

ANALYSIS OF HOUSEHOLD FOOD SECURITY IN THE FOKONTANY AROUND THE ANJOZOROBE-ANGAVO PROTECTED AREA AND STUDY OF THE IMPACTS ON CONSERVATION

Herilala Jean Claude RAKOTONIRINA^{1*}, Haingoson ANDRIAMIALISON¹, Nirina HARIMALALA ANDRIAMBELO²

¹*Anthropobiology and Sustainable Development, Science and Technology Department
PB 906, University of Antananarivo Madagascar*

²*Fundamental and Applied Biochemistry, Science and Technology Department
PB 906, University of Antananarivo Madagascar*

*Correspondent contact: rakotonirinarina5@gmail.com

ABSTRACT

The objective of this study is to study and evaluate household food security in the fokontany around the Anjozorobe-Angavo Protected Area for the well-being of the local population and at the same time for conservation benefits. A retrospective and analytical cross-sectional study was adopted on 1121 households in the nine fokontany around the Protected Area of Anjozorobe District between the PA Abundance period and the PS peak period in 2021. More precisely our study site was formed from Zone A made up of the 2 fokontany of the Rural Commune of Mangamila and 2 fokontany of the Rural Commune of Alakamisy, and zone B composed of 3 fokontany of the Urban Commune of Anjozorobe and the 2 fokontany of the Rural Commune of Ambongamarina. The interview, 24-hour recall, observation and field trip were used to analyze food security and impacts on conservation. To determine the factors influencing food security, Gaussian modeling was carried out. During the AP, 63.14% of households in zone B have better food access than those in zone A with a rate of 53.20%; during the PS, only 26.68% of households in zone B have good food accessibility compared to 21.77% in zone A. The sources of income of households in zone A are more stable with a rate of 39.20 % compared to 27.88% in zone B but they do not cover the needs of the family. During the PS, due to the low stability of sources of income, households in zone B have an alarming situation with the survival strategy index 10.62 compared to 9.30 in zone A; the 2 zones are in a state of extreme vulnerability. During the PA, the calorie needs of the two localities are covered on the contrary during the PS with a deficit of 8.16% in zone A and it is the households in zone B which are the most affected with a deficit of 12.55 %. Bad eating habits, low agricultural production, instability of sources of income, and the occupation of mothers are the identified causes during our surveys. Forestry exploitation such as the manufacture of charcoal, selective cutting of wood, the illegal cutting, the exploitation of timber, making of flower pots, etc. has impacts on the conservation of the forest cover. Factors directly linked to food such as poaching, hunting, gathering can lead to the local extinction of species in the corridor, the same is true for the primary sector which brings together all the activities whose purpose consists of the exploitation of natural resources such as agriculture, livestock breeding and fishing. Household food security in the fokontany around the Anjozorobe –Angavo protected area has negative impacts on conservation. The harmonization of human activities with the conservation of natural resources is a challenge for the Anjozorobe-Angavo NAP, especially since the population depends totally or partially on the exploitation of natural resources.

Keywords: *Food availability, food accessibility, Food consumption, caloric needs, food security, conservation, NAP Anjozorobe-Angavo*

1- INTRODUCTION

At the World Parks Congress in Durban in September 2003, participating countries highlighted the importance of the contribution of protected areas to sustainable development, ecological services, livelihoods and the eradication of poverty.

In terms of development, Madagascar is among the poor countries in the world: the HDI (Human Development Index) rank is 173rd out of 191 countries. According to the Millennium Development Goals (MDGs), each country should make efforts to halve, between 1990 and 2015, the proportion of the population suffering from hunger and this malnutrition still persists in Madagascar despite the efforts of the government and the numerous organizations working in the fight against malnutrition [22]. The country's hunger index remains alarming since 2013 [9].

In 2014, according to the WFP, FAO, and WHO announced that the problems of malnutrition are extremely serious: 8% of the country's total population, or 1.6 million people, suffer from chronic food insecurity (IAC), while approximately one in two households experience temporary or seasonal food insecurity (IAS). This IAS situation manifests itself for a few months at the time of the PS. It is first necessary to set consumption objectives which will be based on studies and research on the state of nutrition and the diet existing in the country and It would therefore require a complete study in the form of numerous anthropological, dietary clinical and nutritional surveys throughout the island.

Madagascar is also recognized worldwide as a country rich in biodiversity with a high endemism rate of around 80%. Madagascar's biodiversity is among the seven richest countries in terms of fauna and flora in the world with endemic species, critically endangered species, endangered and threatened with extinction [13]. However, the degradation of natural resources is alarming in almost the entire country. It implies that protection and conservation actions are among priorities of the ANJOZOROBE-ANGAVO Protected Area managed by the NGO FANAMBY. One of the last vestiges of natural forests in the central Malagasy highlands is one of them, as it is a reserve which is rich in ecosystem.

Based on the findings of preliminary results, the research work is structured around the following questions:

- Is the food insufficiency of local populations a pressure on biodiversity and does food security depend on natural resources?
- What relationships exist between household foods around the protected area and conservation?
- Are there social and economic dynamics that maintain land clearing and deforestation and finally, how can we design concerted sustainable management for well-being and conservation?

However, we believe we can contribute to this difficult task by starting with studies of food security in the fokontany around the ANJOZOROBE-ANGAVO Protected Area in order to analyze food consumption, availability and emerging problems.

The general objective is to study and evaluate food security for the well-being of the local population and to have productive human resources guaranteeing rapid, stable and long-term economic growth and at the same time for goods of conservation.

The specific objectives are as follows:

- to assess the socio-economic characteristics of the population, analyze the rate of coverage of nutritional needs and assess food security;
- to analyze the impacts of food insufficiency and income resources on the environment;
- and to make recommendations to improve household food security to design concerted sustainable management for well-being and conservation.

2- METHODS

2-1- Study site

Our study is carried out at the level of the Anjozorobe-Angavo Protected Area located in the highlands 100km from the city center of Tananarive Madagascar, in the District of Anjozorobe; Urban Commune of Anjozorobe and which affects two regions, Analamanga and Alaotra Mangoro.

The studied areas are divided into two parts:

- **Zone A:** area in the south near the city of Antananarivo, the rural commune of Mangamila and Alakamisy with the fokontany: Antsahafina, Isonjo Avaratra; Ambohibary and Ankazondrano.
- **Zone B:** area in the North near the town of Anjozorobe, the Urban Commune of Anjozorobe and the rural Commune of Ambongamarina with the fokontany: Antsahabe, Amboasarianala, Andranomay; Ambohimaramanana and Ampamoha

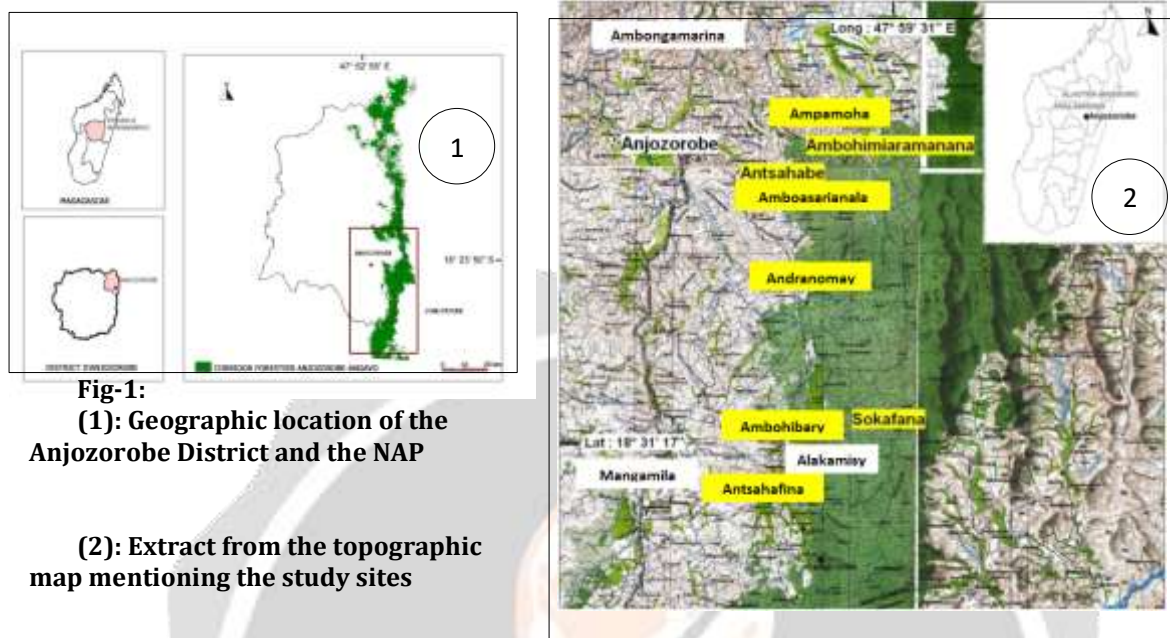


Fig-1:
(1): Geographic location of the Anjozorobe District and the NAP

(2): Extract from the topographic map mentioning the study sites

2-2- Characteristics of the study

2-2-1- Sampling mode

The population studied is the families in the fokontany around the Anjozorobe Angavo Protected Area; the villages to be surveyed are chosen by random sampling so that the sample is the most representative of the population. The total number of households and the fokontany plan are provided by the fokontany Chief and the method is “NO SELECTION”, Method proposed by PSI Madagascar. The basic unit of our study is the family; if several families live in the same household and do not share the same meals, they are surveyed separately.

2-2-2- Type and period of study

This is a transversal, analytical field study conducted in two different periods in Area A and Area B. The first one which took place from March, 2021 until May, 2021 which corresponds to the period of abundance (PA). The second one from November, 2021 until January, 2022 corresponds to the Hunger Season (HS) during which the previous year's crop is exhausted while the next crop has not yet entered.

2-3- Data collection method

The 24-hour recall consists of documentation of all foods and drinks consumed 24 hours before the survey (including quantity and method of preparation). Pre-established questionnaires were simultaneously administered to the families interviewed. Its completion requires contacting the head of the family, preferably the mother and sometimes the father or the eldest person in the family.

Weighings were carried out using 1/10g sensitive scales, at the time of meal preparation, therefore 3 times per day per family. The data collected from households will relate to socio-demographic, socio-economic data, living conditions and food consumption.

2-4- Use of data

After the consistency check, the data collected from the households were coded and entered into EXCEL Version 2010 and Epi info Version 3.4.3, 2017 using a specially designed input mask effect. After the data, the data have

been cleared, the processing and exploitation are carried out on Epi info, and SPSS 20. The information collected during the interviews and discussions is transcribed and analysed before analysis.

2-4-1- Assessment of dietary needs (Aliment Aires)

The table of allocations, recommended per 24 hours in Madagascar, established by the food service of the Ministry of Health, was adopted.

2-4-2- Conversion of quantities consumed into nutrients

The conversions were made by referring to the composition table of common foods of the Central Division of Nutrition and Food and the FAO table of composition of common foods in Africa.

2-5- Statistical analysis-Student's t test

Comparisons of means in the two Areas are made by using analysis of variance (Student's t-test) to see if there is a statistically significant difference between the means of the Food Consumption Scores (FCS) in the two Areas. The Ho assumes that there is no significant difference between the means of the FCS of samples 1 and 2.

- If $p \leq 0,05$: Ho rejected
- If $p > 0,05$: Ho accepted

3- RESULTS AND DISCUSSIONS

3-1- Food Safety

“Food security” is a situation which guarantees a given population, at all times, an access to food both qualitatively and quantitatively. It must be sufficient to ensure a healthy and active life, taking into account eating habits.

The four pillars of food security are access, availability, utilization and stability.

3-1-1- Food availability

To know the changes in the availability of food resources in the affected region, food production and stocks are taken into account.

- **Stock of rice intended for self-consumption**

Given that both areas are agricultural, rice is the main part of their ration.

The household level is divided into three columns to the moment of exhaustion of stocks; For our part, stocks that last less than 2 months are considered “poor”, those that last between 2 to 6 months “average” and those that last more than 6 months are “good”.

Table-1: Distribution of households in relation to rice stock

Rice stock level		Poor	Average	Good	Total
Zone A	Numbers	43	136	71	250
	%	17,2	54,4	28,4	100
Zone B	Numbers	56	150	106	312
	%	17,94	48,07	33,97	100

The rice stock situation is better in the two sites compared to that of the city of Antananarivo, 92% of which have poor rice stocks and only 4% have an average stock [19].

Table-2: Statistical tests on different speculations at the level of the 2 zones

Speculation (Kg)	Zone A	Zone B	T	Ddl	P	Meaning
Rice	300,26	498,23	6,98	464	0,000	+
Cassava	700	830	6,47	464	0,000	+
Other starchy foods	120	210	1,02	464	0,051	-

t: t-test; *dof*: degree of freedom; *P*: probability; (+): there is a significant difference at a 95% confidence interval; (-): no significant difference at a 95% confidence interval.

Using the t test, it is possible to compare the averages of agricultural production in zone A and zone B. There is a significant difference between the production of rice and cassava respectively at $t=6.98$ with $p=0.000$ for rice and $t=6.47$ with $p=0.000$ for cassava. For the other starchy foods, the t test does not present a significant difference at the 5% threshold even if the variances of the two samples are very different with $t=1.02$ and $p=0.051$.

In zone A, the stock of rice intended for consumption is 300.26kg while in zone B 498.23kg per household. Households that have a good stock of rice reach 28.4% in zone A and this situation is better in zone B with a rate of 33.97%.

The stock of rice for self-consumption is not sufficient to meet the needs of the population due to numerous factors: the high numbers of siblings in the family; crop sales to educate children, PPN for the daily life of the family; the estimate for field work for the next crop; the COVID-19 pandemic leading to the cessation of all subsidy and support programs for the agricultural sector.

3-1-2- Food access

Food access is a series of indicators used for food security.

- **Food sources**

Populations eat differently depending on the food source in the regions. The analysis of the sources of origin of the consumed food reflects the access of households in periods of abundance and in lean periods in the two zones.

During the PA, in zone A the main source of food is agricultural production with a rate of 50.10%. During the PS, households acquire the daily ration on Purchase with a rate of 41.07%. Our result is similar to the study carried out in Uganda which shows that households obtained their food largely through purchase [2] and also confirms the study carried out by RALISON LAINGOHARIMIADANA in the rural commune of Ambatomanga in 2023 [18]. . The donation is very low due to the COVID-19 pandemic, it presents only 1.03% during the period of abundance and 0.92% during the lean period.

In zone B, the main source of food is agricultural production, it presents 53.20% during the period of abundance and 30.50% during the lean period. The rate of households having self-production as their primary source of food during both periods is high. This habit depends on the accessibility and availability of food.

- **Accessibility**

Table-3: Food accessibility of households in the 2 zones

Zone	Accessibility	Very low	Low	Average	Good	Total	
A	PA	Numbers	27	37	53	133	250
		Percentage	10,8	14,8	21,2	53,2	100
	PS	Numbers	43	39	112	54	248
		Percentage	17,33	15,72	45,16	21,77	100
B	PA	Numbers	32	16	67	197	312
		Percentage	10,25	5,12	21,47	63,14	100
	PS	Numbers	153	29	46	83	311
		Percentage	49,19	9,32	14,79	26,68	100

During the AP, more than the half of households have good access to food with a rate of 53.2% in zone A and 63.14% in zone B. 21.2% of households in zone A and 21.47% of households in zone B have average accessibility,

14.8% of households in zone A and 5.12% in zone B have low accessibility and households with very low accessibility are 17.33 % in zone A compared to 10.26% in zone B.

3-1-3-Food stability

Table-4: Stability of sources of household income

Stability level	Zone A (N= 250)		Zone B (N=312)		Two zones combined	
	N	%	N	%	N	%
Stable	98	39,20	87	27,88	185	32,91
Moderately stable	60	24	30	9,61	90	16,01
Unstable	92	36,80	195	65,50	287	51,06

In zone A, the sources of income are more stable 39.20% compared to 27.88% in zone B. Households with a moderately stable source of income are represented by 24% in zone A and 9.61% in zone B. The rate of instability of sources of income in zone B is very high compared to that of zone A respectively 36.80% against 65.50%. The sources of income in zone A are varied, while the majority of households in zone B derive their resources from agriculture and livestock.

- **Coping Strategies and Survival Strategy Index (ISS or CSI))**

The analysis of all survival strategies made it possible to produce a survival strategy index [14]. The ISS is a proxy indicator of food access adopted by the WFP/VAM and the FAO.

Table-5: ISS in the 2 zones during the two periods

Adaptation strategy	Periods of abundance		Hunger seasons	
	Area A (N=250)	Area B (N=312)	Area A (N=248)	Area B (N=311)
ISS°	3,43	2,85	9,30	10,62

N: total number, %: percentage, ISS: survival strategy index

°: the higher the ISS, the more households use food-related strategies and are likely to experience a deterioration in their food security.

According to the CSI, the situation is better in zone B during the AP compared to zone A (2.85 against 3.43), the two zones correspond to average vulnerability. On the other hand, during the PS, the situation is alarming especially in zone B (9.30 against 10.62); both areas are in a state of extreme vulnerability.

3-1-4-Dietary diversity score

The dietary diversity score is a good indicator of improved access to food, food consumption and dietary quality. It is also a good indirect indicator of the socioeconomic status of a household. The scores are significantly correlated with calorie consumption per household [12 and 5]. In this study, the higher the SDAM, the better the quality of the diet.

Table-6: Diet diversity

Diet diversity	Zone A		Zone B	
	PA	PS	PA	PS
	n %	n %	n %	n %
Lowest dietary diversity (≤ 3 food groups)	17 6,8	95 38,30	44 14,10	98 31,51
Average dietary diversity (4 to 5 food groups)	96 38,4	100 40,32	99 31,73	132 42,44
High dietary diversity (≥ 6 food groups)	137 54,8	53 21,37	169 54,16	81 26,04
N	250	248	312	311

%	100	100	100	100
Average score of SDAM	7,03	5,36	6,97	5,74

SDAM: Household Dietary Diversity Score; n: effective; % : percentage ; * Total score ranging from 0 to 12, the higher the SDAM, the better the quality of the power supply.

The average household dietary diversity scores (SDAM) are inadequate (Score < 12) during the two periods in the study area. The household diet in zone B is less diversified than the diet in zone A due to the distance of zone B from the city of Antananarivo, where only the weekly Anjozorobe market on Thursdays supplies it. Households experience difficulty accessing food in the PS and have access to an inadequate diet and the conditions of isolation also determine access to local consumption products [16].

Zone B presents the best average SDAM score during the 2 periods including 7.01 in zone A compared to 6.97 in zone B during the PA and 5.74 in zone A compared to 5.36 in zone B during the PS or the maximum value of SDAM is 12. The reasons for this low diversification of SDAM are: the poor local production situation with poor harvest management, prices of food products and eating habits; the mother's occupation with housework who is no longer able to take care of feeding their household; poverty,

The risk of such a diet is micronutrient deficiency and consequently malnutrition [3] and in accordance with our results, dietary diversity is much improved during the lean season [1].

3-1-5- Coverage of nutritional needs

- **Calorie coverage rate**

In a food ration, energy is provided by macronutrients: carbohydrates and lipids, which are different organic chemical substances that meet needs [21].

Table-7: Calorie coverage rate in the 2 zones

Locality		Zone A		Zone B	
Period		PA	PS	PA	PS
Calories	RE	2536	2048	2500	1971
	RT	2340,04	2230	2448,40	2253 ?92
	TC (%)	+8,37	-8,16	+2,11	-12,55

RE: effective ration; RT: theoretical ration; TC: coverage rate

During the PA, it presents an excess of 8.37% in zone A and the needs are covered. In zone B, the actual caloric intake is 2500 Kcal while the theoretical requirement is 2448.40 Kcal, there is an excess of 2.11%. During the PS, the effective ration per ration-day of zone A is 2048 Kcal while the theoretical ration reaches 2330 Kcal, there is a deficit of 8.16%, and in zone B, the deficit is 12.55% because the actual ration of 1971 Kcal does not reach the theoretical ration of 2253.92 Kcal.

3-2- Pressure at the Anjozorobe-Angavo NAP

3-2-1- Demography

Three hundred and fifty million people around the world live in forests [8]. 1.2 billion people in developing countries depend on agroforestry farming systems (World Bank, 2004). Two billion people derive their livelihoods, their firewood, their medicinal plants and their food from these same forests. Natural resources play an important role in the lives of the local population [11].

This study area constitutes a welcoming locality for migrants attracted by the forest resources found there. Above all, the population is estimated at 115,946 inhabitants in 2004. For a maximum fictitious growth rate of 3%, this population number would amount to nearly 138,000 inhabitants in 2014 and also, the corridor contains nearly 25,000 households in total.

Human activities are the tangible pressure causing the impact on the environment [23]. Clearing for agriculture, illegal logging and hunting constitute the main pressures affecting the New Anjozorobe-Angavo Protected Area.

In both areas, the problem of demographic pressure due to arrivals has disrupted the order established by the former occupants and also weighs on the future of agrarian systems which itself has repercussions on the evolution of the forest.

3-2-2-Deforestation

Nowadays, the most alarming situation is the illegal exploitation of the forest, as indeed shown by Rajoelison in 2005 and a similar study in the Masoala National Park [4]. The abuse of the exploitation of forest resources leads to an inestimable loss of flora and fauna wealth.

According to a ONE report in 1995, in the 1950s, the Malagasy forests covered 14 to 16 million hectares, or 24 to 28% of the national territory. Currently forest cover is estimated at 12 million hectares, that of natural forest varies between 9 and 10 million hectares, or 16 to 17% of the total area of the country. Deforestation is occurring at a rate of 110,000 ha per year [10; 11].

Deforestation and forest degradation are among the most serious threats to Madagascar's terrestrial ecosystems [7; 6]. In the Anjozorobe Angavo NAP, this deforestation is mainly due to the extension of the cultivable area, the "tavy", the extension of pastures for zebus.

3-2-3- Clearing

Clearing is one of the major threats affecting the Anjozorobe forest. This type of pressure is caused by insufficient cultivable land and the practice of "tavy2" slash-and-burn agriculture. Currently, a movement of the population, particularly that of the Western slope, towards the forest has been noted and as resources become more and more scarce, the populations, young and mobile, emigrate from the Southern part of the Corridor towards the Northern part where a vast expanse of forest is still intact. This generalizes the pressures to the entire forest.

The annual speed of deforestation is estimated on average at 114 ha/year according to the Manager of the development plan and management of the New Protected Area of Anjozorobe-Angavo. This type of pressure destroys habitats and disrupts the distribution of animals, reducing their surface area and their vegetative composition. This degradation therefore disrupts the distribution of animals.

3-2-4- Selective cutting of wood

It mainly concerns woody species used for the construction of houses, cart wheels and the cart itself, etc.

According to existing data based on a census carried out by FANAMBY in 1999, illegal logging by formal or informal operators from the capital constitutes the greatest threat to the conservation of forest cover; because in 5 years, it affected an area of 6,800 ha. The overall rating for this type of pressure is "High".

3-2-5- Making of charcoal

This is the highest pressure because the Anjozorobe-Angavo forest corridor constitutes one of the major suppliers of energy wood to the nearest urban centers, notably Antananarivo and Moramanga. Wood harvesting for the manufacture of charcoal is most often done (85% of operators) in private forests; the operators are called "owner operators" and they are more present in the eastern part of the NAP.

3-2-6- Hunting

It is practiced illegally by people living near the protected area for multiple purposes. In principle, the meat of certain species is fady (taboo) for natives, but is considered as luxury meat by certain ethnic groups, notably migrants. Consumption constitutes one of the cause of the hunting of these animals, it can also constitute an additional source of income. The local populations, the elimination of hunting cannot be achieved without the provision of alternative protein sources.

This pressure affects several animals, particularly lemurs (*Indri indri*, *Propithecus diadema*) which are classified as threatened in the IUCN red list. Its rating, after analysis, is "High".

Indri indri has an important value because it is considered as an ancestor by the local population. This protects it from poaching because it is taboo or "fady". However, it is still under threat due to the presence of immigrants who do not involved by this culture. In addition, its population continues to decline due to the loss of their natural habitat (clearing and deforestation).

3-2-7- Picking

The following plants are collected: food plants, medicinal plants and orchids (generally endemic).

Traditional knowledge on the use of plants is considered as a heritage and patrimony for the future generation. However, the erosion of this knowledge is currently observed [20], that is to say that people give less importance to

this empirical knowledge. In addition, a lack of written documents also adds to this loss, for example on medicinal plants [15]. Picking lead to the gradual or rapid extinction of these species.

3-2-8- Handicrafts and other activities depending on natural resources

The secondary activities of the population living along the Corridor are: carpentry, blacksmithing, charcoal making, basketry and the making of artisanal rum. These secondary activities play an important role in the lives of the local population by providing food, medicine, materials for tool making and construction but also to improve income resources. Given that large adult trees are the most targeted, local extinction of species would be a great risk if this trend continues.

The species intended for the making of charcoal are a priori Eucalyptus and Pine forests. However, in certain villages, where these two species are absent, the community resorts to charcoal production in the forest. Its overall rating is "Average".

4- CONCLUSIONS

This study shows that the household food situation in the two areas is poor. This results from low agricultural productivity as well as low availability, food and financial stability, the limited food access and the inadequacy of eating behaviors reflected by diversity and eating habits.

The calorie needs of both localities are covered during the AP. The caloric needs in the two zones are not totally covered overall during PS; Almost all households do not have sufficient stocks, rice production is low, and the quantity of cereals consumed is low as well.

Forestry exploitation such as the making of charcoal, selective cutting of wood, illegal cutting, exploitation of timber, the making of flower pots, etc. has impacts on the conservation of forest cover. Factors directly linked to food such as poaching, hunting, picking can lead to the local extinction of species in the corridor, the same is true for the primary sector which brings together all the activities whose purpose consists of the exploitation of natural resources such as agriculture, livestock breeding and fishing.

This work highlighted that the food security of households in the fokontany around the Anjozorobe –Angavo protected area have negative impacts on conservation, the hypothesis is verified and the objectives are achieved.

But generally, the demographic pressure and the correlative saturation of the agrarian space, the opening of traditional societies towards an exchange economy are essential factors, which explain and maintain the movements of the rural population towards the forest area.

The harmonization of human activities with the conservation of natural resources is a challenge for the Anjozorobe-Angavo NAP, especially since the population depends totally or partially on the exploitation of natural resources.

By continuing the undertaken work and proposing new avenues of research such as the analysis of food security of other residents of the NAP, the analysis of household vulnerability from the food security point of view, the identification of species in this corridor, scientists also can contribute to maintain this more optimistic scenario.

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