# THE RUSSIAN FEDERATION

**Information on the forest management reference level of the Russian Federation, submitted in accordance to draft decision of 6th Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol [-/CMP.6], recommendation by the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (Addendum FCCC/KP/AWG/2010/L.8/Add.2)**

## Land use, land-use change and forestry (LULUCF)

The Russian Federation shares the approach that establishes a reference level of absorption (emission) for forest management that equals to natural component in total removals in forests ecosystems. This approach eliminates the natural component of absorption in the forest ecosystems and objectively assesses the result of human impacts on the carbon balance in managed forests. It will provide a fair and scientifically grounded account of absorption of greenhouse gases in managed forests in contrast to approach applied at present time with fixed caps.

Comparison of current level of absorption in managed forests and reference level will promote capacity measures to increase carbon sequestration in forests, maintain and increase carbon stocks in different pools of forest ecosystems, as well as optimization of forest management in countries in Annex I.

In accordance to draft decision of 6th Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, the Russian Federation submits the information on the forest management reference level and proposes to establish such level for the Russian Federation equal to budget of carbon in 1990. This value is **94,735.4** Gg $CO_2$-eq.

Usage of historical data as a reference level should provide the necessary degree of transparency in procedures for establishing reference levels and maintain accounting in the LULUCF sector is comparable with other sectors in which emissions during the commitment period are correlated with the value of 1990 as well.

In this submission provided the information on forest management activities applied on the territory of the Russian Federation; area, distribution and age structure of managed forests; data from national greenhouse gas inventory for carbon budget in managed forests in 1990 and main methodological principles for its estimation; methods to exclude from accounting removals of greenhouse gases in accordance with decision 16/CMP.1, paragraph 1; information on force majeure situations on the territory of managed forests in Russia, and data on carbon budget in pool of harvested wood products in accordance to requirements of paragraph 4 draft decision of 6th Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol.

## Forest management on the territory of the Russian Federation

The managed forests, where systematic anthropogenic activities are being implemented to achieve the necessary social, economical and environmental goals aimed to ensure rational, regular and non-exhaustive forest use, protection and reproduction of forests and wildlife objects and monitoring of forests have been marked within the forest fund territory of Russia. The purposeful activities to use, protect and reproduce forests implemented and governed by the national law is a basis of the stable forest management. Stable management means a spectrum of the economically substantiated and environmentally safe forestry-based activities, whose implementation requires the following conditions:

- availability of data of the regular public accountings based on the forest management materials;

- efficient protection of forests ensuring stabilization and reduction of losses from fires and other damages to plants;
- organized economical activities in forests based on the long-term planning and accounting of their economic purpose and environmental functions.

Forest management in Russia is defined as a system of anthropogenic (economic) activities relating to the rational management and use of forests so that they could stably perform the corresponding environmental (including biological diversity), economical and social functions. Forest management is an integral system of the inter-related organizational and economical activities aimed to ensure a stable and non-exhaustive forest resources use.

The following activities are implemented within the framework of the forest management:

- regular accounting, quantitative assessment and analysis of the condition of the spatial-temporal and resource dynamics of the forest fund is planned and being effected;
- forest-restoration and tending of forests is carried out;
- forests are protected from fires and other reasons of the forest plants disturbances;
- an optimal amount of the forest procurements (calculated felling rate) is defined;
- final felling operations and improvement thinning is performed along with procurement of non-wood raw materials and other forest products.

All mentioned above measures have been implemented in past (including 1990), are implementing at present time and planning for implementation for future forest management activities in the country.

**Age structure of managed forests in the Russian Federation**

The age structure of Russian managed forests is shown on Figure 1. In 1990 categories of ripening, mature and overmature forests in total comprised 57.7 per cent from total area of managed forest.

During 20 years share of mature and overmature stands with domination of coniferous species decreased from 52.5% in1988 to 47.3% in 2008 in connection with forest harvesting of mainly coniferous species. In the same time the share of mature and overmature stands increased with domination of softwood species (from 33.3 % in 1988 to 36.7 % in 2008) and with domination of hardwood species (from 47.0% in 1988 to 48.6% in 2008). According to data of A.S. Isaev et al (1993)[1] annual carbon deposition of ripening stands with domination of coniferous species is around 0,1 t C/ha/yr, hardwood species – 0,25 t C/ha/yr, softwood species – 0,65 t C/ha/yr. Annual carbon deposition of mature and overmature stands assumed to be zero.

More than half of total forest area in Russia belongs to permafrost soils in inclement climate condition. It is determined low productivity and low density of Russian forests. Share of area of forests with low productivity (growth classes – IV – Vb) with domination of coniferous species is 79%, with domination of hardwood species – 71%, with domination of softwood species – 34%. Share of area of stands with low density (less than 0.5) with domination of coniferous species is 52.0%, with domination of hardwood species – 43.3%, with domination of softwood species – 25.4 %.

[1] Isaev A.S., Korovin G.N., Utkin A.I., Pryazhnikov A.A., Zamolodchikov D.G. Estimation of carbon pool and its annual deposition in phytomass of forest ecosystems in Russia // Lesovedenie. 1993 N 5 p 3-10. In Russian

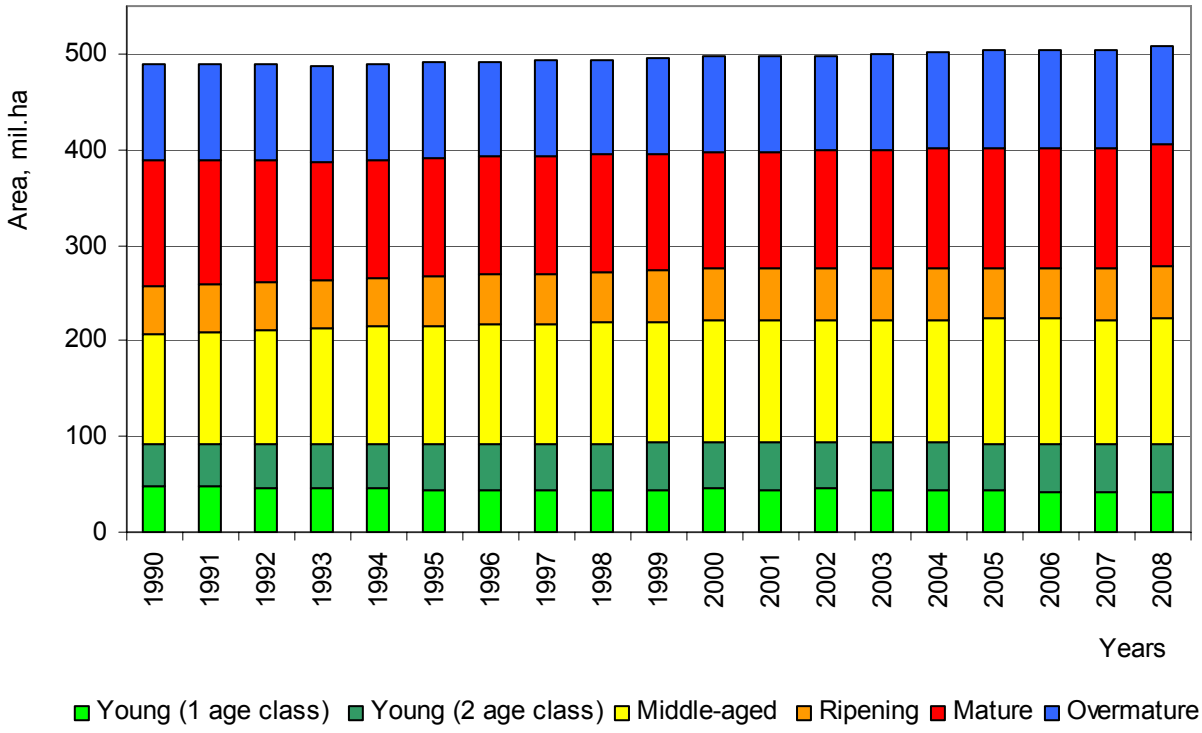


Fig. 1. Age structure of managed forests in Russia during 1990-2008.

**Main methodological principles for estimation of carbon budget of managed forests in 1990 (forest management reference level) in accordance to data of national greenhouse gas inventory**

The managed forests of Russia include forest lands of the forest fund except for the reserve forests. Area and growing stock data of managed forests in Russia are periodically corrected depending on inclusion of new forest territories in management activities. By estimation based on linear interpolation of data from State Accounting of Forest Fund between 01.01.1988 and 01.013.1993, area of managed forests in Russia (without shrubs) comprised in 1990 as much as 564.5 million ha, which corresponds to 72.5 per cent of forest land in the country. Total growing stocks of managed forests was 58.7 billion $m^3$, or 72.4 per cent of total growing stock in the forests of the country as of 01.01.1990.

For estimations we have used activity data for managed forests by regions in Russia as submitted by Federal Agency of the Forest Management (Rosleshoz). Activity data on area and growing stocks of managed forests was taken from data bases of State Forest Register (SFR) as for 1st January 1988, 1993 and annual during 1998-2009. Methodologies and special software for estimation of $CO_2$ sinks and emissions by regional level have been developed by the Center for problems of Ecology and Productivity of Forests of the Russian Academy of Science (CEPF RAS)[2]. Description of methodology and software to estimate carbon budget for each regions is available on web of CEPF RAS: http://www.cepl.rssi.ru/programms.htm.

[2] Zamolodchikov D.G., Chestnuh O.V. Coefficients for conversion of growing stock to phitomass of main forest-forming species in Russia// Forest taxation and forest management.2003. 1(32). P. 119-127 (In Russian).

Utkin A.I., Zamolodchikov D.G., Chestnuh O.V., Korovin G.N., Zukert N.V. Russian forests as reservoir of organic carbon of biosphere// Lesovegenie. 2001. 5. P. 8-23 (In Russian).

Zamolodchikov D.G. Assessment of carbon pool of large forest residues in Russian forests: accounting of the effects of fires and harvesting // Lesovegenie. 2009. 4. P. 3-15 (In Russian).

Main forest species included in estimations: coniferous (pine, spruce, fir, larch, Siberian and Korean pine), hard broadleaved trees (high-forest oak, coppice-forest oak, stone birch and others) and soft broadleaved trees (birch, aspen and others). ). Besides, all other tree species are estimated as a sum (Hornbeam eastern, Amur cork tree, Cork-tree etc.). All these activity data obtained from statistical materials of SFR. At present, the statistical form 4-DLR "The distribution of forest area and growing stocks by dominant species and age classes" of SFR contains activity data on areas and growing stocks for land covered by forests (with differentiation by main tree species and their ages). A statistical form 2-DLR "Characterization of forests by their designed purpose" besides all related information includes areas for different categories of lands temporary non-covered by forests, and non-forested lands of forest fund (fire-sites, cutting sites, grasslands, wetlands, etc.). Before 2008 such statistical information was collected and periodically published in the frames of State Accounting of Forest Fund (Forest Fund of USSR, 1990; Forest Fund of Russia, 1195, 1999, 2003) [3]. Such statistical categories as "Lands covered by forests" and "Temporary uncovered lands" are summed in one category of "Forest lands". These lands supposed to be used for growing of forests. Total area of forest lands in 1990 has been estimated on the base of linear interpolation of data from State Accounting of Forest Fund from 01.01.1998 and 01.01.1993.

In State Accounting of Forest Fund in Russia the category of "Lands covered with forest vegetation" includes forests with domination of trees and shrubs with their density 0.3 or higher (for young forests this value equals 0.4 and higher) and minimal area 1 ha or more. Thus in accordance to national statistics, area of managed forests in Russia include as ecosystems with domination of trees as ecosystems of scrubs.

For the reporting under Article 3.3 and 3.4 of the Kyoto protocol the ecosystems with domination of shrubs shall be excluded, because they do not correspond to the national forest definition adopted in the "National report of the Russian Federation on assigned amount of emissions" (2008) (*ecosystems of trees with minimal forest density (density of trees) of 0.3 (for young stands – 0.4), minimal height of trees in mature age of 5 m and area of 1.0 ha*).

To estimate annual changes in carbon stocks on territory of forest lands the default methodology of IPCC has been applied, which suggests distraction of carbon losses from values of carbon accumulation during considered period (GPG LULUCF, 2003)[4].

In accordance to methodological recommendations of IPCC, analytical estimation of stocks and calculation of carbon budget conducted for following pools:

1) woody biomass (for standing trees);
2) dead organic matter (standing and fallen dead wood);
3) litter;
4) soil organic matter.

The pool of biomass from harvested wood products was included in estimations on the base of default assumption on instantaneous oxidation for total amount of harvested wood carbon.

Territory of Russia situated in the different natural zones and, therefore, carbon parameters significantly vary between zones and regions. In the estimations the principle of zonal-provincial division of Russian territory was applied (firstly this principle was suggested by Isaev

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Chestnuh O.V., Lujin V.A., Koksharova A.V. Carbon stocks in litter of Russian forests// Lesovegenie. 2007. 6. P. 114-121. (In Russian).

Chestnuh O.V., Zamolodchikov D.G., Utkin A.I. Total stocks of biological carbon and nitrogen in soils of forest fund of Russia// Lesovegenie. 2004. 4. P. 30-42 (In Russian).

[3] Forest fund of USSR (as for 1st January 1988). Moscow: VNIIC lesresurs, 1990a. V. 1. 1005 pp. (In Russian).

Forest fund of USSR (as for 1st January 1988). Moscow: VNIIC lesresurs, 1990б. V. 2. 1021 pp. (In Russian).

Forest fund of Russia (as for 1st January 1993). Reference book. Moscow: VNIIC lesresurs, 1995. 281 pp. (In Russian).

Forest fund of Russia (as for 1st January 1998). Reference book. Moscow: VNIIC lesresurs, 1999. 649 pp. (In Russian).

Forest fund of Russia (as for 1st January 2003). Reference book. Moscow: VNIILM, 2003. 640 pp. (In Russian).

[4] Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC program on National GHG inventories. IPCC. 2003.

et al., 1995)[5]. In accordance to that principle the territory of Russia divided by next macroregions: European-Ural part, Western Siberia, Eastern Siberia and Far East. Further each of these macroregions divided by 3 latitudinal (zonal) belts: northern (northern sparse growth of trees and northern taiga), central (middle taiga) and southern (southern taiga, mixed and broad-leaved forests, and forest-steppe). Selection of equation parameters (conversional ratios, etalon average values) is made by respective zonal belt or by zonal-regional polygon.

Analytical estimations of carbon stocks and budget by main carbon pools is described in details in Chapter 7 of *National report of the Russian Federation on the inventory of emissions and sinks of anthropogenic greenhouse gases, not regulated by Montreal protocol, for the period 1990-2008* (2010)[6], which includes following steps:

1. Estimation of carbon stocks in pools of woody biomass, dead organic matter, litter and soil organic matter (layer 0-30 cm) on the base of statistical activity data on area and growing stocks of forests and systems of regional conversional factors. These factors are ratios of carbon stocks in biomass to total stock of stem wood as defined by every tree species and every age group of dominant tree[7].
2. Calculation of annual carbon accumulation in pools of woody biomass, dead organic matter, litter and soil organic matter. The average carbon stocks per area were calculated for each pool in consequent age groups. Next, with regard to duration of stay of tree stands in given age group, the mean year carbon accumulation in each pool of this group was estimated. Total carbon accumulation by each pool in given age group of dominant specie obtained by multiplication of mean annual value on the corresponding area.
3. Estimation of annual carbon losses from clear cuts, destructive fires and other reasons of death of tree stands. For destructive disturbances of forests the assumption was made on instantaneous oxidation of carbon in woody biomass and dead organic matter. In pools of litter and soil organic matter assumed partial decrease of carbon stocks. That approach allows to include post-fires emissions and emissions connected to decay of organic matter on clear cuts sites in the calculations. For estimations the statistical activity data on total area of fire sites and cutting sites used. Average annual disturbances estimated as the ratio of total area under fire and cutting sites to the time of its revegetation. Estimation of carbon losses from clear cuts was made on the base of average values of all carbon pools for mature forests, those are subjects for harvesting. To estimate carbon losses from fires the average values of carbon pools for all forest types of considered regions were used.
4. Estimation of annual carbon budget by each pool (difference between accumulation and carbon losses).

Results of estimations of greenhouse gas sinks and emissions from forest management as for 1990 are shown in table 1. These data include total annual carbon accumulation on the corresponding territory (920,316.0 Gg $CO_2$-eq.), carbon losses from destructive fires and other reasons of death of tree stands (338,896.1 Gg $CO_2$-eq.), as well from clear cuts (447,420.4 Gg $CO_2$-eq.).

It is necessary to note, that losses from clear cuts include emissions from harvested wood products by the assumption on its instantaneous oxidation[8]. Besides, as it is noted above, emissions from destructive fires include not only direct GHG emissions from burning processes of 1990, but as well post-fire emissions from decomposition of organic residues left on fire sites of previous years.

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[5] Isaev A.S., Korovin G.N., Sukhih V.I., Titov S.P., Utkin A.I., Golub A.A., Zamolodchikov D.G., Pryanijnikov A.A. Ecological problems of CO2 sink via afforestation and reforestation in Russia. Moscow. Center of ecological policy. 1995. 156 pp. (In Russian).

[6] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

[7] Zamolodchikov D.G., Utkin A.I., Chestnuh O.V. Coefficients for conversion of growing stock to phitomass of main forest-forming species in Russia// Forest taxation and forest management.2003. 1(32). P. 119-127 (In Russian).

[8] Good Practice Guidance for Land Use, Land-Use Change and Forestry. IPCC program on National GHG inventories. IPCC. 2003.

Thus, total carbon budget in managed forests in 1990 is estimated as high as **94,735.4** Gg $CO_2$-eq.

**Exclusion of removals in accordance with decision 16/CMP.1, paragraph 1.**

In accordance to footnote to paragraph 4 of draft decision of 6th Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, all Annex I Parties should provide the information on methods to exclude removals from accounting in accordance with paragraph 1, decision 16/CMP.1. Besides, there also noted that reference levels including and excluding "force majeure" should be provided.

Paragraph 1 of decision 16/CMP.1 has provisions for exclusion from accounting removals resulting elevated carbon dioxide concentrations above their pre-industrial level; indirect nitrogen deposition; and the dynamic effects of age structure resulting from activities and practices before the reference year.

It is necessary to note, that in line with anticipated principle of implementation of forest management reference level, which supposed to estimate the difference between current level of carbon budget and that fixed reference level, all indirect effects mentioned above should be mutually excluded. Thus, no need to apply any additional measures to fulfill provisions contained in paragraph 1, decision 16/CMP.1.

**Force majeure.**

Concept of "force majeure" is widely discussed during sessions of negotiation process. However final definition of this term still has not been agreed. According to that it is difficult to submit quantitative values for forest management reference level including and excluding situation of "force majeure". "Force majeure" may be considered as extraordinary event or circumstance those occurrences was beyond the control of, and not materially influenced by, a Party. It is suggested that associated annual greenhouse gas emissions by sources and removals by sinks to be in the range from 1 to 5 per cent or more of the total national emissions included in the base year.

As follows from figure 2 and data from national greenhouse gas inventory, 1990 was not a force majeure year in the Russian Federation for total area under fires or for volume of burned wood. Contribution of total $CO_2$ emissions from destructive fires and other reasons of death of tree stands in the Russian Federation in 1990 comprises 10.2 per cent of total national emissions in the base year[9]. This value is in the range of corresponding contributions during 1991-2008, which are from 9.8 to 12.1 per cent. Comparing to data from national greenhouse gas inventories of other Annex I Parties, relatively high contribution of $CO_2$ emissions from destructive fires and other reasons of death of tree stands from total national GHG emissions in the base year in Russia may be explained by the methodology to estimate carbon losses. That includes not only direct emissions from burning etc. during considered year, but as well post-fire emissions from decompositions of organic residues on fire sites of previous years.

If to include contribution of non-$CO_2$ greenhouse gases to total fire emissions of 1990, their role in total national greenhouse gas emissions was 11.4 per cent.

[9] 3 321,718.19 Gg $CO_2$-eq.

Table 1

Carbon budget of managed forests (without shrubs) in 1990, Gg $CO_2$-eq./yr[10]

| Elements of carbon budget | Carbon pools | CRF-2010-11 |
|---|---|---|
| Area, th.ha | | 489 817.7 |
| Carbon accumulation, Gg $CO_2$ $yr^{-1}$ | Aboveground biomass | 527 570.9 |
| | Underground biomass | 147 940.7 |
| | Total woody biomass | 675 511.6 |
| | Dead organic matter | 92 953.7 |
| | Litter | 32 154.2 |
| | Soil organic matter | 119 696.5 |
| | Total | 920 316.0 |
| Losses from destructive fires and other reasons of death of tree stands, Gg $CO_2$ $yr^{-1}$ | Aboveground biomass | -160 899.1 |
| | Underground biomass | -56 352.8 |
| | Total woody biomass | -217 251.8 |
| | Dead organic matter | -38 808.9 |
| | Litter | -11 161.7 |
| | Soil organic matter | -71 673.7 |
| | Total | -338 896.1 |
| Losses from clear cuts, Gg $CO_2$ $yr^{-1}$ | Aboveground biomass | -243 327.4 |
| | Underground biomass | -63 765.7 |
| | Total woody biomass | -307 093.1 |
| | Dead organic matter | -62 569.3 |
| | Litter | -16 307.8 |
| | Soil organic matter | -61 450.2 |
| | Total | -447 420.4 |
| Carbon budget, Gg $CO_2$ $yr^{-1}$ | Aboveground biomass | 123 344.4 |
| | Underground biomass | 27 822.3 |
| | Total woody biomass | 151 166.7 |
| | Dead organic matter | -8 424.5 |
| | Litter | 4 684.6 |
| | Soil organic matter | -13 427.4 |
| | Total | 133 999.5 |
| Direct fire emissions of $CH_4$, Gg $CO_2$-eq. $yr^{-1}$ | | -21 240.7 |
| Direct fire emissions of $N_2O$, Gg $CO_2$-eq. $yr^{-1}$ | | -17 769.2 |
| $N_2O$ emission from drainage of organic soils, Gg $CO_2$-eq. $yr^{-1}$ | | -254.2 |
| **Total budget, Gg $CO_2$-eq. $yr^{-1}$** | | **94 735.4** |

[10] positive values – accumulation of carbon, negative – losses

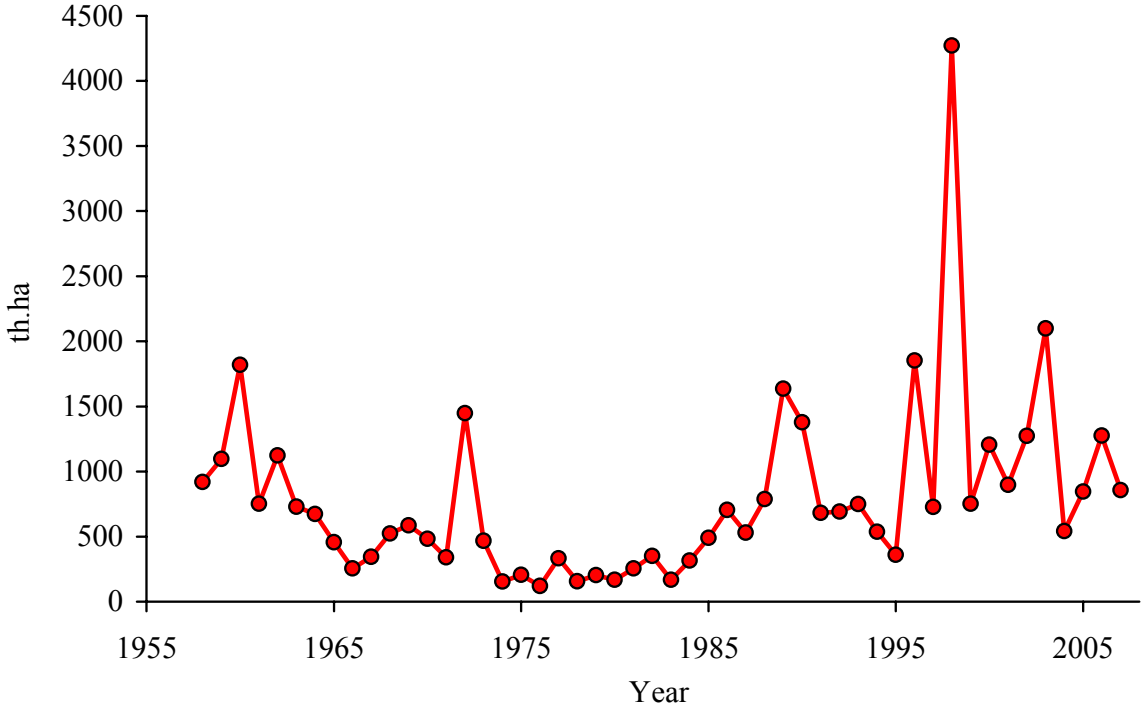


Fig. 2. Dynamic of the area under fires from 1958.

For reason of comparability separately only direct fire greenhouse gas emissions for 1990 have been estimated, without post-fire emissions of $CO_2$. That estimation of emissions of greenhouse gases during burning of biomass was made in accordance to formula (IPCC 2006 Guidelines…, 2006[11])**:**

$$Lfire = A\ M_B\ C_f\ G_{ef}\ 10^{-3}$$

where:

*Lfire* = total amount of greenhouse gas emissions from burning; tons of each greenhouse gas, such as $CH_4$, $N_2O$ etc.,

*A* = area of fire; ha,

*MB* = mass of available biomass for burning, tons/ha. Here biomass, litter and fallen dead organic matter are considered.

$C_f$ = burning coefficient; dimensionless. Default values are used: 0.43 for crown fire and 0,15 for ground fires in boreal forests (in accordance to table 2.6, IPCC 2006 Guidelines…, 2006),

$G_{ef}$ = emission factor; g/kg of burned dry matter (table 2.5, IPCC 2006 Guidelines …, 2006).

On the base of conducted calculations (see table 2) direct fire emissions of greenhouse gases in 1990 were as high as 147,496.2 Gg $CO_2$-eq. That corresponds 4.4 per cent of total national greenhouse gas emissions in the Russian Federation in the base year.

[11] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4 Agriculture, Forestry and Other Land Use. IPCC program on National GHG inventories. IPCC. 2006.

Table 2

Direct greenhouse gas emissions from destructive fires and other reason of death of tree stands in managed forests (without shrubs) in 1990, Gg $CO_2$-eq./yr[12]

| Elements of carbon budget | Without post-fire emissions |
|---|---|
| Losses from destructive fires and other reasons of death of tree stands, Gg $CO_2$ $yr^{-1}$ | -129 117.2 |
| Emissions from fire of $CH_4$, Gg $CO_2$-eq. $yr^{-1}$ | -10 117.2 |
| Emissions from fire of $N_2O$, Gg $CO_2$-eq. $yr^{-1}$ | -8 261.8 |
| Total, Gg $CO_2$-eq. $yr^{-1}$ | -147 496.2 |

**Harvested wood products.**

Additionally the pool of harvested wood products (HWP) for 1990 was estimated including usage of statistical data from 1961 to 1990, and estimated values of activity data for harvesting starting from 1900. Calculations of carbon stock changes in HWPs were made according to methodology of 2006 IPCC[13].

Activity data on production of main types of wood products in 1961-1990 were taken from statistical yearbooks "National economy of RSFSR"[14]. Calculations of exported HWPs during 1961-1989 made by the materials of annual statistical books "External trade of USSR"[15], and for 1990 – by statistical yearbook of Rosstat[16].

In that work the was applied approach by consumed production (RSTOCK-CHANGE), which include carbon stock changes in wood products domestically consumed in the producing country (without imported products). In the pool of HWPs were included category of pulp and paper products and category of wood products. Estimations were made for these categories separately in accordance to corresponding rate of decomposition for each category (half-time of life for wood products equals to 30 years, for pulp and paper – 2 years).

Calculations were made by the next formula (2006 IPCC Guidelines…, 2006):

$$RSTOCK\ CHANGE\ (t)=TC(t)+PIM(t)-PEX(t)-PHWP\ DC(t).$$

where *RSTOCK-CHANGE (t)* – net value for carbon stock change in consumed HWPs during the year *t*, Tg C · $yr^{-1}$;

*TC(t)* – carbon stock in removed from forests wood products during the year *t*, Tg C · $yr^{-1}$;

*PIM(t)* – carbon stock in imported HWPs during the year *t*, Tg C · $yr^{-1}$, in these calculations assumed to be zero;

*PEX(t)* – carbon stock in exported HWPs during the year *t*, Tg C · $yr^{-1}$;

*PHWP DC(t)* – value of carbon losses from HWPs pool during the year *t* in the result of the end of life-time for HWPs, Tg C · $yr^{-1}$.

Results of estimations for pool of HWPs are shown in the table 3 below. Total carbon budget of managed forests (without territories of shrubs) including estimations of HWPs pool for 1990 estimated to be 345,039.3 Gg $CO_2$-eq.

[12] positive values – accumulation of carbon, negative – losses

[13] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4 Agriculture, Forestry and Other Land Use. IPCC program on National GHG inventories. IPCC. 2006.

[14] National economy of RSFSR …, 1962, 1965, 1966, 1976, 1981, 1986, 1990, 1991

[15] External trade of USSR …, 1967, 1971, 1973, 1974, 1975, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989

[16] Russian Federation in 1992, 1993

Table 3

Carbon budget of managed forests (without shrubs) in 1990 including estimation for HWPs pool, Gg $CO_2$-eq./yr[17]

| Элементы углеродного бюджета | Углеродные пулы | Including HWPs pool |
|---|---|---|
| Elements of carbon budget | Carbon pools | 489 817.7 |
| | Aboveground biomass | 527 570.9 |
| | Underground biomass | 147 940.7 |
| | Total woody biomass | 675 511.6 |
| | Dead organic matter | 92 953.7 |
| | Litter | 32 154.2 |
| Area, th.ha | Soil organic matter | 119 696.5 |
| Carbon accumulation, Gg $CO_2$ $yr^{-1}$ | Total | 920 316.0 |
| | Aboveground biomass | -160 899.1 |
| | Underground biomass | -56 352.8 |
| | Total woody biomass | -217 251.8 |
| | Dead organic matter | -38 808.9 |
| | Litter | -11 161.7 |
| Losses from destructive fires and other reasons | Soil organic matter | -71 673.7 |
| of death of tree stands, Gg $CO_2$ $yr^{-1}$ | Total | -338 896.1 |
| | Aboveground biomass | 0.0 |
| | Underground biomass | -63 765.7 |
| | Total woody biomass | -63 765.7 |
| | Dead organic matter | -62 569.3 |
| | Litter | -16 307.8 |
| | Soil organic matter | -61 450.2 |
| Losses from clear cuts, Gg $CO_2$ $yr^{-1}$ | Total | -204 093.0 |
| | Aboveground biomass | |
| | Underground biomass | |
| | Total woody biomass | |
| | Dead organic matter | |
| | Litter | |
| | Soil organic matter | |
| Carbon budget, Gg $CO_2$ $yr^{-1}$ | Total | 377 326.9 |
| Direct fire emissions of $CH_4$, Gg $CO_2$-eq. $yr^{-1}$ | | -21 240.7 |
| Direct fire emissions of $N_2O$, Gg $CO_2$-eq. $yr^{-1}$ | | -17 769.2 |
| $N_2O$ emission from drainage of organic soils, Gg $CO_2$-eq. $yr^{-1}$ | | -254.2 |
| Accumulation by HWPs pool, Gg $CO_2$ $yr^{-1}$ | | 6976.5 |
| **Total budget, Gg $CO_2$-eq. $yr^{-1}$** | | **345 039.3** |

[17] positive values – accumulation of carbon, negative – losses