settlements in China can be traced back to the ancient "unity of nature and man". In January 2005, livable cities appeared in China, and the State Council approved the overall urban planning of Beijing, using the concept of livable cities for the first time. In July of the same year, the State Council requested all regions to consider livable cities as a critical part of urban planning at the National Urban Planning Work Conference (Wang, 2017). Human settlements are places for human labor, life, leisure, entertainment, and social activities. Unreasonable development and utilization of the environment will not only directly cause ecological damage, but also affect the quality of human settlements (Hu et al., 2009),. Therefore, it is of great significance to scientifically analyze the suitability of the ecological environment. The suitability evaluation of regional human settlements is an evaluation unit and indicator based on micro- and natural factors that affect the regional human

settlements used to evaluate the suitability and constraints of the human settlements in regions and counties.

In addition, big data, also known as massive data, refers to data that cannot be captured, managed, and processed using traditional software tools within a specific time frame. It is massive, has a high growth rate, and is diverse, requiring new processing models to improve decision-making, insight, and process optimization capabilities. Through big data technology, valuable information can be quickly found in the massive factor data set of human settlements. The data sources involved in the analysis of this study are characterized by a large volume of data, a wide variety of types, low-value density, fast speed, and high velocity (Wang et al., 2022), which are consistent with the data characteristics of the big data era. Using this as a goal for factor decision analysis, it should be possible to obtain useful decision-making information.

This paper attempts to analyze the suitability of urban human settlements by using GIS technology from the perspective of big data and proposes targeted solutions and methods. Thus, this paper selects counties and small towns in the middle and fringe areas as the research area to make up for their shortcomings in small spatial scales and uses GIS technology and big data methods to determine the weight of human settlement environment evaluation index factors. Then the basic geographic data and population data are combined to establish the Jieyang Human Settlement Environment Index (HEI) model and establish the evaluation model of Jieyang HEI (Hu et al., 2009; Zhou and Ren, 2011; Mao, 2019; Yang, 2021). At the same time, evaluate and analyze the suitability of living environment in Jieyang City. Combining various single factors and multiple factors provides a scientific method for further research on the suitability of human settlements.

2. STUDY AREA

Jieyang City, one of the 14 coastal prefecture-level cities in Guangdong Province, is located in the Chaoshan Plain in the southeastern part of Guangdong, 115°36'30' to 116°37'45" E longitude, 22°53'15' to 23°46'30" N latitude, adjacent to Shantou and Chaozhou in the east, Shanwei in the west, Meizhou in the north, and the South China Sea in the south; it has jurisdiction over Rongcheng District, Jiedong District, Huilai County, and Jiexi County, and is in charge of Puning City (Hou et al., 2017) (Figure 1). The terrain of Jieyang is higher in the north and lower in the south. From north to south, there are mountains, hills, basins, and plains in sequential order. The central, southern, and southeastern parts are the vast and fertile Rongjiang alluvial plain and coastal sedimentary plain. The city's total land resource area is 5,268.83 square meters. Most of the mountains belong to the Lianhua Mountains, with an altitude of 500 to 600 meters. Liwangzhang in Jiexi County is 1,222 meters above sea level, the highest peak in Jieyang City. It has a humid subtropical monsoon climate with abundant sunshine and rainfall. There is no snow and little frost all year round. During summer and autumn, it is often hit by strong tropical storms. Sometimes, due to abnormal monsoon activity or cold waves, there will be drought in winter and spring or low temperatures and rainy weather in early spring.

Jieyang, with a history of over 2000 years, is one of the first provincial historical and cultural cities in Guangdong. In recent years, to create a nationally civilized city and a famous historical and cultural city in policy, Rongcheng District has been taken as the critical position, adhering to the combination of authenticity protection and innovative development, improving the planning and design of the ancient city protection and activation, based on the urban spatial form of "three mountains, two rivers, and one ancient city", protecting historical buildings, ancient villages, and other cultural and cultural facilities, and continuing the historical and cultural context. It also plans to build a modern service core area, a Chaoshan characteristic livable demonstration area, and a "vibrant ancient city". As well as developing the industrial structure and comprehensive transportation network of the new coastal area, we are also promoting the construction of new infrastructure such as the 5G network, intelligent transportation, and charging piles, promoting high-quality development, and creating high-quality urban life in the central urban area with an eco-friendly urban environment and complete urban functions, to achieve a vibrant ancient city that is livable, suitable for work and tourism.

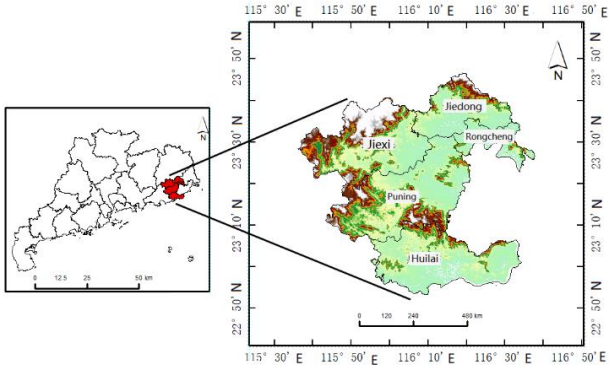

Figure 1 Map of the Study Area

3. METHODOLOGY

3.1 Data Source

With the advent of the big data era, higher requirements are put forward for GIS technology. To carry out technological innovation in various aspects such as big data analysis, high-tech technologies such as big spatial data analysis, big data storage management, and big data stream processing are combined with modern GIS technology to improve the overall technical support for big data analysis. The analysis of this study is based on a big data perspective, so the data sources involved have the characteristics of a large amount of information, multiple types, low-value density, a fast propagation rate, and high timeliness, forming a big data processing mode and combining it with traditional data carriers (vector data and raster data). The specific data sources are as follows:

1) The spatial resolution of the DEM in the study area is 30m, which is derived from geospatial data clouds (http://www.gscloud.cn/).
2) The administrative division data is extracted using the administrative division of Guangdong Province in 2020,

using the vector data .shp format.

3) POI data comes from the planning cloud (http://guihuayun.com/poi/).
4) Surface coverage data is taken from the Earth Big Data Science and Engineering Data Network (https://data.casearth.cn/). Among them, the global 30-meter surface cover is finely classified, and ArcGIS is used to select mask extraction for data tailoring to obtain the 30-meter fine surface cover data of Jieyang. The vegetation index (NDVI) can reflect the coverage of ground vegetation. Currently, NDVI timing data obtained from satellite remote sensing images such as SPOT/ VEGETATION, and MODIS is used.
5) Precipitation data is compiled by CRU TS. It is one of the most widely used climate data sets currently produced by the National Center for Atmospheric Science (NCAS) in the United Kingdom. CRU TS provides global precipitation data with a resolution of 0.5 ° covering the land surface from 1901 to 2020 (https://crudata.uea.ac.uk/cru/data/hrg/).
6) The temperature dataset is based on the global 0.5 ° climate dataset released by CRU and the global high-resolution climate dataset released by WorldClim.
7) The benchmark land price data is derived from the land price data published by the natural resources bureaus of various districts and counties, which are used to indicate the average land use the right price of state-owned construction land under specific circumstances.
8) Demographic data from the "Bulletin of the Seventh National Population Census of Guangdong Province" and the "Jieyang Statistical Yearbook" in 2021.

3.2 Methods

Firstly, based on the geographical and topographic conditions of Jieyang, a range of 1 km by 1 km is selected as the evaluation unit. Using GIS technology, vector data is rasterized, projected, and transformed (all uniformly converted to WGS 1984), and the vector boundaries of the study area are used for clipping. Then, select indicators such as the vegetation index, hydrological index, temperature and humidity index, and economic index, determine the weight of each indicator factor through comprehensive analysis, and construct an indicator system; Establish an essential database of human settlements based on 1km by 1km grid units and single factors such as land cover index, climate suitability, hydrological index, and economic environment index. Finally, from the relationship between individual indicators and population distribution, a Human Settlement Environment Index (HEI) model is constructed for analysis and quantitative evaluation. Analyze the suitability and limitations of human settlements from the evaluation results, combine various types, and establish the spatial pattern of human settlements.

3.3 Evaluation Model

■*Vegetation Index Model*

Vegetation is a natural link connecting elements such as soil, atmosphere, and water. Vegetation change, the hydrological cycle, and hydrological processes in a watershed constitute a feedback regulation system that interacts with each other. The vegetation's dynamic change represents the potential dynamic change of watershed hydrology, and its effects on hydrology and ecology cannot be ignored (Wang and Zhong, 2015). Therefore, the vegetation index is a comprehensive representation of land use and land cover characteristics, and the calculation formula is:

$$LCI = NDVI \times LT_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

In the formula, LCI is the vegetation index; NDVI is the normalized vegetation index; LTi is the weight of each land use in the study area, i=various land use types, i=1, 2, 3... respectively represents land use types such as cultivated land, forest, grassland, construction land, water area, etc. The weights of each land category are listed in Table 1.

Table 1: List of Land Use Types and Weights

Land use classification	Land use type	Weight
Forest	Forested land	0.6
	Shrub woodland	0.6
	Sparse woodland	0.4
	Other forest lands	0.4
Cultivated land	Paddy field	1.0
	Dry farm	0.7
Water area	Graff	0.6
	Lakes	0.6
	Reservoirs and ponds	0.6
	Intertidal zone	0.3
Construction land	Urban land	0.8
	Rural settlements	0.6
	Other construction land	0.4
Grassland	High coverage grassland	0.6
	Medium coverage grassland	0.6
	Ground coverage Grassland	0.6
Unused land	Bare area	0.2
	Other unused land	0.3

■*Hydrological Index Model*

Hydrological conditions refer to the occurrence, development, interrelationships, and laws of various water phenomena in the natural geographical environment, including precipitation, evaporation, runoff, water level, sediment concentration, water temperature, water quality, and ice age. The hydrological index is reflected in socio-economic, scientific, and technological

conditions to ensure the sustainable development of the ecological environment and socio-economic conditions. The calculation formula is:

$WRI = \alpha P + \beta Wa$……(2)

Where: WRI: hydrological index; P: normalized precipitation; Wa: normalized water area; α, β are the weights of the ratio of annual precipitation to water area, α value is 0.8, β value is 0.2.

■Temperature and Humidity Index (THI)

Considering the ease of use of the data and the simplicity of the calculation method, this study adopts the climate suitability calculation of temperature after humidity correction proposed by the Russian scholar Thom in 1959 as an indicator for assessing the environmental climate suitability of the study area.

$THI = 1.8t - 0.55(1-f)(1.8t-26)$ ……(3)

Where THI is the temperature and humidity index; t is the monthly average temperature (℃); f is the relative humidity (%); Considering the complexity of the relationship between topography and climate in the study area, GIS (Kriging interpolation method) spatial interpolation was performed using monthly mean data from meteorological stations in the study area to obtain corresponding parameter values (Li et al., 2018).

■Economic Environment

The benchmark residential land price is closely related to the living standards of residents and is an economic indicator to measure the economic development status of the region. It reflects the economic development status of the region and is positively correlated with its viability. The benchmark land price is the average price of various types of land within the region. It is the average price of land issued by the municipal, county, and above governments in urban planning areas, based on commercial, residential, and industrial uses, for different grades and types of land under existing use conditions (Li, 2017), and it reflects the overall level and trend of land prices.

■Human Settlement Environment Index (HEI)

Based on the quantitative analysis of the correlation between individual indicators and population distribution, a comprehensive evaluation model for the suitability of human settlements, the HEI model, is established based on the land cover index, hydrological index, climate suitability index, and economic environment index.

$HEI_i = \sum_{j=1}^{m} W_{ij}$ (i=1,2,3...n; j=1,2,3....n; m=4) ……(4)

In the formula, HEI is the standardized annual temperature and humidity index, the standardized hydrological index, the standardized land cover index, and the standardized economic environment index obtained using the range standardization method. The weight values used in this article are based on the research results of Feng Zhimin and others (Deng and Zhang, 2014). Guangdong is located in South China, and the weights of corresponding individual indicators are respectively 0.25, 0.2, 0.32, and 0.23 (Table 2).

Table 2 Single factor index weight of human settlements suitability evaluation

	Vegetation index	Hydrological index	Temperature humidity index	Economic environment index
Weight	0.25	0.2	0.32	0.23

4. ANALYSIS OF SUITABILITY OF HUMAN SETTLEMENTS

4.1 Single Element Evaluation of Human Settlements Suitability

■Vegetation Cover Index

Using ArcGIS to calculate and extract the vegetation cover index, the highest value reaches 0.90 (Figure 2), which is close to the highest level in the country (the nationwide highest value is 1). The regional and spatial differences in vegetation cover in Jieyang are large, with the overall situation in the western region being better than that in the eastern region. Areas with higher vegetation cover are primarily distributed in Jiexi County, Jieyang City, Dananshan Street in the western part of Puning City, surrounding areas such as Qingkeng Forest Farm and Daping Farm, and Huicheng Town in the northern part of Huilai County.

The main reason is that Dabei Mountain, located at the southern foot of Lianhua Mountain in the northwest of Jiexi County, has seven peaks with an altitude of more than 1000 meters. Due to topographic reasons, the large-scale development of mountainous areas is greatly restricted. For example, the vegetation coverage rate in the mountainous areas of Jiedong County, Jiexi County, Puning City, Huilai County, and other mountainous areas is high (Wang and Zhong, 2015), and the vegetation ecological status is good. The vegetation index in other regions such as Rongcheng District, Jiedong District, and the south of Huilai County is low. Due to the flat terrain, low-lying terrain, and densely populated areas, construction land, transportation, and water conservancy land are the main areas, while cultivated land, transportation, and water conservancy land are the main ones, causing serious interference with vegetation and causing an adverse ecological environment.

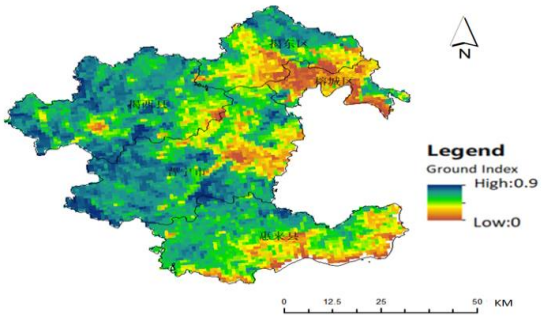

Figure 2 Vegetation Index Coverage Map of Jieyang City

■*Hydrological Suitability Analysis*

The highest value of the hydrological index in Jieyang reaches 0.82 (Figure 3). In terms of spatial distribution, there is a trend toward a gradual decrease from the southern region to the northern region. The lower-valued areas are primarily distributed in Rongcheng District, Jiedong District, Puning City, and Huilai County. The reason is that the region has too much land development, a large artificial ground area, and less rainfall. The high-value regions of the hydrological index are distributed in Beishan Agricultural and Forest Farm in the western region of Jiexi County, Shangsha Town in Liangtian Township, and Dananshan Street and Xiajiashan Town in the southern part of Puning District. The main reasons are dense vegetation, abundant rainfall, rich surface water resources, and high land use efficiency in the western region of Jiexi County; On the other hand, surface water resources are abundant, with high utilization rates and high residential suitability.

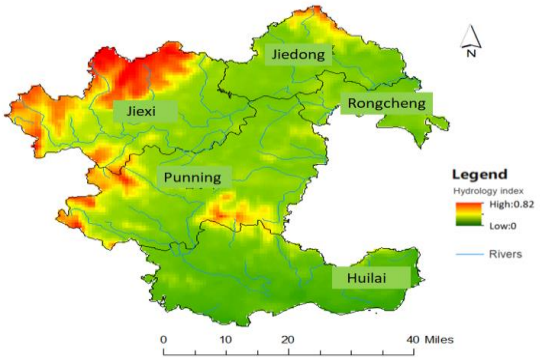

Figure 3 Hydrological Index Distribution Map of Jieyang City

■*Climate Suitability Assessment*

The highest value of climate suitability in Jieyang reaches 0.71 (Figure 4). Overall, the spatial distribution shows a gradual increase from Jiedong District of Jiexi County in the north to Puning City in the middle and Huilai County in the south. Areas with a low temperature and humidity index are distributed in Rongcheng District, Jiedong District, and the west of Jiexi County, partly due to the high altitude of Jiexi County, the mountains being stacked in the northwest, and the temperature being relatively low. The regional temperature and humidity index of Puning City are in a moderate zone, with a moderate degree of residential suitability. Areas with relatively low residential suitability and high temperature and humidity indices are distributed in Qishi Town, Jieyang Nanhai Petrochemical Industrial Zone, Qianfeng Town, Jinghai Town, and other areas in Huilai County. This area is close to the sea, with higher temperatures and humidity than inland areas. The residential suitability of this zone is relatively high.

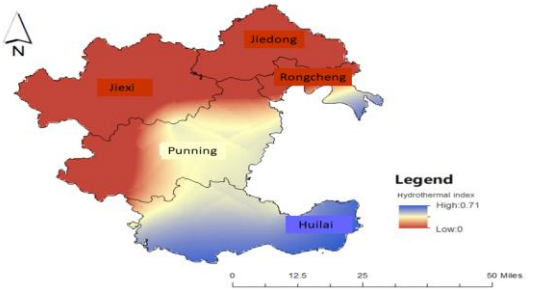

Figure 4 Temperature and Humidity Index of Jieyang City

■*Economic Environment Assessment*

The selection of a residential benchmark land price that is closely related to the economic environment and living standards is an economic indicator for evaluating the suitability of human living environments (Zhang, 2021). Overall, the central area of Jieyang: Liaoyuan Street, Liusha East Street, Liusha West Street, Liusha South Street, Liusha North Street, and the central area of Rongcheng District have a higher benchmark land price index, while the benchmark residential land prices in other areas have slightly decreased. It shows that the southern area of Puning City can generate high economic benefits during the existing utilization process. The population of this area is the largest in Jieyang, with a high per capita GDP and economic development level. Therefore, the benchmark land price in this area is high; Secondly, the distribution of residential benchmark land prices in Huilai County, Jieyang is relatively balanced (Figure 5).

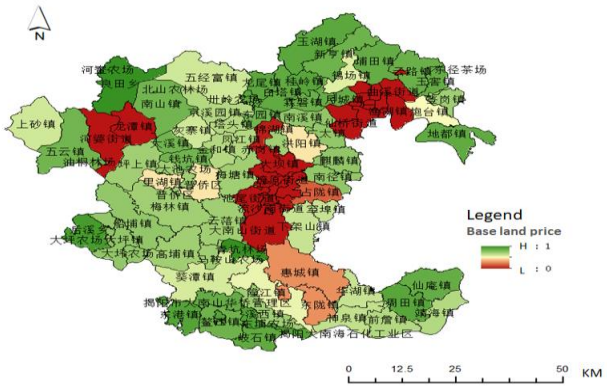

Figure 5 Economic Environment Index of Jieyang City

4.2 Analysis of Spatial Pattern of Human Settlements Suitability

■ *Spatial Pattern of Human Settlements Suitability*

This study, using GIS spatial analysis and essential spatial data such as DEM, land use data, annual average rainfall, water area distribution, annual average temperature, and economic and environmental data, constructs four indicators such as a temperature and humidity index, a ground cover index, a hydrological index, and an economic and environmental index. According to the HEI formula (see Formula 4 and Table 2 for weight values), the natural index of the human settlements environment in Jieyang is obtained, with a value between 24.49 and 72.63 (the higher the index, the better the human settlements environment). Then, using the natural breakpoint method, the calculation results are divided into five categories, namely, unsuitable area, critical suitable area, general suitable area, relatively suitable area, and highly suitable area (Li, et al., 2021), with reference to the zoning standard for human settlements in the "Functional Zoning of National Population Development" (Xu et al., 2020). Obtain the spatial distribution map of human settlement suitability in Jieyang (Figure 6).

The overall distribution trend of the suitability of the human settlements in Jieyang based on topographic relief, ground cover index, hydrological index, and economic environment is as follows: Huilai County and the northwest of Jiexi County in the south of Jieyang have the best livability, followed by Puning City

in the central region, while Rongcheng District and Jiedong District in the east have the weakest livability (Table 3). The entire region is dominated by relatively suitable areas, which account for 33.5% of the total area of Jieyang. The second is the critical suitable area, which accounts for 29% of the land area of the region. Next, the general suitable area is 24%, the unsuitable area is 5.9%, and finally, the highly suitable area accounts for 9.6% of the total area, with significant regional spatial differences, mainly as follows:

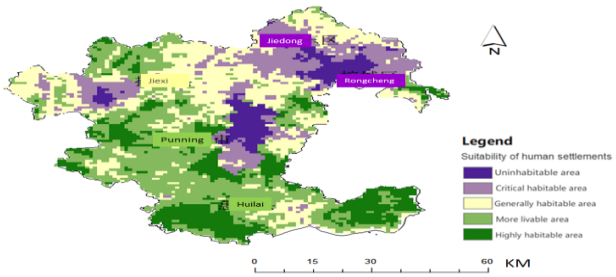

Figure 6: Evaluation Chart for the Suitability of Human Settlements in Jieyang

Table 3 Suitability Assessment of Residential Environment in Jieyang

Type of residential environment	HEI	land		population		Population density(person /km^2)
		area （km^2）	Ratio （% ）	total（ ten thousand people ）	Ratio （%）	
Unsuitable	24.49～39.78	359	6.83	51.45	9.33	1433.24
Critical suitable	39.78～48.38	914	17.40	113.27	20.55	1239.34
General suitable	48.28～54.70	1355	25.79	132.21	23.99	975.74
Relatively suitable	54.70～60.55	1767	33.64	167.19	30.33	946.21
Highly suitable	60.55～72.63	858	16.33	87.07	15.80	1014.82

(1) ***Highly suitable Area***: The residential environment index is between 60.55 and 72.63, with a highly suitable area of 858 km^2, accounting for 16.33% of the total urban area, with a corresponding population of 0.8707 million, accounting for 15.8% of the city's total population, and a population density of 1014.82 people/km^2, These areas are least affected by natural conditions and are the most suitable areas for human habitation. It is mainly distributed in the west and east of most areas of Huilai County, the west of Puning City, Meilin Town, Houxi Township, Chuanpu Town, Pingshang Town, the south of Meitang Town, Yunluo Town, and Xiajiashan Town, bordering Lufeng City in Luhe County, Shanwei, as well as some areas in the west of Jiexi County such as Wuyun Town and Shangsha Town.

(2) ***Relatively suitable area***: The residential environment index is between 54.70 and 60.55, with a relatively suitable area of 1767 km^2, accounting for 33.64% of the total area of Jieyang. The corresponding population is 1.6719 million, accounting for 30.33% of the total population of the city, and the population density is 946 people/ km^2. The natural constraints are small and relatively suitable for human habitation and life. Puning City has fewer natural constraints and is relatively suitable for human habitation and life, mainly distributed in Gaopu Town, Puqiao District, Dananshan Street, Meitang Town, and northern Jiexi County in Puning City.

(3) ***General suitable area***: The residential environment index is 48.28~54.70, with a regional area of 1355 km^2, accounting for 25.79% of the total area. The corresponding population is 1.3221 million, accounting for 23.99% of the city's total population, and the population density is 975.21 people/ km^2. With high suitability, it is suitable for living, production, and life. Human activities have a strong impact on urban construction and the surrounding ecological environment. This region is a typical agricultural region, mainly engaged in planting industry, with relatively lagging industrial development, the economic level is low. The natural factors in this area are limited, mainly distributed in a few areas such as the central area of Huilai County and Puning City. The eastern part of Jiexi County borders the surrounding towns in the central area, and the northern part of Jiedong District borders Meizhou City.

(4) ***Critical suitable area***: The residential environment index is between 39.78 and 48.38, with an area of approximately 914 km^2, accounting for 17.40% of the city's total area. The corresponding population is 1.1327 million, accounting for 20.55% of the city's total population, and the population density is 1239.34 people/ km^2. Meanwhile, it is restricted by multiple factors and mainly distributed in the western area of Jiedong District, Dananshan Street in Puning City, and around Hepo Street in Jiexi County.

(5) ***Unsuitable areas***: The residential environment index ranges from 24.49 to 39.78. The area is 359 km^2, accounting for 6.83% of the city's total area. The corresponding population is 0.5145 million, accounting for 9.33% of the city's total population. The population density is 1433.24 people/ km^2. The population density is the highest. This area is mainly concentrated in Donglong Town, Huilai County, Hepo Street, Jiexi County, and the center of Rongcheng District. Population activity is frequent, and it is a

major population-oriented area in the city. Human activities are limited by natural conditions.

From the residential area of Jieyang (Figure 7), the characteristics of the residential distribution of the population in the study area are as follows: First, the overall population density in the region presents a gradual downward trend from the middle to the surrounding areas; Secondly, the population density in the urban and suburban areas of each district and county is higher than that of other districts; Thirdly, there are significant differences in population density between counties. Areas that are less constrained by natural factors have the largest area and the largest population.

The uninhabitable area is the smallest; accounting for only 6.83% of the total area, but the population density is the highest, mainly distributed in Rongcheng District. This area has been the administrative center of Jieyang with a long history, and the development foundation of traditional villages is good, forming a large village with a high population density. It is the district and county with the highest population density in the city, with a population density of 2795 people/ km2, resulting in the highest population density in unsuitable areas. 49.97% of the population in Jieyang lives in highly suitable or relatively suitable areas.

Overall, the relatively suitable areas and highly suitable areas for human settlements account for about 49.97% of the total area of the city, the generally suitable areas account for 25.79% of the total area of the city, the critical suitable areas account for about 17.40% of the total area of the city, and the unsuitable areas account for about 6.83%.

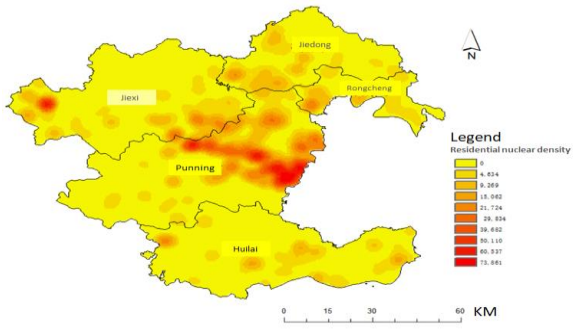

Figure 7: Kernel density of residential areas in Jieyang City

■*Suitability and Limitation of Human Settlements*

Referring to China's natural suitability rating standards, human physiological climate comfort standards, climate resources, and human activities in various regions, the temperature and humidity index, hydrological index, ground cover index, and economic environment of Jieyang were reclassified. The research area was divided into five areas: unsuitable area, critical suitable area, general suitable area, relatively suitable area, and highly suitable area. And make a comprehensive review of each division.

(1) *Suitability analysis of suitable areas for human settlements*

The suitable area usually refers to the generally flourishing vegetation coverage, which is also the natural suitability of the human living environment. The highly suitable region is located in the subtropical monsoon humid climate zone, which has the highest annual average temperature and precipitation in various regions, with very suitable temperatures and humidity. The high precipitation area in Jieyang is located on the windward slope of Lianhua Mountain. There are broad alluvial and pluvial plains along the Lianjiang River in the middle and the Rongjiang River in the north. There are platforms distributed between the plains and hills. The vast majority of the areas have flat terrain, fertile soil, and a good agricultural foundation.

In terms of climate, it is located in the subtropical zone with moderate temperatures. The river network is densely distributed, and Puning City has three major water systems: Lianjiang River, Rongjiang River, and Longjiang River. It is also bordered by the South China Sea. Affected by typhoons and monsoon climate, Puning City has abundant water due to perennial frontal rain and typhoon storms. Due to the well matching of water, heat, and terrain conditions, the agricultural production conditions in the region are very advantageous. The vegetation here is particularly dense, with beautiful mountains and rivers, and beautiful scenery. The optimal combination of natural factors such as water, heat, and ground cover makes the ecological environment particularly suitable for human habitation.

(2) *Restrictive Analysis of Unsuitable Human Settlements*

It is distributed in the central region of Puning City and the vast majority of the western region of Rongcheng District. The terrain of Rongcheng District is slightly like an inverted triangle, widely in the north and narrows in the south. The terrain is high in the southwest and low in the northeast. The climate suitability is low, the annual precipitation is low (about 1125mm), the land use type is mostly artificial surface, and there is too much development and reclamation. In addition, Jieyang City, the area with the highest population density, has frequent population activities and the most densely distributed residential areas. Overall, this area is greatly limited by a single factor or multiple factors and is less suitable for human habitation.

(3) *Analysis of general and critical suitable areas for human settlements*

In regions with good economic development, there are relatively few land resources, but due to high-level development and construction, some regions have suffered serious damage to their land, with poor land coverage. In Jiexi County and Jiedong County, it is a general suitable area. The main limiting factor is that the annual precipitation in this region is the lowest. Due to its tropical location, high temperature, low precipitation, low water storage capacity on the ground platform, and water resource shortage. The distribution area has a medium land cover index, small topographic relief, and most land use types are cultivated land. Agricultural development is good, and the benchmark land price is at a medium level. The distribution range of the general suitable area and the critical suitable area is the largest, and each

area has its own favorable conditions and constraints, but the constraints and suitability levels are different.

5. CONCLUSION

Human settlements are closely related to human life and are a fairly complex system. Due to the professional knowledge and background of scholars, as well as research perspectives and research objectives, different researchers will draw different conclusions when evaluating and analyzing humans. This article mainly studies the suitability of the human settlements in Jieyang, utilizes big data and GIS technology, and determines the weight of the human settlements evaluation index factors. Combining basic geographic data with population data, it establishes the HEI model in Jieyang, establishes an evaluation model for the human settlements evaluation index system, and then conducts evaluation analysis. The main results of the analysis are as follows:

(1) Huilai County in Jieyang and most areas in the western part of Puning City have the best livability, followed by the eastern part of Jiexi County and the central part of Huilai County, while Rongcheng District, Jiedong District, and the central part of Puning City in the eastern part of Jieyang City have the weakest livability. The entire region is dominated by "relatively suitable areas", accounting for 33.64% of the total area of Jieyang; Secondly, the "general suitable area" accounts for 25.79% of the land area of the region; Then, the "critical suitability zone" is 17.40%; "Highly suitable areas" account for 16.33% of the total area; Finally, "unsuitable areas" account for 6.83% of the total area.

(2) The areas with low suitability for human settlements in Jieyang are caused by inappropriate land use. Areas with a high degree of suitability, low population density, good natural factors, and economic environment conditions, are also potential areas for future population orientation, and have a high degree of regional suitability, with great development space.

Overall, this study is based on big data and utilizes the unique technical advantages of GIS to transform conceptual models formed in the conceptual world into operational mechanisms and processes in a non-specific information world. Big data has good benefits in the quantitative assessment of the suitability of human settlements and natural environments. Through comprehensive human settlements assessment models, can better clarify their spatial distribution rules, reflect current differences, and provide a reliable basis for further optimizing decision-making and implementation.

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