Assessing the Floristic Potential of Adakplamè Sacred Grove in South Benin

Mesmes-Juste AMANOUDO[1], Charlemagne D. S. J. GBEMAVO[2], Christine Nougbodé A. I. OUINSAVI[3]

[1]University of Parakou, Faculty of agronomy, Forest Studies and Research Laboratory, BP 123 Parakou, Benin

[2]Laboratory of Biomathematics and Forest Estimates, Faculty of Agricultural Sciences, University of Abomey-Calavi, 04 BP 1525 Cotonou, Benin

[3]University of Parakou, Faculty of agronomy, Forest Studies and Research Laboratory, BP 123 Parakou, Benin

Abstract: ***This study aims at characterizing the flora of Adakplamè sacred grove in Benin. To do this, a floristic inventory was conducted in 40 square plots of 1000m ² size. Structural parameters including trees density, average diameter, basal area, bole height, total height, height of Lorey and density of regeneration were estimated. The allometric height-diameter relationship and diameter size classes' distribution were established. The non-metric multidimensional positioning to individualize plant communities. We recorded 32 plant species belonging to 20 botanical families. Two plant communities were individualized: the semi-deciduous dense forest represented by Ceiba pentandra and Mansonia altissima and the one to Ricinodendron heudelotii and Triplochiton scleroxylon. The specific richness for the two communities was respectively 23 and 30 species considering adult individuals (dbh ≥10 cm). Shannon index value for the two plant communities was respectively about 3.81 and 3.34 bits. Pielou evenness was respectively of 0.74 and 0.78. This forest was characterized by Guineo-Congolese (43.75%) and Guinean (34.38%) species. The phanerophytes and zoochory were respectively the major of biological types and dissemination mode of diaspores. Blackman index was greater than 1 for all vegetal communities translating an aggregate distribution of individuals. The density of natural regeneration was on average 1475 stems/ha.***

Keywords: Structure, Forest, Development, Ewè-Adakplamè

1. Introduction

Since the summit of Rio de Janeiro in 1992, the international opinion has increasingly gained awareness about the preservation of planetary biodiversity. Indeed, the biodiversity offers to human the choice between current advantages of various forms of life and future options related to the various mutation capacity and organisms' adaptation [1]. The measurement of diversity is decisive for ecological researches and diversity conservation [2]. Unfortunately, forest diversity is increasingly being degraded throughout the world [3]. Each decade, 0, 1% of the world plant species disappear [4]. The causes of diversity loss are multiple and may include changes of the climate [5]; ecological factors [6]; over-exploitation of biological resources [7] and land use. At country scale, anthropogenic pressures on natural resources in general and forest in particular become more and more intense because of population increase and ineffective management of forest resources. Surprisingly, sacred groves that were potentially known as biodiversity conservation reserves are now undergoing severe human pressure. This is case the case of Adakplamè sacred grove located at the south-east of Benin in the political district of Kétou. This sacred grove is a natural vestige restricted to certain families of plants which better characterize Benin wet dense forests made up of small islands. It's covered a surface of 507 ha in 1987 and 364 ha in 2007 [8]. In such degradation context, there is urgent need to appreciate the floristic potential of this natural forest in order to gain awareness about its sustainable management. This study has specifically characterized Adakplamè sacred grove plant communities and analyzed the potential of regeneration. This study will provide prerequisite data for establishing sustainable participative management approaches for the wellbeing of the future generations.

2. Literature Survey

The present study was conducted in the district of Kétou, department of Plateau in the south east of Benin. The district of Kétou is located between the latitudes 7°10' and 7°41' 17" North and longitudes 2°24' 24" and 2°47' 40" East [9] (INSAE/RGPH3, 2002). It covers a land surface of 1,775 km ² and comprises six (06) localities [9]. This study was precisely conducted in the sacred grove of Adakplamè (Figure 1). A part of this forest is occupied by agglomerations representing the southern limit [10]. The center of the forest is occupied by Adakplamè village. The forest is bordered in its northern part by a great depression made up of croplands. At the eastern part, it is surrounded by a vast area of cropland crossed by the Ewè-Dogo road. The sacred grove covered less than 400ha of surface.

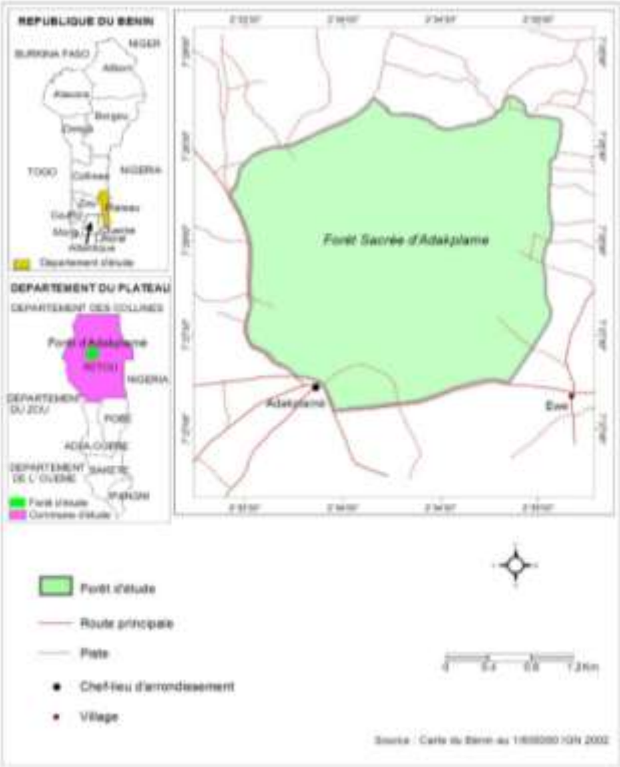

Figure 1: Localization of Adapklamè sacred grove in Benin

3. Methods / Approach

3.1 Data collection

A floristic inventory was carried out in square plots of 1000 m ² (50 m X 20 m) size. The number of plots to be established was estimated based on the theorical formula of [11].

$$A = CV^2 t^2_{1-\alpha/2}/d^2 \quad \textbf{(1)}$$

Where CV is the coefficient of variation of trees basal area. CV was calculated based on a preliminary inventory and equals to 18.12; $t^2_{1-\alpha/2}$ denotes the critical value of student t distribution which converges towards the normal distribution for large samples (>30) and equals to 1.96 at the threshold of 5%. The parameter D is the margin of error related to any parameter estimation. For this study D equals to 4%. On the whole, 40 square plots were established in the forest taking into account its floristic homogeneity. On each tree, we measured the diameter at breast height (dbh) and the total height. Individuals of dbh lower than 10 cm were counted in each plot and were considered as the natural regeneration.

3.2 Data analysis

A matrix of p rows (each row affected to plot) and n columns (each column affected to species) was designed on the basis of species presence/absence within the plots and thus subjected to a non-metric multidimensional positioning (Non-metric Multi-Dimensional Scaling, NMDS) to individualize the various plants communities. An analysis of indicator species (Indicator species analysis) was carried out to identify species that better represent each plant community. Metrics of floristic diversity such as the specific richness, Shannon diversity index of and Pielou evenness were estimated and compared between plants communities.

3.2.1. Floristic diversity

The number of families and species was determined. We estimated Shannon (1949) diversity index (H) using the following formula:

$$H = -\sum pi \log_2 pi \quad (2)$$

Where pi = Ni/N; Ni is the number of the species i within the plots; N is the total number of species within the plots and pi is the occurrence probability of a species within the plots. H varies from 0 to 5 bits and is minimal (H = 0) at plot level if all the individuals within the plot belong to one species and is maximum when all the individuals are equally distributed across all the species [12].Diversity is low when H < 3 bits; average if H lies between 3 and 4 bits; Then high when H ≥ 4 bits.

Pielou evenness (EQ) was determined using the following formula:

$$EQ = {}^{H}/_{\log_2 N} \quad (3)$$

In this formula, N is the total number of species. EQ varies from 0 (community represented by one species) to 1 (all the species have the same importance). Pielou evenness is very useful to compare potential predominance between sites or dates of sampling [12].

3.2.2. Determination of structural parameters

Structural parameters including trees density, diameter of trees with average basal area, and the average height of Lorey were estimated.

Structural parameters	Formula	Formula references
Trees density (N)	$N = \frac{n\times10000}{S}$ (4)	n is the total number of species recorded within the plot, S is the plot size.
Diameter of trees with average basal area	$Dg = \sqrt{1/n \sum_{i=1}^{n} d_i^2}$ (5)	Where n is the total number of trees within all the plots and di is the diameter of a given tree.
Average basal area (m²/ha)	$G = \pi/40000s \sum_{i=1}^{n} d_i^2$ (6)	Where di is the diameter of trees within the plots; and S = 0.1 ha.
Height of Lorey (m)	$H_L = \sum_{I=1}^{N} G_i H_I / \sum_{I=1}^{N} G_I$ (7)	Where gi is given by $G_I = (\pi/4) D_I^2$, gi is tree basal area and hi is the tree total height
Blackman index (To analyze the spatial structure of populations)	$IB = S_N^2/N$ (8)	N and S_N^2 are respectively the average density and the variance of trees density within plants communities

3.2.3. Diameter and height size classes distribution

Diameter and height size classes distribution were adjusted using Weibull 3 parameters distribution. This distribution is prominent in the forest literature due to its great flexibility. Its function of density of probability is given by the following formula [13].

$$f(x) = c/b(\frac{x-a}{b})^{c-1} exp\,[-((x-a)/b^c]\qquad (9)$$

Where x is tree diameter; a is the position parameter; a is null if all trees stages are considered; it is different from zero if the dbh ≥ a. in the present study, a equals to 10 cm for dbh structure and equals to 5 m for height structures. B is the scale parameter and c the shape parameter. Parameters b and c where estimated based on the method of maximum likelihood [14]. The log-linear analysis was carried out to compare the observed dbh distribution to the theoretical distribution of Weibull. This statistical method is more robust than the traditional goodness-of-fit test of Pearson especially in the case of low number of individuals per class.

3.2.4. Allometric relation of growth: Total height – Diameter to 1.3 m above ground

Height-diameter relationship is generally curvilinear and is expressed by a power low function

$$Y = aXb \qquad (10)$$

With Y the total height (m); X the dbh; a and b are the coefficient of the allometric equation. This relation is a good indicator to describe species growth ecological conditions. Its linear form is given by

$$\log(H) = \log(a) + b \times \log X \qquad (11)$$

4. Results/Discussion

4.1 Results

4.1.1 Individualization of plant communities

The NMDS showed two groups of communities in the factorial map (Figure 2). The group 1 consisted of plots established in the dense forest and group 2 consisted of plots established in opened forests. The axis 2 represents the gradient of increasing vegetation cover (from opened forests towards the typical dense forest). By contrast Axis 1 represents the gradient of decreasing vegetation cover (from dense to less dense forests). Species that better characterize Group 1 community were: *Ceiba pentandra* (L.) and *Mansonia altissima* (A.Chev). The second plant community (Group 2) was better characterized by *Ricinodendron heudelotii* (Baill.) and *Triplochiton scleroxylon* (K.Schum) (Table 1).

4.1.2 Floristic diversity and structural characterization of individualized communities

a) Community of *Ceiba pentandra* and *Mansonia altissima*

- **Floristic composition and specific diversity**

A total of 30 species (dbh ≥ 10) were recorded. The number of species varies from one plot to another. The Shannon diversity index (ISH) was 3.81 bits with the Pielou evenness of 0.78. The density of regeneration was 1325 trees/ha.

- **Family diversity and spatial structure**

Nineteen (19) botanical families were recorded in this community. The most represented were the Malvaceae (16.67%) then come Rubiaceae (10%) and Moraceae (10%). The Blackman index (IB) was greater than 1 (1.67).

- **Density and diameter size classes distribution**

The total density of the community was 364 trees/ha. The distribution was left skew (negative asymmetric) with a shape parameter varying between 1 and 3.6 (1.22). The distribution curve was characteristic of monospecific communities with the dominance of smaller individuals of diameter lower than 35 cm (Figure 2).

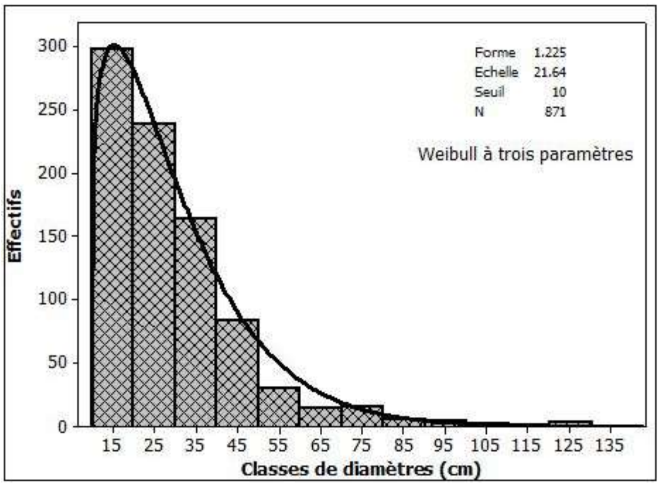

Figure 2: Diameter size classes' distribution adjusted to three parameter Weibull

- **Allometric height-dbh relationship**

The allometric relationship of this community was well adjusted by a linear function (R^2 adjusted = 0.4656; n=948).

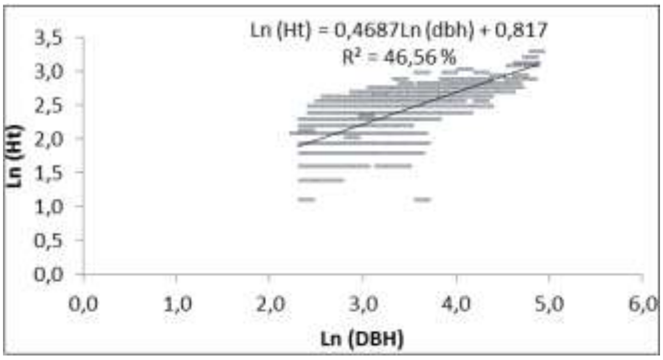

Figure 3: Allometric height-dbh relationship adjusted by a linear function

- **Biological type and dissemination mode**

With regard to the biological types, the phanerophytes were most represented in this community with a strong contribution of Macrophanerophytes and Microphanerophytes which account respectively for 46.67% and 40%.The dominant phytogeographical types were the Guinean (30%), Guineo-Congoleses (50%) and Soudano-Zambesian (13.33%). Regarding the dissemination mode, this community was largely dominated by Sarcochores (78.79%). Zoochory thus is the principal mode of diaspores dissemination in this community.

b) Community of Ricinodendron heudelotii and Triplochiton scleroxylon

- **Floristic composition and specific diversity**

The specific richness of individuals of dbh≥10 was 23 species. Shannon diversity index was 3.37 bits with a Pielou evenness value of 0.74.

Table 1: Community indicator species

Community	Species or group of species	A	B	Val Ind	Probability
Group 1	***Ceiba pentandra+Mansonia altissima***	0.89	0.72	0.80	0.00***
	Mansonia altissima	0.75	0.84	0.80	0.00***
	Nesogordonia kabingaensis+Ceiba pentandra	0.88	0.68	0.77	0.01**
	Ceiba pentandra+Pterocarpus santalinoides	0.88	0.68	0.77	0.00**
Group 2	*Ricinodendron heudelotii+Rinorea dentata*	0.89	0.28	0.506	0.03*
	Ricinodendron heudelotii	0.72	0.91	0.81	0.00**
	Ricinodendron heudelotii+Triplochiton scleroxylon	0.67	0.91	0.78	0.01**
	Celtis mildbraedii	0.67	0.82	0.74	0.03*

A= Specificity, is the probability that the studied site belong to the target site group considering the recorded species. B= Fidelity, is the probability of species occurrence within plots. Val Ind: indicator value. * 5%; ** 1 %; *** 0.1%.

- **Family diversity and spatial structure**

This community is made up of woody species belonging to 16 botanical families. The Malvaceae were the most represented (17.39%) then followed Rubiaceae (13.04%) and Euphorbiaceae (13.04%). The Blackman index of dispersion (IB) was also greater than 1 (1.14).

- **Density and diameter size classes distribution**

The total density of the community was 367 trees/ha. The distribution was left skew (left asymmetry) with a shape parameter varying between 1 and 3.6 (1.24). The distribution curve is characteristic of monospecific communities with the predominance of individuals of diameter ranging between 10 cm and 40 cm and the relative predominance of the first class (10 cm <d <20 cm) (Figure 4).

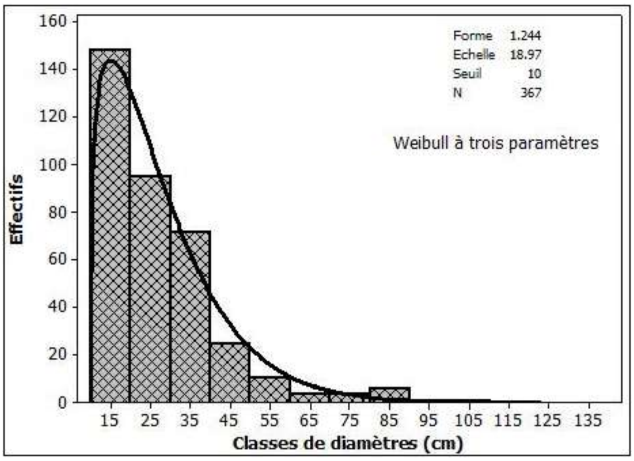

Figure 4: Diameter size classes' distribution adjusted to Weibull three parameters

The basal area was significantly greater in the second group of plant community than in the first group (p<0.01, Table 2)

Table 2: Dendrometric characteristics of individualized groups

Paramètres	*Dense semi-deciduous forest of Mansonia altissima and Ceiba pentandra*	*Dense semi-deciduous forest of Ricinodendron heudelotii and Triplochiton scleroxylon*	*Prob*
	average	average	
Density (m²/ha)	364.62	367	0,926
Lorey height (m)	13.87	13.19	0,374
Average diameter (cm)	28.55	26.74	0,138
Basal area (m²/ha)	1.22	2.79	0,000

- **Allometric height-dbh relationship**

The allometric relationship of this community was well adjusted (R^2 adjusted = 0.483; n=367) by a linear function: Ln (HT) = 0,492Ln (dbh) + 0.729 (Figure 5)

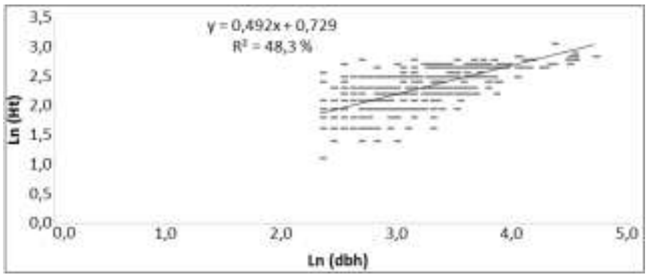

Figure 5: Height-dbh allometric relationship

- **Biological type and dissemination mode**

Considering the biological types, the phanerophytes were the most represented type in this community with a strong contribution of Macrophanerophytes and Microphanerophytes which account respectively for 45.83% and 37.50%. Macrophanerophytes and understory Phanerophytes were relatively represented with respective contribution of 6.21% and 5.53%.

The most represented phytogeographical types were the Guinean and Guineo-Congoleses (56.52%) Regarding seed dissemination mode, this community was largely dominated by Sarcochores (82.61%). Zoochory thus is the principal mode of diaspores dissemination in this community.

4.2 Discussion

In this study thirty-four (34) woody plant species belonging to eighteen (18) botanical families were recorded in the sacred grove of Adakplamè. This relative low number of families would be due to human activities developed by the surrounding local populations. However, this forest is too old due to the considerable presence of understory and wind fallen woods as well.

Concerning the number of species, species richness of Adakplamè was very low compared to the one found by [15] in the natural sacred grove of Pobè, [16] in the sacred grove of Allada, [17] in the sacred grove of Ouémé region, [18] in the classified forest of Lama, [19] in the sacred grove of Adja plateau. Netherless, the presence of a species in a given environment heavily depends on its affinity with the existing mesological conditions, its capacity to compete with other species and the possibility of its diaspores to attain the medium stage of development [20].

The specific richness in this study was lower in Adakplamè sacred grove. This difference may be explained by anthropogenic pressures exerted by the surrounding local populations. It may also be related the difference of sampling scheme between both studies. In term of diversity, the sacred grove of Adakplamè was well diversified with three most important families including the Malvaceae (5 species), Rubiaceae (3 species) and Moraceae (3 species). This is not surprising since vegetal formations of the Dahomey gap are represented by Malvaceae, Rubiaceae and Moraceae families. The relative high diversity in this sacred grove is reflected by the important values of Shannon index (between 3.37 and 3.81bits) and Pielou evenness (between 0.78 and 0.74). The important values of Pielou evenness means species shares approximately the same number of individuals in both communities. Similar findings were observed by [17] and [19] in neighboring sacred groves. Shannon index and Pielou evenness values found in this study are close to those observed by [19] and [18]. Following the biological type, phanerophytes were the most represented in Adakplamè sacred grove. This trend matches with the general tendency suggesting that tropical forests are dominated by phanerophytes [21], [15], and [16]. The predominance of phanerophytes in tropical forests is due to their persistent buds which allow them to adapt to rainfall seasonality [22]. Regarding the phytogeographical type, Guineo-Congolese species were most represented (43.75%) in our study area. This finding matches with those obtained by [15], [16], [17] and [21]. The predominance of Guineo-Congolese species may be explained by the Dahomey-Gap corridor which limits Guineo-Congolese species to the south of Benin [15].

As for dissemination mode, our study area is largely dominated by sarcochores (78.79%) meaning zoochory is the principal mode of diaspores dissemination. This observation is common to all of the country sacred [23]; [15]; [16]; [17]; [19]. The Blackman index for the two communities was greater than 1 indicating an aggregative distribution of individuals which was also observed by [19]. Further, [16] stressed that aggregative distribution is strongly related to the mode of seeds dissemination which is mostly zoochory and also to species temperament. However random distribution was observed in other cases of study.

Trees density in our study area ranged from 364 tiges/ha to 367 tiges/ha. Similar values of density were observed in other neighboring sacred groves [15] - [17]. These values of density are higher than those found by [19] respectively in the neighboring sacred groves of Agonlin and Adja plateau. The important value of regeneration density in this study good news about the future state of our studied sacred grove in the absence of human disturbance. These values of density are relatively lower compared to those of [15] and [17] south Benin sacred groves.

5. Conclusion

The sacred grove of Adakplamè is characterized by two groups of plant communities including the semi-deciduous dense forest represented by *Ceiba pentandra* and *Mansonia altissima* and the semi-deciduous dense forest represented by *Ricinodendron heudelotii* and *Triplochiton scleroxylon*. The specific richness for both plant communities was respectively 23 and 30 species. The value of Shannon index was about 3.81 and 3.34 bits and the one of Pielou evenness was in average 0.76 suggesting the high diversity of the studied sacred grove. With regard to botanical family diversity, twenties families were recorded and the most represented were Malvaceae, Rubiaceae and Moraceae. Guineo-Congolese species accounted much for biological type followed by Guinean ones and Sudanian. The principal mode of seed dissemination is the zoochory. The cumulative basal area for the two communities were respectively 31.85 and 27.98 m^2/ha. We found a relatively higher trees density of 364 and 367 trees/ha indicating the maturity degree of secondary forests. The density of natural regeneration was in average 1475 trees/ha. The mean diameter was about 28.25 and 26.76 cm translating the predominance of medium size species. This study revealed that Adakplamè sacred grove is still well diversified but trees with larger diameter are increasingly being disappeared. Based on our findings, we recommend the enhancement of traditional method of conservation for the sacred grove sustainable management. Barriers should be set to avoid wildfires and illegal logging and agricultural extension.

6. Future Scope

This study conducted in the sacred forest of Adakplamè has for limit, the taking into account of ligneous only. The phytosociological records would have been better following the [24] method with registration of plant species by stratum with their abundance-dominance coefficient. Thus, the herbaceous layer was not taken into account in this study. For further research, it would be important to take into account all strata, to install permanent plots to follow the evolution of this forest for a proposal of conservation measures.

References

[1] S. Vermeulen, I. Koziell, “Integrating and local been worth. With review of biodiversity assessment.

International Institute for Environment and Development", 113p. 2002.
[2] H.P. Lu, H.H. Wagnerc & X.Y. Chena, "with contribution diversity approach to evaluate species diversity", BASIC and Applied Ecology, 8: 1-12. 2007.
[3] J.A. Thomas, M.G. Telfer, D.B. Roy, C.D. Preston, J.J. Greenwood, J. Asher, R. Fox terrier, R.T Clarke and J.H. Lawton, "Comparative roofing stones of total British butterflies, birds, and seedlings and the extinction crisis", Sciences, 303:1879-1881. 2004.
[4] S.L. Pimm, P. Raven, "Extinction of numbers", Nature 403: 843-845. 2000.
[5] O.E. Salted, F.S. Chapin III, J.J. Armesto, E. Berlow, J. Bloomfield, R. Dirzo, E. Huber-sanwald, L.F. Hunneke, R.B. Jackson, A. Kinzig, R. Leemans, D.M. Lodge, H.A. Mooney, Mr. Oesterheld, N.L. Poff, m.t. Sykes, B.H. Walker, Mr. Walker & D.H. Wall, "Total biodiversity scenario for the year 2100", Sciences, 287: 1770-1774. 2000.
[6] J.L. Devineau, "Les indicating woody species of the grounds in savannas and the old fallow of the West of Burkina Faso", Phytocoenologia, 31: 325-351. 2001.
[7] A. Roy, S.K. Tripathi & S.K. Basu, "Formulating diversity vector for ecosystem comparison", Ecological Modelling179, 499-513. 2004.
[8] A. Houngnon, "Community based action to benefit has threatened seedling species: Box study of Bequartiodendron oblanceolatum in Ewè-Adakplamè remnant forest in Benin", The Rufford Fondation. 6p there. 2014.
[9] INSAE, "RGPH3 Final Results, December 2003".2002
[10] PAGS, "Plan of Installation and Management Simplified of the Crowned Forest of Kouvizoun", 47p 2012.
[11] P. Dagnelie, "Statistics theoretical and applied. Volume 2: Statistical inference with one and two dimensions", Brussels: Editions University De Boeck & Larcier, 659p. 1998.
[12] J. Grall & C. Hily, "Traitement of stationnelles data (fauna)", IUEM (UBO)/LEMAR, 10p. 2003.
[13] J. Rondeux, "The measurement of the trees and the forest settlements", Agronomic presses of Gembloux, 2ère Edition, Gembloux: 521p. 1999.
[14] T.E. Burk & J.D. Newberry, "A simple Algorithm for moment-based recovery of Weibull distribution parameters", Forest science, 30: 329-332 (04). 1984.
[15] N. R. Sokpon, "Ecological research on the semi-décidue forest of Pobè in the South of Benin: Vegetable groupings, structure natural regeneration and fall of litter", Doctorate in Science Agronomic, Section Interfacultaire d'Agronomie, Université libre de Bruxelles, 350p. 1995.
[16] T. Sinandouwirou, "Forêts crowned and conservation of the biodiversity: ecological prospection of some villages in the department of the Atlantic", Thesis of Agricultural engineer. 160p. 1997.
[17] F. Gbaguidi, "Forêts crowned and conservation of the biodiversity in the department of Ouémé in the South-east of Benin", Thesis of Agricultural engineer. 164p. 1998.
[18] M. S.S. Toyi, F. Eda, B. Sinsin, "Landscape dynamics of the classified forest of the Lama in southern Benin. Conflict, landscape dynamics and food security in sub-Saharan Africa". International Symposium. 20P, 2017.
[19] A.C. Mahougbe, "Forest crowned and evolutionary dynamics of the vegetation on the Adja plate in the Western South of Bénin", 141p. 2011.
[20] J.L. Devineau, "Structure and dynamics of some tropophilous forests of the African West (Ivory Coast). Ecology, environment", University Pierre and Marie Curie-Paris VI. 1984.
[21] A. Akoegninou, "Contribution under investigation botanical of the small islands of semi-decidues wet dense forests as a People's Republic of Benin", Doctorate, University of Bordeaux III, France, 250p. 1984.
[22] A. Schmitz, "Vegetation of the plain of Lubumbashi (Haut-Katanga)" .388p. 1971.
[23] J.L. Devineau, "Ponderal study of the litters of tree in two types of tropophilous forests in Ivory Coast", Annal of the University of Abidjan series E (ecology), 15: pp.27-62. 1982.
[24] Braun-Blanquet J, "Plant sociology: The study of plant communities". McGray Hill, NewYork and London, 439 p. 1932.

Author Profile

Christine Nougbodé A.I. OUINSAVI: Agronomist with a Master of Science and a PhD in Agricultural Sciences Option: Natural Resources Management, Christine Ouinsavi becomes the first woman Full Professor at the University of Parakou. She is the Director of the Laboratory of Forestry Studies and Research (LERF) and the coordinator of the Doctoral Training in Natural Resources management at the doctoral School of Agricultural Sciences and water. In 2007, she was recognized and awarded by UNESCO-L'Oréal "For Women in Science" and she is member of many scientific association such as African Forestry Research Network (AFORNET), the Organization for Women in Science for Developing World (Owsd) and Benin National Association of Women for education training and Research (AFEFRES-Bénin). Her political career had led her to the position of minister of Trade and that of primary education, Literacy and promotion of National Languages.

Charlemagne D.S.J. GBEMAVO: After the general university study diploma 1 (DEUG1) in economic and management sciences (University of Abomey-Calavi), he studied in agronomic sciences and obtained respectively Engineer, Master of science and PhD degrees in forestry (University of Parakou and Abomey-Calavi). He is a forest research associate in various regional research projects especially Interdisciplinary and Participatory Research on Interactions Ecosystems, Climate and Societies in West Africa Project (RIPIECSA), African Union Jatropha Project (PJUA) and Insects as Feed in West Africa Project (IFWA).

Mesmes-Juste AMANOUDO: PhD student at the Post Graduate School of Agricultural Sciences and Water of the University of Parakou, he graduated for Professional Master degree in Natural Resources Management from the Faculty of Agronomy at the same university. After a Master of Sciences at the doctoral school of Agricultural Sciences and Water, he pursue the thesis within the Laboratory of Forestry Research and Studies. He's areas of expertise are agroforestry, ecology, climate change and forestry.