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EASYPol Module xxx

Carbon Balance pre-appraisal on the WWF Bikin Forest Conservation Project

Application at a design stage of the *EX-Ante* C-balance Tool (EX-ACT version 3.3)

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WWF Bikin Forest Conservation Project

Application at a design stage of the EX-Ante C-balance Tool (EX-ACT version 3.3)

by

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, FAO

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TABLE OF CONTENTS

TABLE OF ABBREVIATIONS

AFOLU	Agriculture, Forest 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
GHG	Green House Gas
GWP	Global Warming Potential
HAC	High Activity Clay
IPCC	Intergovernmental Panel on Climate Change
LAC	Low Activity Clay
MRV	Monitoring, Reporting and Verification
Mt	Million metric tons
N_2O	Nitrous Oxide
tCO_2-e	Ton of CO2 equivalent
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wide Fund

1. Introduction

Objectives

This paper identifies and interprets the main impacts of climate change mitigation, with the Ex-Ante Carbon Balance Tool (EX-ACT), on the WWF Bikin Forest Conservation Project (BFCP). The analysis is based upon past reports, data and opinions from experts. It is nonetheless important to highlight the fact that this is an example of how a carbon balance can be performed on a forestry project. It is hence not a real case study. The paper primarily describes EX-ACT (Ch. 2), followed by the country and the WWF BFCP background (Ch. 3). Further, chapter 4 presents the assumptions behind the analysis. Chapter 5 illustrates the results of the EX-ACT analysis followed by an economic analysis based on the carbon balance results. Chapter 6 concludes the paper.

Target audience

This document particularly aims at current or future practitioners working on the formulation and analysis of investment projects and climate change issues. It also targets workers in public administrations, NGO's, professional organizations or consulting firms. Academics can also find this material useful to support their courses in carbon balance analysis and development economics.

Required background

To fully understand the content of this document the user must be familiar with:
- Concepts of climate change mitigation and adaptation;
- Concepts of land use planning and management

Readers can follow links included in the text to other EASYPol modules or references[1]. See also the list of EASYPol links included at the end of this module[2].

[1] EASYPol hyperlinks are shown in blue, as follows:

a) training paths are shown in **underlined bold font**
b) other EASYPol modules or complementary EASYPol materials are in ***bold underlined italics***;
c) links to the glossary are in **bold**; and
d) external links are in *italics*.

[2] This module is part of the EASYPol Resource Package: Macroeconomic, agricultural, trade and development policy, module1: macroeconomics and instrument of protection.

2. The EX-Ante Carbon-balance Tool (EX-ACT)

EX-ACT is a tool developed by FAO. The tool is aimed at providing ex-ante estimates of the impact of agriculture and forestry development projects/policies/programmes on GHG emissions and carbon sequestration. (Bernoux et al., 2010). The C-balance[3] is selected as indicator of the mitigation potential of the project/policy/programme. EX-ACT can be used in the context of ex-ante project formulation and has the ability to cover a range of projects relevant for the land use, land use change and the forestry sector. It can compute the C-balance by comparing different scenarios: “without project”, i.e. the “Business As Usual” or “Baseline” and “with project”. The main output of the tool consists of the C-balance resulting from the difference between the “with project” minus the “without project” scenario.

EX-ACT was developed mainly using the Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) complemented with other methodologies. Most calculations in EX-ACT use a Tier 1 approach[4] (Bernoux et al., 2010). This, as default values are proposed for each of the five pools[5] defined by the Intergovernmental Panel on Climate Change (IPCC) guidelines and the United Nations Framework Convention on Climate Change (UNFCCC). EX-ACT also allows users to incorporate specific coefficients with the Tier 2 approach from e.g. the project area, in case they are available. EX-ACT measures carbon stocks and stock changes per unit of land, as well as Methane (CH_4) and Nitrous Oxide (N_2O) emissions expressing its results in tons of Carbon Dioxide equivalent per hectare ($tCO_2eq.ha^{-1}$) and in tons of Carbon Dioxide equivalent per year ($tCO_2eq.year^{-1}$).

EX-ACT consists of a set of Microsoft Excel sheets in which project designers insert information on dominant soil types and climatic conditions of project area together with basic data on land use, land use change and land management practices foreseen under projects’ activities as compared to a business as usual scenario (Bernoux et al., 2010).

[3] C-balance = GHG emissions -carbon sequestered above and below ground.
[4] IPCC Guidelines provide three methodological tiers varying in complexity and uncertainty level: Tier1, simple first order approach which uses data from global datasets, simplified assumptions, IPCC default parameters (large uncertainty); Tier 2, a more accurate approach, using more disaggregated activity data, country specific parameter values (smaller uncertainty); Tier 3, which makes reference to higher order methods, detailed modeling and/or inventory measurement systems driven by data at higher resolution and direct measurements (much lower uncertainty).
[5] Above-ground biomass, below-ground biomass, soil, deadwood and litter

3. Background

3.1 Forests in Far East Russia

According to MARF (2009), Russia is the largest country in the world (17 million square km or 1.7 billion ha) and has the largest area of closed forests (7.6-7.7 million square km or 0.76-0.77 billion ha). The latter represents 22 percent of the world's forests. More recently, the Russian Federation defined a Forest Land Fund: according to the Legislation, this category of land includes forest and non-forest land. Forestland includes parcels that are covered with forest vegetation (forested land) and parcels that are not covered with forest vegetation, but are meant for the forest restoration, e.g. clear cuts and burns. Non-forest land also includes land serving for the forest management, such as roads and rides for instance.

These intact forests are arranged in large arrays. (MARF, 2009). 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)*.

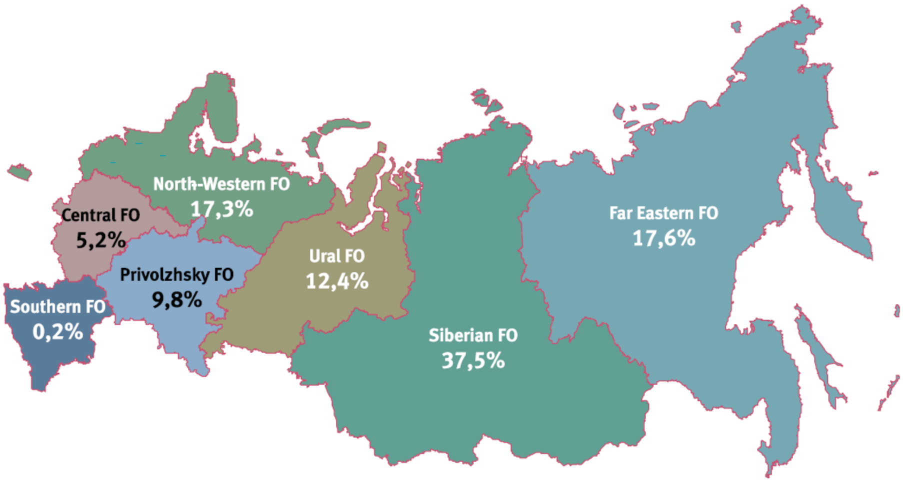

Figure 1. Distribution of forest resources among regions, % of total biomass stock (MARF, 2009)

The project is located in the province of Primorsky in the Russian Far East, bordering China and North Korea *(cf. figure 2)*. The project area is itself located in the middle portion of the Bikin river in the Pozharskii District of the Primorskii Province. The Bikin area is one of the last intact, large scale watersheds not only in the Russian Far East but also in the Northern Hemisphere. Especially the middle and upper reaches of the Bikin River are dominated by mature and virgin temperate coniferous broadleaved forests, which have a particularly high concentration of rare and relict plants. This is the only large scale forest left of the once widespread Ussury taiga. The nomination as a candidate to become a World Heritage Site for natural values reflects the global importance of the project area (GFA ENVEST-WWF[6], 2011).

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[6] *GFA ENVEST, 2011. Gmbh, Bikin Tiger Carbon Project, Permanent protection of otherwise logged Bikin Forest in Primorye, Russia, CBB documentation, WWF, 2011*

Figure 2 gives an idea of where the Bikin Nut Harvesting Zone (NHZ) is. ***The Bikin Nut Harvesting Zone*** features a forest cover of 99%. The main woody species are Korean pine (*Pinus koraiensis*) – 44%, Ajan spruce (*Picea ajanensis*) - 38%, yellow birch (*Betula mandshurica*) – 9%, larch (*Larix Gmelinii*) – 4%, white birch (*Betula alba L.*) – 3%. The most popular are mixed shrubby cedar woodlands with yellow birch (*Betula mandshurica*) and cedar-firry forests with yellow birch (*Betula mandshurica*) and Amur linden (*Tilia amurensis*). Forests with cedar domination usually are less than 600 m above sea level. Firspruce forests occupy the upper parts of slopes, watersheds and upper parts of rivers and spring basins, with mid-level stand quality along Nut Harvesting Zones. Cedar woodland is more productive with mid-level stand quality. Spruce forests of the upper altitudinal mountain zone represent poor stands.
Middle-aged forest stands dominate (43%) in Nut Harvesting Zones, which include cedar woodlands of III-V age class and other woodlands of II-VI age class. Ripening woodlands occupy 26%, mature 28%, old growth 1% of the area (GFA ENVEST-WWF, 2011).

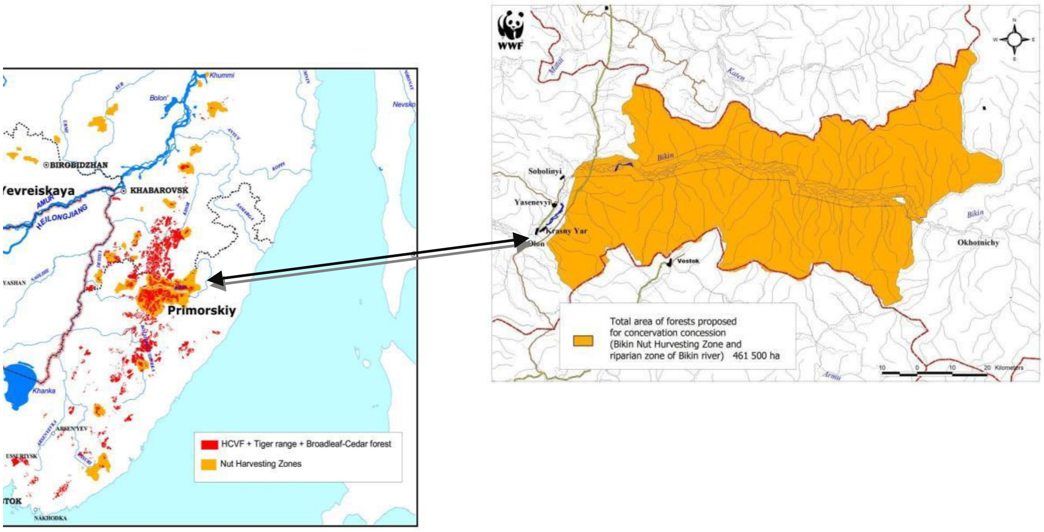

Figure 2: Location of the Bikin NHZ in the Russian Far East

3.2 WWF Bikin Forest Conservation Project (BFCP) description

The WWF BFCP has the following objectives:

- Protect the project area from logging operations
- Contribute to climate change mitigation as a result of reducing emissions from logging
- Development of a carbon finance concept for nature conservation which may serve as lighthouse project/blueprint for similar project activities
- Conservation of the unique biodiversity of the project area including the conservation of Korean Pine stands and preservation of the Siberian Tiger habitat and its main prey, the wild hog.
- Support of the Udege population in the collection and commercialization of NTFPs.

HTTPS://S3.AMAZONAWS.COM/CCBA/PROJECTS/BIKIN_TIGER_CARBON_PROJECT/WWF_BIKIN_CCBDOCUMENTATION_FINAL+DRAFT+F%C3%BCR+T%C3%BCV%5B1%5D.PDF

The proposed project will conserve a unique ecosystem. The project features a share of 43.9% of dominant Korean Pine stands. These mixed broadleaf forests are the major habitat of the Siberian tiger and its prey. Protecting the project area from logging will grant this very impressive animal an intact and untouched habitat in the very long run.

The KfW Bankengruppe, WWF Germany and WWF Russia Amur Branch are implementing the proposed project with the financial support of the German Ministry for Environment (BMU). The project is financed under BMU's International Climate Initiative (ICI) with the specific project title '*Protecting large scale virgin forests in the Bikin area of the Russian Far East to mitigate climate change impacts*'.

The Siberian Tiger is listed in the International Union for Conservation of Nature (IUCN) at the Red List of Threatened Species and the Russian Red Book (IUCN, 2008). The main prey of the Siberian Tiger is wild hog, whose population in the Bikin area is stable even in bad cedar nut crop years, due to the abundance of Dutch-rush. According to the annual monitoring data, the average density per tiger is 0.58 per 100 square km (from 0.29 to 0.97). Around 400 Amur tigers survive in the native Korean pine forests of the Russian Far East and north-east China, where the pine nuts are an essential food source for tiger prey species *(cf. figure 3)*.

Within the context of the WWF BCFP there are different foreseen actions, linked to the preservation of the Siberian Tiger and its main prey. Among the linked actions foreseen, there are: (i) amend the forest legislation to protect Korean pine and oak trees; (ii) amend laws to provide economic incentives to increase prey populations; (iii) establish ecological corridors to connect protected areas in key Amur tiger habitats; (iv) expand the area of the existing nature reserves and national parks in the Amur tiger range; (v) establish protection zones with restricted natural resource use on land adjacent to Protected areas (PA); (vi) provide incentives to PA staff by increasing salaries and supplying needed equipment.

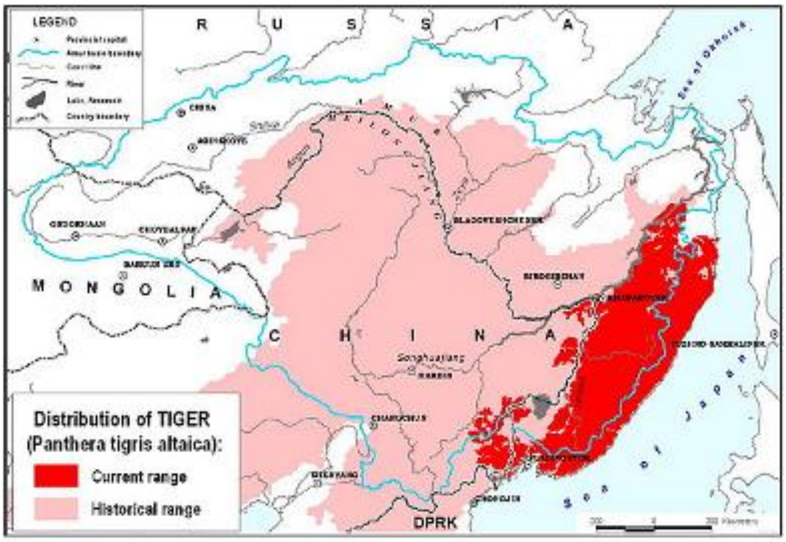

Figure 3. Current and historical range of the Siberian Tiger

4. Structure and basic assumptions of the analysis

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, end of 2010. Further, the analysis was based upon past reports all referred in the bibliography.

4.1 Fixed parameters of the carbon appraisal

In order to appraise the carbon balance of the BCFP, 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 in the EX-ACT tool.

Accordingly, the soil was classified as **High Activity Clay** (HAC) and the average climate is **Boreal** with a **dry** moisture regime. The timeframe of the analysis is **30 years**. In the analysis it is assumed that the implementation phase lasts 10 years, thus the capitalisation is set to 20 years. *(Cf. figure 4)*.

Regarding the Global Warming Potential (GWP) coefficients[7], 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.

Description of the project

Project Name	*WWF Bilkin Project*	
Continent	Asia (Continental)	
Climate	Boreal	
Moisture regime	Dry	
	See "Climate" for Help	
Dominant Regional Soil Type	HAC Soils	
	See "Soil" for Help	
Duration of the Project (Years)	Implementation phase	10
	Capitalisation phase	20
	Duration of accounting	30

GWP (choose values)	
Official-CDM	
CO_2	**1**
CH_4	**21**
N_2O	**310**

Figure 4: Description of the WWF BCFP

4.2 Assumptions for the forest degradation project scenarios

In terms of total carbon stocks based on Bikin Inventories, the project area comprises 31.6 million tC or 115.7 million tCO_2, respectively, with average carbon stocks of 69.2 tC/ha or 254.0 tCO_2/ha. (GFA Envest, 2011). The Tier 2 figure is divided between above ground biomass (37.6 tC) and below ground biomass (15 tC), with a litter coefficient of 5 tC, 12 tC for dead wood. High soil content was also entered with a Tier 2 approach (100 tC). Figure 5 shows the forest characteristics (second line, "Bikin

[7]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.

Forest”) as compared to the Tier 1 approach. The module used in EX-ACT is forest degradation.

:ation proposed within the		Suggested Default Values per hectare (/ha) for corresponding non-degraded forest					
		Above-Ground Biomass		Below-Ground Biomass		Litter	Dead Wood
Ecological Zone	Go to Map	tonnes dm	t C	tonnes dm	t C	t C	tC
Boreal coniferous forest		50	23.5	19.5	9.2	28	0
fill the information ->	Bilkin Forest	79.9	37.553	31	15	5	12
	Specific Vegetation 2	0	0	0	0	0	0
	Specific Vegetation 3	0	0	0	0	0	0
	Specific Vegetation 4	0	0	0	0	0	0

Figure 5: Bikin forest characteristics, Tier 1 versus Tier 2 approach

The assumptions for the evolution of forest degradation and the link to the evolution of fire occurrence have been entered as shown in the module *(cf. figure 6).* Presently, the fire occurrence affects 20% of the area every year. Hence, the forest areas are currently degraded at 20%. Without project, it was assumed that fire would contribute to further degradation of the forest area, rising up to 40%. It was hypothesized that with the project, fire will occur every 5 years rather than each year covering the same area. This would reduce forest degradation by 10%. Such analysis shows the differences in biomass carbon and soil carbon in the three situations, i.e. initial, without project and with project.

Sequence Type	Vegetation Type concerned	Initial State		Final State Without Project				
		Degradation		Degradation		Fire		
		Level	%	Level	%		Interval (year	Rate (%)
Veget.7	Bilkin Forest	Low	20	Moderate	40	YES	1	20
Veget.8	Specific Vegetation 2	Select level	0	Select level	0	NO	1	25
Veget.9	Specific Vegetation 3	Select level	0	Select level	0	NO	1	25
Veget.10	Specific Vegetation 4	Select level	0	Select level	0	NO	1	25

Final State WithProject					Biomass			Soil (variation in 20 yrs)			Delta C Soil*		Emissions par les feu sur la période com					
													Sans Projet			Avec Projet		
Degradation		Fire			Initial	Without	With	Initial	Without	With	Without	With	CH4	N2O	Total	CH4	N2O	Total
Level	%		Interval (year)	Rate (%)	tC	tC	tC	tC	tC	tC	tCO2	tCO2	kg	kg	CO2 eq	kg	kg	CO2 eq
Very low	10	YES	5	20	55.4	41.5	62.3	90.0	55.4	65.7	-6.4	-4.4	409.1	22.6	**15.6**	129.4	7.2	**4.9**
Select level	0	NO	1	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	**0.0**
Select level	0	NO	1	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	**0.0**
Select level	0	NO	1	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	**0.0**

*looses (négative value) and gain (positive value) for soil per

Figure 6: Evolution of fire occurrence using the Forest degradation module in EX-ACT

As a result, table 1 illustrates the carbon balance results for the forest degradation activity with and without the project. The area concerned is 400,000Ha and based upon the management practises from figure 6, the results show a net sink of approximately 50 million tons of CO_2eq that are reduced as a result of improved management practices.

Table 1: Net Carbon Balance results for the forest degradation module

	Total Balance per scenario		**Difference**
	Without project t CO_2eq	***With project tCO_2eq***	
Bikin Forest	77,348,535	27,408,301	**-49,940,234**

4.3 Data entry of fuel kerosene consumption and building investments

Due to the lack of information on project expenses linked to fire controls, some data have been extrapolated from other similar projects in Far East Russia[8]. For fire controls, brigades are created. A fire brigade is a team of fire fighters trained and equipped, provided with mobility means in order to ensure fire control and prevention on a forest area of 200 to 800 km^2. Assuming that every mobilized local fire brigade covers around 250 km^2, there should be 16 brigades of 5-10 volunteers and professionals to cover the full 400,000ha area. It is further strengthened with one 4x4 vehicle or a van and a few lighter vehicles or conveyance, e.g. one motorcycle and two horses.

Figure 8: Fire-fighting team equipped with high-pressure air blowers (source: WCS, 2010)

Every brigade will need a budget to fund regular control field trips in the controlled areas, (200 km per day*150 days per year)= 30,000 Km per year or 3,000 litres of fuel per brigade, hence (3,000*16)=48,000 litres. Helicopter control support attributed to every brigade was estimated to 4 hours per week, with 96 litres of kerosene per hour of flight, 20 weeks per year ((4*96*20 weeks)=7,680 litres of kerosene)*16 brigades=122,880 litres.

Fire-fighting equipment is also used. Those are high-pressure air-blowers with an additional consumption of (2,000 litres per year per brigade*16) =32,000 litres. The gasoil and diesel consumption is computed over a 20 years period, i.e. project period.

In total this is ((48,000+122,880+32,000)=202,880*20)=4,057,600 litres. In m^3, this then becomes a total of 4,057 m^3, assuming a density of 1 *(Cf. table 2).* There is equally a need of an office and garage building of 200 m^2 per brigade, of which 100m^2 of office and 100m^2 of garage. Therefore, there are (200m^2*16)=3,200m^2 of surface required. The information was inserted in the investment module concerning fuel consumption and buildings.

Table 2: Released GHG emissions from fuel consumption and buildings

	Gasoil/Diesel	Associated tCO_2eq
Without project	0	0
With project	4057	10,681
	m2	**Associated tCO_2eq**
Without project	0	0
With project	3,200	1,800
TOTAL (t CO_2eq)		**12,481**

In addition, based on 16 brigades with two horses per brigade, this makes a total number of (16*2)= 32 horses. This information should be inserted in the EX-ACT

[8]WCS, Russia, Fire control in Southwest Primoyre in the Russian Far East – Joined project of the Wildlife conservation Society and the Slavyanka Municipal Government, December 2010

livestock module (cf. table 3). In total, with the project, 247 t CO_2eq in emitted with 32 horses.

Table 3: CO_2 emissions released as a result of 32 horses with the project

	Number	**T CO_2eq**
Horses	32	247

5. Final results of carbon balance for the project

5.1 Final carbon balance

The project results is a net sink of approximately 50 million tons of CO_2eq, which also presents the additionally of the project as compared to the baseline *(cf. table 4)*. The result per Ha over 30 years is -125 tons. 8.6 t of C is sequestered per Ha per year during the implementation phase and 1.9 t of C during the capitalization phase. This amount corresponds to avoided losses of biomass (-30 Mt CO_2) and soil organic matter (-15 Mt CO_2) followed by the avoided N_2O and CH_4 emissions as a result of burning (1.9 and 2.3 Mt CO_2 equivalents).

It is possible to observe from table 4 that the proposed improvements with the project scenario concerning the forest degradation activities, i.e. reduced burning/fires, generates less emissions as compared to the baseline scenario, illustrated in table 1. The improvements in forest degradation also compensates for the necessary investments. In that sense, the decreased fires show the importance of finding a balance between climate change mitigation and the incorporation of preventive measures, i.e. deforestation/firebreaks, as well as capacity building, i.e. investment in infrastructure, vehicles and human capital. This type of analysis can also be linked to an increased resilience of eco-systems as a result of gain in the biomass and soil stocks.

Table 4: Carbon balance results for the WWF BCFP

Components of the project	**Carbon Balance (With project – Baseline) in tCO_2eq**
Forest degradation	-49,940,233
Livestock	575
Other investments	12,481
Total Carbon Balance	**-49,927,177**
Results per Ha	*-124.8*
Results per gas: • *Biomass (CO_2)* • *Soil (CO_2)* • *N_2O* • *CH_4*	 *-30,434,933* *-15,233,707* *-1,918,830* *-2,349,706*

5.2 Uncertainty of results

The level of uncertainty of the appraisal is relatively low, estimated at 19%. It is essentially as a result of Tier 2 data applied in the analysis and the focus on forestry modules for which, IPCC considers lower levels of uncertainty *(cf. figure 9)*. The ** illustrates an uncertainty level of 20% and the * shows an uncertainty level of 10%. This can be found in the carbon balance module of EX-ACT beneath the balance results table.

Indication of the level of uncertainty expected

Components of the Project	Main approach used	CO2 Biomass	CO2 Soil	N2O	CH4	CO2 Biomass	CO2 Soil	N2O	CH4
Deforestation	Tier 1	***	****	**	**	0	0	0	0
Forest Degradation	Tier 2	**	**	*	*	6,089,483	3,044,741	191,908	235,003
Afforestation and Reforestation	Tier 1	***	****	**	**	0	0	0	0
Non Forest Land Use Change	Tier 1	***	****	**	**	0	0	0	0
Agriculture									
Annual Crops	Tier 1	**	****	**	**	0	0	0	0
Agroforestry/Perennial Crops	Tier 1	****	****	**	**	0	0	0	0
Rice	Tier 1	**	****	**	**	0	0	0	0
Grassland	Tier 1	**	****	**	**	0	0	0	0
Organic soils and peatlands	Tier 1	--	****	****	****	--	0	0	0
Other GHG Emissions		CO2 (other)				CO2 (other)			
Livestock	Tier 2	---		**	**	---		49	66
Inputs	Tier 1	***		***	---	0		0	---
Other Investments	Tier 1	***		---	---	4,119		---	---

Problem of permanency may arise

Total uncertainty	9,565,369
Global level of uncertainty (%)	19

Figure 9: Level of uncertainty from the EX-ACT tool.

5.3 Economic cost and return per ton of GHG reduced

In this paper, the present analysis is limited to GHG emissions, which is a project co-benefit among other indicators, e.g. protection of local population, reduction of air pollution, increased supply of forest wood, reduced human health impact of fire clouds and dust and reduced damages of fires on infrastructure and different economic activities.

It is noteworthy to mention that the economic analysis is based on estimated costs from what was discussed during the workshop that took place together with Russian experts *(cf. Appendix 1)*. Table 5 illustrates the estimated costs of the project.

Table 5: Estimated costs of the project

Type of cost	USD per Brigade	Over 10 years	Total project (16 brigades)
Staff	30,000	300,000	4.800,000
Vehicle	25,000	25,000	400,000
Buildings	100,000	100,000	1,600,000
Maintenance	6,750	67,500	1,080,000
Horses	2,000	2,000	32,000
Petrol	12,680	126,800	2,028,800
TOTAL per brigade	-	**621,300**	
TOTAL for 16 brigades	-		**9,940,800**

Based on brigade equipment (maintenance, petrol) and staff, a yearly operational cost per brigade has been estimated around USD 49,430. Investment costs in year 1 include vehicles, offices, horses and so forth. With ten years of implementation activities, the aggregated operational and investment costs are of USD 621,300 USD per brigade. The total cost for 16 brigades is USD 9.94 million. In addition, communication, education and monitoring costs have to be added, estimated to USD 4 million. Therefore the total cost is (9.94+4)= USD 13.94 million.

Based on an aggregate project cost (10 years) of US$ 13.94 million and a carbon balance of -49.9 million tons of CO_2 emissions, the public cost per ton of CO_2 emissions reduction, results in (13.94/49.4)=USD 0.28 per ton CO_2. Using project budget expenses and valuing CO_2 emission reductions at different opportunity prices (USD 6 and USD 8), the following gross returns have been derived (table 6).

Table 6: Simulated economic gross returns of the project

	Economic gross returns	
	At USD 6 / T CO_2eq	**At USD 8 / T CO_2eq**
Gross value of GHG reductions (in million USD)	299.4	399.2
Gross return per USD invested (profitability index)	21.5	28.7
Gross return per Ha of forest protected (in USD/Ha)	748.9	998.5
Gross return per year (in million USD)	9.98	13

At a virtual value of USD 6 per ton CO_2eq, one dollar of investment provides a gross return of USD 21.5 in terms of co-benefit.

For the Economic Net Present Value (NPV) analysis, post project situation operational costs (petrol, staff and maintenance) have been accounted up to year 20. With a 8% discount rate, the project provides a NPV of USD 165 million over 30 years (using USD 6 /T CO_2eq). This is equivalent to an NPV of USD 3.3 per ton of CO_2eq. They show a high return of carbon public value generated *(cf. table 7).*

Table 7: Simulated economic NPV of the project

	Economic NPV	
Discount rate 8%	**At USD 6 / T CO_2eq**	**At USD 8 / T CO_2eq**
NPV of the project (million USD)	165	223
NPV per USD invested (profitability index)	16.6	22.4
NPV per Ha (USD)	412	558
NPV per T CO_2eq (USD)	3.3	4.5

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 PI approach enables to maximize the increment in wealth per dollar invested. 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 case of access to carbon markets.

6. Conclusions

The paper describes the ex-ante carbon-balance analysis performed in Moscow, with project designers. It consolidates different assumptions to figure out the preliminary results of the carbon balance for the WWF Bikin Forest Conservation Project. It proposes a scenario of implementation with fire protection brigades and estimates the economic relevance of such investment in regards to GHG emissions reduction. The results confirm the large potential of GHG emissions reduction provided by wide fire protection public programmes with performances placing it within the best return public investments.

7. Links to other EASYPol materials

- EX-ACT technical guidelines
- EX-ACT policy briefs

8. References

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Appendix 1: List of experts

Name	Title/Role
Anna Eremonko	World Bank, Moscow
Elena Kulikova	WWF, Russia
Olga Khlebinskaya	International Finance Corporation
Olga Khoreva	Russian Academy of Public Administration
Vladimir Berdin Qun Li	World Bank, Moscow
Andrew Mitchell	Forestry Specialist, World Bank
Ron Hoffer	World Bank Environment for Europe and Central Asia
Professor Boris N. Moiseev	Soil Specialist Director of the Forest Institute of Agricultural Sciences