

Characteristics and Management of Wildfire in the Interface of Kunming City, Southwest China

Deng Guangkui¹ He Xinyuan² Wu Deyou² Lishu³ Li Zengping³

¹ Yunnan Forest Nature Center

² Southwest Forestry College

³ Kunming Fire School, Forestry Bureau of Dongchuan District, Kunming

Abstract

Based on analysis of statistics on wildfire in the interface of Kunming from 1989 to 2001, the characteristics of wildfire are given as what follows: First, fire source control is difficult and non-production fire sources are as high as 70.4% because the population density in the area is very high. Second, the fire occurrence and development is closely related to the topography: 89.4% of the fire occurred on the slopes facing the sun; 10.6% on the slopes against the sun; 5.9% on steep slopes, 17.5% on slopes with moderate gradient; 76.6% on gentle slopes; in terms of fire starts, 40.1% is on foothills and 46.3% on hillsides and only 13.6% on the mountain tops. Third, concerning fire break time, about 90% of the fire happens from December to May and 71.3% between 11:00 and 15:00. Finally, wildfire is also related to tree species, forest age and stand features, as is the case with fire occurs in other forest stands.

The current wildfire management strategy and approach includes two aspects, namely administrative and technical. The former are: the head of administration at different levels is fully responsible for fire management under his jurisdiction; fire offices and professional fire crews should be established and reasonably funded at county and township levels; organize and train farmers as volunteer fire crews to guarantee successful initial attack; strengthen the publicity and awareness on fire prevention and safe use of fire; enforce law and regulations strictly, and control the fire sources according to different fire conditions.

The technical measures are: strengthen infrastructure construction and build up the networks of monitoring, transportation, communication and firebreaks; carry out prescribed burning for hazard reduction; improve stand structure and establish greenbelts system and strengthen forest tendering for improving fire resisting capacity of the forests.

Key Words: interface, wildfire characteristics, fire strategy and approaches

1. Physical Context

Kunming, 102° 10'E—103° 40'E, 24° 23'N—26° 33'N, is the capital of Yunnan Province in Southwest China. With a total land area of 21,018 km², Greater Kunming extends, from north to south, for 242 km, and from east to west, for 151 km. The total population is 4,734,000, with a density of 226 persons per square kilometer. The interface, as is discussed in this paper, means a 20 km wide zone surrounding metropolitan Kunming and a 10 km wide belt surrounding the 10 satellite cities under the jurisdiction of Kunming Municipality. The land area of these belts takes up about 30% of the total area of the municipality. Although there is very few separated private houses within the belt, there are thousands of factories, institutions, schools, parks, scenic spots, military installations and villages in the zone.

The relief descends from north to south in a terrace pattern, with the central part higher than the east and west sides. A lake basin, followed by red alpine plateau, dominates the major

topography. Three types of landscape patterns are identified, namely, mid-alpine valleys, basins and plateau karst. Dianchi Lake, the largest fresh water lake in the Yunnan-Guizhou Plateau is located in the area.

Kunming is in a low latitude plateau and the topography is quite diversified, resulting a clear dimensional macroclimate in the area. There are 7 types of climate patterns: cold climate, cold-temperate climate, temperate, warm-temperate, northern tropical, central tropical and south tropical climates. Statistic over the years show the annual average temperature of Kunming is 14.5^o, with July being the hottest at 19.7^o and January being the coldest at 7.5^o; annual rainfall is 1,031mm, with a distinct division between a dry season and a wet season. The wet season lasts from May to October, taking up about 80% of the annual rainfall and the relative moisture is 74%; total sunshine hours in a year is 2,445.6 hours and the average annual heat radiation is 129.78 kilo calorie/ cm² and frost-free days are 240 days a year. Rainfall is not evenly distributed over the year with the wet season claiming about 85% of the total annual precipitation. Moreover, the rainfall in the dry season takes up only 15% of the annual total, hence a long and intensified fire hazard period, which is uncommon in China.

The total land area of Kunming is 2,101,800 ha, of which 1,180,771.9 ha is designated as forestland, taking up 56.2% of the total. About 48.0% of the land is covered by forests, of which 36.5% is woodland, 11.5% is scrubland. Major tree species include: *armand pine*, Yunnan pine, alder, eucalyptus tree, sabina, cypress and so on. A large part of the forests are plantations planted since late 1980s and these middle-aged and young plantations are at fire hazard stages. In the 1980s, 2,069 forest fires were recorded, including 1,406 fire warnings (burned area is no more than 1 ha.), 652 minor forest fires (burned area from 1.1-100 ha.), 10 major fires (burned area from 100.1- 1000 ha.) and 1 very serious fire (burned area more than 1,000.1 ha.). These fires burned 33,369 ha of forest lands, killed 59 persons and injured 58. In the 1990s, 420 forest fires were recorded in the Kunming area, including 381 fire warnings, 38 minor fires and 1 major fire. These fires burned 9,278 ha. of lands, injured 29 persons and killed one. From 2000 to 2002, 100 forest fires recorded. Of these, 59 are fire warnings, 41 are minor fires and the total area burned is 2981.95 ha, with 494.81 ha of forest completely destroyed. Three fire fighters were killed.

Improvements have been made since the 1990s and this is accounted for by several factors. Since the 1987 major wildfire of the Hingan Range in northeast China, China has increased the input in wildfire management and paid greater attention to the learning of advanced experience from other countries.

2. Characteristics of Forest Fires in the Interface of Kunming

The analysis of the characteristics of forest fires in the interface of Kunming is based on the statistics of Yunnan Forest Nature Center, which manages a total area of 1883.8ha of forests extending across 7 townships to the northeast of Kunming. From 1989 to 2001, 234 forest fires are recorded. Of these fires, 194 are forest warnings, 39 are ordinary forest fires and 1 is extremely serious fire. The total area burned is 307.3 ha. and 17.2 ha. forest is destroyed. Total timber loss is 2,480.4 m³ and 1.864 million young trees died. The total direct economic loss is estimated to be 2.8561 million *yuan* and indirect loss to be 104.58 million *yuan*.

2.1. The majority of the fires are resulted from human activities

Although the area managed by Yunnan Forest Nature Center is not large, there are too many

human activities such as horse riding, sightseeing, flower-collecting and other activities. Certain parts of the forests are close to schools and many students enter the forests. What's more, some forests are the only roads leading to rural ecolodge centers. Thousands of tourists pass through these forests every day. In addition, vehicles transport tens of thousands through these forests. During the Sacrificing Day in March, many people pay respect to the passed-way by burning incense. Although there are regulations on the use of production fire during the farming season, most of the fire uses do not have permissions, not to mention the fire prevention precautions. More than 100,000 person/times go in and out of the forests daily. These factors impose a lot challenges on the management of the forest fires. Based on the analysis on the statistics, there are four kinds of wildfire sources. The first is production fire, taking up 24.3%; the second is non-production fire, taking up 70.4%. Human related fires take up 99.1% of the total. (See Table 1) The further breakdowns of these two types of fires are presented in the following table (Table 1).

Table 1 Causes of Wildfire Recorded by Yunnan Forest Nature Center from 1989—2001

Causes	Production					Non-production					A	L
	F	PB	PLF	ST	Others	S	BH	BI	CP	MP		
Fires	13	3	4	33	5	108	8	37	7	4	10	2
Percentage (%)	5.5	1.3	1.7	14.1	2.1	46.2	3.4	15.8	3.0	1.7	4.3	0.9
percentage (%)	24.3					70.4					4.3	0.9

Note: F=farming; PB=prescribed burning, PLF=power line failure, ST=Shooting Training, S=Smoking, BH=barbecue and heating, BI=burning incense, CP=children playing with fire, MP=mad persons playing with fire; A=deliberate arson; L=lighting.

Frequency of human activities is related in direct ratio to the times of wildfire occurrence. Site 1 sees the most frequent human activities and the forest fires happened there take up 35% of the total while Site 7 is mostly in steep mountains where there are not many human activities and thus there are no fires resulted from human activities. (Table 2)

It is usually difficult to track down the wildfire cases. People come in and out of the forests irregularly. The major source of forest fires is the thrown-away cigarettes butts, which do not immediately bring about forest fires. And the spots where forest fires occur can be easily destroyed, making it fairly difficult for investigators to track down reasons of fire. As high as 22.6% of wildfire cases remain unsettled.

Table 2 Relationships Between Human Activities and Wildfire Occurrence from 1989 to 2001

Site	1	2	3	4	5	6	7
Elevation (m)	1977-2112	2163-2237	2107-2309	1965-2317	2081-2351	2058-2278	2125-2458
Mean Gradient (degree)	25	28	28	34	35	35	42
FHA*	high	high	high	Medium	Medium	Medium	Low
Fires	82	51	41	30	16	14	0
Percentage(%)	35	21.8	17.6	12.8	6.8	6	0

FHA* = Frequency of Human Activities;

2.2 Though the majority of fire occurrences are minor ones that have been stopped at the very beginning, their social impacts are great

Statistics show that most forest fires (82.9%) of Yunnan Forest Nature Center belong to wildfire warnings. The second kind of fire is ordinary forest fires, taking up 17.1% of the total. Kunming is surrounded by mountains and there are high frequency of human activities.

Most fires, however, can be timely put out at the initial stage. Yet, forest fires happened at the interface of Kunming brings about very serious social impact. They destroy ecological environment, but also jeopardize the property and life of the local population, and even affect the production and stability of the local communities. The fire happened on March 8, 1990 in the collective forests of Xishang District lasted 6 hours and 266.7 ha. of forests were burned and 180.7 ha. was totally destroyed with a total loss of 3.24 million *yuan*. More than 1123 persons, 336 vehicles took part in the fire fighting. The nearby town of Ciba was totally shaded by heavy smoke in the morning and the whole northeast part of Kunming seemed drowned in fires. Several institutions were in panic for they were just a step away from the fire site.

2.3 Wildfire Occurrence is Closely Related to Topography

Table 4 shows that from 1989 to May 2001, 89.4% fires occurred on the south slopes and 10.6% occurred on the north slopes. The south slopes are comparatively drier, hotter and evaporation there is faster, thus forest fires occur more frequently than the north slopes. Once fire breaks out on the south slopes, it is usually very intense and spreads very quickly too. In terms of gradient, 5.9% occurs on steep slopes, 17.5% occurs on slopes with medium slopes and 76.6% occurs on slopes with small gradient. These figures indicate that steep slopes see fewer human activities, hence fewer forest fires. On the contrary, slopes with small gradient see a lot of human activities, making it easy for forest fires to occur on these slopes.

Table 3 Relationships Between Wildfire Occurrence and Geographical Features from 1989—2001

Site	Slope Aspect		Gradient			Slope Position			Specific Location					
	NS	SS	B	M	S	R	HS	F	RS	BG	IFF	INC	WF	Others
Fires	25	209	14	41	179	32	94	108	71	45	50	19	19	30
%	10.6	89.4	5.9	17.5	76.6	13.6	40.1	46.3	30.3	19.2	21.3	8.2	8.2	12.8

Note: NS=north slope, SS=south slope, B=big, M=medium; S=small, R=ridge, HS=hill side, F=foot, RS=roadside, BG=beside graves, IFF=interface of farm and forest, INC=interface of national and collective forests, WF=within forest

In terms of slope position, 13.6% of fire occurs on upper slopes, 40.1% and 46.3% on middle and lower slopes respectively. This shows in the interface of Kunming, there are more human activities on the lower and middle slopes while there are fewer human activities on the upper slopes.

Table 4 also shows that the likeliest spots for fire breaking out are by the roadside, taking up 30.3% of the total. Second to this is the place where forest and farmland meets, taking up 21.3% and the third place is where the national and collective forests meet, for it is usually a dead corner in terms of management. Very few fires break out in forests without roads and graveyards, taking up only 8.2%.

To sum up, the places with frequent human activities and the dead corners of management are the likeliest places for forest fires. To control and prevent forest fires effectively, it is advisable to strengthen awareness building. During the fire-warning season, the entrances to the mountains should be strictly guarded and no fire sources are allowed to enter the mountains.

2.4 Seasonal and Daily Rules of Wildfire Distribution

Table 4 indicates that forest fires have very obvious seasonal features. Generally speaking, forest fires occur from December to May in the Kunming area. February, March and April

are the critical period for wildfire occurrence. Sometimes, forest fires happen during in August and September. During the critical period, if there is successive drought for several days and the temperature is high and moisture is low and the litter layer is dry, forest fires are likely to occur. A case in point is the period from February to April in 2001; successive drought and high fire hazard make it very difficult to prevent forest fires.

Table 4 Time of Fire Occurrence and Changes by Months from **1989—2001**

Item	Fires	Percentage (%)	
Month	January	32	13.7
	February	39	16.7
	March	73	31.2
	April	49	20.9
	May	14	6.0
	June	2	1.0
	July	0	0
	August	4	1.6
	September	1	0.4
	October	0	0
	November	3	1.3
	December	17	7.5
Time in Day	8:00-11:00	12	5.2
	11:00-15:00	167	71.3
	15:00-18:00	35	15.0
	18:00-8:00	20	8.5
Duration of Drought	Long (6 months)	113	48
	Medium (3 months)	68	29
	Short (1 month)	31	13
	Less than 1 month	30	13

The daily rule of forest fires is as follows: the daily change of forest fires is closely related to the differences in daily sunshine changes. Statistics show that the period from 10:00 to 15:00 is the fire critical period in a day. Fires occurred in this period take up 71.3% of the total. Second to this is the period from 15:00 to 18:00. Next is the period from 18:00 to 8:00 in the second day, taking up 8.5% and fewer fires occur during the period from 8:00 to 1:00, taking up only 5.2% (see table 4) . The period from 11:00 to 15:00 sees the highest temperature in a day. Temperature directly affects the moisture changes and the rise of temperature will quicken the steps for litter layer to become dry. In one word, the higher the temperature, the likeliest of the forest fires.

2.5 Wildfire is Closely Related to the Characteristics of Forests

Wildfire is closely related to species composition of forests (Table 5). Among the forest plantations of Yunnan Forest Nature Center, forest fires are likely to occur in pure coniferous forests. A case in point is the fire occurred in armand pine forests on March 8 1990. Cypress forest comes next. Coniferous forests have high content of lipid and are flammable. Mixed forest of broadleaved species and coniferous species, especially those forests with high coniferous and broadleaved trees and shrubs see fewer forest fires. The shady leaves of the broadleaved trees make the understory more humid. And thorny wild roses grow in such forests, reducing a lot of human activities. Huanglong Valley in Pingdingshan Forest is a case in point. In the deciduous forests, there are more litter layer, which makes the moisture

Table 5 Impacts of Forest Characteristics on Forest Fires

Forest Characteristics		Fires	Percentage
Species Composition	Coniferous	156	67
	Mixed	42	18
	Broadleaf	14	6
	Barren	22	9
Closure	High (0.61-1.0)	134	57
	Medium (0.31-0.6)	60	26
	Low (0.2-0.3)	19	8
	Barren	20	9
Age	Young stands	57	24
	Middle-aged stands	98	42
	Mature stands	58	25
	Barren	21	9
Types of Fire	Surface fire	172	74
	Crown fire	55	23
	Underground fire	7	3

content high, thus fire is hard to break out in such forest. A typical example is the forest in Shuangru Mountain forest, which is composed of 40-year-old robur trees and there is no undergrowth in this forest. So fire is not likely to break out in this forest.

Because of the high moisture content of the leaves, broadleaved evergreen forest is least forest where forest fires can occur. Certain broadleaved species remain green even during the fire hazard period. And the contain a lot of moisture which can prevent fires. Such species include *Myrica rubra Sieb.et Zucc* and *Schima wallichil* choist.

What sees making people confused from Table 5 is the relationships between tree canopy cover, age and forest fires. Generally, stands with small tree canopy cover see a lot of under growth and fires are likely to occur. But how come fires break out in stands with high tree canopy cover in the interface of the city? This is because weeds and other undergrowth can not survive in the stands with high canopy cover, which makes it convenient for people to go into such forests, increasing the human activities. Thus in such stands, fires are more likely to occur. The same principle applies to the age of the stands. In the young stands, there is more grass and it is not easy for people to penetrate. And it is much easier for people to pass through middle aged and old stands, thus more possibilities of forest fire. Most stands in the interface of Kunming are quite young. The canopy of the young stands is low and when fires break out, they turn easily from surface fire to crown fire. But with the mature forests, after thinning, fires are usually surface fire.

3 Wildfire Management Measures

Forest fires are natural disasters characterized by unexpected and destructive features and wildfire management is a technical task involving different aspects of the society. The wildfire management measures can be classified into two categories, namely administrative measures and technical measures. The guideline of wildfire management in China is “prevention first and actively putting out second”. Prevention is the precondition to control and manage forest fires. Once there is forest fire, it is usually difficult to put off in a short time. For this reason, wildfire management should be focused on “prevention”. At the same time, it is necessary to strengthen the capacity building and the construction of infrastructures. This can help to put out the fire at the initial stages.

1. 1Administrative Measures

3.1.1Implement “Administrative Head Fully Responsible” System and Perfect Institutional Set ups

According to *Wildfire Prevention Regulations* issued by the State Council, the policy of “administrative head fully responsible system” is adopted in wildfire prevention. “forestry bureaus at different levels take important responsibility in wildfire prevention”. With the “administrative head fully responsible system”, functional departments sign wildfire prevention contracts with related departments and units and funds are input. The responsibility is specified with individual persons and spots of forests.

The forestry management authorities take important responsibilities in wildfire prevention. During the fire hazard period, the forestry management authorities should lay great emphasize on fire prevention. The key leaders should act as example and the department directors should attend to specific issues in fire prevention and solve the existing problems timely. The phenomenon of “neglect at other times and panic at fires” should be avoided and the management should take initiatives to prevent fires. In 2001, the municipal government signed altogether 3,367 fire prevention responsibility contracts and 338 assistance prevention contracts with different levels of governments and other institutions in the interface of Kunming. This makes fire prevention the concern of all walks of life, but not on the task of the forestry management departments.

Wildfire Prevention Commanding Offices have been set up at the municipal and county levels. At the township level, the wildfire prevention commanding stations have been established and commanding teams have been established at the administrative village level. These offices are in charge of wildfire prevention and management within their respective areas. A forest police force has been established at the municipal level, responsible for the wildfire fighting within the whole municipality. Fire fighting teams have been set up at each county, responsible for the fire fighting in the counties. And seasonal voluntary fire fighting teams have been formed in each township and administrative village, participating in the patrolling and fire fighting in local area. The members of these teams are farmers and they do their farm work at other times. When there is fire, they put out fire or patrol the forests and get some payment. To date, there are 3 special fire fighting teams with a total member of 351 and 74 seasonal voluntary fire fighting teams with a total member of 3,808. Still there are 1,100 voluntary teams and a total of 46,207 persons are involved. More than 4,000 persons have signed contracts to work as forest guards.

3.1.2 Strengthen Laws and Regulations and Manage Fires According to Laws and Regulations

Imperfect laws and poor forest law awareness of the grassroot leaders and the local population constitutes a major cause for wildfire occurrence. In 1988, the State Council promulgated *Wildfire Prevention Regulations*, and the provincial government issued the *Implementation Measures of Wildfire Prevention Regulations* and the Kunming Municipal Government issued *Rules of Wildfire Prevention*. These regulations specified the annual fire hazard period, institutional setups and regulations of prevention and fire fighting. Wildfire prevention is thus regulated by law. What’s more, rules have been established and implemented in some places to manage wild fire sources and improve the management of human activities in the mountains. Sometimes, typical wildfire cases were effectively dealt with according to law and a lot of people were educated. Wildfire management is now conducted based on laws and regulations.

3.1.3 Specific Responsibility Based on Specific Area is the Key to Put out Forest Fire

Forest fires are natural disasters characterized by unexpected and destructive features. At the same time, it requires large amount of investment and time. It calls for the attention of different walks of life. As is specified in the *Wildfire Fighting Regulations*, the local government is the acting authority responsible for the management of forest fires. For this reason, when wildfire occurs, the head of the local government and the director of forestry bureau is the commander of wildfire fighting in the specific area. All other institutions within the area should obey the orders of them concerning fire fighting arrangements. If the fire extends over several counties, the immediate upper authority is the commander for the fire fighting. Only with this arrangement, can the fire fighting arrangements be holistic and unnecessary losses can be avoided.

3.1.4 Strengthen Public Awareness Building

The most important and effective measure in prevention is to control fire sources. To do this, awareness building needs to be conducted and this is the foundation of wildfire prevention. Wildfire prevention is a social work involving all walks of life. It touches upon every households and individual persons. Comprehensive awareness building will help to improve the efficiency of fire fighting. We should make full use of news media, newspapers, posters, wallpapers and publicity vehicles to arouse the public awareness in fire prevention. Mobilize the public to sign fire prevention contracts and to part in no-fire competitions. And let everyone understand the slogan “protect forest and prevention fire is everybody’s duty”. In the long run, people, not only those live in the forest areas, but also those living in cities, will voluntarily take part in the cause of fire prevention. The following chart shows the activities done in awareness building in 2001. Publicizing gatherings: 5,076 times; Teachings in high schools and primary schools: 3,964 times; Posters: 10,000 copies; Announcements for household head: 10,000 copies; Movie shows: 1,424 times; Video shows: 1,018 times; Radio and TV broadcast: 48,000 times; Slogans and wallpapers: 65,000 copies; New permanent publicizing boards: 1,783 pieces; Vehicles used: 2,579 times

3.1.5 Strictly Control Fire Sources in the Open and Reduce Hidden Fire Dangers

Most forest fires are caused by human activities and controlling fire sources, though difficult as it is, is the key to prevent and manage forest fires. The following measures have been adopted in the fire prevention and management in the interface of Kunming. Permit is strictly issued for production fire use. During the fire hazard period, no fires can be used in the open. Special education is carried out for smokers in the open. During the fire hazard period, no smoking is allowed in the forests and breakers will be heavily fined. At the entrance of the mountains, fire sources should be registered and no fire sources are allowed to enter the mountains. The third measure involves the management of incense burning during the tomb-sweeping season. Temporary check points are established at the entrances to mountains; on mountains with many tombs, special persons are assigned to prevent the burning of incense on the tombs. Vehicles are not allowed to enter the forests during the fire hazard period. Educate the parents of children and custodians of mentally handicapped persons to watch out the use of fire by these people; sign contracts to prohibit these people play with fire during the fire hazard period. Strictly manage the tourists, medicine seekers and students in practice. Set up no-smoking and no picnicking signs at the entrance of the forests; open smoking area in places with tourists concentration and make clear the punishment system of fire use during the fire hazard period. Strictly manage the joining areas forests and farmlands, national forests and collective forests and the forest parks. Special persons should be assigned in these areas to prevent the use of fire.

3.2 Technical Measures of Wildfire Management

3.2.1 Strengthen Infrastructure Development

There are presently 39 watchtowers and 68 telescopes and the monitoring coverage is about 79.4% of the total land area in the area. Establish checkpoints at special time and sites are an effective way to reduce fire dangers. Improve the transportation and road conditions in the forest areas by purchasing 133 vehicles used in fire prevention and fire fighting. Purchase communication equipment and guarantee smooth communication during the fire prevention process. At present, a network composed of wired phones, wireless phones, interphone, short wave and ultra-short wave radio stations has been established, covering 75% of the total area. Computer and fax machine network has been established too. Improve wildfire prevention equipment such as grenade, hand tools, ignition device and wind blowers. These are the preconditions to deal with fire prevention effectively.

3.2.2 Strengthen Afforestation Measures and Improve the Fire Fight Capacity of the Forests

Most forests of Kunming area are plantations which are subject to forest fires, especially those renovated pure forest plantations planted since the late 1980s when the Yunnan pine forests were affected by beetles. In order to archive a 95% surviving rate, the density is 1,220 tree/ha. Thinning should have been followed, but it could not be done for lack of funds. For this reason, the litter layer in these forests is very thick and there is potentials of a major forest fire. To deal with this problem, we have adopted some afforestation measures to reduce the fire hazard. One measure is to reduce the openings within the forests. For these openings are usually places with high grass, a likely source for forest fires. Planting some trees on these openings not only improves the productivity of stands, but also reduces the sources of forest fires; the second thing we have done is to strengthen thinning and clearly the thinning sites, which reduces the capacity of litter layer and fire danger; the third measure is to readjust the composition of stands, promoting mixed forests of broadleaved and coniferous forests. This can help to reduce the ignition features of the stand while at the same time beautify the environment. The function of forests in cities has changed from providing timber to maintaining the city environment. Since the 1990s, instead of planting pure coniferous forests, we have been planting mixed forests of broadleaved and coniferous forests, water conservation forests and fruits trees and these forests are beneficial in wildfire prevention.

3.2.3 Strengthen the Construction of Fire Break Projects

(1) Construct green belts

Green belts can effectively stop fire spread. Up to now, 490km of 20m-wide green belts have been constructed with the species of *Alnus nepalensis*, *Schima superba* and other fire-resistant trees. By the year of 2005, another 100 km of greenbelt will be added. The existing belts will form closed networks and play key role in stopping fire spread.

(2) Create fire breaks

The total length of roads in Kunming is 4485 km, and 1129 km of highway is used as special wildfire stopping roads and there is another 2671.6 km of fire breaks. By the year of 2005, another 18.5 km of fire stopping road will be added and 129 km of fire breaks will be constructed. In this way, forest fires spreading will be stopped effectively.

(3) Make use of weed killer in the fire breaks

To build green belts needs a lot of investment and the time circle is too long, yet they are very effective in fire fighting. At present, the construction can only be done step by step. Clearing the weed on the fire breaks involves a lot of labor and cost. Practice has shown that using weed killer to clear the weeds on the fire breaks is a quick, time and money-saving and effective way. The right way to do this is to spray weed killer on the weeds of firebreaks on clear morning in late July and early August. After 2-3 sprays, the weeds will die and planned

burning is followed in the next November. Repeat the process for 2-3 years and the effect will be great.

3.2.4 Improve the Warning System During the Fire Hazard Period

Fire prediction and forecast is an important approach in preventing forest fires. And it also serves as guidance in probing fire use and detecting and putting out fires. Under the condition of flammable material and with presence of fire sources, whether there will be wildfire and fire spreading depends on fire weather. The only thing people can do about fire weather is to predict it. Through prediction of fire, we can take initiatives to arrange the prevention preparations, reducing or avoiding forest fires.

3.2.5 Control Fire at Initial Stages

Forest guards have guarded all the mountains near Kunming against forest fires. Watchtowers and fire prevention checkpoints conduct around the clock monitoring of the mountains. Once fire breaks out, it can be timely reported to the commanding office. Now the special fire fighting teams have been equipped with vehicles and some of these teams station on the fire hazard places. They can react after 5 minutes of the fire warning. And this, fires can be put out in time. In addition, wildfire prevention and protection of forests have become household words. Once fire breaks, the voluntary fire fighting teams will help to put out fire at the initial stages.

4. Wildfire Management Objective during the 10th Five-Year Plan Period (2001-2005)

4.1 Establish Information Center

The construction of the Kunming City Fire Prevention Information System focuses on the following objectives. The system can be responsible for holistic commanding, facilitating and managing wildfire in the Kunming area. It can also master the dynamics of fire and analyze the trend and monitor the fire. In this way, fire-fighting forces can be arranged in time and the reaction at fire warnings can be faster, which consequently improve the comprehensive fire fighting ability and reduce the losses to the least degree. The construction of the information system includes wildfire monitoring and information processing system, fire site communication commanding system and modern office management system.

4.2 Improve Radio Communication Network

Improve radio communication network involves transforming the original 150 Mhz short wave network into 450 Mhz communication network and this will reduce radio interference and guarantee smooth communication. The new network will cover the major forests of Kunming City and 90% of the total land area of the city. The original network can be kept for the daily wildfire prevention communication at the county and township level. Or it may be reserved for future use.

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