ENVIRONMENTAL AND SOCIAL IMPACT STUDY OF THE CEMENT PLANT CONSTRUCTION PROJECT IN THE THIES CLASS FOREST BY CIMAF SENEGAL

BIODIVERSITY STUDY

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HARMONY GROUP

ENVIRONNEMENT - INGENIERIE – MANAGEMENT

Une passerelle vers le développement durable

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1. INTRODUCTION

The Thiès region, the administrative entity in which this study is carried out, has a fairly interesting diversity of natural habitats. From the maritime fringe to the lands located inland, a clearly marked differentiation is felt for the types of plant formations encountered. At the same time, the nature of the artificialization of the environment is clearly different from one locality to another. To a large extent, these environments are subject to strong disturbances linked to fluctuations in the climate. These are the long dry season of 6 to 9 months and the spatio-temporal variability in the distribution of precipitation. To these is added the overexploitation of natural resources for the satisfaction of populations in ecosystem goods and services. These factors combined, would probably contribute to the imbalance of the natural ecosystem with, in particular, disturbances within the various environmental receptors (air, soil, vegetation, fauna, etc.). Despite its special status, the classified forest of Thiès is not immune to these disturbances. Mining activity is one of the main causes of transformation of the natural environment.

This report is structured around the following four main parts:

- A detailed bibliographic review is carried out on the issue of the state of biodiversity and its policy;

- The study on woody vegetation;

- The study on the dynamics of terrestrial and avian fauna;

- Determination of critical habitat.

2. BIODIVERSITY IN THE REGION OF THIES

Like almost all regions of the country, the policy for the conservation and enhancement of nature in the Thiès region had taken shape well before independence. This has resulted in the development of a classified network consisting mainly of classified forests over practically the entire extent of the regional territory.

The principle of classifying natural spaces, often qualified as sensitive and fragile, as biodiversity conservation areas responds to ecological, economic and social considerations.

With a primary conservation vocation assigned to them, these protected areas are therefore subject to strict legislative and regulatory measures for their better preservation from any form of external aggression.

The strategy aims to promote the conservation of biodiversity (plant and animal) in order to ensure socio-economic well-being for populations. Also, forest ecosystems in general, because of their multifaceted functions for society, constitute a support for the protection of populations and their property against extreme natural phenomena including strong winds, floods, etc.

Beyond the first generation of protected areas in the Thiès region, which led to the classification of 13 classified forests, other types have recently emerged in the region. These are the community nature reserves (in Somone and Poponguine) and marine protected areas (in Joal-Fadiouth and Kayar).
These latest initiatives follow on from the recommendations of the International Convention on Biological Diversity (CBD), which entered into force in 1994, following the holding of the Rio de Janeiro summit in 1990 on environment and development. Their role is not only to promote conservation, but they are designed in such a way as to place local populations more at the heart of the institutional management system.
There is also a wildlife reserve in the region: the Bandia reserve managed by private developers with the approval of the Senegalese state for the promotion of ecotourism. This Bandia reserve effectively contributes to the conservation of wildlife. It serves as a place of preservation and reproduction of specimen of terrestrial mammals strongly threatened with extinction in their natural environment. It can also provide individuals for the repopulation of certain areas.
The Thiès region, due to its geographical location, its relatively uneven relief in places, and the richness of its subsoil, has a variety of ecosystem types.

The shrub and tree formations of the glacis on marl and sandy colluvium are characteristic

From the vegetation present in the Niayes dominated by filao, oil palm (in the lowlands, Celtis integrifolia, to agroforestry parks in the village soils through the shrub vegetation located on the hills (Combretum michranthum, Boscia senegalensis, Acacias, Feretia apondanthera), each type of ecosystem contributes in its own way to maintaining the balance of its habitat.

It should also be noted the existence of characteristic formations of the rivers that can be found along the Somone valley as well as on the banks of certain temporary rivers. The presence of water points to the existence in places of degraded forest galleries, but relatively rich in forest species such as Celtis integrofolia (mboul), saba senegalensis (mad), Cola cordifolia (taba), Zizyphus mauritiana (sidèm), Balanites aegyptiaca (soump) etc.

Regarding the fauna, it should be noted that the gradual destruction of its habitat in the Thiès region is largely due to the natural process of desertification linked to drought on the one hand and on the other hand to human actions that have taken place. strongly contributed to imbalances in biotopes, particularly in depression areas and mining areas (limestone and basalt quarries and phosphate mines).

The avifauna mainly concerns pelicans, Gambian geese, white pigs, wood doves, pigeons, guinea fowl, egrets, parrots, ducks, francolins, hornbills, etc.

The fauna consists mainly of hares (Lepus crawshay), ground squirrels (Xerus erythropus), warthogs (Phacochoerus africanus), jackals (Canus mesomelas), civets (Civettictis civetta), patas (Erythrocebus patas), green monkeys or vervets (Chlorocebus cebaeus) etc (IREF.Th, 2019).

The classified forest estate constitutes the main refuge area for fauna, but it should be noted that their peace of mind is increasingly disturbed by the nuisances caused by the various industrial operations.

Alongside this, efforts to introduce and reintroduce are being made, through the Bandia animal reserve, in a part of the classified forest of Bandia, on the basis of a memorandum of understanding with the Water Service and Forests. At this reserve, we can observe several species, including large wild bovids such as Derby elk, Cape elk, buffalo, koba, among others. We can also note the very noticed presence of the Rhinoceros, the giraffe and other reptiles (IREF. Th, 2019).

Ultimately, it can be noted that the presence of numerous protected areas in the Thiès region reflects the importance of the policy for the conservation of its biological diversity. However, the strong envy of its forests poses the problem of conservation of this biodiversity.

3. FLORA AND VEGETATION

The richness of the flora in an ecosystem or set of habitats is linked to that of the ecoregions present. From coastal areas, to sandy plains via the Thiès plateau, we encounter a wide variety of woody vegetation. However, most of the woody resources are said to be found in the classified forest domain. Indeed, the region of Thiès, with its 13 classified forests, has a total area of 94,474 ha, ie a classification rate of 14.31%. It is certainly below the national standards indicated (20%) but is found with forestry formations in a satisfactory state compared to certain localities of the country (IREF Thiès, 2019).

These natural stands are mainly composed of *Acacia seyal*, *Acacia ataxacantha, Combretum micranthum, Boscia senegalensis, Acacia nilotica, Acacia nilotica var. adansonii, Celtis integrifolia, etc.*

In terroir areas, land use is partly determined by an ancestral agroforestry practice which has ended up integrating the tree into the agrarian landscape; which explains the remarkable presence of F*aidherbia albida* parks in the eco-geographic zone of the groundnut basin. To this emblematic species of the Sahel, are added *Borassus aethiopium* and *Adansonia digitata* in the village soils which are the subject of the practice of agriculture.

Concerning the coastal part of the Thiès region, particularly in the Niayes area, the vegetation is characterized by a succession of dunes and inter-dune depressions at the bottom of which ponds often appear linked to fluctuations in the water table. This area is also distinguished from the rest of the region by a mild and humid maritime climate and strong and relatively constant winds. This situation explains the diversity and complexity of the plant formations present due to the presence of both the Sahelian and Sudanese areas overlap. The flora represents more than thirty families with nearly 80 woody species. Around certain lowlands located in the southern part of the coast, dominates Elaeis guineensis (oil palm). The areas flooded during the rainy season and the swamps are characterized by the abundance of ferns. On the coastal dune system, particularly fixed by Aristida longiflora and Hyparrhenia dissoluta, we find Parinari macrophylla, Fagara xanthoxyloides, Aphania senegalensis, Maytenus senegalensis, Leptadenia hastata, etc. On the red dune systems, more continental, appear Faidherbia albida, Acacia tortilis, Tamarindus indica, Balanites aegyptiaca.

In this study we have mainly focused on the vegetation that would be potentially impacted during the implementation of the CIMAF project. It is with this in mind that we collected data on the site's footprint and its immediate outskirts.

Thus, in view of the classified status of the site, a rigorous phytosociological study was carried out in the

field to better study the plant associations. As a reminder, the site is located in the classified forest of Thiès (Figure 1) which constitutes a fairly interesting network of forests in the Thiès region.

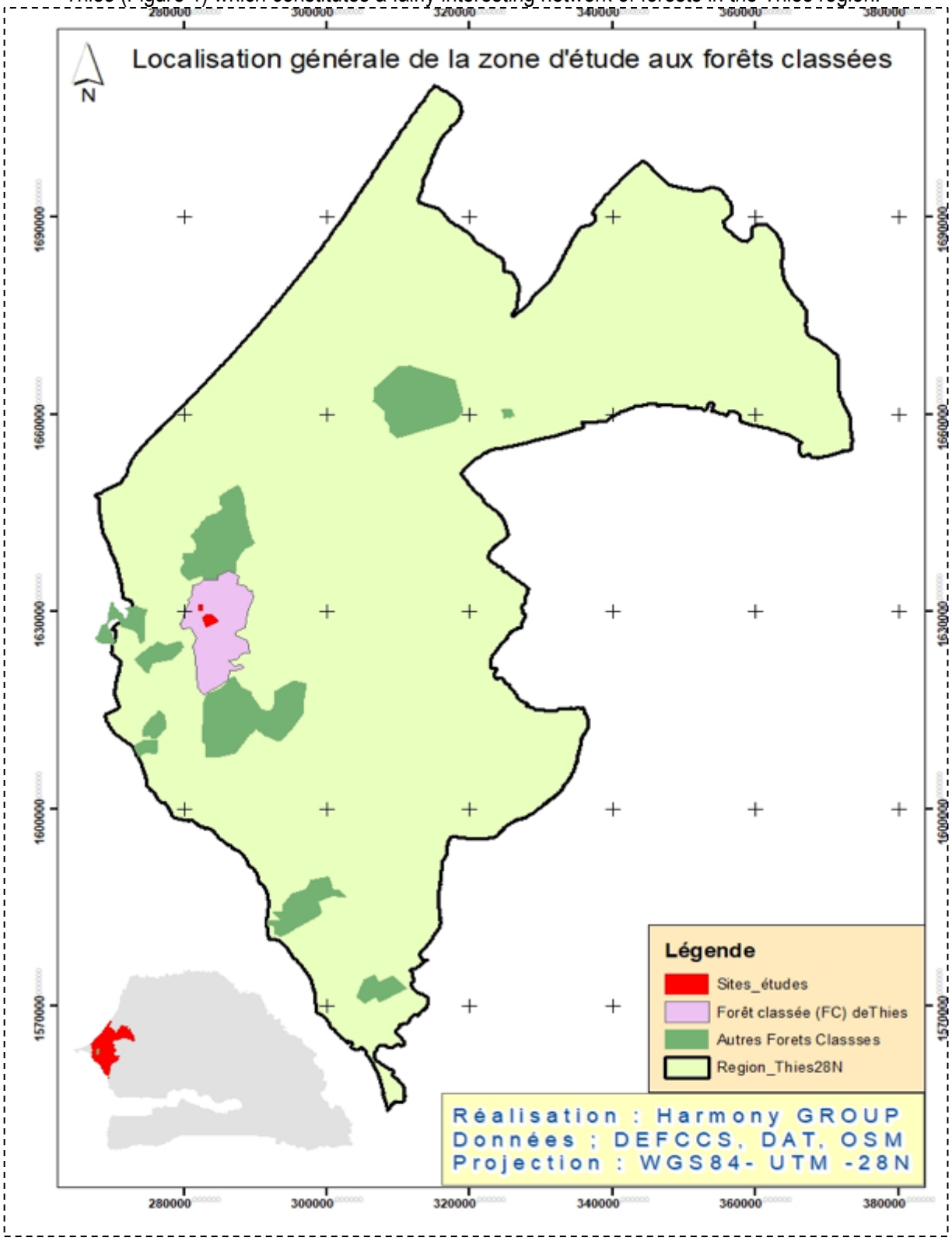

Figure 1: Presentation of the study site and classified forests in the region

3.1. FOREST DATA COLLECTION

3.1.1. SAMPLING

In the preparatory phase of collecting field data, we used very high spatial resolution images (Google Earth) to prepare our survey device. This step was confronted with the ground truth to verify the first lessons learned from the exploration of satellite imagery. Overall, with a few minimal differences, a relative homogeneity, from the point of view of the tree stratum, emerges over the entire hold of the perimeter.

On the basis of this prior information, a single stratum was considered for the random generation of data collection units (plots). Subsequently, the plots were generated semi automatically using version 3.10 of the QGIS software.

In the same logic, 13 plots were sampled (Figure 2). The geographic coordinates were subsequently extracted and projected to the UTM WGS 84 / 28N datum as a prelude to the field phase.

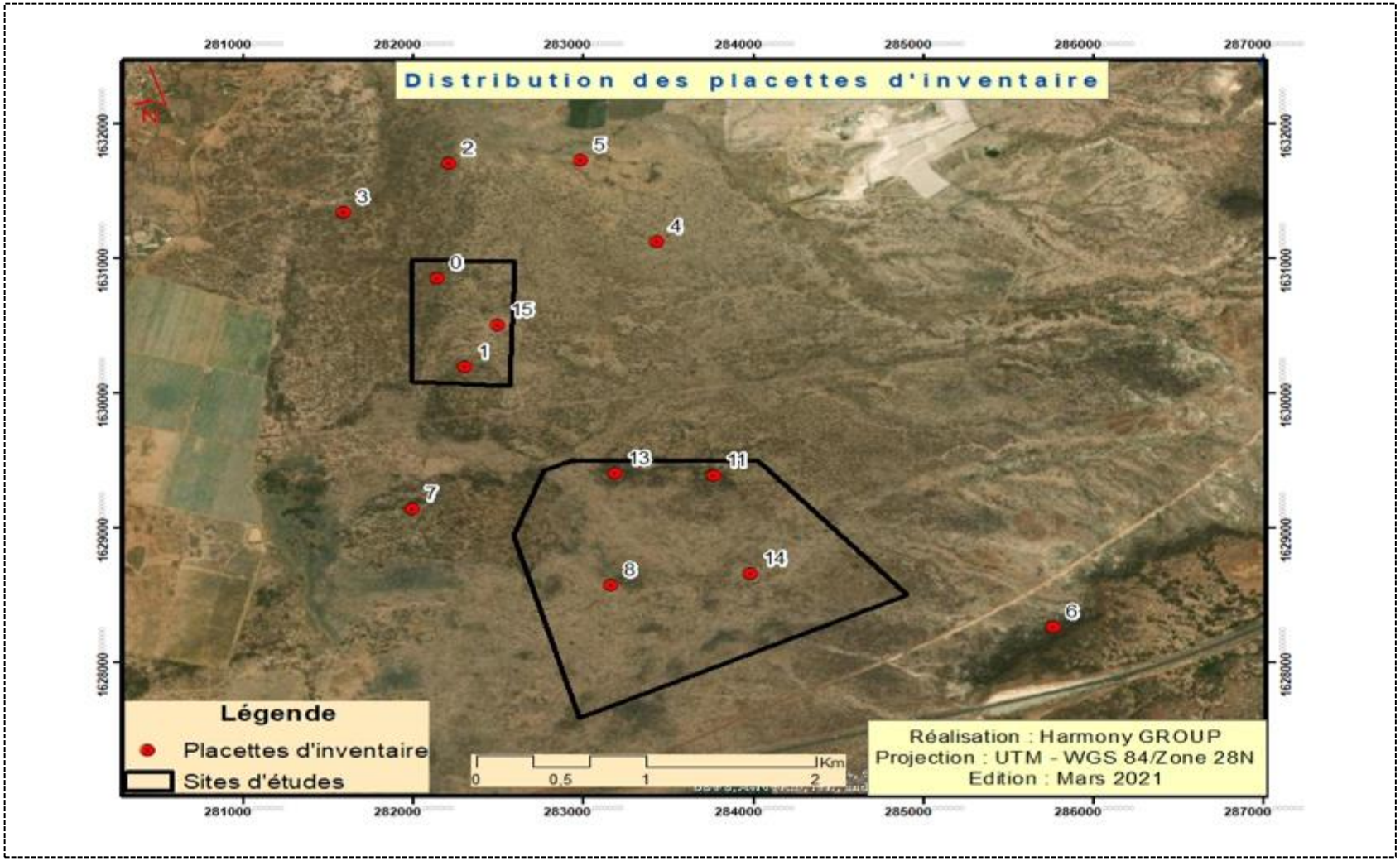

Figure 2: Distribution of Flora sampling plots

3.1.2. TREE STRATA DATA COLLECTION

The inventory was carried out through circular plots 15 meters in radius. In each plot, a systematic count of all individuals, all species combined, was carried out.

All trees with a diameter greater than or equal to 3 cm, at a height of 1.30 meters, were measured using a tape measure. Also, the size of each tree was also estimated.

The species identification was carried out on the basis of our prior knowledge of woody species. We did, however, use the reference works in determining trees like the Flora of Senegal (Berhaut, 1964) and the Ligneux du Sahel (Arbonnier, 2009).

In this present study, only data on woody plants were collected. The current state of the ground marked by a virtual absence of wet grass did not allow them to be clearly identified. However, summary observations made it possible to notice a herbaceous layer dominated by grasses. It is predominantly dominated by grass species such as Cenchrus biflorus and sedges.

3.1.3. TREATMENT OF DATA

The raw data collected from the field was compiled in a tabular database. They were subsequently imported under R software (version 3.5.2) for statistical processing. In this dynamic, we have focused on determining some univariate characteristics such as basal area, density, relative abundance, dominance, and importance value index (IVI) for a careful description of forest stand. These variables are fundamental in the characterization of forest ecosystems. They are defined as follows:-

Basal Area

It is the sum of the cross-sectional areas of trees in a studied area. Usually denoted by G, the basal area is expressed in m2 / Ha. It provides information on the occupation or dominance of the tree resource. It is calculated according to the following formula:

$$g = \frac{\pi D^2}{4}$$

With D = diameter of the tree at 1.30 m (for this study) and g = basal area in m2 / ha.

- Density (D)

Density refers to the number of feet of trees at the scale of a forest. It is expressed according to the number of trees in the stand per hectare.- **Indice de valeur d'importance (IVI)**

It is a variable that provides information on the place occupied by each inventoried species within the stand. The IVI is all the more important as it allows species to be classified according to their degree of

importance within a studied ecosystem. It was developed by Curtis and Macintosh in 1950. It is determined as follows:

IVI = relative abundance + relative dominance + relative frequency

- The relative abundance of a species within a community is the ratio of the average density of that species to the average density of the stand.
- Relative dominance is the ratio of the basal area of the species concerned to the basal area of the stand.
- Relative frequency refers to the ratio between the number of plots where the species is present over the total number of plots that have been inventoried.

However, for an easier interpretation of the IVI, Lindsley (1956) expressed it as a percentage by defining it as the arithmetic mean of the species considering its relative density, relative frequency and relative dominance.

IVI (%) = (Densité relative + Dominance relative + Fréquence relative) / 3

- Estimation of carbon stocks

Forest ecosystems are known to be carbon sinks. Indeed, trees help to sequester atmospheric carbon and keep it within them. It is in this sense that the forest is seen as a powerful means of mitigating climate change because of its ability to cleanse high concentrations of greenhouse gases from the atmosphere. Likewise, any factor leading to forest degradation or deforestation is a source of CO2 emissions into the atmosphere. In this mining project, a change in land use will be noted. Forest land will thus be converted to another use resulting in the loss of carbon stocks throughout the project area. It is in this dynamic that we considered it important to estimate the carbon stocks available before the implementation of the project.

Several approaches make it possible to estimate the biomass or the volume of wood in the forest. Among them, allometric equations seem to be the most practical for estimating the forest resource. An allometric equation is a mathematical formula which puts in relation several variables in particular the volume of wood or the biomass and dendrometric parameters (diameter, height, basal area, density of wood….).

As for forest carbon, it is calculated on the basis of the total biomass contained in a given forest. On this subject, several authors arrived at the results according to which, carbon stocks correspond to approximately 50% of the total biomass (Brown, 1997).

In this study, we will use the allometric model below to calculate the forest biomass and then deduce the amount of aboveground carbon in stocks in the project area and its immediate periphery.

$Y= 0,032DBH^3 - 1,016DBH^2 + 10,87DBH + 7,429$ (Thiam, 2014) avec Y = biomasse en kg,

DBH= *Diameter at breast height* (diamètre à hauteur de poitrine)

3.2. RESULTATS ON THE WOODY VEGETATION CLASSIFICATION

The processing of inventory data resulted in a detailed description of the forest stand. This step seems essential insofar as the guidelines relating to compensation will derive mainly from it.

3.2.1. Horizontal and vertical description of the stand

A first observation is linked to the presence of woody subjects of small diameters and modest heights. The average diameter of the trees inventoried, all classes combined, is 3.4 cm while the average height is 2.25 cm. Indeed, the site is subservient to forest species of small sizes. This reality led us to analyze the data in great detail because in reality all the subjects with diameters less than 3 cm could not be considered here as natural regeneration.

From this perspective, looking at the covering of the tree stratum, all categories of diameter classes considered, the average density per hectare is 1304 trees.

Tableau 1: Average density and basal area per plot

N°	N° Plot	Density (N_ha)	Basal Area (m2/ha)	Carbon Stock (Kg)
1	0	1161	10,06	2907
2	1	1260	0,82	966
3	2	1543	1,13	2455
4	3	1783	1,18	883
5	4	708	0,35	407
6	5	637	0,31	204
7	6	1925	1,61	2484
8	7	1189	0,69	948
9	8	2222	1,76	2478
10	11	1076	1,54	3835
11	13	1260	1,73	3873
12	14	1019	0,60	1143
13	15	1161	0,59	1119

As lessons to be learned, we observe that the highest density (D) and basal area (G) are recorded at plots n ° 8 and 0 with, respectively, the values around 2222 plants / ha and 10.06 m2. /Ha. The average diameter, all classes combined, is 6.87 m while the average height is only 2.63 m.

Regarding the basal area (land use by sections of stems), it is relatively heterogeneous at the scale of the site. From one plot to another a clear difference stands out. Overall, it remains very low for all the plots (G <2 m2 / ha) with the exception of plot No. 0 which ends up with a basal area of 10.06 m2 / ha. This difference is explained by the fact that the baobab with its large trunk has been recorded in this plot.

However, a real contrast, in terms of the size of the diameters, was noted. Indeed, the site and its immediate periphery are mainly occupied by species of small diameters. They tend to colonize the land in numerous bushy tufts. This reality is clearly illustrated in the figure below through which we clearly notice a predominance of trees with diameters less than 3 cm.

P L A C E T T E

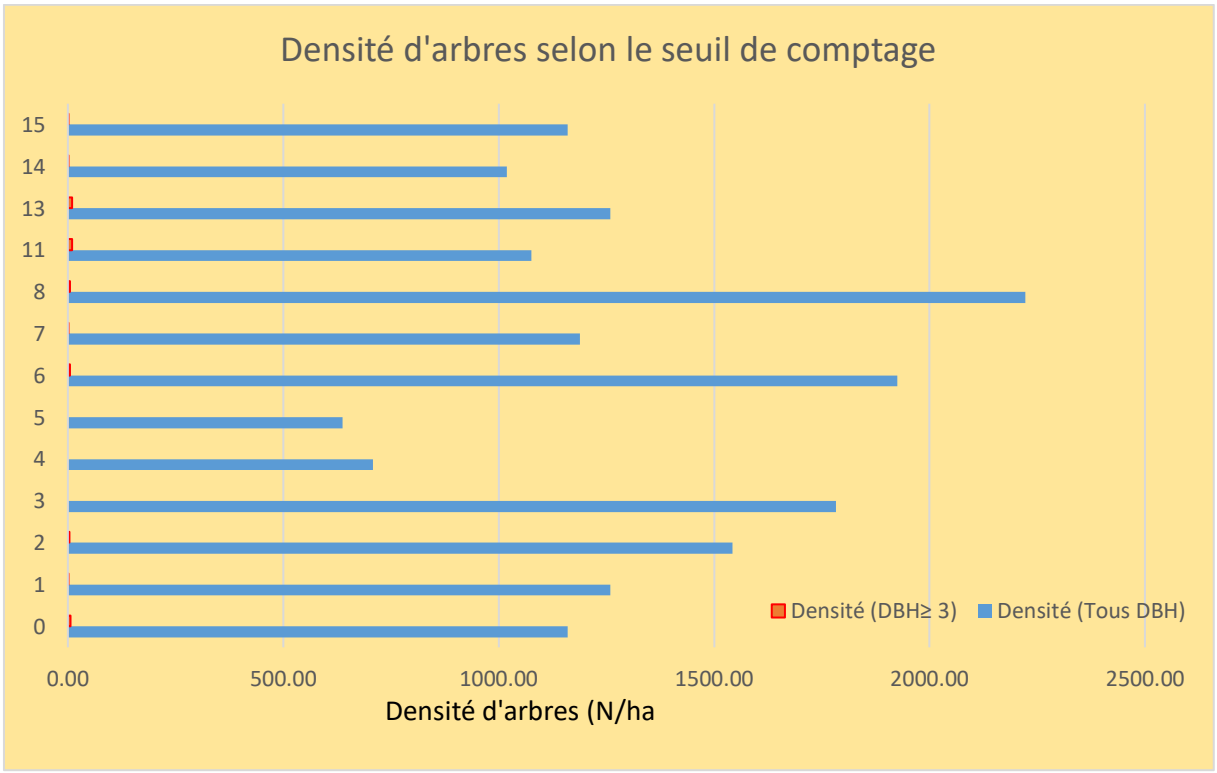

Figure 3: Density of trees and shrubs per surveyed plot

We find that the average density of trees with diameters less than 3 cm per plot ranges from 636 to 2223 trees per hectare while the highest density is only 10 trees / hectare for trees with a diameter greater than beyond 3 cm. The diametric structure indicating the density of trees (Figure 4) shows an irregular distribution between the diameter classes.

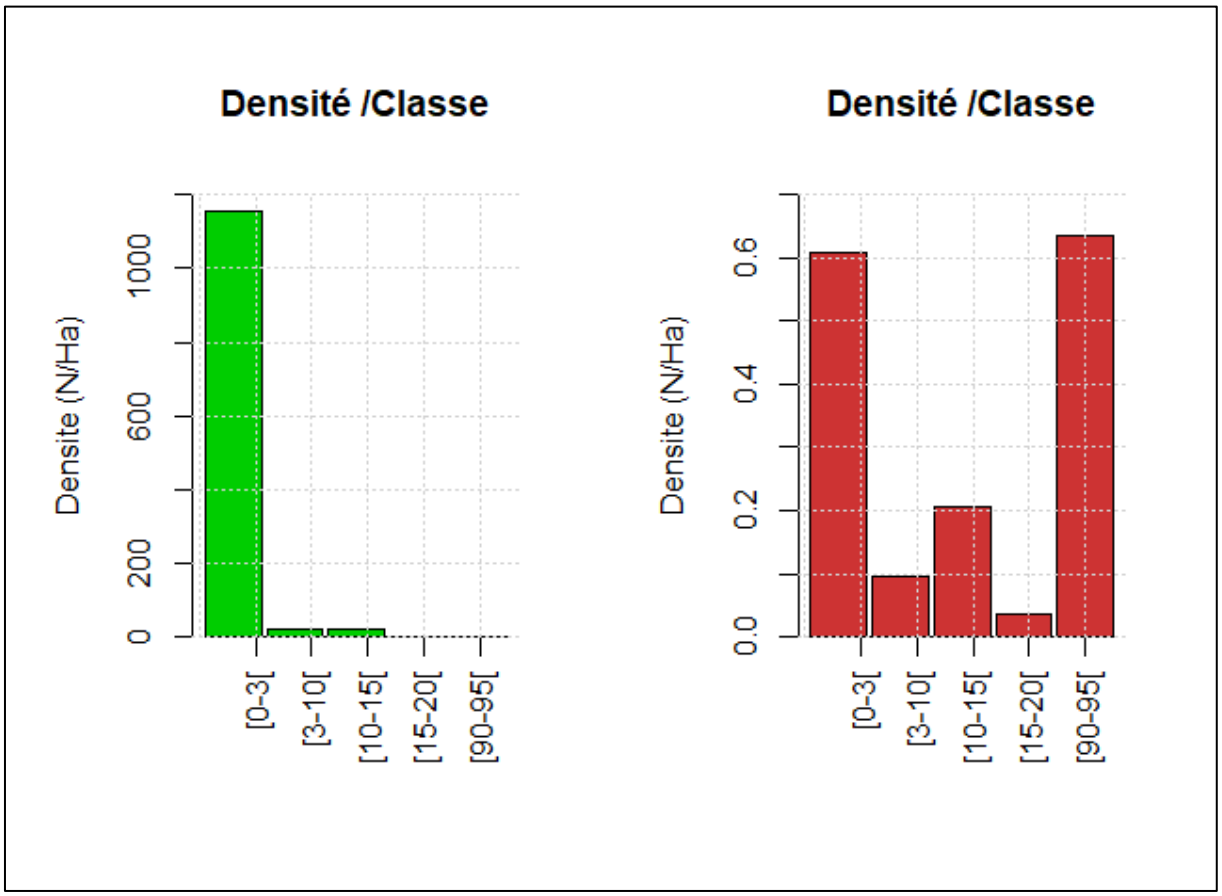

Figure 4: Density and basal area by diameter class

Indeed, the only classes, [0-3]and [3-10] are presented by themselves with 98.07% and 27.63% for a cumulative density of more than 1200 plants / ha.

In contrast to the high density of trees in these aforementioned classes, we note a low abundance within the large diameter classes (trees with a diameter greater than or equal to 10 cm). In terms of abundance, the large classes account for only 1.83% of the woody potential.

These results refer to the conditions of persistent drought and water deficit in the area. To this end, only these species have been able to develop adaptation strategies to cope with persistent stress.

Aussi, une répartition inégale du nombre de pieds selon les espèces est constatée. En termes de densité, les espèces du Genre *Acacia* sont les plus nombreuses suivies de *Boscia senegalensis* et *Combretum micranthum*.

Forest species of the genus Acacia have the particularity of having thorns, which makes them species with a strong ability to cope with difficult station conditions (lack of water, stress, drought, etc.)

Boscia senegalensis for its part, is described as being a Sahelian and Sudanese species also growing on dry sites. Combretum micranthum is labeled as the indicator species for poor soils most often growing on stony soils (Arbonnier, 2000).

It is also important to note the presence, in isolation of the baobab (Adansonia digitata), a density of about 5 feet per hectare in the landscape.

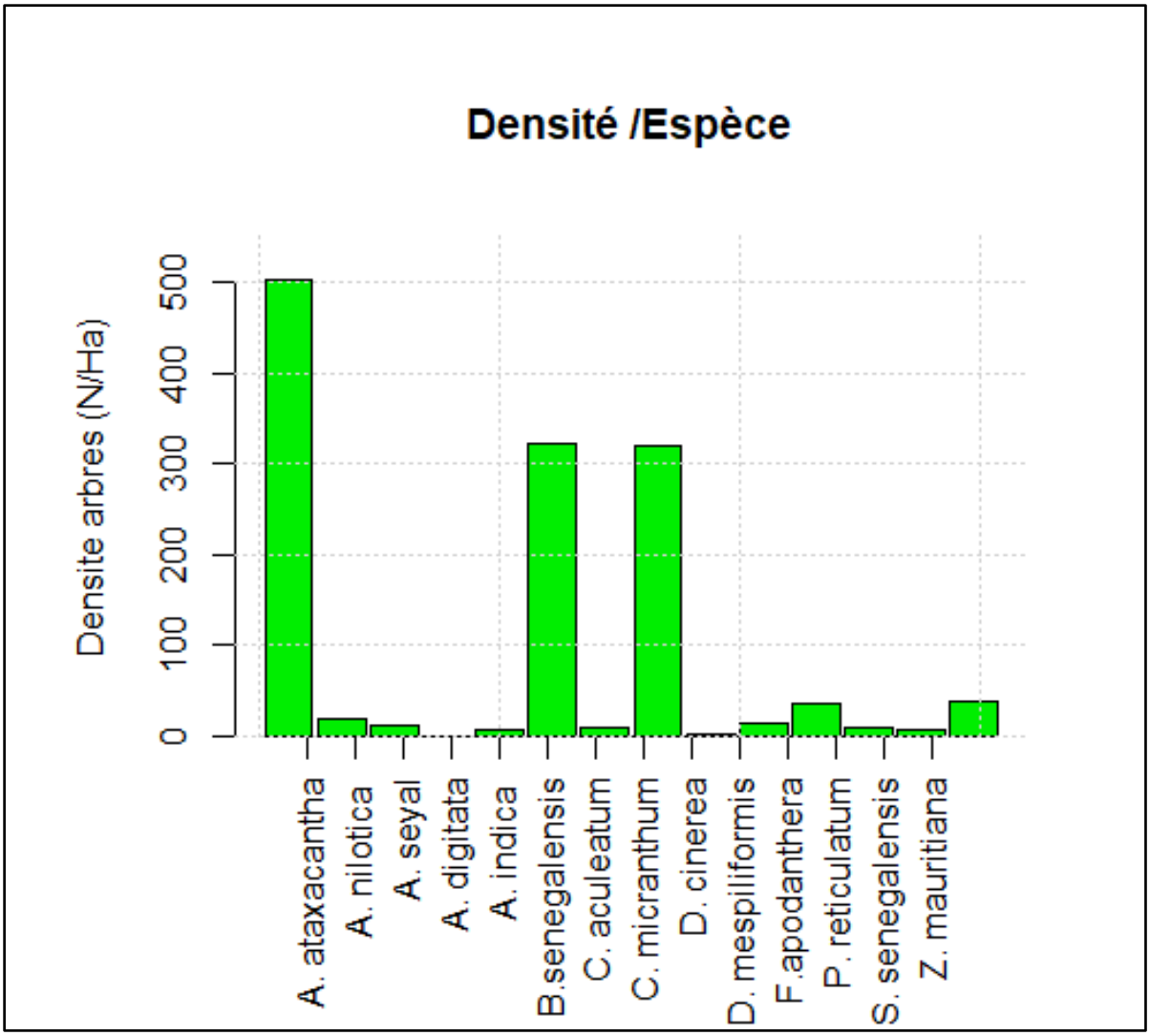

Figure 5: Density of Trees per species

Ultimately, the woody data collection operation identified the presence of 14 species. However, a strong variability is also noted at this level on the weight of each other. The table below specifies the importance value index (IVI) of each of the species inventoried within the license to be exploited.

Tableau 2 : Significance value index of woody species in the project area

Species	Relative abundance	Relative Dominance	Relative frequencey	IVI (X100)
Dichrostachys cinerea	0,07	0,00	0,08	14,83
Combretum aculeatum	0,21	0,01	0,08	29,16
Piliostigma reticulatum	0,23	0,01	0,08	31,54
Saba senegalensis	0,14	0,03	0,15	32,60
Azadirachta indica	0,14	0,06	0,15	35,54
Acacia seyal	0,28	0,11	0,15	54,15
Diospyros mespiliformis	0,30	0,03	0,31	64,28
Adansonia digitata	0,02	0,66	0,08	75,94
Acacia nilotica	0,39	0,05	0,46	90,45
Feretia apodanthera	0,79	0,02	0,46	127,30
Ziziphus mauritiana	0,81	0,08	0,46	135,19
Boscia senegalensis	6,86	0,16	0,62	762,79
Combretum micranthum	6,79	0,17	0,77	772,27
Acacia ataxacantha	10,70	0,25	0,85	1180,12

Based on the results compiled in this table, *Acacia ataxacantha, Combretum micranthum* and *Boscia senegalensis*, remain by far the most represented species on the site. From the point of view of their IVI, they are far ahead of the other species inventoried on the site. The presence of *Saba senegalensis*, on the other hand, is insignificant and interesting both because this area is not its natural habitat. It would be the result of spontaneous regeneration following seed transfer and favorable station conditions. The presence of the seeds in animal excrements or transported by humans would be the potential factors for its regeneration of this part of the classified forest of Thiès.

3.2.2. Evaluation of the woody biodiversity

The growing interest of scientists in biological diversity is supported by the fear that the loss of species and the reduction of genetic diversity could lead to a fragile stability of ecosystem functions. This fear is justified by the rapid transformation of tropical and especially forest landscapes. People affect biodiversity both directly and indirectly, transforming landscapes and habitats. The uncontrolled use of renewable natural resources (forests, pastures, etc.) implies a reduction in initial stocks and the destruction of species. In this part of the study, aspects related to the diversity of the site are detailed, but beforehand, a vast documentary review on this issue is established.

3.2.2.I. General information on biological diversity

Biological diversity or biodiversity can be defined as the set of possible forms of life in a given environment at a specific period. It was during the Rio Earth Summit in 1992 that its follow-up was first recognized as

an international priority, with the ratification of the Convention on Biological Diversity (CBD). However, even today, the terms and measures for monitoring remain complex and difficult to define clearly as it remains technically impossible to carry out comprehensive monitoring of biological diversity. To this end, the CBD has attempted to differentiate between the main types of diversity and then to develop criteria to assess changes in these. These indicators should give an idea of the state of biodiversity, the pressures it is under, among other variables (Rutlshauser, 2015).

3.2.2.2. The main components of diversity

The components of diversity most commonly used in the scientific literature and useful to mobilize to determine the specific richness of a site are: 1) species richness / taxonomic richness and 2) fairness.

Specific richness and taxonomic richness

Species richness was created by McIntosh in 1967. It is measured by the number of species present in a given system. The higher it is, the more diversified the system appears. The notion of species, which is the fundamental basis of species diversity, is the basic taxonomic unit for estimating diversity (Rutlshauser, 2015). The global estimate of the total number of species in an ecosystem by an exhaustive forest inventory, for example, appears impossible. Consequently, this estimate of diversity could be limited by large groups and we can speak of taxonomic richness.

- **Fairness**

According to Rutlshauser (2015), the regularity of the frequency distribution of species, or fairness, is an important element of diversity. This is because the contribution of a group of individuals to the functioning of an ecosystem varies depending on the size. The very abundant frequency of one species mathematically results in the rarity of others. Thus, the more equitably distributed the frequencies of the species, the higher the diversity.

3.2.2.3. Biodiversity estimators

Diversity is estimated at 3 scales: local diversity (or alpha diversity), diversity between sites (beta diversity) and regional diversity (gamma diversity).

Local diversity is a measure of the number of species present in a uniform habitat, of fixed size, and at a given time. Local diversity has been called alpha diversity because this is the indicator that was used by the first author (Fisher).

Beta diversity is similar to alpha diversity, except that it measures the diversity of species between habitats following an environmental gradient.

Gamma diversity, on the other hand, refers to specific diversity on a regional scale. It makes it possible to identify the presence or absence of a species in the study area concerned.

In practice, it is almost impossible to identify all the individuals present in a habitat or region, so sampling is carried out as was the case in this study. The ideally sampled area to determine species richness would be the small one whose inventory would allow at least one individual of each species present in the habitat to be observed. Hence the importance of carrying out a prior stratification of the different types of vegetation prior to any inventory operation in the field. Speaking of diversity indices, several estimators have been developed to estimate the distribution of species from data collected by sampling. Among these different diversity estimators we have among others: Ficher index, Chao estimator, Simpson and Shannon index. These diversity indices make it possible to characterize the balance of abundance of different species within a forest stand.

While it is recognized that it is possible to estimate the total number of species present (by Fisher's alpha index) or absent (by Chao index) in a given space, we can however simultaneously quantify the specific richness and the frequency of species by diversity indices, two of which are the most widely used remain the Simpson index and the Shannon index.

In this study we used the Simpson index to assess site specific diversity.

Concretely, the Simpson index (1949), E, is given according to the following formula:

$$\mathrm{E} = 1 - \sum_{k=0}^{n} Pi^2$$

With notably :

Pi = number of individuals of species i / Number of individuals from the site

The result that will be obtained from this formula is interpreted as the probability that two individuals drawn at random are of different species. Its value is between 0 and 1. For example, E is equal to 0 if the medium consists of only one species from which a maximum probability of being drawn. On the other hand, the more species there are, the more the value of E increases with the regularity of the distribution of the species.

For the record, there is another form of the Simpson index which is still well used in scientific research. It is the following formula (Marcon, E., 2010):

D = $\sum_{s=1}^{S} Pi^2$

This last formula of the Simpson index reflects the probability that two individuals drawn are of the same species. Unlike the first formula, the more the Simpson's value decreases, the more the medium becom es diverse. All these formulas were used in this study to compare their possible complementarity in the a ssessment of the weight of woody diversity in this area. Thus, for a number n species in an area, the ma ximum value of the Simpson's index is obtained from the following equation:

E_{max} = (1 – 1/n). # n= number of species per site

3.2.3.4. Analysis of results obtained from the Simpson diversity index

The estimate of the diversity index E, found a value of the Simpson's index E = 0.057 against a potential maximum value of Emax = 0.90.

Based on this result we end up with a probability of 5.7% that two individuals drawn at random are different, ie of different species. In other words, we have more

90% chance of finding the same species in a group of 2 individuals.

This reflects a very high heterogeneity in terms of the composition of species in individuals at the scale of the site studied. While the number of species found on this site (14) is satisfactory for this part of the region in view of the many constraints for maintaining the habitat in the wild, it is important to note through this result that only some two to three species are the most representative from the point of view of abundance. The three species such as *Acacia ataxacantha, Combretum micranthum* and *Boscia senegalensis* represent 87.81% in terms of the relative abundance of all individuals recorded in the 14 species.

These results also show a very unsatisfactory assessment of the ecological balance between abundance of individuals and specific diversity..

3.3. FOREST ECOSYSTEMS AND THE PROVISION OF SERVICES TO SOCIETY

Ecosystem services represent the benefits offered to human societies by ecosystems. The Millennium Ecosystem Assessment carried out by the United Nations on the concept of the Millennium Challenge Account in 2005 made it possible to distinguish four main categories of services: 1) supply services, 2) regulatory services, 3) support services, and 4) cultural services.

The bibliographic review carried out on forest ecosystems to which are added the results of interviews that we conducted with the forest personnel in charge of the management of this classified forest confirmed an important role that this forest area plays in the well-being. social aspects of the surrounding populations. In general, the ecosystem services provided by forest ecosystems to local communities and according to categories are as follows:

Provisioning services are defined as the tangible products derived from ecosystems, such as food, fuel, materials or medicines for human and veterinary health (hundreds of species of medicinal plants, often in decline or threatened with extinction). extinction are used in the traditional pharmacopoeia).

Although the project site is inside a protected area, the law, in particular the Forest Code in force in Senegal, grants a certain number of user rights to the populations. These rights relate mainly to ecosystem services provision. This is how the area is grazed by the livestock of the populations living in the classified forest of Thiès.

Figure 6: Livestock grazing on the project site

Beyond the grass cover, aerial fodder is the subject of special attention from breeders. At the start of the dry season, before the bush fires pass, the populations devote themselves to the collection of grasses which they store for livestock. According to the few pastoralists met in the field, the irregularity of the rains and the decrease in the amounts of rainfall received in this part of Senegal have ended up making the extensive livestock farming practiced in the area extremely vulnerable. This strategy of collecting herbaceous vegetation is the only possibility open to them to manage the increasingly long lean season in the Sahel.

The sustainable use of the resource is all the more essential for pastoralists as with the high cost of livestock feed that it is no longer within everyone's reach. The goods and services provided by nature have become essential for the survival of livestock. Also, direct harvesting of firewood (photo 3) is constantly noted in the area, as is the collection of wild jujube fruit and monkey bread for local consumption.

Figure 7: Collection of firewood for local consumption

Also, baobab fruits and leaves are regularly harvested, processed and used for domestic needs. Fibers from baobab plants are also frequently collected. They are used in traditional pharmacopoeia and in the repair of livestock enclosures and dwellings.

In the same logic, desert date fruits, jujube and Boscia senegalensis are exploited by the population for local consumption and to a lesser extent for sale on the market.

Regulatory services

They are made up of the benefits provided by the proper functioning of ecosystems, such as climate regulation, flood regulation, pollination or a reduction in the risk of outbreaks of pathogens for agriculture and perennial woody plants, because the pathogens would become more virulent when the ecosystems are fragile, mainly due to the loss of biodiversity.

Thus, woody vegetation plays an important role against dust heaving. The trees have become real ramparts against the invasion of dust in the homes. They also mitigate the impact of water erosion on the degradation of the top layer of land which is largely the source of declining soil fertility. Thus, the natural habitats of ecosystems significantly contribute to the attenuation of rainwater runoff on homes and indirectly fight, at the same time, against the degradation of arable land located upstream and downstream, according to the direction of runoff of rainwater.

Socio-cultural services

They represent the non-material contributions of biodiversity. In a big way, it is the relationship between Man and Nature. As such, nature serves as a place of meditation, which, from a sociological point of view, represents a cultural value of great significance for African societies.

In this rural area, people give significant credit to trees and especially to Adansonia digitata (baobab). Indeed, the baobab, beyond the emblematic aspect it represents for the Republic of Senegal, is the subject of special protection by the rural population. Rituals and prayers and other forms of incantations are often formulated under the baobab trees for the welfare of society.

Support services

These are services necessary for the production of all others. They ensure the proper functioning of the biosphere. Their effects indirectly affect humans and are noticeable in the long term. These services include, for example, the major biogeochemical cycles (water, carbon, nitrogen cycle, etc.) or the primary production of ecosystems. The dependence of human societies, and of all life on Earth, on these ecosystem services demonstrates that human well-being is inseparable from the health of ecosystems, hence the importance of their preservation and their sustainable and sustainable use.

3.4. ANALYSIS OF INVENTORY RESULTS

Over the entire area of direct influence on which the data collection was carried out, 14 woody species were inventoried.

In terms of potential tree cuts, on the basis of the 331 Ha to be exploited and cleared, and starting from the average density of 1303 mature trees / Ha, all species combined, approximately 431,380 plants would risk being cut down during the entire period. project life cycle.

However, the results showed a small size of the tree stems as well as the height of the trees. These low dendrometric parameters of diameter and height are explained by station conditions which do not allow strong growth in diameter and height of trees.

However, the fact remains of the ecological importance of this planted capital present. It not only contributes to the fixation of atmospheric carbon, to the infiltration of rainwater, to the fight against erosion, to the attenuation of the probable impacts of the effect of runoff water, and serves as a habitat to wildlife. With regard to specific diversity, the results obtained from the biodiversity index (Simpson's index) show real heterogeneity in terms of abundance between individuals. This situation is explained by the rather difficult local conditions which hardly favor the regeneration and the balanced distribution of individuals across the territory. The abundance of certain species identified here such as Acacia, Combretum micrantthum, Boscia senegalensis is linked to their strong ability to survive in environments with difficult conditions. These local constraints are, among other things, linked to the drought and the low amounts of rain received in the area.

3.5. MAPPING OF HABITATS AND LAND USE

3.5.1. Satellite data and preprocessing

In this land cover mapping operation, we exclusively used images from Sentinel-2 sensors. This satellite delivers images at high spatial resolution (10 m) over a time step of 5 days (coupling of sensors 2A and 2B).

The images were downloaded from the following site: https://scihub.copernicus.eu/. They date from January 2020, when it becomes easier to identify land objects in this part of the region. Also, any probability of confusion of herbaceous and woody vegetation is almost zero because the annual plants are dried out, grazed and burned.

The images were delivered in digital accounts hence the need for preprocessing. We have thus performed the atmospheric and radiometric corrections using the Semi-automatic Classification Plugin (SCP) extension available under version 2.18 of QGIS. Due to the rugged topography of the Thiès classified forest, the SRTM digital terrain model was used to minimize the effect of land curvature on the quality of the mapping products.

After this phase of image correction, the data, initially in digital counts, was transformed into top-of-the-atmosphere reflectance (TOA). It is from them that we calculated the Normalized Difference Vegetation Index (NDVI). The latter is obtained according to the following formula:

$$\mathrm{NDVI} = \frac{\mathrm{PIR} - \mathrm{Rouge}}{\mathrm{PIR} + \mathrm{Rouge}}$$

With:

PIR = Near infrared spectral band

Red = Red spectral band.

The classification process was carried out on the multispectral band of Blue, Green, Red and Near infrared.

3.5.2. Mapping of vegetation

The project area is mainly occupied by shrubs, the average height of which does not exceed one meter. However, the land use by the tree stratum is very significant, as evidenced by the results of the woody inventory. Considering the species composition and their distribution in space, we come to the conclusion

of a natural stand with a mixture of forest species on the first level of the vertical structure of the vegetation. In the upper floor, we have a few baobab plants which play an extremely important role in the balance of the environment.

On the basis of this information and the availability of satellite data at our fingertips, we conducted the mapping to bring out a single class of vegetation. However, geolocated data on the distribution of baobab plants were also used to locate the baobab stands.

The vegetation index produced was used to map the forest stand. Indeed, NDVI is an indicator that can be used to analyze remote sensing measurements, generally but not necessarily, from a spatial platform, and to determine whether or not the observed target contains living green vegetation. Its value varies from -1 to 1. It is frequently used in the study of vegetation because it is an indicator that provides relatively good information on the chlorophyll activity of plants. A thresholding was carried out so as to extract all the pixels which correspond to the woody vegetation. Verification was done using Google Earth imagery and ground truth.

The result of the woody vegetation mapping process resulted in the occupancy map below.

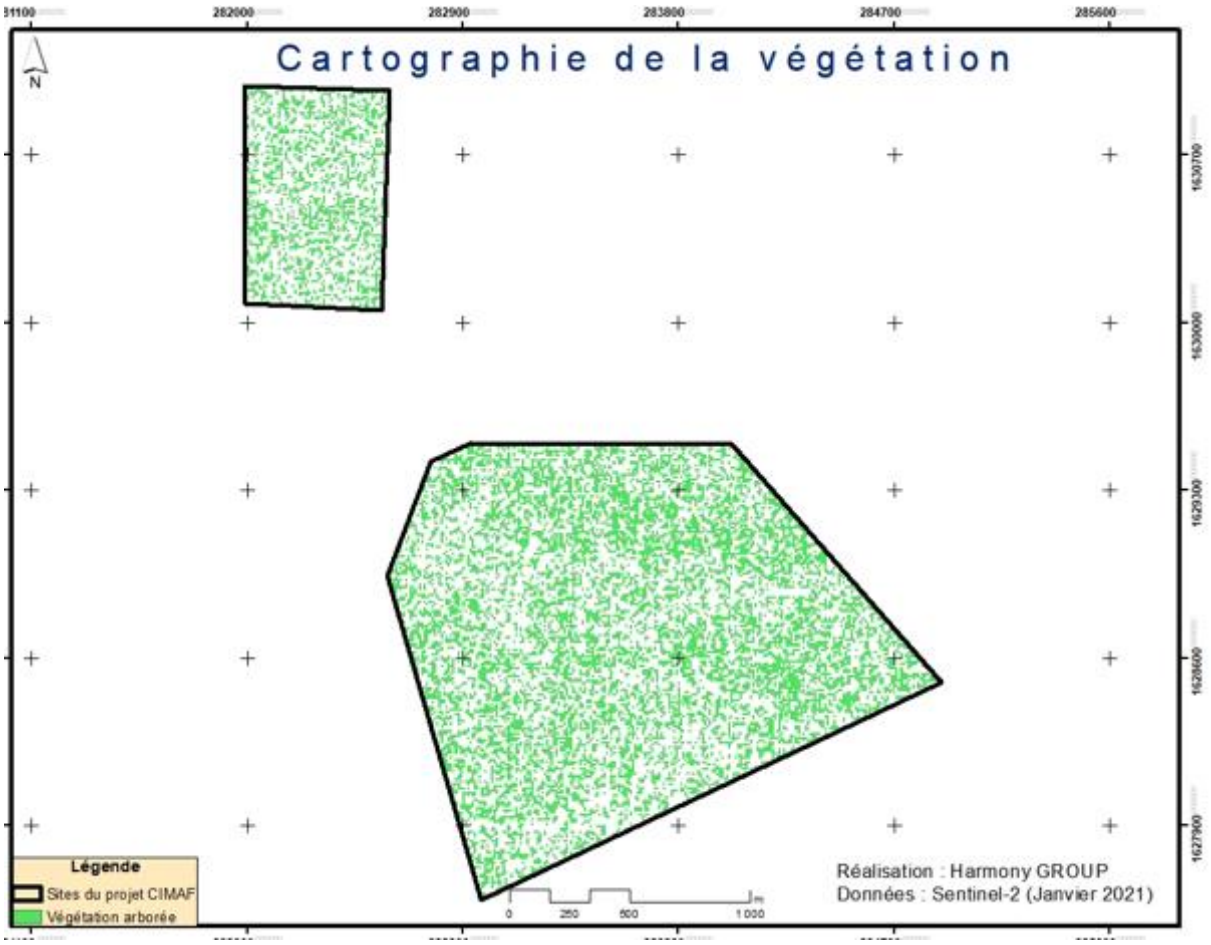

Figure 8: Occupation map of the tree stratum

Of the 331 hectares of the two sites of the permit, 129.49 hectares are effectively occupied by the tree layer (trees and shrubs), ie 39.12% of the size of the perimeter to be exploited.

3.5.3. Mapping od landuse

Mapping using recent high spatial resolution images was conducted to get an idea of the spatial occupation of the project area and its periphery. Mainly, in a buffer zone of 5 kilometers around the project site, three main land use classes could be identified and represented in the figure below.

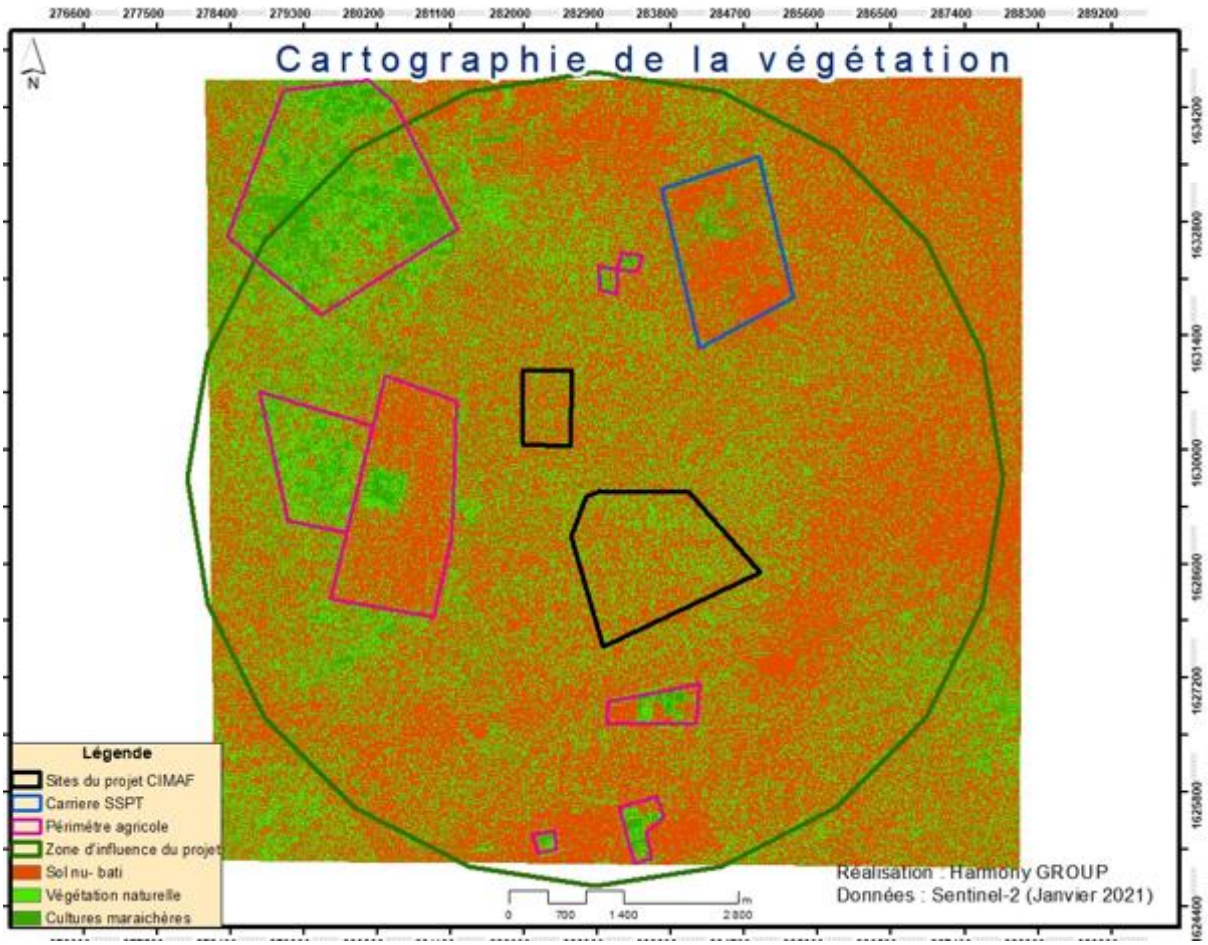

Figure 9: Mapping of land use in the project area

The statistics in terms of space occupation are as follows:

- Bare plowed soil, lateritic soil, stony and built-up areas (tracks and roads) = 585.336ha

- Vegetable crops: 64.10 ha (at the time of mapping);

- Woody vegetation: 309,732 ha

4. FAUNA

The study of fauna in and outside the study area boundaries included avifauna, mammals and herpetofauna. It is important to note that in this part of the country, there are hardly any specimens of large mammals.

4.1. AVIFAUNA

4.1.1. Introduction

The exploitation of natural resources plays a central role in a country's economy. Rational management of these resources is therefore essential to maintain sustainable development. Scientists, governments and populations are increasingly aware of this situation, hence the taking of protective measures at national and international level to avoid environmental degradation.

It is therefore with the objective of preserving the biological diversity of the classified forest of Thiès that an ecological diagnosis with a view to the management of the site, at the request of the promoters, is planned.

This study on the avifauna of the classified forest of Thiès will certainly have made it possible to know and make known part of the natural heritage of the site to the various stakeholders in order to integrate its preservation and enhancement into its day-to-day management.

4.1.2. Methodology

This study focuses on the identification of birds that frequent the CIMAF project site. The aim is to count all the birds present on the project site and the area of influence during the field operation in order to obtain an objective estimate of the abundance without statistical inferences or fundamental assumptions. To do this, we used conventional methods of direct observations following strip transects.

Strip transects are one of the most common monitoring techniques used to determine the composition and density of bird species. The observer performs the counts by walking along a transect line instead of searching for an entire plot (Fig. 3). The methodology is based on the census of birds from linear transects forming a network making it possible to cover the entire sampled area.

When carrying out the transect, the following information is entered:

- List of species contacted (auditory, visual, in-flight contacts).

The spotting of birds is done with the naked eye. Binoculars are used to identify a previously detected bird but not to search for distant birds.

- Number of individuals contacted by species and by observer-bird distance.

The observer-bird distance (x) will be broken down into 3 classes: <50 meters, between 50 to 100 meters and more than 100m.

In general, a minimum of 500 m between two transects is required to avoid double counting. Also, as part of these follow-ups, the transects were at least 1.5 km apart to alleviate this concern.

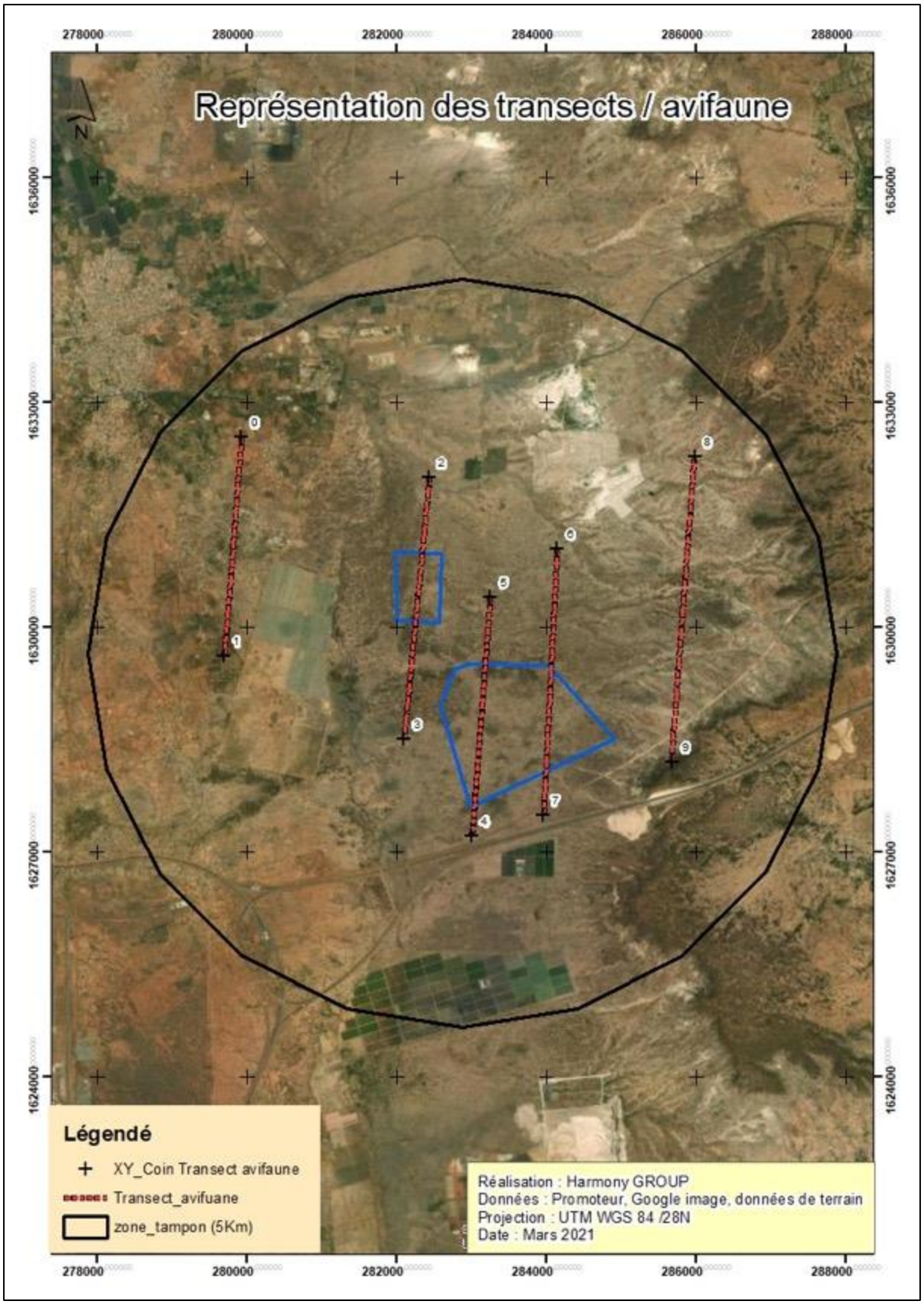

Figure 10: Position of transects in the zone of Influence

The follow-ups took place over three days (March 17, 18 and 19, 2021) on five transects.

For the first day, the transects traveled are the (2-3) measuring 3.5 km and the (4-5) with 3.2 km.

On the second day, the transects traveled are the (6-7) with a length of 3.6 km and the (8-9) with 4.1 km.

On the third day we finished with the 3 km long transect (0-1).

The total length of the transects traveled is 17.4 km.

Observation devices such as Nikon Prostaff binoculars (10x42) and a camera were used as well as a West African bird identification guide (identification keys). For orientation in the field, we used a Garmin Oregon 650t GPS.

Figure 11 : Field equipment used

The Obsmapp application was used for recording observations and part of the data was processed by this tool.

The status, category and status of each species is on the Red List of the International Union for Conservation of Nature (IUCN). Also, the distribution map of each species is listed there.

4.1.3. Results

Analysis of the monitoring records determined the bird species identified on the site. Thus we identified sixty-six (66) species of birds throughout the site and distributed in thirty-three (33) families and fourteen (14) orders.

The results obtained are shown in the following tables.

Tableau 3 : Observations

Jours de suivi	Nombre d'observations	Nombre d'espèces	Nombre d'individus
17/03/2021	199	42	390
18/03/2021	141	46	468
19/03/2021	104	41	284

In total we made 444 observations made up of 66 species (almost the same species were observed during the three days of monitoring) and 1,142 individuals.

58 species including 667 individuals have been identified in the project area; and 55 species including 475 individuals in the buffer zone.

The following table shows the type of observation made and their percentage.

Tableau 4: Types of observation

Types of observation	Number	Perrcentage
Direct Views	387	87,16
Screams	41	9,23
Songs	1	0,23
Nests	14	3,15
Shelters	1	0,23
Total observations	444	100

Tableau 5: List of species identified

N°	Order	Family	Common Name	English name	Scientific Name	No.	IUCN	Category	Situation
1	Passeriformes	Passeridae	Moineau gris	Northern Grey-headed Sparrow	*Passer griseus*	116	LC	non migrant	stable
2	Passeriformes	Estrildidae	Cordonbleu à joues rouges	Red-cheeked Cordon-bleu	*Uraeginthus bengalus*	112	LC	non migrant	stable
3	Passeriformes	Ploceidae	Alecto à bec blanc	White-billed Buffalo-weaver	*Bubalornis albirostris*	76	LC	non migrant	stable
4	Accipitriformes	Accipitridae	Milan noir	Black Kite	*Milvus migrans*	68	LC	migrateur	stable
5	Columbiformes	Columbidae	Tourterelle maillée	Laughing Dove	*Spilopelia senegalensis*	68	LC	migrateur	stable
6	Charadriiformes	Charadriidae	Vanneau à tête noire	Black-headed Lapwing	*Vanellus tectus*	64	LC	non migrant	inconnu
7	Bucerotiformes	Bucerotidae	Calao à bec rouge	Red-billed Hornbill	*Tockus erythrorhynchus*	51	LC	non migrant	stable
8	Passeriformes	Ploceidae	Travailleur à bec rouge	Red-billed Quelea	*Quelea quelea*	51	LC	non migrant	stable
9	Passeriformes	Sturnidae	Choucador à longue queue	Long-tailed Glossy Starling	*Lamprotornis caudatus*	46	LC	non migrant	stable
10	Passeriformes	Sturnidae	Choucador à ventre roux	Chestnut-bellied Starling	*Lamprotornis pulcher*	37	LC	non migrant	stable

N°	Order	Family	Common Name	English name	Scientific Name	No.	IUCN	Category	Situation
11	Passeriformes	Alaudidae	Moinelette à oreillons blancs	Chestnut-backed Sparrow-lark	*Eremopterix leucotis*	34	LC	nomade	stable
12	Columbiformes	Columbidae	Tourterelle vineuse	Vinaceous Dove	*Streptopelia vinacea*	32	LC	migrateur	stable
13	Columbiformes	Columbidae	Tourterelle masquée	Namaqua Dove	*Oena capensis*	31	LC	migrateur	en augmentation
14	Passeriformes	Corvidae	Corbeau pie	Pied Crow	*Corvus albus*	28	LC	non migrant	stable
15	Caprimulgiformes	Apodidae	Martinet noir	Common Swift	*Apus apus*	28	LC	migrateur	stable
16	Passeriformes	Passeridae	Moineau doré	Sudan Golden Sparrow	*Passer luteus*	28	LC	nomade	stable
17	Psittaciformes	Psittacidae	Perruche à collier	Rose-ringed Parakeet	*Psittacula krameri*	25	LC	non migrant	en augmentation
18	Passeriformes	Estrildidae	Amarante du Sénégal	Red-billed Firefinch	*Lagonosticta senegala*	22	LC	non migrant	stable
19	Passeriformes	Pycnonotidae	Bulbul des jardins	Common Bulbul	*Pycnonotus barbatus*	16	LC	non migrant	en augmentation
20	Passeriformes	Malaconotidae	Gonolek de Barbarie	Yellow-crowned Gonolek	*Laniarius barbarus*	16	LC	non migrant	stable

N°	Order	Family	Common Name	English name	Scientific Name	No.	IUCN	Category	Situation
21	Pelecaniformes	Ardeidae	Héron Garde-bœufs	Cattle Egret	*Bubulcus ibis*	16	LC	migrateur	en augmentation
22	Psittaciformes	Psittacidae	Perroquet youyou	Senegal Parrot	*Poicephalus senegalus*	16	LC	non migrant	en diminution
23	Passeriformes	Estrildidae	Beaumarquet melba	Green-winged Pytilia	*Pytilia melba*	15	LC	non migrant	stable
24	Passeriformes	Macrosphenidae	Crombec sittelle	Northern Crombec	*Sylvietta brachyura*	14	LC	non migrant	stable
25	Passeriformes	Ploceidae	Tisserin vitellin	Vitelline Masked Weaver	*Ploceus vitellinus*	12	LC	non migrant	stable
26	Bucerotiformes	Phoeniculidae	Irrisor moqueur	Green Woodhoopoe	*Phoeniculus purpureus*	11	LC	non migrant	en diminution
27	Passeriformes	Ploceidae	Sporopipe quadrillé	Speckle-fronted Weaver	*Sporopipes frontalis*	10	LC	non migrant	stable
28	Columbiformes	Columbidae	Tourtelette d'Abyssinie	Black-billed Wood-dove	*Turtur abyssinicus*	9	LC	migrateur	stable
29	Passeriformes	Cisticolidae	Prinia modeste	Tawny-flanked Prinia	*Prinia subflava*	7	LC	non migrant	stable
30	Passeriformes	Muscicapidae	Agrobate podobé	Black Scrub-robin	*Cercotrichas podobe*	5	LC	non migrant	stable

N°	Order	Family	Common Name	English name	Scientific Name	No.	IUCN	Category	Situation
31	Passeriformes	Phylloscopidae	Pouillot véloce	Common Chiffchaff	*Phylloscopus collybita*	5	LC	migrateur	en augmentation
32	Passeriformes	Cisticolidae	Prinia à ailes rousses	Red-winged Prinia	*Prinia erythroptera*	5	LC	non migrant	stable
33	Passeriformes	Muscicapidae	Agrobate roux	Rufous-tailed Scrub-robin	*Cercotrichas galactotes*	4	LC	migrateur	stable
34	Bucerotiformes	Bucerotidae	Calao à bec noir	African Grey Hornbill	*Lophoceros nasutus*	4	LC	non migrant	stable
35	Columbiformes	Columbidae	Tourterelle rieuse	African Collared-dove	*Streptopelia roseogrisea*	4	LC	migrateur	stable
36	Passeriformes	Sturnidae	Choucador à oreillons bleus	Greater Blue-eared Starling	*Lamprotornis chalybaeus*	3	LC	non migrant	stable
37	Galliformes	Phasianidae	Francolin à double éperon	Double-spurred Francolin	*Pternistis bicalcaratus*	3	LC	non migrant	en diminution
38	Otidiformes	Otididae	Outarde de Savile	Savile's Bustard	*Lophotis savilei*	3	LC	non migrant	stable
39	Passeriformes	Muscicapidae	Rossignol philomèle	Common Nightingale	*Luscinia megarhynchos*	3	LC	migrateur	stable
40	Passeriformes	Cisticolidae	Camaroptère à tête grise	Bleating Camaroptera	*Camaroptera brachyura*	4	LC	non migrant	en augmentation
41	Passeriformes	Laniidae	Corvinelle à bec jaune	Yellow-billed Shrike	*Corvinella corvina*	2	LC	non migrant	inconnu

N°	Order	Family	Common Name	English name	Scientific Name	No.	IUCN	Category	Situation
42	Cuculiformes	Cuculidae	Coucal du Sénégal	Senegal Coucal	*Centropus senegalensis*	2	LC	non migrant	stable
43	Passeriformes	Cisticolidae	Érémomèle à croupion jaune	Yellow-bellied Eremomela	*Eremomela icteropygialis*	2	LC	non migrant	stable
44	Bucerotiformes	Upupidae	Huppe fasciée	Common Hoopoe	*Upupa epops*	2	LC	migrateur	en diminution
45	Passeriformes	Passeridae	Moineau domestique	House Sparrow	*Passer domesticus*	2	LC	non migrant	en diminution
46	Passeriformes	Laniidae	Pie-grièche À Tête Rousse	Woodchat Shrike	*Lanius senator senator*	2	LC	migrateur	en diminution
47	Columbiformes	Columbidae	Pigeon roussard	Speckled Pigeon	*Columba guinea*	2	LC	non migrant	stable
48	Galliformes	Numididae	Pintade de Numidie	Helmeted Guineafowl	*Numida meleagris*	2	LC	non migrant	stable
49	Passeriformes	Platysteiridae	Pririt du Sénégal	Senegal Batis	*Batis senegalensis*	2	LC	non migrant	en diminution
50	Passeriformes	Malaconotidae	Tchagra à tête noire	Black-crowned Tchagra	*Tchagra senegalus*	2	LC	non migrant	stable
51	Passeriformes	Ploceidae	Tisserin gendarme	Village Weaver	*Ploceus cucullatus*	2	LC	non migrant	stable
52	Musophagiformes	Musophagidae	Touraco gris	Western Plantain-eater	*Crinifer piscator*	2	LC	non migrant	stable

N°	Order	Family	Common Name	English name	Scientific Name	No.	IUCN	Category	Situation
53	Columbiformes	Columbidae	Tourterelle à collier	Red-eyed Dove	*Streptopelia semitorquata*	2	LC	migrateur	en augmentation
54	Accipitriformes	Accipitridae	Vautour africain	White-backed Vulture	*Gyps africanus*	2	CR	non migrant	en diminution
55	Passeriformes	Cisticolidae	Cisticole des joncs	Zitting Cisticola	*Cisticola juncidis*	1	LC	non migrant	en augmentation
56	Passeriformes	Viduidae	Combassou du Sénégal	Village Indigobird	*Vidua chalybeata*	1	LC	non migrant	stable
57	Cuculiformes	Cuculidae	Coucou gris	Common Cuckoo	*Cuculus canorus*	1	LC	migrateur	en diminution
58	Falconiformes	Falconidae	Faucon crécerelle	Common Kestrel	*Falco tinnunculus*	1	LC	migrateur	en diminution
59	Pelecaniformes	Ardeidae	Héron mélanocéphale	Black-headed Heron	*Ardea melanocephala*	1	LC	migrateur	en augmentation
60	Passeriformes	Phylloscopidae	Pouillot de Bonelli	Western Bonelli's Warbler	*Phylloscopus bonelli*	1	LC	migrateur	stable
61	Coraciiformes	Coraciidae	Rollier d'Abyssinie	Abyssinian Roller	*Coracias abyssinicus*	1	LC	migrateur	en augmentation
62	Passeriformes	Muscicapidae	Rougequeue à front blanc	Common Redstart	*Phoenicurus phoenicurus*	1	LC	migrateur	en augmentation

N°	Order	Family	Common Name	English name	Scientific Name	No.	IUCN	Category	Situation
63	Passeriformes	Fringillidae	Serin à croupion blanc	White-rumped Seedeater	*Crithagra leucopygia*	1	LC	non migrant	stable
64	Passeriformes	Nectariniidae	Souimanga à longue queue	Beautiful Sunbird	*Cinnyris pulchellus*	1	LC	non migrant	stable
65	Columbiformes	Columbidae	Tourterelle pleureuse	Speckled Pigeon	*Columba guinea*	1	LC	non migrant	stable
66	Passeriformes	Muscicapidae	Traquet motteux	Northern Wheatear	*Oenanthe oenanthe*	1	LC	migrateur	en diminution
Total	**Total : 14**	**33**	**66**	**66**	***66***	**1142**			

Least Concern (LC)

Critically endangered (CR)

All identified species are land birds with the exception of the melanocephalic heron (Ardea melanocephala) (number 59 in Table 5) which is a waterbird. This individual was observed in flight crossing the study area.

Among these birds 65.15% are non-migratory; 31.82% are migrants and 3.03% are nomads.

Only the African Vulture (*Gyps africanus*) (number 54 in Table 5) is Critically Endangered (CR). Unfortunately, we only observed two (2) individuals and one abandoned nest on the site (Figure 10).

Regarding the nests we have listed fifteen (15); including thirteen (13) White-billed Alecto (Bubalornis albirostris) nests, one (1) Yolk Weaver (*Ploceus vitellinus*) nest and one (1) African Vulture (*Gyps africanus*) nest.

In addition, all the nests were built on Baobabs (Adansonia digitata) as shown in the figure below. , with the exception of two nests, one of which is built on a Desert Date palm (Balanites aegyptiaca) and the other on an Acacia seyal (Vachellia seyal).

The White-billed Alecto and the Yolk-billed Weaver breed during the rainy season depending on the region where it is found, therefore between July to October in Senegal.

The African Vulture nests in colonies or alone. In West Africa it breeds almost every month but more actively between October and June.

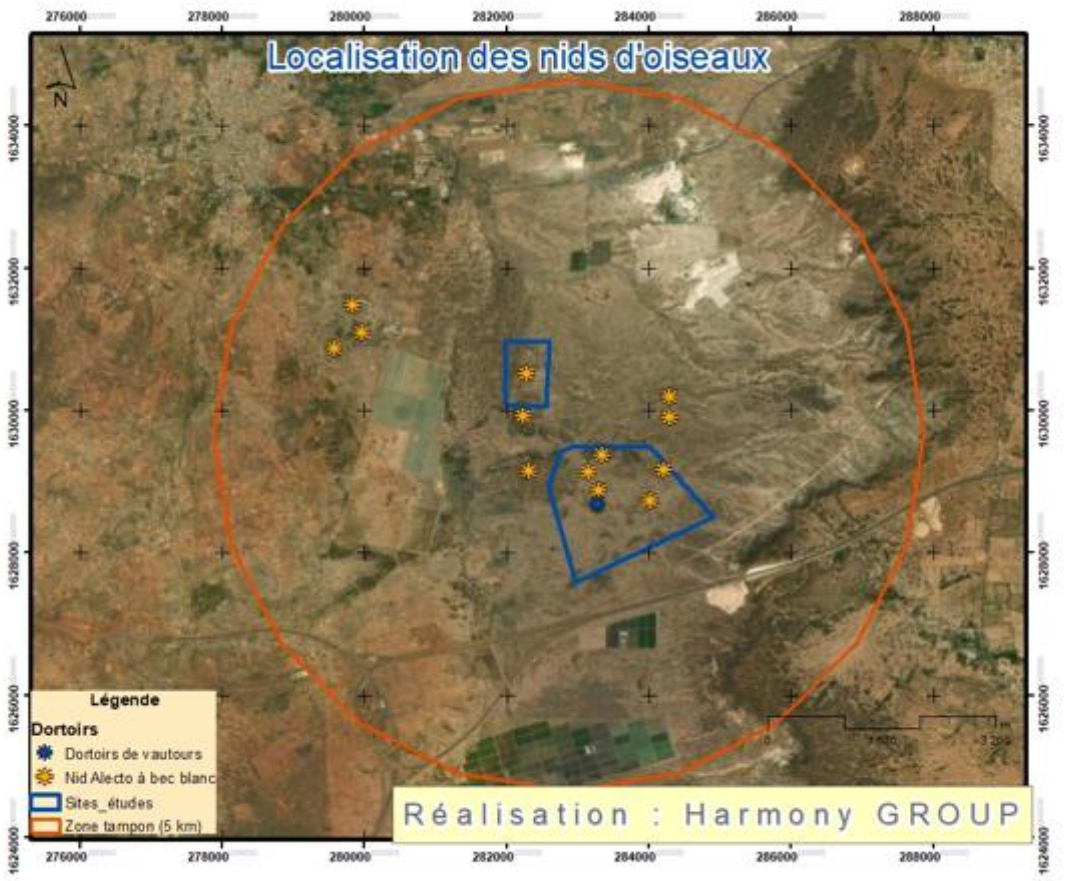

Figure 12 ***:*** *Map of location of bird nests*

Figure 13 : Vulture nests in a Baobab

Source : Harmony Group, mars 2021

Figure 14 : White-billed Alecto nest on a baobab tree

Source : Harmony Group, mars 2021

Figure 15 : White-billed Alecto nest on a desert date palm

Source : Harmony Group, Mars 2021

Figure 16 : White-billed Alecto Nest on Acacia

Source : Harmony Group, mars 2021

Figure 17 :Lamprotornis caudatus

Figure 18 : Lamprotornis chalybaeus

Figure 19 : Vanellus tectus

Figure 20 : Coracias abyssinicus

Figure 21 Tockus erythrorhynchus

Figure 22 Streptopelia vinacea

Figure 23 : Passer domesticus

Figure 24: Bubalornis albirostris

Figure 25 : Laniarius barbarus

Source des Photos : Harmony Group, Mars 2021

4.1.4. Migration Route

Birds generally migrate over a very wide front and follow the coasts. They gather in large numbers in strategic places if they have to cross a sea to continue on their way (eg Gibraltar). This is the case with most water or shorebirds; they take the East Atlantic flyway and follow a well-defined route. However, some species do not have specific routes. They are content just to go to lenient places to spend the winter and this is the case with most land birds. In the case of this study we are confronted with the last case. The distribution of migratory birds observed during this study in the classified forest of Thiès is listed in the appendix.

4.2. TERRETSTRIAL FAUNA

4.2.1. Methodology

4.2.1.1. Linear transects (mammifères)

4.2.1.1.1. Choice of this method

It applies in the present case only to the enumeration of mammals. After the study of the order, the diagnosis of the field through the maps and the prospecting exit in the area to be studied, our choice fell on the method known as "linear transects" (figure below). The three criteria that guided the choice of the method are: the objectives to be achieved, the configuration of the land and the habitat. This method highlights the density of animal populations. It is very suitable for the inventory of mammals. Based on the exploration of satellite images, five (05) line transects were randomly determined while taking into account the heterogeneity of the working perimeter. The main geomorphological units as well as the habitats that characterize them were targeted in determining the transects that were generated using ArcGIS software. Thus, 02 transects completely cross the target area and were largely sufficient to obtain reliable results on the presence or absence of wild mammals on the site of the future quarry and the cement plant. With a view to future monitoring of the impact of the operation of the site, it was considered useful to define transects in the area of influence of the project. Of this, 03 other transects were defined outside the so-called central zone, bringing the total of observation transects to 5.

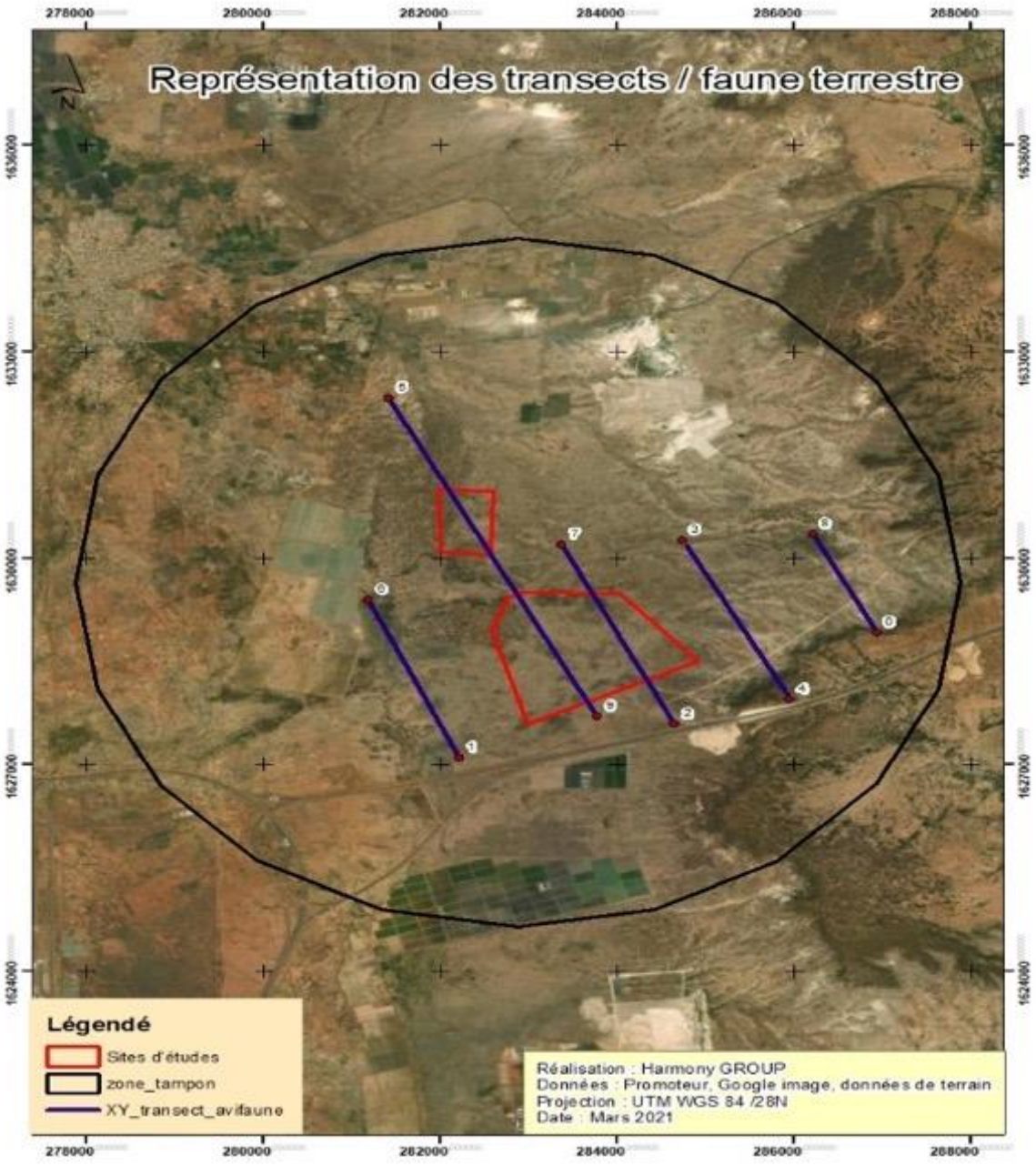

Figure 26: Map of *transects*

4.2.1.1.2. Principles of the method

- A straight line called linear transect is traveled by a team of three (3) people (the first person has a compass and controls the direction of travel and the angle of observation of the animals detected. The second person plays the role. pointer and fills in the sheets. The third ensures the safety of the group and easy their movement. The width of the observation strip is 400 m (200 on both sides) but varies according to the visibility (state of the vegetation);
- The perpendicular or oblique distances on either side of the walking line to the animal are estimated;

- • In most cases, several transversals of length l1, l2 ... ln are measured by the team; their total length (L) = ∑ l;
- • In the field it is easier to determine the oblique distance (DO) and the angle of view than the perpendicular distance (DP) of each of the animals observed, thus
-

$$\frac{DP}{DO} = \sin\alpha \Rightarrow DP = DO \times \sin\alpha$$

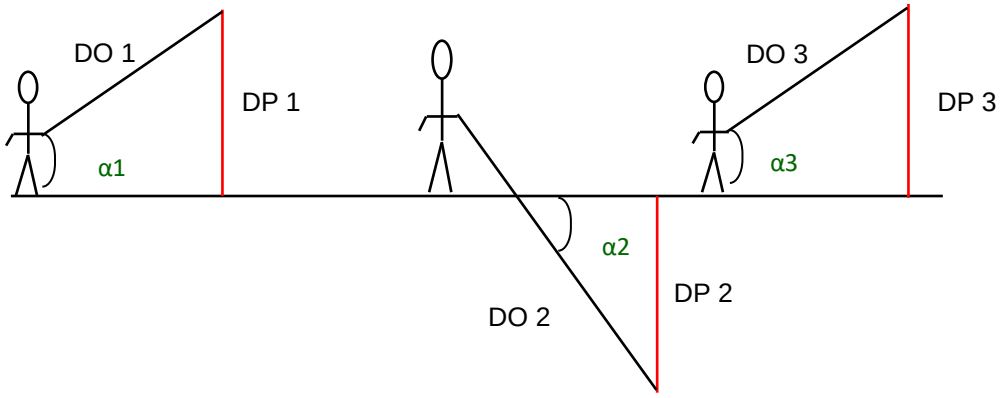

Figure 27 : Diagram of linear transect

a) Calculation of the effective width of the transect (w)

$$\Sigma DP$$

The transect width (w) = (see Table 6)

$$n \text{ animals} / 2$$

The length (L) of the transect is fixed and is already known.

b) Calculation of density (D)

To obtain the population density, divide the number of animals (ΣnI = N) by the sample area (ΣwiLi = SE). (See table 8)

$$\text{Densité D} = \sum_{i=1}^{n} w_i.L_i$$

4.2.1.2. Trap methodology (herpetology)

4.2.1.2.1 Choice of the method

It applies to the inventory of herpetofauna (lizards and snakes). It was set up and offered by the French Society of Herpetology (SHF) in collaboration with the National Center for Scientific Research (CNRS),

the National Forestry Office (ONF) and other scientists. Reptiles (lizards and snakes) are relatively stealthy species whose detection is random. This protocol proposes to any naturalist operator, having knowledge in the identification of reptiles, to implement an inventory whose sampling strategy is sufficient to consider that it is relevant. The implementation of this protocol makes it possible to assess the diversity and density of populations of terrestrial reptiles in natural environments, whether or not they are protected.

4.2.1.2.2. Principle of the method

Prospecting on sight:

In terms of sight detection, a pair of binoculars with a short focusing distance can be useful, as well as a camera for further examination later to remove any doubts of identification. This survey mainly concerns lizards, but also some heliophilic snakes such as the Grass Snake.

- Artificial traps:

With regard to artificial caches, we will use plates made of pieces of plywood instead of plastic sheets. Considering, according to experts, as acquired that the surface of the plates has little influence on the capacity of reception, the objective is to have a good compromise between the transportability of the plate and the need to have a sufficient length to collect the big snakes. We have therefore opted for square plates of 50cm side.

On the natural habitat that one wishes to inventory, one installs a batch of 10 to 12 plates. They are spread over the 5 shelves. The ends of the plates must not correspond to changes in open environments, and will therefore be at least 50 m away from these associated habitats.

So that the reptiles can slip under the plates, it is essential to have 2 tree branches of about 2 cm in diameter, cleared of their branches. We go back within the time allowed to make the observations and count the animals seen or the footprints left.

It is also necessary to add the number of the plate to avoid confusion during the readings.

Figure 28: Trap plates

4.2.2. Results

It includes the examination, synthesis and analysis of field data. Tables (6, 7 and 8) present the results and explain the details and the graphs illustrate the results obtained. They are followed by comments which allow interpretation of the field results.

4.2.2.1. Mammals

Tableau 6 : Presentation of data collected by transect

Transect		**Coordinates GPS UTM**		**hours**		**Longueur (L) Transect (en m)**	**Number of animals observed**	**Width of transect (m)**	**Surface area of transect (s) (ha)**
N°		Départ	Arrival	Départ	Arrival				
T_1	X	0 281 181	0 281 141	10h00	12h05	2 600	29	57,50	14,95
	Y	1 629 457	1 632 314						
T_2	X	0 282 247	0 283 367	10h00	14h50	5 400	11	65,00	35,10
	Y	1 627 040	1 630 193						
T_3	X	0 285 477	0 284 782	09h38	11H35	3 000	01	70,00	14,70
	Y	1 628 599	1 630 185						
T_4	X	0 285 945	0 284 782	09h50	11h41	3 700	09	60,00	22,00
	Y	1 627 984	1 630 185						
T_5	X	0 286 213	0 286 940	09H00	11h45	1 600	00	-	0
	Y	1 630 348	1 628 922						

Tableau 7 : Proportion of the Population observed by species and by transect

	Transects					
Espèce	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**Total**
Erythrocebus patas (Patas Monkey)	19	11	-	09	-	39
Chlorocebus cebaeus (Vervet Monkey)	10	-	01	-	-	11
Terrestrial ; Squirrel	-	X	-	-	X	XX*
Jackal	X	-	-	X	-	XX*
Total animaux comptés (N_e)				**50**		

* (X) *: représente les indices de présence*

The total of observations is 50 distributed as follows:

• 39 patas including 6 young people and 33 adults

• 11 vervets including 01 young and 10 adults

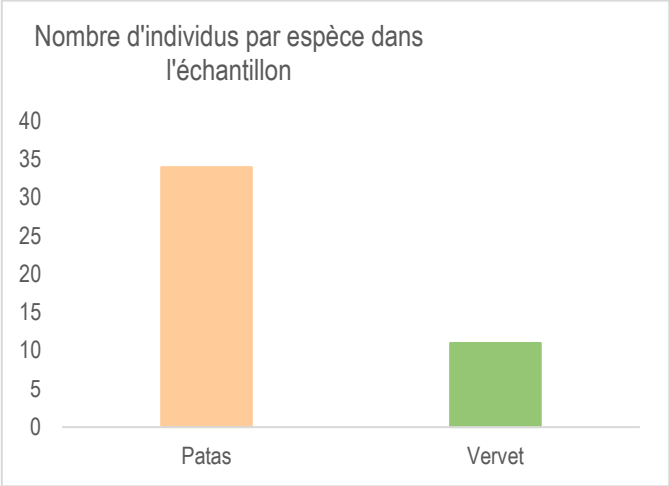

Figure 29: Number of individuals per species

Figure *30* : Vervet monkey in a wetland

Figure 31 : Jackal dropping

- Calculation of the sampled area

  The area of the transects is calculated as follows s = w.L with w = width and L = length of the transect.

Tableau 8 : Width of transects

N° of Transect	Length (L) Transect (m)	Width (w) transect (m)	Surface Area (s) dofu transect (ha)
T_1	2 600	57,50	14,95
T_2	5 400	65,00	35,10
T_3	3 000	70,00	14,70
T_4	3 700	60,00	22,00
T_5	1 600	00,00	00,00
Size of sample (s_e)			**86,3**

- Calculation of the population density over the entire forest

The density in the sample (D) is calculated: D =

N = Number of animals; Se = effective area

D = 86.3

Specific density by species.

- Frequency is the number of times a species has been observed whether alone or in a group. It is calculated by making the ratio between the number of times the species has been seen, over the total number of sightings made.
- As individuals are observed at different distances, the average distance between the animal and the observer is calculated by taking the sum of the observation distances divided by the total number of observations on the transect.
- Specific density is the average of individuals per species per unit area. It is calculated by making the ratio between the total number of individuals of the species over the total area considered.

Tableau 9 : Présentation de la fréquence d'observation et de la densité par espèce

n°	Species	Number of individuals	Number of observations	Observation frequence (%)	Distance average (m)	Specific density
1	Patas	39	03	60%	53,33	1,50 ind/ha
2	Vervet	11	02	40%	60,00	0,41 ind/ha
Total		50	05	-	-	-

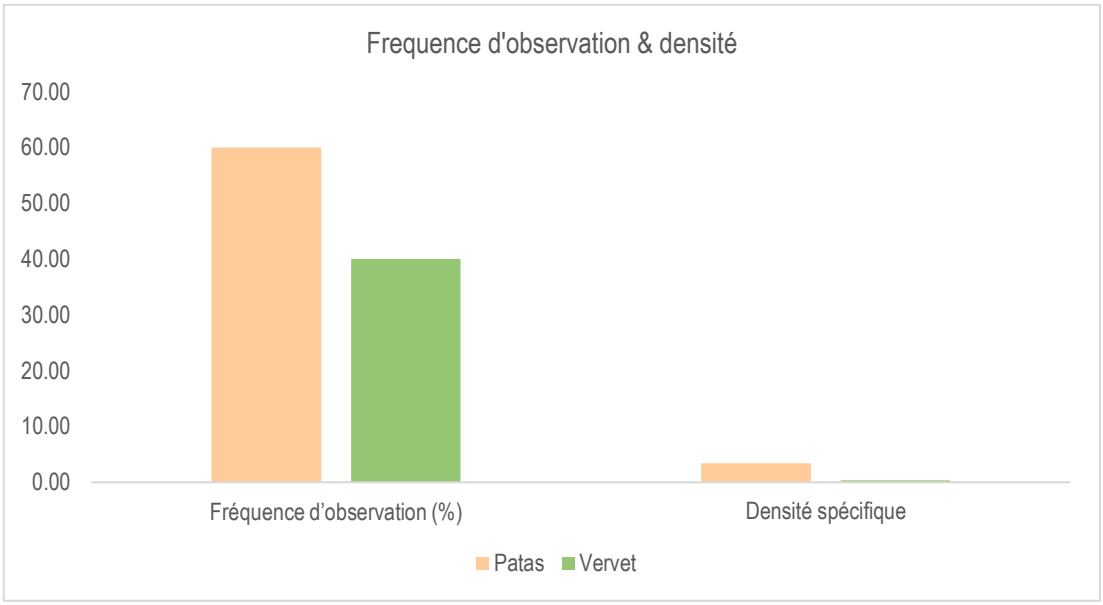

Figure 32 : Frequency and density of observation

Estimation of the population size of the fauna

Taking into account the fact that wild animals are very fearful, some animals hide, others camouflage themselves, the method described above provides that during a land inventory only 30% of the population is counted.

$$\text{Population réelle estimée} = \frac{\text{Proportion détectée}}{30} \times 100$$

Tableau 10 : Estimation of the size of the population

n°	Species	Proportion identified	Population estimated
1	Patas Monkey	39	130
2	Vervet Mokey	11	36
Total		**50**	**166**

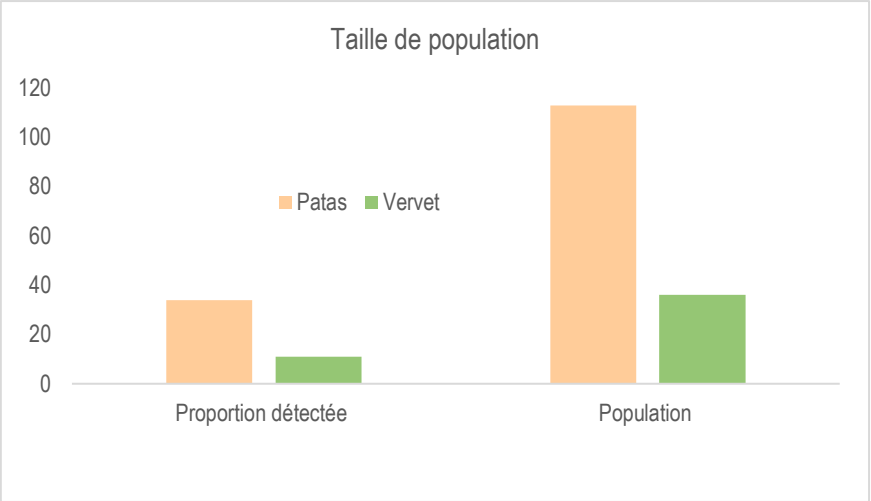

Figure 33 : Population of the fauna

4.2.2.2. Herpetofauna

The trapping device put in place gave the following results:

Tableau 11 : Presentation of the results of the herpetological count

N° Transect		Coordonnées GPS UTM piège	Heures d'observation du piège	Espèce	Nombre
P_1	X	0 285 557	09h05	Serpent	X*
	Y	1 628 425			
P_2	X	0 285 477	09h35	-	-
	Y	1 628 599			
P_3	X	0 283 848	10h35	Serpent	X*
	Y	1 627 645			
P_4	X	0 283 765	11h10	Gecko (*Chirio lacerta*)	01
	Y	1 627 807			
P_5	X	0 282 504	12h20	-	-
	Y	1 627 094			
P_6	X	0 282 404	12h45	-	-
	Y	1 627 647			
P_7	X	0 280 706	12h03	Lézard africain (Agama sp)	1
	Y	1 627 553			
P_8	X	0280 673	11h27	-	-
	Y	1 627 647			
P_9	X	0 286 402	09h46	-	-
	Y	1 629 296			
P_{10}	X	0 286 519	10h20	-	-
	Y	1 629 076			

*X= traces observées sous et au tour du piège

Comment

The low number of catches is explained by the fact that reptiles and amphibians being animals that hibernate a good part of the dry season, the time of the count coincides with this period. actual presence of real activities of reptiles of several forms.

Figure 34 : Snake Moulting

The species observed during the inventory (patas, vervet, snake and gecko) are not protected species in the Code of Hunting and Wildlife Protection (Law 86-04 of January 24, 1986, decree 86-844 of 14 July 1986). They are also not on the IUCN Red List or in the CITES Appendices.

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5.DETERMINATION AND MAPPING OF CRITICAL HABITAT

In accordance with the performance standards developed by the IFC, a Critical Habitat assessment is necessary in order to identify the critical species and / or habitats that are present in the project area and its immediate environment

.5.1. Reminder of concepts

According to the IFC (2012), critical habitats are areas with high biodiversity value. This criterion meets the zones meeting the following characteristics:

- critical habitat for critically endangered (CR) and / or endangered (EN) species;

- habitat of great importance for endemic species and / or with limited distribution;

- Areas of great importance with significant international concentrations of migratory species and / or unique species;

- Seriously threatened and / or unique ecosystems; and

- Areas that are associated with key evolutionary processes. In reality ; Critical Habitat is a sub-category of natural or modified habitats as specified in the provisions of PS6 of the IFC (2012). They can be defined as follows:

- Modified habitats: are areas which can shelter a large proportion of exotic animal and / or plant species and / or whose human activity has considerably modified the primary ecological functions and the composition of species. Altered habitats may include areas developed for agriculture, forest plantations, coastal areas reclaimed from the sea, and areas reclaimed from swamps. Natural habitats: consist of viable assemblages of plant and / or animal species that are largely native and / or whose primary ecological functions and species compositions have not been fundamentally altered by human activity .

5.2. Application area for determining critical habitat

The project area is located in the heart of a protected area: the classified forest of Thiès. For this study, a zone of influence of 5 km around the project was delimited. This approach is consistent with IFC Guidance Note 6 which states that for criteria 1-3, the determination of critical habitat should be based on a "discrete management unit (DMU)".

Thus, prospecting and data collection in this right-of-way served to collect all the information necessary for the determination of critical habitat.

5.3. Protection status of inventoried woody species

By virtue of their economic, ecological, scientific and social importance, tree species, in the current context of forest legislation, each require a status of protection. In this study, we combine Senegalese (forest code) and international (international union for the conservation of nature (IUCN) red list) legislation to determine the protection status of the woody species inventoried in our study site. With regard to the Forest Code in force in Senegal, in its regulatory part, in particular in articles 50, 51 and 52 of decree n ° 2019-110 of January 16, 2019, woody species are divided into the following main categories: - partially protected species; - fully protected species and - species classified, neither in 1) nor in 2) or even legally unprotected species. For the IUCN Red List, the status of animal and plant species are classified as follows: - Not evaluated NE; - Missing data (Data deficient: DD); - Least concern (Least concern: LC) - Near Threatened: NT - Vulnerable (vulnerable: VU) - Endangered (endangered: EN) - Critically endangered (CR) - Extinct in the wild: EW; - Off (extinguished: EX) Details on the legal protection status of the inventoried species are given in the table below.

Tableau 12 : Protection status of woody species present on the studied site

N°	*Species*	*Family*	*National Legislation (Code forestier)*	*IUCN*
1	*Acacia ataxacantha*	*Mimosacées*	*ENN*	*Stable (LC)*
2	*Acacia nilotica*	*Mimosacées*	*ENN*	*Stable (LC)*
3	*Acacia seyal*	*Mimosacées*	*ENN*	*Stable (LC)*
4	*Adansonia digitata*	*Bombacacées*	*ENN*	DD
5	*Azadirachta indica*	*Césalpiniacées*	*ENN*	*Stable (LC)*
6	*Boscia senegalensis*	*Capparacées*	*ENN*	*Stable (LC)*
7	*Combretum aculeatum*	*Combrétacées*	*ENN*	*Stable (LC)*
8	*Combretum micranthum*	*Combretacées*	*ENN*	*Stable (LC)*

9	*Dichrostachys cinerea*	*Mimosacées*	*ENN*	*LC*
10	*Diospyros mespiliformis*	*Ebénacées*	*EIP*	DD
11	*Feretia apodanthera*	*Rubiacés*	*ENN*	DD
12	*Piliostigma reticulatum*	*Cesalpiniacées*	*ENN*	DD
13	*Saba senegalensis*	*Apocynacées*	*ENN*	DD
14	*Ziziphus mauritiana*	*Rhamnancées*	*ENN*	*Stable (LC)*

ENN: unprotected species; EIP: fully protected species.

Thus, on the list of species inventoried on the project site, only one is in the category of species fully protected in Senegal. It is *Diospyros mespiliformis*. On the other hand, it is considered stable according to the classification of the IUCN Red List. However, regardless of their group, any felling, limbing or uprooting of trees, wherever they are in the national domain, is subject to the authorization of the Water and Forestry Service. In the event that the operations take place in a classified environment, an authorization from the Ministry in charge of Water and Forests is required for all access to the premises.

5.4. Protection status of enumerated animal species

5.4.1. Terrestrial Fauna

As a reminder, among the terrestrial animal species that were counted in this study we have the red and green monkeys.

The Red Monkey (*Erythrocebus patas*) is a species not protected by the Code of Hunting and Wildlife Protection of Senegal. On the other hand, it is in the category of near threatened species (NT) according to the IUCN Red List. The green monkey for its part is not only unprotected and is classified as Least Concerned (LC) according to the IUCN Red List.

Tableau 13: Protection status of terrestrial mammals

Species	Identification	National Protection Status	IUCN
Erythrocebus patas (Patas)	vu	Non protégé (NP)	(NT)
Chlorocebus pygerythrus (vervet)	vu	NP	(LC)
Natrix natrix (Couleuvre)	Trace	NP	LC
Canis aureus (chacal)	crotte	NP	LC

5.4.2. Avifauna

The enumeration of avian fauna made it possible to identify 66 species of birds (see section on avian fauna) including the African vulture (*Gyps africanus*). This species is classified as critically endangered in the IUCN Red List.

According to the provisions of Decree No. 86-804 of July 14, 1986 on the Code of Hunting and Wildlife Protection, in article D36, the species is fully protected in Senegal.

5.5. Threshold for critical habitats

For criteria 1 to 3 listed in section 5.1. of this chapter, numerical thresholds are provided in IFC Guidance Notes 6 to determine whether Critical Habitat is Tier 1 or Tier 2. Critical Tier 1 is higher than Tier 2 thus making lower chances of investing in a project. Species that could trigger critical habitat are most often categorized as critically endangered (CR) or endangered (EN). Also, endemic and / or restricted-range species are also critical habitat triggers. Details of the criteria for determining critical habitat are provided in the following table.

Tableau 14: Thresholds for critical habitat from levels 1 and 2.

Criteria	Level 1	Level 2
Critically Endangered (CR) or Endangered (EN) species	Habitat necessary to maintain ≥ 10% of the global population of a species classified CR or EN on the IUCN Red List when there are known and regular occurrences of the species and when the habitat can be considered as a discrete management unit for this species; and Habitat with known and regular occurrences of CR or EN species,	- Habitat that supports the occurrence of a single individual of a species classified as CR or EN on the IUCN Red List and / or habitat containing significant regional concentrations of a species classified as EN on the Red List of IUCN when this habitat can be considered a discrete management unit for this species; Habitat of great importance for CR or EN species that are numerous and / or

Criteria	Level 1	Level 2
	where the habitat is at least one of the 10 discrete management sites in the world for this species.	whose population distribution is not well understood, and where loss of such habitat is likely to impact capacity long-term survival of the species; Where applicable, habitat containing nationally / regionally significant concentrations of species classified nationally or regionally as EN or CR, or having equivalent status.
Endemic and / or restricted species	Habitat known to support ≥ 95% of the global population of an endemic or restricted-range species when that habitat can be considered a discrete management unit for that species (eg, a single endemic site).	Habitat known to support ≥ 1% but <95% of the global population of an endemic or restricted-range species when that habitat can be considered a discrete management unit for that species and when sufficient data are available and / or based on expert judgment.

5.6. Determination of critical habitat

Species that could potentially trigger critical habitat were assessed according to IFC criteria 1-2 and their respective thresholds. The two criteria below are used as a reference to decide on the classification of the ecosystem considered as a critical habitat category. These are mainly:

- Criterion 1: Critically endangered or endangered species

- Criterion 2: Endemic and / or restricted distribution species

On the basis of this principle and by referring to the summary table on the national and international protection status (IUCN Red List), the presence of the African vulture is found in criterion 1, which triggers the critical habitat for the area of the project.

On the other hand, the species listed are not endemic to the area. They are found in other regions of the country and in the Sahelian region.

5.6.1. African Vulture (Gyps africanus)

The African Vulture (Gyps africanus), also called African gyps or white-backed vulture, is a species of scavenging bird in the Accipitridae family.

*Figure 35: Vautour africain (*Gyps africanus*)*

Source : Yathin sk, Mars 2012

African vultures frequent open and sparsely forested areas such as grassy meadows, savannas, swamps and sparse woodlands (Wikipedia).

Most of the time, it only lays one egg (very occasionally 2 or 3), which is one factor in its rapid decline.

5.6.2 Zone of influence of the species in the project area

During the data collection phase, only two individuals of Vulture could be counted. Certainly negligible in number, but the presence of the species is of remarkable importance given the status of endangered species in the wild.

In the project environment, the vulture frequents large trees, especially the baobab. This tree is mainly used as habitat not only for resting but also for nesting. Apart from the observation of two individuals flying over the project area, an abandoned nest on a baobab was identified and mapped (figure below). This refers to the fact that the species therefore frequents the entire area and its surroundings insofar as the baobabs are individually located in a very dispersed manner in this corridor shown in the figure below.

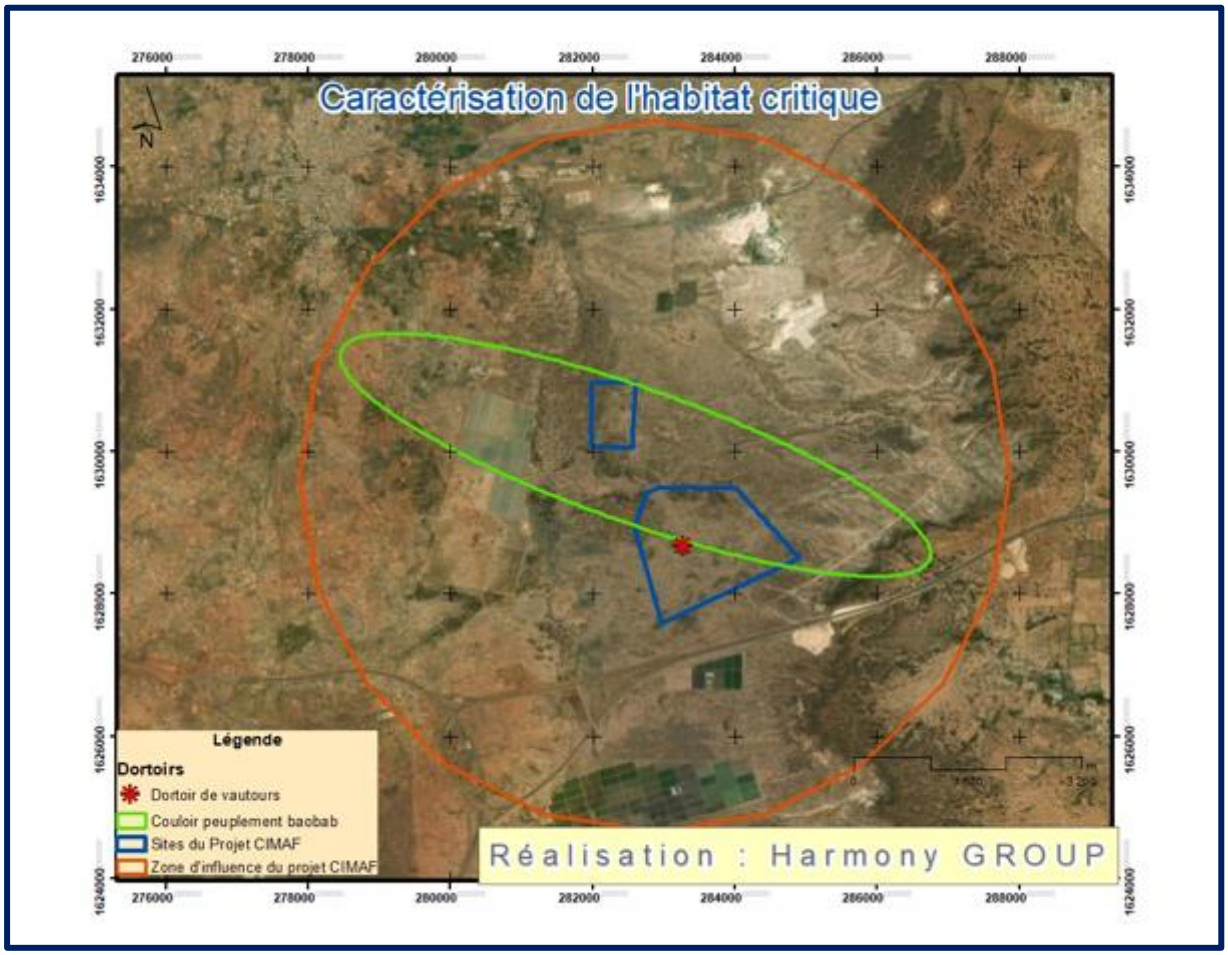

Figure 36 : Materialization of the critical habitat of the area

Ultimately, given the current configuration of the study area in particular and the classified forest of Thiès in general, we are in a modified habitat with a critical habitat due to the presence of a critically endangered species. extinction according to the IUCN Red List (IFC, 2012). Consequently, measures must be taken to limit the impacts on biodiversity and implement a management plan for the safeguard of the baobab stands in the area.

6.PROTECTED AREAS AND IFC PERFORMANCE STANDARDS

According to the 2008 guidelines of the International Union for the Conservation of Nature (IUCN): "a protected area is a clearly defined, recognized, consecrated and managed geographical space, by any effective means, legal or otherwise, in order to ensure long-term conservation of nature as well as the ecosystem services and cultural values associated with it ". According to the objective assigned to the protected area, an international classification has been made to divide the protected areas into 6 main categories.

6.1. Categories of protected areas

Category Ia: Strict nature reserve

Category Ia contains protected areas that are set aside to protect biodiversity as well as possibly geological / geomorphological features, where visits, use and human impacts are strictly controlled and limited to ensure the protection of values. conservation. These protected areas can serve as essential reference areas for scientific research and monitoring. Management objective: Their main objective is to conserve exceptional ecosystems at regional, national or global level and species (individual or in groups).

- Category Ib: Wilderness area

Category Ib protected areas are generally large intact or slightly modified areas, which have retained their natural character and influence, without permanent or significant human habitation, which are protected and managed to preserve their natural state.

Management objective:

To protect the long-term ecological integrity of natural areas that have not been altered by significant human activities, lack modern infrastructure, and where natural forces and processes predominate, so that current and future generations have control. possibility of knowing such spaces.

- Category II: National park

Category II protected areas are large natural or near-natural areas set aside to protect large-scale ecological processes, as well as species and ecosystem characteristics in the region, which also provide a basis for visiting opportunities. of a spiritual, scientific, educational and recreational nature, respecting the environment and the culture of local communities.

Management objective :

Protect natural biodiversity, ecological structure and underlying environmental processes; promote education and recreation.

- Category III: Natural monument

Category III protected areas are set aside to protect a specific natural monument, which may be a topographic feature, a mountain or an underwater cave, a geological feature such as a cave or even a living feature such as an islet. old woodland. These are usually fairly small protected areas and often have a great deal of importance to visitors.

Management objective:

Protect specific exceptional natural elements as well as biodiversity and associated habitats.

- Category IV: Habitat or species management area

Category IV protected areas aim to protect particular species or habitats, and their management reflects this priority. Many Category IV protected areas need regular and active interventions to meet the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

Management objective:

Maintain, conserve and restore species and habitats

- Category V: Protected land or seascape

A protected area where the interaction of humans and nature has produced, over time, an area that has a distinct character, with considerable ecological, biological, cultural and landscape values, and where the preservation of the integrity of this interaction is vital to protect and maintain the area, associated nature conservation and other values.

Management objective:

Protect and maintain important landscapes or seascapes, the associated nature conservation, as well as other values created by interactions with people and their traditional management practices.

-Category VI: Protected area with sustainable use of natural resources

Category VI protected areas preserve ecosystems and habitats, as well as associated cultural values and traditional natural resource management systems. They are generally large, and most of their area presents natural conditions; a certain proportion is subject to sustainable management of natural

resources; and moderate use of natural resources, not industrial and compatible with nature conservation, is considered one of the main objectives.

Management objective: Protect natural ecosystems and use natural resources in a sustainable way, where conservation and sustainable use can be mutually beneficial

.6.2. Thiés Forest

On the basis of this nomenclature, a classified forest, depending on the management method applied to it, can either be included in category IV or VI. Therefore, this site to be exploited must be in line with IFC performance standards in terms of biodiversity conservation and sustainable management of living natural resources.

Thus, given that the classified forest of Thiès is a legally constituted protected area recognized by international bodies, the measures decreed by IFC must be respected with all the necessary rigor. To this end, the following recommendations must be followed with caution, in particular provisions 13 to 19 SP6 standard performance 6. Concretely, these are:

- The client will not convert or significantly degrade natural habitats, unless the following can be demonstrated:

• There are no other viable alternatives in the region for the development of the project in areas of modified habitats;

• Consultation with stakeholders, including affected communities, took into account their views regarding the extent of conversion and degradation;

• any conversion or degradation is mitigated in accordance with the hierarchy of mitigation measures

- In areas of natural habitat, mitigation measures will aim to ensure zero net loss of biodiversity when feasible, and may include appropriate actions consisting of:

• Avoid impacts on biodiversity through the identification and protection of reserved areas;

• Implement measures to limit habitat fragmentation, such as the creation of biological corridors;

• Restore habitats during operations and / or after operations; and

• Implement measures to compensate for loss of biodiversity.

- In cases where a client is able to meet the requirements, the mitigation strategy should be described in a Biodiversity Action Plan. This Plan must aim to achieve the net gains from these biological riches for which the critical habitat has been designated

- Whenever compensation for biodiversity loss is proposed as part of a mitigation strategy, the client must demonstrate, by means of an assessment, that the significant residual impacts of the project on biodiversity can be suitably mitigated.

In addition, the project promoter must, among other things:

- Demonstrate that the proposed development in such areas is permitted by law;

- Act in accordance with the management plans recognized by the public authorities for such areas;

- Consult the promoters and managers of the protected area, the affected communities, indigenous peoples and other stakeholders of the planned project, if applicable; and

- Implement additional programs, as needed, to promote and strengthen the conservation objectives and effective management of the protected area.

CONCLUSION AND RECOMMENDATIONS

This study on biodiversity has made it possible to note a relatively interesting diversity for woody plants, although it should be noted that the tree layer is mainly made up of small shrubs.

Regarding terrestrial fauna, the species observed during the inventory (patas, vervet, snake, jackal) are not on the IUCN red list.

Regarding avian fauna, more than 60 species of birds have been counted including the African vulture (*Gyps africanus*) which has a status of endangered species according to the IUCN red list. . Apart from the observation of two individuals flying over the project area, an abandoned nest on a baobab tree could be identified.

Consequently, measures must be taken to limit the impacts on biodiversity and implement a management plan for the safeguard of the baobab stands in the project area.

In terms of limits, the counting work took place in the middle of the dry season, a period during which climatic conditions are less favorable for the development of wildlife. Food and water are becoming less abundant. Many wild animals exceptionally leave their shelters if they are not totally in hibernation. It therefore becomes more difficult to observe them. This state of affairs is even more accentuated for reptiles and amphibians.

These hazards reinforce the results obtained in mammals largely dominated by primates and presage a higher density during rainy periods.

For herpetofauna, an observation during the rainy season should make it possible to capture and identify more species and more individuals per species.

For the avifauna, it will also be interesting to carry out an inventory at the end of the rainy season (between October, November and December) when most Palaearctic migrants arrive in Senegal and need water points to recharge their batteries.

In any case, the results obtained prove the actual presence of terrestrial and avian animal species which must absolutely be taken into account.

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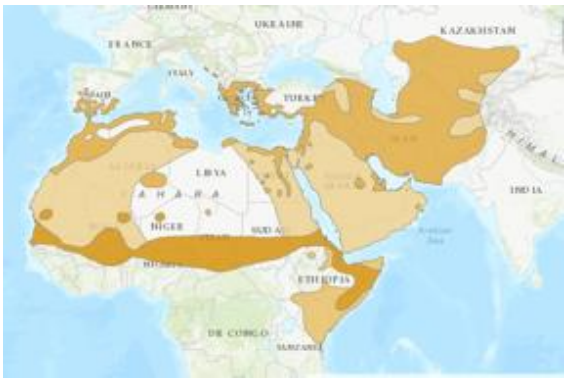
ANNEXE 1 : DISTRIBUTION CARDS OF MIGRATORY BIRDS

Légende

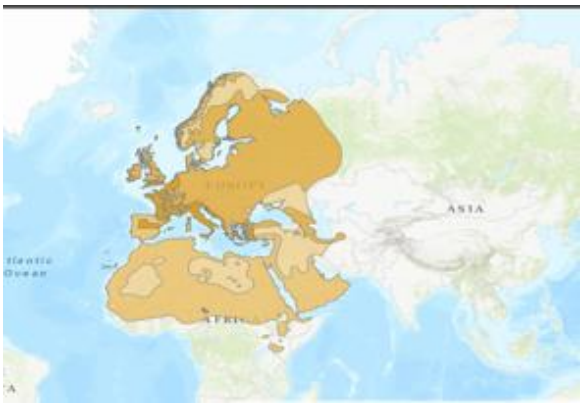
Résident | Reproduction | Introduit

Passage | Non reproduction | Vagabond

Agrobate roux (*Cercotrichas galactotes*)



Pouillot véloce (*Phylloscopus collybita*)



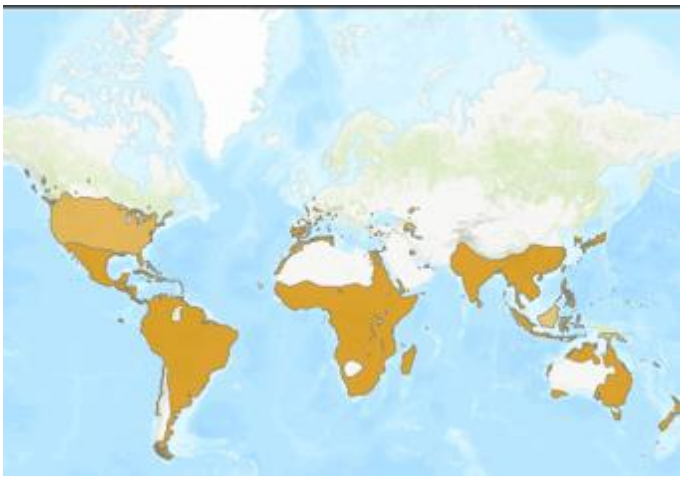
Coucou gris (*Cuculus canorus*)

Rollier d'Abyssinie (*Coracias abyssinicus*)

Faucon crécerelle (*Falco tinnunculus*)

Rossignol philomèle (*Luscinia megarhynchos*)

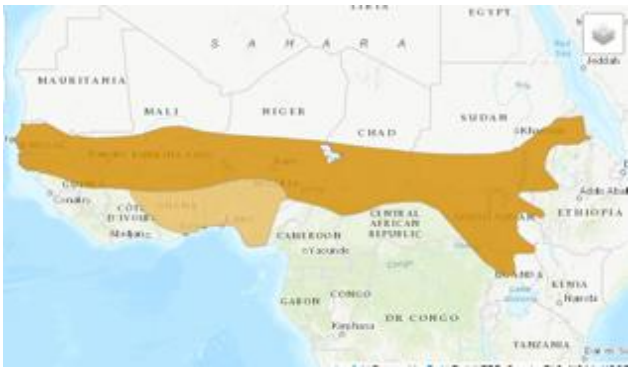
Héron Garde-bœufs (*Bubulcus ibis)*



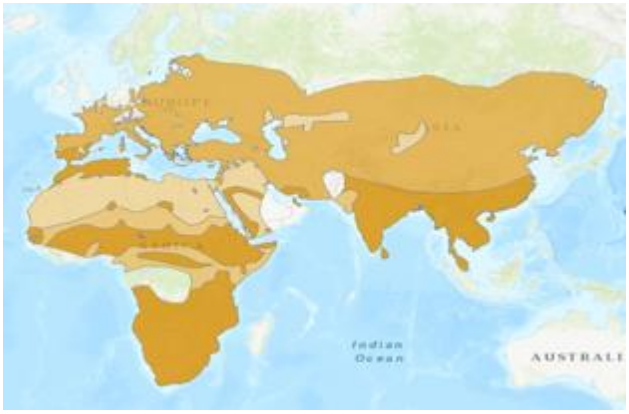
Rougequeue à front blanc (*Phoenicurus phoenicurus)*

Héron mélanocéphale (*Ardea melanocephala)*

Tourtelette d'Abyssinie (*Turtur abyssinicus)*



Huppe fasciée *(Upupa epops)*



Tourterelle à collier (*Streptopelia semitorquata)*

Martinet noir (*Apus apus)*

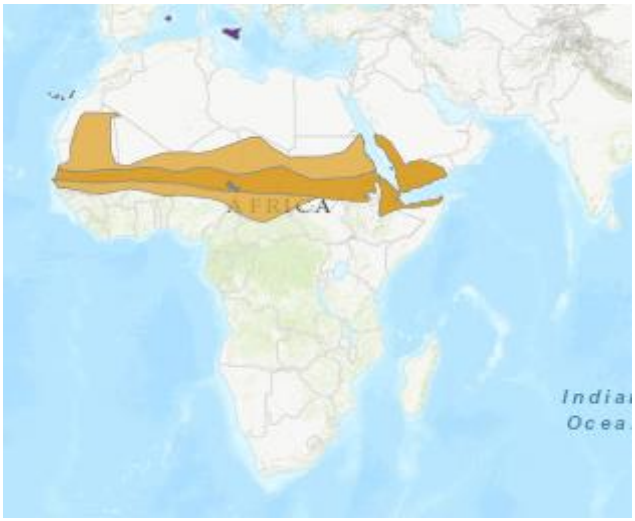
Tourterelle maillée (*Spilopelia senegalensis)*

Milan noir (*Milvus migrans)*

Tourterelle masquée (*Oena capensis)*

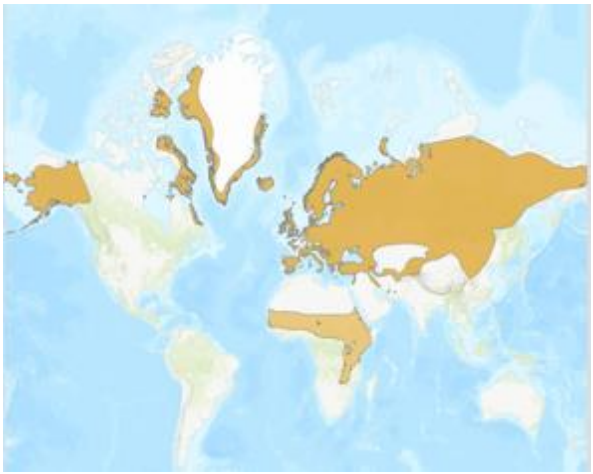
Pie-grièche À Tête Rousse (*Lanius senator senator)*

Tourterelle rieuse (*Streptopelia roseogrisea)*

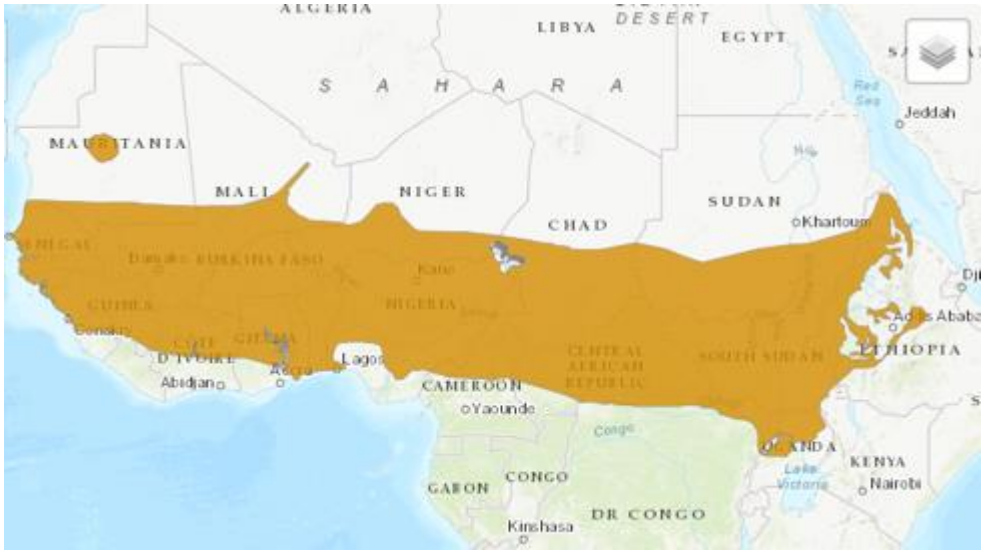


Pouillot de Bonelli (Phylloscopus bonelli)

Traquet motteux (*Oenanthe oenanthe)*



Tourterelle vineuse (*Streptopelia vinacea)*



LISTE DES EXPERTS AYANT PARTICIPE A CETTE ETUDE

Prénom Nom	Fonction
Étude de la végétation	
Mamadou Kora	Chef d'équipe, Ingénieur des Eaux et Forêts, Ms. Télédétection &SIG
Mamadou Diop	Ingénieur Forestier
Mbaye Diouf	Ingénieur Forestier
Fily Berthé	Ingénieur Forestier
Étude de l'Avifaune	
Aissatou Yvette	Chef d'équipe, Biologiste / Écologiste – Experte en ornithologie
Abdoulaye Diop	Doctorant en ornithologie
Mame Bassirou Diallo	Guide de terrain en ornithologie
Étude de la Faune terrestre	
Ndeury Diaw	Chef d'équipe, Ingénieur des eaux et forêts, spécialiste en faune terrestre
Alioune Diouf	Ingénieur des eaux et forets
Ousseynou Diaw	Pointeur
Modou Diama DIaw	Pointeur
Ndiaga Fall	Guide
Mactar Ndiaye	Guide