Features of Serious and Extraordinarily Serious Work Safety Accidents in China

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This paper aims to draw the whole picture of serious and extraordinarily serious (SES) work safety accidents in China. To this end, relevant data were collected from authentic sources like the accident query system of the State Administration of Coal Mine Safety and employed for statistical analysis of the national SES work safety accidents in China from 2005 to 2015. For better presentation, the occurrences and death tolls of SES work safety accidents were plotted for every province in Chinese mainland, and the accidents were classified into different categories by different standards. Then, the author discussed the regional, temporal and classification features of such accidents in great details. The results show that the SES work safety accidents in China during the study period are mainly coal mine accidents and traffic accidents; the leading type of coal mine accidents is gas explosion, and that of traffic accidents is highway accidents. In terms of regional distribution, Shanxi, Guizhou, Hunan, Henan and Yunnan had extremely high occurrence of SES work safety accidents. For coal mine accidents, Shanxi, Guizhou and Henan are the high-risk areas, and March, April, May and October are the peak months; For traffic accidents, Yunnan, Huizhou and Hunan are the high-risk areas, and February, march, April and August are the peak months; For fire accidents, Guangdong, Zhejiang and Jilin are the high-risk areas, and May, November and December are the peak months. The research findings provide a valuable guidance for the prediction and prevention of SES work safety accidents.

1. Introduction

As a vast country, China has witnessed countless severe accidents in many areas, especially coal mining, and suffered from heavy casualties and economic losses. In recent years, the state has stepped up work safety supervision and management, aiming to lower the occurrence of severe work safety accidents (Liu, 2013; Feng and Wang, 2008; Liu and Zhou, 2004).

According to the *Regulations on the Reporting, Investigation and Disposition of Work Safety Accidents*, in terms of death toll, the serious accident refers to an accident killing 10 to 30 people, and the extraordinarily serious accident refers to an accident killing more than 30 people. Compared with 2005, the occurrence of serious and extraordinarily serious (SES) work safety accidents in China dropped by 69.5%, causing 73.5% less fatalities.

Over the years, many scholars have statistically analysed various SES work safety accidents, including coal mine accidents, traffic accidents, and fire accidents (Chen et al., 2012; Li and Sun, 2005; Li et al., 2016; Gao, 2015; Zhao and Luo, 2014), and identified the spatiotemporal features of these accidents. Nevertheless, these studies often focus only on a specific field or industry. The results may have guiding importance in a certain area, but cannot reflect the overall situation of SES work safety accidents in China. In reality, the work safety accidents carry different features depending on the type of industry. Currently, the prediction and prevention of work safety accidents in China are still in the early stage (Liu and Liu, 2010; Liu and Yang, 2011; Zheng and Li, 2015), not to mention the management of hidden dangers. This calls for a general theoretical model on work safety.

Based on the data collected from sources like the accident query system of the State Administration of Coal Mine Safety, this paper summarizes the features of SES work safety accidents in various sectors through the

statistical analysis on the classification and regional features of relevant data in 2005~2015, with the aim of drawing the whole picture of SES work safety accidents in China.

2. Statistical Analysis

Table 1 shows the number and death toll of SES work safety accidents of China in each year. It can be seen that the occurrence and death toll of these accidents has greatly reduced. Specifically, the number of serious work safety accidents dropped by 69.6% from 125 in 2005 to 38 in 2015, while the death toll of such accidents decreased by 73.5% from 2,894 in 2005 to 768 in 2015; the number of extraordinarily serious work safety accidents declined from 17 in 2005 to 4 in 2015, a decrease of 76.5%, while the death toll of such accidents plunged from 1,197 in 2005 to 311 in 2015, down by 74%. In general, there were more serious work safety accidents in 2005, 2006 and 2008, and more extraordinarily serious work safety accidents in 2005, 2008 and 2010.

Table 1: Statistics on the number and deaths of severe and great production safety accidents

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number > 10 people	125	95	77	86	59	73	59	59	49	42	38
Death toll	2894	1570	1359	1819	1031	1272	897	902	879	772	768
Number > 30 people	17	7	6	10	4	9	4	2	4	4	4
Death toll	1197	263	302	667	292	359	151	84	252	235	311

The work safety accidents were divided into the following categories: coal mine accidents, traffic accidents (highway, railway, waterway and airway), building accidents, fishing vessel accidents, firework accidents, dangerous chemical accidents, fire accidents in manufacturing and business venues, etc. According to the statistics on different types of SES work safety accidents (Table 2), the different categories were ranked in descending order of occurrence as traffic accidents (334 cases), coal mine accidents (253 cases), fire accidents (49 cases), dangerous chemical accidents, building accidents, fishing vessel accidents, and firework accidents. Since 2005, the number of SES work safety accidents in China has been declining steadily across the aboard. For instance, the occurrence of SES coal mine accidents dropped from 54 in 2005 to 5 in 2015, and that of transport accidents declined from 50 in 2005 to 15 in 2015.

Table 2: Statistics on different types of SES work safety accidents

| Year	Coal mine	Transportation	Buildings	Fishing vessels	Fireworks	Chemical dangerous goods	Fires	Others
2005	54	50	3	10	1	0	4	3
2006	39	42	1	1	0	6	3	3
2007	28	27	4	1	4	2	7	4
2008	29	35	3	6	2	2	4	5
2009	18	27	3	1	2	1	2	5
2010	19	39	3	1	2	2	6	2
2011	18	28	3	0	1	4	5	0
2012	14	34	2	1	1	1	4	2
2013	15	21	0	0	1	5	4	2
2014	14	16	2	1	1	3	4	1
2015	5	15	1	1	1	4	6	4
Total	253	334	25	23	16	30	49	31

3. Regional Features

Table 3 lists the statistics on the number of SES work safety accidents in each provincial administrative region (hereinafter referred to as province) of Chinese mainland. As shown in the table, SES work safety accidents concentrated in provinces like Shanxi, Guizhou, Hunan, Henan and Yunnan, all of whom are main coal producers in China. Thanks to the tightening supervision of coal mine safety, there was a rapid decline in the number of coal mine accidents. Taking Shanxi for example, the number of SES work safety accidents in 2005, 2007 and 2008 was three times the level in most years; however, only 1 such accident occurred in each of the latest three years. Moreover, Henan and Shandong had twice the number of accidents of other provinces in most years; Guangdong, Yunnan, Hubei and Hunan were also hotbeds of accidents.

Based on the above analysis, the distribution of SES work safety accidents in China was drawn into a map (Figure 1). Then, the provinces were categorized into five levels based on the frequency of SES work safety accidents: extremely high, high, moderate, low, and extremely low.

The extremely high provinces include Shanxi, Guizhou, Hunan, Henan and Yunnan; the high provinces include Shandong, Guangdong, Heilongjiang, Sichuan, Hebei and Liaoning; the moderate provinces include Xinjiang, Jiangxi, Shaanxi, Jilin, Jiangsu, Hubei, and Zhejiang; the low provinces include Chongqing, Anhui, Tibet, Fujian, Guangxi, Gansu and Inner Mongolia; the extremely low provinces include Ningxia, Shanghai, Tianjin, Hainan, Qinghai and Beijing. For each strongly infrequent province, the frequency of SES work safety accident is merely once every 3 years.

Table 3: Distribution of SES work safety accidents in China

Prov	Shanxi	Guizhou	Hunan	Henan	Yunnan	Shandong	Guangdong
No.	63	57	50	49	46	39	35
	Heilongjiang	Sichuan	Hebei	Liaoning	Xinjiang	Jiangxi	Shaanxi
	34	32	28	26	25	23	23
Prov	Jilin	Jiangsu	Hubei	Zhejiang	Chongqing	Anhui	Tibet
No.	22	22	22	20	20	16	16
Prov	Gansu	Guangxi	Fujian	Inner Mongolia	Ningxia	Shanghai	Tianjin
No.	15	15	14	14	9	6	5
Prov	Hainan	Qinghai	Beijing				
No.	5	5	4				
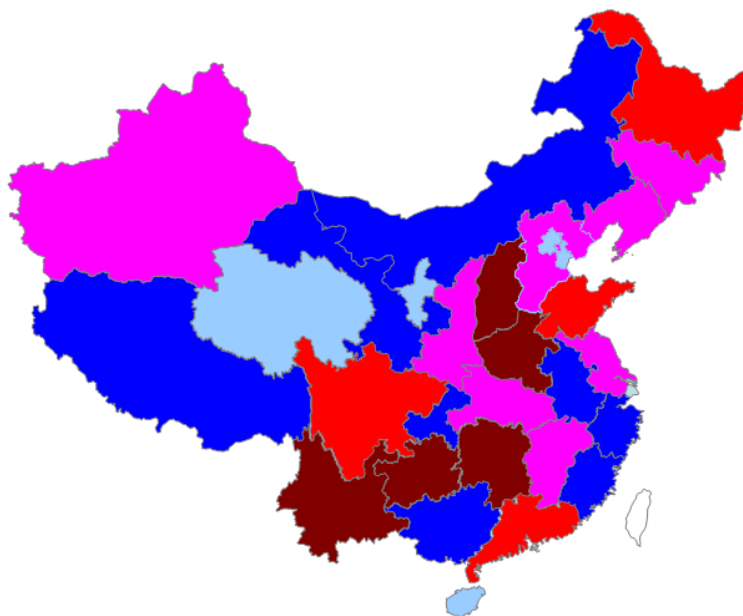
■Extremely high (>40); ■High (31-40); ■Moderate (21-30); ■Low (11-20); ■Extremely low (≤10)

Figure 1: Distribution of SES work safety accidents in China

Similarly, the author prepared the distribution of the death tolls of SES work safety accident in China, and classified the provinces into extremely high, high, moderate, low, and extremely low.

Compared with the categorization based on the number of SES work safety accidents, Yunnan, Sichuan, Liaoning and Tianjin were moved to completely different levels in the classification based on the death toll. Despite the frequent accidents, Yunnan and Sichuan had a relatively small death toll per accident. Therefore, the former was adjusted from the extremely high (occurrence) to the moderate (death toll) level, while the latter from the high (occurrence) to the moderate (death toll) level. By contrast, Liaoning was moved from a relatively low level (occurrence) to a relatively high level (death toll) due to the high death toll per accident. Tianjin received a similar adjustment, owing to the 165 deaths in the 8.12 extraordinarily serious explosion of Ruihai Logistics at Tianjin Port.

Concerning the accidents each killing 100 people, two cases occurred in Shanxi and Heilongjiang, and one in Tianjin, Hebei, Liaoning and Guangdong. Moreover, it can be inferred that the death toll of SES work safety was related to coal mining in many provinces. In terms of work safety, coal mine accidents account for a great portion in SES accidents, as evidenced by the high casualties in Shanxi, Henan, Hunan and Guizhou.

4. Classification Features

4.1 Features of coal mine accidents

For better understanding of the features of coal mine accidents, the author divided these accidents into the following categories: gas explosion, gas outburst, gas combustion, gas poisoning, asphyxia, water penetration, fire, gunpowder explosion, coal dust explosion, roof fall, rock burst, etc. The classification results are illustrated in Figure 2.

In the study period, there were 101 gas explosion accidents, 47 gas outburst accidents and 46 water penetration accidents. In general, roof fall accidents happened rather frequently, but these accidents were too small and localized to reach the SES level. The gunpower explosions were often associated with poor management and supervision. The gas poisoning accidents caused heavy casualties, as they took place in coal seams containing H_2S and other toxic gases. Rock burst accidents mostly occurred in deep mining.

In terms of regional distribution, SES coal mine accidents concentrated in Shanxi, Guizhou and Henan. The situation is particularly serious in Shanxi, which was hit by 43 such accidents. Because of the imbalanced distribution of coal resource, some provinces had no SES coal mine accidents.
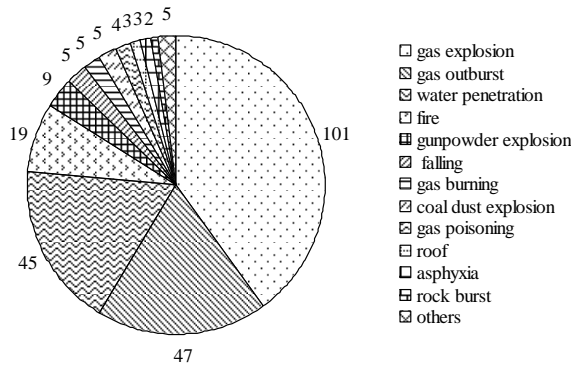

Figure 2: Classification of coal mine accidents

Next, the author investigated the temporal features of the SES coal mine accidents. As shown in Figure 3, more SES coal mine accidents occurred in March, May, October and November than in January, February and June. The peak months of these accidents include March, April and May after the Spring Festival, and October and November near the year-end. The temporal distribution may be explained as follows. First, the workers tend to overlook safety after the Spring Festival; second, the coal mines often blindly increase the production intensity at the end of the year, trying to achieve the annual output target (Yin et al., 2013). According to the relevant research (Zhang et l., 2006), the peak hours of SES coal mine accidents appeared at 9:00~13:00.
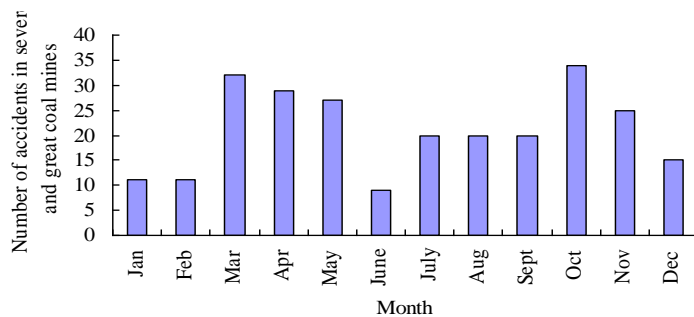

Figure 3: Monthly occurrence of SES coal mine accidents

4.2 Features of traffic accidents

As mentioned before, traffic accidents are split into highway accidents, railway accidents, waterway accidents and airway accidents in this research (Figure 4). As can be seen from Figure 4, highway accidents (308 cases) takes up the biggest share (91.2%) in traffic accidents, followed by waterway accidents (7.1%), railway accidents (4) and airway accidents (1).

From the regional distribution of SES traffic accidents, Yunnan, Guizhou, Hunan, Shandong and Hubei are clearly leading other provinces in the number of such accidents. Among them, Yunnan suffered from 31 traffic accidents, more than any other province. This is probability caused by the complex and underdeveloped road network and high traffic flow. Beijing and Hainan came at the bottom of the ranking on traffic accident occurrence, with only one case in each of them.

According to the monthly occurrence in Figure 5, February, March, April and August are the peak months of SES traffic accidents, while June, September and July are the trough periods. The highest monthly number of such accidents was 43 and the second highest was 37. The most severe traffic accidents concentrated in spring, especially in March, because of the spring burnout and high passenger flow in that period.
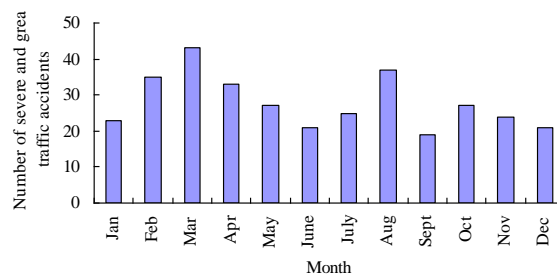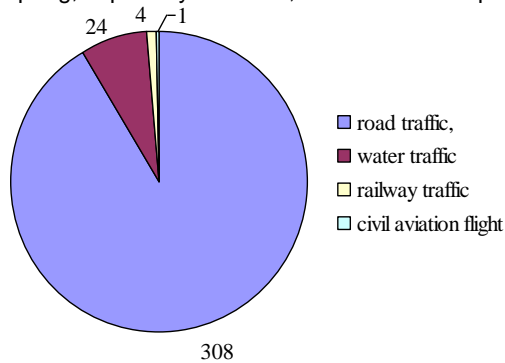

Figure 4: Classification of traffic accidents   Figure 5: Monthly occurrence of SES traffic accidents

4.3 Features of fire accident

The fire accidents were classified by the fire grounds, including production enterprises, residential areas, entertainment venues, shopping malls, hotels, catering places, wholesale markets, family workshops, warehouses, hospitals, and sales offices. Most of these places are public assembly occupancies. If a fire took place in any of the place, it is highly likely to cause major casualties. From Figure 6, it can be seen that manufacturing enterprises (10 cases), residential areas (9 cases), entertainment venues and shopping malls were mostly heavily stricken by fire accidents
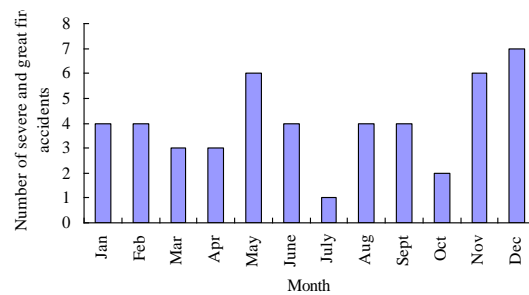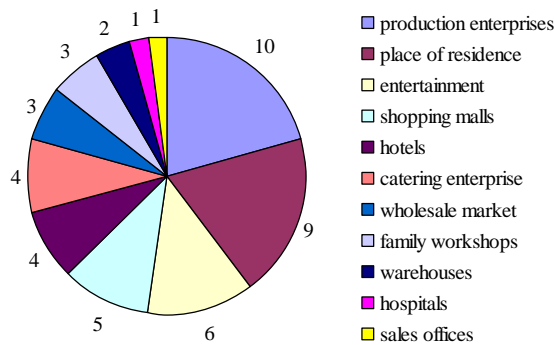

Figure 6: Classification of coal fire accidents   Figure 7: Monthly occurrence of SES fire accidents

In the study period from 2005 to 2015, a total of 48 SES fire accidents happened across China, resulting in 874 deaths. The top 6 accidents, alone, contributed 320 casualties. The deadliest accident took place in Baoyuanfeng Poultry, Dehui City, Jilin Province on June 3, 2013. The death toll of the accident was as high as 121 people. In terms of regional distribution, Guangdong took the lead with 12 fire accidents, followed by 5 in Zhejiang and Jilin.

According to the monthly occurrence (Figure 7), more SES fire accidents happened in May (6 cases), November (6 cases) and December (7 cases). The end of the year is a peak period of these accidents due to

the dryness in winter. On a typical day, SES fire accidents were more likely to occur during the night (30 cases, 61%), followed by the afternoon (20%), and less likely during the morning.

5. Collusions

This paper conducts a statistical analysis of the 2005~2015 SES work safety accidents in China. For better presentation, the occurrences and death tolls of SES work safety accidents were plotted for every province in Chinese mainland, and the accidents were classified into different categories by different standards.

The preliminary discussion shows that coal mine accidents and traffic accidents are the leading categories of SES work safety accidents; Shanxi, Guizhou and Henan were the most heavily-stricken provinces by coal mine accidents, while Yunnan, Guizhou and Hunan were the most affected provinces by traffic accidents. In terms of death toll, Shanxi, Henan, Hunan and Sichuan were top on the list.

Through the analysis of classification features, the following conclusions were drawn for coal mine accidents, traffic accidents and fire accidents. For coal mine accidents, gas explosion accidents is the main category, Shanxi, Guizhou and Henan are the high risk areas, and March, April, May and October are the peak months; For traffic accidents, highway accidents is the main category, Yunnan, Huizhou and Hunan are the high risk areas, and February, march, April and August are the peak months; For fire accidents, the fires at manufacturing enterprises is the main category, Guangdong, Zhejiang and Jilin are the high risk areas, and May, November and December are the peak months.

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