

1st Report

Introduction

White-thighed colobus (*Colobus vellerosus*) is a monkey species that contributes greatly to seed dispersal and tree regeneration through zoochory. Habitat degradation combined with intensive hunting throughout its geographic range has resulted in an inferred decline of more than 80% in the White-thighed colobus population over the past 27 years (Matsuda Goodwin *et al.*, 2020). In the face of this situation, the species may become extinct in the near future if urgent conservation measures are not taken. The objectives of our report are to: (1) determine the factors of habitat degradation of white-thighed colobus in the Wari-Maró gazetted forest ; and (2) assess the degree of regression of white-thighed colobus habitats in the Wari-Maró gazetted forest. This report present the progression of the activities we are carrying out on the species in order to inverse the species decline.

Methodology

- Survey of the population

Surveys were conducted among the local population through direct interviews and focus groups to identify the factors responsible for the degradation of *C. vellerosus* habitats in the Wari-Maró gazetted forest (Photo 1). The triangulation technique was used to control the information received from the interviewees. This technique consists of asking the same question to respondents in several ways in order to obtain real information. At this step, we have already surveyed 480 people and realised 10 focus group discussion.



Photo 1: Group discussion with local people.

After the survey phase, a prospection was conducted in the forest with the local population to assess the factors of habitat degradation (Photo 2). Ten points representing habitat loss/degradation were selected on the land use and land cover map of the forest. The coordinates of these points were entered into the GPS and a survey was conducted with representatives of the population in the forests. At each point, habitat degradation factors were recorded and the reliability of the data collected during the survey was discussed in the field with the population.



Photo 2: Prospection inside the forest to assess habitat degradation factors.

- Spatial and temporal habitat dynamics of *C. vellerosus*

Data used

Spatio-temporal occupancy dynamics of *C. vellerosus* habitats were studied using a time series of Landsat images all multispectral (Biga *et al.*, 2020). The images were obtained from Landsat 7 ETM+ and OLI 2 sensors with a spatial resolution of 30 m (Table1). The year interval considered is 10 years to observe the shift in of habitat occupancy (Jaffrain *et al.*, 2021). All images were acquired at approximately the same time of year, during the high dry season to ensure that the phenological stages of vegetation cover were nearly the same between dates (Ruelland *et al.*, 2010). The image set used was acquired from the United States Geological Survey (USGS) Earth Resources Observation Systems (EROS) data center via the website (<https://earthexplorer.usgs.gov/>). A ground prospection was also performed during the dry season in accordance with the image acquisition period.

Table 1: Satellite images used and their characteristics

N°	Type of image	Scene ID	Bands used	Resolution	Date
1	Landsat 7 ETM	Path: 192 Row: 054	1; 2; 3 and 4 Blue, Green, Red and Near Infrared respectively	30 m	February 2002
2	Landsat 7 ETM	Path: 192 Row: 054	1; 2; 3 and 4 Blue, Green, Red and Near Infrared respectively	30 m	February 2012
3	Landsat 9 OLI 2	Path: 192 Row: 054	2; 3; 4 and 8 Respectively Blue, Green, Red and Near Infrared	30 m	February 2022

Image process

Images were geometrically corrected and geocoded to the WGS (Datum 1984) and Universal Transverse Mercator (UTM) Zone 31N coordinate system. The automatic method based on scene connection was applied with ENVI version 5.0 software, ITT Corporation (Zayoun *et al.*, 2020). The study area was then extracted from the obtained image mosaic to determine the land cover and natural habitat use types by classifying the images. A supervised classification was performed using the Maximum Likelihood algorithm based on the 173 training points available to us (Maiga *et al.*, 2020). The official nomenclature of land use classes in Benin was used to identify the classes present in our study area (Ahononga *et al.*, 2021). The supervised classification was chosen because of the study area. The classification was parameterized by digitising the training areas. Prior to the determination of the training areas, the number of classes was defined to the information collected in the field. The post-classification images were subjected to a 3x3 pixel filter to homogenise the classification.

Then, to improve the quality of the classification, a computer-assisted visual interpretation (Biaou *et al.*, 2019) was used to map the different habitat occupancy classes of *C. vellerosus* in the Wari-Maró gazetted forest. Some classes were spectrally confused and could not be well separated by supervised classification and thus visual interpretation was needed to separate them. In order to facilitate the correction of classification errors using computer-assisted visual interpretation, the results from ENVI are exported as a vector file (.shp), to be grouped into land cover classes in Quantum GIS (QGIS version 2.18). The Google Earth Pro software is consulted for the confirmation of land use units made possible by the Gearth view extension.

Criteria for assessing the dynamics of *C. vellerosus* habitat occupancy

The change in land use was assessed from the area of each class. To obtain these areas, the GroupStats extension (QGIS 2.18) allowed us to generate two-way tables presenting for each of the dates taken in pairs in order to bring out the cumulative areas of each class and their changes over time. To this end, criteria for assessing the evolution of the occupation of *C. vellerosus* habitats in the Wari-Maró gazetted forest were considered as : (i) gross deforestation -conversion of natural plant formations into plantations and anthropogenic plant formations; and (ii) degradation - decrease in the density within natural plant formations.

Results

Factors of degradation of *C. vellerosus* habitats

Investigations conducted with local populations and surveys conducted in the forest have identified four factors responsible for the degradation of the habitats of *C. vellerosus* in the Wari-Maró gazetted forest. These are agriculture (66.42%) (Photo 3), forest exploitation (12.69%) (Photo 4), pastoralism (8.21%) (Photo 5) and climate change (4.47%).



Photo 3: Agriculture (New forest clearing for yam production in Wari-Maró forest. It should be noted that yam production requires fertile land and is always grown at the head of the crop rotation. This leads farmers to clear new forest land for agriculture year after year affecting the *C. vellorus* habitat).



Photo 4 : Forest exploitation (illegal tree logging in the Wari-Maró forest).



Photo 5: Pastoralism (Cattle grazing in the Wari-Maró forest affects habitat quality of *C. vellerosus* habitat).

Degree of regression of White-thighed Colobus habitats in the Wari-Maró gazetted forest

The rate of regression of natural formations in the Wari-Maró gazetted forest is 0.90% from 2002 and 2012 (Table 2) and 16.55% from 2012 to 2022 (Table 3). In 20 years, the species has experienced a regression of 17.45% of these natural habitats. Plantations increased by 166.90% and 22.11% in the intervals from 2002 to 2012 and 2012 to 2022, respectively (Fig. 1). Crops and fallow land also increased significantly.

Table 2: Rate of change of plant communities in the Wari-Maró gazetted forest between 2002 and 2012

	Natural forest formations	Plantations	Crops and fallow land
Area in 2002 (ha)	110239,73	142,85	722,20
Area in 2012 (ha)	109242,11	381,26	112586,20
Annual rate (ha)	-99,76	23,84	11186,40
Rate of Change (%)	-0,90	166,90	15489,34
Annual Rate (%)	-0,09	16,69	1548,93
Rate of Regression (%)	0,90		

Table 2: Rate of change of plant formations in the Wari-Maró gazetted forest between 2012 and 2022

	Natural forest formations	Plantations	Crops and fallow land
Area in 2012 (ha)	109242,11	381,26	112586,20
Area in 2022 (ha)	91159,21	465,55	130584,81
Annual rate (ha)	-1808,29	8,43	12910,34
Rate of Change (%)	-16,55	22,11	8714,87
Annual Rate (%)	-1,66	2,21	871,49
Rate of Regression (%)	16,55		

Conclusion

The factors responsible for the degradation of *C. vellerosus* habitats in the Wari-Maró gazetted forest were agriculture, forest exploitation, pastoralism and climate change. In 20 years, the species has seen a 17.45% decline in its natural habitats.

However, project activities are still ongoing to reduce anthropogenic pressures on the species. We are currently carrying out environmental education activities. After this phase, we will proceed with the reforestation of degraded habitats.

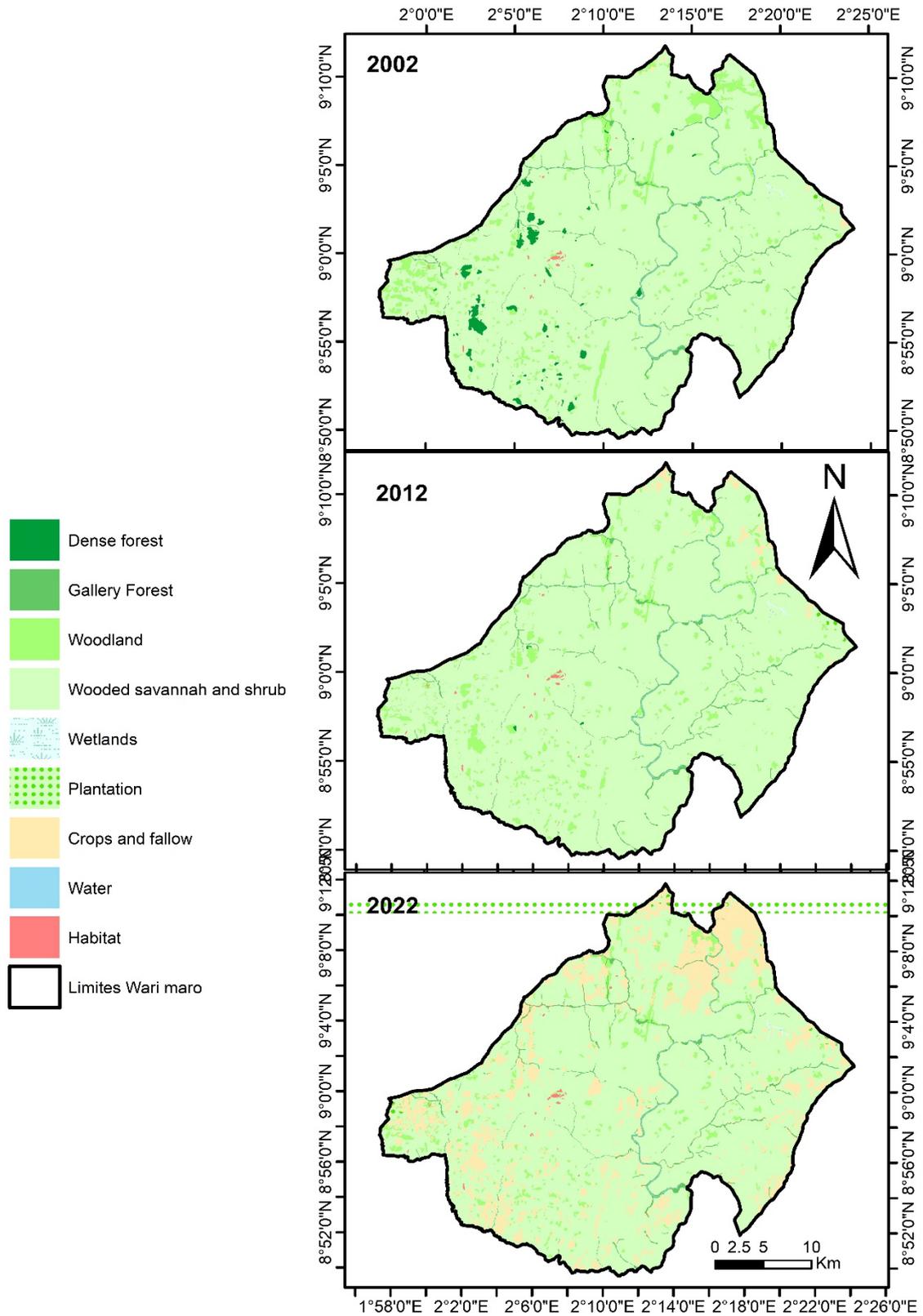


Fig. 1: Land use map of the Wari-Maró gazetted forest.

