Food and Agriculture Organization of the United Nations

Gabon

Greenhouse gas appraisal on sustainable management of critical wetland ecosystems

EX-ACT BLUE CARBON CASE STUDY

Targeting climate change mitigation in agriculture and forestry with EX-ACT

This report presents the results of an Ex-Ante Carbon-balance Tool (EX-ACT) Greenhouse Gas appraisal performed in June 2016 of the project "Sustainable management of critical wetland ecosystems" in Gabon. The project aims to improve protection of biodiversity in selected forested wetlands on the Ramsar list (Bas Ogooue, Monts Birougou and Petit Loango/Sette Cama). This will be achieved through knowledge creation and the development of conservation measures for the management of sustainable wetlands. The project seeks to cover 30 000 ha of forest area under sustainable forest management, benefiting 70 000 households. The GHG appraisal shows that the project has strong potential for climate change mitigation: -444 658 tCO_2-e per year, if the project is implemented successfully.

KEY MESSAGES

- Ramsar sites in Gabon account for 2.8 million hectares, yet about 82 percent of these critical wetland ecosystems do not receive any form of protective activity.
- The project seeks for the sustainable management use and conservation of wetlands (inner and coastal) in Gabon
- If well implemented over 30 000ha, the resulting carbon balance of around will be of **-8.9 million tCO_2-e** over the full 20 year analysis timescale. This equates to about **-14.8 tCO_2-e per hectare per year**.

EX-ANTE CARBON-BALANCE TOOL ◀ EX-ACT

Project description and context

Gabon is a resource-rich country possessing exceptional biodiversity, arable land, forest, mineral (magnesium, iron) and oil resources. The country contains three important terrestrial ecoregions: the Congolian coastal forest, the Northwestern Congolian lowland forest, the Western Congolian forest savanna, and is full of mangrove and swamp forests. Some areas (wetlands and non-wetland ecosystems) have been classified as National Parks and are managed by different agencies and government departments. Since 1987 Gabon has been part of the Ramsar convention on Wetlands of International Importance (WII) and registered nine different sites representing a wide variety of aquatic ecosystems (mangroves, savannas, waterfalls and rapids, lagoons, rivers and lakes) amounting to about 2.8 million hectares (ha). Thus Gabon's wetlands are rich in biodiversity, but are also unprotected. Multiple activities are threatening Gabon's ecosystems: forestry, mining, oil exploitation, fishing and agriculture. Mounting evidence suggest that both biodiversity and ecosystems services need to be conserved outside national parks. Wetlands provide major ecosystems functions such as rejuvenation of groundwater, water purification, mitigation and adaptation to climate change. In Gabon they are critical for providing drinking water and energy to major urban centers. They also sustain fishery production and provide an irreplaceable habitat for fish breeding. However despite sticking to the Ramsar convention, limited action was taken to enact the constituent principles, such as maintaining the ecological characters of WII wetlands.

Project objectives and components

The project "Sustainable Management of critical Wetland ecosystems" aims to enhance the protection of biodiversity in selected forested wetlands on the Ramsar list. It aims to achieve this through knowledge creation and the development of conservation measures for managing sustainable wetlands, e.g. reducing pressure on land, sustainable forestry management and reducing emissions from deforestation and degradation (REDD+). This will be achieved through four different components:

Component #1 (USD 0.6 million) will build knowledge on wetlands in Gabon and set up a reliable monitoring system to provide an early warning of potential alterations to wetland ecosystems.

Component #2 (USD 3.1 million) will support sustainable management of selected critical wetland ecosystems. It will reinforce local capacity (with equipment, planning and monitoring) to manage wetlands and improve livelihoods for local rural communities (through development of tourism), and reduce anthropogenic pressures on these wetlands through monitoring and implementation of management plans.

Component #3 (USD 3.326 million) will strengthen institutional frameworks supporting wetlands management through cross sectoral consultations on wetlands management issues and priorities.

Component #4 (USD 0.485 million) will cover the project management.

The project will benefit three different parties: (1) the national institutions, (2) farmers and fishermen and (3) the communities resident in and near the project sites. The number of direct beneficiaries will be around 70 000 people living within the three WII sites. The project will seek to place 30 000 ha of forest under sustainable forest management and 70 ha of land under sustainable land management practices (Annex 1 PAD607). The number of direct and indirect beneficiaries will be refined with project implementation. The project will span five years and incur a total cost of USD 7.521 million.

The project will focus on three of the Gabonese WII sites: (1) Bas Ogooue (2) Monts Birougou and (3) Petit Loango/Sette Cama. Details on these sites are shown in Table 1. These sites were selected based on the importance of wetland ecosystems services to the local population (including for climate change adaptation and mitigation), the threats to the wetland ecosystems by competing land uses and the initiatives already underway at the sites.

TABLE 1. Ramsar sites and associated characteristics undergoing project implementation

Sites	Characteristics	Area (ha)	Pressure
Bas Ogooue	Alluvial plain	862 700	Dense population, fishing hunting, tourism, competing land uses with slash and burn agriculture, forestry
Monts Birougou	Heavily forested high interiors (swamps and savanna)	536 800	Forestry and mining activities, destructive fishing practices
Petit Loango & Sette Cama	Coastal plain wetlands	480 000 & 220 000	Oil exploitation

Source: Project document.

Methodology and tools used

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 carbon dioxide (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).

EX-Ante appraisal results

Project data used in EX-ACT

In the absence of project, i.e. in the absence of strengthened institutional frameworks, monitoring and local capacity to manage forested wetlands, it is highly likely that land use competition by resource industries (petroleum, forestry, and mining) will put serious pressure on the integrity of these wetland ecosystems. Urban development and unfettered exploitation (deforestation, mining and petroleum exploitation) could compromise the medium to long term capacity of these ecosystems to deliver goods and services needed for biodiversity protection, climate change adaptation and mitigation. This is particularly relevant to Monts Birougou and Petit Loango which are poorly managed wetland sites.

The with-project situation would provide resources with the above components to extend the coverage of management activities in Gabon's wetlands and ensure their sustainable usage and conservation.

In EX-ACT these two scenarios are put in terms of degradation level of forest ecosystems in the "Forest and management" module.

Support for sustainable management (Component #2) is prioritized for mangrove ecosystems (p.10 of PAD607) for the WII in Sette-Cama and Petit Loango. As reported by Ajonina *et al.* (2014), Gabon's mangrove surface area decreased by 19 percent between 2000 and 2014. Deforestation hotspots (over 90 percent in some areas) were located in the peri-urban areas around Libreville, Port Gentil and Sette-Cama. Major drivers of mangrove losses are the over-exploitation of wood, land reclamation for urban development and infrastructures, and degradation from pesticides, eutrophication and hydrocarbon and gas exploitation (Ajonina *et al.*, 2014).

a) Agro-ecological variables

The project area is characterized by a tropical climate with a wet moisture regime. The dominant soil type was specified as LAC soils according to the IPCC classification. While the project will be implemented over a period of about five years, EX-ACT will account for an additional 15 year period of capitalization. This is needed to capture the full picture of the impacts of management and conservation strategies on biomass and soil carbon stocks.

b) Forest degradation and management module

i) Petit Loango and Sette Cama mangroves

We use carbon stock data in undisturbed mangrove swamps in Gabon from Ajonina *et al.* (2014), as a Tier 2 level of information, as shown in Figure 1. Aboveground and deadwood biomass are corrected to tC per ha by multiplying by 0.451 (the fraction of carbon in above ground biomass, as taken from IPCC 2014). For belowground biomass we use the root carbon concentration of 0.36 (Kauffman and Donato 2012). We assume an initial degradation state of the mangrove to be 19 percent, going toward a moderate degradation level (40 percent) in the absence of project, while the project implementation through monitoring and sustainable management of the mangrove will allow recovery to the much lower degradation level of 10 percent.

Figure 1. A Tier 2 approach for mangroves and data from Ajonina *et al.* (2014) for undisturbed mangroves (EX-ACT screenshot)

Back

Use this part only if you want to refine the analysis with Tier 2 coefficients.

(default values are provided for your information only, while EX-ACT will use Tier 2 values automatically wherever specified)

Select level	Default	Tier 2
None	0	
Very low	10	
Low	20	19
Moderate	40	
Large	60	
Extrem	80	90

All values are in t of carbon per ha (tC/ha)

Type of vegetation that will be degraded	Above-ground		Below-ground		Litter		Dead wood		Soil carbon	
	Default	Tier 2	Default	Tier 2	Default	Tier 2	Default	Tier 2	Default	Tier 2
Forest - Zone 1	145.7		53.9		3.65		0.0		60.0	
Forest - Zone 2	122.2		29.3		3.65		0.0		60.0	
Forest - Zone 3	56.4		15.8		3.65		0.0		60.0	
Forest - Zone 4	32.9		13.2		3.65		0.0		60.0	
Plantation - Zone 1	70.5		26.1		3.65		0.0		60.0	
Plantation - Zone 2	56.4		11.3		3.65		0.0		60.0	
Plantation - Zone 3	28.2		7.9		3.65		0.0		60.0	
Plantation - Zone 4	14.1		5.6		3.65		0.0		60.0	
Mangrove	86.6	153.8	42.4	58.9	0.70		10.7	14.9	49.0	277.0

ii) Monts Birougou Foret & Bas Ogooue

We consider the forest type of these two wetland sites to be tropical rainforest. We assume the same degradation level as with mangroves at the start of the project, for both the without and with-project situation. Main threats to these areas are mining and overexploitation of forests for timber and other food products.

c) Information gap and assumptions

Under Component #2 of the project, 30 000 ha of forest area are under sustainable forestry management. We assume an even partition of the surface area between the three WII, although the priority of Component #2 is given to mangrove ecosystems. Given the high productivity of these ecosystems and their ability to store and sequester carbon long-term in the soil, gross carbon flux from management activities in mangrove swamps could be enhanced if we were to consider a larger area. More information would be required here.

We used data from Ajonina *et al.* (2014) for mangroves and corrected them according to each pool compartment (see above). Data from Ajonina *et al.*, (2014) are reported for undisturbed mangroves, whereas mangroves within the region of Sette Cama are disturbed by industrial operations (see Annex 1 here). The authors do acknowledge that more field data would be required to refine their estimation. We also consider here that the soil carbon stock is unexpectedly high. More information would be required here.

The project also makes reference to about 10 hectares of land area in which sustainable management practices will be applied. This is not accounted for the following computations as not enough data are available.

Carbon balance results

The tables shown in Figure 2 summarize the GHGs sequestration and the share of the balance per GHG from above scenario. Results are given in tones of CO_2 equivalent (tCO_2-e). Positive numbers represent sources of CO_2-

e emission while negative numbers represent sinks. The left section of the table summarizes estimated CO_2-e emissions and sinks from the without-project scenario (left column), the with-project scenario (middle column) and the total balance (right column). The middle table details the Carbon Balance under project implementation, showing the CO_2 fluxes from biomass and soil carbon fluxes. The right table details annual CO_2-e fluxes for forest management activities with and without project implementation.

Figure 2. EX-ACT results, gross fluxes and balance of greenhouse gases (GHG) of the without and with-project scenario, the share of the balance for each GHG and annual CO_2-e emissions (EX-ACT screenshot)

Project Name	Management wetlands Gab	Climate	Tropical (Wet)	Duration of the Project (Years)	20
Continent	Africa	Dominant Regional Soil Type	LAC Soils	Total area (ha)	30000

Components of the project	Gross fluxes Without	With	Balance	Share per GHG of the Balance All GHG in tCO2eq CO_2 Biomass	Soil	Other	N_2O	CH_4	Result per year Without	With	Balance
	All GHG in tCO2eq 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 LUC	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
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management	6,225,215	-2,667,949	-8,893,165	-6,982,602	-1,910,563		0	0	311,261	-133,397	-444,658
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	16	16			0	0	0	0	1	1
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	6,225,215	-2,667,934	**-8,893,149**	-6,982,602	-1,910,563	0	0	0	311,261	-133,397	-444,657
Per hectare	208	-89	-296	-232.8	-63.7	0.0	0.0	0.0			
Per hectare per year	10.4	-4.4	-14.8	-11.6	-3.2	0.0	0.0	0.0	10.4	-4.4	-14.8

- The **without-project scenario** is expected to generate about **6.2 million tCO_2-e** over the entire 20 year period of analysis, primarily due to forest Degradation (i.e. deforestation, degradation, thinning, and disturbance from urban and industrial activities).
- The **with-project scenario** sequesters about **2.7 million tCO_2-e** from forest management activities, decreasing the degradation level of wetland forests.

To evaluate the GHG mitigation impacts of the project, the gross fluxes of the with- and without-project scenario should be compared. The difference is described as the Carbon Balance. Implementation of the project results in an overall carbon balance of around -8.9 million tCO_2-e over the full 20 year analysis timescale. This equates to about -296 tCO_2-e per hectare and -14.8 tCO_2-e per hectare per year.

With this impact the project can be described as having significant benefits for climate change mitigation. When translating the IPCC's qualitative uncertainty assessments into a quantitative estimation, as done by EX-ACT, the above carbon balance is given to an uncertainty of about 20 percent.

Discussion and recommendations

Through components #1 to 3, the project seeks to enhance the sustainable management of wetland ecosystems through reducing anthropogenic pressures, enhancing local capacity management, improving knowledge of the ecosystems and monitoring and strengthening institutional framework, among other activities. These should have a leverage effect on anthropogenic pressures and associated degradation of these crucial ecosystems. They will also benefit biodiversity, reduce land and water degradation through appropriate agricultural practices, reduce pollution (from mining extraction, oil exploitation and eutrophication) and improve local livelihoods.

The analysis also highlights that enhanced protection of forested wetlands through conservation measures for **sustainable wetland management yields strong benefits for climate change mitigation**; -444,658 tCO_2-e yr^{-1}. Tropical rainforest and mangroves are highly productive ecosystems. Mangroves are among the most carbon-rich of all ecosystems due to their ability to sequester and store carbon in the soil, as shown in Figure 1 and in Donato *et al.* (2011) and Murray *et al.* (2011) for global comparison. From our scenario, forest management practices in tropical rainforest mitigate about 12.6 tCO_2-e ha^{-1} yr^{-1} while in mangroves they mitigate about 19.2 tCO_2-e ha^{-1} yr^{-1}.

Ramsar sites in Gabon account for 2.8 million hectares, yet about 82 percent of these critical wetland ecosystems do not receive any form of protective activity. Implementing Wetlands monitoring systems, identifying site specific threats, evaluating and prioritizing those threats, and identifying potential protective interventions (such

as pollution control, fishery management and community forestry) will benefit and add value to the ecosystems services of wetlands in Gabon.

The decline of mangroves in West Africa is a result of urbanization, coastal infrastructure development and overexploitation of mangrove products. Mangrove deforestation results in emissions from other greenhouse gases such as CH_4 and N_2O. The conservation of mangroves and other forests in WII can help to reduce carbon emissions, such as the REDD+ programme. Environmental sustainability practices may include sustainable forestry, alternative technologies to reduce the use of mangrove wood for energy and an increased capacity to enhance protected areas. These practices could reduce threats to wetland forests (in particular mangroves), contribute to local livelihoods (through fisheries and tourism) and in the long term contribute in climate change adaptation and mitigation (mangroves migrating inland to cope with rising sea levels).

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EX-ANTE CARBON-BALANCE TOOL [EX-ACT]

The EX-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The tool helps project designers estimate and prioritize project activities with high benefits in terms of economic and climate change mitigation, and it helps decision-makers to decide on the right course to mitigate climate change in agriculture and forestry and to enhance environmental services.

CONTACTS

www.fao.org/tc/exact

Louis Bockel – Louis.Bockel@fao.org

This appraisal was elaborated by Laure-Sophie Schiettecatte, EX-ACT consultant, Agricultural Development Economics Division, FAO.

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