



New South Wales Rural Fire Service

Australia-China Agricultural Cooperation Agreement

**Report on the Visit to China by a Delegation of NSW Rural Fire Service
Officers to investigate Forest Fire Management Arrangements.**

Host Agency: State Forest Administration of PRC

13th March to 29th March 2000

May 2000

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Executive Summary

Overview

China's population is 1.2 billion people and its landmass is 960 million hectares of which 133.7 million (13.92%) is forest. The majority of the forest is located in the southwest and in the northeast. Large areas of the southeast forest have recently been planted to recover bare hills and to strengthen the production of commercial timber. Some 33 million hectares of plantation timber have been established in China. This is the largest plantation of any country in the world. The predominant species are conifers and (more recently) eucalypts. *Eucalyptus* species have been sown in southwest China in recent years under aid-funded programs supported by Australia. One unintended consequence of these programs has been a significant and dangerous change in the fire environment in those provinces where eucalypts have been planted.

China has different fire seasons in different provinces, with the net effect that its overall fire season extends virtually all year. The majority of its fires occur in northeast China and in the southwest provinces. Southwest China is characterised by many small fires and more casualties but the northeast has fewer and larger fires and more serious damage. Guongdong Province has potentially the most volatile fire risk because of the rapid increase in fuel load and because of the cyclic variations in rainfall pattern caused by the El Niño effect.

Chinese records suggest that the number of fatalities being experienced due to forest fires has increased in recent years. This is probably due to the increased emphasis on expedient suppression of fire, which motivates fire fighters to go beyond the capability of their training and equipment thereby placing themselves in life threatening situations.

SFA has responsibility for fire protection on all forest land in China. This includes forest farms and forest areas in provincial and national parks.

Forest fire management in China is organised into five levels. These are:

1. National
2. Provincial
3. Municipal
4. County
5. Town/village.

At each level from County to National, the designated officers in charge will take responsibility for a fire when it elevates to their level of management. Fires that are less than one hectare are classified as Class 1 fires. Fires that are between 1 and 100 hectares are Class 2 fires. Class 3 fires are from 100 to 1000 hectares and Class 4 fires are bigger than 1000 hectares. Officers in charge sign contractual undertakings, and Class 1 and 2 fires are the responsibility of county fire control officers (FCOs). Class 3 fires are the responsibility of provincial FCOs and Class 4 fires are the responsibility of the

provincial control centre. The National control centre in Beijing is responsible for coordination and solving important issues.

When a fire is observed it is reported first to the town or village by telephone. A standard telephone number (95119) is used in Guangdong province. The local residents commence suppression activities organised by town/village authorities and at the same time report the fire to the town/village fire management office. As part of standing procedures, the town/village fire management office reports the fire to the county fire control centre and the county fire control officer assumes responsibility and control of the fire. If the fire becomes a Class 3 fire (> 100 hectares) the county fire control centre reports it to the provincial fire control centre and the provincial fire control officer assumes responsibility for control of the fire. These procedures for reporting and assuming control are well established and are displayed in each fire control centre.

Generally, each county, municipality, province and national level of the organisation has a fire management committee comprising representatives of various agencies such as civic administration, police, army, urban fire service, finance department, meteorology bureau and the SFA. At Municipal level the Mayor chairs the committee and is the Fire Control Officer. Typically the senior officers from SFA who are Deputy Fire Control Officers will support the Mayor. At the provincial level, the Vice-Governor is FCO with the provincial SFA Directors as DFCOs.

Recommendations

The following suggestions are proposed by the NSW RFS delegation for future consideration by SFA:

1. Any proposed projects must have clear and tightly written objectives to ensure demonstrable achievements at key milestones during implementation.
2. There is a need to review the Standard Operating Procedures (SOPs) being used in each province to enhance both direct and indirect attack techniques and fireground management. It is likely that considerable improvements can be made to fire fighter safety and effectiveness by such a review. A national approach should be taken to the development of these SOPs with provision for local variations where these can be justified by differences in terrain, human activity, fuel or weather.
3. Training of fire fighters, crew leaders and fire control officers should be reviewed to take into account any changes to the SOPs. Curriculum development for training programs should be given a high priority. A national approach to a training framework with provincial variations is suggested. While any SOPs and training programs must meet the needs of fire management, they also must fit China's political, cultural and economic structures. This is why it is vital that these materials be developed in China by Chinese experts.
4. The dependence on biological firebreaks in southern China is acknowledged as being appropriate for low intensity fires. Attention should be given to the development of effective procedures for use in medium and high intensity fires, especially in eucalyptus plantations, to deal with

situations where a fire might spot over or burn through a biological firebreak.

5. Consideration should be given to the inclusion of trails along the biological firebreaks to allow vehicles access to the site of a fire.
6. FCOs are rewarded by praise and honours for recording fewer and smaller fires while those who appear to fail in their duty to control fires are criticised and punished. It may be that this arrangement contributes to the under-reporting of fires and the under-estimation of the size of areas burnt.
7. The emphasis on improvements in the effectiveness of fire control centres is appropriate but such improvements must focus on improved procedures and management skills by fire control staff to strengthen their skills in coordinating fire brigades in the field.
8. Fire control staff currently have access to information on fire risks, GIS and fire weather warning systems. The effective use of this information in operational decision-making and the communication of decisions to fire crews are areas for further consideration and possible strengthening.
9. Fireground communication systems, especially in mountainous terrain are a further area for consideration and improvement, including the deployment of mobile repeater stations during high fire danger periods and suppression operations.
10. Fire spotting towers are widely used and give excellent coverage of the area, but may benefit from enhancements such as weather measurement instruments for local weather reporting and maps and compasses for accurately locating smoke plumes.
11. Contact should be promoted between CAoF and CSIRO and in particular Phil Cheney who is undertaking fire research work similar to that being undertaken in China. Mr Cheney had earlier indicated his interest in undertaking collaborative research with China if a suitable project could be identified.
12. Some research programs should be undertaken to test the effectiveness of current methods of community education
13. The central focal point of the above enhancements is the strengthening of fire management systems at the grass roots level. Enhancement of fire control centres at the provincial and municipal levels in Guanxi Province, Zhouqing and Yanji Municipalities is strongly encouraged provided that priority is given to the suggestions above. These centres would become models for other similar fire control centres and fire management systems throughout China.

Background to the Project

As a result of consultations between senior officials from New South Wales Rural Fire Service (NSW RFS) and China's State Forest Administration (SFA), both sides have agreed to closer cooperation in the area of forest fire management, prevention and suppression. It was also agreed that such cooperation would be undertaken under the auspices of the Australia/China Agricultural Cooperation Agreement (ACACA). Before such cooperation could progress it was seen as essential that both SFA and NSW RFS have a clear understanding of each other's organisational arrangements, resources, fire history, operational procedures and future plans for strategic development.

Consideration is being given to a possible aid-funded project in which the NSW Rural Fire Service and SFA would cooperate to undertake an institutional strengthening program to improve China's capacity to manage severe forest fires. Such a program of institutional strengthening would include the establishment of three model fire control centres in selected fire-prone provinces of China.

At the ACACA meeting of February 2000 in Canberra it was agreed that funding should be provided for a delegation of four officers from NSW Rural Fire Service to visit China to undertake a fact-finding delegation to investigate current fire management arrangements. This delegation would report its findings to the ACACA Joint Working Group on Forestry and to the Chinese State Forests Administration. The report will assist the SFA to prepare a plan for strengthening its organisational and management arrangements in relation to forest fires. It is envisaged that SFA will seek aid donor funding to support the implementation of the institutional strengthening phase of the program.

Fact-finding Delegation Description

This delegation enabled four officers from NSW Rural Fire Service to visit fire-prone provinces in south-west and north-east China to assess the forest fire management needs there and, specifically, to identify the opportunities and constraints involved in strengthening the organisation and management of forest fires in China, including the establishment of three fire control centres, one in each of the three target provinces. The mission visited the provinces of Guongdong, Guangxi and Jilin as well as Beijing.

Objectives

At the completion of this mission, the delegation:

1. developed a detailed understanding of forest fire management arrangements in China;
2. identified areas of appropriate cooperation between SFA and NSW RFS;
3. identified other aspects of forest fire management that could be addressed in a program of institutional strengthening;
4. identified likely locations for the establishment of fire control centres; and
5. commenced detailed discussions on the design, location and funding arrangements for such institutional strengthening.

Delegation membership**SFA**

Director Du Yongsheng
Deputy Director Chen Jieping
Huang Xueju

NSW RFS

Assistant Commissioner Ross Smith.
Assistant Commissioner Tony Howe
Superintendent Brian Graham
Duncan Sutherland

Observations by the Delegation**General Overview of China's State Forests Administration**

China's population is 1.2 billion people and its landmass is 960 million hectares of which 133.7 million (13.92%) is forest. The majority of the forest is located in the southwest and in the northeast. Large areas of the southeast forest have recently been planted to recover bare hills and to strengthen the production of commercial timber. Some 33 million hectares of plantation timber have been established in China. This is the largest plantation of any country in the world. The predominant species are conifers and (more recently) eucalypts. *Eucalyptus* species have been sown in southwest China in recent years under aid-funded programs supported by Australia. One unintended consequence of these programs has been a significant and dangerous change in the fire environment in those provinces where eucalypts have been planted.

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Guangdong Province

Guangdong Province is in southern China and has a subtropical climate. Forestry activities are primarily undertaken in mountainous areas of the province. The province comprises 21 cities and 120 counties of which 50 are in mountainous areas.

Guangdong Province has a total area of 17.8m hectares of which SFA forest land comprises 56.7%. In the period 1985 to 1999 the forest cover increased from 4.64 m hectares to 9.9 m hectares through a program of tree planting to restore trees to hills which had been stripped bare in past years. The tree-planting program comprises *Pinus* and *Eucalyptus* species, the latter being supported by aid funding from Australia since 1983.

The province has a high but very seasonal rainfall and experiences forest fires in September to April. In the period 1952 to 1999 the province experienced an average of 1,353 fires per year with higher incidence occurring in years of lower rainfall. Such lower rainfall is typically associated with El Niño events and occurs over a four to six year cycle. These fires burnt an average of 32,400 hectares each year in the province.

Fire protection is provided by professional forest fire brigades, semi-professional brigades and compulsory volunteer brigades. The latter group is made up primarily of farmers and are only called upon to back up the efforts of the professionals.

The average area burnt was 200 hectares. The main causes of such fires are human activities such as agricultural burning, incense, cigarettes and arson. During the entire period, on average, 4 fire fighters were killed and 47 injured as a result of forest fires. Many of these deaths and injuries occurred amongst the ranks of the volunteers.

There are 36 professional brigades in Guangdong Province, each of about 100 members. They are well drilled in direct fire fighting activities and are inspected for their proficiency every two years by provincial officers. They are equipped with wind blowers, flails, brush hooks, chain saws and some knapsack sprays. These brigades have access to troop carriers for deployment and are issued with hand-held portable radios for communication on the fire-ground and back to base. They are issued with protective clothing, helmets, gloves and light canvas boots with strengthened rubber soles. The protective clothing, which is treated with fire retardant chemical, is worn over army service uniform during training and operations. The professional brigades are the first to respond to forest fires (after the local farmers).

There are 462 semi-professional brigades with similar hand-held equipment to the professionals but fewer powered tools and vehicles. They receive some training and are mobilised during the fire season as reserves.

There are 9075 compulsory volunteer brigades in Guangdong Province, each of about 50 to 80 members. Because of the large numbers, these brigades do not receive training, hand tools or protective clothing and undertake suppression activities using farm tools or branches.

Large areas of the flat agricultural land in this province were recently affected by a prolonged frost period that had killed and damaged many agricultural crops including Lychees, Mangoes and Banana trees.

Fire detection in Guangdong Province mainly relies on reports from the public, watch towers and fire patrols. Some of the watchtowers are manned 24 hours per day during the fire danger period. The national headquarters also makes satellite images from NOAA available to provincial and county fire control centres.

The priority for forest fire management in Guangdong province is on prevention. The strategies used include community education, fire bans during severe weather conditions, hazard reduction burning, forest inspection stations and risk management planning.

Community education comprises signboards on roadways, railway stations, and parks and at other strategic locations. Announcements are made on radio and TV, especially when total bans are in place. Fire awareness presentations are also made to school students and to village people.

Total fire bans are imposed when fire weather predictions indicate the likelihood of severe danger of fires. These are based on measurements of relative humidity, rainfall, temperature, wind speed wind direction and atmospheric pressure. China has developed a complex algorithm for calculation of fire danger rating and has validated it in field observations.

Hazard reduction burning is used to a limited extent, primarily in grassland along roadways and railway lines that adjoin forest areas.

Forest inspection stations are roadblocks set up on access roads into the forest. Their purpose is to prevent the movement of combustible materials, including matches and cigarettes, into the forest and to prevent the poaching of timber and other products from the forest.

Risk management planning uses a system of grading different parts of the province according to the likelihood of ignitions, asset exposure and effectiveness of local prevention measures. The grading system takes into account fuel type, population distribution/social activities and climate. Grade 1 areas are most risky while grade 3 is least risky. This information is only applicable to managed forests and is mapped onto both chart maps and GIS computer database. It is used as a guide to fire management, especially suppression activities.

Fire control/suppression arrangements include use of ground troops for direct attack and use of biological firebreaks. Indirect attack tactics including back burning were also described.

Direct attack techniques involve the use of wind blowers to blow the fire out or to blow away the fuel. The technique is supported by other fire fighters with flails who attempt to beat the fire out or push the fuel back into the fire front. These techniques appear effective in direct attack on low intensity fires but are not effective for medium or high intensity fires. Back burning was described but the details were insufficient to assess its effectiveness. Most back-burns are established using biological firebreaks or roadways as the control lines.

Direct attack and biological firebreaks are the principal means of controlling fires. Based on research conducted in Guangdong Province by scientists from the National Forest Fire Research Academy, they are designed to divide the forest area into 100-hectare sections along the ridgelines. A biological

firebreak is formed using a fire resistant tree species *Schima Superba*, which is planted in a 15 to 20 metres wide belt. The tree grows to about 15 metres in height and has a closed canopy. Once established, the plantation restricts light to the under-storey, thereby reducing ground fuel species. In addition, the leaf litter generated by this species is of low combustibility.

Examples of biological firebreaks that were observed showed affective control of ground fuel in some cases but appeared less effective in others. The SFA reported a high maintenance requirement for the first five years after planting the firebreak. Guangdong Province has a plan to establish 83,000 km of biological fire breaks in the period 1999 to 2008, at a cost of RMB700m. With this level of investment, a great deal of the province's fire management effort is resting on the effectiveness of this strategy.

Training programs are undertaken at both the provincial and county levels. The provincial level programs are presented at Guangzhou Forestry School and are primarily for training of fire managers and fire control officers while training at county level is for county FCOs and professional and semi-professional fire fighters. Zhouqing Municipality advises that its local forest fire training facilities are inadequate and new facilities are needed urgently. The municipal priority is on enhanced training rather than improvement in the fire control centre.

Zhouqing Municipality is the preferred location for a model municipal fire control centre because it is in the centre of the rich forest resources of Guangdong Province. Zhouqing municipality has a total area of 1.6 million hectares of which 1.1 million hectares are dedicated for forests. A further motivation for making this municipality the priority is that the SFA staff located in Zhouqing have performed well to date with limited facilities. They acknowledge the need to improve SOPs and training and are enthusiastic to begin as soon as possible.

In the period 1952 to 1998, Guangdong Province reported an annual incidence of fires varying from as low as 185 fires to as high as 8,000 fires. The municipality of Zhouqing had 54 reported forest fires in the period 1995 to 1999 with a total of 467 hectares burnt. A total of 13 of these fires occurred in 1999.

Zhouqing Municipality has fire management responsibility for the Ding Hu Shan nature reserve, an area listed on the UNESCO Man and the Biosphere as being worthy of protection and preservation. Ding Hu Shan Nature Reserve is located within Zhouqing Municipality. It includes 1100 hectares of natural forest that is managed as an outdoor laboratory for research into ecosystems and biodiversity of the region and is a very popular tourist attraction outside the core area of the reserve.

Provincial authorities in Guangdong Province have identified the following strategic priorities for improvement.

1. Enhanced management techniques for preventing and controlling fires;

2. Improved guidelines and orders for control of fires, including enhancement of Standard Operating Procedures;
3. Development of training programs to implement these improved techniques and procedures;
4. Strengthening of the capabilities of officers to take responsibility for fire suppression;
5. Increased diversity of training techniques and technologies; and
6. Improved equipment for management of fires at the municipal fire control centre at Zhouqing.

Provincial authorities indicated that matched dollar-value funding was available from the provincial government to a value of \$AUD3m for a forest fire development program provided that an aid donor could be found. National representatives indicated that an approach would be made through MOSTEC to an international aid agency to support the project.

Guangxi Province

Guangxi Province lies to the west of Guangdong Province and is somewhat poorer in its agricultural industries. The province is 23.6m hectares with 14 cities and 113 counties. The capital city of Guangxi is Nanning. It has a population of 1.28 million people within a total provincial population of 46.3 million. Forestry covers 12.69m hectares of the province or about 53.42% of the land area. Guangxi has been undertaking a comprehensive re-forestation program in recent years in an attempt to recover from the impact of soil erosion and removal of trees from hillsides.

The province has 120 professional and 940 semi-professional brigades along with 7,000 compulsory volunteer brigades.

Guangxi experiences the highest incidence of fires of all Chinese provinces with an average of 478 fires per year from 1989 to 1999. The average area burnt per year was 3062 hectares. On average, three fire fighters are lost to fires annually with 6 being seriously injured. Guangxi Province has a fire season with activity from September to May.

The province has a total of 57,000 km of firebreaks of which 22,000 are biological firebreaks. Progress is slow in the conversion of these to biological firebreaks because it costs RMB4,000 per km to establish a biological firebreak.

A graphic videotape was screened by provincial authorities showing a fire training exercise held in 1992. The video depicted fire fighters undertaking direct attack on a fire using blowers and flails (#2 tools). It was clearly apparent from the video that the fire fighters have abundant energy and adequate equipment but their methods and organisation could be improved upon. Such improvements would quickly render their efforts much safer and more effective.

The distinctive features of Guangxi Province when compared to Guangdong Province are as follows:

1. Guangxi Province has a much larger number of fires;

2. Guangxi is a poorer province than Guangdong Province for a variety of reasons;
3. The province has a large minority group of Zhuang people. Because of this it is an autonomous region for administrative purposes;
4. The capital city of the province is Nanning. The city is quite small but growing very rapidly and has many modern high-rise buildings;
5. The province has a fire aviation centre at Bai She, which operates one helicopter and one fixed-wing aircraft and gives a total area of coverage of 14.77 million hectares. These aircraft are retained under contract for four months each year and are used for fire spotting, water bombing, leaflet drops and deployment of fire fighters.

The fire management problems in Guangxi Province were given as follows:

1. Insufficient budget for fire control management;
2. FCOs and fire fighters are inexperienced and make poor judgements which give difficulties in controlling situations;
3. The province is inadequate in fire coordination and collection of fire information from the field;
4. Training needs to be improved, especially for FCOs and fire fighters; and
5. The communications and fire weather prediction systems are incomplete.

Jilin Province

Jilin Province is about 880 km northeast of Beijing and is very cold at this time of the year. (-11 degrees Celsius). The total territory of Jilin is 18.7 million hectares and its population 26.1 million, most of which are of Han nationality and the rest comprise 43 minority nationalities, including Korean, Man, Mongolian and Hui.

The vast majority of the province's forest is located in the east especially in the Yanbian municipality, which has a high proportion of the Korean minority population. For this reason, Yanbian municipality is an autonomous area for administrative purposes. Yanbian municipality has a forestry area of 4.6 million hectares, which has 3.1 million hectares of forest cover (82%). Yanbian region has an 82% forest cover, which includes Chang Bai Shan nature reserve, a pristine wilderness of 197,000 hectares with outstanding biodiversity and extremely valuable biological values. This nature reserve is listed as part of the UNESCO man and the biosphere program as being of special importance as a wilderness area.

The province has 800 professional fire fighters and 2,000 armed forest police. There are also around 9,000 semi-professional fire fighters. An aerial protection station is located in the province and has at its disposal two helicopters for use in water bombing and fire patrols as well as the deployment of fire fighters using rappelling techniques to gain access to wilderness terrain. One forest police unit is located at Yanji City.

In addition to around 30,000 hectares per year of controlled burning, Yanbian municipality has around 30 wild fire incidents each year in its forest areas. These are largely caused by human activities, which include agricultural burning, cigarette smoking, burning of incense and paper tributes at gravesites and, to a lesser extent, arson. Lightning is a minimal cause of fires.

Because restrictions on access by the population effectively eliminates human causes, lightning is the main ignition source in the Chang Bai Shan nature reserve. Each fire averages around 200 hectares but some spot fire activity is reported. The municipality has a split fire season with activity in both spring and autumn.

The response time for each fire is around one hour. Given the prevailing wind, slope, fuel, fire behaviour and temperature conditions, the average area burnt seems unusually low and may suggest difficulties in estimation of area in hilly and wooded terrain.

In 1987 a very large forest and bush fire broke out in Heilongjiang Province to the north of Jilin. This fire destroyed around 1.33 million hectares of forest and resulted in the deaths of over two hundred people. Given the fire hazards in Jilin Province, there is a very real concern that such a fire could be a threat in the future. In that year, Canadian International Development Agency CIDA provided \$C5.7m of aid funding for the establishment of a fire control centre in Hailongjiang Province. The facility included a fire-monitoring watchtower, fire weather warning risk management system and lightning strike detection equipment. The facility was successful but limited in its coverage and transferability to other locations.

Of particular concern are cross-border fires from both North Korea and Russia. Both these countries use fire extensively for agricultural purposes and neither has the fire control or management arrangements that are in place in China. This means that wild fires sometimes encroach into China from across the national frontiers. Also of particular concern is the fact that Chang Bai Shan nature reserve is surrounded by 700,000 hectares of forest farms which have a significant incidence of fire due to the presence of human activities.

To prevent the spread of fires, Jilin Province makes extensive use of hazard reduction burning, especially along roads and railway lines. Fire breaks are established using tractor and plough on any arable land, especially near national borders but biological fire breaks are not used because of the unavailability of suitable tree species. Community education programs are used to warn people of the dangers of fires. During severe fire weather, total fire bans are imposed and announced through radio and television.

Jilin Provincial officials stated that the main issues for future improvement in the province include:

1. improvements in fireground and back-to-base communications, especially in mountainous terrain;
2. improved fire detection and monitoring technologies which give real-time, high resolution cost-effective detection and monitoring; and
3. training of fire fighters in both front-line fire fighting and in crew leader and fire management skills.

Chinese Academy of Forestry

The Chinese Academy of Forestry (CAoF) is located in Beijing. It is established as a training and research facility and is currently involved in a

wide range of research projects. Presentations were provided on the research findings on biological firebreaks and a project relating to fire behaviour. The researchers confirmed that China has most of its fires in the southern provinces but the biggest and most destructive fires are in the north.

Biological firebreaks are effective for low intensity fires, although low intensity was not defined. Large areas of such firebreaks have been established in the southern provinces based on this research. The effectiveness of biological firebreaks relies on no under-storey in the forest, no low branches on the firebreak trees, high moisture content in the leaves and complete canopy cover. The canopy and high moisture keep the relative humidity high and temperature low reducing the likelihood of ignition. The leaf litter generated by the selected tree species (*Schima Superba*) is of low combustibility. The breaks are planted at a width of 12 to 20 metres with trees at 1.7 metre intervals. Each break is a minimum of 950 metres long and is typically located along a ridgeline.

The research confirmed that some fire spotting occurs in China, especially with well-established fires. Where the flame height is up to one metre, direct attack and biological firebreaks are likely to be effective in controlling the fire. Where the fire intensity produces medium and high intensity fires (1-3 metres of flame height, and > 3 metres of flame height respectively) spotting can be expected and direct attack techniques will be ineffective. It is possible that spotting over a biological firebreak may also occur in these circumstances.

Beijing City Forest Fire Protection

Beijing City has responsibility for large areas of rural land and forests including the mountainous terrain along which sections of the Great Wall are located. This terrain is steep and inaccessible and provides a considerable fire hazard, especially during the dry winter and summer months. A likely source of ignition is cigarettes being dropped by visitors to the Great Wall.

The delegation visited a typical county (Fang Shan County) to observe facilities and fire management arrangements. County authorities have adopted a number of measures to meet the threat of forest fires. These include clearing of fire breaks along the open sections of the Great Wall, prohibition of cigarette smoking on or around the site, public education (using signage) warning of the danger of fires and deployment of fire fighting personnel and equipment at strategic locations along the Great Wall. The equipment cache observed included hand-held carbon dioxide extinguishers and flails. The latter were stored under sheets of corrugated roof iron, suggesting that they were used for training relatively infrequently. Fire management arrangements in areas away from the Great Wall were not considered in any detail.

At Fang Shan County fire control centre authorities also have in place a fire weather warning system, GIS database and remote closed circuit television cameras to detect fires. The GIS database provides the locations and vegetation types of all forest lands and can generate an image of the most efficient means of travelling from a fire station to a forest site. A Russian

delegation had recently visited this fire control centre and had considered the system “primitive”, although it was clear that it was very effective in providing the intelligence needed to manage the threats that were present.

While the delegation was unable to observe fire fighters at this location, it was apparent from the equipment caches observed that the expectation is that any fires would be of small size and low intensity, allowing direct attack. Notwithstanding this, the terrain and fuel load suggests the potential for a medium to high intensity fire under adverse weather conditions. The conditions on the day of the visit were calculated as being very high fire danger (using the Chinese method). (Temperature 20°C, RH 40% and wind speed 43 kph). A total fire ban had been imposed for the county and this advice was conveyed to the community using radio and television announcements. From the observation of two smoke plumes in the vicinity, it was apparent that the ban may not apply to certain areas or to certain types of fires. Given that the SFA only has jurisdiction over forestry land, it may be that the total fire ban does not apply to other land, or that the SFA relies on other authorities to suppress fires on land which is not forest land.

It was apparent that priority was being placed on early detection of fires. The Fang Shan fire control centre was quite modern and well appointed with effective fire monitoring, fire intelligence and communications equipment. How this information is used in fire suppression was not entirely clear but it was apparent that the Chinese authorities saw improved fire intelligence and its use by fire managers as a key priority.

Training of fire fighters in suppression techniques is also a priority, especially in relation to higher intensity fires. The training of fire control officers in fire suppression techniques for higher intensity fires is critical.

State Forests Administration Headquarters, Beijing

The Beijing headquarters of State Forest Administration includes a satellite forest fire detection, monitoring and management centre. This centre provides each province with fire intelligence and monitors fire management activities in all provinces. Where fires become particularly large the national headquarters assumes control from Beijing.

The national headquarters includes equipment and facilities for communication with provincial fire control centres and for exchanging fire intelligence. Provincial authorities advise the national headquarters of known fire activity including planned hazard reduction burning. The national headquarters monitors fire activity using both the NOAA satellite system and Chinese satellites.

NOAA hot spot images can provide an indication of the general location of fires. Provided the limitations of the system are borne in mind the output can be used to determine the general locations of likely fire activity.

Not all hot spots are fire activity and pixels can indicate a potential fire hot spot for reasons other than fire, associated with temperature differentials

across individual pixels. The nominal resolution of 1.1 km per pixel at the nadir, extending to 2.4 km. along the track and 6.9 km across the track, in relation to the motion of the parent satellite, renders satellite monitoring a totally inappropriate tool upon which to base fire response and suppression activity. Nevertheless it is a useful tool for monitoring the overall fire situation. Certainly, in areas of heavy fire concentration in other countries, such as Indonesia, there has been a strong correlation between presence of fire and numbers of hot spots. For example, in severe El Niño induced fire activity in Indonesia in 1997/98, individual hot spots could not be accurately referenced to a particular land fire. The best that could be said was that knowledge of the concentration of hot spots provided a good indicator of areas that should be surveyed using either ground or aerial means, provided that smoke haze from the fires does not limit ground visibility.

In China, all detected fires are considered by National officials then the number is reduced to manageable proportions by elimination of extraneous sightings. Follow up action is taken for larger fires on forestry land. Fires that are part of planned hazard reduction burning on forest estate or fires on other estates or hot spots due to industry are discounted. When an unexplained fire on forestry estate is detected provincial authorities are directed to investigate and report back.

There are some problems with the accuracy of satellite detection because of poor resolution. Experience in Indonesia suggests that the error can be as high as 7 kilometres, which becomes significant in mountainous terrain.

The Chinese State Forest Administration authorities report that their annual average losses due to fires are 900 injuries and 50 deaths per annum along with the loss of 54,000 hectares of forest. Given that these figures only include forest estate, it is likely that the losses in other types of fires (agricultural and grassland fires) would be somewhat higher.

It was very significant to note that, on the day the delegation was due to leave Beijing, very severe fire weather was experienced over large areas of central and southern China. Severe fires were reported in Hubei and Fujian Provinces and news media subsequently reported the deaths of several fire fighters. When invited to comment on the situation, Director Du Yongsheng said

“Our firefighters and local firefighting commanders severely lack effective practical training and on-the-job training, with the result that the casualties of firefighters often occur during the field operations. This kind of situation was heavier during last year and this spring than in previous fire seasons”.

The Chinese authorities are clearly committed to improving their fire management arrangements and they are very interested in seeking help from international fire management agencies to assist them in their endeavours. China recently hosted a delegation from Russia and a Chinese delegation will visit Canada for four weeks in June. The purpose of the visit to Canada is to investigate fire weather warning systems in more detail.

It is Director Du's clear intention to seek the best technologies and ideas that international counterparts have to offer and to adapt those ideas that are suitable to the Chinese situation. In this regard his approach is visionary and very proactive. It also represents an excellent opportunity for Australia to respond. Closer cooperation between Australia and China in the area of forest fire management will strengthen our mutual relationship in an area where both sides have much to offer and also much to learn.

Enhancement of Fire Management Arrangements in China

Ideas for the possible development of a program to enhance fire management arrangements in China were discussed at length. The following points emerged from the discussion:

- China is ready to match any external funding with national and provincial funds on a dollar-for-dollar basis;
- China will seek support from international aid agencies to support this program;
- Fire protection for environmentally sensitive areas such as Chang Bai Shan and Ding Hu Shan nature reserves was also discussed. China may seek funding from the Global Environment Fund (GEF) which is managed by the Asia Development Bank;
- NSW Rural Fire Service indicated that it was available to assist in the future if this was considered appropriate;
- It is unlikely that an aid agency would provide funding for construction of buildings or general provision of equipment. Foreign aid priorities for funding in China include institutional strengthening which may cover the development of improved fire management techniques and improvement of training curriculum. It is essential that these matters be discussed by State Forestry Administration officials with international aid agency representatives in Beijing.

Next Steps

1. It was agreed that NSW Rural Fire Service should report its findings to ACACA as soon as possible;
2. Concurrently, State Forestry Administration should commence the preparation of a proposal for international aid funding. Various sources of funding should be considered;
3. On completion of a first draft proposal for the program, the parties should meet again to consider progress and to clarify outstanding issues. It is anticipated that this visit will be in July or August, 2000;
4. There was strong interest from provincial officials in a possible return visit to Australia. A return delegation will visit Australia in October/November 2000 and will include representatives from Guangdong, Guangxi and Jilin provinces as well as State Forest Administration headquarters officials. It will provide general exposure to forest fire management in Australia with emphasis on development of standard operation procedures, training and fire management through fire control centres. It is anticipated that this delegation will be funded by ACACA under similar terms to this delegation.
5. It is proposed that an additional delegation from China will visit New South Wales between November and February for a more specialised introduction to fire weather-warning systems, risk management planning,

use of aircraft in fire fighting, development of standard operating procedures and standards, and controlled burning. The Chinese delegation will meet all its own costs of this additional delegation.

Suggestions from the Delegation

The following suggestions are proposed by the NSW RFS delegation for future consideration by SFA:

1. Any proposed projects must have clear and tightly written objectives to ensure demonstrable achievements at key milestones during implementation.
2. There is a need to review the Standard Operating Procedures (SOPs) being used in each province to enhance both direct and indirect attack techniques and fireground management. It is likely that considerable improvements can be made to fire fighter safety and effectiveness by such a review. A national approach should be taken to the development of these SOPs with provision for local variations where these can be justified by differences in terrain, human activity, fuel or weather.
3. Training of fire fighters, crew leaders and fire control officers should be reviewed to take into account any changes to the SOPs. Curriculum development for training programs should be given a high priority. A national approach to a training framework with provincial variations is suggested. While any SOPs and training programs must meet the needs of fire management, they also must fit China's political, cultural and economic structures. This is why it is vital that these materials be developed in China by Chinese experts.
4. The dependence on biological firebreaks in southern China is acknowledged as being appropriate for low intensity fires. Attention should be given to the development of effective procedures for use in medium and high intensity fires, especially in eucalyptus plantations, to deal with situations where a fire might spot over or burn through a biological firebreak.
5. Consideration should be given to the inclusion of trails along the biological firebreaks to allow vehicles access to the site of a fire.
6. FCOs are rewarded by praise and honours for recording fewer and smaller fires while those who appear to fail in their duty to control fires are criticised and punished. It may be that this arrangement contributes to the under-reporting of fires and the under-estimation of the size of areas burnt.
7. The emphasis on improvements in the effectiveness of fire control centres is appropriate but such improvements must focus on improved procedures and management skills by fire control staff to strengthen their skills in coordinating fire brigades in the field.
8. Fire control staff currently have access to information on fire risks, GIS and fire weather warning systems. The effective use of this information in operational decision-making and the communication of decisions to fire crews are areas for further consideration and possible strengthening.
9. Fireground communication systems, especially in mountainous terrain are a further area for consideration and improvement, including the deployment of mobile repeater stations during high fire danger periods and suppression operations.

10. Fire spotting towers are widely used and give excellent coverage of the area, but may benefit from enhancements such as weather measurement instruments for local weather reporting and maps and compasses for accurately locating smoke plumes.
11. Contact should be promoted between CAoF and CSIRO and in particular Phil Cheney who is undertaking fire research work similar to that being undertaken in China. Mr Cheney had earlier indicated his interest in undertaking collaborative research with China if a suitable project could be identified.
12. Some research programs should be undertaken to test the effectiveness of current methods of community education
13. The central focal point of the above enhancements is the strengthening of fire management systems at the grass roots level. Enhancement of fire control centres at the provincial and municipal levels in Guanxi Province, Zhouqing and Yanji Municipalities is strongly encouraged provided that priority is given to the suggestions above. These centres would become models for other similar fire control centres and fire management systems throughout China.