The Comprehensive Analysis of Flood Disasters Losses in China from 2000 to 2010

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Abstract. Flood disasters possess the features of high frequency; widen involving, severe damages and so on. An understanding of flood disaster impact including social and economic aspects is becoming a significant factor to find out a comprehensive and participatory approach for long-term disaster risk reduction and management. On the basis of the flood disasters losses in Chinese provinces, municipalities directly under the central government, affected population, disaster area of crops and direct economic loss were utilized as indicators to probe into the flood disaster impact. Thus based on general statistical method and correlation analysis method, this paper analyzed the tendency of flood disasters losses over time on the angle of above aspects, calculated the correlation between affected population, disaster area of crops and direct economic losses, and eventually the empirical correlation was built. The results showed that the ratio of the maximum direct economic loss to the minimum one was the highest among that of affected population and disaster area of crops. Moreover, the impact of flood disaster on Chinese economy showed a decrease tendency, but the extreme weather may still cause the occurrence of national flood disasters leading to serious losses. After analyzing, the conclusion that Hunan, Hubei, Sichuan, Anhui, Henan and Guangxi are areas suffering the most serious flood disasters in China.

1. Introduction

Nowadays, millions of people in the world suffer natural and man-made disasters which take on an increased tendency over time (EM-DAT, 2006). As one of the most serious and frequently-occurred disasters in the world, flood disasters cause more affected people than other natural and man-made disaster across the globe (WHO, 2003). Thus its prevention has become a world-concerned problem and has been getting augment attention from government and researchers.

Located in the East Asiatic continent, China with complex topography, geomorphology and huge regional differences in climates is particularly prone to flood disasters (Zong et al., 2000). Due to the influence of monsoon climate and tropical cyclones, rainstorm flood disasters in eastern China are very outstanding, and there were a flood disaster every two years on average according to statistical materials. In terms of a global analysis referring to the impact of flood disaster, the affected population and economic loss could rank China as the first among the top 10 countries (.EM-DAT, 2006). In 1998, severe floods in the Yangtze River caused over 180 million affected populations (one-seventh of China’s population) across 29 provinces in China (Ministry of Water Resource 1999) and resulted in
over US$30 billion losses (Berz et al., 2000). However, there are not complete and effective indicators or indices that can reflect properly the impacts of flood events.

Flood risk assessment and management are of great importance for flood disaster mitigation. With the evolvement of the flood risk management, flood disaster management gradually switches its core to both physical and socio-economic issues rather than physical protection schemes (Parker, 1995; Treby et al., 2006). This paper mainly aims to improve our understanding to the impact of flood disasters, and the result can valuable for government decision-making and researchers in macro level.

2. Materials and Methods

Data used in this study were from the China civil affair’s statistical yearbook in national bureau of statistics of P.R. China. On the basis of flood disaster losses in each province and municipality of China from 2000 to 2010, this paper mainly involves three indicators including affected population, disaster area of crops and direct economic loss. The general statistical method was utilized to analyze the tendency of flood disasters losses over time on the angle of above aspects. For the in-depth analysis of flood disaster direct economic loss, flood disaster economic loss relative coefficient M was built, in which DL represents the flood disaster direct economic losses (in billion RMB) of the year and GDP (in billion dollars) is the Chinese national gross domestic product of the year.

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M = \frac{DL \times 10000}{GDP}
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M can be used to express the impact of flood disaster direct economic losses to national economy. And finally correlation analysis method was applied to analyze the correlation of affected population, disaster area of crops and direct economic losses with rainfall.

3. Result and Discussion

3.1 Loss Analysis

Since the extreme flood in 1998, the Chinese Government has attached great importance to the prevention and treatment of flood disaster, and increased investments on the fundamental construction of water conservancy, which has made great achievements. During the past decade, the annual mean affected population of flood disaster was 128.315 million, the annual mean disaster area of crops was 10.579 million hectares, and the annual mean direct economic loss was 98.915 billion yuan in China (excluding Hong Kong, Macao and Taiwan area). Annual variation curves of affected population, disaster area of crops and direct economic loss were built according to the corresponding annual data, and the change tendencies could be obviously seen (Fig.1-3).
Since 21st century, 2003 and 2010 have suffered the worst floods. In 2003, the affected population was 193.27 million, disaster area of crops was 12.378 million hectares, and direct economic loss was 119.04 billion yuan. While in 2010, values of the above three indicators with the same units were 199.354, 17.5246 and 350.5, respectively. During this period, the year 2006 had the smallest affected population of 72.608 million, 2008 had the minimum disaster area of crops of 6.4765 million hectares, and 2004 had the least direct economic loss of 49.54 billion yuan. As far as the affected population, disaster area of crops and direct economic loss are concerned, there are fluctuations in each year and no obvious trend of getting bigger or smaller. In this period, the ratio of maximum affected population to minimum affected population is 2.74, and the corresponding ratio for disaster area of crops and direct economic loss are 2.97 and 7.08, respectively. It can be seen from the variation curves that the affected population and disaster area of crops present a kind of periodical variation over time. For the limitation of the sample data, this periodical variation may need further studies.

For a further probe into the relationship between affected population and direct economic loss from 2000 to 2010, the exponential correlation coefficient was calculated based on available statistics. The value of the exponential correlation coefficient is 0.713, indicating a good correlation. Given the
impact of economic and social development on the losses in flood disaster, relative economic loss coefficient (M) was established in this article. M = direct economic loss (unit: 10 billion yuan) \times 10000 / China’s GDP in the corresponding year (unit: 10 billion dollars), without considering the unit conversion. M represents the impact of direct economic loss on national economy. The variation of M over time from 2000 to 2010 was built (Fig. 4). It shows that M has a decreasing trend since 2000 until it has an obvious mutation in 2010. It turns out that the influence of flood disaster on Chinese economy is decreasing gradually, but the occurrence of extreme weather may still cause a national extreme flood and lead to serious loss.

3.2 The Regression Analysis between Precipitation and Loss Indicators

Considering the fast GDP growth, relative economic loss coefficient M, affected population and disaster area of crops were chose as factors to establish relationships with precipitation. Obvious correlations between precipitation and relative economic loss coefficient M, rainfall and affected population, precipitation and disaster area of crops from 2000 to 2010, could be seen from Fig. 5-7. Generally speaking, M, affected population and disaster area of crops increase with the increase of precipitation. From the relation analysis, we can find that the precipitation is a main factor influencing the flood loss and extreme precipitation can make a big disaster loss.
Figure 6. Correlation of affected population and rainfall

Figure 7. Correlation of disaster area of crops and rainfall

3.3 The Distribution of Disaster-Stricken Area

China has a wide territory and large regional differences. The law of flood and flood loss differs widely in different areas. As seen from statistics, the range of the occurrence of flood is quite wide. On the whole, flood happens in every province and city, causing serious threats and great losses. From the statistics of all the provinces and cities in China from 2000 to 2010 (excluding Hong Kong, Macao and Taiwan area), it can be seen that areas that rank the top 6 accumulative direct economic loss are: Sichuan, Hunan, Jiangxi, Guangxi, Henan and Hubei. The total direct economic losses of the top 6 provinces account for 43.67% of the whole country. Areas that rank the top 6 accumulative affected population are: Sichuan, Hunan, Hubei, Guangxi, Anhui and Henan, all of which have a accumulative affected population above 60 million in which the first five areas have a accumulative affected population above 10000 million; while areas that rank the top 6 accumulative disaster area of crops are: Hubei, Henan, Hunan, Anhui, Sichuan, and Shandong. The total disaster area of crop lands account for
50.15% of the whole country. In general, Hunan, Hubei, Sichuan, Anhui, Henan and Guangxi are areas that suffer from most serious flood disasters in China.

Table 1. Accumulative losses in flood disaster for provinces and cities in China from 2000 to 2010 (excluding Hong Kong, Macao and Taiwan area)

| Area         | Affected area (100 million hectares) | Affected population (0.01 million) | Direct economic loss (0.1 billion yuan) |
|--------------|--------------------------------------|-------------------------------------|----------------------------------------|
| Beijing      | 2.87                                 | 9.90                                | 2.17                                   |
| Tianjin      | 1.44                                 | 6.70                                | 2.36                                   |
| Hebei        | 172.76                               | 1491.16                             | 104.63                                 |
| Shanxi       | 153.84                               | 1185.80                             | 109.46                                 |
| Inner Mongolia | 249.45                              | 716.68                              | 126.42                                 |
| Liaoning     | 183.85                               | 1302.82                             | 268.50                                 |
| Jilin        | 146.22                               | 1074.24                             | 577.82                                 |
| Heilongjiang | 656.10                               | 1425.65                             | 198.55                                 |
| Shanghai     | 11.65                                | 46.47                               | 10.11                                  |
| Jiangsu      | 672.39                               | 5720.90                             | 470.24                                 |
| Zhejiang     | 195.67                               | 3602.49                             | 344.94                                 |
| Anhui        | 951.58                               | 10264.23                            | 591.90                                 |
| Fujian       | 208.82                               | 3769.96                             | 502.01                                 |
| Jiangxi      | 634.50                               | 8472.47                             | 819.59                                 |
| Shandong     | 682.29                               | 6232.99                             | 441.62                                 |
| Henan        | 996.17                               | 9608.75                             | 670.34                                 |
| Hubei        | 1141.70                              | 12230.77                            | 627.99                                 |
| Hunan        | 984.40                               | 12728.00                            | 907.39                                 |
| Guangdong    | 349.40                               | 6020.60                             | 410.96                                 |
| Guangxi      | 580.70                               | 10275.52                            | 681.40                                 |
| Hainan       | 114.31                               | 1681.59                             | 221.70                                 |
| Sichuan      | 849.02                               | 15432.80                            | 1005.56                                |
| Chongqing    | 432.90                               | 8460.15                             | 320.28                                 |
| Guizhou      | 288.20                               | 6063.51                             | 192.41                                 |
| Yunnan       | 310.00                               | 5756.57                             | 288.98                                 |
| Tibet        | 16.76                                | 120.77                              | 19.70                                  |
| Shaanxi      | 328.50                               | 4050.63                             | 484.34                                 |
| Gansu        | 160.93                               | 1807.65                             | 250.93                                 |
| Qinghai      | 19.12                                | 223.93                              | 30.43                                  |
| Ningxia      | 34.15                                | 317.56                              | 16.74                                  |
| Xinjiang     | 59.09                                | 559.87                              | 90.52                                  |

4. Conclusion
There is a long history referring to natural flood disasters in China. Chinese government has given great concern to the problems of flood disasters and the re-adjustment work of flood disasters prevention. Over the past three decades, China has enjoyed rapid economic development, and embraced the need for sustainability. By accounting for these factors, several papers have studied the underlying linkages between flood disasters and sustainable development in mainland China. However, as the one of the vital factors influencing the sustainable development of mainland China, the impact of flood disasters should be deeply analyzed for exploiting appropriate flood disaster mitigation policy. Indicators including affected population, disaster area of crops and direct economic loss were used...
in this paper to explore the flood disaster impact. The results showed that affected population, disaster area of crops and direct economic loss all presented a kind of fluctuation variation over time. The ratio of the maximum of affected population to the minimum of that one was 2.74, and the corresponding ratio for disaster area of crops and direct economic loss were respectively 2.97 and 7.08. Through the building and calculation of the relative economic loss coefficient (M), it could be found that the impact of flood disaster on Chinese economy showed a decrease tendency, but the extreme weather may still cause the occurrence of national flood disasters leading to serious losses. Sichuan, Hunan, Hubei, Guangxi, Anhui and Henan ranked the top 6 of affected population. And Hubei, Henan, Hunan, Anhui, Sichuan, and Shandong ranked the top 6 of disaster area of crops, which accounted for 50.15% disaster area of crops on the whole country. Sichuan, Hubei, Jiangxi, Guangxi, Henan and Hubei were the top 6 of direct economic loss, which possessed 43.67% direct economic losses on the whole country. In general, Hunan, Hubei, Sichuan, Anhui, Henan and Guangxi were the areas suffering the most serious flood disasters in China.

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