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Study of the condition of Mangroves in Bombetoka Bay, Rural Commune of Boanamary, Boeny Region, Madagascar

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Abstract:

You can use this document as both an instruction set and as a template into which you can type your own text. In Madagascar, the population of the coastal zone lives at the cost of natural resources, especially the mangroves. This study focused on the condition of mangroves in Bombetoka Bay, Rural Commune of Boanamary, Boeny Region, Madagascar. The purpose is to analyze the state of the mangrove forest. The adopted methodology has made it possible to know the different modes of exploitation of mangrove species. The transect and quadrat methods were used at all four sites: Morahariva, Nosy Tanindrazana, Malainolo, and Tambohobe. The findings from the inventories and measurements of the samples of the quadrats allowed us to calculate the floristic characters. The ecosystem is being over-exploited by the local community. The Avicennia marina species have dominated the remaining forest. The traces of the cuts are much more marked in the easily accessible zones A and C. Mangrove degradation is due in large part to human actions.

Keywords-**Ecosystem, forest, exploitation, population, individuals, degradation.**

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I. INTRODUCTION

The mangrove ecosystem is a sensitive area. All over the world, it went through anthropogenic activities due to demographic pressure, the development of spatial planning through the construction of aquaculture basins, and other coastal infrastructures. In Madagascar, most of the cases studied by scientific experts have shown that degradation prevails over the reconstitution of the mangrove. The area of mangroves in the process of degradation, degraded and tanned mangroves is increasing [1]. In the Rural Commune of Boanamary, deterioration of life following the loss of jobs in the factories, the poor farm profitability due to the drought and the silting of rice cultivation push the coastal populations to abusive exploitation of woody resources, fauna, and flora of the ecosystem. In Bombetoka Bay, these man-made threats are much more evident and persist. Along the coast between the "Fokontany" of Morahariva and Ambonio, large areas of tannes are completely bare because of the previous exploitations of mangroves. Indeed, the issues related to the protection of this ecosystem are mainly human. As part of our research carried out from March to December 2020 on the condition of mangroves in Bombetoka Bay, the question arises about the current level of degradation of the ecosystem

and the future of its vegetation cover. To answer this problem, the hypothesis was formulated: "The mangrove of Bombetoka Bay is in a state of decay". The main objective of this study is to contribute to the assessment of the current condition of the mangrove in Bombetoka Bay, Rural Commune of Boanamary. And the special objectives are: to measure biometric parameters of mangrove species; determine the floristic characteristics by category of species and by the zoning of the studied sites. To put in order the collected data during the field trips, the following plan was established and is divided into three parts: Materials and methods, Presentation of the obtained results followed by interpretations and Results discussion.

II. MATERIALS ET METHODS

1) Area of study overview

1.1) Boeny Region

In the Boeny Region, most of the ecosystems are dominated by savannas estimated at 65% of its extent, followed by forests which occupy about 15%. The region hosts a relatively large area of mangroves, i.e. 64.84ha, which represents 20% of Madagascar's and 2% of the region's natural ecosystem. The mangroves of the Boeny Region are largely located in bays integrated into protected areas [2].

1.2) Evolution of Bombetoka Bay and the Betsiboka River

The formation and evolution of mangroves in Bombetoka Bay are strongly linked to the presence of the Betsiboka River. The fine sediment deposition surface can reach as far as the mouthpiece of the Betsiboka [3]. The backfilling phenomenon has been observed on the plateau of mangrove forests if the turbid water of the river has settled down.

1.3) Geographical demarcation

The study was carried out in the Rural Commune of Boanamary, in the North-West of Madagascar in the Boeny Region. Its geographical demarcation is between 15°45' to 15°46' South latitude and 46°23' to 46°25' East longitude. Its territory is limited by the Marohogo River to the North; the Betsiboka estuary to the South; Bombetoka Bay to the West; the Berivotra plateau and the RN4 to the East.

2) Methodology adopted during field trips

The methodology is a follow-up approach to data collection. It plays an essential role in determining how to access information sources: through direct observations and biological or parametric measurements or surveys.

2.1) Bibliographic study and surveys

The collection of bibliographic data took place throughout the research. The resulting documents are general or specific. The local communities are the main targets as key exploitation actors and who are involved in ecosystem management and restoration activities. They also participate in alternative activities such as aquaculture, beekeeping, and alternative wood plantations [4]. The direct field observation phase was preceded and completed by surveys of local authorities, officials and notables, and the local population. The survey method by questionnaires [5], in the form of a directed interview on the history, the uses or exploitations, the management, of the mangrove, and these resources, was used.

2.2) Vegetation study

The data collection technique is based on the delimitation of the study area in aligned quadrats at the transect level: method of [6]. The transect is a graduated rope with a length of 100m placed crossing the width of the mangrove and perpendicular to the line of the coast from zone A to zone C crossing intermediate zone B. Quadrat samples were taken along this transect along this transect. This location was chosen because the mangrove floristic zoning is installed parallel to the coastline [7] in [8]. The quadrat was formed with a 20 m side frame to be installed in a random manner according to the length of the transect. The objective of its use is to obtain the representativeness of the mangrove from the readings taken and make it possible to determine: frequency or abundance; density (D); relative density (D Rel); basal area(s); and relative dominance (Dom. Relative) and the percentage of species cut.

Rel Frequency (%) $= \frac{n}{N} * 100$ (n: number and N: total number of individuals encountered)

D $= \frac{n}{S}$ (n: number of individuals and S: total base area of species)

D Rel (%) $= (n/N) * 100$ (where n: number and N: total number of individuals encountered)

s $= \pi/4 * d^2$ (s: basal area; d: diameter of the tree at the height of 130 cm from the ground)

Dom. Relative (%) = s (cm^2)/**S** (cm^2)***100** (s: Area occupied by each species (**s** $= \pi/4 * d^2$) and S: Total area occupied by all species

Nb C/nb N*100 where Nb C: Number of tree stumps cut; nb N: Total number of living trees

III. RESULTS ET INTERPRETATION

1) Survey findings

1.1) Ways of using mangrove wood

The main activities observed in this mangrove ecosystem are fishing; the preparation and the sale of coal. The cutting of mangrove trees for personal use: construction of a canoe or house-making arises. According to the surveys carried out with the local population, each species is necessary and the quantity of felled trees depends on the mode of exploitation and its distance from the village. The living of the local population depends directly or indirectly on the mangrove ecosystem. It has become the main actor in the disruption of

natural resources. For the construction of living houses and camp huts, three species of mangrove are the most wanted. These three species belonging to the RHIZOPHORACEAE family are the most appreciated due to their very straight and hard trunk: *Rhizophora mucronata ; Ceriops tagal ; Bruguiera gymnorhiza*. A (4 x 5) m^2 room needs six main poles of 10 to 15cm in diameter, fourteen intermediate poles, a ridge, and two joists of 8 to 10cm in diameter. On average, 20 perches plus 40 batons with respective diameters of 5 to 6cm and 3 to 5cm. A total of 83 pieces of wood are needed. According to the surveys carried out in 2005, villagers requiring the use of mangrove wood for the construction of habitats can collect up to 80 perches every 6 years [8]. The method of use is less destructive for the fishermen's camp because each hut requires an average of 30 round timber of 5 to 8cm in diameter.

The daily fish catch varies from 6.56kg to 9.44kg from April to July. Then it decreased from August to October. There is the second peak of production in November reaching 10.60kg and it dropped to 6.40kg in December. Several factors determine the amount of production and fishermen use them to organize the fishing schedule. Five factors seem to be the most influential on the presence of fish. The first is the climatic season: dry season and rainy season. It plays a very important role in the flow of the river and the abundance of water inlets. The salinity of the water is the second parameter depending on the season and the river flow. The salinity tide delimits the zone of brackish water characteristic of the estuary. The lunar phase, which is divided into four times: new moon, first quarter, full moon, and last quarter, is the third factor. In each lunar cycle, there are four successive tidal phases: two spring tides and two neap tides. This variation in sea level forms the fourth.

1.2) Coal production

Charcoal mining is the main source of mangrove degradation. A couple experienced in this profession produces an average of 120 bags of 103 dm^3 of coal each month, either the equivalent of 12.40m^3 in volume. With a conversion rate of 2/3, this volume corresponds to 18.60m^3 of fresh wood. The biomass of each species by zonation has shown that *Avicennia marina* is the only target species for massive coal production. In zone A, an area close to one hectare will be cleared in one month, corresponding to 700 plants.

The potential customers for the production of charcoal from Bombetoka Bay are the populations of the neighboring riverside villages and especially the population of Mahajanga whose annual need for charcoal in the Boney region is 500 000 tons/year and 78% of production comes from natural forest, and 22% comes from other forest wood [9]. According to the survey conducted among the local population, the monthly income of producers and sellers of charcoal leaving the study area is estimated at 360 000Ar and 600 000Ar.

2) Study of the vegetation

2.1) Mangrove and its distribution

The floristic surveys have been done in four different sites: Morahariva, Tanindraza, Tambohobe, and Malainolo. The eight mangrove species acknowledged in Madagascar have been encountered, but the distribution is different and varies from one area to another. It forms an evergreen forest, most of which is lit and sometimes much degraded.

2.2) Floristic diversity

The distribution of species is different in the study sites. The floristic inventory allowed us to determine the zonation of the mangrove. The census and determination of the species of stumps encountered in the studied plots made it possible to imagine the structure of the forest and the zones of preference for each species.

2.3) Biometric parameters (H et Diam)

The inventory of each plant is followed by the readings of two parametric measurements: the circumference of the tree at 1.30m from the ground to get the diameter at chest level, the maximum height of each individual, the total number of individuals in each quadrat.

2.4) Species characteristic

The characteristics of the mangrove species were set by the values of the calculated floristic parameters. The analyzes and interpretations were made according to the category of species and their zoning. They consist of: the abundance, the density of a species, the relative density, the relative dominance, the capacity of each species, and the percentage of cut species.

3) Interpretation of the findings

3.1) Abundance by species category and zonation

The distribution of the numbers of mangrove trees found in the quadrats shows that the diameter class]5; 15] is the most abundant with a total of 1.478 tree feet. And among these individuals, 1.298 individuals belonging to the species of *Avicennia marina*. The RHIZOPHORACEAE family occupies very low frequencies, 82 feet, including all three species. *Rhizophora mucronata* and *Ceriops tagal* species are almost extinct. The young stage *Avicennia marina* species is therefore the most numerous. Zone C possesses the majority of the species listed with 1,102 individuals. Then comes zone B or intermediate zone with 1.077 feet of mangroves. Zone A is the least populated of the mangrove having 577 feet of trees. *Avicennia marina* is much more numerous compared to others; it reaches 1.041 feet in zone B and 903 feet in zone C.

3.2) Density and relative density

The total density of mangroves, all species included in the study area, is 0.078N/m^2 and more than half is in the diameter class]5; 15] with a value of 0.042N/m^2. This high-density value is due to the presence of *Avicennia marina* whose total density is 0.069N/m^2. And the great part, more than half of this species, is in the adult category with a density of 0.37N/m^2. The RHIZOPHORACEAE family is very rare; it is presented by the *Ceriops tagal* species at a density value of 0.001N/m^2. The *Sonneratia alba* species also has a low density of 0.003N/m^2. Compared to the established zoning, the density distribution is very unbalanced. In all species, the density in zone C and intermediate is 0.031N/m^2 representing 98.90% and the density in zone A is 0.016N/m^2. The high density of the *Avicennia marina* species was observed in the intermediate zone with a value of 0.030N/m^2 equivalent to 81.94%; 0.026N/m^2 in zone C, and 0.014N/m^2 giving 82.67% in zone A.

3.3) Dominance and percentage of strains

The class with a diameter greater than 15cm dominates and has a rate of 70.24%. In this class, *Avicennia marina* dominates the most with a rate of 69.52% followed by *Sonneratia alba* and *Rhizophora mucronata* which have a rate of 0.467% and 0.255% respectively. In zone A, de *Avicennia marina* still largely dominates with a rate of 96.54%. *Sonneratia alba* follows with a rate of 3.322%. The strains were identified with very close values in zone A and C which have respective values of 9.22% and 8.50%. In the intermediate zone, this rate is lower representing 5.46%.

4) Discussions

4.1) Abundance and density

A high abundance of the diameter class] 5; 15] means that the vegetation cover population of the study area is still young. In this class the density is low, around 0.042N/m^2. The high density concerns the species of *Avicennia marina* and is in the intermediate zone. This situation of abundance and density is explained by the strong pressure of the population. The species of *Avicennia marina* thus observed are the remains of felled trees after selective cutting by operators. These are the seedlings that had survived in rudimentary site conditions. Compared to zones B and C, the density is low in zone A (0.016N/m^2). This difference is due to the accessibility of the areas by the operators. Zone A is closer to the village for the littoral mangrove. In the case of the mangrove islets, zone A corresponds to the part of the southern bank, even closer to the village. This selective exploitation of the population was based on the reduction of the circuit route in search of ligneous resources and the ease of loading the obtained products. According to surveys carried out with the local community, the major parts of the products are transported by river and sea.

4.2) Dominance

According to the obtained results, the diameter class]5 ; 15] dominates because dominance is proportional to the area occupied by each species calculated from the diameter value. This dominance concerns the species of *Avicennia marina* and in zone A with a rate of 75.78%. The *Sonneratia alba* species came after, but the rate is low at 28.33% in zone B. The large size of these species indicates that favorable conditions have been met for growth. And the measured individuals are mostly those that are left during the heavy exploitation and they therefore have enough time to increase in diameter.

4.3) Percentage of strains

The percentage of cut trees provides information on the difference in the percentage of stumps observed in the three studied areas. The strains are concentrated in zones A and C. These two zones were noticed for their accessibility to various operators. The percentage value of stumps found in the intermediate zone indicates that the favorable zones are already degraded. This degradation of nearby areas has led operators

IV-CONCLUSION

The Bombetoka Bay mangrove is an estuarine-type mangrove forest on both banks of the Betsiboka River, and another type of mangrove has settled in the middle of the mouthpiece forming a group of islets after heavy sedimentation of the watercourse. The surveys of the floristic characters inside each quadrat installed in the research sites allowed us to determine the current condition of the studied mangrove. Thus, the mangrove ecosystem of Bombetoka Bay is marked by its degraded state and a high abundance of *Avicennia marina*. The density of *Avicennia marina* in the diameter class]5;15] is 46.89%. The RHIZOPHORACEAE family, especially the *Rhizophora mucronata* and *Ceriops tagal* species are the least abundant (0.001N/m2 or 1.192%). Thus, the *Avicennia marina* species is dominant with a rate of 32.78% of the studied population, followed by *Sonneratia alba* (23.72%) and *Rhizophora mucronata* (19.45%). The dominance of these three species is identified in the class of diameters less than 15cm.

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