

FOREST COVER AND FOREST FIRES IN EASTERN HIMALAYA: A STUDY ON ECOLOGICAL DISASTER WITH SPECIAL REFERENCE TO ARUNACHAL PRADESH

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Abstract

Forest is a complex ecological system in which trees are dominant life forms. The word 'Forest' is derived from the Latin word '*Foris*', meaning out-side, the reference apparently being to a village boundary or fence. Thus, originally, a '*Forest*' must have included all uncultivated and uninhabited land. Today, a forest is any land managed for the diverse purposes of forestry, whether or not covered with trees, shrubs, climbers or such other vegetation. Technically, forest has come to be defined as an area set aside or maintained under vegetation for any indirect benefits, namely climate, protective or environmental or for production of wood and non-wood products. In legal sense, a forest can be defined as an area of land notified to be a forest under a forest law. On the other hand forestry concerns theory and practice of raising tree crops of forest and constitutes their creation, conservation and scientific management and the utilization of the resulting resources. The Forest Survey of India (FSI) has come out with the comprehensive picture of forest cover for all the states and regions. It has found the overall coverage of forest area for the whole country is 20.64 percent.. However, the country as a whole lacks quite a bit in terms of forest cover from the ideal situation (33.33%). When looked into the regional level, as expected wide variations is traced. At the macro level North-east as a whole has as much as 66.10 percent of forest cover.

Fire is a basic component of nature. The word "Fire" is derived from the Greek word "*Pyra*" meaning lit-up embers. It is not exaggeration to say that fire and humanity coevolved. The ecology of fire on earth reflects our own existence, that is, its dynamics embody our knowledge or ignorance as well as our will and our capacity to choose. We cannot ignore fire, because no neutral position is possible. Fire can be used as an element for ecology or withheld effectively. We can not ignore our selves as fire agents. Our ancestors made a pact with the nature. We gained fire, which brought power, in return, we agreed to manage fire. We cannot put the fire aside just because we find its ecology complicated or its smoke annoying or it is legally vexing. Forest fire is sometimes desirable or detrimental in specific season to the ecosystem, but Forest fire is used for different means and purposes by the human beings from time to time. It has been used for clearing the agricultural land, driving away the wild beast, for cooking, for heat, for light, pasture land or regeneration of floral and faunal habitation. The history of wild fire in different parts of North East India is long and varied. The present paper is a product of the study on different aspects of forest fire, its origin, desirability and more particularly its impact on the forest ecosystems in the long run with a global perspective in mind. However, the study takes due note on the anthropogenic nature of forest fire in the context of North East India which is also home to one of the most important bio-diversity hot spot. At the same time the process of modern developmental requirements are put against the back drop of the ecology of forest fire to understand and find out an optimal policy on forest fire management technique for the country in general and north east in particular.

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Introduction:

Forest is a complex ecological system in which trees are dominant life forms. The word 'Forest' is derived from the Latin word '*Foris*', meaning out-side, the reference apparently being to a village boundary or fence. Thus, originally, a '*Forest*' must have included all uncultivated and uninhabited land. Today, a forest is any land managed for the diverse purposes of forestry, whether or not covered with trees, shrubs, climbers or such other vegetation. Technically, forest has come to be defined as an area set aside or maintained under vegetation for any indirect benefits, namely climate, protective or environmental or for production of wood and non-wood products. In legal sense, a forest can be defined as an area of land notified to be a forest under a forest law. On the other hand forestry concerns theory and practice of raising tree crops of forest and constitutes their creation, conservation and scientific management and the utilization of the resulting resources.

Forest is a striking feature of the land surface. The forests of a country are a natural asset of great value, which, unlike mineral resources are renewable and can be kept perpetually protected, productive and useful under proper management. Forest represents the largest most complex and most self generating of all ecosystems. They cover about one-third of the land area of the world and constitute one-half of the total biomass. Forests have a direct and beneficial influence on all parts of the biosphere as a result of their heat absorption capacity and conductivity, aero-dynamic roughness, influence on the water cycle and emissivity in the infrared band. They act as buffer zones between man-made ecosystems and represent half of the world's photosynthetic fixation of carbon from the atmosphere, with its concurrent release of oxygen.

It is understood from the human ecology that one-third of forest cover is ideal for land-use pattern and man-environment relationship for sustainable development regime. While the forest cover of 33.33 percent for the whole world is good for the global environment, the continental and the global variations need to be examined for better understanding of the regional disparity in forest cover. The recent data (2006) on forest cover shows that Latin America has a forest cover of 47.7 percent whereas the continent of Asia has as little as 18.5 percent forest cover. The other deficient continents in terms of forest cover are Africa (21.40 %) and Oceania (24.3%). This shows a clear divide in terms of South-east and North-west global position in terms of forest cover. While it has its implications in terms of global environment and other aspects of global climate and economy related to forest cover the disparity of forest coverage within the regions of generally high density Asian region needs to be looked into. Within Asia there is extreme situation of disparity in terms of forest cover with Western and Central Asia (within which India lies) has as little as only 4.0 percent of forest cover which has to be very little in terms of per capita availability of forest cover.

The Indian situation.

The Forest Survey of India (FSI) has come out with the comprehensive picture of forest cover for all the states and regions. It has found that the overall coverage of forest area for the whole country is 20.64 percent. Therefore, the country as a whole lacks quite a bit of forest cover in terms of the ideal situation (33.33%). When looked into the regional level, as expected wide variations are traced at macro level. North-east as a whole has as much as 66.10 percent of forest cover. Given the wide variation in the topography and population pressure the rest of India also shows wide variations in forest cover. From the all India situation it can be safely derived that North-east is the most resourceful macro region

with respect to forest resources which can be valued for the country as well as for the whole world not only for as a global sink but duly recognized as the bio-diversity hot spot.

Table No-1.1. reflects variations among the eight members of the North-east states with respect to forest cover. The major state of Assam has 35.48 percent of its land area under forest cover. This is understandable because this state covers the plain areas of the Brahmaputra and Barak valley. The states of Arunachal Pradesh, Nagaland and Mizoram has more than 80 percent of forest cover and the states of Manipur, Meghalaya and Tripura have no less than 75 percent of its land area under forest. Sikkim is a small state with least area coverage and has as much as 45.97 percentage of its land area under forest. It can be easily analyzed from the figures that all the states are very resourceful in terms of forest cover. What is important to be noted that out of the entire forest cover of the North-east, a total forest cover of 68019 square kilometer (39.25%) lies in the state of Arunachal Pradesh. This is extremely important from the point of view of studying not only the activity of forestry and incidence of forest fire but also how to manage the fire incidence in the state because fire occurrence depends heavily on the origin and aspects of forest fire more than the population pressure or other activities. To substantiate the argument it can be said that fewer number of interacting people with drier forest can create heavy casualty on forest environment. Therefore, a regional analysis within the vast stretch of Arunachal Pradesh forest cover is essential.

Table No-1.1. Forest cover in North Eastern Region (FSI-2003)

Name of State	Geographical Area (in Sq.Km)	Very Dense Forest (Sq.Km)	Moderately Dense Forest(Sq.Km)	Open Forest (Sq.Km)	Total Forest (Sq.Km)	Percentage of Forest
Arunachal Pradesh	83743	13907	39604	14508	68019	81.22
Assam	78438	1684	11358	14784	27826	35.48
Manipur	22327	720	5818	10681	17219	77.12
Meghalaya	22429	168	6323	10348	16839	75.08
Mizoram	21081	84	7404	10942	18430	87.42
Nagaland	16579	57	5650	7902	13609	82.09
Sikkim	7096	458	1904	900	3262	45.97
Tripura	10486	58	4988	3047	8093	77.18
Total	262179	17136	83049	73112	173297	66.10

Forest cover of Arunachal Pradesh.

Arunachal Pradesh with a geographical area of 83743 square kilometer accounts for about 2.55 percent of the total land of the country. While this is significant in terms of purely land availability what is more significant is that 68019 square kilometer of the land area is covered by forest amounting to 81.22 percent of the total land area of the state (Table No-1.2). It is essential here to know the actual legal status of the vast forest land of this low population density state (13 person / sq. km).

Table No-1.2.Geographical area under forest cover in Arunachal Pradesh (FSI-2003).

Districts	Geographical Area (Sq.Kms)	Very Dense Forest (Sq.Km)	Moderately Dense Forest(Sq.Km)	Open Forest (Sq.Km)	Total Forest (Sq.Km)	Percentage of Forest
Changlang	4662	1879	1539	888	4306	92.36
Tirap	2362	459	1042	392	1893	80.14
Dibang Valley	13029	851	5836	2736	9423	72.32
East Siang	3655	448	1944	480	2872	78.58
Lohit	11402	1955	4224	1615	7794	68.36
Lower Subansiri	9548	2286	4745	1704	8735	91.49
Papum pare	3462	754	1699	834	3287	94.95
Upper Siang	7050	736	3676	1198	5610	79.57
Upper Subansiri	7032	849	3803	1155	5807	82.58
West Siang	7813	997	4884	946	6827	87.38
East & West Kameng	11556	2583	5548	2107	10238	88.59
Tawang	2172	110	664	453	1227	56.49
Arunachal Pradesh	83743	13907	39604	14508	68019	81.22

The forests of the state of Arunachal Pradesh are legally classified and notified as reserved forests, protected forests, anchal and village forests reserves, national parks and wild life sanctuaries under the relevant provisions of Assam Forest regulation 1891, Anchal and Village Forest Reserve Act 1978 and 1981 and the Wild life (Protection) Act 1972. Unsurveyed forests where status of right and ownership is not settled are classified as Unclassed State Forest (USF). The USF is an ambiguous term and there is not much departmental control over these lands. It is found from the field experience that all kind of forest mentioned above are not distinct by their identity and all of them are prone to

forest fires of different nature in different regional context. As far as the forest covers at the district level are concerned all the districts except Tawang show more than 70 percent of their land area covered by vegetation. In fact the 56.49 percent forest cover of Tawang is among the healthiest considering its high altitude. It is required to be mentioned here that four different types of forests which are prone to forest fires are covered which has significant coverage as per the recent data available through the survey of Forest Survey of India (FSI) 2003. These are:

- i) Tirap district - Tropical wet evergreen forest - 80.14 percent
- ii) Lower Subansiri district - Sub tropical and pine forest - 91.49 percent
- iii) Papum pare district - Tropical semi evergreen forest - 94.95 percent
- iv) East and West Kameng district – Temperate forest - 88.59 percent

The above regional coverage of five forest types which have been covered under the study are also found to have significant coverage confirmed by the recent data compiled by the appropriate agency (FSI) independently. Hence, the methodology and coverage of the study area is reinforced to find out the real picture of forest fire incidents for the whole state of Arunachal Pradesh.

General Nature of Forest Fire and its role in Forest Ecosystem:

The Earth has known fire for over 400 million years. Life made it possible. Marine life pumped the atmosphere full of oxygen; terrestrial life lathered the crust with fuels. When oxygen and fuel meet a spark under the right circumstances, a fire kindles. Lightning is an ancient and ample ignitor. The fundamental mechanism of combusting lies at the core of the living world. The basic is that when it happens within a cell of living organisms it is called respiration. When it happens out side of living organism, it is called fire (Pyne, 1996). Fire is basic component of nature. The word “Fire” is derived from the Greek word “*Pyra*” meaning lit-up embers. It is not exaggeration to say that fire and humanity

coevolved, like the bounded strands of DNA (Pyne *et.al.*, 1996). Archaeological evidences indicates that human, the unique species of homo sapiens, have been using fire in different ways from 60,000 years ago, since the beginning of their civilization during Paleolithic period in Africa (South and East Africa). Fire offered prehistoric man security against wild beast, medium of communication for social living and intellectual development might have begun at the fire sides (Alexander, 1993). Our capacity as fire creatures defines our ecological imprint as no other trait can. Other animal knock over trees, dig holes, eat plants, and hunt, but only human beings apply and withhold fire. The ecology of fire on Earth reflects our own existence, that is, its dynamics embody our knowledge or ignorance as well as our will and our capacity to choose. We cannot ignore fire, because no neutral position is possible. Fire can be used as an element for ecology or withheld effectively. We can not ignore our selves as fire agents. Our ancestors made a pact with the nature. We gained fire, which brought power, in return, we agreed to manage fire. We cannot put the fire aside just because we find its ecology complicated or its smoke annoying or it is legally vexing. Forest fire is sometimes desirable or detrimental in specific season to the ecosystem, but Forest fire is used for different means and purposes by the human beings from time to time. It has been used for clearing the agricultural land, driving away the wild beast, for cooking, for heat, for light, pasture land or regeneration of floral and faunal habitation. The history of wild fire in different parts of Arunachal Pradesh is long and varied. Even before written records of fire, the evidences of forest fire are traced in the soil profiles land slides and in old-growth trees that have been scarred by fire could be disastrous to the habitation and environment by all quarters. It is universally true that the nature of fire is to burn to ashes. Thus, during different times scale, from ancient to modern, use of fire in forest is inevitable. It has

played a significant role in environmental change (Alexander, 1993). Generally, a spark of fire in the forest is naturally or anthropogenically created. This burns down vast stretch of lush green vegetation.

On the other hand, fire is desirable to forest ecosystem to enrich the adoptability and habitation of wild life. Therefore, it looks a bit amazing even to the ecologist, that almost the opposite is true i.e. the desirability of forest fire. In the ecosystems, where climatic conditions support fire, the plants seem to possess not only fire survival traits but also fire enhancing traits.. Vegetation belts of *Pine*, Grassland and shrubs are examples of fire adopted ecosystems, since their continued existence depends on periodic occurrence of fire.

In any terrestrial forest landscape, the origin of fire can be either natural or anthropogenic, depending upon weather, topography and fuel type, commonly known as the fire triangle (Fig-1)

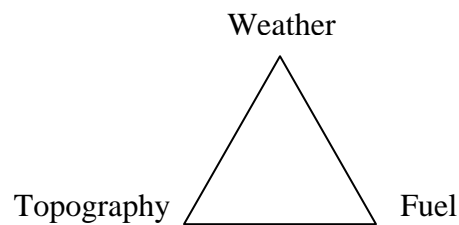


Fig-1: Fire triangle

The origin of natural forest fire is due to spontaneous combustion and spark produced by rockslide, lightning and volcanic eruption. Where as the anthropogenic induced forest fires are either intentionally or unintentionally created. Both types of fire, natural or anthropogenic, may manifest them selves as (Fig -2) (i) Creep fire, (ii) Surface fire, (iii) Ground fires and (iv) Crown fire.

- (i) Creep Fire, is that which spreads slowly over the forest floors and burns with a low flame. In certain areas the fire is confined to the humus layer which lies above the top soil.
- (ii) Ground fire is usually confined to the vegetation of the lower canopy destroying shrubs and herbs. It can also scorch the tree bases.
- (iii) Surface fire burns the shrubs, trees species and trees of the middle canopy.
- (iv) Crown fire is the most devastating type of forest fire, which destroys the entire upper canopy of a forest.

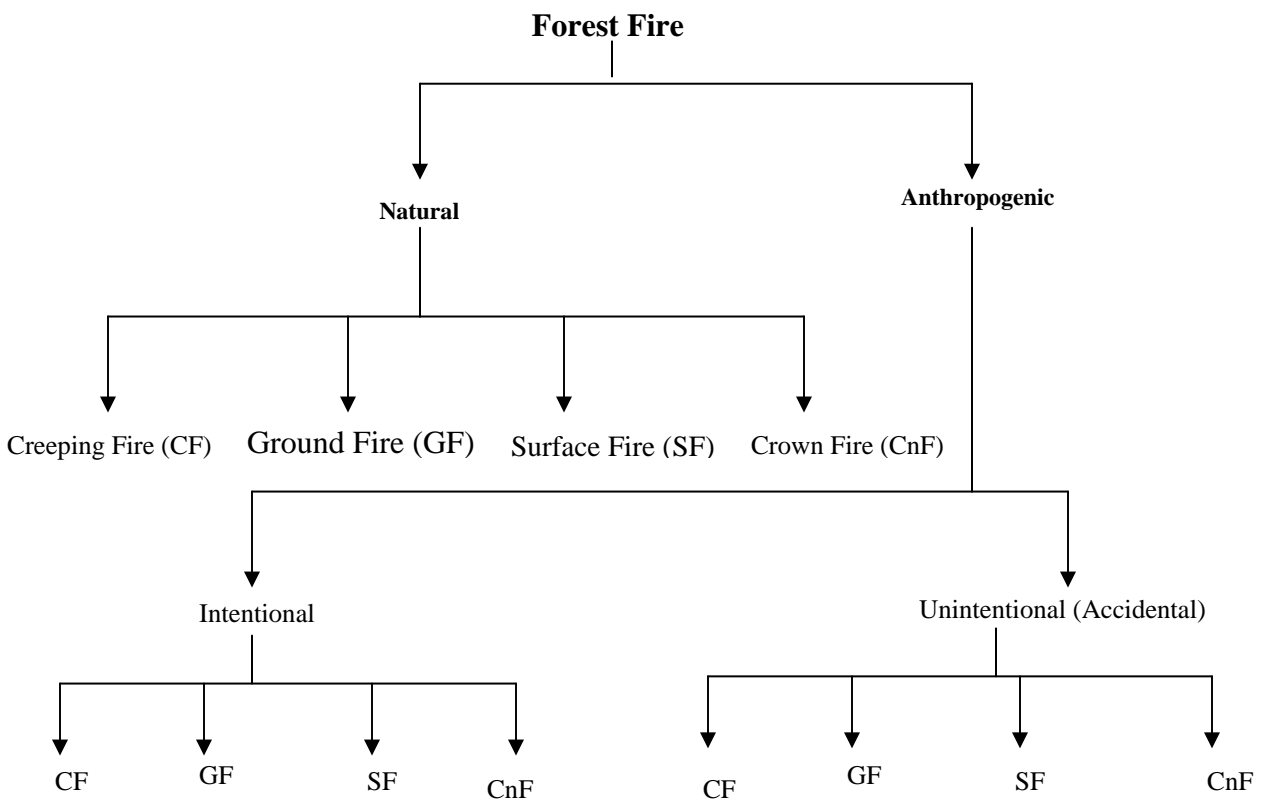


Fig -2. : Types and categories of Forest fire

Effects of fire on vegetation depend on a number of factors along a complex path defined by frequency, magnitude, extent, season, phenological state of the vegetation, combined effects with other disturbances such as storms, diseases, pest attack, etc. On the basis of the impact of fire on vegetation, three major fire regimes could be identified, Nonlethal, Moderate and Lethal. Creep fire, Ground fire, which are generally nonlethal, is now

being restored as a management tool in many developed countries Prescribed categories of light fires of creeping types and ground fires in the forests helps to reduce fuel loading and hence minimize the chances of high intensity wild fires. Surface fire and Crown fire which are detrimental to forest ecosystems, are mostly undesirable However, in reality different affected forest patches would take different times and ways to revert back to pre-burn state and during the process different species will occupy different space, contributing to greater biodiversity at different times. Moreover, some of the grasses, herbs and trees seedling colonize only after the light burn. Light fires of low and moderate intensity also helps unlock the nutrients of the accumulated biomass pool and Effects of fire on vegetation depend on a number of factors along a complex path defined by frequency, magnitude, extent, season, phenological state of the vegetation, combined effects with other disturbances such as storms, diseases, pest attack, etc. On the basis of the impact of fire on vegetation, three major fire regimes could be identified, Nonlethal, Moderate and Lethal. Creep fire, Ground fire, which are generally nonlethal, is now being restored as a management tool in many developed countries Prescribed categories of light fires of creeping types and ground fires in the forests helps to reduce fuel loading and hence minimize the chances of high intensity wild fires. Surface fire and Crown fire which are detrimental to forest ecosystems, are mostly undesirable However, in reality different affected forest patches would take different times and ways to revert back to pre-burn state and during the process different species will occupy different space, contributing to greater biodiversity at different times. Moreover, some of the grasses, herbs and trees seedling colonize only after the light burn. Light fires of low and moderate intensity also helps unlock the nutrients of the accumulated biomass

Table-No-1.3 Forest fire category and its intensity.

Fire category	* Intensity ($\text{KJm}^{-1} \text{S}^{-1}$)	Descriptive of fire flames
Creeping Fire (Warm)	< 500 (Light intensity)	Flames <1m, easily approachable
Ground Fire (Hot)	500-1000 (moderate intensity)	Flames 1-1.5 m, approachable
Surface Fire (Very Hot)	1000-2000 (High intensity)	Flames 1.5-3 m, difficult to approach
Crown fire (Extremely Hot)	> 2000 (Severe intensity)	Flames >3m, uncontrollable

Source: Trollope, W.S.W. 1984

$$* \text{Intensity } (\text{KJm}^{-1} \text{S}^{-1}) = F \times E \times V$$

$$F = \text{Fuel load } (\text{KJm}^{-2})$$

$$E = \text{Energy } (\text{KJg}^{-1}) \text{ assumed to be } 20 \text{ KJ g}^{-1}$$

$$V = \text{Rate of spread.}$$

pool and make them easily available to colonizing plants, breaks the dormancy of the seeds and buds of many species and reduces competition. Thus, the impact of fire on vegetation may be desirable or detrimental, depending on the management regimes. Using fire in modern forest management seems to be the re-invention of an activity practiced by many traditional communities for millennia who could clearly recognize the value of fire for maintaining landscape and hence biodiversity.

Recent history of forest fire in Arunachal Pradesh:

The recent history of incidence of forest fires in the state of Arunachal Pradesh has been studied between 1985 to 2005. As mentioned earlier these incidence have been documented for the four different forest types and respective regions (Table No.1. 4.). It is clear that the incidence of forest fire has increased by more than three fold after 1995. In fact as many as twenty seven fire accidents are recorded between 2001 to 2005 where as there were only six incidences traced between 1985 to 1990. At the regional level

maximum fire incidence (numbering thirty nine) are recorded in the lower temperate forest type of West Kameng district traced into Bomdila Forest Division. Of these thirty nine as many as thirty incidence of forest fire in this Division has been recorded in the last 10 years. All the rest three Forest Divisions in the districts of Tirap, Papum pare and Lower Subansiri also have shown increasing incidences of forest fires in recent times. Therefore, it can be concluded that incidences of forest fire is related to increasing interference of human activities inside natural forest covers. The human activities can be traced into general categories of grazing, jhumming, hunting and poaching and tea cultivation.

Table:No-1.4 Recent history of forest fire in Arunachal Pradesh

Types of Forest/Districts	Frequencies of Forest fires *				Total
	1985-90	1991-95	1995-2000	2001-05	
Tropical wet evergreen forest of Tirap district	2	1	5	2	10
Tropical Semi evergreen forest of Papumpare district	1	0	2	3	6
Sub-tropical and Pine forest of Lower Subansiri district	0	0	1	9	10
Lower temperate forest of West Kameng district	3	6	17	13	39
Total	6	7	25	27	65

Spatial and Causal aspects of forest fire in Arunachal Pradesh:

The spatial and causal aspects of forest fire in Arunachal Pradesh has been studied through primary sources covering the four Forest Divisions namely Deomali, Bandardewa, Hapoli and Bomdila in the districts of Tirap , Papum pare, Lower Subansiri and West Kameng, respectively (Table No-1.5). All the causes traced are recorded to be anthropogenic by nature. These man made causes are divided into two clear cut categories. These are :

- (i) Intentional.
- (ii) Accidental.

It is understood that fire caused by human interaction with forest is categorized into activities like jhumming, grazing, encroachment, hunting, tea cultivation and road construction in that order. Of these activities jhumming is related to controlled

Table:No-1.5 Spatial and Causal aspects of forest fires in Arunachal Pradesh

Types of Forest	Name of Forest Division	Causes		Total area effected (in Hectare)
		Anthropogenic Intentional	Anthropogenic Accidental	
Tropical wet evergreen forest of Tirap district	Deomali	For tea cultivation(1). Burning bamboo flowering (1).	Jhum cultivation(8).	109.50
Tropical Semi evergreen forest of Papumpare district	Bandardewa	Burning bamboo flowering(1). For hunting & poaching(1).	Jhum cultivation(4).	655.20
Sub-tropical and Pine forest of Lower Subansiri district	Hapoli	For hunting & poaching(1).	Jhum cultivation(9).	850.0
Lower temperate forest of West Kameng district	Bomdila	For land encroachment(2). For grazing land (8).	Jhum cultivation(28) From combustible (petroleum) product(1).	1486.12
Total area effected				3100.82

fire which is not considered as fire incidence within the jhumming land. However, a fire escape from the jhumming land and creates forest fires more often than not. These kinds of forest fires are categorized into anthropogenic accidental as their causes. Some times road construction also leads to cause of forest fire (one case recorded). Under the category of anthropogenic intentional causes, several human activities can be identified.

In case of Arunachal Pradesh burning natural forest for development of tea cultivation, for developing grazing land are traced to the Deomali Forest Division (Tirap district) and Bomdila Forest Division (West Kameng District), respectively. The other intentional causes for forest fire created by human beings are burning of bamboo flowering, hunting and poaching and some times for land encroachment which are wide spread in all over Arunachal Pradesh.

The Table No.1.5. also shows the intensity of fire in terms of area affected. It is found that large areas are affected in the western district of West Kameng where as the tropical wet ever green forest of Tirap district is least affected. This is how ever more of approximation as far as the intensity of fire is concerned because the grazing land development in the western Arunachal Pradesh (West Kameng district) covers large tracts of grazing land development which is of intentional and beneficial to the people in that area who rear large herds of cattle. Therefore, it can be deduced that forest fire study has a region specific aspect to its cause and consequences.

Implications of the study:

- Forest Fire is mostly anthropogenic in its origin
- In its broader context it is hazardous for the physical environment
- It is a global problem irrespective of its desirability in specific cases
- In spite of deficit forest cover, India is significantly vulnerable to the hazard
- North Eastern region of this country faces a dual problem of balancing this man made hazard in the regional context of development and livelihood
- Modernization of Agricultural Technology should be region specific
- Desirable forest fires should be included in forest management where as accidental fires are to be prevented through effective awareness building and controlled through modern fire fighting techniques.

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