APPLIED WORK

GHG and Natural Capital Impact of Russia Forest Fire Response Project

Application of the EX-Ante C-balance Tool v5.2

About EX-ACT: The *Ex Ante* Appraisal Carbon-balance Tool aims at providing *ex-ante* estimations of the impact of agriculture and forestry development projects on GHG emissions and carbon sequestration, indicating its effects on the carbon balance.

See EX-ACT website: ***www.fao.org/tc/exact***

Related resources

- EX-ANTE Carbon-Balance Tool (EX-ACT): (i) User Guidelines; (ii) Tool; (iii) Flyer
- See all EX-ACT resources in EASYPol under the Resource package, Investment Planning for Rural Development, EX-Ante Carbon-Balance Appraisal of Investment Projects

EASYPol

Resources for policy making

GHG and Natural Capital Impact of Russia Forest Fire Response Project

by

Louis Bockel, Policy Support Officer, Agricultural Development Economics Division, FAO, Rome, Italy.

Martial Bernoux, UMR Eco&Sols, Institut de Recherche pour le Développement (IRD), Montpellier, France.

Dipti Thapa, Agriculture and Rural Development Department (ARD), World Bank, Washington, USA.

Angela Armstrong, World Bank, Sustainable Development Department, Washington, USA.

for the

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, FAO

FAO 2014

Contents

Table of Abbreviations

AFOLU	Agriculture, Forestry and Other Land Use
CC	Climate Change
CDM	Clean Development Mechanism
CH_4	Methane
CO_2	Carbon Dioxide
DM	Dry Matter
EX-ACT	EX-Ante Carbon-balance Tool
FAO	Food and Agriculture Organisation of the United Nations
FFA	Federal Forestry Agency
FFRP	Forestry Fire Response Project (FFRP)
GHG	Greenhouse Gas
GWP	Global Warming Potential
HAC	High Activity Clay
IPCC	Intergovernmental Panel on Climate Change
LAC	Low Activity Clay
MNRE	Ministry of Natural Resources and Environment
MRV	Monitoring, Reporting and Verification
Mt	Million metric tons
N_2O	Nitrous Oxide
PIU	Project Implementation Unit
tCO_2-e	Tonnes of CO_2 equivalents
UNFCCC	United Nations Framework Convention on Climate Change

1. Background

1.1 Study Framework: Ex-ante appraisal of the FFRP project

A pre appraisal of the Forestry Fire Response Project (FFRP) was developed in 2011 on the basis of the results of a workshop with Russian experts in Moscow. The exercise was conducted as a pre-formulation activity. In 2014, the World Bank decided to update this preliminary scenario, while the project is just starting. This advanced appraisal has benefitted from workshop discussions of a panel of Russian forestry experts (annex 2) including the project technical team in May 2014. It was based on an updated implementation scenario with fire protection brigades, considering both an optimistic climate change scenario (based on past trends) and a pessimistic CC scenario (wide increase of forest fires). The results confirm the large potential of GHG emissions reductions provided by wide fire protection public programmes, placing the project within a high return on public investments. It results in a very high profitability index (NPV per US$ invested). This appraisal also provides performance indicators of the project on climate resilience through increased natural capital, such as the incremental biomass generated and the incremental soil organic carbon, which directly affects the climate resilience of landscapes and watersheds. In line with the working assumptions concerning the impact of forest fire on forest degradation and the uncertainty rate of emission coefficients (38%), results were provided as ranges and are still to be used carefully.

1.2 Russia Forestry Background

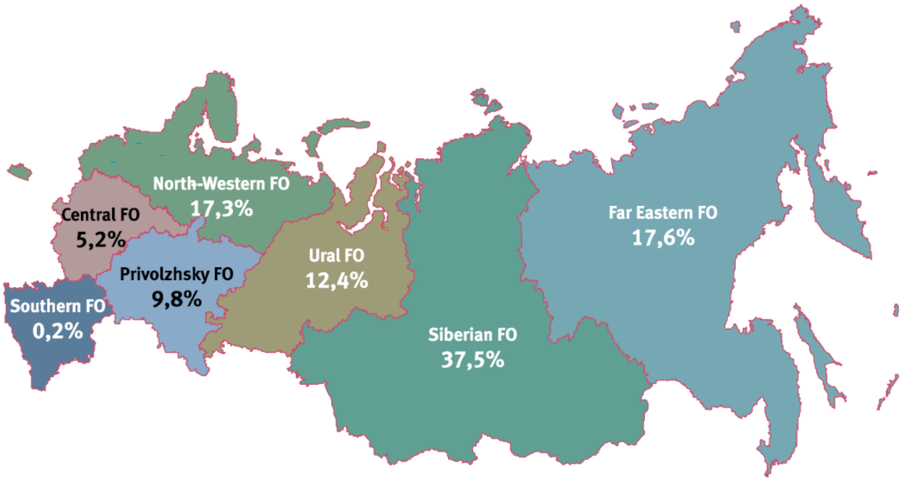
According to MARF[1] , Russia is the largest country in the world (17 million km^2 or 1.7 billion ha) and has the largest area of closed forests (7.6 to 7.7 million km^2 or 0.76 to 0.77 billion ha). The latter represents 22 percent of the world's forests. More recently, the Russian Federation established a Forest Land Fund: according to the Legislation, this category of land includes forest and non-forest land. Precisely, forestland includes parcels that are currently under forest cover (forested land) and parcels that are not covered with forest vegetation, but are planned to benefit from forest restoration, e.g. clear cut and burned area. Non-forest land also includes land that serves the objective of forest management, such as roads.

These intact forests are arranged in large arrays[2]. The forest land share of the forest-tundra sparse forest and taiga zone is 18%, northern taiga sub-zone 18%, middle taiga sub-zone 31%, southern taiga sub-zone 22%, coniferous-broadleaf forest zone 9%, and the steppe forest zone 2%. In terms of geographical location, the far eastern forest accounts for 17.6% of the total biomass stock (cf. figure 1).

[1] MARF, 2009.

[2] MARF, 2009.

Figure 1. Distribution of forest resources among regions, % of total stock



Source: MARF, 2009

1.3 Climate change and forestry fires in Russia

Russia is better equipped to deal with the impacts of climate change than many of its neighbours. Nonetheless, by 2030, climate change appears likely to accentuate some of the stresses that currently plague Russia. Some of the most affected regions are areas where already socio-economic and socio-political relations are attenuated and unsettled. Most of the impacts of climate change will manifest themselves in smaller cities and in the Russian countryside. For example, the long turbulent North Caucasus region will become drier, hotter, and less prosperous than it is today.

The increase in annual mean temperature is expected to be much larger in Russia than the global average increase in temperature. By 2020, its growth will exceed the multi-model spread (standard deviation) which will be 1.1 ± 0.5°C with respect to the period 1980–1999. By the middle of the century, the temperature rise will be even larger (2.6 ± 0.7°C), particularly in winter (3.4 ± 0.8°C). In the southern and north western regions of European Russia, the rise of the lowest daily temperature is expected to be 4–6°C[3].

Fire is a major natural disturbance in Russian natural ecosystems, in particular in forests, due to: (i) a vast extent of natural ecosystems in Russia – forest, wetlands, grasses and shrubs; these comprise almost 90% of all vegetative areas; (i) about 95 percent of Russian forests are boreal forests, and 71% of them are dominated by coniferous stands of high fire hazard; (iii) a significant part of the forested territory is practically unmanaged and unprotected, with large fires (>200 ha) having higher occurrence; (iv) a slow decomposition of plant residues, thus leading to natural ecosystems containing large amounts of accumulated organic matter; and (v) a major part of natural ecosystems that are situated in regions with limited amounts of precipitation and/or frequent occurrences of long drought periods during the fire season, often initiating fires of high severity. [4]

---

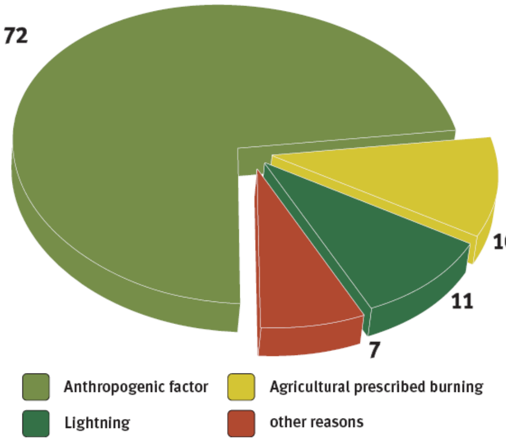
[3] *Climate change Russia* http://www.climateadaptation.eu/russia/climate-change/

[4] *Shvidenko et al, 2011. Carbon Emissions from Forest Fires in Boreal Eurasia between 1998-2010.*

Besides the previously mentioned long term trends, also recently weather instability has increased. Periods with heavy rain alternate with prolonged warm and dry periods, sometimes followed by anomalous heat waves, as e.g. during the summer of 2010. Such climatic variability has negative impacts upon large forested areas, essentially posing threats in the form of forest fires of high intensity, so called catastrophic fires.[5] Every year a vast area of Russian forest burns, ranging from 3 to 15 million ha according to satellite imagery.[6] Nearly 90% of Russia's forest fires are of human origin.

Figure 2 illustrates the ignition causes of forest fires in 2008[7]. Related to forest fires, a recent study[8] assessed the average output of carbon as a result of natural and human-induced fires in Russia. The authors reported that the inter-annual variability of carbon emissions is ranging from 50 Tg C year^{-1} (2000) to 231 Tg C year^{-1} (2003). This implies that there are large GHG emissions related to forest fires that have a direct negative impact on climate and environment.

Figure 2. Forest fires and ignitions causes in %



Source: MARF, 2009.

Current models predict that: (i) future fire regimes in the boreal zone are supposed to double by the end of this century; (ii) substantial increase of catastrophic and escaped[9] fires; (iii) dramatic increase of the intensity of fires and related GHG emissions; (iv) and change of composition of products of burning due to a wider distribution of deep soil burning.[10] Very likely, thawing of permafrost and aridization of landscapes on permafrost will lead to degradation and death of coniferous forests and to a wider distribution of "green desertification". There is a high probability of positive feedback between global warming and the escalation of fire regimes: the increase of CO_2eq in the atmosphere will lead to an increased frequency of long and dry periods.

Historically, the Soviet Union was advanced in terms of forest fire identification and suppression as they had approximately 600 aircrafts, 8,000 smokejumpers, and 70,000 full time forest guards[11]. This capability was dissolved due to budget cuts after the dissolution of the Soviet Union. Consequently, there was a decline of 70% in aircraft flight hours for the purpose of fire control between 1991 and 2002. In parallel, over the same period, the percentage of fires detected by aviation has decreased by 45%. In addition, the average size

[5] *World Bank PID, 2012.*
[6] *MARF, 2009.*
[7] *MARF, 2009.*
[8] *Shvidenko et al., 2010.*
[9] *An escape fire is a fire lit to clear an area of vegetation in the face of an approaching wildfire when no escape exists. Like a backfire, it works by depriving an approaching primary fire of fuel so that when the primary fire reaches where the escape fire started the primary fire cannot continue; there is nothing there to burn.*
[10] *Shvidenko et al., 2011.*
[11] *Shvidenko et al., 2011.*

of fires consistently increased from 1991 to 2002 as a result of shrinking fire management resources.

These negative trends were exacerbated as an unintended consequence of a major reform embodied in a new Forestry Code, which took place on 2 January 2007[12]. This code completely decentralized the responsibility for decreasing and ceasing forest fires to the 89 federal subjects of the Russian Federation [including the 21 republics, 46 oblasts (provinces), 9 krais (territories), and autonomous districts and cities]. Furthermore, the removal of any central authority annihilated the ability to shift resources in real time from regions free of severe fire stress to those suffering from overwhelming attacks.

1.4 Recent policies on forest fire management

The examination of Russia's response to the 2010 fires reveals two important findings:

1. The government fire fighting and other emergency forces were not capable of effectively preventing and containing the fires;
2. Ordinary Russian citizens acting in ad hoc fire fighting units proved to be a critical force in combating the fires.

The Public Commission on Investigation of Causes and Consequences of the Wildfires in Russia in 2010 concluded that, even though it would have been impossible to avoid a sharp increase in the number of wild fires during such a long and severe drought in 2010, it was the government policy that led to the fire catastrophe of 2010. Poor policy decisions aided by the severe weather created a "perfect firestorm" in Russia in 2010 (Climate Adaptation, 2014[13]).

The Russian government responded with several policy initiatives to improve forest fire management on the short-term:

1. more investments in fire suppression and prevention equipment;
2. organizational changes in federal responsibilities for fire prevention and fire fighting;
3. more transparency and accountability by posting satellite photographs of all territories affected by forest fires on the internet.

If the 2010 fires are a sign of things to come, the Russian government needs to be prepared for a significant investment into numerous adaptation measures that go beyond typical fire safety and prevention.

1.5 Forest Fire Response Project (FFRP): framework and implementation status

The development objective of the Forest Fire Response Project for the Russian Federation is **to improve forest fire prevention and management and to enhance sustainable forest management**[14]**.** Furthermore, the project will contribute to raising public awareness and education standards in forestry issues in general, with specific reference to forest fires prevention/control and forest governance issues. There are three components to the project.

The first component of the project is enhancing forest fire prevention, management, and control. This component aims to improve the effectiveness of forest fire prevention and

[12] *World Bank PID, 2012.*
[13] *http://www.climateadaptation.eu/russia/forest-fires/*
[14] C.f. Project Proposal Document.

management by: (i) improving the capacity for early detection and quick response to fight forest fires, and (ii) reducing the number of fires of human origin through awareness raising and environmental education programs. It includes all direct support field fire protection actions mostly targeting the rebuilding and operationalizing of 200 fire brigades.

The second component of the project is building the management capacity for forestry and protected area (PA). This component will increase forest and PA management capacity and help address key policy and management issues that either create perverse incentives or exacerbate conditions contributing to the extent and intensity of fires in the extensive forest landscape and protected areas.

The third component of the project is project management and will finance the operating costs of a Project Implementation Unit (PIU), which will undertake project management functions for both components one and two. The PIU will provide support to the core implementing agencies (Federal Forestry Agency (FFA) and Ministry of Natural Resources and Environment (MNRE) in project management, including procurement, financial management, project coordination, reporting, and monitoring.

The Federal Forest Agency (FFA) covers the extensive forest area (forest fund), and the Ministry of Natural Resources and Environment (MNRE) will implement the project in Protected Areas (PAs).

Physical interventions will focus on 5 pilot regions: Khabarovsk Kray, Komi Republic, Krasnoyarsk Kray, Moscow Oblast, and Voronez Oblast. Within these regions, the following targeted protected areas are:

- Meschera, Okskiy, and Meshcherskiy in the Central Federal Okrug.
- Kerzhensky, Buzuluskiy, Zhigulevskiy, and Samarkskaya Luka in the Volga Federal Okruy.
- Sayano-Shushenskiy, Stolby, and Shushkenskiy Bor in Krasnoyarsk Kray (Siberian Federal Okrug), and
- Bureinkiy, Komsomolskiy, and Bastak in the Far East Federal Okrug.

These regions have been selected by the project design team according to geographic, economic, and environmental criteria. In addition, the project's geographical focus is on forests with high environmental or economic value, which may be situated close to settlements or infrastructure. Hence a fire in those areas implies an increased risk regarding human life loss, severe human health impacts and substantial damage to infrastructure, loss of economic assets or valuable ecological resources, e.g. national parks. Through this wide scope of targeted regions, it is expected that the project will cover around 108 million ha, equivalent to one sixth of Russian Forest area (660 million hectares) with direct field actions on 10 million hectares and indirect effects through institutional partners support, planning and capacity building on 98 million hectares.

2. Methodology, tools and parameters used

2.1 EX-ACT tool

The Ex-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing ex-ante estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The carbon-balance is defined as the net balance from all GHGs expressed in CO_2 equivalents that were emitted or sequestered due to project implementation as compared to a business-as-usual scenario.

EX-ACT is a land-based accounting system, estimating C stock changes (i.e. emissions or sinks of CO_2) as well as GHG emissions per unit of land, expressed in equivalent tonnes of CO_2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. The amount of GHG mitigation may also be used as part of economic analysis as well as for the application for funding additional project components.

EX-ACT has been developed using mostly the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) that furnishes EX-ACT with recognized default values for emission factors and carbon values, the so called Tier 1 level of precision. Besides, EX-ACT is based upon chapter 8 of the Fourth Assessment Report from working group III of the IPCC (Smith, et al., 2007) for specific mitigation options not covered in NGGI-IPCC-2006. Other required coefficients are from published reviews or international databases. For instance embodied GHG emissions for farm operations, transportation of inputs, and irrigation systems implementation come from Lal (Lal, 2004) and electricity emission factors are based on data from the International Energy Agency (IEA, 2013)

The EX-ACT appraisal process is interactive as well as participatory, and can strengthen the overall project design process, especially when a training and workshop element (for project teams, government counterparts, and other stakeholders) is integrated as part of the process. It may facilitate the discussion of ways to create incentives and institutional conditions that can promote their uptake (such as payments for environmental services).

This is an exercise that illustrates how EX-ACT can be applied within the context of the Forestry Emergency Response Project. Therefore, various assumptions are taken within the analysis mainly based upon an expert meeting that took place in Moscow at the end of 2010. Furthermore, the analysis was based upon past reports from the Project Information Document (PID) of the World Bank (2012) followed by several reports[15].

2.2 Fixed parameters of the carbon appraisal

In order to appraise the carbon balance of this project, information on soil and climate are needed to better define the carbon storage. The soil and climate characteristics were defined according to the IPCC climate zones and the World Resource Base (WRB) soil maps that can be found within the EX-ACT tool.

Accordingly, the soil was classified as **High Activity Clay** (HAC) and the average climate as **Boreal** with a **moist** regime. The time frame chosen for the analysis is **25 years**. In the analysis it is assumed that the implementation phase lasts 5 years, thus with a capitalisation set to 20 years.

[15] *MARF, 2009; MNRRF-SFF, 2003.*

Regarding the Global Warming Potential (GWP) coefficients[16], the present analysis uses the same values as those adopted within the Clean Development Mechanism (CDM), i.e., 21 for CH_4 and 310 for N_2O. Figure 3 illustrates the overall description of the project, extracted from EX-ACT.

Figure 3: Description of the FFRP

Project Name	*Forest Fire Response Project Russia*	
Continent	Asia (Continental)	
Climate	Boreal	
Moisture regime	Moist	
Dominant Regional Soil Type	HAC Soils	
Duration of the Project (Years)	Implementation phase	5
	Capitalisation phase	20
	Duration of accounting	25

2.3 Tier 2 Carbon density Coefficients for Russian forestry

According to Sohngen et al.,[17] the average carbon density of Russian forests is 36.2 (±5.5) t C per hectare in phytomass (Figure 4) and 162 (±37.6) t C in soils (top first meter). The estimates for phytomass is well within the range of various studies conducted in the late 1980s and 1990s *(cf. Figure 5).*[18]

Figure 5. Comparison of Sohngen et al. (2005) and other carbon estimates in Russia

Period of Estimation	Carbon Pool in Phytomass (BTCE)	Source
1993–2003	36.2 (±5.5)	Present study
Selected Other Studies		
1988 (Former Soviet Union)	68.7	Kolchugina and Vinson, 1993
1988	35.6	Isaev et al., 1995
1988–1992	32.9	Nilsson et al., 2000
1998	30.6	Pisarenko et al., 2000
1998	32.7	Filipchuk and Moiseev, 2003
1990–1999	N/A	Gytarsky et al., 2002
1993–1995	39.6	Kauppi, 2003

Adapted from Table 3.6 reported by Sohngen et al., 2005.

Nevertheless, it is recommended to use, via the Tier 2 approach in EX-ACT, the above mentioned variables, i.e. 36.2 tC.ha-1, thus 77 t dry matter considering a C content of 47%. It is noteworthy to mention that the IPCC default values for Boreal forest presents the same order of magnitude range, i.e 23.5 tC.ha-1. In the absence of estimates for the other biomass

[16] *The GWP is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is a relative scale, which compares the gas in question to that of the same mass of carbon dioxide (whose GWP is by convention equal to 1.*

[17] *Sohngen et al., 2005.*

[18] *Sohngen et al., 2005.*

compartments, e.g. belowground biomass, litter, dead wood and soil, estimates from Russian experts were considered.[19] The soil carbon content in the top 0-30cm was assumed to be 64.8 tC.ha-1. ([20,21] This represents 40% of the average value proposed for the top soil meter by Sohngen et al.[22] and is close to the default value (68 tC.ha-1) proposed by the EX-ACT Tier 1 approach).

According to the Russian experts, the litter C content proposed by IPCC, i.e. Tier 1 approach in EX-ACT, was too elevated. Therefore, it was proposed to consider a mean value of 5 tC.ha-1. It was considered that the dead wood pool amounts to 15 tC.ha-1. The belowground biomass was estimated using the default ratio of belowground biomass to aboveground biomass for the Boreal forest. Figure 6 shows the forest characteristics (second line, "Average Russian Forest") as compared to the Tier 1 approach. The module used in EX-ACT is forest degradation.

Figure 6: Average Russian forest characteristics, Tier 1 versus Tier 2 approach

Type of vegetation (that will be degraded)	Above-ground		Below-ground		Litter		Dead wood		Soil C	
All values are in t of carbon per ha (tC/ha)	Default	Tier 2	Default	Tier 2	Default	Tier 2	Default	Tier 2	Default	Tier 2
average russia	23.5	36.2	9.2	14.0	47.00	5.0	0.0	15.0	68.0	64.8
Forest - Zone 2	7.1		2.7		47.00		0.0		68.0	
Forest - Zone 3	23.5		9.2		47.00		0.0		68.0	

3. Building the baseline (BAU scenario) and project scenario

3.1 From past trends of forest fire towards future modelling

Table 1 represents the average yearly area burnt from 1998 to 2010 for the whole country. The annual mean burnt forest area for the 13-year period is 4,886,000 ha considering the total national forest area of 640-660 million hectares, an equivalent of 0.8%.

Table1. Average fired areas per year and carbon emissions 1998-2010 by land type

Vegetation	Area, 10^3 ha	Emission, 10^3 t C	including the main emission species, 10^3 t C							
			CO_2	CO	CH_4	NMHC	OC	BC	$PM_{2.5}$	TPM
Forest	4,886.0	82,036.0	68,819.8	6,919.7	836.3	598.8	834.9	82.0	878.1	1,284.6
Arable	402.0	606.3	524.3	46.8	6.8	5.8	3.0	0.6	4.9	7.9
Hayfield	320.4	778.1	671.7	60.8	9.0	7.5	3.9	0.8	6.3	10.2
Pasture	498.4	933.2	810.0	70.3	10.1	8.6	4.7	0.9	7.3	12.0
Fallow	72.1	136.1	118.8	9.8	1.3	1.2	0.7	0.1	1.0	1.7
Abandoned arable	261.4	564.0	491.6	41.2	5.7	5.1	2.8	0.6	4.3	7.2
Wetland	601.7	18,424.6	15,970.1	1,369.3	250.7	108.0	109.3	18.4	126.4	200.1
Open woodland	260.6	6,244.2	5,148.0	593.4	80.8	42.6	61.3	6.2	73.4	104.7
Disturbed forest	202.9	3,687.8	3,108.5	295.3	33.9	28.1	39.2	3.7	39.0	57.4
Grassland	720.2	7,565.7	6,665.0	487.8	82.9	41.8	43.6	7.6	49.3	79.6
Total	**8,225.7**	**120,975.8**	**102,327.7**	**9,894.5**	**1,317.6**	**847.5**	**1,103.3**	**121.0**	**1,190.1**	**1,765.3**

Source: Shvidenko et al 2011

Therefore, applying such past trends on the 108 million hectares of the five regions covered, it was assumed that the area burnt annually is currently equal to 864,000 ha.

[19] *cf. Appendix 1 for the list of participants.*
[20] *Moiseev & Filipchuk, 2003. "Vklad lesov Rossii v uglerodnyy balans planety.[Contribution of the Russian forest to Carbon Balance of the Planet]." Lesokhozyaystvennaya informatsiya, 2003, 1: 27–34. In Russian.*
[21] *Moiseev & Filipchuk, 2003.*
[22] *Sohngen et al., 2005.*

3.2 Fire Evolution expected with climate change

The analysis of model simulations of the fire risk indices in summer compared to satellite data not only indicate the growth of fire risks throughout the 21st century, but the high level of fire risk for separate Russian regions already at the present time. For the European territory of Russia the southern border of forests correlates well with the border of moderate risk of fires for modern climate. Based on model calculations of changes of the meteorological regime (trends of temperature and hydrological regimes), the potential fire hazard is expected to increase especially at southern latitudes by the end of the 21st century.

The number of days with the flammability risk will increase by 5 days per season over most of the country by 2015. In parts of the country that are dominated by forest cover the number of days per year with potential 'high or greater' risk will increase by 20–60% in the southern parts of European Russia and Western Siberia, at middle latitudes in eastern Siberia and the Far East (source: http://www.climateadaptation.eu/russia/forest-fires/).

Projected changes in the climate of West Siberia, especially under the high emissions scenario greatly increases the amount of territory that is likely to experience the hotter weather that sets up extreme fire danger. Under those conditions, the spread of fires in the boreal forests of Eurasia would greatly increase once such a fire is started.[23] If global warming continues at its current pace, the annual fire season in these boreal forests are likely to start earlier and end later, and become more severe. In fact, if we continue on our current path of high heat-trapping emissions, the region is projected to see forest fires during June and July at two to three times its current rate[23]. Some 1 billion metric tons of organic matter and older-growth trees could burn (around 1.7 billion tCO2eq), accelerating the release of stored carbon and creating a dangerous global warming amplification or feedback loop. Some parts of Russia have shown more extreme warming. In the Arctic, south Chukotka and Kamchatka regions temperatures rose 150 to 200 per cent more than in the rest of the country (Siberia time reporter[24], 2014).

Two options are therefore considered for the future baseline scenario

CC scenario	Impact forest fire occurrence
Low: Limited temperature increase with low fire increase	The area affected by forest fires will remain at 0.8% of the total forested area throughout the next 25 years: 864 000 ha burnt per year within the project area.
High: Higher temperature increase with high fire increase	In line with climate models and further temperature growth, the forest area burned will reach 4% of the total forested area: 4.37 million ha per year.

[23] http://www.climatehotmap.org/global-warming-locations/western-siberia.html

[24] *"...Natural Resources Minister Sergei Donskoi warned at a conference chaired by Prime Minister Dmitry Medvedev: 'The forest fire situation is tense in Russia this year. Due to a shortage of precipitation the forest fire season has begun almost one and a half months ahead of the norm.' By 2 April 2014, 17 forest fires had been registered across 2,000 hectares. Among the areas now at risk after a faster-than-usual snow melt are the south of Siberia to the territory of the Far Eastern Federal District, to Baikal and the Amur regions. 'It was the hottest April 1 on record for several western Siberian cities, including Novosibirsk, Tomsk, Kemerovo, Barnaul and Gorno-Altaysk,' said Renad Yagudin, of the Novosibirsk meteorological service. 'The average temperature in Russia increased 0.4 degrees every ten years. Overall, the temperature in the area is 6.5-16.2 degrees Fahrenheit (2-9 Celsius) higher than the record set in 1989.'*

3.3 Impact of fire occurrence on forest degradation

Distinction between deforestation and degradation

Deforestation:

FAO, 2001:

- The term deforestation is defined as the elimination of a forest or stand of trees where the land is thereafter transformed to a non-forest use. Deforestation is normally done by logging or burning of trees.
- Deforestation implies the long-term or permanent loss of forest cover. It includes areas of forest converted to agriculture, pasture, water reservoirs and urban areas.

UNFCCC, 2001:

- the direct human-induced conversion of forested land to non-forested land.

Forest degradation

- FAO, 2000: a reduction of canopy cover or stocking within the forest.
- FAO, 2003: the long-term reduction of the overall potential supply of benefits from the forest, which includes carbon, wood, biodiversity and other goods and services.
- IPCC, 2003c: the overuse or poor management of forests that leads to long-term reduced biomass density (carbon stocks).

In line with the definitions above, forest fire and other external pressures (insects, parasite, extractions) are conducive of forest degradation which could be partly counterbalanced by forestry natural regeneration capacity. Therefore we consider the long term impact of forest fire in terms of forest degradation within EX-ACT modelling.
Within the two options of CC scenarios, the impact on forest degradation was considered to be as follow:

Table 3: Impact of forest fire on forest degradation by EX-ACT climate change scenario

CC LOW SCENARIO: LIMITED TEMP. INCREASE WITH LOW FIRE INCREASE

Without project	With project
Without project: The impact of the current intensity of fire occurrence will generate a slow trend of forest degradation. The forest area is currently at a low level of degradation (20%) and it could lose 0.1% of additional biomass per year in the baseline scenario (2-3% of degradation over 25 years) driving to a moderate degradation.	With project: In project areas protected by fire brigades (10 million ha), forest capital will improve (reduction of forest degradation) of 0.2% per year (+5% in 25 years). In other project forest areas supported only by improved capacity of institutions, the forest capital will remain constant.

Type of vegetation that will be degraded	Degradation level of the vegetation: Initial state	At the end without project	At the end with project	Fire occurrence and severity: Without (y/n)	Periodicity (year)	Impact (% burnt)	With (y/n)	Periodicity (year)	Impact (% burnt)	Area (ha): Start (ha)
Forest Zone 1	Low	Moderate	Very low	YES	1	0.80%	YES	1	0.3%	10,000,000
Forest Zone 1	Low	Moderate	Low	YES	1	0.80%	YES	1	0.7%	98,000,000
Select the vegetation	Select level	Select level	Select level	NO	1	0%	NO	1	0%	0

CC HIGH SCENARIO: HIGHER TEMPERATURE INCREASE WITH HIGH FIRE INCREASE

Without project	With project
Without project: Losses of 0.4% of additional biomass per year are estimated in the baseline scenario (10% of degradation in 25 years) on 103.1 M. ha of forest areas. The other 4.9 M. ha will switch to highly degraded forest (50% of degradation due to "catastrophic" forest fires)	With project: The project areas supported by Fire brigades (10 M. ha) could improve by 0.2% per year (5% on 25 years). The 93.1 M.ha of project forest areas supported only by improved capacity of institutions lose 10% of biomass on 25 years. The 4.9 M. ha face similar degradations

Type of vegetation that will be degraded	Degradation level of the vegetation: Initial state	At the end without project	At the end with project	Fire occurrence and severity: Without (y/n)	Periodicity (year)	Impact (% burnt)	With (y/n)	Periodicity (year)	Impact (% burnt)	Area (ha): Start (ha)
Forest Zone 1	Low	Large	Very low	YES	1	4.00%	YES	1	1.0%	10,000,000
Forest Zone 1	Low	Large	Large	YES	1	4.00%	YES	1	3.0%	93,100,000
Forest Zone 1	Low	Extrem	Extrem	YES	3	15%	YES	3	15%	4900000

3.4 Inputs – investments

While not being in the centre of a GHG impact analysis, project implementation leads to the consumption of a wide range of inputs, energy resources and generates investments whose carbon footprint is accounted for as part of an impact analysis.

The project should mobilize around 200 forest fire brigades covering approximately 500km2 (20x25km). A fire brigade is a team of fire fighters trained and equipped, provided with mobility means in order to ensure fire control and prevention. They work around 8 months per year (32 weeks) with 4x4 vehicles as well as trucks and use on average 280 litres of fuel per week (40-45 l per day). The aggregate fuel and gasoil consumption of the project per year was estimated at 1780 m3.

6.2 Energy consumption (electricity, fuel,…)

Description and unit to report	Quantity consumed per year				
	Start	Without	*	With	*
Electricity (MWh per year)					
Please select the country of origin	0	0	D	0	D
Liquide or gaseous (in m^3 per year)					
Gasoil/Diesel	0	0	D	1780	I
Gasoline	0	0	D	0	D
Gas (LPG/ natural)	0	0	D	0	D
Butane	0	0	D	0	D
Propane	0	0	D	0	D
Ethanol	0	0	D	0	D
User defined (Tier 2):	0	0	D	0	D
Solid (in tonnes of dry matter per year)					
Wood	0	0	D	0	D
Peat	0	0	D	0	D

In terms of investments in buildings and roads, it was roughly estimated that every brigade will benefit from building facilities accounting for 50 m^2 of garages and 50 m^2 of offices per fire brigade and thus a total aggregate of 10,000 m^2 (50 m^2 x 200 brigades). Furthermore additional forest access roads will be needed and were estimated at 600 km of secondary concrete roads (4 m wide). As will be seen in the later analysis, this expectedly has a negligible impact on the overall GHG impact.

6.3 Construction of new infrastructure for the project (irrigation systems, buildings, roads)

Description and unit to report	Surface concerned		
	Without	With	
Irrigation systems (total in ha)			
Solid set sprinkle	0	0	
Please select	0	0	
Buildings and roads (total in m^2)			
Garage (concrete)	0	10000	100 m2 of garage per fire brigade
Offices (concrete)	0	10000	100m2 of office per fire brigade
Road for medium trafic (concrete)	0	2400000	600 km of forest roads

4. Appraisal results

4.1 FFRP Project Carbon Balance Appraisal – Low CC scenario

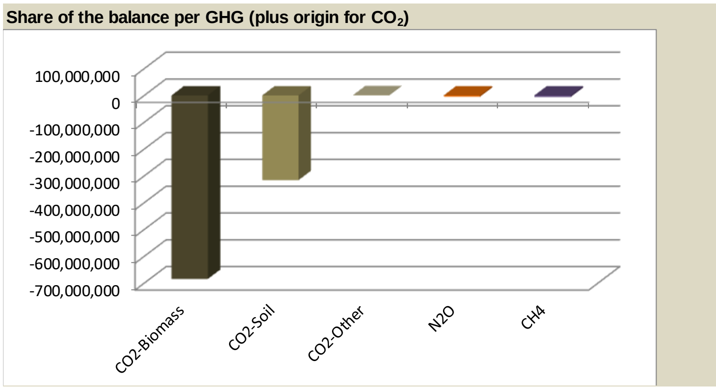
As described in detail further above the Low Climate Change scenario impacts the project area of 108 million ha by the continuation of past risk intensity for forest fires. The table below summarizes the main results of the more favourable scenario: Over the full duration of analysis of 25 years, the project will generate marginal benefits of 1.01 billion tonnes of CO2-equivalents, the so called carbon balance.

Carbon balance of the Forest Fire Response Project under a low temp growth Climate Change scenario

Name of the project	Forest Fire Response F	Climate	Boreal (Moist)	Duration (yr)	25
Continent	Asia (Continental)	Soil	HAC Soils	Total area (ha)	108000000

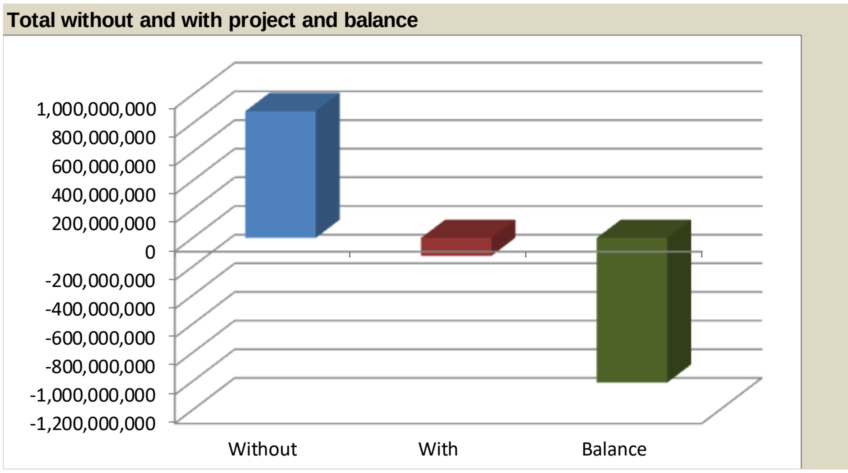
Component of the project	Gross fluxes Without	 With	 Balance	Share per GHG of the Balance Result per GHG CO_2 Biomass	 Soil	 Other	 N_2O	 CH_4	Results per year without	 with	 Balance
	All GHG in tCO_2eq Positive = source / negative = sink										
Land Use Changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other	0	0	0	0	0		0	0	0	0	0
Agriculture											
Annual	0	0	0	0	0		0	0	0	0	0
Perennial	0	0	0	0	0		0	0	0	0	0
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestock	0	0	0				0	0	0	0	0
Degradation	884,786,000	-126,520,203	-1,011,306,203	-684,684,000	-316,008,000		-4,771,360	-5,842,844	35,391,440	-5,060,808	-40,452,248
Inputs & Investments	0	894,011	894,011			894,011	0		0	35,760	35,760
Total	884,786,000	-125,626,193	**-1,010,412,193**	-684,684,000	-316,008,000	894,011	-4,771,360	-5,842,844	35,391,440	-5,025,048	-40,416,488
Per hectare	8	-1	-9	-6.3	-2.9	0.0	-0.1	0.0			
Per hectare per year	0.3	0.0	-0.4	-0.3	-0.1	0.0	0.0	0.0	0.3	0.0	-0.4

This is equal to an impact of 9 t CO2-e per hectare or 0.4 t CO2-e per hectare and year. Reflecting the focus of the project on degraded forest which high level of C rehabilitation, the FFRP has thus a huge climate mitigation impact which is mostly due to the wide forest coverage area, although a quite low mitigation intensity on a per hectare basis.



The impact per carbon pool and GHG corresponds to avoided losses of biomass (684 Mio t CO_2) and soil organic matter (316 Mio t CO_2) followed by the avoided N_2O and CH_4 emissions as a result of burning (4.8 and 5.8 Mt CO_2 equivalents). With a percentage of uncertainty of 37%.

Total without and with project balance



The figure on the left shows how the project allows to transform the territory from being a net source of GHG emissions (situation without project) linked with wide forest fires and forest degradation (884 million t CO2eq) to becoming a net sink of carbon (-125 million t Co2 eq) with the project.

Differentiating concerning the concerned carbon pools, the project mostly enriches carbon levels in biomass (-684 million t CO2-e) and in soil (-316 million t CO2-e).

While the above values provide the expected technical mitigation impact, it is at the same time important to associate also a rough monetary value with the in that way generated benefits.

While with the current uncertainties of future climate change impacts it is strongly uncertain how much costs each tonne of today emitted CO2-e will induce to society, it is nevertheless necessary to assume a reference price for current policy making purposes, that helps to provide a rough orientation of the value of mitigation measures. Using here the Social Cost of Carbon by the US Interagency Working Group allows illustrating the relevant and significant impacts generated in terms of climate change mitigation by the FPRP beyond a pure non-monetary estimation of the mitigation potential.

Based on a Social Cost of Carbon of 21 US$ per ton (US Interagency working Group[25]) and discounted at 10% over the 25 years of the carbon balance appraisal, the net present value of the GHGs mitigation is estimated at US$ 7.7 billion. This NPV is down to US$ 1.1 billion if assuming a low price of carbon at 3 US$/ tCO_2.

4.2 FFRP project carbon balance appraisal – High temperature growth and climate change scenario

Assuming instead a higher risk scenario with higher temperature growth and high forest fire growth, in which Russia is facing a much greater increase of forest fire. It will generate a big increase of GHG Gross flows in both without project (4.75 billion tCO_2) and with project (4.1 billion tCO_2) situations since the rate of forest fire is four times higher.

The overall mitigation benefits are reduced roughly by over 40% and the carbon balance accounts only for 654 million tCO_2-e. This illustrates to some extent the resilience of the project to a dramatic CC scenario (net carbon balance remaining very high) but its limited capacity to limit expansion of gross flows of CO_2 emissions from forestry which remain over 160 million tCO_2 per year in the with project situation.

[25] *Interagency Working Group on Social Cost of Carbon. (2010). Social Cost of Carbon for Regulatory Impact Analysis. Interagency Working Group on Social Cost of Carbon. New York: United States Government.*

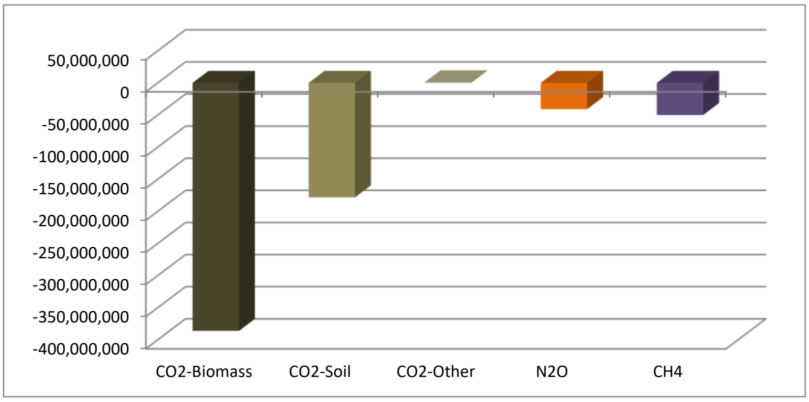
Carbon balance of the Forest Fire Response Project under a High CC scenario

Name of the project	Forest Fire Response Project		Climate	Boreal (Moist)				Duration (yr)	25		
Continent	Asia (Continental)		Soil	HAC Soils				Total area (ha)	108000000		
Component of the project	**Gross fluxes**			**Share per GHG of the Balance**					**Results per year**		
	Without	**With**	**Balance**	**Result per GHG**					**without**	**with**	**Balance**
	All GHG in tCO_2eq			**CO_2**			**N_2O**	**CH_4**			
	Positive = source / negative = sink			**Biomass**	**Soil**	**Other**					
Land Use Changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other	0	0	0	0	0		0	0	0	0	0
Agriculture											
Annual	0	0	0	0	0		0	0	0	0	0
Perennial	0	0	0	0	0		0	0	0	0	0
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestock	0	0	0				0	0	0	0	0
Degradation	4,755,990,748	4,100,846,439	-655,144,309	-386,100,000	-178,200,000		-40,836,873	-50,007,436	190,239,630	164,033,858	-26,205,772
Inputs & Investments	0	894,011	894,011			894,011	0		0	35,760	35,760
Total	4,755,990,748	4,101,740,449	**-654,250,298**	-386,100,000	-178,200,000	894,011	-40,836,873	-50,007,436	190,239,630	164,069,618	-26,170,012
Per hectare	44	38	-6	-3.6	-1.7	-0.4	-0.5	0.0			
Per hectare per year	1.8	1.5	-0.2	-0.1	-0.1	0.0	0.0	0.0	1.8	1.5	-0.2

In more detail the graph above shows that especially the results of biomass stock changes have been reduced. The net present value of the GHGs mitigation is estimated at US$ 712 million, when using a carbon market price of US$ 3 / tCO_2.

Analysing impacts by carbon pool shows that this strong CC scenario, has mostly a reduced impact in term of biomass stock generated when compared to the more optimistic CC scenario.

GHG Impacts by Carbon Pool and GHG



4.3 Incremental Natural Capital Generated

As a project that rehabilitates degraded forest areas and engages in fire forest protection, the FFRP improves landscape and watershed forest coverage improving landscape climate resilience capacity in areas affected by water stress and contributes to biodiversity conservation. It thus produces a set of benefits that are clearly distinct from their climate change mitigation achievements and are closely related to the incremental existence of additional biomass and reactivation of the ecosystem. While most of the benefits are of public nature, environmental resources and non-degraded natural capital may also provide an important source for income and food security.

The EX-ACT estimates related to changes in stocks of above ground biomass and below ground carbon also allow providing an estimation of changes in natural capital stocks as follows:

Incremental Natural Capital Generated through Project Implementation

	INCREMENTAL CAPITAL GENERATED BY THE PROJECT		
Project:	Forest Fire Response Project Russia		
	High CC scenario	**Units**	**Quantity** (units)
Area	108000000		
Duration:	25		
	Natural Capital		
Direct private value			
A01	Incremental accumulated SOC on cultivated land (soil fertility)	t C	-
A02	Incremental stocks of non-timber biomass	t dm	134,670,387
	Fuelwood and -material	t dm	11,222,532
	Fodder	t dm	11,222,532
	Anti-erosive watershed coverage	t dm	112,225,323
	Compost	t dm	-
A03	Incremental stocks of NTFP in forestry and agro-forestry		
Indirect private value			
A04	Incremental area with erosion protection	ha	-
A05	Incremental area with increased drought resilience	ha	-
Public value			
A09	Incremental timber stocks in forestry and agro-forestry	t dm	26,405,958
A10	GHG balance (reduced emissions and C sequestration)	t CO2-e	654,250,298
	Total natural capital		

The table above (here for the high CC scenario) illustrates how the project leads to an increase in tradable timber stocks of roughly around 26 mio t of dry matter due to the project, compared to 134 mio t of non-timber biomass valued mostly as anti-erosive watershed coverage over the full period of analysis of 25 years. Thereby the differentiation into further sub-components is based on assumptions.

Rehabilitation processes thus lead to important increases in biomass stocks with their multiple benefits.

When using instruments of environmental valuation, as e.g. willingness to pay, selected indicators can also be translated into monetary values: Valuing timber at 54 USD per cubic meter (after subtracting logging and transport costs) and thus utilizing the average between the higher European and lower US-American timber price[26], the over 25 years created incremental timber stocks have a net present value estimated at 504 mio USD.

The Total Economic value (TEV) of incremental natural capital generated on 25 years by the project aggregated impact ranges between 1.4 and 2.4 billion US$ of public value (value of

[26] *This price is very conservative when compared to export prices currently applied in the region: Russian timber exported to China and Japan ranging between US$ 131 and US$ 176 /m3 (source: http://whatwood.ru)*

high CC and limited CC scenarios) mostly due to Carbon Balance (45%) and incremental timber stocks (37%).

4.4 Return per dollar invested in FFRP

Within the objective to select projects that have the potential to maximize the total NPV of the capital budget, the profitability index (PI) is used to compare projects regarding the return on capital. Using the PI approach permits to maximize the increment in wealth per dollar invested. With a project cost of 121 million US$, considering the lower carbon price and a conservative estimate of timber value, the resulting NPV accounts for 1.4 to 2.4 billion US$. The profitability index per dollar of investment is thus between 10 and 20 dollar of incremental natural capital generated.

Within this project, the profitability index, i.e. NPV per dollar invested, underlines the high relevance of public investments for fire protection. It also illustrates the relevance of fire protection for private forest investments and opens a window for business opportunities in the case of access to carbon markets.

5. Bibliography

Ahmadi Karech H. (2013). *Comparison of Carbon sequestration quantity in Haloxylon aphyllum and Stipagrostis plumosa in Iran Desert Area.* World Applied Sciences Journal 21 (8): 1190-1193,.

Drakenberg. (2011). *Sida's Helpdesk for Environment and Climate Change Albania Policy brief.* Sida's Helpdesk for Environment and Climate Change.

FAO. (2010). *Global Forestry Ressource Assessment 2010 Country Report - Kazakhstan .* Roma: Forestry Department.

IEA. (2013). Retrieved from www.iea.org

IPCC. (2006). *Intergovernmental Panel on Climate Change – IPCC. IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme.*

Krylov V. (2004). *Rational Use of the Beneficial Properties of the Forest – the Basis for Conserving and Increasing Its Productivity.*

Lal, R. (2004). *Carbon Emission from Farm Operations.* . Environment International, v. 30, p. 981– 990.

Schillhorn-Van Veen et al. (2005). *Rangelands in Transition: The Resource, the Users and Sustainable Use.* Washington: World Bank Technical Paper No. 31384.

Sehring J. (2012). *Forests in the context of climate change in Kazakhstan - Working paper No 60.* Center for international Development and Environmental Research (ZEU).

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., et al. (2007). *Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report.* IPCC.

WOCAT. (2014). Saxaul plantation for stabilisation of sandy soils compiled by Firdavs Faizulloev,. WOCAT 2014.

World Bank. (2005). *"Forest Protection and Reforestation Project: Kazakhstan." World Bank Project Appraisal Document.* Washington, DC: World Bank.

World Bank. (2013). *Kazakhstan, Overview of Climate Change Activities.* World Bank Climate Change Knowledge Portal,.

Yesserkepova I. (2010). *Kazakhstan : Forests and Climate Change in Eastern Europe and Central Asia. Forests and Climate Change working paper.* FAO.

Annex 1: Data used in EX-ACT modules (optimistic scenario)

- **Land Use change Module**

Surfaces evolutions by land use / category (hectares - ha)		State at the beginning	Without Project	With Project
Forest/Plantation		108,000,000	108,000,000	108,000,000
	Annual	0	0	0
Cropland	Perennial	0	0	0
	Rice	0	0	0
Grassland		0	0	0
Other Land	Degraded	0	0	0
	Other	0	0	0
Organic soils		0	0	0
Total area =		108,000,000	108,000,000	108,000,000

- **Forest management module**

5.1. Forest degradation and management

Available AEZ: **1.Boreal coniferous forest - 2.Boreal tundra woodland - 3.Boreal mountain systems - 4.**

Type of vegetation that will be degraded	**Degradation level of the vegetation** Initial state	At the end without project	with project	**Fire occurrence and severity** Without (y/n)	Periodicity (year)	Impact (% burnt)	With (y/n)	Periodicity (year)	Impact (% burnt)	**Area (ha)** Start (ha)	Without (ha)	*	With (ha)	*	**Total En** (tCO Without
Forest Zone 1	Low	Moderate	Very low	YES	1	0.80%	YES	1	0.3%	10,000,000	10,000,000	D	########	D	81,924,630
Forest Zone 1	Low	Moderate	Low	YES	1	0.80%	YES	1	0.7%	98,000,000	98,000,000	D	########	D	802,861,370
Select the vegetation	Select level	Select level	Select level	NO	1	0%	NO	1	0%	0	0	D	0	D	0
Select the vegetation	Select level	Select level	Select level	NO			NO			0	0	D	0	D	0
Select the vegetation	Select level	Select level	Select level	NO			NO			0	0	D	0	D	0
Select the vegetation	Select level	Select level	Select level	NO			NO			0	0	D	0	D	0

* Note concerning dynamics of change : **D correspond to "Default"**, "I" to Immediate and "E" to Exponential (Please refer to the Guidelines)

Tier 2

scenario of low increase in fire recurrency

Total area fired per year: 864000 (without), 716000 (with)

Total forest degradation: 884,786,000

- **Input and energy module**

6.2 Energy consumption (electricity, fuel,...)

Description and unit to report	Quantity consumed per year Start	Without	*	With	*		**Total Emissions** (tCO2-eq) Without	With	**Balance**
Electricity (MWh per year)									
Please select the country of origin	0	0	D	0	D		0	0	0
Liquide or gaseous (in m³ per year)									
Gasoil/Diesel	0	0	D	1780	I	1,792	0	117,161	117,161
Gasoline	0	0	D	0	D		0	0	0
Gas (LPG/ natural)	0	0	D	0	D		0	0	0
Butane	0	0	D	0	D		0	0	0
Propane	0	0	D	0	D		0	0	0
Ethanol	0	0	D	0	D		0	0	0
User defined (Tier 2):	0	0	D	0	D		0	0	0
Solid (in tonnes of dry matter per year)									
Wood	0	0	D	0	D		0	0	0
Peat	0	0	D	0	D		0	0	0
Total from energy							0	117,161	117,161

* Note concerning dynamics of change : **D correspond to "Default"**, "I" to Immediate and "E" to Exponential (Please refer to the Guidelines)

Tier 2

6.3 Construction of new infrastructure for the project (irrigation systems, buildings, roads)

Description and unit to report	Surface concerned Without	With		**Total Emissions** (tCO_2-eq) Without	With	**Balance**
Irrigation systems (total in ha)						
Solid set sprinkle	0	0		0.0	0.0	0.0
Please select	0	0		0.0	0.0	0.0
Buildings and roads (total in m²)						
Garage (concrete)	0	10000	100 m2 of garage per fire brigade	0.0	6,560.0	6,560.0
Offices (concrete)	0	10000	100m2 of office per fire brigade	0.0	4,690.0	4,690.0
Road for medium trafic (concrete)	0	2400000	600 km of forest roads	0.0	765,600.0	765,600.0
Please select	0	0		0.0	0.0	0.0
Please select	0	0		0.0	0.0	0.0
Please select	0	0		0.0	0.0	0.0
Please select	0	0		0.0	0.0	0.0
Total from construction				0	776,850	776,850

Tier 2

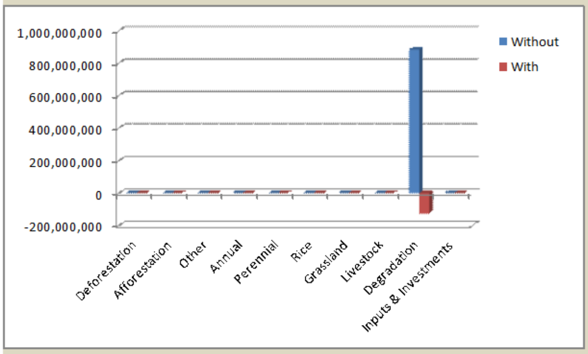
Annex 2: List of experts and scientists involved in 2011 and 2014 appraisals

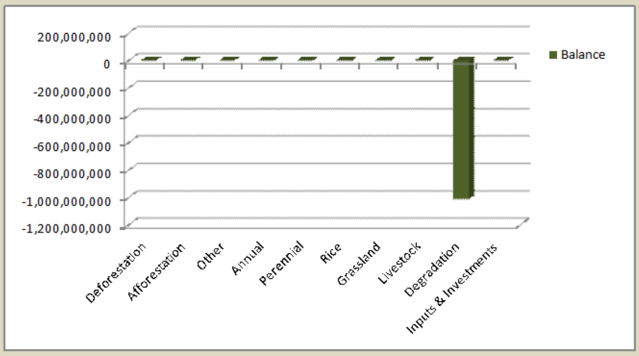
Name/Имя	Position/Должность
1. **VORFOLOMEEV Vladimir V.**	**Unit Manager, Analytical Unit, International Department, Roslesinforg, Federal Forestry Agency** **Начальник аналитического отдела Департамента международной деятельности ФГУП «Рослесинфорг»**
2. **KUZMICHEV Evgeniy P.**	**Consultant, Project Team, Forest Fire Responses Project** **Консультант проектной группы проекта «Реформирование лесоуправления и меры по борьбе с лесными пожарами в России»**
3. **SHUKTOMOV Evgeniy Yu.**	**Project Consultant Team Manager, Forest Fire Responses Project** **Руководитель группы проектных консультантов проекта «Реформирование лесоуправления и меры по борьбе с лесными пожарами в России»**
4. **KATKOV Dmitriy M.**	**Forest Project Economic Assessment Expert** **Эксперт по экономической оценке проектов в лесном секторе**
5. **TUZOV Vasiliy K.**	**Deputy Director, Russian Forest Health Centre** **Заместитель директора ФБУ «Рослесозащита»**
6. **BABURINA Aleksandra G.**	**Unit Manager, Analytical Unit, Russian Forest Health Centre** **Начальник информационно-аналитического отдела ФБУ «Рослесозащита»**
7. **SERGEEV Valentin I.**	**Senior Specialist of the First Category, Legal Department, Federal Forestry Agency** **Старший специалист первого разряда Правового управления Рослесхоза**
8. **KONSTANTINOV Artyom V.**	**Deputy Director, St-Petersburg Forestry Research Institute** **Заместитель директора ФБУ «СПбНИИЛХ»**
9. **ZIMINA Elena A.**	**Deputy Unit Manager, Department of Science, Education and International Cooperation, FFA** **Заместитель начальника отдела Управления науки, образования и международного сотрудничества, Рослесхоз**
10. **EVLANOVA Elena V.**	**Consultant to the Department of Finance, Budget Policy and Payment Administering, FFA** **Консультант Управления финансов, бюджетной политики и администрирования платежей, Рослесхоз**
11. **GRIGORYAN Armen R.**	**Consultant to the Ministry of Natural Resources and the Environment of the Russian Federation** **Консультант (Минприроды России)**
12. **Krutsko Yana**	**Department of Economics and Finance of the Ministry of Natural Resources and the Environment of the RF** **Сотрудник Департамента экономики и финансов Минприроды России.**
13. **Nemova Vladislava**	**Environmental Specialist, World Banks Moscow Office**
14. **Marina Smetasnina**	**World Bank expert Workshop Organiser**
15. **Anna Eremonko**	**World Bank, Moscow**
16. **Elena Kulikova**	**WWF, Russia**
17. **Olga Khlebinskaya**	**International Finance Corporation**
18. **Olga Khoreva**	**Russian Academy of Public Administration**
19. **Vladimir Berdin Qun Li**	**World Bank, Moscow**
20. **Andrew Mitchell**	**Forestry Specialist, World Bank**
21. **Ron Hoffer**	**World Bank Environment for Europe and Central Asia**
22. **Professor Boris N. Moiseev**	**Soil Specialist Director of the Forest Institute of Agricultural Sciences**

Annex 3: Framework of results: Low temperature increase/ optimistic CC scenario

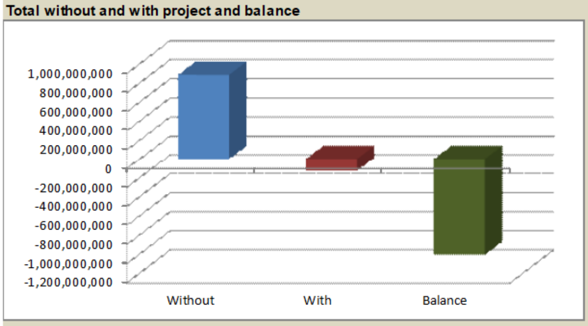
Name of the project	Forest Fire Response Pro	Climate	Boreal (Moist)	Duration (yr)	25
Continent	Asia (Continental)	Soil	HAC Soils	Total area (ha)	108000000

Component of the project	Gross fluxes: Without	With	Balance	Share per GHG of the Balance / Result per GHG: CO_2 Biomass	CO_2 Soil	CO_2 Other	N_2O	CH_4	Results per year: without	with	Balance
	All GHG in tCO_2eq										
	Positive = source / negative = sink										
Land Use Changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other	0	0	0	0	0		0	0	0	0	0
Agriculture											
Annual	0	0	0	0	0		0	0	0	0	0
Perennial	0	0	0	0	0		0	0	0	0	0
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestock	0	0	0				0	0	0	0	0
Degradation	884,786,000	-126,520,203	-1,011,306,203	-684,684,000	-316,008,000		-4,771,360	-5,842,844	35,391,440	-5,060,808	-40,452,248
Inputs & Investments	0	894,011	894,011			894,011	0		0	35,760	35,760
Total	884,786,000	-125,626,193	**-1,010,412,193**	-684,684,000	-316,008,000	894,011	-4,771,360	-5,842,844	35,391,440	-5,025,048	-40,416,488
Per hectare	8	-1	-9	-6.3	-2.9	0.0	-0.1	0.0			
Per hectare per year	0.3	0.0	-0.4	-0.3	-0.1	0.0	0.0	0.0	0.3	0.0	-0.4

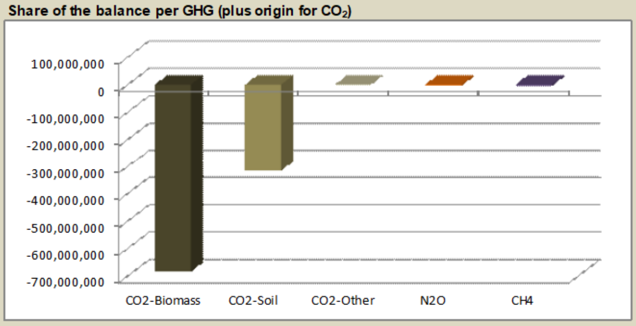




Total without and with project and balance



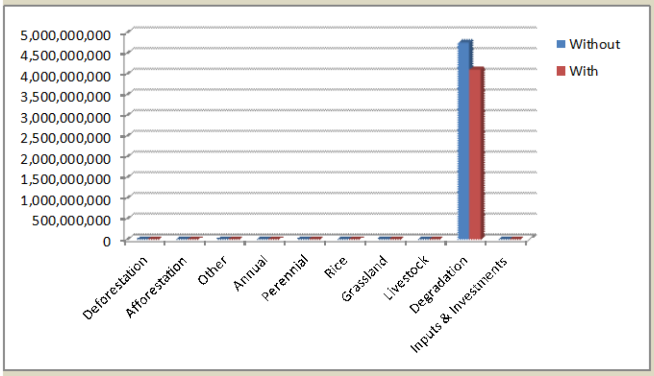
Share of the balance per GHG (plus origin for CO_2)

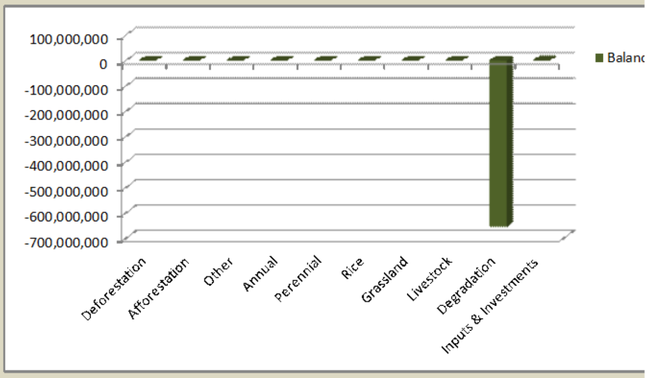


Annex 4: Framework of results: High temperature growth / pessimistic CC scenario

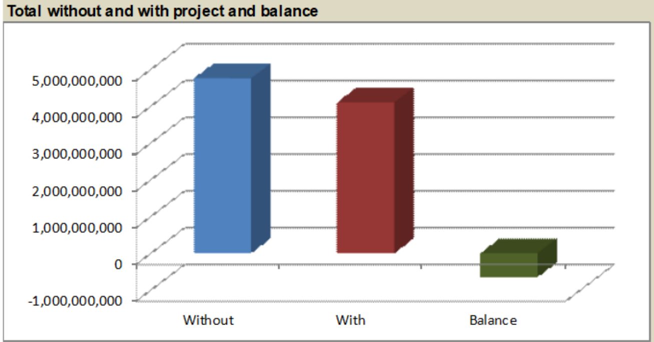
Name of the project	Forest Fire Response Projec	Climate	Boreal (Moist)	Duration (yr)	25
Continent	Asia (Continental)	Soil	HAC Soils	Total area (ha)	108000000

Component of the project	Gross fluxes Without	With	Balance	Share per GHG of the Balance / Result per GHG: CO_2 Biomass	CO_2 Soil	CO_2 Other	N_2O	CH_4	Results per year without	with
	All GHG in tCO_2eq									
	Positive = source / negative = sink									
Land Use Changes										
Deforestation	0	0	0	0	0		0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0
Other	0	0	0	0	0		0	0	0	0
Agriculture										
Annual	0	0	0	0	0		0	0	0	0
Perennial	0	0	0	0	0		0	0	0	0
Rice	0	0	0	0	0		0	0	0	0
Grassland & Livestocks										
Grassland	0	0	0	0	0		0	0	0	0
Livestock	0	0	0				0	0	0	0
Degradation	4,755,990,748	4,100,846,439	-655,144,309	-386,100,000	-178,200,000		-40,836,873	-50,007,436	190,239,630	164,033,858
Inputs & Investments	0	894,011	894,011			894,011	0		0	35,760
Total	4,755,990,748	4,101,740,449	**-654,250,298**	-386,100,000	-178,200,000	894,011	-40,836,873	-50,007,436	190,239,630	164,069,618
Per hectare	44	38	-6	-3.6	-1.7	-0.4	-0.5	0.0		
Per hectare per year	1.8	1.5	-0.2	-0.1	-0.1	0.0	0.0	0.0	1.8	1.5

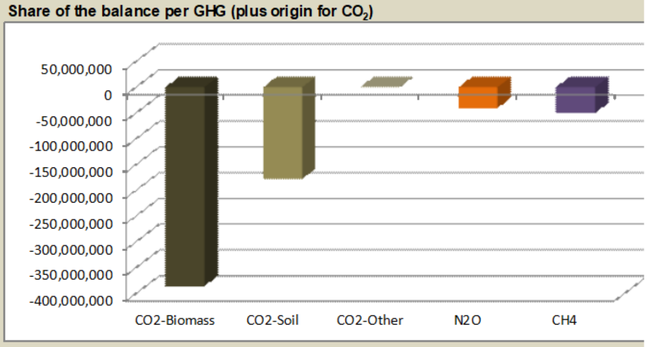




Total without and with project and balance



Share of the balance per GHG (plus origin for CO_2)



Annex 3: Tentative impact estimate of the FFRP project on Natural Capital (Incremental Economic Value)

INCREMENTAL CAPITAL GENERATED BY THE PROJECT						
Project:	Forest Fire Response Project Russia					
	low temp increase CC scenario	**Units**	**Quantity** (units)	**Economic price (US$)**	**Estimated total Value (US$)**	
Area	108000000					
Duration:	25					
	Natural Capital					
Direct private value						
A01	Incremental accumulated SOC on cultivated land (soil fertility)	t C	-	$ 11.37	$ -	(i)
A02	Incremental stocks of non-timber biomass	t dm	238,815,487			(ii)
	Fuelwood and -material	t dm	19,901,291	$ 5.00	$ 99,506,453	5%
	Fodder	t dm	19,901,291	$ 5.00	$ 99,506,453	5%
	Anti-erosive watershed coverage	t dm	199,012,905	$ 1.00	$ 199,012,905	50%
	Compost	t dm	-	$ 5.00	$ -	0%
A03	Incremental stocks of NTFP in forestry and agro-forestry					
Indirect private value						
A04	Incremental area with erosion protection	ha	-	$ 94.80	$ -	(iii)
A05	Incremental area with increased drought resilience	ha	-	$ 11.70	$ -	(iv)
Public value						
A09	Incremental timber stocks in forestry and agro-forestry	t dm	46,826,566	$ 52.63	$ 894,834,976	(v)
A10	GHG balance (reduced emissions and C sequestration)	t CO2-e	1,010,412,193	$ 3.00	$ 1,100,586,229	(vi) npv
	Total natural capital				**$ 2,393,447,016**	
	(i) 1.18 USD/t SOC per year discounted over 20 years (wander Nissen 2013)					
	(ii) differentiating potential uses: fuelwood, fodder, .. At opportunity prices (Bajcain Shakya 2005)				0.373868722	
	(iii) based on cost of soil erosion of 1.32 USD/ton (Acharya 2010)					
	(iv) based on willingness to pay 2 US$/ha / year discounted on 8 years					
	(v) timber price derived from international market USD 52.63 per t of timber using European price and US price in 2012 US$ 50 /m3 average divided by 0.57 density - 12 US$ o					
	(vi) either carbon market (3 US$/T) or US Interagency on social cost of carbon in 2013 (21 USD) Eco value computed as NPV (higher value to quick GHG reductions)					

INCREMENTAL CAPITAL GENERATED BY THE PROJECT						
Project:	Forest Fire Response Project Russia					
	High CC scenario	**Units**	**Quantity** (units)	**Economic price (US$)**	**Estimated total Value (US$)**	
Area	108000000					
Duration:	25					
	Natural Capital					
Direct private value						
A01	Incremental accumulated SOC on cultivated land (soil fertility)	t C	-	$ 11.37	$ -	(i)
A02	Incremental stocks of non-timber biomass	t dm	134,670,387			(ii)
	Fuelwood and -material	t dm	11,222,532	$ 5.00	$ 56,112,661	5%
	Fodder	t dm	11,222,532	$ 5.00	$ 56,112,661	5%
	Anti-erosive watershed coverage	t dm	112,225,323	$ 1.00	$ 112,225,323	50%
	Compost	t dm	-	$ 5.00	$ -	0%
A03	Incremental stocks of NTFP in forestry and agro-forestry					
Indirect private value						
A04	Incremental area with erosion protection	ha	-	$ 94.80	$ -	(iii)
A05	Incremental area with increased drought resilience	ha	-	$ 11.70	$ -	(iv)
Public value						
A09	Incremental timber stocks in forestry and agro-forestry	t dm	26,405,958	$ 52.63	$ 504,606,189	(v)
A10	GHG balance (reduced emissions and C sequestration)	t CO2-e	654,250,298	$ 3.00	$ 712,638,737	(vi) npv
	Total natural capital				**$ 1,441,695,571**	
	(i) 1.18 USD/t SOC per year discounted over 20 years (wander Nissen 2013)					
	(ii) differentiating potential uses: fuelwood, fodder, .. At opportunity prices (Bajcain Shakya 2005)					
	(iii) based on cost of soil erosion of 1.32 USD/ton (Acharya 2010)					
	(iv) based on willingness to pay 2 US$/ha / year discounted on 8 years					
	(v) timber price derived from international market USD 52.63 per t of timber using European price and US price in 2012 US$ 50 /m3 average divided by 0.57 density - 12 US$					
	(vi) either carbon market (3 US$/T) or US Interagency on social cost of carbon in 2013 (21 USD) Eco value computed as NPV (higher value to quick GHG reductions)					