RUSSIAN FEDERATION FIRE 2002 SPECIAL

PART I

The Wildland Fire Season 2002 in the Russian Federation
An Assessment by the Global Fire Monitoring Center (GFMC)

Introduction

In 2002 international media focussed on the fire episodes in the United States of America and Australia. A series of extreme wildfires affected more than 3 million hectares (ha) of wildlands and populated areas in the USA. In Australia more than half of the 154,000 ha of Australia's Capital Territory (A.C.T.) was left charred and 530 houses burned after the 2002-2003 fire episode. In neighbouring Victoria 1.14 million ha forest and bush land were affected by wildfires during the same period. These events raised public concern about the trend of increasing wildland fire severity and the inability of control. The dry summers in the northern and southern hemispheres revealed the changing exposure and vulnerability of ecosystems and society in two countries that are considered to be world leaders in wildland fire management.

A similar trend towards increasing fire problems, however, is also observed in other regions of the world, especially in the boreal zone of Eurasia, predominantly on the territory of the Russian Federation and neighbouring Kazakhstan, Mongolia and the North of the People's Republic of China. In August / September 2002 extended smoke pollution from peat fires and forest fires in the European part of the Russian Federation was covered by international media, especially in the neighbouring smoke-affected countries, but otherwise there was a limited international interest on wildland fires in the Eurasian region.

The Global Fire Monitoring Center (GFMC) monitored the situation over the whole year 2002. The regular updates during the fire season are published three times per week on the GFMC website under *Current & Archived Significant Global Fire Events and Fire Season Summaries*" (1). Besides regular reports by the Aerial Forest Protection Service *Avialesookhrana* (Ministry for Natural Resources of Russia) the GFMC published observations of forest fires in Russian Asia, the largest part of the Russian Federation, using satellite data received by the Fire Laboratory of the Sukachev Institute for Forest, Russian Academy of Sciences, Krasnoyarsk. Figures 1 and 2 provide examples of daily and 10-days fire occurrence and up-to-date burned area maps.

Early warning of wildland fires is provided by the Eurasian Experimental Fire Weather Information System (example: Figure 3). The system has been developed by forest fire researchers from Canada, Russia and Germany is displayed on this website starting 18 July 2001. Complete information and a set of daily fire weather and fire behaviour potential maps covering Eurasia (the Baltic Region, Eastern Europe, countries of the Commonwealth of Independent States, and Mongolia) can be accessed through the GFMC (2).

After the fire season the GFMC encouraged its partners in the government institutions and the academia of the Russian Federation to evaluate the fire season. Retrospective analyses of the 2002 fire season have been prepared for this special GFMC report by *Avialesookhrana*, the Fire Laboratory of the Sukachev Institute for Forest (Russian Academy of Sciences, Krasnoyarsk), the Soil Science Faculty, Lomonosov State University (Moscow), and this summary assessment by the GFMC.

Fire Reports: Discrepancies between Ground, Aerial and Space Surveys

The first two reports authored by the Aerial Forest Protection Organization *Avialesookhrana* and the Krasnoyarsk Fire Laboratory reveal the problems of accurate fire impact assessment. There are obvious discrepancies between the reported sizes of area burned by ground or aerial observations versus the data derived from satellite sensors.

The area under protection and monitoring by *Avialesookhrana* covers a total of 690 million hectares of vegetated land, primarily forests. *Avialesookhrana* relies on aircraft and ground-based means to monitor ongoing fires and report fire summaries for daily updated statistics. The organization is facing severe financial and logistical constraints resulting in reduced availability of modern equipment, personnel and flight hours to adequately monitor and map fires from the air and on the ground. Thus, the reported total area affected by wildfires of 1.834 million ha (1.2 million ha forest land and 0.634 million ha non-forest land) on the area of jurisdiction does not reflect the complete picture.

The Krasnoyarsk satellite receiving station covers the Asian part of Russia, approximately one billion ha of vegetated land area between the Urals in the West and Sakhalin Island in the Far East. The surveyed area includes all vegetation types (forest, tundra, steppe, etc.). In this region the active fires depicted by NOAA AVHRR and derived burned area in 2002 was 11.7 million ha in Russia and 2.8 million ha in neighbouring Kazakhstan. The burned area derived from AVHRR fire counts, however, bears an uncertainty and must be adjusted. According to the Fire Laboratory there is an overestimation of areas burned by small fire events due to the system-inherent low spatial resolution of the AVHRR sensor (= 1 km^2 or 100 ha). Deducing all fire events smaller than six AVHRR pixels (equivalent to 600 ha) would reduce the overall size of area burned in 2002 in the Russian Federation and Kazakhstan by ca. 16 percent. However, the Krasnoyarsk fire laboratory meanwhile is using the most conservative algorithm of fire detection, and all high-temperature events are identified as a fires with probability 95%.

On the other hand there are fire events that were not recorded by the satellite due to cloud cover. This may partially compensate the overestimation of burned area assessments by fire event counts. Since the total size of area burned in Asian Russia mainly depends on large fires the total range of error is assumed to be in the magnitude of 20 percent or less.

Intercomparison of data generated by various institutions is needed to verify the fire datasets. For instance, comparison the 2002 fire dataset for Irkutsk Oblast with the products of the Irkutsk Institute of Solar and Terrestrial Physics reveals a similar magnitude of fire occurrence: The Krasnoyarsk Laboratory recorded 882 fire events affecting a total of 554,665 ha, whereas the Irkutsk Lab recorded 1055 fires affecting a total of 625,800 ha.

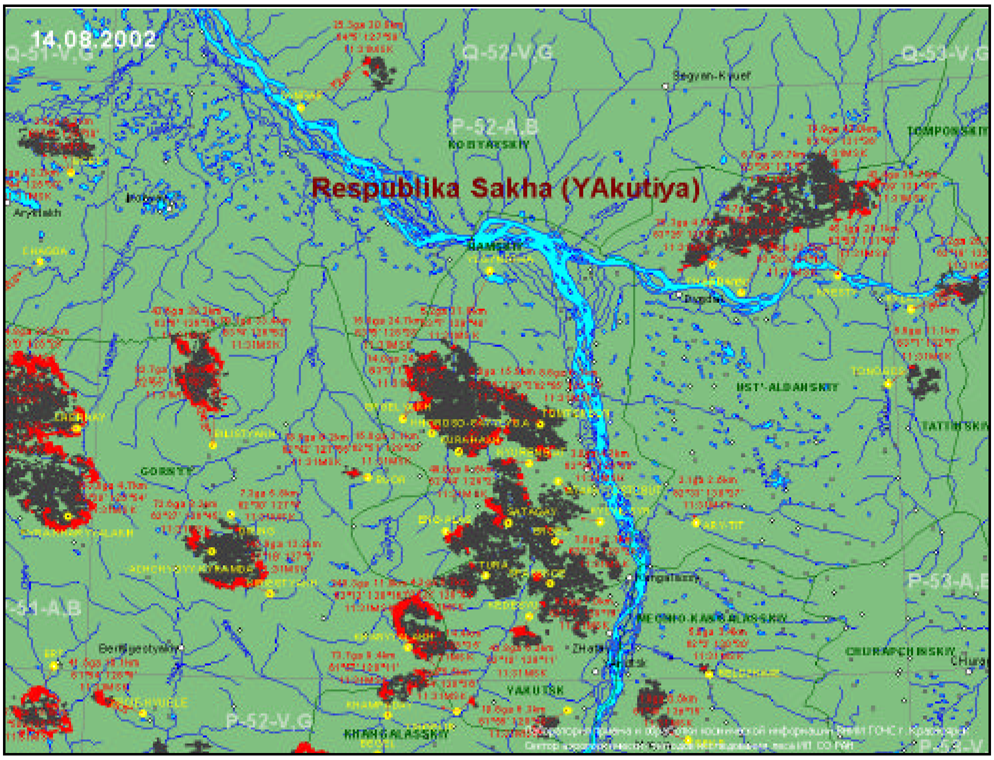

Figure 1. Example of a fire activity and burned area map produced daily by the Fire Laboratory, Sukachev Institute for Forest (Russian Academy of Sciences, Krasnoyarsk) and published by the GFMC. This example shows the situation in a fragment of Yakutyia Republic on 14 August 2002.

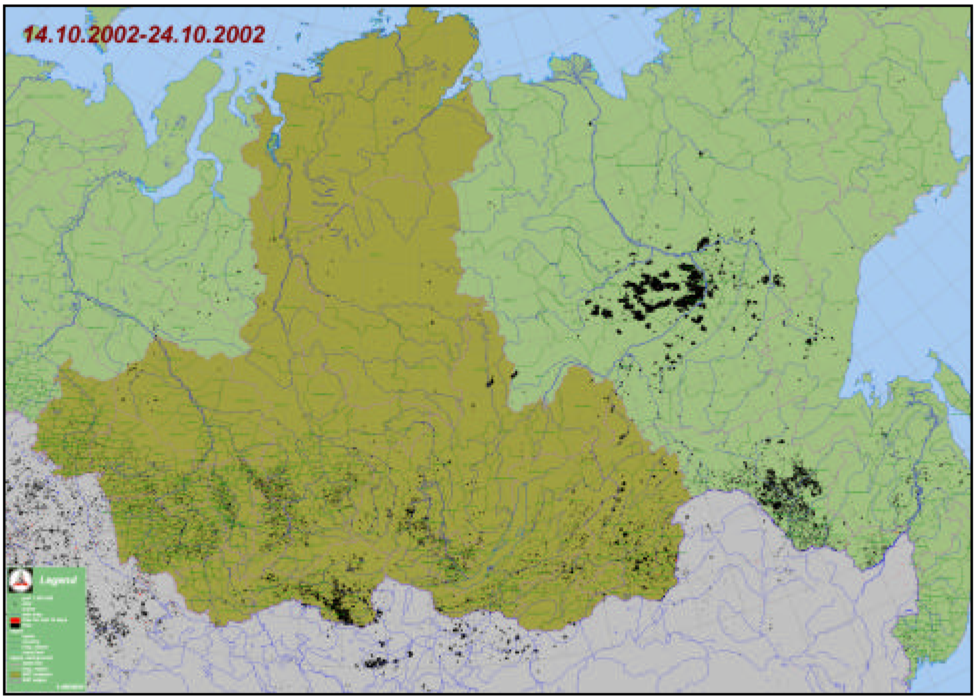

Figure 2. Example of a map showing 10-days active fires and total up-to-date burned area. These maps are produced by the Fire Laboratory, Sukachev Institute for Forest (Russian Academy of Sciences, Krasnoyarsk) and published three times per week by the GFMC. This example shows the distribution of fires at the end of the fire season 2002.

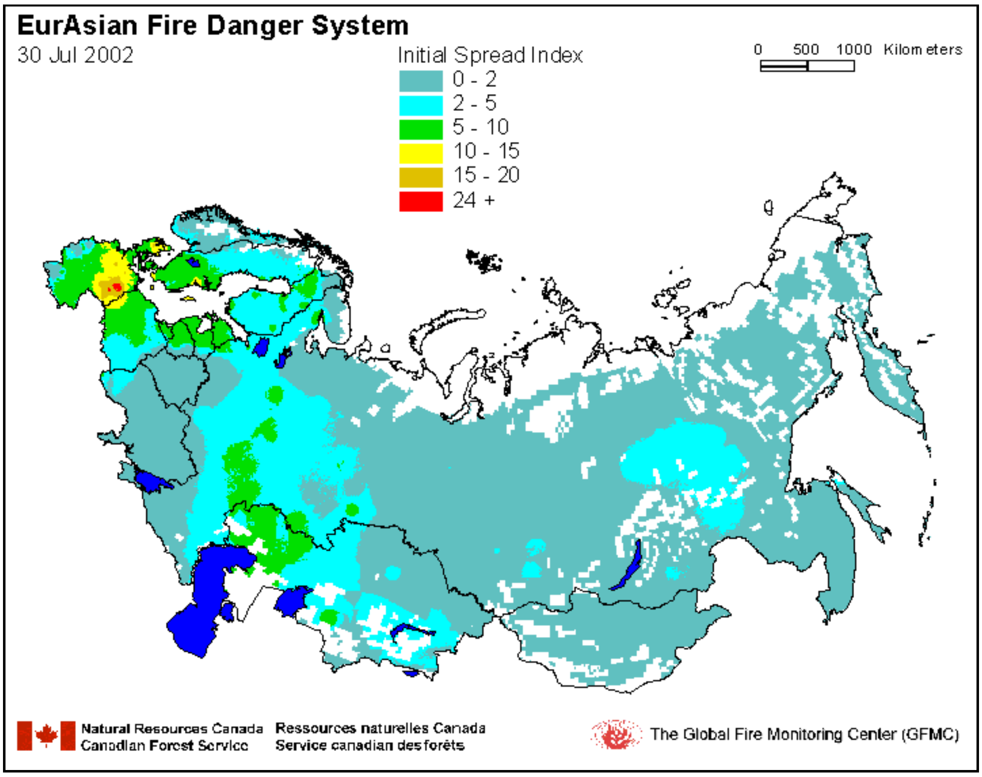

Figure 3. An example of the daily Experimental Fire Weather Index (FWI): 30 July 2002. The system is still lacking sufficient inputs of weather data from some of the countries covered. Therefore the system is currently updated by the Canadian Forest Service and will be put back in service during the 2003 fire season.

Other datasets are not yet directly comparable with the Krasnoyarsk data for the Asian part of Russia. For instance, the Global Burnt Area 2000 initiative (GBA-2000) of the Global Vegetation Monitoring (GVM) Unit of the Joint Research Center (JRC), in partnership with other six institutions, has produced a dataset of vegetated areas burnt globally for the year 2000, using the medium resolution (1 km) satellite imagery provided by the SPOT-Vegetation system and to derive statistics of area burnt per type of vegetation cover (3). The global dataset available for the year 2000 provides area burned by nations. The dataset reveals a total area burned in all vegetation types of Russia during the fire season 2000 of 22.38 million ha, thereof 3.11 million ha forest, 3.31 million ha woodland, 5.3 million ha wooded grassland, and 10.66 million ha other land (including 7 million ha croplands). The GBA-2000 number of 6.4 million ha forest and woodland burned must be compared with the reported area burned for the *Avialesookhrana* region of 1.64 million ha (4) and for the Asian region of Russia (that is covered by the Krasnoyarsk satellite receiving station) of 9.7 million ha of all vegetation types (5). A similar discrepancy was found for 1998: An analysis of the fires in Siberia depicted by satellit was 13.3 million ha – an area five time higher than the Avialesookhrana statistics for the same year (6).

Concluding from the discrepancies between the different satellite datasets on the one side and conventionally collected fire data on the other side the question of absolute accuracy of satellite data seems to be of minor concern. Most important is to analyse and close the extremely large gap between the datasets of the operational users and the remote sensing institutions.

Fire Characterization and Fire Impacts

Inaccurate fire reports and statistics constitute a major impediment for the evaluation of the forest fire situation in the country and a problem for appropriate strategic planning in forest fire management and in forestry in general.

However, even more important is another fundamental problem which relates to the use of observational fire data and fire reports for operational purposes and for decision support in fire suppression. There is a lack of applied methods and procedures for real-time assessment of fire characteristics such as fire behaviour and fire severity, neither by operational application of remote sensing methods nor by the conventional observations from the air and on the ground. However, some progress has been made through recent research efforts to characterize forest fires of different intensities in central Siberian pine forests (7).

Such real-time observational information is essential to support decision making in an ongoing fire situation, e.g. supporting decisions to let burn a fire of low or moderate intensity for (a) economic reasons, (b) setting priorities to action other fires that need priority response, or (c) utilizing the expected beneficial impacts of the fire on the forest ecosystem (e.g., fuel reduction, silvicultural reasons, etc.). Figures 4 and 5 provide examples of different fire intensities in a *Pinus sylvestris* forest in Central Siberia.

There is also a lack of applied methods and procedures for short-term assessments of fire damages that would allow to generate more useful qualitative statistical information in addition to counting of fire events and quantifying total size of area affected by fire. The reporting and statistical evaluation system used by *Avialesookhrana* allows to distinguish area burned by surface vs. crown fires. With some restrictions this allows at least to conclude that an area affected by crown fires will be partially or completely damaged. However, fire reports provided for statistical evaluation do not include information on economic, ecological or fire-management related consequences of surface fires.

Figure 4. Typical surface fire of medium frontal fire intensity levels ranging between 1500 and 5000 kW/m. Location: Bor Forest Island Experiment, Central Siberia, July 1993 (8).

Figure 5. Ground view of typical high-intensity surface/intermittent crown fire behaviour with frontal fire intensity levels of 25,000 to 28,000 kW/m. Location: Bor Forest Island Experiment, Central Siberia, July 1993 (8).

The use of Geographic Information Systems (GIS) allows at least to determine in which kind of vegetation type the fires have been burning. Fire maps laid over the vegetation classification maps reveal that during the 2002 fire season wildfires mainly affected stands of Siberian larch (*Larix sibirica*) in the Republics of Yakutyia and Tyva, and in Amur Region (Figures 6-8).

Inter-Annual Variability of Hotspot Regions

The 2002 fire report by Sukhinin et al. provides a forest fire activity map for the year 2002. Figures 9a-e in this report use Sukhinin's maps for the 5-year period 1998 to 2002 to highlight the geography of inter-annual dynamics of fire activities. Spatial distribution of areas burned are given by different degree in the Eastern part of Russia derived from interpolated NOAA AVHRR data.

These maps of the past five years that cover central Russia demonstrate how the centres of large and disastrous fires are moving through the Asian part of Russia. It is interesting to note that the concentration of hotspot regions in the Southern part of Siberia and Western-Central Yakutyia remind to the fire severity scenarios that have been predicted by climate-change models (Global Circulation Models - GCMs) since the early 1990s. One of these scenarios is provided in Figure 10. It is based on the GCM of the Canadian Climate Center (CCC) and compares fire severity rating across Russia under the current climate conditions vs. a projected climate-change scenario (9).

The observational data and the scenarios have important implications on the national fire management policy, i.e. the organizational arrangement of forest fire protection in the Russian Federation, and provide arguments for maintaining a strong federal component in forest fire management. No single province (i.a.w. the Russian nomenclature: Oblast, Krai, Respublika, Autonomous Region) can handle alone these extreme fire situations. The extremely large and severe fires that have been experienced in the past 15 years always required response through the centrally managed capabilities of the Federal Forest Service and its operational wing *Avialesookhrana*.

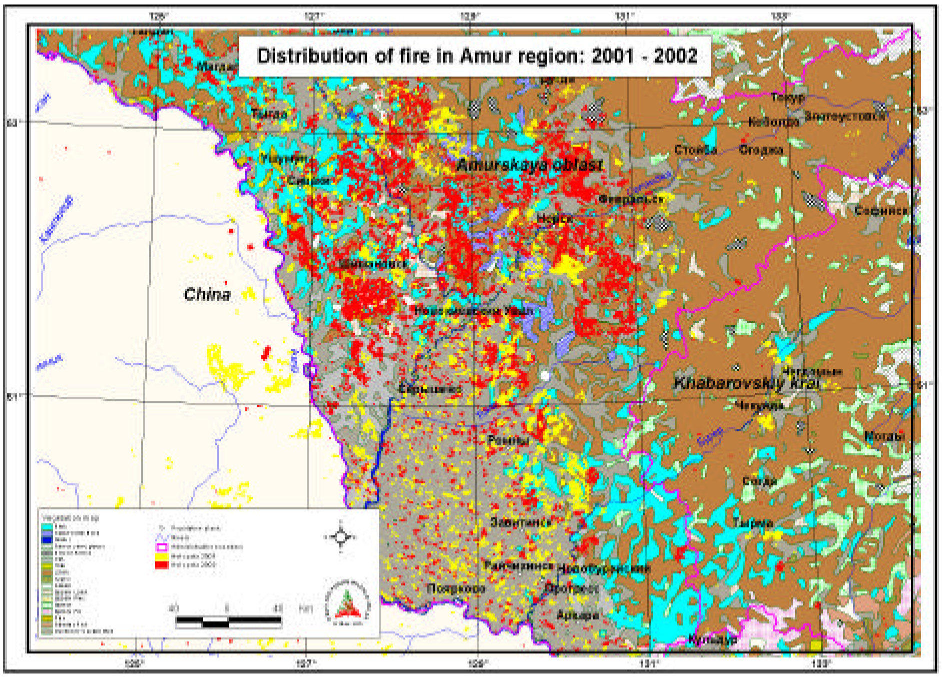

Figure 6. Vegetation type affected by wildfires in Amur Region during the fire season 2002. The colours indicate: brown - larch forest, light blue – birch, grey – non-forested. Source: A. Sukhinin, Fire Laboratory, Sukachev Institute for Forest, Russian Academy of Sciences, Krasnoyarsk.

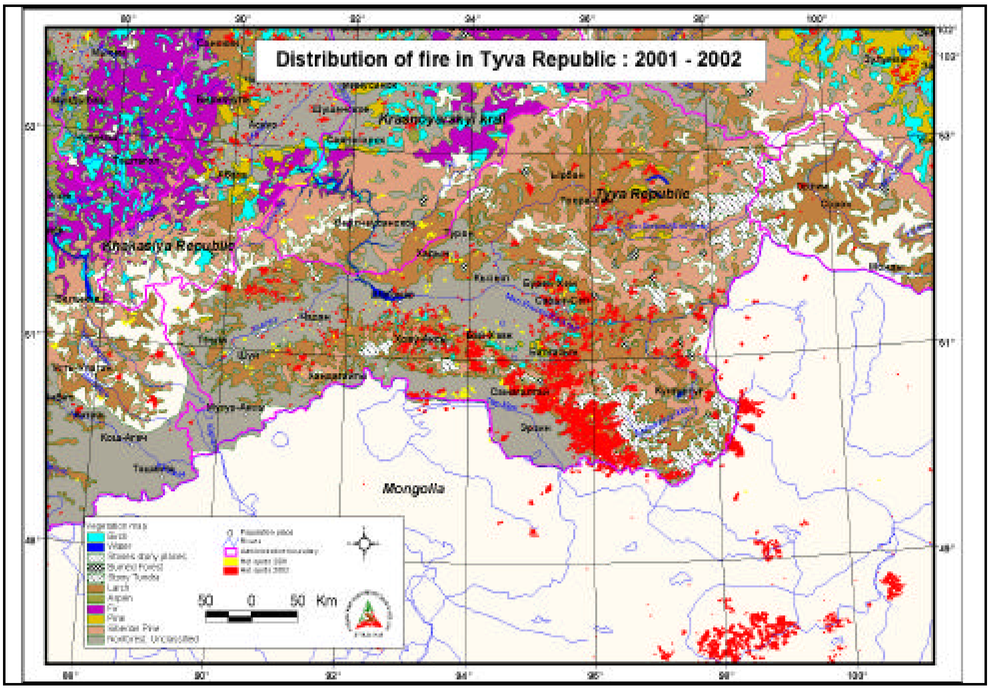

Figure 7. Vegetation type affected by wildfires in Tyva Republic during the fire season 2002. Source: A. Sukhinin, Fire Laboratory, Sukachev Institute for Forest, Russian Academy of Sciences, Krasnoyarsk.

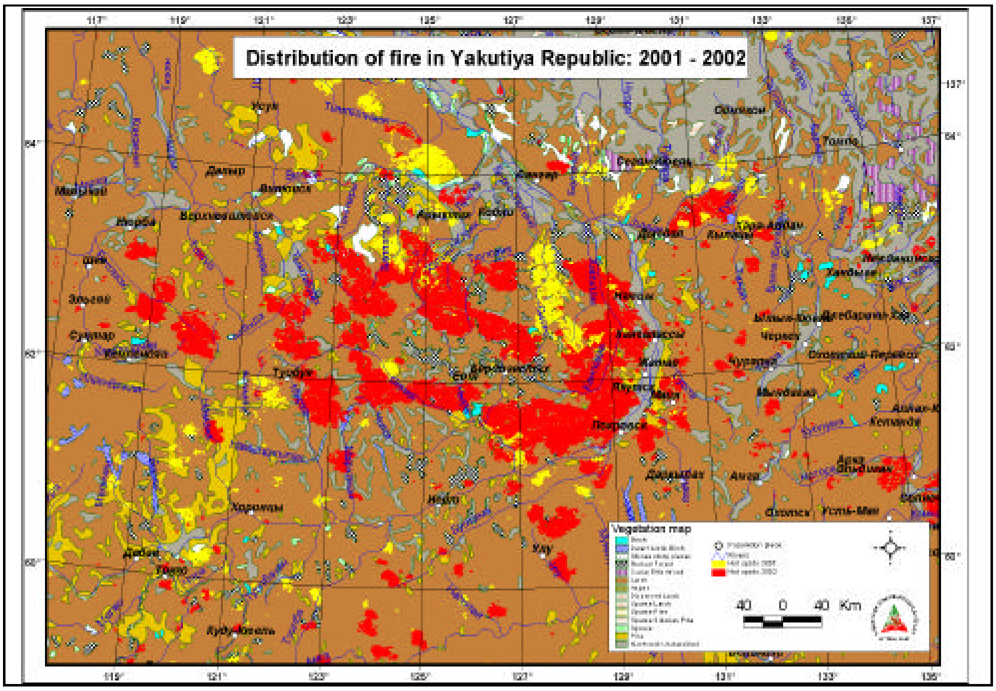

Figure 8. Vegetation type affected by wildfires in Yakutyia Republic during the fire seasons 2001 (yellow) and 2002 (red). The forest cover predominantly affected by fire in this part of Yakutyia is Siberian larch forest (brown colour). Source: A. Sukhinin, Fire Laboratory, Sukachev Institute for Forest, Russian Academy of Sciences, Krasnoyarsk.

Peat Fires – an Increasing Problem in the Boreal Zone

According to the Wetlands International Russia Programme peatland fires are a common phenomenon in the Russian Federation (10). In late July 2002 a severe fire episode started that mainly affected the regions Tver, Vladimir, Ryazan, Nizhnij Novgorod, and the North-West region. On 31 July 2002 ABC News reported *"Muscovites awoke on Wednesday to find their city covered in smog with the smell of burning from wildfires raging outside the Russian capital. A slight easterly wind pushed the smoke toward the city, as far as the centre, but was not strong enough to disperse it, said meteorological experts quoted by Moscow Echo radio. Moscow media said the smoke posed a health risk to residents of the city. The authorities have identified 76 separate wildfires in the Moscow region, which has been affected for several weeks by a heat wave, Moscow Echo radio reported. According to the emergencies ministry, the surface area of forest on fire around Moscow has risen sharply in the past 24 hours, reaching ca. 100 ha, ITAR-TASS reported"* (11). On 6 September 2002 the European Water Management News (EWMN) reported that the number of peat and forest fires had doubled in Moscow Region within 24 hours. The resulting haze reduced the visibility to less than 100 meters in the Russian capital, and the concentration of carbon monoxide exceeded the norm by more than three times (12).

The smoke pollution in Moscow Region between end of July and early September 2002 reached alarming levels and did not only cause a dramatic reduction of visibility but also had detrimental impacts on the health of the Muscovite population. It is well known that smoke from vegetation fires has a number of solid and gaseous constituents that dangerous to human health, e.g., particulates smaller than micrometers in aerodynamic diameter, formaldehyde, Polycyclic Aromatic Hydrocarbons (PAHs), or carbon monoxide (CO).

Figure 9a. Fire activity map of 1998

Figure 9b. Fire activity map of 1999

Figure 9c. Fire activity map of 2000

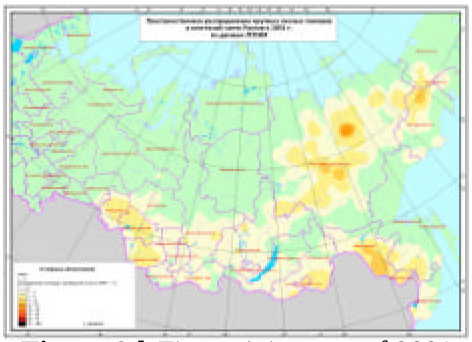

Figure 9d. Fire activity map of 2001

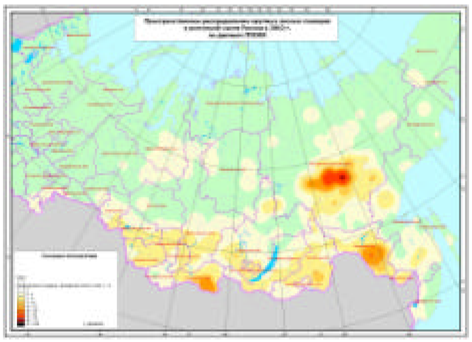

Figure 9e. Fire activity map of 2002

Figure 9a-e. Spatial distribution of areas burned by different degree in the Eastern part of Russia in the fire season of 1998-2002, derived from interpolated NOAA AVHRR forest fire data. Zones are delineated by colours that represent the ratio of the burned area to the total area marked by the colour.

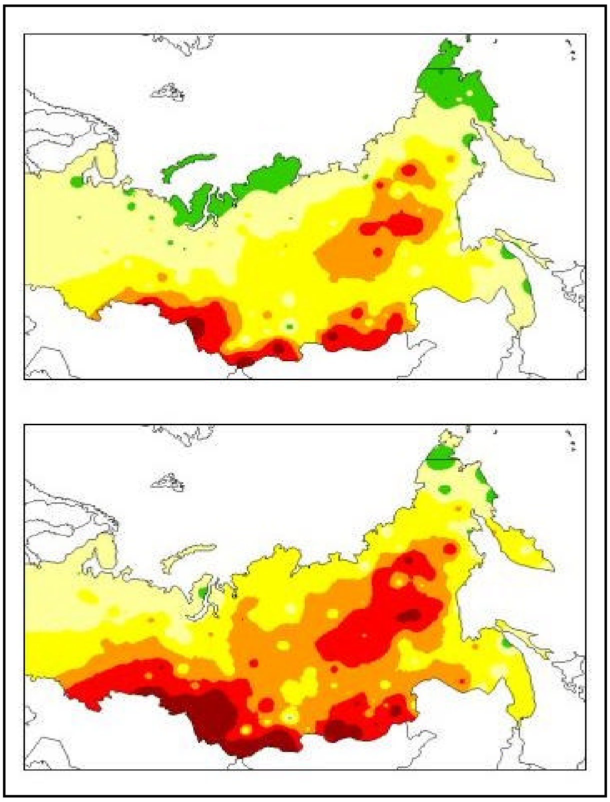

Figure 10. Seasonal fire severity rating across Russia under current climate conditions (upper) in comparison to a projected $2xCO_2$ climate (lower), based on the Global Circulation Model (GCM) of the Canadian Climate Center (CCC). Note the significant increase in the severity and geographical extent of high to extreme fire danger conditions (9).

Most concerning are the impacts of particulates on the respiratory / cardiovascular systems. They cause, among other, respiratory infections in adults and acute respiratory infections in children, acute and chronic changes in pulmonary function, respiratory symptoms, asthma attacks, and cardiovascular diseases (13, 14). An increase of hospital admissions was noted in Moscow. At present no information is available on increased daily mortality due to peat fire smoke pollution.

Peatlands in Western Russia have been drained and used for agricultural purposes since the early 19th Century. As Minaeva (10) stresses the fen peatlands were used as agricultural fields but are out of use now. Lands where peat was extracted were abandoned without recultivation and left to the management of local administrations of the *Rayons* which normally have no funds to properly manage and protect the former wetlands. In most cases the fires started outside the peatlands, caused by forest visitors, hunters, tourists, or by agricultural burning and burning activities along roads. Legislation is not clear, and there is no law enforcement. During the peak of peatland burning many people continued to visit the forests around Moscow, even when the fire situation was quite obvious.

Figure 11. Firefighters combat the flames in a peat bog in a forest about 160 km from Moscow, on 1 August 2002. Source: Associated Press / The Russia Journal (15).

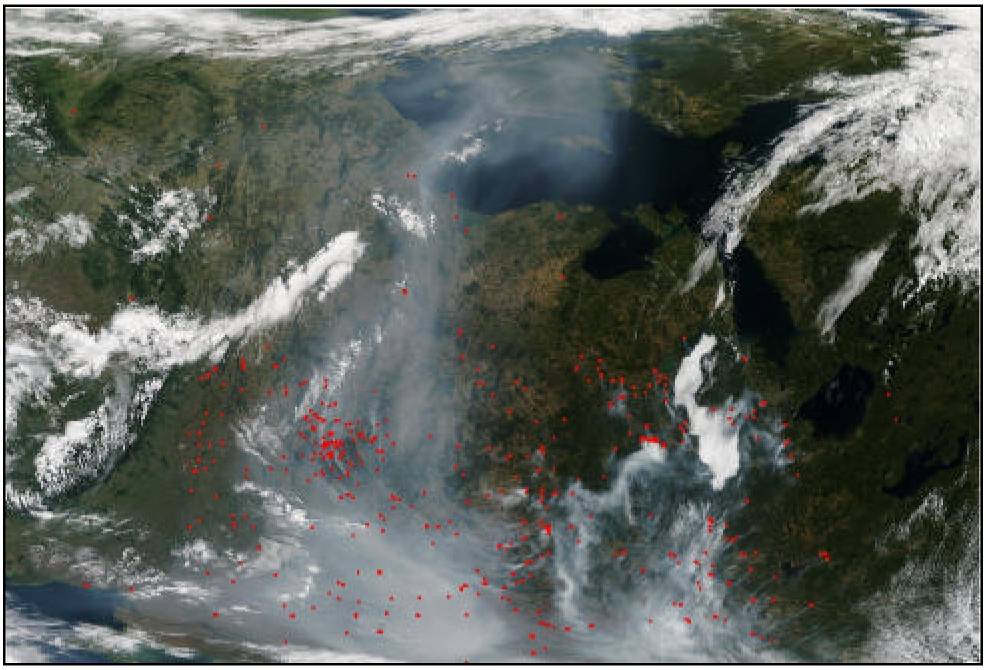

Figure 12. Satellite scene (MODIS composite) of Western Russia on 4 September 2002. The heat signatures of the peat and forest fires are given in red colour. The smoke plumes (light blue haze) stretch from Western Russia to Belarus, Poland and the Baltic Sea. Source: True-colour image by Moderate-Resolution Imaging Spectroradiometer (MODIS), resolution 2 km (16).

Currently there are plans to restore peatlands by flooding. These plans that have been pushed by the Ministry for Emergency Situation (EMERCOM) but in many places are opposed by peat extractors or owners of *datcha* properties that have been established on former peatlands.

The paper by Bannikov et al. in this special report provides a in-depth case study of peat fires in Western Russia. The report reveals the problems arising from peat fires and the necessity to develop land-use plans that would avoid future fire and smoke disasters in Western Russia.

Russia's Peatlands and Forests – A Carbon Bomb?

The implications of emissions from fires in the boreal system on atmospheric and climate have received increased attention by the science community. Numerous case studies, models and estimates on the contribution of fires in the circumpolar boreal forest zone have been produced over the past 15 years. One of the most recent research efforts investigated the contribution of the fires of 1998 in Siberia on the emissions of greenhouse gases to the atmosphere (17). According to the detailed observations by satellite mapping and fire impacts the authors conclude that the fires that affected 1.1 million ha. About 35 million t of phytomass were consumed by these fires and released close to 18 million tons (t) of carbon to the atmosphere which contributed to the formation of 52 million t of carbon dioxide, 5 million t of carbon monoxide and other radiatively active trace gases and aerosol particles.

This case study may serve as an example to be used for extrapolating emissions of other years, e.g. the year 2002. Based on the average amount of phytomass burned per area unit of 30 t / ha – a number that reflects reasonably well the fuel consumption in many forest ecosystems – the fire emissions from Russia during the 2002 fire season would be 10-fold compared to the fire emissions calculated for Siberia in 1998 (fires on 11.7 million ha of forests and other vegetation in Asian Russia would consume 350 million t of phytomass and release ca. 180 million t of carbon to the atmosphere).

As it is predicted by Global Circulation Models the impact of climate change will affect mostly the Russian Federation. Longer and more extreme forest fire seasons will be more frequent in future. As a consequence it is likely that more fires will burn in forests and in dried peatlands. Extreme droughts will also lead to an increasing danger of occurrence of high-intensity and high-severity fires in those forests where long-term fire suppression has resulted in the built-up of combustible material.

Based on the assumption that climate-change predictions will become reality the area affected by wildfires in the Russian Federation, mainly in Siberia, will increase by at least 50 percent or double over the next three decades. Taking the 2002 satellite data as a baseline the average forest area burned during the next decade fire may exceed 15 to 20 million ha per year. This number is a conservative assessment considering the fact that the above-cited Global Burnt Area 2000 (GBA-2000) product provides already a total of more than 20 million ha burned in the year 200.

Assuming that these future fires on 15-20 million ha per year will become predominantly high-intensity fires and also affect deep organic layers, the amount of fuel consumption will exceed 50 tons per ha, equivalent to 25 tons of carbon. The emission of this amount of carbon will contribute to the greenhouse effect if the forest is destroyed and will not recover. Additionally more than 50 tons of carbon may be released by post-fire decay of the fire-affected forests. A size of 15 to 20 million ha burned forest will release 375 to 500 million tons of carbon by fire and 750 million to 1 billion tons of carbon released by decay of forest biomass after fire. In accordance with global standards the "value" of each ton of excess carbon released by fire-destructed forest is 10 $US. The predicted release of this amount of carbon thus has a damage potential of 7.5 to 10 billion $US per year.

However, this number reflects only the main constituent of radiatively active greenhouse gases and aerosols. Other ecological damages are not included here. We assume that the long-term damages by forest destruction through high-intensity fires will lead to additional losses in the sector of socio-economy of more than 300 to 400 million US-Dollars per year.

The health effects of fire emissions on rural and urban populations have not yet been expressed in costs. However, we assume that fire smoke caused by forest fires has contributed to a dramatic health impact on people, such as in the Far East in 1998 and especially in Moscow Region in 2002.

These assumptions do not yet include further consequences of regional warming. The expected melting of permafrost sites, possible drying of large peat-swamp areas will have further repercussions on future fire scenarios. One of the possible consequences of permafrost melting and fire in Eastern Siberia would be the disappearance of extended regions of larch forests. The loss of potential forest area would significantly reduce the carbon storage potential of the region.

It must be clarified at this stage that these numbers are assumptions based on an extrapolation of the current trend. However, the concerns about this trend is shared by those who have observed a comparable development in the tropical forests during the last 15 years.

Towards an Amended Fire Management Policy and Strategy

The current status of the forest fire situation and the trends as defined in this assessment are challenging the development of a fire management policy and a strategic fire management plan that takes into account the manifold human-caused and natural factors that exert an enormous pressure on Russia's forests.

An amended fire policy is required that should address the upcoming threats by two major principles. First, the future fire management policy should be based on sound ecological principles, i.e. the integration natural fire and the active use of prescribed management fires, where applicable, to stabilize forest ecosystems. Second, the Ministry for Natural Resources should give highest priority to improve national to regional fire management capabilties by adequate training of personnel and supply of financial resources to restore and improve the fire management capabilities of the Federal Forest Service.

Beginning in the early 1990s the Russian Federation has been an active partner in a number of international programmes in the field of forest fire. Joint fire research programmes are underway since 1992-93 (18). In 1993 and 1996 Russia was host of the International Conferences "Fire in Ecosystems of Boreal Eurasia" and "Forest, Fire and Global Change" (FAO/ECE) (19, 20). Russia through *Avialesookhrana* is member of the FAO/ECE/ILO Team of Specialists on Forest Fire (21) and the Working Group on Wildland Fire of the United Nations International Strategy for Disaster Reduction (ISDR) (22). Russia also contributed to the FAO GLobal Forest Fire Assessment 1990-2000 (23). Currently Russia is also member of the International Liaison Committee for the preparation of the 3rd International Wildland Fire Conference and the Global Wildland Fire Summit that will take place in October 2003 (24).

These international activities have contributed to a better understanding of the environmental, social and economic significance of forest fires in Eurasia, especially the implications of a change of fire regimes on the sustainability of forests, atmosphere and climate. Thus, there is a growing international interest to jointly work with Russia in the field of fire science, management and policy development during the coming years. The Round Table "Key Ways of Protection of Forests from Fire in the Russian Federation" at the All-Russian Forestry Congress in Moscow, 24-28 February 2003, will provide an opportunity to develop common visions for synergies in cooperation and sharing of solutions.

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RUSSIAN FEDERATION FIRE 2002 SPECIAL

PART II

The Fire Season 2002 in Russia
Report of the Aerial Forest Fire Service *Avialesookhrana*

The Aerial Forest Fire Service of Russia *Avialesookhrana* includes 24 regional airbases across the Russian Federation and a fleet of 102 aircraft. The total area under protection comprises 690 million hectares (ha) including 12,9 million ha of reserved forests. There are about 270 subdivisions in the structure of *Avialesookhrana* that are responsible for organization of reconnaissance, combat and monitoring wildland fires. Before the start of the 2002 fire season contracts were signed to lease 257 airplanes and helicopters out of which 120 are small planes with a capacity of carrying 6 smokejumpers, four planes with a payload capacity of 5000 kg of cargo or 20 firefighters, 40 light helicopters and 93 helicopters Mi-8 to carry up to 4000 kg of cargo, or to operate helibuckets for aerial fire suppression including the use of retardants. The size of this mixed fleet of leased aircraft was calculated based on an expectation of a level of low fire danger in 2002. More than 3800 firefighters (smokejumpers and helirappellers) were trained to be ready for fire suppression in 2002.

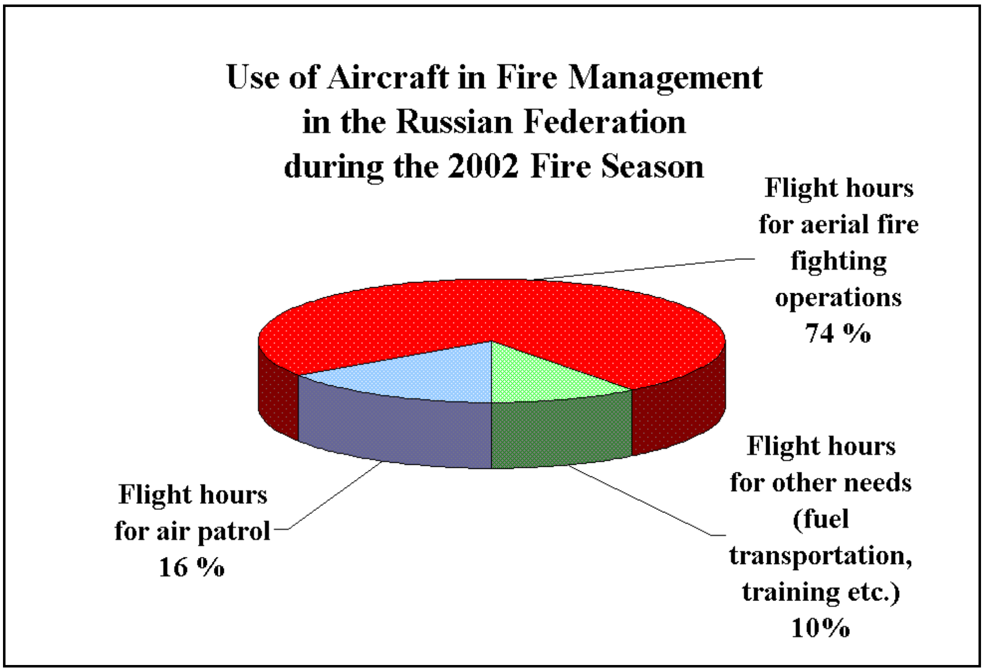

Figure 1. Use of aircraft in fire management in the Russian Federation during the 2002 fire season.

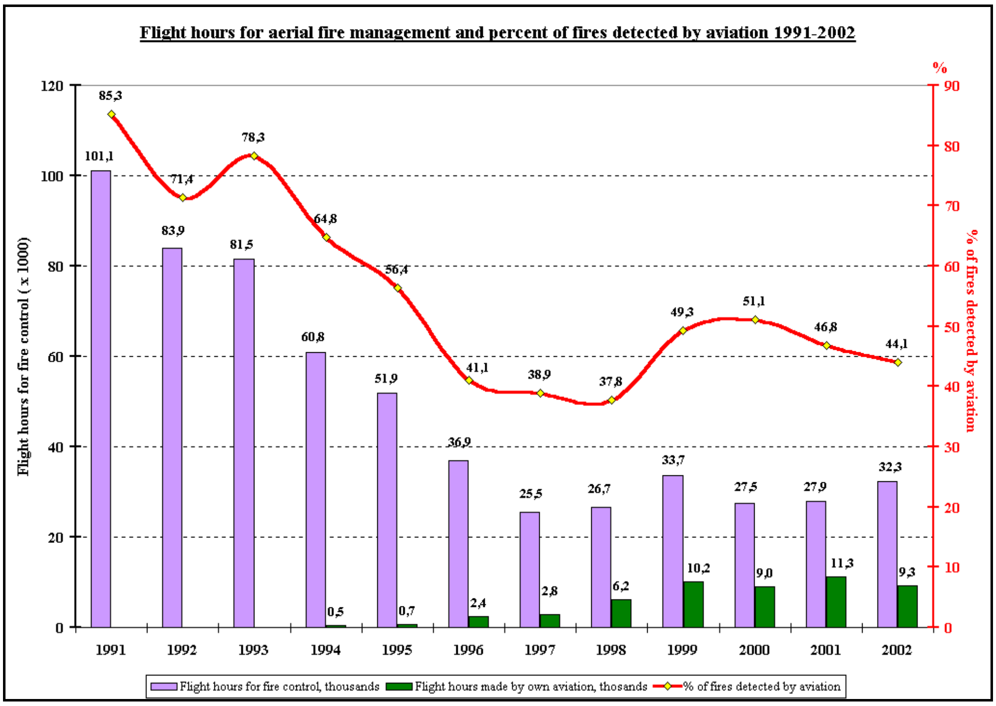

Figure 2. Flight hours for aerial fire management and percent of fires detected by aviation 1991-2002.

The 2002 fire season in Russia, however, turned out to be extremely severe. During the period between April and October 35,800 fires were recorded on the territory under the jurisdiction of *Avialesookhrana*. According to the survey reports of the local branches (subdivisions) of *Avialesookhrana* the area affected by fire was 1.2 million ha forest land and 0.634 million ha non-forest land. To remind at this stage: The record of the number of fires registered in the recent past was 36,500 in 1998. The main causes of fires in 2002 were:

- Local population – 58 %
- Lightning – 12 %
- The rest – 30 % were from power lines, real routes, and unknowns.

About 44 % of the fires that occurred in forests under the jurisdiction of the Ministry of Natural Resources were detected by patrolling aircraft. For comparison, in the 1980s the percentage of fires detected by aerial patrols was about 80%.

In the 2002 fire season 995 fires were designated as large fires (size >200 ha).

The outbreak of extended fires started in April - May on the territory of the Far East region, mainly affecting the Republic of Yakutia, and Khabarovsk and Chita Regions. On some days the fire authorities of Khabarovsk Region alone had to respond to 255 fires daily. Special attention was paid to protection of towns and villages to prevent homes and populations from fires. Hundreds of firefighters from various different airbases were sent to assist fire battles in Yakutia, Chita and Khabarovsk. For example, about 600 smokejumpers and helirappellers were ferried to Yakutia's hot spots. Two amphibian scoopers Beriev-12 (capacity: 6000 litres) were deployed to help the Yakutian firefighting forces to attack fires from the air. Nearly 350 drops of water (2100 tons) helped to stop 21 km of fire edges. Weather conditions in Yakutia were extremely unfavourable to get fires under control. As a consequence 151 fires spread to the size of the large category. The main reason of flames were agriculture burns in spring (May) and lightning in summer (July, August).

According of satellite data fires in Yakutia have passed nearly 5 million. ha (source: satellite data from the Institute of Forest, Krasnoyarsk, 2002).

At the same time dry and hot weather conditions resulted in large amounts of forest fires in Tuva Republic. The main reason of fires were escaped prescribed fires set by local people on the mountain slopes to collect wild deer antlers for selling them to the Asian market, mainly to China, and to manage pasture lands. Out of the total of 481 wildfires 129 large fires burned about 1 million ha (source: satellite data from the Institute of Forest, Krasnoyarsk, 2002).

In the second part of the summer (July, August) and beginning of fall (September) high the European area of the Russian Federation experienced high fire danger, notably in around Sankt Peterburg (Leningrad Oblast), Novgorod, Vologda, Tver, and Moscow Regions. Fires were mainly caused by visitors to forests who collected berries and mushrooms, and hunted wild game. In August alone about 11,300 fires (31 % of the annual total) were registered. Moscow Region suffered 1900 wildfires in forests and in bog lands. The smoke of peat fires disturbed millions of people. Many people suffered respiratory infections, asthma attacks and had to be taken to hospitals. There are no exact data available on chronic obstructive pulmonary diseases and cardiovascular diseases.

In addition to their fire management tasks the regional airbases were involved in pest and disease control. For these purposes more than 500 million ha of forests were covered by aerial observation during the 2002 fire season. That helped to discover the serious insect infestation spots in the beginning of their activity and to provide required response in due time. Over 50 special expeditions, including specialists of *Avialesookhrana* and Forestry Departments, were dispatched by aircraft to explore surveillance spots. Many regions have extreme pest and disease problems that requires special attention of the State Forestry Service and affiliated Institutions.

A total of 32,200 flight hours were flown during the season by *Avialesookhrana*'s own and leased aircraft for fire management and pest and disease control. This number corresponds to just 30 % of the annual flight hours in the early 1990s. Thanks to own aviation over 2000 fire fighters were sent from base to base to assist on fire fighting. But there still were unresolved problems of financing aerial operations that would ensure the timely, early detection of wildfires instead of delayed detection that resulted in delay of response.

During the fire season of 2002 new fire fighting equipment has been tested and used in wildfire suppression, e.g. pumps, drip torches, fire engines and the foam injection system SPS-1 used in the VSU-5. Two Hot Shot Crews that had been trained by U.S. Forest Service instructors worked across Siberian fires. A new type of parachute *Lesnik*-3 (Arbalet) was tested and approved for future development and use in aerial operations under a joint interagency programme with the Ministry of Emergency Situations (EMERCOM).

International exchange programmes with the U.S. Forest Service and the U.S. Bureau of Land Management (BLM), the Forest Services of Canada and China, and the Global Fire Monitoring Center (GFMC) helped to share information and modern technologies to address wildland fires as a global problem.

For the future an effective fire management in Russia and a functioning modern aerial forest fire service there is a need of:

- Definition of priority zones in the protected territory;
- Timely provision of finances *Avialesookhrana* before the start of the fire season (for training, maintenance, and other preparatory activities);
- Signing fire management agreements with other landowners that have wildland fire problems;
- Creation of a special programme for the management of large fires;
- Creation of a National Wildland Fire Management Training Centre.

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RUSSIAN FEDERATION FIRE 2002 SPECIAL

PART III

The 2002 Fire Season in the Asian Part of the Russian Federation

1. Introduction

The Forest Fire Research Laboratory, Remote Sensing Unit, of the V.N. Sukachev Institute of Forest, Russian Academy of Sciences, Siberian Branch, is located in Krasnoyarsk, Russian Federation. With the downlink antenna and software, which was provided and installed by NASA Goddard Space Flight Center in 1994, for receiving and processing data from the Advanced Very High Resolution Radiometer (AVHRR) on the satellites of the U.S. National Oceanic and Atmospheric Administration (NOAA) the laboratory has been progressively using spaceborne information to monitor fire danger, activities and effects in forests and other vegetation in the Asian part of the Russian Federation and adjoining countries (Kazakhstan, Mongolia, China). The laboratory cooperates with the Global Fire Monitoring Center (GFMC) which disseminates its products at international level (1, 2). Through the GFMC the laboratory is also contributing to the Working Group Wildland Fire of the Interagency Task Force for Disaster Reduction, UN International Strategy for Disaster Reduction (ISDR) (3). The laboratory cooperates closely with the Global Terrestrial Observing System (GTOS), Global Observation of Forest Cover (GOFC) / Global Observation of Land Dynamics (GOLD) project, Forest Fire Monitoring and Mapping Implementation Team (4).

After looking at wildland fires from space since almost a decade, it becomes clear that the 2002 fire season was representative in terms of spatial fire occurrence and fire danger dynamics across the Asian part of Russia. Qualitative and quantitative parameters of fire severity and coverage, however, indicate this was an extreme fire season suggesting further aggravation of fire situation in the forest in general.

2. The spring fire danger peak

Spring came early to the Asian Russia in 2002 and the fire season, thus, started 30-35 days earlier than usually. Forest fires were recorded as early as in the beginning of March. Multiple spring forest fires were recorded in the Trans-Baikal Region, the Republic of Buryatia, and in Tchita Region (where extended fires burned in 2001). Warm and sunny mid-April anticyclone weather enhanced early snowmelt and rapid forest fuel drying in western and eastern Siberia. Forest fires were recorded in Novosibirsk, Tomsk, Omsk, and Irkutsk Regions, Ust-Ordyn Autonomous Area, Krasnoyarsk and Altay Regions, and Tyva and Khakasia Republics. The fire situation still remained unchanged in Buryatia and Tchita region. High forest fire activity and fire danger rate persisted till mid-May in the above administrative units of the Russian Federation. The high fire danger period ended in late May primarily due to the onset of the vegetation period and sudden weather changes in Siberia and Trans-Baikal region.

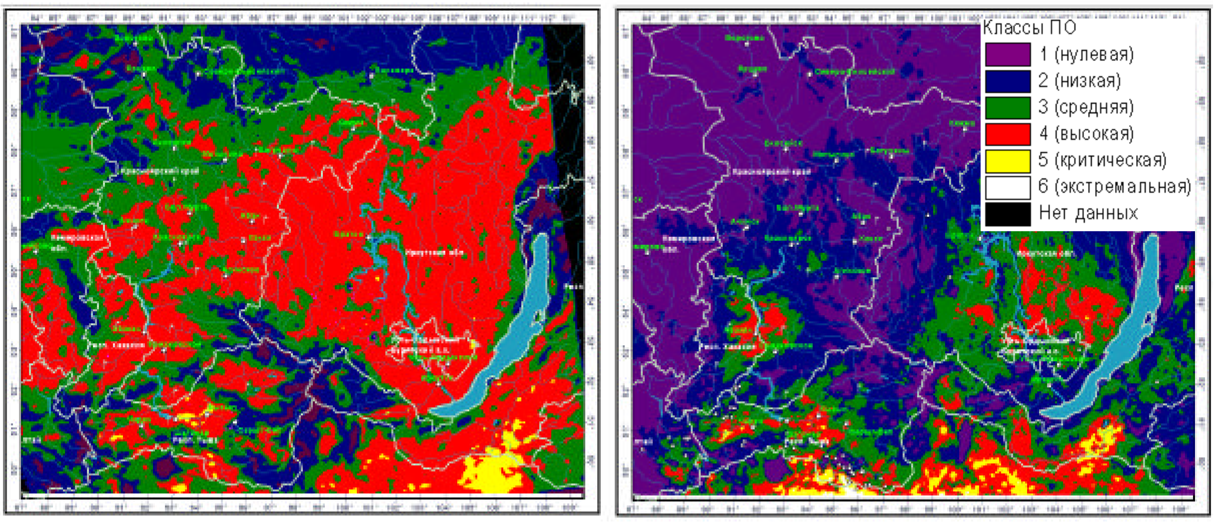

Figure 1. Fire danger class distribution across Siberia and Baikal region (a) 14 April 2002, and (b) 31 May 2002.

Figure 1 reflects the effects of an extended cyclone that occurred over western and eastern Siberia, as well as in Trans-Baikal region, which brought the fire danger down to Classes 1 and 2 by 31 May 2002. However, fire danger remained high (Class 5) in the south of eastern Siberia and created suitable conditions for fire activities in Tyva Republic. Here, maximum fire activity was observed in late May through mid-June, with decreasing activities by the end of June.

The spring fire danger peak of the 2002 fire season, thus, occurred first, as always, in the southern areas bordering China and Mongolia. High fire danger then spread into the geographic depressions and plains and reached 55°N. A spatial fire danger pattern like this is normally observed every year and to a certain extent accounts for extended forest fire outbreaks.

3. The summer fire danger peak

The next fire danger peak (the summer peak) occurred closer to the end of June. Although it was not as prolific as that in spring, it consisted of three consecutive fire activity surges that ended in late August. Fires were especially frequent in Krasnoyarsk Region (June-July), Tyva Republic (from mid-July onward), Evenkia (up to 16 fires a day), Chita region (late summer), Buryatia (August), and Irkutsk Region.

Multi-year observations have revealed statistically significant spatial trends of fire situation development. Most evident is a lag in time needed for forest fuel to attain high flammability and, hence, a time lag in forest fire occurrence. Mass fire outbreaks are normally observed once a year (mid-summer) in the interior (continental) eastern Siberia and Yakutyia. The 2002 fire season was not an exception. Big areas burned in forest fires in Evenkia. The total forest area that was burned by fires of various severities (52,293.8ha) turned out to be 8 times that suffered from fires in 2001.

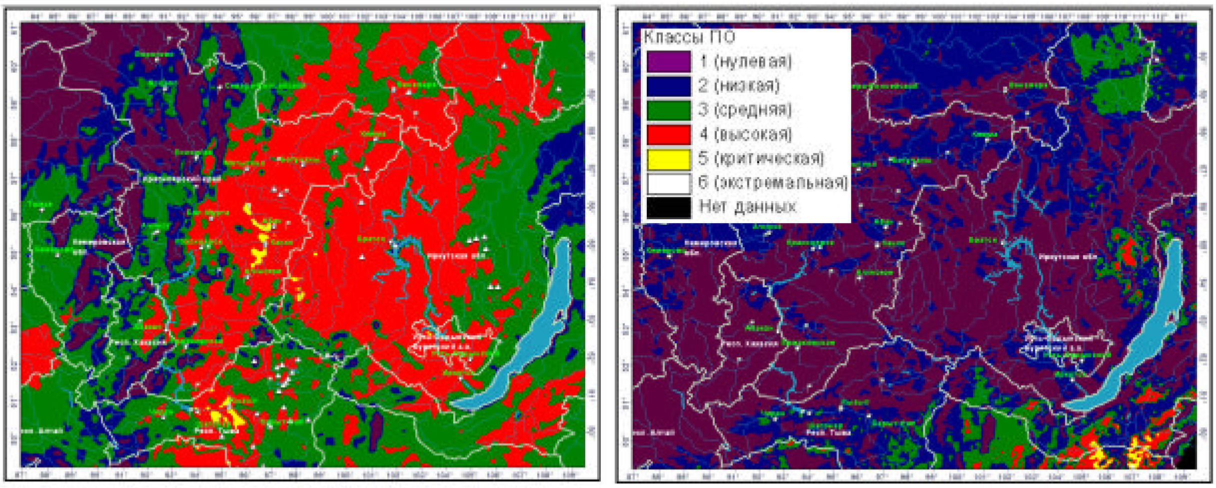

Figure 2. Fire danger class distribution across Siberia and Baikal region (a) 22 July 2002, and (b) 2 July 2002.

In Yakutyia, the 2002 fire situation was remarkable for extreme fire danger rates, a great number of forest fires, and vast areas damaged by fire to this or that extent. This situation can be attributed to weather conditions that prevailed over the Republic at that time. A very big anticyclone reigned in Yakutyia during 2.5 months. In the absence of rain, forest fuels of all types dried out very rapidly; moreover, green grass failed to stop spreading fires, since it was under a water stress. All these factors accounted for that the 2002 forest fire coverage was unprecedented.

4. The 2002 Fall Fire Situation

Multiyear statistical fire data analysis allows to conclude that the fall season does not normally cause troubles in terms of fires in the northern and central parts of interior eastern Siberia. This is related to climate in that mean daily air temperature decreases and precipitation occurs more often. A warm spell occurring usually in the middle of October is insufficient for forest fuels to get dry. The southern parts, especially foothills, are subject to the third (fall) fire activity peak. This peak has been observed annually over several past decades in eastern Siberia, for example.

In 2002, the autumn fire activity increase fell within September till mid-October. The most significant forest fire damage was recorded in Krasnoyarsk, Altai, Kemerovo, Novosibirsk, Tchita, Irkutsk, and Omsk Regions, as well as Buryatia and Tyva Republics. The spatial fire occurrence pattern generally agrees with multiyear observations.

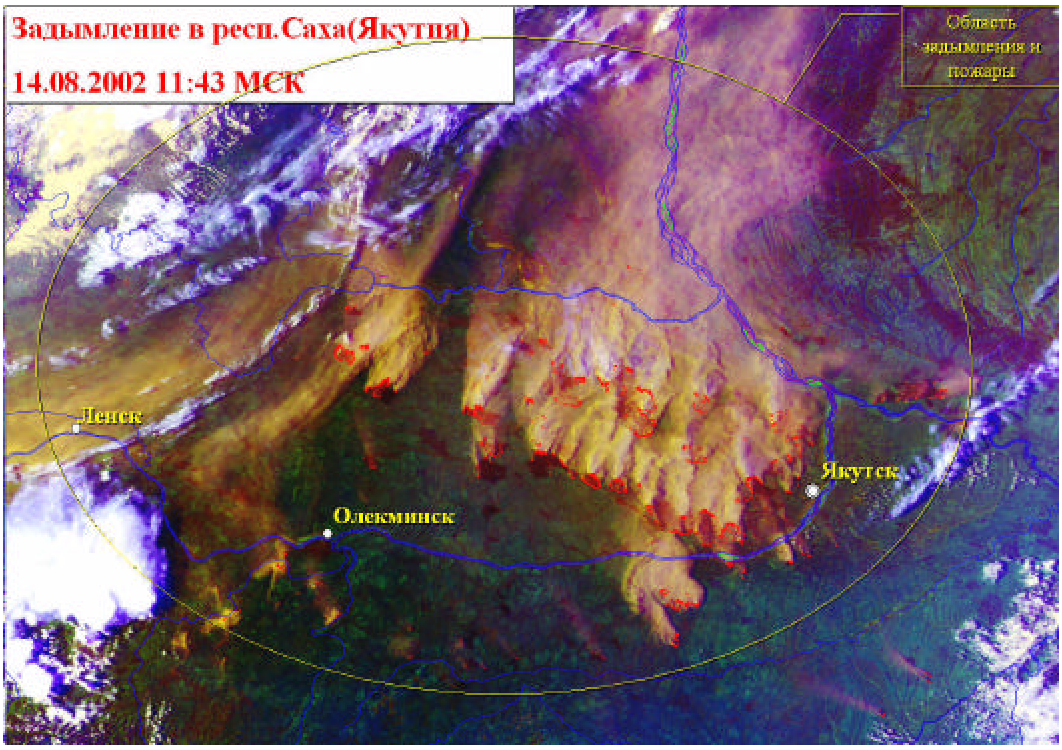

Figure 3. Fire activity peaking during the 2002 fire season in Yakutyia depicted by NOAA AVHRR (14 August 2002).

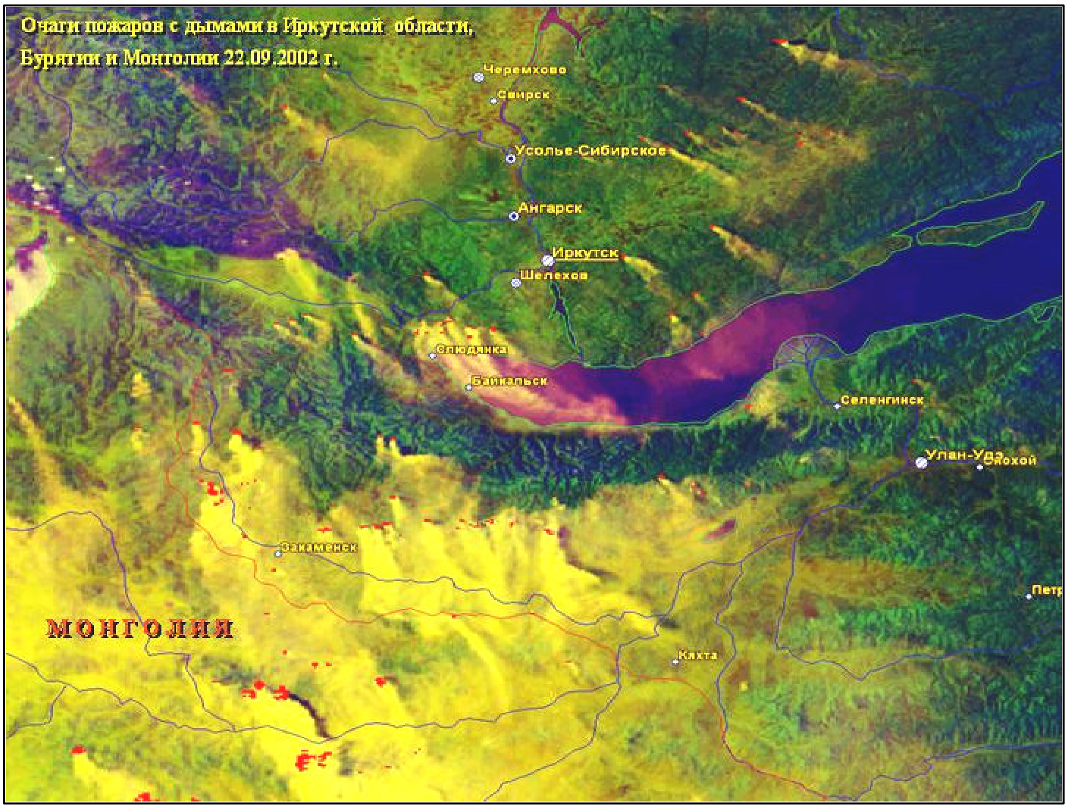

Figure 4. The 2002 fall fire activity increase in Buryatia and Irkutsk Region (22 September 2002).

5. Comparative Analysis of the 2002 forest fire activity data

During the 2002 fire season a total of 2,575 NOAA-12, NOAA-15, and NOAA-16 images were archived. From these images 9,780 near-IR and thermal IR images were processed and analysed for active fires and burn scars, 2,147 images (visible band) for obtaining integrated cloudiness pictures, and 96 for monitoring snow-covered areas.

A total of 10,355 forest fires were identified based on the 2002 images (the fires identified in the previous year of 2001 totalled 7,095), with the total area burned evaluated 11,766,795 ha and 7,560,015 ha, respectively. The 2002 forest fire occurrence and area burned in the Asian part of Russia are shown in Figure 5.

Seasonally, the 2002 fire activities in the regions of interest were characterized by three peaks, in spring (late March to late May), summer (late June to late August), and fall (September to early October) (Figure 5). The spring fire activity peak is noticeable for a big number of fires (450-480) and a small total area burned (200,000 – 380,000 ha), whereas the latter tends to increase in summer and fall episodes (600,000 to 1 million ha).

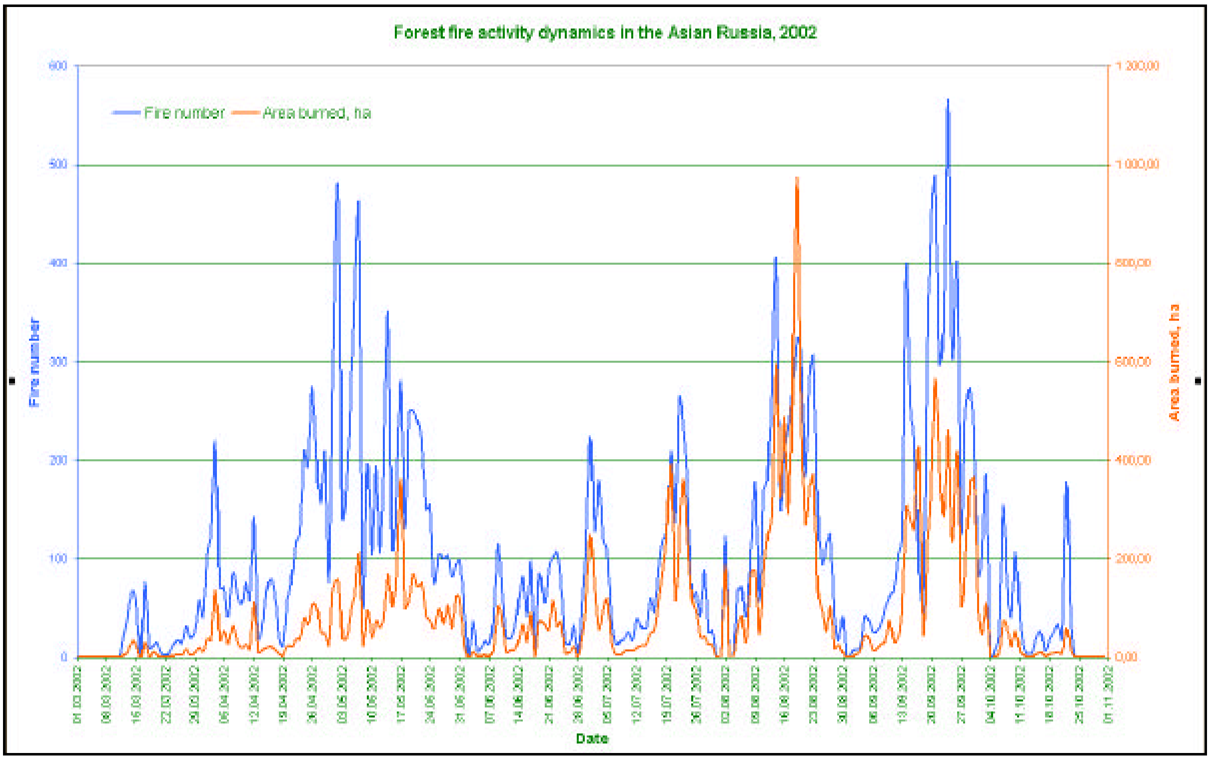

Figure 5. Dynamics of the 2002 forest fire activities between 1 March and 25 October 2002 in the Asian part of Russia. The blue line (numbers left) shows the number of fires, the red line (numbers right) shows the area burned (ha x 1000).

The highest forest fire activity was recorded for the Russia's Asian administrative units shown in Table 1. The 2002 fire data obtained in Kazakhstan (*) are given for comparison. The fire statistics for all Asian Russia administrative units are summarized in Figure 6.

Table 1. Forest fire occurrence depicted by satellite in the Asian part of Russia and in Kazakhstan during the fire seasons of 2001 and 2002.

Administrative Unit	**Number of fires (2001 / 2002)**	**Total area burned (ha) (2001 / 2002)**
Respublika Sakha (Yakutiya)	991 / 829	3,619,387 / 5,026,940
Amurskaya oblast	1103 / 1633	938,737 / 1,824,000
Krasnoyarskiy krai	525 / 1064	170,800 / 411,200
Altaiskiy krai	753 / 967	24,970 / 319,000
Chitinskaya oblast	549 / 884	259,400 / 846,300
Irkutskaya oblast	474 / 889	299,190 / 556,030
Respublika Tuva	148 / 571	66,665 / 1, 082,200
Respublika Khakasiya	69/257	31,234 / 140,267
Khabarovskiy krai	221 / 309	266,260 / 337,751
Respublika Buryatiya	208 / 660	81,053 / 328,179
Kazakhstan *	3 020 *	2,813,620*

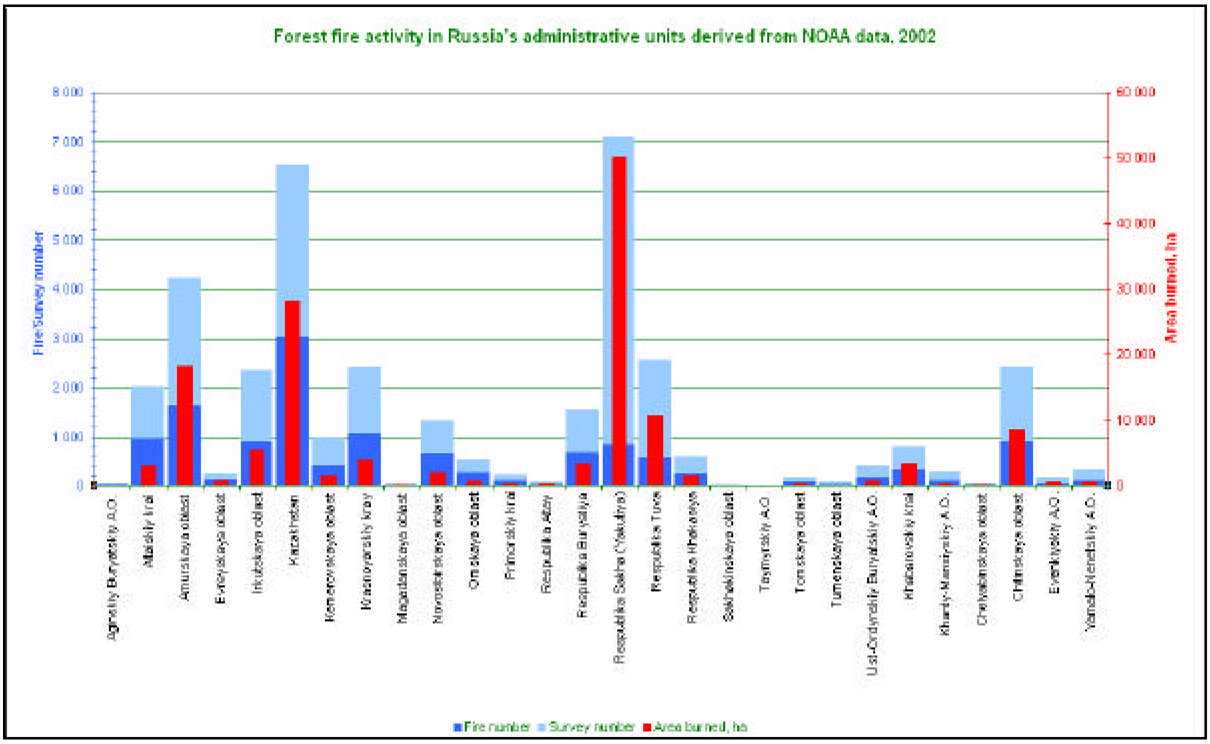

Figure 6. Forest fire activity during the 2002 fire season in Russia's administrative units and in Kazakhstan derived from NOAA data. The red columns provide the total area burned in 2002 (in km^2; 1 km^2 = 100 ha). The dark blue columns show the number of fires (separate fire events), the light blue columns show the number days during which the fires have been observed (e.g., most fires in Yakutyia were going on more than month; thus, light blue columns are equal or more than dark blue columns in each case.

Comparison of fire statistics among the administrative units under study shows a trend for both total area burned and mean fire size to increase (Table 2).

Table 2. Mean forest fire size in the regions of the highest fire activity during the fires seasons 2001 and 2002.

Region	**Mean forest fire area, ha**	
	2001	**2002**
Respublika Sakha (Yakutiya)	3 652	6 064
Amurskaya oblast	851	1 117
Respublika Tuva	450	1 895
Evenkiyskiy A.O.	466	986
Khabarovskiy krai	1 205	1 093

Insufficient funding and, hence, inadequate technical and human fire suppression resources for hotshot response forest fires is among the reasons accounting for the tough current situation. On the other hand, the systems that are in place for predicting conditions favourable for fire occurrence and spread represent a sound basis for the allocation of fire available suppression resources, appropriate fire prevention planning, and provide a decision support for fire suppression.

Tables 1 and 2 show the regions with highest forest fire activities in 2001 and 2002. Like in the previous year, Sakha Republic (Yakutyia), Amur Region, and Tyva Republic have been affected most by forest fire activity in this year. Noticeably, the mean fire size was twice and three times that in 2001 in Yakutyia and Tyva, respectively. Figure 7 provides data for other regions.

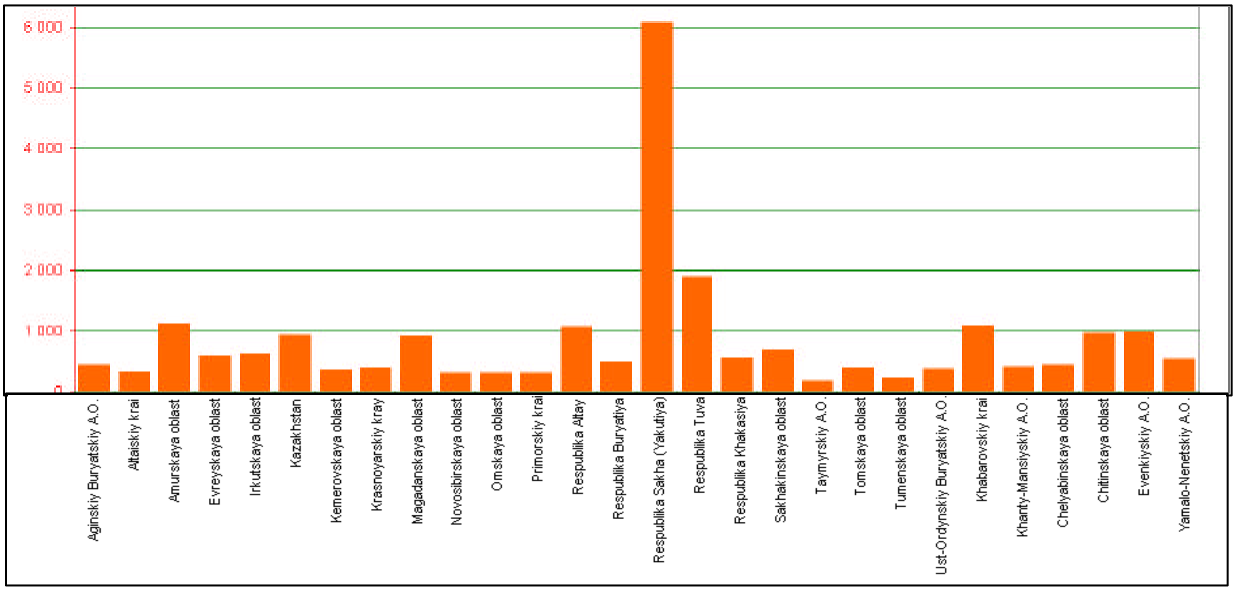

Figure 7. Mean forest fire size (ha) by administrative units of the Russian Federation and in Kazakhstan during the fire season of 2002.

In a forest fire activity map (Figure 8), the highest fire occurrences are denoted by the orange colour tints. Analysis of the 2002 forest fires has revealed the following high fire activity areas:

- Yakutyia: the central part and along Lena and Aldan rivers
- South of Amur Region: between Burea and Zea rivers
- South of Tyva Republic
- East of Krasnoyarsk Region, along its border with Novosibirsk Region.

Large forest fires occurred infrequently and uniformly across the rest of the area under analysis.

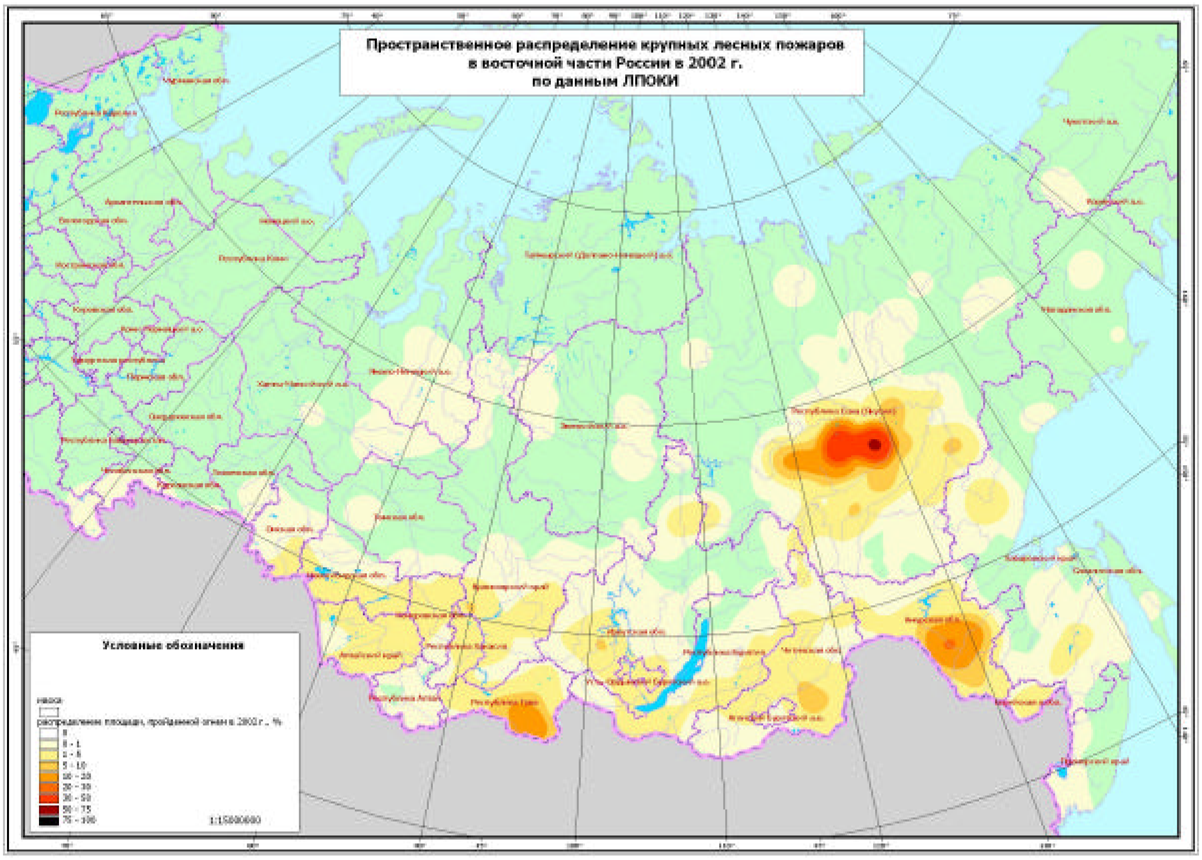

Figure 8. Spatial distribution of areas burned by different degree in the Eastern part of Russia during the fire season of 2002, derived from interpolated NOAA AVHRR forest fire data. Zones are delineated by colours that represent the ratio of the burned area to the total area marked by the colour.

6. Analysis of spaceborne fire data in the period 1996-2002

The statistics obtained of the 1996-2002 forest fires derived from NOAA satellites allows to track the general fire activity trends in every administrative unit. However, the 7-year dataset cannot explain the causes of forest fire outbreaks (natural vs. human-caused). On the other hand, it becomes clear from the data that both number of fires and area burned have increased considerably over the past several years. Interestingly, the values increase either suddenly or gradually, in a cycling way. The cycling differs among the interior (continental) regions, i.e. Krasnoyarsk Region, Sakha Republic, Tyva, and Baikal Region. The 7-year period of interest was stable in Tyva Republic, with fire frequency and area burned slowly but steadily decreasing during the 1997-2001 period. The 2002 fire season was classified as extreme, though (Figure 9).

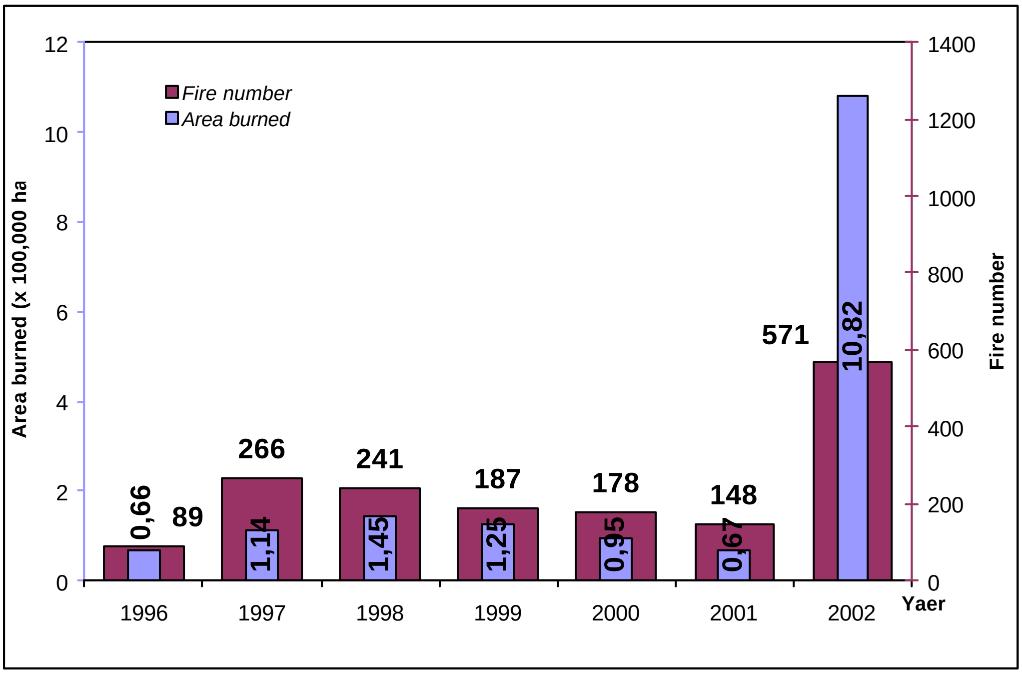

Figure 9. Fire activity diagram for Tyva Republic for the period 1996-2002

While Krasnoyarsk region neighbours Tyva, it has its own fire activity dynamics related to different seasonal weather trends, microclimate, as well as differences in forest distribution and population density. Figure 10 shows three extreme fire seasons (1996, 1999, and 2002) characterized by a great number of fires and an increase in area burned (400,000 to 800,000 ha). However, a large number of fires in 1997 (1,107) did not result in large forest area burned (only 400,000 ha).

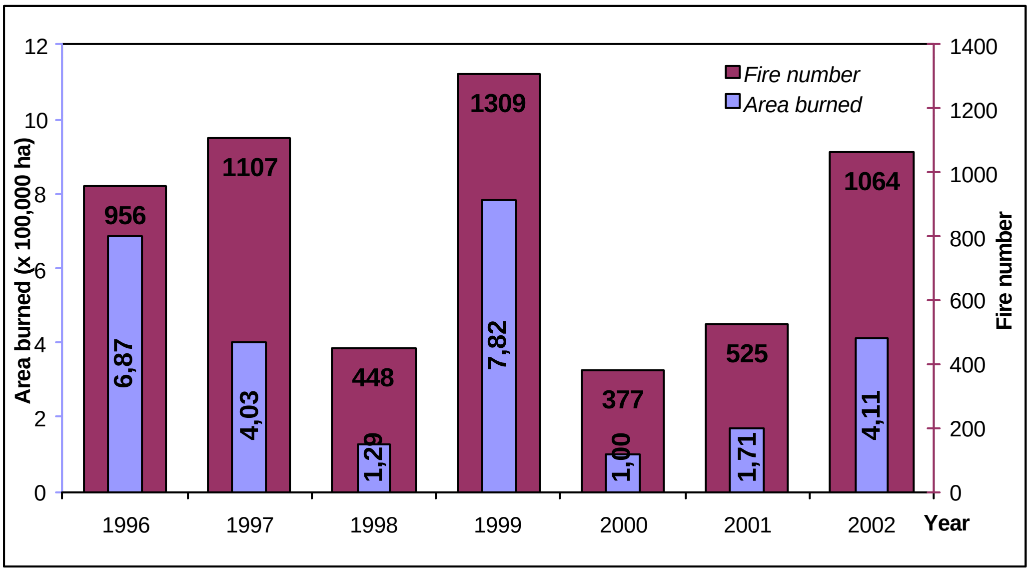

Figure10. Fire activity diagram for Krasnoyarsk Region for the period 1996-2002

The number of forest fires and the area burned have steadily increased since 1998 in Amur region, with an exception of the year 2001 (Figure 11). The extreme 2000 fire season is attributed to a long drought. However, the trend for the number of fires to increase is related primarily to extending forest use practices in this region.

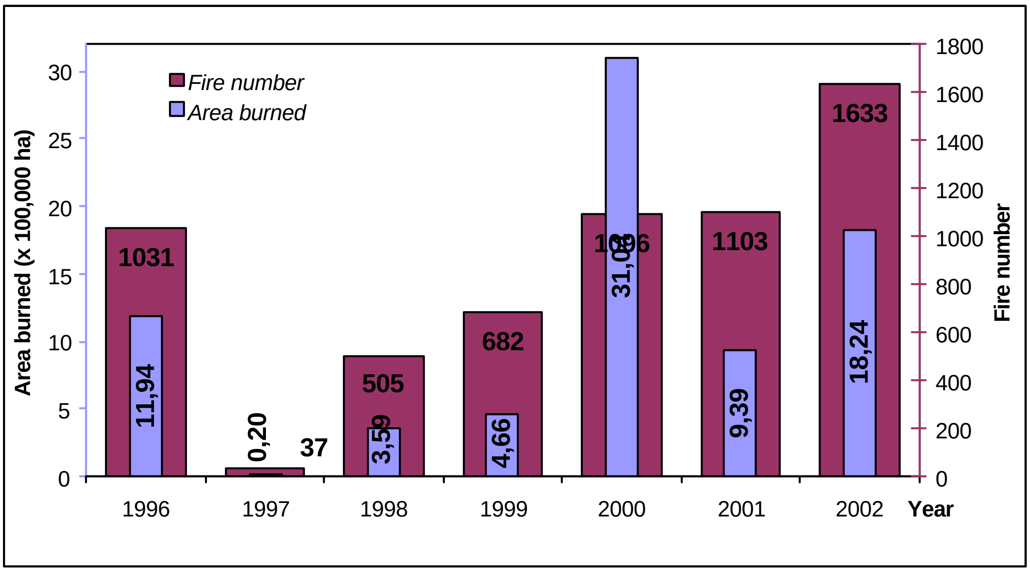

Figure11. Fire activity diagram for Amur Region for the period 1996-2002

The 7-year period under analysis suggests three exceptional fire years (1998, 2001, and 2002) in the Republic of Sakha (Yakutyia). Although the number of forest fires did not varied widely over this period (829-991), forest areas damaged by fire increased greatly (Figure 12). The total area burned in 2002 (5,027,000 ha) was 4 times than the area burned in 1998 (1,226,000 ha).

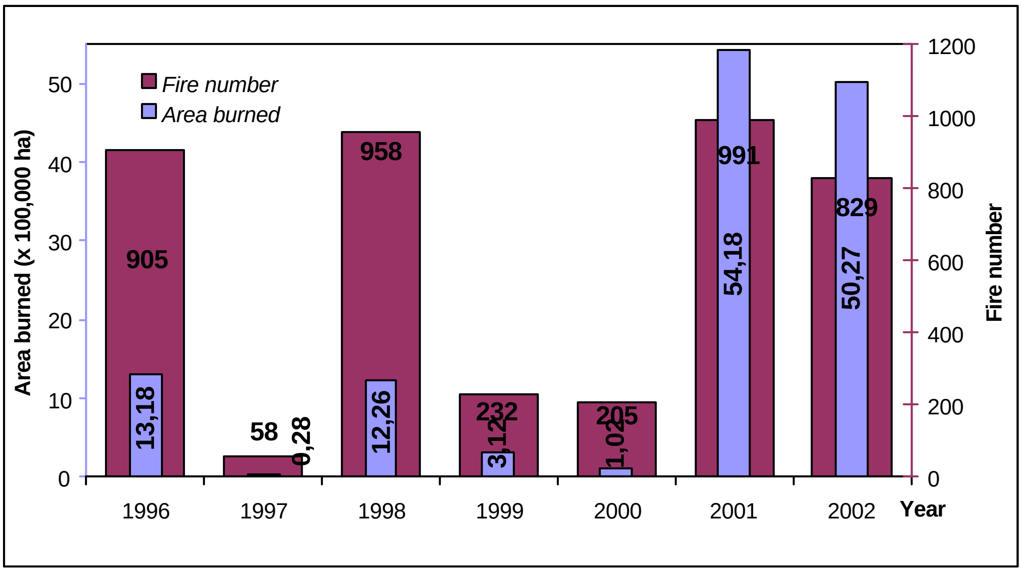

Figure12. Fire activity diagram for Sakha Republic (Yakutyia) for the period 1996-2002

7. Conclusions and outlook

To sum up, the forest fire situation turned out to be exceptional in a number of Russia's administrative units in 2002. The values of many fire-related parameters exceeded the average 7-year values by up to an order of magnitude. Regarding the entire Asian Russia, 10,355 forest fires were recorded an affected a total of 11,766,795 ha, with the mean fire size of 1,095 ha (Figure 13; Appendix I). Based on these values, about 11,000 fires can be expected to occur in 2003 and may possibly affect 13 million ha (Figure 13).

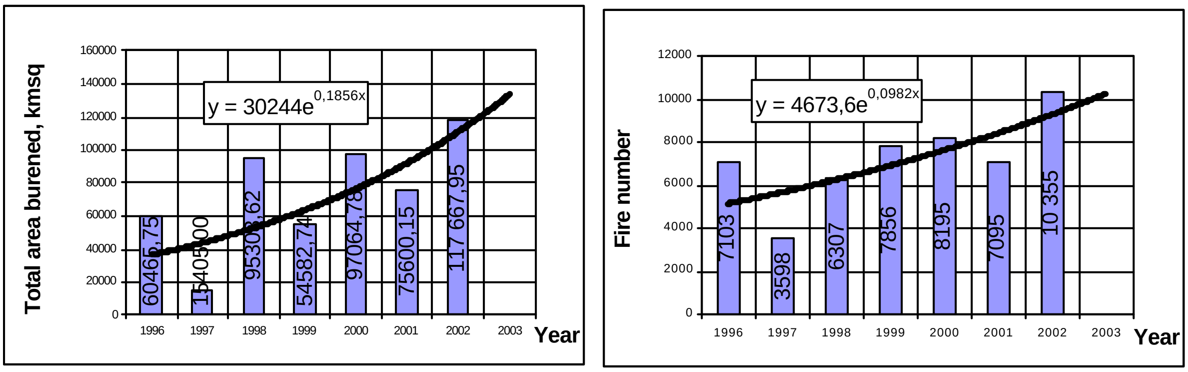

Figure 13. Summary of forest fire statistics 1996-2002 for the Russian Federation and prediction for the year 2003.

Acknowledgements

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(4) Global Observation of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) - Fire Mapping and Monitoring Team: http://gofc-fire.umd.edu/

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Appendix I

Forest fire occurrence depicted by satellite during the 2002 fire season in the Asian part of the Russian Federation (by administrative units) and in Kazakhstan

Administrative Unit	**Area Burned (ha)**	**Number of Fires**	**Mean Fire Size (ha)**
Aginskiy Buryatskiy A.O.	8 080.71	18	448.93
Altaiskiy krai	319 089.93	967	329.98
Amurskaya oblast	1 823 933.69	1 633	1 116.92
Evreyskaya oblast	68 892.11	117	588.82
Irkutskaya oblast	556 030.40	889	625.46
Kemerovskaya oblast	152 916.51	431	354.79
Krasnoyarskiy kray	411 275.97	1 064	386.54
Magadanskaya oblast	14 448.13	16	903.01
Novosibirskaya oblast	196 173.76	644	304.62
Omskaya oblast	82 198.84	271	303.32
Primorskiy krai	31 893.73	103	309.65
Respublika Altay	29 795.60	28	1 064.13
Respublika Buryatiya	328 179.07	660	497.24
Respublika Sakha (Yakutiya)	5 026 939.65	829	6 063.86
Respublika Tuva	1 082 220.91	571	1 895.31
Respublika Khakasiya	140 267.20	257	545.79
Sakhakinskaya oblast	4 897.91	7	699.70
Taymyrskiy A.O.	748.25	4	187.06
Tomskaya oblast	28 032.63	70	400.47
Tumenskaya oblast	7 675.93	33	232.60
Ust-Ordynskiy Buryatskiy A.O.	67 846.25	178	381.16
Khabarovskiy krai	337 750.88	309	1 093.04
Khanty-Mansiyskiy A.O.	36 378.22	87	418.14
Chelyabinskaya oblast	11 332.61	25	453.30
Chitinskaya oblast	846 332.97	884	957.39
Evenkiyskiy A.O.	52 293.80	53	986.68
Yamalo-Nenetskiy A.O.	56 618.67	104	544.41
Total Asian Russia	**11 722 244.33**	**10 252**	**1 143.41**
Kazakhstan	2 813 620.89	3 020	931.66
Total Asian Russia and Kazakhstan	**14 535 865.22**	**13 272**	**1 095.23**

RUSSIAN FEDERATION FIRE 2002 SPECIAL

PART IV

Fires on Drained Peat Soils of Russia – Causes and Effects

Background

Unfortunately fires occurring on drained peat soils in the European part of Russia are common facts. The area of peat lands burned range between several hundreds and thousands hectares every year. The year 2002 was an extreme year.

What are the causes of these peat fires? First, the climatic peculiarities of Western Russia are characterized by dry and hot periods during summer that commonly last many weeks and sometimes months. These climate features result in drying of the upper layers of drained peat soils. The second cause concern the peculiarities of drained peat utilization outside the Chernozem zone of the Russian Federation. Almost all peat sites have been drained by channels and the level of the groundwater table was regulated by pump stations. As a result of at last ten years of the difficult economical situation in Russia many of these stations are not maintained and are degrading. The water regime of drained peat soils in this situation is thus depending on climate conditions only.

A third cause for peat fires in Russia is the low level of agricultural cultivation on peat soils. Modern methods of agricultural utilization of peat soils in West Europe and North America are involving a layer of sand under peat soil. This method prevents the spread of fires. Unfortunately until today there are no territories cultivated by this methods in Russia.

Thus, these climatic and economic factors promote the fire occurrence in peat lands in the European part of Russia. The situation is very similar in the other center of peat fires – South East Asia.

Impacts of Peat Fires: Nutrient Losses and Emissions to the Atmosphere

What are the consequences of peat fires in European Russia, and what are distinctions of it in other world regions?

The destruction of soil organic matter is the most striking result of this type degradation (Fig. 1 and 2). In drained agricultural peat soils the content of mineral components is 10-20% only, and the consequences of fire are catastrophically for these soils. After combustion of the peat layer depressions are formed on the surface of the land affected. Depth and area of these depressions are determined by the groundwater layer and the depth of the mineral bottom. A complete combustion of the peat profile down to the mineral layer is the most extreme situation. This occurs quite regularly in European Russia because many drained peat lands have rather shallow organic layers (100 cm or less) (Zaidelman et al. 1999, 2000). This is in contrast to South East Asia where the depth of peat can be 4-6 m and more.

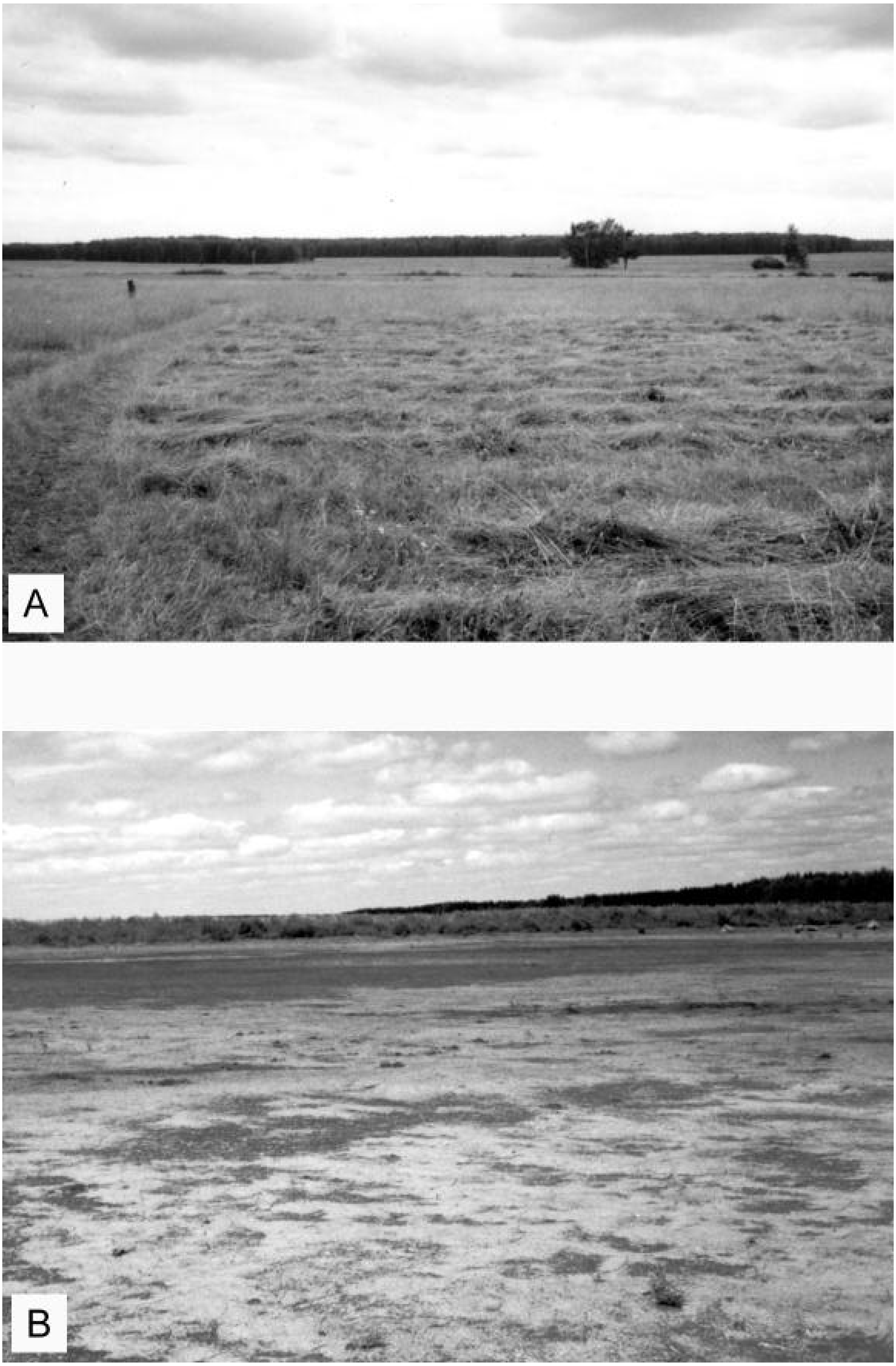

Figure 1. Drained peat land before (A) and after (B) fire in Rjazan region (100 km East of Moscow).

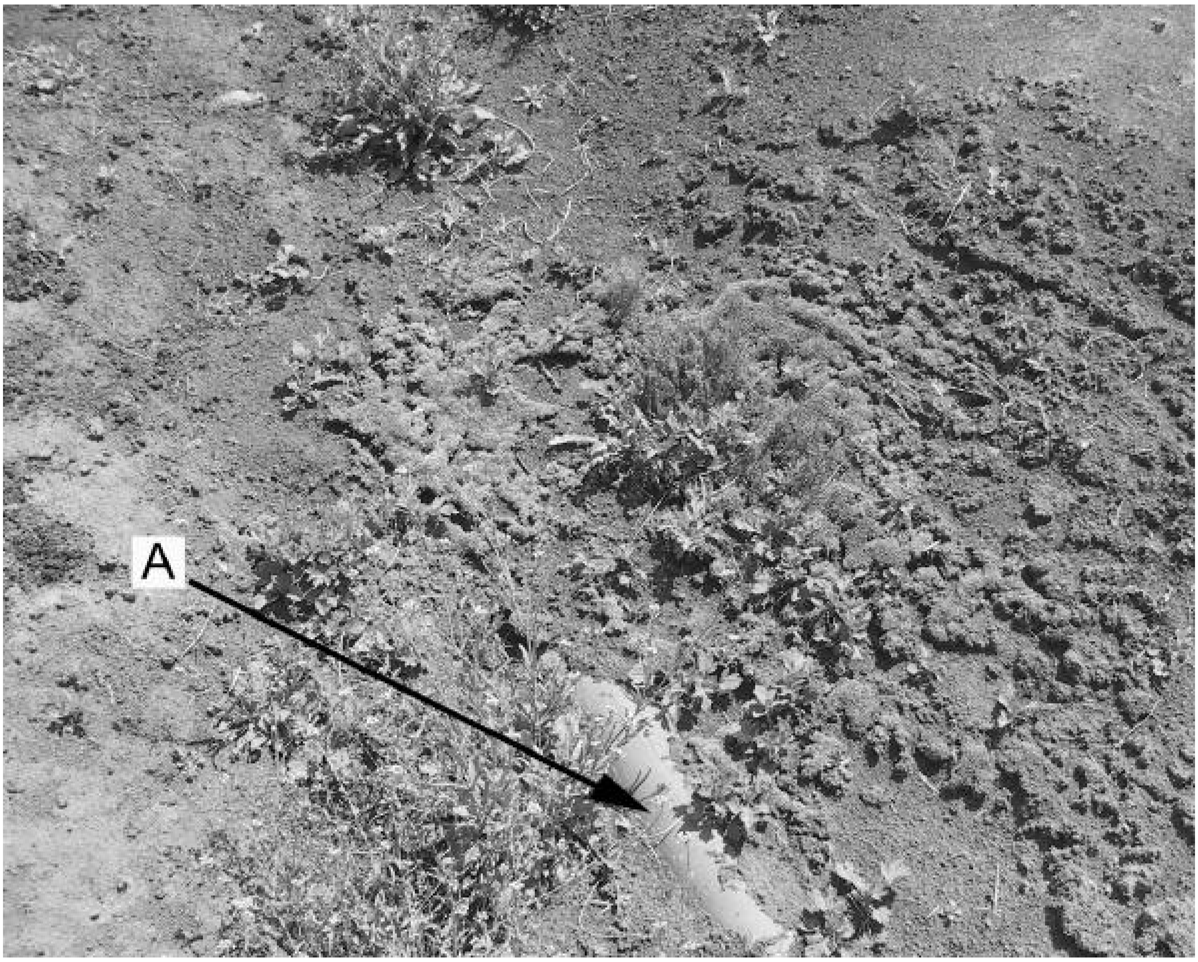

Figure 2. Surface of combusted peat soil. The arrow (A) shows a ceramic drain pipe. In Moscow region draining of peat soils has been done in 80 cm depth.

This depressions result in further drainage of neighbouring, not yet degraded peat soils, resulting in an increase of fire hazard. On the other hand the ground level of burned peat sites are lower than those not affected by fire. As a result, the swamping of the degraded area creates additional problem to recultivation and rehabilitation of this territory. As a result of this the most fertile agricultural lands of Russia are reduced.

The next problem of fire consequences in drained peat lands is the formation of peat ash and its accumulation in large scale. The compounds and properties of ash depend on the characteristics of the burned peat. All peat mineral components are accumulated and concentrated in ash (Table 1). The ash ranges are from light-alkaline to alkaline (pH 8.0-10.0 and higher) whereas peat pH is 3.0-7.00. Studies of water solubility components of ash showed that the ash consists of a mixture of many elements. Their concentrations exceed those of the peat by ten times and more. Ash is transported very easy to the groundwater, rivers, ponds, and neighbouring lands by water and wind.

It is further important to investigate gas emission of gaseous compounds of peat fires, especially the oxides of carbon. The emission of 130-200 m^3 of CO and CO_2 is the result of combusting 1 m^3 only. These gaseous product can be transported over large distances. For examples, the smoke from peat burning Northern Friesland in 1657 went as far as to Krakov (Goldammer 1998). Smoke from peat fires in Moscow region travelled to Sweden and Germany 2002. The contribution of Russian’s peat fires to world's CO_2 and CO emissions is not as much as from peat fires in South East Asia. However, the vicinity of these fires to large cities (Moscow, Sankt Peterburg, Vladimir, Rjazan and others) has significant negative influences on human health.

Table 1. Compounds of peat and ash (mg/kg) taken in Rjazan Region.

Elements	*Peat (mg/kg)*	*Ash (mg/kg)*	
		Immediately after fire	*One year after fire*
Al	93802	604061	657920
K	30956	57451	40485
Ñà	15810	37648	25574
Ð	6419	22370	19143
Mg	5527	23528	13041
Fe	3070	121763	101365
Ti	1946	87170	100800
Ì n	339	1429	887
Â	27	143	119
Ni	11	112 *	89 *
Ñî	11	31	27
Cd	0.11	0.36	0.30
Ñu	9	48 *	47 *
Ðb	4	91 *	73 *
Ge	1	4	3

* - content of element for mineral bottom is more than limit danger concentration

Finally it is necessary to note that natural rehabilitation of burned peat land takes much longer than the rehabilitation of burned forests. For example, the rehabilitation of a forest in the European part of Russia needs ca. 50 years. In contrast the formation 50 cm of peat requires about 300 years as minimum.

Unfortunately, taken into account the extensive spreading of drained peat fires in the world and high negative effects on ecological and economic conditions this process is studied very insufficiently. Especially for studies of degraded territories recultivation.

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