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**LAND USE AND FIRE RISK: THE INTERFACE OF FOREST, AGRICULTURAL  
LAND, WILDLANDS AND RESIDENTIAL AREAS**

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# LAND USE AND FIRE RISK: THE INTERFACE OF FOREST, AGRICULTURAL LAND, WILDLANDS AND RESIDENTIAL AREAS

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## SUMMARY

The vast majority of forest and other wildland fires of the ECE region and in other regions of the world are caused by man. In many land-use systems the application of fire follows traditional practices which are still alive today. However, methods of vegetation management have changed. In many European countries the rural space is subjected to a demographic process of depopulation and over-aging, to less intensive use of vegetation and to an increasing risk of wildfires. The wildfire hazard is greatest at the interface of regularly burned and fire-sensitive land uses. Forest adjoining regularly burned agricultural and pasture lands are often affected by escaping fires. Wildfires are also spreading from areas of vegetation into residential or urban zones. These fires at the wildland residential interface represent a major risk to the human environment and involve high economic losses. The fire problem at the interface of different land uses can only be solved by an integrated approach in which the complex of fire uses and fire causes.

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## 1. Introduction

Within the ECE region the vast majority of forest fires are caused by man. According to the most recent ECE/FAO Forest Fire Statistics (ECE/FAO 1990) the information on the known causes of fires show that only three percent of fires in Europe are started by natural sources (lightning) (Table 1). In the remote and less accessible northern environments of North America, the USSR and also in the neighbouring People's Republic of China lightning-caused fires play a more important role, e.g. igniting one third of all fires in Canada between 1985 and 1987 (ECE/FAO 1990, Table 1) and in Northeast China between 1966 and 1986 (GOLDAMMER and DI 1990).

According to the data provided by Table 2 the fires caused by human activities contribute to 95% of the average area annually affected by fire in Europe. Within the category of fires started by "negligence", agricultural and forestry operations contribute to 22% and 6% of the numbers of fires and 34% and 2% of the respective area affected by fire (Table 3 and 4). Data from selected countries in Europe show that the reported fire statistics often include a high amount of burned non-forest land (agricultural lands, wildlands) (Table 5).

This information may reflect the mutual influence of the fires in various land-use systems and vegetation types within the ECE region. In other parts of the world, especially in the tropical countries, the interlinks between fire in the various land-use patterns and forests are even more pronounced. The traditional slash-and-burn agriculture (shifting cultivation), large-scale burning of grazing lands and the application of fire in forest conversion activities in many cases are the predominant sources



of uncontrolled wildfires escaping into the surrounding forest.

Wildfires are also affecting the wildland/residential interface, either being originated in the natural vegetation and burning into residential areas, or being started as ex-urban fires and spreading into the surrounding vegetation.

Methods and technologies developed for the prevention and suppression of forest fires often cannot cope with the multiple fire influences from outside of the forests: Expertise, technical capabilities and responsibilities of forest fire management organizations are largely restricted to the particularities of wildland fires.

Vice-versa, the fire scene outside of forests is governed by different jurisdictional responsibilities. The urban fire brigades are trained and equipped for fighting structural or industrial fires. Nevertheless they are often responsible for forest fire suppression. An ECE-wide survey in 1985 (GOLDAMMER 1988) revealed that in 10 countries (out of 20 member countries investigated) the responsibilities in forest fire prevention and fire suppression are shared by the ministries of agriculture (through the forest departments, responsible for fire prevention) and the ministries of the interior (through the fire brigades, responsible for fire suppression). Additional tasks are often taken over by the armed forces (provision of heavy equipment, airplanes for transport of personnel and airborne fire suppression, mass dispatch of personnel, logistics, etc.). The sharing of tasks in land and fire management by two or more administrative bodies with relevant different background of expertise and philosophies may create conflicts but also offer opportunities in collaboration.

In this introductory contribution to the ECE/FAO/ILO Seminar on Forest Fire, Land Use and People the main fire problems at the interface between different land uses are highlighted. For a better understanding of the terminology used in this context, a few terms need to be clarified.<sup>1</sup>

### **Forest Fire**

Any fire occurring on land defined as forest according to national or international classifications.

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<sup>1</sup> Two comprehensive wildland fire management glossaries are available at present. The FAO terminology (FAO 1985) is a multilingual terminology in which the terms are defined in English. Translations of the terms are given in Spanish, Italian, German and French. The updated glossary of the Society of American Foresters (SAF 1990) differs from the FAO glossary in that it includes the full ICS (Incident Command System) terminology as well as several hundred additional terms commonly used in the United States. However, the author of this paper does not entirely agree with the definitions given in both glossaries. Therefore the definitions given in this article differ from the FAO and SAF glossaries.

## **Wildland Fire**

Any fire occurring on wildlands. Wildlands are defined as vegetated areas that are not intensively managed (e.g. abandoned agricultural lands with natural succession, extensively grazed lands with a woody component, degraded forest ecosystems, protected vegetation under a nature conservation scheme, non-commercial forests, etc.).

## **Wildfire**

Any unplanned natural and man-made fire that is not meeting the vegetation management objectives and thus requires a suppression response.

## **Prescribed Fire**

Any fire burning within prescription (a written statement that defines fire characteristics and impacts required to attain planned resource management objectives).

## **Wildland/Residential Interface**

The zone or boundary line between wildlands and any residential areas (urban areas, villages, scattered structures, industrial activities, etc.).

## **2. Changing Land Uses, Landscape Patterns and Fire Regimes**

From the very beginning of the cultivation of land in North America, Europe and Eurasia fire has been an important tool for converting forest and other wildlands into agricultural and pastoral lands. Burning practices had different objectives. Fires were set for

- hunting purposes (driving game or preparing attractive grazing spots for wildlife)
- removing woody and shrub vegetation for preparing and maintaining pasture lands
- slash-and-burn agriculture, clearing fields and agricultural residues
- removing forest residues and raw humus to induce regeneration of healthy and productive forest stands.

Many of the traditional burning practices were still alive early this century. In Scandinavia the burning of raw humus for site preparation and improvement was a common practice that lasted up



to the post-World War II era. Swidden agriculture was practiced all over Europe and Eurasia. This European form of shifting cultivation was closely linked to forest management: Small forest patches were clearcut and burned. For one to three years agricultural products were grown between the rows of natural or of planted regeneration of the stand. The forest regeneration was secured by the swidden agriculturist who then left the site and moved to the next plot.

This intensive and combined land-use system was born in an environment where space for agriculture became scarce. The burning of organic matter that could otherwise not be utilized was advantageous because the intercrops took up the released nutrients. Burning of the non-utilized vegetation was also useful in creating openness and accessibility of the land.

Additional plant biomass was utilized to satisfy the increasing demand for energy. Collection of fuelwood and intensive management of energy forests (coppice stands) was the contemporary way to supply the required energy for cooking, heating and for the early industries of the pre-coal era.

Grazing of animal husbandry inside of forests and other wildlands was a common practice all over Europe. This intensive silvopastoral land use also contributed to the shaping of the pan-European landscapes between Scandinavia and the Mediterranean Basin. Plant biomass was not only consumed by the animals. In the heathlands of Central and Western Europe the shepherds periodically burned the heather vegetation in order to obtain tender regeneration of plants that was acceptable for sheep browsing. Burning practices were similar in the Mediterranean landscapes. The combined effect of browsing and repeated burning together with the effects of the intensive utilization of organic matter (for burning in home fires or for use in cattle stables) often lead to soil impoverishment but resulted in an overall reduction of wildfire hazard. In addition, the rural population was highly motivated to protect their limited forest resources from the detrimental influences of wildfires.

Dramatic changes in land use and demography took place in the wake of the industrialization of Europe. Altered methods in forestry and agriculture and the availability of cheap and convenient fossil energy sources involved less intensive consumption of plant biomass. A general trend of urbanization depleted the rural lands from the young generation of farmers and villagers and, with this, from the capability to actively engage in the protection of forests and other land against fires. LOURENÇO et al. (1990) recently demonstrated the importance of demographic development on forest fires in Central Portugal. In nine counties investigated an average decline of population between 1911 and 1987 was ca. 20%, with extremes of up to 47% in one council. Population density in one council declined from 106 down to 43 inhabitants/km<sup>2</sup>. Demographic aging of that region may be represented by following numbers: Between 1970 and 1981 the share of people younger than 19 years declined



from 33 to 28%, and the percentage of population older than 60 years increased from ca. 20 to 25%.

The decrease of human activities in the rural landscapes of Europe has resulted in an increase of wildfire hazard. Vegetation succession on abandoned fields and fuel accumulation in forest and other wooded land have increased the loads of available fuels and the risk of high intensity fires. People have become less cautious concerning the use of fire. The traditional expertise to use fire, wisely adapted to the local requirements, seems to be lost.

In North America another trend is being observed. The inhabitants of the overcrowded metropolitan areas are moving back to the countryside. More and more homes are being built on scenic sites and slopes in forests and other wildlands. These activities in formerly unoccupied space involve alterations of the fuel complex and create new fire risks.

In the less developed regions of the world, in the tropics and subtropics, the rural space faces the problem of becoming overpopulated and overexploited. With enhancing demand for agricultural and grazing lands fire is being used in shorter intervals and on larger areas. This leads to an alarmingly progressing process of deforestation and savannization.

It can be concluded that fire regimes and wildfire hazard are dependant on the quality and quantity of human involvement in the rural space. The decline of rural population and less intensive use of agricultural lands in the industrial societies may lead to enhanced wildfire risk, and same does the increase of population and demand for resources in the less developed regions of the world.

### **3. Fire Hazards at the Interface of Wildlands, Forests and Residential Areas**

Residential areas intermixed in forest lands and other wildlands have always been exposed to high wildfire risk. Large-scale wildfire disasters affecting human settlements have repeatedly occurred in many countries. In the last Century one of the worst fire years in the USA was 1871 when perhaps 1,500 people died in the in the Peshigo fire and another 750 in the Humboldt fire, both in the State of Wisconsin (more details of the fire history of the USA is given by PYNE [1982]).

In the late 20<sup>th</sup> Century the wildfire threat to residential areas (cities, villages, suburbs, and scattered structures) has not changed. On the contrary, the increasing spread of home building activities from urban areas into the rural wildlands is creating new risks. Wildfires running into scenic residential areas repeatedly left hundreds and thousands of structures destroyed. Some examples from the USA, Australia and China may reflect the

magnitude of this problem (US Forest Service 1987, GOLDAMMER and DI 1990):

- o During 13 days of September 1970 about 750 wildfires raged through the State of California. The fires burned 772 homes on ca. 250,000 ha wildlands, killed 6 people and required suppression costs of 233 million US-\$.
- o The 1983 "Ash Wednesday Fires" in Australia burned 2,582 homes and 300,000 farm animals on ca. 340,000 ha of forested, pasture and urban lands; more than 3,500 people were injured, 77 people died in the flames.
- o The worst recent fire year in the USA (1985) ended with ca. 1,400 structures burnt or damaged and 44 people dead.
- o In the People's Republic of China the "Great Black Dragon Fire" of May 1987 raged over 1.5 million ha of land, thereof 870,000 ha forest, and burned whole villages and forest farms (totalling 614,000 square meters of houses). More than 56,000 people were left homeless, and ca. 200 people were killed during the wildfire.

The many single disasters which are occurring repeatedly each year in the Mediterranean landscapes are not counted. Countless are also the villages and townships in tropical countries that are destroyed by wildfires sweeping over from the wildlands into the residential areas. In the tropics the construction materials of houses are often natural products, e.g. wood, bamboo, grasses, leaves, etc. The flammability of these materials corresponds to natural wildland fuels, thus making these structures extremely flammable during the dry (fire) season. Fire statistics from Myanmar (Burma) show that during the 1985 wildland fire season (January to June) 5% of all structural fires in the country were caused by forest fires (GOLDAMMER 1988b).

During wildfire suppression at the wildland/residential interface responsible fire agencies and firefighters are often faced with a dilemma. On the one side the wildfire threat requires the concentration of all capabilities to rescue human lives and property. On the other side there are natural resources that need to be protected. To whom are the priorities to be given ?

#### **4. The Attitude of the Mobile Society to the Fire Problem**

The interdependence between the fire problem and the modern urbanized society goes far beyond the "static" boundaries of the wildland/residential interface. In both the industrialized countries and in the less developed regions of the world people are becoming more and more mobile. Mobility in the modern



societies relates to the employment sector and to tourism. The latter is a new form of land use that is of increasing economic importance all over the world. Unlike permanent residents of the rural space, the migrating population and the tourists do not develop an attitude of responsibility towards the land they are visiting. The extra-urban space is rather being considered as a consumer's good than as a natural resource to be preserved and managed on a sustained base. The numerous fires started by tourists speak for themselves.

Another expression of a rooted-out society is the increasing arson. VELEZ (1990) recently summarized the arson research in Spain. He demonstrated that arson is highly connected with the conflicts arising at the interface of different land uses.

## **5. Challenges to Policies and Politics**

A series of international and national activities demonstrate that the threat of fire to the human and economic resources is taken seriously. The International Decade for Natural Hazard Reduction (IDNHR), for instance, has added the fire problem to be included in the list of disasters (NATIONAL RESEARCH COUNCIL 1987). Other activities are devoted to highlight the problem of fire at the "wildland/urban interface", largely concentrating on the protection of man and his homes against wildland fires<sup>2</sup>. But where is the lobby for a better protection of forest and other land resources against the destructive man-caused fires? Are there any adequate international and national initiatives existing? And if yes, are they understood?

There is obviously a gradient between the the northern and the southern countries within and outside of the ECE region. In Northern and Central Europe the occurrence and the impacts of forest and other wildland fires is less than in the Mediterranean region. And in general, the importance of fires is also less in the boreal and temperate zone as compared to the tropics and subtropics.

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<sup>2</sup> Following books and guides offer comprehensive information and advice on protection of structures against wildfires:

- "Wildfire Strikes Home!" (US FOREST SERVICE 1987)
- "Protecting People and Homes from Wildfire in the Interior West" (US FOREST SERVICE 1988)
- "Wildland Home Fire Risk Meter" (available at USDA Forest Service, Intermountain Research Station, Missoula, Montana)
- "Wildfire News and Notes" (newsletter edited by the National Fire Protection Organization, Quincy, Massachusetts)
- "The Complete Australian Bushfire Book" (WEBSTER 1989)



Despite of the fact that many national agencies have invested tremendous technical efforts in wildfire prevention and suppression, the positive signals cannot yet be recognized. It seems timely that we explore the deeper roots of the complex of fire causes which are obviously not yet understood by the responsible land managers.

## 6. Conclusions

Fire has been and still is an important tool in various land-use systems. Fire regimes and fire impacts, however, have changed over time. Today we must recognize that we are beginning to reach the limits of the carrying capacity of many landscapes. Because of the increasing socio-cultural, ecological, economical and even aesthetic demands on our landscapes, fires become less tolerable. The fire problem is not any more a phenomenon or a problem to be addressed by a single agency with its particular philosophy. Like other phenomena in the development of the post-modern society the fire problem can be tackled only by an integrated approach of all those who participate in the multiple benefits our lands offer.

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**Table 1: Number of fires known causes (1985-1987 average)  
in the ECE region (source ECE/FAO 1990)**

	Europe	Canada	USA <sup>a</sup>
Human causes, of which	97	66	91
Arson	50	9	36
Negligence	47	57	55
Natural causes	3	34	9
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>

<sup>a</sup> USA, 1985 only

**Table 2: Area of fires by known causes (1985-1987 average)  
in the ECE region (source: ECE/FAO 1990)**

	Europe	Canada	USA <sup>a</sup>
(percentage of total known causes)			
Human causes, of which	95	18	100
Arson	60	1	17
Negligence	35	17	83
Natural causes	5	82	--
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>--</b>

<sup>a</sup> USA, 1985 only (percentage of human causes only)

**Table 3: Percentage of number of fires caused by negligence (1985-1987 average)  
in the ECE region (source: ECE/FAO 1990)**

	Europe (14 reporting countries)	Canada
General public	26	31
Agricultural operations	22	26
Communications	4	6
Forestry operations	6	10
Other industrial activities	2	10
Other	40	17
<b>TOTAL</b>	<b>100</b>	<b>100</b>

**Table 4: Percentage of area of fires caused by negligence (1985-1987 average)  
in the ECE region (source: ECE/FAO 1990)**

	Europe (9 reporting countries)	Canada
General public	34	24
Agricultural operations	34	20
Communications	5	2
Forestry operations	2	12
Other industrial activities	5	4
Other	20	38
<b>TOTAL</b>	<b>100</b>	<b>100</b>



**Table 5: Non-forest land burned in selected countries of the ECE region  
(1985-1987 average) (source: ECE/FAO 1990)**

	Area of non-forest land burned	As a percentage of total area burned
	(ha)	(%)
Italy	82 010	62
Spain	52 310	21
Greece	8 457	14
Portugal	4 866	5
Cyprus	2 552	93
Norway	348	89
Netherlands	123 001	86