Climate project methodology № 0010

Reforestation (large-scale)

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Contents

1. Terms and definitions

Climate project (greenhouse gas project) – a set of measures ensuring the reduction (prevention) of anthropogenic greenhouse gas (GHG) emissions or an increase in the absorption of greenhouse gases compared to the baseline.

Greenhouse gas project developer (GHG project developer) – individual or organization that has overall control and responsibility for a GHG project.

Greenhouse gas baseline (GHG baseline) - Quantified reference point(s) for GHG emissions and/or GHG removals that would occur in the absence of the GHG project, expressing the baseline scenario against which project emissions and GHG removals are compared.

Baseline scenario - Hypothetical development reference that best represents the conditions most likely to arise in the absence of a GHG project.

Project scenario - expected level of GHG emission reduction or GHG removal increase, different from the baseline scenario, that will be achieved as a result of the project activity.

Project activity - the specific set of measures and/or technologies applied to the project, that alter the conditions identified in the baseline scenario and which result in GHG emission reductions or removals.

Carbon unit - verified result of the implementation of the climate project activities, expressed in the mass of greenhouse gases equivalent to 1 ton of carbon dioxide

Carbon credit (offset credit) - transferrable instrument certified by government or independent certification bodies to represent an emission reduction of one metric ton of CO_2, or an equivalent amount of other greenhouse gases

Project territory - The geographic area in which the project activities are implemented.

Project boundary - The specification of GHG sources, sinks, and reservoirs associated with the project and baseline scenarios

Carbon pool - a reservoir of carbon that has the potential to accumulate (or lose) carbon over time (encompasses aboveground biomass, belowground biomass, litter, dead wood and soil)

Monitoring - Continuous or periodic evaluation of GHG emissions, GHG removals, or other GHG-related data

Crediting period – The period in which verified and certified GHG emission reductions or increases in net anthropogenic GHG removals by sinks attributable to a climate project activity, as applicable, can result in the issuance of carbon units. The time period that applies to a crediting period for a climate project activity, and whether the crediting period is renewable or fixed, is determined in accordance with Section 4 of this methodology.

Invasive species – an organism introduced by man into places out of its natural range of distribution, where it becomes established and disperses, generating a negative impact on the local ecosystems and species. An invasive species is likely to cause economic harm or harm to human health.

Reforestation – a complex of processes, including those caused by special technological and organizational measures, aimed at the establishment of young closed forest stands of woody species on the lands designated for reforestation.

2. Scope and applicability

Reforestation project activity consists in a better than in the baseline scenario forest reproduction through human-assisted planting and seeding on temporarily deforested and degraded forest areas, including the entire cycle of silviculture.

2.1 Applicability

This methodology is applicable under the following conditions:

a) Project activity is performed on lands of the forest fund temporarily not covered by forest vegetation (burnt areas, clear-cuts, glades, wastelands, dead stands) or on agricultural lands with degraded forest shelterbelts;
b) Reforestation activities, including the initial site preparation and forest stand care, in the Russian Federation must be carried out in accordance with the Order of the Ministry of Natural Resources of the Russian Federation dated December 25, 2020 №1014 "On approval of reforestation rules, structure of reforestation project, procedure for development of reforestation project and its amendment”
c) Project activities do not contradict the legislation of the Russian Federation, as well as the legislation of the subjects of the Russian Federation, where the project is implemented, and are carried out in accordance with the documents of the national standardization system in the field of limiting greenhouse gas emissions;
d) The land subject to the project activity does not fall in wetland category;
e) Areas with organic soils shall not be drained or irrigated (except for irrigation for planting);
f) Soil disturbance (through ploughing, digging of pits, stump removals, infrastructure, etc.) attributable to the project activity, if any, is:

- Done in accordance with appropriate soil conservation practices;
- Limited to the first five years from the year of initial site preparation;
- Not repeated, if at all, within a period of 20 years;
- In less than 10% of the organic soils area, if any.

g) Project area must not have been cleared of native ecosystems to create GHG emissions reductions/removals within 10 years prior to the project start date;

h) Species planted are restricted to those likely to have occurred under historic natural forest conditions in the project area, per best available knowledge (relevant literature and/or consultation with local experts). Invasive species and monocultures are not allowed for use in the project activity.

i) It is recommended to use at least 5 native woody plant species. Exceptions towards reduction of the minimum number of species may be permitted in the northern and middle taiga zones, and shall be justified and supported by species analysis of representative plots of undisturbed natural forest ecosystems*;*

j) Project activities shall not include changes in surface and shallow (<1m) soil water regimes through flood irrigation, drainage or other significant anthropogenic changes in the groundwater table;

k) All land areas registered under any other GHG program (both voluntary and compliance-oriented) must be transparently reported, excluded from the project area and monitored over time .

2.2. Scope

2.2.1. Geographical boundaries

The spatial boundaries of a project must clearly be defined, so as to facilitate accurate measuring, monitoring, accounting, and verifying of the project's emissions reductions and removals. The geographical boundaries of a project are fixed and cannot change over the project period. The project activity may contain more than one discrete area of land. When describing physical project boundaries, the following information must be provided per discrete area:

a) Name of the project area (e.g., compartment number, allotment number, local name);

b) Map(s) of the area

c) Geographic coordinates of each polygon vertex along with the documentation of their accuracy

d) Total land area;

e) Details of landholder and user rights

2.2.2. Carbon pools

The carbon pools selected for accounting of carbon stock changes are shown in table 1.

Table 1. Carbon pools selected for accounting of carbon stock changes

Carbon pool	Whether selected	Justification/Explanation
Above-ground biomass	Yes	This is the major carbon pool subjected to project activity
Below-ground biomass	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity
Dead wood Litter and Soil organic carbon	Optional	Carbon stock in these pools may increase due to implementation of the project activity

2.2.3. GHG emissions

All GHG emission reductions should be quantified and converted to CO_2-eq. using 100-year global warming potential (GWP) values from the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

3. Baseline methodology

The baseline scenario reflects the level of greenhouse gas emissions that would have occurred in the absence of project activity. The baseline scenario should be clearly defined in order to enable the comparability between the greenhouse gas balance resulting from the project activity and the absence of it.

When developing a baseline, the project developer must ensure that net GHG emissions in the baseline scenario are not underestimated in order to intentionally or unintentionally inflate project results. The identified scenario must be realistic and credible on the basis of verifiable information sources, such as national or regional forestry statistics reports, published peer-reviewed studies in the project region, results of surveys conducted by or on behalf of the project developer prior to the initiation of project activities. Project developers should describe in detail all the steps that were taken to conduct the estimates (i.e., data collection, choice or development of methodology, coefficients, etc.) and provide all the results obtained from the calculations for each year of the crediting period.

In the case of reforestation projects, the baseline scenario will be natural regeneration specific to the project area. Note that the rate of natural forest reproduction strongly depends on the vegetation zone. For instance, in the taiga and mixed forest zone the level of greenhouse gas absorption by pioneer softwood species may be higher than in the project scenario. More significant additionality can be achieved on low-forested or degraded lands. In this case, the developer must credibly demonstrate that natural reforestation is limited or absent. If single trees are remnant when preparing the site for project activities, they are either excluded from the project area or taken into account in both the project and baseline scenarios.

The baseline net GHG removals in tCO_2 yr-1 shall be calculated as follows:

Equation 1

$$\Delta C_{BSL} = \Delta C_{BM} + \Delta C_{LI} + \Delta C_{DW} + \Delta C_{SOIL}$$

Where:

ΔC_{BSL}	=	Total baseline net GHG removals by sinks in a year; t CO_2
ΔC_{BM}	=	Change in carbon stock in biomass within the project boundary in a year, t CO_2
ΔC_{LI}	=	Change in carbon stock in litter within the project boundary in a year, t CO_2
ΔC_{DW}	=	Change in carbon stock in deadwood within the project boundary in a year, t CO_2
ΔC_{SOIL}	=	Change in carbon stock in soil within the project boundary in a year, t CO_2

In its turn, the net change in carbon stocks in pools, expressed in tCO2, is calculated based on the summation of individual homogeneous areas - strata. Stratification of the territory is performed according to the types of vegetation, soils, type of land use, etc:

Equation 2

$$\Delta \mathrm{C}_{POOL} = MW_{CO2} \times \sum_{i=1}^{I} \mathrm{C}_{POOL,i} \times A_{POOL,i}$$

Where:

$\Delta \mathrm{C}_{POOL}$	=	Carbon stock change in the concerned pool (biomass, litter, dead wood, soil), tCO_2;
MW_{CO2}	=	Ratio of molecular weights of CO_2 and C, 44/12, dimensionless

i	=	1,2,3...I stratum;
$C_{POOL,i}$	=	Carbon stock in the concerned pool in stratum i (biomass, litter, dead wood, soil), tC ha^{-1};
A_{POOL}	=	Area of stratum i, ha.

3.1 Carbon biomass estimation

The annual biomass carbon stock per hectare in the baseline scenario is estimated by ex-ante modelling of tree growth and stand development. Under this method existing characteristics of the project area (climatic conditions, soil, slope, native typical species) are used in combination with various regional growth course models.

3.1a BCEF method

Step 1

For each tree species, choose a growth model from existing literature. (e.g., Shvidenko et al., 2008). The available models can be in the form of yield tables, growth curves/equations, etc.

Step 2

From the selected growth model, identify the stem volume per hectare for the relevant species and age.

Step 3

Calculate the biomass conversion and expansion factor (BCEF) for the selected species on the basis of age, site index, and relative stocking. The a0-a5 model parameters for forests of the Russian Federation could be taken from (Schepaschenko et al, 2018), and the site index and relative stocking from taxation descriptions of forest areas similar to the project area in the same region.

Equation 3-4

$$BCEF = BCEF_{st} + BCEF_{br} + BCEF_{fol} + BCEF_{ro} \quad (3)$$

$$BCEF_{fr} = a_0 + a_1 \log A + a_2 \log SI + a_3 RS + a_4 A + a_5 RS \quad (4)$$

Where:

$BCEF_{fr}$– biomass conversion and expansion factor for fraction fr, t/m^3;

st – stem fraction;

br – branch fraction;

fol – foliage fraction;

ro – root fraction;

a_0–a_5 – model parameters;

A – age;

SI – site index;

RS –relative stocking.

Step 4

Convert the stem volume to carbon stock in biomass.

Equation 5

$$C_{BM,j,i} = V_{j,i} \times BCEF_j \times (1 + R_j) \times CF$$

Where:

$C_{BM,j,i}$ – carbon stock in biomass in tree species j in stratum i, tC/ha;

$V_{j,i}$ – stem volume of tree species j in stratum i, m^3/ha;

$BCEF_j$ – biomass conversion and expansion factor for species j, t/m^3;

R_j– root-to-shoot ratio, taken equal to 0.39 if the stock of above-ground biomass is less than 75 t/ha or 0.24 if the stock of above-ground biomass is more than 75 t/ha;

CF – biomass-to-carbon conversion factor, 0.5 by default;

j – 1,2,3...J species;

i – 1,2,3...I stratum.

3.1b Model system method

It is also possible to use systems of models such as EFIMOD, FORRUS, ROMUL, CO2-fix, etc. for the ex-ante estimation of carbon stocks in biomass. Project developers should specify which model is used, as well as describe in detail the input data and their sources.

3.2 Estimation of dead wood, litter, and soil carbon

If selected, dead wood, litter, and soil pools should be estimated, in both the baseline and project scenarios. For this purpose, a combination of stand dynamics model EFIMOD 2, soil organic matter dynamics model Romul_Hum and soil climate model SCLISS may be used.

4. Project crediting period

For validation, projects can be submitted to the validation and verification body, the implementation of which was started no earlier than 2 years before submission for validation.

Project timeline consists of separate crediting periods. The duration of the crediting period shall be a maximum of 15 years with option of renewal twice.

The crediting period shall not start before the registration of the project in the Register of Carbon Units.

5. Additionality

Additionality shall be demonstrated using Tool #1 Demonstration of the additionality of the project activity.

6. Monitoring plan requirements

Project developers must design and implement a monitoring plan that includes procedures for measuring, that is, obtaining, recording, aggregating and analyzing the data and information needed to quantify and report GHG emissions or removals related to the project and baseline scenarios.

The monitoring plan should include the following:

(a) The purpose of the monitoring;

(b) A list of parameters subject to measurement and monitoring;

(c) Categories of data and information to be reported, including units of measurement;

(d) Sources of data;

(e) Monitoring methodologies, including estimation, modelling, measurement, calculation approaches and uncertainty

(f) Frequency of monitoring;

(g) Roles and responsibilities of participants related to monitoring, including procedures for authorization, approval, and documentation of revisions to recorded data;

(h) Control procedures, including internal validation of the input data, conversions, and outputs, as well as correction procedures;

(i) GHG information management systems, including data hosting and security, and data management, including procedures for transferring data between different types of systems or documentation.

Project monitoring allows the use of remote forest canopy survey methods:

- aerial photography from drones;
- high resolution space imagery;

- laser sensing placed on airborne carriers.

The necessary condition for the use of remote sensing methods is the ability to estimate the number of trees indicating the taxon (species, subgenus, and genus of trees) and to obtain the height and diameter of the tree crowns in the project area.

6.1 Recommendations for carbon stock monitoring

When performing reforestation projects, regular assessment of achieved carbon stock changes in the pools of biomass, dead wood, litter, and soil must be conducted:

Equation 6

$$\Delta C = \Delta C_{BM} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SOIL}$$

Where:

ΔC – total carbon stock change since the start of project activities; tC $year^{-1}$;

ΔC_{BM} – carbon stock change in the biomass pool, tC $year^{-1}$;

ΔC_{DW} – carbon stock change in the dead wood pool, tC $year^{-1}$;

ΔC_{LI} – carbon stock change in the litter pool, tC $year^{-1}$;

ΔC_{SOIL} – carbon stock change in the soil pool, tC $year^{-1}$.

Conversion from carbon units to CO_2 should be performed by multiplying carbon stock changes by -44/12 using Equation 7:

Equation 7

$$CO_2 = \Delta C \times (-44/12)$$

Where:

CO_2 –CO_2 flow, tCO_2;

ΔC – carbon stock change, tC;

44/12 – conversion factor, dimensionless.

6.1.1. Biomass

The estimation of carbon stock changes in the biomass pool due to reforestation is performed using Equation 8.

Equation 8

$$\Delta C_{BM} = (C_{BM\_after} - C_{BM\_before}) \times A / D$$

Where:

ΔC_{BM} – carbon stock change in the biomass pool, tC $year^{-1}$;

C_{BM_after} – carbon stock in the biomass pool after the start of project activities; tC ha^{-1};

C_{BM_before} – carbon stock in the biomass pool before the start of project activities; tC ha^{-1};

A – the area of land on which the reforestation project is implemented; ha;

D – time period between experimental measurements of the carbon stock in the biomass pool on the project area, years.

A periodic (annual or once every 5-10 years) inventory of growing stand, seedlings and undergrowth of tree species is conducted in order to estimate the biomass stocks. The stand includes trees with stem diameter of more than 8 cm at the height of 1.3 m. Young trees with stem diameter of less than 8 cm at the height of 1.3 m are considered undergrowth. The inventory is conducted by methods that ensure the identification of the number of trees, seedlings and undergrowth with an error of not more than 10 percent. Thirty plots are established in areas up to 5 hectares, 50 plots from 5 to 10 hectares, and 100 plots over 10 hectares. The size of survey plots is 400 m2 for growing stock surveys and 100 m2 for undergrowth surveys. The species, height, and stem diameter at the height of 1.3 m are taken into account. Self-seeding of 1-2 years old is not considered.

Depending on the initial data obtained, the estimation of different biomass fractions is performed using allometric models, including crown diameter and tree height as parameters:

Equation 9

$$\ln P_i = a_0 + a_1 \ln H + a_2 \ln D_{cr} ,$$

or tree height and stem diameter:

Equation 10

$$\ln P_i = a_0 + a_1 \ln H + a_2 \ln DBH,$$

Where:

P_i - biomass in absolutely dry condition of stems with bark, branches skeleton, needles (foliage), above-ground part and roots (respectively *Pst*, *Pbr*, *Pf*, *Pa* and *Pr*), kg;

H - height of the tree, m;

D_{cr} - crown diameter, m;

DBH- stem diameter at breast height, cm.

Table 6.1. Characteristics of equations 9 and 10

Species or group of species	Biomass fraction	Constants of equation (1)			Constants of equation (2)			R_2 *		*SE* *	
		a_0	a_1	a_2	a_0	a_1	a_2	(1)	(2)	(1)	(2)
Pine	*Pst*	-3.2484	2.3927	0.7586	-3.5919	1.1437	1.6275	0.976	0.988	0.47	0.32
	Pbr	-3.5496	1.3197	1.7788	-4.9291	-0.4181	2.8385	0.940	0.938	0.75	0.76
	Pf	-2.6645	0.8007	1.7480	-4.1273	-0.7283	2.6522	0.906	0.897	0.81	0.84

	Pa	-2.3633	2.0420	1.0193	-3.0475	0.7693	1.8662	0.968	0.981	0.52	0.41
	Pr	-3.9142	1.9909	0.9533	-4.9370	0.8402	1.9803	0.951	0.944	0.64	0.69
Spruce	*Pst*	-2.9575	2.4913	0.2392	-3.0336	2.0299	0.5797	0.971	0.974	0.44	0.41
	Pbr	-2.9723	1.4858	1.2800	-3.3940	1.8760	0.3123	0.924	0.896	0.62	0.73
	Pf	-2.4413	1.3898	0.7690	-2.6957	0.9877	0.8100	0.869	0.868	0.69	0.70
	Pa	-1.8450	2.1185	0.4739	-2.0031	1.7948	0.5743	0.960	0.961	0.47	0.47
	Pr	-2.8998	1.7198	0.9085	-3.4488	1.4058	0.9185	0.952	0.954	0.61	0.60
Fir	*Pst*	-2.9575	2.4913	0.2392	-3.0336	2.0299	0.5797	0.971	0.974	0.44	0.41
	Pbr	-2.9723	1.4858	1.2800	-3.3940	1.8760	0.3123	0.924	0.896	0.62	0.73
	Pf	-2.4413	1.3898	0.7690	-2.6957	0.9877	0.8100	0.869	0.868	0.69	0.70
	Pa	-1.8450	2.1185	0.4739	-2.0031	1.7948	0.5743	0.960	0.961	0.47	0.47
	Pr	-2.8998	1.7198	0.9085	-3.4488	1.4058	0.9185	0.952	0.954	0.61	0.60
Larch	*Pst*	-3.6559	2.5903	0.8256	-3.3289	1.3845	1.3905	0.969	0.987	0.38	0.24
	Pbr	-3.0706	1.1133	1.9212	-3.2205	-0.1917	2.1326	0.932	0.911	0.51	0.59
	Pf	-3.3507	0.7475	1.7233	-3.4786	-0.4339	1.9208	0.876	0.853	0.58	0.64
	Pa	-2.8487	2.2658	1.0182	-2.6044	1.0407	1.5224	0.969	0.986	0.36	0.24
	Pr	-0.5821	0.5916	1.8637	-1.6042	-0.8031	2.5524	0.700	0.721	0.69	0.67
Cedar**	*Pst*	-2.5579	1.9903	1.1096	-3.2653	0.9483	1.6857	0.958	0.977	0.40	0.30
	Pbr	-2.5847	1.1642	1.7494	-3.6546	-0.1458	2.3366	0.880	0.906	0.62	0.55
	Pf	-1.9251	0.5159	1.9816	-3.1356	-0.9572	2.6364	0.848	0.894	0.58	0.49
	Pa	-1.4480	1.6119	1.3220	-2.2795	0.4535	1.9284	0.945	0.971	0.43	0.31
Cryptomeria	*Pst*	-2.8535	2.2423	1.1368	-3.6249	1.3787	1.4366	0.984	0.984	0.14	0.14
	Pbr	-3.3491	0.9538	2.5647	-5.0212	-0.7818	3.0229	0.945	0.909	0.24	0.31
	Pf	-0.7733	0.5665	1.8165	-2.0782	-1.0398	2.5276	0.885	0.947	0.24	0.16
	Pa	-1.6639	1.7995	1.3790	-2.5883	0.7874	1.7063	0.983	0.980	0.13	0.14
	Pr	-2.6137	1.6386	1.5098	-3.6513	0.4502	1.9504	0.973	0.978	0.16	0.15
Cypress	*Pst*	-1.7860	2.0776	0.4186	-3.5791	0.6996	2.1071	0.928	0.994	0.31	0.09
	Pbr	-0.8541	0.5023	1.4036	-4.2802	-1.3786	3.5915	0.762	0.972	0.42	0.15
	Pf	-0.0928	0.7522	0.1031	-1.6284	-0.7460	1.9883	0.553	0.878	0.34	0.19
	Pa	-0.4506	1.5907	0.5523	-2.5020	0.1055	2.3579	0.886	0.993	0.33	0.08
	Pr	-1.3824	1.5122	0.5027	-3.5027	-0.1076	2.4860	0.854	0.990	0.36	0.10
Douglas**	*Pst*	-13.188	5.6405	-	-7.1015	3.0918	0.7693	0.958	0.988	0.13	0.07
	Pbr	-25.9695	8.0538	0.4335	-19.6165	5.0765	1.4082	0.862	0.889	0.43	0.39
	Pf	-	4.6197	0.2943	-8.1481	1.8516	1.2036	0.728	0.780	0.38	0.35
	Pa	-13.4656	5.7169	-0.0421	-7.3811	3.1478	0.8097	0.955	0.988	0.14	0.07
Birch	*Pst*	-4.8045	2.9127	0.6253	-3.4725	1.1568	1.6545	0.955	0.986	0.41	0.23
	Pbr	-5.7668	2.2617	1.2545	-4.1172	-0.2623	2.6566	0.876	0.938	0.73	0.51
	Pf	-4.9498	1.5025	1.1359	-3.7883	-0.3629	2.0858	0.851	0.902	0.61	0.49
	Pa	-4.4832	2.7961	0.7577	-3.0891	0.8755	1.8703	0.943	0.980	0.47	0.27
	Pr	-3.7279	2.3956	0.2353	-3.3319	0.3981	2.0299	0.821	0.984	0.67	0.15
Aspen and poplars**	*Pst*	-4.0075	2.0536	1.6066	-3.7752	1.0645	1.7992	0.938	0.991	0.30	0.12
	Pbr	-3.7558	0.4156	3.1638	-2.9323	-1.6573	3.5480	0.846	0.943	0.60	0.37
	Pf	-3.9394	0.2241	2.6885	-3.2324	-1.6842	3.1602	0.791	0.967	0.60	0.24
	Pa	-3.5324	1.8460	1.7906	-3.1864	0.7054	2.0151	0.926	0.988	0.34	0.14
Linden**	*Pst*	-4.8754	3.1643	0.3170	-4.2273	1.2493	1.7973	0.890	0.989	0.44	0.14
	Pbr	-3.7502	1.9167	0.6814	-3.0828	-0.8215	2.7557	0.660	0.885	0.72	0.42
	Pf	-4.3079	1.4374	0.6879	-4.1730	-0.3150	1.9702	0.600	0.683	0.69	0.62

	Pa	-4.0476	2.9120	0.3724	-3.4196	0.9134	1.9099	0.867	0.983	0.46	0.16
Alder**	*Pst*	-5.2688	2.5164	1.3219	-3.6405	0.7795	1.9666	0.963	0.996	0.24	0.07
	Pbr	-7.4280	1.4468	3.2791	-4.4308	-1.4914	3.8172	0.921	0.928	0.42	0.40
	Pf	-7.4051	1.3924	2.4827	-5.1805	-0.7736	2.8447	0.909	0.909	0.37	0.37
	Pa	-5.0977	2.3968	1.5236	-3.3182	0.5227	2.1676	0.960	0.994	0.25	0.09
Oak**	*Pst*	-4.8897	2.9380	0.9356	-3.5782	1.2025	1.7416	0.983	0.996	0.27	0.14
	Pbr	-5.3653	1.6865	2.4446	-2.3860	-2.2777	4.1539	0.931	0.958	0.62	0.49
	Pf	-4.3817	0.9144	1.8570	-2.1543	-2.0512	3.1237	0.903	0.930	0.51	0.43
	Pa	-3.6444	2.2244	1.5306	-1.9734	-0.0097	2.4285	0.920	0.920	0.60	0.60
Beech	*Pst*	-7.0424	3.6349	0.9830	-3.4630	0.9143	2.0178	0.981	0.998	0.28	0.09
	Pbr	-8.3692	2.9395	1.9533	-4.1988	-0.4831	3.0181	0.948	0.955	0.53	0.50
	Pf	-6.0540	1.7314	1.4092	-0.3418	-2.5603	3.0884	0.890	0.963	0.52	0.30
	Pa	-6.6188	3.4798	1.1162	-2.8717	0.6046	2.1842	0.980	0.998	0.28	0.08
	Pr	-9.4846	4.0811	0.5825	-2.3883	-0.8150	2.8319	0.873	0.987	0.45	0.15
Ash	*Pst*	-5.5052	3.2511	0.6154	-3.4031	0.9774	1.8969	0.951	0.993	0.37	0.14
	Pbr	-8.8510	3.3211	1.4418	-5.7736	0.2357	2.8483	0.911	0.952	0.61	0.45
	Pf	-5.9419	2.2613	0.3642	-3.7172	-0.2742	1.9697	0.737	0.826	0.67	0.55
	Pa	-5.1055	3.1186	0.7713	-2.9158	0.8088	1.9931	0.948	0.990	0.38	0.17
	Pr	-6.4246	2.4717	1.6552	-3.7186	0.7230	1.7707	0.974	0.951	0.18	0.25
Black locust	*Pst*	-6.0674	3.5274	0.2219	-4.0203	1.3945	1.6113	0.986	0.997	0.26	0.13
	Pbr	-8.7106	3.4521	1.0172	-5.3541	0.0784	2.8013	0.952	0.959	0.55	0.51
	Pf	-6.2924	2.1115	0.7108	-3.0734	-1.1741	2.6220	0.909	0.944	0.48	0.38
	Pa	-5.8507	3.4556	0.3645	-3.5336	1.0627	1.8515	0.984	0.996	0.28	0.14
	Pr	-6.1719	3.0281	0.3662	-4.1722	0.9728	1.6105	0.973	0.983	0.33	0.26
Willow**	*Pst*	-3.5616	1.6770	1.9024	-4.1950	1.3580	1.6113	0.990	0.995	0.21	0.13
	Pbr	0.1060	-1.8624	4.6239	-3.4979	-1.0773	3.1376	0.982	0.846	0.30	0.85
	Pf	-0.3589	-1.4312	3.2192	-2.7032	-1.0801	2.2967	0.964	0.774	0.29	0.72
	Pa	-1.6450	0.6277	2.6254	-3.0553	0.6430	1.9808	0.993	0.993	0.17	0.15
Maple**	*Pst*	-6.9681	3.8389	0.5222	-3.1350	0.7518	2.0143	0.940	0.980	0.30	0.18
	Pbr	-7.7613	2.5504	2.0788	-2.5050	-1.4429	3.4399	0.938	0.926	0.36	0.39
	Pf	-7.4901	2.1207	1.4187	-3.8551	-0.6443	2.3695	0.941	0.933	0.26	0.28
	Pa	-6.6197	3.6755	0.7345	-2.4794	0.3710	2.2604	0.950	0.991	0.28	0.12
Elm**	*Pst*	-5.2602	2.7644	1.2447	-3.5246	1.0983	1.7758	0.952	0.987	0.33	0.17
	Pbr	-7.0314	2.1650	2.4414	-4.1727	0.4877	2.1442	0.974	0.947	0.24	0.34
	Pf	-6.7861	1.8773	1.4925	-5.5365	2.3035	0.0889	0.966	0.887	0.21	0.39
	Pa	-4.8141	2.6275	1.4102	-2.9604	1.0683	1.7356	0.963	0.987	0.28	0.17
Chosenia**	*Pst*	-7.4048	3.8444	0.4270	-4.4928	1.4131	1.6960	0.940	0.996	0.38	0.09
	Pbr	-4.5895	1.8236	0.8807	-0.5952	-3.2605	4.3129	0.907	0.891	0.95	0.54
	Pf	-4.7792	1.6765	0.4596	-2.5934	-1.7183	2.9793	0.933	0.944	0.67	0.30
	Pa	-7.1133	3.6925	0.6273	-3.3965	0.7574	2.0369	0.920	0.998	0.43	0.07
Hawthorn**	*Pst*	-1.2292	-0.4783	2.8221	-2.0545	0.4938	1.1043	0.890	0.987	0.18	0.13
	Pbr	-8.7548	3.7923	4.2467	-1.4592	-1.6520	3.0043	0.878	0.909	0.53	0.51
	Pf	-4.8641	0.0136	4.8245	-2.0072	-1.7531	2.5305	0.850	0.980	0.41	0.17
	Pa	-2.7379	0.6191	3.7607	-0.8835	-0.4459	1.8918	0.908	0.994	0.27	0.10
Bird cherry tree (Padus)**	*Pst*	-3.4531	1.1458	2.8662	-5.0460	3.2890	0.5714	0.997	0.989	0.10	0.19
	Pbr	-3.1006	-0.1337	4.0271	-0.1911	-2.4202	2.6795	0.931	0.995	0.56	0.14
	Pf	-4.4110	1.2171	1.7441	-4.0550	1.0991	0.8809	0.974	0.997	0.22	0.07
	Pa	-2.7375	1.0709	2.8082	-2.6197	1.4371	1.1765	0.987	0.996	0.21	0.12
Manchurian walnut **	*Pst*	-	3.0941	3.2584	-3.8442	0.9762	2.0147	0.947	0.996	0.38	0.11
	Pbr	-	1.7032	4.2788	-3.5582	0.5692	1.7373	0.969	0.949	0.24	0.31
	Pf	-7.9702	0.9044	3.4339	-2.4775	0.0720	1.3514	0.981	0.945	0.13	0.22
	Pa	-9.8508	2.7308	3.4642	-2.9247	0.7603	1.9869	0.954	0.997	0.34	0.08
	Pst	-4.3112	0.6069	3.8326	-1.3446	0.0631	1.9938	0.920	0.972	0.41	0.24

Amur maackia **	*Pbr*	-3.9659	-0.4487	4.5136	-0.9784	-0.6933	2.1472	0.904	0.917	0,43	0.40
	Pf	-2.9007	-0.7695	3.3428	-0.4107	-1.1676	1.7003	0.903	0.978	0.29	0.14
	Pa	-3.4548	0.3118	3.9561	-0.5073	-0.1598	2.0125	0.917	0.963	0.40	0.27
Amur corktree **	*Pst*	-6.4711	2.6980	1.7243	-2.8523	0.7836	1.7956	0.947	0.992	0.39	0.15
	Pbr	-8.6881	1.1436	4.2409	-1.2428	-1.8452	3.2566	0.935	0.993	0.42	0.14
	Pf	-1.5768	0.2913	0.9945	-0.0339	-0.1695	0.6018	0.943	0.901	0.09	0.12
	Pa	-5.8167	2.3121	2.0624	-1.7361	0.3150	1.9503	0.946	0.995	0.37	0.11

Note: * R_2 - coefficient of determination, SE - standard error of the equation. ** - no data on the mass of the roots.

A coefficient of 0.5 is used to convert biomass to carbon stock.

A ratio of above-ground biomass to below-ground biomass is used to estimate carbon stocks in the below-ground biomass of a stand, taken as 0.39 (with above-ground biomass stock less than 75 t/ha) or 0.24 (with above-ground biomass stock over 75 t/ha).

Additional allometric equations and equation parameters for determining tree biomass and stem wood volume as well as data on wood density and coefficients to estimate tree biomass based on wood volume data are available at: http://www.globallometree.org/ (registration required).

6.1.2. Litter and soil

Performing representative measurements of the dynamics of carbon stock in pools of litter and soil involves the establishment of permanent sample areas, within which sampling will be carried out randomly throughout the duration of the project. Depending on the total area allocated to the project, each sample area should be from 0.5 to 1 hectare.

When selecting a sampling scheme, the scale of the project area and key environmental parameters (e.g., topography) must be taken into account. The latter factor can serve as a stratification parameter, and in sampling it is necessary to ensure the fullest possible spatial account of the heterogeneity of the territory. The recommended periods of repeated measurements are 5 years.

Litter sampling is carried out on 50 cm x 50 cm plots in 10-fold replications within each sampling area. Samples of litter are dried to absolutely dry state and weighed. Calculation of the carbon stock in the litter pool is carried out by multiplying the absolute dry weight of the sample by the average carbon content, which is taken to be 0.4.

Sampling of soils is conducted in accordance with GOST 17.4.3.01- 2017 ("Soils. General requirements for sampling") and GOST 17.4.4.02-2017 ("Soils. Methods of sampling and sample preparation for chemical, bacteriological, helminthological analysis").

Soil sampling is carried out taking into account the vertical structure, heterogeneity of soil cover, topography and climate of the area, as well as taking into account the characteristics of pollutants or organisms. Sampling shall be conducted at sample sites laid out so as to prevent environmental distortion of the analytical results. It is advisable to outline the sample sites on a coordinate grid, indicating their numbers and coordinates.

Samples are taken along the profile from soil horizons or layers so that in each case the sample represents a part of the soil typical of genetic horizons or layers of a given soil type. When investigating soil carbon stock changes, samples are taken from horizons from a depth of 0 to 5 cm and from 5 to 20 (up to a maximum of 30) cm.

At least one combined (mixed) sample weighing at least 1 kg from a sample area of 0.5 to 1 ha consisting of 5-10 point samples shall be taken.

Soil samples for chemical analysis are dried to air-dry state according to GOST 17.4.3.01-2017. Air-dried samples are stored in cloth bags, cardboard boxes or glass containers. To determine chemical substances, the soil sample in the laboratory is scattered on paper or tracing paper and kneaded with a pestle large lump. Then inclusions are selected - roots of plants, insects, stones, glass, coal, bones of animals, as well as new formations - druses of gypsum, lime cranes, etc. Soil is ground in a mortar with a pestle and sifted through a sieve with a hole diameter of 1 mm. Selected neoplasms are analyzed separately, preparing them for the analysis in the same way as a soil sample.

Chemical analysis for the total organic matter content of soils is conducted in accordance with GOST 26213-91 ("Soils. Methods for determination of organic matter") - by the method of Tyurin in the modification of TSINAO. Carbon content in the organic matter of soils is taken equal to 58%. Recalculation to soil carbon stock is made taking into account soil volume mass (g cm-3) according to equation 11.

Equation 11

$$C = \sum_{i=1}^{n} \left(\frac{H_i}{100} \frac{K_C}{100} \frac{(100 - K_{Si})}{100} D_i \, L_i \, K_{met} \times 10 \right)$$

Where:

C – soil carbon stocks for a stratum of soil or litter, kg/m^2;

n – number of horizons in the soil profile;

H_i – organic matter content of a particular soil horizon, %;

K_C – carbon content in organic matter (0.58), %;

K_{Si} – stoniness of the horizon, %;

D_i – horizon density, g/cm3;

L_i – thickness of the horizon, cm;

K_{met} – correction factor relative to the method of determining the content of organic matter according to Tyurin;

10 – conversion coefficient g/cm^2 to kg/m^2.

6.1.3 Fires on the project area

In the case of fires on the reforestation project area, the assessment of direct greenhouse gas emissions (CO_2, CH_4, N_2O) from fires is performed according to Equation 12:

Equation 12

$$L_{FIRE} = A \times M_B \times C_f \times G_{ef} \times 10^{-3}$$

Where:

L_{FIRE} – amount of greenhouse gas emissions from fire; tons of each greenhouse gas, e.g., CO_2, CH_4, N_2O;

A – burned area, ha;

M_B – mass of fuel available for burning, tons/ha. This includes biomass, litter, and dead wood;

C_f – combustion factor; dimensionless. Values of 0.43 for top fire and 0.15 for bottom fire are used;

G_{ef} – emission factor; g/kg dry matter burned.

Table 6.2. - Coefficients of major greenhouse gas emissions from fires, g kg^{-1} substance burned (to use as a quantitative value for G_{ef})

	CO_2	**CH_4**	**N_2O**
Forests	1569±131	4,7±1,9	0,26±0,07

6.1.4 Emissions from fossil fuel combustion

Calculation of CO_2 emissions from fossil fuel combustion under the project activities is performed according to Equation 13.

Equation 13

$$C_{FUEL} = \sum_{k=0}^{n} Vk \times EFk$$

Where:

C_{FUEL} – CO_2 emissions from fuel combustion, t;

Vk – amount of fuel k combusted;

EFk – coefficient of CO_2 emission from fuel combustion k.

Methane emissions are converted to CO_2 equivalent by multiplying by the global warming potential value of 25. Nitrous oxide emissions are converted to CO_2 equivalent by multiplying by the global warming potential value 298.

6.2. Monitoring areas

In order to prove that the rate of natural reforestation assessed by the Project Developer in the baseline scenario remain adequate during the crediting period, this methodology requires setting monitoring areas for each of the project strata. Each monitoring zone covers 0.25 hectares and is allocated beyond the project boundary on an area that is as similar to the project area as possible in terms of soil type, water regime, slope, exposition, previous land use and etc. When selecting the location for the monitoring area, it is recommended to take into account that the seeds of trees planted under the project activities may affect the forest reproduction rates in the monitoring area.

The first examination of the monitoring area is carried out just before the start of project activities, and then repeated at least every 5 years in accordance with the monitoring plan requirements.

7. Project scenario

The project scenario represents the balance of greenhouse gases that is expected to occur as a result of the project activity, i.e. reforestation with selected species. Similarly to the baseline scenario, the project scenario must be clearly defined, realistic, credible and based on verifiable sources of information. Project developers should describe in detail all the steps that were taken to conduct the estimates (i.e., data collection, choice or development of methodology, coefficients, etc.), and provide all results obtained from the calculations for each year of the crediting period.

When developing the baseline scenario, stand growth and development are modeled similarly to the baseline scenario in accordance with the Equations 1-5, taking into account the selected species, planting plan, forest site characteristics, etc., and the emissions associated with fossil fuel combustion required for the project activity are estimated using Equation 13. In order to ensure comparability, the same tree growth models, climatic conditions, and other independent of the presence or absence of project activities parameters and assumptions must be used both in the baseline and project scenarios.

7.1. Risk management

When developing the baseline and the project scenario, it is necessary to take into account the types of use and purpose of the territory where the climate project is being implemented, both at the present time and in the future. This information can be obtained from territorial planning documents, which determine the purpose of territories based on a combination of social, economic, environmental and other factors in order to ensure sustainable development of territories, development engineering, transport and social infrastructures, ensure the interests of citizens and their associations, Russian Federation, constituent entities of the Russian Federation, municipalities (Urban Planning Code of the Russian Federation dated December 29, 2004 N 190-FZ (as amended on December 29, 2022), Chapter 3).

As part of the project implementation, it is recommended to develop a risk assessment system with a description of the most likely risks that may arise at all stages of the climate project. For such an assessment, the project developer should develop a detailed matrix with the following information, as a minimum:

1. The main stages of the implementation of the climate project.

2. Description of the risks that may arise at each stage of the climate project.

3. Description of the probability of occurrence of risks. For this, the rating options "low, medium, high" or any other understandable numerical scales can be used.

4. Description of the impact of each risk on the results of the entire project. This can also be done using "low, medium, high" or any other understandable numerical scale.

5. Description of the period of influence of each risk on the entire climate project.

6. Development of measures to minimize or avoid each type of risks

7. The time for the implementation of each measure that reduces or prevents the occurrence of risks is indicated.

Table 7.1. Risk management

Stage of climate project implementation	**Description of risks**	**Probability of occurrence**	**Impact on the project**	**Impact period**	**Risk minimization methods**	**Implementation period**
		1. low 2. medium 3. high	1. low 2. medium 3. high	1. Preparation period 2. 1-2 years after the implementation 3. The entire period of the climate project	Detailed description of mitigation measures for each risk	Description of the time frame for the implementation of these activities

		Scale from 1 to 5 or others	Scale from 1 to 5 or others			

8. Leakage assessment

According to the Order of the Ministry of Economic Development of Russia dated May 11, 2022 N 248 project activities should not lead to an aggregate increase in greenhouse gas emissions or reduce their absorption levels outside the scope of such activities.

At the same time, it is necessary to consider and fully account for if project leaks exist in accordance with the methodology below.

There are three types of leakage:

1) Market leakage occurs when projects significantly reduce the production of a commodity causing a change in the supply and market demand equilibrium that results in a shift of production elsewhere to make up for the lost supply.

2) Activity Shifting leakage is related to activities that directly cause carbon-emitting activities to be shifted to another location outside of the project boundaries, cancelling out some or all of the project's carbon benefits.

3) Ecological leakage occurs when the project activity causes changes in GHG emissions or fluxes of GHG emissions from ecosystems that are hydrologically connected to the project area.

GHG emissions from leakage may be determined either directly from monitoring, or indirectly when leakage is difficult to monitor directly but where scientific knowledge provides credible estimates of likely impacts. Leakage occurring outside the host country (international leakage) does not need to be quantified. Projects should not consider positive leakage i.e., where GHG emissions decrease or removals increase outside the project area due to project activities.

9. Non-permanence risk analysis

Non-permanence risk is one of the major risks for forest climate projects. The return of carbon accumulated during the project back into the atmosphere may occur as a result of a forest fire on the area or as a result of clear-cutting after the end of the project. Therefore, the project developer must guarantee that at the end of the project period the results will be maintained for 100 years. The permanence of the results can be ensured by effective forest fire protection or the ban on logging. If such guarantees cannot be provided, then the amount of emission reductions/enhanced removals achieved by the project should be discounted in proportion to the number of years not covered by guarantees.

10. Methods to prevent double counting, negative impacts on the environment and society

Project activities must not negatively impact the environment or local communities. The project developer should identify and mitigate any negative environmental and socio-economic impacts of project activities, and engage with local stakeholders during project development and implementation.

In terms of human rights, the project:

- respects internationally proclaimed human rights including dignity, cultural property and uniqueness of indigenous people;
- is not complicit in Human Rights abuses;
- does not involve and is not complicit in involuntary resettlement;
- does not involve and is not complicit in the alteration, damage or removal of any critical cultural heritage.

In terms of labour standards, the project:

- respects the employee's freedom of association and their right to collective bargaining and is not complicit in restrictions of these freedoms and rights;
- does not involve and is not complicit in any form of forced or compulsory labour;
- does not employ and is not complicit in any form of child labour;
- does not involve and is not complicit in any form of discrimination;
- provides workers with a safe and healthy work environment and is not complicit in exposing workers to unsafe or unhealthy work environments.

In terms of environmental protection, the project:

- does not involve and is not complicit in significant conversion or degradation of critical natural habitats;
- does not involve planting of monocultures or invasive species;
- does not result in a change in the water regime;
- does not result in a loss of biodiversity.

In terms of anti-corruption, the project:

- respects the employee's freedom of association and their right to collective bargaining and is not complicit in restrictions of these freedoms and rights;
- does not involve and is not complicit in corruption.

In order to increase the social factor and the significance of the climate project for the local communities, it is recommended to allocate 10-15% of the benefits received from carbon credits to the budgets of the municipalities where the climate project is located

11. Update of the baseline at the renewal of the crediting period

At the renewal of crediting period the project is subject to verification with elements of validation and a technical assessment by a validation and verification body to determine necessary updates to the baseline, the additionality and the quantification of emission reductions.

In order to update the baseline the approach to its definition, the main parameters and assumptions used in the analysis are revised and updated. The baseline shall be representative of the conditions for the beginning of a new crediting period and be valid for that period.

The additionality at the renewal of the crediting period is checked for compliance to the criteria under Tool #1 at the date of the beginning of the new crediting period.

12. Normative references

1. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4 Agriculture, Forestry and Other Land Use (https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html)

2. Forest Code of the Russian Federation of December 4, 2006 N 200-FZ (as amended on December 29, 2022)

3. GOST R ISO 14064-1-2021. National Standard of the Russian Federation. Greenhouse gases. Part 1. Requirements and Guidance for Quantification and Reporting of Greenhouse Gas Emissions and Absorption at the Organization Level (approved and enacted by Rosstandart Order No. 1029-st dated 30.09.2021);

4. GOST R ISO 14064-2-2021. National Standard of the Russian Federation. Greenhouse gases. Part 2. Requirements and Guidelines for Quantification, Monitoring and Reporting Documents for Projects to Reduce Greenhouse Gas Emissions or Increase Their Absorption at the Project Level (approved and enacted by Order No. 1030-st of Rosstandart dated September 30, 2021);

5. GOST R ISO 14064-3-2021. National Standard of the Russian Federation. Greenhouse gases. Part 3. Requirements and Guidance for Validation and Verification of Greenhouse Gas Statements (approved and enacted by Rosstandart Order No. 1031-st of 30.09.2021);

6. GOST R ISO 14065-2014 National Standard of the Russian Federation. Greenhouse gases. Requirements for greenhouse gas validation and verification bodies for their application in accreditation or other forms of recognition (approved and enacted by Order of Rosstandart of 26.11.2014 № 1869-st);

7. GOST R ISO 14066-2013. National Standard of the Russian Federation. Greenhouse gases. Requirements for competence of greenhouse gas validation and verification groups (approved and enacted by Order of Rosstandart of 17.12.2013 № 2274-st);

8. GOST R ISO 14080-2021. National Standard of the Russian Federation. Greenhouse Gas Management and Related Activities. System of approaches and methodological support for the implementation of climate projects (approved and enacted by Order of Rosstandart No. 1033-st dated 30.09.2021);

9. IPCC 2006. Guidelines for National Greenhouse Gas Inventories of the Intergovernmental Panel on Climate Change, 2006 / Edited by S. Iggleston, L. Buendia, K. Miwa, T. Ngara and K. Tanabe. // T.1-5. - IGES// Hayyam. 2006.

10. Methodology for afforestation/reforestation (A/R) GHGs emission reduction & sequestration (https://globalgoals.goldstandard.org/403-luf-ar-methodology-ghgs-emission-reduction-and-sequestration-methodology/)

11. Order of the Ministry of Economic Development of Russia dated May 11, 2022 № 248 "On approval of the criteria and procedure for classifying projects implemented by legal entities, individual entrepreneurs or individuals, as climate projects, the form and procedure for reporting on the implementation of a climate project" (Registered with the Ministry of Justice of Russia on May 30, 2022 № 68642)

12. Order of the Ministry of Natural Resources and Environment of the Russian Federation of December 4, 2020 № 1014 "On Approval of the Rules of reforestation, composition of the reforestation project, the order of development of the reforestation project and making changes in it" (registered with the Ministry of Justice on December 18, 2020 № 61556);

13. Order of the Ministry of Natural Resources of Russia dated May 27, 2022 № 371 "On approval of methods for quantitative determination of greenhouse gas emissions and greenhouse gas removals" (from March 1, 2023, except for certain provisions, coming into force on March 1, 2024);

14. Schepaschenko D., Moltchanova E., Shvidenko A., Blyshchyk V., Dmitriev E., Martynenko O., See L., Kraxner F. (2018) Improved Estimates of Biomass Expansion Factors for Russian Forests // Forests. – 9, 312. P. 1-23. – https://doi.org/10.3390/f9060312

15. Urban Planning Code of the Russian Federation dated December 29, 2004 N 190-FZ (as amended on December 29, 2022)

16. Usoltsev V. A., Chasovskikh V. P., Noritsina Yu. V. Allometric models of tree phytomass for laser sensing and ground-based carbon pool taxation in Eurasian forests: a comparative analysis // Siberian Forest Journal. 2016. № 4. pp. 1-76

17. VM0007 REDD+ Methodology Framework (REDD+MF), v1.6 (https://verra.org/methodologies/vm0007-redd-methodology-framework-redd-mf-v1-6/)