INVESTIGATION AND RESEARCH ON FIRE BEHAVIOR OF MAY 6 FOREST FIRE OF DAXINGANLING,CHINA

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ABSTRACT

From May 6 to Jane 2 in 1987, Owing to over accumulated fuels and weather enviorment of high fire danger, May 6 catastrophic forest fire occured in northern part of Daxinganligh forest area as result of man caused reason.At night of May 7,the rate of spread reached 9-45 km/hr, flame heigh 7~8 m,even over 10 m,fire front intensity 5,000~90,000 kw/m. It was a storm fire which interwaved with a fierce and fast surface fire and fast crown fire.Different special fire behaviors occured,such as fire spread in way of fierce burning and jumping, main fire belt which was high temperature thermal current,baking combustion.etc.
Key word: Forest fire, fire behavior, investigation and research.

1. INTRODUCTION

From May 6 to June 2, a catastrophic forest fire (May 6 forest fire for short) occured in northern part of Daxinanling forest area. After fire, chinese goverment organized relatived research and educational institutions to investigate and research on the fire behavior. In this article, the investigations put the stress on different fire behavior of main fire belts at night of May 7. The investigation results indicated that because of over accumulated fuels in forest, and of weather condition of high fire danger, high intensity and special fire behavior occured in May 6 forest fire.

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* The author took part in fire fighting and investigation on May 6 forest fire for himself.

2. OUTLINE OF FIRE OCCURANCE AND DEVELOPMENT

The rate of spread and fire intensity of May 6 fire at night of May 7. reached higher indexes, it was blow-up time[3].The fire did not go out untill June 2, the coordinate of fire was N 53° 33′ ~52° 30′, E 121° 5′ ~125° 0′, the burned area was 1140,000 ha (Fig.1), among which 870,000 ha forest land suffered the fire.

Forest ecology system is a typical dissipative structure[1] , which takes material cycle and energy flow open system as a form which exists in natural world. Northern Daxinanlin forst belongs to coniferous forest of frigid temperate zone, which is regional climax which takes Xinan Larch (Larix gmelini L) as dominant tree. Because of low temperature, fuels are not susceptible to be resolved. The fuel investigation of northern Daxinanling forest in 1987. indicated that, the accumulated fuel quantity which including layer of withered branches and leaves on the ground surface, semi- decomposed layer and shrub layer within 1 meter high, reached in range of 16~50 T/ha, susceptible fuel reached 20~30 T/ha[2].

Affected by EI Nino phenomena[3],since 1980s,the weather condition in Daxinanling forest area was abnormal. The centre of distinct high temperature ,arid climate,low humidity occured[5].Owing to influnce of warm current of Lake Baykal moving east, the temperature went up for four days running, the highest temperature reached 24.1℃, relative humidity went down to 4%, moisture content of fire fuels went down to 2%. On the day when May 6 fire occured,on the influnce of warm current and dry cold front, cold air mass and warm air mass produced intense frontal surface. Atmosphere and wind direction were not steady. The blast was strong[6] . These were main factors of fire behavior characters of May 6 fire.

3. FIRE BEHAVIOR CHARACTERS OF MAY 6 FOREST FIRE

(1) Fast rate of fire spread.

The fire spread parameters, which were observed in fast fire spread period in Gulian fire field at night of May 7,are arranged in table 1. Caculated from table 1, the distance from the igniting point to Amur was 72 km, the fire spreaded 3 hours. The mean rate of spread was 18.0

Table 1 Fire spread parameters in different sectors from igniting point to Amur

Sector	Time period	Distance	Spread time	Rate of fire
Igniting point-Xilinji	19:08-19:20	7.5 km	20 min	22.5 km/hr
Xilinji-Yuying	19:20-19:30	7.5 km	10 min	45.0 km/hr
Yuying-Tugiang	19:30-19:50	15 km	20 min	45.0 km/hr
Tugiang-Amur	19:50-23:10	27.5 km	200 min	8.9 km/hr

km/hr. But the rate of fire spread in sector Xilinji-Yuying,and sector Yuying- Tuqiang were 45. 0 km/hr. It could be proved by the fact that the fire head was nearly as fast as the command car which was driven from Yuying to Tuqiang in the evening. Moreover, topography had direct influnce on fire spread,the fire in Amur river valley which flows from east to west, spreaded 70 km up to Amur from Xilinji by a western air current.

(2) High fire intensity

Practical investigation of main fire front in Gulian indicated that, the fuels on ground surface of 20-30 T/ha were burned over 95%, flame height reached up to 7～8 m, even 10 m, flame thickness up to 4～5 m, like a fire wall. When the fire passed, low moisture branches were easily ignited,but the fire which was spreaded forward by surface fire did not reach height of tree crown (see photo 1).

With the help of Brown fire intensity equation [1] , there are two equations for the caculation of fire intensity,as lollowing:

$$I = H \cdot W \cdot (1-M) \cdot R \quad \cdots\cdots (1)$$

$$I = 3(10h)^2 \quad \cdots\cdots (2)$$

(1) is Brown's classical fomula of fire intensity.

(2) is Brown's field experienced formula, its error ranged ±20%. The physical meanings of symbols are as following:

I—Fire intensity (unit: KW/m)

H—Mean heat value of fuel (in 4000 Kcal/kg)

W—Moisture weight of fuel burned (unit:kg/m^2)

M—Moisture content of fuel,(appr. 5%)

R—Rate of forest fire spread (unit: m/s)

h—Flame height (unit:m)

According to fomula (1) , the indexes of fire intensity in each sector in Gulian fire field are arranged in table 2.

Table 2. Indexes of fire intensity in every sector in Gulian fire field at night May 7.

Indexex / sector	R	H	W	M	I
Ignifing point-Xilinji	6.25	4000	2.0	5 %	47500
Xilinji-Yuying	12.5	4000	2.0	5 %	95000
Yuging-Tuqiang	12.5	4000	2.0	5 %	95000
Tuqiang-Amur	2.47	4000	2.0	5 %	18772

Caculated according to formula(2) ,the fire front intensity is between 14700～3000 KW/m.

(3) Special fire behaviors

(A) Fire spread moved forward in way of fierce combusion and jumping. Under the extreme conditions of fast wind and high fire intensity, groups of convection columns occured, ascending heat air current hoisted burning debris which were blown advanced into sky[a] , so that they formed "spark rain", new fire field occured. Spreading fire from undulate hill, especially one side of ridge, in air masses of red hot fuels,formed reddish orange fire of several hundreds metres long which could be seen by naked eyes. Both Mohe county town and Pangu forest farm were ignited and damaged by such fire.

(B) Main fire belt was a thermal current. Which burned fiercely ,the air were muddy and red-hot, The temperature reached 800～1000℃.After the high thermal current had passed over ditch and pond, bushes on the two sides were as neat as knife cutted. When hight thermal current hit towns, without flame being seen, rows of houses were fired at the same time. Two people were killed by high temperature in railway station of Malin and Tuqiang, lying at open land 10 m away from fire, the bodies were toasted brown.

(C) Baking burning phenomena existed commonly.Under condition of fire enviorment, red hot smoke filled in the air, fire flame rediated all around, once fuels touched fire source, baking burning would occur, burning front spreaded all around along fuels, further,rapid combusion occured within fuel, strong light and heat were given out. The baking burning occured when fire hit piles of snag,slash,and houses.

(D) Thermal current propagated along converge passageway. In May 6

fire, a bridge that there were no fuels in 10m head on fire, when its piers were bured down, the bridge collapsed in horizontal level. This was because that when high temperture thermal current accumulated at one side of high way, only when if came across the bridge openings, accumulated heat quantity converged, then thermal air current of high temperature, high speed and high energy, went through the bridge openings quickly.

(E) Wind produced by fire. Many places which had certain angle with main fire belt were so burned that a burned black forest belt appeared,this is because that high intensity fire made red hot thermal air current produce turbulent current and blast, and produce strong extracting power along mountain slope up to ridge.

4.CONCLUDING REMARKS

May 6 forest fire blew up at night of May 7. Affect by warm spring and dry cold front transit, the different fire behavior characters above mentioned appeared. Uninterrupted and thorough research on fire behavior has important theoretical and practical significance.

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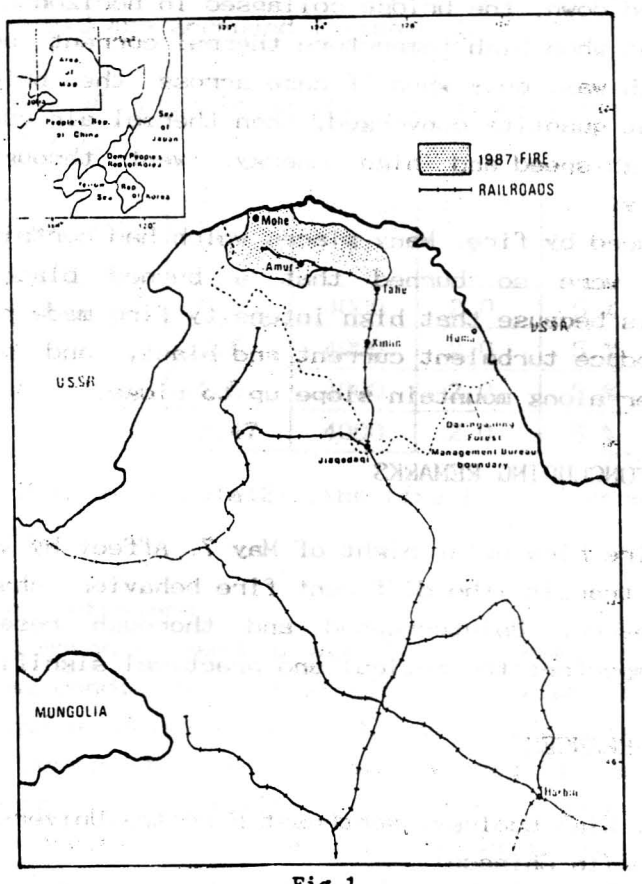

Fig.1
General location of the Daxinganling Forestry Bureau the great China Fire of 1987 within the Helongjiang Province, northeastern China.

Photo 1. May 6 forest fire was spreading, photoed by Jin Xiaozhong.