

NOT FOR QUOTATION

# What Do We Know About the Siberian Forests?

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## Abstract

This article presents official statistics on the Siberian forest. It addresses the concerns about the deterioration of the forest resources in all regions of Siberia. Emphasis is given to the need for development of sustainable harvesting measures.

## 1. Introduction

The Siberian forests have recently become an important topic for public debate. This debate is concerned with the future development of forest resources. Rosencrantz and Scott (1992) fear that the ongoing economic transition will result in an increased harvest, which will stimulate the sagging Russian economy, but further degenerate the environment and break down indigenous cultures. Knight (1992) indicates that after three decades of relentless and uncontrolled exploitation of the natural resources, the bills are now due in one of the world's last great natural frontiers. Stanglin (1992) states that Siberia has become something like the wild West, in that local authorities are expanding the exploitation of natural resources without any type of restrictions. Gusewelle (1992) reports that 4 million hectares of taiga are depleted every year. Cejka (1992) states that two hectares of forests in Siberia are lost every minute. WWF (1992) fears that international timber companies will erode the original forests of the Far East of Siberia.



Feshbach and Friendly (1992) point out that no other industrial civilization has so systematically, or for so long, poisoned its natural resources and people as the USSR has.

We agree with these concerns about the deterioration of forest resources of Siberia. In this article we present available official statistics on the Siberian forests in a condensed form.

Siberia is a vast region, encompassing the area from the Urals to the Pacific Coast (from 60° east to 170° west longitude – about 8,000 km) and from the Chinese and Mongolian borders to the Arctic islands (from 48° to about 80° north latitude – nearly 3,500 km). The total area of Siberia is 1,280 million hectares, which is about 30 percent larger than the US continental territory. About 605 million hectares are covered with closed forests (forested areas); these areas make up about 48 percent of the total area. Nearly 450 million hectares are covered with coniferous species. The total growing stock of stemwood is 61.4 billion m<sup>3</sup> of which 51 billion m<sup>3</sup> is made up of coniferous species. About 33 billion m<sup>3</sup> (nearly 55 percent) of the growing stock are classified as mature and overmature forests. The forested area of Siberia constitutes about 20 percent of the total world forested area and nearly 50 percent of the total world coniferous forested area. Nearly 65 percent of the Siberian forests are growing in areas with permafrost and more than 60 percent of the forested areas are classified as mountain forests. The majority of the indigenous Russian people (nearly 40 different tribal groups) lives in the Siberian forests.

The woody biomass of the Siberian forests has been estimated to sequester nearly 30,000 million metric tons of carbon. Kolchugina *et al.* (1992) have estimated the contribution of the Siberian forests to the global carbon cycle. They suggest that the Siberian forests constitute a net sink of nearly 500 million metric tons of carbon annually.

The Siberian forest resources have been monitored; but the inventory methods differ, and some of the inventory data are not accurate. By the end of 1990, about 55 percent of the total forested area had been inventoried by acceptable on-site methods and about 24 percent had been measured by a combination of remote-sensing and on-site sampling measurements. About 21 percent of unmanaged and unexploited areas (in the extreme north and northeast) had been inventoried between 1948 and 1954 by an aerial method which was not very precise. These areas are now being re-inventoried using more precise methods; this inventory should be completed by 1995.



**Table 1.** Distribution of the Siberian forests over vegetational zones, expressed in percent.

	Forest fund (FF) <sup>a</sup>	Forest land (FL) <sup>a</sup>	Forested area (FA) <sup>a</sup>
Tundra	11.3	1.0	-
Forest tundra	3.8	3.0	3.2
Total taiga	76.8	86.9	87.4
Sparse taiga	16.5	20.4	16.2
Northern taiga	8.2	7.2	6.5
Middle taiga	33.6	38.8	43.6
Southern taiga	18.5	20.5	21.1
Mixed forests	2.5	3.2	3.3
Northern	1.6	2.0	2.0
Southern	0.9	1.2	1.3
Deciduous forests	1.9	2.2	2.5
Forest-steppe	1.6	1.6	1.6
Steppe	0.5	0.6	0.5
Meadow and sparse forests	1.6	1.5	1.5
Total	100.0	100.0	100.0

<sup>a</sup>See explanation in Section 3.

Source: Unpublished data from VNIIZ Lesresurs, 1988.

## 2. Climate and Vegetational Zones

Climatic and soil conditions vary greatly, in both latitudinal and longitudinal directions in Siberia. Kurnaev (1973) has identified eight forest vegetational zones and four additional different subzones for the taiga. These zones are presented in *Figure 1*.

The distribution of the Siberian forests over different vegetational zones is presented in *Table 1*. From *Table 1* it can be seen that taiga is the dominant forest type which, in turn, is dominated by middle and southern taiga.

## 3. The Extent of Forest Resources in Siberia

Siberia is divided into three major economic regions: West Siberia, East Siberia, and Far East. These regions are illustrated in *Figure 2*.



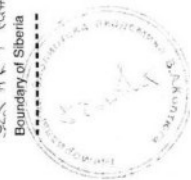


Semi-desert  
 North  
 South  
 Desert  
 North  
 South

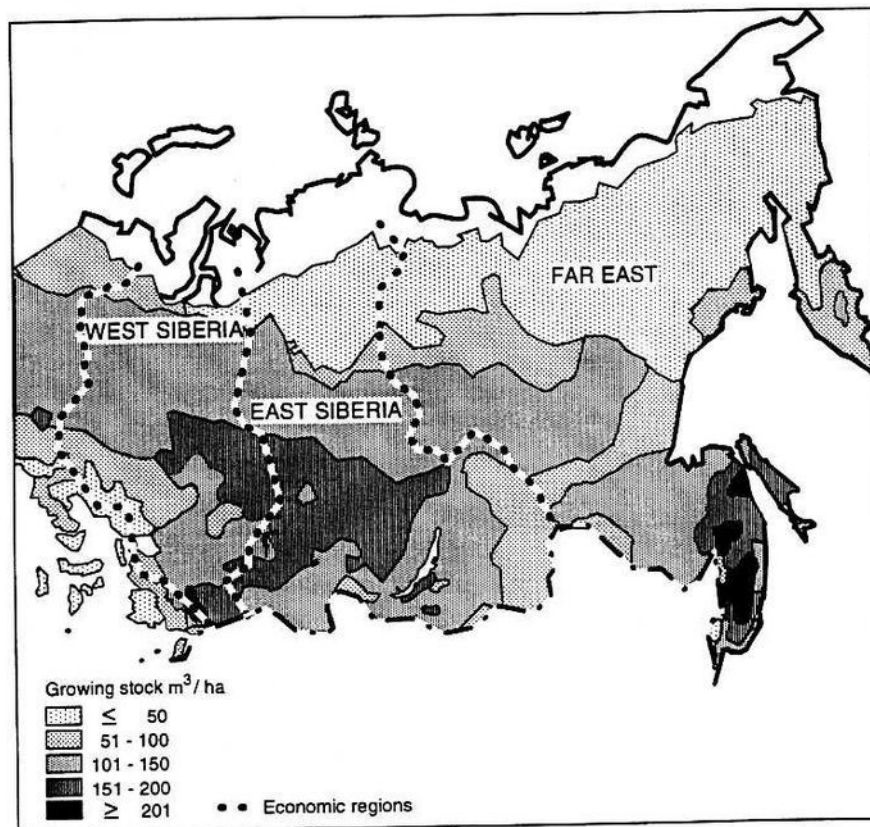
Deciduous forests  
 Forest steppe  
 Steppe

Northern taiga  
 Middle taiga  
 Southern taiga  
 Mixed forests: Northern  
 Southern

Vegetational Zones (by Kurnaeve)  
 Arctic desert  
 Tundra: (a) flat (b) mountain  
 Forest tundra  
 Meadow and sparse forests  
 Sparse taiga



## ECONOMIC REGIONS AND GROWING STOCK



**Figure 2.** Map of the three economic regions and distribution of growing stocks in Siberia. Source: *Atlas of the USSR Forests*, 1973.

The forest resources are classified in different ways in Russian statistics. The forest fund (FF) is made up of areas covered by forests and those not covered by forests but which could be used for forestry production under certain conditions. The forest fund is divided into forest land (FL), which is either covered by closed forests (called forested area, FA) or temporarily not covered areas (unforested area like harvested areas and burned areas), and nonforest land (NFL), which includes the following:



- Areas which are not suitable for forest production under current conditions.
- Areas with other land-use functions such as pastures, arable lands, peat production, farmsteads, etc.

These two areas must be managed by a forest authority to be classified as nonforest land.

In *Table 2* we have attempted to illustrate the links between the different forest classifications according to the forest state account in January 1988. The different forest areas are given in million hectares and the growing stock is expressed in billion m<sup>3</sup>. The forest categories (FF, FL, and FA) are divided into three groups according to the function of the forests:

- Group I: Mainly protected forests.
- Group II: Protected forests with restricted possibilities for industrial exploitation.
- Group III: Forests for industrial exploitation.

The distribution of different forest groups is also presented in *Table 2*. From this table it can be seen that 92 percent of the Siberian forests is under state forest management and about 80 percent belongs to forests designed for industrial exploitation.

Of the 544.4 million hectares classified as forested area and managed by forest authorities, 271.6 million hectares are classified as commercial forests in operations, 179.0 million hectares are not utilized due to unfavorable economic conditions, and 93.8 million hectares are protected from industrial exploitation. Thus, about 50 percent of the forested area is currently available for industrial exploitation today.

In *Appendix Table 1* we present the development of the forested area, growing stocks, and other forest measures for the period 1966–1988. From these aggregated official statistics it can be seen that the forested area and the growing stock have been rather stable during the 1980s. The same can be said about the annual allowable cut (AAC) and the relation between the AAC and the actual harvest. The actual harvest is only about 30 percent of the estimated AAC. However, it should be pointed out that these aggregated figures do not tell us anything about the subregional development. The very low extent of plantations and thinnings in the region is worth noting. This is a clear indication of nonsustainable forest management.

*Table 3* shows the distribution of major species over forested area and growing stock. The discrepancies between *Table 2* and *Table 3* are explained



**Table 2.** Extent of the Siberian forest resources. Forested areas are expressed in million hectares and growing stock in billion m<sup>3</sup>.

Category	Total Russia	Total Siberia	West Siberia	East Siberia	Far East Siberia
TA	1,710.0	1,180.8	242.7	412.3	525.8
FF	1,182.6	973.2	150.6	315.4	507.2
FL	884.4	710.6	95.5	255.2	359.9
FA	771.4	605.1	90.1	234.4	280.6
GS	81.6	61.4	10.8	29.3	21.3

By form of management

Category	State forest mgmt.		Other ministries	
	Colchoses	Sovchoses	Colchoses	Sovchoses
FF	938.0	16.2	5.9	13.1
FL	680.3	11.4	5.9	13.0
FA	576.8	10.3	5.7	12.3
GS	58.2	1.2	0.6	1.4

Category	Forest authority	Long-term lease
FF	847.0	91.0
FL	635.9	44.4
FA	544.4	32.4
GS	56.2	2.0

By groups of forests

Category	I			II			III		
	I	II	III	I	II	III	I	II	III
FF	133.1	17.6	696.3	23.0	0.1	67.9			
FL	85.2	15.9	534.8	8.2	0.0	36.2			
FA	76.2	14.9	453.3	5.5	0.0	26.9			

TA = Total area.  
 FF = Forest fund.  
 FL = Forest land.  
 FA = Forested area.  
 GS = Growing stock.

Source: Goskomles, 1990, 1991.





**Table 3.** Distribution of major species over forested area and growing stock. Forested area (FA) is expressed in million hectares and growing stock (GS) in billion m<sup>3</sup>.

Species	West Siberia		East Siberia		Far East		Total	
	FA	GS	FA	GS	FA	GS	FA	GS
Coniferous	56.4	6.8	180.2	24.9	199.7	17.7	436.3	49.3
Pine	28.7	3.0	32.1	5.5	12.0	1.2	72.9	9.7
Spruce	5.4	0.6	12.4	1.8	13.7	2.4	31.5	4.8
Fir	3.8	0.5	9.4	1.6	1.8	0.3	15.0	2.4
Larch	5.9	0.6	102.8	11.6	168.8	12.9	277.5	25.1
Hard deciduous	-	-	-	-	11.6	1.1	11.6	1.1
Beech	-	-	-	-	6.6	0.6	6.6	0.6
Oak	-	-	-	-	4.0	0.3	4.0	0.3
Soft deciduous	21.9	2.8	31.4	2.7	15.2	1.1	68.2	6.6
Birch	17.0	2.0	26.4	2.1	11.6	0.7	55.0	4.8
Aspen	4.7	0.8	4.8	0.7	1.1	0.1	10.6	2.5
Total	78.3	9.6	211.6	27.7	227.6	2.0	516.4	56.9

Source: Goskomles, 1990 and 1991.

by the fact that *Table 3* includes only major species and does not take into account shrubs and other coppice, which are accounted for in *Table 2*. According to the inventory definitions of the former USSR, shrubs are regarded as forested areas only in regions where closed forests are unable to grow due to climatic conditions.

In *Table 3*, it can be seen that coniferous species is the dominant species group throughout Siberia. Pine is the main species in West Siberia, and in other regions larch dominates. In total, larch is the most common species in Siberia. It can also be seen that soft deciduous (mainly birch and aspen) are quite well represented throughout Siberia. Hard deciduous species are only present in the Far East region.

The Siberian forests are growing under rather severe climatic conditions and are, in many cases, poorly stocked. Data on the distributions of forests over site indices and density classes are presented in *Table 4*. The site indices in Russia are determined by the stand's average height, age, and type of regeneration. The site index is given for five main classes, where index I is the best and V the worst; some of the main classes are further divided into subclasses (*Table 4*). The density is determined by the relation





of basal area of monitored stands and the basal area for a theoretical optimal stand under actual site conditions.

The information in *Table 4* includes only major species and excludes shrubs and other coppice. From this table it can be seen that more than 30 percent of the forested area has an extremely low density (0.3–0.5), the majority of which is located in East Siberia and the Far East. It can also be seen that more than 40 percent of the forests are growing on poor sites (site indices V and Va), the main part being located in the Far East region.

The average growing stock ( $\text{m}^3$  of stemwood per hectare) for different species and different longitudes for the forested area is presented in *Table 5*, which lists some of the vegetational types discussed earlier. As can be seen from this table there is a very big variation in the growing stock between different species and different locations in Siberia.

Currently, there are no calculations for the total biomass of the Siberian forests available. However, assuming that the underground biomass is about 25 percent of the stemwood, and that the crowns constitute about 20 percent of the volume for stemwood, we get a total of woody biomass of living trees of about 92 billion  $\text{m}^3$  in Siberia. There is no systematic inventory available on dead wood. Different estimates exist and range between 12 billion and 18 billion  $\text{m}^3$ , which indicates a woody biomass total of about 110 billion  $\text{m}^3$  in Siberia.

#### 4. Development of the Forested Areas (FA) and Growing Stocks (GS)

In *Appendix Table 1* we list the official statistics on the development of the forested areas managed by the forest authority in Siberia at the aggregate level. There are difficulties in analyzing the development of the forests over time in Siberia (and in Russia). Inventory instructions, definitions, and other standards have changed; these changes make an accurate comparison over time difficult. However, most of the changes took place in 1964 and were implemented during the period from 1970 to 1973.

According to the data in *Appendix Table 1*, the decline in growing stock was 1.4 billion  $\text{m}^3$  of the forested areas for all of Siberia during the period from 1966 to 1988. But these development figures are somewhat misleading. During this period the average yearly harvest was less than 150 million  $\text{m}^3$ . This gives a total harvest for the whole period of about 3 billion  $\text{m}^3$ . The minimum average increment is estimated to be 1.2  $\text{m}^3$  per hectare for each



**Table 4.** Distribution of forested area (FA) with major species over site indices and density classes. Errors in totals are due to rounding.

Site index	Density	West Siberia			East Siberia			Far East			Total Siberia			
		Total	Soft		Total	Soft		Total	Soft		Total	Soft		
			Coniferous	deciduous		Coniferous	deciduous		Coniferous	deciduous		Coniferous	deciduous	
II and better	0.8-1.0	2.1	0.6	1.5	2.5	1.5	1.0	0.7	0.4	0.3	5.2	2.4	0.0	2.8
	0.5-0.7	5.9	1.8	4.1	6.2	4.1	2.1	3.3	1.8	1.3	15.4	7.7	0.1	7.5
	0.3-0.4	1.4	0.5	0.9	1.3	0.8	0.5	1.1	0.5	0.5	3.8	1.8	0.0	1.9
III	0.8-1.0	2.2	0.8	1.5	15.4	12.8	2.6	3.6	2.5	0.9	21.2	16.1	0.2	4.9
	0.5-0.7	9.4	4.9	4.5	53.1	43.7	9.4	16.2	11.8	3.5	78.8	60.4	0.9	17.4
	0.3-0.4	2.5	1.4	1.1	29.1	27.5	1.6	7.7	6.0	1.3	39.3	34.9	0.4	3.9
IV	0.8-1.0	2.0	1.3	0.7	9.1	7.2	1.9	8.0	6.9	0.8	19.1	15.5	0.3	3.4
	0.5-0.7	11.5	8.6	2.9	37.5	31.8	5.7	36.0	31.3	3.0	84.9	71.7	1.6	11.6
	0.3-0.4	3.3	2.5	0.7	11.4	10.1	1.3	17.7	15.9	1.1	32.4	28.5	0.7	3.2
V	0.8-1.0	1.1	0.8	0.3	4.2	3.5	0.7	7.5	6.6	0.3	12.8	10.8	0.7	1.3
	0.5-0.7	12.0	10.3	1.7	21.2	18.7	2.5	43.6	39.6	1.0	76.7	68.6	2.9	5.2
	0.3-0.4	7.3	6.6	0.7	10.0	9.2	0.8	31.4	29.7	0.4	48.8	45.6	1.3	2.0
Va and worse	0.8-1.0	0.8	0.7	0.1	1.3	1.0	0.2	2.7	2.4	0.1	4.8	4.0	0.3	0.5
	0.5-0.7	9.1	8.4	0.7	6.1	5.3	0.8	21.3	19.4	0.4	36.5	33.1	1.5	1.9
	0.3-0.4	7.7	7.2	0.5	3.2	2.8	0.3	25.8	24.9	0.2	36.7	34.9	0.7	1.0
Total		78.3	56.4	21.9	211.6	180.2	31.4	226.6	199.7	15.2	516.4	436.3	11.6	68.5

Source: Goskomles, 1990, 1991.



**Table 5.** Average growing stock (m<sup>3</sup> of stemwood per hectare) for different species and longitudes within forested areas (FA).

Species	Longitude									
	61-70	71-80	81-90	91-100	101-110	111-120	121-130	131-140	141-150	151-160
<i>Middle taiga</i>										
Pine			107	212	193	138	148	172	-	
Spruce			201	200	190	131	148	182	214	
Fir			222	228	192	193	-	129	136	
Cedar			223	174	181	157	198	100	-	
Larch			98	183	168	128	129	160	176	
Birch			125	103	87	75	75	100	102	
Aspen			154	192	148	151	106	125	175	
<i>Southern taiga</i>										
Pine	210	130	158	188	199	141	135	145	-	-
Spruce	220	189	223	173	158	122	162	202	200	193
Fir	246	215	222	214	202	-	-	230	174	-
Cedar	170	211	210	163	196	161	200	257	-	-
Larch	216	183	181	171	187	139	135	186	142	181
Oak	-	-	-	-	-	-	54	150	100	-
Birch	165	143	122	100	117	79	82	127	94	76
Aspen	186	180	147	193	160	94	151	157	84	168
<i>Deciduous forests</i>										
Pine	273	93	147	-	-	-	-	122	-	-
Spruce	240	226	182	-	-	-	-	208	-	-
Fir	284	292	206	-	-	-	-	193	-	-
Cedar	372	188	181	-	-	-	-	247	-	-
Larch	211	220	119	-	-	-	-	225	-	-
Oak	130	-	-	-	-	-	-	105	-	-
Birch	130	119	142	-	-	-	-	115	-	-
Aspen	156	149	163	-	-	-	-	128	-	-
<i>Forest-steppe</i>										
Pine	231	148	195	184	164	140	175	-	-	-
Spruce	-	130	142	202	175	116	200	204	-	-
Fir	-	-	178	262	181	-	259	198	-	-
Cedar	-	224	186	198	147	111	157	211	-	-
Oak	-	-	-	-	-	-	77	105	-	-
Birch	110	102	101	131	88	76	79	122	-	-
Aspen	115	117	126	194	104	108	160	119	-	-

Source: Unpublished data from VNIIZ Lesresurs, 1988.



**Table 6.** Developments of forest area (FA) and growing stock (GS) in some Siberian subregions. Forested area is expressed in million hectares and the growing stock in billion m<sup>3</sup>.

Region	1983		1988		Difference 1983-1988	
	FA	GS	FA	GS	FA	GS
Yakutsk	128.2	9.8	125.6	8.8	-2.6	-1.0
Tyumen	43.1	5.1	41.8	4.7	-1.3	-0.4
Irkutsk	54.5	8.6	51.8	8.6	-2.7	0.0
Krasnoyarsk	112.0	13.9	111.3	13.8	-0.7	-0.1
Total	337.8	37.4	330.5	35.9	-7.3	-1.5

Source: Goskomles, 1989.

year. Thus, the total increment during the period studied was about 13 billion m<sup>3</sup>, and the actual total loss was

$$13 - 3 + 1.4 \approx 10 - 12 \text{ billion m}^3.$$

Thus, according to this calculation nearly all of the increment during the period studied is lost for one reason or another. By this simple calculation we can illustrate that the growing stock losses are significant in Siberia and correspond to a loss of about 20 percent of the existing Siberian growing stock during the period from 1966 to 1988. Sheingaus (1989) has estimated the total losses in the Far East region to be 4.6 billion m<sup>3</sup>, which is roughly seven times more than the harvested volume.

The losses are more evident if we study some of the subregions during the period from 1983 to 1988. The developments of the forested area and growing stock for some Siberian subregions are presented in *Table 6*.

During this five-year period there has been an average loss of 2 percent of the forested area and of 4 percent of the growing stock. These developments may also indicate that the rate of losses has increased during the 1980s, although it partially may be explained by changed inventory data during this period.

## 5. Forest Management

In Russia the annual allowable cut is given only for final fellings of commercial wood. The AAC was 382 million hectares in forests managed by forest



**Table 7.** Actual harvest of commercial wood in 1990 in Siberia, expressed in million m<sup>3</sup> under bark.

Forest groups	Forested area in mill. ha <sup>a</sup>	Total harvest	Industrial wood harvest	Final felling				
				Coniferous	Hard deciduous	Soft deciduous	Thinnings	Other fellings
I	76.4	2.5	1.6	1.8	—	0.7	2.7	2.7
II	14.9	7.5	5.1	5.3	0.1	2.1	1.1	0.5
III	453.2	115.6	85.3	101.0	1.0	13.6	3.0	10.5
Total	544.4	125.6	92.0	108.0	1.1	16.4	6.8	13.7

<sup>a</sup>Forested area under management of a forest authority.  
Source: Unpublished data from Goskomles, 1991.

authorities in 1990. Commercial wood comprises industrial wood and fuel wood.

The AAC was distributed as follows: coniferous, 261 million m<sup>3</sup>; hard deciduous, 6 million m<sup>3</sup>; and soft deciduous, 115 million m<sup>3</sup>. The actual harvest was only 125.6 million m<sup>3</sup> which corresponds to about 33 percent of the allowable cut. Details of the harvest in 1990 are presented in *Table 7*. From this table it can be seen that coniferous species made up a major part of the harvest and the harvesting potential of deciduous species was not utilized. The rate of thinnings is very low and only corresponds to about 5 percent of the total harvest. A normal thinning rate in the Scandinavian countries is between 20 and 25 percent of the total harvest. The actual conditions show that the intensity of the forest management with respect to thinnings in Siberia is low.

About 800,000 hectares are harvested annually as clear cuts in Siberia. Nearly 85 percent of the clear cuts are carried out as very large-scale clear cuts. The operations are carried out with heavy equipment, which destroys from 50 percent to 80 percent of the undergrowth. The most common method of regeneration after the clear cuts is natural regeneration. The rate of artificial reforestation is low in Siberia (*Table 8*).

The rate of survival of the reforestation is low due to low-quality planting and to forest fires. During the period from 1983 to 1985 over 300,000 hectares of the reforested areas were destroyed, which corresponds to about 10 percent of the reforested areas. In the Far East region, 1.4 million hectares have been planted, of which only 640,000 hectares have survived.

About 60 percent of the forest fund (approximately 600 million hectares) is under some form of forest fire protection. Forest fires on the rest of the



**Table 8.** Artificial reforestation in Siberia, expressed in thousand hectares.

Region	Accumulated total reforestation	Reforestation (planting and seeding)	
	January 1988	1985	1988
Western Siberia	1,261	82	80
Eastern Siberia	1,393	78	77
Far East	641	56	56
Total	3,295	216	213

Source: Isaev, 1991.

**Table 9.** Forest fires in Siberia in 1989 and 1990.

Region	Number of fires	Burned area in thousand hectares				Burned timber in mill. m <sup>3</sup>
		Forest land	Forested area	Non-forest land	Forest fund	
<i>1989</i>						
Western Siberia	6,625	1,128	1,106	279	1,407	46.9
Eastern Siberia	4,420	69	46	11	80	1.0
Far East	2,349	397	319	118	515	16.5
Total	13,394	1,594	1,471	408	2,002	64.4
<i>1990</i>						
Western Siberia	2,638	34	31	30	64	0.5
Eastern Siberia	7,661	715	691	47	762	11.9
Far East	2,958	608	586	226	834	10.9
Total	13,257	1,357	1,308	303	1,660	23.3

Source: Unpublished data from Goskomles, 1991.

territory are not registered and nothing is done to control them or extinguish them. On the areas protected from forest fires there are 10,000–15,000 fires annually and about 1 million to 1.5 million hectares of forested area are destroyed every year. Statistics on forest fires before 1988 are not reliable. Sheingaus (1989), for example, argues that the official statistics on forest fires in the Far East region for the period 1970–1978 should in reality be increased by seven to ten times. Information about forest fires in 1989 and 1990 is presented in *Table 9*.

Based on the 1989 and 1990 forest fire statistics it can be concluded that each fire causes a loss of about 100 hectares of forested area and 2,000–5,000 m<sup>3</sup> of timber. About 25 million hectares of unforested land in Siberia are due to forest fires. The unforested land in Siberia from harvesting is about 15 million hectares. Areas with sparse stands account for



**Table 10.** Forested areas (FA) attacked by insects and diseases requiring sanitation measures, expressed in thousand hectares.

Region	1975	1980	1985	1988	Average 1975-1988
Western Siberia	202	326	505	91	266
Eastern Siberia	1,690	209	24	93	590
Far East	124	99	42	104	183
Total	2,016	634	571	288	1,039

Source: Isaev, 1991.

55 million hectares. This means about 95 million hectares of forested area are not in real production in Siberia.

Damage from insects and diseases is also a serious problem in Siberia. The official statistics of areas requiring sanitation measures due to such attacks are presented in *Table 10*. Annually some 1 million hectares of forested areas are officially reported to be seriously affected by insects and diseases. However, the official figures seem to be underestimates. According to the Committee on Forests of the Russian Federation (1992) the area seriously attacked by the insect *Limtria dispar* alone in 1991 was estimated to be about 1.4 million hectares. The mature and overmature forests have a large amount of rotten wood. There are reports from the Far East region illustrating that *Pinus korajensis* has a 58 percent rate of root rot and the figure for larch is nearly 70 percent.

In addition to the problem of fires and insects, there is also damage caused by anthropogenic sources in Russia and Siberia. Official reports estimate that about 6.5 million hectares of the forest fund in Siberia have negative development due to anthropogenic sources. However, there is no reliable monitoring of all of Russia and Siberia for this kind of decline. The official figures on anthropogenic effects on forests seem to be seriously underestimated. For example, the Norilsk metallurgical group of industrial plants, located north of Krasnoyarsk, had damaged more than 2 million hectares of land by 1989, of which 565,000 hectares were forested area (Kovalev, 1990). Emissions from the Bratsk aluminum plant have damaged 140,000 hectares of coniferous forest. The amount of forests destroyed by oil and gas production in West Siberia is more than 1 million hectares (Vovonin, 1989). There are several other areas with similar severe damage in Siberia.

The wasteful management of the forest resources is a major problem in Russia and Siberia. According to Goskomles (1990a) the harvesting losses





**Table 11.** Examples of wood waste in timber harvest in Siberia.

Region	Average growing stock in harvestable stands m <sup>3</sup> /ha	Average removed volume m <sup>3</sup> /ha
Primorsky kraj	184	82
Khabarovsk kraj	143	98
Amur	131	80

Source: Goskomles, 1990.

(wood waste) are great (*Table 11*). Based on the figures in *Table 11* it can be seen that about 40 percent of the harvested volume is left in the forests. Other reports from Siberia illustrate total losses of from 50 percent to 60 percent of the removed wood (harvesting, transportation, and industry). Nilsson *et al.* (1992) have also presented figures for wood waste (harvesting, transportation, and industry); they report that, on average, about 20 percent of the harvested volume for all of Russia is wasted.

## 6. Discussion

Based on official statistics, it can be seen that the forest resources are deteriorating slowly but significantly in Siberia. The basic reason for the deterioration is driven by the former Communist doctrine that man should control nature – “achieve social mastery over nature through technology.” There had been several attempts to improve the situation during the former Communist era but without any success. In spite of many discussions and scientific recommendations during this era the forest resources were solely regarded as a source of raw materials and not as an environmental asset.

The exploitation of the Siberian forests started after the Second World War with the objective of supplying the forest companies in the European part of the former USSR with raw material. The harvest was carried out with wasteful methods. The harvesting companies operated by a “cut and run” principle whereby after harvesting the easily accessible timber in one area, the operations were closed down and moved to a new area.

Legislation during the Communist era endorsed the principle of sustainable management of the forest resources, but this principle, as well as public opinions and scientific recommendations concerning forest management, was completely ignored.



**Table 12.** Information on the transportation network in Siberia in 1990.

Region	Length in 1,000 km				Density in m/ha		
	Total	Rail-ways	Total roads	Roads with hard cover	Total	Total roads	Roads with hard cover
Western Siberia	106	6	100	14	0.8	0.7	0.1
Eastern Siberia	143	6	137	22	0.5	0.4	0.1
Far East	90	7	83	11	0.2	0.2	0.02

Source: Isaev, 1991.

Between 1950 and 1970, large forest industrial concerns were established. The locations of these industries were far from the wood supply. The average transportation distance between stump and industry was 1,800 km in 1990 in Russia. Timber was transferred seven or eight times at reloading points, which caused tremendous losses. In addition, no greenfield pulp and paper mills have been built in Russia in the past 20 years.

Huge losses have been caused by floating and drafting, which constituted nearly 70 percent of the long-distance transportation of the harvested wood during the 1970s in Siberia (Timofeev, 1967). In 1990 the floated and drafted wood was about 40 percent of the harvested wood (Goskomstat, 1990). Recent environmental legislation has prohibited drafting.

The construction of electric power stations along the large Siberian rivers has led to additional losses of wood. There are no statistics available on total losses, but for the Angara-Jenesej River basin the losses are reported to be more than 10 million m<sup>3</sup> during the past 10 years.

The lack of infrastructure is a major bottleneck for development of the forest sector in Siberia. Information about the transportation network in 1990 in Siberia is presented in *Table 12*. In the table it can be seen that the infrastructure is far from well developed. A well-developed infrastructure has between 10 and 15 meters of roads per hectare of forested area. Because of the lack of infrastructure it is possible to utilize only about 30 percent of the forested area for commercial operations (Academy of Sciences of the USSR, 1990). About 180 million hectares (with a growing stock of 16 billion m<sup>3</sup>) in the far north and northeast are not suitable for industrial exploitation. The cedar forest (34 million hectares with a growing stock of 6 billion m<sup>3</sup>) has been excluded from industrial operations by legislation.

By the end of 1992 the federal forest legislation had still not been established in Russia and Siberia. A reconstruction of the federal forest administration is currently taking place. In November 1992 the Russian State Forest



Service was established. This service reports directly to the Russian federal government. Discussions are under way in this new organization on how to finance the forest management and its operations. Many difficult problems have to be solved concerning the new administration and legislation. Meanwhile, practically all of the administrative units of Siberia have established their own regulations and legislation concerning forest management without waiting for the establishment of federal regulations.

The definition of property rights of the forest resources (and other natural resources) in the Russian constitution is regarded to be inaccurate and inconsequential. There is also a struggle going on concerning the division of power between local and federal authorities. Many of the formerly centralized management systems are vast, and new systems are being implemented slowly and irregularly.

The key issue in Siberian forestry is to establish a sustainable management and development policy of the forest resources from ecological, economic, and social points of view. Studies of the Far East region of Siberia have calculated the amount of forest cover required to achieve sustainable development of the territory (Goskomles, 1990). Of the 47 forest management regions investigated only 25 had a forest cover which could guarantee sustainable development, meaning that nearly 50 percent of the region has unsustainable development.

Perhaps the most difficult problem in achieving sustainable development of the forest resources is securing the funds required: funds, which are not available in Russia today.

Based on the available statistics it can be seen that the forest resources of Siberia have gone through a slow but significant deterioration. On the other hand, the forest resources of Siberia are enormous, and only about one-third is currently utilized for exploitation. It is also obvious that the sustainable harvest could be increased by about 200 million m<sup>3</sup> per year under favorable economic conditions. Therefore, there still seem to be possibilities of saving the forest resources of Siberia with respect to sustainable development of global change aspects, biodiversity, wood supply, and socioeconomic aspects if decisive actions are taken immediately.

However, it should be pointed out that there are still gaps in the knowledge about the status and development potentials of the Siberian forests. Therefore, the International Institute for Applied Systems Analysis, based in Laxenburg, Austria, and the Russian Academy of Sciences, Moscow, have initiated a joint integrated project to identify suitable strategies for sustainable development of the forest resources, and for the required development



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of industry, infrastructure, and society (Nilsson and Isaev, 1992). The study will deal with forest resources, forest management, global change aspects, ecology, infrastructure, industry, markets, and socioeconomic factors. The study began in 1992 and is scheduled to be completed in 1996.



**Appendix Table 1.** Development of forested areas, growing stocks, and other forest measures during the period from 1966 to 1988. The forested areas presented include only major species which are managed by a forest authority (see Table 2). Thus, forested areas under long-term lease are not included.

	West Siberia			East Siberia			Far East			Total Siberia			Difference 1983-1988				
	1966-1973	1983-1988	1966-1973	1983-1988	1966-1973	1983-1988	1966-1973	1983-1988	1966-1973	1983-1988	1966-1988						
Forested area (million ha)	72.7	75.9	74.4	73.2	203.2	207.7	215.0	211.4	194.8	202.6	209.0	212.5	430.7	488.4	497.1	-1.3	
Coniferous	47.1	53.0	51.7	51.9	172.5	176.6	182.9	180.1	175.2	181.1	186.8	188.2	395.1	407.7	421.4	420.2	-1.2
Decid.	23.8	26.6	25.9	26.3	32.3	32.8	32.1	32.1	9.3	9.8	10.7	11.3	61.4	69.2	68.7	69.7	+1.0
Spruce and fir	8.2	8.2	8.1	8.6	18.8	20.8	22.0	21.7	15.3	15.0	15.4	15.0	42.3	44.0	45.5	45.3	-0.2
Other	10.7	12.5	13.0	11.6	22.0	22.6	23.7	23.5	4.0	3.7	3.2	3.4	36.7	38.8	39.9	38.5	-1.4
Total growing stock (billion m <sup>3</sup> )	8.7	9.7	9.5	9.2	27.3	27.0	27.7	27.6	20.8	20.3	19.4	18.6	56.8	57.0	56.6	55.4	-1.2
Coniferous	6.2	6.8	6.6	6.4	24.7	24.4	25.0	24.9	19.2	18.5	17.7	16.6	49.1	49.7	49.3	47.9	-1.4
Growing stock mature and overmature stands (billion m <sup>3</sup> )	6.5	7.0	6.5	6.1	20.6	20.1	19.3	18.6	15.6	14.9	13.3	11.7	42.7	42.0	39.1	36.4	-2.7
Unforested area (million ha)	11.2	9.1	6.1	4.5	25.4	21.9	16.8	19.4	74.0	72.1	64.5	66.3	110.6	103.1	87.4	90.2	+2.8
Plantations (million ha)	0.4	0.7	1.1	1.3	0.2	0.5	1.1	1.4	0.1	0.2	0.5	0.6	0.7	1.4	2.7	3.3	+0.6
Annual allowable cut (million m <sup>3</sup> )	99.5	101.9	103.2	103.5	149.3	159.7	174.2	175.6	113.8	102.4	103.9	106.9	362.6	364.0	381.3	386.0	+4.7
Actual final felling (million m <sup>3</sup> )	19.4	20.4	18.5	20.3	58.3	61.5	61.9	60.7	26.4	33.4	34.5	36.5	104.1	115.3	114.9	126.5	+11.6
Actual thinning (million m <sup>3</sup> )	1.3	2.1	2.2	2.3	0.9	1.8	2.4	2.6	0.5	1.0	1.3	1.4	2.7	4.9	5.9	6.3	+0.4
Average growth, (m <sup>3</sup> /ha/yr)	1.3	1.5	1.5	1.4	1.3	1.3	1.3	1.2	1.0	1.0	0.9	0.9	1.17	1.2	1.16	1.1	-0.06

Source: Goskomites, 1989.



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