NATIONAL
DIRECTIVE

SELECTION for INDUSTRIAL AGRICULTURE:

Guidelines for oil palm development

National Land Allocation Commission (CNAT)

Ministry in charge of Agriculture

Ministry in charge of Forests and Environment

National Climate Council

OVERVIEW

With this directive, the Gabonese government lays out national requirements to guide its palm oil sector towards operations aligned with the country's sustainable development engagements, which are applicable to all agro-industrial crops in Gabon.

Palm oil: A strategic decision

Oil palm cultivation is not new to Gabon, but its increasing global demand makes it a very attractive crop today[1,2]. Oil palm cultivation offers the highest yield of vegetable oil per hectare, requiring up to 10 times less surface area than other oilseed plants. It is a crop that is more naturally adapted to Gabon, being native to Africa, not genetically modified, and requiring fewer inputs, fewer pesticides and less energy to produce compared to other vegetable oils[3] . As part of its commitment to diversify its economy, Gabon has made the strategic decision to encourage this sector, which would place the country among the main producers of palm oil in Africa[4] .

The need to regulate the establishment of oil palm in Gabon

These new opportunities also call up possible risks, numerous questions, and require important political decisions to assure the sector is developed in a sustainable manner.

The impacts of palm oil expansion on the environment and on social and cultural resources surveyed in other parts of the world often paint a somber picture of the possible consequences of such expansion if it is not sufficiently regulated. The government is therefore committed to dealing with these actions in a proactive and preventive manner to minimize possible negative impacts and promote positive outcomes.

In Gabon, concerns particularly relate to the high proportion of tropical rainforest cover, high carbon stocks, and abundance of priority conservation species, such as great apes and elephants, many of which are protected by national lawse[5] as well as by international conventions to which Gabon adheres[6] .

Compliance with requirements in three phases of development

To best support development of the sector and guide producers and regulators in the application of national and international standards, the government provides guidelines to comply with throughout the three phases of oil palm development: **(i) site selection, (ii) environmental and social impact studies; and (iii) monitoring and evaluation.**

This document serves to guide the first phase, which aims to identify productive sites, maintain areas of conservation interest, and take into account areas used by rural populations. With this in mind, the government carried out an analysis of the productivity of industrial oil palm cultivation across the country, and, in parallel, the mapping of essential sites to be preserved or managed at the national level, due to their high conservation values (HCV) for biodiversity and ecosystems, or their high carbon stocks (HCS). Taking HCV and HCS into account is an important basis for responsible palm oil production, essential for certification and access to international markets that increasingly demand responsible sourcing. This national directive presents these analyses and their results, highlighting suitable sites for responsible oil palm cultivation.

The other two phases concern the development of the Environmental and Social Impact Study (ESIA) and the implementation of the Environmental and Social Management Plan (ESMP), which are already defined by existing regulations.

[1] *FAO (2011) Southeast Asian forests and forestry to 2020: Subregional report of the second Asia-Pacific forestry sector outlook study. Food and Agriculture Organization, United Nations, Bangkok.*

[2] *Hawkins D, Chen Y (2011) A growth story for Africa. World Agriculture Report. Sept. 5.*

[3] *In comparison with soy, oil palm yields over 8 times the amount of oil per hectare, and needs 15 times fewer pesticides, 6 times fewer fertilizers, and 6 times less energy to produce one ton of oil (The Guardian, 2014 - https://www.theguardian.com/sustainable-business/ng-interactive/2014/nov/10/palm-oil-rainforest-cupboard-interactive).*

[4] *Gabon Emergent Strategic Plan (2012) Republic of Gabon.*

[5] *Decree n °0164/PR/MEF, 19/01/2011, Annexes 1 et 2.*

[6] *United Nation's Convention on Biological Diversity (CDB), ratified in 1997; African Convention on the Conservation of Nature and Natural Resources (Algier's Convention), ratified in 1998; Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), entered into force in 1989; Convention on the Conservation of Migratory Species of Wild Animals (CMS), entered into force in 2008.*

Safeguards offered by the government of Gabon

Beyond guaranteeing a robust identification of sites, the government wishes to develop the sector by aligning with international best practices. For environmental, social and societal protections, Gabon requires, at minimum, compliance with the national interpretation of RSPO (Roundtable for Sustainable Palm Oil) principles and criteria for certification: all companies invested in this sector must comply. This is the minimum benchmark; Gabon will accept any other form of equivalent or more demanding certification standards.

Each concession or association of small producers will be subject to annual monitoring by the government to inspect and ensure respect of environmental and social commitments. This government monitoring will be supplemented by certification audits (RSPO or equivalent).

Application of these guidelines

These guidelines are to be used with implementation manuals for RSPO certification, which constitutes the minimum requirement in the Republic of Gabon for any industrial development of oil palm, including the purchase of palm nuts from small producers.

The target audience includes palm oil producing companies currently operating in Gabon or planning to do so, government officials responsible for overseeing oil palm projects, as well as stakeholders consulted during preparatory works (public consultations and mutual agreements with civil society and independent experts, related to due diligence and monitoring studies).

In producing these guidelines, the government aims to orient development to the most productive lands for oil palm cultivation, while ensuring protection of Gabon's globally-important biological resources, ecosystem services, and the rights of rural communities who depend on the land.

[7] *RSPO P&C: https://rspo.org/principles-and-criteria-review*

Contents

1 Context and framework of a new agricultural model in Gabon

1.1 Promoting the creation of a competitive agricultural sector

Since 2010, Gabon's economic development policy has been based on the implementation of the Gabon Emergent Strategic Plan (PSGE). The PSGE sets the government's principal targets for public policy until 2025. Through the PSGE, the government embarked on an ambitious program of economic and social transformation, the implementation of which aims mainly at diversification and growth through progressive transformation of natural resource sectors, particularly mining, agriculture, and fisheries, as well as environmental sustainability.

Revitalizing the agricultural sector is also at the heart of Gabon's Economic Recovery Plan, presented in 2017. This plan aims to replace half of food imports through the intensification of subsistence crops, and to promote the establishment of agro-industrial sectors that provide jobs and help to catalyze stable, sustainable local economies, to offset Gabon's centralized economic poles of Libreville and Port-Gentil.

Identifying agricultural land use, and issuing land titles and agricultural operator licenses, are prerequisites to strengthening the national agricultural ecosystem. Land allocation must also consider the heritage values of our country, to which Gabon is also very committed. The agricultural expansion necessary for our country must not jeopardize the biological reserves or ecological and ecosystem functions of our environment. It also must not hamper the development of local communities, but on the contrary, be a lever out of rural poverty.

1.2 Governance framework

The work of selecting sites for development of the agricultural sector is aligned with a legal framework and institutions governing the management of natural and cultural resources in Gabon, and ensuring proper respect for the principles of sustainable development. We indicate references to the main texts which guided the process on a legal and regulatory level:

- **The Constitution of the Republic of Gabon,** dated March 26, 1991, amended by laws dated March 18, 1994, September 29, 1995, April 22, 1997, and October 11, 2000, which provides the framework and guidance for the country's environmental and social policies;
- **Law No. 002/2014** dated August 1, 2014, regulating Sustainable Development in the Republic of Gabon;
- **Law No. 007/2014** dated August 1, 2014, on the Protection of the Environment;
- **Law No. 22/2008** dated December 10, 2008, the Agricultural Law in the Republic of Gabon;
- **Law No. 23/2008** dated December 10, 2008 on Sustainable Agricultural Development Policy;
- **Law No. 03/07** dated August 27, 2007 relating to National Parks;
- **Law No. 16/2001** dated December 31, 2001 the Forestry Law;
- **Law No. 05/2000** dated October 12, 2000 the Mining Law;
- **Law No. 2/94** dated 23 December 1994, on the Protection of Cultural Heritage;
- **Law No. 3/81** dated June 8, 1981, establishing the framework for Town Planning Regulations;
- **Law No. 15/63** dated May 8, 1963, establishing the Land Ownership Regime;
- **Law No. 6/61** dated May 10, 1961, regulating Expropriation for Public Use.

The national institutions responsible for implementing and monitoring this national directive are:

- **National Land Allocation Commission (CNAT);**
- **Ministry in charge of Agriculture**
- **Ministry in charge of Forests and the Environment;**
- **National Climate Council.**

1.3 The need to develop a new model of agriculture

The government has chosen not only to develop a competitive agricultural sector in Gabon, but to develop it in a well-designed and well-managed manner, both for its people and its environment.

This decision was motivated by experiences of agro-industrial growth in other regions of the world, specifically those of monocultures (single crop farming systems) which can be developed to the detriment of important environmental resources, and cause negative social and cultural impacts, which are sometimes catastrophic. In Indonesia, more than half of agricultural expansion (in this case linked to oil palm) has taken place at the expense of carbon-rich and biodiversity-rich forests and in peatland[8] areas.

Compared to intact or selectively logged forests, these monocultures are biologically very poor, causing forest fragmentation and harmful effects on the edges of adjacent forests[9] . Other direct risks include soil erosion and degradation, and water pollution from improper use of pesticides and fertilizers[10] . More impacts relate to carbon loss and possible long-term instability of ecosystems, causing ecological disfunction, climate imbalance, pathologies, etc.

These risks pose problems to the environment as well as to the people, leading to public health concerns. Often, these monocultures also compete with other land uses, or cause conflicts with local communities. The negative impacts can be intensified by the large influx of new workers into rural areas, causing increased demand for food, fuel and fiber from neighboring forests, and direct competition for land[11] .

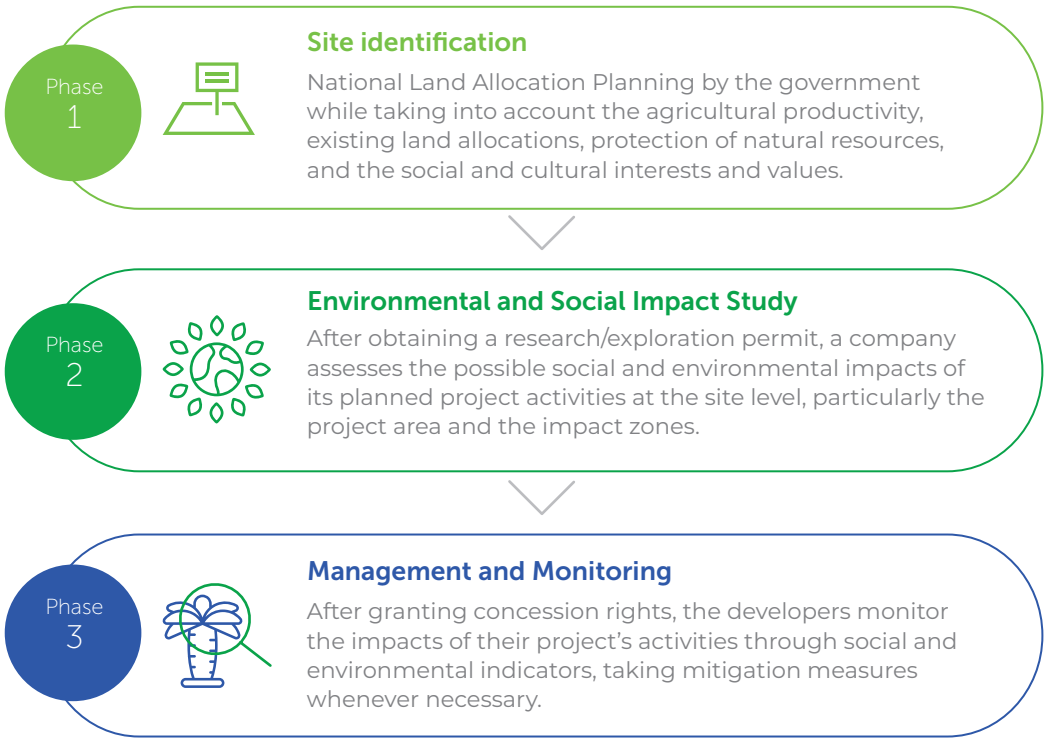
In view of these possible negative impacts, Gabon commits to take all measures to ensure the development of a new model that is better aligned with its national context. Gabon's heavy forest cover (23.6 Mha[12], or 88% of the country) requires the government to take specific measures to sustainably develop the agricultural sector with minimum negative impact on its environment and communities. Gabon is also determined to create jobs for its people and to maintain standards that protect and promote current and future generations.

[8] *Koh LP, Wilcove DS (2008) Oil Palm: Disinformation enables deforestation. Trends in Ecology and Evolution, 24.*
[9] *Linder, JM (2013) African primate diversity threatened by "new wave" of industrial oil palm expansion. African Primates 8:25-38.*
[10] *WWF (2012) Palm oil investor review. Investor guidance on palm oil: The role of investors in supporting the development of a sustainable palm oil industry. WWF, Washington, D.C.*
[11] *Karsenty, A (2012) Large-scale acquisition of rights on forest lands in Africa. Report to Rights and Resources, Washington, D.C.*
[12] *Fichet LV, Sannier C, Makaga EM, Mertens B (2012) Monitoring forest cover change at national level in Gabon for 1990, 2000, and 2010 with optical imagery. IEEE International Geoscience and Remote Sensing Symposium, Juillet 2012, Munich.*

1.4 Sustainable agricultural development process

To best support development of the sector and help producers adhere to national and international standards, the government guides them on meeting requirements throughout all phases of agricultural development, which are: (i) the selection of crops and sites; (ii) environmental and social impact studies; and (iii) monitoring and evaluation (Figure 1).

Figure 1 *Environmental and social management guidelines for the three phases of development of an agro-industrial project*



PHASE 1: Site Selection

The basis for achieving profitable production, while minimizing negative environmental and social consequences, is careful and well-designed site selection. This document outlines the government's national perspective, by providing an analysis of oil palm productivity for Gabon, an assessment of available space considering other land uses, and an identification of essential sites to manage its natural heritage. These are areas of high conservation value (HCV) in terms of biodiversity, ecosystem interest or heritage, as well as areas with high carbon stocks (HCS). The consideration of HCV and HCS is an important basis for responsible production, and an essential factor for possible certifications and access international markets that increasingly demand responsible sourcing.

PHASE 2: Environmental and Social Impact Study

Once the potential site has been selected and a prospection permit is granted by the government, an Environmental and Social Impact Assessment (ESIA) is required by law to identify and map the important ecological, biological, social and cultural characteristics that would be threatened in the area and its surroundings. ESIA implementation is defined by existing regulations[13].

PHASE 3: Management and Monitoring

After the ESIA, developers must mitigate pressure on these resources and monitor their evolution over time through an Environmental and Social Management Plan (ESMP). The ESMP dictates the intensity of spatial and temporal monitoring to be carried out by plantation developers.

This directive serves as a guideline for the first phase, which aims to identify productive and accessible sites, while maintaining areas of interest for conservation commitments. The other two phases, related to the Environmental and Social Impact Study (ESIA) and the implementation of the Environmental and Social Management Plan (ESMP), are defined by existing regulations.

1.5 Recognizing High Conservation Values (HCV)

The concept of HCV is an internationally-recognized, generic framework for identifying important areas to be protected based on their ecological, biological, social, and cultural values, especially in the context of industrial development. Six main criteria are involved, four of which deal with environmental values: biodiversity, landscapes, ecosystems, and ecosystem services[14] . Translating the generic HCV framework into practice requires countries to perform a national interpretation to define the relevant values to be protected in each national context. The first version of Gabon's national HCV interpretation[15] was carried out for the forestry sector, and could be updated to address the impacts related to agricultural development.

[13] *Law No. 007/2014 dated August 1, 2014, on Protection of the Environment in Gabon, and Decree No. 539/PR/MEFEPEPN dated July 15, 2005, regulating Environmental and Social Impact Studies in Gabon.*
[14] *High Conservation Value Resource Network (2014) The Six HCVs. Available at: http://www.hcvnetwork.org/*
[15] *Stewart C, Rayden T (2008) Une interprétation nationale des forêts à haute valeur pour la conservation pour le Gabon. Proforest, U.K.*

To bridge this gap, the environmental characteristics of HCVs 1 to 4 were mapped at the national level (when possible), and divided into four management categories: a "green" zone where agro-industry is least likely to have a negative impact on these environmental resources; "light green" and "yellow" zones where these resources could be threatened and should only be considered with specific management; and a gray or "masked-out" zone in which the government prohibits expansion of agro-industry (Table 1). Areas with HCV 5 and 6, linked to traditional and cultural use, were not addressed in this analysis because they are very locally specific and variable; they must be identified during the impact study. For this, Gabon encourages the use of participatory mapping to define village territories and farming areas exhaustively.

Table 1. *Environmental criteria corresponding to HCV 1 to 4 in Gabon*

Resources to protect	**Green zone** Development permitted	**Light Green Zone** Develop with caution	**Yellow Zone** Develop with great caution	**Shaded zone** Development Prohibited
Protected areas **HCV 1.1**	Land not subject to legislation or managed for protection	Peripheral zone of National Park	Buffer zone of National Park, Ramsar Site	Reserve (Presidential, faunal), National Park, Hunting Domain, Arboretum, Historic area, World Heritage Site, conservation series, zone closed to logging
Priority species **HCV 1.2, 1.3, 1.4** -Threatened, endangered, rare, range-restricted species	Less suitable habitat for widespread species (distributions covering >5% of country)	Suitable habitat for widespread species (>5% of country)	Suitable habitat for moderately widespread species (1-5% of country)	Localities/key habitat for restricted species (<1% of country); reproduction zones, nesting sites, feeding grounds, seasonal /migratory congregations
Intact Forest Landscapes **HCV 2**	Non-intact forest landscapes			Intact forest landscapes (IFL)
Rare or threatened habitats or ecosystems **HCV 3**	More widespread habitats	Habitats covering 1-5% of the country, of which ≥10% is in parks and <50% is disturbed. Or those covering 6-10%, of which <10% in parks, or ≥50% disturbed	Habitats covering 1-5% of the country, of which <10% is protected in parks, or ≥50% is disturbed	"Rare" habitats (covering <1% of the country) that are not yet protected
Drainage basins, sensitive water resources **HCV 4.1**			Zones subject to seasonal flooding	Large water bodies; 1km buffer from coast or large lagoons; 10-500m buffers from rivers depending on their width; sensitive floodplain
Erosion control **HCV 4.2**			Average terrain: Slope 10◦ to 20◦	Rugged terrain: Slope ≥20◦

Data used to define HCV zones

1.1 indicates protected areas – the country's primary conservation strategy – which harbor a wealth of biodiversity. HCV 1.1 protects this biodiversity by defining areas necessary to maintain to support the country's protected areas[16].

1.2, 1.3, 1.4 correspond to threatened, endangered, rare, endemic, or restricted-range species: their habitats must be preserved for the species to survive. To identify priority species, a conservation assessment was conducted for terrestrial amphibians, reptiles, birds, and mammals in the country (Table 2)[17]. The distributions of 33 of these priority species were mapped and used for identification of HCV[18].

2 represents large landscape areas with an intact ecological function. We used global data on intact forest landscapes (IFL)[19] to represent areas that are relatively intact and large enough to maintain biodiversity. However, the global analysis of IFLs provides a general picture; a national interpretation and more detailed analysis on the ground is necessary and is in progress.

3 represents naturally rare ecosystems, and those threatened by habitat loss. To address this, 30 types of biophysical habitats were mapped according to ecological, topographic, climatological and land cover gradients, then analyzed in terms of rarity (extent of distribution), protection (representation in parks) and threat (road disturbance; Figure 2)[20]. This classification gives a first indication of the level of rarity or threat of broad habitat types at the national level, meant to guide field studies prior to any development. It should be noted that a habitat of limited distribution that is unprotected can go from a gray zone to a yellow zone, if a sufficient amount is in the process of becoming legally protected at the level of HCV 1.1.

4.1 & 4.2 relates to the ecological integrity of water resources and land stabilization, which are essential ecosystem services for limiting the risk of flooding and erosion. Surface water, sensitive inundated areas, wetlands and floodplains[21] were identified for protection, as was "rugged" terrain prone to erosion. Riparian and wetland buffer zones must be identified to protect coastlines, waterbodies, rivers and streams, with buffer width for rivers and streams defined by the national interpretation of RSPO standards. Additional buffers may be necessary based on the results of the ESIA. Slopes > 20° must be protected and lesser slopes managed in the field.

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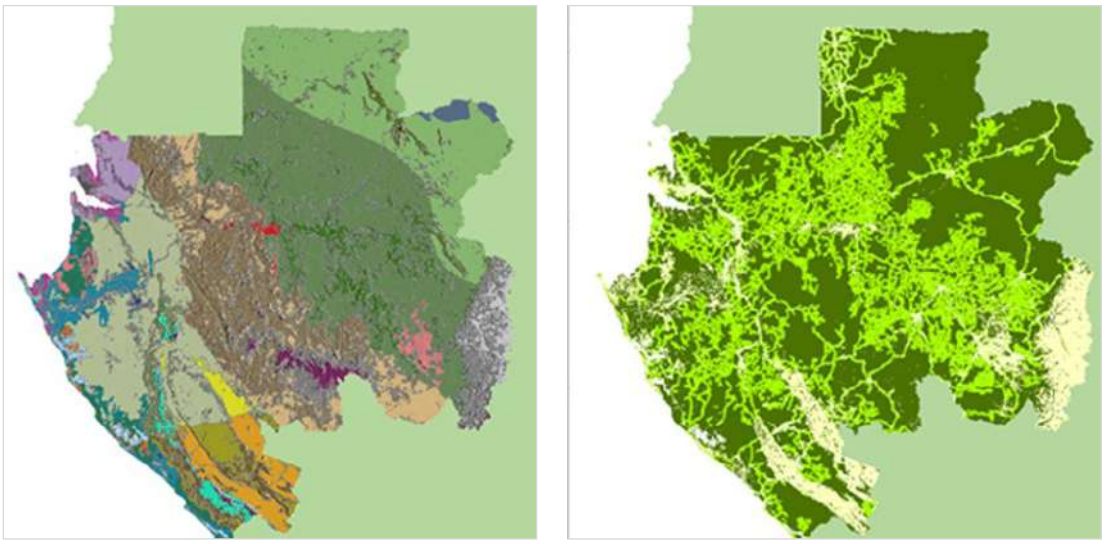
[16] Refers to 'zone closed to logging' in table above, Gabon Cabinet Decision (2011).
[17] Drawn from Lee (2014) and updated by ANPN and DGFAP (2020) species protection evaluation exercise. This dataset represents a starting point and should be completed with other taxonomic and functional groups.
[18] Species and habitats divided into three categories based on their distributions. The most restricted are often so limited that scientific practice requires conserving a large part of their distribution to ensure survival. All are subject to field study to determine appropriate management.
[19] Intact Forest Landscape is an internationally recognized concept, defined as an extent of forest >50,000 ha in area and >10km in width. Data (2016) from www.intactforests.org. A national interpretation of this global concept is however necessary.
[20] Habitat map and analysis of protection in parks drawn from Lee (2014) doctoral thesis. Data on disturbed zones, proxied by road access, compiled from historic data and satellite imagery (WRI 2013, unpublished at the time, but now integrated into openstreetmap.org).
[21] Unpublished data, TNC-Gabon.

Table 2: Priority species whose distributions were used for the identification of HCV 1.2-1.4. *Criteria include: 1) globally threatened or endangered species, IUCN Red List (CR = critically endangered; EN = endangered; VU = vulnerable); 2) species protected by CITES; CMS; AEWA; Algiers Convention; 3) species likely threatened at the national level, assessment by taxonomic experts in Gabon, criteria from the IUCN National Red List; 4) endemic or near-endemic species (in <3 countries, including Gabon); 5) significant share of the world population in Gabon; 6) species that are naturally rare, have restricted or special distributions, or are habitat specialists.*

English name	Scientific name	French name	IUCN Red List CR EN VU	CITES	CMS/AEWA	Algier's Convention	Nationally threatened	Endemic/ Near-endemic to Gabon	Important population in Gabon	Rare/habitat specialist in Gabon
Western lowland gorilla	*Gorilla gorilla*	Gorille de l'ouest	CR	CITES I	CMS I/Gorilla Accord	A				
Chimpanzee	*Pan troglodytes*	Chimpanzé	EN	CITES I	CMS I/ II	A				
Black colobus	*Colobus satanas*	Colobe noir	VU	CITES II		B				
Mandrill	*Mandrillus sphinx*	Mandrill	VU	CITES I		B				
Red-capped mangabey	*Cercocebus torquatus*	Cercocébe collier blanc	EN	CITES II		B				
Sun-tailed monkey	*Allochrocebus solatus*	Cercopithéque à queue de soleil	NT	CITES II		B		Enmique		
Serval	*Leptailurus serval*	Serval	LC	CITES II		B				
Leopard	*Panthera pardus*	Panthére ou Léopard	VU	CITES I	CMS II	B				
Golden cat	*Caracal aurata*	Chat doré	VU	CITES II		A				
African manatee	*Trichechus senegalensis*	Lamantin	VU	CITES I	CMS I/ II	A				
African forest elephant	*Loxodonta africana*	Eléphant	VU	CITES I	CMS II	B				
Hippopotamus	*Hippopotamus amphibius*	Hippopotame	VU	CITES II		B				
Giant forest hog	*Hylochoerus meinertzh ageni*	Hylochére	LC			B				
Waterbuck	*Kobus ellipsiprymnus*	Cobe defassa	LC			B				
Southern Reedbuck	*Redunca arundinum*	Cobe des roseaux	LC			B				
Grimm's duiker	*Sylvicapra grimmia*	Céphalophe de Grimm	LC							
Bongo	*Tragelaphus eurycerus*	Bongo	NT			B				
Pink-backed Pelican	*Pelecanus rufescens*	Pélican gris	LC		AEWA	A				
Yellow-billed Stork	*Mycteria ibis*	Tantale ibis	LC		CMS II/AEWA	A				
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	Jabiru d'Afrique	LC			A				
Sacred Ibis	*Threskiornis aethiopicus*	Ibis sacré	LC		CMS II/AEWA	A				
African spoonbill	*Platalea alba*	Spatule d'Afrique	LC		CMS II/AEWA	A				
Peregrine Falcon	*Falco peregrinus*	Faucon pelerin	LC	CITES I	CMS II	B				
African river martin	*Pseudochelidon eurystomina*	Pseudolangrayen d 'Afrique	DD							
Dja River Warbler	*Bradypterus grandis*	Bouscarle géante	NT					Near-endemic		
Grey-necked Picathartes	*Picathartes oreas*	Picatharte à cou gris	VU	CITES I		A				
Loango Weaver	*Ploceus subpersonatus*	Tisserin a bec gréle	VU							
Keeled hinged terrapin	*Pelusios carinatus*	Péluse carénée	NE					Near-endemic		
Maran's hinged terrapin	*Pelusios marani*	Péluse de Maran	NE					Near-endemic		
Nile crocodile	*Crocodylus niloticus*	Crocodile du Nil	LC	CITES I		B				
Omboue worm lizard	*Cynisca bjfrontalis*	Amphisbéne d'Omboué	LC					Endemic		
Perret's worm snake	*Leptotyphlops perreti*	Serpent-ver de Perret	NE					Near-endemic		
Pauwels' blind snake	*Letheobia pauwelsi*	Serpent aveugle de Pauwels	NE					Endemic		
Ocellate water snake	*Hydraethjops laevis*	Couleuvre aquatique océllee	NE					Near-endemic		

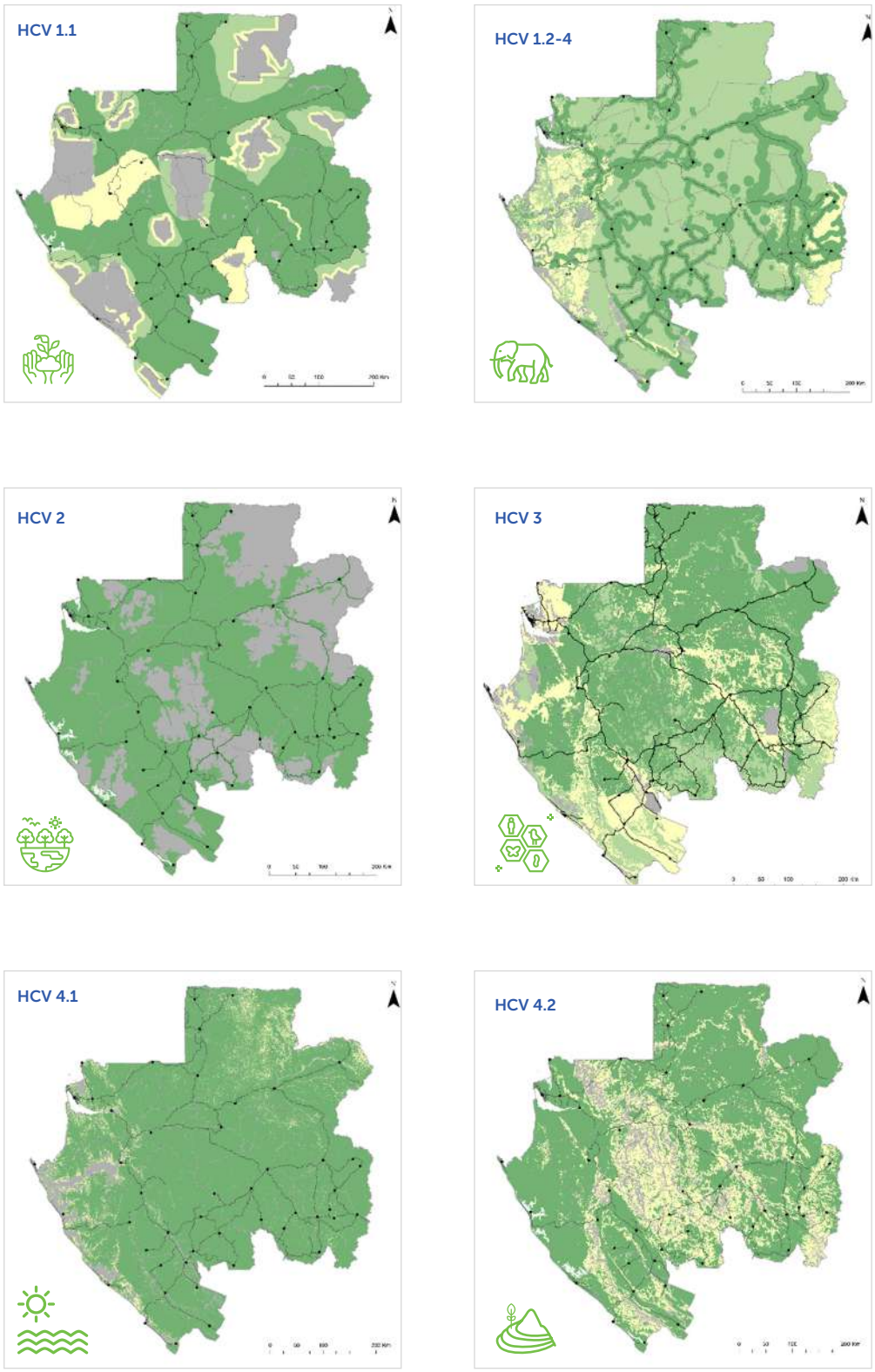
Figure 2. Data used to determine HCV 3. *On the left, each color represents a different ecological habitat unit. On the right, light green represents areas impacted by road use/development.*



Graphical representation of each HCV

Each HCV was mapped, as in Figure 3, to give an indication of zones at different risk levels at a national level. However, it is necessary to carry out more detailed field analyses to confirm or refine this first level of classification, and to adapt the development of selected crops accordingly. It is important to note that certain areas identified as acceptable or favorable for agricultural development with precautions may, during subsequent studies, turn out to harbor HCVs not detected during the national analysis. Conversely, when field studies provide credible scientific evidence that a site identified as prohibited for HCV does not meet the criteria in the field, and especially when efforts are made to considerably protect the values that do exist there, activity could possibly be authorized by competent authorities responsible for implementing this directive. For example, given the development potential in the HCV 3 savannas, the landscape containing this value in the Mouila-Ndendé zone has been studied in the field to determine biologically appropriate reserves to be protected, which were then set aside as HCV 1.1. The landscape around Franceville is currently undergoing a similar study, which intends to protect at least 30% of the savannas.

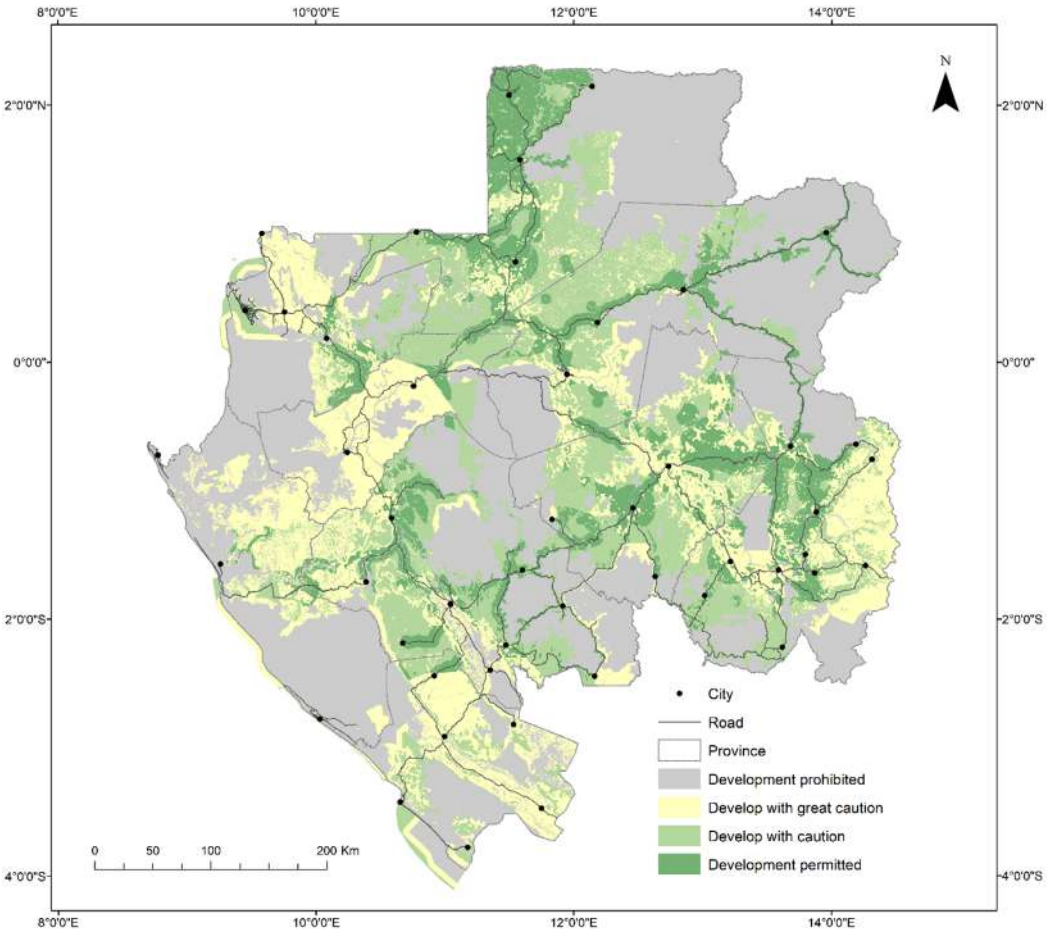
Figure 3. Areas classified by management category (Table 1), for different High Conservation Values: *HCV 1.1 Protected areas; HCV 1.2, 1.3 and 1.4 Priority species - threatened, rare, restricted range; HCV 2 Landscapes of intact ecological function; HCV 3 Rare or threatened habitats; HCV 4.1 Sensitive water resources; HCV 4.2 Erosion control*



These 6 maps representing HCV zones 1 to 4 were combined to produce an overall synthetic map *(Figure 4).* As stated above, this first, national level indication serves to provide overall guidance and must undergo more detailed field analyses during specific impact studies.

At this stage of analysis, we note that half of the country could be developable (14.5 million hectares, or 54% of the country), the other half in gray is prohibited from development (12.1 million hectares, or 46% of the country). However, this does not yet account for areas with high carbon content (HCS), areas that will potentially prove to be important to protect in field studies, or areas to be conserved for local populations *(HCV 5 and 6).*

Figure 4. Synthetic map of zones with High Conservation Values, *a compilation of all maps presented in Figure 3*



1.6 High Carbon Stocks (HCS)

In addition to their biological and ecological values, tropical forests store large amounts of carbon, in the form of above-ground biomass, below-ground biomass, and soil carbon. The High Carbon Stock (HCS)[22] approach aims to identify important areas to protect or restore based on their capacity to store carbon, thereby preventing its release and limiting greenhouse gas emissions when forests are converted or cut. These areas may include both natural forest areas and degraded lands that can be restored to accumulate carbon over the long term.

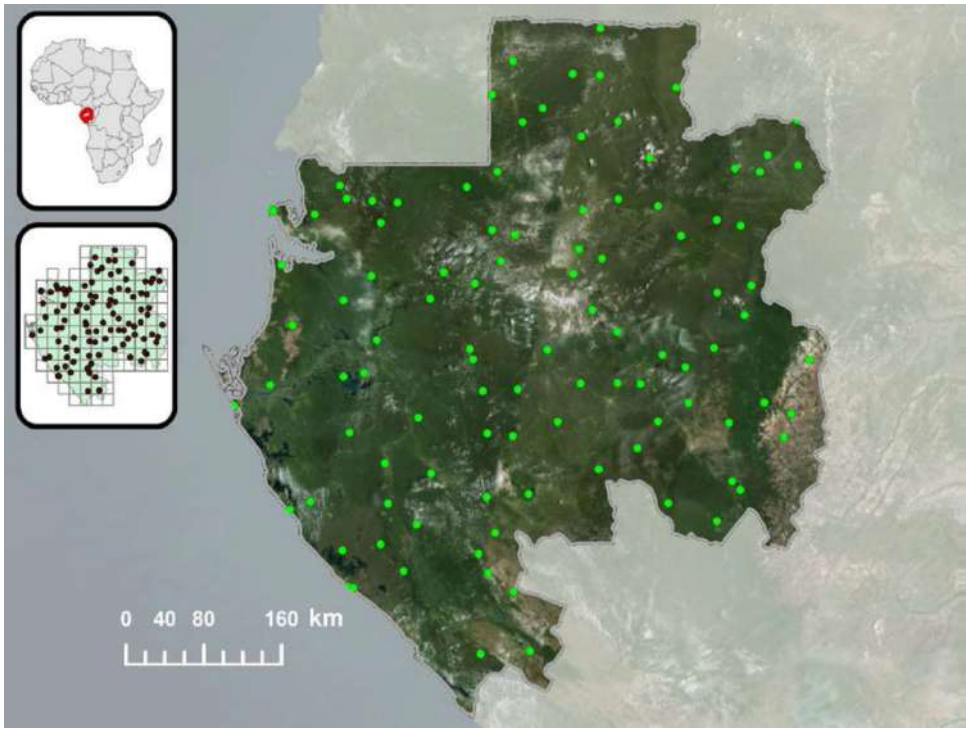
Key to this approach is the identification of carbon threshold values, above which land conversion should be avoided. In Gabon, we conducted field studies to measure carbon to determine threshold values specific to our forests.

A correlation exists between the level of carbon and the nature of a forest which allows a categorization of forest types, with the most mature and intact formations containing the most carbon. However, while the carbon threshold that qualifies a forest as HCS is an important element in identifying HCS areas, it is not the only factor – the surface area of the forest and the nature of the stand must also be considered. In addition, the HCS criterion alone is not always relevant for defining areas to protect – low-carbon formations of great conservation interest also exist in Gabon (dwarf forests, inselberg vegetation, swamps, savannas, etc.).

Identifying HCS

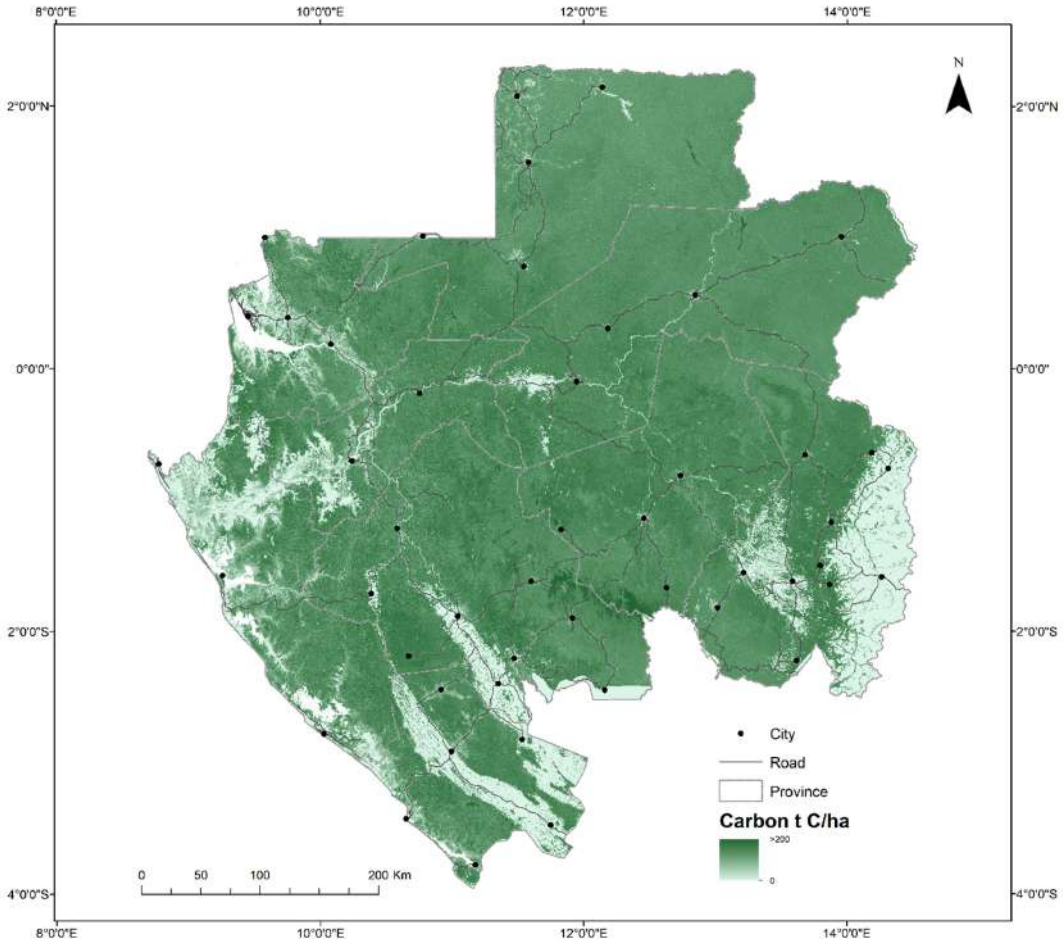
To measure and monitor its forest resources, Gabon launched a national inventory of its natural resources (IRN) in 2012. The inventory is based on a network of 1-ha permanent forest plots distributed in a systematic, random sampling design across the country, to allow an unbiased estimate of carbon stocks *(Figure 5)*. A first set of data from 104 plots was analyzed together with satellite images to interpret carbon stocks across Gabon *(Figure 6)*. A second phase of field data collection is currently underway to strengthen this first interpretation.

Figure 5. National Inventory of Natural Resources (IRN) of Gabon. In the first phase, 104 inventory plots were established in a systematic, random sampling design covering the entire country. Teams of field technicians trained in forest monitoring methods measure the diameters and heights of trees, making it possible to estimate above-ground biomass and carbon stocks. Data collection for the second phase is currently underway.



[22] *http://highcarbonstock.org/wp-content/uploads/2016/11/Final-HCS-Convergence-Agreement-.pdf*

Figure 6. Above-ground carbon distribution *calculated from 104 forest plots and satellite images*



Based on the field data collected, the average carbon content of secondary forests in Gabon is 101.2 ± 31.9 t C / ha, with a value corresponding to the upper 95% confidence interval of 118 t C / ha. By comparison, that of ancient primary forests averages 180.1 ± 14.0 t C / ha .

While conversion of naturally forested habitat usually leads to carbon loss, it may not necessarily, depending on the capacity of the crop to store carbon itself. For example, teak (wood production), rubber (rubber production), and cocoa (cocoa production) sequester carbon themselves.

[23] *Forests with significant disturbance due to current or past human activity, and where the plant population contains a majority of pioneer or secondary species.*

[24] *These carbon estimations were calculated using allometric equations in Chave et al. (2014) Improved allometric models to estimate the aboveground biomass of tropical trees. Global Change Biology 20(10) :3177-90. Note that estimates of carbon could be adjusted in the future using a new Gabon-specific allometric equation (e.g. Ngomanda et al. (2014) Site-specific versus pantropical allometric equations: Which option to estimate the biomass of a moist central African forest. Forest Ecology and Management 312: 1–9.)*

In terms of oil palm sequestration, the amount of carbon stored in a mature plantation is 72 t C / ha. The value of carbon stored is in fact cyclic, since palms are replaced at the end of their rotation of 25 to 30 years. The carbon sequestered at maturity is reduced to a value close to zero when the palm trees are cut and replaced. When calculating carbon balances with this dynamic, the average carbon sequestered during the cycle is therefore 36 t C / ha over the duration of the rotation. Thus, planting oil palm in areas with an initial biomass less than 36 t C / ha will allow for a positive carbon balance – the ability to remove C02 from the atmosphere.

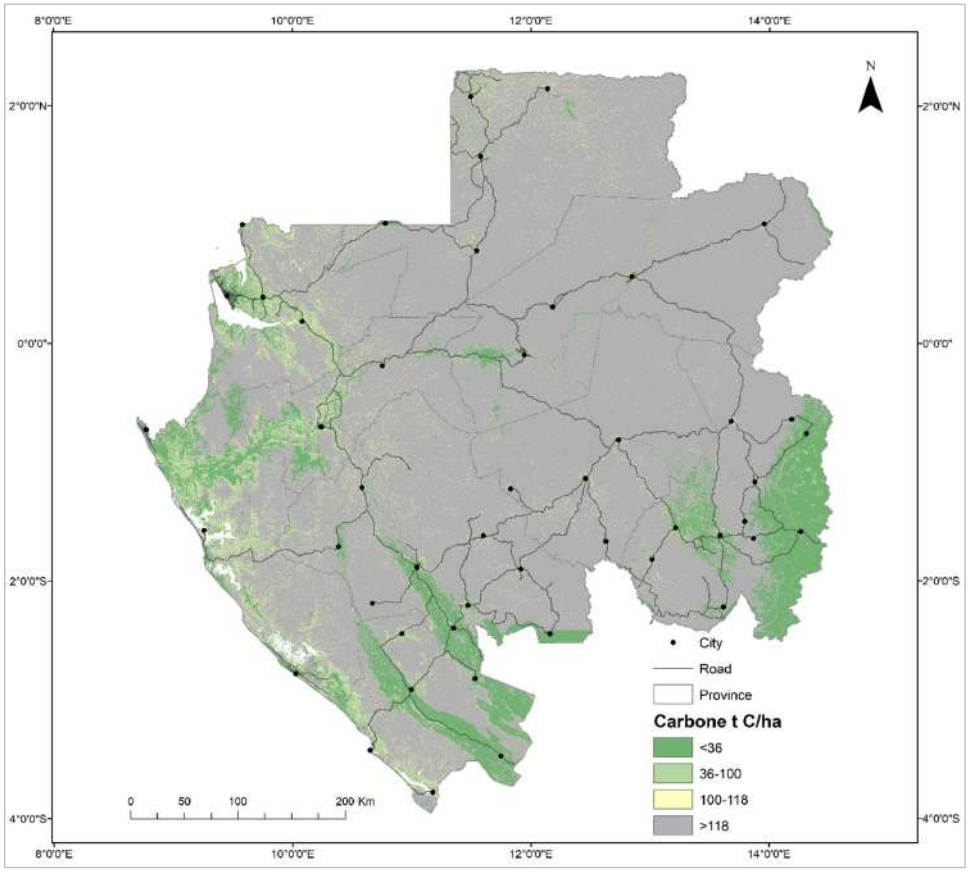
HCS management

Based on these data, thresholds were established for carbon management for the country (Table 3, Figure 7). Agriculture is favored in green zones – areas with less than 36 t C / ha – as their conversion would minimize carbon loss, or even improve sequestration, in the case of plantation trees. Zones in light green (from 36 to 100 t C / ha), and especially in yellow (from 100 to 118 t C / ha) will only be considered for agriculture after a detailed study of their type of forest cover. If field evaluation indicates the area is degraded forest with low conservation and/or heritage value, it could be used for agricultural activities. However, if field assessments determine the forest to be of high conservation value, agricultural expansion will be prohibited. Beyond the threshold of 118 t C / ha, cultivation of oil palm is prohibited.

Table 3. Above-ground carbon values by development category

Resources to protect	**Green zone** Development permitted	**Light Green Zone** Develop with caution	**Yellow Zone** Develop with great caution	**Shaded zone** Development Prohibited
Carbon stocks	<36 t C/ha	36 to 100 t C/ha	100 to 118 t C/ha	>118 t C/ha

Figure 7. Carbon management zones. *The development of oil palm is prohibited in zones masked in gray (20.9 Mha, or 80% of the country); subject to specific management in zones shown in yellow (1.1 Mha) and light green (1.1 Mha); and subject to standard management in areas in green (2.9 Mha, or 11% of the country).*



2 Context and framework of a new agricultural model in Gabon

2.1 Oil palm: a strategic government decision

Land is a precious, fragile, and limited resource. It is coveted by various stakeholders, including local populations. The decision to devote arable land to agro-industrial production must therefore be strategic and justified. The choice of crop and its agronomic suitability in one region or another must be scrupulously studied to ensure agricultural optimization, in terms of productivity as well as local and national benefits. This is an essential prerequisite for the validation of an agricultural project.

The choice of oil palm plantations is a strategic decision by the government, for several reasons, the most important being:

Its natural growth potential.

Oil palm is native to Africa, with a long and proven history in Gabon. Its intensive cultivation and use dates back 2800 years, in central Gabon .

Its high yield per hectare.

Growing oil palms requires almost 10 times less area than other oilseed plants .

Realistic, sustainable job creation.

One of the main motivations for development of the sector is the creation of new work opportunities. However, due to its hardiness and adaptability, oil palm is less labor-intensive than other crops, which is ideal for a country like Gabon, with its low population density.

After long deliberations and consultations, the government concluded that oil palm is a crop that offers the best economic and social outcomes for an environmental footprint that can be minimized when development is planned and implemented to high standards. That said, the positive economic and social benefits of palm oil production should be sought only if the environmental and social impacts are kept at acceptable levels at each stage of development.

[25] *Oslisly R, White L, Bentaleb I, Gavier C, Fontugne M, Gillet J, Sebag D (2013) Climatic and cultural changes in the west Congo Basin forests over the last 5000 years. Phil. Trans. R. Soc. B.*
[26] *Rival A, Levang P (2013) La palme des controverses – Palmier à huile et enjeux de développement. Ed. QUAE, 98p.*

2.2 Agricultural productivity of oil palm cultivation

To identify the most important zones in terms of development, the agricultural productivity of industrial oil palm cultivation was mapped across Gabon.

Based on current technologies available, zones suitable for productive, large-scale cultivation were identified by taking into account annual and seasonal rainfall, dry season length, temperature, elevation, hilliness, soil texture, pH, cation exchange capacity and drainage *(Table 4, Figure 8)*. These factors impact crop yields and economic viability, and thus the overall likelihood that oil palm could be cultivated profitably at an industrial scale.

The study determined suitability thresholds for each factor based on the literature and in consultation with agronomists with field experience in Gabon *(Table 4)*. These factors were then combined into a single map indicating areas of oil palm productivity *(Figure 9)*.

During development of this model, agronomists visited sites located along the corridors of Libreville-Ndendé, Libreville-Makokou, and Franceville-Plateaux Batékés to verify and refine the map iteratively with spatial analysts. Field verification of other zones remains to be done and could significantly alter the map and surface area predictions.

According to this analysis, nearly **3.2 million** hectares of land (~ 12% of the country) appear to be 'Very productive' for industrial oil palm cultivation, and **9.8 million** hectares (~ 38% of the country) 'Productive'.

Table 4. *Oil palm productivity indicators*

	Factor	Very productive	Productive	Marginal	Non-productive
Climate*	Mean annual temperature	> 23.5 ^{0}C	23.0 – 23.5 ^{0}C	20.0 – 23.0 ^{0}C	
	Mean annual rainfall	>1750 mm		1500 – 1750 mm	< 1500 mm
	Mean driest 1/4 of year	> 90 mm	50 – 90 mm	20 – 50 mm	< 20 mm
	Mean wettest 1/4 of year	> 650 mm	600 – 650 mm	550 – 600 mm	
Topography^@	Elevation	< 500 m	500 to 650 m		> 650 m
	Hilliness (topographic ruggedness of catchments)	Flat (TPI std <5)	Sloping (TPI std 5 – 7)	Hilly (TPI std 7 – 13)	Rugged (TPI std >13)
Soil[#&] and inundation[%$]	Texture	All other textures	Sandy clay (25-55% clay and 60-85% sand)		Heavy clay (> 70% clay) and sand (> 85% sand)
	Coarse fraction	Low		High	
	Cation exchange capacity	> 16 cmol/kg		< 16 cmol/ kg	
	Soil acidity (pH)	4 – 6		3.4 – 4 and 6 – 6.7	
	Inundation	No inundation			Inland water bodies & wetlands (swamps, coastal wetlands, flooded, alluvial & mangrove forests)

*Sources: * Database - WorldClim. Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. ^ SRTM DEM. Jarvis, A, Reuter H, Nelson A, Guevara E (2008) CGIAR-CSI SRTM 90m Database. Hole-filled SRTM for the globe, version 4. @ Jenness, J (2006) Topographic position index (TPI) v. 1.2. Flagstaff, AZ: Jenness Enterprises; We calculated the standard deviation of the TPI raster per catchment. Catchments (average size 21km^2) were generated using Arc Hydro Tools (ArcGIS), on a hydrologically-corrected SRTM (Lehner, B, Verdin K, Jarvis A (2008) New global hydrography derived from spaceborne elevation data. EOS, Transactions American Geophysical Union 89:93-94). # ISRIC – World Soil Information (2013) Soil property maps of Africa at 1 km. Available online at: http://www.isric.org/data/soil-property-maps-africa-1-km. & Field data taken by oil palm agronomists in Gabon. % World Wildlife Fund (2004) Global Lakes and Wetlands Database: Lakes and Wetlands Grid (Level 3). Available online at: http://worldwildlife.org/publications/global-lakes-and-wetlands-database-lakes-and-wetlands-grid-level-3. $ Lehner, B and P Doll (2004) Development and validation of a global database of lakes, reservoirs and wetlands. Journal of Hydrology 296/1-4: 1-22.*

Figure 8. Maps of criteria used to assess productivity for industrial oil palm cultivation, showing the extent of Very productive, Productive, Marginal and Non-productive categories

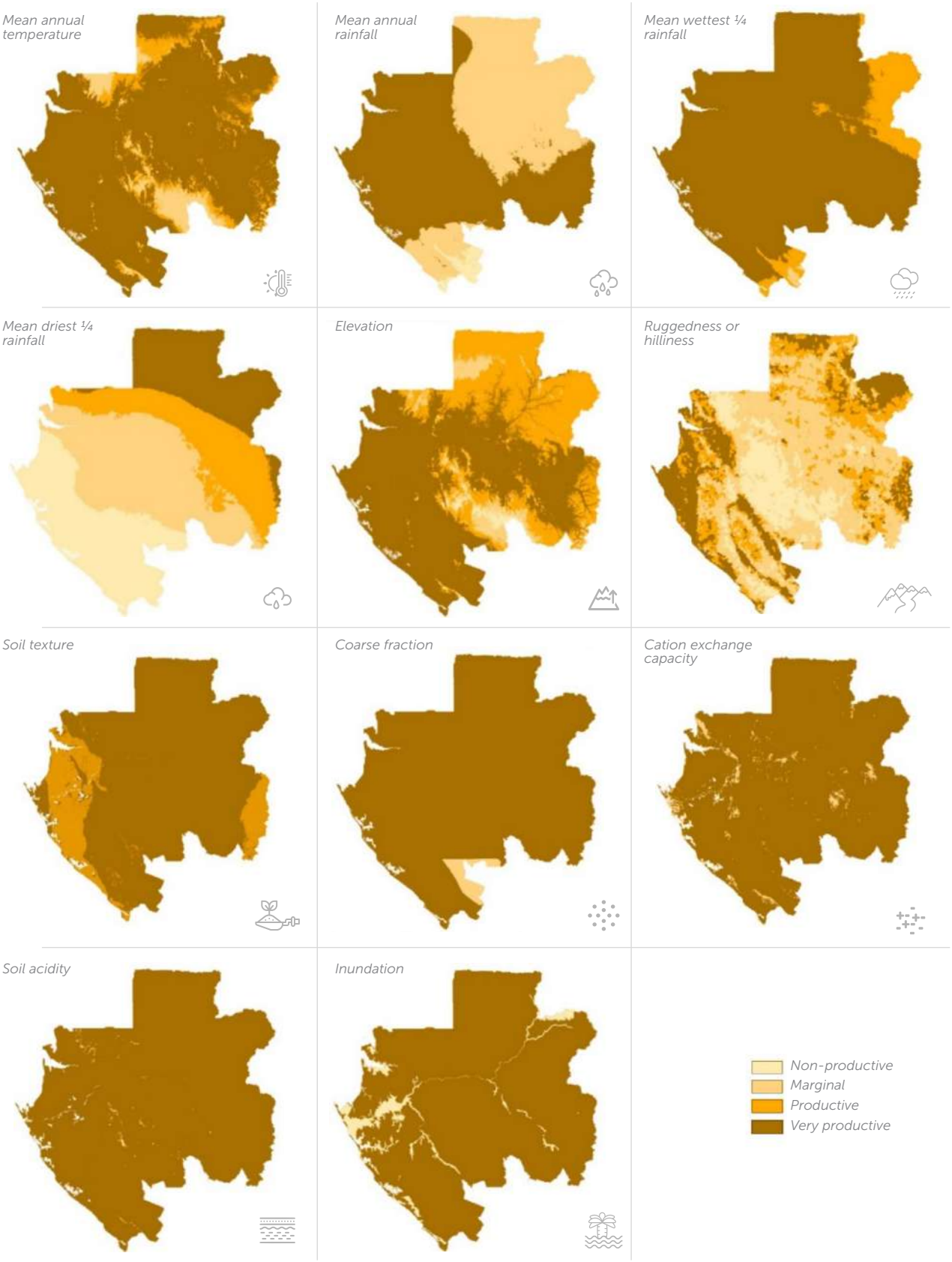
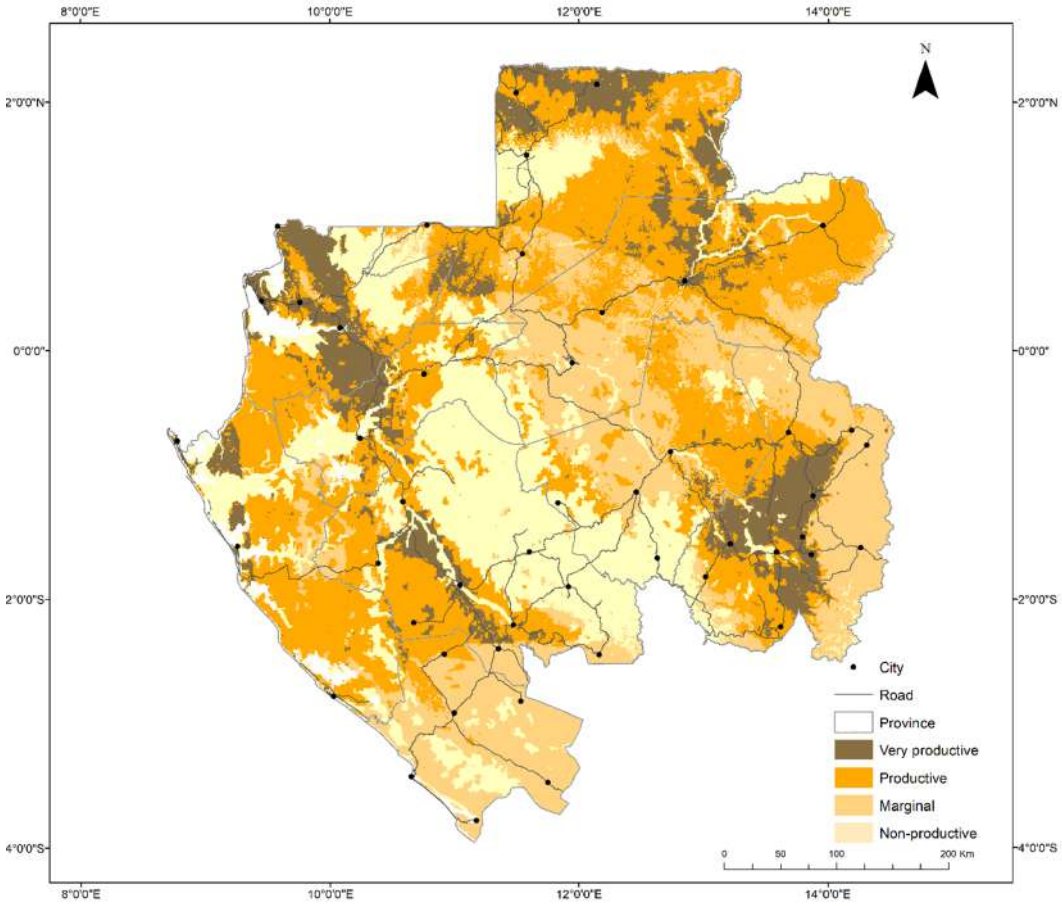


Figure 9. Suitability of oil palm for industrial operations *based on climate, topography, soil, and inundation. Area of "Very productive" land: 3.2 Mha (31,784 km2), or 12% of the country. "Productive" land: 9.8 Mha (98,026 km2), or 38% of the country. These potential areas do not yet include areas to be protected, which significantly reduce these opportunities - see below.*

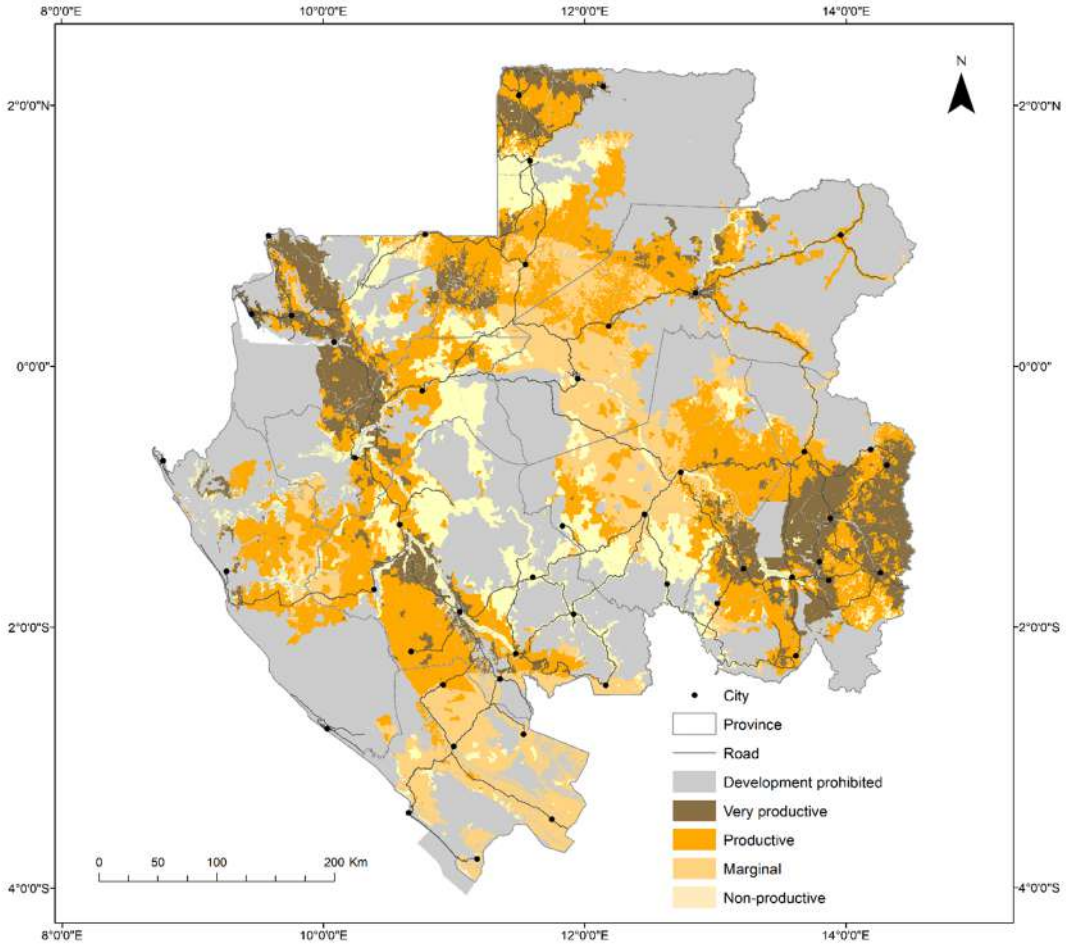


2.3 Productive sites for oil palm outside the HCV and HCS zones

Area available for oil palm cultivation outside HCV zones

By overlaying the map of oil palm productivity *(Figure 9)* with the highest level HCV zones where development is prohibited (areas in gray, Figure 4), several regions were identified as agriculturally productive without infringing on the highest environmental conservation values at the national level *(Figure 10)*.

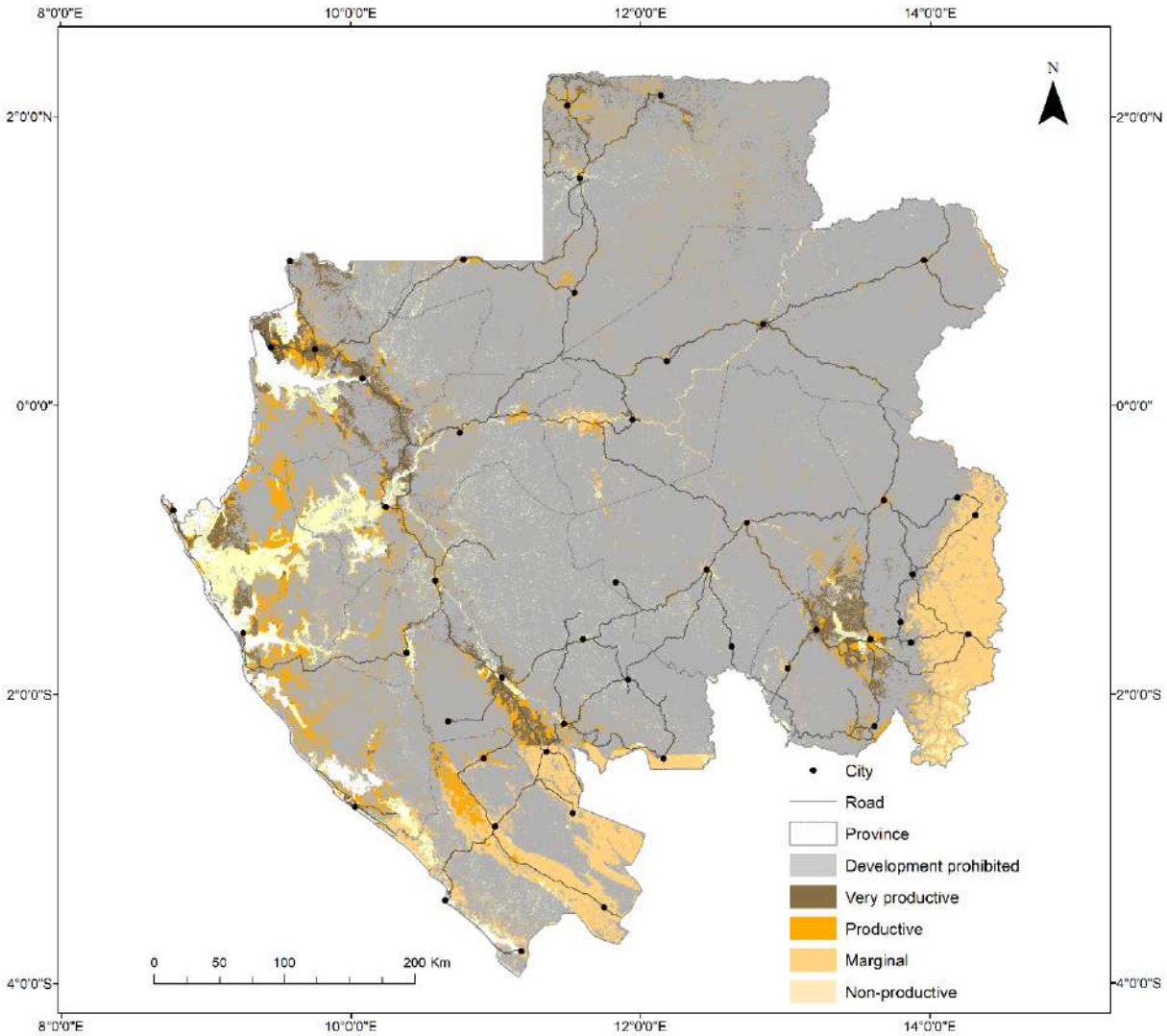
Figure 10. Oil palm suitability and areas where development is prohibited for HCV. *This map overlays the gray prohibited zones for HCV 1-4 (Figure 4) on top of the oil palm productivity map (Figure 9). Non-gray areas would be available for agriculture without infringing on the highest HCV 1-4. The "Very productive" category is 2.1 million hectares (20,855 km2, or 8% of the country). The "Productive" category represents 5.5 million hectares (54,574 km2, or 21% of the country). Note, this does not include HCS or social elements (HCV 5-6) that must also be considered.*



Area available for oil palm cultivation outside the highest HCS zones

By overlaying the map of oil palm suitability *(Figure 9)* with the highest level HCS zones where development is prohibited *(areas in gray, Figure 7)*, several regions were identified as agriculturally productive without infringing on the highest carbon stocks at the national level *(Figure 11)*.

Figure 11. Oil palm suitability and areas where development is prohibited for HCS (above-ground biomass greater than 118 t C / ha). *This map overlays the gray prohibited zones for HCS (figure 7) on top of the oil palm suitability map (Figure 9). Non-gray areas would be available for agriculture without infringing on the highest carbon stocks. The "Very productive" category measures 0.8 million hectares (8,143 km2, or 3% of the country). The "Productive" category represents 1.2 million hectares (12,296 km2, or 5% of the country).*



Area available for oil palm cultivation outside of the highest HCV and HCS zones

By overlaying the map of oil palm suitability (Figure 9) with the highest HCV and HCS zones where development is prohibited *(Figures 10 and 11)*, several regions were identified as agriculturally suitable without infringing on the highest HCV 1-4 or HCS at the national level *(Figure 12, Table 5)*. A large overlap exists between zones excluded for HCV and HCS (9.4 million hectares, or 36% of the country). Outside of this overlap zone, 44% of the country is excluded only for HCS, and 9% only for HCV. The area remaining for industrial oil palm cultivation in the "Very productive" category is 506,156 ha, and in the "Productive" category is 668,875 ha; together, representing 4.5% of the country.

Figure 12. Oil palm suitability and areas where development is prohibited for HCV and HCS. *This map overlays the prohibited zones for HCV and HCS (Figures 10 and 11) on top of the oil palm suitability map (Figure 9). Non-gray areas would be available for agriculture without infringing on these HCV and HCS resources. The "Very productive" category measures 506,156 hectares, or 1.9% of the country. The "Productive" category represents 668,875 hectares, or 2.6% of the country. Together, these suitable areas represent 4.5% of the country.*

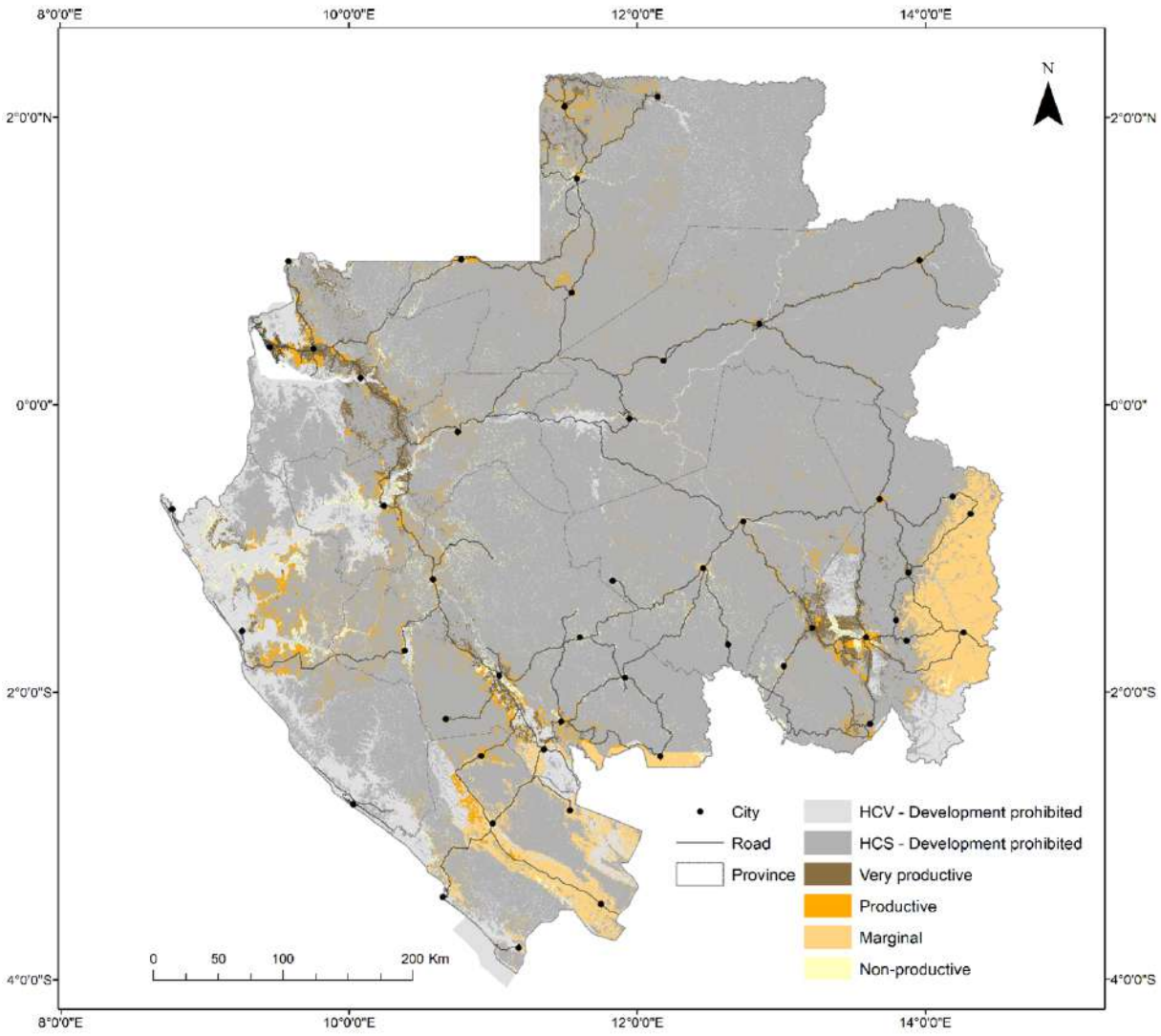


Table 5. Potential surface area for industrial oil palm cultivation in Gabon, excluding areas where development is prohibited for HCV, HCS, and both. The most important categories (shown in bold) are those that are "Very productive" (506,156 ha) and "Productive" (668,875 ha), together representing 4.5% of the country.

Oil palm suitability	Area in Gabon (Mha)	Excluding the highest HCV 27 category (Mha)	Excluding the highest HCS category (Mha)	Excluding both (Mha)
Very productive	**3.2**	**2.1**	**0.8**	**0.5**
Productive	**9.8**	**5.5**	**1.2**	**0.7**
Marginal	**6.7**	**4.3**	**2.0**	**1.4**
Non-productive	**6.3**	**2.6**	**1.1**	**0.4**
Total	**26.0**	**13.6**	**5.1**	**3.0**

[27] *We note, again, that these calculations are based on environmental variables only. Field-level studies are required to identify and protect social elements, specifically HCV 5-6 which relate to local land use and cultural values.*

2.4 Conclusions and perspectives

These national guidelines for site selection of industrial oil palm development were produced to demonstrate our will to promote sustainable agriculture and guide investors and regulators towards responsible production that respects Gabon's commitments to economic development as well as environmental conservation.

The spatial analysis is the result of fieldwork coupled with satellite imagry interpretation and other country-wide data. The results provide a first identification of suitable areas for industrial oil palm cultivation that minimize environmental risk, nationally.

This analysis does not replace environmental and social impact studies or HCV and HCS field studies, which are mandatory before any decision to grant development authorization. Through these field studies, it is important to validate – or if necessary to adjust – the risk maps according to realities on the ground, in particular to integrate social aspects (HCV 5-6) which are not included in this national-level directive, due to their local variability.

These national guidelines are dynamic and intended to evolve based on the results of current and future research. However, its objective will remain: to guide the development of the oil palm industry without compromising the biodiversity, ecosystems, and rural populations of Gabon.

Guidelines for other agricultural crops are being considered. In the meantime, this directive is applicable to all agro-industrial crops.