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RUSSIAN FEDERATION FIRE 2002 SPECIAL

PART III

The 2002 Fire Season in the Asian Part of the Russian Federation: A View from Space

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 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.

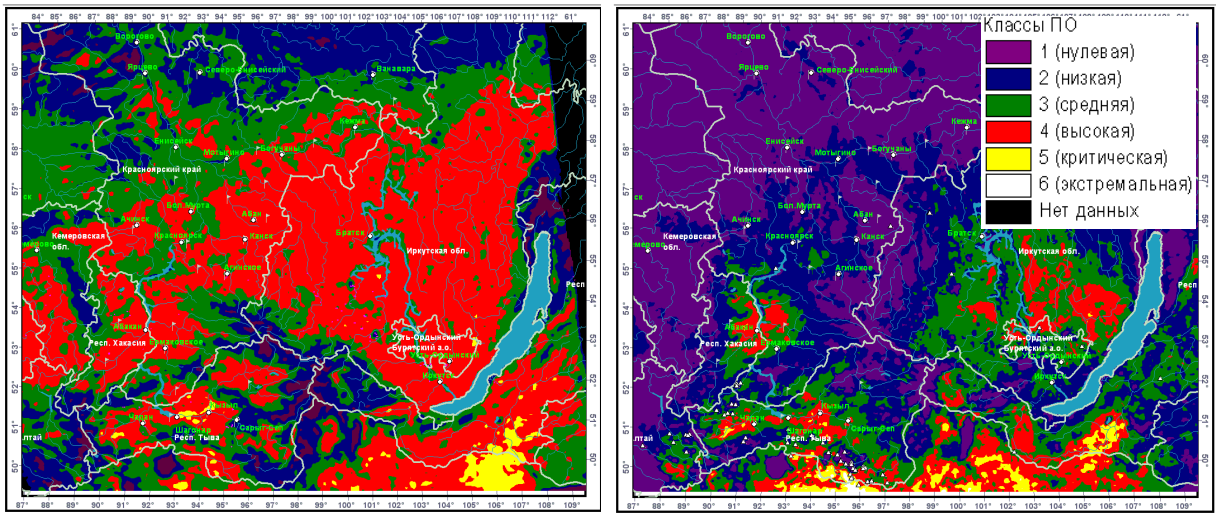


Figure 1. Fire danger class distribution across Siberia and Baikal region (a) 26 April 2002, and (b) 31 May 2002.

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.

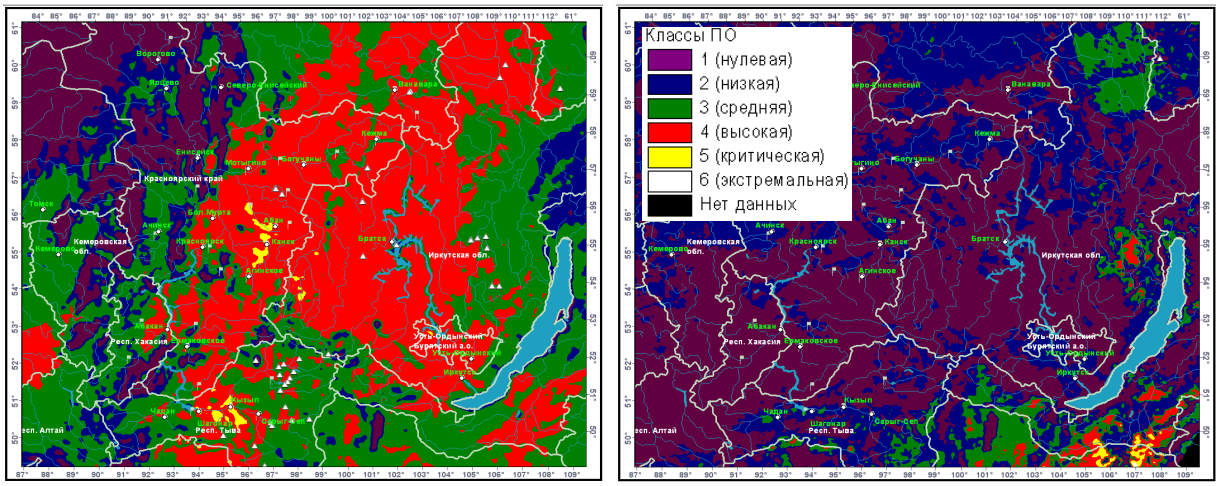


Figure 2. Fire danger class distribution across Siberia and Baikal region (a) 22 July 2002, and (b) 2 July 2002.

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.

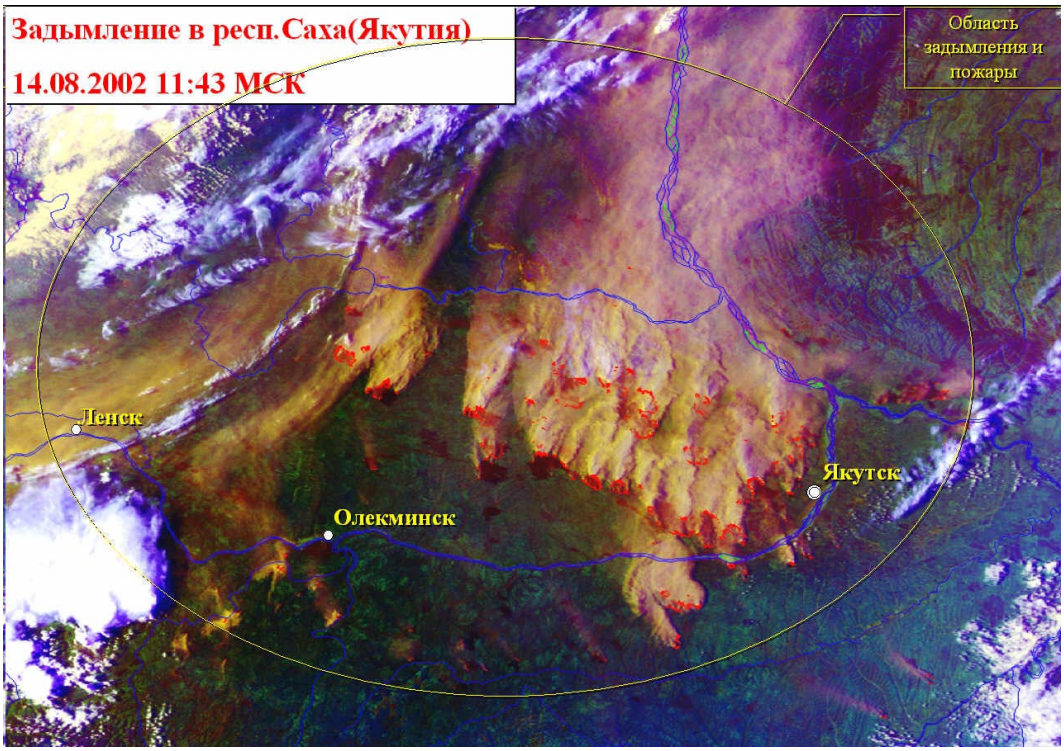


Figure 3. Fire activity peaking during the 2002 fire season in Yakutyia depicted by NOAA AVHRR (14 August 2002).

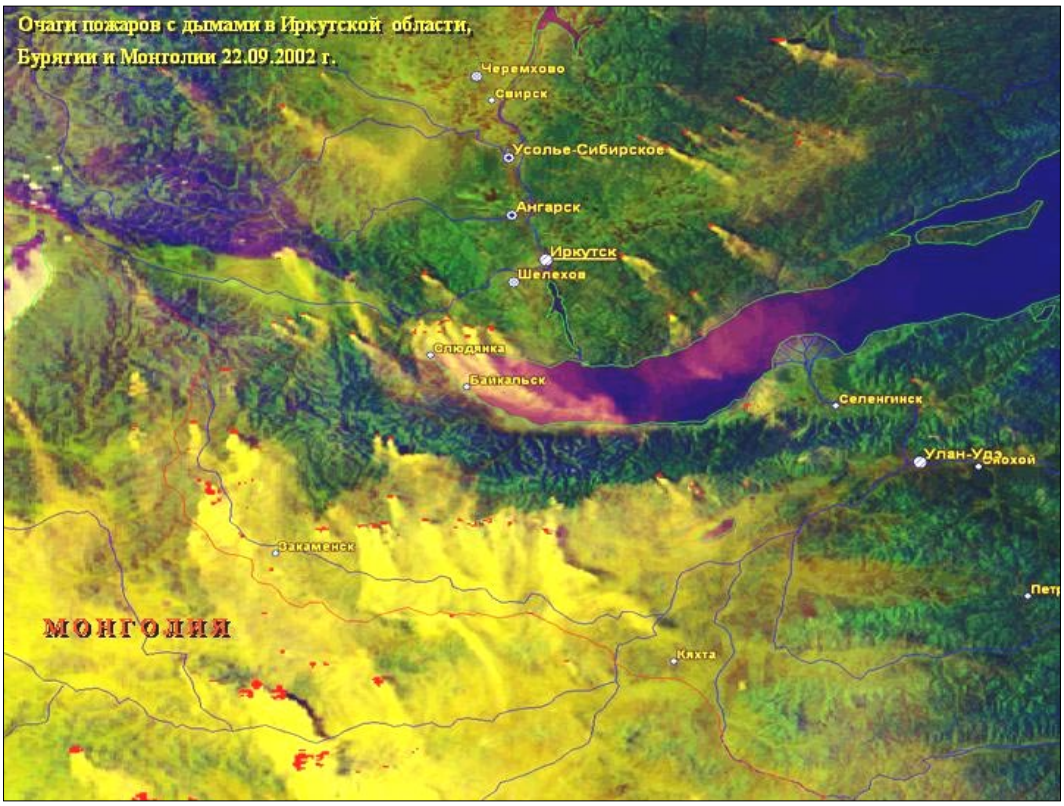


Figure 4. The 2002 fall fire activity increase in Buryatia and Irkutsk Region (22 September 2002).

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).

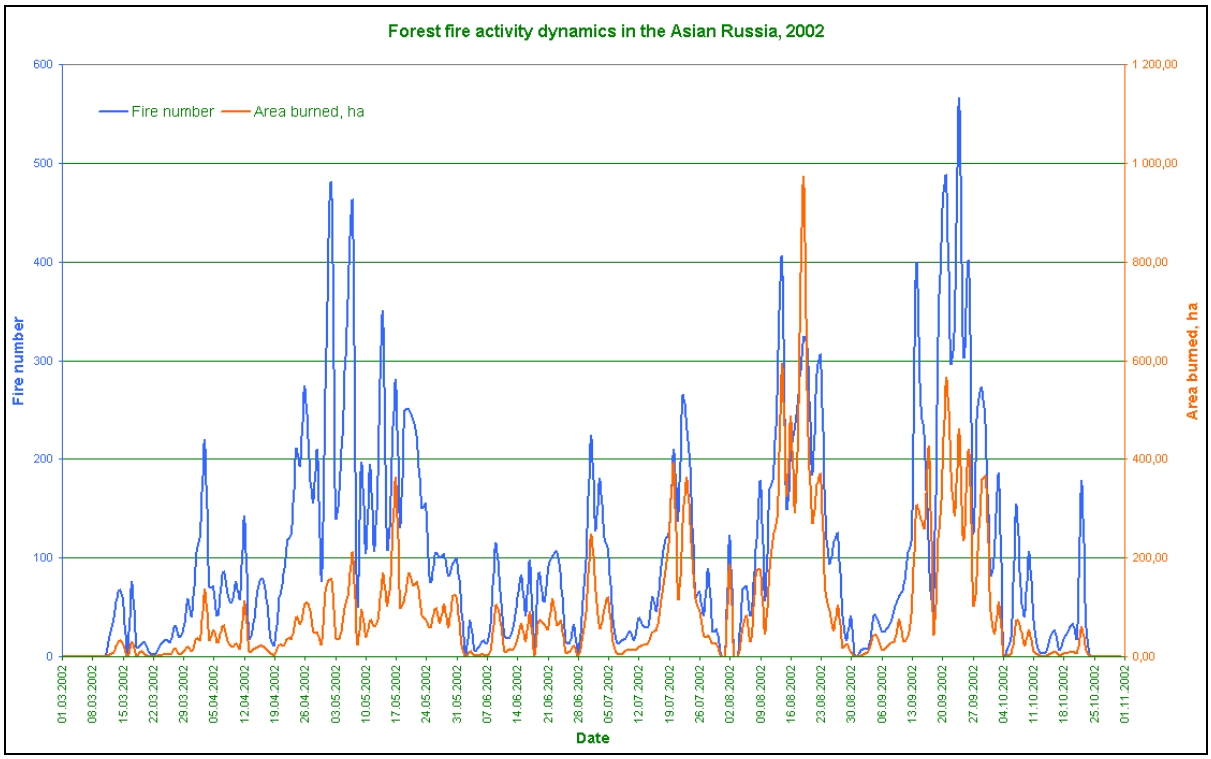


Figure 5. Dynamics of the 2002 forest fire activities between 1 March and 25 October 2002 in the Asian part of Russia. The blue line (numbers left) shows the number of fires, the red line (numbers right) shows the area burned (ha x 1000).

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*

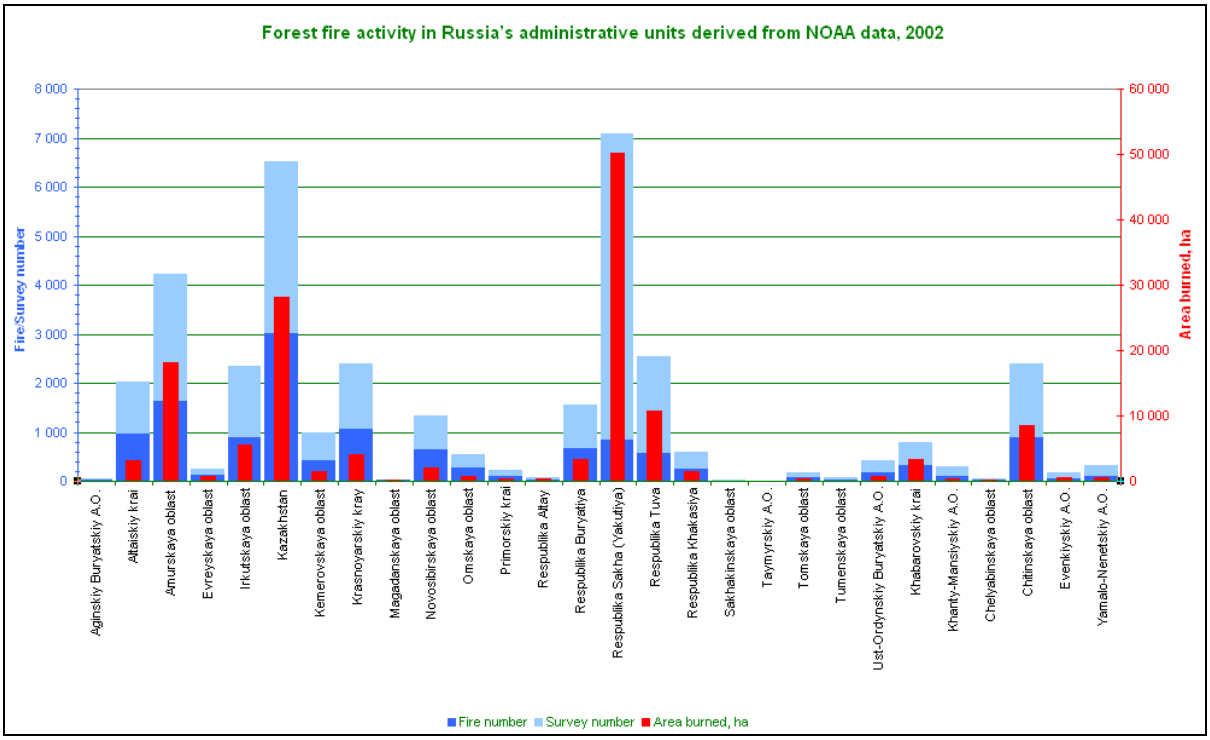


Figure 6. Forest fire activity during the 2002 fire season in Russia's administrative units and in Kazakhstan derived from NOAA data. The red columns provide the total area burned in 2002 (in km^2; 1 km^2 = 100 ha). The dark blue columns show the number of fires (separate fire events), the light blue 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.

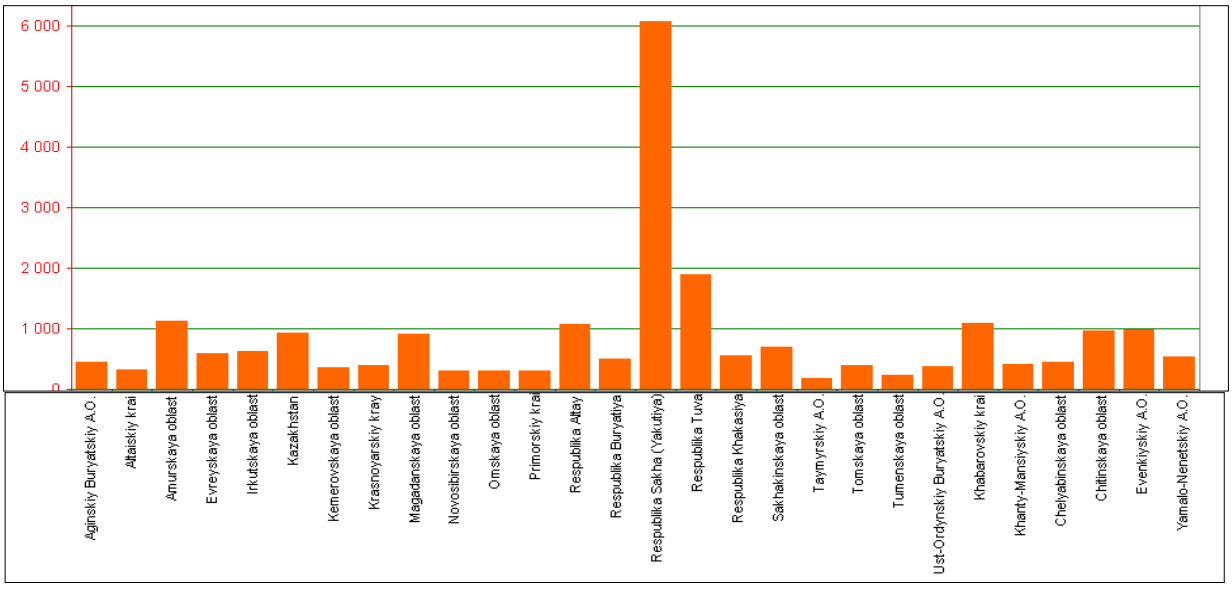
Tables 1 and 2 show the regions with highest forest fire activities in 2001 and 2002. Like in the previous year, Sakha Republic (Yakutyia), Amur Region, and Tyva Republic have been affected most by forest fire activity in this year. Noticeably, the mean fire size was twice and three times that in 2001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



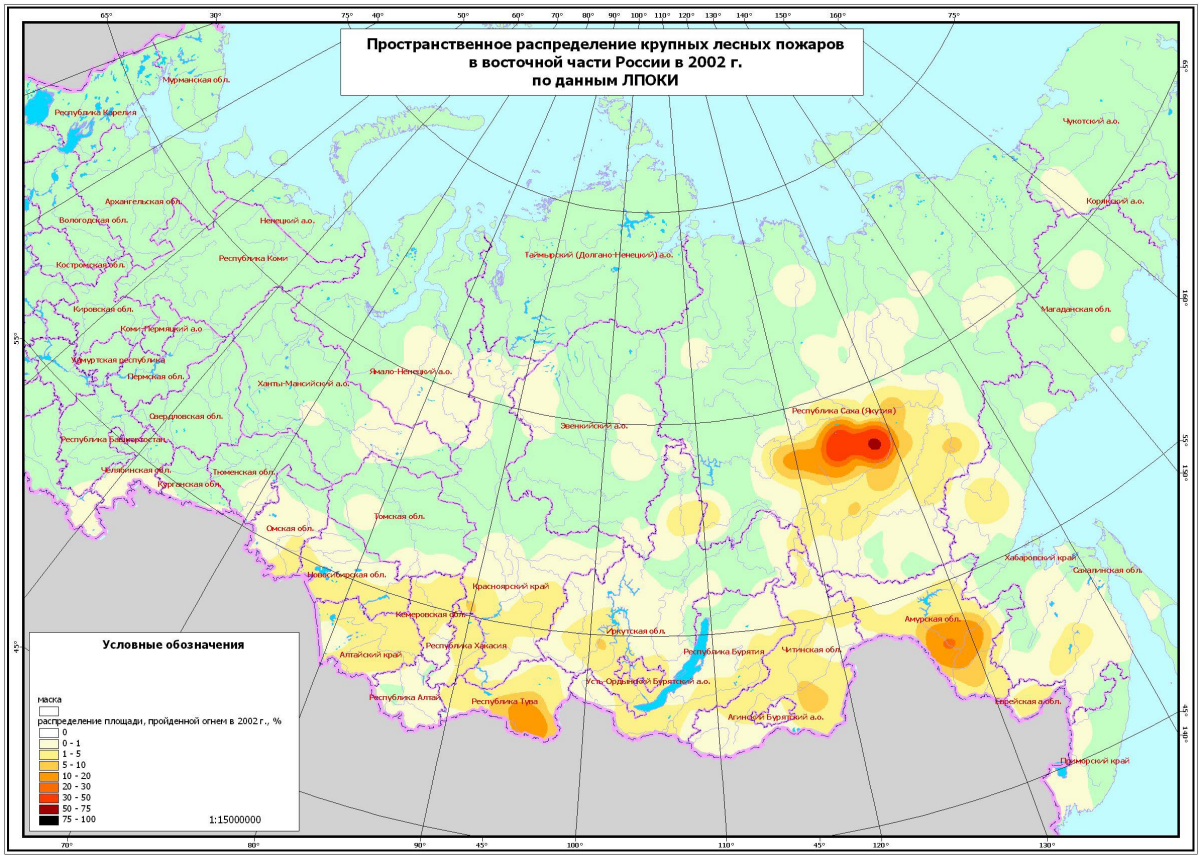


Figure 8. Spatial distribution of areas burned by different degree in the Eastern part of Russia during the fire season of 2002, derived from interpolated NOAA AVHRR forest fire data. Zones are delineated by colours that represent the ratio of the burned area to the total area marked by the colour.

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).

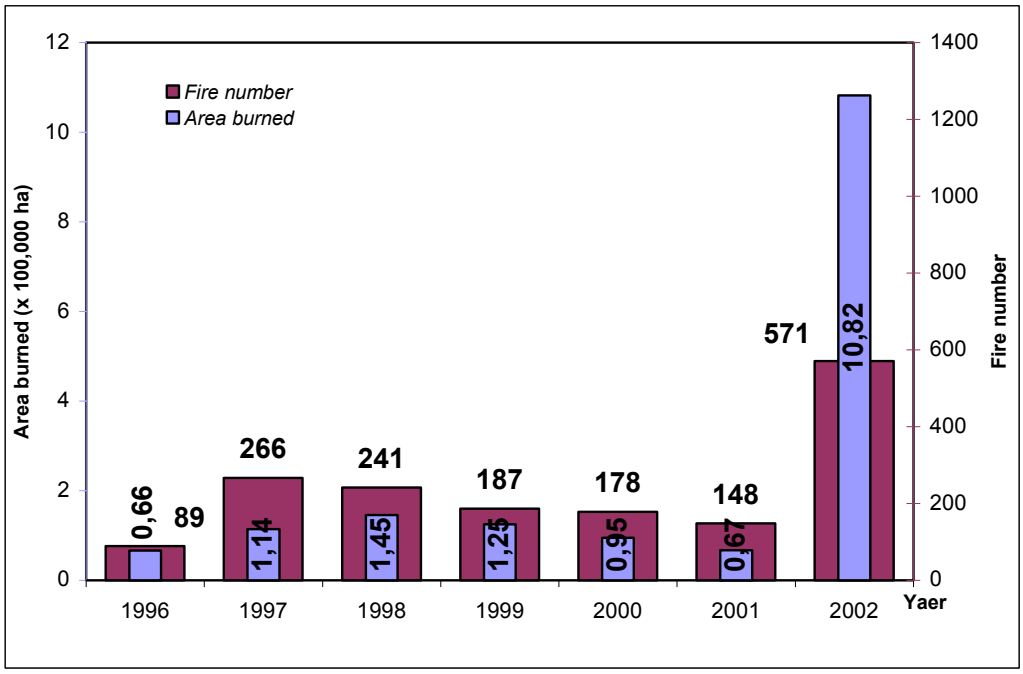


Figure 9. Fire activity diagram for Tyva Republic for the period 1996-2002

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).

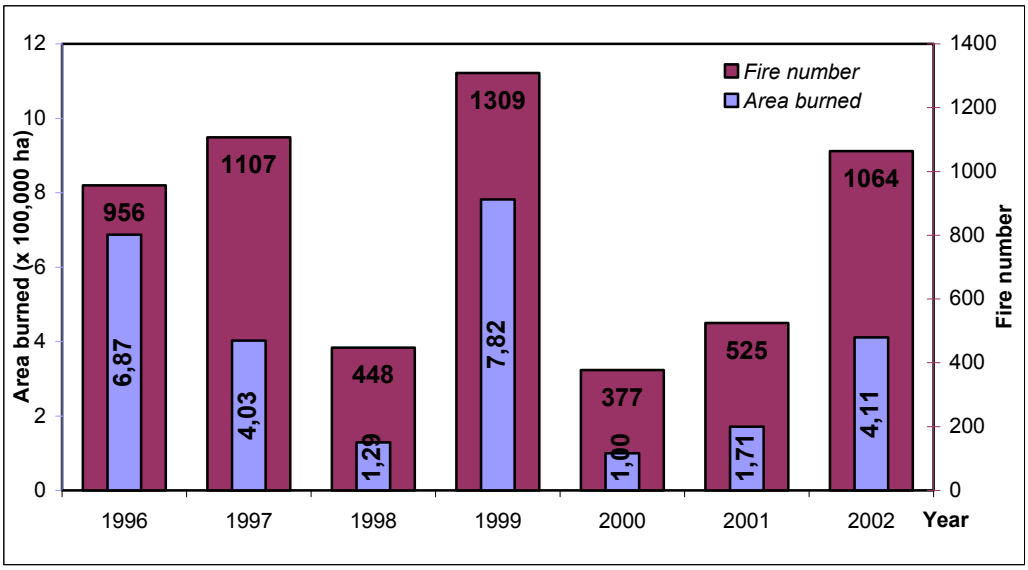


Figure10. Fire activity diagram for Krasnoyarsk Region for the period 1996-2002

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.

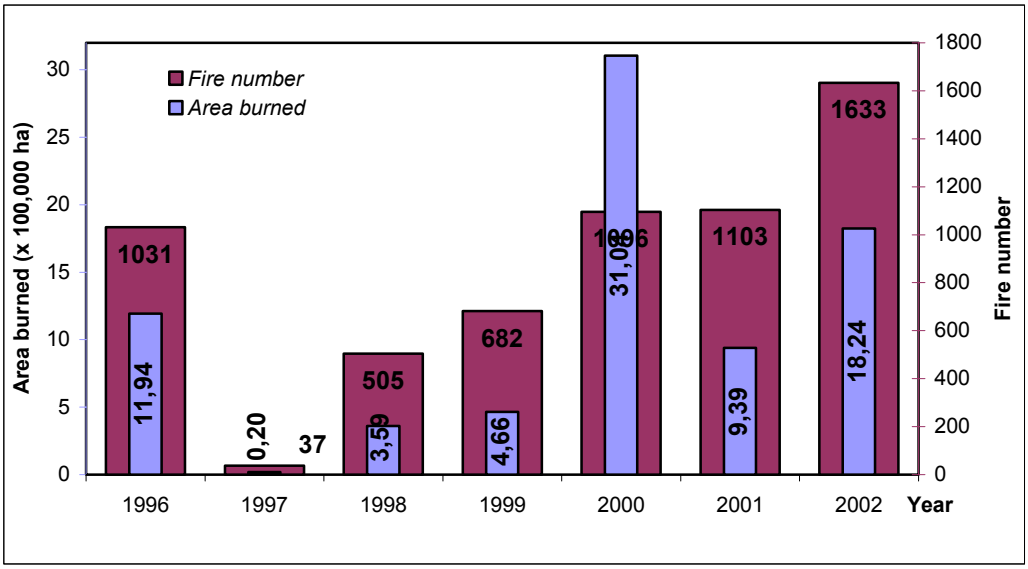


Figure11. Fire activity diagram for Amur Region for the period 1996-2002

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).

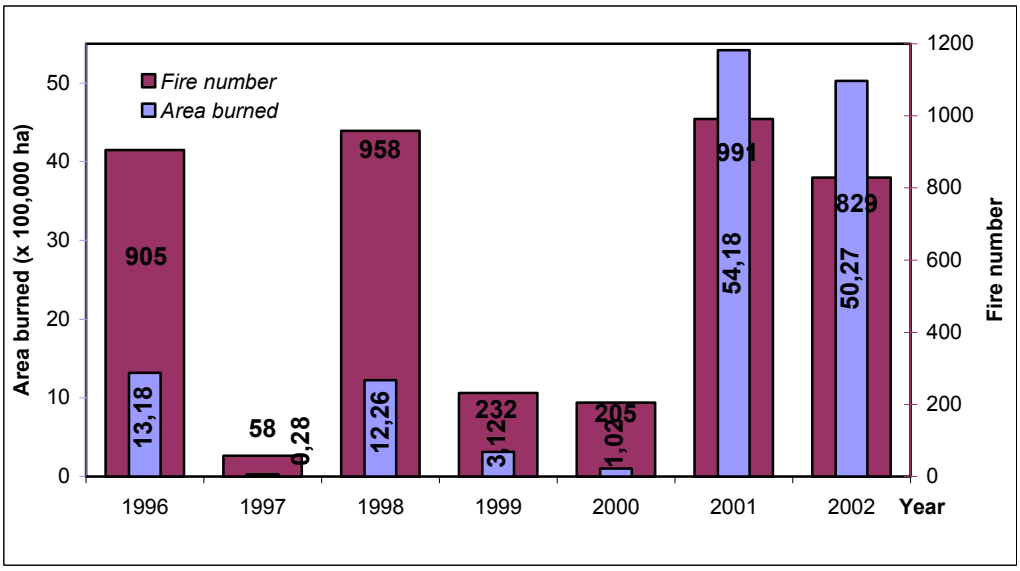


Figure12. Fire activity diagram for Sakha Republic (Yakutyia) for the period 1996-2002

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, 10,252 forest fires were recorded an affected a total of 11,722,244 ha, with the mean fire size of 1,143 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).

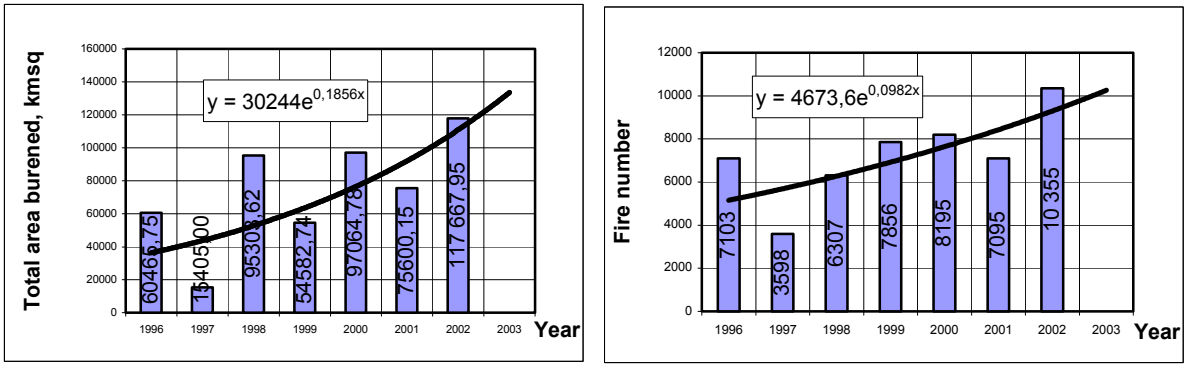


Figure 13. Summary of forest fire statistics 1996-2002 for the Russian Federation and prediction for the year 2003.

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(1) Global Fire Monitoring Center (GFMC): http://www.fire.uni-freiburg.de

(2) Fire maps of the Forest Fire Research Laboratory, Remote Sensing Unit, V.N.Sukachev Institute of Forest, on the GFMC website (daily updates and archive):
http://www.fire.uni-freiburg.de/current/globalfire.htm and
http://www.fire.uni-freiburg.de/current/archive/archive.htm#RUSSIAN FEDERATION

(3) UN-ISDR Inter-Agency Task Force For Disaster Reduction, Working Group on Wildland Fire: http://www.unisdr.org/unisdr/WGroup4.htm

(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**