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Recent Trends of Forest Fires in Central Asia and Opportunities for Regional Cooperation in Forest Fire Management

1. Introduction

Over the past decade, many countries have witnessed a growing trend of wildfires of extreme severities in forest and non-forest lands. This has been noted also in Central Asian countries where large fire situations in forest and steppe ecosystems have resulted in considerable ecological and economic damages. Sometimes these wildland fires have transnational impacts, for example smoke pollution and its impacts on human health and safety; loss of biodiversity; or site degradation at landscape level leading to desertification, flooding, and reduced food security. The depletion of terrestrial carbon by fires burning under extreme conditions in some vegetation types, especially in temperate and boreal wetlands, is an important factor in causing disturbance in the global carbon cycle.

Increasing vulnerability of human populations living in or around forest environments – in the wildland-residential / urban interface – has been noted throughout the world. Projected trends of climate change impacts on vegetation cover and fire regimes, as well as observed demographic and socio-economic trends suggest that wildland fire may continue to play a major role in the destruction of vegetation cover resulting, among other, in increasing occurrence of weather-related secondary ecological and humanitarian disasters such as mass movement of soil cover and extreme flooding.

2. The Wildland Fire Situation in Central Asia

In the recent years the Global Fire Monitoring Center (GFMC) has monitored the fire occurrence in some parts of Central Asia. In the GFMC database there is almost no information available on forest fires in Azerbaijan, Dagestan, Georgia, Kyrgyzstan Tajikistan, Turkmenistan and Uzbekistan. Thus, examples are given for countries for which more detailed knowledge is available (Mongolia, Kazakhstan and the Central Asian part of the Russian Federation).

Mongolia

Some data are available on fire occurrence in Mongolia (Goldammer 2001). Here the highest forest fire hazard is found in the submontane larch (*Larix sibirica*) and pine (*Pinus sylvestris*) stands growing on seasonally freezing soils. These stands are distributed on Khentey, East Khentey and Khubsugul foothills that are characterised by an extremely continental climate. Forest fire statistics for the period 1963 to 1997 reveal that the majority of fires burned within the central and eastern parts of the forested area. This can be attributed to the predominance of highly fire susceptible (highly flammable) pine and larch stands. Moreover, economic activity is much higher here as compared to other parts of the region. Extreme fire seasons are caused by long droughts. Fires burn from April to July under such conditions. The average fire season usually has two peaks. One peak is during spring (from March to mid June) and accounts for 80 per cent of all fires. The other fire peak falls within a short period in autumn (September to October) and accounts for 5 to 8 percent of all fires. In summer, fires occur very rarely (only 2 to 5 percent of the total) because of heavy rains.

In one of the most sparsely populated countries in the world, it is difficult to get accurate information on fire causes. It is known, however, that during the main fire seasons (spring and late fall), no natural fire causes exist. The recent increase in the number of fires is related to the opening of markets once highly controlled or restricted. The vast majority of fires are not deliberately set to clear land. Rather, it is a function of carelessness. One example is the collection of elk antlers for sale to European and Chinese markets. During the previous regime, a single, state run enterprise managed this market under strict controls and guidelines. Today, it is open to virtually anyone.

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Fires start for three reasons:

1. Antler collection starts in the bitter cold of February when fire is simply a survival tool.
2. Sparks from vehicle exhaust pipes in remote forests.
3. Tracer bullets left by the Russian military have entered the game hunting market and are used to hunt elk for the blood antlers which have a higher value in the market place.

The most obvious consequence of frequent and intense fires is the loss of forested land. The current fire pattern is affecting 14 percent of this resource annually. The brief growing season and low growth capacity of the trees means that these forests may take 200 years or more to regenerate. In addition to their commercial value, these forests are a precious ecological resource. They contain the sources of virtually all rivers in the country including the inflow to Lake Baikal (Russia), the largest fresh water lake in the world. They protect soil, rangelands, provide habitat for wildlife and serve as windbreaks.

The intra-annual distribution of fires has been documented by seven forest protection air bases for the Khanngai and Trans-Baikal forest zones for the period 1985 to 1994. In these zones, fire activity is the highest in April and May with 33.3 percent and 48.1 percent of their total number in a fire season, respectively. Fires start in late March and early April, immediately after snow melt when forest fuels are drying rapidly on southern- and western-facing slopes.

Mongolia is experiencing a dangerous increase in wildfires. From 1981 to 1995, forest and steppe fires burned an average of 1.74 million ha annually. In 1996 and 1997, the area affected by fire was 10.7 and 12.4 million ha respectively – an increase of more than six-fold. The areas hardest hit by these increases have been the forested regions. The typical forest fire season (1981-95) swept through some 140 000 ha (on average 8 percent of the total area burned), already a large area. However in 1996 and 1997, this figure radically increased to nearly 18 times the previous average - some 2.5 million ha annually, corresponding to ca. 22 percent of the total land area affected by fire. In these two years alone more forested areas burned than were harvested over the last 65 years. Figures 1 provides a map showing the forest and steppe areas burned in 1997.

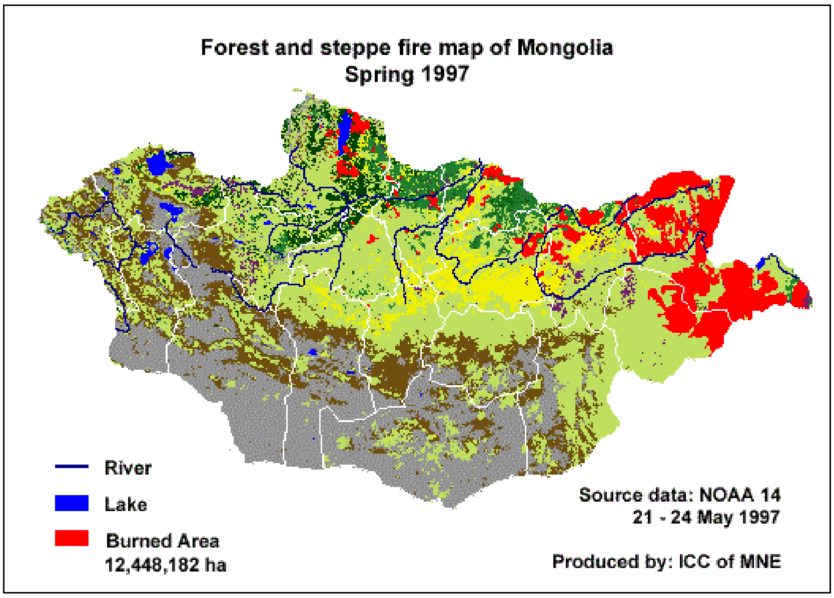

Figure 1. Forest and steppe fire map of Mongolia for the spring fire season 1997. Source: Information & Computer Center (ICC), Ministry for Natural> Resources and Environment.

Kazakhstan

In Kazakhstan fire and pest management has become an increasing concern (Arkhipov et al. 2000). Fires are part of the natural ecosystem cycle, but the great majority (over 80%) are caused by humans. The average area damaged by fire annually in Kazakhstan increased from about 4,000 hectares over the 1985-90 period to 20,000 hectares over the 1996-2000 period (with an additional catastrophic high of 200,000 hectares in 1997). This was only partly due to the increased public access to forests (the number of fires has increased insignificantly); the main reason for a major increase in severity and extent of fire impact (i.e. area burned) is due to the lack of timely fire detection and control which deteriorated because of the lack of financing. Also rural people on farm land adjacent to forests, tend to burn off vegetation and such fires may accidentally spread to forests. Public budgets for fire and pest management have declined, and there is a need to shift expenditures from suppression of fires or pest outbreaks which have already started, to fire prevention and public awareness (which is much more cost-effective). In addition, and linked to budget, finance and governance issues, some fires may have been deliberately started to circumvent the 'no cutting' rule for healthy forests. Fire-damaged timber is presently allowed to be harvested for sanitary reasons at low stumpage prices, and can be a lucrative source of income. Fires and pests are a major concern in the north and northeast, especially in the relic pine forests of the Irtysh River watershed where over 100,000 hectares were severely damaged by fires in 1997 and are being increasingly damaged by pests and uncontrolled 'sanitary' cutting since then.

Table 1. Classes of natural fire danger by V. Arkhipov (Arkhipov et al. 2000)

Danger Class	Groups of Forest Types, Planted and Deforested Territories	Characteristic Fire Types and phases of their origin
1 Very High	Coniferous saplings. Logged sites of dry and fresh pines, larch, fir and grassy cedar forests, bushy broad grassy silver fir forests. Dry and rocky pine forests. Damaged and dying tree stands (died dry stands, sites of storm debris and wind Falls, unfinished harvest sites, slash, insect-damaged stands).	Surface fires during the whole fire season. Crown fires occur on sites with high fuel loads.
2 High	Young pine forests, especially with pine undergrowth. Periodically dry larch forests. Cedar forests on country rocks of southern slopes. Dry growing conditions of flood-plain forests.	Surface fires are possible during the whole fire season. Crown fires occur during the phase of highest fire intensity.
3 Medium	Continuous harvest areas of coniferous forests in moist and wet sites. Dry fir forests, fresh larch and fir forests, wet pine forests. Mountainous-valley silver fir and fir forests. Cedar forests of remaining types of a forest. Fresh growing conditions of flood-plain forests. Radical and derivative fresh birch and aspen groves and their cut sites.	Surface and crown fires are possible in phases of summer fire maxima, and in mountain forests - in phases of spring and autumn maxima.
4 Low	Wet pine forests. Wet dark-coniferous taiga forests. Wet larch forests. Mossy-grassy silver fir forests, wet fir forests. Mossy fir forests. Bushy, dog-rose and aspen fir forests. Apple, birch and aspen groves. Wet growing parts of flood-plain forests. Black saksaoul.	The occurrence of fires is possible in phases of spring and autumn fire maxima. In a phase of summer maxima the fires are possible in pine forests
5 Very Low	Sub-alpine coniferous forests. Cedar forests on bare rocks. Wet birch and aspen groves. Damp poplar groves. Willow groves of all types. All types of saksaoul (except black saksaoul).	The start of a fire is possible only under extraordinarily unfavourable conditions.

Russian Federation

The ecology and management of forest fires in Russia have been subject of a large number of publications (see summary by Goldammer and Furyaev 1996). In this paper we concentrate on the

question of statistical data. The official statistics show that in Russia between 20,000 and 40,000 fires occur annually affecting an area of 2 to 3 million ha of forest and other lands (Davidenko et al. 2003). They are detected and controlled only in protected forests and protected pasture lands. However, the use of the space-borne sensors such as the NOAA/AVHRR Advanced Very High Resolution Radiometer) and more recently Terra/Aqua/MODIS (Moderate Resolution Imaging Spectroradiometer), ENVISAT/MERIS (Medium Resolution Imaging Spectrometer) and Terra/ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer), permitted considerable improvement in the detection of active fires along with better estimation of areas burned and impacts (Siegert et al. 2005).

For example, before the 1980s it was reported that, on average, fires annually burned 1.5 million ha in the boreal forests on the territory of the former Soviet Union Recent investigations based on satellite imagery revealed that the magnitude of fires had been underestimated. Surveys using remote sensing ascertained that boreal zone fires burned annually an average of 8 million ha with considerable fluctuation between years. For example in 1987 satellite image evaluation revealed a total area burned in the East-Asian regions of Russia of about 14 million ha (Figure 2). It must be noted, however, that this fire-affected area derived from satellite imagery included forests, other wooded lands and other land, including wetlands.

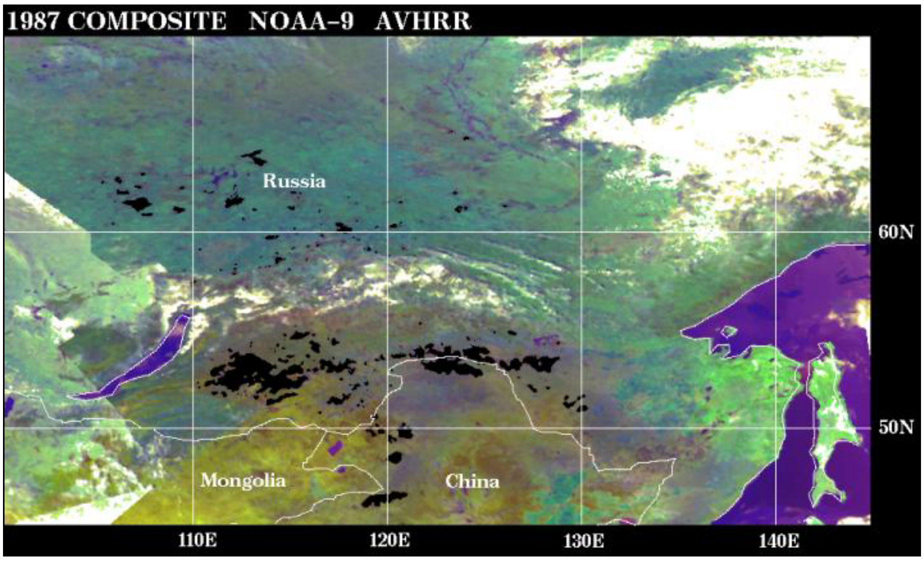

Figure 2. NOAA-AVHRR-derived burn scar map of the fire season of 1987 (Cahoon et al. 1994).

A number of severe fire seasons followed, especially the seasons 2002 and 2003. Table 2 shows the magnitude of fires affecting the territory of the Russian Federation as reported by the government agencies and as depicted by satellite-based remote sensing.

The table reveals the problems of accurate fire size and 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 in 2002-2003 on the area of jurisdiction does not reflect the complete picture.

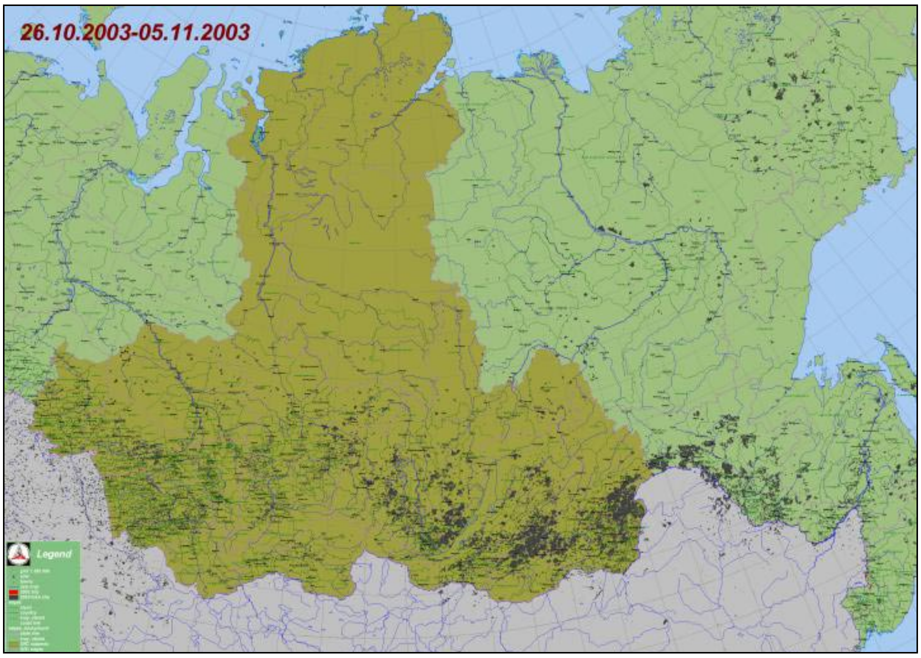

Figure 3. NOAA-AVHRR-derived burn scar map of the fire season of 2003. Source: Sukachev Institute for Forest.

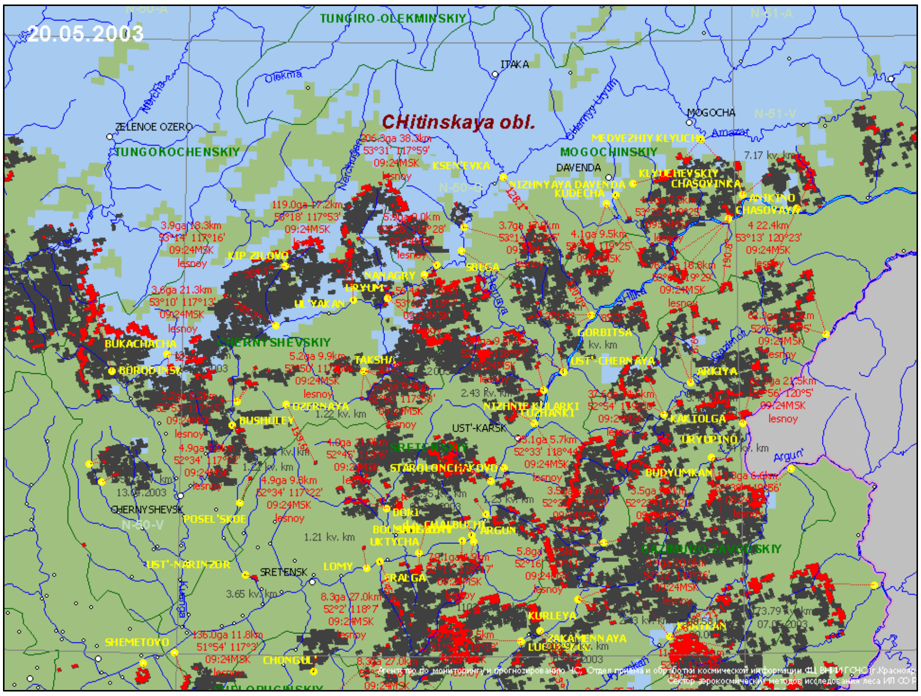

Figure 4. Example of a satellite-derived (NOAA-AVHRR) daily burn scar map, showing a fragment of Yakutia, 20 May 2003. These maps are generated daily by the Fire Laboratory of Sukachev Institute for Forest and displayed on the website of the Global Fire Monitoring Center (GFMC).

The Krasnoyarsk satellite receiving station at the Sukachev Institute for Forest, Krasnoyarsk, is now capable of downloading and processing both AVHRR and MODIS data. The region covered includes 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.) and are therefore much higher (Table 2).

Another recent study of the fires of 2003 occurring in the region between 110.27°E to 131.00°E and 49.89°N to 55.27°N evaluated data from MODIS, MERIS and ASTER sensors and compared these with NOAA AVHRR. The study revealed that more than 20.2 million ha of forests and other lands had been affected by fire in this region in 2003 (Siegert et al., 2004).

There are also other datasets on fires in the Russian Federation which are not directly comparable with the observations of 2003. For instance, the initiative "Global Burnt Area 2000" (GBA-2000) of the Global Vegetation Monitoring (GVM) Unit of the Joint Research Center (JRC), conducted in partnership with other six institutions, has produced a dataset of vegetated areas burnt globally for the year 2000. GBA-2000 used the medium resolution (1 km) satellite imagery provided by the "SPOT-Vegetation" system to derive statistics of area burned per type of vegetation cover. The global dataset available for the year 2000 provides area burned by nations. The dataset shows 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 of forest, 3.31 million ha of woodland, 5.3 million ha of wooded grassland, and 10.66 million ha of other land (including 7 million ha prescribed burning of croplands). The GBA-2000 number of 6.4 million ha of forest and woodland burned must be compared with the reported area burned for the *Avialesookhrana* region of 1.64 million ha (Avialesookhrana 2002) 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 (Sukhinin 2003, pers. comm.). Table 3 shows all GBA data for the Central Asian Countries, including the Russian Federation, and its immediate neighbours.

For the future use of satellite data for operational and ecological monitoring purposes it is now very important to be able to distinguish between fires that are causing damages to forests and other ecosystems (e.g., peatlands) and those fires burning in forests and open lands that are not harmful or that are even beneficial for ecosystem stability and productivity.

Table 2. Comparison of wildland fire data for the Russian Federation: Agency reports vs. satellite-generated data. For details: See text.

Year	Agency Reports based on Ground and Aerial Observations			Satellite Derived Data (NOAA AVHRR) Based on Fire Counts and Derived Area Burned		
	Number of fires reported	Total area burned (ha)	Forest area burned (ha)	Number of fire events investigated	Total area burned (ha)	Forest area burned (ha)
2002	35,000	1,834,000	1,200,000	10,355	11,766,795	n.a.
2003	28,000	2,654,000	2,074,000	16,112	17,406,900	14, 474, 656

Table 3. Data of total area burned in Central Asian countries and its immediate neighbours in the year 2000, obtained from the Global Burnt Area 2000 initiative (GBA-2000).

Country	Area Burned in 2000 (ha)	Country	Area Burned in 2000 (ha)
Afghanistan	69 200	Russia	22 384 100
Azerbaijan	54 200	Tajikistan	42 900
Georgia	16 500	Turkmenistan	26 600
Kazakhstan	8 165 200	Ukraine	2 165 500
Kyrgyzstan	108 300	Uzbekistan	51 100
Mongolia	2 628 700	**Total**	**35 712 300**

Other Central Asian Countries

Very limited amount of information on occurrence and impacts of wildland fires in other Central Asian countries is available to the GFMC. The data based on the remote sensing study "Global Burnt Area 2000" (Table 3), however, shows that outside of the three countries described above the fires do occur in forest, grasslands and steppes. An emergency situation was monitored in Afghanistan where on 12 June 1999 a fire broke out in the forest of the Sholake valley, Kunar province of Afghanistan. On 17 June 1999 the local authorities reportedly were unable to control the fires. On 18 June the fire advanced rapidly through Dara Pech valley, some 30 kilometers south of the provincial capital Asadabad. The Islamic Emirate of Afghanistan in Islamabad which provided the update to the United Nations Office for the Coordination of Humanitarian Assistance to Afghanistan (UN-OCHA) in Islamabad has transmitted updated information via the United Nations Office for the Coordination of

Humanitarian Assistance to Afghanistan in Islamabad that over 10 km^2 of forest had been completely destroyed. Some 300 livestock had been killed and 10 villages burned. No human casualties have been reported. On 21 June 1999 several thousand families reportedly fled their homes and international help was requested to fight the fires. According to that report at least four people have been killed.

In this case the international community was unable to assist Afghanistan in fighting these disastrous fires. However, the Afghanistan case was a reason to reflect about the creation of international mechanisms for mutual (bilateral, multilateral) assistance in wildland fire emergencies (see final part f this paper).

3. Transboundary Effects of Wildland Fires: Fire Emissions, Public Security and Health

Short- to long-distance transport of smoke within Central and East Asia has been noted during the last years. The fire episode of 1998 caused severe smoke pollution in the Far East of Russia. In 2003 the extended wildfires in the Trans-Baikal region resulted in severe smoke pollution of Mongolia and China. Smoke plumes generated by fires burning in forests, grasslands and swamps in Irkutsk, Chita and Buryatia regions travelled as far as Sakhalin, Japan, North America and finally Europe.

The consequences of smoke pollution were recorded in Khabarovsk. The situation worsened starting midday of 15 October 2004. Some air quality parameters are recorded by six monitoring stations in Khabarovsk city. Together with smoke the wind transported dust in the city. The dust content before 15 October was 0.4 mg/m^3, between 15 and 18 October 2004 – 0.9 mg/m^3, and after 18 October 2004 – 0.5 mg/m^3. In the center of the city at 13.00 of 18 October the value was 0.9 mg/m^3 (equivalent to 1.8 maximum permissible concentration - MPC), at 19.00 the same day – 2.3 mg/m^3 (= 4.6 MPC).

Highest concentrations of carbon monoxide (CO) – the trace gas most dangerous to human health – were recorded close to the fires burning in the Jewish Autonomous Region. In the center of Khabarovsk city CO values reached 7.3-7.7 mg/m^3 (= 1.5 MPC); in other monitoring stations the values between 15 to 20 October 2004 ranged from 7.8 mg/m^3 (= 1.6 MPC) to 25.8 mg/m^3 (= 5.3 MPC).

Elevated radioactivity transported airborne from fires occurring in radioactively contaminated vegetation of Eurasia, notably radioactive caesium (CS-137), has been observed after forest fires in the Chernobyl nuclear accident zone (Dusha-Gudym 1996, 1999, 2002, 2005). It is assumed that wildfires burning on former nuclear weapons test sites in Central Asia, e.g. in Semipalatinsk Region (Kazakhstan), result in release and uncontrolled aerial transport of radionuclides and may affect neighbouring countries.

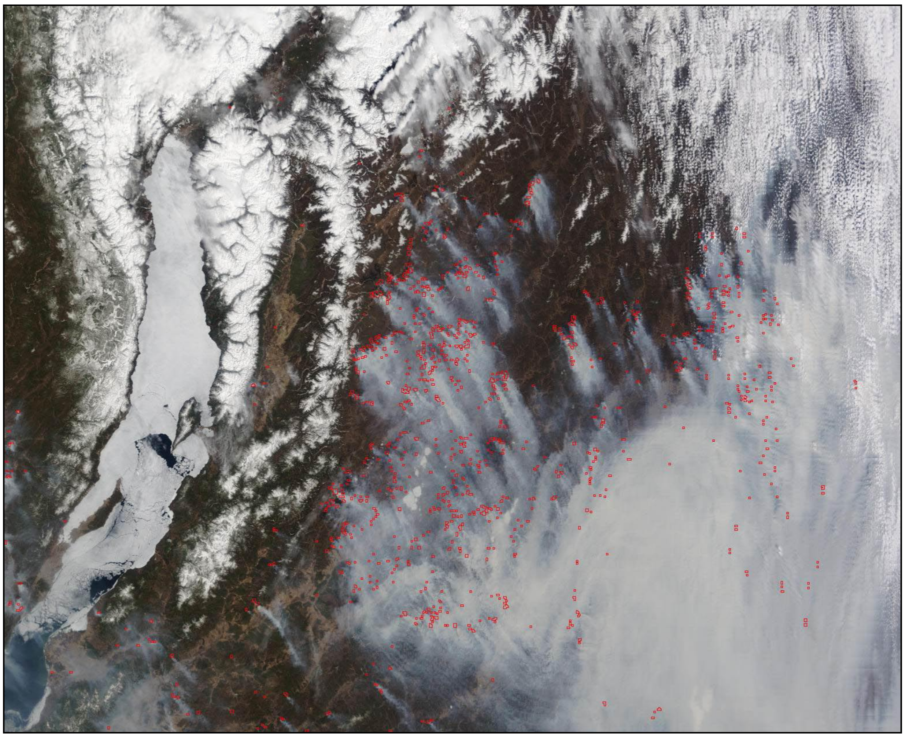

Figure 5. Smoke produced by fires burning on 8 May 2003 at 0400 UTC (11:00 local time) in the region Southeast of Baikal Lake. Source: Moderate-Resolution Imaging Spectroradiometer (MODIS).

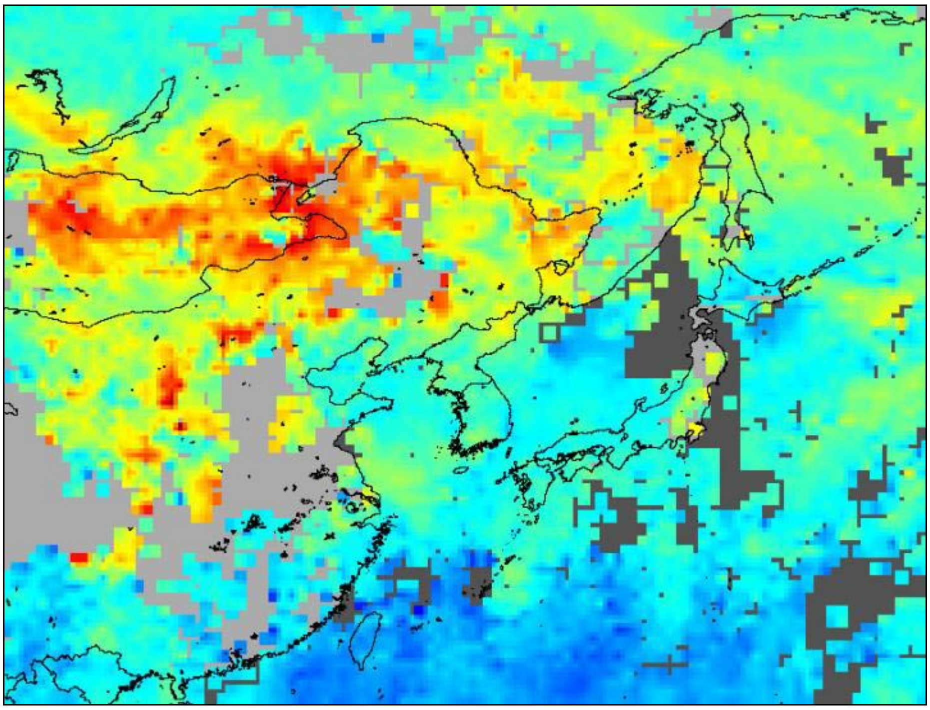

Figure 6. Accumulated carbon monoxide concentration for the period 3-8 May 2003 originated by smoke from wildland fires in the Transbaikal Region. The image shows measurements of carbon monoxide captured by the Measurements of Pollution in the Troposphere (MOPITT) sensor on the Terra satellite, with values ranging from zero (dark blue) to 360 parts per billion (red). Source: NASA Earth Observatory (http://earthobservatory.nasa.gov/)

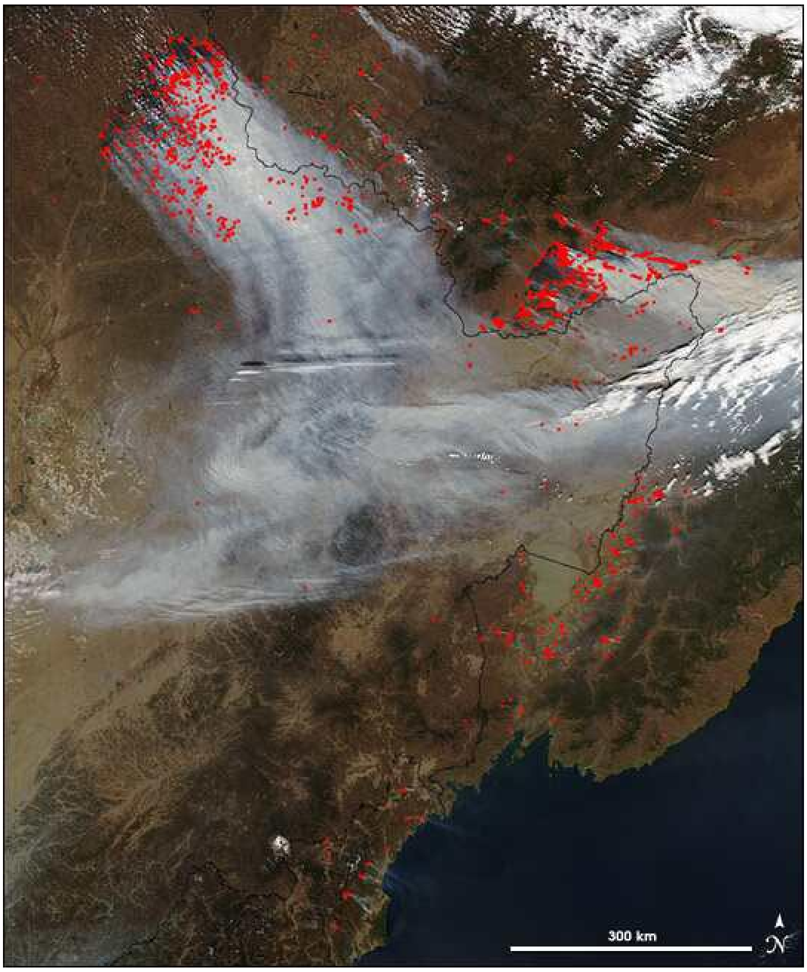

Figure 7. Smoke transport from fires (marked in red) in northern China (top left) and south-eastern Russia (right) on 15 October 2004 as depicted by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite. Source: http://earthobservatory.nasa.gov

Figure 8. View of smoke-haze pollution of Khabarovsk city center on 16 October 2004.

4. The Challenge for Central Asia

Fire is an important natural process in some forest and steppe ecosystems of Central Asia. People have also traditionally used fire as a land-management tool. The challenge is to develop information tools and management capabilities that recognize both the beneficial and traditional roles of fire, while reducing the incidence and extent of uncontrolled burning and its adverse impacts.

The trend of increasing fire occurrence throughout the world and also in Central Asia is stirring the international community to address the problem collaboratively. The development of informal partnerships, joint projects and formal agreements among governments and between government and non-governmental institutions is essential to enable nations to develop sustainable fire management capabilities.

In order to share human and technical resources in wildland fire management, a number of collaborative activities have been initiated throughout the world during recent years. Representatives from Central Asia already have participated in international and regional conferences such as the 3rd International Wildland Fire Conference (Sydney, Australia, October 2003) and the "ECE/FAO conference on Cooperation in Wildland Fire Management in the Eastern Mediterranean, Near East, Balkans, Central Asia (Turkey, 30 March – 2 April 2004)". In Antalya the establishment of a Regional Central Asia Wildland Fire Network to be tied to the Global Wildland Fire Network has been discussed (see Annex).

Based on the presentation of this report and the discussion at the Central Asian Forest Congress the delegates of the Central Asian countries are encouraged to endorse the GFMC/FAO "Framework for the Development of the International Wildland Fire Accord" and formulate specific recommendations to the FAO Ministerial Meeting on Forests in March 2005.

Source: Paper prepared for the Regional Forest Congress «Forest Policy: Problems and Solutions»

25-27 November 2004, Bishkek, Kyrgyzstan, by

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