

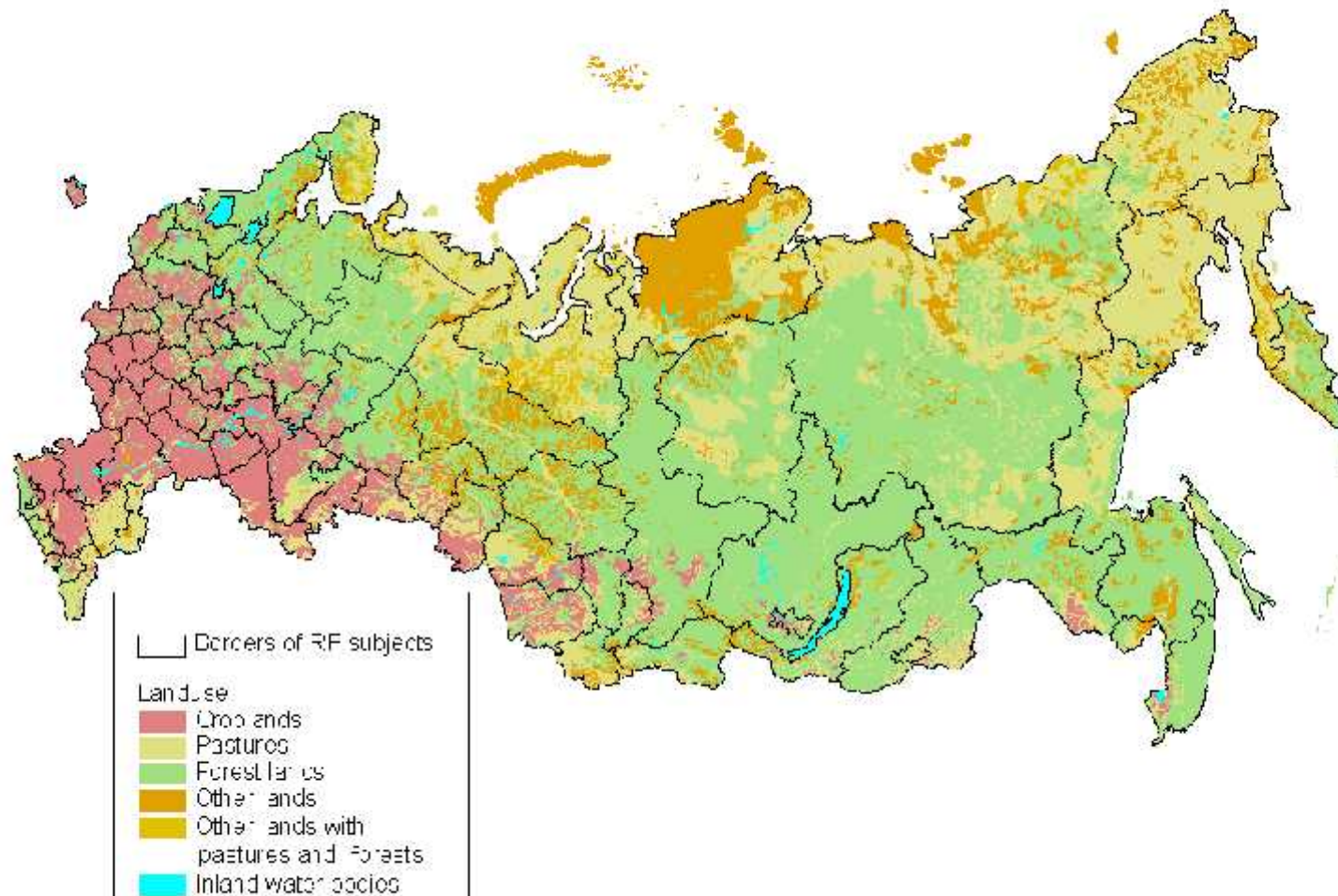
Forest and agriculture greenhouse gas modeling forum

Carbon budget of Russian forests and farmlands: potential and reality for climate mitigation

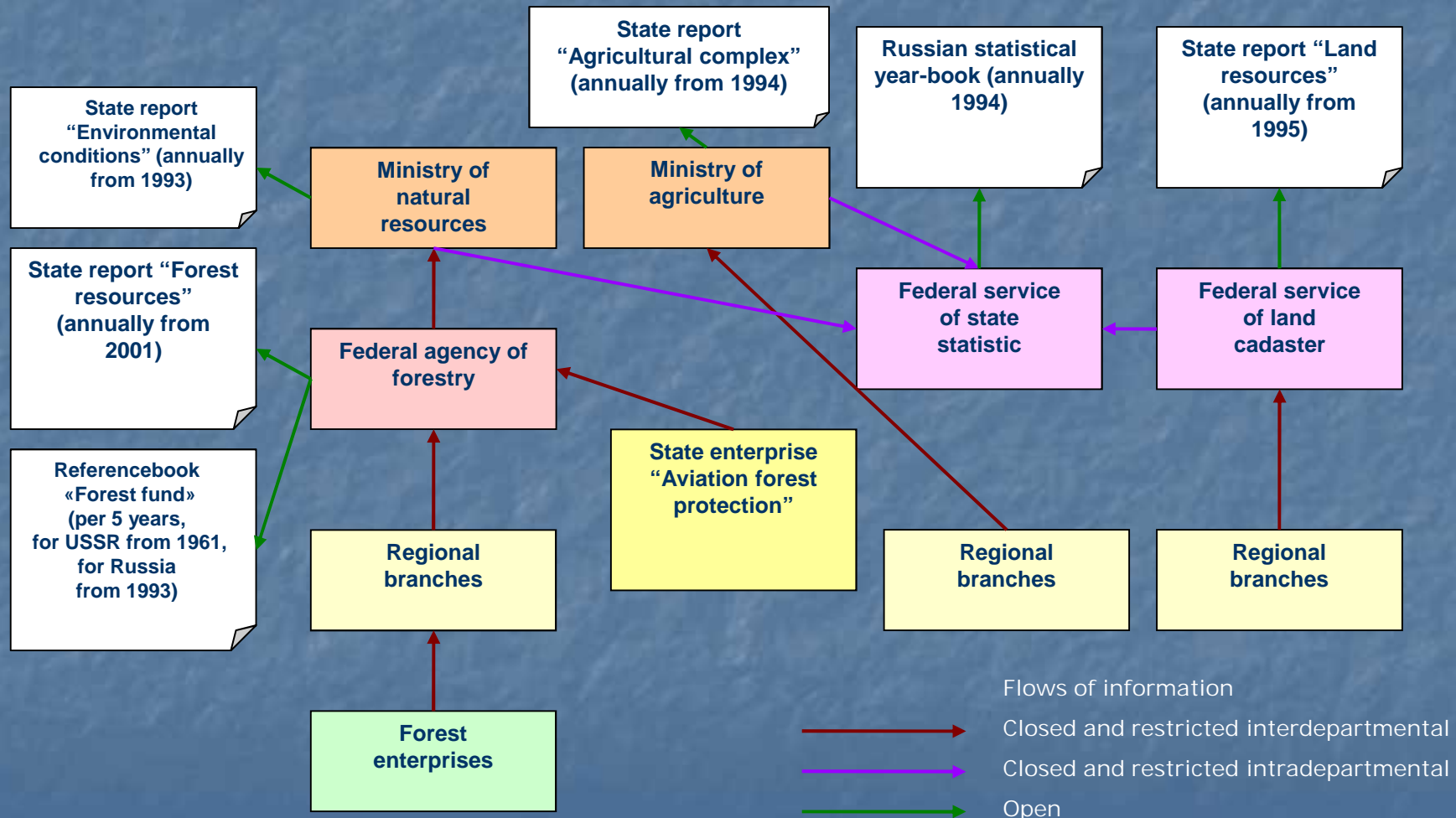
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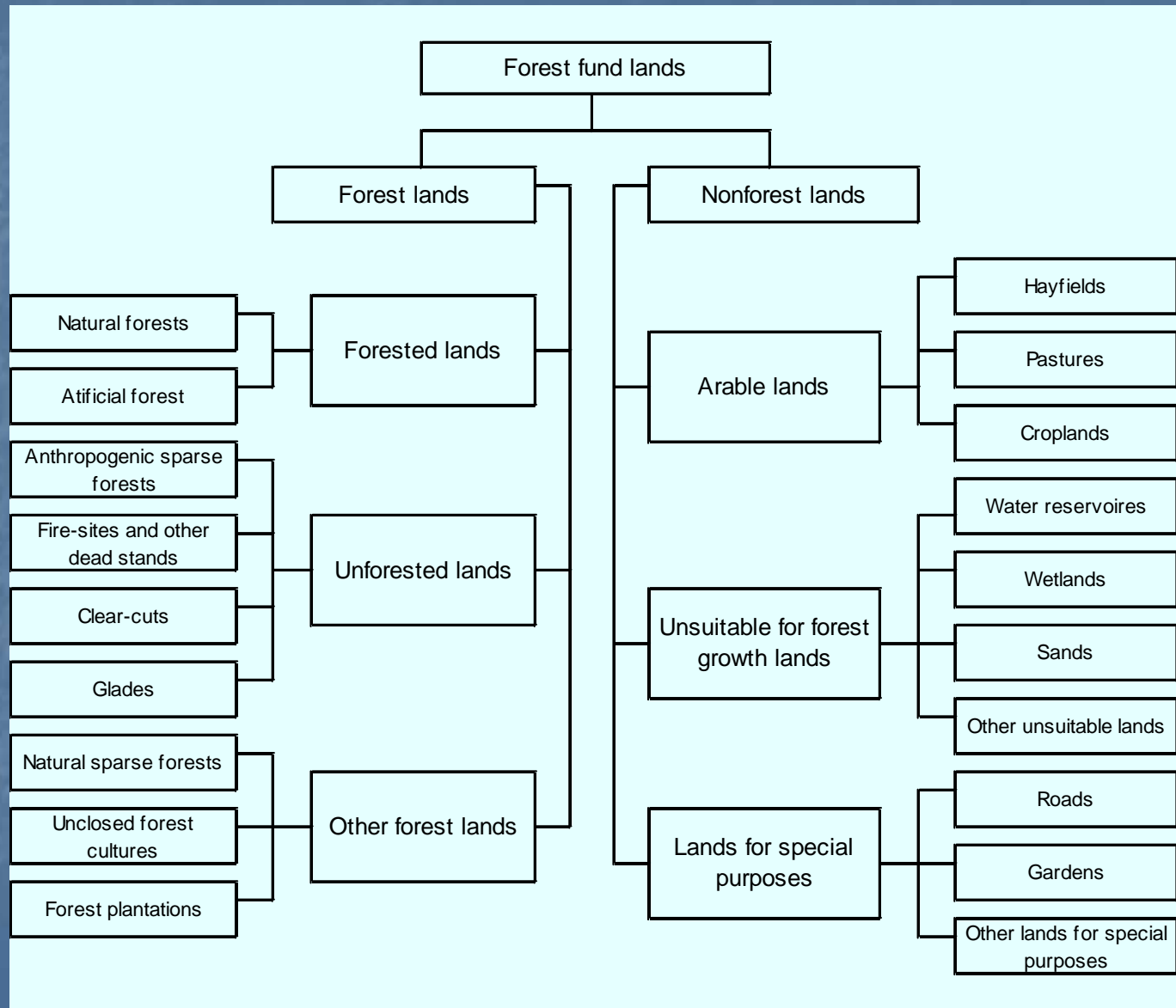
Land use types in Russia



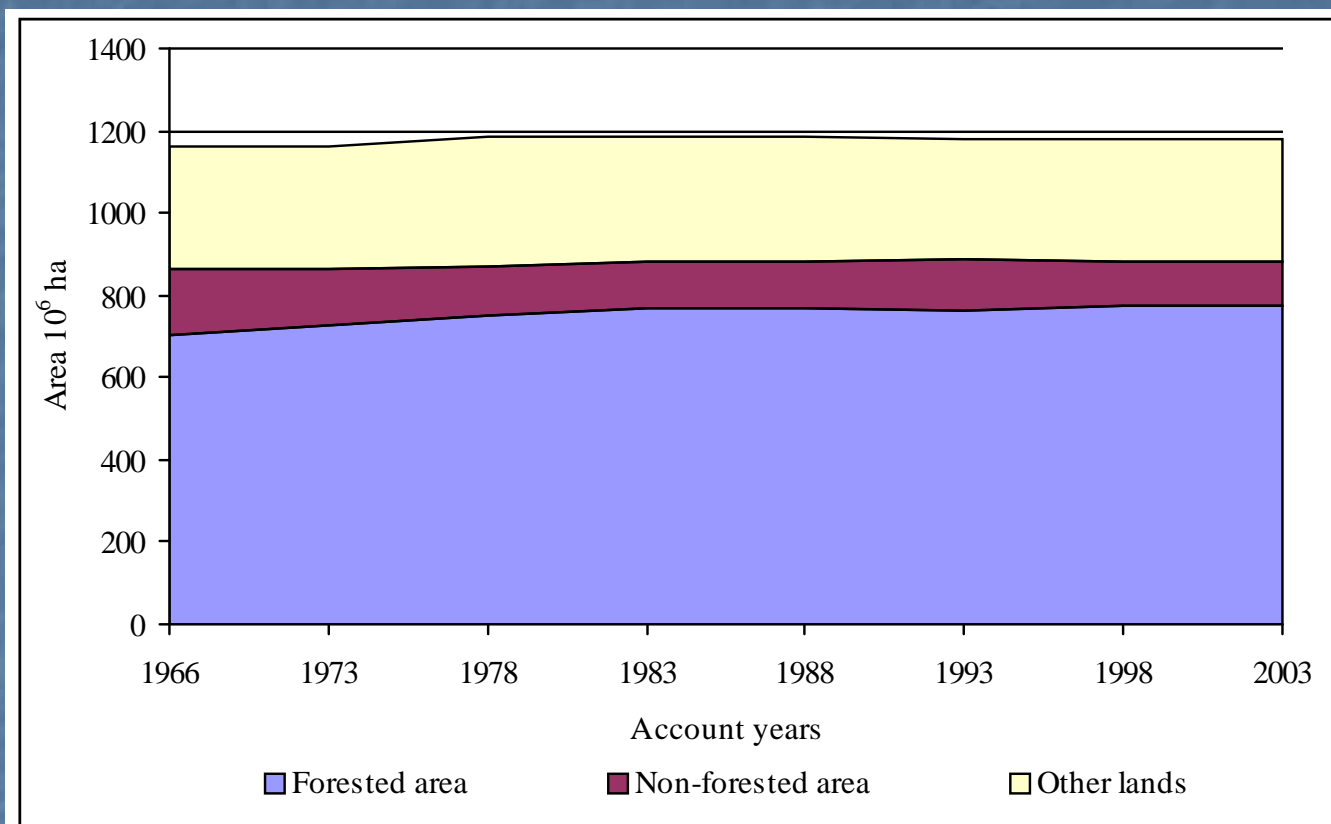
Official information sources for land use and forestry



Structure of Russian forest fund

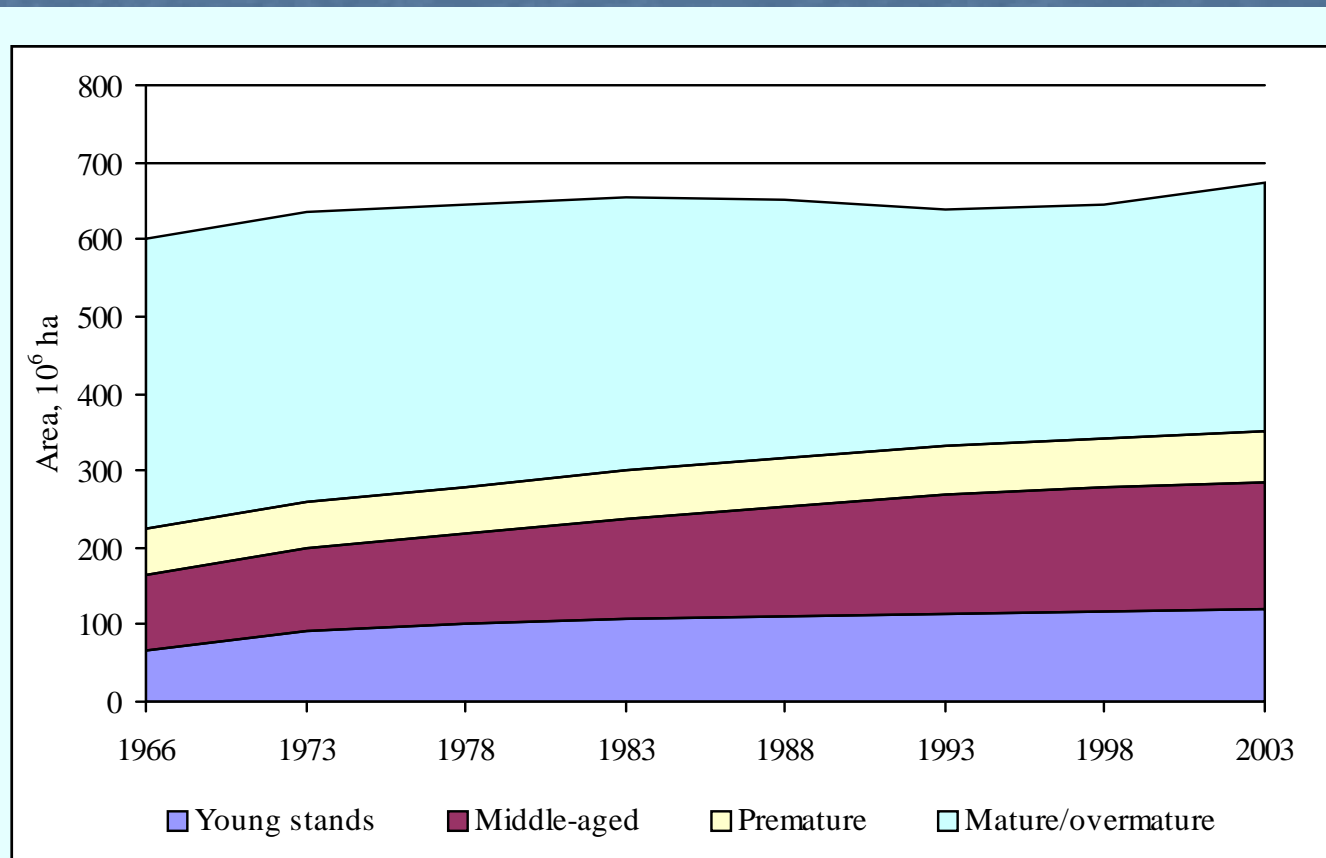


Area dynamics of Russian forest fund



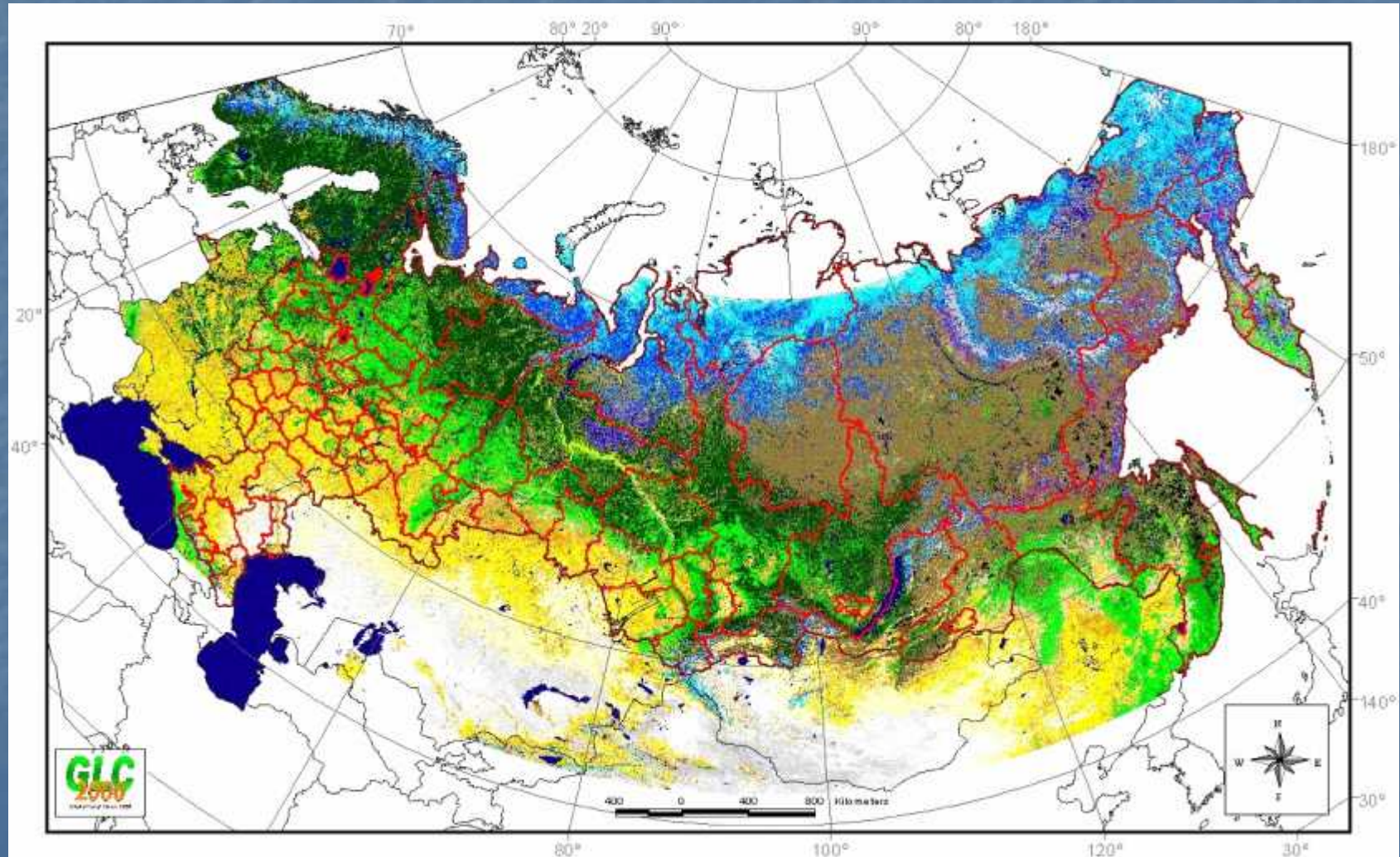
Forest Fund structure	Main category areas by year, 10 ⁶ ha							
	1966	1973	1978	1983	1988	1993	1998	2003
Forested area	705.6	729.7	749.5	766.6	771.1	763.5	774.2	776.1
Non-forested area	157.4	132.4	122.8	113.9	113	123	107.8	106.8
Other lands	298.9	299.3	313.9	307.2	298.5	294.4	296.6	296.0
Total	1161.9	1161.4	1186.2	1187.7	1182.6	1180.9	1178.6	1179.0

Forest area dynamics by age groups

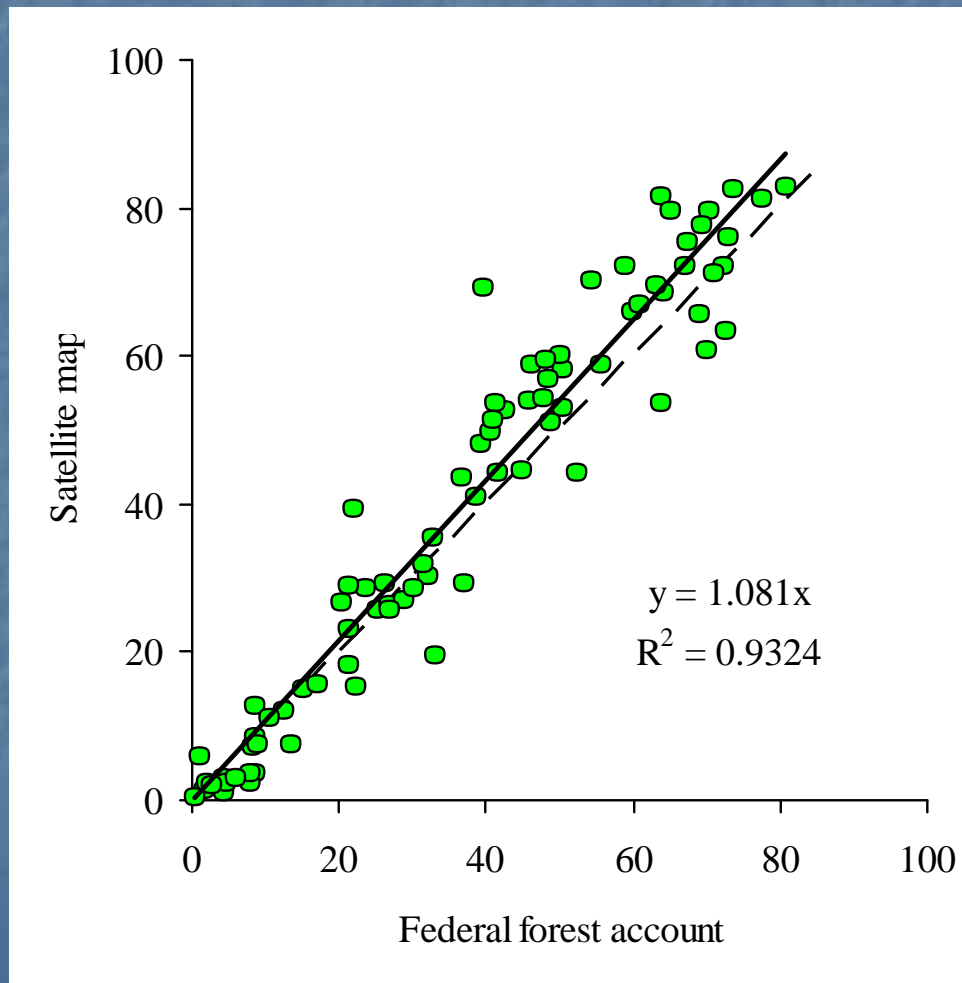


Age groups	Forest-forming species area by year, 10 ⁶ ha							
	1966	1973	1978	1983	1988	1993	1998	2003
Young stands	66.97	91.05	102.08	108.08	112.11	114.98	118.01	121.27
Middle-aged	96.36	108.25	116.59	128.02	139.31	153.52	158.69	162.73
Premature	60.37	59.02	59.05	63.44	64.34	62.18	66.16	68.05
Mature/overmature	377.23	375.84	368.72	355.31	337.12	307.53	303.03	321.92
Total	600.93	634.16	646.44	654.85	652.88	638.21	645.89	306.79

SPOT4-VEGETATION derived land cover map of Northern Eurasia (Bartalev et al., 2003)



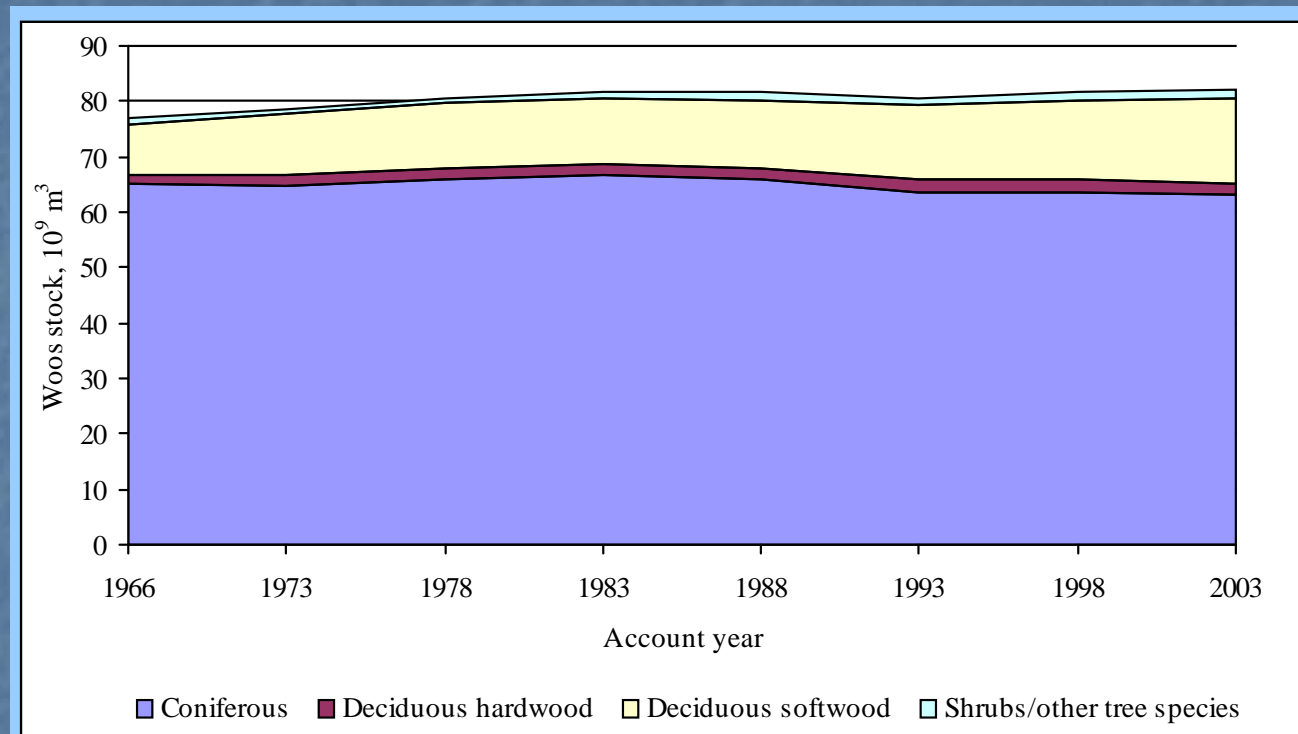
Percentage of forest lands by forest account and by satellite map



Total area of forests
and sparse forest by
Forest Fund Account is
767 mln. ha.

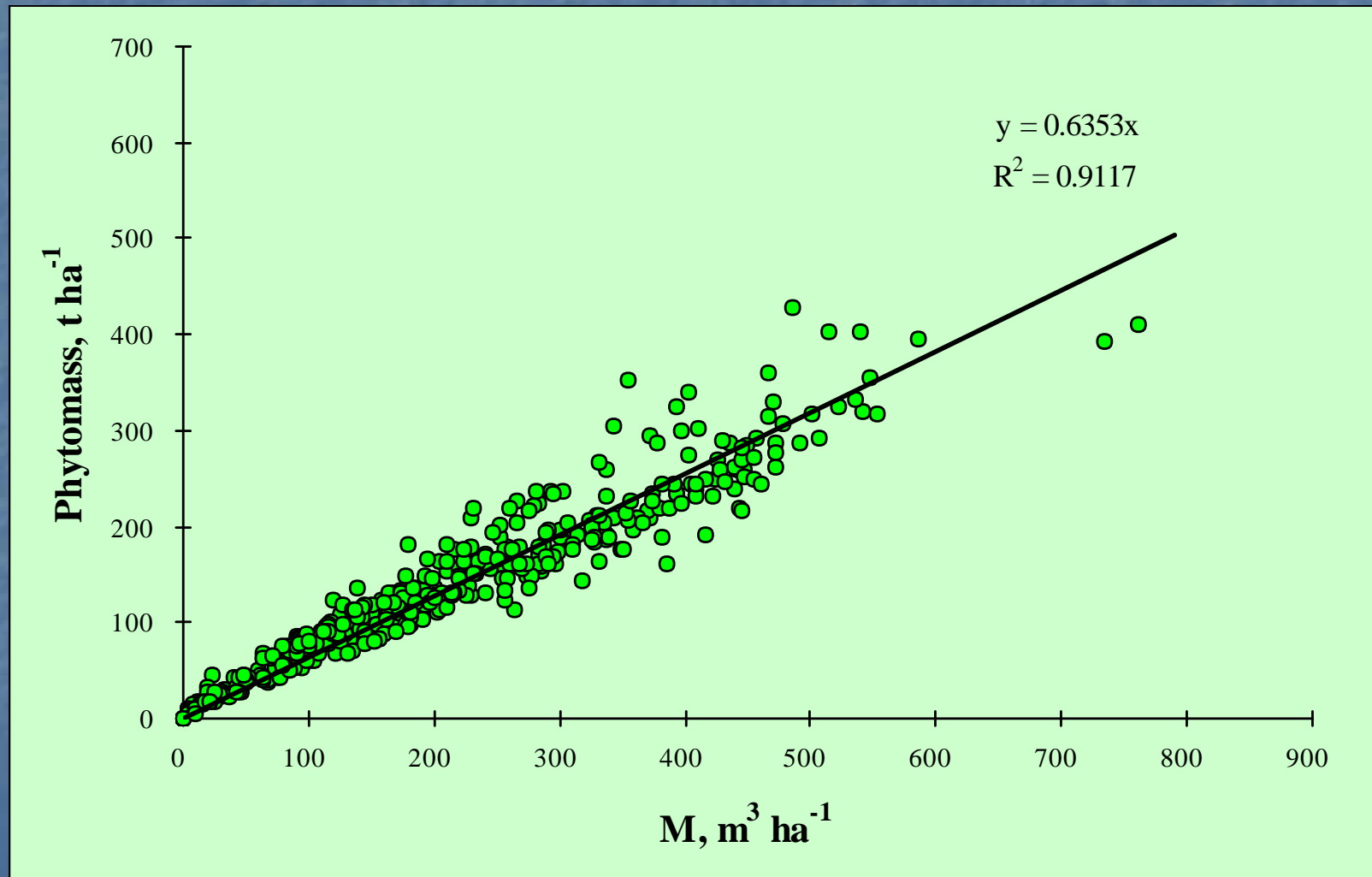
Total area of forests by
satellite map is 796
mln. ha.

Tree volume dynamics by groups of species

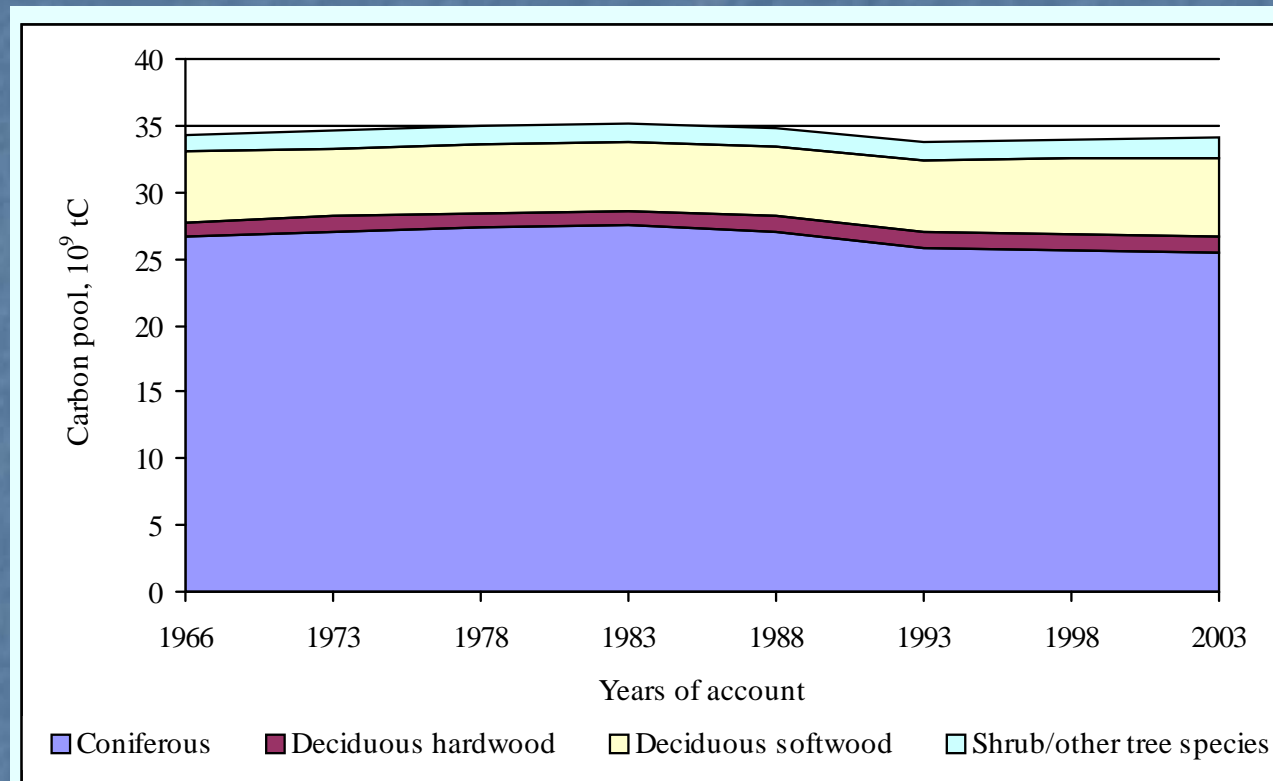


Category forests	Wood growing stock by account year, 10^9 m^3							
	1966	1973	1978	1983	1988	1993	1998	2003
Coniferous	65.0	64.9	66.1	66.6	65.8	63.7	63.7	63.2
Deciduous hardwood	1.7	1.9	1.9	2.0	2.0	2.1	2.1	2.2
Deciduous softwood	9.1	10.9	11.6	11.9	12.4	13.4	14.4	15.1
Shrubs/other tree species	1.1	1.0	1.1	1.4	1.5	1.5	1.7	1.7
Total	77.0	78.7	80.7	81.9	81.7	80.7	81.9	82.1

Total phytomass vs. tree volume in pine stands

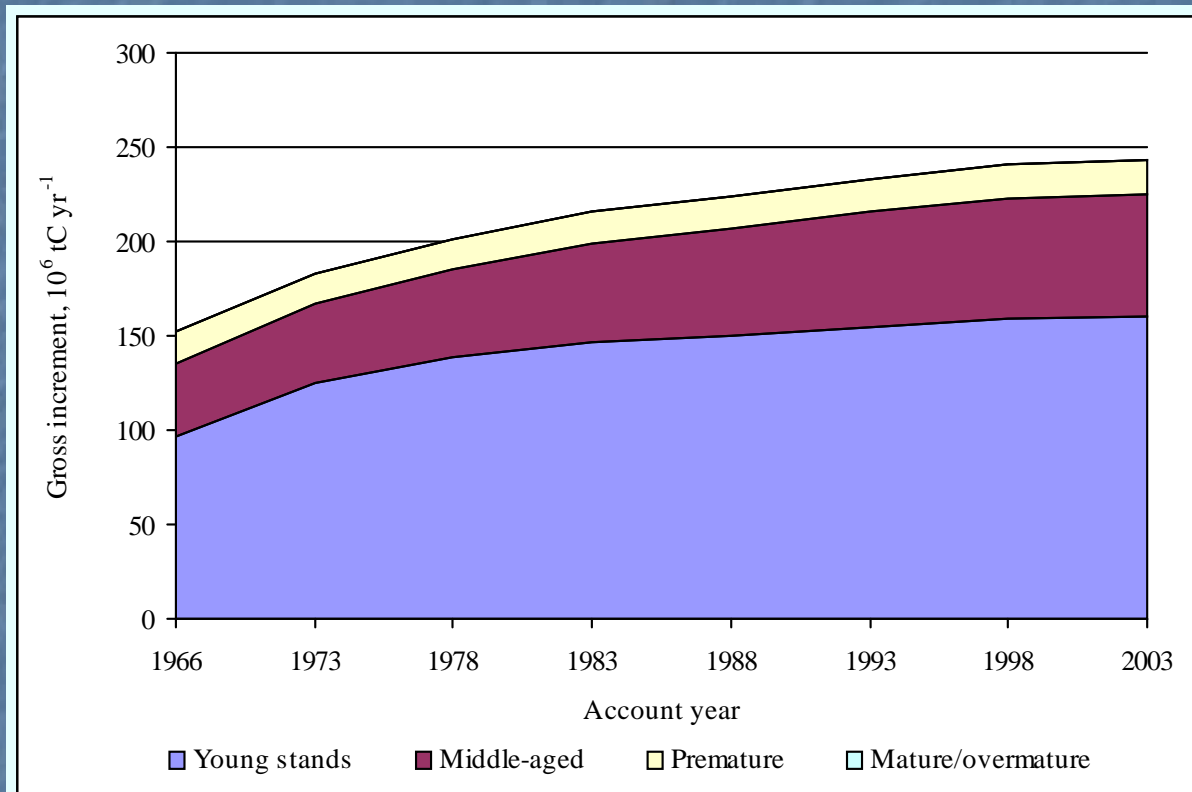


Dynamics of carbon pool in phytomass by dominant tree species



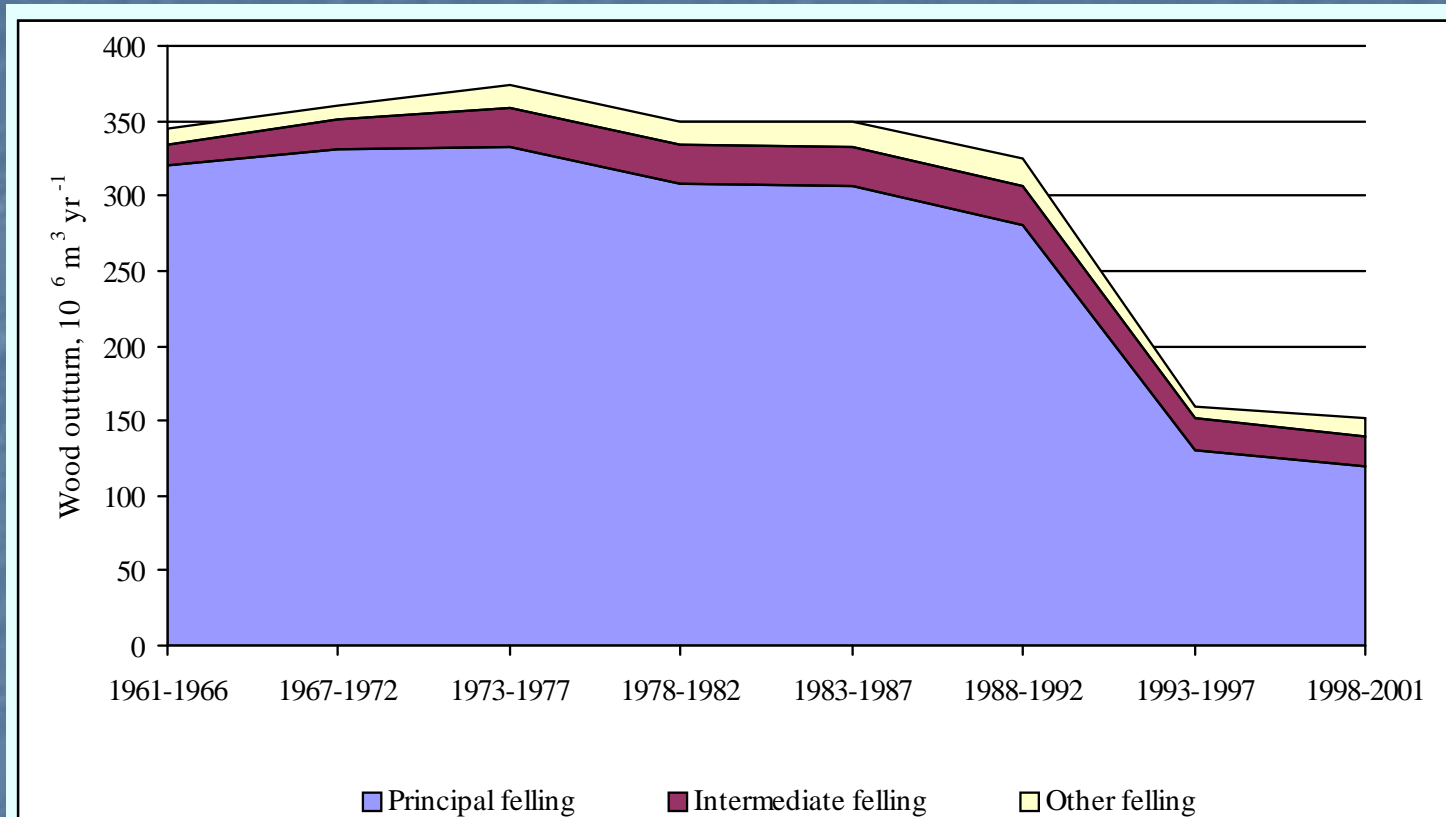
Groups of forest forming tree species	Carbon pool, 10 ⁹ tC							
	1966	1973	1978	1983	1988	1993	1998	2003
Coniferous	26.70	27.02	27.31	27.50	27.08	25.83	25.67	25.46
Deciduous hardwood	1.06	1.15	1.13	1.16	1.14	1.16	1.17	1.20
Deciduous softwood	5.25	5.13	5.17	5.17	5.14	5.30	5.62	5.86
Shrub/other tree species	1.28	1.28	1.29	1.31	1.43	1.53	1.54	1.55
Total	34.29	34.58	34.91	35.14	34.79	33.83	34.01	34.07

Gross increment of carbon pool in phytomass



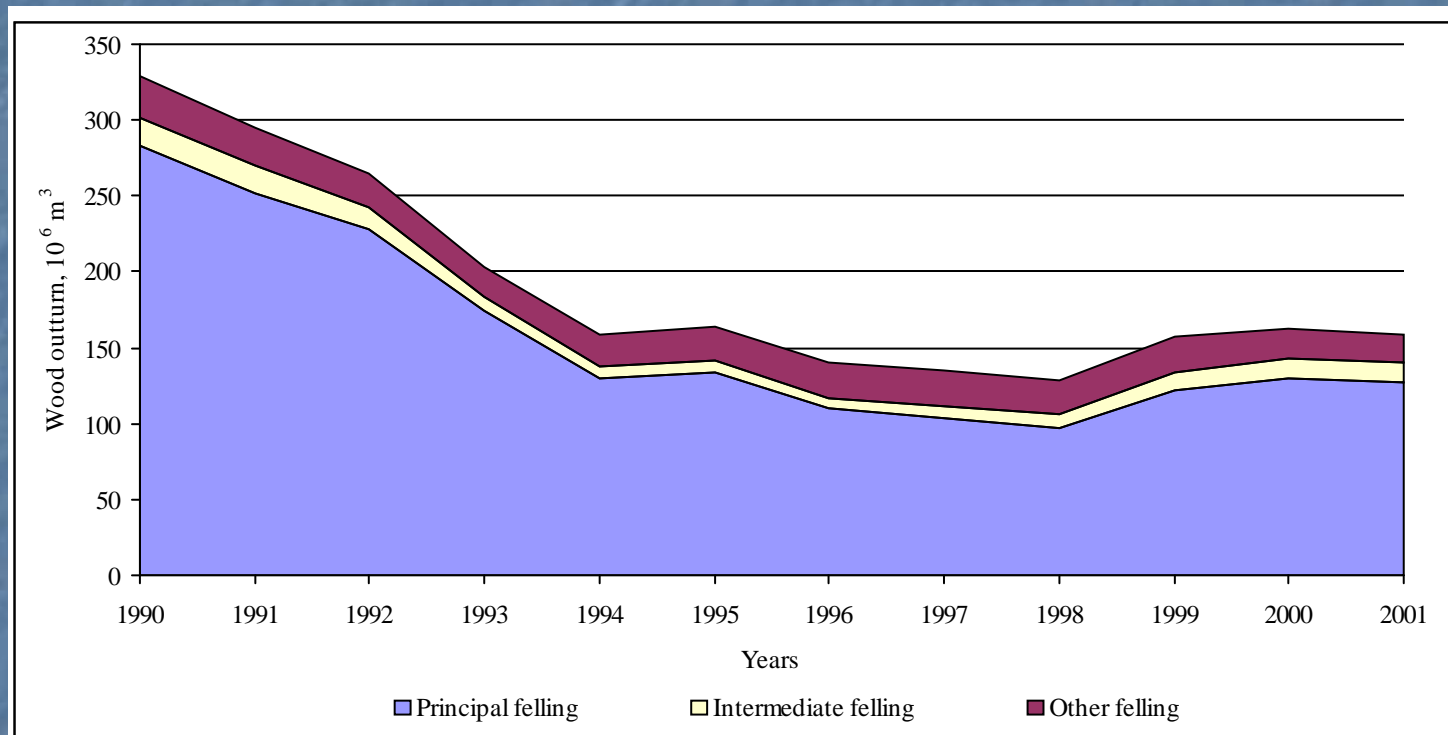
Age groups	Carbon deposition, 10^6 tC yr ⁻¹							
	1966	1973	1978	1983	1988	1993	1998	2003
Young stands	96.5	124.7	138.7	146.7	150.4	154.8	159.1	160.4
Middle-aged	39.0	42.5	46.5	51.9	56.3	61.5	63.9	65.1
Premature	16.3	15.4	16.1	17.0	16.9	16.4	17.5	17.8
Mature/overmature	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	151.9	182.6	201.3	215.7	223.6	232.7	240.6	243.3

Amounts of harvested timber (1961-2001)



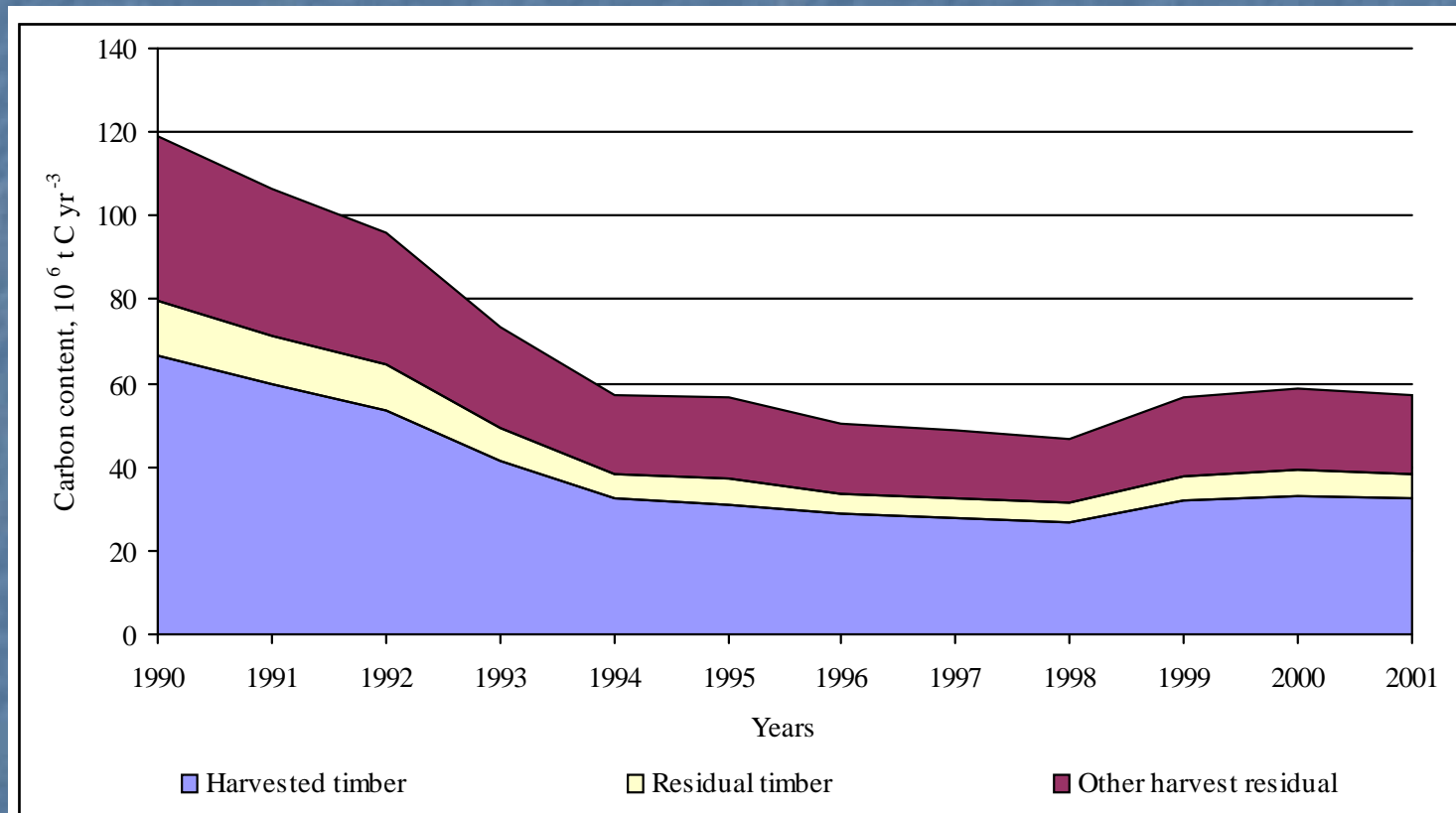
Types of forest exploitation	Amounts of harvested timber, $10^6 \text{ m}^3 \text{ yr}^{-1}$							
	1961-1966	1967-1972	1973-1977	1978-1982	1983-1987	1988-1992	1993-1997	1998-2001
Principal felling	320.3	331.2	333.0	308.6	306.9	280.2	130.5	118.9
Intermediate felling	14.5	19.1	25.4	25.6	26.4	26.0	21.8	20.5
Other felling	9.6	9.4	15.0	14.8	16.7	18.9	7.6	12.4
Total	344.4	359.7	373.3	349.0	350.0	325.1	160.0	151.7

Amounts of harvested timber (1990-2001)



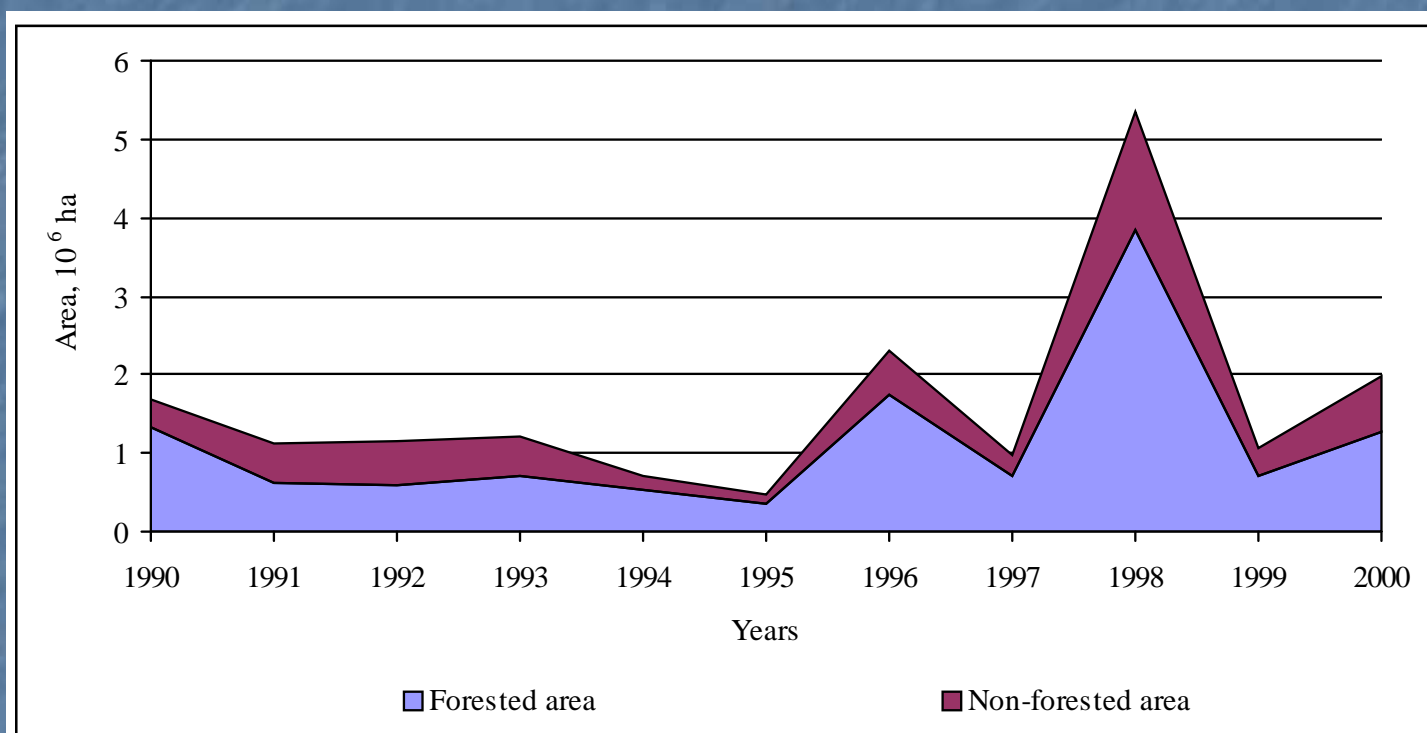
Types of forest exploitation	Amounts of harvested timber, 10 ⁶ m ³ yr ⁻¹											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Principal felling	283.2	251.7	227.5	174.2	130.4	134.1	110.5	103.4	96.8	121.6	130.0	127.0
Intermediate felling	18.9	18.1	14.7	9.4	6.9	7.2	6.5	8.2	9.9	12.4	13.4	13.8
Other felling	27.5	24.7	22.8	20.1	20.7	22.6	22.7	23.1	22.2	22.9	18.7	18.2
Total	329.6	294.5	265.0	203.7	158.0	163.9	139.7	134.7	128.9	156.9	162.1	159.0

Carbon fluxes, associated with forest harvesting



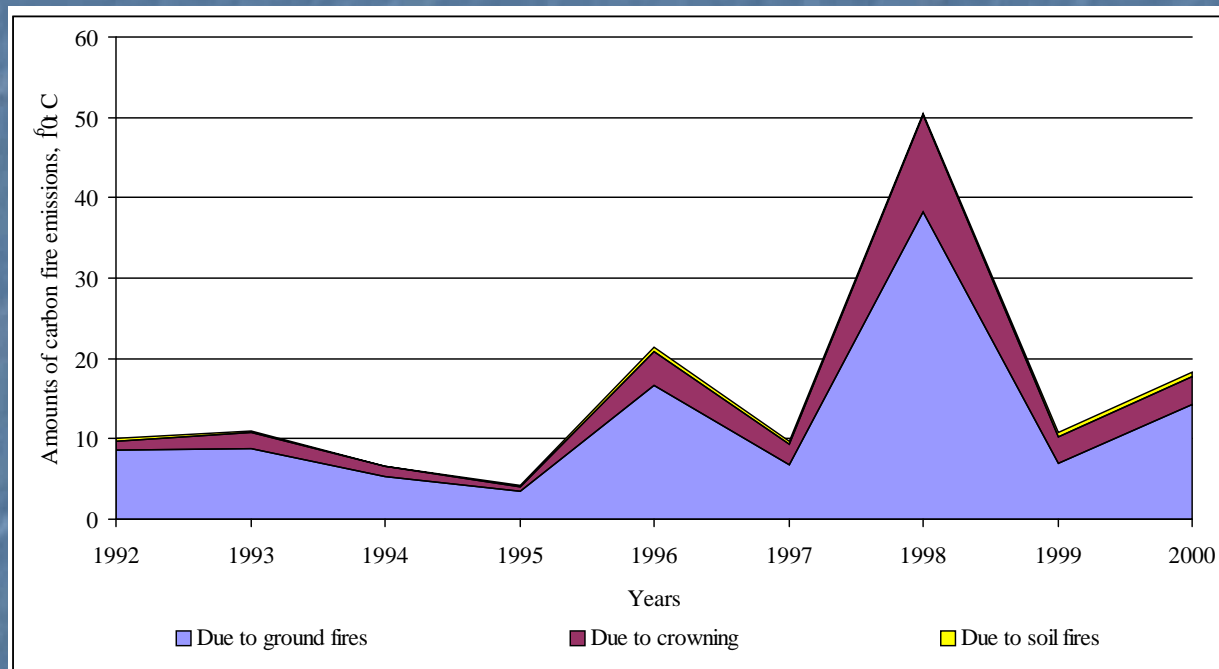
	Carbon content, $10^6 \text{ tC year}^{-1}$											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Harvested timber	66.7	59.6	53.7	41.4	32.3	31.1	28.7	27.8	26.6	32.2	33.0	32.4
Residual timber	13.2	11.8	10.6	8.0	6.0	6.2	5.1	4.9	4.7	5.8	6.3	6.1
Other harvest residual	39.2	34.9	31.5	24.2	18.7	19.5	16.6	16.0	15.3	18.7	19.2	18.9
	119.1	106.3	95.8	73.6	57.0	56.8	50.4	48.7	46.6	56.7	58.5	57.4

Area of forest fires in protected part of forest fund



Category areas	Forest fire area by year, 10 ⁶ ha										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Forested area	1.33	0.61	0.60	0.72	0.53	0.35	1.73	0.70	3.84	0.71	1.27
Non-forested area	0.36	0.52	0.54	0.48	0.19	0.11	0.58	0.28	1.50	0.34	0.70
Total	1.69	1.13	1.14	1.20	0.72	0.46	2.31	0.98	5.34	1.05	1.97

Fire emissions on protected forest area



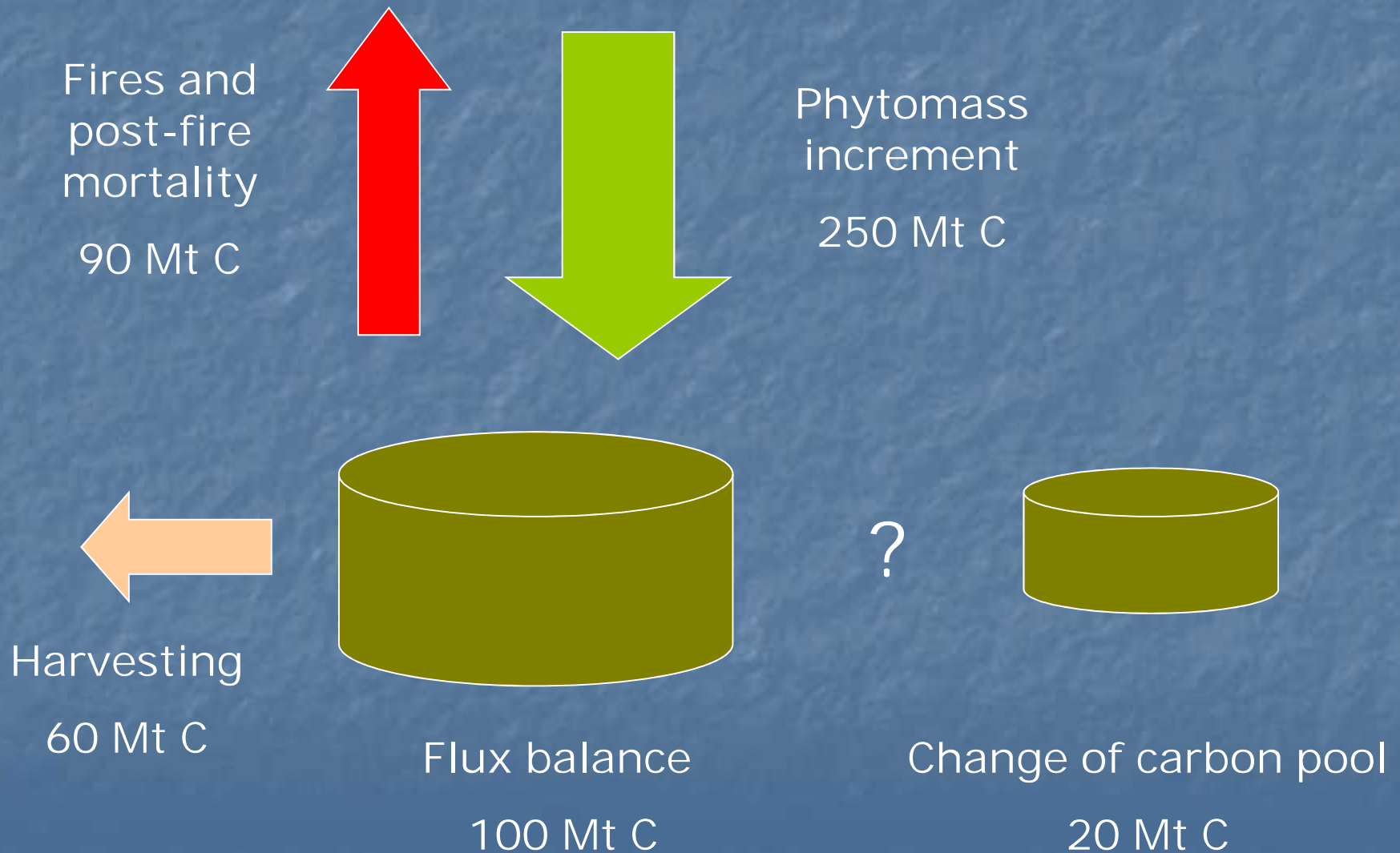
The average rate of fire emissions on protected area is 15 Mt C yr⁻¹.

The emission on whole area of the forest fund can be estimated as 30 Mt C yr⁻¹.

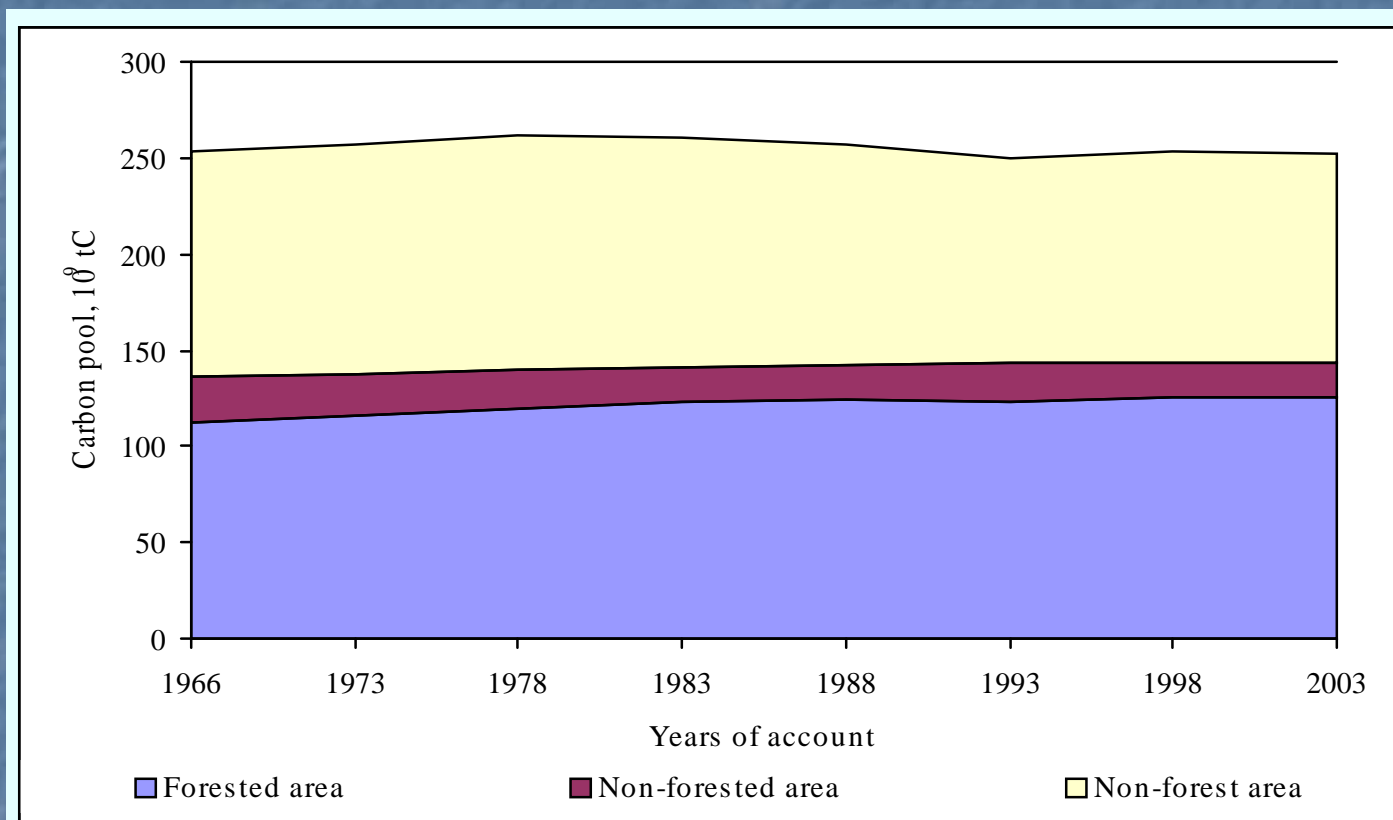
Fire types	Amounts of fire emissions per years, 10 ⁶ t C											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
Due to crowning	5.48	2.32	1.12	2.08	1.23	0.47	4.10	2.54	12.13	3.27	3.44	
Due to ground fires	11.29	8.02	8.64	8.76	5.27	3.48	16.70	6.81	38.16	7.01	14.29	
Due to soil fires	0.08	0.44	0.39	0.10	0.17	0.25	0.53	0.32	0.19	0.46	0.54	
Total emissions	16.85	10.78	10.15	10.94	6.67	4.2	21.49	9.6	50.49	10.75	18.27	

Post-fire mortality adds also 60 Mt C yr⁻¹.

Annual budget for carbon pool in living phytomass of Russian forests (1993-2003)

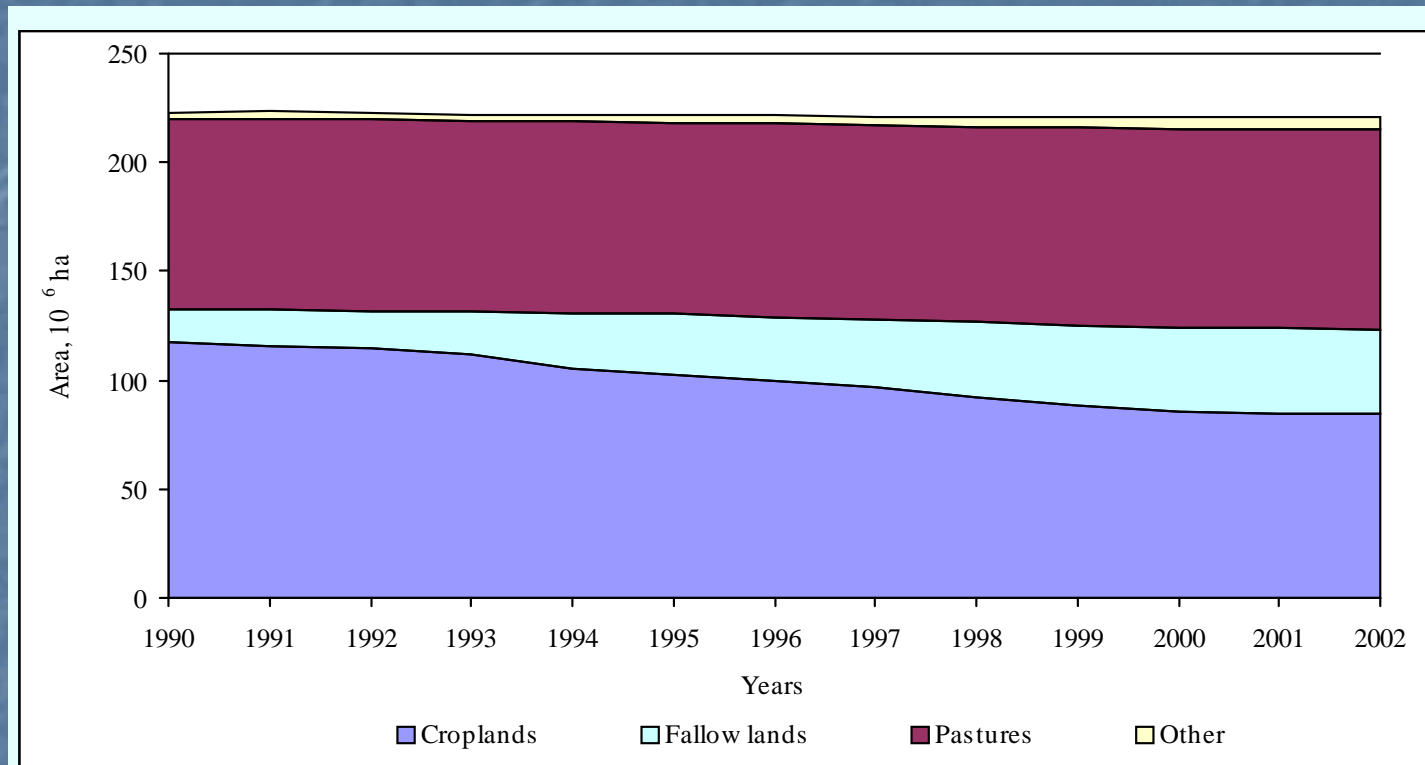


Soil carbon pool (0-100 cm soil layer) in Russian forest fund



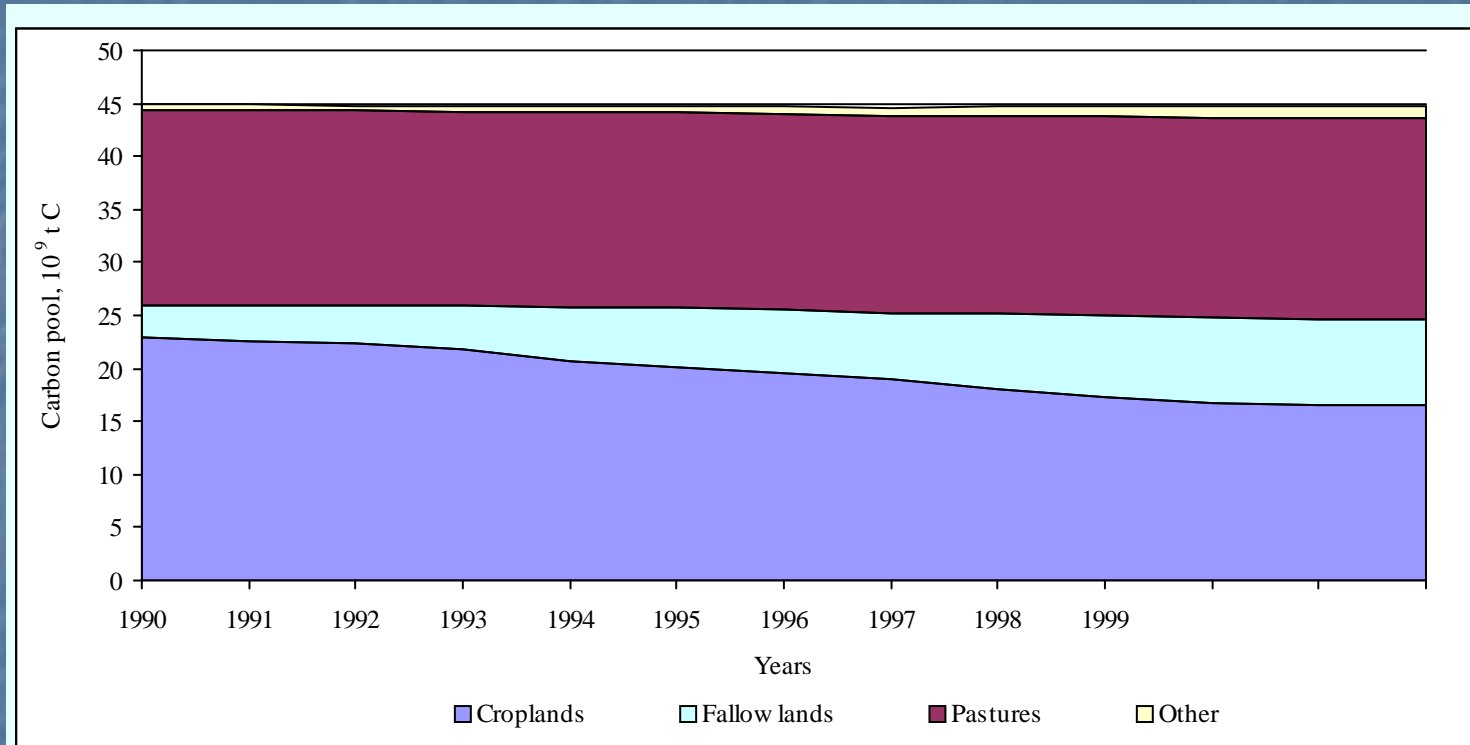
Forest fund structure	Carbon pool, 10 ⁹ tC							
	1966	1973	1978	1983	1988	1993	1998	2003
Forested area	112.4	116.2	119.5	122.7	124.1	123.5	125.4	125.7
Non-forested area	24.2	21.1	19.8	18.5	18.4	20.3	18.1	18.0
Non-forest area	116.5	120.0	123.0	118.9	114.1	106.5	110.2	109.1
Total	253.1	257.2	262.3	260.1	256.5	250.3	253.7	252.8

Dynamics of agricultural areas in Russia



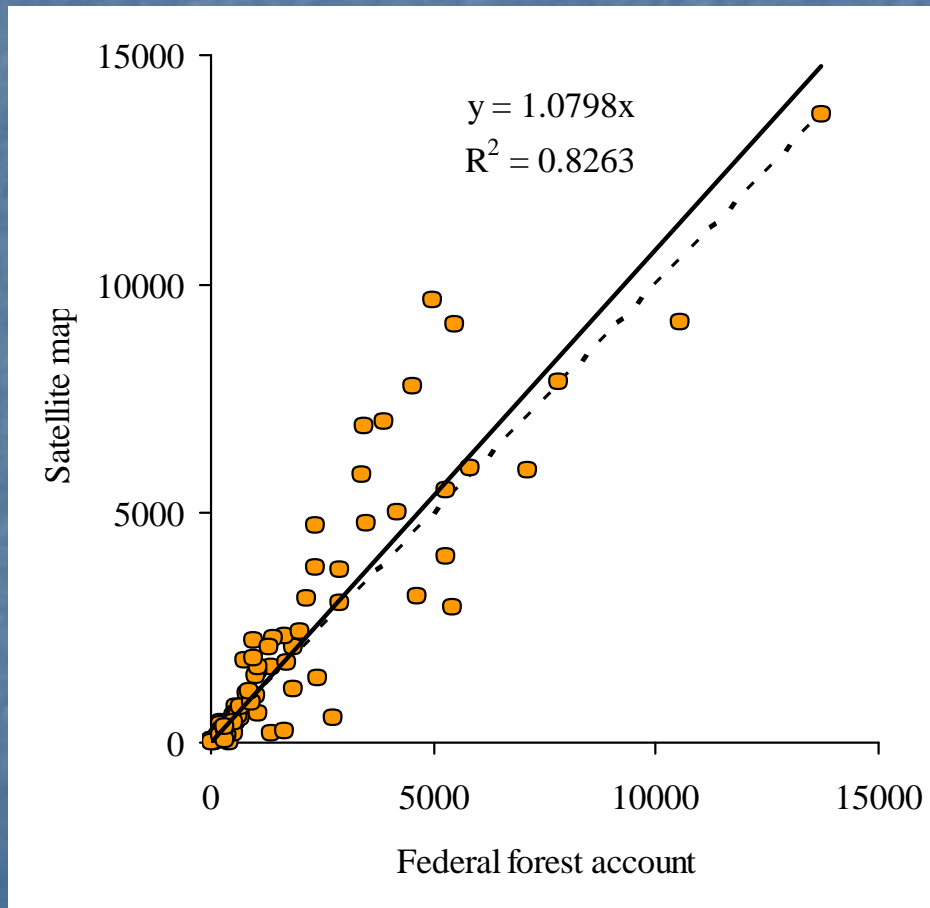
Type of land use	Agricultural areas by year, 10 ⁶ ha												
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Croplands	132.3	132.2	132.0	131.7	130.7	130.2	128.9	127.5	126.5	125.3	124.4	123.9	123.5
Including sowing	117.7	115.5	114.6	111.8	105.3	102.5	99.6	96.6	91.7	88.3	85.4	84.8	84.6
fallow land	14.6	16.7	17.4	19.9	25.4	27.7	29.3	30.9	34.8	37.0	39.0	39.1	38.9
Pastures	88.0	87.9	87.9	87.5	88.0	88.2	88.8	89.2	89.9	90.6	90.9	91.1	91.3
Other	2.8	3.3	2.4	2.9	3.1	3.5	3.9	3.8	4.8	5.2	5.8	6.0	6.1
Total	223.1	223.4	222.3	222.1	221.8	221.9	221.6	220.5	221.2	221.1	221.1	221.0	220.9

Soil carbon pool in agricultural lands



Type of land use	Carbon pool by year, 10 ⁹ tC												
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Croplands	26.0	26.0	26.0	26.0	25.8	25.8	25.5	25.3	25.1	24.9	24.8	24.7	24.6
Including sowing fallow land	23.0	22.6	22.4	21.9	20.6	20.1	19.5	18.9	18.0	17.3	16.7	16.6	16.6
Pastures	18.3	18.3	18.3	18.2	18.3	18.4	18.5	18.6	18.7	18.9	18.9	19.0	19.0
Other	0.5	0.6	0.5	0.6	0.6	0.7	0.8	0.7	0.9	1.0	1.1	1.2	1.2
Total	44.9	45.0	44.8	44.8	44.7	44.8	44.8	44.6	44.8	44.8	44.8	44.8	44.8

Area of softwood forests by forest account and by satellite map

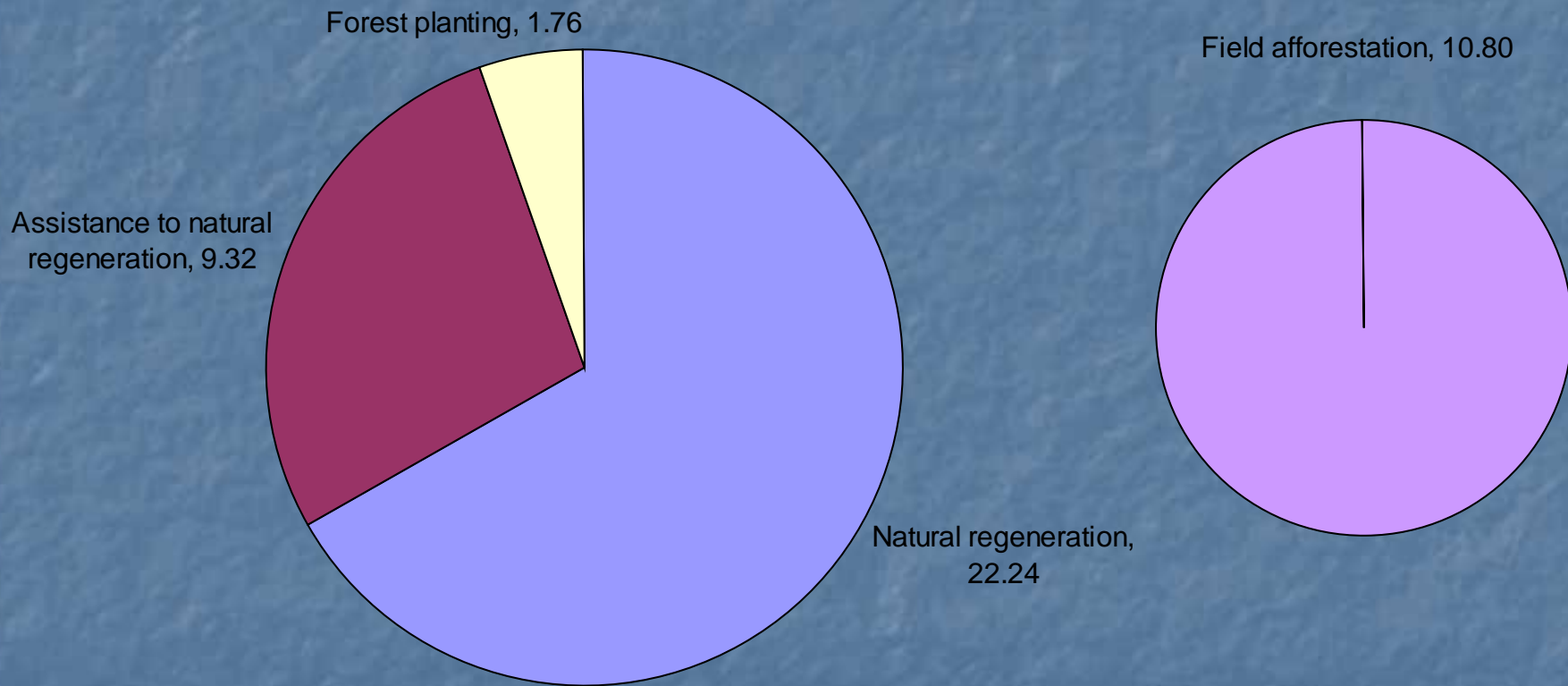


The area of softwood forest in European Russia is on 21 mln. ha more then shown in Forest Account.

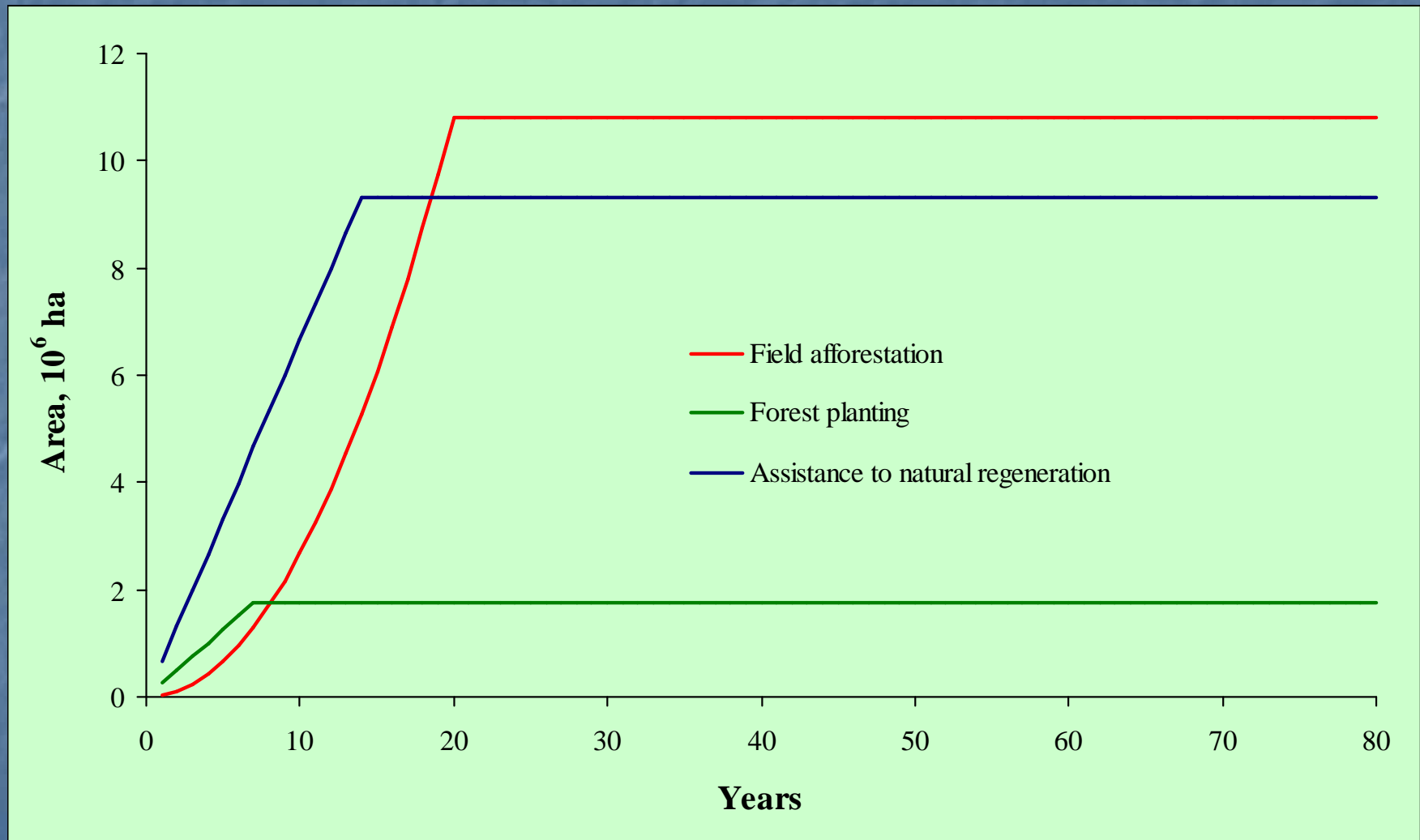
This is young forests on uncultivated agricultural lands.

The present level of carbon sink to phytomass as this forests is 25.6 Mt C yr⁻¹.

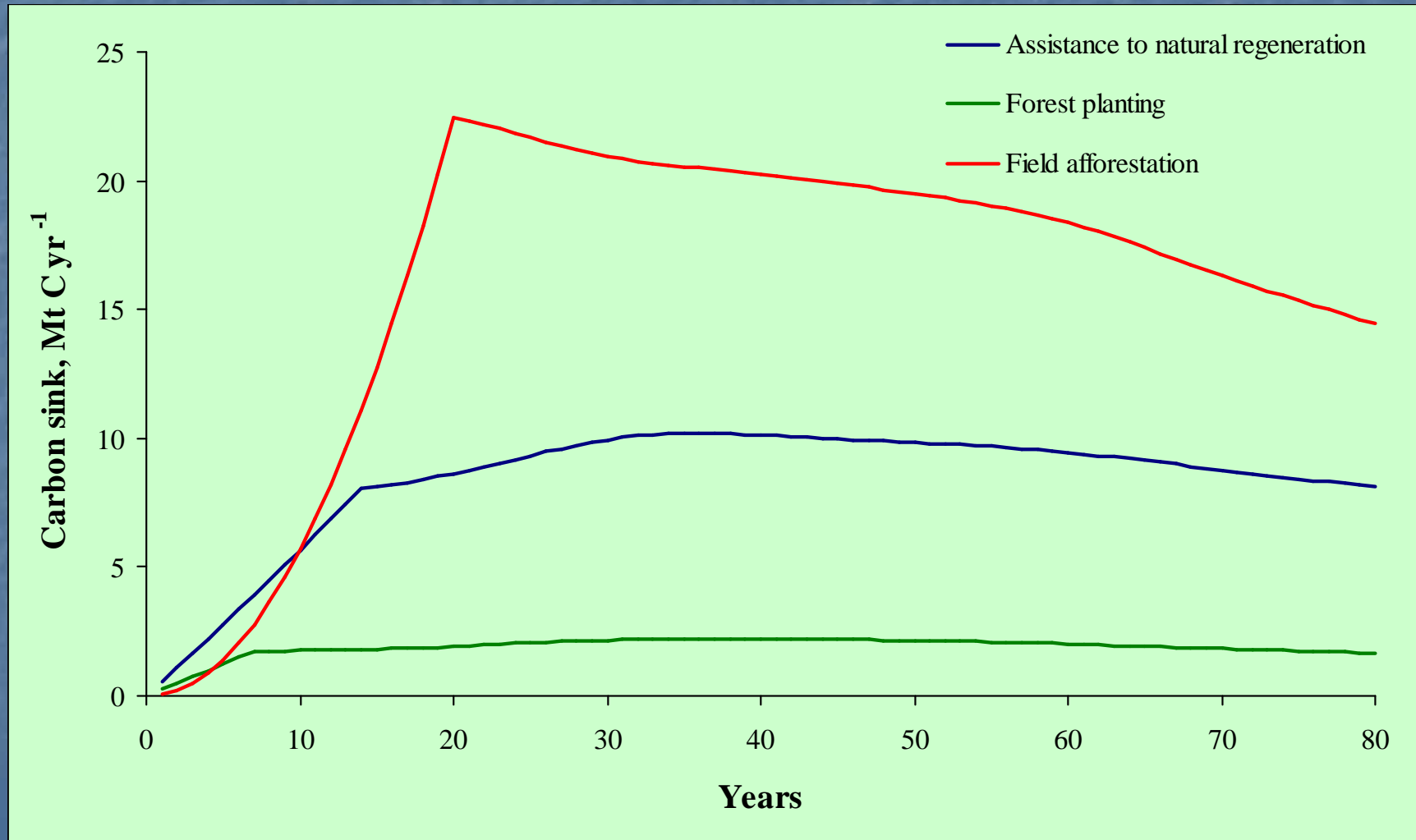
Areas, available for reforestation and field afforestation (mln. ha)



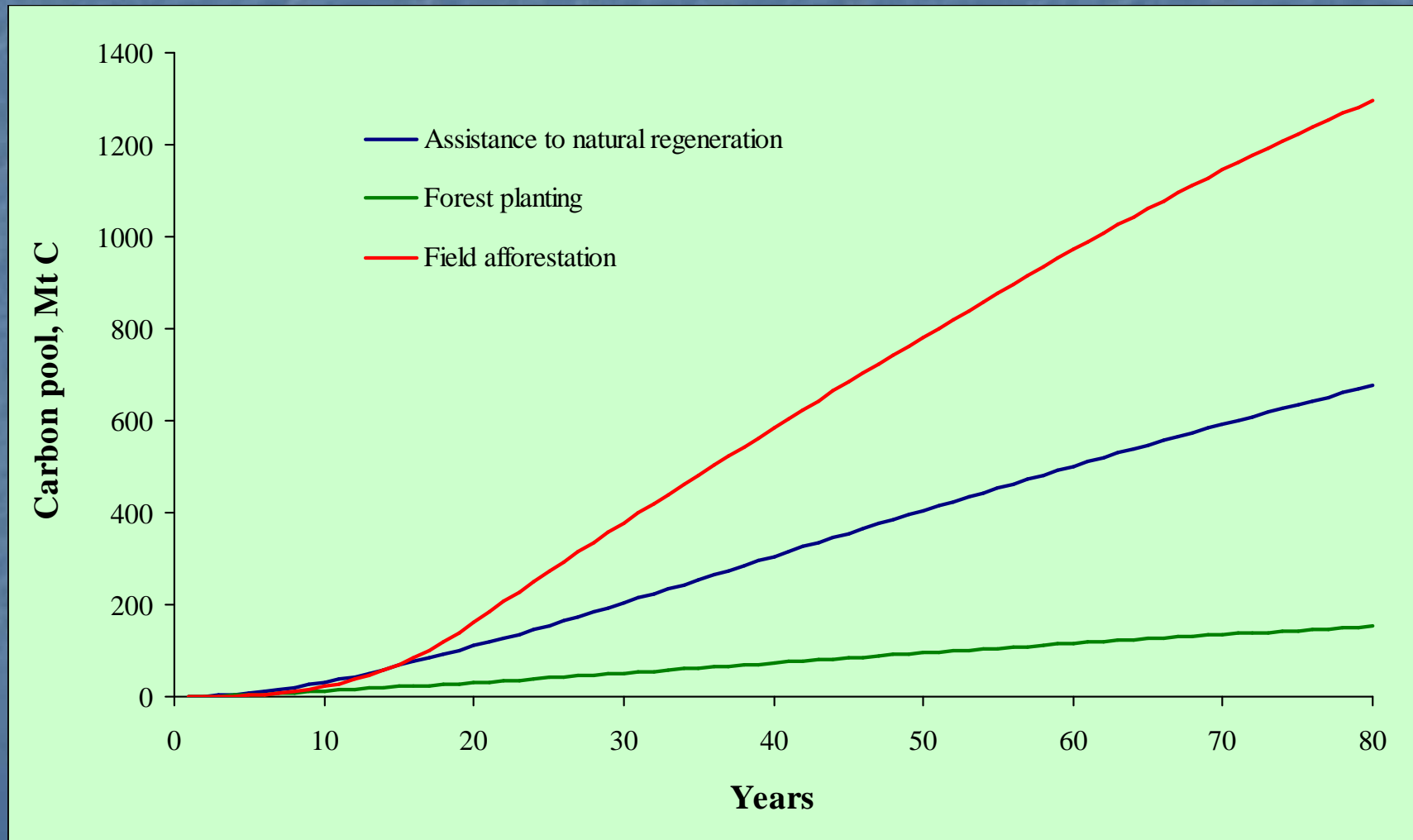
Scenarios of area development



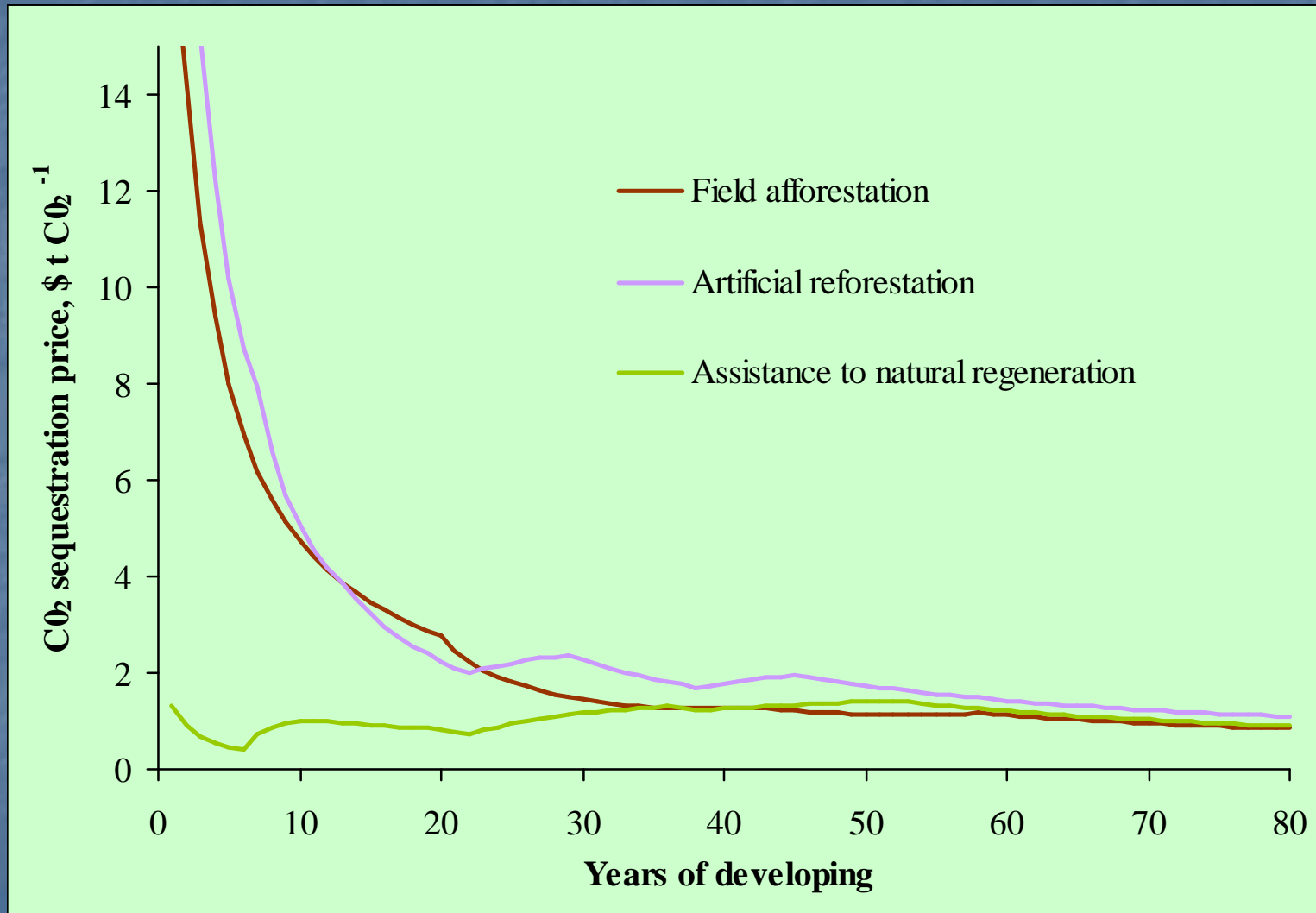
The dynamics of annual carbon sequestration



The dynamics of carbon pool in phytomass



The price of CO₂ sequestration



Climate mitigation trends, potential and activity in Russia

- The carbon sink due to forestry trends
20 or more Mt C yr⁻¹
- The carbon sink due to agricultural trends
25 Mt C yr⁻¹
- The potential of artificial reforestation
10 Mt C yr⁻¹
- The potential of field afforestation
16 Mt C yr⁻¹
- The implemented projects of carbon mitigation (450 ha in Saratov district and 50 ha in Voronezh district)
500 t C yr⁻¹

The area, appointed by local administration for afforestation projects

Subject of Russian Federation	Area, ha
Voronezh district	8720
Buryatia republic	500
Belgorod district	10400
Kaliningrad district	1500
Volgograd district	500

Conclusions

- Russia already made the important contribution to climate mitigation (without aiming do it).
- Russia possesses great potential for mitigation by afforestation and reforestation.
- The above potential practically is not used at present time.
- There is the big interest to climate mitigation projects at local administrative level of Russian Federation.