The Relationships between Socioeconomic Factors and Fire in China

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Abstract

Correlation analysis shows that in China, socioeconomic factors have notable influence on fire. But the degree of correlation between them in China is different from that in other countries. The fire data in China sounds paradoxical between two periods and the research indicates that fire rate has poor relation with the college education, while in foreign countries they are revealed as negative correlation. The paper also concentrates on the complexity of fire system and puts forward a proposal of combining the methods of statistics and complexity research to analysis fire data. Then the paper presents some ideas of statistics principle in fire data. Finally, we try to discuss how socioeconomic factors have influence on fire and make some prediction on fire situation in China.

Introduction

As a product of human actions, fire will inevitably be influence by them. Fire is different from other disasters in that it has intimate relation with human actions. In recent years, with the development of economy, the risk of fire has become one of the most urgent disasters in China. Although the government has taken measures to deal with it, the fire risk doesn't seem to mitigate significantly. In foreign countries, researches indicate that the risk of fire is not the same in every region[1]. Climate, building stock characteristics, and socioeconomic factors greatly influence fire rates. This paper mainly concentrates on relations between the socioeconomic factors and fire.

Most of original studies relating socioeconomic characteristics to fire rates were conducted and published in the late 1970s. Virtually every one of them has shown that lower levels of income are tied to an increased risk of fire either directly or directly. An early study attempting to quantify this relationship was published by Schaeman, Hall, Schainblatt, Swartz, And Karter in 1977[1]. The authors found that three variables were most effective in explaining variations in fire rates. These were parental presence, or the percentage of children under the age of 18 living with both parents; poverty, defined as the percentage of persons whose incomes fell below the poverty line; and under-education, or the percentage of persons over the age of 25 who had fewer than eight years of schooling. Each of these variables tested alone explained an average of over 39 percent of the variation in fire rates between census tracts for each of the cities, for Fairfax County, and for the combination data set.

Recent work was done by Jennings[2]. He attempted to conceptualize the complex interrelationships between environment, structure, and human factors as they were

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related to fire and choose four variables to represent the socioeconomic concepts in his model, such as building stock, social/household system, demographics, economics. Multiple regression analysis revealed that each variable in Jennings' final model was significant and that together they accounted for 63 percent of the variation in residential fire rates across census tracts. Jennings found that income and education were highly positively correlated, meaning that income rose as education levels rose, so education had to be dropped from the regression analysis. Jennings' model was an important step toward developing and testing a theory of fire ignition and losses.

In 2002, Yang Lizhong[3] tried to study fire data of China from 1997 to 2000. He made a conclusion that the characteristics of the relations between socioeconomic factors and fire in China were different from foreign countries. Fire rates in China increased as the economic developed, which was just opposite to that in the foreign countries. However, only four years' fire data were selected in his work and only fire rate was used as the only parameter to represent the fire situation in China.

Data and method

This paper studies fire data from 1952 to 2000 in China. However, the method of fire recording changed greatly in 1997. Many small fires are recorded after 1997 and fire rates after this year can not be compared directly with the year before. So, fire data are divided into two sections in the study. Furthermore, fire rate, death rate, loss rate are selected to describe fire situation. Restricted by the availability of data, economic level and education level are chosen to present the socioeconomic factors, each of which are denoted by average GDP and college education. In order to find out the relationship between socioeconomic factors and fire, correlation and partial correlation analysis is adopted here.

Results and Discussions

The first period of fire data is from 1952 to 1996, during which the coefficient of correlation between socioeconomic factors and fire shows that high economic level will bring about a better fire situation than low economic level. Furthermore, this phenomenon becomes more reliable if the fire data period is divided into shorter ones. The coefficients of correlation between average GDP and fire rates in period 1952-1996,1978-1989 and 1990-1996 are -0.507,-0.739 and -0.722 respectively. Figs.1 and 2 reinforce this. The fire rates slow down each year slowly except in the politic unsteady period and the sudden up rise in year 1990.

The second period of fire data from year 1997 to year 2000 has been studied in Yang Li zhong et al's work[3]. In this paper, fire death and average loss are added to describe the fire situation. It seems that in China fire situation is worse in poor area than that of rich one from the correlation coefficient between average GDP and fire rates, which is 0.862. However, in this period, the value of P is 0.138, which means that the degree of significance in correlation analysis is not very high. Some of the results are explained in Figs.3 and 4. In Guangdong province, the coefficients of correlation between average GDP and death rates or fire loss are negative while the coefficient between average GDP and fire rates is positive (0.729) and the value of P

is 0.271. On the contrary, the coefficient between fire rates and average GDP in Shanghai is -0.957

Fig. 1

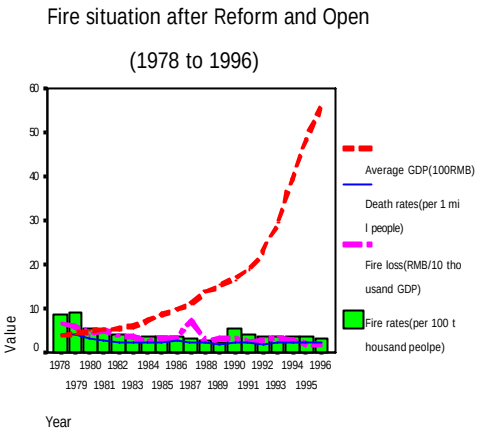

Fig. 2

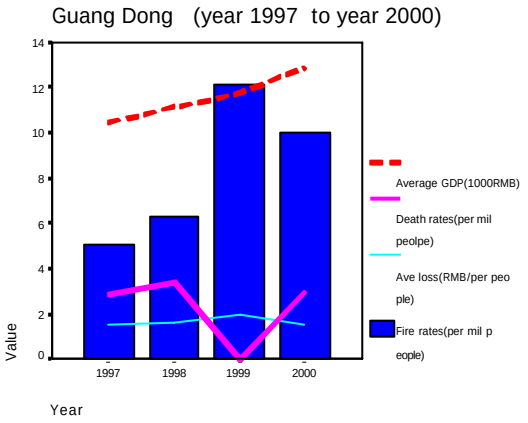

Fig. 3

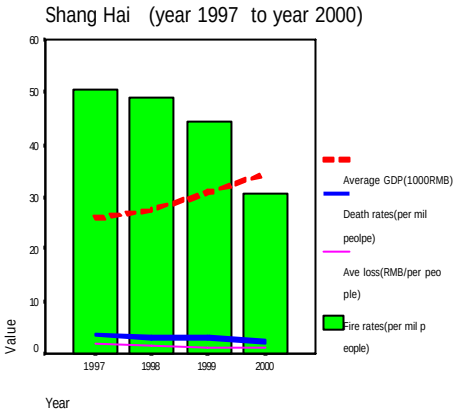

Fig. 4

When comparing the coefficients of these two periods, every year the fire situation almost maintains a decreasing tendency with the development of China. It also appears to rebound in some area recent years especially in the stage after the Reform and Open of China. All the above tells us high economic level will not inevitably result in a high fire area.

Maybe the truth is that higher economy level will cause more energy consumption, more combustible material, higher possibility of fire, in other words, it is natural resource consumption increasing with economy rising, which may increase the possibility of fire occurrence. And at the same time, higher income level can also put a downward pressure on fire risk, which lies in higher economic level will go with a better ability of fire prevention and higher demand of fire safety. In this sense, we can say the result is that in China fire rates decrease as the economic develops which is the same as foreign countries. However, the fire situation doesn't relax at the same time; it can also become urgent in certain area during some years because of some negative impacts caused by the development of economic.

As we have known, the fire is influenced by education and almost all the studies in foreign countries reveal that the correlation coefficient between them is negative[4].

But in what degree does education influence fire and how do they react? In order to get a clear correlation between education and fire in China, partial correlation analysis is adopted here. When controlling for fire rates, it is interesting to find that coefficients of correlation between college education and other fire factors such as death rates, loss rates and vital fire rates are irregular. For example, the partial correlation coefficients between college education rate and loss rates are positive in province 2, 7 and 8 and negative in province 1 and 5. What's more, the relationship between them in province 3, 4 and 6 seems unclear. All the above have shown that in China the correlation between college education and fire is not obvious. These coefficients in eight provinces are enumerated in Table 1.

Table 1 Partial correlation coefficients of College education & Fire
(Controlling for fire rates)

	Pro.1	Pro.2	Pro.3	Pro.4	Pro.5	Pro.6	Pro.7	Pro.8
Death rates	0.8493	0.9845	0.8046	0.9915	-0.2813	0.9883	0.5573	-0.4642
Loss Rates	-0.9954	0.9998	0.0374	-0.2280	-0.9821	0.1714	0.6460	0.9790
Vital rates	-0.9998	-0.2497	0.9810	-0.4806	-0.8320	0.7874	-0.8434	-0.7081

In fact, income and education are highly correlated, which means that income rises as education level rises. Although education can influence fire directly by people's right behavior and good habits, the college education is still in a poor status in China and only a few of people have the opportunity to take it. It surely can not influence the fire situation greatly. Combining the two statuses of college education in China and foreign countries, we can conclude that when the education level achieves a high degree it can decrease the fire risk, but before this, it does not have distinct influence on fire. For example, Beijing has the most developed high education in China and partial correlation analysis shows that there is a decrease tendency in the fire rates (-0.656) from 1997 to 2000 when average GDP is controlled.

Since the level of college education in China is still in a poor status, it's not a good parameter to describe the relation between socioeconomic factors and fire. Furthermore, almost all the investigations of fire incidence show that lack of public education on fire safety is a main reason of fire ignition in China, so we should use public fire safety education to represent education factors on fire. Unfortunately, the data record can not be found.

To learn more about how the socioeconomic factors relate to fire, the fire data of Anhui from year 1987 to year 1996 are studied here. As indicated in Fig. 5, it is strange to find that the pattern of correlation between socioeconomic factors and fire in Anhui is different from that of China. As the economic develops, the fire rates also increases. Maybe a more meaningful phenomenon is that the increase in fire rates fluctuates year by year severely. It is not an easy thing to predict in which year the fire incidence will occur more than another.

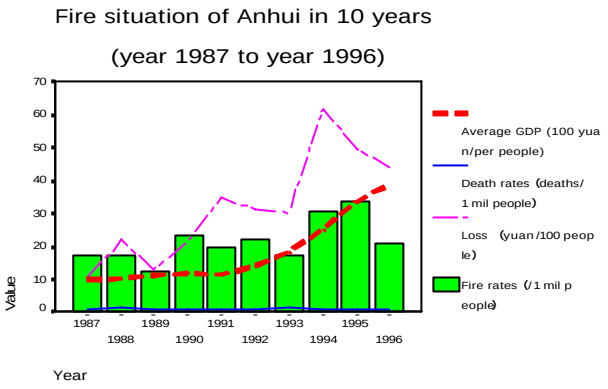

Fig. 5

In fact the fire is a complicated system in the macro level and the socioeconomic factors related to fire rates are sensitive to each province's unique conditions. These can be traced back through the history of a province's population, buildings, the climate even the politics. We can not get rational rule of correlation between socioeconomic factors and fire unless having considered for other factors. So it's easy to interpret why the tendency of fire situation in Anhui is not the same with that of China now. To get a better understanding of the relationship between economic level and fire situation, a model including more variables such as climate, population and government policy should be established. Furthermore, the method of combining randomness research and complexity research to analysis the fire data should be used.

In the following section a principle of fire statistics is discussed. As demonstrated in Table 2, in different year fire rates differ greatly in different provinces when average GDP is nearly the same. For example, although GDP are almost the same in Yun Nan (2000), Qing Hai(1999) and Hu Nan(1997), the fire rates are 68,127 and 38 respectively, among which the highest fire rates is twice more than the lowest. What's more, such significant difference can even occur in a same year. Actually, this may also be an embodiment of the complexity of fire system.

Table 2 Numbers of fire rates in different provinces & different years

Year	Province	GDP / caput	Fire rates
2000	Yun Nan	4637 (RMB)	68
2000	Shan Xi	4549 (RMB)	106
1999	Qing Hai	4662 (RMB)	127
1997	Hu Nan	4643 (RMB)	38
2000	Jiang Su	11773 (RMB)	150
1999	Guang Dong	11728 (RMB)	121

In 1977, Schaenman, Hall, schainblatt, Swartz, and Karter[1] found that inner–city comparisons of fire rates were useless, which means that it should be cautious to use correlation analysis to compare fire data in different area directly. The authors found that significant variations in fire rates in given cities from year to year made it untenable to use socioeconomic variables to explain variations in fire rates across cities. For this reason, Schaenman et al. refocused their efforts on studying intra-city variations in fire rates. But in New Zealand[5], an index of socioeconomic deprivation

(NZDep 96) has been developed and validated as a measure of socioeconomic factors, relative to the wider society, at small area level. The NZDep 96 is small enough to obey the Law of large numbers, so it can avoid the affect from other factors and correlation analysis can be used directly. On the other hand, if fire data and economic data of each province are added up, it's also appropriate to make the correlation analysis on a whole. This is because comparison is in fact not used directly in the process of analysis.

Remarks

Before drawing the conclusion, some ideas about fire research in macro level should be proposed. Since all the models referred in this paper considered only some variables of socioeconomic factors, the fire data may emerge in an irregular form. A model including more parameters should be conceived and methods should also be improved. Furthermore, accurate data is the key to ensuring the fire safety and also an important basis of fire research, so a detailed database with standardized and consistent data of fire incidence should be created or improved on.

To summarize, we may conclude that the relationship between socioeconomic factors and fire is the same with that of foreign countries. Now that China is in a special stage of development, in some area the fire situation don't relax as economic develops and in opposition it even becomes more acute. We should guard ourselves and strength our prevention on fire.

Acknowledgement

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