

**Framework for Fire Management Planning, Prevention and Control  
For  
Afforestation in Ha Tinh, Quang Binh and Quang Tri Provinces,  
Vietnam  
(KfWII)**

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### **3 ABBREVIATIONS**

- FDR - Fire Danger Rating
- FFPS - Forest Fire Prevention and Suppression
- FPD - Forest Protection Department (Kiem Lam)
- KfW - Kreditanstalt für Wiederaufbau
- MARD - Ministry of Agriculture and Rural Development
- PAM - Programme Alimentaire Mondial
- PMU - Project Management Unit
- ROS - Rate of Spread

## 4 EXECUTIVE SUMMARY

The recently established *Pinus merkusii* plantations of the KfWII afforestation program in Ha Tinh, Quang Binh, and Quang Tri Provinces in Vietnam were evaluated for wildfire threat. Historically, many of these areas were formerly moist and dry deciduous tropical hardwood forests. These forests contained minimal amounts of fuel (leaf litter) that would occasionally burn during seasonal droughts. Today, the establishment of dense, mono-cultures of *Pinus merkusii* is altering the normal fuel complex with the addition of highly flammable pine needle litter and even-aged stand structures. Currently, a low fire hazard/risk exists within the young plantations. However, as the plantations mature, fire hazard will increase. Mature plantations of *Pinus merkusii* established by previous projects are already showing signs of increased fire hazard and occurrence. With the increased frequency and severity of El Nino driven drought events in the past 20 years, the size and duration of unwanted wildfire events may also increase. If the long-term forest management objective is to retain *pinus* as the predominate species, mitigation of the developing fuels hazard through intensive fuels management and enhancing fire suppression capabilities is needed. Silvicultural/fuels management activities such as pruning, thinning, reduction of live and dead understory fuel, and wider tree spacings are recommended. In addition, a less-systematic plantation establishment scheme to achieve a diversity of species, size classes, and densities that emulate natural forest conditions would be more resistant and resilient to disturbance. Finally, the construction of „white“ or clear fuel breaks in key locations would provide improved access and more effective fire control „anchor points“ from which fire suppression actions could be initiated.

A strong organizational framework and technical knowledge for fire management exists with the cooperative efforts of People’s Steering Committees and the Forest Protection Department, however a lack of financial resources limits the existing capacity and future enhancement of fire suppression capabilities of local people and government authorities. Knowledge and acceptance of „no burn“ policies are well understood, but accidental fires continue to occur. Fire management could be improved within the project area by enhancing prevention, detection, and suppression capabilities, as well as collection and transfer of Fire Danger Rating information. The design and development of a national fire prevention symbol or mascot geared towards children would improve the fire prevention awareness message. Installation of lookout towers, weather stations and fire danger rating boards would improve detection and information transfer. Knowledge and capacity building could be improved through providing specific training in various technical aspects of fire management. Four options are conceptualized to enhance the fire management infrastructure. Each option has a focus on prevention and detection and also includes varying levels of improvement of suppression capabilities through the purchase of specialized firefighting equipment. Specific details of each option will be developed by the Project Management Units.

## 5 INTRODUCTION

The KfWII project has supported 14,804 households in 56 communes (250 villages) to establish 22,230 hectare of production forest in three (3) Provinces (Ha Tinh, Quang Binh, and Quang Tri) in Central Vietnam. Approximately 66% Pinus/Pinus+Acacia and 34% Acacia and other species have been progressively established since 1997. The general objective of the plantations is to contribute to protection of forest resources (by increasing forest cover and reducing soil erosion) and generate income for upland farmers in remote areas by harvesting forest products (i.e. resin) and receiving payments from individual deposit accounts (Kirchoff 2002).

Based on the combined factors of seasonal drought (April - September), natural grass/shrub vegetation, fine dead litter fuels, and land use practices of the local population, an evaluation of the wildfire threat on the long-term sustainability of the existing pine plantations was conducted by assessing the fire risk, fuels hazard, suppression capabilities, and values at risk (Annex A).

The forest plantations established via KfWII have an important long-term, economic and strategic value for local, district, provincial and national development. The plantations are valuable because of their inherent character as a renewable natural resource and significantly contribute to the total forest cover within each Province (Table 1). Recommendations are based on the assumption that the long-term forest management objective is the sustainable management of the pine plantations. To protect the plantations from forest fires, practical fire management objectives must be clearly defined and the responsibility shared between the people and the government. If long-term forest management objectives would change, then fire management objectives and practices would also change. A strong organizational framework is essential to coordinate, support and implement fire management for the numerous, scattered, small-landholdings on which the plantations exist.

**Table 1: Forest area coverage for three Provinces in Central Vietnam(sources: Minh and Binh 2002, MARD 2001).**

Province	Total Forest Cover (ha)	KfWII Plantations (ha)	Total Plantations (ha)	Natural Forest (ha)
Ha Tinh	605,574	6,728	37,138	169,367
Quang Binh	803,760	7,868	38,851	447,837
Quang Tri	465,134	7,634	35,064	103,097

Considering the large investment the KfWII project has made to establish the forest plantations (US\$225/hectare), additional investment to improve the capability of local people and the Forest Protection Department (FPD) to minimize fire-caused damages to the plantations has been recommended by KfWII National Project Management Unit (NPMU) staff. There is no full-proof method or guarantee that additional investment will be 100% effective in fully protecting the plantations from fire, but investing in



fire management now can mitigate the fire-caused damages that may occur in the future.

Several laws and decrees have been issued on forest fire prevention and suppression in Vietnam (Azrina 2002) that include:

1. September 11, 1972 – Presidential Ordinance on Forest Protection.
2. 1991 – Law on the Protection and Development of Forests, articles 18, 20, and 22
3. Decree No. 22/CP/1995 – Regulation on the Prevention and Suppression of Forest Fires, Articles 6, 8, 17.
4. Directive No. 177/TTg/1995 – Urgent measures for Forest Fire Prevention and Suppression.
5. Decree No. 77/CP/1996 – Administrative Sanction in Forest Management, Protection and Management of Forest Products.
6. Directive No. 7/1998 – Strengthening the Prevention and Fight Against Forest Fires.
7. Decision No. 1856/1998 – Development of Forecast Levels for Forest Fires.
8. Directive 19/1998 – Urgent Measures for the Prevention and Fight Against Forest Fires.
9. Decision No. 86/1998/QD-TTg - establishment of Central Steering Committees for Forest Fire Prevention and Suppression at national, provincial, district and commune levels.

The above regulations are a comprehensive regime for dealing with forest fires, however problems exist from inadequate human and financial resources, and jurisdictional overlap between Forestry Law and Laws on Environmental Protection (Azrina 2002). Implementation of the above regulations requires that all levels, including government and non-government institutions, foreign donors, and specifically communes and villages, whose livelihoods are partially dependent on the sustainable management of forest plantations, must strictly obey these policies and support the protection effort.

The above regulations must be financially supported from National, Provincial and District levels to clearly establish the roles, responsibilities, duties and functions that are necessary for fire prevention, detection, suppression, enforcement and fuels management. A high priority must be given to strengthening institutions involved in the protection of forests from fire, especially at the Provincial, District, Commune and village levels. Coordination and cooperation between the Forest Protection Department, KfWII Project Management Units, and local governments is needed to ensure adequate personnel, suppression equipment, and financial resources are available to effectively involve local communities in fire management.

A well-developed knowledge exists at the National level of the basic needs and appropriate implementation measures for fire management (Hung et al 1999, Hung 2000, 2001). However, there is also an honest recognition of the inherent limitations of fully developing and applying fire management at the local levels (Hung et al 1999). Aspects such as conducting fire prevention education, calculating and disseminating Fire Danger Rating data, establishing effective lookouts, responding to fires in a timely manner, fire

fighter training, organization and fuels management have been documented (Hung et al 1999, Hung 2000, 2001). However, a lack of available finances at all levels has limited the full and consistent implementation of this knowledge. Despite this, certain aspects are functioning in specific areas and local people with vested interests in the land are carrying out minimal levels of fire suppression. The opportunity exists to further develop fire management knowledge at the National level and improve the fire prevention, detection, suppression, and fuels management activities at the Provincial, District, Commune and village levels.

## 6 TERMS OF REFERENCE

The short-term expert will assist the project to assess the risks of fire, explore the potential and necessary activities and equipment for fire prevention measures. The main purpose of the assignment is to come up with an implementation framework for fire prevention measures on which basis the Provincial Project Management Units can formulate detailed work plans and co-ordinate implementation of recommended measures accordingly. His/her primary tasks are as follows:

1. In close co-operation with the national fire expert on fire prevention conduct a survey in the project area to assess the risks of fire for sustainable management of the established plantations.
2. Explore the potential of fire prevention measures including necessary activities and equipment. Assess and discuss the proposal of the Vietnamese counterpart for fire prevention.
3. After discussion with the Vietnamese counterpart an implementation framework should be outlined in view of implementation within the next 3 years and the available funds.
4. Recommend specific training and capacity building measures.
5. Recommend how to effectively involve local communities into the activities and maintenance of established fire protection infrastructure.
6. Prepare a short report (max. 20 pages) covering the above mentioned tasks.
7. Present the implementation framework in a half-day workshop in Hanoi.

Duration of the assignment: 1.0 month

## 7 METHODS

The international fire management expert (Mr Bradford M Sanders), in close cooperation and assistance from the Vietnamese counterparts consisting of the national expert on forest fire management (Dr Pham Ngoc Hung) KfWII national staff (Mr Quach Dai Ninh), and an experienced interpreter/translator (Ms Doang Kim Thoa), performed the following:

1. Literature review of available and relevant documents in following areas (References):
  - a. Vietnamese forest-sector policy (5 million ha reforestation program)
  - b. Forest fire management in Vietnam
  - c. Institutional/organizational framework of the Forest Protection Department, MARD
  - d. KfWII Project Implementation documents
  - e. Fire management planning outlines from other countries
  - f. Other relevant documents
2. Conduct rapid field surveys and interviews within aforementioned provinces and selected districts/communes (Annex B) to review the following (Annex C):
  - a. Fuel type/composition, loading, configuration, and arrangement within plantations and of adjacent areas
  - b. Access, water sources, existing/available fire suppression equipment, fire break construction, communication capabilities at all levels (farmer, village, commune, district, province)
  - c. Farmer/village/commune level use of fire for land-use practices, season, procedures, policies and regulations, penalties
  - d. Existing fire management organizational structure, responsibility, enforcement and relationships and agreements between all levels
  - e. Mechanisms for information transfer and use of fire prevention information, Fire Danger Rating and reporting fires
  - f. Fire detection, initial response/capability, and extended fire suppression mobilization capacity
  - g. Institutional financial support and mechanisms for carrying out fire prevention, suppression and fuels treatments
3. Conduct a daily review session with Team members to discuss the following topics:
  - a. What did we see, hear, and learn from our discussions and site visits?
  - b. What elements of a fire management organization are in place and which ones are missing?
  - c. What are the problems exist to prevent and suppress fires?
  - d. What are some possible solutions, needs, and recommendations we can offer to improve the capacity to protect the plantations? (must be practical, useful, and effective).
  - e. Clarification of details relevant to fire management.
5. Identify/recommend appropriate fire suppression equipment for various

- levels. Obtain summarized lists of fire equipment, infrastructure and desired training needs from each province and district.
6. Identify/recommend fire suppression training needs for farmers, village fire crews, district FPD staff.
  7. Identify how local communities and district FPD staff (or other appropriate/responsible agency) to cooperate and assist each other with fire prevention and suppression responsibilities
  8. Identify/recommend additional capacity-building measures and opportunities such as:
    - a. Standard Operating Procedures for fire management
    - b. Review of job descriptions for FPD staff
    - c. Training of Trainer development
    - d. Development of fire prevention information and educational materials
    - e. Facilitation of meetings for involving communities in fire management
    - f. Developing formal “cooperation agreements” between all levels
    - g. Budget development, procedures, and allocations
  9. Develop an outline for implementing above recommendations during the next three years using available funds
  10. Present the results of the mission to appropriate staff at MARD.

## **8 RESULTS & DISCUSSION**

### **8.1 General Fire Management Considerations**

Fire management is the process of effectively minimizing the negative impacts of fires on the environment, human health, and valuable investments, such as homes, crops, forest plantations and other improvements, and the use of prescribed fire to meet management objectives. Three major components for managing the fire threat are:

1. Fire prevention through education and awareness programs and enforcement of regulations.
2. Fire detection, safe/effective initial fire suppression response, and mobilization/logistical support for large fire incidents.
3. Fuels management to meet ecological and human needs.

An effective fire management system is characterized by:

1. An officially designated organization lead by a single official that is responsible for preventing and suppressing fires. This organization can be replicated at various levels and each level can be delegated varying degrees of responsibility based on capabilities and needs.
2. Prompt detection and reporting of fires.
3. Well-organized, equipped and trained fire suppression crews.
4. Prompt initial-response to reported fires.
5. Availability and use of proper equipment suitable for the terrain, fuels and expected fire behavior.
6. Cooperation between government agencies, institutions, communities, and small landowners whose assistance is needed in large fire, emergency situations.
7. Written cooperative agreements (and/or regulations) with adjoining fire organizations for assistance and aid that are established well in advance of a fire event.
8. Written strategic and operational (tactical) fire management plans that provide direction, assign responsibility, and define budget parameters.

Applying these major fire management components and characteristics is most effective on large, continuous areas of land, where ownership and land-uses are stable and consistent, boundaries are well defined, and where land management activities are uniformly applied. Fire management planning is tiered (directly linked) to overall forest and land management plans, policies, and objectives and identifies fire hazards/risks, strategies, values to be protected, and agencies responsible for implementation. The overall goal is to facilitate the coordinated effort to protect life, property, other valuable assets, and meet the direction of overall land management objectives.

Forest fire management preparedness and fuels management activities are essentially an insurance policy that is used to protect and minimize damages to valuable forest resources. Consistent financial support is needed to ensure the training, equipment, personnel, and standard

operating procedures are constantly applied and prepared for implementation at a moments notice. Fuels management activities must also be regularly applied to maintain fuel loadings in a non-hazardous condition. The benefits of preparations and investments in fire management may be difficult to realize in the short-term during periods of little or no fire activity, however the ability of the organization to effectively respond to wildfires during severe dry periods will be optimized.

### **8.1.1 Existing Fire Management Conditions**

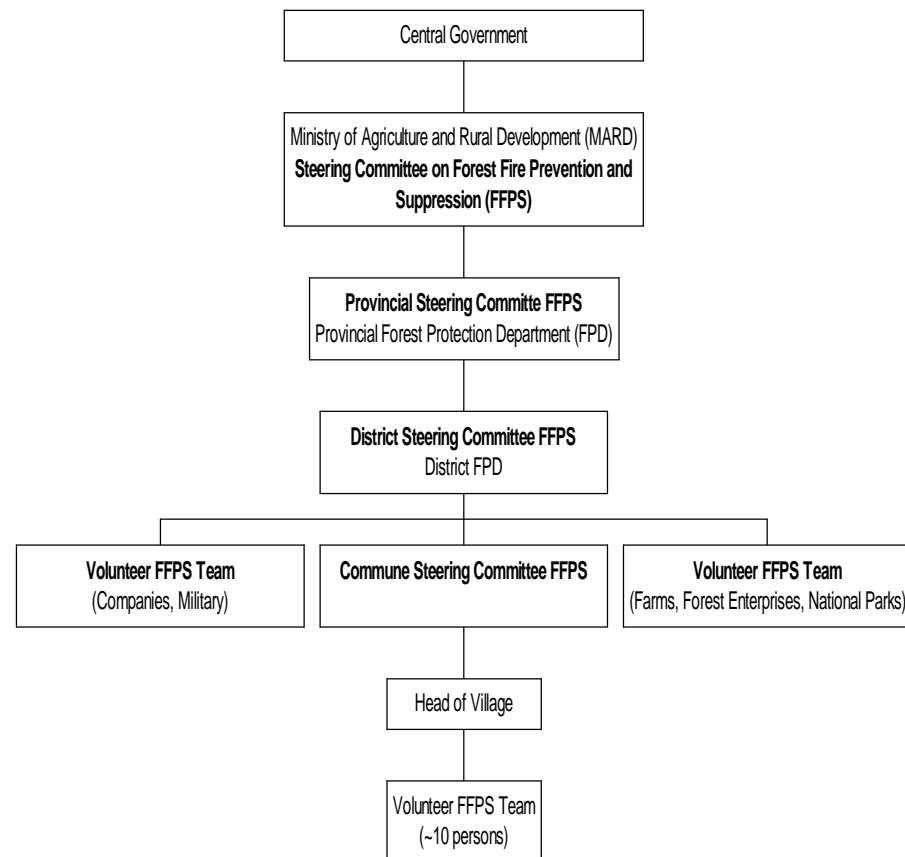
The KfWII plantations are generally scattered blocks of land ranging in size from 5 to 150 ha with multi-ownerships averaging approximately 1.5 ha per household. Plantations are commonly intermixed with other land uses such as upland agriculture, rice farming, grazing, and adjacent to mature Pinus or Acacia plantations previously established by other donor funded projects such as PAM, Project 327 and the current 5 Million Hectare Reforestation Program. Land use rights are granted by the District government for 50 years (Red Book Certificate) in the name of the female marriage partner, usually the year after plantation establishment. Delineation of land between households is commonly marked with by a narrow strip of Acacia trees. The primary land use is expected to remain forest plantation until 2010. At this time, land-use agreements permitting annual withdrawals from individual deposit accounts for establishing and tending the plantations, will expire.

The current Vietnamese fire management policy on forested lands is total fire exclusion to minimize the negative impacts of fire on soils. (Hung 2001). However, it is impossible to expect the total elimination of all fires from a natural or managed forest environment, especially with a large pine component. Therefore, a measure of the effectiveness of a fire management program is how well the organization initially responds to and safely controls an unwanted wildfire to minimize natural resource damage. Generally, if a forest wildfire is not controlled within the first 24 hours after detection, more extensive firefighting efforts, in terms of personnel and equipment, will be needed. Based on experience from the United States (GAO 1999), Canada, Australia, and Vietnam (Hung, pers. Comm.), a 90-95% effectiveness in initial attack can be expected during the dry (fire) season, provided that adequate personnel and equipment are available. Even with the most basic tools and effort, most fires can be successfully controlled within a 24 hour period (usually less than 40 ha)

One focus of fire management should be to ensure there is a safe and efficient system for detecting, responding, and suppressing fires within this 24 hour time frame, with the goal of suppressing fires at less than 40 ha as the determining element for success.

Field interviews identified the existence of a clear and definable organization (Hung, 1999) for fire management within Ha Tinh, Quang Binh, and Quang Tri provinces consisting of People's Steering Committees, Forest Protection Department staff, Commune and village leaders, as well as local farmers with either vested interest in protecting their forest plantations or mandatory participation as a community member (Figure 1).

Examples of District and Commune level fire prevention and suppression regulations were obtained (Hai Son Commune 2003, Vinh Linh District 2003). These documents clearly identify Steering Board members, authority, roles and responsibilities, expectations, links to legislation, and make recommendations for improvement. Interviews with farmers and other officials at all levels indicated a common knowledge, appreciation, and acceptance of these regulations and organizational structure along with proven basic implementation. Interviews at all levels noted that financial support was lacking to fully implement the basic components of fire prevention and awareness training, detection, compensation for firefighting, and improving suppression equipment capabilities.



**Figure 1: Fire management organization in Vietnam.**

## 8.2 Fire Ecology

Fire is an ecological disturbance process that cannot be totally eliminated from any natural environment provided there are available fuels and a potential ignition source. A basic premise of fire ecology is that wildland fire is neither innately destructive nor constructive: it simply causes change. Whether these changes are viewed as desirable or not depends upon their compatibility with long-term land/forest management objectives. Irrespective of a human viewpoint, change is biologically necessary to maintain a healthy ecosystem, which can be characterized by one that is both resistant and resilient to periodic natural disturbances. Land managers can manipulate



fire-caused changes in the environment to meet the needs of both humans and the ecosystem, while at the same time preserving the underlying natural processes and functions by varying the timing, frequency, and intensity of fire disturbance (i.e prescribed fire).

The KfWII plantation areas have undergone significant land-cover changes during the past centuries. Historically, deciduous tropical hardwood forest covered much of the area, however past intensive land use practices and more recently the impacts of war have altered or removed the natural vegetative cover. The establishment of *Pinus merkusii* and Acacia (and other species) forest plantations is the latest land use. Although fire is often not thought of as a common disturbance process in deciduous tropical forests, the occurrence of seasonal dry periods make fuels (grass-herb layer, shed leaves) flammable and allow for the spread of ground fires. The frequency and severity of such fires are not well documented in Vietnam. Historically, in South Asia, fires were ignited by humans for swidden agriculture, grazing, and collection of non-wood forest products (Goldammer 1997). The ecological impacts of periodic fires promote fire tolerant trees that replace species growing in an undisturbed environment.

The tropical pure pine forests of South Asia, e.g., *Pinus khesyia*, *Pinus merkusii*, *Pinus roxburghii*, most often are the result of a long history of regular burning (Goldammer 1997) because of the flammable conditions created by the presence of dead needles. *Pinus merkusii* displays many fire-resistant characteristics that include:

1. thick bark
2. 2-4 year grass-stage of thick needles that protects the terminal bud from low-intensity fires while a deep tap-root develops
3. prolific natural regeneration on disturbed sites.

*Pinus merkusii* naturally forms open savannah forests that typically develop into dense forests if fires are suppressed. Fire intervals longer than 3-5 years allow broadleaved species to overgrow pine seedlings and may cause high-intensity fires. Annual fires inhibit natural regeneration during its 2-4 year grass-stage. Fire-climax forest communities are formed when exposed to frequent (3-5 years), low-intensity, surface fires. Mature stands are generally resistant to periodic dry season burning if maintained in an open savannah/grass condition. However, fire can damage the tree if large portions of bark are removed for resin collection or understory vegetation and fine, dead fuels are allowed to accumulate. Long-term Integrated Fire Management processes combining weeding and prescribed burning are needed to maintain open stands (Kosketa and Luukkanen, Luukkanen et al., Technical Note No. 58, 2000).

The establishment of KfWII *Pinus merkusii* plantations in areas that were historically deciduous tropical hardwood forests creates significant challenges for fire management to the sustainable management of the forest plantations. Although *Pinus merkusii* grows very well in the thin, poor soils of the project area, it probably did not naturally grow in these areas, and its flammable characteristics increase the probability that fires will occur during the annual dry season. As a result, intensive fuels management treatments and fire protection mechanisms will be needed to meet the current policy of fire exclusion and for long-term sustainability of the plantations.

### 8.3 Fuels Hazard

Fuels can be classified into four groups – grasses, shrubs, timber, and slash. The differences in fire behavior among these groups are related to the fuel load, size and shape by size classes, compactness (bulk density), horizontal continuity, vertical arrangement, moisture content and chemical content. Fire Rate of Spread (ROS) and intensity (flame length or heat output) are dependent upon various combinations of the above characteristics. In the United States, thirteen (13) fuel models describe the general burning characteristics of the above four groups. Fuel models are a quantitative means of describing a fuel complex and mathematically calculating fire behavior. Choosing a fuel model depends on the fuel component that is primarily contributing to fire spread, most often the fine dead vegetation such as needles, grasses or forbs. Fuel models describe the severe period of the fire season when wildfires pose greater control problems and impact natural resources. Fuels hazard is a qualitative rating (i.e. low, medium, high) assigned to a fuel complex to describe its susceptibility to ignition, wildfire behavior and severity, and the suppression difficulty it represents (Anderson 1982).

The 14,580 ha of KfVII pine plantations range in age from 3-5 years old with average pine heights of 150cm or less, and over 90% survival at spacings of approximately 2.5 x 3 meters. The existing, observed vegetative fuel complex occurring between the pines can be described as persistent shrubs that almost totally cover the soil surface areas. A moderate grass, fern, and forb component is also present. Occasional palmetto shrubs were observed in some areas, as well as occasional coniferous forbs. No large woody debris was observed on any site, and only low to moderate amounts of fine dead fuels were present. Fuel bed depth ranged from 10 – 100 cm with total dead and live fuel loads estimated at less than 5 tons/hectare. These conditions can be described as Fire Behavior Fuel Model 5 (Anderson, 1982) where generally fires are not very intense because surface fuel loads are light, the shrubs are young with high live fuel moisture contents and little dead material. Fires generally burn in this fuel type only in the driest of dry seasons. Additional observations and experience are needed to determine the potential volatility of these shrubs based on the content of oils and waxes (Fire Behavior Fuel Model 7) where fires can occur at higher live fuel moisture contents due to this increased flammability. Generally, the fuels hazard for the existing pine forest plantations is low to moderate depending upon the amount of vegetative curing that occurs in the live fuels during the six month dry season. At present, fire behavior (ROS, intensity) is expected to remain low for the next 3-5 years, however this will begin to change as the pines grow and the amount of fine, dead needle-cast begins to accumulate on the ground and become draped in the shrubs.

Several Pinus merkusii plantations established since 1977 through the World Food Program „Programme Alemnbaire Moudial“ (PAM) project were examined to provide an indication of how the fuel conditions in the KfVII plantations will appear in the future. Generally, these mature plantations were approximately 5 – 10 meters in height, and had been thinned from approximately 2,500 trees/ha down by varying degrees to as low as 600-800 trees/ha. All plantations had completely closed canopies

and heavy shading. The fuels complex observed in these stands varied depending upon management activities conducted (i.e. brush cutting, branch pruning, resin collection), however the persistent element that was different from the young KfWII plantations was the increased amount of long-needle, fine, dead, fuel on the ground and draped in the shrubs. The presence of long-needle litter is described as Fire Behavior Fuel Model 9. During dry seasons, long-needle litter is easily ignited due to its high surface area-to-volume ratio allowing for rapid drying, contributes to rapid ROS due to its horizontal continuity and „spotting“ potential, and it promotes „torching“ of overstory trees due to the vertical draping of needles in branches and shrubs. Evidence of these characteristics were witnessed at a site in Quang Binh province where approximately 2 ha were burned in June 2002 and the fire „jumped“ across existing access roads approximately 5 meters wide. All discussions with local farmers indicated that fires were primarily the most difficult to control in mature pine stands than in the existing young stands of the KfWII project.

In summary, Fire Hazard is generally low in the existing young KfWII plantations and expected to remain so for another 3-5 years. However, within the next 5-10 years, Fuel Hazard will dramatically increase with stand age as long-needled, fine, dead litter begins to accumulate within the pine plantations. Additionally, the cumulative Fire Hazard in the project area is increasing with the continued establishment and maturity of pine plantations by PAM, Project 327, and the 5 Million Hectare Reforestation Program. To mitigate this cumulative impact, intensive fuels management treatments and effective prevention and suppression programs will be necessary.

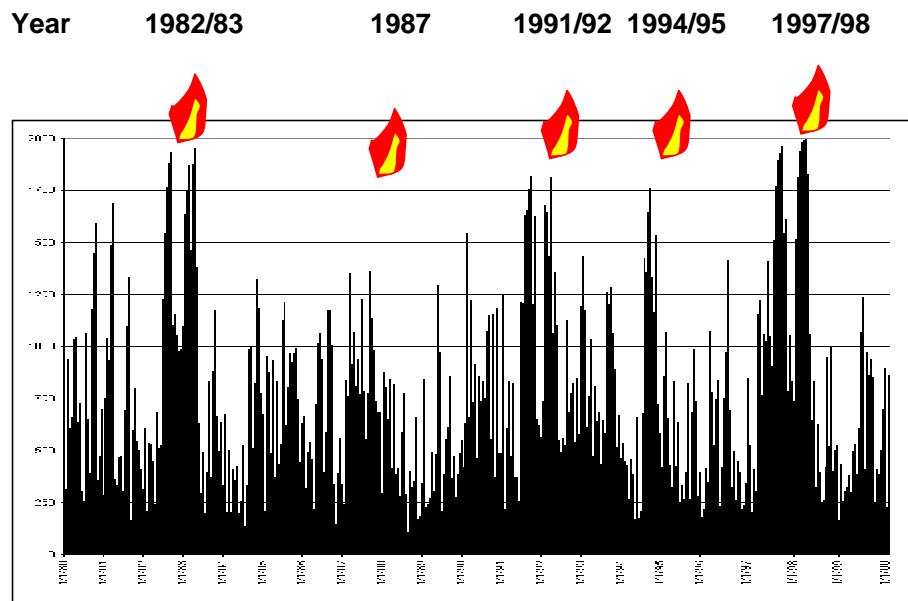
### **8.3.1 Weather**

Seasonal and long-term droughts within the project area (usually El Nino driven) allow forest and grassland vegetation to become available for burning. Seasonal drying occurs between April to September, with drought occurring from May to August (Hung 2001). Twenty year average meteorological data for the three provinces indicate that during the normal dry season, average humidity's range from 83-86%, temperatures average 24-30 C, and average number of rain days range from 6-13 per month (Kuster and Altemeier). Discussions with PPMU staff and local farmers indicated that temperatures can reach a maximum of 45 C and that strong westerly winds consistently blow in from Laos during the peak of the dry season.

Weather data collection stations were not observed at any of the District Forest Protection Department offices in the project area. Meteorological data and forecasts are commonly obtained by the District Forest Protection Departments via evening television news broadcasts.

Unwanted wildfires almost exclusively occur during the normal April – September dry season. However, numerous and widespread fires are most likely to occur and cause significant resource damage during periodic El Nino Southern Oscillation (ENSO) drought events. Historic weather records have documented the occurrence of El Nino events for more than 100 years (Goldammer 1997). El Nino events have been occurring at an increased

frequency and intensity in the past 20 years, with an average occurrence of once every 5 years (Siegert et al 2001). El Nino weather patterns are caused by an increase in sea-surface temperatures in the Pacific, causing significant worldwide climatic changes depending upon the intensity and duration of the ocean's warming (Goldammer 1997). In Southeast Asia, including Vietnam, El Nino weather patterns cause severe and extended drought periods to occur, creating hazardous (dry) fuel conditions that contribute to the probability of ignition and size of wildfires. Interviews consistently noted that significant past fire activity occurred in 1994/95 and again in 1998 within the project area. This corresponds with past El Nino events (Figure 2).



**Figure 2: Drought indices showing the periodic occurrence of El Nino events coinciding with severe fire seasons (Goldammer & Hoffmann 2001)**

### 8.3.2 Fire Danger Rating

A Fire Danger Rating (FDR) system evaluates the various factors of fuels, weather, topography, and risk to assess the daily fire potential of a broad area by describing the general conditions over thousands of hectares that affect an initiating fire. A FDR system is a tool to assess the day-to-day fire business decisions such as the focused implementation of fire prevention activities, posting of lookouts and patrols, availability of fire suppression personnel, implementation of no burn policies, and identifying when the use of prescribed fire is safe. Fire Danger Rating systems vary between countries depending upon general climate conditions, fuel types, and organizational needs.

Vietnam's Fire Danger Rating system has been in development since 1981, with implementation occurring at various levels in selected provinces and districts. The FDR system uses a grading system from 1 – 5 (Low – Medium-High-Dangerous-Extreme) that is based on daily temperature, humidity, and rainfall data as well as fuel moisture content and days without

rain (Hung 2001). Each FDR grade is associated with a list of standard procedures and activities that each District Forest Protection Department must implement in conjunction with the Provincial, District, and Commune Steering Committees on Forest Fire Prevention and Suppression. At its most fully developed, FPD staff collect weather data, calculate FDR based on a mathematical formula, contact commune leaders on a daily basis to notify them of the current FDR and post this on Fire Danger Rating Boards that are strategically placed in forest areas to inform the local population and increase awareness. Additionally, the Fire Danger Rating for every Province and District is announced on the national nightly television news broadcast of NTV.

Within Ha Tinh, Quang Binh, and Quang Tri provinces, there are no District Forest Protection Department offices that are directly collecting weather data or calculating the FDR. Further, there are no Fire Danger Rating Boards located in the communes in which the KfWII plantations are located.

#### **8.4 Fire Risk**

Fire risk is defined as a fire causative agent broadly defined by two categories, either natural or human-caused. In Vietnam, natural ignitions from lightning are rare and/or have not been documented. Human-caused ignitions are the primary reason for fires to ignite. Human ignitions are related to the numbers of people living or using an area, access into the area and the predominate land-use activities. A qualitative assessment of fire risk was conducted based on field surveys, interviews of farmers and officials, observations of land-use practices, review of available fire occurrence statistics and discussions with counterparts.

All of the plantations are within close proximity to villages and access is generally good with a continuous network of paved roads leading to dirt roads, established foot paths and forest trails that are commonly used and well known. Agricultural activities are the predominate land use. All areas of the project indicated that a „no burn policy“ is implemented during the dry season. Hung (2001) indicates strong enforcement and prosecution have occurred in the past, but interviews during this mission did not reveal any known prosecutions to occur in the local area.

Six of ten districts involved in the project were visited. In all cases, no fires were reported within the KfWII plantations for the years 2001, 2002, and 2003 (thru March), however fires were reported to occur prior to 1997. 1998 was often referred to as an active year for fires because of the numbers and size of fires. Fires were reported during the past 3 years, but all occurred in the older *Pinus merkusii* plantations established through the PAM project. Often the numbers of fires provided by PPMU or FPD staff reflected fire activity within the entire province, but again, no reports of fires within the established KfWII plantations were noted. The National Forest Protection Department compiles burn area data from all provinces in Vietnam. Burn area data for January – November 2002 are displayed in Table 2.

**Table 2: Burned Area by Province, January - November, 2002**  
(source: [www.kiendlam.org.vn](http://www.kiendlam.org.vn))

Province	Burned Forest Area (Hectare)
Ha Tinh	12
Quang Binh	96
Quang Tri	146
Total	254

Villagers and government officials attribute the cause of reported fires as follows (in no particular order):

1. Cigarette smoking in the forest
2. Cooking in the forest
3. Charcoal manufacturing
4. Farming
5. Conflicts between landowners
6. Vegetation clearing to reveal bombs and metal
7. Hot weather that would cause bombs to explode
8. Incense used at grave sites adjacent to forest areas
9. Prayer fires used in an effort to retrieve buffalo that were lost in the forest
10. Children using fire to smoke-out bees to collect honey or bee larvae, while watching buffalo.

The above fire causes are viewed as general guesses as opposed to the results of specific investigations. The over-riding and repeated cause for fire in all 3 provinces was to blame „naughty children“ for collecting honey while herding buffalo. The incidences of bombs in the ground causing fires were unique to Quang Tri province.

In general, Fire Risk is currently low and expected to remain low until 2010. Knowledge and adherence of the „No Burn Policy“ is well established. Additionally, the number of fires has decreased with the issuance of „Red Book“ Certificates that now provide a vested interest in the land by assuring long-term, secure land tenure for many households. However, as obligations to maintain the land in forest cover are fulfilled and withdrawals from the KfWII projects Individual Savings Accounts are completed, Fire Risk may increase. The possibility of a change in land-use patterns may increase the use of fire for land clearing unless additional regulations are passed that mandate the land remain in forest cover for additional time.

If land-use does begin to change by 2010, Fire Risk may dramatically increase. This will coincide with the increasing Fire Hazard that will develop as the forest plantations mature and increased loading of long-needed dead litter begins to drape in shrubs and accumulate on the ground. The impacts of this increased Fire Hazard/Risk after 2010 will be most dramatic with a coinciding severe El Nino drought event.

## **8.5 Fire Detection**

After fire prevention education and awareness programs, prompt detection of fires is the first step in minimizing the damage from unwanted fires. Fire

detection can be accomplished through various means such as ground-based foot or motorized patrols, fixed lookout towers, or aerial surveys from airplanes in locations and at times when fire risk is high, usually based on the current Fire Danger.

Within the KfWII project area, there are no permanently established lookout towers. Interviews indicated that effective locations for constructing towers is known and desired. Currently, only casual means of detection are used, as there is no formal fire detection system or procedures implemented. Guidelines for fire detection relative to Fire Danger Rating are established (Hung 2001). All interviews indicated that gongs (bells) would be used by the lookout to notify villagers (fire crew) of a fire.

## **8.6 Fire Prevention/Community Involvement**

A fire prevention program primarily consists of continuous and targeted messaging to prevent the ignition of an unwanted fire. The strategies that are most effective in dealing with human-caused ignitions are education and enforcement. It is difficult to assess the overall effectiveness of fire prevention programs because it is impossible to determine how many fires there could have been without these programs. However, the most effective implementation of prevention strategies occurs immediately before, during or after an unwanted fire is ignited. The challenge is to be proactive, and implement effective education, patrols, and enforcement in high risk, high hazard, and high value areas during periods of high fire danger.

Field interviews identified that the District Forest Protection Department conducts annual fire prevention awareness training in most communes of the project area. Little written information seemed readily available to deliver this message due to a lack of finances. The assignment of one or two FPD rangers to each commune facilitates the delivery of the fire prevention message. In general, field interviews indicated a high awareness among farmers and village leaders for the need to prevent fires and adherence to „no burn policies“ during the dry season. This would indicate a strong link exists between fire management authorities and local people and that community involvement in fire prevention is relatively effective. PMU and FPD staff indicated that since the issuance of Red Book Certificates to individual households, the number of fires has decreased substantially. This would indicate that Community Based Fire Management concepts although informally applied, are generally working.

It was noted that a National Fire Prevention mascot does not yet exist in Vietnam. The design, development and socialization of a National Fire Prevention mascot could enhance the linkage between the Forest Protection Department and local communities by further promoting education and awareness programs.

## 8.7 Fire Suppression

Fire suppression is based on the ability of a well trained and equipped fire crew to safely and rapidly respond (Initial Attack) to a wildland fire, contain or control the fire within a 24 hour period (or certain size limit), and be ready to respond again by the next day. If a wildland fire exceeds the capacity of Initial Attack fire fighters and continues to burn for multiple days (Extended Attack), additional logistical support (food, water, supplies, etc), equipment, and personnel need to be mobilized and coordinated. The additional equipment that is often needed in extended attack fires includes high-pressure pumps and hose, fire engines, mobile water storage tanks, and bulldozers or tractor-plows to construct fireline at a more rapid rate than fire fighters with handtools can produce. Finally, as more people and equipment are assigned to a fire, additional supervisory and coordination personnel will also be required and formal Incident Command System (ICS) organizational frameworks maybe needed to efficiently manage the situation.

To effectively implement Initial Attack and Extended Attack fire operations, increasing capability levels of response are desirable. For example, the following equipment capabilities may be applied:

1. Village - fire crews with handtools, small water pumps and hose
2. Commune – High pressure water pumps and hose, additional handtools
3. District FPD – Several High pressure water pumps, 1-2 “slip-on” Engines, additional handtools
4. Provincial FPD – small bull-dozer and fire-plow with transport vehicle

The quantity and capacity of each type of equipment is based on site-specific needs such as access, terrain, fuel types, fire hazard/risk, water sources, etc.

Field surveys indicated that there is basically no specialized fire suppression equipment used or available at any level (village, Commune, District and Provincial FPD). Equipment that is used for fire suppression includes personally owned farm tools and branches to swat out the flames. Only two of six District FPD offices reported having any fire suppression tools, and this amounted to 20-25 fire flappers, hardhats, drinking water containers, and miscellaneous items. Additionally, there was no communication equipment such as 2-way radios, safety equipment, chainsaws, water pumps or hose. Furthermore, providing shoes to fire crews was mentioned several times.

The responsibility for fire suppression is directly on the landowners at the village level. Most villages reported having an established fire crew that was re-organized each dry season, but village/commune leaders also have the right to conscript all villagers to participate in fire suppression. Approximately 20 District Forest Protection Staff work at each office, but their primary responsibility is in coordination and support functions, not in direct fire suppression. For fires that escape Initial Attack, Forest Fire Prevention and Suppression Steering Boards at Commune, District and Provincial levels are responsible for mobilizing any and all available resources (i.e. military, police, city fire departments, etc), decision-making and financial obligations. FPD staff is responsible for carrying out Steering Board decisions through support and coordination functions to the fire crews.



Despite these limitations, fire suppression does occur. A 2 hectare burned area from June 2002 was observed within an 18-20 year old *Pinus merkusii* plantation. It was reported that approximately 50 villagers responded to the fire between 10am to 3pm when its spread was contained. Only branches and a few brush knives were used. FPD staff arrived a day later to check on the fire. Without training and specialized handtools, safe and effective fireline construction is very difficult and dangerous.

## 9 SIGNIFICANT FINDINGS

Following are the significant findings following interviews and field review of KfWII *Pinus merkusii* plantations within Ha Tinh, Quang Binh, and Quang Tri Provinces.

1. *Pinus merkusii* is a fire resistant tree species that naturally grows in open, savannah conditions and can survive low-intensity ground fires.
2. The KfWII *Pinus merkusii* plantations are established at a high density and uniform size/age class that exceeds that which occurs naturally and therefore at risk to damage from fire.
3. Fire Hazard/Risk is currently low in the young plantations because of low dead fuel accumulations and low fire occurrence, but fire hazard (fuels) will increase with stand age as dead fuel loadings (long-needle litter) begin to accumulate on the ground and drape in the trees.
4. A strong and well established organizational framework exists between FPD, People's Steering Committee's and local farmers to implement fire management activities, however financial and human resources are limiting the continued development and effectiveness of this framework.
5. Annual education programs conducted prior to the dry season by the District FPD have raised awareness of the need to prevent fires. Issuance of Red Book Certificates (and therefore long-term land-use rights) has resulted in a reduction of fires occurring.
6. Unwanted fires have primarily occurred in the mature pine plantations established by past projects (PAM) in the past 18-30 years. Although some fires occur every year, the most significant past fire activity occurred simultaneously during years when El Nino drought events have been documented.
7. Although there are various causes, the predominate fire cause was to blame children for collecting honey while herding buffalo's.
8. No lookout towers (detection system) exist. District FPD's do not collect weather data, calculate Fire Danger Rating, nor are there FDR sign boards to post this information.
9. Local farmers form village level volunteer fire crews are the primary labor force for initial attack fire suppression. Specialized wildland fire and safety equipment are not available, so personal handtools and tree branches are used.
10. During large fire events, FFPS Steering Committee's have decision-making and financial authority to mobilize additional suppression personnel. FPD staff carry out this direction by providing coordination and support functions to fire suppression crews.
11. „Green“ fuel breaks (planted strips of Acacia or natural shrubs) and existing roads are the primary pre-established fuel breaks within the plantations. „White“ or „clean“ fuel breaks were not observed or constructed.
12. Periodic maintenance cutting (twice per year) of shrub vegetation and pruning of Acacia does occur in most locations as a requirement for tending the plantations and receiving payments from household savings accounts.

## 10 CONCLUSIONS

The plantation establishment, survival rates, and transfer of secure land tenure to upland farmers via the KfWII afforestation program contributes to the protection of forest resources and potential generation of income in rural areas, but the long-term sustainability of the plantations is threatened. *Pinus merkusii* is resistant, dependent, and adapted to periodic, low-intensity surface fires during seasonal dry periods. Efforts to completely exclude fire will be difficult and in the long term, non-sustainable. At present, the young *Pinus merkusii* plantations are a low fire hazard/risk, but the current policy of „fire exclusion“ increases fire hazard by allowing dead, long-needed, litter, live fuel loadings, and „ladder fuels“ to accumulate with stand age, eventually leading to the threat of high-intensity, stand-replacing wildfire. The dense, even-aged, mono-culture plantations will be difficult to sustain in the long-term without intensive fuels management treatments and protection efforts. The threat of wildfire will be most significant during severe El Nino drought periods, especially after 2010 when possible land-use changes begin as expiration of individual deposit accounts occurs. The numerous, scattered, small-landholdings of KfWII upland farmers will complicate fire suppression coordination if numerous or large fires occur.

Upland farmers currently have a high awareness of the negative impacts of „unwanted“ wildland fire. The Forest Protection Department and Forest Fire Prevention and Suppression Steering Committee's provide a strong, well-established organizational framework for managing wildfire threats. Technical knowledge exists to deliver the fire prevention message and coordinate the suppression of wildland fires. However, inadequate financial resources limit the operational capability of villagers and FPD staff to safely and efficiently suppress „unwanted“ wildland fires. Additionally, training and experience are needed in fire ecology concepts and integrating fuels management with silviculture and forest management.

Future forest plantation establishments should incorporate fire/fuels management into the planning process from the very beginning. Specific fire/fuels management objectives must be developed to meet the objectives of long-term forest management. As forest management objectives change, so will fire/fuels management objectives. Items such as species selection, tree spacing, intermediate silvicultural treatments, and wildfire threat analysis are important to mitigating fire/fuels management concerns. Integrating fire/fuels management planning into forest management planning can reduce potential economic losses from unwanted fires. By accounting for natural ecological disturbance processes, providing for silvicultural diversification, and developing effective fire protection measures, long term, sustainable forest management can be achieved.

## 11 RECOMMENDATIONS

The following recommendations are related to fuel management, fire prevention, training, and infrastructure enhancement. To maximize effectiveness, all recommendations should be implemented based on site-specific needs. Implementation should be facilitated through Project Management Units and Forest Protection Department staff.

### 11.1 Fuels Management

The management of fire-adapted pine species at stand densities and structures beyond that which occur naturally, are inherently at risk to damage from wildland fires. As the high density, even-aged, mono-culture pine plantations mature, the fire hazard will increase due to increased long-needle litter accumulations. There is a potential for moderate to high-intensity, stand-replacing fires to occur during severe (El Nino) drought events. The following silvicultural practices and fuels treatments are recommended for long-term sustainability, to reduce fire hazard and maintain the pine as the dominant tree species:

1. Pruning of branches to reduce vertical „ladder fuels“ and maintain separation between tree crowns and ground fuels.
2. Periodic thinning of *Pinus merkusii* to create more open canopy conditions. Stand densities should be reduced from the established 2,000 to 1,300 trees/ha down to 600-800 trees/ha. The timing of these thinnings needs additional study.
3. Periodic reduction of understory live fuel vegetation and especially fine, dead fuel accumulations (pine needles) through either mechanical/hand cutting and removal or prescribed burning every 3 - 5 years. Although the cutting and removal of live and dead vegetation is effective, it is also labor intensive and does not promote nutrient recycling to promote tree growth on the poor soils. Prescribed fire, although not widely accepted or used in Vietnam, is the natural, ecological disturbance process for maintaining *Pinus merkusii* and does promote soil nutrient recycling. Rotational grazing of buffalo's or goats will aide in the reduction of live fuels, but damage to young trees is possible and this does not remove the dead needle litter, only live grasses and some shrubs.
4. Since tree survival rates have exceeded 90%, future plantation establishment should consider wider tree spacings to minimize the need for intermediate thinnings.
5. Establish a mixture of tree species of *Acacia* and pine to reduce long-needle litter accumulations and break up fuel continuity. Narrow strips of *Acacia* (2-3 rows) will probably not be effective in preventing fire spread, especially on extremely dry, windy days. Fire rate of spread may be reduced, but not halted.
6. Stand structures should emulate those that occur naturally, i.e. open conditions, with a variety of age/size classes occurring in small patches and in occasional mixtures with other species.
7. Establish clean fuel breaks, exposing mineral soil in easily defendable locations such as ridges. A pre-established fuel break alone will not stop the spread of fire. A fuel break must be periodically maintained and primarily provides easy access and a

starting point (anchor point) for which fire suppression crews can begin constructing „direct“ fireline or be used as „in-direct“ fireline from which a burn-out can be accomplished to contain a fire. All firelines and fuel breaks must be actively patrolled while a fire is burning to check for „spotting“ or „slop-overs“ across the fireline.

## 11.2 Fire Prevention

Develop a National Fire Prevention symbol or „mascot“ that is especially designed and promoted for children as they are the next generation that will adopt and utilize the forests of the future. This symbol should be easily recognizable, contain a simple message, and be appealing to children so that fire prevention education can be viewed as a positive, environmentally friendly activity. Several countries utilize fire prevention mascots such as „Smokey Bear“ in the United States and „Si Pongi“ in Indonesia. A fire prevention mascot can be marketed in a variety of ways such as posters, patches, toys, story books, brochures, radio/television advertising, public events, etc.

The fire prevention message should be designed to differentiate between when fire is „wanted“ or „unwanted“. For example, „wanted“ fires are those that are appropriately used to achieve specific land management objectives, during safe, planned, controlled, and well-supervised conditions, such as using prescribed fire for fuels management in forests. „Unwanted“ fires are those that burn by accident, with malicious intent, occur during dry periods, and cause damage to natural resources or personal property.

A suggested „mascot“ for Vietnam is the buffalo since this is already a nationally recognized symbol, a common animal found in rural areas, and one that children are often responsible for watching while grazing. In addition, the primary cause of wildfire was children collecting honey while watching buffalo grazing. Another potential „mascot“ may be a honeybee, for the obvious reasons.

## 11.3 Training

Initially, a series of workshops involving Provincial/District FPD staff, Commune and village leaders, as well as Project Management Unit staff would be necessary prior to and during implementation of any of the infrastructure enhancement options.

Several fire training opportunities exist to improve the capacity of villagers and FPD staff to prevent and suppress wildland fires. Some of the training would only be pertinent if modern equipment and safety items were purchased and if FDR capabilities were enhanced.

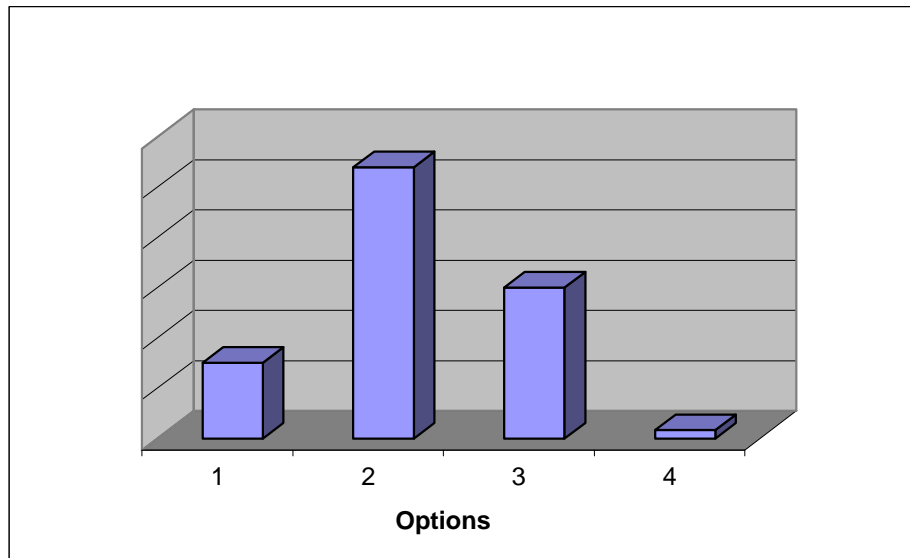
1. Fire Prevention, education and awareness in village and schools
2. Basic fire behavior training
3. Fireline tactics, strategies, and safety
4. Modern fire equipment use and maintenance (i.e. handtools, pumps and hose, chainsaw, engines, etc.)

5. Fire Danger Rating procedures, calculations, and information dissemination
6. Basic Incident Command System (ICS)
7. Fuels management planning
8. Prescribed fire principles and use
9. Fire Ecology
10. Study tours of forest fire management programs within Thailand, Indonesia, New Zealand, United States, Canada, and Australia for PMU and FPD staff.

#### **11.4 Infrastructure Enhancement**

Four conceptual options are presented to enhance and improve the infrastructure of fire management to include fire prevention, detection, Fire Danger Rating, and fire suppression capabilities. These options are presented to provide the KfWII National Project Management Unit, Ministry of Agriculture and Rural Development, KfW Bank, and/or other donors a range of choices to logically proceed with the continued development of forest fire management capabilities and capacity building in Ha Tinh, Quang Binh, and Quang Tri provinces. All options are based on field surveys of existing and anticipated fire management needs, the international experts practical experience, Vietnamese experts practical experience and requested needs list from each Provincial Project Management Unit or Forest Protection Department. Each option is unique in terms of complexity and financial commitment. The common link between all options is a focus on fire prevention and detection since basic fire suppression response is already occurring by local people and directed by Steering Committees at various levels. It is recognized that suppression capability needs significant enhancement and this is an expensive and financially burdensome commitment. Options 1, 2, and 3 will require additional financial support beyond that which is currently available from KfWII residual funds. Option 4 utilizes existing available residual funds. Figure 3 display relative costs for each option. Specific details (Appendix D and E) of will be developed by National and Provincial Project Management Units and may include specific portions of the above programmatic recommendations for fuels management, fire prevention, and training.

Fore each of the following Infrastructure Enhancement options, equipment acquisition, distribution, and training should be facilitated through Project Management Units and Forest Protection Department staff.



**Figure 3: Comparison of relative costs between infrastructure enhancement options.**

#### 11.4.1 Option 1

**General Description:**

With limited international expert guidance and advice, enhance Province-wide **Fire Prevention** through pre-fire activities such as existing training and awareness programs, detection, communication development and enhancement of fire suppression capability at village level using locally available equipment sources, practicalities and methods.

**Conceptual Description:**

Construct lookout towers, Fire Danger Rating and Fire Warning Boards in all Communes as needed. Install Weather Stations at each District FPD. Construct Fuel Breaks in key locations based on local needs and knowledge. Improve direct communications between village, commune, Forest Protection Department, and FFPS Steering Boards for the reporting and coordination of fires. Fully finance the implementation of existing fire prevention/suppression training at all levels. Provide a small quantity of locally manufactured and traditionally used handtools and safety equipment to village fire crews (10 persons/village) as incentive for and enhancement of fire suppression response (Annex D).

**Implementation Period:** 3 years.

#### 11.4.2 Option 2

**General Description:**

With longterm, multiple international experts advice, implement all activities in Option 1, plus develop an **Integrated Fire Management (IFM)** program in three (3) provinces to enhance all aspects of fire management including fire prevention, information dissemination, fire suppression, and fuels management.

**Conceptual Description:**

An Integrated Fire Management program addresses the social and technical problems and challenges of human-caused fires. IFM involves the facilitation of multi-stakeholder and community consultation processes to develop a common understanding about fire-related concerns and issues. IFM is based on cooperation between local communities and land managers to find compromises and solutions in developing and refining a fire management program. A comprehensive fire management plan combining fire information dissemination, fire prevention and fire suppression/fuels management activities will be developed as an integrated element of an overall sustainable resource management strategy.

Significant investment is made to improve rural fire suppression capability of village, commune, District and Provincial FPD through the purchase and import of specialized, ground-based fire suppression equipment such as handtools, water pumps, engines, dozers, transport, and communication systems. Additionally, land-use planning, fire organization and community-based fire management concepts are developed, as well as other capacity building measures such as review and implementation of existing laws and decrees to harmonize and clarify overlappings between forestry, fire, and environmental laws.

**Implementation Period:** 5-7 years.

#### 11.4.3 Option 3

**General Description:**

With limited international expert advice, develop a „Pilot-project“ **Fire Management** program in one District within each of 3 Provinces combining the best available local components and supplementing with modern fire suppression components. After a two-year development phase, expand to province-wide level.

**Conceptual Description:**

Limit the implementation of activities in Option 1 to one District within each of 3 Provinces and more fully develop the fire suppression capabilities of village, commune, District and Province by utilizing a combination of locally available equipment supplemented with specialized fire suppression pumps, hose, and heavy equipment. Following a 2-year initial proto-typing phase, evaluate and expand to a „full-scale“ province-wide level based on the best elements learned from the 3 Districts. This option allows for more adjustments and adaptations based on actual implementation results, and will be a more cost-effective use of financial resources.

**Implementation Period:** 5 years.

#### 11.4.4 Option 4

**General Description:**

With limited international expert advice, utilize **Available Funds** via the KfWII residual fund to moderately enhance fire prevention and suppression capabilities in 3 fire prone Communes within each of 3 Provinces using locally available equipment and techniques.

**Conceptual Description:**

Construct one lookout tower per commune (9 total), construct Fire Danger



Rating boards and design and develop a new forest fire prevention symbol/ "mascot". Construct "clean" fuel breaks, conduct fire prevention training, provide printed educational information, and provide existing village fire crews with additional local/traditional tools and equipment (Annex E) in preparation for the coming dry season.

**Implementation Period:** 2.5 years.

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## **13 ANNEXES**

- Annex A - Components of a Wildfire Threat (Hazard/Risk) Analysis
- Annex B - Mission Itinerary
- Annex C - Field Survey Inventory Form
- Annex D - Equipment and Activity List for Infrastructure Enhancement Option 1
- Annex E - Equipment and Activity List for Infrastructure Enhancement Option 4