Spatial pattern analysis of Higher Geographical Education in China

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Abstract: In order to analyze the spatial pattern of higher education in geography science in China, the data of geographic science colleges and universities and the total population and GDP of each region were established in 2007, 2011 and 2016, based on ArcGIS 10.3 spatial analysis and formulas such as extreme value ratio, discrete coefficient, geographic concentration index and related analysis methods. The research shows that the gap in the scale of inter-provincial development of geography science majors in China is gradually increasing, but the distribution imbalance of institutions is gradually decreasing. The spatial pattern is formed by the combination of topography, population, economy, and policy. There are still some problems today. Finally, the countermeasures and suggestions for promoting the rational development of the spatial pattern of higher education in geography science are put forward.

1. Introduction
Universities are places for training professional talents. Therefore, the spatial distribution of higher education will greatly affect the social development and economic progress of a region [1-3]. Geography science has researched the interaction and relationship between the Earth's surface, humanism elements and its space-time laws [4], geographic science is widely used in economic politics, climate change, education and teaching, and regional planning. Since the 20th century, universities have successively opened geography science majors to meet the needs of geography talents to economic, social and basic education. Although China's higher education develops rapidly, there are obvious regional differences in the scale of geography higher education, which leads to the difference in the output of geographical talents in different regions and makes a contradiction between supply and demand of geographical talents and local society. Therefore, this paper researches the spatial pattern of geography higher education in different years, analyzes its influencing factors, and conducts in-depth exploration of current problems. This research can help to optimize the spatial pattern of the profession, improving the fairness of higher education.

2. Data and methods
The paper used the breakpoint method to research the changes in spatial pattern in the past decade. The data mainly comes from the National of Education College Admissions Information Network, China Statistical Yearbook, China Education Statistics Yearbook. Choose 2007 to 2016 as the beginning point and end point of the research time, 2011 as the middle point. (Excluding Hong Kong, Macao and Taiwan)

The difference in the number of geography science at the provincial scale can be characterized by
the extremes ratio $K$. The balance of the national quantity scale of geography science can be characterized by the coefficient of variation $C_v$. The aggregation of the quantitative scale in the national spatial pattern can be characterized by the geographic concentration index $G$.

3. The analysis of spatial pattern

3.1 Change of quantity scale
The number of undergraduate institutions offering geography science courses in China has changed significantly in 2007-2016 (Figure 1). The number of institutions step in 2016 was more than twice that of 2007, and the increase rate was faster in 2007-2009, after that, the whole showed an increase trend except individual years.

![Figure1. Changes in the number of undergraduate colleges offering geography science majors in China in 2007-2016](image)

3.2 The analysis of spatial pattern

3.2.1 Spatial characteristics
We calculated the extreme ratio, coefficient of variation and geographic concentration index according to the formula (Table 1). As shown in Table 1, the number of extreme value of institutions opened has increased over three years. It showed that the number of geography higher education had a large gap between provinces scale, and this gap is increasing and tending to an extreme year after year. The discrete coefficient results showed that the discrete coefficient was 0.96 in 2007, which is very close to 1. It explained that geography higher education has almost reached an absolutely unbalanced state in spatial; the discrete coefficient was 0.65 in 2011. It explained that geography higher education balance has been improved of spatial distribution; the discrete coefficient was still higher than 0.5 in 2016. It explained that geography higher education distribution was still unbalanced on the national scale. The index has decreased year by year according to the results of the geographical concentration index; all index are between 19-25, which is larger than absolute equilibrium state, but there is a large gap from absolute concentration; It showed that concentration is lower and be gradually lessen.

| Table1. Spatial characteristics data for 2007, 2011 and 2016 |
|-----------------|-----|-----|-----|
|                | 2007 | 2011 | 2016 |
| Extreme value ratio | 7    | 10   | 12   |
| Discrete coefficient | 0.96 | 0.65 | 0.63 |
| Geographic concentration index | 24.74 | 21.33 | 19.05 |
3.2.2 Accumulation area distribution

Figure 2. Geographical science major higher education space scale cluster

Figure 3. Geographical science major higher education space scale cluster in key university
On the basis of weak centralization, the aggregation characteristics of geography higher education in China were further drawn (Figure 2). In 2007, geography higher education had two accumulation areas in spatial, one in Shandong and the other in Sichuan. Other provinces are sporadic, and even some provinces have no institutions. In 2011, the accumulation area moved to near Shandong, Henan, Hubei. And all provinces have opened geography higher education college. In 2016, the accumulation area became a region of Henan and its surrounding provinces. The other regions were scattered. In general, the accumulation area is mainly in Central China, there is no big movement, and the geography science majors have always been concentrated in spatial.

In order to analyze the differences between geography science in different institutions, the aggregation characteristics of geography higher education in China's key universities are obtained (Figure 3). In 2007, the mainly areas of geography science in key universities were Guangdong Province; Individual provinces were scattered; Most provinces had no institutions. In 2011, its accumulation area was centered on Hubei, and the number of institutions in Jilin Province and the west area increased. In 2016, its accumulation area was similar to that of 2011. The number of institutions in Jiangsu Province had increased, but many provinces still had no institutions. In general, the accumulation area is mainly in the inland areas and west areas of Shanxi to Guangdong, and the geography higher education in key universities had always been concentrated in spatial.

Overall, the scale of China's geography higher education had gradually evolved from east to west or north-south to a trend of increasing first and then decreasing. In the national space, it was high in the central and eastern regions and low in the surrounding area. In the east-west direction, the quantity scale of change was greater than the north-south direction, and the change was decreasing. It shows that the difference from the central to sides was gradually decreasing.

4. Analysis of factors affecting spatial pattern

4.1 The impact of population on spatial pattern

Based on the population data of each region in 2007, 2011 and 2016, according to the five-category classification of the provinces, calculate the total number of universities and the corresponding population in each level of the three years to analyze the relationship between them. In 2007, the population factor had no significant impact on the spatial pattern of geography higher education. In 2011, the mainly influence on the spatial pattern of geography higher education was population factors. In 2016, the total population was in line with the two fold lines of the number of institutions. It indicated that the influence of population factors on the spatial pattern of geography higher education also increases first and then decreases.

4.2 The impact of the economy on the spatial pattern

Based on the GDP data of each region in 2007, 2011 and 2016, according to the five-category classification of the provinces, calculate the total number of schools and the corresponding economic aggregates in each of the three years to analyze the relationship between them. In 2007, the spatial pattern of geography higher education of economic factors did not have a significant influence. In 2011, economic factors had more influence on the spatial pattern of geography higher education. In 2016, economic factors had less influence on the spatial pattern of higher education in geography majors. In addition, from 2007 to 2016, the correlation coefficient of them increased first and then decreased, indicating that the economic has gradually weakened in recent years.

5. Discussion on the current situation of spatial pattern

5.1 Provincial burden imbalance

The scale of geography higher education in most provinces was not in harmony with the development of the local economy. The number of institutions in which they operate was more or less than the economy. Calculate the proportion of the number of institutions in each province in the three years,
and the proportion of the total GDP of the corresponding provinces to the whole country (Table 2). In the overburdened provinces, the number of colleges offering this major is relatively high, and there may be problems in the quality of professional teaching. The scale of local geography talents is too much, and geography undergraduates will have unsalable talents when they are employed. These provinces should strive to improve the quality of running schools, control the number of institutions in the province and can even take a combined school to adjust the scale. In addition, it is necessary to promote the development of the surrounding provinces with low burdens, and to play a joint role.

| Economic burden of geography higher education in provinces in 2007, 2011 and 2016 |
|-------------------------------|-----------------|-------------------|
| 2007                          | 2011            | 2016              |
| burdened                      | SX, HE, AH, SD, SC, HI, XZ, GZ | AH, JI, GZ, HN, SH, XZ, QH, HD, NC | GZ, JI, XZ, YN, GS, SH, NX, XJ, QH |
| moderate burden               | NM, SX, JX, HL, HB, HA, GZ, SX, YN | SX, HB, HL, JX, NM, HN, SD, QX, SC, GX, YN, XJ | SX, HE, HL, NM, JX, AH, HA, SD, HB, HA, GX, QX |
| unburdened                    | LN, BJ, SH, JS, FJ, ZJ, HI, GD, QH, GS, NX, XJ | TJ, LN, BJ, ZJ, JS, HB, SH, FJ, GD | TJ, BJ, LN, SH, JS, ZJ, GC, GD, FJ |

In the unburdened provinces, the number of universities offering geography science major is relatively less, and there may be a shortage of geography talents. In this regard, these provinces can appropriately expand the institutions of geography science to meet the needs of local development for geography talents, and exert its economic initiative and promote the development of geography science.

In the moderate burdens provinces, it can Countermeasures for the coordinated development of quality and quantity, and discover the potential of the universities and achieve a common improvement in quality and quantity.

5.2 The number of key universities is too less
In the late 1990s and early 20th century, China has set up a group of 985, 211 universities. The rank of these universities is basically in the domestic leading position, but the number of key universities offering geoscience majors is relatively less. In terms of quantity, the growth rate of the number of institutions was more than the number of key universities. It showed that the geography higher education and the development were generally low. In terms of distribution, key universities were concentrated in the east area. Therefore, there was a clear gap between the institutions in the East, Central and West regions in terms of enrollment and competitiveness in applying for research funding. This is the problem of the development of quality and quantity in the construction of geography science majors in some provinces.

6. Conclusion
The irrational phenomenon of the spatial pattern of geography higher education has already contradicted the development of society. So the development of reasonable coordination through various strategies has become an urgent problem to be solved. This paper analyzes the spatial pattern of geography higher education in three years, and discusses the relationship between geography and its spatial pattern and existing problems. Get the following conclusions and make recommendations:

1. In the past ten years, although the gap between geography higher education is gradually increasing, the balance of national distribution is gradually increasing, indicating that the spatial pattern of China's geography higher education is gradually becoming more reasonable.
2. The spatial pattern of geography higher education is mainly influenced by the humanistic
environment. The economy and population are positively correlated with the number of institutions, and their influence is increasing first and then decreasing.

(3) The spatial pattern geography higher education in China is unreasonable. For example, the scale gap of regional development is very different. The provincial economy has an unbalanced burden on the scale of development, the overall quality level of geography science is low and the gap in regional higher education quality is too much and the scale of education is mainly concentrated in provincial capitals. These problems hinder the rational development of the spatial pattern of geography higher education.

(4) In order to make the spatial pattern reasonable, the economy of the western should be derived to promote coordinated development. For example, increase the education expenditure in the west area, develop the specialty geography science, and create a path of geographically science professionalism; At the same time, the number of geography science in key universities should be increased; In addition, the central and eastern provinces should adjust the scale and distribution of geography higher education level to make the geography higher education and coordinated development with quantity.

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