

**Government of Nepal
Ministry of Forests and Soil Conservation
Department of Forests**

Makawanpur District Forest Office

Forest Fire Management Plan



Makawanpur District

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Foreword

Forest fire is considered as a problem in forest management systems in Nepal since we have not been able to use it as a management tool. The Fire Management Plan; the first of its kind in Nepal; is an important initiation to safeguard forest and biological resources by reducing fire damages through mobilizing government, non-government, private sector, civil society and local people.

The Plan is prepared with the support of the Foreign Office, Federal Republic of Germany, Office for Humanitarian Assistance and the Global Fire Monitoring Center. The preparation of the Plan is based on the substantial efforts and assistance from numerous experts, professionals, organizations, and local communities who extensively shared their ideas and expertise. I would like to express sincere thanks to all those who contributed to this effort.

I am thankful to the plan preparation team of Mr. Sundar Prasad Sharma, Mr. Krishna Prasad Acharya, Mr. P. Daniel Kraus, Mr. Ananta Ram Bhandari and Mr. Kiran Timilsina for their contributions. Moreover, I am grateful to Mr. Rishi Ram Tripathi, District Forest Officer of Makawanpur and his team, community forest user groups and local communities for their inputs. I believe that successful implementation of this plan will be instrumental in shaping future forest management strategies in Nepal.

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Executive Summary

It is common that forest fire occurs every year in Nepal, particularly in the forests of Terai and Churia hills. Government of Nepal has given less priority in managing forest fire due to limited resources. Nepal has adopted various forest management approaches including community forestry, leasehold forestry, protected forestry and government managed forestry. All categories of forests are affected by fire albeit the magnitude varies. Community forests and leasehold forests are less affected as compared to protected forests and government managed forests. Nevertheless, no comprehensive fire management plan exists in the country till date. The plan aims to fulfill the gap. This fire management plan highlights basic forest fire information, existing practices adopted by local communities in suppressing forest fire, and fire prevention and control strategies to be adopted into community managed, government managed, and protected forests in Makawanpur district.

The district fire management plan intends to prevent and control forest fire with strategies of ensuring people's participation, promoting indigenous knowledge, emphasizing preventive measures, and enhancing multi-stakeholders' networking. The management plan is prepared in the spirit of participatory approach. Various participatory tools including focus group discussion, key-informant interviews and observations were used. In addition, various documents were reviewed while preparing the plan.

Makawanpur district is divided into three fire zones including highly fire sensitive zone, moderately fire sensitive zone and less fire sensitive zone, based on causes and effects of forest fire. The criteria set for zoning include occurrence of forest fire, forest types and availability of fuel loads, distance from settlements, roads and trails, and forest management regimes.

Proposed fire preventive measures include risk reduction through increased awareness level of the stakeholders; and hazard reduction through reducing fire fuels, construction of fire lines, and adoption of prescribed burning in highly and moderately fire sensitive zones. Fire control measures proposed in the plan include developing effective fire detection and communication systems; and suppressing fire through developing appropriate institutions and well equipped fire crews with traditional as well as modern fire fighting equipments and tools at various levels. The plan also recommends contingent recovery planning for rehabilitating fire damaged areas. A fire management work plan is prepared for the next five years.

Acronyms

AFO	Assistant Forest Officer
BISEP-ST	Biodiversity Sector Program for Siwaliks and Terai
BZMC	Buffer Zone Management Committee
CBO	Community Based Organization
CF	Community Forest
cft	cubic feet
CFUG	Community Forest User Group
CNP	Chitwan National Park
DCP	Development/Conservation Partner
DDC	District Development Committee
DFO	District Forest Office/District Forest Officer
DFP	Focal Person at District Forest Office
DoF	Department of Forests
FECOFUN	Federation of Community Forestry Users, Nepal
GIS	Geographical Information System
GoN	Government of Nepal
GPS	Global Positioning System
IFP	Focal Person at Ilaka Forest Office
LRP	Local Resource Person
NGO	Non-Governmental Organization
NGSP	Non-Governmental Service Provider
NTFP	Non Timber Forest Products
OFMP	Operational Forest Management Plan
PA	Protected Areas
PRA	Participatory Rural Appraisal
PWR	Parsa Wildlife Reserve
RFP	Focal Person at Range Post
RS	Rupees
VDC	Village Development Committee

Table of Contents

Foreword	i
Executive Summary	ii
Acronyms	iii
Table of Contents	iv
List of Tables	vii
List of Figures	vii
List of Photographs	vii
List of Annexes	viii
1. Introduction	1
1.1. Forest Fire	1
1.2. Forest Management Approaches	1
1.3. The Fire Management Plan	2
2. Makawanpur District: a Glimpse	3
2.1. Location	3
2.2. Physiography	3
2.3. Geology and Soils	4
2.4. Climate and Seasons	4
2.5. Hydrology and Drainage	4
2.6. Land Use	5
2.7 Demography	6
2.8. Caste and Ethnicity	7
2.9. Economy and Livelihood	7
3. Forest Management in Makawanpur District	8
3.1. Forest Resources	8
3.2. Forest Types	8
3.3. Forest Management Regime	10
3.3.1. Community Forestry	10
3.3.2. Leasehold Forestry	10
3.3.3. Protected Areas	11
3.3.4. Government Managed Forestry	11
4. Objectives of Fire Management Plan	12
5. Fire Management Strategy	13
6. Methodology	15
6.1. Focus Group Discussion	15
6.2. Key Informants Survey	16
6.3. Observation	17
6.4. Documents Review	17
7. Forest Fire in Makawanpur District	18
7.1. Occurrence and Frequency of Forest Fire	18
7.2. Fire Season	18
7.3. Duration of Fire	18

7.4. Fire Fuels -----	19
7.5. Causes of Forest Fire -----	19
7.6. Fire Zones -----	21
8. Damages and Impacts of Forest Fire -----	24
8.1. Nature of Damages -----	24
8.2. Impacts of Forest Fire -----	26
8.2.1. Environmental Impacts -----	26
8.2.2. Socio-economic Impacts -----	27
9. Existing Fire Management Practices -----	29
9.1. Preventive Measures -----	29
9.1.1. Fuel Breaking Practices -----	29
9.1.2. Hazard Reduction -----	29
9.1.3. Risk Reduction -----	29
9.2. Control Measures -----	30
9.2.1. Fire Detection and Communication System -----	30
9.2.2. Suppression of Forest Fire -----	30
9.3. Legal Provisions -----	31
10. Existing Capacity of District Forest Office -----	32
10.1. Organization and Human Resources -----	32
10.2. Supportive Community Based Organizations -----	32
10.3. Supportive Infrastructures -----	32
11. Fire Management Planning -----	34
11.1. Fire Prevention -----	34
11.1.1. Fire Risk Reduction -----	34
11.1.2. Fire Hazard Reduction -----	35
11.2. Preparedness -----	35
11.2.1. Fire Crews -----	35
11.2.2. Fire Fighting Tools and Equipments -----	36
11.2.3. Training and Orientation -----	36
11.2.4. Cooperation and Networking -----	36
11.3. Fire Control -----	36
11.3.1. Fire Detection and Communication -----	37
11.3.2. Fire Suppression -----	37
11.4. Reporting and Monitoring -----	39
11.5. Recovery and Rehabilitation -----	40
12. Work Plan -----	41
13. Benefit-Cost Analysis of the Plan -----	45
Reference -----	46
Annexes -----	48

List of Tables

1. Land use types of Makawanpur district -----	5
2. Caste and ethnic distribution in Makawanpur district -----	7
3. Livelihood options of Makawanpur district -----	7
4. Species wise volume of the forest in Makawanpur district -----	8
5. Status of community forestry in Makawanpur district -----	10
6. Status of leasehold forestry in Makawanpur district -----	11
7. Occurrence of forest fire in Makawanpur district -----	18
8. Fire zones in Makawanpur district -----	22
9. Forest area covered by fire zones in Makawanpur district -----	23
10. Fire affected area by forest regime in Makawanpur district -----	24
11. Estimated annual loss of sawlog by forest fire in Makawanpur district -----	25
12. Estimated annual loss during conversion of sawlog into firewood by fire -----	25
13. Estimated annual loss by forest fire in Makawanpur district -----	25
14. Development stage and status of forest in Makawanpur district -----	26
15. Fuel breaking lines in the CF of Makawanpur district -----	29
16. Supportive CBOs in Makawanpur district -----	32
17. Road network in Makawanpur district -----	33
18. Transportation vehicles to be arranged in Makawanpur DFO -----	39
19. Benefit-Cost situation of proposed work plan -----	45

List of Figures

1. Location map of Makawanpur district -----	3
2. Major river systems of Makawanpur district -----	5
3. Land use map of Makawanpur district -----	6
4. Forest types of Makawanpur district -----	9
5. Location map of fire sensitive zone in Makawanpur district -----	23
6. Map showing road network in Makawanpur district -----	33
7. Proposed organizational structure of district forest office, Makawanpur -----	38
8. Reporting and monitoring flow chart -----	40

List of Photographs

1. Focus group discussion at Manahari Ilaka forest office -----	15
2. Key informant showing fire prone areas -----	16
3. Fire practiced during BANDEVI worship -----	17

List of Annexes

1. Existing organizational structure of Makawanpur district -----	48
2. List of fire fighting tools and equipments to be available for fire crews -----	49
3. Local fire fighting tools to be available for CFUG -----	50
4. Communication system in government managed forest -----	51
5. Communication system in community forest -----	52
6. Communication system in protected areas -----	53
7. Glossary of fire related terms -----	54

1. Introduction

1.1. Forest Fire

Forest fire is considered as a major cause of forest degradation in Nepal. About 90 percent of the forested area in the plain was burnt out one to three times every year (Sharma 1996.a). The majority of fires are surface fire. About 400,000 ha forest area burned annually (Bajracharya 2002). Most of the fires are anthropogenic.

Forest fires not only destroy timber and non timber forest products but also manipulate all three levels of biodiversity, *i.e.* genes, species, and ecosystems. High intensity fires may create a significant threat to human life and property.

However, all fires are not harmful. Fire is a forest management tool if it is used appropriately. It is important for forest regeneration, in some cases, and maintaining wildlife habitats. In several habitats, fire plays a critical role in the health of ecosystems and in maintaining their biological diversity (NBS, 2002). Managed fire destroys weeds and undergrowths, and not only reduces competition with the main species but also reduces fire hazards in the forest. It promotes sprouting to be more nutritious and palatable for grazing and browsing animals.

Forest fire can broadly be classified into surface fire, ground fire, and crown fire. Surface fire consumes leaf litter, grasses and other materials in the surface of the forest and is less harmful. Ground fire is more harmful than surface fire since it damages underground biomass along with the undergrowth and other surface materials. Crown fire advances from top to top of trees. It damages crowns of the tree and spread very rapidly. It is the most dangerous type of forest fire.

A study (Sharma 1996.a) conducted in Manahari in Makwanpur district (inner Terai) revealed that the fuels are mostly continuous, and one to four layers of leaves of sal (*Shorea robusta*) and other species comprise about 95 percent of the volume, of which sal leaves account for about 90 percent. Other surface fuels are twigs and grasses. The volume of the available fuel was found to be 10.7 tonnes oven dry weight per hectare. The fuel type (*i.e.* forest cover type) is mixed forest comprising 70 percent sal, 10 percent asna (*Terminelia alata*), and 20 percent other species. The fuel type pattern is more or less homogeneous with some natural (streams, small rivers, etc.) and cultural (roads, foot trails, etc.) barriers. The rate of spread of the fire in experimental burnings in Manahari forest area (Terai) in the given conditions was found to be about 0.25 m/min and the form was found to be elliptic. The flame height was found to be about 25 cm.

The fire season starts from mid-March to the end of May in the Terai region (Sharma 1996 a, Kanel 2007). A fire had observed in high mountain forest in December 2007 (Goldammer 2007).

1.2. Forest Management Approaches

Government of Nepal has adopted various approaches to manage the forests in the country. Major strategies of forest management in Nepal are: community forestry, leasehold forestry, government managed forestry, and protected forestry. Nepal has adopted community forestry as main approach of forest management since 1990s. In community forestry, state control and protected forests areas are being transformed to local people control. Local people are

managing community forests, to meet their forest product needs, based on their indigenous knowledge synergized with technical inputs by the forestry technicians. Leaseholds forestry is practiced in Nepal through handing over patches or blocks of degraded forest to local communities or private enterprise. The communities or enterprises have rights over land for leased period but they have to maintain or improve existing forest condition. Government has managed itself the large blocks of forests in Terai region. In the hills, forest patches which are not under community control are under government control. The forests that are inaccessible, or far from the settlements are under this category. Protected forests are the legally strict areas where forests are preserved as biodiversity hotspots or protected areas.

1.3. The Fire Management Plan

It is common that forest fire occur every year in Nepal, particularly in the forests of Terai and Churia range. But, unfortunately, the government of Nepal has very limited initiatives on the prevention and control of forest fire. Statistical data on fire are missing. There is no systematic and complete record of forest fires or their impacts in Nepal (NBS, 2002). A national level workshop of District Forest Officers, held from November 5 to 7, 2007 in Kathmandu, realized that prevention and control of forest fire is an important component of forest protection in Nepal. The susceptibility of forest fire in Makawanpur district is higher due to its geographical location ranging from Churia hill to Mahabharat range.

All category forests including community forests, leasehold forests, government managed forests, and protected forests are affected by forest fire although the extent is varied. Leaseholds forests are less affected by forest fire since they are in degraded form and usually are small patches or blocks. Leasehold forestry dealt with this management plan is pro-poor leasehold forestry. Community forests, government managed forests, and protected forests are highly affected by forest fire.

Community forests are at high risk of forest fire. The main reasons are contiguous blocks and adoption of passive forest management. Community forests are in contiguous blocks with no physical separation of forest patches and, hence, fire will easily move to adjoining community forests. Moreover, the forest blocks within the CF are not physically separated, which means that the fire will easily spread to adjoining blocks. The adoption of fire preventing mechanism such as construction of forest road, fire line is lacking or are very negligible, and forest fire can spread easily and difficult to control. Community forestry is adopting passive forest management approach, which means removal of dead and dying trees from the forest, and emphasize on protection rather than management. The practice has resulted in high density forest. As a consequence, trees are closer to each other with increasing fire hazards and increasing volume of leaf each year.

In government managed forest and protected forest, the frequency of forest fire is higher than the community managed forest. The reasons behind are less accessibility of the forest, low attention in fire management, and weak institutional mechanism in forest fire control. Government managed forests in the hills are inaccessible since government has handed over accessible forests to local communities as community forest. It is difficult to control fire in such inaccessible forests. The government has paid very less attention in forest fire management (NBS, 2002). Existing machinery of the department of forest is weak since it lacks trained persons and equipments and tools to prevent and control forest fire.

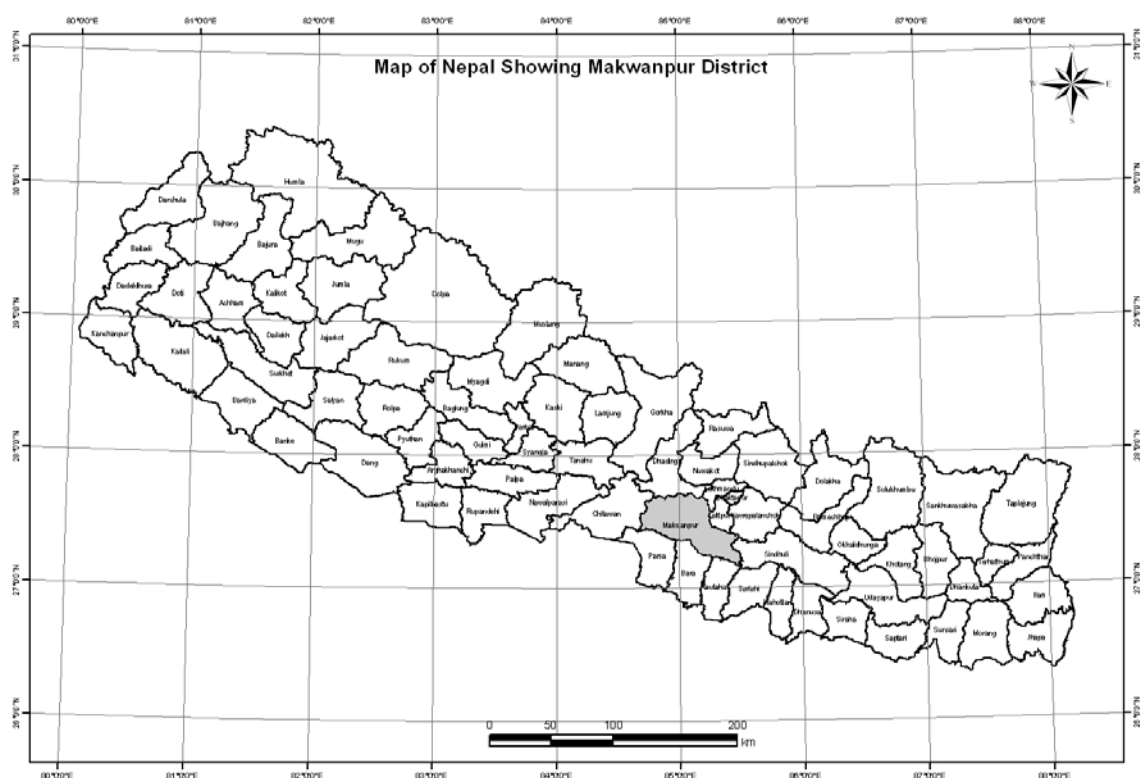
Development of an appropriate fire management planning and implementation mechanism is needed to address the contemporary issues on forest fire and institutionalize the best indigenous practices. The fire management plan highlights basic forest fire information, existing practices adopted by local communities in suppressing forest fire, and fire prevention and control strategies to be adopted into community managed, government managed, and protected forests in Makawanpur district.

2. Makawanpur District: a Glimpse

2.1. Location

Makawanpur district, located between 84°41' and 84°35' E longitude and 27°21 and 27°40' N latitude, lies in Narayani zone of the Central Development Region of Nepal. The district is surrounded by Sindhuli, Lalitpur, Kavreplanchok and Kathmandu districts in the east, Chitwan in the west, Kathmandu and Dhading in the north and Rautahat, Bara and Parsa districts in the south. The district covers 244457 ha landmass which is about 1.65% of the total landmass of the country. Makawanpur district is accessible by 47 km of East-West highway, 110 km of Tribhuvan highway and several district level roads. Hetauda municipality is not only district headquarter of Makawanpur but also headquarter of Central Development Region of Nepal. The location map of Makawanpur district is presented in Figure 1.

Fig. 1. Location map of Makawanpur district



2.2. Physiography

Makawanpur district lies between 166m and 2584m above mean sea level. The district can broadly be divided into two physiographic regions *i.e.* Mahabharat hills in the north and Churia hills (also called Siwaliks) in the south. About 75% landmass of the district is mountainous and rest 25% is dead hills to plane lands (DDC, 2007). The slopes of northern Mahabharat hills are often very steep.

2.3. Geology and Soils

The geological composition of the district is rather complex. The Mahabharat hills composed of sandy stone, lime, quartzite and gneiss. Physical property of the soil varies in the valleys and hills within the Mahabharat range. Productivity of the soil is higher in low lands as compared to hills. Soil texture in the hills is medium to light texture with predominance of coarse grain and gravel of very high permeability, and acidic in nature. The Siwaliks hills are composed of coarsely and loosely bedded stones, crystalline rocks, shale and conglomerates. The soils in the Siwaliks hills are primitive, shallow, and acidic in nature (DFO, 2003). The textures of the soils are sandy with low capacity to retain water. Lesser moisture containing capacity of the soils promote forest fire.

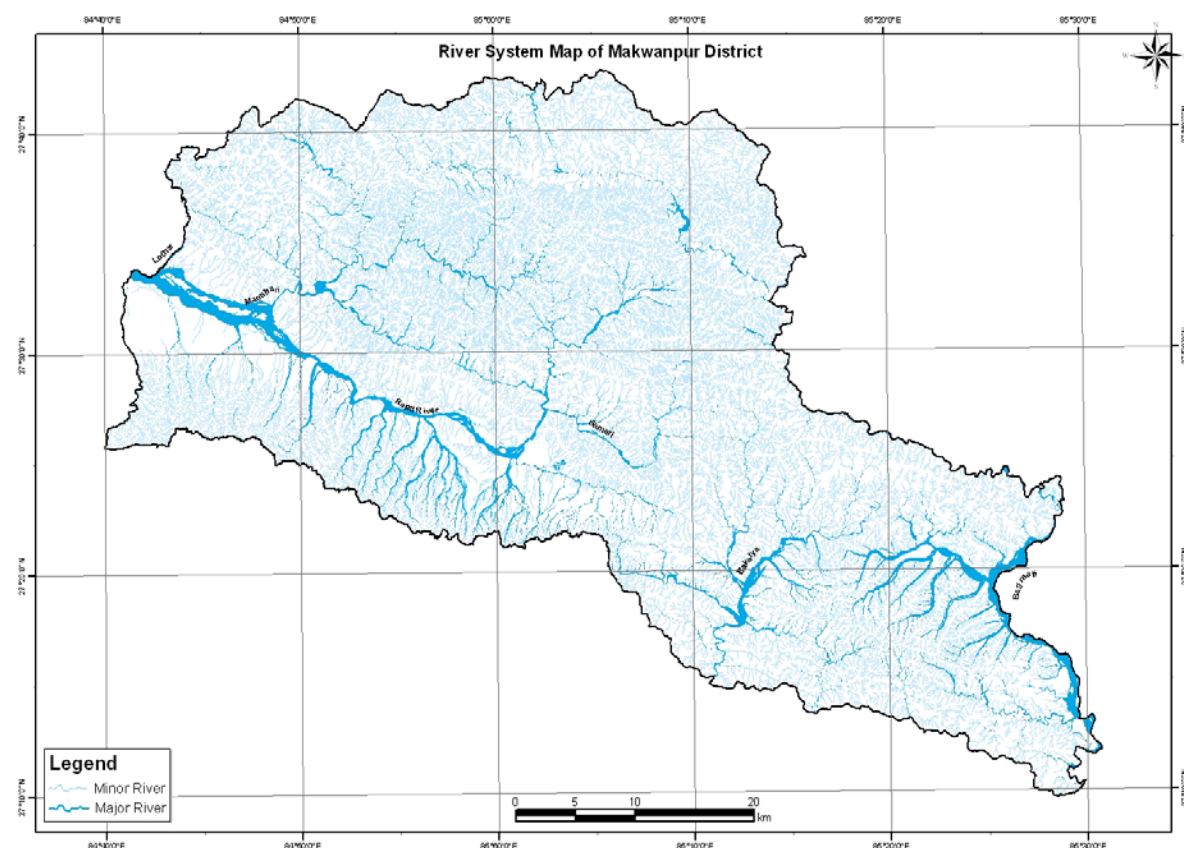
2.4. Climate and Seasons

Climatic variation in the district ranges from tropical to temperate. Tropical and sub-tropical climate exists in the southern part of the district, in the Churia range. In the northern part, the Mahabharat range, predominated by the temperate climate. Makawanpur district can broadly be divided into three seasons: cold, hot, and rainy season. Cold season exists between December and February. The temperature in cold season falls down to 6.6⁰C (average) but in the up hills, particularly in Daman and Simbhanjyang area, snowfall occurs. Forest fire problems do not exist during the cold season in this district. Hot season exists between March to June with the average temperature of 32.9⁰C. This is the fire hazard season in the district. Monsoon remains active, generally, from July to September in this district, and, is called rainy season. Average rainfall is 2274 mm in Churia hills and 1908.6 mm in Mahabharat range. Rainy season is a less fire hazardous season. Average relative humidity of the district is 73.5%.

2.5. Hydrology and Drainage

The major river systems in the districts are Rapti and Bagmati. Rapti River originated from Chisapani and Bhimphedi of Mahabharat range is a tributary of Narayani River, one of the major river systems of Nepal. Samari, Karra, Manahari, and Lothar streams are the tributaries of Rapti River. Bagmati River flows in the eastern boarder of the district. Indrasarowar, 2.2 km², is an artificial lake constructed for Kulekhani hydro power dam. It lies in Kulekhani VDC within the Mahabharat range. Kulekhani hydro power dam is consists of total 8 sub-watersheds which cover Markhu, Chitlang, Bajrabarahi, Daman, Kulekhnai, Palung and part of Tistung VDCs. Major river systems of the district is presented in Figure 2.

Fig. 2. Major river systems of Makawanpur district



2.6. Land Use

Major land use types of Makawanpur district is forest which covers about 59% of the total 2444.57 km² landmass of the district. Other land use types are cultivated land, bushes and pastures, rivers, protected areas, industrial areas and settlements. Table 1 presents the major land use types in Makawanpur district.

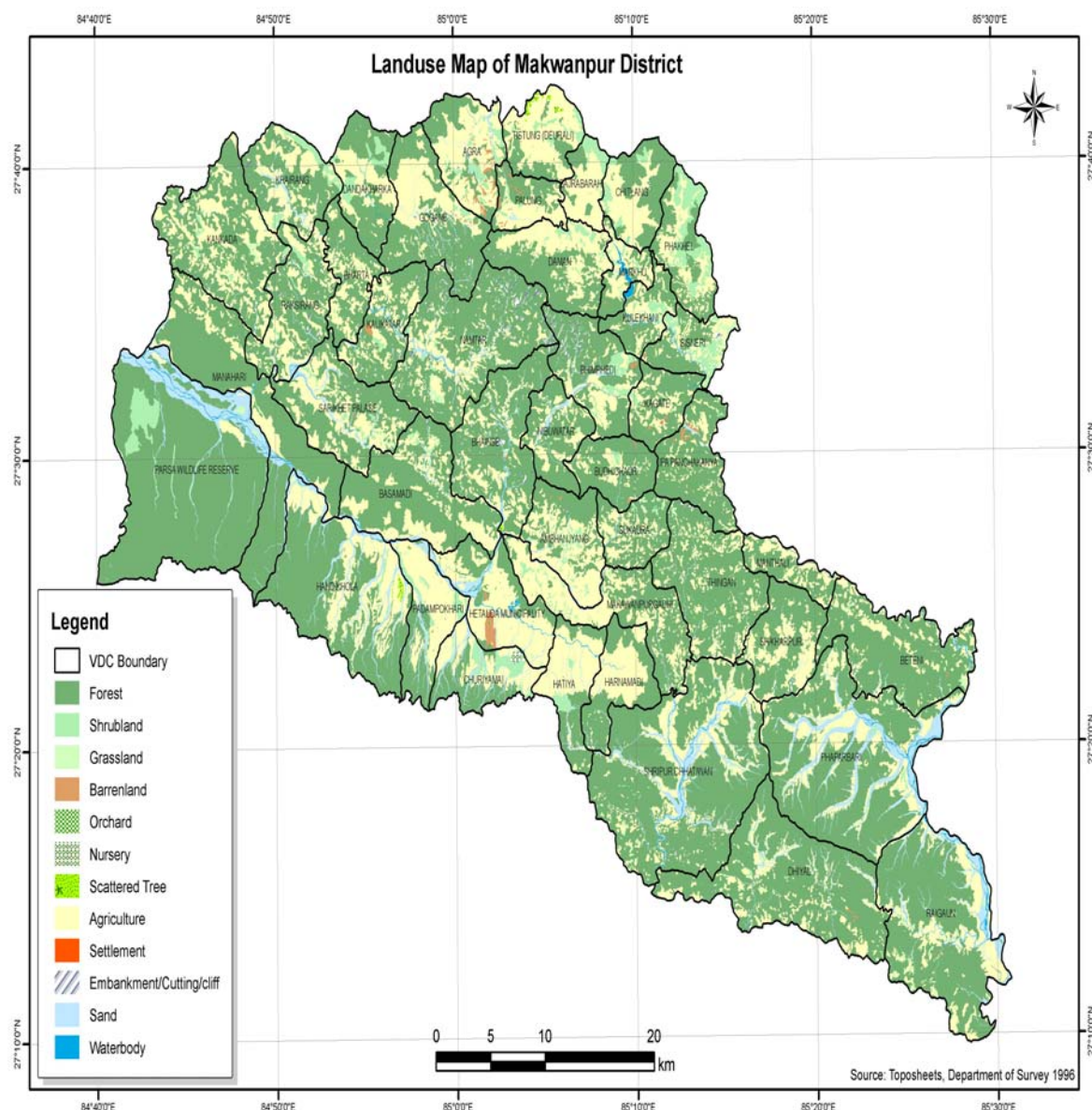
Table 1. Land use type of Makawanpur district

<i>SN</i>	<i>Land use type</i>	<i>Area (Hectare)</i>	<i>Percent</i>
1	Forest	144,558	59.14
2	Agriculture	61489	25.15
3	Bushes & pasture land	4968	2.03
4	River	16710	6.83
5	Protected areas	15125	6.19
6	Industrial area	1607	0.66
	Total	244,457	100.00

Source: DDC, 2007

Land use map of the district is presented in Figure 3.

Fig. 3. Land use map of Makawanpur district



2.7. Demography

Total population of Makawanpur district is 392,604 (as of 2001) which includes 199,144 male and 193,460 female. About 82.5% of the population belongs to rural areas of the district while rest 17.44% belongs to urban areas including Hetauda municipality. Total households in the districts are 71,112 with average of 5.52 members per household/family (DDC, 2007). Annual population growth rate of the district is 2.13% which is lower than the national average 2.24%. Average population density of Makawanpur district is 162 people per square km which is slightly higher than the national average (157 people per square km).

2.8. Caste and Ethnicity

Makawanpur district is diverse in caste and ethnic composition as all four castes and several ethnic groups reside over here. Tamang is the most dominant ethnic group with the population of about 47%. Brahmin and Chhetry ranked second and third position respectively by population. Magar and Chepang ethnic groups have also a representative population with

4.57% and 3.91% respectively followed by Dalits with 2.7%. Chepang ethnic groups in the district practice shifting cultivation and some Dalits depend on forest for charcoal for subsistence through their traditional occupation. Caste and ethnic distribution of the district is presented in Table 2.

Table 2. Caste and ethnic distribution in Makawanpur district

Ethnic group	Population	Percent
Tamang	185,874	47.34
Brahmin-Hill	58,575	14.92
Chhetri	41,467	10.56
Newar	26,764	6.82
Magar	17,939	4.57
Chapang	15,353	3.91
Kami	10,529	2.68
Rai	8,192	2.09
Others	27911	7.11
Total	392,604	100.00

Source: ISRSC, 2002

2.9. Economy and Livelihood

The major economy of the district is subsistence farming although industrial sector also contributes in it. About 80.7% of the total population depends on agriculture and livestock while rest 17.3% depends on small or family business, industry, business and other sectors. Comparatively larger number of population depends on industry in the district since Hetauda is one of the largest industrial estates in the country. Electricity generation is also an important source of income for the district due to Kulekhani hydro-power. Major livelihood options of the district are presented in Table 3.

Table 3. Livelihood options of Makawanpur district

SN	Livelihood options	Percent
1	Agriculture/Farming	82.7
2	Business, industry, services, etc.	17.3
3	Total	100

Source: DDC, 2007

3. Forest Management in Makawanpur District

3.1. Forest Resources

Makawanpur district is rich in biodiversity due to a high variation in altitude and climate. Forest and shrub together covers 67.4% of the total area of the district. The average volume of growing stock is 152m³/ha with minimum 142 m³/ha and maximum 162 m³/ha (DFRS, 1999). Total volume and species wise volume of the forest of the district is presented in Table 4.

Table 4. Specie wise volume of the forest in Makawanpur district

SN	Local name	Botanical Name	Volume (1000 m ³)	Percent
1	Khair	<i>Acacia catechu</i>	0.9	0.01
2	Karma	<i>Adina cordifolia</i>	35.9	0.41
3	Siris	<i>Albizia species</i>	6.9	0.08
4	Semal	<i>Bombox ceiba</i>	42.1	0.48
5	Katus	<i>Castanopsis species</i>	132.6	1.51
6	Satisal	<i>Dalbergia latifolia</i>	27.7	0.32
7	Sandan	<i>Desmodium oojeinense</i>	3.6	0.04
8	Bot Dhayero	<i>Lagerstromia parviflora</i>	50.4	0.57
9	Hallunde	<i>Lannea coromandelica</i>	18.6	0.21
10	Champ	<i>Michelia species</i>	49.4	0.56
11	Hill mixed	Miscellaneous hill species	700.6	7.97
12	Terai mixed	Miscellaneous terai species	636.6	7.24
13	Khote salla	<i>Pinus roxburghii</i>	165.7	1.88
14	Gobre salla	<i>Pinus wallichiana</i>	160.3	1.82
15	Khasru	<i>Quercus species</i>	484.7	5.51
16	Chilaune	<i>Schima wallichiana</i>	75.5	0.86
17	Sal	<i>Shorea robusta</i>	4823	54.86
18	Amaro	<i>Spondias species</i>	1.8	0.02
19	Jamun	<i>Syzyium jambos</i>	107.9	1.23
20	Asna	<i>Terminalia alata</i>	1038.9	11.82
21	Barro	<i>Terminalia belerica</i>	72.7	0.83
22	Unknown species		156.3	1.78
Total			8792.1	100.00

Source: DFRS, 1999

3.2. Forest Types

Major forest types found in Makawanpur district are Sal forest, Terai hardwoods forest, Chirpine forest, Upper mountain hardwood, Quercus forest, and Riverian forests. Sal (*Shorea robusta*) forest is the most dominant forest with over 50% of total volume of reachable forests in the district. Sal forest and Terai hardwoods found in Churia hills and lower part of Mahabharat range and includes Asna (*Terminalia tomentosa*), Barro (*Terminalia belerica*), Karma (*Adina cordifolia*), Jamun (*Eugenia jambolana*), Botdhayaro (*Lagerstroemia parviflora*), Chilaune (*Schima wallichii*). Chirpine (*Pinus roxburghii*) forest is found in the midhills and upper ridges of Churia hill. Upper mountain hardwood forest includes Painyu

Fig. 4. Forest type of Makawanpur district (ecological map)



3.3. Forest Management Regimes

The forest resources in Makawanpur district are managed through major four approaches *i.e.* community forestry, leasehold forestry, government managed forestry and protected areas.

3.3.1. Community Forestry

Community forestry is one of the major forest management strategies of Nepal adopted since 1980s. The program has been implemented in Makawanpur district since its initiation in the country. A total of 318 community forest user groups (CFUGs) have been formed covering 48,916 households comprising 66% of total households and 61% of total population in the district. Approximately 47,470 hectare (ha) of the forests, 28.83% of total forest area in the district, is being managed under community forestry. CFUGs practice passive forest management approaches as they mostly remove dead and dying trees from the forests. They practice pruning and cleaning activities based on technical inputs provided by the forestry technicians through district forest office (DFO). The DFO facilitate in preparing and implementing periodic community forest operational plan. The status of community forestry in the district is presented in Table 5.

Table 5. Status of community forestry in Makawanpur district

SN	Description	Quantity	Remarks
1	Forest area handed over to the CFUG	47,470 ha	28.8% of the total forest
2	Average size of a community forest	159.83 ha	
3	Number of forest user groups formed	318	
4	Total households covered	48,916	66% of total households
5	Average households in a CFUG	165	
6	Per capita (household) community forest	0.97 ha	
7	Population benefited from community forestry	240,000	61.13 % of total population
8	Number of all-women user group	5	1.68% of total CFUGs

Source: DFO, 2007

3.3.2. Leasehold Forestry

The leasehold forestry for the poor has been launched since 1995 in Makwanpur district. This program aims to improve livelihoods of the households below poverty line. Under this program, degraded forest is handed over to smaller groups of poor people ranging from 5-15 households ensuring them long term use rights (*i.e.* for forty years with the possibility of extending additional forty years). The program has been implemented in 23 village development committees (VDC) and one municipality. A total of 290 leasehold groups have been formed comprising 1818 households. A total of 1253 hectare of forests, 0.76% of the total forest of the district, are being managed under leasehold forestry. Leasehold groups practice cultivation of short rotation income generating forest crops and non timber forest products (NTFP) with the technical assistance of DFO along with District Livestock Office. The present status of leasehold forestry of the district is presented in Table 6.

Table 6. Status of leasehold forestry in Makawanpur district

SN	Facts on Leasehold Forestry	Quantity
1	No of leasehold groups	290
2	Forest area handed over as leasehold forest	1253 ha
3	Total household covered	1818
4	Number of VDCs covered	23 VDCs and 1 municipality
5	Average size of leasehold group	6.27 households
6	Average size of leasehold forest per group	4.32 ha
7	Per capita (household) forest	0.69 ha

Source: LFLP, 2007

3.3.3. Protected Areas

Protected Areas cover 15125 hectare of forests which constitute 6.19% of total forest area of the district. Chitwan national park and Parsa wildlife reserve are extended to the southern part of the district. Buffer zones lie around both protected areas. Chitwan national park buffer zone covers a segment of Manahari VDC while Parsa wildlife reserve buffer zone covers segments of Manahari, Handikhola, Padam Pokhari and Churiamai VDCs of Makawanpur district. Forest within the protected areas and their buffer zones are managed by the Department of National parks and Wildlife Conservation under the National Parks and Wildlife Conservation Act, 1973 and Buffer Zone Management Regulation 1996, both of which are conservation oriented.

3.3.4. Government Managed Forestry

All forest areas excluding community forests, leaseholds forests, private forests and protected areas are categorized as government managed forests. In Makawanpur district, government managed forests cover 100803 hectare of forests which consists 61.22% of total forest area. Those forests are managed by district forest office under the Forest Act 1993 and Forest Regulations 1996.

4. Objectives of the Fire Management Plan

The objective of the fire management plan is to safeguard forest and biological resources in Makawanpur district by reducing fire damages through mobilizing government, local bodies, non-governmental organization, private sector, civil society, and local people.

The fire management plan aims to:

- Assess the status, damages and impacts of forest fire;
- Identify fire sensitive areas and causes of forest fire;
- Create awareness among stakeholders for forest fire management;
- Identify preventive and control measures of forest fire; and
- Prepare a comprehensive five-year work plan for forest fire management.

5. Fire Management Strategy

The fire management plan reckons fire as an integral part of entire forest protection system. The plan has adopted four pillars of strategies.

5.1. Ensure People's Participation

Fire management plan is based on the participation of local people in planning, preventions, control, and monitoring and evaluation. Fire is not something that can be excluded from people's daily lives. Local communities use fire to cultivate crops, harvest NTFPs and manage pests. The objective of the strategy is to make local communities responsible, with full ownership, for fire management. Local people, who are often blamed for fire ignition, have the most to lose in the event of a forest fire. Local communities can play a significant role in preventing and controlling forest fires, in the local situations, that have a detrimental impact on their lives and, hence, they should be involved in the process. Moreover, weak state machinery and fire management experience of Nepal, and increasing control of local people in forest management has led to develop people based strategy in forest fire management.

5.2. Promote Indigenous Knowledge

Fire is one of the major disasters in Nepal especially in the Terai and Churia region. People in the regions are aware of the potential fire damages and have controlled the spread of fire to minimize destruction of private property and community assets through adopting traditional methods. The uses of fire can be sustainable in many agricultural, pastoral and agro-pastoral systems that have depended on locally based knowledge being passed from generation to generation (Ganz & More, 2002). Local level information and experiences need to be examined and understood. Indigenous knowledge and practices of fire management, which are sustainable, have been demolished due to increase in population, increasing trend of migration from villages to urban centers, dislocation of people from their traditional settings, and disassociating younger generations from the elders holding the knowledge. There is an urgent need to document the indigenous knowledge and practices for developing and implementing sustainable fire management. The fire management plan explores, adopts and promotes the indigenous knowledge and practices of the locality in preventing and controlling forest fire.

5.3. Emphasize Preventive Measures

Rural economy of the region is primarily based on subsistence farming with low income and capital. The loss of fire, if any, could lead very hardship in the livelihoods of the local communities. Moreover, the damages in forest products could lead towards detrimental effect in biodiversity and environment. The fire management plan considers preventive measures as the best option to minimize the negative impacts of forest fire on forest resources, biodiversity and environment and to sustain livelihoods of the dependents.

5.4. Enhance Multi-Stakeholders' Networking

Participation of all stakeholders in fire management is enhanced to effectively implement it. The fire management plan anticipates to develop partnership between government agencies, local bodies, non-governmental organizations (NGO), community based organizations (CBO)

and civil society in forest fire management. It expects coordination and networking between DFO, department of forest (DoF), Chitwan national park (CNP), Parsa wildlife reserve (PWR), CFUGs and their networks and federations, Buffer zone management committees (BZMC), VDC, district development committee (DDC), Hetauda municipality, Hetauda industrial estate, donors and other concerned agencies and stakeholders.

6. Methodology

The fire management plan was developed through the extensive consultation with government representatives at various levels, experts and professionals, and local communities. Participatory appraisal methods were executed among stakeholders including district forest office staff, non governmental organization personnel, local government representatives, community forestry user groups and their networking and federations, private sector, civil society and local communities.

6.1. Focus Group Discussion

The focused groups are considered one of the important sources for collecting both qualitative and quantitative information on specific topics of interest. If focus group discussions are handled carefully the participants can provide critical information that ordinary respondents often can not tell in a personal interview. Focus group discussion was carried out with community forestry user groups, CFUG federations and networking committee members formed at Ilaka forest office level, DFO staff to collect in-depth information regarding basic fire information in the community forests, leasehold forests, protection forests and government managed forests of the district; environmental and socio-economic impacts of forest fire; and indigenous techniques that are practiced in preventing and controlling forest fire (photograph #1). It was also employed to estimate forest product damages by fire. Total four focus group discussions, one each at three Ilaka forest office level and one at district level, were organized.



Photograph #1: Focus group discussion at Manahari Ilaka forest office premises

6.2. Key Informants Survey

Key informants are those persons who possess deeper understanding about the objective and expected outcome of the study and are willing to share their ideas and provide valuable information on critical issues of the activity, its strengths, weakness and opportunities. Semi-structured Interview was conducted with the key informants to triangulate the data. It was employed to collect basic fire information and to estimate forest product damages by fire in

the district (photograph #2). Selected DFO officials, CFUG members, elder persons, school teachers, social and conservation workers, and those who are involved in community based resource management were considered as the key informants. All together 15 key informants were interviewed representing the district.



Photograph #2: Key informant showing fire prone areas

6.3. Observation

It is believed that careful observation can bring greater clarity to the ambiguities of particular social surroundings. Observation was made during the field visits (photograph #3) particularly in the sources and distribution of fire fuels, fire hazards and indigenous methods adopted by the local communities and stakeholders in preventing forest fire.



Photograph #3: Fire practiced during BANDEVI (goddess of the forest) worships

6.4. Documents Review

Various documents including district operational forest management plan and operational plans of selected community forests were reviewed. Annual plans and reports of district forest office were also reviewed. In addition, annual reports of district level government and non governmental organizations, regional support unit and district support unit of BISEP-ST, leasehold forestry program, and district development committee were reviewed.

7. Forest Fire in Makawanpur District

7.1. Occurrence and Frequency of Forest Fire

The information on the occurrence and frequency of forest fire in the district was obtained for past 10 years (Table 7). The information shows that forest fire occurs every year in the district. Commonly it occurs twice a year. Both Mahabharat range and Churia hills are affected by fire. Frequency of forest fire in Churia hills is higher as compared to Mahabharat range. The stakeholders, including forest users and DFO officials, believe that the extent of forest fire and its damage is decreasing in recent years after involving local communities in forest management compared to the past when the forest was managed by the government alone.

Table 7. Occurrence of forest fire in Makawanpur district

Year	Fire Occurrence
1997	Yes
1998	Yes
1999	Yes
2000	Yes
2001	Yes
2002	Yes
2003	Yes
2004	Yes
2005	Yes
2006	Yes

Source: Field Survey, 2007

7.2. Fire Season

The risk of forest fire is very high during hot-dry season. The forest of the district is affected by fire between March and June since the period is very hot and dry. Monsoon wind is the main source of rains in Nepal, which is, generally, active between June and August. Cold season exists between November and March. Fire does not occur during rainy season and winter season in the district.

7.3. Duration of Fire

The forests in the district are suffered by surface fire and ground fire. Duration of ground fire is longer, consequently damages more. In Churia range forest fire remains active for longer time. The duration of forest fire depends on forest regime, fuel type and direction and speed of the wind. Fire lasts for longer period in government managed forest than community forests. The reasons behind are CFUG members remains active to suppress fire in their community forests, government managed forests are less accessible, and the government efforts on fire management is not effective. Sharma (1996a.) observed the fire spread at the rate of 0.25m per minute in Manahari forest. Generally, fire spreads at a speed of 100-300 mph in the region although it varies with the topography, type of fuels and wind speed. Based on the data collected during the field visit, it is estimated that the duration of fire ranges from 3 hours to 5 days. The duration of burning within a place lasts for thirty minutes to one hour depending on the accumulation of leaf litter and other fire fuels in the particular forest. It is

seldom practiced to suppress fire while it affects in the government managed forests of remote areas. Consequently, it spreads towards the large areas of accessible forests and settlements as well. Initiatives were only made to suppress fire when it attacks to community forests or adjacent settlements. As a result, the duration of forest fire and extent of loss from it is higher.

7.4. Fuels

Types of fuels in the forest are ground fuels including leaf litters, branches and dead woods, grass, dead and fallen trees, logs, stumps, dead roots, brush and regenerations. The leaf litters from tree species, especially Sal, is one of the main sources of fire fuel in the district. Sal is a deciduous tree which produce high amount of foliage and shades during the dry season. Less decomposability of Sal leaves, on the one hand, and seldom collection of Sal leaf litter by local people, on the other, promote fire hazards in Sal dominated forests. It is estimated that about 90% Sal forests are prone to fire. Pine trees, including needles and resin, and Asna (*Terminalia alata*), a fire sensitive tree, are also the sources of fire fuel. Moreover, the forest is encroached by the invasive species such as Banmara (*Eupatorium odonatum*) which produce high amount of fire hazards within a short period. The dead and fallen trees of all species are also the major sources of fire fuels particularly in the government managed forest and protected areas. But, in community forests, CFUG members collect dead and fallen trees for their subsistence use and sell.

7.5. Causes of Forest Fire

Very few fires are naturally caused in Nepal (NBS, 2002). Karkee (1991) observed that 40% of forest fires in the mid-hills are caused by accidents while 60% are started deliberately.

Cattle grazing for new grass and smokers alone share about 45 percent of fires among all known causes of forest fires. Natural causes (e.g. thunderstorms) of fire are not reported. About 64 percent of fires are set by people intentionally; about 32 percent of fires are due to accidental/carelessness, and about 4 percent by unknown causes (Sharma 1996.a).

Another studies (Kanel 2007, Kunwar 2005) revealed that fire incidents were 58% deliberate, 22% negligence and 20% accidental. Most of the forest fires are manmade and caused by various human activities (Kanel, 2007, Sharma, 1996.b).

However, almost all forest fires in Makawanpur district are caused by human beings. The causes of forest fire in the district were observed as:

- Grazing inside the forest is a common practice in all categories of forest in Makawanpur district. Grazers and grass collectors set fire in the forest to reduce shrubs to make clear grassland for grazing. They believe that fire increases nutritious grasses for grazing.
- Grazers, grass collectors and trekkers leave burning match sticks and cigarettes in the forest, intentionally or unintentionally, that originate forest fire.
- Poaching is one of the threats of forest and biodiversity conservation in the district. Poachers/hunters set fire in the forest to trap wild animals like deer and wild boars. They set fire making fire circle leaving a single outlet for the animals so that wild

animals run away towards the outlet where poachers/hunters are waiting to kill them. In addition, animal sighting become easy after forest fire since it consumes leaf litters, bushes, and undergrowth.

- Forest encroachment is a problem in the rural areas, particularly in the hills, of the district. Local residents encroach nearby forest to extend their cultivated lands. They set fire to convert forest into cultivated land.
- In the north western hills of the district, particularly Kakada, Raksirang, Khairang, Charikhet VDCs, shifting cultivation practice exists. Chepang ethnic groups are mainly involved in shifting cultivation. They use fire to clean forest for cultivation and such fire can be extended to the other areas as well.
- Charcoal production is a common practice mainly in buffer zone areas and in the boarder side of Kathmandu district. Laliguras (*Rhododendron arboretum*) is commonly used for charcoal production in the hills while Sal (*Shorea robusta*), Jamun (*Eugenia jambolana*) and Botdhagero (*Lagestromia parviflora*) in the foothills and valleys. Scheduled caste group, traditionally involved in charcoal production for manufacturing and maintaining agricultural and household tools and equipments. Charcoal is not only used in the district but also supplied to Kathmandu. The remaining fire after charcoal burning inside the forest leads to a harmful forest fire.
- The economy of the rural area of the district is based on subsistence farming and people have less capital and income opportunities. Poor socio-economic conditions of the people encourage them in setting fire in the forest to get dry firewood for subsistence and for sell. It dries pole sized trees and shrubs to convert firewood to be available after few days of fire incidents.
- Crop depredation by wild animals in areas nearby the forests, particularly around Chitwan national park and Parsa wildlife reserve and their buffer zones, is creating human wildlife conflicts in the district. It was reported that local residents set fire, in the boarder areas between forests and private land, to take away wild animals that damage crops and domestic animals.
- Local people practice fire in the forest to burn unnecessary dry leaves/leaf litters to make clean trail and ground. It reduces snakes, scorpions and mosquitoes which are harmful to human beings. Sometimes, shifting cultivators or people in the vicinity of the forest set fire for preventing their crops from locusts.
- Local communities believe that fire increases the fertility of the soil. Fire produces ash that is available for the downside cultivated areas as a fertilizer. People in the vicinity, sometimes, set fire for this purpose.
- NTFP collectors set fire in the forest to collect various products. It is easier to collect Kurilo (*Asparagus racimos*) and mushrooms in the burnt areas. In some parts of the district hemp is available which is used to produce hashish. People involved in preparing hashish collect resin from Gobre Salla (*Pinus wallichiana*) through boring it. They set fire for this purpose. Remaining fire after collecting wasps, honey and resins also cause forest fire.

- Although it is not common, local communities identified bamboo as a fire igniter. Friction exerted between bamboo culms within the clumps sometimes produce fire.

7.6. Fire Zones

The forests of the district is divided into three fire zones including highly fire sensitive, moderately fire sensitive, and less fire sensitive zones based on causes and effects of forest fire.

The criteria set for zoning are:

- Occurrence of forest fire in the past
Fire occurrence history of particular areas is taken into account while zoning the district. Those areas where forest fire occurs more frequently are categorized as high fire sensitive zones whereas other areas are categorized as less fire sensitive zones.
- Forest types and availability of load fuel
It is observed that Sal (*Shorea robusta*) dominated forest patches are more fire sensitive since it produces large amount of leaf litters which are less degradable and people rarely collect it. Pine forest is sensitive to fire due to its needles and resin content. Chilaune (*Schima wallichii*) dominated areas are less sensitive to fire since leaf litters are highly degradable within a short period of time.
- Distance from settlements, roads and trails
Forest areas nearby the settlements, in general, are more fire sensitive than the other areas due to possibility of extending fire from the settlements. Similarly, possibility of ignition of fire is higher in the forests adjoining trails or roads. On the other hand, the distant and inaccessible forests are less affected by people and have a less possibility of fire incidents.
- Forest patches with the specific utilization
Patches of forests which are used for specific purposes are considered during fire zoning. Charcoal production areas and shifting cultivation areas are highly sensitive to forest fire.
- Forest management regime
Leasehold forests are less susceptible to fire since they are small patches of degraded forest and leasehold communities are actively involved in managing it. Community forests are less sensitive as compared to government managed forests and protected areas. The reason behind is increasing ownership of local communities on community forests and utilization of dead and dying trees.

Based on the criteria set above, three fire zones are classified in Makawanpur district and are presented in Table 8.

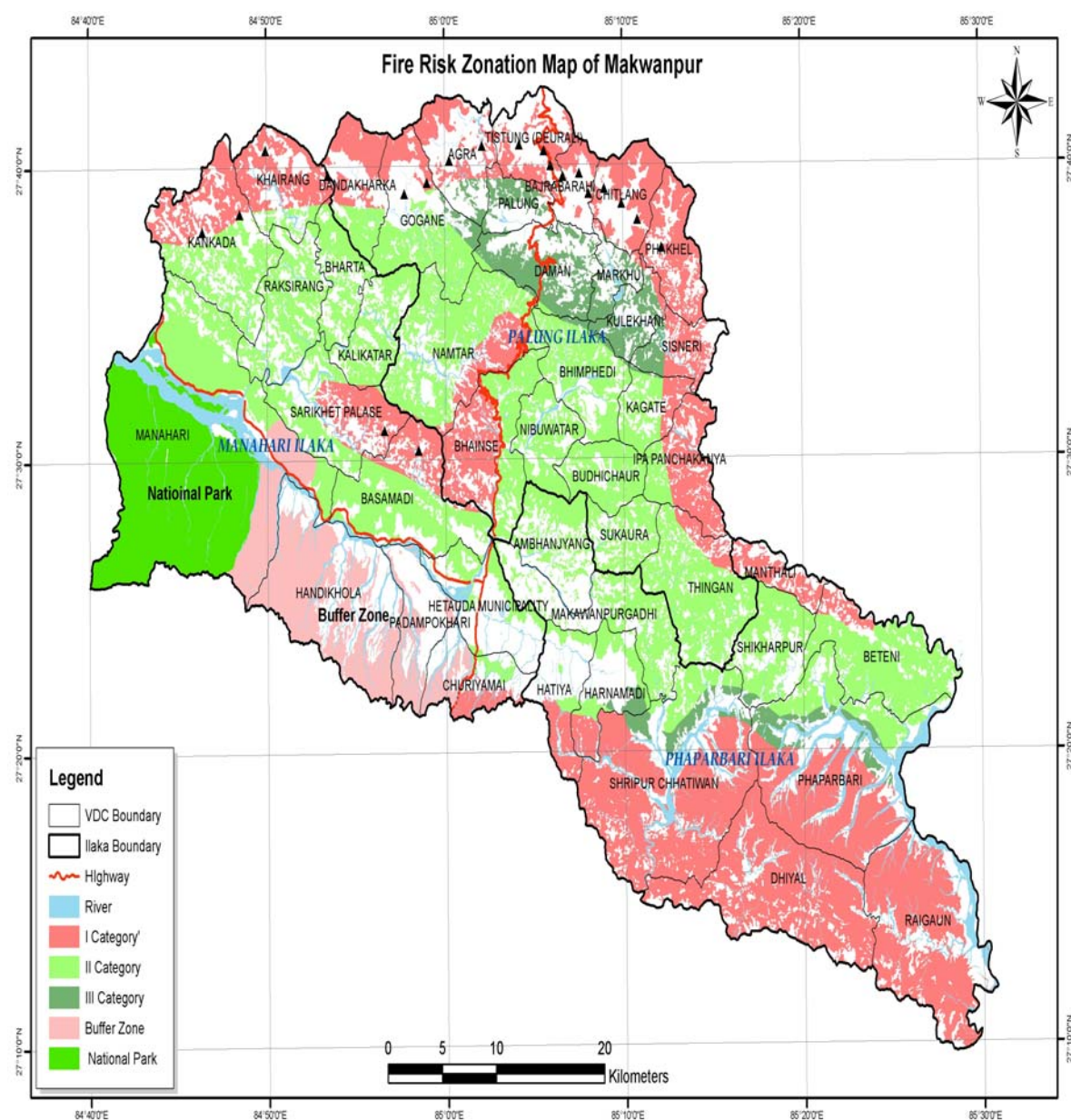
Table 8. Fire sensitive zones in Makawanpur district

SN	Fire Zone	Description	Area/Range
1	Highly Fire Sensitive Zone	<ul style="list-style-type: none"> • Fire occurs annually or bi-annually • Equipped with fire sensitive 	<ul style="list-style-type: none"> • Most of the forest area of Raigaun, Dhiyal. Phaparbari, Sripur-Chhatiwan,

		species including Sal (<i>Shorea robusta</i>), Saj (<i>Terminalia alata</i>), Chirpine (<i>Pinus roxburghii</i>), etc. • Nearby the settlements, roads and trails • Forest area where shifting cultivation is practiced (north-west hills of the district) • Forest area where charcoal is produced (north-east hills and buffer zone areas of the district). • Forest encroachment areas	Churiamai, Sarikhet-Palase, Basamadi, Khairang, Kakada, bhaise, Palung, Dadakharka, Agra, Tistung, Gogane, Deurali, Chitlang, Bajrabarahi, Phakel, Sisneri, Kagate, Ipa-Panchakanya VDCs. • Part of the forest area of Hatiya, Harnamadi, Namtar, Manahari VDCs. • Area covered by Chitwan national park, Parsa wildlife reserve and respective buffer zones
2	Moderately Fire Sensitive Zone	• Fire occurred once in a three to five years • Fire sensitive species including Sal, but streamlines and other moist areas where fire is not frequent. • Less accessible forests and forests far from the settlements, roads and trails.	• Forest areas in the rest VDCs excluding highly fire sensitive and less fire sensitive zones.
3	Less Fire Sensitive Zone	• Forest areas where fire did not occur for last five years • Inaccessible forests where influence of people is negligible	• Most of the forest areas of Kulekhani, Markhu VDCs. • Part of the forest areas of Phaparbari, Sripur-Chatiwan, Harnamadi, Agra, Gogane

Location map of fire sensitive zone in the district is presented in Figure 5. Category I indicates highly fire sensitive, category II indicates moderately fire sensitive, and category III indicates less fire sensitive zones. Forests within protected areas (national parks and buffer zones) are identified highly fire sensitive areas. It is due to the conflicts between wildlife and local communities, and decreased ownership of local people on protected areas.

Fig. 5. Location Map of Fire Sensitive Zone in Makawanpur district



The fire zoning results show that, about 54% of the forest of Makawanpur district is highly sensitive to fire whereas about 41% forest is moderately fire sensitive. Remaining 5% forest of the district is less fire sensitive. Forest area covered by all three fire zones in Makawanpur district is presented in Table 9.

Table 9. Forest area covered by fire zones in Makawanpur district

SN	Fire sensitive zone	Area (ha)	Percentage
1	Highly Fire Sensitive	85741	54
2	Moderately Fire Sensitive	64995	41
3	Less Fire Sensitive	8780	5
	Total	159516	100

8. Damages and Impacts of Forest Fire

8.1. Nature of Damages

Forest fires in Nepal are perhaps less severe than in other countries, but are still capable of inflicting considerable damage, especially to young plantations (Jackson, 1994). Forest fire is one of the important elements to damage forest resources in Makawanpur district. All categories of forests including leasehold forest, community forest, protected areas and government managed forest are damaged by fire each year albeit the extent of loss is not identical. Leasehold forests are less damaged (approximately 10%), while forests within protected areas and government managed forests are highly damaged (approximately 45% each). Community forests are damaged approximately 30% of the total. It is estimated that about 40% forest of the district is damaged by fire each year. The estimated fire affected area by forest regime is presented in Table 10.

Table 10. Fire affected area by forest regime in Makawanpur district

SN	Forest Management Type	Forest area coverage (Total)		Forest area affected by fire (estimated)		Major forest products affected
		ha	%	ha	%	
1	Leasehold Forest	1253	0.76	125	10%	No serious damage observed
2	Community Forest	47470	28.83	14241	30%	Leaf litter, logs in inaccessible areas, NTFPs
3	Protected Forest	15125	9.19	6806	45%	Firewood, logs, stumps, NTFPs
4	Government Managed Forest	100803	61.22	45361	45%	
	Total	164651	100	66534	40.41	

It was observed that fire damages almost every forest products including standing trees, branches, foliages, fallen trees, poles, regenerations and NTFPs. No serious damage was observed in leasehold forest. In community forest, mostly regeneration and pole sized trees are destroyed. It is estimated that about 70-80% regeneration is lost annually by forest fire. Mature and over-mature trees are also destroyed in government managed forest and forest within protected areas.

Few representative blocks were observed to quantify the loss by forest fire in government managed forests and protected areas in the district. It was estimated, based on the discussions, that 1.52 cft/ha sawlog was completely lost per year. Moreover, 0.46 cft/ha sawlog was partially damaged by fire and converted into firewood.

Quantity of sawlog lost per year and the economic value of annual loss is estimated. The result of the estimation is presented in Table 11.

Table 11. Estimated annual loss of sawlog by forest fire in Makawanpur district

SN	Forest Type / Species	Estimated annual loss of sawlogs by forest fire			
		% of loss	Quantity lost (cft)	Market rate (RS)	Amount lost (RS)
1	Sal (<i>Shorea robusta</i>)	55	43613	400	17,445,064
2	Terai hardwoods	24	19031	250	4,757,745
3	Pines	7	5551	100	555,070
4	Upland broadleaves	14	11101	100	1,110,141
	Total	100	79296		23,868,020

Total quantity of sawlog lost per year was estimated to be 79,296 cft. The loss varied between forest types of the district. A total of 43613 cft, 55%, Sal logs were lost followed by Terai hardwoods with 19031 cft, 24%. Similarly, 5551 cft, 7%, Pine logs and 11101 cft, 14%, upland broadleaf logs were lost per year by forest fire. Total annual loss of sawlog is estimated as RS 2,38,68,020 based on market price.

Partial loss of sawlog is estimated as the loss during conversion of saw log into firewood. The quantity and amount due to conversion of sawlog into firewood is presented in Table 12. Further, total firewood loss due to forest fire in the district was estimated to be about 72 chatta which is equivalent to RS 72,000 based on market price (Table 12).

Table 12. Estimated annual loss during conversion of sawlog into firewood by fire.

S N	Forest Type/Species	Estimated annual loss of sawlog (partial) by forest fire				Value of converted firewood (RS)	Total loss during conversion (RS)
		% of loss	Quantity lost (cft)	Market rate (RS)	Amount lost (RS)		
1	Sal	55	13,198	400	5,279,340	23,997cft = 599,925kg = 80chatta*	total amount loss–value of converted firewood
2	Terai hardwoods	24	5,759	250	1,439,820		
3	Pines	7	1,680	100	167,979		
4	Upland broadleaves	14	3,360	100	335,958		
	Total	100	23,997		7,223,097	800,000	6,423,097

* 1 cft = 25 kg, 7500kg = 1 chatta

Total annual loss by forest fire in Makawanpur district, including complete loss and partial loss of sawlog, is estimated and presented in Table 13.

Table 13. Estimated annual loss by forest fire in Makawanpur district

SN	Particular	Quantity	Amount in RS
1	Loss of sawlog	79296 cft	23,868,020
2	Loss due to conversion of saw logs into firewood	23997cft (less 80 chatta)	6,423,097
3	Loss of firewood	72 chatta	72,000
	Total annual loss		30,363,117

The estimation of total annual loss by fire in the district is based on market price which is equivalent to be RS 30,363,117.

8.2. Impacts of Forest Fire

8.2.1. Environmental Impacts

Loss of Soil and Microorganisms

Fire-induced loss of soil cover negatively affects hydrological regimes and soil properties, leading to severe erosion and loss of productive topsoil. High economic losses are caused by damaging valuable timber and non-timber resources, natural regeneration, and planted forests (ITTO 1997).

Most of the micro organisms that shelter on the surface are damaged by forest fire. Fire burnt area becomes dry and detrimental for the micro-organisms. About three-fourth area of the district is mountainous. When surface materials and undergrowth is consumed by fire, the bare area becomes susceptible to soil erosion. Various landslides can be observed in the fire affected areas of the district.

Change in Age Gradation

Forest fire is a threat for the fire sensitive species and it may lead to changing species composition in the long term. Species with the character of fire hardiness survive, and fire sensitive species disappear if the area is continuously affected by forest fire. There is no significant effect observed in the alteration of species composition in the district, but the age gradation is altered due to the effect of forest fire. Since regenerations and pre-matured trees are highly affected by fire and can not survive if fire incidents occur frequently. As a consequence, only mature trees exist in the forest which alters age gradation in the fire affected areas with the non-affected areas. This scenario is common in Sal dominated forests in the various locations of the district due to its dying back characteristics. Operational forest management plan (OFMP) of Makawanpur district (1995/96-1999/2000) analyzed the development stages of forest, which is presented in Table 14.

Table 14. Development stage and status of forest in Makawanpur district

Development Class	Area (ha)			Percentage
	Manahari	Phaparbari	Total	
Regeneration area	0	0	0	0
Sapling forest	0	0	0	0
Pole forest	0	0	0	0
Middle-aged forest	404	465	869	46
Mature forest	688	319	1,007	54
Total	1,092	784	1,876	100

Source: OFMP, 1995

The above table shows that the area under regeneration, sapling and pole stage forest is negligible in the district. Most of the forests in the district are matured and semi-matured. Forest fire might have contributed to this result since the fire easily damages to regeneration and younger aged forest.

Environmental Pollution

Forest fires produce atmospheric pollutants. In addition, accumulation of pollutant gases after burning cause the temperature to rise, which contribute in the global warming. Although

atmospheric pollutants and their effects in temperature was not assessed due to limited time and resources availability, local communities realize that the surrounding atmosphere become polluted when fire incident occurs. It also causes respiratory problems such as asthma, bronchitis, etc.

Loss of Biodiversity

Local people set fire to reduce mosquitoes, scorpions and snakes, which directly affect the population of insects and herpeto-fauna. Forest fire causes loss of ground flora, undergrowth, under storey, and even tree crowns. Consequently, habitats of wildlife including insects, reptiles, birds, and small to mega mammals are being lost. Similarly, plant diversity is also affected due to the fire. Invasive species such as *Eupatorium* replace other plant species and they regenerate profusely after forest fire, which reduce species richness. Local communities noticed diminishing population of pigmy hog in repeatedly burned areas.

8.2.2. Socio-economic Impacts

Loss of Forest Products

It is observed in Makawanpur district that forest fire affects all parts of the trees including leaves, branches, timber and roots. Less intensive fire consumes leaves and small branches, and converts green branches and whole trees into dead ones. Highly intensive fire consumes all the materials including fallen trees, logs, and standing trees. The damages and losses of the matured or semi-matured trees have high economic impacts. The loss of timber and firewood is higher in government managed forest and protected areas as compared to community and leasehold forests. It is due to the active participation of local communities in preventing and suppressing fire in their forests.

Two types of log damages were observed in the district. First one is the total loss in which all logs are consumed by forest fire. Second, the partial loss or devaluation in which sawlog is converted into firewood. In case of firewood, almost complete loss was observed.

Loss of Regenerations

Regeneration is highly affected by forest fire since they are damaged even by surface fire. Surface fire is most common in the district. The loss of regeneration has ecological and economic impacts in the long run.

Loss of NTFPs

Most of the poor people, in Nepal, depend on NTFPs for their livings as well as for medicine. NTFPs have a very crucial economic role in the rural community. In Makawanpur district, local communities residing in the villages, particularly far from Hetauda, consume NTFPs for traditional medicines. Kurilo (*Asparagus racemos*), Sarpagandha (*Rauwolfia serpentina*), Chiraito (*Swertia chiraita*), Jiwanti (*Desmotrichum fimbritum*), Majitho (*Rubia manjigh*), Somlata (*Ephedra gerardiana*), Sikakai (*Acacia concinna*), Pipla (*Piper peepuloides*), Satuwa (*Paris polyphylla*), Dalchini (*Cinnamomum zeylanicum*), Babiyo (*Eulaloipsis binata*), Dar (*Boehmeria regulosa*), Kaulo (*Machilus odoratissima*), and various species of bamboos are important NTFPs used by the communities in the district. Most of the NTFPs including

herbaceous plants and shrubs are more susceptible to forest fire since they are damaged by surface fire as well.

Detrimental to Human Health

Fire spreads diseases, particularly lungs and eye diseases, in the surroundings. Local communities in the district have experience of eye diseases in the past when the forest was damaged by fire. Moreover, forest fire creates environmental pollution which affects in the human health and economy.

Loss of Private Property

Sometimes, forest fire spreads to adjoining settlements which may lead to the loss of livestock, human life and property. In the past, few households in Raigaun VDC who resided in the vicinity of the forest have lost their houses and cattle shades. However, such loss is very seldom nowadays since communities are being involved in forest management. They remove fire hazards nearby their houses before the commencement of hot dry season.

9. Existing Fire Management Practices

Since forest fire occurs every year in most of the forests in the district, local communities and other stakeholders have taken initiatives to prevent and control fires based on their indigenous knowledge. The measures adopted by various stakeholders including district forest office and local communities to prevent and control forest fire are briefly mentioned hereafter.

9.1. Preventive Measures

9.1.1. Fuel Breaking Practices

Few community forests such as Sundar CF, Apkhola CF initiated preventing fire through constructing and maintaining fuel breaking lines. They clean shrubs and leaf litters, but no trees, within the aligned fuel breaking lines. Estimation has been made about existing fuel breaking lines based on 28 community forests. The community forests were selected based on stratified random sampling. The district was divided into three strata with reference to the existing sectors (*Ilaka*) of the District Forest Office (DFO). Community forests were randomly selected from each stratum. The result of the estimations is summarized in Table 15.

Table 15. Fuel breaking lines in the CF of Makawanpur district

SN	Fuel breaking line as of CF operational plan (average width 2 m)	
	Description	Length (km)
1	Annual average per hectare	0.05
2	Annual average per CF	0.89
3	Annual total in the CF of the district	273.35

9.1.2. Hazard Reduction

CFUGs remove Banmara (*Eupatorium odonatum*) and other unnecessary weeds, which are good sources of fire fuels, nearby the settlements to reduce fire hazards. They practice it before the commencement of hot dry season. Users remove dead and dying trees according to their operational plan, usually each year, which results in reducing fire hazards in the CF.

9.1.3. Risk Reduction

Since almost all fires in the district are caused by human beings, public awareness is an important step to prevent fire risks. DFO and few CFUGs have initiated public awareness activities to reduce fire risk, particularly to the poor people who reside in the villages, far away from the market places, and was blamed for initiation of forest fire. DFO has allocated RS 200,000 for this purpose and few community forests, including Sundar CF, have allocated budget to aware local communities.

9.2. Control Measures

Following measures have been adopted in the district to control forest fire:

9.2.1. Fire Detection and Communication System

Fire incidents in the forests of the district are detected through:

Forest/Fire Watcher

In the past, district forest office was supported to hire seasonal fire watchers during fire hazardous season in Makawanpur district. They were mobilized to prevent and control forest fire. But, nowadays this practice is stopped due to limited resources of the DFO. Most of the CFUGs in the district have employed one or two forest watcher to look after the forest. They inform to the users if they detect fire in the forests and involve in fire suppression activities.

Grazers

Grazing is a common practice in Makawanpur district although it is prohibited in the erosion hazard areas within most of the community forests. Cattle grazers inform to the users if they detected fire flames inside the forest.

Adjacent Households

People who reside nearby the forest are more active in detecting fire since they are the most threatened of loss. They inform to CFUG, DFO or other stakeholders as appropriate when fire flame is detected in the adjoining forests.

Patrolling

Patrolling is practiced in community forests mostly by forest watcher employed by the CFUGs. During fire hazard season, users are also involved in patrolling to detect fire and other illegal activities. Such type of patrolling is not common in government managed forests and protected areas.

9.2.2. Suppression of Forest Fire

Once fire flame is detected in the forest, local communities gather and suppress the fire based on their own indigenous techniques. The materials and techniques used in the district in suppressing forest fire are:

Soil

Soil is one of the most common and widely used materials to suppress forest fire. People dig the earth through domestic tools like spade and shovel to speck fire.

Water

Water is used everywhere to suppress the fire. Local communities utilize water to control fire when it is available in the surroundings. It is common nearby the settlements and easily water available areas.

Beating

Green branches and leaves are used to beat forest fire by teams of users involved in fire control. It is the most common techniques adopted in the district to suppress forest fire.

Traditional Tools

Various tools made at local level, including fire rake, spade, shovel, knife, etc, are used to suppress forest fire in various parts of the district. Fire rake is helpful to remove leaf litters and other fire fuels. It is widely used for fuel breaking purpose.

Counter Fire/Back Fire

Counter fire/back fire is adopted to retard the acceleration of forest fire in various part of the district. Particularly, people who reside nearby forest practice back fire to prevent forest fire approaching settlements.

Fire Breaking/Fuel Breaking

As leaf-litter is one of the major sources of fuel of forest fire, it is removed within a limited strip of community forest, particularly around settlements, to retard the acceleration of forest fire.

9.3. Legal Provisions

Setting fire in the forest is prohibited according to Forest Act 1993. The offender will be punished up to RS 10,000 or an imprisonment up to one year or both depending on the damages. National Parks and Wildlife Conservation Act 1973 also prohibits initiating fire in the protected areas. It is illegal to set fire in community forests and leasehold forests. In case of community forest, legal provision of forest fire offence is mentioned in operational plan but varies from one CFUG to another.

10. Existing Capacity of District Forest Office

10.1. Organization and Human Resources

The district forest office of Makawanpur is supported with three Ilaka forest offices, fifteen range posts and a troop of armed security guards. All together 131 staff and 24 armed forest guards are working under district forest office in protecting and managing forests. But, unfortunately, none of the DFO staff have received a single fire management training so far. Moreover, no fire fighting equipments and tools are available in the district forest office. Organizational structure of DFO of the district is presented in Annex I.

10.2. Supportive Community Based Organizations

A total of 318 CFUGs and 290 leasehold groups have been formed in the district. All of those community based organizations are involved in forest management activities in the district with the facilitation of DFO. All together 4896 households are affiliated to CFUGs and 1818 households are affiliated to leasehold groups. Besides, there are CFUG networking committees at Range Post level and CFUG federation at district level in Makawanpur. Table 16 presents the supportive CBOs exist in the district.

Table 16. Supportive CBOs in Makawanpur district

SN	CBO	Number	Households	Population
1	Community Forest User Group	318	48916	240000
2	Leasehold Group	290	1818	12663
3	CFUG networking committee	15		
4	FECOFUN	1		

10.3. Supportive Infrastructures

Road and trails constructed by various stakeholders including road department, DDC, VDC, CFUG and other stakeholders also act as good fire lines. Makawanpur district is equipped with excellent network of roads and trails. There are two national highways including East-West and Tribhuvan highway. In addition, there are several roads and trails within the district. A total of 33 VDCs are accessible either by black top or gravel road. All of these roads and trails are useful for preventing and controlling forest fire. However, there is no wide road and river to fragment large blocks of the forest. District and national level road network that exists in the district is presented in Table 17.

Table 17. Road network in Makwanpur district

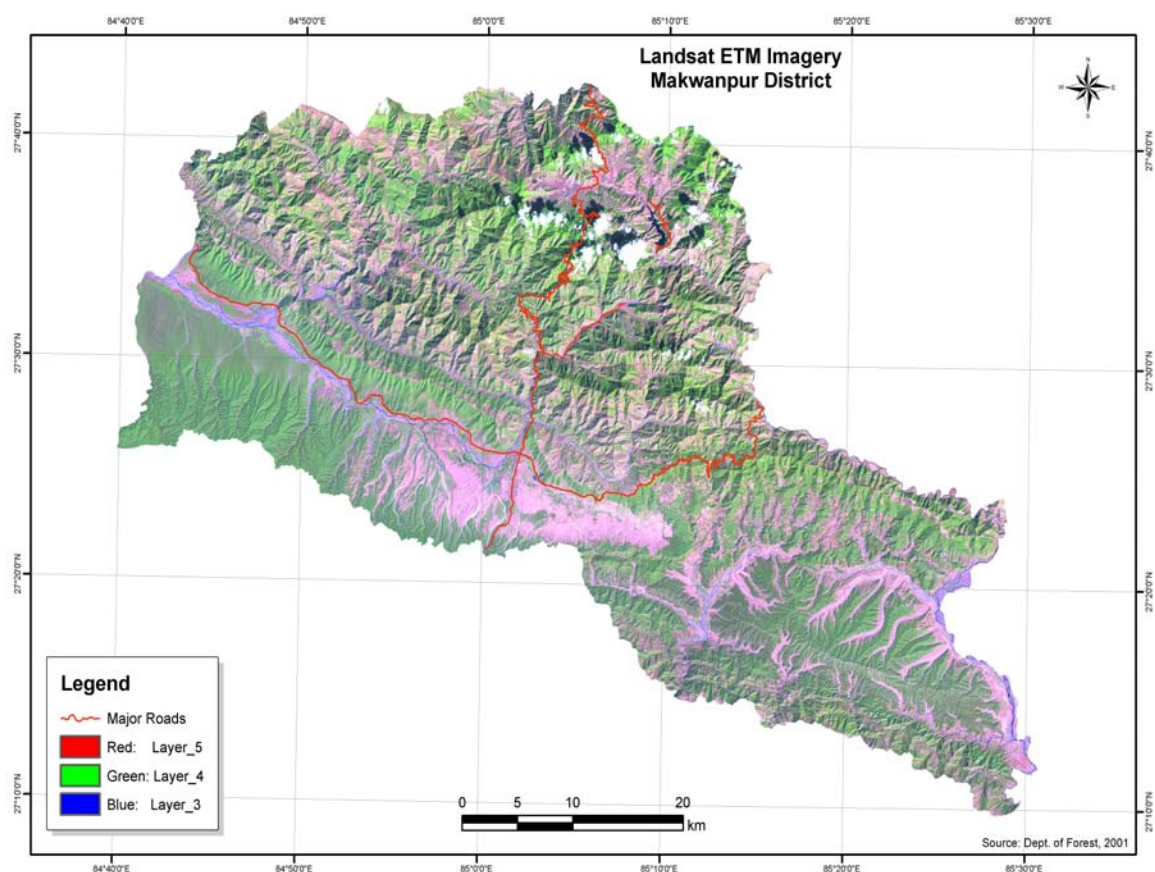
SN	Road Network	Length (km)	Remarks
A	National Highways		
1	Tribhuban Highway (Chure-Sopyang)	110	Black top
2	East-West Highway (Chure-Lothar)	47	Black top
B	District Road		
1	Hetauda-Bhimbhedi	23	Black top
2	Hetauda-Faparbari	45	Black top + gravel
3	Kunchhal - Kulekhani	18	Gravel
4	Bhimphedi-Kulekhni-Fakhel-Kathmandu	53	Black top + gravel
5	Chunia-Namtar	11	Gravel

6	Daman - Dandabas	10	Gravel
7	Samari - Aambhanjyang	6	Gravel
8	Hetauda - Thingan	42	Gravel
9	Hetauda - Padampokhari	10	Gravel

Source: DDC, 2007

Road network of the district is presented in Figure 6. In addition, networking mechanism, with fire brigade of Hetauda municipality and Hetauda industrial estate, police, and army need to be established in the future.

Fig. 6. Map showing road network in Makawanpur district.



11. Fire Management Planning

Fire management voluntary guidelines (FAO 2006) emphasizes the actions of the concerned organizations or persons – who suppress fires, conduct fuel treatment activities or prevent civilians from engaging in dangerous or risky actions – will not be effective if they are not following a clear legal, institutional and policy framework.

11.1. Fire Prevention

The two basic steps in preventing forest fires are reducing risks and reducing hazards. Risk is the chance of a fire starting as determined by the presence of activity of causal agents, most likely due to human factor. Risk is reduced most likely through increasing public awareness. Hazard is a source of danger such as availability of load fuels in the forests to ignite and extend fire. Hazard is reduced by compartmentalizing a forest with firebreaks (fire lines in which all vegetation is removed) and reducing the buildup of fuel (litter, branches, fallen trees, etc.) by removing materials for utilization or by prescribed burning.

Following activities will be implemented to prevent fire:

11.1.1. Fire Risk Reduction

Following public awareness activities are proposed to reduce fire risks by mobilizing CFUGs, local clubs, students, CBOs, NGOs and other concerned stakeholders.

Awareness and Education

- Aware CFUG members, leasehold group members, buffer zone communities and local people residing in the vicinity of the forests. Inhabitants of the remote based VDC settlements, cattle grazers and NTFP collectors will be given priority for the awareness activities. Special awareness program will be launched in the north-west hill and north-east hill settlements where shifting cultivation and charcoal burning practice, respectively, is common.
- Educate school children regarding short and long term environmental and socio-economic impacts of forest fire.
- Enlighten pros and cons of forest fire through mass media, an effective means of extension. Develop and broadcast awareness program through local Frequency Modulus (FM) radio (s).
- Organize workshops and mass meetings to discuss environmental and socio-economic impacts of forest fire among various stakeholders including CFUG, VDC, FECOFUN, local NGOs, local clubs, community based organizations, etc.,
- Periodically organize street theaters, dramas and demonstrations related to forest fire and its consequences.

Information Materials

- Prepare and distribute posters, pamphlets and other information materials. Target group will be CFUG members, leasehold group members, buffer zone communities, trekkers, grazers, etc.
- Prepare, display and mount information boards (sign boards, hoarding boards, warning boards, etc) in public places, view points, and resting places. Adequate sign boards will be mounted along the trails that cross through forests. Information boards

will be mounted along Tribhuvan highway, East-West highway, and district level roads.

- Prepare and distribute guidelines for visitors, firewood collectors, NTFP collectors, cattle grazers in Nepali language.
- Prepare and demonstrate audio-visual shows.

Legal Measures

- Form and implement fire restrictive rules and regulations to discourage fire initiators

11.1.2. Fire Hazard Reduction

Following activities will be implemented to reduce fire hazards in the district

Fire Fuel Reduction

- Encourage CFUG members and local communities to collect leaf litters, fallen trees and other forest products that are fire hazardous.
- Remove fire hazards from fire sensitive areas before commencement of hot dry season (March to June).
- Initiate fuel breaking belts through removing fire fuels in fire sensitive zones particularly in Churia hills.
- Encourage stall feeding to lessen the number of cattle grazers in the forests.

Fire Line Construction

- Construct and maintain networks of fire lines inside community forests, government managed forests and forests within the protected areas in the district.

Controlled Burning

- Controlled burning will be practiced in the fire sensitive zones particularly in Churia hills and the adjoining forests to village settlements.

11.2. Preparedness

Preparedness is an important component of this fire management plan. The plan recommends forming active fire fighting crews at various levels including CFUG, range post, Ilaka and district levels, and equipped them with fire-fighting tools and equipments, local or modern as appropriate. In addition, various training and logistic arrangement are recommended.

11.2.1. Fire Crews

Fire crews will be formed at all levels including CFUG level, range post level, Ilaka forest office level and district level incorporating various stakeholders.

Active fire fighting crews including three fire watchers, hired for fire season, will be formed in each Range Post before the commencement of fire hazard season. The crew members will be accountable to focal person in the Range Post. They will be responsible for prevention, detection, communication and suppression of forest fire in their region. The seasonal fire watchers will be hired, from the local residents, for 4 months starting from mid February to

mid June. The hired fire watchers will be trained before assigning them. The crews will be equipped with fire fighting tools and equipments, including safety measures.

A fire crew with forest watcher and representatives of users will be formed in each CFUG. The fire crew is responsible to prevent and control fire within community forest and will be accountable to CFUG. It will cooperate to focal person at Range Post in monitoring and reporting of fire management. The crews will be equipped with local fire fighting tools and equipments.

11.2.2. Fire Fighting Tools and Equipments

A set of modern equipments will be provided to range post level during this plan period. Fire fighting tools and equipments will be stationed at each range post level CFUG networking committee under monitoring of a focal person of respective range post. In addition, local fire fighting tools will be positioned at CFUG level. Initially the fire crews of the community forest will utilize the same set of equipments available at range post level CFUG networking committee. Gradually each CFUG will be equipped with fire fighting tools and equipments. A set of fire fighting tools and equipments proposed for range post level and CFUG level is presented in Annex II and annex III respectively.

11.2.3. Training and Orientation

Training and orientation program will be organized regarding fire prevention methods and techniques, fire line construction, and use of fire fighting tools and equipments. The training will be provided to:

- Armed forest guards
- Forest/Fire watchers: employ seasonal fire watchers for fire sensitive zones and orient and train them.
- CFUG members
- Leasehold group members
- Buffer zone communities
- Local resource persons: develop and train local resource persons

11.2.4. Cooperation and Networking

The plan proposes to establish and maintain cooperation and networking within stakeholders including CFUGs, leasehold groups, FECOFUN, DFO, Police, Army, VDC, DDC, CNP, PWR, networking of CFUGs, fire brigade of Hetauda municipality and Hetauda industrial estate etc. This networking forum will be utilized to prevent and control fire in the district.

11.3. Fire Control

Effective fire control begins with a field survey and map to identify the areas at risk, delineate them, and define and improve the barriers or firebreaks that may limit fire spread. Natural barriers include rivers, lakes, ridge tops, etc. Artificial barriers include roads, canals, and power-line tracks, but usually extra firebreaks must be cut to link these and provide wider gaps that fire cannot readily jump. Forest roads, access for forest products collection and recreation, are of critical importance in fire fighting.

Detection is the first step in fire suppression. Fire surveillance is essential during seasons of high risk. Once a fire has been detected, the next step is fire suppression. The first job is to stop or slow the rate of spread of the fire, and the second job is to put it out. Suppression is accomplished by breaking the “fire triangle” of fuel, temperature, and oxygen by robbing the fire of its fuel (by physically removing the combustible material or by making it less flammable through application of soil, water, or chemicals); by reducing its temperature (through application of soil, water, or chemicals and partial removal or separation of fuels); and by reducing the available oxygen (by smothering fuels with soil, dirt, water, or chemical substances).

To control fire following activities will be taken into consideration:

11.3.1. Fire Detection and Communication

Fire Detection

- Train and orient forest/fire watchers.
- Initiate rotational patrolling through the users.
- Construct fire watch towers particularly in Churia range.

Fire Alarm and Communication

- Establish and operate communication systems like hand mike, phone, bell, FM radio, etc.
- Communication systems to be adopted are presented in annex 2, annex 3 and annex 4.

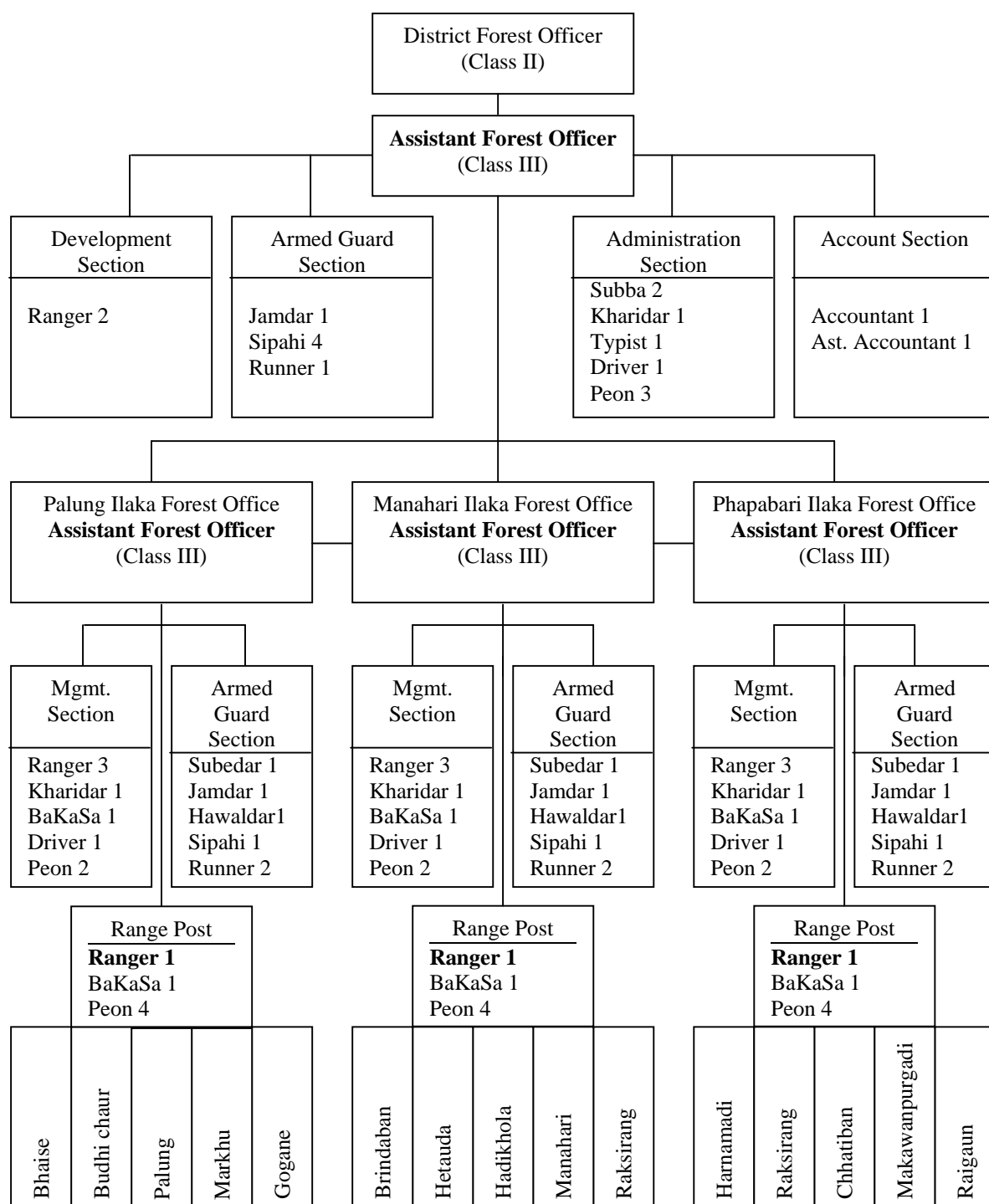
11.3.2. Fire Suppression

Appropriate planning is a must to control forest fire. Planning will be done at district, Ilaka, range post and CFUG levels considering institutional set up, fire crews with fire fighting tools and equipments and suppression techniques.

Appropriate Institutions

Existing institutional setting of district forest office is not proactive in managing forest fire. A focal person responsible for fire prevention and control is proposed in district forest office, Ilaka forest offices and Range posts. Assistant Forest Officer in DFO and Ilaka forest office and Ranger in Range post will be assigned for fire management planning, implementation and monitoring. Proposed organizational structure of district forest office is presented in Figure 7.

Fig. 7. Proposed organizational structure of district forest office, Makawanpur



(Bold letter denotes the focal person responsible for fire management planning, implementation and monitoring)

Basic Transportation Facility

Since Makawanpur district is well equipped with road networks for transportation. Transportation facility is very important for fire management including patrolling, mobility of fire crews, suppression and coordination and networking among various stakeholders. Various transportation vehicles including pick ups for district and Ilaka forest office and bicycles for range posts are proposed to be arranged for fire management. The vehicles proposed are presented in Table 18.

Table 18. Transportation vehicles to be arranged in Makawanpur DFO

SN	Vehicle	No	Location
1	Pick Up/ Delivery Van	4	One for district forest office, three for Ilaka forest offices
2	Bicycles	30	15 for each range post, 15 for CFUG networking committee at range post level

Well Equipped Fire Crews

Well equipped fire fighting crews formed at various levels such as CFUG level, Range Post level and district level will be mobilized to control forest fire in the district.

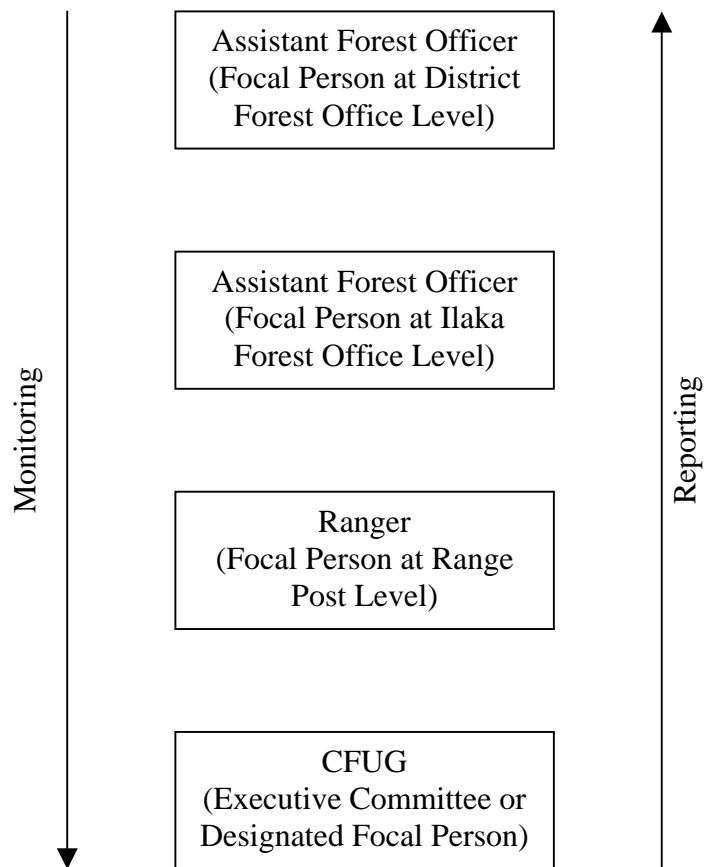
Appropriate Suppression Techniques

Forest fire will be suppressed through the adoption of indigenous methods, traditional tools, modern equipments and tools, and counter fire as appropriate. Fire suppression is generally practiced into three phases. Phase I: attack which includes cut off and restricts forest fire. Phase II: circling around the forest fire with control line. Phase III: mopping up forest fire. Counter fire or back fire will also be practiced to retard the acceleration of main fire.

11.4. Reporting and Monitoring

Focal person in each level, ranging from district level to range post level, will report and monitor fire prevention activities. In addition, fire documentation and database will be maintained and updated in district forest office under the supervision of district focal person. The feed back of the monitoring will be considered in future planning and implementation. Reporting and monitoring mechanism is presented in Figure 8.

Fig. 8. Reporting and monitoring flow chart



11.5. Recovery and Rehabilitation

Recovery of fire damaged area is an important task to be planned. Following activities will be undertaken to recover the fire affected areas:

- Clean up debris from fire lines
- Removal of dead or affected trees
- Regenerate fire damaged site

Fire damaged area will be rehabilitated through planting appropriate species. Priority will be given to NTFPs and fire resistant indigenous species.

12. Work Plan

Components and Activities	Unit	Qty	Unit Cost (RS)	Total Cost (RS)	Year 1		Year 2		Year 3		Year 4		Year 5		Responsible unit	Implementing Agency	Funding Source
					Activity	Cost	Activity	Cost	Activity	Cost	Activity	Cost	Activity	Cost			
1. Increase Public Awareness																	
1.1. Workshop (Ilaka level 3, range post level 15)	No	90	10	900	18	180	18	180	18	180	18	180	18	180	FP	DFO	GoN/DCP
1.2. Mass meeting (range post level)	No	75	5	375	15	75	15	75	15	75	15	75	15	75	Range post	DFO	GoN/DCP
1.3. Street theater	No	25	15	375	5	75	5	75	5	75	5	75	5	75	DFP	NGO/CBO/NGSP	GoN/DCP
1.4. Audio-visual show	No	25	10	250	5	50	5	50	5	50	5	50	5	50	DFP	NGO/CBO/NGSP	GoN/DCP
1.5. Poster, pamphlets production	LS			250		50		50		50		50		50	DFP	DFO	GoN/DCP
1.6. Sigh board prepare and mount	No	75	5	375	15	75	15	75	15	75	15	75	15	75	DFP	DFO	GoN/DCP
1.7. Hoarding board prepare and mount	No	10	10	100	4	40	3	30	3	30					DFP	DFO	GoN/DCP
1.8. School program (education, quiz etc)	LS			100		20		20		20		20		20	DFP	DFO	GoN/DCP
1.9. Guidelines for visitor, grazer, collectors	LS			100		20		20		20		20		20	DFP	DFO	GoN/DCP
1.10 Produce and broadcast audio aid through FM	No	40	7	280	8	56	8	56	8	56	8	56	8	56	DFP	DFO	GoN/DCP
1.11. Miking during fire hazard seasons	LS			50		10		10		10		10		10	DFP	DFO	GoN/DCP
2. Enhance Capacity of District Forest Office on Fire Management																	
2.1. Identify focal person at all level including district, Ilaka and range post level and assign fire management duties (meetings)	LS			50		10		10		10		10		10	DFO	DFO	GoN/DCP

2.2. Training to focal person on fire reporting, monitoring and coordination	No	5	50	250	1	50	1	50	1	50	1	50	1	50	DFP	NGO/C BO/NG SP	GoN/DCP
2.3. Training to armed forest guards and forest guards on fire equipment handling and fire suppression	No	10	50	500	2	100	2	100	2	100	2	100	2	100	DFP	NGO/C BO/NG SP	GoN/DCP
2.4. Hire seasonal fire watcher	No	225	12	2700	45	540	45	540	45	540	45	540	45	540	DFP	DFO	GoN/DCP
2.5. Training to fire watcher on fire equipment handling and fire suppression	No	10	50	500	2	100	2	100	2	100	2	100	2	100	DFP	NGO/C BO/NG SP	GoN/DCP
3. Enhance Capacity of CFUG and Local Resource Person (LRP)																	
3.1. Identify LRP to support CFUGs and leasehold groups (meetings, interactions, etc.) (2 LRP/range post level)	No	30		50		50									RFP	CFUG network ing	GoN/DCP
3.2. Training to LRP on fire equipment handling and suppression	No	5	50	250	1	50	1	50	1	50	1	50	1	50	DFP	NGO/C BO/NG SP	GoN/DCP
3.3. Training to CFUG members on preparing fire lines and prescribed burning	No	75	50	3750	15	750	15	750	15	750	15	750	15	750	DFP.	Range Post	GoN/DCP
4. Law Enforcement																	
4.1. Legal awareness workshop (range post level)	No	75	10	750	15	150	15	150	15	150	15	150	15	150	DFP	NGO/C BO/NG SP	GoN/DCP
4.2. Implement regulations															DFO	DFO	DFO
5. Ensure Multi-stakeholders' Networking																	
5.1. Identify multi-stakeholders to be involved in fire management (meeting, interaction)	No	5	10	50	1	10	1	10	1	10	1	10	1	10	DFO	DFO	GoN/DCP
5.2. Conduct multi-stakeholders' consultation meeting, workshop (district level)	No	5	20	100	1	20	1	20	1	20	1	20	1	20	DFO	DFO	GoN/DCP

6. Reduce Fire Hazards																	
6.1. Construct fuel breaking lines in community forests	km	100	2	200	20	40	20	40	20	40	20	40	20	40	DFP	CFUG	CFUG
6.2. Maintenance of fuel breaking line	km	80	2	160			20	40	20	40	20	40	20	40	DFP	CFUG	CFUG
6.3. Construct fire lines in government managed forests	km	25	50	1250	5	125	5	125	5	125	5	125	5	125	DFP	DFO	GoN/DCP
6.4. Maintenance of fire lines	km	20	10	200			5	50	5	50	5	50	5	50	DFP	DFO	GoN/DCP
6.5. Prescribed burning	ha	150	5	750	30	150	30	150	30	150	30	150	30	150	DFP	DFO	GoN/DCP
7. Establish Fire Detection Mechanism																	
7.1. Participatory patrolling	LS			375		75		75		75		75		75	Range post	Range post	GoN/DCP
7.2. Construct fire watch tower (3 watch tower per Ilaka forest office level)	No	9	20	180	3	60	3	60	3	60					IFP	Ilaka Forest Office	GoN/DCP
7.3. Install and operate radio communication (walky talky)	LS			200		200									DFO	DFO	GoN/DCP
8. Systematize Fire Control Measures																	
8.1. Procure tools and equipments, at least one set at range post level	set	15	500	7500	15	7500									DFO	DFO	GoN/DCP
8.2. Procure local tools and equipments, one set per CFUG	set	300	5	1500											CFUG	CFUG	GoN/DCP
9. Fire Reporting and Monitoring																	
9.1. Monitoring and reporting of fire management	LS		30	150		30		30		30		30		30	DFP	DFO	GoN/DCP
10. Establish Transportation Facility																	
10.1. Procure pick up/delivery van (DFO 1, Ilaka forest office 3)	No	4	2000	8000	4	8000									DFO	DFO	GoN/DCP

10.2. Procure bicycle (each for range post and range post level CFUG networking group)	No	30	5	150	30	150									DFO	DFO	GoN/DCP
11. Fire Management Planning																	
11. 1. Pilot community based fire management plan (prepare CFUG level fire plan, one at each Ilaka forest office level and pilot them)	No	2	1000	2000	1	1000	1	1000							DFO	DFO	GoN/DCP
11.2. Recovery of fire damaged areas	LS		100	500		100		100		100		100		100	DFO	DFO	GoN/DCP
Total				35220		19911		4091		3091		3001		3001			

GoN = Government of Nepal

(All costs in RS 1,000)

DCP = Development/Conservation Partner

NGSP = Non Governmental Service Provider

DFP = Focal person at district forest office

IFP = Focal person at Ilaka forest office

RFP = Focal person at range post

DFO = District Forest Office (r)

13. Benefit-Cost Analysis

The fire management plan anticipates to drastically reducing the loss by forest fire in the district after its implementation. The value of loss, hence, is taken into account as benefits. The value of sawlog and firewood of the district which was lost annually and devaluation of sawlog into firewood was estimated to be RS 30,363,117. Total annual average cost of the work plan is proposed to be RS 7,044,000. Table 21 presents the benefit-cost situation of the work plan.

Table 19. Benefit-cost situation of proposed work plan

Average annual benefit	Average annual cost	Benefit-Cost ratio
3,03,63,117	70,44,000	4.31

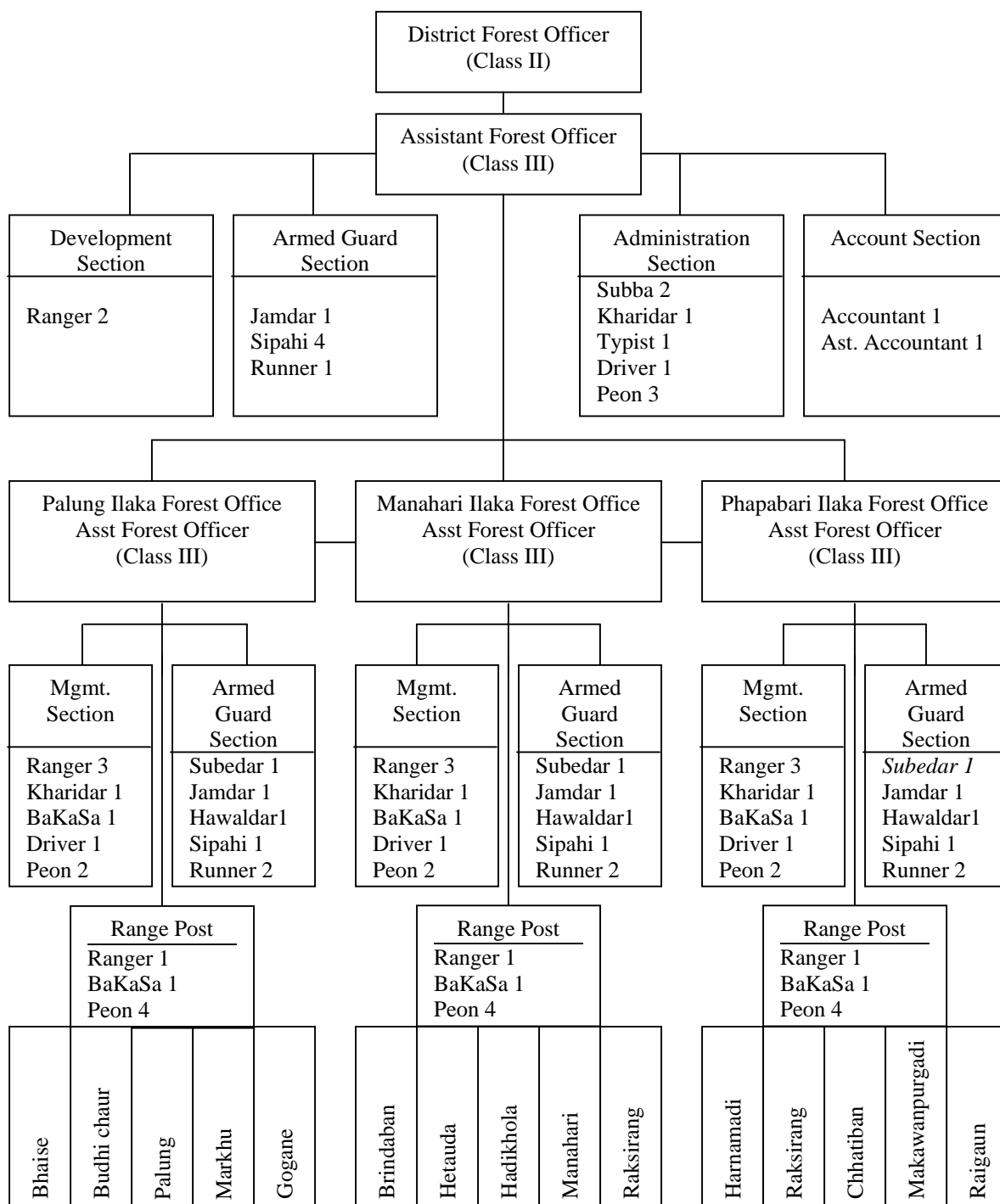
The benefit-cost ratio of proposed work plan is 4.31. The benefit included in the calculation is direct benefit only from sawlog and firewood. Fodder, leaf litter and other products (the economic value of the products is quite significant) are not included in the estimation. The benefit-cost ratio will be increased considerably if those products are included. Furthermore, indirect benefits of implementing the fire management plan such as ecosystem and biodiversity conservation and environmental maintenance are not included in the benefit-cost analysis.

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Annex I: Existing Organizational Structure of Makawanpur District Forest Office



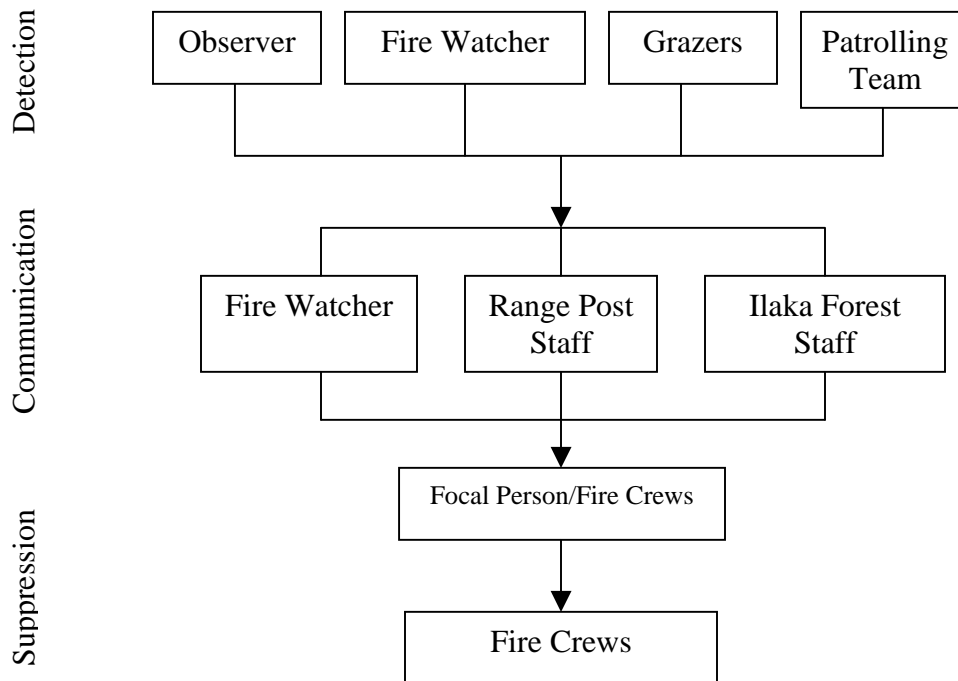
**Annex II: List of Fire Fighting Tools and Equipments to be Available for Fire Crews at
Range Post Level**

SN	Tools and Equipments	Quantity
1	Swatter	12 sets
2	Shovel	12 sets
3	Rake	12 sets
4	Rake-hoe	12 sets
5	Axe-hoe	12sets
6	First Aid Kit	2 sets
7	Jumpsuit (Small 16, Medium 6, Large 8)	30 sets
8	Gloves	30 sets
9	Helmet	30 sets
10	Boot	30 sets
11	Back-pack Pump, Collapsible	12 sets
12	Drip Torch	5 sets
13	Water Pump, 3.5 HP	2 set
14	Hose Reel with Roller	1“ * 100’
15	Container, 1000 lit.	2 set
16	Kestrel Weather Station	2 set

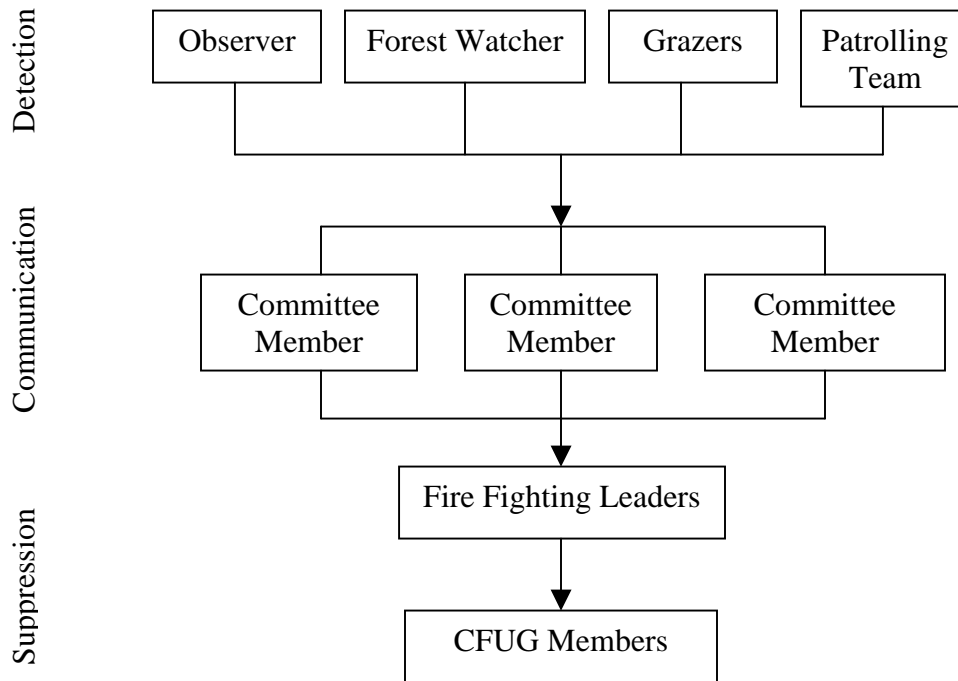
Annex III: Local Fire Fighting Tools to be Available for CFUG

SN	Tools and Equipments	Quantity	Remarks
1	Fire rake	6	
2	Axe	6	
3	Hand Saw	6	
4	Shovel	6	
5	Spade	6	
6	Knife (Khukuri)	6	

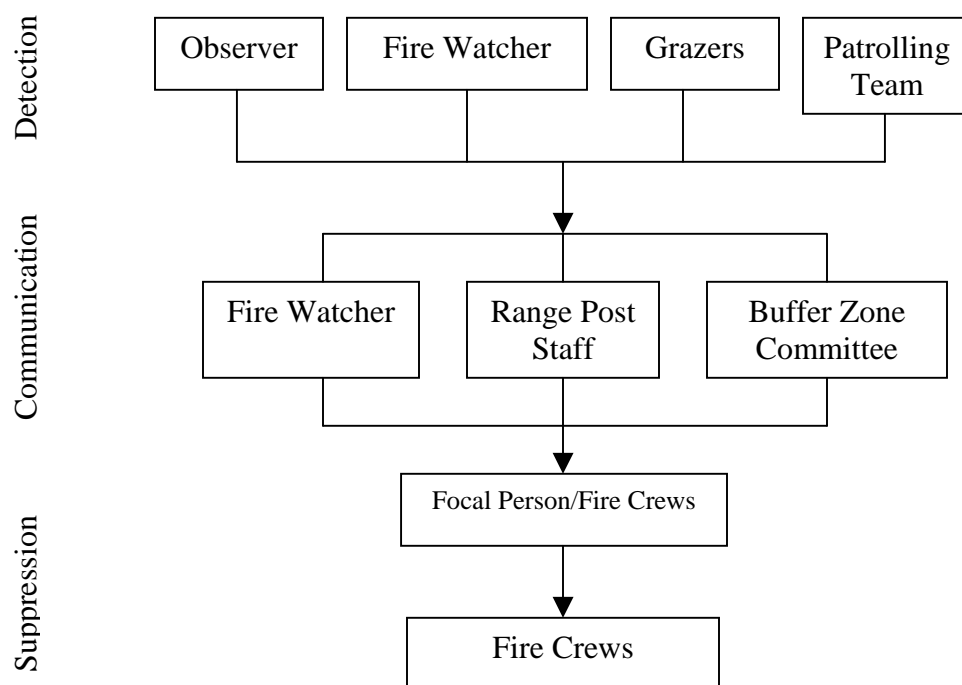
Annex IV: Communication System in Government Managed Forest



Annex V: Communication System in Community Forest



Annex VI: Communication System in Protected Areas



Annex VII: Glossary of Fire Related Terms

Term	Description
action plan	Any tactical plan developed by any element of the ICS in support of the incident action plan.
air pollution	The general term alluding to the undesirable addition of substances (gases, liquids, or solid particles) to the atmosphere that are foreign to the natural atmosphere or are present in quantities exceeding natural concentrations.
available fuel	The portion of the total fuel that actually burns or would actually burn under specified burning and fuel conditions.
backfire	A fire spreading, or set to spread, into or against the wind: (1) As used in fire suppression: A fire set along the inner edge of a control line to consume the fuel in the path of a forest fire and/or change the direction of force of the fire's convection column (Note: doing this on a small scale and with closer control, in order to consume patches of unburned fuel and aid control-line construction (as in mopping-up) is distinguished as "burning out, firing out, clean burning"); (2) As used in prescribed burning: designation of fire movement in relation to wind (syn. backing fire, cf. flank fire).
backfiring	A form of indirect attack where extensive fire is set along the inner edge of a control line or natural barrier, usually some distance from the wildfire and taking advantage of indrafts, to consume fuels in the path of the fire, and thereby halt or retard the progress of the fire front
backpack pump	A portable water container equipped with a hand pump and back-pack straps carried on the back of fire fighters; used for applying water or fire retardant, in suppression and mop-up operations (syn. bladder bag, pack pump)
combustion	Consumption of fuels by oxidation, evolving heat and generally flame (neither necessarily sensible) and/or incandescence. Combustion can be divided into four phases: preignition (or preheating), flaming, smoldering, and glowing.
Community-Based Fire Management (CBFiM)	Fire management approach based on the strategy to include local communities in the proper application of land-use fires (managed beneficial fires for controlling weeds, reducing the impact of pests and diseases, generating income from non-timber forest products, creating forage and hunting, etc.), wildfire prevention, and in preparedness and suppression of wildfires. CBFiM approaches can play a significant role in fire management, especially in most parts of the world where human-based ignitions are the primary source of wildfires that affect livelihood, health and security of people. The activities and knowledge communities generally practice are primarily those associated with prevention. They include planning and supervision of activities, joint action for prescribed fire and fire monitoring and response, applying sanctions, and providing support to individuals to enhance their fire management tasks. Communities can be an important, perhaps pivotal, component in large-scale fire suppression, but should not be expected to shoulder the entire burden.
controlled burning	Outdated term which had been used instead of the term Prescribed Burning (cf. prescribed burning)
counter fire	Fire set between main fire and backfire to hasten spread of backfire. The act of setting counter fires is sometimes called front firing or strip firing (syn. Draft fire).
crew	An organized group of firefighters under the leadership of a crew boss or other designated official.
detection	The process of discovering, rectifying, locating and reporting wildfires by ground, aerial, and spaceborne means.
fire	Simultaneous release of heat, light, and flame, generated by the combustion of flammable material.
fire control	All activities concerned with protection of vegetation from fire (cf. fire exclusion,

	fire prevention, fire suppression).
fire crew	A general term for two or more firefighters organized to work as a unit (cf. suppression crew).
fire damage	Any effects of fire that are detrimental or damaging in terms of the attainment of forest management and other land use objectives (Note: for fire damages in plants and animals use fire Injury).
fire danger	A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and fire impact; often expressed as an index.
fire frequency	The average number of fires or regularly occurring fire events per unit time in a designated area. (cf. fire cycle, fire interval).
fire hazard	(1) A fuel complex, defined by volume, type, condition, arrangement, and location, that determines the degree both of ease of ignition and of fire suppression difficulty; (2) a measure of that part of the fire danger contributed by the fuels available for burning. Note: Is worked out from their relative amount, type, and condition, particularly their moisture contents (syn. hazard).
fire hazardous area	Those wildland areas where the combination of vegetation, topography, weather, and the threat of fire to life and property create difficult and dangerous problems.
fire history	The reconstruction and interpretation of the chronological record, causes and impacts of fire occurrence in an ecosystem in relation to changes of past environmental, cultural and socio-economic conditions. Fire history evidence is based on analysis of charcoal deposits in soils, sediments, and ice, dendrochronology (fire scar analysis), historical documents, and fire reports.
fire impact	The effect of fire on the ecosystem in terms of biophysical alterations (e.g., crown scorch, mineral soil exposure, depth of burn, fuel consumption).
fire incidence	The average number of fires in a specified area during a specified time period.
fire intensity	A general term relating to the heat energy released in a fire (more specific term: cf. fireline intensity).
fire management	All activities required for the protection of burnable forest and other vegetation values from fire and the use of fire to meet land management goals and objectives. It involves the strategic integration of such factors as a knowledge of fire regimes, probable fire effects, values-at-risk, level of forest protection required, cost of fire-related activities, and prescribed fire technology into multiple-use planning, decision making, and day-to-day activities to accomplish stated resource management objectives. Successful fire management depends on effective fire prevention, detection, and presuppression, having an adequate fire suppression capability, and consideration of fire ecology relationships.
fire management plan	(1) A statement, for a specific area, of fire policy and prescribed action; (2) The systematic, technological, and administrative management process of determining the organization, facilities, resources, and procedures required to protect people, property, and forest areas from fire and to use fire to accomplish forest management and other land use objectives (cf. fire suppression plan, preattack plan, pre-suppression planning).
fire occurrence	The number of fires started in a given area over a given period of time.
fire prevention	All measures in fire management, fuel management, forest management, forest utilization and concerning the land users and the general public, including law enforcement, that may result in the prevention of outbreak of fires or the reduction of fire severity and spread (syn. Prevention, cf. Fire Control)
fire rake	Long-handled combination rake and cutting tool, the blade of which is constructed of a single row of three or four sharpened teeth (syn. rake).
fire season	(1) Period(s) of the year during which wildland fires are likely to occur and affect resources values sufficient to warrant organized fire management activities; (2) a legally enacted time during which burning activities are regulated by State or local

	authority.
fire suppression	All activities concerned with controlling and extinguishing a fire following its detection. (Syn. Fire Control, Fire Fighting). Methods of suppression are: Direct Attack - A method whereby the fire is attacked immediately adjacent to the burning fuel. Parallel Attack - A method whereby a fireguard is constructed as close to the fire as heat and flame permit, and burning out the fuel between the fire and the fireguard. Indirect Attack - A method whereby the control line is strategically located to take advantage of favorable terrain and natural breaks in advance of the fire perimeter and the intervening strip is usually burned out or backfired. Hot Spotting - A method to check the spread and intensity of a fire at those points that exhibit the most rapid spread or that otherwise pose some special threat to control of the situation. This is in contrast to systematically working all parts of the fire at the same time, or progressively, in a step-by-step manner. Cold Trailing - A method of determining whether or not a fire is still burning, involving careful inspection and feeling with the hand, or by use of a hand-held infrared scanner, to detect any heat source. Mop-Up - The act of extinguishing a fire after it has been brought under control.
fire suppression plan	A document containing the essential elements of actions necessary to save human life and property, and minimize fire damage(s). May apply to an overall fire suppression program for a broad area but most often it is for site-specific situations (cf. fire management plan, preattack plan).
fire triangle	Instructional aid in which the sides of a triangle are used to represent the three factors (oxygen, heat, fuel) necessary for combustion and flame production; removal of any of the three factors causes flame production to cease (cf. fire Behavior triangle, fire environment triangle, fire fundamentals triangle).
firebreak	Any natural or constructed discontinuity in a fueled utilized to segregate, stop, and control the spread of fire or to provide a control line from which to suppress a fire; characterized by complete lack of combustibles down to mineral soil (as distinguished from fuel break). (cf. control line)
firefighter	Person whose principal function is fire suppression
fireline	(1) A loose term for any cleared strip used in control of a fire; generally that portion of a control line from which flammable materials have been removed by scraping or digging down to the mineral soil; (2) a cleared, permanent firebreak. (cf. control line)
fuel break	Generally wide (20 - 300 meters) strips of land on which either less flammable native vegetation is maintained and integrated into fire management planning, or vegetation has been permanently modified so that fires burning into them can be more readily controlled (as distinguished from firebreak). In some countries fuel breaks are integrated elements of agro-silvopastoral systems in which the vegetative cover is intensively treated by crop cultivation or grazing. Some fuelbreaks contain narrow firebreaks which may be roads or narrower hand-constructed lines. During fires, these firebreaks can quickly be widened either with hand tools or by firing out. Fuelbreaks have the advantages of preventing erosion, offering a safe place for firefighters to work, low maintenance, and a pleasing appearance (cf. control line, agrosilvopastoral system, buffer strip/zone).
hazard reduction	Treatment of living and dead forest fuels to reduce the likelihood of a fire starting, and to lessen its damage potential and resistance to control (cf. fuel treatment).
human-caused fire	Any wildland fire (usually in the context of wildfire causes) caused by human carelessness or malicious use of fire (syn. people-caused fire, person-caused fire; outdated term: man-caused fire).
ignition	The initiation of combustion.
incident	An occurrence either human-caused or natural phenomenon (in this terminology incident means wildfire), that requires action or support by emergency service

	personnel to prevent or minimize loss of life or damage to property and/or natural resources (element of the Incident Command System [ICS]).
lookout tower	Structure that elevates a person above nearby obstructions to sight for fires; generally capped by some sort of house or cupola (syn. fire tower, tower cupola; cf. lookout house).
preparedness	(1) The state of being ready to cope with a potential fire situation (syn. readiness). (2) Mental readiness (awareness) to recognize changes in fire danger and act promptly when action is appropriate (syn. readiness).
prescribed burning	Controlled application of fire to vegetation in either their natural or modified state, under specified environmental conditions which allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to attain planned resource management objectives (cf. prescribed fire). Note: This term has replaced the earlier term "Controlled Burning".
rehabilitation	The activities necessary to repair damage or disturbance caused by wildfire or the wildfire suppression activity (cf. restoration).
risk	(1) The probability of fire initiation due to the presence and activity of a causative agent. (2) A causative agent. (3) A number related to the potential of firebrands to which a given area will be exposed during the rating day element of the U.S. NFDRS) (syn. fire risk).
smoke	Suspension in the atmosphere of small particles (solid, liquid) produced by combustion, thermal decomposition or thermal evaporation.
uncontrolled fire	(1) Any fire which threatens to destroy life, property, or natural resources, and (a) is not burning within the confines of firebreaks, or (b) is burning with such intensity that it could not be readily extinguished with ordinary tools commonly available.

Source: http://www.fire.uni-freiburg.de/literature/show_complete.php