ESTIMATING THE GREENHOUSE GAS EMISSION POTENTIAL DUE TO CONSTRUCTION WORK ON THE 225 kV SEGOU - BAMAKO HIGH VOLTAGE BI-TERNAL ELECTRIC LINE IN MALI IN A CONTEXT OF CLIMATE CHANGE

ABSTRACT

The aim of this study is to assess the carbon emissions resulting from the construction of the power line linking Bamako to Ségou. It focuses on direct emissions, more specifically those linked to the degradation and destruction of the project's vegetation cover. To collect the data, surveys were set up on the project right-of-way, through which 3,302 individualtreeswereinventoried*in situ* at the three sites. Circumferencewasmeasured at 1.30 m from the ground surface. Allometricequationswereused to estimatebiomassdirectly, usingtreediameter as a predictor. Emission factorswerethenused to estimate the potentialgreenhousegasemissionsresultingfromtreefellingduring power line construction. The standard errorassociatedwith the carbon fraction in dry biomasswascalculated. Several plant species can befound in the Ségou, Koulikoro and Dioïlaproject areas, providinglocal populations with a range of ecosystem services, including micro-climateregulationthroughcarbonsequestration or absorption of atmosphericCO_2 . The implementation of the projectwillundoubtedlyresult in the felling of thesetrees. This fellingwillgenerateemissions of 22.11 t.eqCO2/ha in Ségou, 16.56 t.eqCO_2 /ha in Koulikoroand 15.43 t.eqCO_2 /ha in Dioïla. Across Ségou, Koulikoro and Dioïla, trees in the project right-of-way represent a reservoir of 34.04 t/ha of above-ground woody biomass. This biomass represents a carbon reservoir of around 16.58 t.C/ha. Felling the trees in the right-of-way will transform this carbon sink into a carbon source, with emissions estimated at 60.78 t.eqCO_2 /ha. It is therefore urgent to take compensatory measures by erecting compensatory reforestation areas.

Keywords: *Mali, Greenhouse gas emission potential, power lines, emissions accounting, carbon, carbon dioxide*

1. INTRODUCTION

In Mali, as in all developing countries, the energy sector plays a crucial role in the provision of basic social services. However, it has to be said that the country's energy system is still in a state of disrepair, which is slowing down its development. In fact, electric power is the lifeblood of income-generating opportunities in all development sectors, notably agriculture, food processing, light and heavy industry, etc.

To develop its energy sector, in 2006 the Malian government adopted a policy aimed at improving the operational efficiency of the existing electricity system and increasing access to modern energy services. This policy has benefited from the financial support of several donors, one of the most recent of which is a $150 million financing agreement for the electrification of the city of Bamako and its outskirts. The 2016-2025 action plan, based on the Optimal Investment Master Plan (PDIO) for the electricity sub-sector drawn up in 2008 and updated for the 2015-2035 period, calls for the construction of a 225 kV line linking

Bamako to Ségou. The implementation of such a project must take into account environmental and social aspects in order to best preserve the biophysical and socio-economic environment for sustainable and harmonious development (World Bank, 2019).

Indeed, the corridors of power lines to be rehabilitated and reinforced are often occupied by human settlements, with all the risks of electrocution and impacts from the electromagnetic waves emitted by the lines. For the new lines to be created, including the Ségou-Bamako line, the corridor to be identified is certainly occupied by fields and dwellings of all kinds. It is therefore essential to apply the environmental and social provisions in force for the project, in order to identify and assess the impact of the line's construction work on the environmental components and socio-economic framework of the localities crossed. Accounting for carbon emissions provides an essential basis for assessing efforts to achieve "peak carbon dioxide emissions" and "carbon neutrality" objectives, which can contribute to the implementation of the new power system [Shu, Y.B. et al., 2021].

The construction of the Ségou-Bamako line requires carbon accounting during the construction phase. Most carbon emissions from conventional power systems come from the combustion of fossil fuels during electricity generation [Kang, C. et al., 2015]. As a result, current research into carbon accounting in the electricity sector focuses mainly on the electricity generation phase [Ge, Z. et al., 2023]. In the future, the share of clean power generation will continue to increase [Wei, W., et al., 2020], leading to a significant reduction in carbon emissions during the power generation phase. However, the proportion of carbon emissions from the construction phase of electricity transmission and transformation projects will continue to increase in overall power system emissions [Wei, W., et al., 2020]. Therefore, research into carbon emissions accounting systems during the construction phase of power transmission and transformation projects is of great importance in establishing a useful database for carbon emissions in the power system.

In existing research, carbon emissions have mainly been calculated at building level only. To date, very few detailed calculations of carbon emissions during the construction process of electrical equipment have been carried out.

The accounting pool is divided into three stages based on the characteristics of the power line and substation construction process, namely generation, transmission and construction. The aim of this study is to assess the carbon emissions resulting from the construction of the power line linking Bamako to Ségou. It focuses on direct emissions, more specifically those linked to the degradation and destruction of vegetation cover on the project's right-of-way.

2. MATERIAL AND METHODS

2.1 Presentation of the project's receiving environment

Mali is a Sahelian country, with variations fromnorth to south, fromariddesert zones to humidSudanian zones, passing throughsemi-aridsectors. Geomorphological, geological and biologicalforms have adapted to the varyingaridity of the climate in different parts of the country.

The corridor of the selected power line crosses a receivingenvironmentwhosecharacteristics are just as varieddepending on the regioncrossed. The line crosses the regions of Koulikoro, Ségou and Dioïla (Fig.1).

The study area islocated in the Sahelian zone, and therefore has a climatecharacterized by two (2) seasons: a dry season and a rainyseason. The Ségou regionisdrained by the waters of the Niger River, which crosses the region in a roughlysouth-north direction, and the Bani River to the south of Ségou. The Bani and Niger rivers are very important water currents, covering a watershed network of around 300 km. Theseriversalsoofferenormous hydro-agricultural potential (Markala dam and Talo weir in operation).

Natural factorsaffecting air quality are largely due to the production and transport of particles by vehicles on the RN6, as well as naturalphenomenasuch as the harmattan. Air qualitydegradationfactors in the area are alsoanthropogenic (bush fires are veryfrequent in the area). Potentialreceptors in the area are the villages crossed by the high-voltage line and the immediatevicinity of the project.

The study area ischaracterized by a gentlyslopingtopographyof sandy, alluvial, silty and clayeyplains and lowlandssuitable for ricegrowing and livestockrearing. The geologyisrepresented by loose sandy-clay formations of the intercalary and terminal Continental (Quaternary). The UpperCambrian Koutiala sandstoneborders the southern part of the Segouregion. The lithologyisalsomarked by Quaternary surface formations consistingmainly of old and recentalluvium, dunes and sandy areas frequentlyencountered in the Macina and Niono circles. In the Ségou region, there are 9 types of soil:dead and flattened dunes, flattened dunes, plain soils (2 types), lateriticcuirasssoils, hydromorphicsoils (lightly or not flooded), regularlyfloodedhydromorphicsoils, rockysoils and specialsoils.

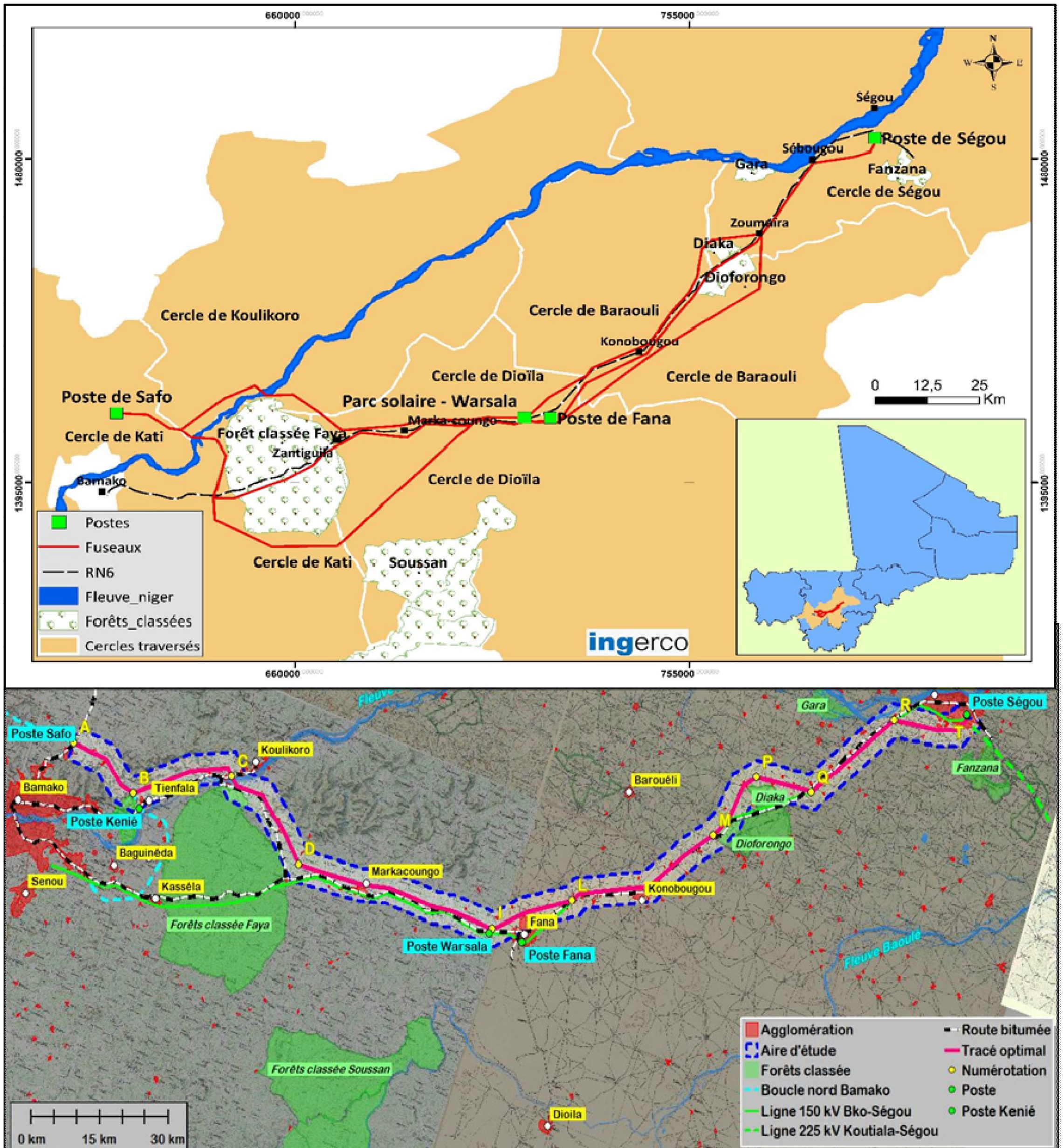

Fig.1. Geographical location of the project'sreceivingenvironment

The projectislocated in six (6) communes in the Ségou region, which, like other communes in Mali, have experiencedrapiddemographicgrowth over the pasttwodecades, with an estimated population of 433,725 in 2023. Ségou is the mostpopulous commune in the zone, witharound 204,850 inhabitants. It shouldbenoted, however, that the rural exodusishaving a considerable impact on theselocalities.

The economicactivities of the populations in the study area are essentiallybased on pettytrade, fishing, agriculture (marketgardening), livestockbreeding, industry and handicrafts. The data collected in the fieldindicate the following land-use unit statistics:2,335,956.38 m² of fields, 1,676.29 m² of physical structures (wells, henhouses, septic tanks, toilets, basements), 5,195 m² of empty plots and 5,484.42 m² of cement buildings, 1,478.94 m² of banco buildings, 4,639.60 ml of banco boundarywalls, 1,780 ml of cementboundarywalls, 150 m² of mosques and 1,672.34 m² of vergé.

2.2 **Equipment** used

Data collection and processing equipment includes:

- a GPS for geographic coordinates;
- a decameter for measuring tree circumference;
- a camera to capture images in the field;
- Excel 2016 software for data processing.

2.3 *In situ* surveys

The observation unit is the project right-of-way. Treecircumferenceis the main dendrometric data collected. An exhaustive and systematictreeinventorywascarried out in the Ségou, Koulikoro and Dioïlalocalities. Data and analyses at right-of-waylevel are extrapolated to the surface area of one hectare to estimatebiomass.

A total of 3,302 treeswereinventoried*in situ* at the three sites. Circumferencewasmeasured at 1.30 m from the ground surface.

2.4 Method for estimating above-ground woody biomass (Ba)

In forestry, severalmodels can beused to estimatetreebiomass. *Firstly*, allometricequations for direct biomass estimation, usingpredictorssuch as diameter, height, crown dimensions, volume and treebiomass.

Secondly, we note indirect methodsthat use a cubage rate to convertdiameter, and possiblytrunkheight, intotrunk volume and thentakeintoaccountwooddensity to converttrunk volume intotrunkbiomass. The latter isthenextended to total above-groundbiomass*via* a biomass expansion factor [Panzou *et al.,* 2016;Maliro*et al.,* 2010].

This research has opted for the use of allometricequations for direct biomass estimation, usingtreediameteras a predictor.

As the researcharea islocatedin the Sudaniandomain, where the climateis tropical with an averagerainfall of lessthan 1,500 mm/year, the allometricequation of Mbow*et al.* [2014] is best suited to suchclimatic conditions, and wasthereforeused to estimatewoodyabove-groundbiomass. The formula of this model is: $B_a = 1{,}929 \times D + 0{,}116 \times D^2 + 0{,}013 \times D^3$

WithBa:Above-groundbiomass in kg, D: Diametermeasured at breastheight (cm).

2.5 Estimated CO emissionpotential$_2$

There are two main approaches to accounting for greenhousegasemissions: the calculationapproach and the measurementapproach. The former can bedividedintotwocategories:the methodbased on carbonemissionfactors and the methodbased on ecologicalbalance analysis. Of thesetwomethods, the measurementapproachrequires on-site measurement data of emission sources, which enables precisecalculationresults to beobtained. Given the complex nature and long duration of power line and substation construction work, as well as project volume analysis, the use of the carbonemission factor method for estimatingemissionsismore appropriate[Gao, H., et *al*., 2023]. The carbonemission factor methodiswidelyused and simple to implement. Therefore, thismethodisadopted in the presentresearchto estimate the potentialcarbonemissions due to treefelling in the right-of-way of the transmission line construction project.

To calculate the above-groundbiomasslossesthatwillresultfrom the felling of trees in the project right-of-way, emissionfactors in CO equivalent$_2$ are calculatedusing the followingequation:

$EF = B_a \times FCFC_{(Ba)} \times FCC_{(\,eqCO2)}$

*EF:*emissionfactorst.eq CO_2 */ha;* B_a : above-groundbiomass in t.MS; $FCFC_{(Ba)}$: conversion factor for the carbon fraction of biomassequal to 0.487 proposed by Gendehou*et al.* (2012).

$FCC_{(éq\ CO2):}$ Conversion factor from Carbon to CO equivalent$_2$equal to 44/12.

2.6 Uncertainty in estimatingabove-groundwoodybiomass and CO_2

The standard errorassociatedwith the carbon fraction in dry biomass (FC) is 0.206 (Réjou-Méchain *et al.,* 2017). The 95% confidence intervalaround FC istherefore ± 1.96. Sincecarbon stock is the product of biomass (Ba) and FC, the error on carbon stock isestimated by following the classicrule of error propagation in the case of a product of uncertainquantities:

$$Ec = \text{Ba} \times \sqrt{\left(\left(\frac{\text{EBa}}{Ba}\right)^2 + \left(\frac{\text{EFC}}{FC}\right)^2\right)}$$

WithEC:error on carbon stock (tC/ha), EBa: error on above-groundbiomass Ba (in tMS/ha) and E: error on carbon fraction in dry biomass (in tMS/ha).

3. RESULTS AND DISCUSSION

Within the project area in Ségou, Koulikoro and Dioïla, there are a number of plant speciesthatprovidelocal populations withvariousecosystem services, includingmicroclimateregulationthroughcarbonsequestration or absorption of atmospheric CO_2 (Table 1).

Table 1:Floristicspecies in the Ségou project right-of-way

Scientific name	Bambara name	Status	Number	Di_moy (m)	Ba (tMS/ha)	C (t/ha)	EF (t.eqCO_2 /ha)
Vitellariaparadoxa	Shi	EIP	1053	2,47	7,872	3,834	14,057
Adansonia digitata	Zira	EIP	235	2,84	2,820	1,373	5,036
Acacia albida	Balanzan	EIP	232	1,58	0,480	0,234	0,857
Tamarindus indica	Ntomi	EIP	23	2,58	0,337	0,164	0,602
Manguifera indica	Mangoro	EVE	10	2,6	0,233	0,114	0,417
Ficus platyphylla	N'kaba	FR	*1*	2,95	0,216	0,105	0,385
Parkia biglobosa	Nèrè	EIP	11	2,48	0,210	0,102	0,375
Ficus gnafalocarpa	Toroba	FR	1	1,93	0,064	0,031	0,114
Borassus aethiopum	Sébé	EPP	42	1,17	0,046	0,023	0,083
Bombax costatum	Bumbu	EPP	3	1,31	0,022	0,011	0,040
Azadirachta indica	Neem	BO	11	1,12	0,019	0,009	0,035
Jatropha curcas	Bagani	FR	434	0,4	0,014	0,007	0,025
Anacardium occidentale	Sômô	EVE	23	0,88	0,013	0,007	0,024
Lanneamicrocarpa	Mpékuba	FR	4	1,02	0,011	0,005	0,020
Annonasquamosa	Sunsun	EVE	2	0,97	0,009	0,004	0,015
Balanites aegyptiaca	Zèguènè	BF	3	0,93	0,008	0,004	0,014
Ziziphus	N'tômônô	FR	25	0,5	0,003	0,001	0,005

mauritiana							
Eucalyptus camaldulensis	Mantilatumyiri	BO	75	0,42	0,003	0,002	0,006
Tectona grandis	Tèki	BO	1	0,55	0,001	0,001	0,003
			2188	**Sum**	**12,38**	**6,03**	**22,11**
				Average	**0,65**	**0,32**	**1,16**
				Deviation	**1,86**	**0,91**	**3,32**
				± 95% CI	**1,04**	**0,72**	**1,39**

Di_mean:Meandiameter; Ba: Above-groundbiomass; C: Carbon; EF: Emission factor; t.eqCO_2 /ha: Tonne of carbondioxideequivalent per hectare, ± 95% CI: Uncertainty
EIP: Espèce Intégralement Protégée; EPP: Espèce Partiellement Protégée; BO: Bois d'œuvre; FR: Fruitier; EVE: Espèces à valeur économique, BF: Bois de feu.

Source:*2023 fieldsurvey*

A total of 19 species have been identified inthe Ségou region, including 5 fully protected species (EIP), 2 partially protected species (EPP), 3 species with economic value (EVE), 3 species used as timber (BO), 5 fruit species (FR) and one firewoodspecies (BF).

Analysis of Table 1 shows that the trees in the project right-of-way in Ségou represent a reservoir of 12.38 tonnes of biomass per hectare, i.e. a carbon stock of around 6.03 t/ha. Implementation of the projectwillundoubtedlyresult in the felling of thesetrees. This fellingwillgenerateemissions of 22.11 t.eqCO_2 /ha. These values containdisparitiesbetween the differentspecies. The felling of *Vitellariaparadoxa*treeswillgenerate 14.06 t.eqCO_2 /ha, while the felling of *Tectona grandis* treeswillresult in almost 0.003 t.eqCO /ha.$_2$

Table 2 shows the plant species in the project right-of-way in Koulikoro.

Table 1 Floristic species in the project area in Koulikoro

Scientific name	Bambara name	Status	Number	Di_moy (m)	Ba (tMS/ha)	C (t/ha)	EF (t.eqCO_2 /ha)
Manguifera indica	Mangoro	EVE	209	2,6	4,69	2,285	8,38
Vitellaria paradoxa	Shi	EIP	235	2,12	2,84	1,381	5,06
Adansonia digitata	Zira	EIP	25	2,90	1,21	0,592	2,17
Parkia biglobosa	Nèrè	EIP	2	2,45	0,33	0,162	0,60
Bombax costatum	Bumbu	EPP	6	1,22	0,05	0,024	0,09
Citrus sinensis	Lemouroub a	EVE	549	0,40	0,04	0,021	0,08
Borassus aethiopium	Sébé	EPP	6	1,17	0,04	0,021	0,08
Anacardium occidentale	Sômô	EVE	9	0,97	0,03	0,014	0,05
Ziziphus mauritiana	N'tômônô	FR	85	0,5	0,02	0,007	0,03
Eucalyptus camaldulensis	Mantilatum yiri	BO	56	0,42	0,01	0,003	0,01
Jatropha curcas	Bagani	FR	160	0,40	0,01	0,007	0,02
Carica papaya	-	EVE	205	-	-	-	-
Psidium guajava	-	EVE	5	-	-	-	-
Musa sp	Namassa	EVE	20	-	-	-	-
			1572	**Sum**	**9,27**	**4,52**	**16,56**
				Average	**0,84**	**0,41**	**1,51**
				Deviation	**1,54**	**0,75**	**2,76**

	± 95% CI	**0,99**	**0,69**	**1,33**

Di_moy: Average diameter; Ba: Above-ground biomass; C: Carbon; EF: Emission factor; t.eqCO_2 /ha: Tonne of carbon dioxide equivalent per hectare,
EIP: EspèceIntégralement Protégée; EPP: EspècePartiellement Protégée; BO: Bois d'œuvre; FR: Fruitier; EVE: Espèces à valeuréconomique.

Source: *2023 field survey*

A total of 14 species have been identified in theKoulikoro region, including 3 fully protected species (EIP), 2 partially protected species (EPP), 6 species of economic value (EVE), 1 species used as timber (BO), 2 fruit species (FR).

Analysis of Table 2 shows that in Koulikoro, the trees in the project right-of-way represent 9.27 tonnes of biomass per hectare, or a carbon stock of around 4.52 t/ha. The greenhouse gas emission potential of the trees in the Koulikoro right-of-way is estimated at 16.56 t.eqCO_2 /ha. The felling of these trees will transform this carbon sink into a carbon source. These values contain disparities between the different species. Indeed, felling *Manguifera indica* trees will generate 8.38 t.eqCO_2 /ha, while felling *Jatropha curcas*trees will result in almost 0.02 t.eqCO /ha.$_2$. Table 3 shows the plant species within the project's right-of-way in Djoïla.

Table 3: Plant species within the project's right-of-way in Dioïla

Scientific name	**Bambara name**	**Status**	**Number**	**Di_moy (m)**	**Ba (tMS/ha)**	**C(t/ha)**	**EF (t.eqCO_2 /ha)**
Vitellaria paradoxa	Shi	EIP	1142	2,12	6,35	3,090	11,33
Adansonia digitata	Zira	EIP	54	2,90	1,00	0,486	1,78
Manguifera indica	Mangoro	EVE	52	2,6	0,70	0,340	1,25
Parkia biglobosa	Nèrè	EIP	21	2,45	0,32	0,157	0,58
Ficus gnafalocarpa	Toroba	FR	6	1,93	0,10	0,047	0,17
Tamarindus indica	Ntomi	EIP	4	1,58	0,05	0,023	0,09
Borassus aethiopium	Sébé	EPP	23	1,17	0,04	0,018	0,07
Bombax costatum	Bumbu	EPP	9	1,22	0,03	0,013	0,05
Azadirachta indica	Neem	BO	13	1,12	0,02	0,012	0,04
Elaeisguineensis	N'ten	EVE	3	1,12	0,02	0,008	0,03
Eucalyptus camaldulensis	Mantilatumyiri	BO	181	0,42	0,01	0,004	0,02
Lanneamicrocarpa	Mpékuba	FR	1	1,02	0,01	0,005	0,02
Ziziphus mauritiana	N'tômônô	FR	75	0,5	0,01	0,003	0,01
Carica papaya	-	EVE	146	-	-	-	-
			1730	**Sum**	**8,64**	**4,21**	**15,43**
				Average	**0,66**	**0,32**	**1,19**
				Deviation	**1,74**	**0,84**	**3,10**
				± 95% CI	**1,16**	**0,81**	**1,55**

Di_moy: Average diameter; Ba: Above-ground biomass; C: Carbon; EF: Emission factor; t.eqCO_2 /ha: Tonne of carbon dioxide equivalent per hectare,
EIP: EspèceIntégralement Protégée; EPP: EspècePartiellement Protégée; BO: Bois d'œuvre; FR: Fruitier

Source: Field survey, 2023

A total of 14 species have been identified in theDioïla region, including 4 fully protected species (EIP), 2 partially protected species (EPP), 3 species of economic value (EVE), 2 species used as timber (BO), 3 fruit species (FR).

Analysis of Table 3 shows that in Dioïla, the trees in the project right-of-way represent 8.64 tonnes of biomass per hectare, or a carbon stock of around 4.21 t/ha. The greenhouse gas emission potential of the trees in the Dioïla right-of-way is estimated at 15.43 t.eqCO_2 /ha. The felling of these trees will transform this carbon sink into a carbon source. These values contain disparities between the different species. Indeed, felling *Vitellaria paradoxa* trees will generate 11.33 t.eqCO_2 /ha, whereas felling *Ziziphus mauritiana*trees will induce almost 0.01 t.eqCO /ha.$_2$

A total of 5,490 trees were identified in the project area, including 3,037 fully protected species (EIP), 89 partially protected species (EPP), 1,233 species of economic value (EVE), 340 species used as timber (BO) and 791 fruit trees (FR).

Overall, in the Ségou, Koulikoro and Dioïla localities, the trees in the project right-of-way represent a reservoir of 34.04 t/ha of above-ground woody biomass. This biomass represents a carbon sink of around 16.58 t.C/ha. Felling the trees in the right-of-way will transform this carbon sink into a carbon source, with emissions estimated at 60.78 t.eqCO_2 /ha. Compensatory measures therefore need to be taken, with compensatory reforestation areas of 1.5 ha per locality, i.e. 4.5 ha of plantations based on indigenous species with high sequestration potential or fast-growing species such as: *Gmelina arborea, Eucalyptus camaldulensis, Khaya senegalensis, Tectona grandis.* Longer transmission lines mean higher carbon emissions. Clearly, as the distance of lines increases, so does the need for construction materials and electrical equipment, such as overhead lines and pylons, leading to higher carbon emissions. By 2022, electricity generation will be responsible for around 40% of global CO2 emissions. Of these electricity-related emissions, 73% come from coal-fired power plants, and 22% from gas-fired power plants (https://www.planete-energies.com/fr/media/article/production-delectricite-ses-emissions-co2).

The major new solar and wind power projects are intended to demonstrate the low-carbon trajectory that the African continent could "directly" take to develop its electricity production. Analysts are forecasting 315 GW to 620 GW of new power capacity in Africa by 2030, with, in some scenarios, "a 7 to 12-fold increase" in the share of non-hydro renewables during this period. According to Ti Liu et *al* (2024), terrain has a significant impact on the carbon emissions intensity of line projects (carbon emissions per unit length of line, i.e. total carbon emissions divided by line length). Where the proportion of marshy land is high in the line construction zone, carbon emissions from construction projects are higher.

Wang et *al*. developed a life-cycle accounting model to analyze carbon emissions from the coal-electricity chain in China (N. Wang et *al*., 2018). They found that life-cycle carbon emissions are higher than direct emissions from coal-fired power generation by 10-13%. Yu et *al*. used life-cycle analysis to calculate the carbon emission coefficient for China's coal-to-electricity chain (Yu et *al*., 2014).

4. CONCLUSION

The aim of this study is to assess the carbon emissions resulting from the construction of the power line linking Bamako to Ségou. It focuses on direct emissions, more specifically those linked to the degradation and destruction of plant cover in the project area. In the project right-of-way in Ségou, Koulikoro and Dioïla, there are several plant species that provide local populations with various ecosystem services, including micro-climate regulation through carbon sequestration or absorption of atmospheric CO2. The implementation of the project will undoubtedly result in the felling of these trees. In all the localities of Ségou, Koulikoro and Dioïla, the trees in the project right-of-way constitute a carbon reservoir. Felling them will generate significant CO_2 emissions.

Estimating the GHG emission potential of the 225 kV Ségou - Bamako high-voltage power line is essential for informed decision-making. By integrating a rigorous analysis of environmental effects and adopting appropriate mitigation strategies, this project can not only meet local energy needs but also contribute to the fight against climate change. The implications of this research underline the need for a sustainable approach to energy infrastructure planning, combining economic growth with environmental responsibility.

The results show the need to integrate sustainable construction practices to minimize emissions. In addition, the use of local materials and the adoption of efficient construction technologies could significantly reduce the carbon footprint.

It is therefore important to:

- Use low-carbonmaterials.
- Integrate green technologies throughout the projectlifecycle.
- Establisha robustenvironmental management plan to monitor and mitigateemissionsduring construction and operation.

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