Dynamic Analysis and Research on Environmental Pollution in China from 1992 to 2014

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Abstract. The regular pattern of development of the environmental pollution events was analyzed from the perspective of statistical analysis of pollution events in recent years. The Moran's I and spatial center-of-gravity shift curve of China's environmental emergencies were calculated by ARCGIS software. And the method is global spatial analysis and spatial center of gravity shift. The results showed that the trend of China's environmental pollution events from 1992 to 2014 was the first dynamic growth and then gradually reduced. Environmental pollution events showed spatial aggregation distribution in 1992-1994, 2001-2006, 2008-2014, and the rest of year was a random distribution of space. There were two stages in China's environmental pollution events: The transition to the southwest from 1992 to 2006 and the transition to the northeast from the year of 2006 to 2014.

1. Introduction
In recent years, the frequency of environmental pollution events was significantly increased, which gradually attracted the attention of countries, and there were more and more researches on sudden environmental pollution events in the world. Such as study on sudden environmental events of agricultural non-point source [1], a study on major environmental pollution events in China in 2002-2006 [2], Jie Yang et al analyzed the dynamic variation of environmental pollution accidents in China's 1995-2012 sudden environmental events by using ESDA spatial statistical analysis method and MATLAB space panel metering model [3]. Lei Ding et al made a temporal and spatial evolution analysis of China's 1995-2012 sudden environmental events by using ESDA spatial statistical analysis method and nonparametric correlation analysis [5], and so on. The study of environmental pollution events has been the focus of attention and the analysis of time and space more intuitive image of the dynamic changes in the accident. Therefore, in this paper, the environmental pollution events in China from 1992 to 2014 was taken as the object of study, and the environmental pollution events is analyzed, which can provide reference for risk prevention and management in environmental area.

2. Research Methods
2.1. Spatial Statistical Analysis
Spatial statistical analysis method is mainly for the Exploratory Spatial Data Analysis method (ESDA) that was shown by global spatial autocorrelation and local spatial autocorrelation analysis. In this paper, the global spatial autocorrelation analysis of environmental pollution events was selected by the
Moran Index (Moran’s I) to measure the global spatial variation [6,7,8].

2.2. Spatial Center of Gravity Transfer Curve
The spatial center of gravity model was an important index to describe the spatial distribution of geographical objects. The change trajectory of national sudden environmental events in time and space was reflected clearly and objectively by the space center of gravity of the national pollution events in different periods and the direction, distance and angle of the center of gravity coordinates [2,4,9-10].

3. Spatial Evolution of Environmental Pollution Events in China

3.1. Analysis of the Time Evolution of Environmental Pollution Events in China
Based on the statistical data, the total number of sudden environmental events over the years was analyzed. As shown in Figure 3.1. On the whole, the overall change in sudden environmental events showed a dynamic growth in the first half of the period from 1992 to 2014, and the trend of declining in the second half of the year. The number of events occurred between 416-3001 times, the total frequency of 32616 times, an average of 1418 times. Prior to 2007, annual sudden environmental events occurred more frequently in China, of which the highest number of events in 1994 reached 3001. After 2007, the annual number of sudden environmental events in China tended to be stable, with 416 in 2009 being the lowest. The transition year was 2006. That was because Songhua River water pollution event caused serious consequences and social influence. Sudden environmental pollution caused by China's attention. January 2006 by the State Council issued a corresponding guidance document "national emergency response to environmental emergencies plan" to establish and improve the regional emergency environment emergency response mechanism to strengthen the accident environmental risk management. Which played an important role in the decline of sudden environmental events in 2006 and beyond.

![Figure 3.1. Frequency of environmental pollution incidents in China.1992-2014](image)

3.2. Spatial Distribution Changes
The number of sudden environmental events in China from 1992 to 2014 was divided into five grades from low to high. Draw the spatial distribution map with reference to the natural fracture point was divided into 5 grades from low to high (0-15 times were in very low frequency or no statistical area, 16-50 times were in the low frequency area, 51-100 times were in the medium-low frequency area, 101-200 times were in the medium-high frequency area, more than 2000 times were high frequency area). There were choose 1992 (starting year), 1994 (peak year), 2000, 2006 (turning year), 2010 and 2014 (end year) for the analysis of breakpoints.

In figure 3.2, (1) The provinces with more than 100 sudden environmental events were 11, 11, 8, 2, 1 and 1 in 1992, 1994, 2000, 2006, 2010 and 2014 respectively, and the risk zone of high frequency occurred gradually. (2) From 1992 to 2014, the area where the event occurred was in the eastern and
central regions, and the area where the event occurred was in the northeast and west. (3) From 1992 to 2000, sudden environmental events were transferred from the eastern coastal areas to the Midwest inland areas (1992→1994→2000). From 2006 to 2014 (2006→2010→2014), the events mainly showed the situation of local agglomeration in the central and western regions of Sichuan and Chongqing and the mid-west region, in the case where the total amount of sudden environmental events was relatively reduced. Only the sudden environmental events in Shanghai more than 100 times, 161 times in 2010 and 108 times in 2014, the prevention of environmental pollution accidents still could not be ignored. It can be seen from the sudden space analysis images of all provinces and regions in China during 1992 to 2014, areas where sudden environmental events occur are mainly concentrated in the southern areas such as Guangdong and Guangxi, the western areas such as Hnnan and Jiangxi, the western areas such as Sichuan and Gansu and the eastern coastal areas such as Jiangsu. The total number of events in Guangxi Zhuang Autonomous Region was 3786 times, which is related to the rapid development of regional economy and the layout of dangerous pollution sources such as heavy chemical industry [4].

1992
3.3. Changes in Spatial Relations
As could be seen from this paper: (1) The Moran's I index of environmental emergencies in 1992-1994 ranged from 0.11 to 0.161, indicating that the occurrence of sudden environmental events in these three years generally had the spatial agglomeration and distribution trend. In 1995-2000, the Moran's I index of sudden environmental events ranged from -0.170 to 0.095, that showed a small random distribution. The Moran's I index excluding sudden environmental events was 0.013 that showed a random distribution in 2007. Moran's I index values were in the range of 0.099-0.275 in the other years that showed a trend of spatial aggregation distribution. This indicated that the emergent environmental events presented a trend of spatial aggregation distribution in 1992 to 1994 and random distribution in 1995 to 2000 and spatial aggregation distribution in 2001 to 2014. (2) The index of Moran's I in a sudden environmental event was negative only in 1996 and 1998 that showed the negative correlation of global space and the rest were positive showed a positive correlation in space during 1992 to 2014. The test of significance level between 2001 and 2014 showed significant spatial agglomeration trend except the test value of 0.687 (Moran's I index of 0.013) was large in 2007, indicated that during this period, the sudden environmental events in the neighboring provinces had some space between the interrelationship.

3.4. Space Center of Gravity Transfer
In order to reveal the regional change of the total environmental events more intuitively from 1992 to 2014, this article calculated the center of gravity coordinates of each year according to the formula (2) and calculated the distance and direction of gravity center of consecutive years with ARCGIS10.2. Drawing the trajectory curve of space center of gravity of environmental events.

From Figure 3.3 we could see: (1) The focus of sudden environmental events in China concentrated at 108.78-116.84°E, 29.32-32.62°N, and the provinces were concentrated in central regions such as Anhui, Henan, Hubei and Hunan. (2) The tendency of the center of gravity shift of the general accidental environmental events in the whole country could be divided into two stages: the trend of shifting to the southwest from 1992 to 2006 and the trend of shifting to the northeast from 2006 to
2014. The general case showed the trend of the southwestern provinces that turned to the eastern coastal areas of Jiangsu, Zhejiang and Shandong after they gathered in space. (3) From the center of gravity of the rate of sudden environmental events in China during 1992-2014, we could see that the general environmental emergencies were greater than 100 km/year and higher than other years in 1994-1999 (southwest), 2001-2010 (southwest-northeast) and 2013-2014 (southwest) of which 2006-2007 (northeast) center of gravity transfer rate of 415.77 km/year was the highest. (4) The reason of the center of gravity of the sudden environmental events shifted to the southwest may be related to the transfer of regional industries brought by China's grand development of the western region in 2000. In 2004, the policy raised by China on the rise of the central region and the construction of the economic zone in the Yangtze River Delta caused the focus of environmental events shifted to the eastern coastal areas such as the northeast Jiangsu, Zhejiang and Shanghai.

![Figure 3.3. Change in the center of environment pollution incidents in China, 1992-2014](image)

4. Conclusion
(1) The trend of environmental events in China from 1992 to 2014 showed the decreasing first and then gradually decreasing. The Moran's I showed that the environmental events had a tendency of spatial aggregation and distribution in 1992 to 1994, 2001 to 2006, 2008 to 2014, and the other years were randomly distributed in space. Which showed that the occurrence of environmental emergencies and the inter-provincial inter-related had a certain relationship.

(2) The direction of the center of gravity of the total national environmental pollution transfer was divided into two phases: the transition to the southwest from 1992 to 2006 and the transition to the northeast from 2006 to 2014. Those showed that the total environmental pollution in China after the southwestern provinces gathered and then turned to the dynamic trends of the eastern coastal areas in Jiangsu, Zhejiang, Shandong provinces. This showed that the shift in gravity of environmental pollution events had a certain relationship with the changes of national policies.

Analyzed the dynamic changes of environmental events in China from the perspective of space and time in 1992 to 2014 and explored the correlation between the occurrence areas of environmental events. It was of some reference significance for the research on sudden environmental events.

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6. References

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