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DRAFT

Biospheric Role of Siberian Ecosystems

A Research Proposal - Part I

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1. BACKGROUND

Siberia occupies a total area of 1276 million hectares, which is nearly 30 percent more than the territory of the continental U.S. This huge territory is located between the Urals and the Pacific Ocean, encompassing a distance of some 8000 km, 60° East to 170° West longitudinally. The territory encompasses about 3500 km between the 80° to 48° northern latitude, and represents all vegetational zones between arctic desert to semi-desert. Natural conditions vary greatly in Siberia, but the territory is mainly constituted by forest land. The total area of Siberia's Forest Fund is 973.2 million hectares. Arable land accounts for only 32.0 mln hectares, and the remaining territory is constituted by urban area, inhabited area, industrial enterprises, state land reserves, etc.

The territory of Siberia is divided into 3 economic regions - West Siberia (WES), East Siberia (EAS), and Far East (FEA) - Table 1.

Table 1. Distribution of land in Siberia by economic regions.

No.	Regions	Total land area, mln sq. km	Categories of Land-use, mln ha				
			Land belonging to the Forest Authority				Arable Land
			FF	FL	FA	PFC	
1	WES	2.43	150.6	95.5	91.1	37.1	19.6
2	EAS	4.12	315.4	255.2	234.5	56.9	9.5
3	FAE	6.22	507.2	359.9	280.6	45.1	2.9
Total		12.77	973.2	710.6	605.1	47.4	32.0

Notes are: 1. Data is taken from official sources of the former Soviet Union. 2. Thereto forest data all from the last Forest State Account (Forest fund...1990, 1991). 3. FF - Forest Fund -Lands under the Forest Authorities Management; FL - Forest Land, i.e. areas which are suitable for forest production under current conditions; FL includes FA - Forested Area - Lands covered by closed forest and Unforested Area (UFA) and FL temporary without forests.

Total growing stock of Siberia's forests is 61.4 billion cubic meters (Forest Fund). About 85% (516.4 million hectares and 56.9 billion cubic m.) of the total FA is covered by stands of dominant species and are under State Forest Management. Coniferous

occupy 436.2 mln ha (growing stock 49.3 billion cubic m), of which 277.5 mln ha are consituted by larch stands (99% of total existence in Russia), 72.9 mln ha of pine (about 65% of total extent in Russia), 39.5 mln ha of cedar (Pinus sibirica a ~ P. corejansis) = (98%), 46.5 mln ha of spruce and fir (50%), soft deciduous - 68.5 mln ha (mainly birch and aspen), hard deciduous stands - 11.6 mln ha. Nearly 40% of the forest are mountainous.

Practically all of the climatic zones of the northern hemisphere are present in Siberia: from arctic deserts, tundra and forest tundra, mixed forest to sparce forest and meadows, semi deserts and deserts, but the principal main vegetational zone - taiga covers more than 60% of the Forest Fund and 87% of the Forested Area of the total territory.

The natural ecosystems of Siberia play a great biospheric role. The wood alone contains nearly 30.10^9 tons carbon. The content of carbon in bogs is at least four times larger (> 120.10^9 t). The lastest estimates show that the forest ecosystems in former USSR constitute a yearly net sink of carbon of the size of $0.5 \cdot 10^9$ t C (Kolchugina et al., 1992) annually. Unpublished material indicate a net annual sink of $(0.8 \pm 0.1)\ 10^9$ t C for Russia and about $0.5 \cdot 10^9$ for the Siberian forests.

The watershed function of the Siberian ecosystems (primarily the forests) has an important function: more than 80% of the total river drain of Russia (~3500 m^3 per km^2) is formed in Siberia and flows into the Arctic and Pacific oceans.

The status of Siberia's natural ecosystems varies, but as a whole they are not sutainable. However, it is a large territory, and about one third is practically undisturbed by any anthropogenic sources (280.2 mln hectares of total FF area apply to the so-called non-used forest and 50% of total FF area are not under any management). On the other side there are large territories practically destroyed and disordered.

About 290 mln ha of the forested area constitutes area applicable for commercial

harvesting: during the last 25 years about 14 billion m^3 of the commercial wood was harvested (final felling). But an almost complete absence of control and sustainable approach of the harvesting operations have caused huge losses of wood and forests. In addition only the most valuable wood was removed from the forest and the rest has been left. Official sources report a rate of waste wood in the range of 40-60% (State Programme, 1991 and State Report, 1992).

After harvesting, stands are left either destroyed as sparce stands or as unforested area. In spite of the low utilization level of the Annual Allowable Cut (AAC) (only about 50% is used in total Russia and 30% in Siberia), it was admitted by official sources that overharvesting of specific species and qualities took place in 1991 with about 2.5 million m^3.

On average, the forest area burned by forest fires is more than 7 times the area cut annually (State Programme...1991). Annually, forest fires destroy about 2 million hectares, including 1.5 mln ha of forested area. The forest area, which is covered by fire protection area is only about 60%.

Considerable damage of the ecosystems is caused by industrial utilization of the territory. Gas- and oil-production have destroyed millions of hectares, especially in the WES (official data reports are considerably less than reality). The length of the pipe lines in Russia is 132.9 thousand km and breakdowns have caused spills of nearly 1 mln tons of oil annually. During 1991, more than 10 billion cubic meters of gas were burned in the torches only in the Tumen region. Although the average concentrations of emissions are not high in Siberia (average SO2 concentrations were 1-2 micro gr/m^3), there are vast areas of ecosytems destroyed by anthropogenic sources. In 1991 the Norilsk metallurgical combine emitted 2.4 mln tons of sulphur. The long lasting emissions from this industry have caused the death of nearly 2 million hectares of northern landscapes, including 0.5 million hectares of northern forest taiga. In the Irkutsk region 90% of the arable lands have a higher rate of contamination than is allowed. The estuaries of Lena and Amur rivers have a 5-10 times higher rate of contamination than is accepted by the authorities. High levels of contamination are

also observed in arctic sea areas, such as Barenz, Karskoje, Laptjevich, and Bering.

The northern ecosystems are very brittle and their recovery after disturbances requires a long time. Reforestation after final felling is very difficult and often practically impossible over centuries in areas with the most extreme climatic conditions in Siberia.

The "State Report of the Environment of the Russian Federation" (1992) identified 13 regions in which the general ecological situation was classified as "critical" i.e. dangerous to human health; 7 of them are situated in Siberia.

The great transitions which characterize Russia currently can be most dangerous for the environment and the forests. The utilization of forests can be become uncontrolled resulting in harvests of higher productivity stands in areas with existing infrastructure. Violation of Russia's nature protection legislation has and is quite common.

The Siberian forest ecosystems are of great importance, not only for Russia, but also on a global scale. To establish the principle of sustainable development of the biosphere, there is a need to have full information about the status and trends of the development of the nature. Information about Siberian ecosystems is insufficient, and has so far in many cases been inaccessible. In spite of numerous publications dealing with significant problems in the separate field of natural science in Russia, there are practically no publications that could give complete information or guidelines for policymaking in Russia or at an international level.

To estimate the biospheric role of the Siberian ecosystems, a system analyses' approach seem to be suitable. To consider the links of all ecosystems within their landscapes this kind of approach is necessary.

The problem of finding the satisfying landscape structures is now actively investigated in science. For Siberian forests the landscape structure is of high importance, at least from two points of view. Firstly, for a number of the undisturbed and unchanged forest areas of Siberia, there is the possibility to provide the initial implementation of relevant

landscape structure management. Secondly, there are many prerequisites for improving the structure of Siberian landscapes and their biospheric role: the presence of a large territory of the unforested area: 55 mln ha of sparse wood, 26.7 mln ha ***(check data in the other manuscript)*** postfire territories without regeneration of forests, 102 mln hectares of bogs, etc.

According to Russian researchers (Budyko, Israel, 1987), the climae change in Siberia is estimated to affect the north-eastern part most. The assumed warming may reach 4-5° C at the 64°, and higher latitudes in year 2015, and at the end of the next century 8-10° C. This scenario can be explained by the weakening of the global wind system (Solomon 1985) at changed climate conditions. Corresponding to this and other scenarios (Kimmins J.P., Kurz W.A. 1989), the warming will be accompanied with some increasing precipitation in Siberia although in the center and southern part of the Far East there is a high probability for decreased precipitation. In general, such changes will provide better forest growth conditions with increased productivity within the boreal zone (Kellomaki et al. 1988, Shvidenko and Roshkov 1992), but simultaneously forest fires, diseases, and insects will increase. The role and behavior of permafrost in the global change perspective is not completely understood. There is more than 400 million ha of land with permafrost in Siberia. The fluxes of methane and other gases after thawing of permafrost are uknown. In some regions of Siberia the formation of northern steppe can arise.

To a large extent it is unknown what climate warming can bring to the boreal forest as a whole, and particularly to Siberian forests: the changes of the metabolism and structure of the boreal forest needs a very long time, and the reactions to increasing summer temperatures and precipitations are not simple to estimate and are not evident. During the last 5 years, the average annual temperature anomalous constitute +0.6°C, compared with the period 1951-80, for the whole territory of the Russian Federation.

At an average rate of increased temperature of +3°C for the next 100 years, the majority of woody species is estimated to move their northern boundary at a speed of

nearly 2 km/year. Coniferous species are probably not able to move at such speed due to natural barriers (mountains, seas, deserts, agricultural land, urban territories, etc.).

The forest management will play an important role under a changing climate. This is evident with the presence of large areas of unevenaged stands (more than 50% of the Siberian forest), low-density stands (161 mln hectares have a density of 0.3-0.4), and with large disturbed forest areas.

Conclusions:

1. Siberian ecosystems are of great importance in terms of the sustainable development of the biosphere. Their state and dynamics are subject to global interest.

2. Information and knowledge about the Siberian ecosystems are, in many respects, incomplete and have so far been inaccessible.

This proposal, Part I of the Biospheric Role of Siberian Ecosystems, deals with the generation of the required databases. Part II will deal with the specific analyses to be carried out on the Biospheric Role of the Siberian Ecosystems.

The proposed study will play an important role in the activities in the framework of the International Boreal Research Organization.

3. CONCEPTUAL FRAMEWORK OF THE DATABASES

The basic territorial unit in the databases will be ecoregions, which are to be formed on the basis of natural/forestry/agricultural conditions. An ecoregion is considered as a minimal territorial unit which will may later be merged into other ecological,

administrative and economic units. We have identified a preliminary list of about 70 ecoregions for Siberia, which are presented in Appendix 1.

The databases will be linked to a GIS system. A few information systems are available in Russia concerning land, forests and water (Roshkov, 1991). These systems are intended to be used for the development of the required GIS-system as well as the following maps.

1. Maps of phytomass, mortality and production (Bazilevich, unpublished, scale 1:8 x 10^6).
2. Soil map (1987, scale 1:2.5 x 10^6).
3. Forest map (1990, scale 1:2.5 x 10^6).
4. Map of natural/agricultural division.
5. Map of administrative-territorial division.
6. Vegetation map.
7. Land use map.
8. Map of forestry division into ecoregions.
9. Map of land erosion.

To generate the required databases, sets of auxilary models have to be developed.

1. Models for the productivity of the Siberian forest ecosystems (increment and natural mortality).
2. Models of the total amount of biomass and its fractions (stemwood, crows, leaves, and underground biomass).
3. Models for estimation of critical ecophysiological paramaters.
4. Models for exogenic influences on ecological processes.

Initial data for these models will be collected from scientific publications (Bazilevich et al., 1986; Kobak, 1988; Smazin, 1980; Sagreev, 1992; and Utkin et al., 1973) and from unpublished experimental and local data.

The available data for extreme northern territories are insufficient:

- data for the tundra, forest tundra and the reserved part of the northern taiga (about 400 million ha) are more than 35 years old and generated by non-accurate methods;
- inventory of peatlands and bogs is insufficient; and
- inventory of areas burned by forest fires is non-existent.

It is necessary to use remote sensing information to update these areas.

The proposed work to generate the databases will be coordinated by the IIASA core-team together with collaborators from:

- the International Forestry Institute and Center for Ecology and Productivity (Moscow, Academician A. Isaev);
- Dokuchajev Soil Institute (Moscow, Professor V. Roshkov);
- Institute of Global Ecology and Climate Change (Moscow, Professor I. Nazarov, Dr. R. Karaban);
- Institute of Wood, (Krasnoyarsk);
- Novosibirsk institutes (Professor V. Sedych);
- Far East Forestry Institute (Khabarovsk, Dr. D. Efremov).

The databases are estimated to be completed in mid 1994.

Appendix 1

ECOREGIONS

Number	Administrative units West Siberia	Ecoregions' name economic region
1	Tjumen oblast (Tju)	Tju tundra
2		Tju forest tundra
3		Tju north taiga
4		Tju middle taiga
5		Tju south taiga
6		Tju forest steppe
7	Tomsk oblast (To)	To middle taiga
8		To south taiga
9	Omsk oblast (O)	O south taiga
10		O forest steppe
11		O steppe
12	Nobosibirsk oblast (N)	N south taiga
13		N forest steppe
14		N steppe
15	Altaj kray (A)	A forest steppe
16		A steppe
17		A mountain taiga
18	Kemerovo oblast (KE)	KE south taiga
19		KE mountain forest steppe
20		KE mountain south taiga
21	Krasnoyarsk kraj (Kr)	Kr tundra
22		Kr forest tundra
23		Kr north taiga
24		Kr middle taiga
25		Kr south taiga
26		Kr forest steppe

27		Kr mountain north taiga
28		Kr mountain middle taiga
29		Kr mountain south taiga
30		Kr mountain forest steppe
31	Irkutsk oblast (I)	I middle taiga
32		I south taiga
33		I forest steppe
34		I mountain taiga
35	Chita oblast (Ch)	Ch mountain middle taiga
36		Ch mountain south taiga
37		Ch forest steppe
38	Bourjat republic (B)	B mountain middle taiga
39		B mountain south taiga
40		B steppe
41	Tuva republic (T)	T mountain forest steppe
42		T mountain taiga
43	Jakutia-Socha republic (JA)	Ja tundra
44		Ja forest tundra
45		Ja north-west north taiga
46		Ja east-west mountain north taiga
47		Ja middle taiga
48		Ja mountain middle taiga
49	Magadan oblast (M)	M tundra
50		M mountain forest-tundra
51		M mountain north taiga
52	Amur oblast (Am)	Am mountain middle taiga
53		Am south taiga
54		Am mixed forests
55		Am forest steppe

56	Khabarovsk kray (Kh)	Kh mountain north steppe
57		Kh mountain middle steppe
58		Kh mountain south steppe
59		Kh mixed forests
60	Primorsky kraj (P)	P mountain south taiga
61		P mixed forests
62		P forest steppe
63	Sahalin oblas (S)	S middle taiga
64		S mountain south taiga
65	Kamtshatka (Ka)	Ka tundra
66		Ka mountain forest tundra
67		Ka south taiga
68		Ka mountain sparce forests and meadow

Appendix 2

VARIABLES TO BE INCLUDED IN THE DATABASES

Identification

1. Ecoregion
2. Administrative units (oblast, kraj)
3. Area (All areas are shown in thousand hectares if not indicated otherwise)
4. Population
5. Latitudes and longitudes
6. Macro-relief
7. Landscape structures
8. Average altitude
9. Land-use (i = type of land-use; j = area; I = 7; J = 1)
   Data are given in table forms, i - number of lines, j - number of columns
10. Infrastructure
11. Roads
    i=8; types of roads and indexes
    (1) total km, includ.
    (2) railways
    (3) broad gauge lines
    (4) automobile roads,
incl. (5) with hard cover,
    (6) earth roads
incl. (7) with all season exploitation
    (8) winter road
    j=9; length, km, by types of roads
    (9) total, including
    by (10) I, (11) II, (12) III classes of automobile roads,
    (13) log transport roads
    (14) general use roads
12. Pipelines
13. Anthropogenic disturbances (i = type of land-use, j = kind of disturbance, k = area)
14. List of administrative districts and forestry enterprises, including in ecoregion
15. Types of forest inventory
    i = 3, i - type of inventory
    j = 1, j - inventoried area

Atmosphere

1. Address (ecoregion)
2. (1-23) Monthly (1-12) and yearly (13) data (format 23x13):
   - average temperature (t) of air, °C (1)
   - average t of soil surface, °C: average (2), average maximum value (3), average minimum value (4), absolute maximum value (5), absolute minimum value (6)
   - average t of soil at different depth, °C: 5cm (7), 10cm (8), 15cm (9), 20cm (10); (due to measurements by drawing out thermometers: 0.2m (11), 1.0 (12), 2.0 (13), 3.0 (14), 4.0 (15), 5.0 (16)
   - sum of precipitation, mm (17)
   - sum of solar radiation, kcal/cm^2 (18)
   - sum of radiation balance, kcal/cm^2 (19)
   - average albedo, percent (20)
   - average wind speed, m/sek (21)
   - absolute maximum air t (average long period value for absolute month's maximums), °C (22)
   - absolute minimum air t (average long period value for absolute month's minimums), °C (23)

   Note: In column (13) by lines (1)-(4), (7)-(16), 20, 21 are given yearly average data; by lines (5), (6), (22), (23) - absolute maximums (minimum) for all the observation period; in columns (17), (18), (19) - sums per year.
3. (1-6) Vegetation period data;
   - sum of active temperatures (>10°C), °C(1)
   - sum of active temperatures (>5°C), °C(2)
   - sum of precipitations during vegetation period >10°C, mm (3)
   - sum of precipitations during the vegetation period >5°C, mm (4)
   - vegetation period >10°C, days (5)
   - vegetation period >5°C, days (6)
4. (1-5) Snow cover, cm:
   - average depth of snow by last decade of month (1);
   - maximal average depth of snow during winter, cm (2)
   - maximum from maximal snow depth during winter, cm (3)
   - maximum from minimal depth of snow during winter, cm (4)
   - duration of snow coverage, days (5)
5. Average content CO_2 (%) in July
6. Average content CO_2 (%) in February
7. Concentration of O_2 in July
8. Concentration of O_2 in February
9. Average content of methane, %
10. Average content of NO_x
11. Average content of CCFC, %
12. Emissions of CO_2, t./year
13. Emissions of SO_2, t./year
14. Emissions of NO_x, t./year
15. Solid matter, t./year
16. Emissions of heavy metals, t./year

17. Deposition - sulphur
18. Deposition - nitrogen
19. Deposition - heavy metals
20. Balance of CO_2 during the vegetation period
21. Balance of CO_2 during year

Biosphere (vegetation)

1. Ecoregion
   A. Forests
2. Distribution of Forest Fund area and growing stock by public forms of management, basic categories of forest fund lands and species' groups (5 x 16)
   i=5: forms of management
   1) under state forest management
   2) incl. areas of long-period on-lease
   3) forests of other ministries
   4) forests of sovchosos 5) forest of colchosos
   j=16: Area (1-10)
   1) Total forest fund;
   2) Forest land
   3) Forested area, total
   4) incl. Coniferous
   5) Hardleaves
   6) Softleaves
   7) Mature and overmature coniferous
   8) Mature and overmature hardleaves
   9) Mature and overmature softleaves

   Growing stock (10-16)
   10) Total
   11) incl. Coniferous
   12) Hardleaves
   13) Softleaves
   (14-16) mature and overmature stands
   14) Coniferous
   15) Hardleaves
   16) Softleaves

3. Distribution of Forested Areas over different categories of land (49 x 23) i=49 names of groups of forests, protective categories and categories of land-use
   1) Total forests 1,2,3 groups
   2) Group I forest (GIF), total

   from GIS 3) Watershed forests, total

   incl. 4) Restricted belts along banks
   5) from last category (FLC) - acceptable for exploitation (AFE)
   6) Restricted belts of spawning reservoirs
   7) FLC - AFE

   from G1F 8) Protective forests, total

   incl. 9) Erosion protection forests
   10) FLC - AFE
   11) incl. Protective belts along roads
   12) FLC - AFE
   13) especially valuable forests
   14) state field - protective forest belts
   15) forests in steppe

16) FLC - AFE
from G1F 17) Sanitary forests, total
incl. 18) green zone forests
19) forest parks
20) green zone forests AFE
21) spring protective forests (I + II zones)
22) protective resort forests (I + II zones)
23) protective resort forests (III zones)
24) FLC - AFE
25) city forests
from G1F 26) Special forests, total
incl. 27) forest reserves
28) national and nature parks
29) scientific and historical forests
30) forests for nut production
31) forests for fruit yield
32) sub-tundra forests
33) FLC-AFE
34) sub-alpine forests
35) FLC-AFE
36) Group II forests (GIIF), total
37) incl. special zones and belts of GIIF
38) Group II forests - AFE
39) Special zones and belts of GIIF - AFE
40) Group III forests (GIIIF), total
41) incl. special zones and belts of GIIIF
42) unused (reserved) forests
43) Group III forests - AFE
44) Special zones and belts of GIIIF - AFE
45) Forests on long-term lease, total
incl. 46) long-term lease group I forests
47) Long-term lease group II forests
48) Long-term lease group III forests
49) Long-term lease forests transferred to agriculture

j=23 Categories of land-use
1) Total Forest Fund area
2) Forested area
incl. 3) Forest Plantations
4) unclosed young forest plantations
5) nursery and seed plantations
6) Unforested areas
incl. 7) sparse woods
8) post-fire areas and dead stands
9) unforested cutting areas
10) glades
11) Forest lands, total
12) Non-forest lands, total

incl. 13) arable lands
14) hayfields
15) pastures
16) water
17) gardens
18) roads, line cuttings
19) farmsteads
20) bogs
21) sands
22) glaciers
23) unproductive areas

4. Distribution of areas and growing stocks by dominant species and age groups (35x19) for each protective category.

i=35 Species and Group of Species
1) Main forest species, total
incl. 2) Coniferous, total
incl. 3) Pine
4) Spruce
5) Fir
6) Larch
7) Cedar
8) Juniper
9) Hardleaves, total
incl. 10) Oak high productivity
11) Oak low productivity
12) Beech
13) Hornbeam
14) Ash
15) Maple
16) Elm
17) Stone Birch
18) Saksaul
19) White acacia
20) total low productivity hardleaves
21) Softleaves, total
incl. 22) Birch
23) Aspen
24) Grey alder
25) Black alder
26) Lime
27) Poplar
28) Willow tree
29) Other species, total
30) Shrubbery, total
incl. 31) Birch-shrub

32) Jusgun
33) Willow-shrub
34) Floor pine
35) Juniper

j=19 Indexes, areas and growing stocks
1) cutting age low limit
2) forested areas, total
incl. 3) young stands of I age class
4) young stands of II age class
5) middleaged, total
6) FLC - including in AAC calculation
7) premature
8) mature and overmature, total
incl. 9) overmature
10) growing stock, total
incl. young stands of I (11) and II (12) age classes
13) middleaged
14) premature
15) mature and overmature
incl. 16) overmature
17) general average increment, thousand cubic meter
18) middle age
19) type of stands age structure

5. Distribution of main species forested areas by densities and site indexes (35x18)

i=35 (5x7) Age groups and densities.
1) Young stands, total
incl. 2) density 0.4
3) density 0.5
4) density 0.6
5) density 0.7
6) density 0.8
7) densities 0.9-1.0
8)-14) middleaged, as previous item, only 9) density 0.3-0.4
15)-21) premature, as previous item
22)-28) mature and overmature, as previous item
29)-35) all age groups, as previous item

j=18 Areas by species groups and site indexes
1) Coniferous, total
incl. 2) II bonitat class and high
3) III bonitat
4) IV bonitat
5) V bonitat
6) Va and lower bonitat class
7)-12) hardleaves, as previous items
13)-18) softleaves, as previous items

6. Colhosos forests (23x12)

i=23 Land-use and forest categories
1) total forest fund area
2) forested areas
3) growing stock
incl. 4) forest plantations area
5) forest plantations growing stock
6)-7) young stands of I age class: area and growing stock
8)-9) young stands of II age class: area and growing stock
10)-11) middleaged stands: area and growing stock
12)-13) premature stands: area and growing stock
14)-15) mature and overmature: area and growing stock
incl. 16)-17) overmature: area and growing stock
18) unclosed young forest plantations
19) unforested areas, total
incl. 20) sparse wood; 21) post fire areas;
22) unforested cutting areas; 23) glades
j=12 Species and group of species
1) coniferous, total
incl. 2) Pine; 3) Spruce, Fir; 4) Cedar
5) Hardleaves, total
incl. 6) Oak high productivity; 7) Oak low productivity;
8) beech
9) softleaves, total
incl. 10) birch; 11) aspen;
12) Total

7. Potential productivity of locations (7x4)

i=7: basic type of the ingenious forests
j=4: 1) area
2) maximal productivity in age of maturity
3) Age of maturity
4) Probable percent of the maximum productivity realization

8. LIA (Leaf index area)

9. CLE (canopy light extinction)

10. Ground surface area
Note: 8-10 data are given for 7 basic forest association (forest type groups)

11. Structure of biomass (% by stem wood over bark) max. 7 basic forest types

1) **living phytomass** - total
incl. 2) wood of crown 3) stump
4) roots

5) wood of minor layers (shrubs, etc.)
6) foliage (needles)
7) floor cover
8) green phytomass of minor layers
9) **dead** total

incl. 10) overground wood
11) underground wood
12) litter
13) underground mortmass (non-wood)
14) **production** total

incl. 15) wood
16) stem wood
17) crown wood
18) leaves/needles
19) rest of phytomass (non-wood)
20) underground phytomass (non-wood)
21) bark of stem wood
22) specific gravity

12. Natural mortality (7x20)
i=7; 1-7) main species (forest type groups)
i=6; natural mortality (percent of growing stock) by stands types;
1) young stands;
2) middleaged;
3) premature;
4) unevenaged mature and overmature;
5) other mature and overmature

13. Quality of timber (7x20)
i=7: code of forest type (species)
j=20: percent of industrial wood (1-10)
fuel wood (11-20) by 2 age groups (premature, mature and overmature) and 5 classes of average diameter groups.

14. AAC (3x2)
i=3: species groups; 1) coniferous, 2) hardleaves, 3) softleaves
j=2: volume of; 1) commercial and 2) industrial wood

15. Actual felling harvesting (4x3)
i=4; types of cutting: 1) clear cuttings, 2) gradual and selective; 3) others;
4) clear sanitary cutting

j=3 Growing stocks
1) allowed for cutting
2) actually harvested commercial wood
3) actually harvested industrial wood

16. Distribution unforested and non-forest lands by type of forest regeneration (7x9)
i=7 types of lands
1) unforested areas needed for reforestation
incl. areas with natural regeneration by
2) coniferous and 3) deciduous forests
4) area needing assistance of natural regeneration
5) area suitable for artificial reforestation
incl.6) area available for reforestation
7) stands needing planting or sawing reconstruction
j=9 Areas by categories of lands
1) unforested total
2) sparse wood, 3) post fire areas, 4) unforested clear cutting areas, total
incl.7) bogs, 8) sands, 9) total

17. Forest plantations (13x5)
i=13 Types of reforestation and species
1) forest plantations, total
incl.2) Pine, 3) Spruce, 4) Cedar, 5) Oak
incl.6) stands reconstruction total
incl.7) Pine, 8) Spruce, 9) Oak
Additionally, plantations in low density forests, 10) total,
incl.11) Pine, 12) Spruce, 13) Oak
j=5 Areas by categories
1) total, transferred into closed forests
2) unclosed young forest stands
during the last 5 years
3) transferred into closed forests
4) dead forest plantations
5) forest plantations final felling areas

18. Assistance of natural regeneration (9x5)
i=9 Types of regeneration
1) assistance of natural regeneration, total
incl.2) by coniferous
3) FLC - on clear cutting areas with undergrowth conservation
4) by hardleaves
5) by softleaves
6) natural forest regeneration, total,
incl.7) coniferous, 8) hardleaves, 9) softleaves
j=5 1) total area
incl.2) transferred in closed forests
3) unclosed young stands, total
incl.4) areas with unsatisfactory regeneration
5) dead and write off account

19. Intermediate treatment of stands (15x15)
i=15 Indexes
1) stands needing thinning and selective sanitary cutting (TSSC), total
incl.2) stands with dominant coniferous species
3) stands with dominant hardleaves species
4) softleaves stands
5) areas needing TSSC on forestry requirements, total
incl.6) stands with dominant coniferous species,
7) hardleaves, 8) softleaves
During last 5 years transferred from softleaves stands
9) total, incl. 10) in coniferous stands, 11) in hardleaves
Actual average TSSC during last 5 years:
12) area
13) harvested volume, total
incl14) harvested commercial wood
15) harvested industrial wood
j=5 Data by type of thinnings
1) precommercial thinnings in young stands
2) thinning
3) commercial thinning
4) total thinnings
5) selective sanitary cuttings

20. Distribution of total Forest Fund area by type of fire protection and levels of fire danger (8x1)
i=8 1) onground protection
2) onground protection with air patrolling
3) air protection
4)-8) Forest Fund area distribution by level of fire danger, respectively, I - V classes

21. Average area of the forest fire
1) total
incl.2) crown fire
3) ground fire on forested area
4) ground fire on non-forest land
5) ground fire on unforested area
6) volume of burned and damaged wood

22. Post fire regeneration (3x2)
i=3 Type of regeneration
1) by coniferous
2) by deciduous
3) transfer to unforested area
j=2 Indexes
1) Transition percent during first 10 years
2) Average period of reforestation

23. Pine stands tapping (7x2)
i=7 Indexes
1) Suitable areas, mature and overmature
2) premature
incl. area under tapping 3) mature and overmature stands, 4) premature,
5) stat deficient for tapping 6) area available for annual tapping
j=2 1-2) types of tapping

24. Insect damage
i - species of insects (i = 3:1) total, incl. 2-3) 2 main species
j - area
k - percent of damage

25. Disease damage (as previous item)

26. Anthropogenic and natural damage
i = 6 by 1) air pollution, 2) industrial utilization
3) oil-gas-production, 4) wind, 5) other reasons, 6) total
j = 2, 1) area and 2) percent of damaged area

27. Changes in land use
i = type of change
j = rate of change (percent per year)

28. Bogs - total area (items 28-34 - on forest fund area)

29. Distribution according to type
i=3: 1) upper, 2) lower, 3) transitional
j=1, area

30. Biomass of bogs
i=11: fraction of biomass
1) total (living)
2) overground
incl. 3) wood
4) underground
5) mortmass (total)
incl. 6) wood
7) litter
8) underground
9) production, total
10) underground
11) wood
j = 3 types of bogs

31. Peat
i = type of land-use 1)-3) bogs; 4) forests; 5) others
j = area
k = depth, cm

32. Content of organic matter in peat
    i = 5 types of land-use
    j = 1 percent of dry weight

33. Average content of C, %

34. Emission of methane, t/ha. year

35. Hayfields
    i = 3 type of hayfields
    j = 5 1) total biomass t/ha
    2) incl. overground t/ha
    3) production, t/ha year
    4) mortmass t/ha
    5) incl. underground t/ha
    k=1 grade of degradation

36. Pasture
    As previous item

37-39. reserve
    For description of other types of non-forest land and unforested areas

B. Agricultural Land

1. Arable land, total area
2. Area distribution by type of cultivation
   i = 3 type of cultivation
   j = 5 1) total area
   2) average productivity, t/ha
   3) percent of land erosion
   4) restocked value of humus
   5) input of organic fertilizer
3. Hayfield - see forests
4. Pasture - see forests
5. Bogs - see forests
6. Reserve block
   i = 3 type of land use (agriculture)
   j = 3 1) area
   2) productivity
   3) peculiarities

Pedosphere

1. Ecoregion
   Forests
2. **Soil** predominant type/subdominant
3. Percentage of area
4. Definition by FAO
5. Definition by Soil Taxonomy
6. Accompany type/sub-type
7. Percent of area
8. Including type/subtype
9. Percent of area
10. Soil formative rock
11. Erosion degree
12. Total content of C in the upper layer (0-20 cm) %
13. Content of C, t/ha in the layer 0-20 cm
14. Content of C, t/ha in the layer 0-100 cm
15. C humin acid/C phulo acid
16. C/N
17. Humification index
18. Humification rates, t/ha year
19. Maximum CO_2 flux by respiration, mg/m^2 hour
20. Average CO_2 flux by respiration per vegetation period
21. Average CO_2 flux per year
22. CO_2/O_2
23. CO_2 content in carbonates
24. Available nitrogen
25. Arable land - see 2-24
26. Other categories of lands - see 2-24

Hydrosphere

1. Ecoregion
2. Type of water reserves
3. Total water surface
4. Density of river networks km/100 ha
5. Run-off produce
6. Water content in snow
7. Acidity of snow
8. Acidity of water
9. Carbonates
10. Average emission of CO_2, tonnes/ha/year
11. Content of solid matter, gr/L
12. Contamination of water
    i = main pollutants
    j = number of limit allowed contents
13. Content of C in water
14. Content of P in water
15. Speed of evtrofication of water reservoirs

Lithosphere

1. Ecoregion
2. Prevailing solid rock
3. Texture
4. Permeability
5. Area of permafrost
6. Type of permafrost
7. Average depth of permafrost
8. Soil
9. Content of C in organic matter
10. Deposits - types
11. Stock
12. Area of influence, km^2
13. Size of C emissions kg/ha year
14. C emission from the bowels of the earth, kg/ha
15. Carbonates to be present in the bowels of the earth

Note: Code of ecoregions has to include - vegetational zone, province, economic region

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