FOREST FIRES AND DYNAMICS OF FOREST COVER

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Summary

Forest fires are probably the most dangerous form of a landscape fire. Evidence of forest fires has been found in deposits from the Carboniferous period. Forest fires have always occurred naturally, but since *Homo sapiens* first learned how to use fire, the majority of forest fires have been of anthropogenic origin, approximately in 40 to 90% of total occurrence. "Wild fires" have had a significant effect in determining composition and natural rhythms of forests. According to estimates available each year about 20 million hectares of forest vegetation are affected by fire. In Russia alone the area suffering from fire is estimated asabout 10 million ha (up to 2 million ha per year). The frequency of fires exerts a major influence on the structure and dynamics of forests (especially in regions with long dry seasons).

Full recovery after a crown fire can take 100 to 150 years, but the interval between crown fires is likely to be 300 to 400 years, particularly in wet forests—a sufficiently long period to allow recovery. Ground fires are followed by secondary pyrogenic succession as a mechanism of regeneration, and complete recovery takes from 5 to 30 years, or occasionally longer. Information about frequency of fires can be determined from dendrochronogical studies (using data from tree rings). A special ecological group of plants, the pyrophytes, are well represented in the secondary succession after a fire. These plants have adaptations to tolerate ground fires (e.g. very thick bark, seeds with a very thick coating, small leaves, ready establishment of shoots from burnt wood, effective wind dispersal of seeds, etc.).

The global carbon cycle is heavily influenced by the ability of forests to act as a carbon sink, storing carbon within their phytomass, and carbon emission from forest fires is also another important part of the cycle. The mass of carbon emitted to the atmosphere during and after crown fires in the boreal belt of northern Eurasia can be more than 100 to 150 tons per ha. Fire protection and monitoring now uses satellites and space stations (for remote sensing), as well as aircraft control, fire-towers and masts, and special mechanized teams. But fire control is still entirely absent in a large part of eastern Russia (eastern Siberia) and in other countries.

1. Introduction

Forest fire is a type of landscape fire, a broad category which also comprise fires of steppe, bog, grassland, and tundra. Forest fires are usually more disastrous than fires in other habitats because of the large volume of plant matter burned and the rapid spread of the fire.

In the formal statistics of many countries forest and non-forest fires are not distinguished (e.g. in Spain, Portugal, Greece, etc.), partly because of the nature of the vegetation. National forests in these countries can includes scrubby terrain, e.g. *garrigue* and *maquis*, grassland and agricultural land as well as forest. A single forest fire would usually burn other habitats in addition to forest. Nevertheless, from a global perspective, forest fires are regarded as being substantially different from other types of fire, on account of their scale and consequences.

Forest fires are mostly of anthropogenic origin—from 40 to 90%. But fire played a decisive role in the development of natural forests even before their occupation by humans. The composition, rhythm of functioning and dynamic succession of forests have, to some extent, been determined by the impact of “wild fire”. This particularly applies to many types of pine woods (*Pinus spp.)*, larch woods (*Larix spp.)*, and oak forests (*Quercus spp.)*. Evidence of forest fires has been found in deposits from the Carboniferous period.

Fire has been a determining factor in the process of adaptation of plants; many species are well adapted to survive fire and regenerate shortly after. Such plants represent a special ecological group—the pyrophytes and they can be met in natural ecosystems of all the climatic zones of the Earth, from the tundra to the tropics. They have the following characteristics:

- seeds are able to germinate after fire (a good example is *Pinus contorta* in Florida, USA);
- trees may have a very thick bark which protects the underlying wood from ground fires (e.g. various species of *Pinus, Quercus,* and some trees in dry savanna, such as the monkey-bread tree, acacia, etc.);
- the crowns of trees are relatively high, with little understorey, so a ground fire may not develop into a crown fire (characteristic of acacia, eucalyptus and pines, etc.);
- the seeds can have a very thick hard coating, and may only be able to germinate after fire, and
- buds are readily produced from burnt wood and the shoots do well in absence of

competition from other plants (most ground vegetation in the postfire period comprises plants with wind-blown seeds, which arrive after the fire and germinate in the bare ground).

2. Forest and fire

In 1997, the World Conservation Monitoring Center produced a map showing forest cover on the Earth 8000 years ago. Compared with the contemporary situation, it indicates that since the start of the human expansion on the Earth different continents have irreversibly lost 30-70% of their forests. Furthermore, only 1% of European forests, 20% of Asian forests, and 60% of South American forests can be regarded as pristine (e.g. the primary forests in the North American mountains, the Amazonian basin, Oceanic islands and vast territories, mainly of taiga, in Russia). (See Table 1).

Region	**Forests 8000 years ago, 1000 km^2 (F)**	**Contemporary forests (CF)**		**Contemporary pristine forests**		
		1000 km^2	**% of F**	**1000 km^2**	**% of F**	**% of CF**
Africa	6799	2302	34	527	8	23
Asia	15,132	4275	28	844	6	20
North and Central America	12,656	9453	75	3909	31	41
South America	9736	6800	70	4439	46	65
Europe except Russia	4690	1521	32	14	0.3	1
Russia	11,759	8083	69	3448	29	43
Oceania	1432	929	65	319	22	34

Source: WCMC, Global Biodiversity, 2000

Table 1. Territory of contemporary and preserved pristine forests in the world

Fire as a natural factor in principle cannot play a determinative role in the reduction of forest area, but it plays an important contributing role in combination with three major causes of deforestation—logging, mineral extraction and clearance for agriculture. The frequency and number of anthropogenic forest fires increases rapidly in connection with such activities.

The contribution of fire to deforestation is higher on the perimeter of forest ecosystems, e.g. on the northern and southern margins of the taiga, and on the upper boundary of forest cover in mountainous areas. For example, a fire is responsible for the 100-300 km wide, relatively deforested tundra belt in northern Eurasia. In this case, the climate and soils are favorable for forest vegetation but periodically fires set back the growth of trees. They also play a determining role in the expansion of grasslands in zonal ecotones: the “forest-steppe” in Eurasia, “forest-prairie” in North America, “forest-pampas” in South America and “forest-grassland” (or forest-savanna) in Africa, South Asia and Australia.

For several millennia, grassland fires made for the purpose of pasture improvement have maintained well defined grassland "islands" within forests, by diverting natural processes. Fire on its own cannot replace forest with non-forest vegetation, particularly in transitional situations of environmental gradient, e.g. in dry habitats, patches of land with a high water table, and so on. Destruction of forests by fire in wetlands may give rise to waterlogging and peat formation, but trees will return in the absence of further fire. Fires in dry sandy and stony areas in temperate climates lead to formation of heathland or dry acid grassland, both of which are susceptible to frequent fires, particularly where there is little or no grazing. In both cases, the frequency of fire (the “cycle of fire”) can be considered as a major factor of deforestation but not a fire itself.

A general understanding of forest fire coverage can be obtained from OECD data. This shows the trends in areas of burnt woodland in selected countries representing different natural zones (see Table 2)**.**

Country	**1980**	**1985**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Canada	4.78	0.76	0.93	1.58	0.87	1.97	6.29	6.57	1.88	0.50
Russia	0.17	-	1.38	0.68	0.69	0.75	0.54	0.36	1.85	0.73
USA	1.25	2.13	2.20	1.30	1.28	1.83	1.65	0.79	2.45	1.57
Mexico	0.11	0.15	0.10	0.27	0.05	0.24	0.14	0.31	0.49	0.11
Greece	0.03	0.10	0.03	0.02	0.06	0.05	0.05	0.02	0.02	0.03
Italy	0.05	0.08	0.10	0.02	0.04	0.11	0.04	0.02	0.02	0.05
Spain	0.26	0.49	0.20	0.26	0.11	0.10	0.44	0.14	0.06	0.09
Turkey	0.01	0.03	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01
France	0.02	0.06	0.07	0.01	0.02	0.02	0.03	0.02	0.01	0.02

Source: OECD (1999)

Table 2. The dynamics of forest fires during 1980 to 1997 in selected countries of Europe and North America,

3. Global and national statistics of forest fires

At the international conference “Fire and Environment” of 1992 a decision had been made to establish the Global Vegetation Fire Information System (GVFIS), providing a technical basis for a future Global Fire Monitoring Center. At present, these actions are integrated into a project called “Global Vegetation Fire Inventory”. Previously, more or less complete statistics on forest fires had been accumulated by the European Economic Commission (EEC). This had included data on fires in the USA and Canada (EEC/FAO, 1993). In China, statistics on fires are compiled by the Ministry of Forestry. In its reports since 1949, 4660 fires have been recorded with an average affected area of 1 million ha (10,000 km^2) and 105 casualties, each year.

The economic losses caused by fires are estimated as US$ 125,000,000 annually, but there is a lot of uncertainty about the data. The FAO experience of fire statistics collection (FAO Global Wildland Fire Statistics; FAO, 1992) confirmed a distinct lack of data and their contradictory interpretation. Efforts to use this data in global biosphere models of carbon cycling and climate change, and for comparative international studies, turned out to be erroneous. The relevant chapters in the reports of the World Resources Institute (World Resources: A Guide to the Global Environment, 1998-1999) do not include this data.

The statistics on forest fires for the last 20 years can be found in the annual reports of OECD (OECD Environmental Data, 1999), based on informational support from GRID Arendal UNEP. A few countries have scientific centers carrying out intensive collection of fire statistics. Mention should be made of the Fire Research Group of the Max Planck Institute for Chemistry in Germany. In Russia, corresponding units have been created in the International Forest Institute (Moscow) and the Institute of Forests and Timber (Krasnoyarsk) of the Russian Academy of Sciences. In the latter, very intensive studies have been recently started aimed at estimation of carbon emissions caused by forest fires, for carbon credit estimations.

These studies have been also performed within the framework of such international organizations, programmes and projects as:

- International Geosphere-Biosphere Programme (IGBP) and its projects: Global Emission Inventory Activity, International Global Atmospheric Chemistry, Biomass Burning Experiment, etc.
- The International Boreal Forest Research Association, Fire Working Group;
- The EEC/FAO Team of Specialists on Forest Fire.

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Biographical Sketch

Arkady Alexanrovich. Tishkov (born in 1950) is one of leaders in the present-day biogeography and nature conservation. Graduated from the biological faculty of Moscow State University in 1973. he has been working in the Institute of Geography, Russian Academy of Sciences. Since 1990, he has become Head of Laboratory and a professor at the International Independent University of Ecology and Politology.

In 1979, he obtained a scientific degree for his thesis entitled is "Bryophyte Communities in Tundra and Taiga Ecosystems", and in 1994 he was awarded Doctor of Sciences and Professor of Geography (his second thesis was entitled "Geographical Regularities of Natural and Anthropogenic Successions".

He has participated in many expeditions, e.g. the Taimyr peninsula, Magadan region, Kola peninsula, Spitsbergen (Norway), Uzbekistan, Ukraine, Hymalayas (China), and other regions.

He is scientific secretary of the editorial office of "Proceeding of Russian Academy of Sciences: Geographical Series", editor of "Problems of Regional Ecology", secretary of the section "Flora and Fauna Conservation" in the Higher Ecological Council under the State Parliament of Russia, a member of the Nature Protected Areas Commission of the Russian Academy of Sciences, a member of the Biogeography Commission of the International Geographical Union, and coordinator and Deputy Chief Editor of "First National Report: Biodiversity Conservation in Russia".

In recent years, he has supervised 12 PhD students in geography and published over 350 research papers and monographs including: *Geographical regularities of structure and functioning of ecosystems* (1986); *Geographical regularities of ecosystem dynamics* (1986); *The basis of modern biogeography* (1993,1995); *Ecological restoration of disturbed areas in the North* (1996); and *The future of steppes* (1997). His research interests are geography of biodiversity, succession, ecological restoration, and biodiversity conservation.

Current research projects for which he is acting as leader include: climatic fluctuations and successions of zonal vegetation (1993-1994), changes of biodiversity after invasions of exotic species (1993-1995), small watershed vegetation dynamics in southern taiga (1993-1994), biogeographical effects of alien species invasions (1995-1997), and biodiversity conservation, a GEF Project (1996-2001).