A Study on the Spatial and temporal distribution of population in Yunnan Province Based on BigDate

Pan Mei,Niu Lede*,He Yanrong
Tourism and Geography College of Yunnan Normal University ,Yunnan Kunming 650500
*Corresponding author:Niu Lede
niulede@163.com

***Abstract*—Based on the data collected from the fourth, fifth and sixth census of administrative units at county level in Yunnan Province, the temporal and spatial distribution of its population is studied and analyzed with the spatial analysis function of ArcGIS and the method of geostatistics. The normal distribution of population density data is explored and analyzed with the help of histogram, normal QQ chart and Voronoi chart. From the results, it can be found that the population distribution of Yunnan Province is not balanced. The population distribution of central Yunnan, mainly in Kunming, is concentrated, while the population distribution is relatively concentrated in northeast and Southeast Yunnan and relatively sparse in northwest and Southwest Yunnan.**

Keywords: Yunnan Province; ArcGIS geostatistics; Kriging; population distribution

I. Introduction

The population presents a certain spatial distribution pattern in a certain geographical environment[1]. Population distribution, also known as the geographical distribution of population, refers to the distribution of population in geographic space within a certain period of time. Population density is not only an important manifestation of population distribution, but also the main indicator of demographic change[2]. The law of population distribution variation is conducive to providing reference for optimizing population spatial allocation and improving the healthy operation and coordinated development of population ecosystems in specific regions, and guidance for policy formulation and socio-economic development in specific regions.

Based on the different Kriging interpolation methods and population change analysis as well as the population of Yunnan Province in the past 20 years, this paper uses the population density data of Yunnan Province to explore the application of the Kriging method in population distribution, compares and analyzes the fitting effect of different models and the differences of relevant parameters to establish an optimal fitting model so as to make an unbiased and optimal estimation of the population distribution in Yunnan Province and generate the optimal population density interpolation map, thus studies the characteristics of the spatial and temporal distribution of population in Yunnan Province in the past 20 years.

II. Data sources and processing

The basic data of this paper includes the data of Year 1990 (the fourth census), 1995, 2000 (the fifth census), 2005 and 2010 (the sixth census) and the spatial data of county-level administrative regions in Yunnan Province. The population data is provided by the Yunnan Statistical Yearbook and the spatial data is obtained by vectorization. To ensure data continuity and reliability between the three censuses, the geometric center of the county administrative region is selected.in this paper to extract the population density indexes of year 1990, 1995, 2000, 2005 and 2010 in each county administrative region for statistical analysis.

III. Analysis and Discussion

A. Data distribution analysis

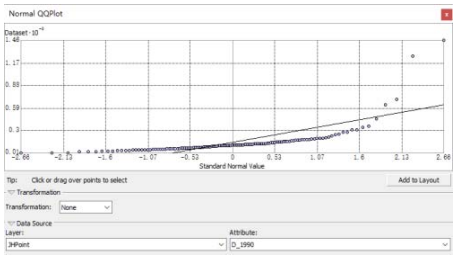
An exploratory analysis of population density data of 129 county-level administrative units in Yunnan province was made to learn more about the data and get the initial information about the data,thus making better decisions about issues related to its data.

a. Histogram analysis

Population density has obvious outliers on the left and its frequency distribution is non-normal. As can be seen from Table 1,the kurtosis coefficient is between 32-44, which is much larger than the symmetry value of 3. The mean value is greater than the median value, and the skewness coefficients are all between 5-7 and greater than 0, showing a non-positive bias distribution. After logarithmic transformation (Log) of population density, the kurtosis coefficient is close to 3, the mean value is close to the median, and the skewness coefficient is close to 0, obeying the normal distribution.

b. Analysis by Normal QQ plot

The frequency distribution is skewed according to the histogram analysis. The data of population density in five major years in the past 20 years in Yunnan Province are analyzed with normal QQ plot. The results verify the rationality and correctness of the logarithmic transformation, as shown in Figure 1-5.



978-1-7281-6698-8/20/$31.00 ©2020 IEEE
DOI 10.1109/ICITBS49701.2020.00122

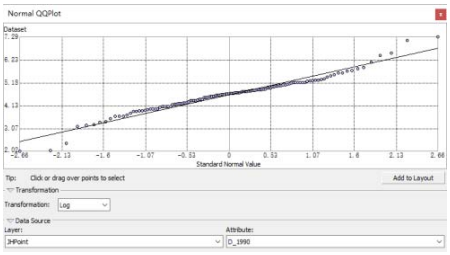
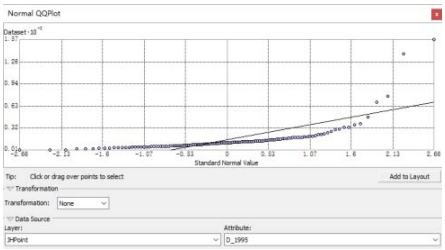


Figure 1. QQ plot of the normal population density of Yunnan province in 1990(left: before transformation; right: after logarithmic transformation)



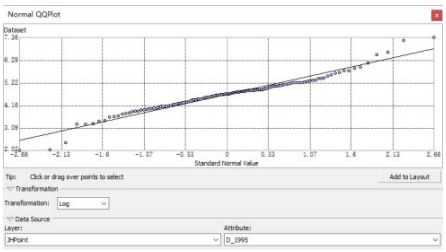
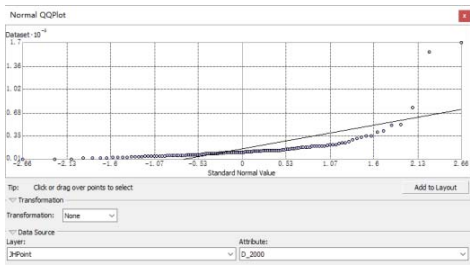


Figure 2. QQ plot of the normal population density of Yunnan province in 1995(left: before transformation; right: after logarithmic transformation)



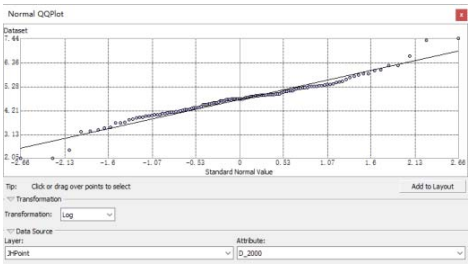
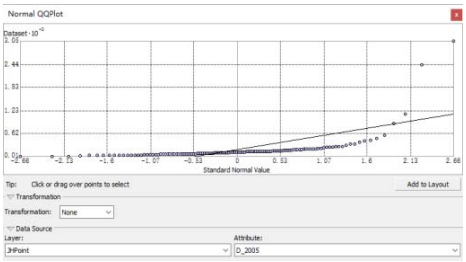


Figure 3. QQ plot of the normal population density of Yunnan province in 2000(left: before transformation; right: after logarithmic transformation)



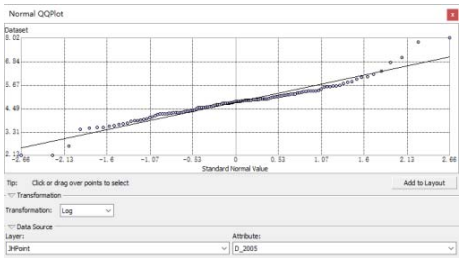
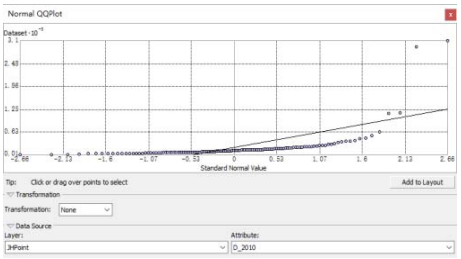


Figure 4. QQ plot of the normal population density of Yunnan province in 2005(left: before transformation; right: after logarithmic transformation)



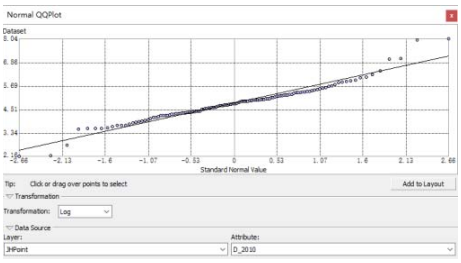


Figure 5. QQ plot of the normal population density of Yunnan province in 2010(left: before transformation; right: after logarithmic transformation)

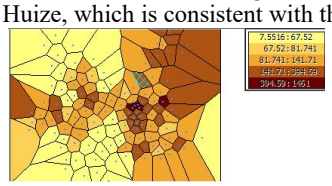
As can be seen from the left figure, the sampling points of population density data of Yunnan Province are not distributed on the same straight line. and individual sampling points deviating from the straight line may be outliers. In this paper, the logarithm transformation is performed to distribute the sampling points on the same straight line. As can be seen from the right figure, the sampling points are distributed into a straight line after logarithm transformation, and the sampled data obey normal distribution.

c. Finding local outliers with Voronoi diagram

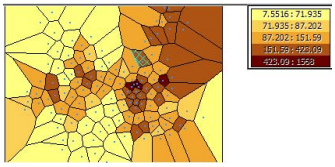
Through the analysis by histogram and the normal QQ plot, it can be found that there are abnormal values in the data of sampling points. Therefore, Voronoi diagram is used to find local outliers. It could be preliminarily

inferred that the outliers may be the points with a very large population density and the points with a very small population density in Yunnan province. The result is shown in Figure 6.

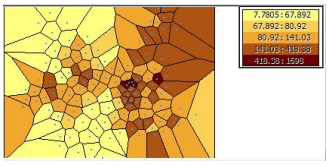
As can be seen from the figure, in the Voronoi diagram, the faces whose colors are completely different from the surrounding adjacent plane domain and the ones shown by halos could be points with very high population density and points with very low population density,or the points with a large difference from the population density of the surrounding areas. For example, the color of Wuhua District and Panlong District in central Yunnan Province is deepest, representing the highest population density, while the color of Deqin County, Shangri-La County, Derung-Nu Autonomous County Gongshan and Jiangcheng Hani and Yi Autonomous County is the lightest, representing the lowest population density. The color of Dongchuan area in 1990 and 1995 shown by halo line is different from the surrounding areas of Xundian, Luquan and Huize, which is consistent with the inference.



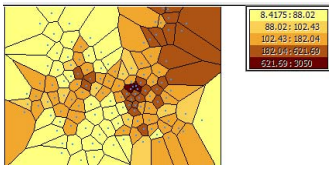
(a)Year 1990



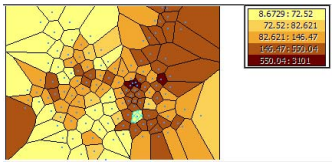
(b)Year 1995



(c)Year2000



(d)Year2005

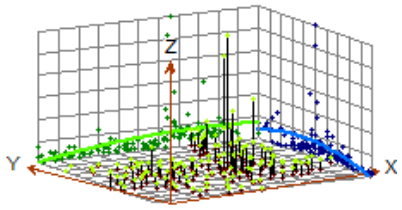


(e)Year 2010

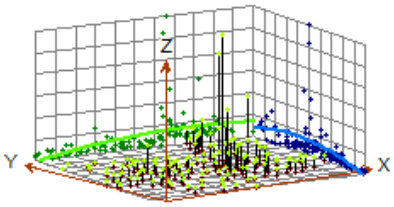
Figure 6. Vironoi analysis chart of population density in Yunnan Province

d. Trend analysis

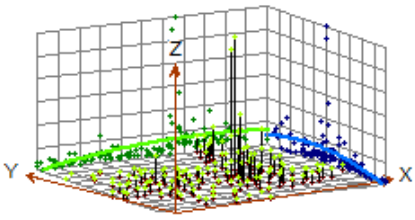
Taking the counties and districts of Yunnan Province (X, Y, population density) as spatial coordinates, the points determined by all counties (X, Y, population density) are projected onto an east-west and a north-south orthogonal planes, and then an optimal fitting line can be made by projecting points, thus making a three-dimensional perspective of each year (Figure 7).



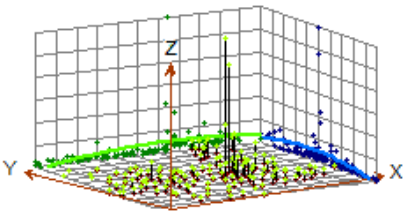
(a) Year 1990



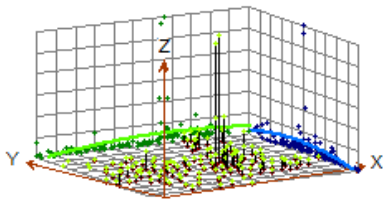
(b) Year 1995



(c) Year2000



(d) Year2005



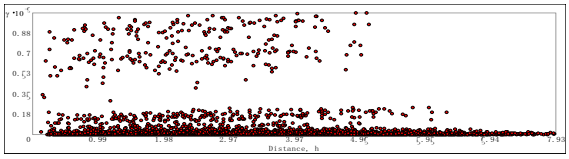
(e) Year2010

Figure 7. The chart of population density distribution trend in Yunnan Province

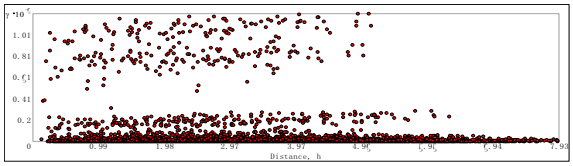
As can be seen from the figure, in five years of data, the best fitting line for the east-west direction (green line) and the north-south direction (blue line) is not a straight line, which indicates that the population density of each county-level administrative region in Yunnan Province has a certain spatial trend in a specific direction. The fitting curve of year 1990, 1995, 2000, 2005 and 2010 is almost a straight line in the east-west direction. The population density from west to east increased significantly and showed a trend of slowing down year by year, indicating that the population distribution in Yunnan Province is high in the east and low in the west, and the sparse difference of population density decreases year by year. In the north-south direction, the fitting curve shows an inverted U-shape, and the population density shows a pattern of high in the middle and low in the south-north direction. From 1990 to 2010, the population density shows a gradual trend from the middle to the north-south direction.

B. Semivariable function/covariance cloud

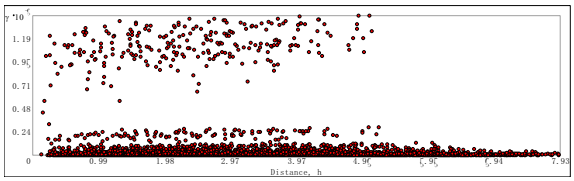
Through preliminary exploration, it can be found that most of the point pairs in 1990, 1995, 2000, 2005, and 2010 are concentrated in the lower area, with a few distributed at the top. The overall distribution of point pairs is basically consistent with the feature that the closer the distance in space is, the stronger the similarity is; the farther the distance is, the weaker the similarity is[3-4]. Semi-variance cloud chart of five-year logarithmic population density in Yunnan province is shown in Figure 8



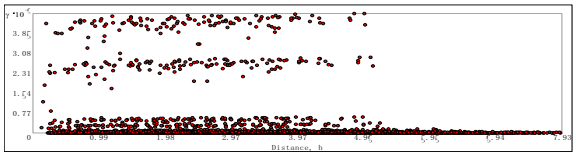
(a) Year1990



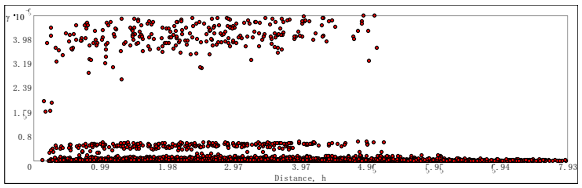
(b) Year 1995



(c) Year 2000



(d) Year 2005



(e) Year 2010

Figure 8. Semi-variance cloud chart of logarithmic population density in Yunnan province

In order to make the change of population density distribution in Yunnan Province more visual and intuitive, the population density of counties in Yunnan Province is divided into 8 grades of <25, 25-50, 50-100, 100-200, 200-400, 400-600, 600-800 and >800 based on the distribution of population density in Yunnan Province and the principle of population density classification. In this paper, analysis is carried out by classifying those with a population density of less than 100 people /km2, between 100-600 people / km^2 and more than 600 people / km^2 as a concentration area with low population density, with medium population density and high density population, respectively.

Spatial pattern: in the past two decades, the spatial distribution of population density in Yunnan Province shows obvious imbalance and aggregation. The population density in Kunming shows a state of aggregated distribution, with a zonal spread trend to the east-west direction from Kunming. The population density decreases gradually in the direction of north and south with east-west direction as the main line.

Density grade: those with high population density show a pattern of one area and two points, whose spatial shape is approximately circular; those with medium population density are mainly distributed around the highly concentrated area and extends axially to the west of Yunnan, whose spatial distribution shows a pattern of centralized distribution and directional dispersion; those with low population density are mainly distributed in the northwest and southwest of Yunnan, showing a trend of decreasing layer by layer.

Local changes: There are no significant changes in western regions, such as Ruili, Longchuan, Yingjiang and Luxi. For example, the population density of Yingjiang County was between 100-200 people/ km^2 in 1990 and only 50-100 people km^2 in 2000, and the population density was mostly 100-200 people/km^2 in 2010.In Southwest Yunnan, Simao and Jinggu has the most significant change in population density. In 1990, the population density of most areas of Simao was 25-50 people/km^2 and show an increasing trend year by year, and in 2010, the population density increased to 50-100 people/ km^2. In northeast Yunnan, the population density of Zhaotong, Yongshan, Zhenxiong and other places showed an increasing trend from 1990 to 2010. In southeast Yunnan, the population density of Gejiu and Pingbian in Hani-Yi Autonomous Prefecture of Honghe and Qiubei and Guangnan in Wenshan Zhuangand Miao Autonomous Prefecture increased.

IV. Conclusion

The population density of Yunnan Province obeys normal distribution after logarithmic transformation. After comprehensive analysis, the interpolation effect of population density by spherical model based on the simple Kriging model is the best.

In the past two decades, the population density of Yunnan Province has shown a growing trend on the whole, among which Kunming had the largest population density and the fastest growth rate, followed by Zhaotong. Diqing has the lowest population density, with the slowest growth.

The population distribution of Yunnan Province is unbalanced and centralized. The population distribution in the past five years is spatially high in the east and low in the west in the east-west direction, and upward in the south and north, showing a small population density in the north and south and a large population density in the middle. Throughout Yunnan Province, the densely populated areas are distributed in central Yunnan mainly dominated by Kunming because of the rapid economic development, pleasant climate and excellent environment in central Yunnan. The moderately dense areas are mainly distributed mainly in Zhaotong in the northeast Yunnan, the southeast Yunnan mainly in Hani-Yi Autonomous Prefecture of Honghe, and the zonal extension areas extending from Kunming to the west because of moderate economic development and good ecological environment. The low density areas are mainly in the northwest Yunnan dominated by Diqing Tibetan Autonomous Prefecture, northwest Yunnan dominated by Nujiang of the Lisu Autonomous Prefecture, Southwest Yunnan dominated by Xishuangbanna and Lincang because of complex terrain, extreme climate and bad environment, which have a negative impact on population development, resulting in sparse population distribution.

REFERENCES

[1] Zhang Jinzong, Zhu Yuxin, Li Shengming. The Application in Spatial Distraction of Population of Gansu Province Based on Geostatisticai Analysis of ArcGIS [J]. *Northwest Population Journal*,2010,31(3): 91-94.

[2] Mei Lin, Chen Yan. Evolution Characteristics And Forming Mechanism Of Population Density Spatial Pattern In Jilin Province [J]. Human Geography, 2014,18 (4): 92-97.

[3] Li Hongfen, Hu Guangdao, Li Jiangfeng. Grain Analysis of Land Use Spatial Pattern Based on Geo-Statistic Method[J].Geography and Geo-Information Science, 2008, 24 (5): 6-10.

[4] Tang Guoan, Yang Xin. ArcGIS Spatial Analysis Experiment Course [M].Beijing: Science Press, 2012, 421-423.