Vol-4, Issue-3 PP. 108-119 ISSN: 2394-5788

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

FOREST DYNAMIC AFTER ABANDONING COCOA FARMING IN THE AZAGNY NATIONAL PARK (SOUTHERN CÔTE D'IVOIRE)

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ABSTRACT

In order to contribute to the sustainable management of the Azagny National Park (ANP) in southern Côte d'Ivoire, a study on forest dynamics after abandonment cocoa plantations was initiated. The target of this study was to assess the level of recovery of the ancient cocoa plantations. To this end, two types of ancient cocoa plantations have been studied. The first is an ancient plantation abandoned in 1986 and the second is a plantation abandoned in 2000. These ancient plantations have now become secondary forests. The floristic and structural parameters as well as recovery parameters of secondary forest were compared with those of an intact forest which is an old growth forest on dry land. The method used is the surface survey which consisted to delimit plots of 500 m² in each of the three types of space. A total of 470 species in 300 genus and 97 families were recorded. The old growth forest is more diversified than the secondary forests grown from cocoa. There is no floristic similarity between secondary cocoa forests and old growth forest. The basal area, pioneer index and regeneration potential of secondary cocoa forests are statistically equal to those of old growth forest. This indicates that ancient cocoa plantations are evolving towards the forest.

Keywords: dynamic, recovery, cocoa, Azagny National Park, Côte d'Ivoire.

1. INTRODUCTION

In the world today, nearly 1.3 billion people work in agriculture. Of these, 96 p.c live in countries of the South where family-type agriculture, based on a slash-and-burn system, has long been labeled unsustainable. (**Adou Yao, 2000 ; Ferraton and Touzard, 2009**). Indeed, this practice would constitute one of the main engines of the degradation of the forest cover (**Fairhead and Leach, 1998**). Like most countries in West and Central Africa, Côte d'Ivoire inherited from the colonial period the role of exporter of tropical agricultural products, in particular that of cocoa the first producing country (**Assiri et al., 2012**). This has led to a degradation of forest cover, especially in southern of Côte d'Ivoire, and a significant loss of biodiversity (**Aké Assi, 1998 ; Adou Yao et N'Guessan, 2006**). In order to curb the degradation of vegetation cover in the ivorian south forest, the government of Côte d'Ivoire adopted a series of laws between 1968 and 1974 aimed at creating a network of protected areas to which the Azagny National Park belongs (ANP) (**Koffi**

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et al., 2015). Prior to the creation of this park, dense rainforests and cocoa plantations existed. And in this park, the state of Cote d'Ivoire decided to free the planters in successive waves (**Koffi et al., 2015**). The first clearance took place in 1986 and the second in 2000. Cocoa plantations abandoned as a result of these periods were transformed into secondary vegetation formations. Is the reconstruction of the vegetation of these old plantations possible?

For **Guillaumet and Adjanohoun (1971)**, the recovery of the forest after peasant activities depends more on the local station conditions, the previous cultures and their intensity, the surrounding vegetation, the rigor of the temperature and the illumination. According to **Vroh (2013)**, a vegetation's recovery is possible after agricultural activities in the south forest of Côte d'Ivoire. However, can this situation of natural recovery, which is possible in southern Côte d'Ivoire, be generalizable for all cultures? Until now, there are no studies on the vegetation's dynamic of after abandoning cocoa plantations in the south forest of Côte d'Ivoire.
The present study attempts to test the hypothesis that abandoned cocoa plantations may be able to regenerate and reach the state of an evergreen forest.
It is in this context that the present study, whose general objective is to assess the level of recovery of ancient cocoa plantations abandoned in 1986 and 2000 in the ANP. More specifically, quantitative diversity, the structural parameters of vegetation and the pioneer index and regeneration potential of these ancient plantations were determined.

2. MATERIAL AND METHODS

2.1. Study site

Our study site is the Azagny National Park (ANP). It is located in southern Côte d'Ivoire (Figure 1). It extends between two administrative departments (Grand-Lahou and Jacqueville). This park covers an area of 21.850 ha and is part of the phytogeographical region of Upper Guinea, which stretches from Togo to Senegal (**White, 1983**). The vegetation presents itself as a mosaic of biotopes very different from one another, ranging from grassy savannah to evergreen forest through secondary formations and fallow. The relief of the Azagny National Park is unrugged and composed of a vast marshy depression that dominates to the north a set of low plateaus. The climate is of the subequatorial type (**Avenard et al., 1971**). It has two seasons: a rainy season and a dry season. The rainy season is spread over two periods: from March to July and from September to December (**Gnagbo, 2015**). The dry season also spans two periods: January to February and August. The average rainfall is 1650 mm at an average annual temperature of 26 ° C and an average relative humidity of about 85% (**Eldin, 1971; Roth et al., 1979**).

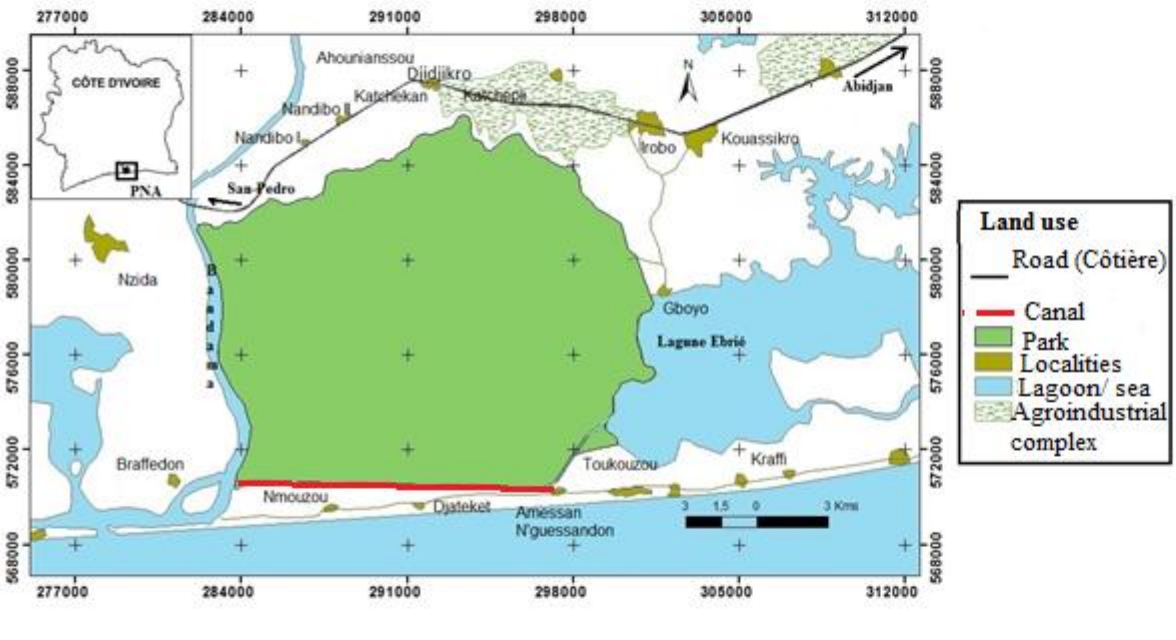

Figure 1: Limits of the Azagny National Park and its location in Côte d'Ivoire

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2.2. Data collection

Two ancient abandoned cocoa plantations in 1986 and 2000 and an evergreen forest were inventoried. The inventory sites, the previous crop and the age of the sites were identified after a survey of agents of the Ivorian Office of Parks and Reserves, manager of the park. The data collection consisted of a surface survey completed by An itinerant inventory. The surface survey consisted of delimiting plots of 500 m² (25 mx 20 m) in the study sites. In each plot, the diameter of all woody individuals of diameter at breast height (DBH) greater than or equal to 5 cm was measured. The minimum value of DBH retained is 5 cm because this value is assumed to take into account a large number of diversity (**Adou Yao, 2005; Kouamé et al., 2008**). Unidentified species in the field were sampled and subsequently determined by comparison with samples from the Herbarium of the National Floristic Center.

2.3. Analysis and treatment of floristic and structural data

2.3.1. Floristic Data

A floristic catalog covering all the species present in our 120 plots has been established, to which we added the additional species listed during the itinerant surveys. In order to compare the specific diversity of the different sites, we calculated the specific richness, the Shannon's index (**Shannon, 1948**), the evenness index of **Pielou (1966)** and Simpson's index (**Simpson, 1949**).
The specific richness of a given site is the number of species on this site (**Koffi et al., 2015**). Its measure consists in counting all the species listed on a site without taking account of their abundance.
The other three indices were calculated according to the following mathematical formulas:

$$DS = 1 - \Sigma\,(Ni\,(Ni - 1)) / (N\,(N - 1)))$$

$$E = H' / \ln S$$

$$E = H' / \ln S$$

In these formulas, H 'represents the diversity index of Shannon, DS, the Simpson index, E the evenness index, Ni is the number of individuals of a species i and N the total number of individuals of all species.
The Shannon's index reflects the degree of disorder of a site on the basis of the proportions of the species observed and takes into account the number of species inventoried and their abundance (**Legendre and Legendre, 1984**). The diversity is small when H 'is less than 3, moderate if H' is between 3 and 4 and then raised when H 'is greater than or equal to 4 (**Legendre and Legendre, 1984**; **Frontier and Pichod-Viale, 1955**). When a list of species and their associated frequencies is available, the Simpson Diversity Index (DS) is used to account for the abundance of one or a few species. This index is highly dependent on the number of rare species (**Simpson, 1949**). The evenness index of Pielou reflects how individuals are distributed across species (**Adjakpa et al., 2013**). It is maximal if individuals are distributed in the same way across species. It varies from 0 (one species has a very high abundance) to 1 (all species have the same importance).
To evaluate the floristic resemblance between two spaces, the similarity index of Morisita-Horn (MH) was used. In contrast to Sørensen, which is used in many works (**Kouamé, 1998; Kouka, 2000 and Ouattara et al., 2013**), the similarity index of Morisita-Horn makes it possible to take into account, in addition to the presence of species, their Abundance to evaluate the floristic resemblance (**Krebs, 1989)**. Indeed, two sites can be very similar on the basis of the nature of the species present without these having the same numbers of individuals (**Simpson, 1949 ; Novotny and Weiblen, 2005)**. This index was calculated on the basis of all the species present in each space. The mathematical formula of this index is the following:

$$MH_{ij} = (\Sigma\, P_{is}P_{js}) / (\Sigma\, P^2_{is} + \Sigma\, P^2_{ij})$$

In this formula, Pis and Pjs represent respectively the probabilities that the species s is drawn from the i and j records. The values of this index vary from 0 to 100. The more the two floristic lists have species of similar abundance in common, the more MH tends towards 100. The more the two floristic lists are different in species, the more MH tends towards 0. All these indices were calculated from the MVSP 3.1 software.

2.3.2. Structural characteristics

The treatment of the structural data allowed to estimate the density, the basal area and the distribution of the individuals by class of diameters. Density consisted of a count of stems per hectare. Whereas the basal area was obtained by applying the following formula:

$$S = D^2 \times pi / 4$$

D represents DBH. The basal area is related to the circumference of individuals.
The stem distribution curve as a function of diameter classes was established to account for vertical vegetation structuring (**Gounot, 1969 ; Chatelain, 1996)**.

2.3.3. Level of recovery and regeneration potential

The Pioneer Index (PI) was calculated by determining the proportions of frontier, non-frontier and heliophilic species. This index determined the state of perturbation or reconstitution of the sites (**Aubreville, 1956 ; Mangenot, 1955 ; Prevost, 1981)**. This index is commonly used in Côte d'Ivoire **(Adou Yao, 2005; Vroh et al., 2011)** and does not take into account the species of hydromorphic medium due to the instability of their habitats **(Hawthorne, 1995).** The formula for calculating the IP is as follows:

$$IP = 100\ [(2\ Pi + nPi) / Nb\ Espèces]$$

In this formula, Pi is the number of pioneer species; nPi is the number of non-pioneer but heliophilic species and Nb is the total number of species at the site. To characterize the perturbation / reconstitution state of a medium through this index, five classes of values (Table 1) ranging from 0 (undisturbed site) to 200 (highly disturbed to completely transformed site) were established by **Hawthorne (1995).**
The regeneration analysis was carried out on the basis of the regeneration potential (PR) according to the formula:

$$PR = Nj / N$$

Nj: total number of seedlings (DHP <5 cm); N: total number of all trees.

Table 1: Meaning of PI values according to Hawthorne (1995)

IP values	**Comments**
$0 \leq IP < 25$	Site undisturbed to very disturbed / site completely reconstituted
$25 \leq IP < 50$	Poorly disturbed site / good recovery
$50 \leq IP < 100$	Medium disturbed / medium vegetation recovery
$100 \leq IP < 150$	Fairly disturbed site / weak recovery
$150 \leq IP < 200$	Site very disturbed to completely transformed / very low recovery

2.4. Statistical analysis

In the absence of normality and homogeneity of distributions, Kruskal-Wallis non parametric tests were performed to compare the means of diversity, density, basal area, pioneer index and regeneration potential in different categories of space. Paired comparison tests were performed using the 5% Dunn post-hoc test (**Koffi et al, 2016**).
A Multiple Factor Analysis (MFA) was carried out on the type of biotopes (old cocoa plantations and evergreen forest) and on the quantitative variables that are the various parameters calculated to explain the correlation between these two types of variables.

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All these analyzes were carried out using the FactoMineR Package of software R.3.2.

3. RESULTS

3.1. Floristic diversity of biotopes

In total, 120 plots were identified, ie 40 plots in each of the biotopes. In terms of species, there are 470 species in 300 genera and 97 families. The evergreen forest records the greatest number of species. This number is 235 species (Table 2). While the secondary forest from cocoa abandoned in 2000 contains the lowest number of species species that is 54 species. The evergreen forest is the richest biotope floristically with a specific richness of 90.9 ± 22.8 species. In contrast, secondary forest from abandoned cocoa in 1986 is the poorest biotope with an average value of species richness of 33.1 ± 15.6 species. The differences between means of specific richness are significant ($\chi^2 = 52.7$, $P < 0.001$). The mean value of the Shannon index indicates that the evergreen forest is the most diverse. The mean value of the Shannon index in this biotope is 4.2 ± 0.4 bits. This index has a low mean value which is 2 ± 0.4 bits in the secondary forest originating from abandoned cocoa in 2000. This biotope is the least diversified. The differences between the means of the Shannon index are significant ($\chi^2 = 8.8$, $P = 0.01$). When considering the Simpson index, evergreen forest has the highest average value of 0.9 ± 0.04. Secondary forest from abandoned cocoa in 2000 has the lowest average value. This value is 0.7 ± 0.02. The analysis of the evenness index indicates that the species are more evenly distributed in the evergreen forest. In this type of biotope, the evenness index is 0.9 ± 0.1. In the secondary forest of abandoned cocoa trees in 2000, the species are the least distributed equally. In this biotope, the eveness index is the lowest with a value of 0.6 ± 0.1.

Table 2: Vegetation diversity in the three types of biotopes inventoried in the NAP

Types of spaces	**Evergreen forest**	**Sec. For.Cocoa_1986**	**Sec. For.Cocoa_2000**
	Floristic richness		
Nb. Species	235	181	54
Nb. Generas	171	127	49
Nb. Families	68	64	32
	Floristic diversity		
Average of Specific Richness (SR)	**90.9 ± 22.8^{b}**	33.1 ±15,6^{a}	36.8 ± 21,8^{a}
Average of Shannon Index (H')	4.2 ± 0,4^{b}	2 ± 0.5^{a}	2 ± 0.4^{a}
Average of Simpson Index (DS)	0.9 ± 0.04^{b}	0.8 ± 0.1^{a}	0.7 ± 0.02^{a}
Average of Evenness Index of Pielou (E)	0.9 ± 0.1^{b}	0.8 ± 0.2^{a}	0.6 ± 0.1^{a}

For.sec.Cocoo_1986: Secondary forest from abandoned cocoa in 1986; For.sec.Cocoa_2000: Secondary forest from abandoned cocoa in 2000.
The mean values assigned to the same letter are not significantly different at the 5 p.c. threshold

Table 3: Matrix of similarity

	Sec.For.Cocoa_1986	**Sec.For.Cocoa_2000**	**Evergreen forest**
Sec.For.Cocoa_1986	100		
Sec.For.Cocoa_2000	**88.2**	100	
Evergreen forest	14.8	12.1	100

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3.2. Floristic similarity

The Morisita-Horn index indicates that the floristic resemblance between the dense forest and secondary forest from abandoned cocoa in 2000 is low (12.1 pc) as mentioned in Table 3. While the floristic resemblance is very strong (88.2 pc) between the secondary forests originating from cocoa.

3.3. Density, basal area and distribution by diameter class of woody stands in the study site

Stem density is higher in the evergreen forest with a mean value of 5824 ± 90.9 stems / ha (Table 4). On the other hand, the secondary forest from abandoned cocoa in 2000 has the lowest average density of 1826 ± 19.3 stems / ha. The differences between mean values of density are significant ($\chi^2 = 58.5$, $P < 0.001$).

As regards the basal area, the evergreen forest has the highest average value, 15.6 ± 6.6 m^2 / ha. On the other hand, the lowest average value, 13.9 ± 7.9 m^2 / ha, was observed in the secondary forest originating from abandoned cocoa in 2000. The differences between the mean values of this parameter are not significant ($\chi^2 = 0.9$, $P = 0.6$).

The best fit of individual distributions per diameter class is achieved with a polynomial function. The figure 2 shows the distribution by class of individual diameters.

The distribution histograms of individuals by diameter class all have an inverted "J" shape (Figure 2). In the intact forest and secondary forest from cocoa abandoned in 2000, the number of individuals of large diameters is not negligible. On the other hand, in the secondary forest from abandoned cocoa in 1986, the number of individuals decreases as the diameter increases.

Table 4: Mean values of the structural parameters

	Density (Nb. stems / ha)	**Basal area (m^2 / ha)**
Evergreen forest	5824 ± 90,9[b]	15,6 ± 6,6[a]
Sec.For.Cocoa_1986	2916 ± 38,3[b]	15,16 ± 8,8[a]
Sec.For.Cocoa_2000	1826 ± 19,3[a]	13,88 ± 7,9[a]

Sec.For.Cocoa_1986: Secondary forest from abandoned cocoa in 1986; Sec.For.Cocoa_2000: Secondary forest from abandoned cocoa in 2000.

The mean values assigned to the same letter are not significantly different at the 5 p.c. threshold.

3.4. Characterization of plots groups in the Azagny National Park

3.4.1. Identification of plots groups

The first two axes of the MFA alone have a cumulative variance of 49.07 pc (Table 5).

Thus, on the negative side of axis 1, records of secondary forest originating from cocoa are placed. On the positive side of the same axis, distributions of dense forest are distributed.

Similarly, on the negative side of axis 2, records of secondary forest from cocoa trees abandoned in 2000 and those of dense forest are positioned. On the other hand, on the positive side of this axis, there are the secondary forest surveys of abandoned cocoa trees in 2000.

3.4.2. Description of groups of plots

The Hierarchical Ascending Classification (HAC) was performed on the coordinates of the first 7 factorial axes of the AFM, which gave 98.18 p.c. of total inertia, distinguishes three (3) groups of dense forest plots, secondary forests from abandoned cocoa in 1986 and 2000 (Figure 3). These three types of biotopes are quite distinct. Four parameters did not participate in the formation of the different groups of biotopes. These are: basal area, density, regeneration potential and pioneer index.

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The first group (G1) includes only secondary forest plots of abandoned cocoa in 2000. The second group (G2) consists only of secondary forest plots of abandoned cocoa in 1986. Finally, the third group (G3) comprises only evergreen forest plots.

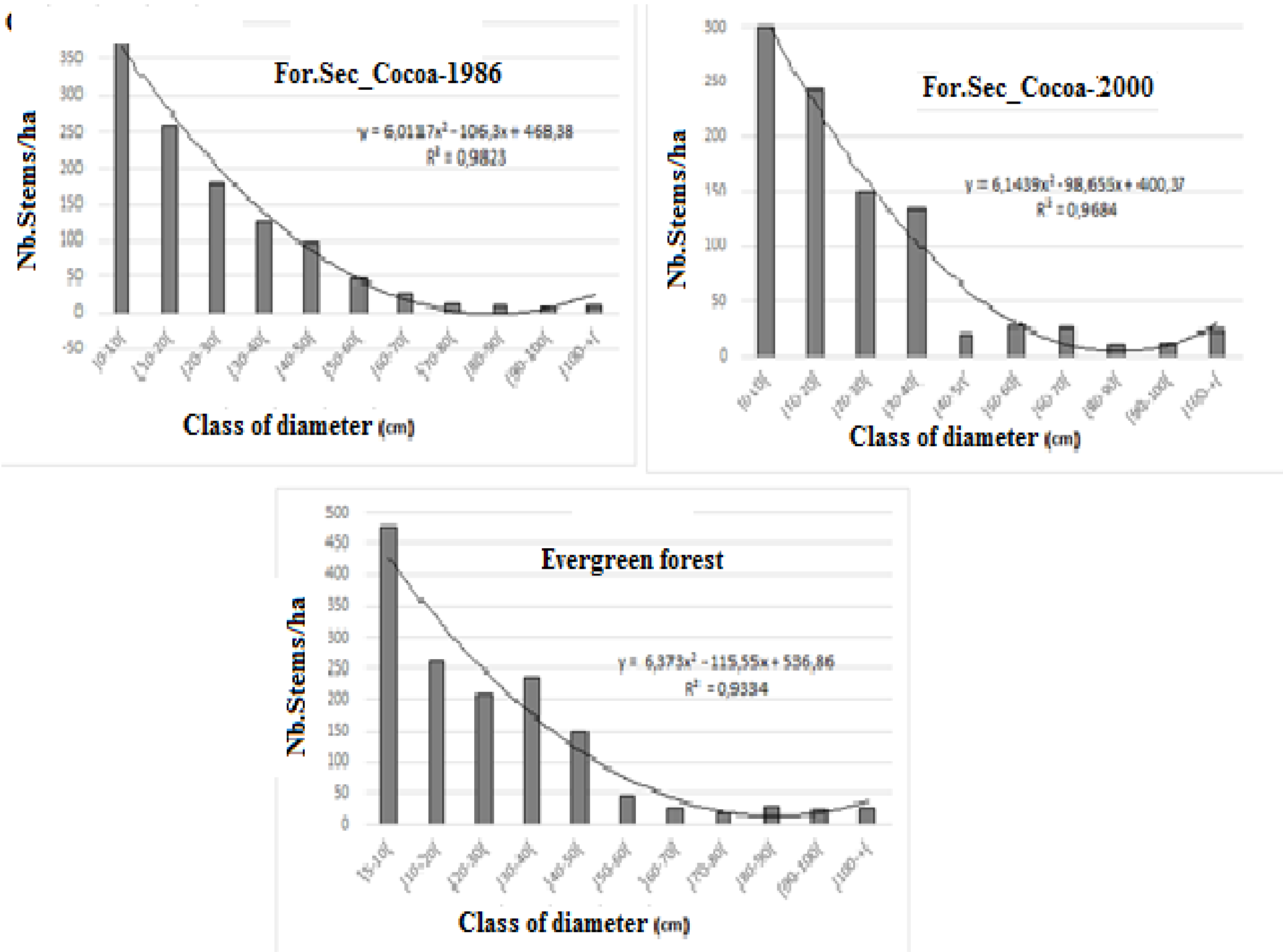

Figure 2: Distribution of stems by diameter classes in the various biotopes of the Azagny National Park

Table 5: Eigen values and contribution of groups of descriptive variables of Biotopes

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7
Eigen value	2,1	1,3	1,1	0,9	0,7	0,5	0,1
Percentage of inertia	30,4	18,7	16,6	12,8	10,5	7,4	1,7
Cumulative percentage of inertia	30,4	49,	65,7	78,5	89,1	96,5	98,2
	Contribution of Variable Groups Used						
Diversity	45,3	1	0,4	2,3	3,3	0,8	95,9
Structure	4,4	26	48,9	82	16,3	22	0,4
Recovery	5,2	20,5	49,5	7,9	44,5	70,8	0,8
Biotopes	45,1	52,5	1,2	7,8	35,8	6,4	2,9

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3.5. Recovery and regeneration potential

The mean value of the pioneer index is higher (107.3 ± 51.3) in the secondary forest from abandoned cocoa trees in 2000 (Table 6). This biotope is the most degraded and has the lowest recovery level. Whereas dense forest is the most conserved forest with an average value of the pioneer index which is 83.1 ± 15.9. The differences between the mean of this index are not significant ($\chi^2 = 2.1$, P = 0.3).

Considering the potential for regeneration, the mean value is the highest (20.5 ± 23.8 pc) in the secondary forest from cocoa abandoned in 1986. Secondary forest from abandoned cocoa in 2000 has the highest mean value (12.95 ± 13.15 pc) There is no significant statistical difference between the mean of this parameter at 0.05 pc ($\chi^2 = 0.25$, P = 0.88).

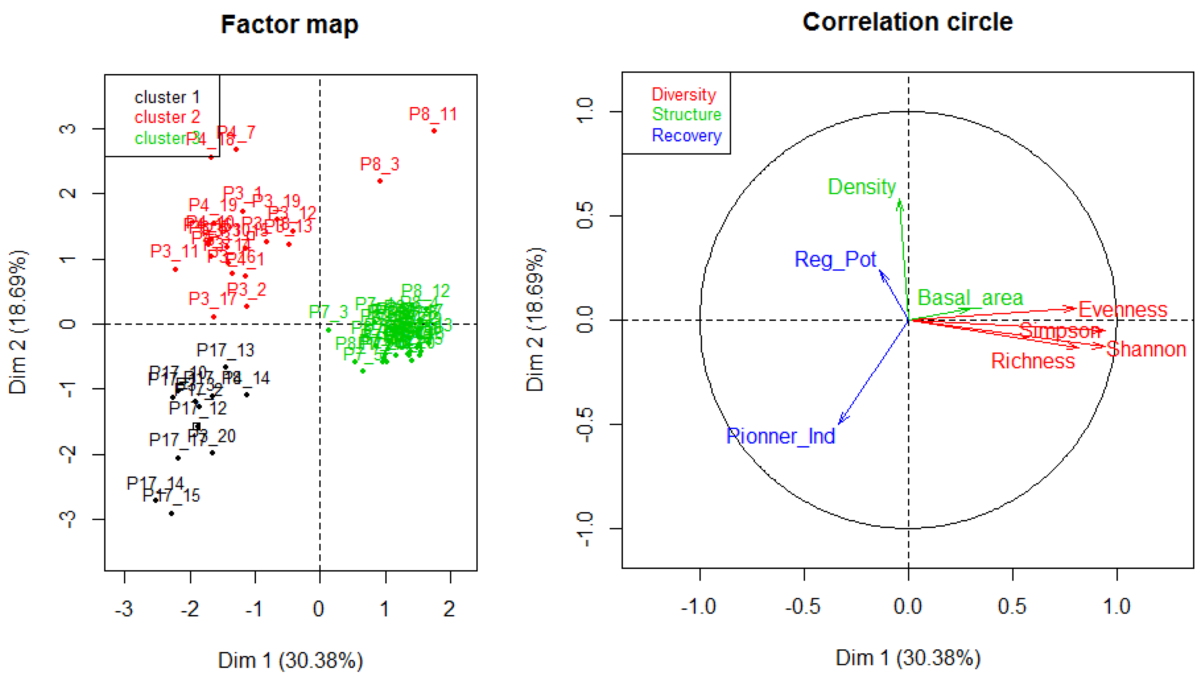

Figure 3: Factor map and correlation circle of the variable groups used in Multiple Factor Analysis

Table 6: Average value of the pioneer index and the regeneration potential in the various biotopes of the Azagny National Park

	Pioneer Index (PI)	Regeneration Potential (R.P)
Evergreen forest	83.1 ± 15,9^{a}	15.5 ± 15.3^{a}
For.sec.Cacao_1986	89.8 ± 26.7^{a}	20.5 ± 23.8^{a}
For.sec.Cacao_2000	107.3 ± 51,3^{a}	13 ± 13.2^{a}

Sec.For.Cocoa_1986: Secondary forest from abandoned cocoa trees in 1986; Sec.For.Cocoa_2000: Secondary forest from abandoned cocoa trees in 2000.

The mean values assigned to the same letter are not significantly different at the 5 p.c. threshold.

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4. DISCUSSION

During forest recovery, changes in vegetation and vegetation structure depend on the ability of species to adapt to environmental conditions and their ability to exploit abiotic resources (**Raoanaivo et al., 2015).** The increase in diversity depends on the age of the biotope. As the age of the biotope increases, the diversity is high. This increase in wealth and diversity according to the age of abandonment is explained by the return of forest species to the oldest plant formations. This phenomenon is termed species turnover by ecologists (**Van Gemerden et al, 2003**). Several authors such as **Connell (1978)** and **Sheil et al. (2003)** argue that the parameters of floristic richness and diversity in the reconstruction phase of tropical forest vegetation increase with age. In fact, according to these authors, in the case of natural or anthropogenic disturbances, during the first phase of replanting, which may go beyond 60 years **(Guillaumet et Adjanohoun, 1971)** or more than 100 years (Cordonnier, 2004), the number of species increases As age increases. In the southern zone of Côte d'Ivoire, **Koffi et al. (2016)** also showed that after cultural abandonment, diversity increases with age of abandonment. On the other hand, secondary education from abandoned cocoa trees in 2000 is richer than that abandoned in 1986, in terms of specific wealth. This trend is due to a difference in cultural practice during both periods. After the 1986 disengagement, farmers practiced cocoa farming under a heavy forest cover to camouflage the plantations. The plantations were created under the canopy of large forest trees. The high specific wealth of the secondary forest originating from abandoned cocoa trees in 2000 was due to ecological conditions that would favor the recruitment and arrival of new taxa. This recruitment will lead to an increase in the specific wealth.

The similarities measured with the Morisita-Horn coefficient show a very weak resemblance between the dense forest and the two secondary forests. The intact forest thus has a good part of its species which differ from those of the two secondary forests. This situation could be attributed to the cultivation of cocoa trees which preceded the abandonment of these sites. Using the same coefficient, the resemblances between the two types of secondary forest are strong. These two types of secondary forest would have the same floristic background. The age of abandonment would not have significantly altered the floristic composition. Several authors, including **Yoni (1997); Ouédraogo (1993) and Foumier *et al*., (1996),** have argued that it is rather the edaphic factors that remarkably modify the floristic composition for the old plantations.

The mean values of the densities obtained in the three types of spaces are statistically different from one another. This would mean that cocoa and the age of abandonment would contribute to a significant change in the density of individuals in an area. The densities obtained in the three types of spaces are superior to those obtained by **Gentry (1982)** for neotropical forests. Indeed, this author places the densities in the range of 167 to 1947 stems / ha. This difference is explained by the fact that (**Gentry (1982)** considered only individuals with diameters greater than 10 cm.

The basal area values are statistically equal to each other for the three types of spaces. This would mean that old cocoa plantations would evolve towards a forest. However, these values are lower than those obtained in dense forests according to **Mosango and Lejoly (1990).** Indeed, these authors claim that in dense forest, the basal areas vary between 23 and 50 m² / ha.

The distribution of individuals in diameter classes follows a steadily decreasing pattern, with a maximum in the first diameter classes. **Sonké (1998)** obtained the same results in the Dja Wildlife Reserve in Cameroon. In nature, such a configuration is the sign of a state of equilibrium **(Bouko et al., 2007)**, which is typical of a good natural regeneration **(Puig, 2001).** This shows that, thanks to the growth of the numerous individuals of regeneration, the plant formations of the ANP will continue. Also, the inverted "J" structure obtained for secondary cocoa forests indicates that these forests are in the process of reconstitution **(Riera et al., 1990).** The richness and diversity of flora considered globally are not very precise indicators of the state of reconstitution of the environments **(Foumier et al., 1996).** Therefore, the mean values of the pioneer index (PI) of the three forest types were compared. This comparison indicates that there is no significant difference between these values. This suggests that the secondary forests from the secondary forest from cacao would have good resilience, although these forests remain less diverse than the evergreen forest. The potential for regeneration does not appear to be influenced by the age and previous cropping of the plots. However, this result is to be taken with reserve, because the forests studied did not all undergo the same mesological factors. These factors are the cumulative duration of cultivation or forest proximity. All of these findings on replenishment or regeneration suggest that traditional agriculture, in which forest clearing is not followed by fire before cultivation as in the Azagny area, would potentialities of the environment and would allow the regeneration or reconstitution of the forest once the plantations have been abandoned, as already mentioned (Kahn, 1982).

Multiple Factor Analysis (MFA) coupled with a Hierarchical Ascending Classification (HAC) has resulted in a clear separation of records from different forests. This separation reflects the low species resemblance between these three forest types (evergreen forest and secondary forests). Plots of intact forest are those with the highest average values of specific wealth, they are the most diversified and least degraded. It is also these plots which have the highest densities in stems, with larger basal areas. While the secondary forest plots of cocoa trees abandoned in 2000 have low values of floristic diversity and structural parameters. This distinction also shows that the floristic composition of secondary forests is closely dependent on the age of abandonment and the previous cultivation of the plots.

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Our results are confirmed by those of **Alexandre (1989),** which explains that the floristic evolution is related to the structural evolution.

5. CONCLUSION

This study allowed us to understand the process of forest dynamics observed after abandoning the cocoa farming in the Azagny National Park in the south of Côte d'Ivoire. The results showed a possibility of reconstitution of the vegetation after abandoning the cocoa farming by considering the structural parameters. The results of this study may be useful in the development of the management and management plan for this protected area. Furthermore, in view of the results obtained in the ANP which is located in the forest zone, cocoa farmers are invited to practice cocoa farming under shade in order to promote the resilience of old plantations and the sustainability of natural resources. Moreover, this study is one of the pioneers carried out in the Azagny area with regard to the post-cultural dynamics of vegetation after abandoning cocoa. These data may serve as a reference for the study of the post-cultural natural recovery in the ANP, among others, in the southern zone of Côte d'Ivoire.

6. REFERENCES

[1] **Adjakpa, B. J., Yedomonhan, H., Ahoton, L. E., Weesie, P. D. M. and Akpo, E. L. , 2013.**"Structure et diversité floristique des îlots de forêts riveraines communautaires de la vallée de Sô du Bénin''. *J. Appl. Biosci*. 65, pp. 4902 – 4911.

[2] **Adou Yao, C. Y., 2005.**"Pratiques paysannes et dynamiques de la biodiversité dans la forêt classée de Monogaga (Côte d'Ivoire)''. Thèse Doctorat unique, Département Hommes Natures et Société, Université MNHN, Paris. 233 pp.

[3] **Adou Yao, C. Y. et N'Guessan, E. K., 2006**. "Diversité floristique spontanée des plantations de café et de cacao dans la forêt classée de Monogaga, Côte d'Ivoire''. *Schweiz. Z. Forstwes*. 157 (2), pp. 31–36.

[4] **Aké Assi, L., 1998.** "Impact de l'exploitation forestière et du développement agricole sur la conservation de la biodiversité biologique en Côte d'Ivoire''. *Le flamboyant* 46.pp. 20-21.

[5] **Aké-Assi, L., 2001.**"Flore de la Côte d'Ivoire 1, catalogue, systématique, biogéographie et écologie. Genève, Suisse : Conservatoire et Jardin Botanique de Genève''. *Boisseria*57, 396 p.

[6] **Aké-Assi, L., 2002.**"Flore de la Côte d'Ivoire 2, catalogue, systématique, biogéographie et écologie. Genève, Suisse : Conservatoire et Jardin Botanique de Genève''; *Boisseria*58, 441 p.

[7] **Alexandre, Y. D., 1989.**"Dynamique de la régénération naturelle en forêt dense de Côte d'Ivoire. Stratégies écologiques des arbres de la voûte et potentiels floristiques''. ORSTOM, *Collection étude et Thèse*, 102 p.

[8] **Assiri, A.A., Kacou, E. A., Assi, F.A, Ekra, K.S., Dji, K.F, J. Y., Couloud, J.Y. et Yapo, A. R, 2012.** "Rentabilité économique des techniques de réhabilitation et de replantation des vieux vergers de cacaoyers (*Theobroma cacao* L.) en Côte d'Ivoire''. *Journal of Animal and Plant Sciences*, 14 (2): 1939 – 1951.

[9] **Aubreville,A., 1956.**"A la recherche de la forêt en Côte d'Ivoire''. *Bois et Forêts des Tropiques*, 56-57, pp. 17-47.

[10] **Avenard, J. M., Eldin, M., Girard, G., Sircoulon, J., Touchebeuf, P., Guillaumet, J. L., Adjanohoun, E. etPerraud, A. 1971.** "Le milieu naturel de Côte d'Ivoire''. *Memoire ORSTOM*, n°50 Paris, France: 392 p.

[11] **Bouko, S. B., Sinsin, B. et Soulé, G. B., 2007.**"Effets de la dynamique d'occupation du sol sur la structure et la diversité des forêts claires et savanes du Bénin''. *Tropicultura*25(4), pp. 221-227.

[12] **Chatelain, C., 1996.**"Possibilités d'application de l'imagerie satellitaire à haute résolution pour l'étude des transformations de la végétation en Côte d'Ivoire forestière''. Thèse Doctorat ès- Science., Faculté des Sciences, Université de Genève, Suisse, 206 p.

[13] **Connell, J. H.,1978.** "Diversity in tropical rain forest and Coral Reefs''. *Science* 199, pp. 1302-1310.

[14] **Cordonnier T., 2004.** "Perturbations, diversité et permanence des structures dans les écosystèmes forestiers''. Thèse de Doctorat de l'Ecole Nationale de Génie Rural des Eaux et des Forêts, 256 p.

[15] **Eldin, M., 1971.**"Le climat''. *In* : Avenard, J. M., Eldin, M., Girard, G., Sircoulon, J., Toucheboeuf, P., Guillaumet, J. L., Adjanohoun, E. et Perraud, A. le milieu naturel de la Côte d'Ivoire. Mémoire ORSTOM n° 50, ORSTOM, Paris:pp. 75 – 108.

[16] **Fairhead, J. and Leach, M. 1998.**"Reframing Deforestation: global analyses and local realities –Study in West Africa''. *Routledge*, Global Environemental series, London (England), 238 p.

[17] **Ferraton,N. etTouzard, I., 2009**. "Comprendre l'agriculture familiale : diagnostic des systèmes de production''. *Edition Quae*, CTA, Presse Agronomique de Gembloux, 135 p.

GLOBAL JOURNAL OF ADVANCED RESEARCH
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[18] **Foumier, A. Floret C. and Gnahoua, G-M., 1996.**“Végétation des jachères et succession post-culturale en Afrique tropicale’’. In *La jachère en Afrique tropicale. Dossier MAB 16*, eds. C. Floret, R. Pontanier and G. Serpentier, pp. 123-168. UNESCO, Paris, 2001.

[19] **Frontier, S. and Pichod-Viale, D., 1955**. “Ecosystèmes : structures, fonctionnement, évolution’’. Collection d’écologie 21; Masson; Paris (2ème édition révisée et augmentée), 477 p.

[20] **Gentry, A. H., 1982.**“Patterns of neotropical plant species diversity’’. In: M.K. Hecht, B. Wallace and G.T. Prance (eds.). *Evolutionarybiology*, 123-135. New York, Plenum Press.

[21] **Gnagbo, A., 2015.** “Diversité et distribution des épiphytes vasculaires dans les forêts côtières de Côte d’Ivoire : Cas du Parc National d’Azagny’’. Thèse Doctorat d’état, UFR Biosciences, Université Félix Houphouët-Boigny. 208 p.

[22] **Gounot, M., 1969.**“Méthodes d’étude quantitative de la végétation’’. Masson and Cie, Paris, 314 p.

[23] **Guillaumet, J. L. et Adjanohoun, E., 1971.** “La végétation de la Côte d’Ivoire’’. *In* Avenard, J.M., Eldin, E., Girard, G., Sircoulon J., Touchebeuf P., Guillaumet, J.L., Adjanohoun, E. et Perraud, A. (eds.) 1971. Le milieu naturel de la Côte d’Ivoire. ORSTOM n°50, Paris, pp. 157-263.

[24] **Hawthorne, W. D., 1996.**“Holes and the sums of parts in Ghanaian forest: regeneration, scale and sustainable use’’. Proceedings of the Royal Soc. Edinburgh 104 pp. 75-176.

[25] **Hawthorne, W. D., 1995.** “Ecological profiles of Ghanaian forest trees’’. *Tropical Forest Paper* 29, 345 p.

[26] **Kahn, F., 1982.**“La reconstitution de la forêt tropicale humide Sud-ouest de la Côte d’Ivoire’’.ORSTOM, collection mémoires 97, Paris, 151 p.

[27] **Koffi, K. A. D., Adou Yao, C. Y., Vroh, B. T. A, Gnagbo, A. et N’Guessan, K. E, 2015**. “Diversités floristique et structurale des espaces anciennement cultivés du Parc National d’Azagny (Sud de la Côte d’Ivoire)’’. *European Journal of Scientific Research*. Vol. 134 No 4, pp.415-427.

[28] **Kouamé, N. F., 1998.** “Influence de l’exploitation forestière sur la végétation et la flore de les forêts classée du Haut-Sassandra (Centre-Ouest de la Côte d’Ivoire)’’. Thèse Doctorat 3e Cycle, UFR Biosciences, Université Cocody-Abidjan. 227 p.

[29] **Kouamé, D., Adou Yao, C. Y., Kouassi, K. E., N'Guessan, K. E. and Akoi, K., 2008**.“Preliminary floristic inventory and diversity in Azagny National Park (Côte d'Ivoire)’’. *European Journal of Scientific Research*, 23 537 – 547.

[30] **Kouamé, D., 2009.**“Rôle des animaux frugivores dans la régénération et la conservation des forêts : cas de l'éléphant (*Loxodonta africana cyclotis*) dans le Parc National d'Azagny (sud-ouest de la Côte d'Ivoire)’’. Thèse unique de doctorat, Univ. Cocody-Abidjan, 208 p.

[31] **Kouka, L. A., 2000**. “Recherches sur la flore, la structure et la dynamique des forêts du Parc national d'Odzala (Congo-Brazzaville)’’, *Acta BotanicaGallica: BotanyLetters*, 149:2, 225-235.

[32] **Krebs, C. J., 1989.**“*Ecological Methodology’’*. Harper and Row, New York, 654 p.

[33] **Legendre L. and Legendre, P., 1984**. “Écologie numérique: La structure des données écologiques’’. Masson, Paris et les Presses de l'Université du Québec 8, 335 p.

[34] **Mangenot, G., 1955.** “Etude sur les forêts des plaines et plateaux de la Côte d’Ivoire’’. *Etudes éburnéennes* 4 : pp. 5-61.

[35] **Mosango M. et Lejoly J., 1990.**Les forêts denses à*Piptadeniastrum africanum*et*Celtis mildbraedii* des environs de Kisangani (Zaïre). Mitteil. Staatssinst. Allg. Bot. Hambourg., 23 (b) : 853-870.

[36] **Novotny,V. And Weiblen, G. D.,2005**. “From communities to continents: beta-diversity ofherbivorousinsects’’. *Annales ZoologiciFennici*42, pp. 463-475.

[37] **Nusbaumer, L., 2003.**“Structure et composition floristique de la forêt classée du Scio (Côte d'Ivoire). Etude descriptive et comparative’’. Diplôme, Université de Genève, 150 p.

[38] **Ouattara, D., Vroh, B. T. A., Kpangui, K. B. And N’guessan, K. E., 2000.** “Diversité végétale et valeur pour la conservation de la réserve botanique d’Agbaou en création, Centre-ouest, Côte d’Ivoire’’. *Journal of Animal and Plant Sciences*, 20 (1): 3034 – 3047.

[39] **Ouédraogo M. 1993.**“Écologie comparée de deux espèces graminéennes pérennes *Andropogon ascinodis* C.B. Cl. et *Schizachyriumsanguineum* (Retz.) Alston dans la région de Bondoukuy’’, mém. ingén., option élevage, Ouagadougou, Institut du développement rural (LD.R.)-Orstom, 125 p.

[40] **Pielou,E. C., 1966.** “Species diversity and pattern diversity in the study of ecological succession’’. *Journal of theoretical biology*, 10: 370 – 383.

[41] **Prevost,M. F., 1981.**“Mise en évidence de graines d’espèces pionnières dans le sol de forêt primaire en Guyane’’. *Turrialba* 31 (2), pp. 121-127.

[42] **Puig, H., 2001.**"Diversité spécifique et déforestation : l'exemple des forêts tropicales humides du Mexique''. *Bois et forêts des tropiques*, n°268 (2).

[43] **Rasoanaivo, N. S., Tahinarivony, J. A., Ranirison, P., Roger, E., and. Gautier, L., 2015.** "Dynamique post-culturale de la végétation dans la presqu'île d'Ampasindava, Domaine du Sambirano, Nord-ouest de Madagascar.'' *Malagasy Nature*, 9: 1-4.

[44] **Riera, B., Puig, H. et J. P. Lescure, 1990.** "La dynamique de la forêt naturelle''. *Bois et Forêts des Tropiqes*, 219 :69-78.

[45] **Roth, H. H., Mülhenberg, M., Röben, P. and Steinhauer, B., 1979**. "Etat actuel des parcs nationaux de la Comoé et de Taï ainsi que de la Réserve d'Azagny et propositions visant à leur conservation et à leur développement aux fins de promotion du tourisme''. *Tome IV: Réserve d'Azagny. FGU KRONBERG, Kronberg, Allemagne et Abidjan*: 164 pp et annexes.

[46] **Shannon, C.E., 1948**. "The mathematical theory of communications''. *The Bell System Technical Journal*, 27: 379 – 423.

[47] **Sheil D. and Van Heist, M., 2000.**"Ecology for tropical forest management''. *International ForestryReview*2, pp. 261-270.

[48] **Sheil, D. and Burslem, F.R.P., 2003.** "Disturbing hypothesis in tropical forests''. *Ecology and Evolution 18*, pp. 18-26.

[49] **Simpson, E. H., 1949**. "Measurement of diversity''. *Nature*, 163: 160-163.

[50] **Sonké, B., 1998.**"Études floristiques et structurales des forêts de la réserve de faune du Dja (Cameroun)''. Thèse de doctorat, Université Libre de Bruxelles, 267 p.

[51] **Van Germerden, B.;H. Olff, M. Parren, P. E. and Bongers,F., 2003.**"Recovery of conservation values in Central Africa Rain forest after logging in shifting cultivation''. *Biodiversity and Conservation* 12, pp. 1553-1570.

[52] **Vroh, B. T. A., Kouamé, N. F. andTondoh E. J., 2011.** "Etude du potentiel de restauration de la diversité floristique des agrosystèmes de bananiers dans la zone de Dabou (Sud Côted'Ivoire)''. *Sciences et Nature* 8 (1), pp. 37-52.

[53] **Vroh, B. T. A., 2013**. "Evaluation de la dynamique de la végétation dans les zones agricoles d'Azaguié (sud-est, Côte d'Ivoire)''. ThèseDoctorat d'état, UFR Biosciences, UniversitéCocody- Abidjan. 208 pp.

[54] **White, F. 1983**. "The vegetation map of Africa. A descriptive memoir. United Nations Educational, Scientific and Cultural Organization'', *Natural Resources Research*, 20: 1-356.

[55] **Yoni, M., 1997**. "Les jachères à Andropogon gayanus en savane soudanienne. Influence du sol et des pratiques culturales (cas de Bondoukuy, Burkina Faso)'', D.E.A. sciences biologiques appliquées, option biologie et écologie végétales, faculté des sciences et techniques, université de Ouagadougou, Laboratoire de botanique et biologie végétale-I.R.D., 125 p.