THEIR CAUSES AND CONSEQUENCES, FOREST FIRES IN PRIMORSKIY AND KHABAROVSKIY KRAIS

Alexander Sheingauz[1]

INTRODUCTION

The Report embraces Primorskiy and Khabarovskiy Krais, which are subjects of the Russian Federation. They are the most economically developed and heavily forested provinces of the Russian Far East (RFE). A description of these territories was given in Report 1. Here, as in the previous Report, we retain for analyzing these territories the term "S-RFE" (the southern part of the RFE).

For many centuries forests of the S-RFE have grown under the influence of wild forest fires that covered this territory with a natural frequency. In 1854, the planned and constant development of the S-RFE territory and its forests had begun. This development has increased the sources of fires and made forest fires more frequent. The wild fires have been replaced by anthropogenic ones and have became not just one of many factors of forest growth, but as a main factor of forest resource status and dynamics.

The data collection and report writing had been made by a team under the supervision of Prof. Dr. Agr. Sci. Alexander Sheingauz, Economic Research Institute, Far Eastern Division, Russian Academy of Sciences (Khabarovsk, Russia). The team was formed on the base of the Khabarovskiy Krai ecological non-governmental organization "Ecodal".

NATURE OF FOREST FIRES

The Primorskiy and Khabarovskiy Krais stretch along western Pacific coastline from northeast to southwest as one tract of 2460 km length and 800 km maximum width. Their climate zones vary from mountain deserts to rich boreal mixed forests and prairie-forest meadows.

There is the official Russian classification of territory according to fire danger classes. It divides all forest area into 5 classes with different coefficients of fire danger classes (Table 1.1).

Along with forest inventory, each forest block (50-800 hectares) is allocated to one of the fire danger classes. Hence it gives a distribution of the *leskhoz*'s territory as a whole by fire danger classes (Table 1.2).

One can see that the average fire danger class in both of the Krais is similar: 2.8 in the Primorskiy Krai and 2.7 in the Khabarovskiy one. However, the distribution types are very different. In Primorskiy Krai more than 2/3 of the territory is concentrated in the III (middle) class and less than 1 percent in the utmost classes (I and V). In the Khabarovskiy Krai the distribution by classes is more even.

There are two main sources of information about forest fires. The first source is official. It is based on the data that are created for each fire by *leskhoz* and air base staff. The data are compiled forperiodical official review. The second source is detailed descriptions and studies (often long-term) of single biogeocoenosis[2] as large forest tracts that are contained in the scientific literature. Both of these sources are supplemental to each other [Starodumov, 1966].

[1] Prof., Dr., Head of the Department of Natural Resource and Infrastructure Problems, Economic Research Institute, Khabarovsk, 680042 Russia. E-mail:sheingauz@ecrin.khstu.ru

[2] Biogeocoenosis is homogeneous area of land surface that has specific structure of living organism association (coenosis) and inorganic components (soil, solar energy, etc.). They are in a state ofmutual dynamic interaction, in interchange of matter and energy. The term has Russian origins but now it has become international. It is the main unit of elementary level forest inventory.

Table 1.1. Territory classification of fire danger classes according to forest growth conditions

Class	Dange level	Coeffi-cient	Territory type
I	very high	1.0	Sites not covered with forest but with grass and lichens. Forests with grass and lichens as above-soil cover. Deciduous forests on the southern slopes.
II	high	0.7	Mixed and deciduous forests on the western and eastern slopes.
III	middle	0.5	Mixed forests on the foothills. Fir-spruce forests with moss, grass and brush. Larch forests with wild rosemary and dead leaves as above-soil cover. Deciduous forests on the northern slopes.
IV	moderate	0.2	Mixed and deciduous moisture forests on the valley.
V	low	0.1	Larch and fir-spruce forests with sphagnum on wet and swamp sites. Swamps.

Source: Far Eastern Forestry Research Institute, 1998.

Table 1.2. Territory Distribution by Fire Danger Classes

Fire Danger Classes	Primorskiy Krai		Khabarovskiy Krai	
	area, 1000 ha	Percent	area, 1000. ha	percent
I	0.7	5.9	17.9	24.3
II	2.3	19.4	12.7	17.2
III	8.1	68.3	29.7	40.3
IV	0.8	6.3	3.5	4.8
V	0.01	0.1	9.8	13.3
Total	11.9	100	73.7	100

Sources: data of the Krais' Forestry Service Directorates.

Biogeocoenosis and even lower level forest fires almost in all instances appear to be episodic and catastrophic wild disasters causing absolute loss. On the level of forest tract and higher, at least in the forest zone of the S-RFE (and it is almost its whole area), forest fires should be considered as something given by the Heavens as an inevitable factor of this cover existence and development [Sheingauz et al., 1980].

Fire influence on larger forest cover units has a definite trend to either burning mechanism description itself or loss evaluation. At the same time, on the level of heterogeneous taxonomic forest cover units, the resulting influence of fires looks different and more diversified than on biogeocoenosis, parcels at the vegetative organism level.

The S-RFE is unique in the respect that researchers-and eye-witnesses were able to record practically the whole scene of natural forest development and transformation. It is obvious that detailed forest development scenes can not be reconstructed, but the completeness of such can be higher here than in other regions [Methodical Recommendations, 1986].

These studies' data show that, before the mass colonization onset (mid- 19th Century), the S-RFE forest cover had clear and rather wide-scale pyrogenesis traces.

Fire occurrence constantly increased in the process of the territory's development. This is confirmed by direct and indirect data. The causes of these phenomena are definitely multiple, but the main fire cause is anthropogenic [Telitsyn, 1983] (Table 1.3).

The probability of fire is increased by [Sheshukov, 1979]:

- domination of coniferous forests;
- periodic repeat of extreme dry seasons;
- abundance of dangerous fire starting material(dry grass and leaves, bushes, etc.);
- mountainous relief;
- territory inaccessibility;
- strong wind regime.

Table 1.3. The Causes of forest fires, average for 1988-1997, (percentage)

Causes	Krai	
	Primorskiy	Khabarovskiy
Careless behavior of population with fires	64.0	57.9
including: logging operations and	…	5.1
survey expedition operations	…	6.5
Agricultural burning of grasslands	25.0	12.2
Lightning	4.8	16.1
Others	6.2	13.8
Total	100	100

Sources: Data of the Krais' Forestry Service Directorates.

SIZE AND ALLOCATION OF FOREST FIRES

The average duration of fire danger season in Khabarovskiy Krai is 200 days per year which varies from 155 days in the north to 210 days in the south. In Primorskiy Krai the average duration is 225 days with variation from 215 in the north to 300 in the south [Solodukhin, 1955] (Pictures 1 and 2).
Fire number and burnt area manifest very wide fluctuations from year to year (Table 2.1).

Accordingly, the frequency and spread of fires are very different in both of the Krais -- the average fire size in 1998 in Primorskiy Krai was 49.5 ha and in Khabarovskiy Krai it was 322.7 ha. In Primorskiy Krai, 0.1 fires arose per 1 thousand citizens each year. In Khabarovskiy Krai the figure is higher: 0.5 fires per 1 thousand citizens.

To take a more long term look at fire registration, after the Second World War one can calculate in Primorskiy Krai 6 peak years of burnt area and 9 peak years in Khabarovskiy Krai. Catastrophic fires, that periodically occur once in 10-12 years, cause changes of forest cover many times surpassing average annual ones [Kurbatskiy, Sheshukov, 1978; Recommendations for Control, 1987].

Thus, the forest fire situation in Primorskiy and Khabarovskiy Krais are very different for 2 reasons:

The type of forest vegetation - in Primorskiy Krai the share of coniferous is less.

The intensity of forest management - in Primorskiy Krai it is higher.

Such strong factors of forest dynamics as logging operations correlate with allocation of forest fires but not so closely as everybody thinks. Hence, in some regions the leading factor of forest cover dynamics appears to be fire influences other than logging operations. In addition, the cutting volume is inertial in time and therefore stable enough in years, but fire area and fire intensity fluctuate annually [Telitsyn, 1988].

Table 2.1. Fire number and burnt area

Year	Primorskiy Krai			Khabarovskiy Krai		
	Number of Fires	Burnt Area, th. ha	Average fire, ha	Number of Fires	Burnt Area, th. ha	Average fire, ha
1988	217	4.3	19.8	1224	353.0	19.8
1989	351	19.3	55.0	997	115.7	55.0
1990	227	1.3	5.7	953	130.9	5.7
1991	127	3.1	24.4	291	11.5	24.4
1992	216	6.9	31.9	372	17.1	31.9
1993	262	14.4	55.0	651	60.3	55.0
1994	78	3.3	42.3	278	13.0	42.3
1995	178	22.5	126.4	569	53.8	126.4
1996	187	6.8	36.4	1128	191.0	36.4
1997	425	13.3	31.3	389	34.0	31.3
1998*	556	58.6	105.4	1262	1900.0	105.4
Average	256.7		49.5	737.6		322.7

* to October 26. Source: Far Eastern Forestry Research Institute.

CATASTROPHIC FOREST FIRES OF 1998 IN KHABAROVSKIY KRAI

In Khabarovskiy Krai after the spring of 1998 (end of May) a serious lack of humidity had formed. Against usual monsoon summers, only 15-25 percent of average precipitation had fallen in June to August. The September and the first half of October was also dry, as usual. This created a very dangerous forest fire situation.

By the middle of July there existed 40-50 fires each day. They were controlled by local Forestry Service, which involved all current and reserved possibilities. This service consisted of all personnel of the Forest Guard, staff and equipment of 44 forest fire-chemical stations, 350 forest firemen, and 290 forest fire parachuters. The employees and bulldozers of logging firms were also involved 480 fires were extinguished.

At that time the smoke had become so thick that air apparatus couldn't operate. The fire control was lost. A state of emergency was officially announced in Krai, and entry into the forest was prohibited for the local population. From that moment the forces of the Russian Emergency Ministry, some regular military troops, and forest firemen from other Russian regions were involved. On the most dangerous days this force consisted of up to 2000 persons, and 500 machines including 150 bulldozers, etc.

The main goal of that period was not to extinguish fires but to defend settlements, communication lines, roads, etc.

Rain and snowfall began in the middle of October. Fires were extinguished fully by October 22.

The damage consisted of 2201.8 thousand hectares of burnt area including 1563.3 thousand hectares of area covered by dense forests. The wood stock loss was equal to 154.3 million cubic meters. Ecological and economic damage was estimated at 4.6 billion rubles (207.2 million of US dollars) [Kolomytsev, Sheshokov, 1999].

AFTER-EFFECTS OF FIRES ON FOREST COVER

According to the last state forest inventory that had taken place on January 1, 1998 (before the catastrophic fires in Khabarovskiy Krai), the burnt area amounted to 41.4 thousand hectares (0.3 percent of total forest land use) in Primorskiy Krai and 1461.1 thousand hectares (2.0 percent of total forest land use) in Khabarovskiy Krai. If we keep in mind that long-term presence of dead forests, sparse forests and waste land are mostly linked with repeated fires, then the share of burnt area increased to 1.1 percent in Primorskiy Krai and 5.2 percent in Khabarovskiy Krai.

In general, the influence of fires appears higher than the influence of cutting and therefore they are "factor number 1" for structure and dynamics of the Russian Far East forest cover [Natural Resources, 1995; Sheingauz et. al, 1996].

It is difficult to have full and reliable figures of fire after-effects. The reasons are [Sheingauz, 1979]:

- incomplete forest resources coverage by reliable inventory;
- not simply poor, but deliberately misrepresented forest fire records;
- practically lacking fire consequence records especially on prolonged fires, etc.

However, rather large-scale relative to territory and relatively long-term records have been compiled. Not always do they allow the developing of numerical models, however using specially developed methods, one can obtain rather adequate expert estimations (Table 4.1).[3]

The figures in Table 4.1 are underestimated rather than overestimated. Close correlation between pyrogeneity and forest disturbance in the Russian Far East as a whole is obvious (correlation coefficient is 0.82).

Table 4.1. Degree of pyrogenesis and forest cover destruction, (percent of territory)

Krai	Share of lands with associations of pyrogenic origin	Forest cover disturbance
Prymorsky	39	31
Khabarovsky	29	36

Source: author's calculations

[3] *Sheingauz, A.S.* Methods for evaluating acyual area rate of burning using forestry inventory data. In: Forest Fires and Their effects. Krasnoyarsk, 1998, pp. 66-69. [in Russian].
Karakin, V.P., and *Sheingauz*, A.S. The urgency of the problem related to effective natural resource use. "Geography and Natural Resources". 1988, vol. 3, pp. 14-21. [in Russian].

At the moment, plenty of information has been accumulated. It can provide numerical indices to judge rates and scales of forest transformations under fires. For both of the *krais* there are the rows of forest inventory, which are reliable from 1966, i.e. they contain 7 observation times [Sheingauz, 1996]. The main features are:

- approximate balance of forest cover ruining and natural reforestation with some exceeding of the latter;
- very exact transformation of coniferous forest to deciduous;
- also exact transformation of mature and over-mature forests to young stands;
- the long-term non-productivity in places where fires repeat two or more times, sometimes in such places losses consist not only of wood but soil also [Sheshukov, 1996].

FIRE CONTROL SYSTEMS

The state system of forest fire control has a strong structure (Fig. 5.1). It is part of the Forestry Service and has two verticals. The first vertical is the Forest Guard, which is the main pivot of the Forestry Service. It consists mainly of the federal staff, the staff of *krai* directorates and the staffs of *leskozes*. Fire control is part of their usual control duty. The second vertical is the specialized fire control service. It consists of a chain of air bases for fire control. Fire control is their main duty.

According to Russian Forest Code, fire control is financed from the federal budget. Each year *krai* directorates and *leskhozes* plan their fire control measures: construction of forest roads, water reservoirs and fire barriers, laying of mineral strips on ground, establishing of fire equipment depots, etc. All these measures are financed either from state budget or from funds of the *leskhoz* (Table 5.1).

The expenses to combat fire are also planned according to average annual levels. If the average level is exceeded, this item of financing is enriched from central funds.

Air bases are also financed from state budgets for staff salary, equipment purchase, and lease of airplanes and helicopters. If the average level of fire occurrence is exceeded, the financing of airbases is enriched from central funds also.

Unfortunately, in recent years there have been large insolvencies in covering extra expenses and so part of these extra expenses has been covered by *krais'* budgets.

Table 5.1. Annual cost for fire control

Item	1992[4]	1995	1996	1997
Primorskiy krai				
Total expenses for fire control, million rubles	8.5	990.3	1463	2615
Thousand US dollars*	44.0	218.2	288.5	452.3
Including fire combat, million rubles	0.3	280.2	248	1005
Thousand US dollars*	1.3	61.7	48.9	173.8
Total expenses per 1 fire, million rubles	0.035	5.6	7.8	6.2
Thousand US dollars*	0.2	1.2	1.5	1.1
Khabarovskiy Krai				
Total expenses for fire control, million rubles	54.3	7134.5	17969.0	10744.0
Thousand US dollars*	281.4	1572.2	3543.5	1858.2
Including fire combat, thousand rubles	17.7	3500.1	12756.0	4149.0
Thousand US dollars*	91.5	771.3	2515.5	717.6
Total expenses per 1 fire, million rubles	0.144	12.5	15.9	27.6
Thousand US dollars*	0.7	2.8	3.1	4.8

*According to average annual exchange rates. Sources: Krais' directorates of the Forestry Service.

[4] There exist more early range financial data from 1948. However it cannot be used because of two reasons:
1. The prices in the period 1948 to 1991 were not free; they were allocated, so they cannot be compared with current free market prices. After 1991 the prices have not only another monetary level but another structure and principals of rise.
2. Those data cannot be converted into the international level (USD, yens or DM) because the real exchange rate was implemented in Russia only since 1992.

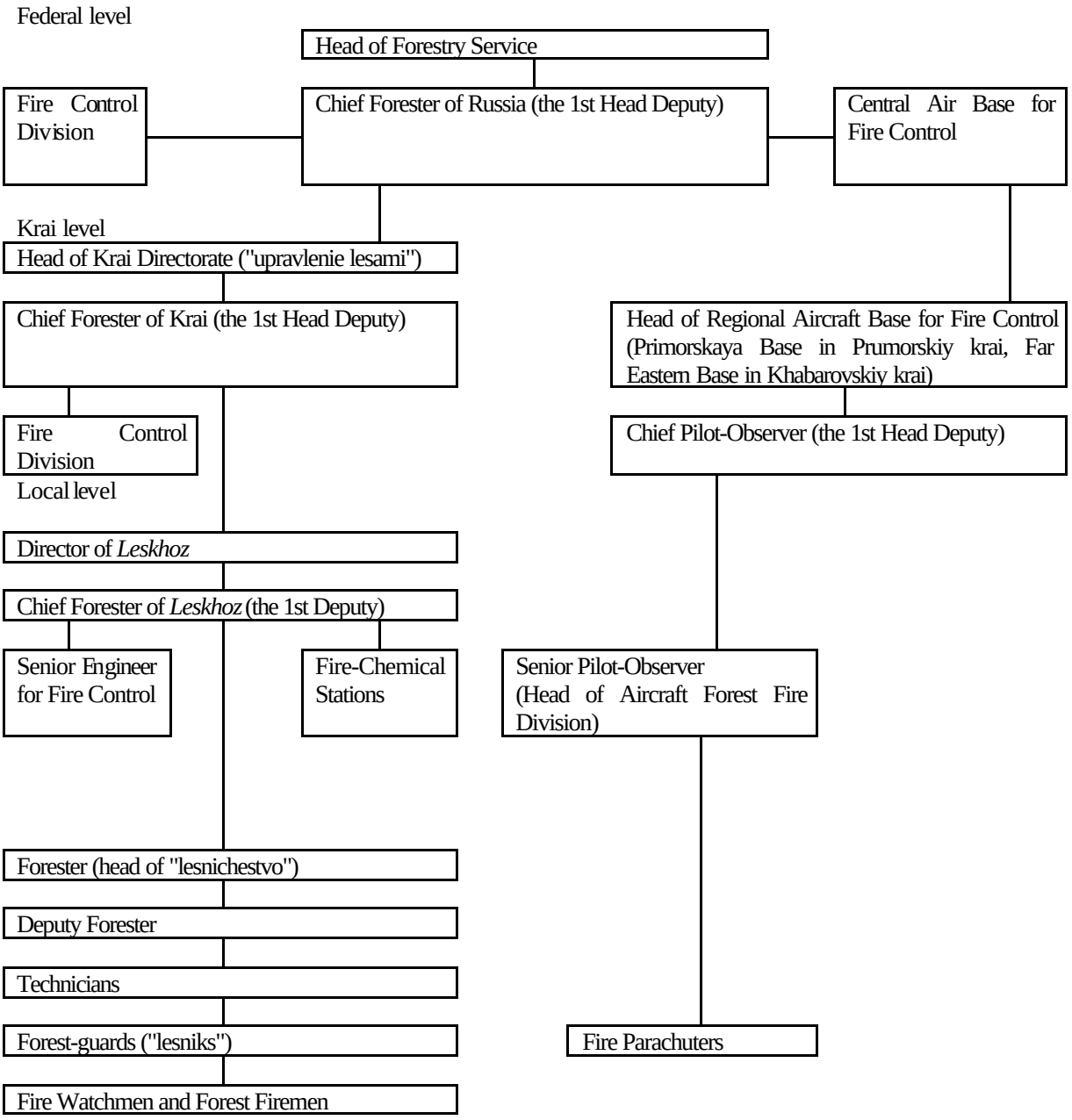


Figure 5.1. Scheme of Fire Control Structure
The left branch is the Forest Guard, the right branch is the specialized fire service.

LEGISLATIVE BASE

The legislative base of forest fire control includes the Forest Code of the Russian Federation adopted by the State Duma (the Russian parliament) and such federal Forest Service acts as:

- Rules of Fire Safety in the Forests of the Russian Federation;
- Instruction for Discovery and Extinguishing of Forest Fires;
- Instruction for Fire Preventive Measures in Forests;
- Status of Fire-Chemical Stations.

To these acts are affiliated:

- Regulations of State Control for Status, Use, Reproduction, Protection and Defense of Forests;
- Statute of State Forest Guard;
- Rules for Timber Harvest In Far Eastern Forests.

The local Forest Code of Khabarovskiy Krai is adopted now by Krai's Legislative Duma and is produced for the Governor's sign. It will become a part of the legal base after completing the process.

Many clauses of the federal and local Forest Codes consist of demands to obey fire control safety. There is also a special chapter devoted to forest protection and defense. It considers:

- goals, tasks and order of fire control;
- the state system of fire control;
- the air fire control system;
- participation of federal and krai's authority;
- participation of non-government organizations in forest control;
- duties of forest users in the scope of fire control;
- duties of citizens and firms.

According to the Codes, all participants of forest use , whether persons or firms, must obey all fire control rules very strictly. They must take part in the prevention and extinguishing of fires. In the sense of fire control, the Forest Guard has many rights, it can prescribe special measures, penalties, can prohibit access to the forest in case of high danger or weather.

When a fire begins the staff of Forest Service must mobilize regular and reserve forces and organize fire extinguishing as soon as possible.

All forest users must develop systems of fire barriers, water reservoirs, etc. They must use only such techniques and technologies that are not dangerous. When there is a fire they must send their staff and machines in to battle the fire..

Generally speaking, the fire control system that is provided by the abovementioned acts is well developed and very systematic. So it is the fact that it often fails in reality is not linked with bad acts but with lack of funds and forces.

Other official and semi-official documents develop these items: Recommendations for Forest Fire Control, 1978; Recommendations for Control, 1987; Telitsyn, 1988, etc. They provide directions for the Forest Guard and forest fire control staff on how to operate for fire prevention and fire extinguishing.

SOCIAL-ECONOMIC ASPECTS OF FOREST FIRES

1. Population Attitude to Fires

Over recent history, the S-RFE population had very dramatic changes of structure, size and behavior. So its treatment of forest fires was very different over time [Sheingauz, 1971, 1973].

Primary aboriginal tribes as a whole have tried to protect their areas from fire damage. But it has been the behavior of the tribes to consider fur as the main goods. Those tribes, which wanted the meat of hoofed animals, used fires for burning some areas to attract elk, deer, etc., by the new growth of grass and branches of young trees [Sochava, 1931]. Sometimes, big fires were originated from wars between tribes [Kolesnikov, 1956].

As mentioned in Chapter 4 of Report 1, the development of the S-RFE territory was accompanied with burning of taiga for agriculture. However, in social aspects there were different national relations to the process [Mevzos, 1927]. Migrants from forested Central Russia, Belorussia, Ural and Siberia were habitual to forests and could use their amenities. So for them the Far Eastern taiga was a source of goods. However, migrants from steppe Ukraine, Moldavia and from Korea were not habitual to forests, they were afraid of it and very often they

burnt it as their enemy, seeing it as a source of wild animals that destroyed their fields and mosquitoes that bit them and their cattle.

I mentioned also about the role of spring and autumn burning of grass areas to gain a high productivity of hayfields in Report 1. From the time of the first migrant until now, this is a mighty source of forest fires and a big social and ecological problem.

A new wave of forest burning increase arose in the early 1930s and it continues until now. It was generated with the industrialization of forest logging. This process brought into the forest many machines with their flames and sparks; many people with campfires, cigarettes, etc. The Taiga was filled with fire sources.

The beginning of the last wave can be linked to mass private motorization in the 1970s-1980s. It made achievable many forest tracts and brought in the forests many people who didn't have knowledge of forest behavior.

One of the biggest problems of forest fires was and still is the indiscipline of populations. In spite of all forestry propaganda, they continue to not extinguish campfires, throw about non-extinguished cigarettes, etc. So, as long as such behavior remains, it is impossible to solve forest fire problems.

Another social problem is the common population's conviction that in the S-RFE there are abundant forests and forest fires don't represent significant damage. Such conviction is decreased after catastrophic years (one can see an example of this in 1998-1999) but 2-3 years later the imagination of forest well being is restored.

2. Social Losses

Maybe it is possible to affirm the S-RFE population didn't suffer from forest fires till 1976. Yes, sometimes families lost their usual hunting or beekeeping areas, hunting houses, etc. Larger losses were the burning of logging bases. In such cases the term of forest camp-settlement existence became shorter and loggers' families were forced to change their location earlier than they planned.

The fires of 1976 in Khabarovskiy Krai were the first case of direct social and economic losses [Kurbatskiy, Sheshukov, 1978]. At that time data about forest fires, especially data of direct losses, were top secret. However, it is known that those fires had burnt not only forest sites but also not less than a dozen forest settlements, some sawmills and some military ammunition depots. Maybe about a hundred people perished.

In the sense of losses, the fires of 1976 were more catastrophic than of 1998. So it is possible to maintain that the achievement of 1998 was ostensibly the prevention of asset lose and fatalities.

3. Economic Damage

There is an official method to calculate the economic damage of forest fires. It estimates the stumpage value of burnt wood multiplied by some coefficient (usually between 5 and 10). Such estimation is very far from real economic losses. For example, in 1996 the total damage in Khabarovskiy Krai was estimated as 428.5 million rubles or US$84040, i.e. $440 per 1 hectare of burnt area.

The loss estimation of 1976 had to be dozens of million rubles especially if one takes into account the ruining of ammunition in the military depots.

It is evident that direct wood lose estimation alone doesn't reflect real total losses. To cover such an incorrect approach, the coefficient of 5 to 10 is implemented, but this is not based in any way on reality . The current standpoint of real forest value demands the inclusion into such estimations many different forest amenities and fire control costs. Such an approach was fulfilled for the estimation of losses after fires of 1998 in Khabarovskiy Krai [Kolomytsev, Sheshukov, 1999]. Total physical loss was determined as 1563.3 thousand hectares of densely forested area or 154.3 million cubic meters of wood, i.e. 99 cubic meters per hectare. The wood value was estimated as 1556.2 million rubles or US$70.7 millions. This gives $45 per hectare, less than in 1996 because a coefficient of 3 not 10 was implemented and because ruble devaluation occurred. The ecological loss was estimated not only for dense forest areas but for all burnt areas, that is 2201.8 thousand hectares. This consisted of 3002.1 million rubles or US$62.0 per hectare.

So ecological-economical loss was estimated for stand areas at US$107 and for non-forested areas at US$62 per hectare. However, this is a temporary method that demands further development.

Today some international organizations (World Bank, WWF, etc.) want to help Khabarovskiy Krai with its post-fire problems. They are promising some funds. Such help must be considered not only as financial aid but also mainly as social phenomena.

CONCLUSION

The forest fires in the conditions of Primorskiy and Khabarovskiy Krais have 4 to 5 times higher impact than the logging operations in these areas. The loss manifests first of all in timber stock. At the same time, the situation in different forest areas is highly discrepant. On one hand, vast waste lands endure for long time. On the other hand, during the last 10 to 15 years the total forested area has expanded owing to the emergence of young stands. Natural reforestation and some positive results of long-term efforts to control the fires explain the latter.

According to estimations, the biologic potential of forest lands is currently only 1/2 utilized and the areas of especially strong anthropogenic pressure - only 1/3. The main factor of this pressure is forest fires.

The abovementioned supports the thesis that holds forest fires as dominating factors of forest status and dynamics in the reviewed territory and accordingly determines fire control as the main goal of forest management strategy in both of the Krais.

REFERENCES

Kolesnikov B.P. Cedar Forests of the Far East. Moscow-Leningrad, 1956. 263 p.

Kolomytsev V.M., Sheshukov M.A. What Did Fire Illuminated in Khabarovskiy Krai? In: Forest Newspaper. 1999. 15 January. (Rus.)

Kurbatskiy N.P., Sheshukov M.A. About Forest Fires in Khabarovskiy Krai. In: Forestry. 1978. # 4. P. 79-83. (Rus.)

Methodical Recommendations for Forest Dynamics Analysis. Compiled by A.S.Sheingauz. Khabarovsk, 1986. 41 p. (Rus.)

Mevzos G.M. Far Easter Population, Its Structure and Change. In: Productive Forces of the Far East. Vol. 5. Khabarovsk-Vladivostok, 1927. (Rus.)

Natural Resources and Environment in Northeast Asia: Status and Challenges (Collective of authors). Ed. by A.Sheingauz & H.Ono. Tokyo: The Sasakawa Peace Foundation. 1995. 120 p. (Eng.)

Recommendations for Forest Fire Control in the Far Eastern Regions. Compiled by H.P.Telitsyn et al. Khabarovsk, 1978. 33 p. (Rus.)

Recommendations for Control of Large Forest Fires in the Far East. Compiled by H.P.Telitsyn. Khabarovsk, 1987. 48 p. (Rus.)

Sheingauz A.S. Forest Development and Forest Resource Consumption in the Far East before Mid of the XIX Century. In: Proceedings of the Far Eastern Forestry Research Institute. Moscow, 1971. P. 11-29.

Sheingauz A.S. Forest Development of the Far East and Use of Their Productivity from Mid of the XIX to Mid of the XX Centuries. In: Forest Productivity Increase in the Far East. Moscow, 1973. P. 84-110.

Sheingauz A.S. Method of Fire Diffusion Calculation on the Inventory Data. In: Burning and Fires in Forest. Proceeding of the 1st All-Union Conference. Vol. 3. Krasnoyarsk, 1979. P. 66-69. (Rus.)

Sheingauz A.S. The Role of Fire in Forest Cover, Structure and Dynamics in the Russian Far East. In: Fire in Ecosystems of Boreal Eurasia. J.G.Goldammer and V.V.Furyaev (eds.). Forestry Sciences. Vol. 48. Dodrecht-Boston-London: Kluwer Academic Publishers, 1996. P. 186-190. (Eng.)

Sheingauz A.S., Dorofeeva A.A., Efremov D.F., Sapozhnikov A.P. Complex Forestry Regionning. Vladivistok, 1980. 142 p. (Rus.)

Sheingauz, Alexander S., Vladimir P. Karakin, Vladimir A. Tyukalov. Forest Sector of the Russian Far East: a Status Report. Khabarovsk-Vladivostok: Economic Research Institute, USAID EPT/RFE, 1996. 50 p. (Eng.)

Sheshukov M.A. Importance of Fire in Forest Formation under Various Zonal-Geographic Conditions of the Far East. In: Fire in Ecosystems of Boreal Eurasia. J.G.Goldammer and V.V.Furyaev (eds.). Forestry Sciences. Vol. 48. Dodrecht-Boston-London: Kluwer Academic Publishers, 1996. P. 191-195. (Eng.)

Sheshokov M.A. Impact of Fires on Taiga Biogeocoenosis Development. In: Burning and Fires in Forest. Proceeding of the 1st All-Union Conference. Vol. 3. Krasnoyarsk, 1979. P. 81-96. (Rus.)

Sochava V.B. In the Elk's Land. In: Soviet North. 1931. # 10. (Rus.)

Solodukhin E.D. Burnt Areas in the Coniferous-Broad-leafed Zone in the Primorskiy Krai and Forestry Measures in Them. Science Candidate Dissertation. Vladivostok, 1955. 22 p. (Rus.)

Starodumov A.M. The Nature of Forest Fires in the Far East. Moscow, 1966. 59 p. (Rus.)

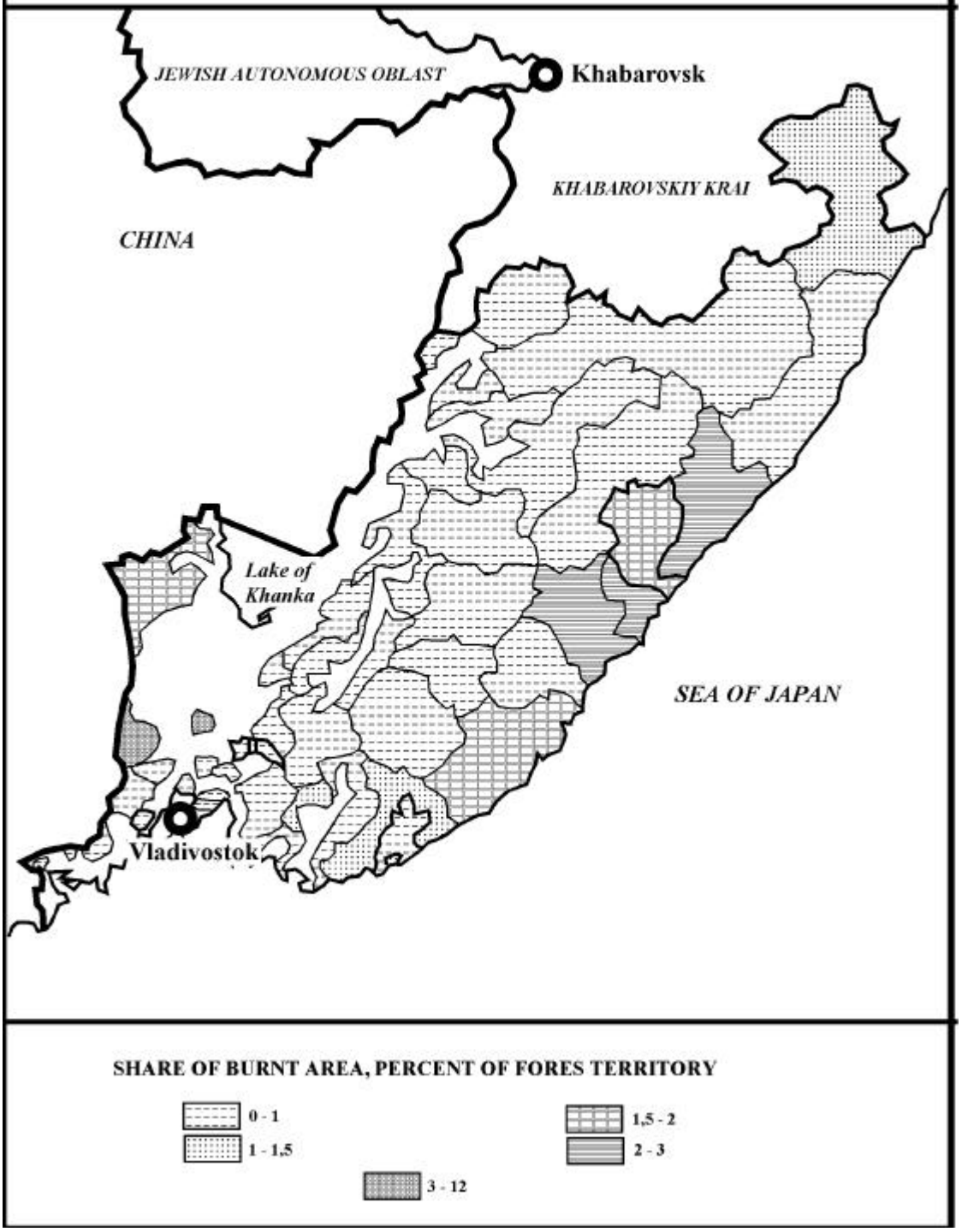
Telitsyn H.P. Forest Fires, Their Prevention and Extinguishing in Khabarovskiy Krai. Khabarovsk, 1988. 95 p.

(Rus.)
Telitsyn H.P. Impact of Forest Attendance on the Fire Frequency. In: Proceeding of Far Eastern Forestry research Institute. Vol. 25. Khabarovsk, 1983. P. 111-118.

Picture 1.

PERCENTAGE OF BURNT FOREST AREA IN PRIMORSKIY KRAI, 1988-1997

Source: Far Eastern Forestry Research Institute



Picture 2. **PERCENTAGE OF BURNT FOREST AREA IN KHABAROVSKIY KRAI, 1988-1997** Source: FE Forestry Res. Institute