

# **FIRE DISASTERS**

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## PART-I: GENERAL FIRE

### Definitions

For longer than recorded history, fire has been a source of comfort and catastrophe for the human race. **Fire** is rapid, self-sustaining oxidation process accompanied by the evolution of heat and light in varying intensities. Fire is believed to be based on three elements being present: fuel, heat and oxidizer. Fire disasters can occur above the ground (in tall buildings and on planes), on the ground, and below the ground (in mines). Sometimes they occur in circumstances that are unexpected or unpredictable. Firestorms can be natural or human-generated. **Natural firestorms** develop from forest fires like one happened in Peshtigo, Wisconsin, in 1871. It burned more than 2,000 square miles of forest and killed approximately 2,300 people. **Human-generated firestorms** result from incendiary bombing. In Hamburg, Germany, on February 27, 1943, the Allied Forces dropped bombs that caused a firestorm, which destroyed 3.2 square miles of the city and killed 21,000 residents. In Dresden, Germany, on February 13 and 14 1945, bombs induced a firestorm that burned 4.6 square miles of the city and killed 135,000 people.

### Types

All fire incidents can be divided in many ways depending on the cause of fire outbreak, but broadly there are two types of fires, one is natural and other is manmade. Forest fires can be either due to natural or manmade reasons. All residential and non-residential structural fires are largely manmade. Similarly, all industrial and chemical fires are due to explosions or fires made by humans or due to machine failures.

**Natural:** Fires which are considered as natural are basically earthquake, volcanic eruption and lightning - generated fires. The fire and explosion risk associated with an earthquake is a very complex issue. Compared with ordinary (normal) fires the fire and explosion hazard related to earthquakes can constitute a substantial and heavy risk. Damage to natural gas systems during an earthquake is a major cause of large fires. Again probably the most significant direct impact of power systems on fire following an earthquake is that electric power is a major fire ignition source. In addition to dropped distribution lines, power circuits in damaged houses are another major ignition source. There have been cases where as many as two-thirds of all ignitions after an earthquake has been attributable to power system.

**Manmade:** Fire caused by human/machine errors are considered as manmade fires, e.g. industrial or chemical fire disasters, fires at social gatherings due to Electrical short circuit fires, accidental fire and kitchen-fires. Rural and urban residential and non-residential structural fires are also largely manmade fires. Any confined fire could be due to many reasons like, cooking

fire confined to container, chimney or fuel fire confined to chimney, incinerator overload or malfunction, fuel burner/boiler malfunction, and trash fire.

**List Of Major Work Place Fire Hazards:**

**Flammable chemicals:** found in laboratories, shops, art studios, maintenance activities (painting, cleaning, auto repair...) engines, boilers and other heating appliances.

**Processes involving open flame:** Welding, brazing and similar operations, cooking, smoking, and some lab operations.

**Heat producing devices:** Drying (both in the laundries and laboratories), cooking, heat producing devices such as hot plates and space heaters

**Use and disposal of chemicals:** Experiments in labs, hazardous waste handling, oily rags in art studios, and shops.

**Electrical equipment:** Short circuits and malfunctioning equipment.

**Causal/Contributing Factors**

Casual factors include heat source, equipments involved in the ignition, item first ignited, and factors contributing to ignition. These factors describe what, how and why some form of heat ignited the specific material involved.

**Causes include:**

Cooking/heating equipment

Intentional

Electrical

Open flame or ember

Appliance, tool or air conditioning

Child playing

Other heat source

Natural causes: earthquake, volcanic eruption and lightening

Other equipment

Smoking material

**Contributing factors**

Principal factors contributing to fires across the globe include:

Wood shingle / thatched roofs

High wind

Congested access

Inadequate water distribution system

Lack of exposure protection

Inadequate public protection (i.e. fire department inadequacies)

Unusual hot or dry weather conditions

Delay in discovery of fire

Inadequate personal fire protection

Delay in raising the alarm

### **History & Impacts**

Indian fire service, which was first established in Bombay (1803), followed by Calcutta (1822) and Madras (1908) thus completed 200 years. After independence (1958) the Standing Fire Advisory council under Ministry of Home Affairs recommended various aspects of uniform fire service development throughout the country. In 1997, Ministry of Home Affairs declared that a total of 1754 (excluding 278 tailor-made fire stations operating exclusively in industrial sector) fire stations with 5149 fire appliances/vehicles and 50,730 fire professionals are functioning throughout India. However, these services are limited to urban and industrial areas. However, studies show that major fire incidents in India are due to the explosion in the fireworks factory and homemade fireworks followed by residential fires/urban slum fires and others. Each year, 450-470 people in India lose their lives to burn injuries caused by firecrackers and ironically a majority of them are children and women. The Loss Prevention Association of India Ltd (LPA) maintains that thousands of cases pertaining to burn injuries go unreported. In 2002 the LPA has urged the government to introduce a ban on the sale of fireworks to children below 15 years. **Analyses of data showed that the total number of deaths due to fire in 2001, 2002 and 2003 was 5787 and total property loss was estimated to be Rs. 1046 crore in India.**

The vast majority of all fire-related mortality and morbidity in USA result from non-catastrophic fires, i.e. fires occur in residential areas. An analysis of annual mortality data from 1978 through 1984 in USA shows that an average of 4,897 persons died each year in residential fires. A similar analysis of data from 1979 through 1985 indicates that smokes inhalation accounted for two-thirds of the deaths and burns accounted for one-thirds.

### ***Chronology of Fire disasters across the Globe***

1. The Great London Fire of September 2, 1666: the entire city of London was hugely destructed by fire within 5 days, although the number of death was limited to only six. The London of 1666 was a city of half-timbered and pitch-covered medieval buildings, mostly with thatched roofs. By the end of the fire, some four-fifths of the city had been destroyed-approximately 13,200 houses, 87 churches, and 50 livery halls spread over an area of 436 acres.
2. A fire in New York city in 1835 destroyed 500 buildings

3. The great Chicago Fire of 1871 destroyed much of the city – at least 17000 structures and caused 250 deaths. The loss in today's rate is estimated to be more than \$9532 million.
4. A fire in Boston in 1872 destroyed 800 buildings
5. A church fire in Birmingham in 1902 killed 115
6. Firestorm in Mont Pales on Martinique killed approximately 30000 in 1902
7. In 1903 the deadly fire in the Iroquois Theater, USA accounted for 602 deaths
8. The firestorm that followed the Great San Francisco Earthquake of 1906 leveled much of that city.
9. Over 2000 people succumbed to deaths while munitions ship exploded in Halifax, New Southamton.
10. Tokyo earthquake of 1923 killed approximately 130000 persons by fire alone due to explosion in chemical and petrochemical factories (non-functioning of explosion suppressing equipment due to electricity failure during the EQ).
11. Fire accounted for 31.2% of all disasters in USA from 1941 through 1975. Furthermore, it accounted for 26.9% of all disaster associated mortality. Fully 68.3% of the fires and 47.1% of all associated deaths occurred in houses and apartments. Only 7.4% occurred in temporary public residences (hotel and boarding houses), 4.3% in treatment centers, and 0.9% in public places. The total number of deaths due to fire was more than 23,000. The Coconut Grove club fire in Boston in 1942 killed 491 people. An explosion in ship in Texas city resulted in 468 deaths.
12. A nightclub fire in Kentucky in 1977 killed 164.
13. The gas cloud explosion killed 500 people and injured many more in Mexico City in 1990s
14. Over 260 people were killed in a fire in Ethiopia in 1991.
15. A fire in a toy factory in Bangkok in 1994 killed 231 people.
16. A theater fire in China in 1994 killed 300.
17. Over 500 were killed in a school fire in India in 1995
18. Fire in a hotel in Thailand in 1997 resulted in 90 deaths
19. Explosion in World Trade Centre in 2001 accounted for more than 3000 deaths
20. Paraguay supermarket fire in August 2004 resulted in at least 423 deaths and 139 missing.

### ***Chronology of Fire disasters across India***

Ever since Independence, accidents in buildings, mainly from fires, across the country have caused extensive loss of life and property. Yet hardly any long-term safety measures have been

put in place. Some of the major fire incidents that occurred in India in the past four decades are listed out below.

1. On 31/1/1974 an explosion in a rail transport (fire work products) in led to deaths of 42 people in Allahabad
2. A total of 78 people were died and 88 were injured due to fire in a cinema hall in Tuticorin, Tamil Nadu on 29/7/1979
3. Similarly, in 1981, explosion in a firework factory in Mettupatti killed 32 workers, including women and children.
4. In 1992 two separate incidents of firework disasters in Tharia and Ludhiana accounted for 25 and 40 deaths respectively.
5. Explosion at a firecracker factory in Rohtak, Haryana on 24/5/95 resulted in a death toll of 23 people, which included 13 women, 6 children and 4 men.
6. Over 500 people were dead and 300 injured due a fire in school function in Dabwali, Haryana on 23/12/1995
7. In the same year a fire at a cinema theater in Delhi killed more than 60 people and injured hundreds.
8. An accidental fire in the Brihadeswara temple in Thanjavur district of Tamil Nadu on 9/6/1997 resulted in more than 60 deaths and 250 were injured in the stampede to escape
9. At least 204 people died due to a fire in a religious discourse at Baripada, Orissa in February 1997.
10. At least 45 people were killed (16 women and eight children were among the death) and 16 seriously injured on 7/11/1999 in Sonapat, Haryana, when a fire began after sparks from some high-tension wires over the market fell over a firecracker shop an adjoining clothes store. Some 25 stores, some of them selling plastic wares, were completely gutted.
11. In November 2002, at least 17 people were killed and 27 injured (five in critical conditions) when two gas cylinders in a van carrying fireworks exploded, bringing down several houses nearby at Athur near Salem. Those dead included seven men, five women and five children. 15 houses on either side of the street came down in the explosion, trapping and killing the people inside them. Crackers, stored in one of the buildings, were being loaded into the van, which was already carrying two gas cylinders. The van was gutted in the fire.

12. A blast occurred on 4/11/04 in Srikakulum, Andhra Pradesh as explosives stored unauthorised by a cracker manufacturer in Chinna Bazar area caught fire. The incident killed 13 and seriously injured 13 others. Several other nearby houses have been badly damaged. This was an illegal factory; they had no licence for manufacturing firecrackers.
13. A fire breakout in a school at Kumbakonam on 16th July 2004 resulted in 93 deaths of primary school children.
14. Several hundred tsunami survivors at Nagapattinam, Tamil Nadu are homeless again after fire gutted their temporary shelters. The blaze was started by fireworks being used to celebrate Diwali. The 90 families affected have been re-housed in a local hall on 1.11.2005.
15. Fire engulfed three illegal firecracker factories in Khusropur village (22 miles east of the state capital Patna, eastern state of Bihar) on 15/9/05 accounted for at least 35 deaths and injured at least 50 people. The factories were being run from three houses in the village. The fire was sparked by an electrical short circuit and quickly spread to the flammable material stored in the factories.
16. Fire in a fireworks plant in Tamil Nadu on 22.2.2006 killed 10 and seriously injured 19. The fire was caused by an explosion at a stack of 'rockets' being dried, against rules, under trees. Extremely hot climate and friction had triggered the explosion, the resultant fire spread instantly to the shed where 'packed rockets' had been stored and from there, it spread to other sheds.
17. Fire breakout in a trade fair in Meerut, UP on 10.4.06 killed more than 57 people and injured thousands.

## **Fire Prevention Plan & Mitigation Measures**

### **Flammable Chemical Proper Handling and Storage procedures:**

Chemicals use and storage at the university are either covered under the specific Chemical Hygiene Plan in each or laboratory or under the Hazard Communications Policy. These plans and policy define safe storage and handling of chemicals. Basically we either follow the manufactures recommendation or industry standards and guidelines.

### **Potential ignition sources and their control procedures:**

Open flames, electrical equipment, heat producing devices, and use and disposal of chemicals. The control procedures for these sources are detailed in the Chemical Hygiene Plan, and the following guidelines 5.1 Office Safety, 7.1 General Shop and Work Site Safety, 7.10 Welding and Cutting, and 11.6 Hazardous Waste Satellite Accumulations Areas. Smoking is not permitted in the interior of any University vehicle or building, with the exception of residence halls.

**Types of Fire Protection Equipment and systems to control fires:**

Many systems are in place including the following; Fire suppression equipment (sprinklers and fire extinguishers); Proper storage areas (flammable storage rooms and cabinets); Fire alarms and detectors; Building systems such as doors, walls, ceilings, and floors.

**Job Titles responsible for maintenance of systems installed to prevent or control ignitions or fires:** Various groups at Facilities Management (FM) including: Electrical Shop, Plumbing Shop, and Carpenter Shop. See Director of Facilities Management for details.

**Job Titles responsible for control of fuel source hazards:**

All employees who use or store fuel sources are responsible for control. Major sources such as heating plants and gasoline storage are the responsibility of FM shops such as the Steam Plant, HVAC shop, and the Garage.

**Housekeeping:**

Housekeeping is the responsibility of the individual employee and Facilities Management. In general the individual is responsible for their workspace and the Facilities management is responsible for waste receptacles and the common spaces on campus. Hazardous waste is removed upon request of the waste generators by the department of Environmental Health and Safety.

**Training:**

All employees are required to receive Basic Safety and Area Specific training upon beginning at the University and annually thereafter, included in this training are fire prevention and emergency action plan training.

**Maintenance:**

The maintenance of heat producing equipment is the responsibility of the department and employees using the equipment. In the case of area specific equipment such as coffee pots, microwave ovens, and hot plate it is the responsibility of the department using the workspace. In the case of building systems it would be the responsibility of Facilities Management. In all cases employees would follow the manufacturer's instructions and practices or industry standards as appropriate.

**Specific Guidelines:**

When decorating for any mass gathering event please observe the following safety precautions:

- All trees and wreaths are to be artificial and flame-resistant. Unless specifically inspected and approved by the Fire Department. Documentation should be available to prove their flame resistance.

- Only use decorations that are noncombustible or have a label that states that they are "flameproof," "flame-resistant," or "flame-retardant." Keep the label to document acceptability.
- Electric lights or lit decorations are acceptable only if they are labeled with Underwriters Laboratory or Factory Mutual approval. Inspect light strings for frayed or bare wires, cracked sockets, loose connections and damaged insulation. Replace the entire string of lights if any of these safety deficiencies are present. Always follow the manufacturer's recommendations.
- No lit candles, open flames, or spark-producing devices are permitted.
- Do not obstruct corridors, stairways, exits or doors from closing. Decorations are not to be hung so as to obstruct exit lights, sprinkler pipes or heads, smoke detectors, fire alarm pull stations, portable fire extinguishers or cabinets, or other safety apparatus.
- Do not place decorations near electrical equipment or other heat sources. Do not hang decorations from sprinkler heads.
- Do not route electrical cords across aisles or corridors (tripping hazard) or under doors.
- Keep extension cords to a minimum. Extension cords must have 3-prong grounded outlets.

### **Initiatives**

Since independence, a lot of initiatives have been taken in India to ensure and strengthen fire safety measures in the country. To name a few, Fire Force Bill, Fire Services Bill, Fire Prevention and Safety Act for fire safety of buildings, Discipline Code for Fire Services, inclusion of the subject Fire Protection and Control in the 7<sup>th</sup> Schedule of the Constitution, Explosives Rules for hazardous fire crackers, Model Rules for provision of Fire Fighting Equipment under the Factories Act, review of existing Legislation (such as the Petroleum Act, the Cinematograph Act, the Factories Act, etc), capacity building of the fire personnel, awareness programmes and delinking the state fire service administration from the control of the police are some of the major initiatives taken by Govt. of India.

### **DELHI FIRE PREVENTION AND SAFETY ACT, 1986**

The capital of India with its ever-increasing population in far-flung colonies & crowded localities and unplanned growth has always been a city with heavy fire risk. The risk has now been further increased with the expansion of industries and construction of high-rise buildings in the National Capital Territory of Delhi. Many of the high-rise buildings in the Delhi have not yet been provided with inbuilt fire fighting arrangements, which are considered to be very essential from fire safety point of view. To ensure safety of such buildings and their occupants, the Building Bye-laws

were adopted and duly notified by the Delhi Administration of 23rd June 1983. The Building Byelaws are further being up-dated.

The Delhi Fire Prevention and Fire Safety Act, 1986 has already been notified by the Government of India in a Gazettee on 12th December, 1986 and rules framed there under are in force from 2nd March, 1987.

There were about 220 multi-storeyed buildings, which were initially identified as the buildings not having the required fire safety requirements as required under Building Byelaw. With the strenuous effort of Delhi Fire Service the number has been reduced from 220 to 86. Now only 86 buildings are yet to comply with the recommendations. Out of these buildings 29 are Govt. buildings and 57 are private buildings.

### **Issue of Fire Safety guidelines-fire prevention wing**

The Delhi Fire Service issues fire safety guidelines to the various agencies for which the cases are to be referred to Chief Fire Officer, Delhi Fire Service through the building authorities concerned or licensing authorities in line with the bldg. by laws/relevant code of practices.

In case of high-rise buildings i.e. 15 meter or more in height a questionnaire has to be filled & submitted by the architect along with the plans. In order to avoid inconvenience all the information required in the questionnaire should be properly indicated. The fire safety guidelines should ensure that the information is correctly provided. The public is also advised to submit 3 sets of plans along with

the duly filled in questionnaire and the building model. The fire prevention wing is headed by a Deputy Chief Fire Officer and assisted by a Divisional Officer and Station Officers.

- Issue of No Objection Certificate
- Once the guidelines have been issued by the fire department the application for obtaining no objection certificate may be submitted to the Chief Fire Officer by the builder/owner of the premises.
- The owners/builders are further advised to ensure the compliance of all the fire safety guidelines before the approach the Chief Fire Officer for No Objection Certificate.
- No inspection fee is levied by the fire service for such inspection or issue of NOCs. In case of any difficulty the matter should be reported to the Dy. Chief Fire Officer or the Chief Fire Officer. The Chief Fire Officer or Dy. Chief Fire Officer may also be contacted in case there is a delay in carrying out the inspection or issue of fire safety guidelines, or issue of NOC after the inspection has been carried out etc.

- The department does not levy any charges for this job for the time being.

Other states and Uts were advised to follow the Delhi Fire Prevention and Fire Safety Act.

### **Future Plans**

- Beginning of Rural Fire Service in India
- Training of fire services for carrying out search and rescue operations in the aftermath of disasters and provision of adequate number of trained manpower.
- Meeting the deficiencies as per minimum requirements in the availability of fire stations and fire units at state and district level. This would help to reduce response time 3-5 min. in urban area & 7-10 min. in rural areas.
- Upgrading the 12 existing state level training centres and establishing one Fire Training Institute in each of the remaining 23 states/UTs.
- Public awareness campaign, protective clothing to operational staff, better command & control system.

### **Dos & Don'ts**

#### **What to do Before a Fire**

The following are things you can do to protect yourself, your family, and your property in the event of a fire:

#### **Smoke Alarms**

- Install smoke alarms. Properly working smoke alarms decrease your chances of dying in a fire by half.
- Place smoke alarms on every level of your residence. Place them outside bedrooms on the ceiling or high on the wall (4 to 12 inches from ceiling), at the top of open stairways, or at the bottom of enclosed stairs and near (but not in) the kitchen.
- Test and clean smoke alarms once a month and replace batteries at least once a year. Replace smoke alarms once every 10 years.

#### **Escaping the Fire**

- Review escapes routes with your family. Practice escaping from each room.
- Make sure windows are not nailed or painted shut. Make sure security gratings on windows have a fire safety-opening feature so they can be easily opened from the inside.
- Consider escape ladders if your residence has more than one level, and ensure that burglar bars and other antitheft mechanisms that block outside window entry are easily opened from the inside.
- Teach family members to stay low to the floor (where the air is safer in a fire) when escaping from a fire.

- Clean out storage areas. Do not let trash, such as old newspapers and magazines, accumulate.

### **Flammable Items**

- Never use gasoline, benzene, naphtha, or similar flammable liquids indoors.
- Store flammable liquids in approved containers in well-ventilated storage areas.
- Never smoke near flammable liquids.
- Discard all rags or materials that have been soaked in flammable liquids after you have used them. Safely discard them outdoors in a metal container.
- Insulate chimneys and place spark arresters on top. The chimney should be at least three feet higher than the roof. Remove branches hanging above and around the chimney.

### **Heating Sources**

- Be careful when using alternative heating sources.
- Check with your local fire department on the legality of using kerosene heaters in your community. Be sure to fill kerosene heaters outside, and be sure they have cooled.
- Place heaters at least three feet away from flammable materials. Make sure the floor and nearby walls are properly insulated.
- Use only the type of fuel designated for your unit and follow manufacturer's instructions.
- Store ashes in a metal container outside and away from your residence.
- Keep open flames away from walls, furniture, drapery, and flammable items.
- Keep a screen in front of the fireplace.
- Have heating units inspected and cleaned annually by a certified specialist.

### **Matches and Smoking**

- Keep matches and lighters up high, away from children, and, if possible, in a locked cabinet.
- Never smoke in bed or when drowsy or medicated. Provide smokers with deep, sturdy ashtrays. Douse cigarette and cigar butts with water before disposal.

### **Electrical Wiring**

- Have the electrical wiring in your residence checked by an electrician.
- Inspect extension cords for frayed or exposed wires or loose plugs.
- Make sure outlets have cover plates and no exposed wiring.

- Make sure wiring does not run under rugs, over nails, or across high-traffic areas.
- Do not overload extension cords or outlets. If you need to plug in two or three appliances, get a UL-approved unit with built-in circuit breakers to prevent sparks and short circuits.
- Make sure insulation does not touch bare electrical wiring.

**Other**

- Sleep with your door closed.
- Install A-B-C-type fire extinguishers in your residence and teach family members how to use them.
- Consider installing an automatic fire sprinkler system in your residence.
- Ask your local fire department to inspect your residence for fire safety and prevention.

**What to do During a Fire**

If your clothes catch on fire, you should:

- Stop, drop, and roll - until the fire is extinguished. Running only makes the fire burn faster.

To escape a fire, you should:

- Check closed doors for heat before you open them. If you are escaping through a closed door, use the back of your hand to feel the top of the door, the doorknob, and the crack between the door and door frame before you open it. Never use the palm of your hand or fingers to test for heat - burning those areas could impair your ability to escape a fire (i.e., ladders and crawling).

Hot Door	Cool Door
Do not open. Escape through a window. If you cannot escape, hang a white or light-colored sheet outside the window, alerting fire fighters to your presence.	Open slowly and ensure fire and/or smoke is not blocking your escape route. If your escape route is blocked, shut the door immediately and use an alternate escape route, such as a window. If clear, leave immediately through the door and close it behind you. Be prepared to crawl. Smoke and heat rise. The air is clearer and cooler near the floor.

- Crawl low under any smoke to your exit - heavy smoke and poisonous gases collect first along the ceiling.
- Close doors behind you as you escape to delay the spread of the fire.
- Stay out once you are safely out. Do not reenter. Call 9-1-1.

## What to do After a Fire

The following are guidelines for different circumstances in the period following a fire:

- **If you are with burn victims, or are a burn victim yourself**, call 101, cool and cover burns to reduce chance of further injury or infection.
- **If you detect heat or smoke** when entering a damaged building, evacuate immediately.
- **If you are a tenant**, contact the landlord.
- **If you have a safe or strong box**, do not try to open it. It can hold intense heat for several hours. If the door is opened before the box has cooled, the contents could burst into flames.
- **If you must leave your home** because a building inspector says the building is unsafe, ask someone you trust to watch the property during your absence.

### Connected Links for Important Sites

[www.ibiscom.com/rome.htm](http://www.ibiscom.com/rome.htm)

[www.mmdtkw.org](http://www.mmdtkw.org)

### References

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## PART-II FOREST FIRE DISASTER IN INDIA

### 1. INTRODUCTION

*Definition:*

**A wildfire, also known as a forest fire, vegetation fire, grass fire, brush fire.** The word "wildfire" originated as a synonym for Greek fire, a napalm-like substance used in medieval Europe as a naval weapon; the word attained its present meaning by a common misunderstanding of the expression "spread like wildfire".

Forests face many hazards but the most common hazard is forest fire. Forest fires are as old as the forests themselves. They pose a threat not only to the forest wealth but also to the entire regime of fauna and flora seriously disturbing the bio-diversity, the ecology and environment of a region.

During summer, when there is no rain for months, the forests become littered with dry senescent leaves and twigs, which would burst into flames ignited by the slightest spark. And thus the inevitable does happen. The Himalayan forests particularly Garhwal Himalayas of Uttaranchal State have been burning regularly during the last few summers, with colossal loss of vegetation cover of that region.

Forest fires can be either natural or controlled and caused by heat generated in the litter and other biomes in summer through carelessness of people (human neglect). Sometimes, forest fires purposely caused by local inhabitants.

### 2. VULNERABILITY

The most vulnerable stretches of the world are the youngest mountain ranges of Himalayas. The forests of Western Himalayas are more frequent vulnerable to forest fires as compared to those in Eastern Himalayas. This is because forests of Eastern Himalayas grow in high rain density. With large scale expansion of Chir (Pine) forests in many areas of Himalayas, the frequency and intensity of forest fires has been increased since 1990.

Table-1 shows the pattern of total land area, forest area recorded and total cropped area in vulnerable Himalayan states of India towards forest fire.

**Table 1: Vulnerable Himalayan States of India towards Forest Fire**

S.No	State	Total land Area (ha*)	Forest area Recorded ha (%)	Total cropped area (ha)
1	Manipur	2211000	602000 (27.23)	186000
2	Arunchal Pradesh	8374300	5154000 (61.55)	167369

3	Himanchal Pradesh	3367600	1046900 (31.09)	974800
4	Assam (Hill Distt)	1522200	296200 (19.46)	169300
5	Sikkim	710000	257000 (58.95)	152000
6	Meghalaya	2243000	940000 (41.91)	241000
7	Mizoram	2102000	1303000 (61.99)	65000
8	Tripura	1049169	606168 (57.78)	456000
9	Nagaland	1513774	862532 (56.98)	200500
10	Uttaranchal	5358595	3424857 (63.91)	1099306
11	Jammu & Kashmir	4505000	2747000 (60.98)	1066000

Source: Development of Agriculture in the Himalayan State of India (Sherpa 1995)  
\*ha- Hectares

*The affected area happens to be in the Ganga – Yamuna watershed, the most vital of the country's four watersheds. According to reports available the devastation caused by fire in 1999 as extensive with more than 80,000 hectares of forests turned to ashes by the first week of May. While in 1995, forest fires particularly in Uttaranchal state had destroyed more than 3,75,000 hectares of forest wealth (Table-2).*

**Table 2: Estimates of forest area affected by fire in U.P. and Uttaranchal.**

Year	Area	Percentage of forest area affected by fire		
		Frequent	Occasional	Total
1988	Whole of State	-	-	58.00
1995	Tehri Garhwal	4.80	41.80	46.30
	Tarai area	40.50	34.10	74.60
	South U.P.	5.20	25.10	30.30
	U.P. Hills Region (Uttaranchal)	2.31	58.70	61.01
	Average	8.50	-	-

Source: *Journal of Indian Buildings Congress. Vol. 4, No.1,1997*

Table (3) reveals that in the inventoried areas on an average 53.1 % forest area is affected by fire. It ranges from low as 6.8 % in Upper Subansiri in Arunachal Pradesh to as high as 97 % in Dadra and Nagar Haveli. Of the total inventoried forest area, on an average 8.92 % is affected by frequent fire and 44.25 % by occasional fire. These results do not necessarily mean that these areas are affected annually by frequent or occasional fires but indicate that the areas are definitely prone to heavy or light fires and there have been incidences in the past.

**Table 3: Extent of Fire in inventoried Forest Areas of India**

State Or District (No. Of Samples)	Incidence of Fire (%)		
	Frequent	Occasional	Total
Singbhum	8.7	53.4	62.1
West Champaran (N 96)	15.1	80.2	95.3
Assam (N 2462)	4.3	29.5	33.8

Cooch Bihar (N 75)	15.6	35.8	49.4
Tehri Garhwal	4.8	41.4	46.2
Koraput (N 1354)	8.6	61.0	69.6
Tarai (U.P.) (N 536)	40.5	34.1	74.6
South (U.P.) (N 831)	5.2	25.1	30.3
Puruliya (N 112)	15.1	30.4	45.5
Kalahandi (N 423)	30.4	52.0	82.4
Riapur (N 809)	13.0	50.0	63.0
Shimoga (N 418)	7.5	39.2	46.7
Chikmagalur/ Hussan (N 357)	11.7	31.3	43.0
Dadra & Nagar Haveli (N 62)	-	97.0	97.0
Manipur (N 1880)	4.0	38.0	42.0
Tripura	6.0	83.0	89.0
Lower Subansiri	7.6	43.5	51.1
Arunachal Pradesh (N 328)	-	-	-
Upper Subansiri (N 224)	-	6.8	6.8
Sikkim (N 401)	-	33.2	33.2
Meghalaya (N 1659)	4.1	37.8	41.9
Mysore (N 338)	6.1	51.2	57.3
Darjeeling (N 130)	5.4	25.6	31.0
U.P. Hill (Uttaranchal) (N 1235)	2.3/ 8.5	58.7	69.5
Shimla/ Rohru / Chopal (H.P.)	2.5/ 6.6	51.0	60.1
Chamba, Lahaul Spiti Kinnaur (N 261)	1.7/ 6.2	37.0	44.9
S.E. Rajasthan (N 2446)	0.5/ 0.6	226	23.7
Shivalik Range Of Haryana, Punjab (N 145)	-/3.5	28.2	31.7
Jammu Region (N 428)	0.5/2.1	33.2	35.8
Dhulia (N 356)	2.3/ 5.6	49.7	57.6
Nasik / Thane, Raigad (N 846)	4.0	51.0	55.0
Raigarh (M.P.) (N 561)	16.0	61.0	77.0
<b>Mean</b>	<b>8.9</b>	<b>44.2</b>	<b>53.1</b>

Source: The State of Forest Report (1995)\_Forest Survey of India, Dehradun.

### 3. CAUSESS

Forest Fires are, however, nothing unusual. They occur regularly, especially in summers, throughout the world. Forest fires can broadly be classified into three categories:

1. Natural or controlled forest fires.
2. Forest fires caused by heat generated in the litter and other biomes in summer through carelessness of people (human neglect) and
3. Forest fires purposely caused by local inhabitants.

Many forest fires start from Natural causes such as LIGHTNING which set trees on fire. Periodic lightning induced fires have been recorded throughout history from India, Southeastern and Central United States, Australia, Finland and Eastern and Southern Africa. However, rain extinguishes such fires without causing much damage. In the United States and some other countries such **Natural Fires** are allowed to burn and die out as a part of Forest Management

strategy. The most forest fires are the result of human neglect. A casual throwing away of a smouldering bidi, cigarette butt or a spark from a picnicker's open hearth in a desiccated forest can often be sufficient to start a fire in summer. Such fires usually start on the ground as the dry litter (senescent leaves and twigs) catches fire easily. Then, flamed by strong winds, the flames soon engulf vast tract forest turning them to ashes and, therefore, cause extensive damage unless controlled in time.

#### 4. HISTORY

In Himachal Pradesh over 450 cases of forest fires were reported in **1995**. In addition to accidental wildfires, controlled burning has been used traditionally for forest clearances by villagers for various purposes and as a means of management to promote the regeneration of desired tree species or the re-growth of grazing plants including grasses. Controlled burning has been used as a genuine forest management measure in the US for decades.

But sometimes the forest fires do get out of control as it happened in the famous Yellowstone National Park in the US and in Indonesia in **1997**. Recently in India, large areas of Chir (pine) forests were burnt in Uttaranchal. However, in Western Europe, especially Britain, heath lands are burnt at intervals of 10-12 years to maintain a dense uniform stand of heather.

There had been a prolonged dry spell during the summer of **1999**, which resulted in a large number of forest fires in Himachal Pradesh. In Uttaranchal region, the Forest Department of Kumaun division said that forest fires are by and large caused by man-made reasons (The Times of India, April 30, 1999).

##### 4.1. Famous forest fires

###### *North America*

Fire	Area	Year	Size	Notes
<u>Miramichi Fire</u>	<u>New Brunswick</u>	<u>1825</u>	3,000,000 acres (12150 km <sup>2</sup> )	Killed 160 people
<u>Yachina Fire</u>	<u>Oregon</u>	<u>1846</u>	450,000 acres (1,800 km <sup>2</sup> )	
<u>Nestucca Fire</u>	<u>Oregon</u>	<u>1853</u>	320,000 acres (1,300 km <sup>2</sup> )	
<u>Silverton Fire</u>	<u>Oregon</u>	<u>1865</u>	1,000,000 acres (4,000 km <sup>2</sup> )	Worst recorded fire in state's history
<u>Coos Fire</u>	<u>Oregon</u>	<u>1868</u>	300,000 acres (1,200 km <sup>2</sup> )	
<u>Peshtigo Fire</u>	<u>Wisconsin</u>	<u>1871</u>	1,200,000 acres (4900 km <sup>2</sup> )	Overshadowed by the Great Chicago Fire occurring the same day

<u>Bighorn Fire</u>	<u>Wyoming</u>	<u>1876</u>	500,000 acres (2,000 km <sup>2</sup> )	
<u>Thumb Fire</u>	<u>Michigan</u>	<u>1881</u>	1,000,000 acres (4,000 km <sup>2</sup> )	Killed 250+ people
<u>Hinckley Fire</u>	<u>Minnesota</u>	<u>1894</u>	160,000 acres (650 km <sup>2</sup> )	Killed 418 people and destroyed 12 towns
<u>Adirondack Fire</u>	<u>New York</u>	<u>1903</u>	450,000 acres (1,800 km <sup>2</sup> )	
<u>Great Fire of 1910</u>	<u>Idaho-Montana</u>	<u>1910</u>	3,000,000 acres (12,000 km <sup>2</sup> )	Killed 86 people
<u>Cloquet Fire</u>	<u>Minnesota-Wisconsin</u>	<u>1918</u>	100,000 acres (400 km <sup>2</sup> )	Killed between 400 and 500 people
<u>Mann Gulch fire</u>	<u>Montana</u>	<u>1949</u>	4,500 acres (18 km <sup>2</sup> )	Killed 13 firefighters
<u>Capitan Gap fire</u>	<u>New Mexico</u>	<u>1950</u>	17,000 acres (69 km <sup>2</sup> )	
<u>Tillamook Burn</u>	<u>Oregon</u>	<u>1933, 1939, 1945, 1951</u>	355,000 acres total (1,400 km <sup>2</sup> )	Swept through the same region of Oregon four times
	<u>Maine</u>	<u>1947</u>	175,000 acres (710 km <sup>2</sup> )	A series of fires that lasted ten days; 16 people killed
<u>Laguna Fire</u>	<u>California</u>	<u>1970</u>	175,425 acres (710 km <sup>2</sup> )	382 homes destroyed and 8 people killed; the largest fire in the state's history until the <u>Cedar Fire</u>
<u>Yellowstone National Park fires</u>	<u>Wyoming-Montana</u>	<u>1988</u>	800,000 acres (3,200 km <sup>2</sup> )	
<u>Oakland Hills firestorm</u>	<u>California</u>	<u>1991</u>	1,520 acres	Killed 25 and destroyed 3469 homes and apartments within the cities of Oakland and Berkeley
<u>South Canyon fire</u>	<u>Colorado</u>	<u>1994</u>		Killed 14 firefighters
	<u>Florida</u>	<u>1998</u>	300,000 acres (1,200 km <sup>2</sup> )	2200 fires, during drought season; burned 150 homes, \$390 million timber lost, 80,000 evacuees, \$133 million in fire suppression costs
<u>Mesa Verde National Park fire</u>	<u>Colorado</u>	<u>2000</u>		
<u>Rodeo-Chediski</u>	<u>Arizona</u>	<u>2002</u>	467,066	Threatened, but did not burn the town of <u>Show</u>

<u>fire</u>			acres	<u>Low, Arizona</u>
			(1,890 km <sup>2</sup> )	
<u>Hayman Fire in Pike National Forest</u>	<u>Colorado</u>	<u>2002</u>	137,760 acres	9 firefighter deaths, 600 structures fires
			(557.5 km <sup>2</sup> )	
<u>Florence/Sour Biscuit Complex Fire</u>	<u>Oregon</u>	<u>2002</u>	499,570 acres	
			(2,000 km <sup>2</sup> )	
<u>Okanagan Mountain Park Fire</u>	<u>British Columbia</u>	<u>2003</u>	500,000 acres	Displaced more than 5,000 inhabitants
			(2,000 km <sup>2</sup> )	
<u>Cedar Fire</u>	<u>California</u>	<u>2003</u>	280,278 acres	The largest fire in California history; burned 2,232 homes and killed 14 in San Diego County. It was one of 15 major fires in <u>Ventura, Los Angeles, San Bernardino, and San Diego</u> counties covering 721,791 acres (2,920 km <sup>2</sup> ), killing 24, displacing 120,000 and destroying 3,640 homes. Damage estimated at 2 billion <u>USD</u> (See <u>NASA</u> images: <a href="#">[1]</a> <a href="#">[2]</a> )
			(1,134 km <sup>2</sup> )	

## In Australia

- Black Friday Bushfires of 1939 (South Australia) (Country Fire Service)
- Black Sunday Bushfires of 1956 (South Australia)
- Ash Wednesday fires of 1980 and 1983 (Victoria and South Australia) (Country Fire Service, Country Fire Authority)
- Forest fires in early-1993 in eastern Australia
- The November 1997 fire in the Sydney area (New South Wales Rural Fire Service)
- 2001 - 2002 forest fires in Australia? primarily affected the Sydney area and caused damages to some properties.
- Canberra bushfires of 2003
- Black tuesday bushfires of 2005 (Eyre Peninsula South Australia)

## In Europe

- Kuźnia Raciborska Fire in Poland, burned 90.62 km<sup>2</sup> of forest and killed three people (including two firefighters) on August 26, 1992.
- Penteli Fire in Greece affected in June and July, 1995 in the Penteli mountains and lasted for almost the weekend from Friday.
- 1998 forest fires in Greece, a series of forest fires affected the Athens area, Avlona, Taygetus and Olympus mountains and other places. The fire began in the beginning of the summer season.
- 2000 forest fires in Greece, a series of forest fires affected Greece including Agioi Theodoroi and eastern Corinthia at the beginning of July 2000
- 2000 fires in Southern Europe in July 2000 consumed forests and buildings in southern France, parts of Iberia, Corsica, and most of Italy including the southern part and Greece during the heatwave dominating southern Europe with 40 to 45°C temperatures caused the phenomena.
- July 17, 2005 - Guadalajara province, Spain, a 130 km<sup>2</sup> forest fire and 11 dead firefighters. Regional responsible of Department of the Environment out of post because of this deadly toll. A barbecue sparked deadly blazes.

- 2005 East Attica Fire in Greece - Forest fires ravaged East Attica on July 28, 2005 from Agia Triada Rafinas to west of Rafina. The fires began at around 11:00 (EET) (8:00 AM GMT) consuming 70 km<sup>2</sup> of forests, properties and farmlands. The fire spread quickly after a few hours with winds of up to 55 to 70 km/h and spread near the suburban housings of Athens near Rafina causing dense smoke. The fire reached Kallitechnio and the settlements by around 3:30 (EET) and devastated homes leaving some people homeless and evacuated people in areas around Agia Triada Rafinas, Agia Kyriaki Rafinas, Kallitechnio, Loutsá, Neos Vourzas and the Rafina area mostly on the hillside areas. Pine trees were devastated. Firefighters didn't put out the blaze until the winds calmed down around 5:00 (EET). It took hundreds of fire trucks, firefighters, planes, 65 firefighting helicopters from all over the surrounding areas and most of Greece to put out the blaze. A stretch of Marathonos Avenue became closed.
- July 29, 2005 - a day after the enormous Attica fire, another series of fires occurred throughout Greece, entirely in Preveza including Monolithi consuming properties and a campground, Ioannina and Xiromeni of Aitolokarnania.

## 5. DAMAGE ASSESSMENT

Each fire may burn forests from a few hectares to several thousand hectares depending upon season, vegetation, type, forest intensity, and direction of the wind and topography of the area. History shows that incidents of fires in the forests started on a big scale since 1916 and continued till 1930/31 and hundreds of acres of forests were destroyed in the process. During last 10 years Chir (pine) forest area burnt in different ranges of the Kunihar Forest Division of Himachal Pradesh varied from 12 ha to 350 ha with an average of over 130 ha per year for this range alone. In

Central Himalayas (Uttaranchal) had large-scale devastating fires, which engulfed nearly all Uttaranchal districts in May-June **1995**. According to a study undertaken by Indian Space Application Centre (ISRO), it was found that the forest fires affected 21.5% of the total forest area in the four districts of Uttaranchal. i.e. Almora, Chamoli, Tehri and Pauri. The total fire affected area was 211500 ha. Table -4 shows the number of incidences of forest fire in different years occurred in Uttaranchal.

**Table- 4: Number of Incidences of Forest fire in different years occurred in Uttaranchal.**

S. No	Year	Number of Instance (Fire)	Ground Fire (GF) / Crown Fire (CF)
1.	1987-88	5473	G.F.
2	1988-89	4711	G.F.
3	1989-90	4311	G.F.
4	1990-91	4325	G.F.
5	1991-92	6316	G.F.
6	1992-93	2345	G.F.
7	1993-94	1004	G.F.

8	1994-95	-	-
9	1995-96	2,737	G.F.

**Source: Journal of Indian Buildings Congress. Vol. 4, No.1, 1997**

## 6. TYPES OF FOREST FIRE

Forest fires differ depending upon its nature, size, spreading speed, behavior etc Basically this can be sub grouped into four types depending upon their nature and size as follows:

### 6.1 Underground Fire

*Under ground fire is the fire of low intensity consuming the organic matter beneath and the surface litter of forest floor is sub-grouped as underground fire. In most of the dense forests occurring in the wetter parts of Himalayas, a thick mantle of organic matter is found on top of the mineral soil. This fire spreads in by consuming such materials. These fires usually spread entirely underground and burn for some meters below the surface.*

This fire spreads very slowly and in most of the cases it becomes very hard to detect and control such type of fires. They may continue to burn for months and destroy vegetative cover of the soil. The other terminology for this type of fire is Muck fires while in some countries; it is referred to as Ground fires.

### 6.2 Surface Fires

Surface fire is the most common forest fires that burn undergrowth & dead material along the floor of the forest. In general it is very useful for the forest growth and regeneration. If grow in size this fire not only burns ground flora but also results to engulf the undergrowth and the middle story of the forest. Surface fires spread by flaming combustion through fuels at or near the surface- grass, dead & down limbs, forest needle & leaf litter,



**Surface Fire**

land clearing. Thus a surface fire is "A fire that burns surface litter, other loose debris of the forest floor and small vegetation. This is the most common type of fire in timber stand of all species. It may be a mild, low-energy fire in sparse grass and pine needle litter, or it may be a very hot, fast moving fire where slash, flammable under story shrubs, or other abundant fuel prevails. A surface fire if spreads, may burn up to the taller vegetation and tree crowns as it progresses.

### 6.3 Ground Fires

There is no clear distinction between underground and ground fires. The smoldering for sometime under ground fires changes into Ground fire. This fire burns root & other material on or beneath the surface i.e. burns the herbaceous growth on forest floor together with the layer of organic matter in various stages of decay. They are more damaging than surface fires they can destroy vegetation completely. These fires are fires in the sub surface organic fuels, such as

duff layers under forest stands, Arctic tundra or taiga, and organic soils of swamps or bogs.

Ground fires burn underneath the surface by smoldering combustion & are most often ignited by surface fires. Thus a Ground Fire

consumes the organic material beneath the surface

**Ground**

litter of the forest floor. In many forest types, particularly in northern latitudes, at higher elevations, and in bog areas in all locations, a mantle of organic material accumulates on top of the mineral soil. A true ground fire spreads by a slowly smoldering edge with no flame and little smoke. These fires are often hard to detect and are the least spectacular & slowest moving.

Fighting such fires is very difficult and tedious job.

#### **6.4 Crown Fires**

Crown fire is the most unpredictable fire, which burns the top of trees & spread rapidly by wind. In most of the cases surface fires invariably ignite these fires. Thus a Crown Fire is a fire that advances from top to top of trees or shrubs more or less independently of the surface fire. In dense conifer stands on steep slopes or on level ground, with a brisk wind, the crown fire may race ahead of the supporting surface fire. This is most spectacular kind of forest fire.

Since it is over the heads of ground force it is

uncontrollable until it again drops to the ground, and since

it is usually fast moving it poses grave danger to the fire fighters becoming t



**Crown Fire**

### **7. FOREST FIRE PREVENTION**

The subject of forests is in the concurrent list of the Constitution of India. The Central Government and State Governments are both competent to legislate on the issue. The issues relating to policy planning and finance are the primary responsibility of the Government of India. The field administration of the forests is the responsibility of the various state governments. The state Government thus has the direct responsibility of the management of forest resources of the country. The state forest departments therefore, carry out the fire prevention and control measures. Each State and Union Territory has its own separate forest department. At the Government of India level, Inspector General of Forests & Special Secretary to the Government of India is the head of the professional forest service in the country. Additional Inspector General of Forest and Deputy Inspector Generals assist Inspector General of Forests & Special Secretary. The Forest Protection Division in the Ministry, which is headed by a Deputy Inspector General of Forests, looks after Forest Fire prevention. The Ministry is implementing a plan scheme "**Modern Forest Fire Control Methods**" in India under which the state governments are provided financial assistance for fire prevention and control.

India has a history of scientific forest management for over 130 years. Forestry practices have been developed for a large number of forest types and species in India. The forests are managed through well-prepared forest working plans and fire prevention and control has always constituted an important component of the working plan. In south and Southeast Asia including India, “ **Slash and Burn**” method of Farming is used by the tribes of hilly areas, in which they cut down and burn small areas of the forest and use the cleared land for cultivation. This method of burning offers them not only the cheapest means to clear the forests, but also free fertilizers in the form of ash from the burnt vegetation on a limited scales. But when it is indiscriminately practiced, as is being done at present, the damage can be irreversible. Mostly, the prescriptions relate to employing traditional practices like creation and maintenance of fire lines, fire tracks, control burning, engaging firewatchers during the fire seasons etc. The villagers situated in and around forest areas are also legally supposed to assist the forest department staff in extinguishing the fires. These methods proved quite effective in controlling forest fires in the country, but gradually due to population pressure on forests and resultant conflicts and resource hunger, it became difficult to check forest fires in India through these methods. More and more biotic pressure increased the fire incidences resulting in poor regeneration in forest areas. In view of this, it was felt necessary to implement a modern forest fire-fighting regime in the country. A UNDP project was implemented during 1985 to 1990 in the country to address the problem of resource damage from uncontrolled forest fires. The project primarily focused on involving a systematic approach to deal with forest fire damages through tapping of the knowledge gained by some developed countries in preventing, detecting and suppressing forest fires, and its transfer to India. Under this project, a pilot project was launched in two states viz: Uttar Pradesh and Maharashtra, where severe fires had affected around 50% of the forest area. The two states offered different ecological and physical characteristics and therefore, offered a good opportunity to try the technologies of forest fire prevention and control.

Based on the success of this project, the Government of India, Ministry of Environment & Forests initiated a scheme entitled "Modern Forest Fire Control Methods" since 1992-93. The scheme was launched during the 8<sup>th</sup> Plan period in 11 states where the major forest fires occur. The project covered 60% of the forest areas of the country. Under the scheme, the Government provided financial assistance to state forest departments for procurement of hand tools, fire resistant clothes and fire fighting equipments, wireless sets, construction of fire watch towers, fire finders, creation of fire lines and for research, training and publicity on fire fighting. Under the Central Government an air operation wing was maintained. The project has been continuing during the 9<sup>th</sup> plan period (1997-2002) and four more states are being added to the list. The Central component of the scheme envisages closing the Air Operation Wing (as it is felt to

strengthen the traditional and cost effective methods) and introducing a component of close monitoring of forest fires for creation of data base through Forest Survey of India and involvement of research institutes and other agencies for generating more information on forest fires for better planning and management. Yet another dimension is being added to the project by involving the village forest protection committees constituted under the Joint Forest Management (JFM) programme. The JFM programme is being implemented in 22 states through 35,000 village forest protection committees over an area of 7 million ha. It is proposed to invoke the people's interest and enlist their support for fire prevention and fire fighting operations. The Government is considering setting up of a **National Institute of Forest Fire Management** with satellite centres in different parts of India to bring the latest forest fire fighting technologies to India through proper research, training of personnel and technology transfer on a long-term basis. Notwithstanding the existing efforts, it is still felt that there is an acute shortage of resources for forest fire prevention, detection, and control and also for research, training and equipments. All attempts need to be made to obtain more financial resources and technical assistance within the country and also to tap the external funding sources for developing permanent fire fighting capabilities.

#### *8. PREPAREDNESS AND MITIGATION MEASURES*

Forest fires are usually seasonal. They usually start in the dry season and can be prevented by adequate precautions. Different State Governments are aware of the severe damage caused by fires to forests and ecology of the area. Successive Five Year Plans have provided funds, for forest fire fighting. However, results have not been very encouraging so far. Traditional methods of fire control are inadequate and limited in India. The modern methods of fire control are yet to be placed on the ground in the required measure.

During the British period, the fire was prevented in the summer through removal of forest litter all along the forest basis. This was called “ **Forest Fire line** “. This line used to prevent fire breaking into the forest from one compartment to another. It proved effectively and the collected litter was burnt in isolation. At the same time, the utility of these leaves should be explored. Generally, the fire spreads only if there is continuous supply of fuel (Dry vegetation) along its path. The best way to control a forest fire is, therefore, to prevent it from spreading, which can be done by creating Fire Breaks in the shape of small clearings or ditches in the forest. Use of water is usually the last resort, as delivering water on to the fire in dense forests on hill slopes, is usually a tricky job, In many developed countries, special aircrafts equipped with water tanks are used to drop tonnes of water on the burning trees. Unfortunately, in **India**, there is as yet no

proper action plan to control forest fires. As a result, once started the fires rage on for weeks, destroying vast tracts of prime forest area till the rains come and douse them.

## 9. *IMPACTS OF FOREST FIRES ON BIOLOGICAL ENVIRONMENT*

Forest fires also pose serious health hazard by clearing polluting smoke and noxious gases, as the events in Indonesia after the forest fires on the islands of Sumatra and Borneo in 1977 have shown. The burning of vegetation gives off not only carbon di oxide but also a host of other, noxious gases (Green house gases) such as carbon monoxide, methane hydrocarbons, nitric oxide and nitrous oxide, that lead to **global warning** and ozone layer depletion (Mutaz & Farraj, 1990). So, the thousands of people suffered from serious respiratory problems due to these toxic gases.

Burning forests and grasslands also add to already serious threat of global warning. Forests play a vital role in keeping the level of carbon dioxide in the atmosphere in check. Forests, grasslands and agricultural lands make up bulk of the global biomass, and biomass burning is a global phenomenon today. Recent measurements suggest that biomass burning may be a significant global source of methyl bromide, which is an ozone depleting substance.

The recent forest fires in the hills of Garhwal (Uttaranchal) may be only a small part of the overall global problem. But if looked at from the point of view of the fragile Himalayan ecology, they portend a dark future. Already large areas of the Himalayan forests have cleared indiscriminately for agriculture making them vulnerable to **soil erosion** and **landslide**. The only way to save the fragile Himalayan ecosystem from recurring forest fires is to put in place viable disaster management action plans.

## 10. **INITIATIVES:**

### 10.1 **NATIONAL FOREST POLICY, 1988**

In Resolution No. 13/52-F, dated the 12<sup>th</sup> May 1952, the Government of India in the erstwhile Ministry of Food & Agriculture enunciated a Forest Policy to be followed in the management of State Forests in the country. India's National Forest Policy amended in 1988 presents a visionary strategy for future forest conservation & management laying emphasis on protection of forest against encroachment, fire & grazing. The subject of forests is in the concurrent list of the Constitution of India. The Central Government & State Governments are both competent to legislate on this issue. The principle aim of the New National Forest Policy is " *to ensure environmental stability and maintenance of ecological balance.*" The policy addresses the problem of forest fires in the context of forest protection in the following specific terms:  
*" The incidence of the forest fires in the country is high. Standing trees and fodder are destroyed on a large scale and natural regeneration annihilated by such fires. Special precautions should be taken during the fire season. Improved and modern management practices should be adopted to deal with forest fires."*

## **10.2 Policy of forest fire (Rehabilitation and Response)**

Every year one-third of all forests are damaged or affected by fire, and so an effective policy of forest fire prevention and control is extremely important. It was in this context that the modern forest fire control project was taken up in five districts of Uttaranchal viz., Pithoragarh, Rampur, Nanital, Pilibhit and Almora in 1985. The area proposed to be covered was 3,72,693 hectares. The following achievements are understood through these projects:

- Development and demonstration of modern fire control techniques.
- Preparation of division wise fire management plans.
- Estimation of forest fires
- Development and application of a forest fire danger rating system/
- Training of personnel
- Full fire protection of timber depots.
- Manufacture of fire finders and hand tools within the country and standardization of fire control equipment.

## **11. FUTURE PLAN**

### **11.1 National Plan for Forest Fire Management**

The Para 4.8.2 of National Forest Policy has addressed a systematic plan for Forest Fire Management. According to the National Plan for Forest Fire Management special precautions should be taken during the fire season. Improved and modern management practices should be adopted to deal with forest fires. The main objectives of the National Plan can be summarized as follows:

- To strengthen the Organization responsible for Forest Fire Management.
- To coordinate the States/U.T's plans for Systematic Forest Fire Management.
- To provide input regarding training, research, extension, and publicity for the Systematic Forest Fire Management.
- To coordinate International Transfer of technology and training.

The state governments are encouraging Joint-Forest Management (JFM) by involving the people in afforestation programme. In Uttaranchal and Himachal Pradesh with a part of the forest is being managed by Forest Panchayats. In the Eastern Himalayan states local people through Village Councils and District Councils manage a substantial part of forest. So involvement of the people in forest management will certainly help in preventing forest fires by using a judicious combination of traditional and modern fire fighting methods.

## 11.2 Research Issues

In India, there is an urgent need to initiate research in the fields of fire detection, suppression, and fire ecology for better management of forest fires. The research and technology developed in western countries always suitable for the Indian environment. Thus, it is essential that original research specific for Indian conditions be conducted. The Government is considering setting up a National Institute of Forest Fire Management with satellite centres in different parts of the country to bring the latest forest fire fighting technologies to India through proper research, training of personnel, and technology transfer on a long term basis.

## 12. Research

1. Sarita Kanyal (2002): Forest fire Disasters of Kumaun Himalaya, Ph.D. Thesis submitted to the Kumaun University.

## 13. Dos and Don'ts

### What to do BEFORE & DURING Fire-

- Try to maintain *FOREST BLOCKS* to prevent dry litter from forests during summer season.
- Try to put the fire out by digging or circle around it by water, if not possible to call a Fire brigade.
- Move farm animals & movable goods to safer places.
- During fire listen regularly to Radio for advance information & obey the instructions cum advice.
- Forests Officials, Local peoples and Tribals living in Forests should play a constructive role before, during & after the fire of the Forest.
- Follow the effective monitoring & warning systems(including remote sensing for curing or drying out of vegetation)
- Teach the causes and harm of fire to your family and others.
- Do not be scared when a sudden fire occurred in the Forest, be calm & encourage to others & community to overcome the problem patiently.
- Do apply seasonal mitigation measures i.e. *Fuel reduction*

### *What one should not do*

- One should not throw smouldering cigarette butt or bidi in the forests.
- Pickners should not leave the burning wood sticks.
- Don't enter the forest during the fire.
- Don't left the dry litter during summer season.
- Tribals should not use Slash & Burn method indiscriminately on large scale.

### 13. CONCLUSION

Among disasters, the forest fire has been emerging as the most common disaster since last decade, disturbing the bio-diversity, the ecology and environment of a region. The forests of Western Himalayas are more frequent vulnerable to forest fire as compared to those in Eastern Himalayas. In 1995 forest fire had destroyed more than 3.75 million hectares of forest wealth in Uttaranchal alone. Of the total inventoried forest area of the country, on an average 8.92% is affected by frequent fire and 44.25% by occasional fire. Today, the most forest fires are the result of human neglect. The best way to control a forest fire is to prevent it from spreading by creating Fire Breaks in the shape of small clearings or ditches in the forests. Burning of forests and grasslands add also to already serious threat of global warming and pollution and may be a global source of methyl bromide, which is ozone, depleting substance. In India there is as yet no proper action plan to control forest fires. In Himalayan states, the involvement of the people under Joint Forest Management may certainly be helpful in preventing forest fires by using the modern fire fighting methods.

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## 15. WEBSITES

[State-wise Forest Fires in India \(1998-1999 and 1999-2000\)](#)

[State-wise Forest Fires in India \(1-4-97 to 31-3-98\)](#)

[State-wise Forest Fires in India \(1-4-96 to 31-3-97\)](#)

[Integrated Forest Fire Management Project \(IFFM\)](#)

[Forest Fire Prevention and Control Project \(FFPCP\)](#)

[SPOT Images of Forest/Plantation Fires in South East Asia \(1997, 1998 & 1999\)](#)

[National Incident Management Situation Report](#)

[National Interagency Coordination Center.](#)

[California Department of Forestry and Fire Protection Web site](#)

[Florida Department of Forestry Web site](#)

[Forest Fire Situation in Australia](#)

[Seasonality of Forest Fires in Bhutan](#)

[Fire Situation in Brazil \(1999\)](#)

[Forest Fire Management in Canada](#)

[Forest Fire Situation in India](#)

[Causes and Impacts of Forest Fires: A Case Study from East Kalimantan, Indonesia](#)

[Fire Situation in the United States](#)