Forest fire Situation and Management in China

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Abstract: The area of China is large and the natural environment is very complex. The average forest cover per person is very low. Plantation and secondary forest account for greater proportion of the total forest in China, and forest fire is severe. The forest fire occurrence is induced by many factors, as the forest fires in China are affected by inter-annual variability of weather and the regional distribution of fuel. Forest fires in China are characterized by distinct spatial and temporal distribution. The provinces that have more number of occurrences and burned area concentrate on the Northeast and Southwest of China, and impacted by atmosphere current and seasonal monsoon, the fire season of the two regions have distinct seasonal variation. Human caused fires dominate the most parts of all the fires. Fire prevention in China stands to the guideline of "take prevention first and extinguish actively". Since 1987, we have strongly enhanced the prevention, fighting, and management of forest fires. In order to strengthen the leadership of forest fire management, Forest Fire Headquarters were set up successively in total 30 provinces, autonomous regions, and municipalities. The main measures to manage forest fires are to raise public awareness through publicity and educational activities, manage forest fires by legislation, firefighting team development, and mobilize the power of society to prevent forest fires, reinforce the infrastructure construction and key fire danger zones management. China utilizes many means to prevent, monitor, and fight forest fires. In the long time for future, how to manage the forest fires effectively, decrease the load of fuel in the forest, and avoid large forest fires occurrences are still the challenges we face in forest fires management.
Key words: forest fires; fuel; fire season; forest fire management

Forest is the main body of terrain ecosystem, and play an important role in maintains the balance of terrain ecosystem. The government of China always pays much attention to the reproduction and protection of forest. The forest coverage has increased from 8.6% to 16.55% in the late 50 years. By the fifth statistics of forest resources during 1994-1998, that the forest area is 158,900,000 ha, the stocking 12,490,000,000 m^3, the forest coverage 16.55%, and the latent stocking 11,267,000,000 m^3. The forest area per person is only 0.12 ha, and the stocking per person 9.63 m^3, which is far lower than the average level of the world. The forest resources cannot meet the needs of society development. The China government takes the forestation as the centre task for ecology construction. The reinforcement of forest resources protection, especially the fire prevention, is the most important component of environmental construction.

The "Daxing'anling conflagration" in 1987 is the turning point of the fire prevent in China. With summarizing the experiences and studies on the forest fires occurrence, the China government has enhanced the fire management and techniques on the whole. As a result, the integrated ability of fire control increased and fire damage decreased sharply.

1 Fire situation

By the influences of location, topography, climate, forest distribution and the human activities, the forest fires in China are very serious. By Statistics, the number and area of forest fires has obvious temporal variation. The most severe years include 1951, 1955, 1956, 1961, 1962, 1972, 1976, 1977, 1979 and 1987. Before 1987, the average number of forest fires is 15,932, the average burned area 947,000 ha, and damage ratio 8.5‰. Since 1988, the average number of forest fires per year is 6,574, the average burned area 51,500 ha, and the damage ratio 0.43‰.

The conflagrations in recent years:

May 6 - June 2, 1987, the severe "87 catastrophe" in Daxin'anling Mountain lasted 27 days. The total burned area is 1,330,000 ha, and burned forest area 1,140,000 ha, and the fire burned three forest bureaus and seven forest centers. 614,000 m^2 houses were damaged, and 213 persons were killed in the fire and 226 persons wounded. 58,800 fire fighters and 96 planes took part in the fire fighting, and the direct economical damage is 500,000,000 Yuan. The fire damaged large areas of young forest, mature forest and old-growth forest.

2 Fire environment in China

The forest fires mainly depend on the weather variation. And the fire occurrence, fire area and fire severity have close correlation with biomass accumulation. Forest fire mainly concentrated on the region with large area forest.

The fire seasons in different forest region are different. China lies on the north hemisphere, which is impacted by the atmosphere circulation and monsoon. So the fire seasons in Northeast, Inner Mongolia, South and Southwest are different. The natural conditions, such as drought conditions, wind, precipitating, temperature and snow coverage, impact the period of fire season.

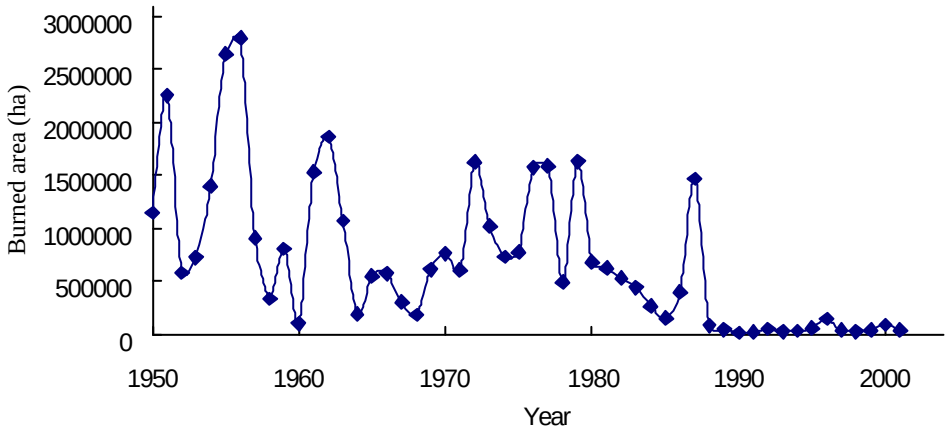


Fig.1 Forest fire number in China during 1950-2001

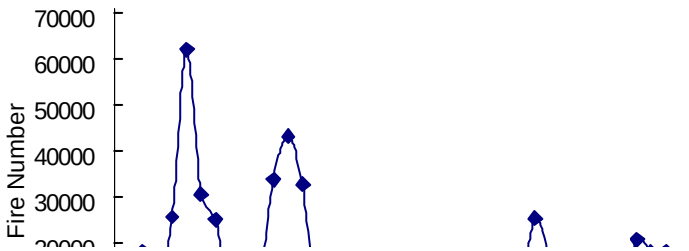


Fig.2 Burned area in China during 1950-2001

2.1 Temporal distribution of forest fires

2.1.1 Daily change of forest fires

Sunlight and precipitation impact the temperature and relative moisture, and then affect fire occurrence, fire spread and fighting efficiency. Most forest fires occur between 10-17 o'clock, and fighting in evening and morning with low temperature and weak wind can get better effect.

2.1.2 Seasonal change of forest fires

Impacted by the atmosphere circulation and monsoon, the fire seasons in different regions of China have obvious change. In general, the spring fire season in Northeast and Inner Mongolia is from March 15 – June 15, and the severe period is from April to May. The autumn fire season is from September 15 to December 15, and the severe period is from February to April. The fire season in the south and southwest is from December 15 to the end of May and the severe period is from February to April. Fire season in the Northwest is from April to October, and the important period is from July to September. When there is a special drought climate, forest fires also occur in the summer and the damage is very severe.

2.1.3 Annual change of forest fires

Fire circles in China are 5-6 years or 10 years, have close relation with periodic climate change, especially some anomaly weather condition, such as long time drought, high temperature, big wind etc.

2.2 Spatial distribution of forest fires

By statistics, the provinces with most burned area and number of fires are Heilongjiang, Inner Mongolia, Yunnan, Guangxi, Guizhou and Sichuan province. The distribution of forest fires in these provinces is not even, most of the fires occurred in about 100 counties.

2.2.1 Number of forest fires

Fire number in south China is more than that of the northeast and Inner Mongolia, but the burned forest area is less. For the impact of tiny topography, ecotone of forest and grassland and the monsoon, the fire in the northeast and Inner Mongolia spread very quickly. For the characteristic of different regions, the prevention and fighting measures are different in Northeast and Inner Mongolia.

The provinces with most fire number include Yuannan, Guangxi, Fujian, Hunan, Zhejiang, Guizhou, Guangdong, Sichuan, Jiangxi etc, in which the fire number account for more than 80%.

2.2.2 Burned area

The provinces with largest burned area include Heilongjiang, Inner Mongolia, Yunnan and Guangxi. The four provinces account for 74% of all the burned forest area in China. Sichuan, Guizhou, Guangdong and Fujian provinces account for about 20%. The burned area mainly concentrates in the northeast and southwest. For these regions account for larger proportion

of forest area, complicated fire environment, high flammability and other factors that are difficult to control, make the region have high ratio to occur large area forest fires.

2.3 Fire Causes

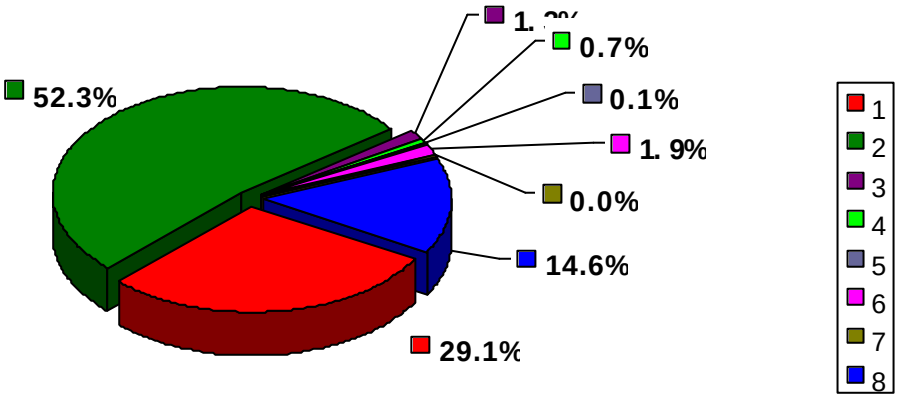
By statistics in 2001, anthropogenic cause above 98% to occur, deforestation burning,

2.4 Impacting factors of forest fires in China

Forest fires are natural disaster, are the disaster impacted greatly by human being. The forest fires are also affected by other factors.

Tab.1 Fire causes number and frequency in 2002

Total fire number in 2002	Fire from working	Fire from daily activities	Arson	Fires from other provinces	External fires	Lightning fires	Other natural fires	Unknown Causes
7527	2194	3935	96	54	6	144	1	1097
100%	29.1%	52.3%	1.3%	0.7%	0.1%	1.9%	0.0%	14.6%



1.Fire from working, 2. Fire from daily activities. 3. Arson. 4.Fires from other provinces. 5. External fires. 6. Lightning fires. 7. Other natural fires. 8 Unknown causes.

Fig.3 Fire causes frequency in 2002

2.4.1 Weather change

With a weather change, the surface temperature, moisture and wind change rapidly, especially when the weather is long drought, high air temperature and big wind can greatly impacts the

fire occurrence and spread. Daxing'anling Mountain locates in the continental monsoon zone, where fire season is long, air temperature increases quickly, fire danger rating very high.

2.4.2 Natural conditions

In the northeast and Inner Mongolia forest, for the special physiognomy and weather conditions, lightning fires occur very frequent, in some special years, lightning fire account for above 30% of the total fires. In some region, peat self-ignition and rock sparkle can also ignite the forest fuel, and most of the places are remote with few persons to reach.

2.4.3 Human activities

Most of the forest fires are cause by man's activities. For careless, most of them are caused in the procedure of working. Deforestation burning, smoking and incendiary is also the main causes to ignite the forest. Under the weather conditions of drought and high air temperature, it is very easy to cause forest fires when wild fire sources exist.

2.4.4 Distribution of fuel

The distribution of forest in China is very uneven. The primitive forest only distributes in some remote places with inconvenient traffic and weak fire management. In southwest region forests distribute in some mountains, which is very difficult to reach and fighting. There is large area secondary forest in China and these forests are damaged many times. So forest form is fragmented, and herb is very flourishing. All of these increased their flammability. Some young forests, plantations and some shrubs are also easy to cause forest fires.

2.4.5 Backward techniques and weak fire prevention facility

Fire prevention involves multidiscipline and multi-techniques, for the limits of our fire prevention research, the means of fire prevention and fighting is still pristine. The fundamental facilities and the ability to control forest fires can not adapt to the increasing fire occurrence.

3 Forest fire management in China

The prevention and fighting of forest fires is a sociality work. With the guideline of "Prevention mainly and fighting actively", our purposes is to decease fire occurrence and damage to the lowest level.

3.1 Organization of fire prevention in China

Headquarters of fire prevention and branches have been established at different administration level. There are 3085 fire prevention headquarters and 3257 branches, and 16945 staff. During fire season, the administration personnel keep on duty day and night and make the forest fire information informed timely.

3.2 Propaganda and education

Increase the fire prevention consciousness in society. By setting post, slogan, broadcast, TV, publication and internet and other activities to disseminate fire prevention knowledge, strength the management of fire source and persons to enter into forest.

3.3 Establish forest fire prevention laws and regulations

According to "Forest Law" and "Forest Fire Prevention Act", all the provinces constitute "Forest Fire Prevention Act Implementation Measures", and establish the fire management system with fire sources management, persons management who to enter into the forest and education as the work center.

3.4 Establish forest fire-fighting team

There are 22 aerial fire prevention satiations and 7 forest fire prevention police armies in

northeast and southwest forest region. We established about 10,000 semi-specialized fire prevention teams in some counties with abundant forest, and there are about 294,000 persons take parts in the teams.

3.5 Prevent forest fire by social power together

In fighting large forest fires, many government sectors involve in the work, such as transportation, weather, police and other agencies. Supports from these sectors play an important role in control the conflagrations.

3.6 Infrastructure Establishment

The establishment of fundamental facilities is the material base of fire prevention and fighting. The government provide expert subsidy for the fundamental facilities establishment. For example in 1998, the total money that the government provided added up to 1 billion Yuan. The different level governments provide complimentary money to buy all kinds all fire fighting equipments. To fight large area forest fires, we established 3 fire fighting material storage centers in Beijing, Northeast and Southwest, and the local governments have also established about 4200 material storage centers.

3.7 Synthetic management of key fire danger regions

According to the distribution principle and characteristics of forest fires, the government enhanced the establishment of fundamental facilities and management of forest fires in northeast, Inner Mongolia and southwest region since 1996.

4 Measures and techniques of forest fire prevention in China

The level of technique and management of forest fires increases with the recognition of forest fires damage. Some techniques, such as fire rate prediction, fire monitoring and large area fire fighting, are put in the prevention, fighting and management of forest fire.

4.1 Regionalization of fire danger regions

Classify different forest fire danger rating according to the combustion of tree, human density, mean precipitation, air temperature, wind speed, roads network density etc. Classify all the counties into 3 rate danger regions by the administration boundary. There are 2130 regions that are included in 3 fire danger rate regions in China. By the classification of the fire danger regions, we can guide the fire prevention and management effectively.

4.2 Forest fire danger rating forecast system

To determine the fire weather danger rating by five factors provided by local weather stations, these five weather factors are air temperature, relative humidity, precipitation, wind, biological characters. The fire weather danger rating is classified into five classes:

? : No danger, the fuel can not be ignited.

? : Low level danger, the fuel is difficult to be ignited.

? : middle level danger, the fuel is not easy to be ignited.

? : High level danger, the fuel is easy to be ignited.

? : Extreme level danger, the fuel is very easy to be ignited.

The local forest fire headquarters manage and prevent forest fires according to the fire danger rating. Local forest fire headquarters cooperate with the local weather stations, and forecast the fire danger rating.

4.3 Forest fire monitoring

4.3.1 Ground patrol

Patrol in the forest to prevent the occurrence of forest fires according to different fire danger

rating and time by men. Inspect the passerby and vehicles to know whether their behaviors accord with the fire prevention. Mange the fire sources to prevent fire occurrence.

4.3.2 Watchtower monitoring

By the distribution of forest and the topography, build watchtowers to monitoring the occurrence of forest fires, identify the location of the fires and transmit the fire information to the forest fires directing headquarters. There are about 10000 watchtowers in the whole country and cover above 85% of all the forest area.

4.3.3 Television monitoring

In some important area, we use the television monitoring technique to monitor forest fires and it has the advantages of large area cover, good quality image, sequence, saving etc. This means has been used in many important areas.

4.3.4 Aerial monitoring

4.3.5 Remote sensing monitoring

Use the red and near infrared bands to detect the hot spot information from ground surface, and monitor the fire occurrence and fire spread by interpret the image from meteorological satellites. By this way, we can cover large area region, get the information quickly, receive sequence information and can detect the dynamic change of forest fires. We have constructed 3 satellite monitoring centers in Beijing, Kunming and Wulumuqi, compose the satellite monitoring network and the effect is very well.

4.3.6 Lightning monitoring

In Daxing'anling Mountain, monitor the location and intensity of lightning to complement the monitoring of the occurrence of lighting fires by lightning detecting and location equipments. We built one AF station and 4 DF stations in Inner Mongolia and Daing'anling Mountain.

4.4 Forest fire resisting techniques

Firebreak is one effective means of resisting fire spread and decreasing damage. With our research achievements, we have built large quantity of fuelbreaks in south China, which play an actively role in fire prevention.

4.4.1 Building fuelbreak

Fuelbreak can resist the fire spread, can be the control line of fire fighting, and also can be the simple bypass of passing material and fire fighting crews. There have been 490,000 km firebreaks in China by now. The mean measures to build fire lines including of bulldozer, weeding herb with herbicide or manpower, and prescribed burning.

4.4.2 Building shaded fuelbreaks

To build shaded fuelbreaks with the plantation establishment or rebuild from the closed forest. The property of fire prevention trees includes fast growing, strong germinating, and high moisture content and fire resistance. Due to the property of shaded fuelbreak, the fire is not easy to spread in the forest.

4.4.3 Fire prescription

Prescribed burning in proper time to reduce the fuel loading, and decrease the fire danger rating.

4.5 Forest fire fighting

To extinguish forest fires needs experienced director and fighter team, effective fire fighting tools and equipment, and good fundamental facilities and logistics guarantee. The mean

measure and means of forest fires fighting as follows:

4.5.1 Fighting fires with simple tools

Use fire fighting bat, shovel and other hand tools to fight low intensity surface fires.

4.5.2 Fighting fires with Air Jet Extinguisher

Block the fuel and decrease the temperature with Air Jet Extinguisher, it can effectively put out the initial fire and moderate surface fire. There are 92,000 Air Jet Extinguisher.

4.5.3 Fighting fires with water

Water is the most effective extinguishing agent, Tank trucks, fire pumps and other equipments using water can effectively fight surface fires, ground fires, low intensity crown fires and mop up fire scars.

4.5.4 Fighting fires with extinguishing bombs

Using extinguishing bombs to control fire front, can fight the fire with other means.

4.5.5 Fighting fires with back fire

In fire fighting, especially when the fire is very intense, the fire fighters can not approach the fire. Under this conditions, fighting fires with fires is usually be used. Choose the roads, rivers as the control line, and ignite the backfire in proper place so as to form fire prevention line.

4.5.6 Fighting fires by helicopter landing and rappeling

Use the helicopters to carry the fire fighters and tools, or use the rappeling to slip down to the ground. Every year, we hire about 50 helicopters in northeast, Inner Mongolia and southwest to fight fires.

4.5.7 Fighting fires with plane

Use plane to carry chemical extinguishing agent or water to fight the fire directly. There are 5 chemical extinguishing agent bases in key forest region. Usually use M-8, M-171 and AS-350 helicopter to fight fire line, and use AS-350 helicopter to fight initial lightning fires or mop up fire scars.

4.5.8 Fighting fires with artificial rainfall

Under the condition of cumulonimbus, artificial rainfall can be used in fire fighting. This means is widely used in northeast and southwest.

5 Prospect of forest fire prevention in China

Fire prevention in China is very severe. With the increasing plantation, forest area expand, especially the area of young forest and half-mature forest increase quickly, the task of forest protection and fire prevention become more heavy. Prescribed burning has not been widely used in large area, this leads to the accumulation fire fuel, and the potential fire danger rating becomes very high.

With the reforming of forest region, many persons enter into the forest for tour and other economical activities, potential fire sources become more than ever, and the fire sources management becomes more difficult.

Due to the anomaly of global climate, drought, high temperature, big wind become more frequent than ever, the fire danger rating is very high.

Fire fighting equipments are relative old and fire fighting technique is low, the means of forest fire prevention and fighting can not adapt to the needs of forest fire management, especially lack of the ability and means of controlling large area forest fires.

The fire prevention in China should meet the needs of our country, abiding by the guideline

of “prevention mainly and fighting actively”. It is necessary to transmit the experienced fire fighting to scientific fire fighting, develop technologies and increase the investment in fire prevention. We will strength the construction of fundamental facilities and fire fighting equipments, increase the education level of fire fighters, advance the fire research technique application, and increase the management level and the synthetic ability of fire fighting. We will do our best to decrease the fire damage and improve the environment.

References

Du Yongsheng, Forest Fire Management in China, Initial Attack, 1999(2):13-15

Du Yongsheng, Shu Lifu, The amelioration of precision to detect forest fires using meteorological satellites. Forest fire prevention, 1995(2): 9-12

Shu Lifu, Du Rongsheng, Forest fire situation in the world. Harbin: Northeast University Press, 2000

Forest statistics of China (1990-2000). Beijing: Chinese forestry press.

Forest statistics of China (1988-2000). Beijing: Chinese forestry press.