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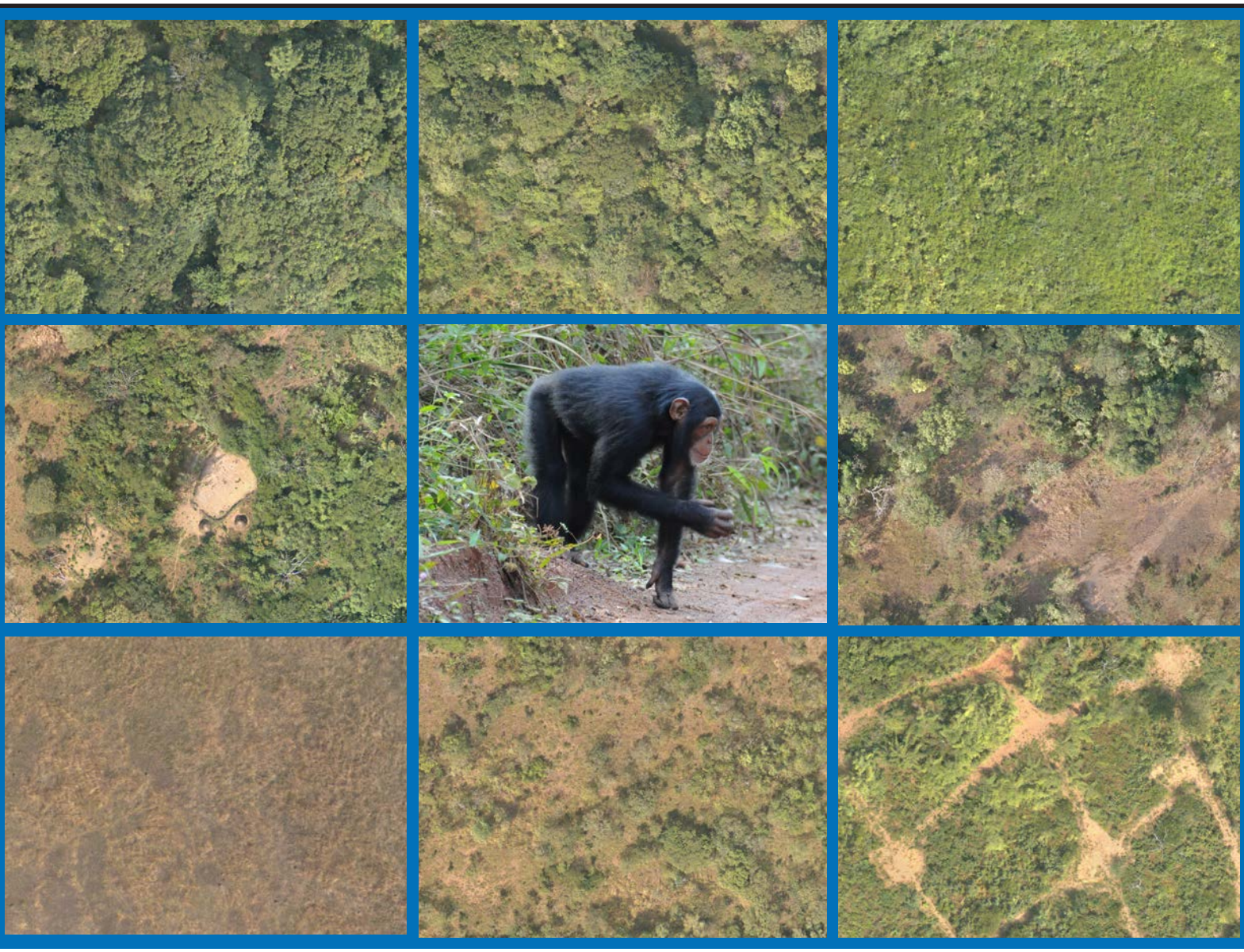

Natural habitats and Chimpanzee refugees Aerial Survey for the GAC dam project

Preliminary report

DECEMBER 2016

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1/ INTRODUCTION

This preliminary report is related to the natural habitat and chimpanzee refuges aerial survey that Sylvatrop Consulting undertook based on an emergency request from GAC.

In the frame of its environmental management plan, GAC is due to undertake biodiversity and critical habitat species survey before all kind of operation that could impact biological environment.

Beside mining operations, the GAC project need to build a dam in order to create a water reservoir that will provide water to the mine plant.

ERM have been contracted to undertake a Pre-Clearing Biodiversity survey. While doing the fieldwork, ERM team found chimpanzees in the future reservoir area and collected various ground informations (nest presence, feeding reliefs, track, et.).

In order not to delay construction operations too long, GAC had to react very fast and use proactive options that will allow them to take the right decisions.

UAV have proved to be efficient to provide accurate data regarding natural habitats, land use and chimpanzee surveys (Sylvatrop Consulting, 2016).

1.1 CONTEXT

Since 2004, GAC owns a 116 Km^2 Bauxite mining and refining project in Guinea, in Tinguilinta, sub-prefecture of Sangarédi, prefecture of Boké, in the north-west of Conakry. The agreement also includes a port concession in the coastal city of Kamsar. From 2004 to 2006, SEIA was performed and approved by the Guinean government. The original studies concerned mining and refining operations in the northern part of the concession.

In 2013, GAC appointed independent environmental consultants, Environmental Resource Management (ERM), to develop SEIA Addendum. The SEIA Addendum aimed to complete the previous SEIA studies by concentrating the effort in the southern half of the concession and to update (where applicable) the previous SEIA studies undertaken by GAC. After submission, a final approval decision is pending.

Besides mining activities field, the Bauxite Export Project plans the development of transportation infrastructures and storage facilities within the concession area and at the port concession. Following the SEIA Addendum recommendations, GAC should limit impacts on biodiversity.

GAC plans to proceed with bulk sampling on Plateau 20, which includes the establishment of a dam in order to provide the mine plant wit water. Considering SEIA Addendum recommendations, GAC asked SYLVATROP Consulting to investigate the habitats and chimpanzee's refugees all over the dam footprint area.

In this context, SYLVATROP Consulting has conduct a natural habitat and chimpanzee aerial drone survey.

1.2 OBJECTIVE

Provide to GAC a report on chimpanzee refugees and nesting sites as well as with a mapping of habitat.

1.3 SURVEYED AREAS

The report is covering the planned haul road footprint and the bulk sample extraction site(s). Works focused essentially on a 80m-wide corridor of the haul road, and the "A" defined bauxite extraction areas.

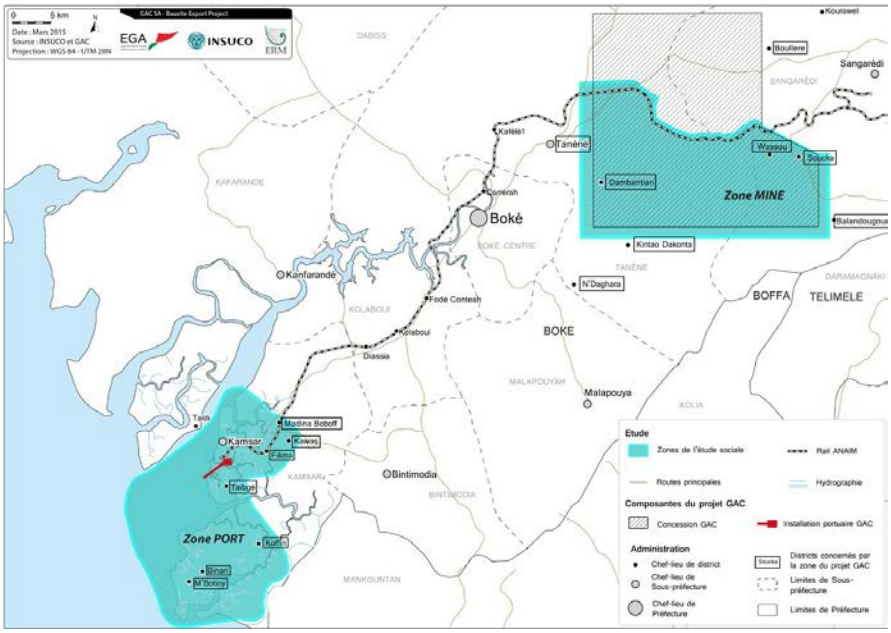

Figure 1: *Representation of the GAC project geographical position*

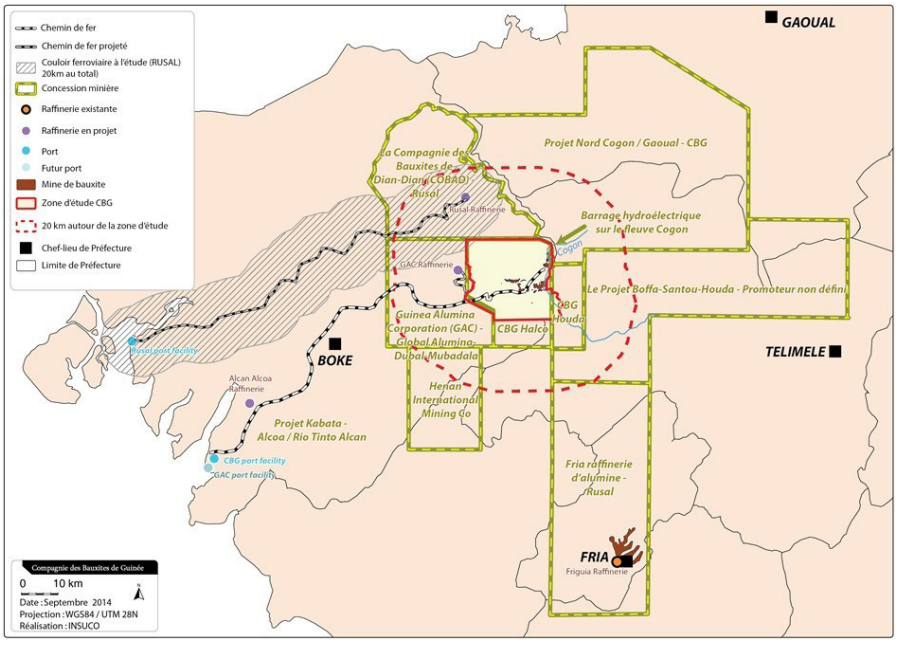

Figure 2: *Representation of the GAC project concession*

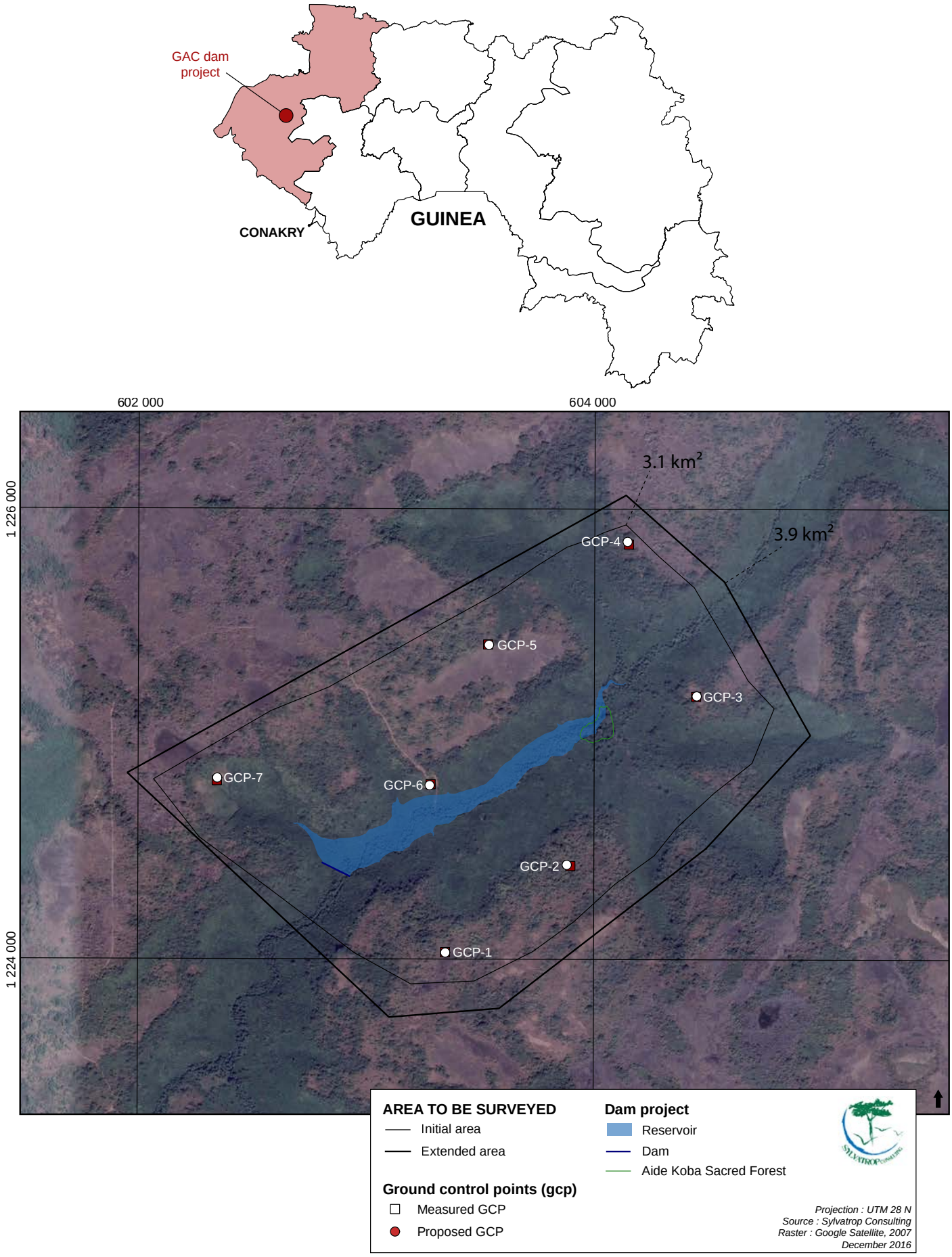

Figure 3: *Representation of the area to be surveyed*

2/ UAV'S AERIAL SURVEY

2.1 OBJECTIVES

The objective is to achieve and produce geo-referenced aerial images in two and three dimensions for the perimeters of the dam using UAV (Unmanned Aerial Vehicles).

2.2 PROJECT AREA

Areas to be covered are those presented in figure N° 3.

2.3 SPECIFIC OBJECTIVES

- Prepare flight plans and plan the number of flights per day;
- Conduct a preliminary site visit to determine take-off and landing sites and to prepare the Ground Control point settings;
- Carry flights and take pictures;
- Save Images
- Generate ortho-mosaics and digital terrain models
- Creation of 2D and 3D models.

2.4 METHODOLOGY

2.4.1. UAV AND OTHER MATERIALS

In order to provide the best services to the GAC Project and considering the particularities of the request services, we used a Senseflye Bee.

The eBee is a ready-to-deploy mini drone with a modular wing design. Its flying software allow it to fly close enough to the ground in order to deliver 5cm GDS images which are exactly what is needed for the haul road survey.

A QX350 for aerial security, videos and mission documentation. The QX 350 is a quad-copter being used for three different purpose :

- First it allows to take videos and pictures of areas where are chimpanzees nest in order to help for nest identification.
- Secondly it's being use in order to document the mission by taking photos and videos of the team and the other UAV.
- Third, QX 350 allow the team to have "a look" in the surroundings before launching the other UAVs. This is a very important security phase especially during dry season when peoples set fires in the bush.

2.4.2. AERIAL IMAGERY METHODOLOGY

Etape 1 (Office)	Determination of all areas to discover and of area, based on the information provide by the client
Etape 2 (Office)	Flight plan elaboration Flight numbers planification
Etape 3 (On site)	Taking of and landing areas determination Ground Control point planification
Etape 4 (On site)	Flights and aerial images acquisition
Etape 5 (On site)	Uploading of images
Etape 6 (Office)	Orthomosaic, DTM, DSM and 3D models production

2.4.3. IN FIELD OPERATION

Thanks to GAC understanding, we had the possibility to use our own vehicle that is specially equipped in order to produce energy all day long. Being based in Sangaredi instead of at Tinguilitta allowed the team to benefit for an important flexibility in terms of hours of work.

The team was composed of:

- The main pilot in charge for building up the flights and operate them
- The second pilot in charge for assisting the main pilot but also in charge of all security aspects for both the machine and the people
- The driver.

In order to get the best quality results, we flew the drone in order to provide approximately 5cm / pixel accuracy images.

Seven geo-referenced Ground Control Points (GCP) that have been set by GAC topographic team with a Differential GPS in order to reach cm level accuracy in the three dimensions (x, y, z).

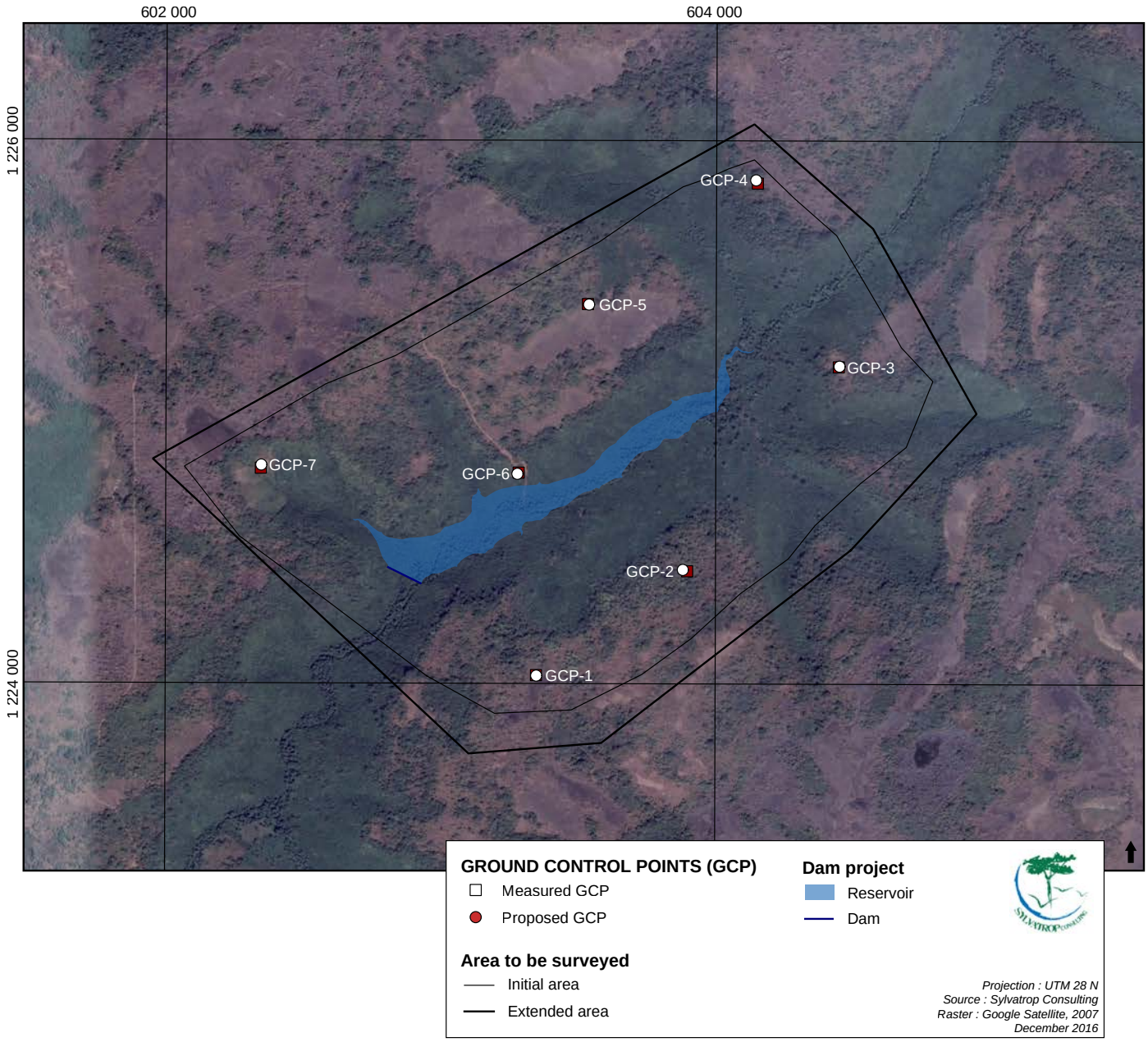

Figure 4: *Area to be surveyed with Ground Control Point*

Figure 5: *The Sylvatrop Consulting UAV team with Chimpanzee specialist assistant*

As shown in table 1 taken from the Sylvatrop Consulting internal drone technical report, the ground control points allow to know the whole project average error. This error was lower than 1 cm.

Name	X error (mm)	Y error (mm)	Z error (mm)	Total (mm)
GCP 1	-0.90	-3.54	0.97	3.78
GCP 2	-1.23	-0.61	-0.28	1.40
GCP 3	0.74	0.38	0.21	0.86
GCP 4	0.25	0.62	-0.16	0.69
GCP 5	4.77	-4.59	-0.54	6.64
GCP 6	-6.06	13.6	-1.03	14.96
GCP 7	2.68	-7.52	3.06	8.55
TOTAL	**3.15**	**6.29**	**1.30**	**7.15**

Table 1: Ground Control Point coordinates and average error

Figure 6 : *Example of one Ground Control Point pictured by the drone*

Flights have been operated using our eBee UAV that allows to work in remote areas and is well adapted for small to medium project in hilly and mountainous areas.

In order to be able to follow "natural" contour lines as much as possible, the area has been divided in two sub-areas A and B.

A total of 19 flights have been operated in 4 days.

3964 images have been taken with a 80% longitudinal ovelap and 65% lateral overlap. Data have been processed with Agisoft Photoscan (v.1.2.6 build 2834).

The main constrains the team faced with was:

- The difficulty to find a plan area for taking of and landings
- The mist. Every morning the area was covered with mist that did not allow any taking off before 10 AM and even sometime later. (see operation data sheet in Annex 1)

As much as possible the flights have been operated in order to follow the natural contour lines.

3/ NATURAL HABITAT PART

3.1 PRINCIPAL OBJECTIVES

Elaborate an operational natural habitat baseline study for the entire impacted area with operational decisional tools, usable for the whole project duration.

3.2 SPECIFIC OBJECTIVES

- Provide a natural habitat knowledge of the area,
- Constitute a reference statement for the natural habitat monitoring,
- Give geo-referenced qualitative and quantitative data with adapted analysis,
- Propose decisional tools for road and dam construction infrastructures' design.

3.3 METHODOLOGY OF THE NATURAL HABITAT SURVEY

The natural habitat survey is based on the aerial mapping obtained from the drone operations.

Given the the accuracy of the orthomosaïc built from the drone images, it has been possible, for a trained botanist, to identify all habitats and map them.

3.4 NATURAL HABITAT CLASSIFICATION

We used the same habitat classification than the one used in the frame of the ERM SEIA. This is the Yangambi (1956) classification (confirmed by Letouzet 1969, Knapp 1973 and Menaut 1979) that work for all African ecological areas.

4/ CHIMPANZEE PART

4.1 AERIAL CHIMPANZEE NEST SURVEY

4.1.1. MAIN OBJECTIVE

The objective is to achieve and produce geo-referenced aerial images in two and three dimensions for the perimeters of the dam footprint area using UAV (Unmanned Aerial Vehicles) that will be used for chimpanzee nest identification, impact analysis and mitigation strategy recommendation.

4.1.2. SPECIFIC OBJECTIVES

- Identify all chimpanzee nesting areas in the surroundings of the dam project,
- Produce an analysis of the dam construction impact on the chimpanzee's habitat and refuges,
- Identify a feasible strategy to mitigate the negative impacts and enhance the positive ones.

4.1.3. IDENTIFICATION OF CHIMPANZEE NESTING AREAS

Most of chimpanzee's nest could be seen on the photos taken by the drone. Some of the nest that are being built under the canopy cannot be seen but because the photos are being taken with a 7° angle, and based on previous study undertook in the same region, it is possible to identify almost 80% of the nests.

All the 3962 photos have been analysed one by one in order to detect chimpanzees nest.

Figure 7 *: Example of nest identification on one photo*

4.1.4. IMPACT ANALYSIS

Identification of nesting areas and nesting refugees, coupled with accurate orthomosaic and 3D imagery allows to get an understanding of the various disturbances that will occurs on chimpanzee's population.

4.1.5. STRATEGY FOR IMPACTS MITIGATION AND MONITORING

This part of the report is based on the results from the habitat impact analysis and the chimpanzee's impact analysis. It includes mitigation and support strategy and propose some recommendations for an action plan during the dam construction and exploitation phases.

4.1.6. MONITORING TOOLS

For each category of impact, it is particularly interesting to elaborate some indicators that give opportunity to evaluate the impact of the project in the future. Environmental and ecological indicators will be built for each kind of impact, which will be given for the "year 0". All the calculation methodologies will be explained to give the opportunity to the future evaluators to calculate these indicators at "year 0+x".

5/ RESULTS

The results presented in this report are preliminary ones.

5.1 DRONE SURVEY

5.1.1. FLIGHTS

A grassy savanna area has been chosen for taking off and landing place.

A total of 19 flights have been operated, producing 3964 photos.Flights have been operated with a mean height of 190m above ground level allowing a average accuracy of 6,01 cm/pixel.

Figure 8 *: Grass savanna used for taking off and landing area*

Figure 9 *: Checking the flight and preparing the next one at the landing area*

Figure 10 *: Ready for taking-off*

Figure 11 *: Taking off*

5.1.2. CALCULATION SYNTHESIS

5.1.2.1. Connection points:

Connection points are automatically generated by the software that recognize between each of the photos similar pixels. Connection points with re-projection error over 20 cm have been deleted in order to get a better accuracy.

A total of 2,128,865 points have been identified. The result has been optimised up to the ground control points in order to reposition all the photos.

5.1.2.2. Point cloud:

In order to obtain a very accurate ortho-mosaic, the point cloud has to be densified. This very time consuming process produced a point cloud with 521,123,851 points for a 4.4 km2 area (118 point/m2).

The point cloud corresponds to a three-dimension model of the concerned area. Vegetation and human construction are represented in 3D.

5.1.3. CREATION OF AN ACCURATE ORTHOMOSAÏC

The orthomosaic, presented here under (Figure 12). Is delivered in JPG file (and GIS files) to the client.

Its accuracy is about 6cm/pixel which means that each of the pixel is about 6cm x 6cm.

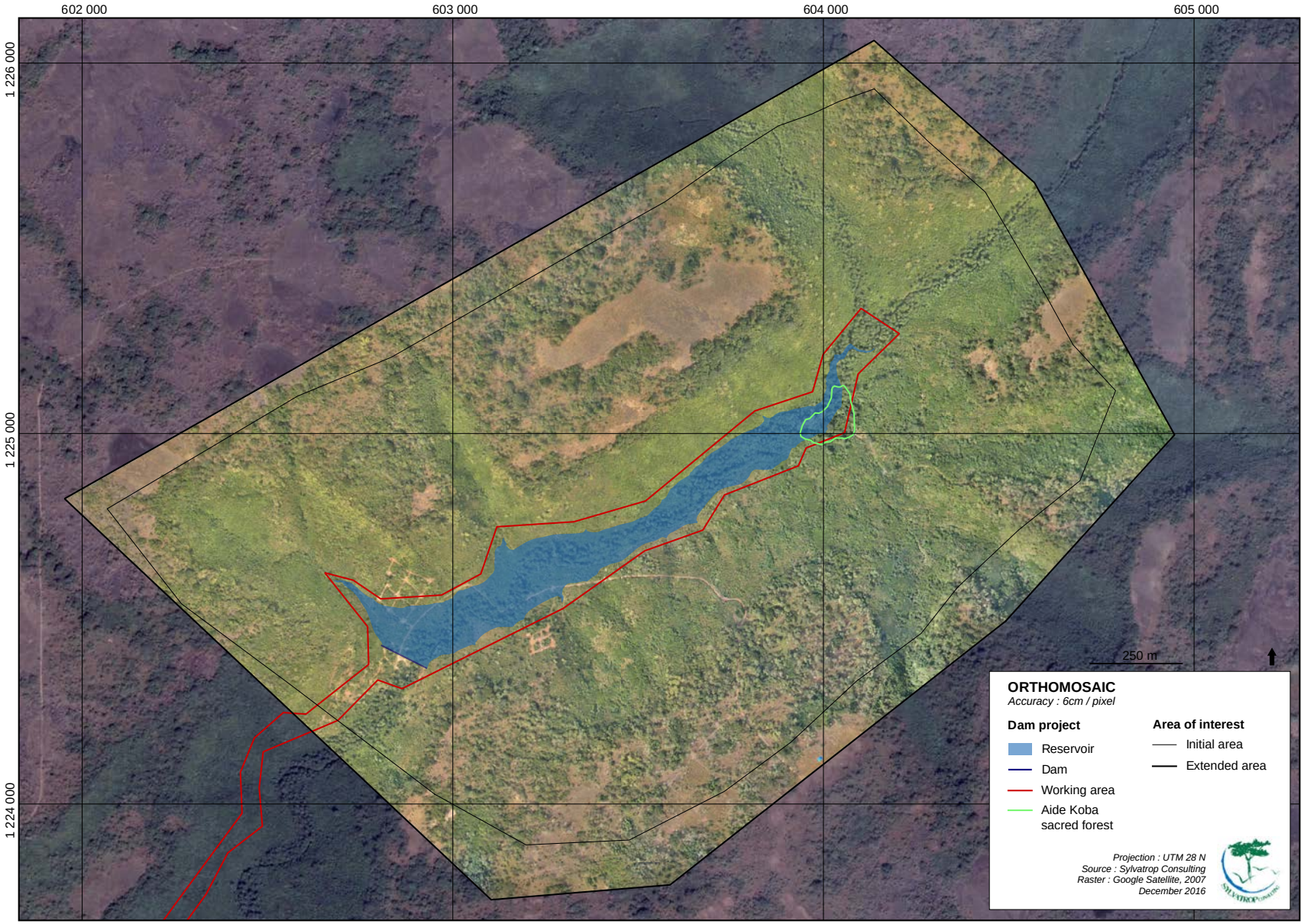

Figure 12: *Representation of the orthomosaic in its environment*

5.1.4. CREATION OF 3D MODEL OF THE AREA (TO BE DELIVERED IN THE FINAL REPORT)

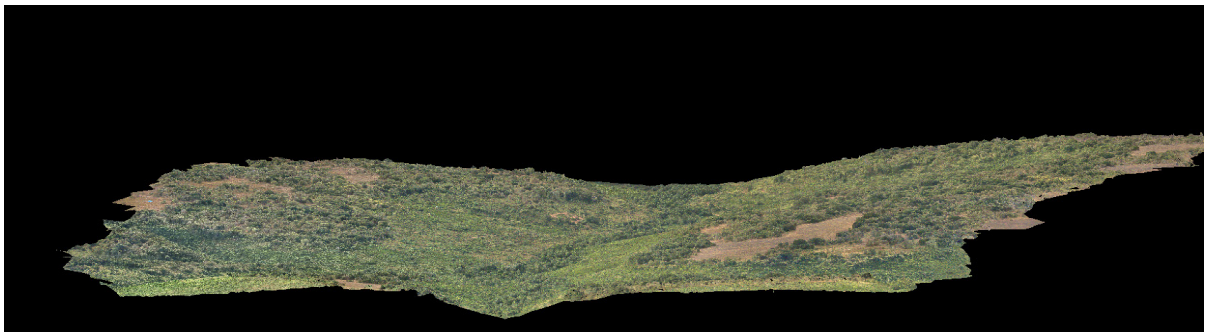

Figure 13 *: Representation of the 3D model*

5.2 HABITAT MAPPING

The habitat mapping is based on the habitat classification given by ERM but we also considered the White (1983) classification as shown in table 2 here under.

No	Habitat	Degradation level	Description
1	Woodland	Lightly degraded to degraded	Group of trees about 8m high with canopy cover about 40% or more. Undergrowth dominated by Graminae. Upper stratum composed with Danielia oliveri, pterocapus erinanceus, Parkia biglobosa, prosopus africana…
2	Wooded savannah	Degraded	Herbaceous area with trees of which the upper stratum is composed with Parkia biglobosa, Danielia oliveri, pterocarpus erinanceus…
3	Fallow	Degraded to very degraded	Agricultural area at a stand by phase with dominant Dialium guineense, Dichrostachys cinerea ...
4	Isolated forest patch	Lightly degraded	Small (<50 ha) and isolated area in the middle of agricultural land. Upper canopy is composed with Cola cordifolia, Parinari excelsa, Albizia zygia, Morinda geminata…
5	Shrub savannah	Degraded	Area with shrubs about 3m to 7m high. Main species are Sorendeia jugandifolia, Uvaria chamae, Annona senegalensis…
6	Grass savannah	Degraded	Area covers with Graminae and other grass with or without ligneous plant that covers no more than 10% of the area. Main species are Andropogon gender
7	Shrub	Degraded	Closed area with shrub and lianas between 3m to 7m high

Table 2: Recorded habitat in the surveyed area based on ERM information and White (1983) classification

No critical habitat has been recorded although woodland and wooded savannahs as well as Isolated forest patch hold some tree species like that could be of primarily importance for chimpanzee which is a critical habitat species.

Photos of each of these habitats are presented in appendix 2.

5.2.1. HABITAT MAPPING USING THE ORTHOMOSAÏC

A total of 379,3 Ha have been surveyed and mapped.

As shown in figure n°14 and table n°3 here under, the most important habitat that covers the area is the one named mosaic of the slope (43,95%).

Of course, this habitat is not an official one and cannot be found in the botanical literature. This class has been created by ERM in order to describe a habitat that covers the slopes and is made with a mixed of various fallows and Shrub land that also include sometime a few palm trees.

The gallery forest is mainly composed with palm trees. All other ligneous species have almost disappeared and only a few of them seem to occur at some place and especially in a small area that is designed as a sacred forest. Only in an area corresponding to the Aide Koba Sacred Forest, remains a few large trees in this valley (see figure 13).

Dense forest represents 3,86% of the whole habitat in the surveyed area, while woodland represent 8,83% and wooded savanna represent 23,8% of the whole habitats.

	Habitats	Area (m^2)	Area (ha)	%
Anthropic	mining activities	47 248	4,72	1,25
	rice fields	35 333	3,53	0,93
	camp	5 349	0,53	0,14
Natural habitat	gallery forest	192 772	19,28	5,08
	dense forest	146 495	14,65	3,86
	woodland	334 936	33,49	8,83
	mosaics of the slopes	1 667 249	166,72	43,95
	wooded savanna	902 980	90,30	23,80
	mixed savanna	232 901	23,29	6,14
	bowal	228 017	22,80	6,01
	TOTAL	**3 793 280**	**379,3**	**100**

Table 3: Habitat surface area

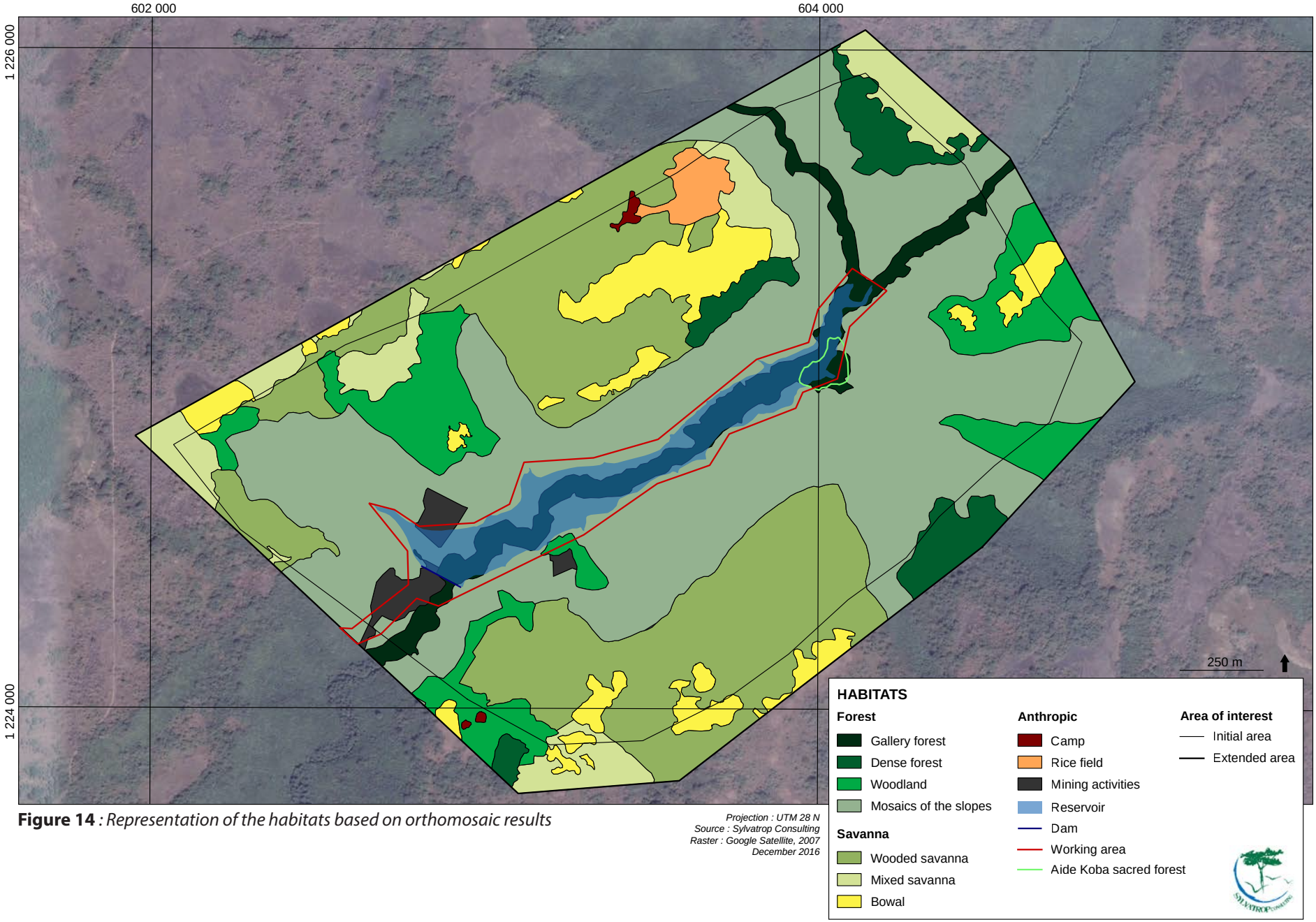

Figure 14 : *Representation of the habitats based on orthomosaic results*

Projection : UTM 28 N
Source : Sylvatrop Consulting
Raster : Google Satellite, 2007
December 2016

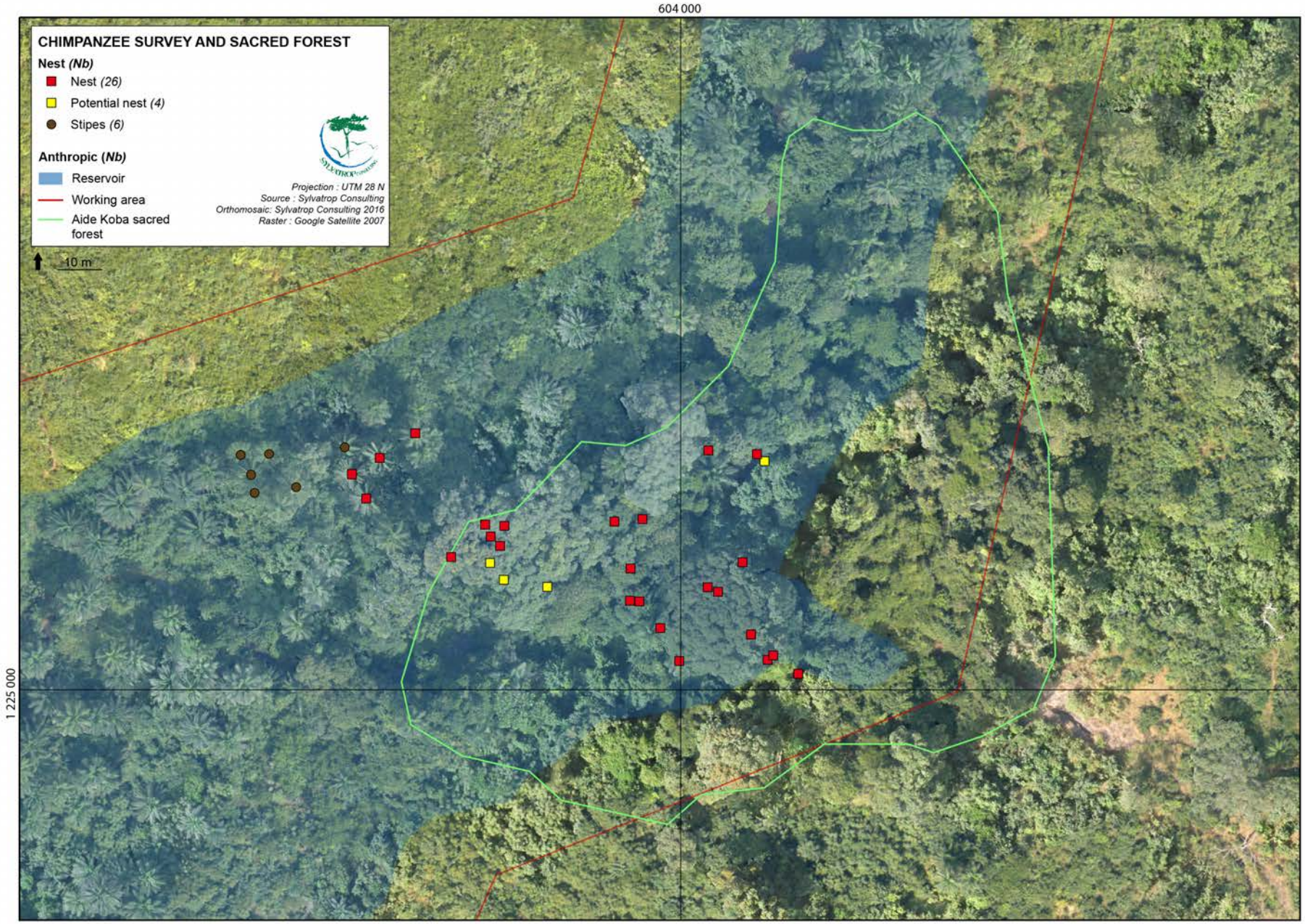

Figure 15 : *Representation of the Aide Koba Sacred Forest habitats with orthomosaic results*

5.2.2. HABITAT MAPPING USING THE 3D REPRESENTATION (TO BE PRESENTED IN THE FINAL REPORT)

5.3 CHIMPANZEE SURVEY

The second purpose of this drone survey was to identify important nesting areas and chimpanzee's refuges.

Although chimpanzees are recognized as good flagship, umbrella and environmental indicator species (Junker et al. 2012) their survival is today critically put at risk, which explains their protection at both the national and international levels. They are integrally protected by Guinean law which has listed them as "in peril" in the "Monographie National de la Diversité Biologique" (République de Guinée 1999, 2004). As the outcome of the international reassessment in 2016 of the status of *Pan troglodytes* populations, the IUCN Red List of Threatened Species upgraded the *verus* subspecies (West African chimpanzee) from "Endangered" to "Critically Endangered" (Humle and al. 2016). This re-evaluation has been motivated by the fact that the total population loss estimated over a three-generation period (69 years) has been estimated to exceed 80%, mainly due to habitat loss and fragmentation resulting from anthropic activities in an increasing human demography context, poaching and disease outbreaks (Formenty et al 2003).

Chimpanzees is thus considered as one of the most important species of conservation concern in the context of the GAC project development. In order to be able to build up a proper mitigation and avoidance strategy, GAC needs to benefit from as much as possible information's regarding this species. Beside of nest counting that allow to get a picture of the population's size, knowing exactly where chimpanzees are used to nest and what are their main refuges will give the opportunity to avoid the most important areas they belong to.

5.3.1. DETECTION OF CHIMPANZEE NEST AND OTHER ITEMS

As shown in Figure 16, the detection of nests is not a problem for those that, as in the experience of Andel et al. (2015), are located in the upper part of the canopy.

The old nests of big-brown to grey colour are more visible and more easily detectable than new nests and / or recent nests that are still green. It is however possible to identify recent and new nests by paying attention to small variations of the foliage as well as the inclination of the branches.

The ease of detection of new and recent nests seems also vary depending on the tree type in which they are made.

Figure 17 shows a detail of the Figure 16. It is easy to notice that the nests, although close to one another, are not all of the same colour and therefore, they do not have the same age. Gray coloured nests are much older than brown ones.

Of course, we cannot use visual nest degradation rates that have been determined from studies conducted from the ground since they consider the nests seen from below. The perception of the degradation of nests is different when viewed from the sky. But based on these observations we can state that the concerned area is being used since a while and that chimpanzees frequently nest there.

Figure 18 shows chimpanzee nests in palm trees. The palm trees are often used by chimpanzees

not only to spend the night but also for food. Some areas of gallery forest where there are many palm are heavily used by chimpanzees. The detection capability of nests and palm trees where chimpanzees consumed stipes (the stalk that support the leave structure) is excellent. This is therefore a good way to determine important areas for the animal.

Figure 16: *Nest detection in "hotspot area"*

Figure 17 *: Zoom in Figure 16 and various nest age detection*

Figure 18 here under shows chimpanzee nests in palm trees. The palm trees are often used by chimpanzees not only to spend the night but also for food. Some areas of gallery forest where there are many palms are heavily used by chimpanzees. The detection capability of nests and palm trees where chimpanzees consumed stipes (the stalk that support the leave structure) is excellent. This is therefore a good way to determine important areas for the animal.

Figure 18 *: Stipes eaten and nest detection in palm tree*

As shown in Figure 19 here under, we spotted 637 items, among which 506 nest of various ages, 97 potential nests (item that are not 100% identified as nest but could be nests) and 34 palm trees that have been used for feeding (stipes removed).

Most of the nest are situated in dense forest (154 nest) and woodland habitat (138 nests) (see Figure 20 and 21).

The Aide Koba Sacred Forest seems also to be an important area for the chimps. According to ERM, chimpanzees are used to go there to eat fruits from remaining fruiting trees.

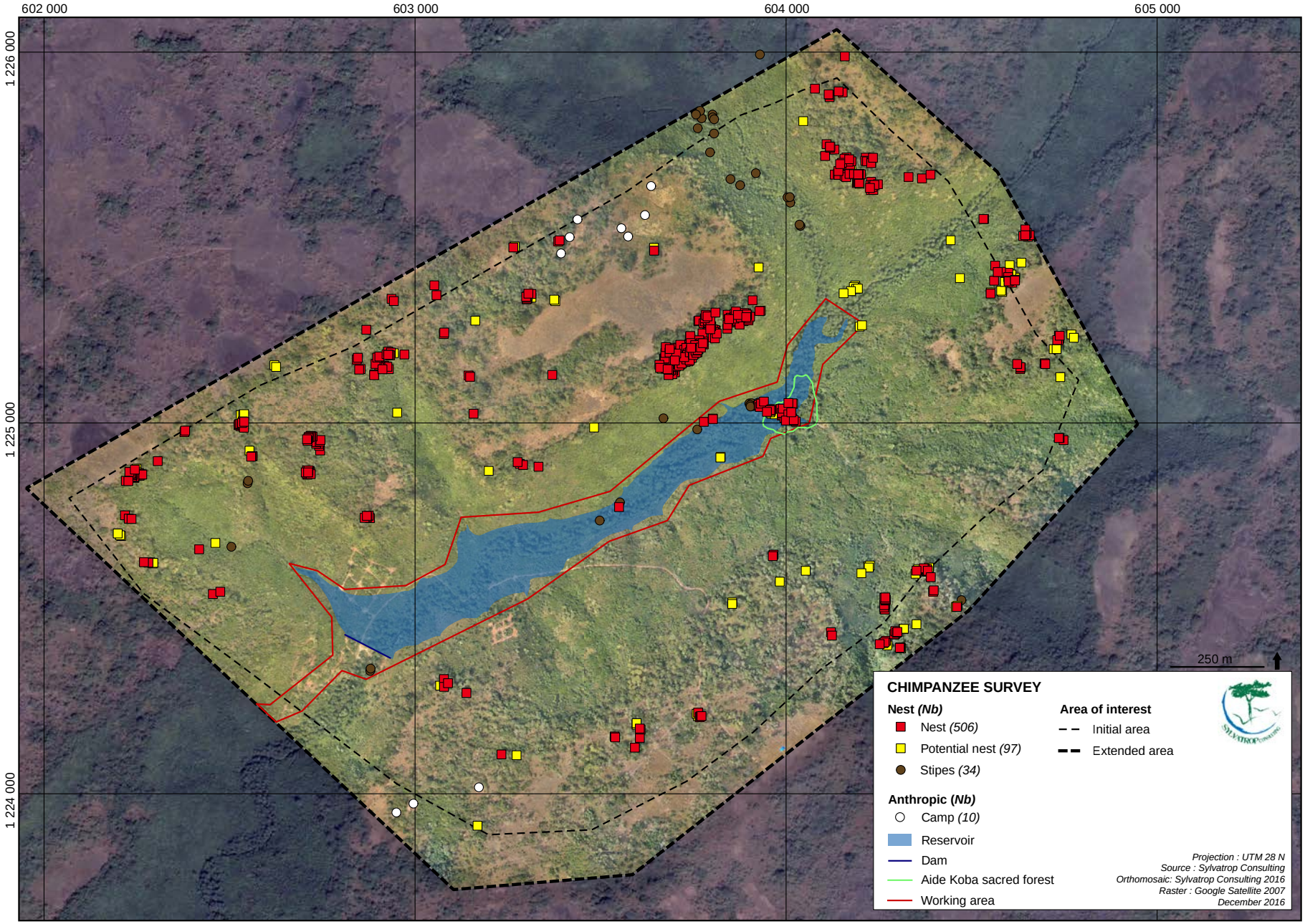

Figure 19: *Representation of the chimpanzee survey results based on orthomosaic*

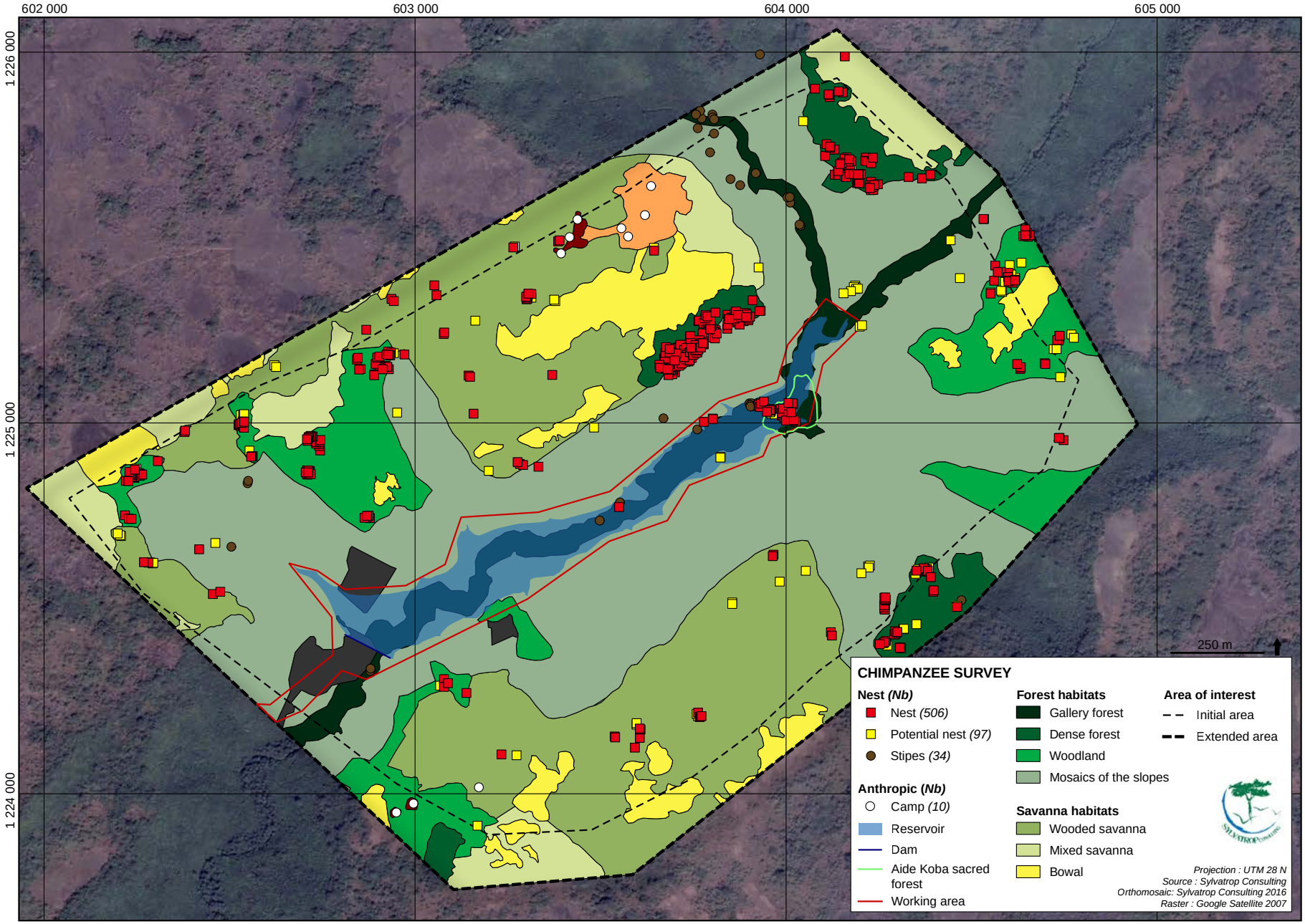

Figure 20 : *Representation of the nesting and refugee's areas based habitats*

5.3.2. IMPORTANT CHIMPANZEE AREAS AND REFUGE IDENTIFICATION

As shown in figure 19 and 20 above and in Figure 21 here under, all the plateaus border up to the valley are being used by chimpanzees for nesting purpose.

A 50m X 50m mesh analysis allows to put in light the most important nesting areas (Figure 21).

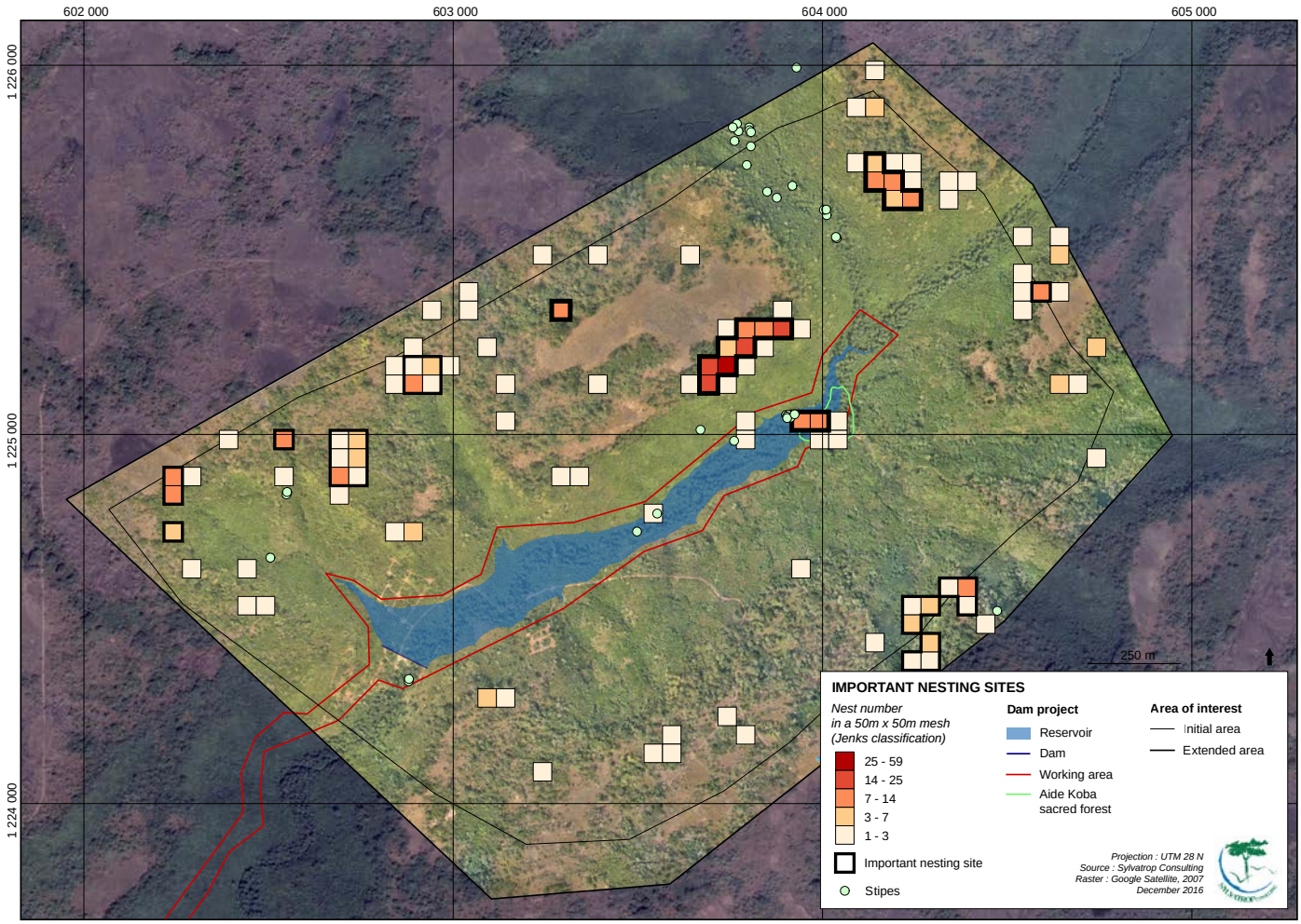

Figure 21: *Representation of the refugee's areas on the orthomosaic*

5.4 IMPACT ANALYSIS

Our impact analysis is based on the Figure 22 here under that shows the habitat loss and the position of important chimpanzee nesting sites compared to the dam foot print and the construction road alignment.

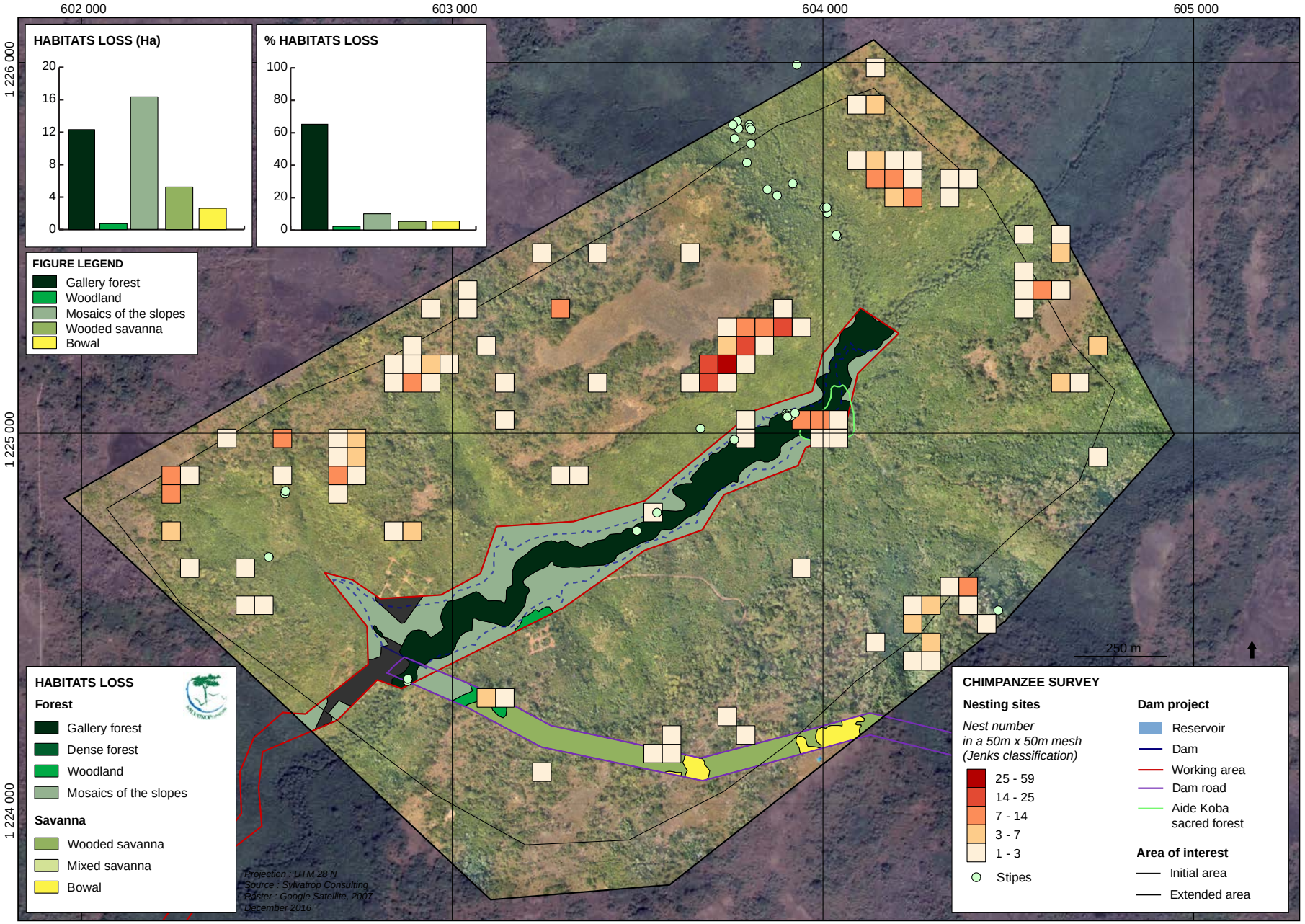

Figure 22: *Representation of the habitats loss based on the orthomosaic*

5.4.1. IMPACT ON HABITATS

A positive impact of the dam construction is that it will constitute a lake that will be a permanent source of water and will contribute to natural vegetation growth all around the dam footprint.

At that stage, and as shown in figure 22 above, only the dam footprint and the road alignment can be considered in the impact analysis. In fact, we do not have the related information regarding the construction phase.

We would have need to know what places that are expected to be used for construction equipment, materials and machineries storage on the construction site.

As shown in table 4 and in Figure 22:

- A total of 10,1% of the surveyed area's habitats will be lost. It seems an important loss at the surveyed area scale, but compared to the whole project area, this loss is not that important.
- The most impacted natural habitat will be the gallery forest (63,7% loss) and the mosaic of the slope (9,9% loss).
- A large part of the Aïde Koba sacred forest will be lost as well (Figure 13 and 22).

When it comes to the gallery forest loss because corresponding to the dam foot-print, it is important to keep in mind that this gallery forest is mainly composed with palm trees because most of the ligneous species have been removed by the communities' activities.

Also, the most important part of the woodlands and wooded savanna loss will be caused by the construction road opening.

Habitats	Habitat areas	Habitat areas		Habitat loss		Loss (% /habitat)
		m²	Ha	m²	Ha	
Anthropic habitat	Mining activities	47248	4,7	23080	2,31	48,8%
	Rice fields	35333	3,5			
	Camp	5349	0,5			
Natural habitat	Gallery forest	192772	19,3	122700	12,27	63,7%
	Dense forest	146495	14,6			
	Woodland	334936	33,5	7087	0,71	2,1%
	Mosaics of the slopes	1667249	166,7	164770	16,48	9,9%
	Wooded savanna	902980	90,3	53120	5,31	5,9%
	Mixed savanna	232901	23,3			
	Bowal	228017	22,8	11558	1,16	5,1%
TOTAL			**379,3**		**38,23**	**10,1%**

Table 4: Habitats loss

5.4.2. EXPECTED IMPACTS ON CHIMPANZEES

Two common threat to most medium and large mammal's species are the loss of habitat and bushmeat hunting.

All mammals' species could face with the same kind of impact but could react differently.

Primates are mostly threatened by hunting and loss of habitat. Some primate species have huge adaptation capacities to disturbance and can survive if their habitat is preserved.

According to recent observation made in the Sangarédi area, it seems that chimpanzee could adapt to high level of perturbations as nesting sites have been found less to 2 kms from an active mining site in Sangarédi (author comm pers.).

Impacts	Impact sources	Magnitude	Sensitivity	Impact significance
Direct Loss of species habitat (incl critical habitat or species related habitat)	Mine and road openings Bushfires Timber and charcoal exploitation	Large	High	Major
Habitat fragmentation	Road openings Bushfires Timber and charcoal exploitation Enlargement of human settlements	Large	High	Major
Habitat degradation	Dust production Noise production Vibration production	Medium	High	Major
Displacement of species	Dust production Noise production Vibration production Human presence	Medium	High	Major
Direct loss of individuals	Hunting Bushfire Collision with vehicles	Large	High	Major
Population reduction by Workers and communities indirect impact	Hunting Bushfire Timber Charcoal Waste Water management Agricultural land extensions	Large	High	Major
Disturbance by local communities	Hunting Bushfire Timber Charcoal Waste Water management Agricultural land extensions	Medium	Medium	Moderate

Table 5 : Theoretical assessment of impacts on chimpanzee

Although it is not the majority, chimpanzees nesting sites have been found in the dam foot print.

This nesting site is the one corresponding to the Aide Koba sacred forest that is also a feeding site.

This could be considered as a "red flag" because it seems like the trees have been used several times.

For now, we do not know how many chimpanzees and/or group of chimpanzees are used to live in this area. There are huge probabilities that groups are just passing by as the area is too small to constitute a chimpanzee territory. Of course, it could be part of one group or different group territory. Gathering this critical information would need to undertake new and complementary survey with the aim to identify exactly how many chimpanzees are used to nest and feed in and around the dam footprint.

As we found nesting sites north and south to the valley, it sounds reasonable to expect that chimpanzees are used to cross the valley.

But because we do not get field information's regarding their path and direction of travel, we cannot be 100% sure about. There are possibilities that they turn around the valley in order to benefit from the tree covers.

Chimpanzee has shown to be an exceptional adaptive animal, so we believe that once the valley will be flooded, they will just turn around the lake. Of course, it will take them a bit of time to "understand" what happen, but we must also consider that the flooding will take time before the water will be at its highest level.

So if the Aide Koba sacred forest could be preserved from flooding, we believe that this dam project will not have a dramatic impact on chimpanzee population.

5.5 PROPOSITIONS FOR MITIGATION AND AVOIDANCE STRATEGY

Figure 23 here under shows a proposition that could allow to mitigate and/or avoid some of the impacts that result from the dam construction phase and especially the construction road opening.

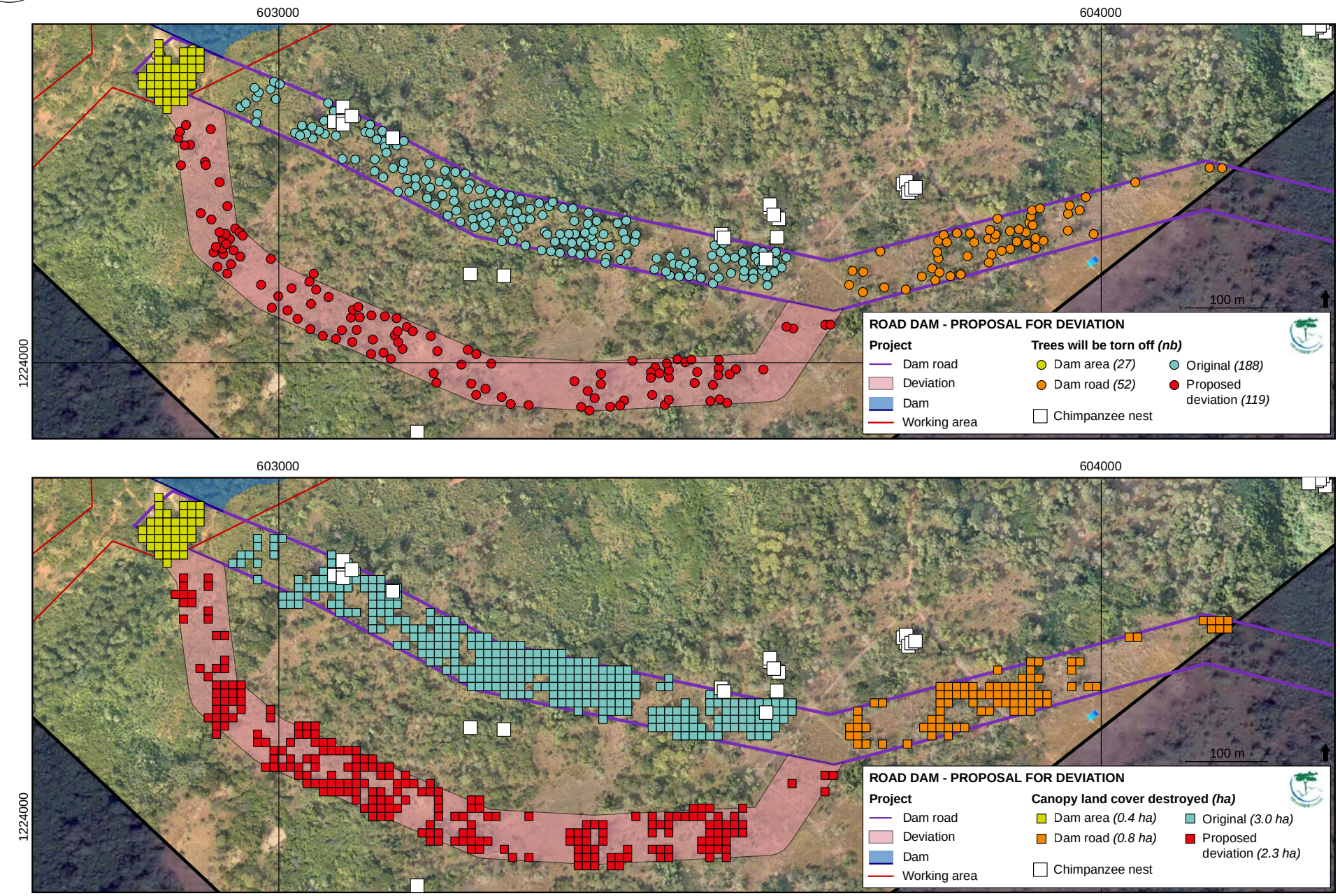

Figure 23: *Representation of the habitats loss and proposition for avoidance strategy*

5.5.1. MITIGATION AND AVOIDANCE STRATEGIES FOR HABITAT CONSERVATION

Although the dam foot print cannot be changed, there could be opportunities to modify a bit the access road alignment in order to minimize the impact on the habitat.

Our proposition allows to minimize the direct impact of the construction road on the habitats.

As shown on Figure 23, changing a bit the road alignment will save 69 trees that mainly contribute to wooded and mixed savanna habitats. In terms of canopy area, the deviation proposition will save 0,7 Ha of "woodland".

During the construction phase, mitigation and avoidance strategies should also focus on:

- Minimizing dust emission especially during the dry season by using irrigation systems during road construction, and transportation of construction materials;
- Setting up physical limits to the working areas with a surveyor's system so communities would not enter in the area ;
- Start a plant nursery program in order to be prepared for re-vegetation activities.
- Store the removed top soil for re-vegetation activities.

The re-vegetation program should start immediately after the clearance for the areas that are at the border of the haul road and the mining site. We suggest to organize it in two different but complementary ways:

- Large areas that have been completely cleared from vegetation should be re-vegetated by using a common reforestation program that should use only local species identical to those that have been cleared. The first step should be to plant Graminae and herbaceous species together with shrub in order to avoid as much as possible the installation of invasive plant. The second step should be to plant mixed local species tree.
- Small cleared areas should be re-vegetated by using an Assisted Natural Regeneration approach in order to restore the impacted habitat. Assisted natural regeneration (ANR) is a simple, low-cost forest restoration method that can effectively convert deforested lands of degraded vegetation to more productive forests. The method aims to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and recurring disturbances (e.g., fire, grazing, and wood harvesting). Compared to conventional reforestation methods involving planting of tree seedlings, ANR offers significant cost advantages because it reduces or eliminates the costs associated with propagating, raising, and planting seedlings.

5.5.2. MITIGATION STRATEGIES AND AVOIDANCE FOR CHIMPANZEES

Table 6 here under shows the various mitigation and avoidance strategy that could apply for medium and large mammals including chimpanzees.

Level	Mitigation measures	Applies for roads and parking's for materials	Applies for dam site
1	Delimitation of no go area	On each side of the roads. Propositions will be provided in the final reports.	Propositions will be provided in the final reports.
	Modification of the footprint area	The roads alignment could be modified in order to avoid chimpanzees nesting sites and woodlands areas. To be discuss with engineers'.	Not applicable
	Identification of fauna corridors	On each side of the roads and parking's, Woodlands areas plateau should be preserved.	Not applicable
	Re-vegetation program implemented	At the immediate border	At the immediate border
	Identification of wildlife crossing place	Applicable. To be discuss with engineers'	Not applicable
	No Hunting policy for all GAC workers	Regular awareness must be done at the base level	
	Support to hunting regulation	Based on the results of a deep real hunting survey, sharing the results with the concerned population would make people understands that it is their interest to enter into a "new way" of wildlife management	
2	Environmental education	Environmental program to raise awareness among children and adults about environmental issues and wildlife protection.	
	Dust suppression	Spraying water on the road using a tanker truck	Spraying water using tanker truck or fixed water tank during construction period
3	Strict demarcations	Demarcation could be made with painted rocks. Awareness toward the workers and the communities must be made for the limits to not be crossed.	
	Strict speed limit regulation	In order to avoid collision with wildlife, reduce noise and dust emission. A simple way to do it is to oblige 4X4 vehicles to be driven using the L4 gear. Same principle should be applied for trucks and machine using special pre-determined gear.	
	Good waste management	I must be forbidden for all workers to throw away wastes in the bush, on mining site or on the road. Recycling or reusing waste system should be implemented. For example: - Plastic bags could be recycled into yarn that is used to create fabrics or bags that generate incomes for the communities. - Cans made with aluminium could be used to build solar cocking stove. Etc.	

Table 6: Mitigation and avoidance strategies for medium and large mammals

In the context of the dam construction, most of the impacted areas cannot be avoided but as shown on Figure 23 above, it could be possible to modify a little bit the construction road alignment in order to avoid some of the chimpanzees nesting site.

In fact, our proposition allows to avoid 4 nesting sites areas that are being used by chimpanzee.

6/ CONCLUSION

This drone (UAV) survey, at this preliminary stage, allowed to:

- Draw an updated ortho-mosaic of the dam foot print area ;
- Get much useful complementary information regarding habitats that occurs in the dam footprint ;
- Identify all the important chimpanzee nesting site in and out the dam footprint as well with some of their feeding sites ;
- Identify refuge areas for chimpanzees that could be impacted by the dam ;
- Propose avoidance strategy for the construction road alignment that allow to minimize its impact on habitat and clearly avoid chimpanzee nesting areas.

The information we gathered, if compared and crossed with chimpanzee's information's from the field and especially chimpanzees path and direction of travel/movements, will allow to understand how the dam area is really used by the chimpanzees.

Also it will allow to clearly understand if and how the chimpanzees are going up and down to the valley from north to south or south to north, or if they are turning around the valley from one nesting site to another one. This information is a critical one in order to properly understand the real impact of this dam project on the chimpanzees that are using this area.

7/ APPENDIX

7.1 APPENDIX 1: LITERATURE CITED (WILL BE COMPLETED IN THE FINAL REPORT)

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7.2 APPENDIX 2 : PHOTOS OF VARIOUS HABITATS

Figure 24 *: Representation of mining activites*

Figure 25 *: Representation of the Bowal habitat*

Figure 26: *Representation of the mixte savanna habitat*

Figure 27: *Representation of the gallery forest habitat*

Figure 28: *Representation of the dense forest habitat*

Figure 29: *Representation of the woodland habitat*

Figure 30: *Representation of the wooded savanna habitat*

Figure 31: *Representation of the "mosaic of the slope" habitat*

Figure 32: *Representation of a farming camp*

Figure 33: *Representation of rice field and farming camp*