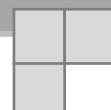




## 2016 SCIENTIFIC ACTIVITIES REPORT OF THE LABORATORY OF APPLIED ECOLOGY (LEA)

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## Foreword

The Laboratory of Applied Ecology (LEA) at the Faculty of Agronomic Sciences (FSA), University of Abomey-Calavi (UAC) Benin was created in 1994 by Professor Brice Sinsin.

LEA is one of the advanced research institutions on natural resources management in Benin. The major research fields in which LEA is currently involved include (i) desertification and land degradation, biodiversity and climate change, (ii) carbon stock measurement and monitoring of carbon sequestration, (iii) agriculture productivity and capacity building in organic agriculture, (iv) ethnobotany and new crops development, (v) management of agroforestry systems; (vi) ecological restoration of degraded land, (vii) conservation and sustainable management of wild palms, (viii) management of Non Timber Forests Products, (ix) management of protected areas (National Parks, hunting zones, community conservation areas), (x) bio Monitoring of wildlife, (xi) red list of threatened plants and wildlife, (xii) grassland ecology, (xiii) Ecological and organic agriculture.

Scientific research at LEA up to now has yielded more than 450 scientific publications in peer-reviewed international journals, books and proceedings of scientific conferences. Moreover, LEA has executed and has been involved in several projects (e.g DADOBAT-UE; SUN-UE; BIOTA-West; LOEWE; UNDESERT-EU; Edulink-European Union; Global Climate Change Alliance; CORAF/WECARD) on sustainable management of natural resources and/or tree domestication in Africa.

Up to date, the major achievements of LEA are the following: (i) climate change, vulnerability assessment and natural/climatic risk management in the coastal area of Benin, (ii) conservation and management of more than 10 forest genetic resources in Benin (e.g: *Adansonia digitata*, *Blighia sapida*, *Caesalpinia bonduc*, *Irvingia gabonensis*, *Pentadesma butyracea*, *Sclerocarya birrea*, *Tamarindus indica*, *Borassus aethiopum*, *Raphia sudanica*, *Dialium guineense*, etc.); (iii) management of more than 10 agroforestry systems involving medicinal plants in Northern Benin (e.g Community gardens of Papatia, Monts Kouffé, Dangbo, Porga, etc.) ; (iv) ecological restoration of more than 5 degraded areas (e.g. Lama forest reserve and Swampy forest of Lokoli in Southern Benin; semi deciduous forest of Bassila and Wari Maro in Northern Benin; etc.); (v) management of at least 5 protected areas in Benin (Biosphere Reserves of Pendjari and W in Northern Benin, trois rivières forests reserves, Goungoun and Sota forests in Northern Benin, Lama forest reserve in Southern Benin, etc.) ; (vi) Red list of threatened plants and wildlife in Benin (IUCN Red Book of Benin) ; (vii) remote sensing and mapping of vegetation (Swampy Forest of Lokoli, Dense Forest of Lama; Biosphere Reserves of Pendjari and W; etc.); (vii) atlas of biodiversity of Benin.

LEA works closely with many international and national partners (research institutions, NGOs, local communities and decision makers). LEA networks and working groups include:

- About 5 full Professors and 20 Associate Professors from many Departments (Regional Planning, Geography, Chemistry, Soil Science, Botany, Socio-economics, etc.) at the University of Abomey-Calavi ;

- International Scientific Groups such as AETFAT, IUCN (WCPA; SSC ; CWRSG), etc.;
- International Institutions involved in nature conservation and biodiversity management i.e. World Union for Nature Conservation (IUCN), Bioversity International, World Agroforestry Centre, Wildlife Management, Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) etc.;
- Networks such as the South Saharan African Forest Genetic Program (SSAFOGP), Society for Ecological Restoration (SER-USA), African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE / ICRAF), African Forest Forum (AFF), etc.
- NGOs and Universities (Belgium, Burkina-Faso, Cameroon, Canada, Côte d'Ivoire, Denmark, France, Ghana, Germany, Japan, Mali, Niger, Nigeria, The Netherlands, Senegal, Sierra Leone, Switzerland, Togo, UK, USA, Uganda, South Africa, Kenya, Mozambique, Namibia, etc.).

This report is the ninth edition following eight consecutive previous reports since 2007. It is intended for several audiences of researchers in Benin and abroad, partners, developers, donators and other professionals interested in the fields of applied ecology. It summarizes the research activities performed at the laboratory in 2016 and is organized into nine major sections. Section 1 presents the methodology used to gather information included in the report and shows how various indices have been calculated. Section 2 focuses on the types of research (individual, national teams, regional teams and international teams), types of publications (thesis, peer review articles, proceedings, technical reports, and newsletter), trends of publications for the last eighteen years (1998 – 2016) and the analysis of language of publications according to the types of publications at the laboratory. Section 3 provides a summary of conferences and seminars organized by the LEA in 2016 and those attended by researchers from LEA. Section 4 describes the research projects and research grants obtained at the laboratory in 2016 whereas section 5 shows details about active human resources at LEA as well as visitors who were in the laboratory in the framework of bilateral collaboration. Section 6 discusses the research activities performed at the laboratory in 2016 while section 7 shows the references used. The appendixes are presented in the section 8, showing full details on references of the different types of publications, research projects and grants as well as on conferences and visiting research in the laboratory. Finally, abstracts of publications in 2016 in peer review journals have been presented in the section 9 to allow easy searching and understanding of the full length papers.

## 1. Data collection

The methodology used for this report was mainly based on the research activities performed by researchers and students of the laboratory of applied ecology (LEA) in 2016.

First, information related to dissertations (Postgraduate and undergraduate students), scientific articles (published, in press and under review) in peer-review journals and those published through proceedings, books of abstracts and technical reports were used. For each category of publication, the indices of specialization related to the scientific fields in which the works have been performed were assessed. Also, as far as the published papers in peer-review journals are concerned, two groups of papers were established: articles with Impact Factor and others (Web of Science of Thomson). Only publications addressing authors and/or co-authors in LEA were considered. Furthermore, collaborations and co-publications with scientists from African countries and others countries have been detailed throughout the report.

The types of research were expressed respectively as the ratio between the number of publications produced individually or by co-publication with national, regional or international teams and the total number of publications in the laboratory.

Trends of publications from 1998 to 2016 were assessed both for proceedings and published articles in peer review journals (with Impact Factor or others). The ratio French/English was computed for various types of publications including those in press.

For data processing, the following indices were calculated:

- *Specialization Index of publications* which is the ratio between the number of publications in a given field or discipline and the total number of publications when considering all disciplines;
- *Impact Factor (IF) Index of Publication* for a given field of publication which is the ratio between the number of publications having an Impact Factor and the total number of publications in peer review journals related to the considered field of publication;
- *Weighted Impact Factor Index of a given field of publication* which is the product of the Impact Factor Index of Publications and the arithmetic sum of impact factor indices as described in the web of science of Thomson;
- *Index of co-publication at country vs. continental level* which is the ratio between the number of co-publications at country vs. international level and the total number of co-publications in the laboratory;
- *Estimated cost per publication* which is the ratio between the estimated budget of LEA at a given year and the total publication at this year;
- *Estimated cost per impact factor unit* is the ratio between the estimated budget of LEA at a given year and the arithmetic sum of impact factor indices;
- *Contribution of LEA to scientific publication at Faculty of Agronomic Sciences (FSA) and University of Abomey-Calavi (UAC)* which is the ratio between the total publication at LEA and the total publication at FSA or UAC.

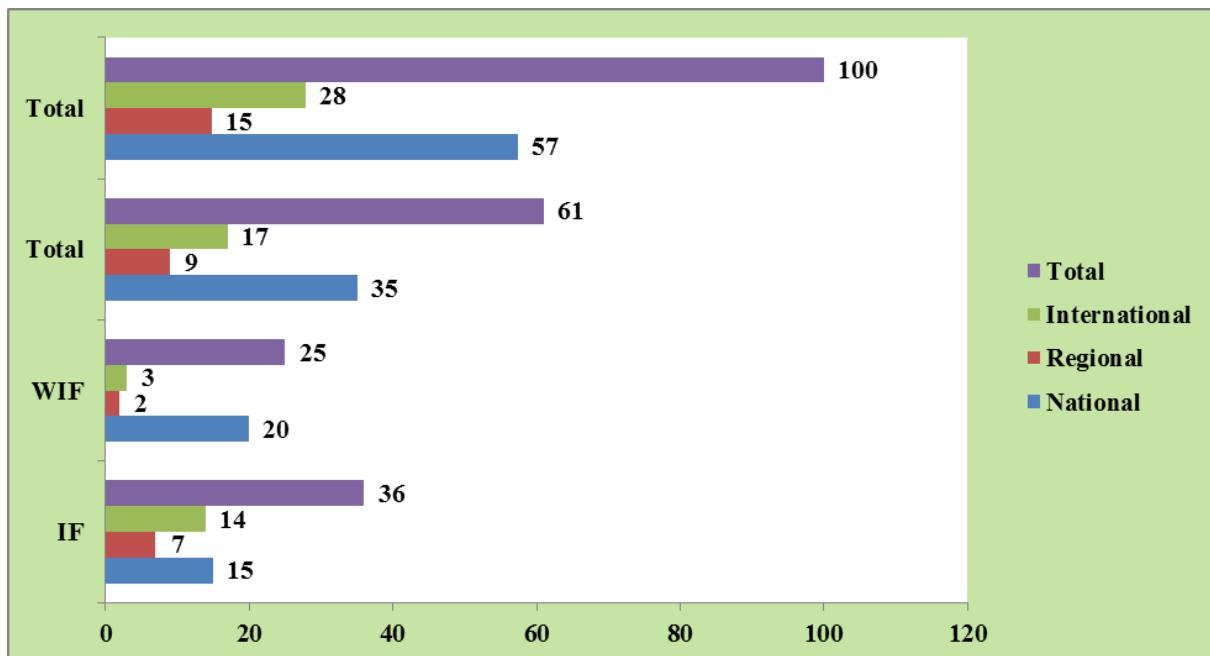
Information related to the conferences and seminars (organized by the laboratory and the ones to which the researchers from the laboratory have participated), research projects, grants, prices and awards are presented in the report.

To allow the assessment of the full references used to compute this report, a session named “appendices” has been inserted at the end of the report as well as the abstracts of the published papers in the peer review journals.

## 2. Types of research and publications at LEA in the year 2016

### 2.1 Type of research at LEA

The published articles of the research team at LEA in 2016 were mostly produced through national teams (35 papers out of 61). About 59% of the original research papers from LEA were published in international journals with Impact Factor. In most cases, these papers involved national and international partners (Figure 1).



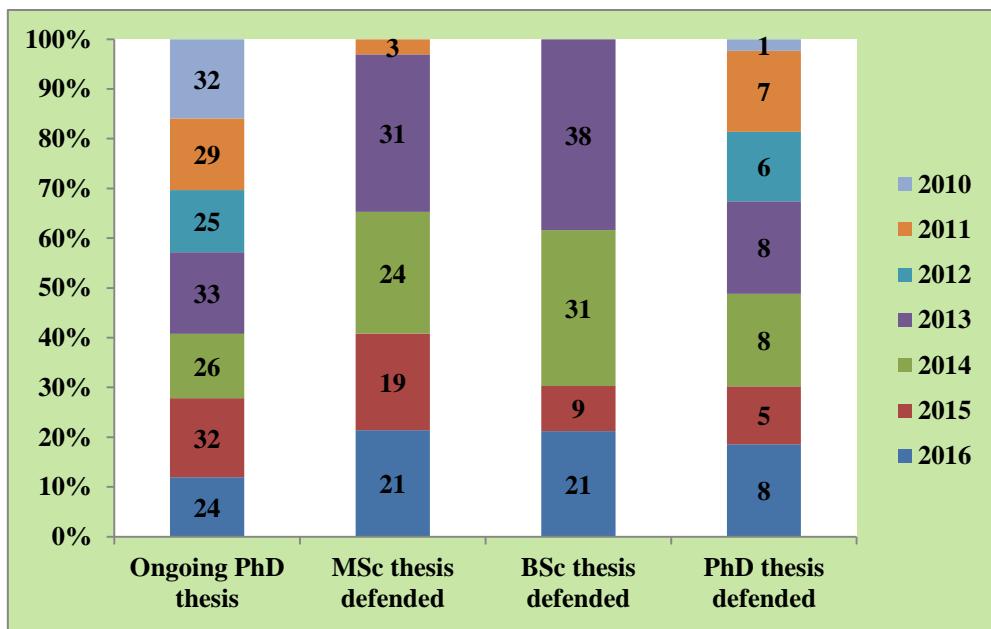
**Figure 1:** Scale context of research activities in LEA in the year 2016

Legend: IF = Impact Factor; WIF = Without Impact Factor

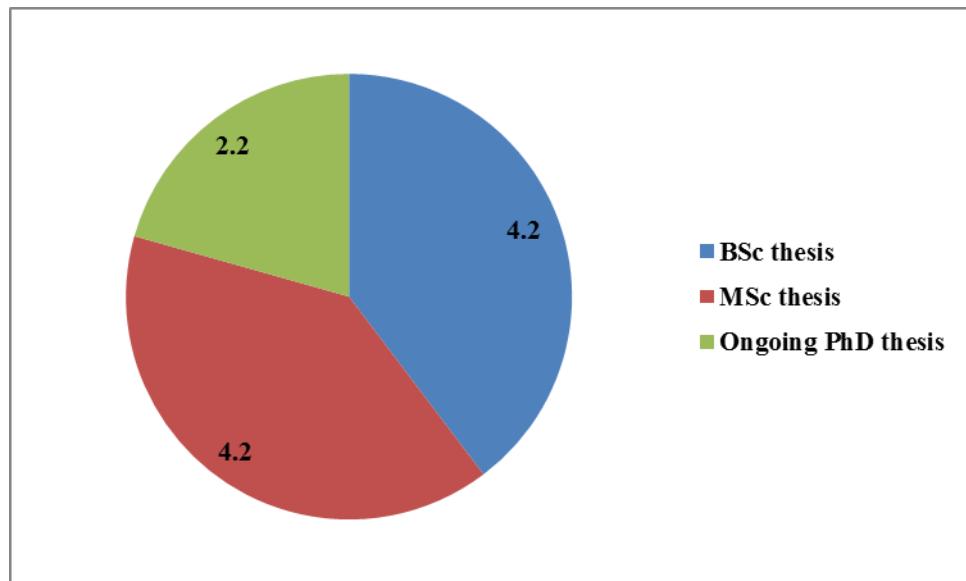
### 2.2 Type of publications at LEA in 2016

#### 2.2.1 Theses at LEA

The number of enrolled students in Master degrees in 2016 (21 students) increased since 2007 due to the system LMD started at the University of Abomey-Calavi since 2007. The LMD allow more students to attend the course. The number of enrolled students in PhD degrees at LEA has increased globally from 2010 to 2016 (Figure 2). Eight PhD students have defended their PhD in 2016 at LEA. The professors of LEA (full and associate) were actively involved in promoting and supervising of PhD and MSc theses (figure 3). One professor supervised at least 3 ongoing PhD and 5 MSc theses in 2016. The same trend is also observed between associate and assistant professors for the supervision of BSc thesis in 2016 (5 students per associate or assistant professor).



**Figure 2:** Trends of types of defended and ongoing PhD Theses from 2010 to 2016

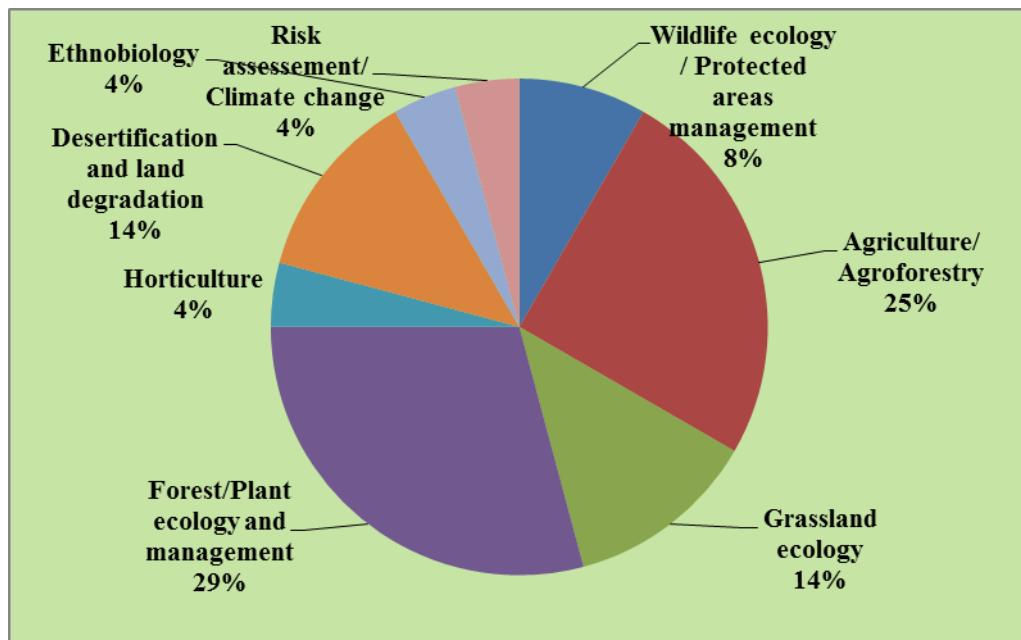


**Figure 3:** Number of students supervised per professor at LEA in 2016

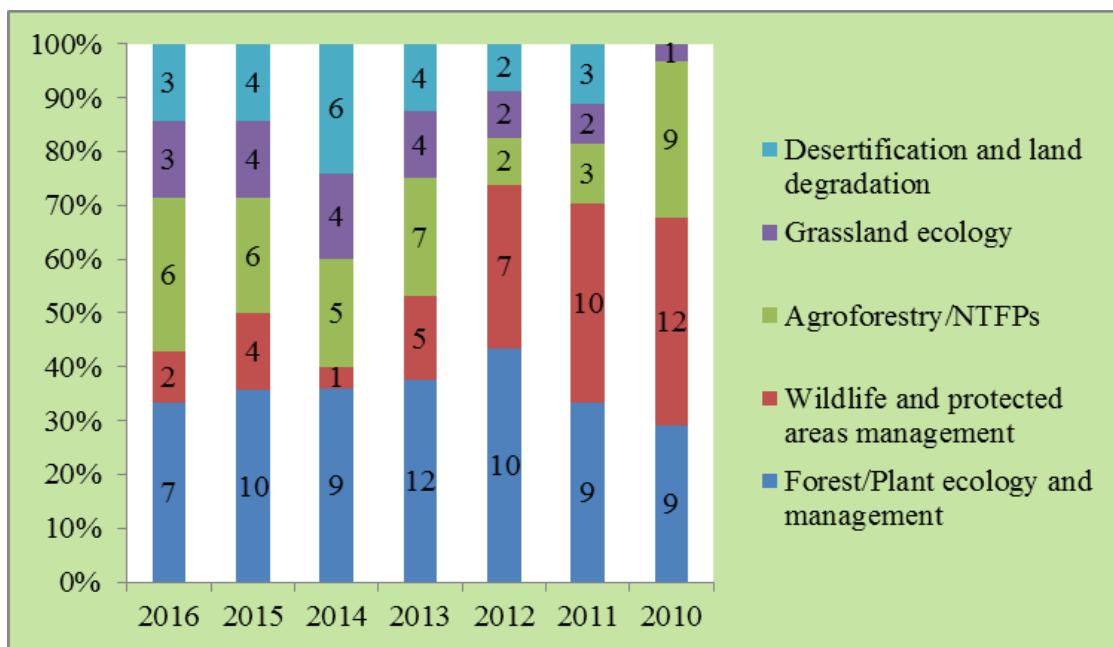
#### 2.2.1.1 Ongoing PhD theses at LEA in 2016

Eight main fields of research were covered by the PhD students at LEA in 2016 (Figure 4). Forest and Plant Ecology management (29%), Agriculture/Agroforestry (25%), Risk assessment/climate change (4%) and Horticulture (4%) are respectively the most and less represented (Figure 4). Figure 5 highlights that PhD research in LEA was mainly focused in the fields of: Forest and Plant ecology, Wildlife management, Agroforestry and NTFP (Figure 5). This is congruent with the laboratory's main research projects.

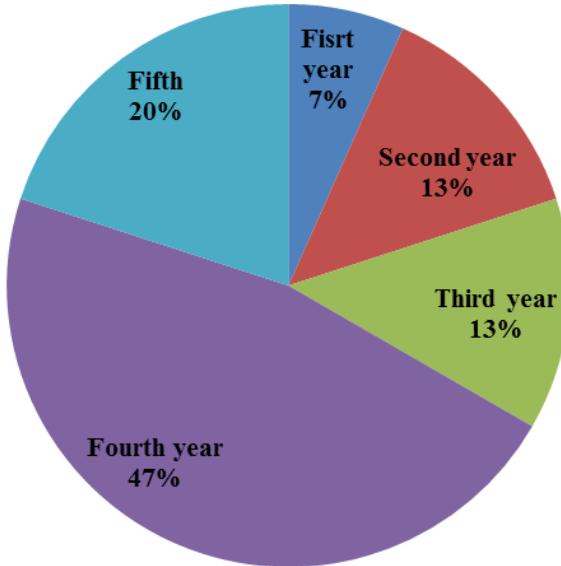
Eighty percent (80 %) of the students enrolled in PhD have already spent at least 3 years for their research activities while 20% are beginning (first and second year) their thesis at LEA in 2016 (Figure 6).



**Figure 4:** Spectrum of ongoing PhD thesis and related field of research in 2016



**Figure 5:** Trends of ongoing PhD thesis according to the fields of research from 2010 to 2016



**Figure 6:** Typology of PhD students in LEA based on the number of year related to their research activities

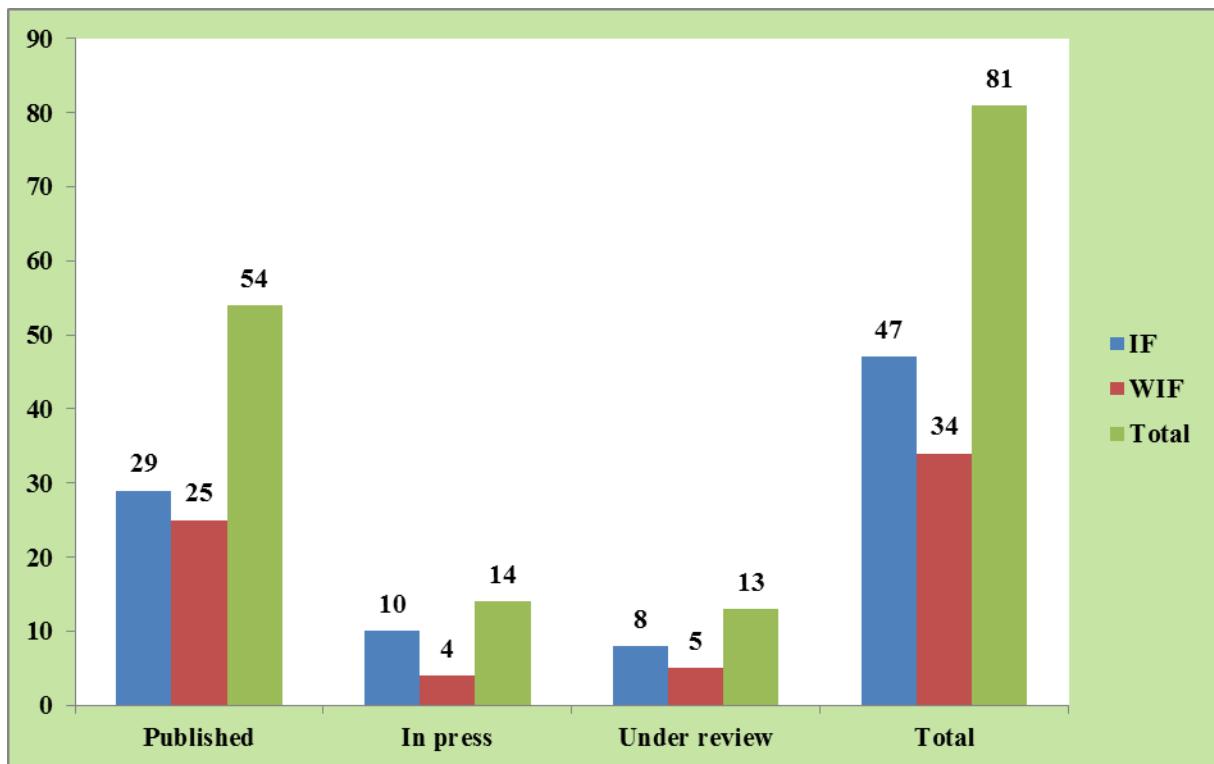
## 2.2.2 Scientific productions at LEA in 2016

A total of 88 scientific publications were produced by teams of LEA in peer-reviewed journals in 2016, 61 papers were already published; 14 in press and 13 under review. Moreover, 2 articles were published in proceedings, 3 abstracts were published in the books of abstracts and 6 technical report elaborated.

### 2.2.2.1 Publications in peer review journals

#### (i) Number, categories and impact factor indexes of publications

The published articles in 2016 are mostly in the peer review journals with IF (54 %) compared to the number of published papers in other peer reviews journals (46 %), (Figure 7). The number of articles in press (71% vs. 29%) and under review (62% vs. 38%) also follows the same trend. Full references (authors, journals, etc.) of the publications are provided in appendices 6, 7, 8, 9, 10 and 11.



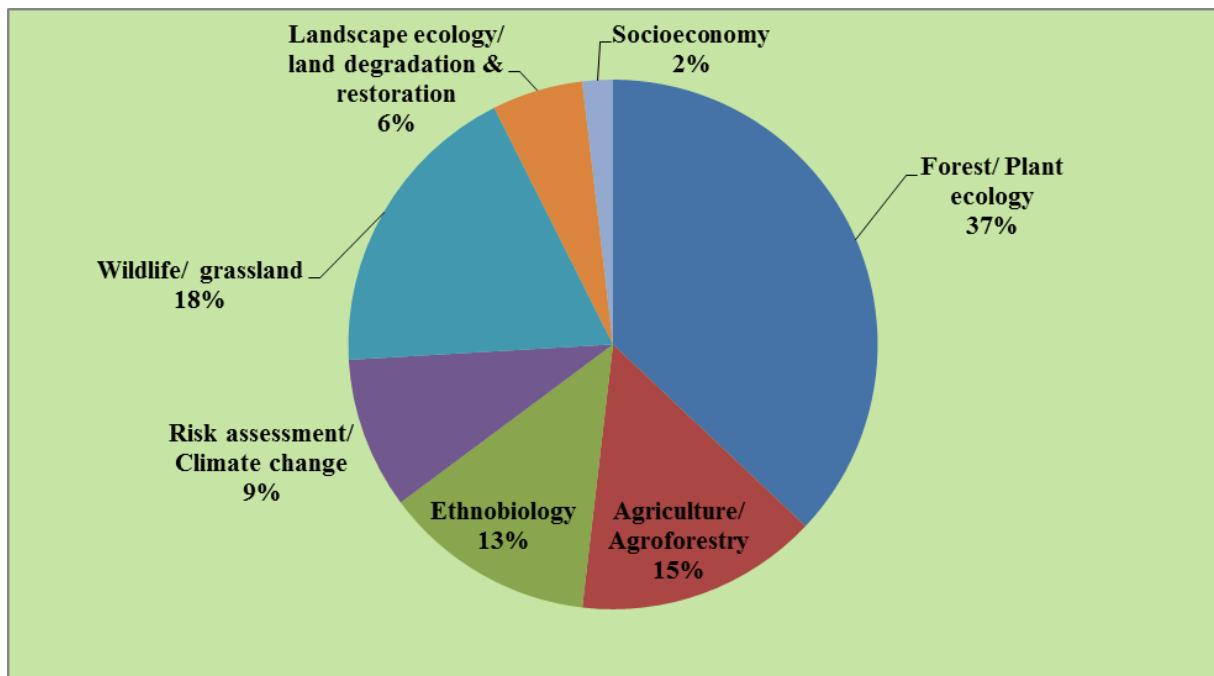
**Figure 7:** Spectrum of scientific productions of LEA in 2016

Legend: IF = Impact Factor; WIF = Without Impact Factor

## (ii) Specialization Indexes of publications

### a) Published articles

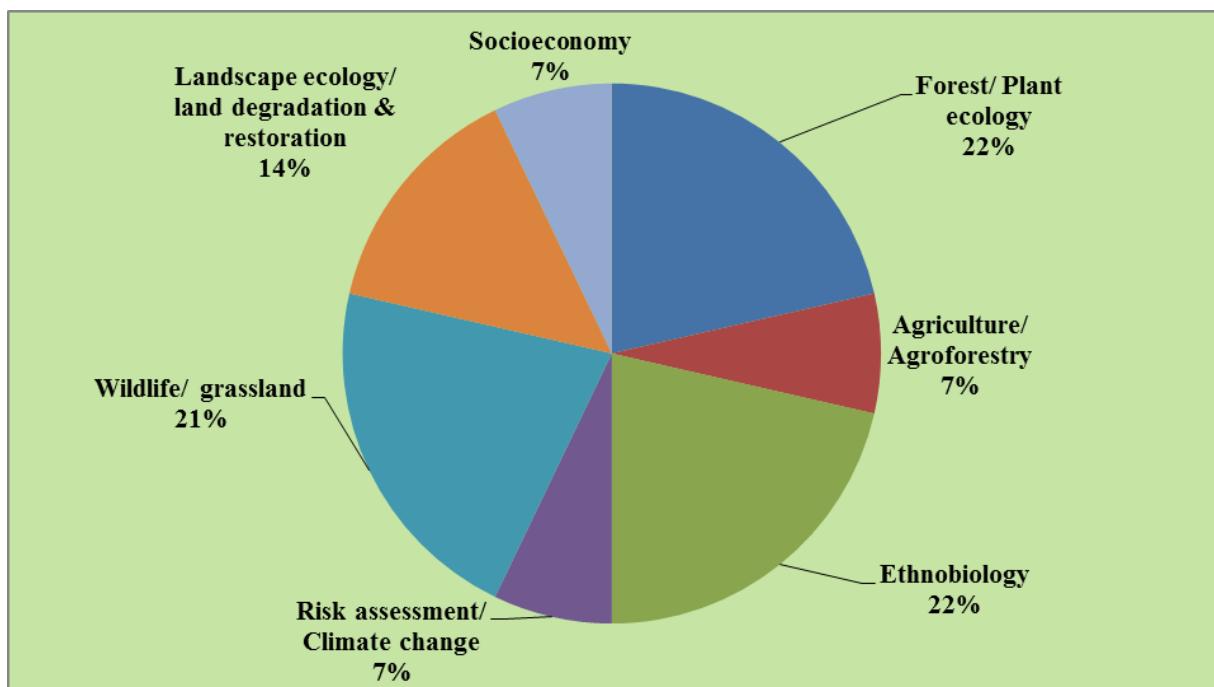
The published articles in 2016 cover various fields of research as the previous year including Forest and Plant ecology (20 papers), Wildlife and Grassland (10 papers), Agriculture and Agroforestry (8 papers), Ethnobiology (7 papers), Risk assessment and Climate change (5 papers), Landscape ecology/Land degradation (3 papers) and socioeconomic (1 papers). Most articles were published in Forest and Plant ecology, Wildlife and Grassland, Agriculture and Agroforestry and Ethnobiology which are the main research's field of LEA.



**Figure 8:** Published articles according to the fields of research in 2016

**b) Articles in press**

Ethnobiology (3 manuscripts), Forest and Plant ecology (3 manuscripts) and Wildlife/grassland (3 manuscripts), will provide more original research papers in the next year.

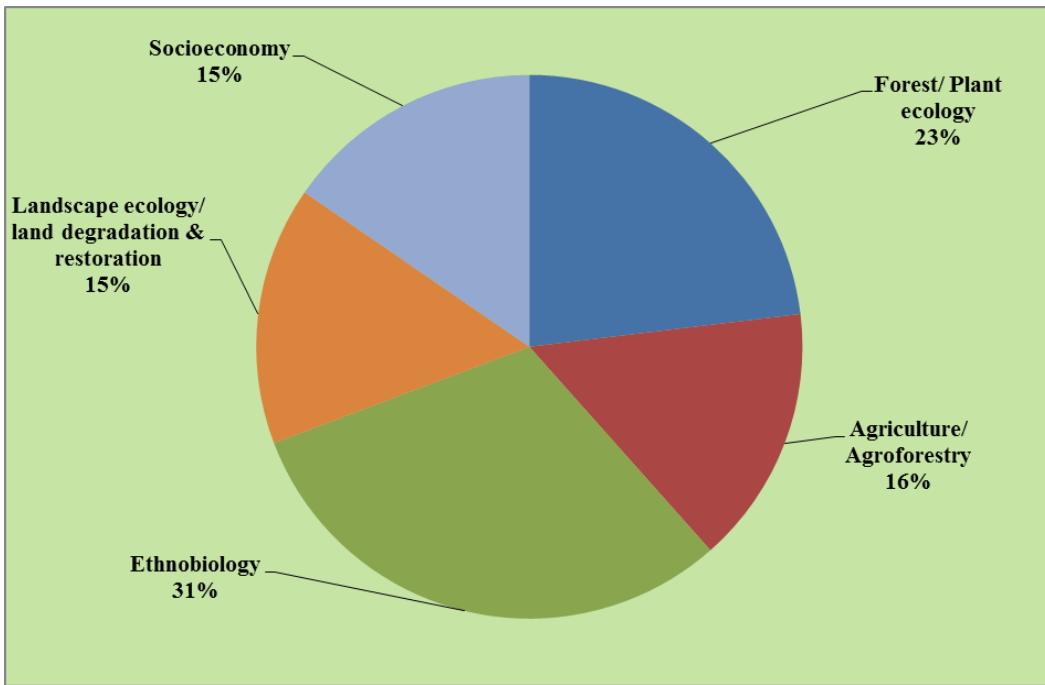


**Figure 9:** Articles in press according to the fields of research in 2016

**c) Articles under review**

Fields having more articles under review were Ethnobiology (4 manuscripts), Forest/plant ecology (3 manuscripts), Landscape Ecology/Land degradation & Restoration (2

manuscripts), Agriculture and Agroforestry (2 manuscripts). These fields have also contributed more in articles published and in press confirming these areas as the more scientifically productive within LEA.



**Figure 10:** Articles under review according to the fields of research in 2016

### (iii) Weighted Impact Factor Index of publications

Publications which have highly contributed to gain the Impact Factor of the laboratory in 2016 were related to Forest/Plant ecology, Wildlife/grassland, Risk assessment/Climate change, Landscape ecology/Land degradation & restoration, Ethnobiology, and Agriculture/Agroforestry (table 1). Therefore, these fields of publication are the ones in which the recorded scientific publications in LEA had the highest Impact Factor in 2016.

**Table 1:** Weighted Impact Factor Indices of publications according to the disciplines of specialization

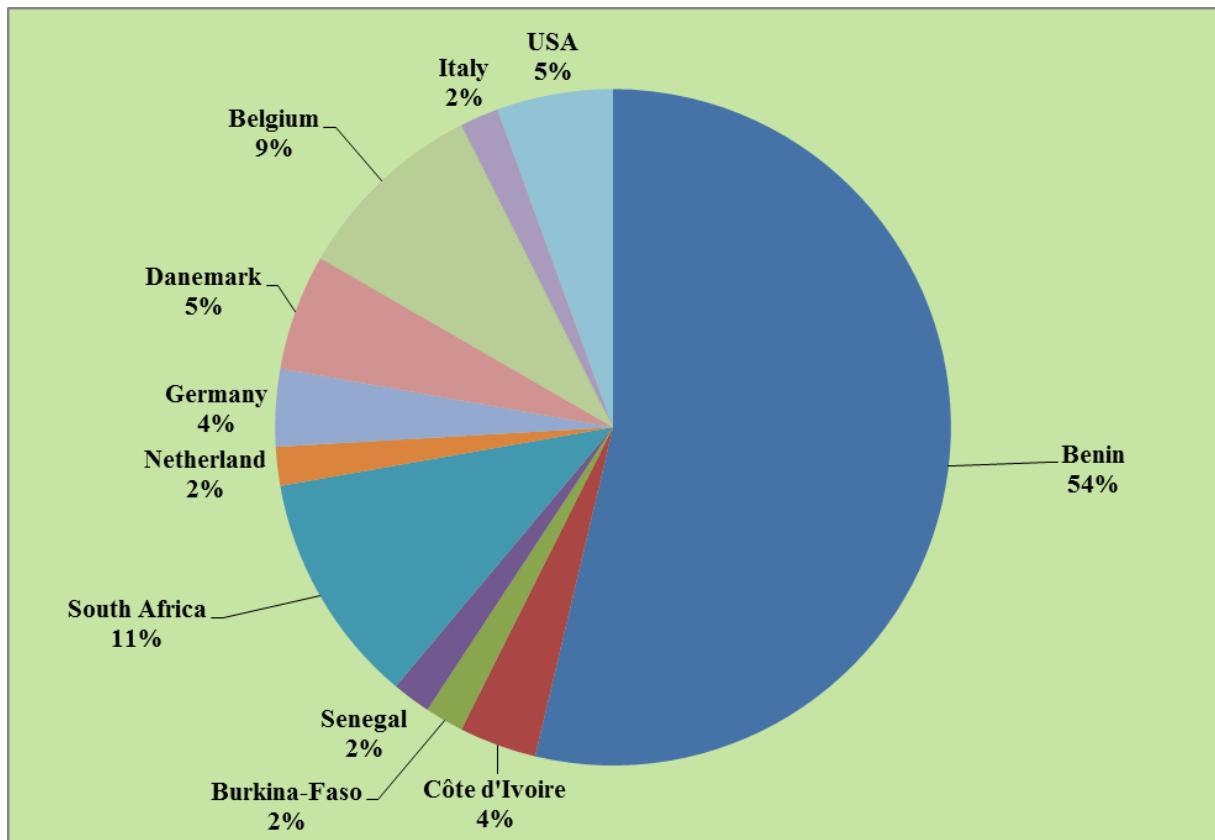
Field of publication	Total number of publications related to the field in peer review journal	Total number of publications related to the field in the reviews having an impact factor	Weighted Impact Factor indices
Agriculture/Agroforestry	8	3	<b>1.208</b> (1.538, 0.426, 1.258)
Ethnobiology	7	1	<b>0.286</b> (2.00)
Forest/Plant ecology	20	13	<b>10.640</b> (1.470, 0.875, 0.910, 1.258, 0.875, 1.944, 0.88, 0.31, 0.32, 2.537, 2.9, 0.875, 1.215)
Landscape ecology/Land degradation & restoration	3	2	<b>2.787</b> (3.751, 0.43)
Risk assessment /Climate change	5	3	<b>3.169</b> (2.086, 0.486, 2.709)
Wildlife/Grassland	10	6	<b>6.072</b> (0.457, 0.455, 1.595, 5.947, 0.541, 1.126)

(O: The numbers in bracket are the Impact Factor (IF) recorded respectively for each article having an IF in a given field of publication

*(iv) Indices of co-publications in peer review journals*

*a) Country level*

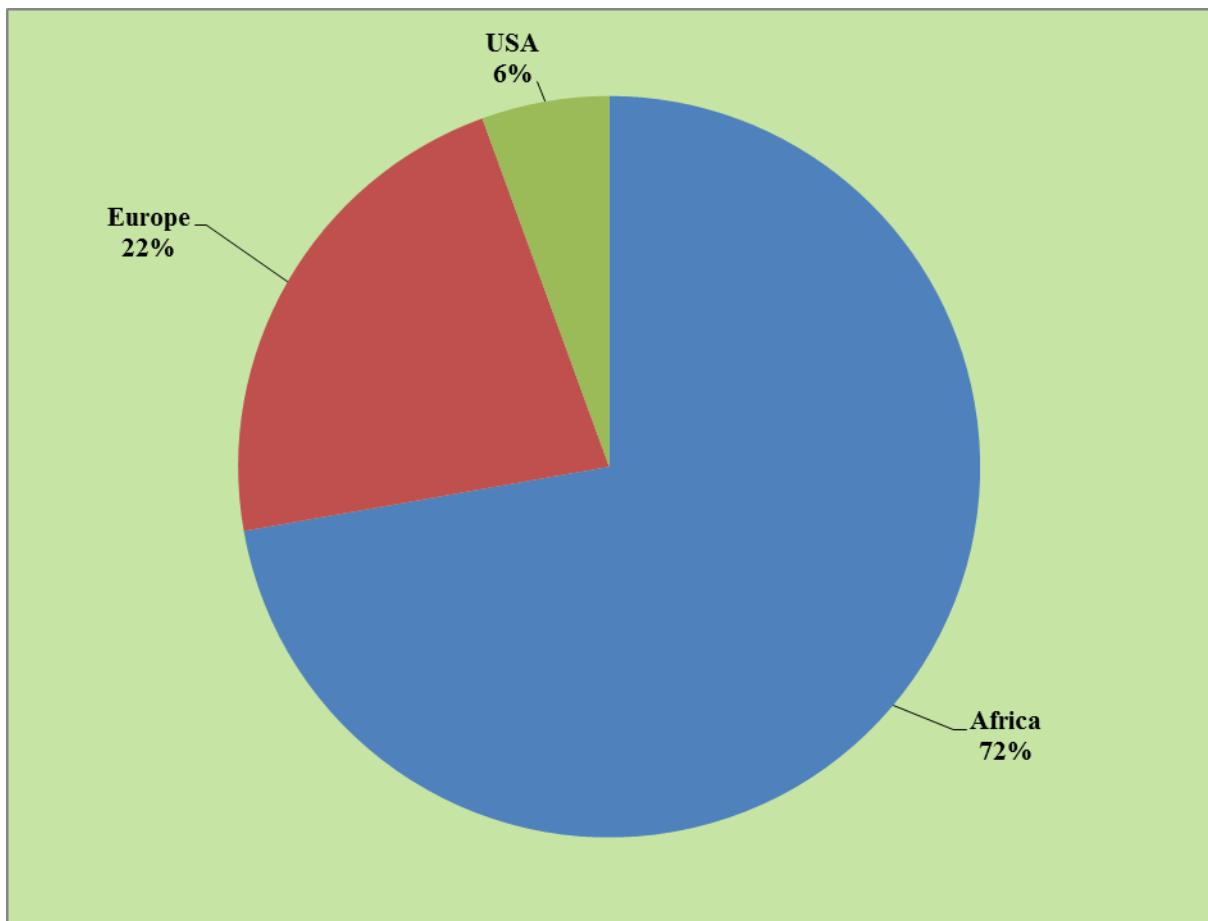
LEA works with a wide partnership at local and international training and research institutions. Research teams within LEA used to publish their research papers in collaboration with national and international scientists (figure 11). At country level, most of the publications were written with researchers from Benin (29 publications out of 54).



**Figure 11:** Diversity in indices of the LEA co-publications in peer review journals at countries scale in 2016

*b) Continental level*

At continental scale, the most important articles were co-published with Africans (39 publications: mainly Beninese), European scientists (12 publications) and American (3 publication) scientists (Figure 12).

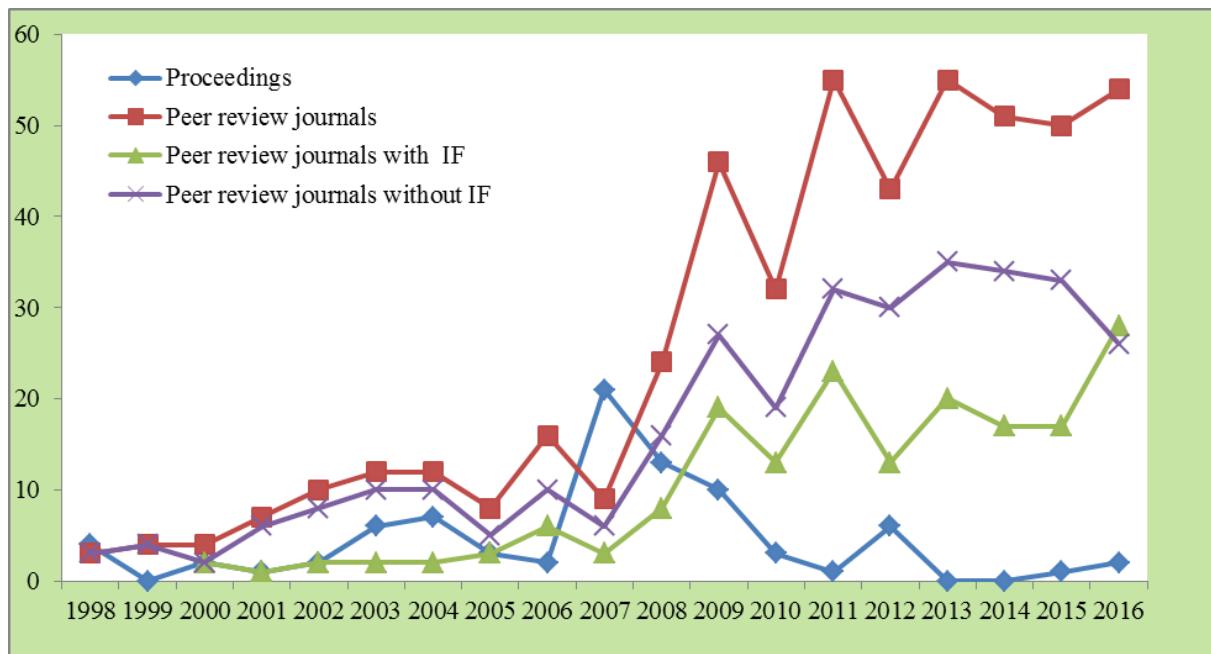


**Figure 12:** Diversity in indices of LEA co-publications in peer review journals at continental level in 2016

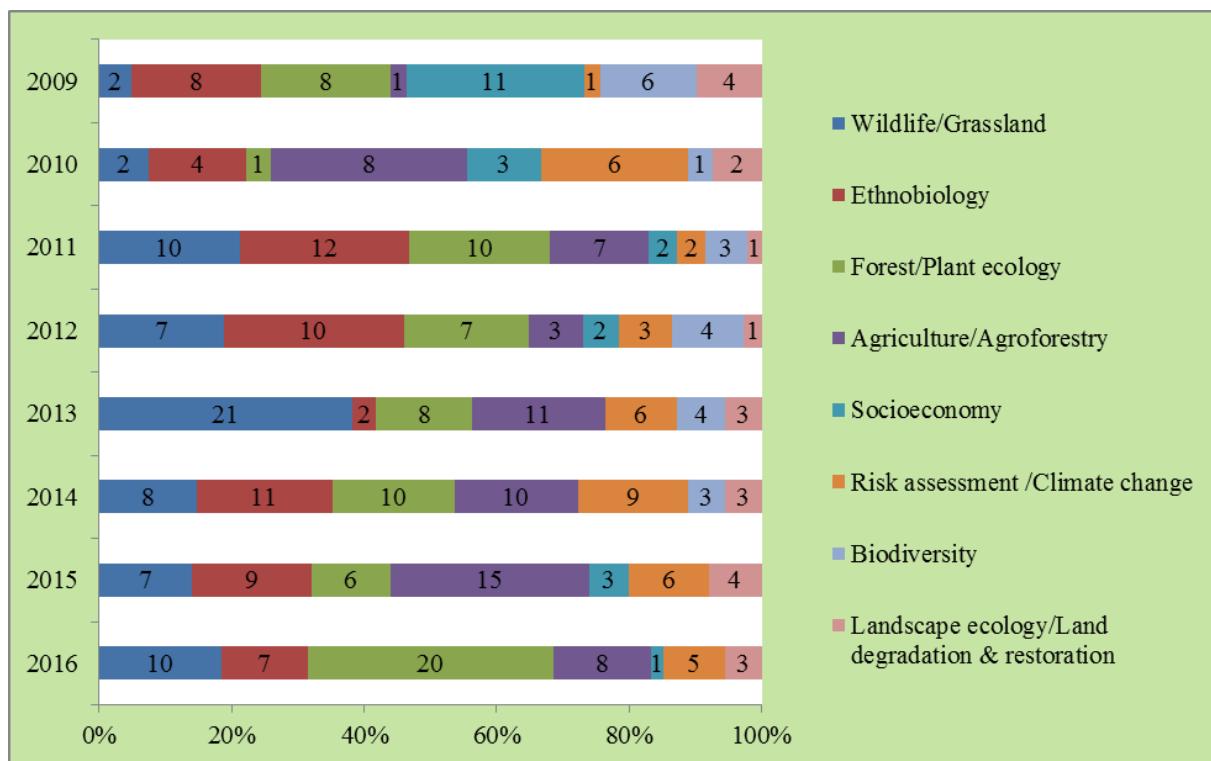
#### **2.2.2.2 Trends of publications in peer review journals and proceedings from 1998 to 2016**

Publications in peer review journals have globally increased from 1998 to 2016 with the highest peak in 2011, 2013 and 2016. Publishing in peer review journals with Impact Factor has started in the laboratory in 1994 with 1 to 3 publications per year till 2005. For a given year, the publications in peer review journals with Impact Factor were generally lower compared to the ones in other peer review journals except in 2016 (Figures 13a).

Forest and Plant ecology, Wildlife and Grassland, Ethnobiology, Agriculture and Agroforestry are the research fields in which the most publications are obtained since 2010 at LEA (Figure 13b). This confirms these areas as the main research's field of LEA.



**Figure 13a:** Trends per types of publications from 1998 to 2016



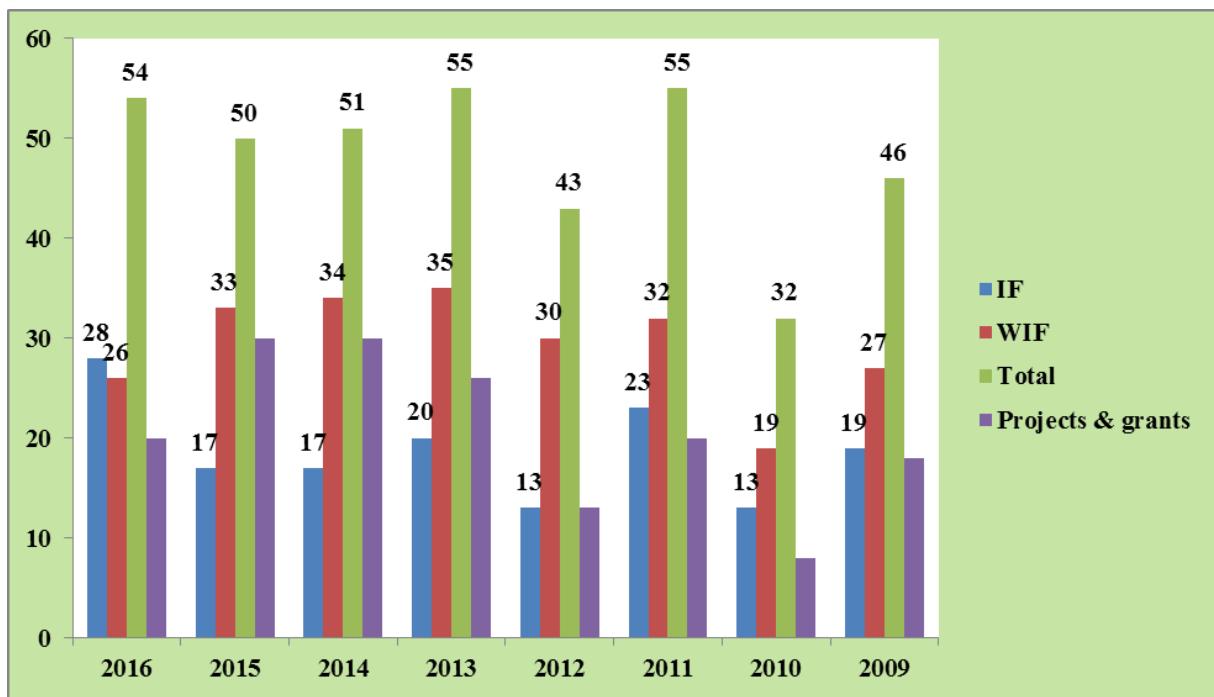
**Figure 13b:** Spectra of publications according to the fields of research from 2010 to 2016

### 2.2.2.3 Trends of research projects, research grants and publications in peer review journals from 2010 to 2016

The research projects and small grants have increased at LEA since 2010 (figure 15). The highest number of research projects and small grants is observed in 2014 and 2015 (30). The same trend is

also observed with publications in peer review journals which globally increase since 2010. Thus while the number of project increase, the number of papers published also increase. Moreover, this trend is more observed with the number of papers published in impact factor journal. Indeed, the number of published papers in impact factor journal varied from 13 papers with 8 research projects and small grants to 17-28 papers with 18-30 projects and small grants. With more research projects and small grants, researchers at LEA published more papers in peer review journals particularly in impact factor journals.

The budget per year at LEA from 2010 to 2016 vary from 125 000 Euro to 170 000 Euro. While the budget increased, the cost per publication decreased (table 2). In addition the total impact factor increased with lower cost of publication per impact factor unit. This is due to the increasing number of grantees PhD and MSc students involved in research projects and small grants who have more time for research and publishing. Thus with more funds, more publications are done at lower cost.



**Figure 14:** Spectra of publications, projects and small grants from 2010 to 2016

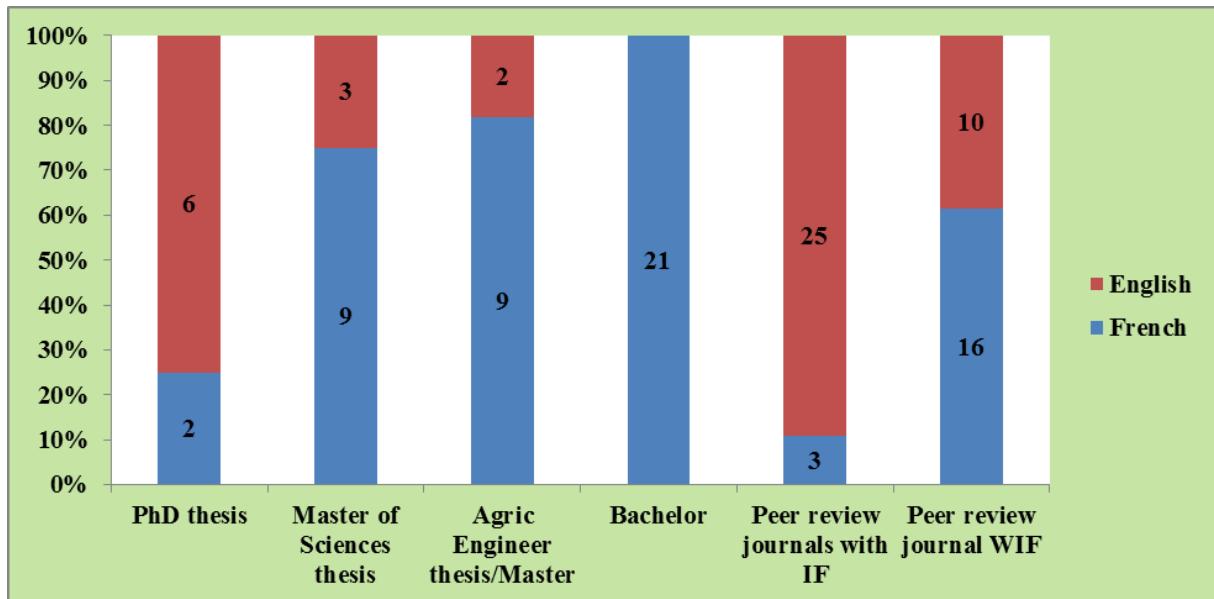
**Table 2:** Estimated cost per publication and per IF unit from 2010 to 2016

Year	Total Publication	Total IF unit	Estimated budget of LEA/year	Cost (Euro)/publication	Cost (Euro)/IF unit
2016	54	41.174	155000	2870	3765
2015	50	20.721	170000	3400	8205
2014	51	23.84	185000	3627	7760
2013	55	19.826	165 000	3000	8322
2012	43	11.6355	155 000	3605	13321
2011	55	27.0247	160 000	2909	5921
2010	32	12.628	125 000	3906	9899
2009	46	21.498	145 000	3152	6745

Mean budget of projects per year  $\approx$  100 000 Euro; Mean budget per grant per year  $\approx$  5000 Euro

#### **2.2.2.4 French/English ratio according to the types of publications**

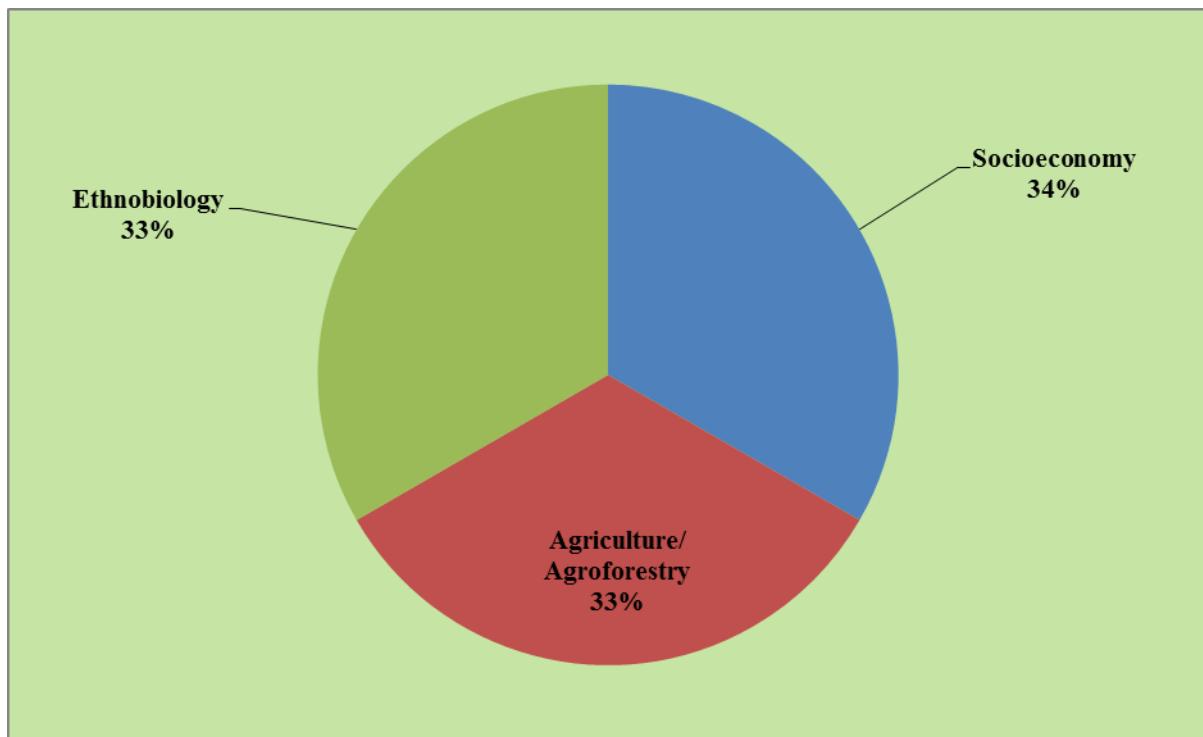
At one side, PhD thesis and many articles in peer journals with impact factor were most written in English. At the other side, bachelor, master thesis, agro ingeneer thesis and articles published in peer journals without impact factor were most written in French (Figure 15).



**Figure 15:** French/English ratio for various types of publications in LEA in 2016

#### **2.2.2.5: Abstracts: number of publications and indexes of specialization**

A total of 3 abstracts were published in books of abstracts of scientific conferences in 2016. These abstracts were linked to three disciplines (Socioeconomy, Agriculture/Agroforestry and Ethnobiology) with respectively one abstract (figure 16). Full references of these abstracts are provided in appendix 13.

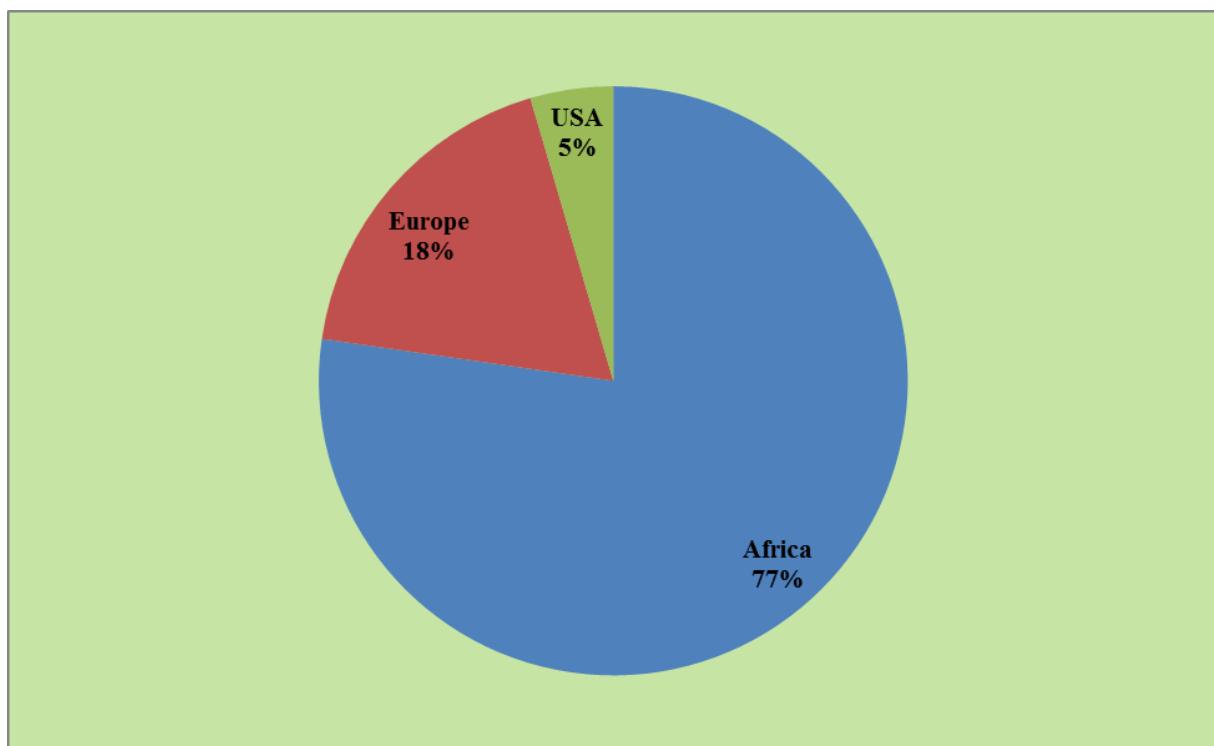


**Figure 16:** Indices of publications specialization in books of abstracts in 2016

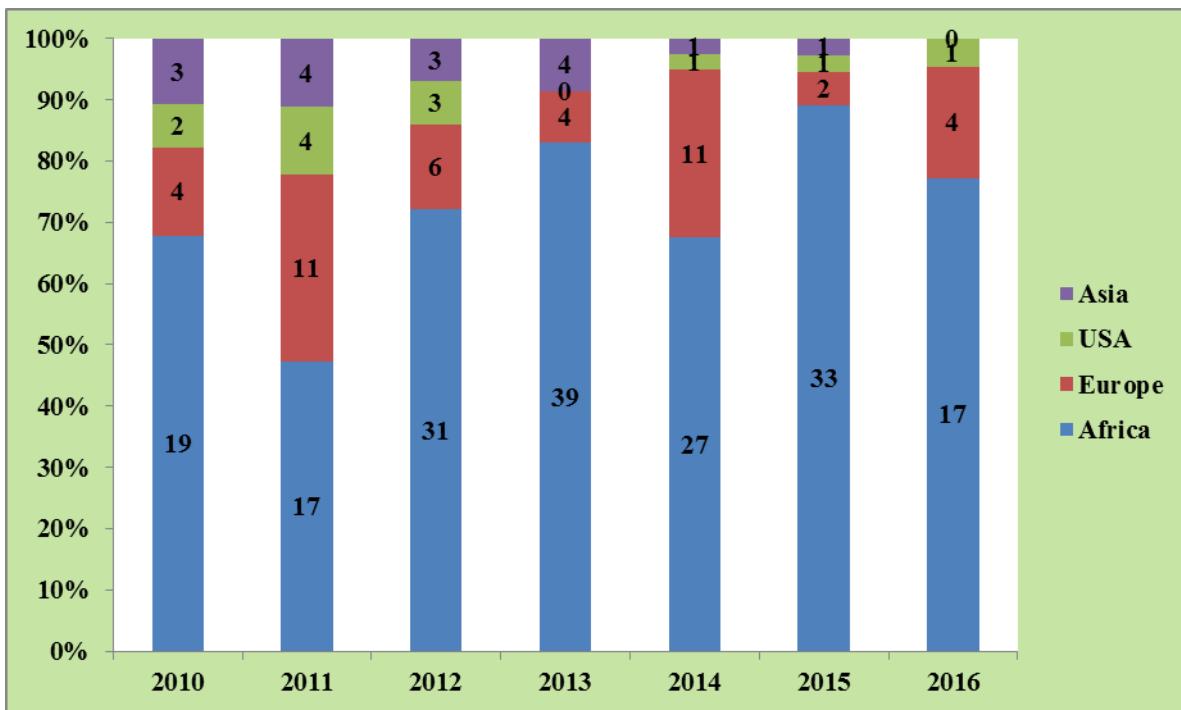
### 3. Conferences and seminars from 2010 to 2016

The participation of researchers at LEA to conferences and seminars has increased from 2010 to 2016 (figure 18) with the highest peak in 2013. The researchers at LEA have participated more to conferences and seminars in Africa than in the others continents. In 2016, researchers at LEA have participated to 22 conferences. About 77% of these conferences were held in Africa, 18% in Europe, and 5% in USA (Figure 17). Details related to these conferences/workshops are listed in appendix 15. Most of the conferences and seminars at which the researchers at LEA have participated were financially supported (table 4). The LEA has started internal seminars focusing on scientific information since 2012. A total of 13 communications were developed in 2016 during the seminars. These seminars mainly addressed thems related to " Integral ecology framework: application to agro-pastoral dams ecosystem services management in Northern Benin" developed by Dr Kpera G.N., "Drones and conservation" developed by Abdelaziz Lawani, lecturer and researcher at the University of Kentucky (USA),, "functioning of grasslands ecosystem: dynamics, spatial distribution and nutrients contents of tropical grasses fodders" developed by Ms. Ir. Myrèse Ahoudji; "Gestion et modélisation de la dynamique des parcours de transhumance dans un contexte de variabilités climatiques au nord-est du Bénin" developed by M. Ir. Paolo Lesse; "Biologie de la conservation des plantes ligneuses médicinales au Bénin: diversité, vulnérabilité et priorisation" developed by M. Alain Yaoitcha; " African wild palms: Ecological patterns, knowledge gaps, conservation and domestication in Benin " developed by M. Rodrigue Idohou; "Genetic diversity, ecology and potential expansion of *Rhamphicarpa fistulosa*

(Horchst) Benth., hemiparasitic weed of rice in Sahel and Sudanian zones” developed by Ms. Norliette Zossou; “Taxonomy and the Global Taxonomy Initiative” developed by Dr Marie-Lucie Susini; “Ethnobotanique, écologie et distribution géographique des plantes utilisées dans le traitement traditionnel de l'hypertension artérielle en République du Bénin (Afrique de l'Ouest) ” developed by M. Anselme Bio ; “Tree-ring anatomy, age structures, dynamic in carbon budget and demography of West African tree-populations undergoing selective timber logging and repeated forest fires” developed by M. Franck Sinsin; “Domestication et stratégies paysannes de gestion des arbres à grand potentiel agroforestier du Bassin du Congo: synthèses des activités et perspectives de recherche” developed by Dr Marie-Louise Avana-Tientcheu ; “Eleveurs, bovins de race Borgou et prédition de la valeur nutritive des ligneux fourragers les plus appétés du Nord-Bénin” developed by M. Habirou Sidi Imorou and “Isotope stable ecology in mammalian herbivore assemblage from West African savanna: what have we done so far and what next? ” presented by Dr Sylvestre Djagoun.



**Figure 17:** Level of participation of LEA’s researchers to international conferences in 2016



**Figure 18:** Trends of participation of LEA's researchers to international conferences from 2010 to 2016

**Table 3:** Cost\* of participation to conferences and seminars from 2010 to 2016

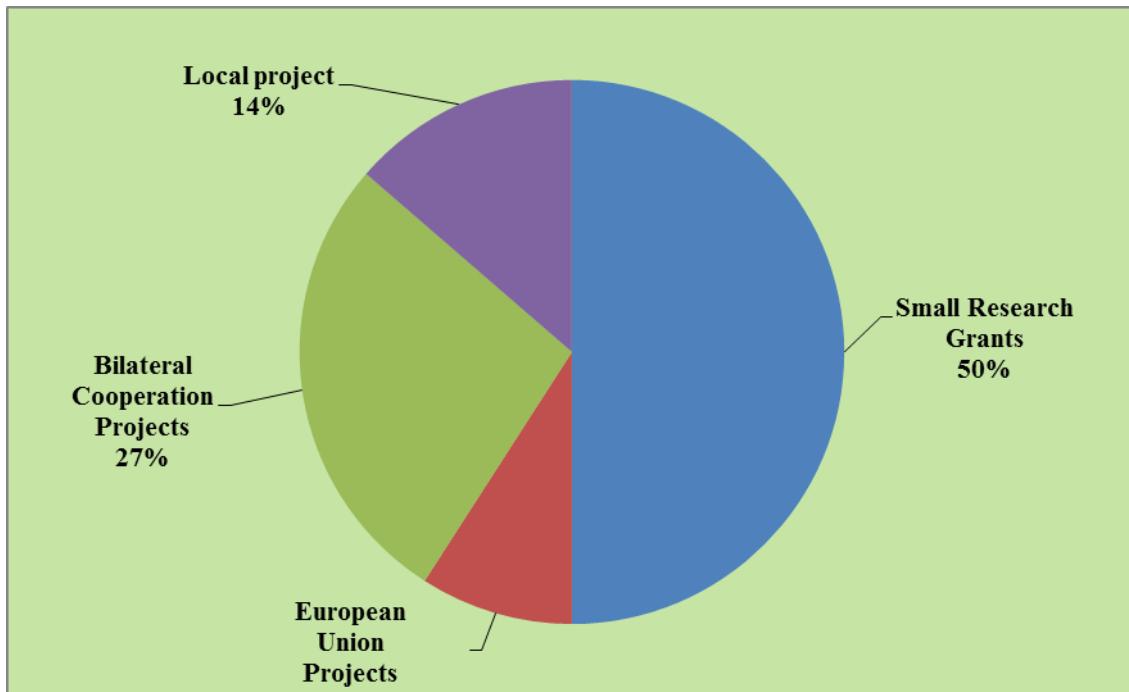
Year	Africa	Europe	USA	Asia	Total	Financial support	Contribution of LEA/UAC
2010	19000	10000	5000	7500	41500	35165	6333
2011	17000	27500	10000	10000	64500	58833	5667
2012	31000	15000	7500	7500	61000	50667	10333
2013	39000	10000	0	10000	59000	46000	13000
2014	27000	27500	2500	2500	59500	50500	9000
2015	33000	5000	2500	2500	43000	32250	10750
2016	17000	10000	2500	0	29500	20114	9386

\*Cost per conference: Africa ≈ 1000 Euro; International (Europe, USA, Asia) ≈ 2500 Euro

#### 4. Research projects, research grants and prize at the LEA in 2016

The research activities undertaken by LEA were mainly funded by international foundations and institutions (Rufford Small Grants, International Fondation for Science, Global Taxonomy Initiative, Organization for Women in Science for the Developing World, and Georg Foster Research Fellowship: 55%), regional and international co-operation projects (Institut Royal des Sciences Naturelles de Belgique, SASACID\_ANAFE, Biovision Africa\_Kenya and Switzerland (SDC), Institut Royal des Sciences Naturelles de Belgique, RUFORUM, and African Union: 30 %), and local institution in Benin (University of Abomey-Calavi and INRAB: 15%) (Figure 19). Most of the PhD as well as senior scientists at LEA are involved in these projects for their research activities. Details (objectives,

beneficiaries, etc.) on these projects and grants are described in appendixes 16 and 17. Moreover, 06 international recognitions have been awarded to the researchers from LEA in 2016 (appendix 18).

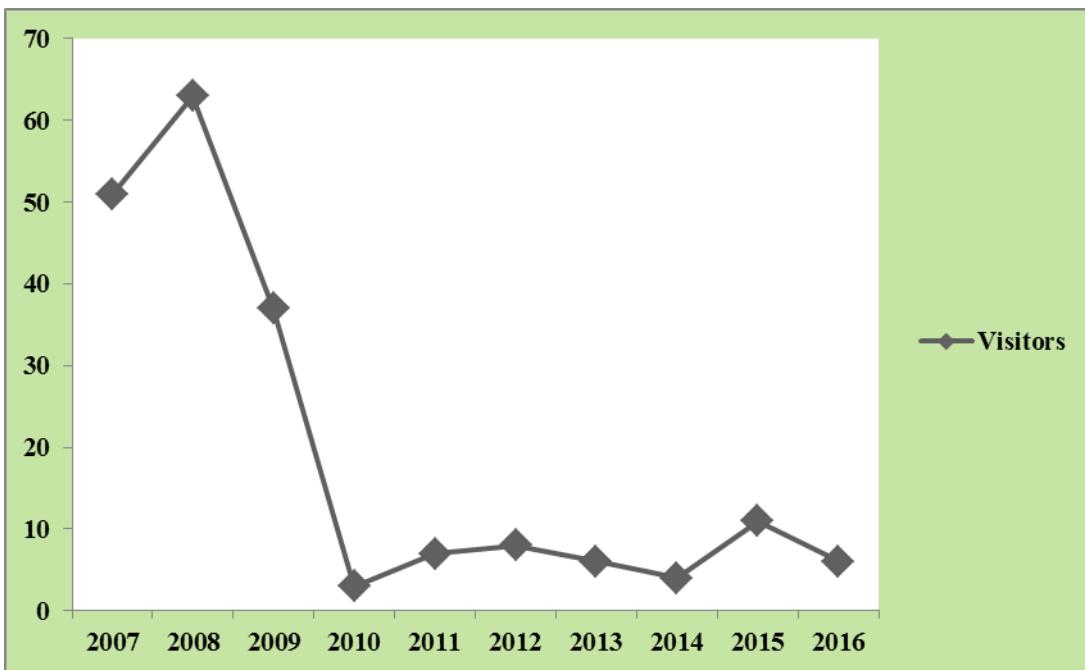


**Figure 19:** Spectrum of research funding in 2016

## 5. Human resources and visiting researchers in the LEA in 2016

Human resources in LEA during 2016 are about 30 main investigators and senior scientists, 24 PhD students, actively participating to research activities within the laboratory. Moreover, 5 technicians and 3 drivers are used on permanent basis for the fieldworks. Specifically, LEA houses 5 Full Professors (Professeur Titulaire Conseil Africain et Malgache pour l'Enseignement Supérieur CAMES), 20 associate Professors (Maître-Conférences/CAMES), several assistant Professors (Maître-Assistant/CAMES), assistant (PhD) and junior researchers (MSc and BSc students). Details about these human resources are shown on the web site of LEA ([www.leabenin-fsauac.net](http://www.leabenin-fsauac.net)).

Furthermore, in the course of the year 2016, LEA has welcomed 6 researchers as visitors vs. 69 in 2009, 63 in 2008 and 51 in 2007, (Figure 20). The visitors welcomed in the previous years (2007, 2008 and 2009) were mainly students through NGOs while since 2010 the visitors welcomed were Professors through collaboration or project.



**Figure 20:** Trends of visiting researchers welcomed at the LEA from 2007 to 2016

## 6. General discussion and conclusion

Various types of publications were produced by LEA's researchers in 2016 as it was the case in previous years. It is important to notice that the total number of published papers in peer review journal in 2016 is similar to the published papers in 2015, 2014 and 2013. The global trend of published papers in peer review journal in LEA had increased since 1998. This can be explained by the increase of researchers, research projects and grants holding a PhD, PhD students and MSc student since 2006. Indeed, with more projects and grants, more papers are published with lower cost per publication and impact factor unit. The number of published articles in journals with Impact Factor has considerably increased since 2008. This means that researchers are improving their publication skills and the quality of their investigation. Another driver for this is the change in the requirements before defending a PhD thesis at the Faculty of Agronomic Sciences which hosts LEA (having at least two published original research papers). In the other hand, requirements for upgrading academics grades within the CAMES system (*Conseil Africain et Malgache pour l'Enseignement Supérieur*) is another important driver for increasing high quality papers within LEA. As such, the scientific capacity of LEA research teams is increasing. Published articles in 2016 were mostly produced in team at African level (77 % mainly Beninese). Published article in peer journal with impact factor were mostly co-written with international colleagues while published articles in other peer journals were more likely written by teams at national level. A reason for that could be the requirements for writing in English for original papers to be submitted in most impact factor journals. Field research such as Forest and Plant ecology, Wildlife and Grassland, Agriculture and Agroforestry, Ethnobiology were the most to contribute to original research papers in LEA. This trend is expected to remain the same in 2017.

Publications which have highly contributed to gain the Impact Factor of the laboratory in 2016 were related to Forest/Plant ecology, Wildlife/grassland, Risk assessment/Climate change, Landscape ecology/Land degradation & restoration, Ethnobiology, and Agriculture/Agroforestry. These disciplines are then the most important in terms of scientific impact of LEA in 2016.

To date, almost no scientific works was done with the scientists from Latino America, Australia, Middle East China and even Northern Africa. This suggests the need of more and sustainable efforts for building cooperative research networks basically using interactive research topics and funds from these parts of the world. Moreover, since 2007, few scientific papers have been published with scientists at a regional level (West Africa). In 2016, 54% of the articles have been co-published within national team while 22% have been co-published with European and 6% with American scientists. As such, regional scientific collaborations should be developed for the following years since Benin shares with its neighboring countries similar research problems which need regional solutions and then should be solved regionally through research activities involving laboratories in the region.

Based on the findings from the present report, it is suggested that LEA:

- (1) helps for capacity building among its research teams in order to be able to publish more scientific papers in peer review journals having a high IF;
- (2) develop more research collaboration at regional level;
- (3) develop curricula in the fields of applied ecology for regional training purposes;
- (4) continue monitoring biodiversity at continental level;
- (6) develop conservation and domestication strategies for some edible and medicinal forest and savannah resources;
- (7) develop guidelines for fieldwork in applied ecology for para ecologists;
- (8) monitor threatened and endangered plants and animals species at regional level.

## 7. References

- <http://scientific.thomson.com/products/wos/>
- [www.leabenin-fsauac.net](http://www.leabenin-fsauac.net)
- [www.notesdecologie.bj.refer.org](http://www.notesdecologie.bj.refer.org)
- [www.fsa.bj.refer.org](http://www.fsa.bj.refer.org)

Publications in LEA in 2015-2016 (cf. appendices)

Proceedings in LEA in 2015-2016 (cf. appendices)

Theses in LEA in 2016 (cf. appendices: PhD, MSc and agronomist degree).

Publication in UAC in 1998 – 2016.



## **8. APPENDIXES**

## 2016 SCIENTIFIC ACTIVITIES REPORT OF THE LABORATORY OF APPLIED ECOLOGY

*Appendix 1: Ongoing PhD thesis in LEA*

N°	Student full name	Number of year since the start of the PhD	Research topics	Fields of Research
1	ABDILAHY ALI Mohamed	3 <sup>rd</sup> year	Evaluation de l'efficacité thérapeutique des plantes dites anti-diabète de la république de Djibouti	<i>Ethnobiology</i>
2	AGBANI Onodjé Pierre	more than 5 <sup>th</sup> year	Etat de conservation et viabilité des populations de quelques espèces ligneuses soudanaises menacées du Bénin.	<i>Plant ecology and management</i>
3	AGONYISSA Didier	more than 5 <sup>th</sup> year	Species diversity variation in sudanian Isoberlinia doka and Isoberlinia tomentosa woodland in relation to plot sizes and landuse pressure in Benin.	<i>Plant ecology and management</i>
4	AÏTONDJI Akouavi Léa	4 <sup>th</sup> year	Evaluation des impacts écologique, socio-économique et paysager des carrières non sablonneuses au Bénin	<i>Desertification and land degradation</i>
5	AZIZOU El-Hadj Issa	more than 5 <sup>th</sup> year	Facteurs déterminants de cogestion pour la conservation des ressources naturelles de la réserve de biosphère transfrontalière du W/Bénin.	<i>Wildlife /protected areas management</i>
6	EDON Aderomou Tinuadé Solange	more than 5 <sup>th</sup> year	Baobab regeneration in Benin	<i>Forest/Plant ecology and management</i>
7	GOUSSANOU A. Cedric	4 <sup>th</sup> year	Estimation, fluxes and monitoring of changes in carbon stock of tropical forest ecosystems: Case study of dense semi-deciduous moist forests in Benin	<i>Forest and Climate change</i>
8	HEDJI Carine Christiane	4 <sup>th</sup> year	Valorisation d'aliment à base de <i>Azolla</i> spp, de feuilles de <i>Moringa oleifera</i> , de son de riz, se viscères de poisson et de poulet en production de porc et de poulet	<i>Grassland ecology</i>
9	HOUNDANTODE Justin	more than 5 <sup>th</sup> year	Problématique de gestion et valorisation des eaux usées du Bénin en cultures maraîchères : cas de l'amarante dans la commune de Sème Kpodji.	<i>Horticulture</i>
10	HOUNDONOUGBO Sènanmi Hermann Juliano	1 <sup>st</sup> year	Ecology, conservation and domestication of the African locust bean tree <i>Parkia biglobosa</i> (Jacq.) R. Br. (Mimosaceae) in Benin, West Africa	<i>Agroforestry/NTFPs</i>
11	KOLIMEDJE Emilie Norberte	2 <sup>nd</sup>	Pouvoir saprotrophique des champignons dans la décomposition de la litière dans la forêt classée de Pahou	<i>Forest/Plant ecology and management</i>
12	KOMBIENOU Pocoum Damé	more than 5 <sup>th</sup> year	Impacts des systèmes agricoles et de l'occupation des terres en zone montagneuse de la chaîne de l'Atacora au Nord-Ouest du Bénin Impacts des systèmes agricoles et de l'occupation des terres en zone montagneuse de la chaîne de l'Atacora au Nord-Ouest du Bénin	<i>Agroforestry/NTFPs</i>
13	TCHIBOZO Vital	3 <sup>rd</sup> year	Evaluation of zooeconomics performances of pigs and rabbits feed with different foodstuffs based on maize and corn bran varieties in Benin	<i>Agriculture/Agroforestry</i>

14	HAMADOU Moussa	2 <sup>nd</sup> year	Stratégies d'adaptations aux changements climatiques : Valorisation des potentialités fourragères d'écotypes de mil ( <i>Pennisetum glaucum</i> (L) R. Br) cultivés au Niger pour l'élevage sédentarisé d'ovins de race locale.	<i>Agriculture/Agroforestry</i>
15	MALIKI Rafiou	more than 5 <sup>th</sup> year	Evaluation de la durabilité écologique et socio-économique des systèmes de cultures sédentarisés à base d'igname : Développement des modèles bio-économiques.	<i>Agroforestry/Non Timber Forest Products</i>
16	OKOU Farris Aurlus Yissegnon	5 <sup>th</sup> year	The Atacora mountain under the drivers of land use and their impacts on species establishment	<i>Desertification and land degradation</i>
17	SARE Baké Adissatou	more than 5 <sup>th</sup> year	Climatic variability and dynamic of agroforesterie parks in the W Transboundary of biosphere reserve in Benin.	<i>Agriculture/Agroforestry</i>
18	SEWADE Clément	4 <sup>th</sup> year	Gestion rationnelle des ligneux fourragers dans les terres de parcours pour la conservation de la biodiversité au Bénin	<i>Grassland ecology</i>
19	SINASSON Sanni Koupamba Gisèle	4 <sup>th</sup> year	Distribution, structure and dynamics of <i>Mimusops andongensis</i> Hiern in Benin	<i>Forest/Plant ecology and management</i>
20	TOUDONOU A. S. Christian	more than 5 <sup>th</sup> year	Utilisation and conservation of snakes: case study from ball python ( <i>Python regius</i> ) in Benin.	<i>Wildlife /protected areas management</i>
21	ZAKARI Soufouyane	5 <sup>th</sup> year	Vulnérabilité des parcours de transhumance aux changements climatiques dans le bassin versant de la Sota (Bénin)	<i>Grassland ecology</i>
22	TODAN Appolinaire	4 <sup>th</sup> year	Implications des mutations agraires et sociodémographiques sur la gestion des ressources ligneuses sur le plateau adja au Bénin	<i>Forest/Plant ecology and management</i>
23	AGBOMAHENAN Saturnin	5 <sup>th</sup> year	Erosion et Dynamique des états de surface dans la Basse vallée de l'Ouémé	<i>Desertification and land degradation</i>
24	ADJASSE Martin	4 <sup>th</sup> year	Les îlots de forêts sacrées et communautaires du centre Bénin : écosystèmes marginaux à protéger et conserver pour le maintien en équilibre de la diversité biologique	<i>Forest/Plant ecology and management</i>

**Appendix 2: Completed bachelor degree in 2016**

N°	Student full name	Research topics	Fields of Research
1	IGARI-KOROGONE O. B. Brice	Utilisation des produits de la ruche: préparation de boissons alcoolisées à partir du miel et de la bougie à partir de la cire d'abeille	
2	HOUNDJIGBIO Coffi Félix	Innovations pour la protection des cultures maraîchères : Cas de l'utilisation du tourteau de neem contre les nématodes sur le site maraîcher de Houéyaho, ville de Cotonou	<i>Horticulture</i>
3	HOUNGNON Ghislain & BONOU Cédric	Innovations pour la transformation des racines et tubercules : Cas de la râpeuse de manioc à mécanisme de pressage	<i>Agricultural machinism and mechanical construction</i>

N°	Student full name	Research topics	Fields of Research
4	HOUSSOU Mèdésse Antoine & HOSSOU Calvin	Innovations pour la transformation des fruits : Cas d'un extracteur du jus de mangue à palettes fabriqué à Colombe Industrie	<i>Agricultural machinism and mechanical construction</i>
5	KINTOGANDOU S. Herbert Rodolphe & SALAOU Abdou Mouizz Bodounrin	Innovations pour la gestion durable des sols dans les champs d'ananas : Cas du film polyéthylène dans la Commune d'Allada	<i>Agronomy</i>
6	TOUMOUDAGOU Kouandeka & WOTTO Aimé Roscame	Innovations pour la facilitation de l'accès des producteurs aux semences : Cas de la production locale de semence certifiée de soja ( <i>Glycine max</i> ) dans la Commune de Glazoué	<i>Agronomy</i>
7	DEHOUE Sègonhan Habib & YALOGBO Sèna Urielle Gwladis	Innovations pour l'amélioration du rendement des cultures : Cas de l'utilisation de l'inoculum ( <i>Bradyrhizobium japonicum</i> ) dans la culture de soja dans le village Dovogon, commune de Zogbodomey	<i>Agronomy</i>
8	CHODATON Gilles Yélognissé & HESSOU Rodrigue Sèdjro	Innovations pour la réduction des adventices dans un champ de papayers : Cas de la technique d'association de cultures dans la Commune d'abomey-Calavi	<i>Agronomy</i>
9	ADEOSSI Raoul	Etude diagnostique des systèmes élevages bovins sur le cordon littoral de la commune de Ouidah	<i>Livestock Production Systems</i>
10	ADJATIN Coralie	Etude diagnostique du systeme d'elevage des bovins dans la commune de grand-popo	<i>Livestock Production Systems</i>
11	GBAGUIDI Marietta Bonnevie Houefa	Etude diagnostic d'un élevage biologique d'escargots sur la ferme CEDEC de l'ONG BOUGE à Sékou (Allada - Benin)	<i>Agriculture écologique et biologique</i>
12	ADOUNGOTCHODO Libérale Mahinléo	Etude diagnostique de l'élevage biologique des canards au CEDeC-ONG Bouge à Sékou (Allada-Bénin)	<i>Agriculture écologique et biologique</i>
13	HOUENOU Jésugnon Ezéckiel	Etude diagnostique du cantonnement forestier de djougou (cfd) et la problematique de gestion des plantes aromatiques dans les terroirs riverains	<i>Aménagement et Gestion des Forêts et Parcours Naturels</i>
14	CHAFFA Kolawolé Thierry	Etude diagnostique de la direction du parc national de la Pendjari : connaissances endogenes de la biodiversité des plantes Aromatiques et épices sauvages dans les terroirs riverains de la Reserve de biosphère de la pendjari	<i>Aménagement et Gestion des Forêts et Parcours Naturels</i>
15	GANDAHO Mahugnon Mihinnoudéa Cléo-Claudia	Etude diagnostique du cantonnement Forestier de kandi : problematique de la Gestion des épices sauvages et plantes Aromatiques	<i>Aménagement et Gestion des Forêts et Parcours Naturels</i>
16	ANATO Moréas	Gouvernance locale, connaissances ethnobotaniques, ethnozoologiques et services ecosystemiques des mangroves, cas de la lagune de porto-novo	<i>Aménagement et Gestion des Forêts et Parcours Naturels</i>

N°	Student full name	Research topics	Fields of Research
17	Iyê Oloufèmi Aphrodite Yétissan OGOUVIDE	Aptitude à la germination des graines et croissance des plantules de <i>Pterocarpus erinaceus</i> Poir. dans la zone Guinéo-congolaise au Bénin	Aménagement et Gestion des Forêts et Parcours Naturels
18	HOUNGA Carlos Quartus	Gouvernance locale, connaissances ethnobiologiques et services ecosystemiques des mangroves de hio dans la commune de Ouidah	Aménagement et Gestion des Forêts et Parcours Naturels
19	DJEHO M. Carlosse Marie-Lionel	Test de provenance et effet de la durée de conservation sur la germination et la croissance du baobab africain ( <i>Adansonia digitata</i> L.) dans la zone Soudano-Guinéenne du Bénin	Aménagement et Gestion des Forêts et Parcours Naturels
20	AÏDJIHOUNDE Kévin	Gouvernance locale, connaissance ethnobotanique et ethnozoologique et perceptions locales des services écosystémiques des mangroves de la commune de Ouidah	Aménagement et Gestion des Forêts et Parcours Naturels
21	HESSOU Nick Romatic	Gouvernance locale, connaissances ethnobotaniques, ethnozoologiques et service ecosystemique de la mangrove de Houakpê Daho	Aménagement et Gestion des Forêts et Parcours Naturels

*Appendix 3: Completed master or agronomist engineer degree in 2016*

N°	Student full name	Research topics	Fields of Research
1	AKAKPO Jeanne	Diversité et ethnobotanique des lianes dans la forêt classée de la Lama au Sud-Bénin	Aménagement et Gestion des Forêts et Parcours Naturels
2	ALLAGBE Cédrick-Freddy	Effets du stress hydrique et de <i>Bemisia tabaci gennadius</i> sur la germination et la croissance de <i>Manihot esculenta</i> et de <i>Manihot glaziovii</i> au Bénin	Aménagement et Gestion des Forêts et Parcours Naturels
3	DOSSOU AHOGBEGNON Euden Koumassou	Contribution à la gestion durable des mangroves du site Ramsar 1017: Gouvernance locale, Diversité floristique, structure et services écosystémiques des mangroves	Aménagement et Gestion des Forêts et Parcours Naturels
4	do-REGO Mouléro Eunock	Etude écogéographique, modélisation des habitats favorables et analyse gap de conservation des 20 espèces des Parents Sauvages des Plantes Cultivées prioritaires pour la conservation au Bénin	Aménagement et Gestion des Forêts et Parcours Naturels
5	Constant Sètondé GNANSOUNOU	Structure, dynamique et utilisation de la mangrove cotière de Grand-Popo (Bénin)	Aménagement et Gestion des Forêts et Parcours Naturels
6	HOUINATO G. N. Fréjus	Etude ethnobotanique des ligneux et rôles écosystémiques des forêts de la commune de Djougou pour la conservation et la domestication des espèces ligneuses utiles	Aménagement et Gestion des Forêts et Parcours Naturels

N°	Student full name	Research topics	Fields of Research
7	Mikhaïl J.D. Dotou PADONOU	Evaluation ethnobotanique et écologique de <i>Uvaria chamae</i> P. Beauv au sud du Bénin	Aménagement et Gestion des Forêts et Parcours Naturels
8	PRUDENCIO Moriel	Gestion intégrée des terroirs riverains de la forêt classée des trois rivières : Analyse de la vulnérabilité et stratégies paysannes d'adaptation selon l'approche Ecosystem based Adaptation en contexte de changement climatique.	Aménagement et Gestion des Forêts et Parcours Naturels
9	Curie Prosny Sènami HOUEDHOUME GANSE	Perception des communautés locales de la dégradation du couvert forestier et son impact sur les ressources en eau dans la partie méridionale du bassin versant du Zou	Aménagement et Gestion des Forêts et Parcours Naturels

*Appendix 4: Completed Master of Sciences degree in 2016*

N°	Student full name	Research topics	Fields of Research
1	David SEMEVO	Assessing of sustainable management potentialities of three most important NWFP in the bordering areas of Pendjari Biosphere	Natural resources management
2	Ella Sèdé MAFORIKAN	Effet du poids des graines de Baobab ( <i>Adansonia digitata</i> L.) sur la germination et la croissance des plants en pépinière au Bénin	Gestion des Ressources Naturelles et de la Biodiversité
3	Halidou Hamado Abdoulzakou	Contribution des produits forestiers non ligneux (PFNL) dans la réduction de la pauvreté et l'amélioration des conditions de vie des populations au Niger : Cas du département de Torodi	Gestion des Ressources Naturelles et de la Biodiversité
4	Daniel NDIZIHIWE	The role of ants in governing large herbivores on acacia trees: a meta analysis	Gestion des Ressources Naturelles et de la Biodiversité
5	Bidosséssi Eliane Juliette ASSOGBADJO	Effet des provenances, des traitements et des caractéristiques morphométriques sur le taux de germination des noix de <i>Raphia hookeri</i> (G. Mann & H. Wendl).	Gestion des Ressources Naturelles et de la Biodiversité
6	Victoire EDALO	Evaluation des perceptions locales de l'impact des feux de végétation sur les services écosystémiques dans la Réserve de Biosphère de la Pendjari	Gestion des Ressources Naturelles et de la Biodiversité
7	Conceptia J. A. QUENUM	Caractérisation morphologique et essai de germination des noix de <i>Raphia sudanica</i> A.Chev. au Bénin	Gestion des Ressources Naturelles et de la Biodiversité
8	Doris Houssou	Potentiel écologique et structure spatiale des fruitiers sauvages alimentaires dans les forêts galeries du Sud Bénin (Basse vallée de l'Ouémé)	Gestion des Ressources Naturelles et de la Biodiversité
9	Abdoulzakou Halidou HAMADO	Contribution des produits forestiers non ligneux (PFNL) à la réduction de la pauvreté et l'amélioration des conditions de vie des populations au Niger : Cas du département de Torodi	Gestion des Ressources Naturelles et de la Biodiversité
10	Ali Mbodou Langa	Importance socioéconomique et évaluation de l'impact des changements climatiques sur la distribution des aires favorables à <i>Khaya senegalensis</i> (Desr.) A. Juss au Tchad	Gestion des Ressources Naturelles et de la Biodiversité
11	DJOGBENOU Ecce Fivode Sèdoté Enagnon Anyse	Ant mediated effects of mega-herbivores on the dynamics of savanna plants : Acacia-ants-elephant tritrophic interactions in the Pendjari Biosphere reserve	Management of Natural resources

N°	Student full name	Research topics	Fields of Research
12	KAMASSI SOULEY Zeinabou	Evaluation éco-phénotypiques de <i>Boscia senegalensis</i> (Pers.) Lam. Ex Poir. (Capparaceae), une espèce de soudure dans le département de Kollo au Niger	<i>Management of Natural resources</i>

**Appendix 5: Completed Doctorate thesis in 2016**

N°	Student full name	Diploma (Doctor, PhD, etc..)	Research topics	Institution/Specialisation
1	Ago Expedit Evariste	Doctor	Dynamic of carbon fluxes between the atmosphere and some West African ecosystems: a case study of forests and savannah under a Sudanian climate in Benin	Université de Gembloux, GHG flux, Climate change, Exchanges atmosphere-terrestrial ecosystems
2	Cocou Aristide Franck Sinsin	PhD	Tree ring anatomy, age structures, dynamic in carbon budget and demography of West African tree populations undergoing illegal timber logging and repeated forest fires	Faculté des Sciences Agronomiques, Université d'Abomey-Calavi
3	Mamoutou SANOGO	Doctorat	Influence du zonage sur les pratiques agropastorales et leurs effets mutuels sur la phytodiversité dans la Réserve de Biosphère de la Boucle du Baoulé au Mali	Institut Supérieur de Formation et de Recherche Appliquée (Mali) / Rangeland management
4	AHOUDJI Carmelle Myrèle	PhD	Grasslands ecosystem functioning: patterns of establishment of dominant plant species, grass tussock growth, ecology and fire impacts on grassland dynamics	Faculté des Sciences Agronomiques, Université d'Abomey-Calavi / <i>Grassland ecology</i>
5	AVAKOUDJO Julien	PhD	Donga valuation: Processes, Management and valorized Opportunities in Karimama District (Northern Benin)	Faculté des Sciences Agronomiques, Université d'Abomey-Calavi Desertification and land degradation
6	BIO Anselme	PhD	Ethnobotanique, distribution spatiale et écologie des plantes entrant dans le traitement de l'hypertension artérielle au Bénin	Faculté des Lettres, Arts et Sciences Humaines Université d'Abomey-Calavi / <i>Agroforestry/NTFPs</i>
7	GBAÏ N. Innocent	PhD	Impact des systèmes d'exploitation des ressources naturelles sur les écosystèmes dans le Bassin de la Beffa	<i>Ecosystems restoration</i>

N°	Student full name	Diploma (Doctor, PhD, etc..)	Research topics	Institution/Specialisation
8	Alix Frank Rodrigue IDOHOU	PhD	African wild palms: Ecological patterns, knowledge gaps, conservation and domestication in Benin	Faculté des Sciences et Techniques, Université d'Abomey-Calavi/ Sciences Biologiques Appliquées (Ressources Phylogénétiques)

**Appendix 6: Articles published in peer-review journal with Impact Factor (IF) in 2016**

Disciplines	N°	Authors' Names	Title of the article	Journals	Impact Factor
Risk assessment/ Climate change	1	Ago Expedit Evariste, Agbossou Euloge Kossi, Cohard Jean-Martial, Galle Sylvie, Aubinet Marc	Response of CO <sub>2</sub> fluxes and productivity to water availability in two contrasting ecosystems in northern Benin (West Africa)	<i>Annals of forest science</i> , 73(2), 483-500.	2.086
Risk assessment/ Climate change	2	Ago Expedit Evariste, Agbossou Euloge Kossi, Ozer Pierre, Aubinet Marc	CO <sub>2</sub> measurement and carbón sequestration in West African terrestrial ecosystems. A review.	<i>Biotechnologie, Agronomie, Société, Environnement</i> 20(1), 68-82.	0.486
Risk assessment/ Climate change	3	Dossou-Yovo Elliott Ronald, Brüggmann Nicolas, Jess Naab Huat Joël, Ago Expedit Evariste, Agbossou Euloge Kossi	Reducing soil CO <sub>2</sub> emission and improving upland rice yield with no-tillage, straw mulch and nitrogen fertilization in northern Benin	<i>Soil &amp; Tillage Research</i> 156, 44-53.	2.709
Agriculture/ Agroforestry	4	Gbedomon RC, Assogbadjo AE, Salako VK, Fandohan AB, Glèlè Kakai R	Exploring the spatial configurations of home gardens in Benin.	<i>Scientia Horticulturae</i> 213: 13–23	1.538
Wildlife/ grassland	5	Sèwadé C, Azihou AF, Fandohan AB, Houéhanou TD, Houinato M	Diversité, priorité pastorale et de conservation des ligneux fourragers des terres de parcours en zone soudano-guinéenne du Bénin.	<i>Biotechnologie, Agronomie, Société et Environnement</i> 20(2): 113-129	0.457

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>	<b>Impact Factor</b>
Ethnobiology	6	Gbedomon CR, Floquet A, Mongbo R, Salako KV, Fandohan AB, Assogbadjo A, Glele Kakai R	Socio-economic and ecological outcomes of community based forest management: A case study from Tobé-Kpobidon forest in Benin, Western Africa.	<i>Forest Policy and Economics</i> 64: 46–55	2.00
Forest/ Plant ecology	7	Goussanou C.A., Guendehou S., Assogbadjo A.E., Kaire M., Sinsin B., Cuni Sanchez A.	Specific and generic stem biomass and volume models of tree species in a west african tropical semi-deciduous forest.	<i>Silva Fennica</i> 50(2), 1474.	1.470
Forest/ Plant ecology	8	Gbeffe, K.A., Houehanou, D.T., Habiyaremye, M., Assede, E.P. et al.	Effects of termite mounds on composition, functional types and traits of plant communities in Pendjari Biosphere Reserve (Benin, West Africa)	<i>African Journal of Ecology</i>	0.875
Wildlife/ grassland	9	G. N. Kpéra, G. A. Mensah, N. Aarts & A. J. van der Zijpp	Water quality as an indicator of the health status of agro-pastoral dams' ecosystems in Benin: An ecosystem services study.	<i>Aquatic Ecosystem Health &amp; Management</i> , 19:4, 441-451 <a href="http://dx.doi.org/10.1080/14634988.2016.1257896">http://dx.doi.org/10.1080/14634988.2016.1257896</a>	0.455
Forest/ Plant ecology	10	Idohou R., Assogbadjo A. E., Azihou F., GlèlèKakaï R., Adomou A.	Influence of the landscape context on stand structure and spatial patterns of the doum palm ( <i>Hyphaene thebaica</i> Mart.) in the Republic of Benin (West Africa)]	<i>Agroforestry Systems</i> , 90 : 591 – 605.	0.910
Forest/ Plant ecology	11	Hounkپvi A., Azihou A. F., Kouassi E. K., Porembski S., GlèlèKakaï R.	Climate-induced morphological variation of black plum ( <i>Vitex doniana</i> Sw.) in Benin, West Africa	<i>Genetic Resources and Crop Evolution</i> , 63: 1073 – 1084.	1.258
Forest/ Plant ecology	12	Salako V. K., Azihou A.F., Assogbadjo A.E., Houéhanou T.D., Kassa B.D., GlèlèKakaï R.L.	Elephant-induced damage drives spatial isolation of the dioecious palm <i>Borassus aethiopum</i> Mart. (Arecaceae) in the Pendjari National Park, Benin	<i>African Journal of Ecology</i> , 54: 9 – 19.	0.875
Wildlife/ grassland	13	Djagoun C.A.M.S., Codron D., Sealy J., Mensah G.A. & Sinsin B.A.	Isotopic niche structure of a mammalian herbivore assemblage from a West African savanna: Body mass and seasonality effect	<i>Mammalian Biology-Zeitschrift für Säugetierkunde</i> , 81(6), 644-650.	1.595
Wildlife/ grassland	14	Gaubert P., Njiokou F., Ngua G., Afiaademanyo K., Dufour S., Malekani J., Gonodel Bi S., Tougard C., Olayemi A., Danquah E., Djagoun C.A.M.S., Kaleme P., Mololo C. N., Stanley W., Luo S-J. & Antunes A.	Phylogeography of the heavily poached African common pangolin ( <i>Pholidota, Manis tricuspidis</i> ) reveals six cryptic lineages as traceable signatures of Pleistocene diversification.	<i>Molecular Ecology</i> 25(23), 5975-5993.	5.947

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>	<b>Impact Factor</b>
Wildlife/ grassland	15	Musco N., Koura B.I., Tudisco R., Awadjihè G., Adjolohoun S., Cutrignelli M.I., Mollica M.P., Houinato M., Infascelli F., Calabò S.	Nutritional characteristics of forage grown in south of Benin	<i>Asian-Australian Journal of Animal Science</i> 29(1), 51-61.	0.541
Forest/ Plant ecology	16	Sinasson Sanni, G.K., Shackleton, C.M., Glèlè Kakai, R.L., and Sinsin, B.	Forest degradation and invasive species synergistically impact <i>Mimusops andongensis</i> (Sapotaceae) in Lama Forest Reserve	<i>Biotropica</i>	1.944
Landscape ecology/ land degradation & restoration	17	Shackleton, C.M., Ruwanza, S., Sinasson Sanni, G.K. et al.	Unpacking Pandora's Box: Understanding and Categorising Ecosystem Disservices for Environmental Management and Human Wellbeing	<i>Ecosystems</i> 19(4), 587-600.	3.751
Forest/ Plant ecology	18	Sylvanus Mensah, Thierry Dèhouégnon Houéhanou, Achille Ephrem Assogbadjo, Kenneth Agbesi Anyomi, Amadé Ouedraogo & Romain Glèlè Kakai	Latitudinal variation in the woody species diversity of <i>Afzelia africana</i> Sm. habitats in West Africa	<i>Tropical Ecology</i> 57(4): 717-726, 2016	0.88
Landscape ecology/ land degradation & restoration	19	Sessi Gilles Christian Adjahossou, Gérard Nounagnon Gouwakinnou, Dèhouégnon Thierry Houehanou, Akoeugnigan Idelphonse Sode, Alain Séakpo Yaoitcha, Marcel Romuald Benjamin Houinato, Brice Sinsin	Efficacité des aires protégées dans la conservation d'habitats favorables prioritaires de ligneux de valeur au Bénin	<i>Bois et Forêts des Tropiques</i> , 328 (2), 67-76.	0.43
Wildlife/ grassland	20	Kindomihou MV., Sinsin B., Holou RYA, Ambouta J-M K, Gruber W., Adjolohoun S., Houinato M., Herbauts J., Lejoly J., Meerts P.	The effect of seasonal variations, covariations with minerals and forage value on Itchgrass' foliar silicification from Sudanian Benin	<i>Silicon</i> 8(4):487–496 (2016) DOI 10.1007/s12633-015-9355-y	0.860
Agriculture/ Agroforestry	21	Idohou, R., Peterson, A.T., Assogbadjo, A.E., Vihotogbe, R.L., Padonou, E., Kakai, R. G	Identification of potential areas for wild palm cultivation in the Republic of Benin through remote sensing and ecological niche modeling	<i>Genetic Resources and Crop Evolution</i> , 1-11	1.258
Forest/ Plant ecology	22	Agbahoungba S., Assogbadjo A.E., Chadare F.J., Idohou R., Salako V.K., Agoyi E.E., Glele Kakai R.L.	Ecological diversity and conservation of wild edible fruit trees species in the Lama Forest Reserve in Benin	<i>Bois et Forêts des Tropiques</i> , 329 (3) 53-56	0.32

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>	<b>Impact Factor</b>
Forest/ Plant ecology	23	Mensah S., Veldtman R., Assogbadjo A.E., Glele Kakai R., Seifert T.	Tree species diversity promotes aboveground carbon storage through functional diversity and functional dominance	<i>Ecology and Evolution</i> 6 (20), 7546-7557	2.537
Forest/ Plant ecology	24	Cron G.V., Karimi N., Glennon K.L., Udeh C.A., Witkowski Ed.T.F., Venter S.M., Assogbadjo A.E., Baum D.A.	One African baobab species or two? Synonymy of <i>Adansonia kilima</i> and <i>A. digitata</i> .	<i>TAXON</i> 65 (5), 1037-1049	2.9
Forest/ Plant ecology	25	Mensah S., Assogbadjo A.E., Salako K.V., Ago E.E., Glele Kakai R.	Accounting for tree spatial distribution in a comparison of plot sizes and shapes in dense forest and woodland in Benin (West Africa)	<i>African Journal of Ecology</i> 54(1)	0.875
Forest/ Plant ecology	26	Idohou R., Assogbadjo A.E., Glele Kakai R. & Peterson A.T.	Spatio-temporal dynamic of suitable areas for species conservation in West Africa: eight economically important wild palms under present and future climates	<i>Agroforestry systems</i> 1-14	1.215

**Appendix 7: Articles published in peer-review journal without IF in 2016**

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>
Wildlife/ grassland	1	B. A. Djossa, P. M. S. Agonglanon, A. Afanou et G. A. Mensah	Analyse de quelques paramètres d'élevage du rat roussard ( <i>Arvicanthis niloticus</i> , Desmarest, 1822) en captivité étroite à Kétou au sud-est du Bénin	BRAB :Numéro spécial Agronomie, Société, Environnement & Sécurité Alimentaire - Août 2016 :p 46-56
Forest/ Plant ecology	2	E. B. Ayihouenou, A. B. Fandohan, A. I. Sodé, N. G. Gouwakinnou et A. B. Djossa	Biogéographie du néré ( <i>Parkia biglobosa</i> (Jack.) R. Br. ex. Don.) sous les conditions environnementales actuelles et futures au Bénin	BRAB :Numéro spécial Agronomie, Société, Environnement & Sécurité Alimentaire - Août 2016 : p 93-108
Forest/ Plant ecology	3	Dossa K., Toni H., Azonanhoun P., Djossa A.B.	Caractérisation de quelques peuplements naturels de Baobab ( <i>Adansonia digitata</i> L.) et des pressions subies dans les différentes zones chorologiques du Benin	<i>Journal of Applied Biosciences</i> 93:8760 – 8769
Risk assessment/ Climate change	4	Moutouama JK, Fandohan AB, Biaou SSH, Amahowe OI, Moutouama FT, Natta AK	Potential climate change favored expansion of a range limited species, <i>Haematostaphis barteri</i> Hook f.	<i>Journal of Agriculture and Environment for International Development</i> 110 (2): 397-411
Risk assessment/ Climate change	5	E. N. Houngbo	<i>Agroécologie, la solution à l'insécurité alimentaire face au changement climatique en Afrique</i>	Bulletin de la Recherche Agronomique (BRAB)
Wildlife/ grassland	6	Paolo Lesse, Marcel Houinato, Fortuné Azihou, Jonas Djenontin, Brice Sinsin	Typologie, productivité, capacité de charge et valeur pastorale des pâturages des parcours transhumants au Nord Est de la République du Bénin	<i>International Journal of Innovation and Applied Studies</i> , 14: 132 – 150.

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>
Forest/ Plant ecology	7	Oyélèyè Fafunkè Titilayo Dotchamou, Gilbert Atindogbé, Akomian Fortuné Azihou, Houédougbé Noël Fonton	Caractérisation de la répartition spatiale des arbres de <i>Parkia biglobosa</i> (Jacq.) R. BR. au Bénin	Revue CAMES - Science de la vie, de la terre et agronomie, 4 : 59 – 67.
Ethnobiology	8	Marcel T. Donou Hounsoye, Achille E. Assogbadjo, Thierry Houehanou, Romain L. Glele Kakai, Clément Agbangla	Facteurs socioéconomiques influençant l'usage des raphias au Benin (Afrique de l'ouest)	REV. CAMES : Science de la vie, de la terre et agronomie - VOL.04 NUM.01. 2016
Ethnobiology	9	D.T. Houéhanou, A. E. Assogbadjo, F. J. Chadare, S. Zanco & B. Sinsin	Approches méthodologiques synthétisées des études d'ethnobotanique quantitative en milieu tropical	Annales des Sciences Agronomiques 20 - spécial Projet Undesert-UE : 187-205 (2016)
Ethnobiology	10	Fifanou G. Vodouhe, Hubert O. Dossou Yovo, Flora J. Chadaré, Nancy Gélinas, Achille E. Assogbadjo, Ousmane Coulibaly	Valuing the Potential of Non-timber Forest Products in Financial Valuation of Savannah Formation in Sudanian Region	Universal Journal of Agricultural Research
Agriculture/ Agroforestry	11	BAHINI M.J.D., BABATOUNDE S., ABOH A., SAÏDOU A., KINDOMIHOU V., MENSAH G. A.	Production de gaz in vitro et valeur nutritive des fanes de seize variétés à usage multiple de niébé ( <i>Vigna unguiculata</i> L, Walp) cultivées au Bénin.	<i>Journal of Applied Biosciences</i> 105: 10134-10151 (2016). <a href="http://dx.doi.org/10.4314/jab.v105i1.10">http://dx.doi.org/10.4314/jab.v105i1.10</a>
Wildlife/ grassland	.12	A. B. Aboh, S. H. S. Honvou, I. Gbégo Tossa, G. A. Zoffoun et G. A. Mensah	Effet de la pâture des ovins sur le rendement en grains de maïs et de fourrage et les propriétés du sol dans le système d'association de cultures maïs- <i>Lablab purpureus</i> au Bénin.	<i>Bulletin de la Recherche Agronomique du Bénin</i> (BRAB). ISSN sur papier (on hard copy) : 1025-2355 et ISSN en ligne (on line) : 1840-7099. Disponible en ligne (on line) sur le site web <a href="http://www.slire.net">http://www.slire.net</a> .
Forest/ Plant ecology	13	Glèlè Kakai R., Salako V.K., Padonou E.A., Lykke A.M.	Méthodes statistiques multivariées utilisées en écologie	Annales des Sciences Agronomiques 19(1): 9-26
Forest/ Plant ecology	14	Strandberg B., Lykke A.M., Padonou E.A	Méthodes d'estimation objective du recouvrement de la Végétation et de la biomasse herbacées	Annales des Sciences Agronomiques 19(1): 1-7
Forest/ Plant ecology	15	Mcghee W., Saigle W., Padonou E. A., Lykke A.M	Méthodes de calcul de la biomasse et du carbone des arbres en Afrique de l'Ouest	Annales des Sciences Agronomiques 19(1) : 29-48
Agriculture/ Agroforestry	16	Dossa K., Niang M., Assogbadjo A.E., Cisse N., Diouf D.	Whole genome homology-based identification of candidate genes for drought tolerance in sesame ( <i>Sesamum indicum</i> L.)	<i>African Journal of Biotechnology</i> 15(27), 1464-1475
Forest/ Plant ecology	17	Dossou-Yovo H.O., Assogbadjo A.E., Sinsin B.	The Contribution of Termitaria to Plant Species Conservation in the Pendjari Biosphere Reserve in Benin.	<i>Environment and Ecology Research</i> , 4, 200-206

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>
Landscape ecology/ land degradation & restoration	18	Akpona T.J.D., Idohou R., Assogbadjo A.E., Salako V.K., Glele Kakai R.	History, Impact of Soil Types on Stand Structure and Growth of the Dry Zone Mahogany ( <i>Khaya senegalensis</i> (Desr.) A.Juss.) in Plantation in Benin (West Africa)	<i>Environment and Ecology Research</i> 4(4)
Education	19	Assogbadjo A.E., Idohou R. & Sinsin B.	Review of the higher education system in Benin: Status, challenges, opportunities and strategies for improvement	<i>African Journal of Rural Development</i> , 1(2)
Agriculture/ Agroforestry	20	Gbedomon R.C., Salako V.K., Chadare F.J., Glele Kakai R., Assogbadjo A.E.	Gendered motivation for home gardening and maintenance of agro-biodiversity: a case study in Benin, West Africa	<i>Annales des Sciences Agronomiques</i> 20(2)
Agriculture/ Agroforestry	21	Tchetangni Y. A, Assogbadjo A.E., Houehanou T et Bello D.O	Perception paysanne des effets du changement climatique sur la production des noix d'anacardier ( <i>Anacardium occidentale</i> L.) dans la commune de Savalou au Benin	<i>European Scientific Journal</i> 12 (14)
Ethnobiology	22	Donou Hounsoye M.T., Assogbadjo A.E., Houehanou T., Glele Kakai R.L, Agbangla C.	Facteurs socioéconomiques influençant l'usage des Raphias au Benin (Afrique de l'Ouest)	<i>Revue de CAMES Science de la vie, de la terre et agronomie</i> 4(1)
Agriculture/ Agroforestry	23	Houedjissin S.S., Azokpota P., Assogbadjo A., Ahanhanzo C., Hounhouigan J.D.	Traditional classification, perception, and preferences for tallow tree ( <i>Pentadesma butyracea</i> Sabine) organs in Benin: implications for domestication and conservation	<i>Journal of Applied Biosciences</i> 93
Ethnobiology	24	Ayena A.C., Agassounon D.T.M., Assogbadjo A.E., Adoukonou- Sagbadja H., Agbangla C., Ahanhanzo C.	Usages et vulnerabilité de <i>Pterocarpus Santalinoides</i> L'her. Ex De (Papillionoideae), une plante utilisée dans le traitement des gastro-enterites dans le sud du Benin	<i>European Scientific Journal</i> 12 (6)]
Ethnobiology	25	Donou M.T., Houehanou T., Assogbadjo A.E., Glele Kakai R.L., Agbangla C.	Use of Raffias' species ( <i>Raphia spp.</i> ) and its impact on socioeconomic characteristics of harvesters in Benin (West Africa)	<i>International Journal of Biomolecules and Biomedicine</i> , 5 (1)

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>
Wildlife/ grassland	26	Henschel P, Petracca L. S., Hunter L. T. B., Kiki M., Sewadé C., Tehou A. and Robinson H. S	Determinants of distribution patterns and management needs in a critically endangered Lion panthera leo population.	<i>Frontiers in Ecology and Evolution</i> 4:110. doi: 10.3389/fevo.2016.00110.
Agriculture/ Agroforestry	27	Koura T.W., Kindomihou V., Dagbenonbakin G. Janssens M, Sinsin B.	Quantitative assessment of palm oil wastes generated by mills in Southern Benin.	<i>African Journal of Agricultural Research</i> 11 (19): 1787-1796 (2016) DOI: 10.5897/AJAR2013.8124
Forest/ Plant ecology	28	Alain Sèakpo YAOITCHA, André Boya ABOH, Alex Gbèliho ZOFFOUN, Marcel HOUINATO, Guy Apollinaire MENSAH, Brice SINSIN, Elie Léonard AKPO,	Potentiel de régénération des chantiers de production du charbon de bois au Centre-Bénin.	<i>International Journal of Biological and Chemical Sciences</i> , ISSN 1997-342X (Online), ISSN 1991-8631 (Print).

**Appendix 8: Articles in press in peer-review journal with IF in 2016**

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>	<b>Impact Factor</b>
Agriculture/ Agroforestry	1	T. J. D. Akpona, H. A. Akpona, B. A. Djossa, M. K. Savi, K. Daïnou, B. Ayihouenou & R. Glèlè Kakaï	Impact of land use practices on traits and production of shea butter tree ( <i>Vitellaria paradoxa</i> C.F. Gaertn.) in Pendjari Biosphere Reserve in Benin	<i>Agroforestry Systems</i> DOI 10.1007/s10457-015-9847-1	1.22
Ethnobiology	2	Assogba GA, Fandohan AB, Salako VK, Assogbadjo AE	Utilisations de <i>Bombax costatum</i> (Malvaceae) dans les terroirs riverains de la Réserve de Biosphère de la Pendjari, République du Bénin	<i>Bois et Forêts des Tropiques</i>	0.192
Landscape ecology/ land degradation & restoration	3	Goussanou C.A., Guendehou S., Assogbadjo A.E., Sinsin B.	Application of site-specific biomass models to quantify spatial distribution of biomass stocks and historical emissions from deforestation in a tropical forest ecosystem in West Africa	<i>Journal of Forestry Research</i>	0.6
Ethnobiology	4	Houndonougbo J., Idohou R., Salako V. K., Fortune A. A., and Glèlè Kakaï R.	Local perceptions of elephant- <i>Borassus aethiopum</i> (Arecaceae) interactions in the Pendjari National Park in Benin	<i>Bois et Forêts des Tropiques</i>	0.192

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>	<b>Impact Factor</b>
Forest/ Plant ecology	5	Alain K. Gbeffe1, Thierry D. Houehanou1, Muhashy Habiyaremye, Emeline S. P. Assede, Alain S. Yaoitcha1, Luc Janssens de Bisthoven, Etotépé A. Sogbohossou, Marcel Houinato and Brice A. Sinsin	Effects of termite mounds on composition, functional types and traits of plant communities in Pendjari Biosphere Reserve (Benin, West Africa)	<i>African Journal of Ecology</i>	0.87
Forest/ Plant ecology	6	Inoussa, M.M., Padonou, E.A., Glèlè Kakaï, R., Lykke, A.M., Bakasso, Y., Mahamane, A., Saadou, M.	Structural and ecological indicators of <i>Pterocarpus erinaceus</i> and <i>Anogeissus leiocarpa</i> in woodland in the W National Park of Niger, West Africa	<i>South African Journal of Botanic</i>	1.244
Risk assessment/ Climate change	7	A.E. Assogbadjo, S. Mensah, R. Glele Kakai	The relative importance of climatic gradient versus human disturbance in determining population structure of <i>Afzelia africana</i> in West Africa	<i>Southern Forests</i>	0.696
Landscape ecology/ land degradation & restoration	8	K. Gandji, V. Salako, A.E. Assogbadjo, V.O.A. Orekan, R.L. Glele Kakai, B.A. Sinsin	Evaluation of the sustainability of participatory management of forest plantations: the case study of Wari-Marø Forest Reserve, Republic of Benin (West Africa)	<i>Southern Forests</i>	0.696
Socioeconomy	9	S. Mensah, R. Veldtman, A.E. Assogbadjo, C.Ham, R. Glele Kakai, T. Seifert	Ecosystem service importance and use vary with socio-environmental factors: A study from household-surveys in local communities of South Africa	<i>Ecosystem services</i>	4.307

**Appendix 9: Articles in press in peer-review journal without IF in 2016**

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>
Wildlife/ grassland	1	Ivan Bossima Koura, Serena Calabò, Luc Hippolyte Dossa, Nadia Musco, Monica Isabella Cutrignelli, Marcel Romuald Benjamin Houinato	Nutritional value of cereal and legume crop residues fed to ruminant in Republic of Benin	<i>Journal of Nutritional Ecology and Food Research</i>
Wildlife/ grassland	2	Zinzalo R., Akouehou G., Kindomihou V., Sinsin B.	Facies de végétation et caractérisation pastorale des agrosystèmes à <i>Elaeis guineensis</i> dans le périmètre Zè-Allada-Toffo au Sud-Bénin	<i>International Journal of Biological and Chemical Sciences</i>
Ethnobiology	3	Donou M.T., Houéhanou T., Assogbadjo A.E., Glèlè Kakaï R.L., Agbangla C.	Use of Raffias' species ( <i>Raphia spp.</i> ) and its impact on socioeconomic characteristics of harvesters in Benin (West Africa)	<i>International Journal of Biomolecules and Biomedicine</i> , 5 (1), 1-19

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>
Wildlife/ grassland	4	Doha Y. G. AWOHOUEDJI, Séverin BABATOUNDE, Alex Gbêliho Zoffoun, Sylvie Hounzangbe-Adote, Marcel Houinato, Ibrahim Traoré Alkoiret & Guy-Appolinaire Mensah	<i>In vivo digestibility of Boerhavia diffusa and Khaya senegalensis</i> in West African Dwarf sheep in the Sudano-Guinean zone in Benin.	South African Journal of Animal Science

**Appendix 10: Articles under review in peer-review journal with IF in 2016**

<b>Disciplines</b>	<b>N°</b>	<b>Authors' Names</b>	<b>Title of the article</b>	<b>Journals</b>	<b>Impact Factor</b>
Ethnobiology	1	Fandohan AB, Chadare FJ, Gouwakinnou NG, Tovissode CF, Bonou A, Djonlonkou FS, Houndelo LFH, Sinsin CLB, Assogbadjo AE	Usages traditionnelles et valeur économique de <i>Synsepalum dulcificum</i> (Schumach. & Thonn.) Daniell	Bois et Forêts des Tropiques	0.192
Landscape ecology/ land degradation & restoration	2	Goussanou C.A., Guendehou S., Sinsin B.	Variation in soil organic carbon along soil profile and across three vegetation types in a tropical forest in West Africa	Carbon Management	2.092
Ethnobiology	3	Gisèle K. Sinasson Sanni, Charlie M. Shackleton, Achille E. Assogbadjo and Brice Sinsin	Local Knowledge on the Uses, Habitat and Change in Abundance of Multipurpose <i>Mimusops</i> Species in Benin	Economic Botany	1.109
Forest/ Plant ecology	4	Sinasson S., G.K, Shackleton, C.M., and Sinsin, B.	Reproductive phenology of two <i>Mimusops</i> species in relation to climate, tree diameter and canopy position in Benin (West Africa)	African Journal of Ecology	0.875
Forest/ Plant ecology	5	Assédé, E.P.S., Djagoun, S.C., Azihou, A.F., Gogan, Y.C., Kouton, M.D. et al.	Efficiency of conservation areas to protect orchid species in Benin, West Africa	South African Journal of Botanic	1.2
Forest economics	6	Fifanou G. Vodouhe, Nancy Gélinas, Jean-Claude Ruel and Stéphane Tremblay	Profitability of Commercial Thinning in Natural Black Spruce Forests in Quebec	Forests	1.583
Landscape ecology/ land degradation & restoration	7	Padonou, E.A., Bachmann, Y., Lykke, A.M., Sinsin, B	Land use land cover change mapping and prediction of future extension of bowé in West Africa (Benin)	Land use policy	2.768
Forest/ Plant ecology	8	Christensen, S.N., Barfod, AS., Sambou, B., Niang-Diop, F., Diop, M., Padonou, EA., Lykke, AM	Tree density, diversity and decline in Senegalese farmlands	Agroforestry system	0.910

**Appendix 11: Articles under review in peer-review journal without IF in 2016**

Disciplines	N°	Authors' Names	Title of the article	Journals
Forest economics	1	Assogbadjo A.E., R. Idohou, Chadare F.J., Djagoun C.A.M.S., Akouehou G. & Mbairamadji J.	Prioritization of Non Timber Forest Products for economic valorization in Benin (West Africa) using an innovative approach	African Journal of Rural Development
Ethnobiology	2	Kolimedje Emilie Norberte,Djego Gaudence , Yorou S. Nourou	Etude ethnomycoloque et importance socioéconomique des champignons dans la commune de Zangnanado au BENIN	<i>Annal des Sciences Agronomiques</i>
Agriculture/ Agroforestry	3	Fantodji, L., Padonou, E.A., Assogbadjo, A.E.	Variation phénotypique des organes de Irvingia gabonensis (Aubry-Lecomte) Baill dans le phyto-district Plateau au Bénin	<i>Annal des Sciences Agronomiques</i>
Ethnobiology	4	Atanasso, J.A., Padonou, E.A., Houehanou, T., Chadare, F., Koura, K., Assogbadjo, A.E., Sinsin, B.	Local perception on the habitat and uses of Lippia multiflora Moldenke in West Africa (Benin)	<i>Agronomie Africaine</i>
Agriculture/ Agroforestry	5	Atanasso, J.A., Padonou, E.A., Houehanou, T., Chadare, F., Koura, K., Assogbadjo, A.E., Sinsin, B	Caractérisation écophénotypique de Lippia multiflora Moldenke au Bénin (Afrique de l'Ouest)	<i>Cahier d'Agriculture</i>

**Appendix 12: Publications in proceedings in 2016**

Field of research	N°	Authors' Name	Title	Full References
Wildlife/ grassland	1	Hédégbétan, G.C., Martin, D., Kpéra, G.N., Tchankpan, C.M., Martin, S. and Shirley, M.H.	Community-based crocodile conservation in the Sitatunga Valley Natural Reserve in Benin.	Hédégbétan, G.C., Martin, D., Kpéra, G.N., Tchankpan, C.M., Martin, S. and Shirley, M.H., 2016. Community-based crocodile conservation in the Sitatunga Valley Natural Reserve in Benin. In IUCN (Ed). Proceedings of the 24 <sup>th</sup> Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN convened at Skukuza, South Africa, 182-185.
Wildlife/ grassland	2	Kpera, G.N., Mensah, G.A., Aarts, M.N.C., Tossou, C.R. and van der Zijpp, A.J.	Innovation platform as a conducive space for reducing human-crocodile conflicts in agro-pastoral dams in Benin.	Kpéra, G.N., Mensah, G.A., Aarts, M.N.C., Tossou, C.R. and van der Zijpp, A.J., 2016. Innovation platform as a conducive space for reducing human-crocodile conflicts in agro-pastoral dams in Benin. In IUCN (Ed). Proceedings of the 24th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN convened at Skukuza, South Africa, 2016, 42-51

**Appendix 13: Abstracts in books of abstracts in 2016**

Field of research	N°	Authors' Name	Title	Full References
Rural Economics	1	Houngbo, N. Emile ; Djihinto, C. Angelo & Sinsin, A. Brice	Le riz, une spéculation d'intégration économique ouest africaine sous-exploitée	9th Edition, National Scientific Workshop, Benin National Institute of Agricultural Researches, Résumés & Abstracts, 22-24 November 2016, p 48.
Agriculture/ Agroforestry	2	Koura B.I., Hounodonougbo M.F., Calabro S., Hougnandan P., Houinato M.	Effect of groundnut haulms and soybean pods supplementation on feed intake, digestibility and growth performances of sheep fed urea treated maize stover base diet	5ème Journées des Sciences de la Vie : Environmentally friendly technologies: challenges for adaptation and sustainable development (JSV 2016) – du 04 au 06 Août 2016 à l'Université de Dschang au Cameroun, Cameroon Forum for Biological Sciences (CAFOBIOS), Livre des résumés, 57-58
Ethnobiology	3	Gisèle K. S. Sinasson, Charlie M. Shackleton, Achille E. Assogbadjo, Brice Sinsin	Local knowledge on the uses, habitat and abundance of multipurpose <i>Mimusops</i> species in Benin (West Africa)	Book of Abstracts, Page 46. Society for Economic Botany (SEB) Conference on “Cultural Resilience and Resource extraction: Preserving Plants and People of Degraded Ecosystems”.

**Appendix 14: Technical Reports and books in 2016**

Field of research	N°	Authors' Name	Title	References
Forest/ Plant ecology	1	Assédé, E.P.S., Kouton, M.D., Geldenhuys, C., Sinsin, B.	Habitat and Plant Species of the Biosphere Reserve of Pendjari	Les Edition Plurielles, Cotonou, Bénin, 128 p.
Landscape ecology/ land degradation & restoration	2	Bob, S., Zietsman, J., Geldenhuys, C., Assédé, E.P.S. et al.	Fire in contemporary African landscapes: Status quo, risks and opportunities	Working on fire group, World Bank, Pretoria, South Africa.
Education	3	Emile Nounagnon Houngbo	Manuel de didactique et de pédagogie universitaires. A l'intention de l'Afrique noire francophone	Editions HDH Internationales, Cotonou, 216 pages
Wildlife/ grassland	4	Matsuda Goodwin R., Oates F. J., Nobimè G., Segniagbeto H. G. & Mittermeier A. R., 2016a.	<i>Cercopithecus erythrogaster</i> ssp. <i>erythrogaster</i> . The IUCN Red List of Threatened Species 2016a.	<a href="http://www.iucnredlist.org/details/40003/0">http://www.iucnredlist.org/details/40003/0</a>

Wildlife/ grassland	5	Matsuda Goodwin R., Oates F. J., Nobimè G., Segniagbeto H. G., Ikemeh A. R. & Mittermeier A. R., 2016b	<i>Cercopithecus erythrogaster</i> . The IUCN Red List of Threatened Species 2016b.	<a href="http://www.iucnredlist.org/details/40003/0">http://www.iucnredlist.org/details/40003/0</a>
Forest/ Plant ecology	6	Yaoitcha A. S., Boya A. B., Zoffoun G. A., Houinato M., MENSAH G. A.	Caractérisation des peuplements des espèces ligneuses exploitées pour la production du charbon au Centre-Bénin	<i>Bibliothèque Nationale (BN) du Bénin, 4<sup>ème</sup> trimestre, ISBN : 978-99919-2-566-0, 10 p.</i>
Forest/ Plant ecology	7	Yaoitcha A. S., Houehanou D.T., Fandohan A. B., Zoffoun G. A., Houinato M., Mensah G. A., Sinsin A. B.	Priorisation pour la conservation d'espèces ligneuses utilitaires de la Réserve de Forêt de Wari-Maro	<i>Bibliothèque Nationale (BN) du Bénin, 4<sup>ème</sup> trimestre, ISBN : 978-99919-2-568-4, 12 p.</i>

**Appendix 15: Participation at workshops/conferences in 2016**

N°	Title and period	Type of presentation (oral, poster, ..)	Name of the participants from LEA	Cost
1	24th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN convened at Skukuza, South Africa, 23-26 May 2016	Oral presentation : Innovation platform as a conducive space for reducing human-crocodile conflicts in agro-pastoral dams in Benin	Kpéra G. N.	Supported by CSG/SSC/IUCN
2	24th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN convened at Skukuza, South Africa, 23-26 May 2016	Poster presentation : Community-based crocodile conservation in the Sitatunga Valley Natural Reserve in Benin	Kpéra G. N.	Supported by CSG/SSC/IUCN
3	Utilizing and Conserving Natural Resources under Climate Change in Africa 5 – 7 December 2016	Poster	Franck C. A. SINSIN	
4	10th General Assembly of the African Academy of Sciences (AAS), 20 – 23 June 2016, Kasane, Botswana	Attendance only	Akomian Fortuné Azihou	Full support by the African Academy of Sciences
5	Humboldt Kolleg meeting, 5 – 7 December 2016, Ouidah, Benin	Oral presentation	Akomian Fortuné Azihou	Financial support of the Alexander von Humboldt Foundation

6	Society for Economic Botany (SEB) Conference on “Cultural Resilience and Resource extraction: Preserving Plants and People of Degraded Ecosystems”. Kentucky, USA, 5 <sup>th</sup> -9 <sup>th</sup> June 2016.	<i>Oral</i>	SINASSON S. K. Gisèle	3000 USD
7	IUCN Primate Specialist Group Workshop for the red listing of African primates à Sapienza University, Rome en Italie 18 au 23 avril 2016	Oral presentation Benin primate diversity	Dr. NOBIME Georges	UICN
8	Leibniz Alumni Workshop à Berlin et visite du Musée Alexandre Koeing de Bonn, Leibniz Association de Berlin en Allemagne 21 au 28 novembre 2016	Oral presentation Primateological research in Benin (West Africa).	Dr. NOBIME Georges	Leibniz Association
9	Tropentag 2016, September 19 - 21, in Vienna, Austria "Solidarity in a competing world - fair use of resources"	<b>Poster:</b> How Quantitative Ethnobotany Involves Biodiversity Conservation: an Approach on Wari-Maré Forest Reserve (Benin)	Thierry Houehanou	
10	Université des vacances du Laboratoire de Cartographie : Quelle formation de la jeunesse pour la relève de qualité et le développement durable du Bénin ? 08 - 11 août 2016	Oral	Fifanou G. Vodouhe	
11	Humboldt Kolleg Meeting in Ouidah, Benin : 5-7 december 2016	Oral	Fifanou G. Vodouhe	
12	EOA 2016: Mainstreaming Ecological Organic Agriculture (EOA) into National Policies, Strategies and Programmes in Africa. Workshops on 2016 activities, operationalization of the Work Plan 2017 and building capacity of the PIPs. Bohicon. December 19 – 20, 2016.	Attendance	Valentin Kindomihou	
13	EOA 2016: Mainstreaming Ecological Organic Agriculture (EOA) into National Policies, Strategies and Programmes in Africa. Conference on EOA: Advances in executives Activities in West Africa and for Network reinforcement. Grand Popo, Bénin. October 26 – 28, 2016.	Attendance	Valentin Kindomihou	
14	JSIL 2016: XVI <sup>th</sup> Edition of International scientific days of Lomé (JSIL 2014). Campus of Lomé, Togo. Presentation on “Forage potentials of <i>Pennisetum glaucum</i> : a review”. October 3-8, 2016.	Oral	Moussa Hamadou Valentin Kindomihou	
15	EOA 2016: Representative of the Benin National organic network to the building of the terms of references for revision of 2015 – 2020’Actions plan, Bio vision African trust, Beninese Network for Promoting Organic Agriculture (OBEPAB), Switzerland Cooperation and African Union. Bohicon, Benin. May 3 – 4, 2016	Attendance	Valentin Kindomihou	

16	WAAPP 2016: West African Agricultural productivity Programme (WAAPP-World Bank). Planning and identification of key domains for research and trainee for the National Centre for specialization in livestock breeding (CNS – Livestock breeding/WAAPP). Niamey, Niger. Consultants and trainers. April 18 – 22, 2016	Attendance and consultancies	Valentin Kindomihou Frédéric Hounodonougbo Appolinaire Mensah	
17	Emile Agbangba 'PhD thesis defense; Title: "Pineapple ( <i>Ananas comosus</i> ) growth, yield and fruit quality responses to mineral fertilization in Benin". Cheick Anta Diop University, Doctoral School of Life, Health and Environmental Sciences (ED-SEV), Dakar, Senegal. January 13 – 20, 2016.	Thesis Report and Board Member	Valentin Kindomihou	
18	Marrakech, Maroc; 1 <sup>er</sup> au 18 novembre 2016 22 <sup>ème</sup> Conférence des Parties de la Convention-Cadre des Nations Unies sur les Changements Climatiques (COP 22), la 12 <sup>ème</sup> Conférence des Parties agissant comme Réunion des Parties au Protocole de Kyoto (CMP12) et la 1 <sup>ère</sup> Conférence des Parties agissant comme Réunion des Parties à l'Accord de Paris (CMA1).		Zoffoun G. Alex	4.500.000 FCFA
19	Journées Scientifiques Internationales de Lomé (JSIL-2016) XVII <sup>e</sup> Édition du 03 au 08 octobre 2016, Campus de l'Université de Lomé pp.192-193.	Poster : Importance socio-économique du palmier à huile : produits et sous-produits	Zoffoun G. Alex	700.000 FCFA
20	Journées Scientifiques Internationales de Lomé (JSIL-2016) XVII <sup>e</sup> Édition du 03 au 08 octobre 2016, Campus de l'Université de Lomé p.191.	Oral : <u>Viabilité des marchés de drêches de brasseries dans la Commune de Porto-Novo au Bénin,</u>	Zoffoun G. Alex	idem
21	Journée de la Renaissance Scientifique de l'Afrique (JRSA), édition 2016, 27–30 juin 2016, Institut des Sciences Biomédicales Appliquées (ISBA), Champ de Foire, Cotonou.	Oral : Knowing bowelization, its impact on biodiversity, soil and human livelihoods in West Africa	Padonou, E.A.	
22	Rufford Small grant conference, 29-30 October 2016, Erata Hotel, Accra, Ghana.	Oral : Best practices for combating bowelization in West Africa	Padonou, E.A.	
23	Fifth Regional Universities Forum for Capacity Building in Agriculture Biennial Conference. Hotel Grand VIP, Cape Town, South Africa, 17-21 October, 2016	Oral / Chair of session	Assogbadjo A.E.	RUFORUM
24	8th Trondheim Conference on Biodiversity; Trondheim (Norway), 31 May – 3 June 2016.	Participant	Assogbadjo A.E.	Government of Norway
25	Sub Regional workshop on strengthening the forest laws, good governance and fair trade in East Africa; (ECOWAS Commission, Headquarters, Conference Room 368); Abuja (Federal Republic of Nigeria), 23 to 25 May 2016.	Participant	Assogbadjo A.E.	African Forest Forum (AFF)

26	TWAS Research Grants Conference - Shaping Careers in Science, Trieste, Italy, 18-22 April 2016	Oral	Assogbadjo A.E.	TWAS
27	WASCAL international advisory board meeting. Bingerville (Côte d'Ivoire), 11-13 January 2016	Participant	Assogbadjo A.E.	WASCAL

**Appendix 16: Research projects of LEA in which you have been involved in 2016**

N°	Title of the project	Sources of Funding	Objectives of the project	Status (ongoing or ended)	Estimated fund
1	Identifying suitable ecotypes for Agroforestry Fruit Trees for future climates	The Alexander von Humboldt Foundation	<ul style="list-style-type: none"> <li>1. Comparing inter-annual variation in plastic traits among different ecotypes of three key AFT species.</li> <li>2. Examining how ecotype-specific plasticity could affect species distributions under current and future environments, using different demographic indicators.</li> <li>3. Modeling and mapping current and future potential range of different ecotypes of three key AFT species. Combining results from different plasticity indicators to derive more plausible predictions.</li> </ul>	Ongoing	6,500 Euros
2	Renforcement des capacités des acteurs de la conservation pour une mise en pratique des acquis de la recherche scientifique dans la Réserve de Biosphère de la Pendjari (RBP)	Institut Royal des Sciences Naturelles de Belgique	Améliorer l'état des connaissances et l'utilisation des acteurs de la conservation par les acquis de la recherche.	Ongoing	
3	Developing adaptive conservation strategies for African crocodile species under different climate scenarios in West Africa		<ul style="list-style-type: none"> <li>- Assessing the current potential suitable climatic niche for <i>C. suchus</i>, <i>M. cataphractus</i> and <i>O. tetraspis</i> in Benin;</li> <li>- Assessing the impact of climate change on the geographic range of the suitable climatic niche for <i>C. suchus</i>, <i>M. cataphractus</i> and <i>O. tetraspis</i> under different climate scenarios;</li> <li>- Assessing the effectiveness of the national protected areas network to protect <i>C. suchus</i>, <i>M. cataphractus</i> and <i>O. tetraspis</i> under current and</li> </ul>	Ongoing	

N°	Title of the project	Sources of Funding	Objectives of the project	Status (ongoing or ended)	Estimated fund
			future climatic conditions.  - Analyzing implications for adaptive management strategies.		
4	Enhancing elephant protection in Pendjari and the wider Parc W Landscape	Species Grant	Overall project goal: Enhance anti-poaching activities in Pendjari, and the wider Parc W landscape Specific objectives: 1. Support the ranger capacity- resources in the Pendjari and W park 2. Establish fully equipped rapid response units in the Pendjari and W park 3. Secure elephant corridors in the Pendjari and W park landscape 4. Train regional customs, judicial, prosecutorial and law enforcement officials on wildlife crimes	ongoing	USD 81,300
5	Grazing lands in the periurban area of Southern Benin: characteristics and farmers' management practices	Fondation Internationale pour la Science (IFS), Bourse individuelle de recherche N° B/5863-1	-	Ongoing	12000 dollars USD
6	Effets Combinés des Activités Anthropiques et de la variabilité Climatique sur les Ressources naturelles et Systèmes d'Elevage du cordon littoral du Bénin (ECARESE)	FNRSIT	-	Ongoing	30.000.000 F CFA
7	Projet de partenariat entre le LEA et l'IRSNB	IRSNB	1. Renforcer les capacités de l'université d'Abomey-Calavi à répondre aux préoccupations de la DPNP, et des AVIGREFs sur la gestion des feux et leurs impacts sur les habitats et la faune dans la Réserve de Biosphère de la Pendjari, tout en valorisant l'expertise de l'IRSNB.  2. Informer et sensibiliser les acteurs et les bénéficiaires des services inhérents au parc (entre autres CENAGREF et AVIGREFs) sur les valeurs de ces services écosystémiques.	ongoing	

N°	Title of the project	Sources of Funding	Objectives of the project	Status (ongoing or ended)	Estimated fund
			3. Contribuer au réseau CHM national pour renforcer la coopération scientifique et technique		
8	Biologie de la Conservation et Ethnopharmacologie des Ligneux médicinaux de la pharmacopée béninoise (BIOCEL)	Fond National des Recherches Scientifiques et des Innovations Technologiques (FNRSIT)	(i) Evaluer la diversité et la disponibilité des principales espèces ligneuses médicinales employées pour le traitement des maladies humaines et animales les plus récurrentes ; (ii) Déterminer les aires prioritaires de conservation des principales espèces ligneuses médicinales; (iii) Evaluer <i>in vivo</i> les propriétés médicinales des principales espèces ligneuses utilisées pour le traitement des pathologies animales la plus récurrente.	ongoing	
9	Ecological Organic Agriculture	Biovision Africa_Kenya and Switzerland (SDC)	- Ecological and organic agriculture - Organizing and developing value chains in west Africa - Developing local markets and SPG approach with actors - Implementing producers and boost the partnership network - Mainstreaming (EOA) into National Policies, Strategies and Programmes in Africa 2014-2018.	Ongoing	
10	Utilisation des parents sauvages des plantes cultivées pour améliorer l'adaptation des systèmes de cultures au stress biotique et abiotique dans le contexte des changements climatiques	Fond National des Recherches Scientifiques et des Innovations Technologiques (FNRSIT)	-	Ongoing	10.000.000 FCFA

**Appendix 17: Research Grants in 2016**

N°	Title of Grant	Beneficiaries	Status (ongoing or ended)	Estimated fund
1	Equipment Subsidy Grant of the Alexander von Humboldt Foundation	Dr Ir Adandé Belarmain FANDOHAN	Ongoing	19,490 Euros
2	IFS Individual research grant	Dr KOURA Bossima Ivan	Ongoing	12000 dollars USD
3	International Foundation for Science (IFS) Individual Research Grant	SINASSON S. K. Gisèle	Ended	11560 USD
4	Organization for Women in Science for the Developing World (OWSD) Postgraduate Fellowship and co-supervision in South Africa	SINASSON S. K. Gisèle	Ended	30000 USD
5	Georg Forster Research Fellowship (HERMES) for Postdoctoral Researchers: Improving the efficiency of conservation and management strategies of the threatened tree species, <i>Afzelia africana</i> Sm. using morphological and molecular tools on its West African populations	Thierry Houehanou	ongoing	
6	Rufford Small Grant: Towards botanic garden setting through community-based knowledge for forest genetic resources conservation and training students in Sudanian zone of Benin	Thierry Houehanou	ongoing	
7	Rufford Small Grant, Great Britain	Dr Ir NAGO Gilles	Ended	GBP 5,000
8	IFS (International Foundation for Science) Research Grant n° D/5691-1, Sweden	Dr Ir NAGO Gilles	Ongoing	USD 11,380
9	Alumni Research Grant of Global Taxonomy Initiative (GTI) - Belgian National Focal Point, CEBioS, Brussels, Belgium	Dr Ir NAGO Gilles	Ongoing	1,986 Euros
10	Fonds Compétitifs pour la Recherche à l'Université de Parakou Edition 2016	Dr Ir NAGO Gilles	Ongoing	FCFA 1,500,000
11	Second Rufford Small grant	Elie Antoine Padonou	Ongoing	GBP 5,000

**Appendix 18: Prizes and nomination in 2016**

N°	Title of prize / nomination	Nominee	Estimated fund
1	Prize : IUCN/SSC/CSG Encouragement Award for research on Crocodile in West and Central Africa	Kpéra G. Nathalie	1,000 \$ US
2	Nomination : Vice-Chair West and Central Africa for Crocodile Specialist Group/International Union for Conservation of Nature and Natural Resources (IUCN/SSC/CSG)	Kpéra G. Nathalie	
3	Nomination : « Chargée de Recherche » of CAMES	Kpéra G. Nathalie	

4	Affiliate membership of the African Academy of Sciences (AAS) for the period 2016 – 2020.	Akomian Fortuné Azihou	
5	Georg Forster/Alexander-von-Humboldt	DJAGOUN C.A.M.S.	
6	African-German Network of Excellence in Science (AGNES) Grant for Junior Researchers	Elie Antoine Padonou	1000 Euro

**Appendix 19: Visitors received in 2016**

N°	Full names of visitors	Provenance	Responsibles in LEA	Topics
1	Prof Dr Carsten Dormann & Dr Gita Benadi	University of Freiburg, Germany	Dr Ir. Adandé Belarmain FANDOHN	Population modelling & Ecology
2	Serena Calabro and Pasquale Terracciano	Italy	Prof HOUINATO	Animal nutrition
3	Bianca Gasparri	Italy	Prof HOUINATO	Animal biotechnology and reproduction
4	Giulia Esposito	South Africa	Prof HOUINATO	Wild animal biotechnology
5	Emiliano Raffrenato	South Africa	Prof HOUINATO	Animal nutrition
6	Prof. Reiko Matsuda Goodwin	Fordham University (USA)	Dr. NOBIME Georges	Projet de suivi écologique des espèces de primates menacées notamment du colobe de Geoffroy <i>Colobus vellerosus</i> au Bénin
7	Marie Louise AVANNA	University of Tschang / Cameron	Prof ASSOGBADJO	Conservation and domestication of wild edible forest trees

## **9. Abstracts of Publications**

# Articles published in peer-review journal with Impact Factor (IF) in 2016

## 1. Exploring the spatial configurations of home gardens in Benin

Rodrigue Castro Gbedomon<sup>a</sup>, Achille Ephrem Assogbadjo<sup>b</sup>, Valère Kolawolé Salako<sup>a</sup>, Adandé Belarmain Fandohan<sup>c,b,a</sup>, Romain Glèle Kakai<sup>a</sup>

<sup>a</sup>Laboratoire de Biomathématiques et d'Estimations Forestières, Université d'Abomey-Calavi, 04 BP 1525, Cotonou, Benin ;

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### ABSTRACT

Although home gardeners could logically install plant species at different places around their homesteads, there is no quantitative evidence of how home gardens (HGs) are spatially configured and how these spatial configurations (SCs) discriminate plant species within HGs. Using spatial position analysis with respect to homestead and garden inventories, this paper explores the SCs of 360 HGs and assesses their constituent species as well as their prevalence across seasons, agro-ecological zones (AEZs) and phyto-geographical districts (PDs) in Benin. The association between SC and species composition was tested using correlation coefficients and Jaccard dissimilarity. A non-metric multidimensional scaling and a canonical discrimination analysis were performed to detect SCs discriminating AEZ and PDs. Relative frequencies of each SC were calculated per PD and displayed on the Benin map using ArcGIS 10.0 software. Eight SCs were distinguished, and 90.55% of HGs contained at least two SCs. Except for yards, SCs shared no or few species. The occurrence and prevalence of SCs varied across AEZs and PDs. Because HGs have multiple SCs and dynamic components, their size and shape may not always be objective indicators in the HG horizontal structure analysis.

**Keywords :** Spatial configurations; Home gardens; Species composition; West Africa.

## 2. Diversité, priorité pastorale et de conservation des ligneux fourragers des terres de parcours en zone soudano-guinéenne du Bénin

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### ABSTRACT

Fodder trees are important for livestock survival in dryland Africa. In view of the pressure faced by these trees, and their consequent rarity noted in rangelands, a study was conducted in the Sudan-Guinean transition zone of Benin at the level of the local population surrounding the protected forests of Monts Kouffé, Wari-Maré and Ouémé Supérieur. This study aimed to inventory the fodder trees, analyze the local perception of factors threatening target fodder trees, according to different sociolinguistic groups and prioritize fodder trees for conservation. Ethnobiological surveys and ecological data from the available literature were used to construct a database following different criteria. The citation rates of the fodder trees by the surveyed populations were used to establish pastoral priority, while their conservation priority was established using a combination of four methods and nine criteria. Forty-eight fodder trees belonging to 17 families dominated by Leguminosae (27.1%) and Moraceae (16.6%) were reported. These species were distributed among 37 genera, with the genus *Ficus* being the most represented (16.6%). Palatability, species availability and the impact of tree fodder on animal productivity were the criteria used by the surveyed sociolinguistic groups in their selection of fodder trees. The prioritization methods yielded ten top ranked species: *Afzelia africana*, *Pterocarpus erinaceus*, *Khaya senegalensis*, *Vitellaria paradoxa*, *Mangifera indica*, *Ficus platyphylla*, *Balanites aegyptiaca*, *Annona senegalensis*, *Ficus umbellata* and *Daniellia oliveri*. With the aim of establishing the sustainable management of pasture lands, we suggest that priority be given to the aforementioned species of fodder trees as part of restoration, afforestation/reforestation and plantation activities.

**Keywords :** Benin, ruminants, surveys, biodiversity conservation, browse plants, pastoralism, selection criteria

### **3. Socio-economic and ecological outcomes of community based forest management: A case study from Tobé-Kpobidon forest in Benin, Western Africa**

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Forest Policy and Economics 64: 46–55

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#### **ABSTRACT**

Community forestry, promoted as a “win–win” forest management strategy yielded a variety of results that includes both failure and relative success. The willingness of government to hold control over forest resources while transferring only part of property rights to local communities is one of the major constraints. Therefore, there is a need to explore alternative approaches, which enhance the position and accountability of local communities in community forest management. This study evaluated socio-economic and ecological outcomes of community forestry in a context of important property rights conceded to local communities. The study was conducted using focus groups discussions, forest income evaluation and assessment of forest resources and their dynamics. Findings showed that institutional design with important property rights conceded to local communities partially empowered local communities and reduced threats while improving the condition of forest resources. The approach also yielded positive economic outcomes that enabled bordering populations to make up to 25% of their global annual income from the forest. However, the sustainability of this scheme of forest management was mostly limited by the financial dependency on local non-governmental organization, by local institutions and discrepancy in forest benefits sharing among local forest users.

**Keywords :** Community forestry; Traditional institutions; Socio-economic and ecological outcomes; Benin

### **4. Specific and generic stem biomass and volume models of tree species in a West African tropical semi-deciduous forest.**

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#### **ABSTRACT**

The quantification of the contribution of tropical forests to global carbon stocks and climate change mitigation requires availability of data and tools such as allometric equations. This study made available volume and biomass models for eighteen tree species in a semi-deciduous tropical forest in West Africa. Generic models were also developed for the forest ecosystem, and basic wood density determined for the tree species. Non-destructive sampling approach was carried out on five hundred and one sample trees to analyse stem volume and biomass. From the modelling of volume and biomass as functions of diameter at breast height (Dbh) and stem height, logarithmic models had better predictive capabilities. The model validation showed that in absence of data on height, models using Dbh only as variable was an alternative. The comparison of basic wood densities to data published in literature enabled to conclude that the non-destructive sampling was a good approach to determining reliable basic wood density. The comparative analysis of species-specific models in this study with selected generic models for tropical forests indicated low probability to identify effective generic models with good predictive ability for biomass. Given tree species richness of tropical forests, the study demonstrated the hypothesis that species-specific models are preferred to generic models, and concluded that further research should be oriented towards development of specific models to cover the full range of dominant tree species of African forests.

**Keywords:** non-destructive sampling; basic wood density; allometric equations; carbon stock

## **5. Effects of termite mounds on composition, functional types and traits of plant communities in Pendjari Biosphere Reserve (Benin, West Africa)**

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### **RESUME**

Understanding the role of termite mounds in biodiversity and ecosystem functioning is a priority for the management of tropical terrestrial protected areas dominated by savannahs. This study aimed to assess the effects of termite mounds on the diversity of plant functional types (PFTs) and herbaceous' net aboveground primary productivity (NAPP) in plant communities (PCs) of the Pendjari Biosphere Reserve. PCs were identified through canonical correspondence analysis performed on 96 phytosociological 'relevés' realized in plots of 900 m<sup>2</sup>. PFTs' diversity was compared between savannahs and mounds' plots using generalized linear models. In each plot, 7 m<sup>2</sup> subplots were harvested and NAPP was determined. Linear mixed models were performed to assess change in herbaceous NAPP regarding species richness, graminoids' richness, specific leaf area and termite mounds. There is no specific plant community related to mounds. However, the occurrence of termite mounds induced an increase of woody and forbs diversity while the diversity of legumes and graminoids decreased. These diversity patterns led to decreasing of PCs' NAPP. This study confirms that termite induced resource heterogeneity supports niche differentiation theory and increased savannah encroachment by woody species.

**Keywords:** net aboveground primary productivity, Pendjari Biosphere Reserve, plant functional diversity, Savannah ecosystems, termite mounds.

## **6. Water quality as an indicator of the health status of agro-pastoral dams' ecosystems in Benin: An ecosystem services study. Aquatic**

Ecosystem Health & Management, 19:4, 441-451

<http://dx.doi.org/10.1080/14634988.2016.1257896>

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### **ABSTRACT**

Based on a study in three agro-pastoral dams in Nikki, Sakabansi and Fombawi in northern Benin, this article aims to characterize their physical, chemical and microbiological water quality. The ecosystem services framework underlies this article. Water of the three dams was sampled in the field and analysed at the laboratory. Means of variables were compared with standard values (norms) for drinking water set by both Benin and the World Health Organization. Agro-pastoral dams' water quality is problematic because of the significantly high levels of nitrite, nitrate, iron, and chemical oxygen demand. Water in these dams is unsuitable for both human and livestock consumption because it is contaminated with harmful bacteria including total Coliform, Escherichia coli, spores of Clostridium, *Enterococcus faecalis*, *Salmonella typhi*, *Salmonella typhimurium*, *Salmonella enteritidis* and *Campylobacter jejuni*. This study concluded that one solution for maintaining agro-pastoral ecosystem health consisted of watershed management based on monitoring ecosystem services such as water quality.

**Keywords:** pollution, Crocodiles, sustainable water resources management

## **7. Influence of the landscape context on stand structure and spatial patterns of the doum palm (*Hyphaene thebaica* Mart.) in the Republic of Benin (West Africa)**

Idohou R., Assogbadjo A. E., Azihou F., GlèlèKakaï R., Adomou A.

*Agroforestry Systems*, 90 : 591 – 605.

### **ABSTRACT**

*Hyphaene thebaica* Mart. (doum palm) is an agroforestry tree with high ecological and economic value, but currently its populations are harvested excessively, which is likely to increase in the future. This study assessed the current status of this species with regard to increasing landscape modification and human pressure in Benin. We compared the structure of adult palms in farmlands to those within the Biosphere Reserve of Pendjari (BRP). In addition, spatial patterns and sex ratio of the species were compared between both land use types. Results showed that mean diameter (adult palms) and density (adult palms and seedlings) were significantly higher ( $P<0.001$ ) in BRP than in farmlands. However, no significant differences were noticed for doum palm height and density of juveniles ( $P>0.05$ ). The pair correlation function showed globally a random

pattern for all palm life stages, albeit with a weak aggregation in farmlands. In the BRP, a strong aggregated pattern is observed for seedlings, whereas all other palm life stages showed globally a random pattern. Moreover, no spatial association was observed within palm life stages and between palm life stages and other tree species, but did exist between females and seedlings in the BRP. The sex ratio did not depart from 0.5 in both land use types. We conclude that in spite of the land use difference, the doum palm species is still well preserved. However, rapid land-use intensifications may lead to increasing pressure on the species populations in the future.

**Keywords:** Conservation, Distribution, *Hyphaene thebaica*, Point pattern analysis, Sex-ratio.

## 8. Climate-induced morphological variation of black plum (*Vitex doniana* Sw.) in Benin, West Africa

Hounkpèvi A., Azihou A. F., Kouassi E. K., Porembski S., GlèlèKakaï R.

*Genetic Resources and Crop Evolution*, 63: 1073 – 1084.

### ABSTRACT

There are evidences that plant morphology is shaped by genotype, but local environment mainly climate influences morphology as well. In this study the morphological variability of *Vitex doniana*, a multipurpose tree species was characterised in relation with climatic parameters in order to provide insights to the species possible responses to future climate change. Morphological data were collected on 102 trees randomly selected along unfixed transects in the three climatic zones of Benin. Data were collected on fruiting trees at three levels: tree (trunk and canopy), leaves and fruits. Variance components were estimated for identification of variability sources regarding leaves and fruits characteristics. The most important discriminant descriptors regarding climatic zones were selected through a stepwise discriminant analysis. Relationship between those discriminant morphological traits and bioclimatic variables were assessed through a redundancy analysis. Our findings confirmed that there is an important variability of morphological traits of the species and climate, mainly some of its extremes parameters plays a non-negligible role. Trees in the Sudanian region are the biggest with fruits producing little pulp while individuals in the more humid Guinean region present a higher amount of pulp whereas Sudano-Guinean trees are the tallest with larger leaves. Although the climate-induced variability of the species is relatively low, the study gives insights in probable effects of climate variability on its morphology. Population genetic studies are required for a better understanding of climatic impacts on *V. doniana* in order to develop selection and domestication schemes which could contribute to its conservation.

**Keywords:** Agroforestry species, Benin, Bioclimatic variables, Plant morphology, Savannah, *Vitex doniana*.

## 9. Elephant-induced damage drives spatial isolation of the dioecious palm *Borassus aethiopum* Mart. (Arecaceae) in the Pendjari National Park, Benin

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*African Journal of Ecology*, 54: 9 – 19.

### ABSTRACT

Spatial patterns (SP) of treefall by elephants is known to be clustered across landscapes as a result of food selection and group foraging. Yet, few studies have explicitly elucidated how elephant pressure (EP) alters SP and tree-to-tree distance of tree species especially for dioecious plant species, at stand scale. Using the pair-correlation function and distance to the nearest neighbour on spatial data from five plots of 1–1.5 ha, this article compared SP of damaged and undamaged individuals and tree-to-tree distance of the dioecious palm *Borassus aethiopum* Mart. in stands of low versus high EP in the Pendjari National Park. We tested the hypothesis that high EP would modify SP and results into isolated adults. Nested ANOVAs were used to compare distances. The overall SP of individuals did not vary, but distance among living adults was twofold extended in stands of high EP. The Janzen–Connell escape hypothesis is supported by our data for ungrazed saplings. The study concluded that increasing EP reduces density and induces spatial isolation of adults that may increase pollination failure and threat persistence of *B. aethiopum*.

**Keywords:** Benin, *Borassus aethiopum* Mart., damages, *Loxodonta africana* Blumenbach, pair-correlation function, spatial pattern

## 10. Isotopic niche structure of a mammalian herbivore assemblage from a West African savanna: Body mass and seasonality effect

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### ABSTRACT

Understanding the mechanisms of species coexistence within local assemblages can play a crucial role in conservation of a species. There is little understanding of how large mammalian bovid species from West Africa partition diet resources, and to what extent they may vary their diet and habitat selection seasonally in order to coexist. Here we studied an assemblage of eleven bovid species in Pendjari Biosphere Reserve, West Africa and used faecal stable isotopes of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) to test the impact of body mass diet partitioning at a seasonal scale. We found a significant positive relationship between isotopic niche similarity and body size similarity both in dry ( $p < 0.001$ ) and wet ( $p < 0.001$ ) season. Partitioning of carbon isotope niches is at least partly due to interactions amongst species rather than historical effects. Our findings also show numerous patterns in resource partitioning amongst the 11 bovid species studied, suggesting that different species used dietary resources in contrasting ways. In practice, actual resource competition between bovid species is difficult to demonstrate, but there exists much overlap in diet along the stable carbon isotope axis for most of the studied species. However we conclude that in our study area, especially in the wet season, niche breadth and diet overlap remain large. Abundant resources and low herbivore densities mean there is no need for herbivores to specialize, because they do not have to compete over scarce resources.

**Keywords:** diet breadth, body mass, browser, grazer, competition, coexisting.

## 11. Phylogeography of the heavily poached African common pangolin (*Pholidota, Manis tricuspis*) reveals six cryptic lineages as traceable signatures of Pleistocene diversification

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### ABSTRACT

Knowledge on faunal diversification in African rainforests remains scarce. We used phylogeography to assess (i) the role of Pleistocene climatic oscillations in the diversification of the African common pangolin (*Manis tricuspis*) and (ii) the utility of our multilocus approach for taxonomic delineation and trade tracing of this heavily poached species. We sequenced 101 individuals for two mitochondrial DNA (mtDNA), two nuclear DNA and one Y-borne gene fragments (totalizing 2602 bp).

We used a time-calibrated, Bayesian inference phylogenetic framework and conducted characterbased, genetic and phylogenetic delineation of species hypotheses within African common pangolins. We identified six geographic lineages partitioned into western Africa, Ghana, the Dahomey Gap, western central Africa, Gabon and central Africa, all diverging during the Middle to Late Pleistocene. MtDNA (cytochrome b + control region) was the sole locus to provide diagnostic characters for each of the six lineages. Treebased Bayesian delimitation methods using single- and multilocus approaches gave high support for ‘species’ level recognition of the six African common pangolin lineages. Although the diversification of African common pangolins occurred during Pleistocene cyclical glaciations, causative correlation with traditional rainforest refugia and riverine barriers in Africa was not straightforward. We conclude on the existence of six cryptic lineages within African common pangolins, which might be of major relevance for future conservation strategies. The high discriminative power of the mtDNA markers used in this study should allow an efficient molecular tracing of the regional origin of African common pangolin seizures.

**Keywords:** evolutionary significant units, molecular tracing, pangolins, Pleistocene diversification, trade monitoring, tropical Africa

## 12. Nutritional Characteristics of Forage Grown in South of Benin

Nadia Musco, Ivan B. Koura, Raffaella Tudisco, Ghislain Awadjihè, Sébastien Adjolohoun, Monica I. Cutrignelli, Maria Pina Mollica, Marcel Houinato, Federico Infascelli, and Serena Calabò

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Asian Australas. J. Anim. Sci., Vol. 29, No. 1 : 51-61 <http://dx.doi.org/10.5713/ajas.15.0200>

### ABSTRACT

In order to provide recommendations on the most useful forage species to smallholder farmers, eleven grass and eleven legume forages grown in Abomey-Calavi in Republic of Benin were investigated for nutritive value (i.e. chemical composition and energy content) and fermentation characteristics (i.e. gas and volatile fatty acid production, organic matter degradability). The *in vitro* gas production technique was used, incubating the forages for 120 h under anaerobic condition with buffalo rumen fluid. Compared to legume, tropical grass forages showed lower energy (8.07 vs 10.57 MJ/kg dry matter [DM]) and crude protein level (16.10% vs 19.91% DM) and higher cell wall content (neutral detergent fiber: 63.8% vs 40.45% DM), respectively. In grass forages, the chemical composition showed a quite high crude protein content; the *in vitro* degradability was slightly lower than the range of tropical pasture. The woody legumes were richer in protein and energy and lower in structural carbohydrates than herbaceous plants, however, their *in vitro* results are influenced by the presence of complex compounds (i.e. tannins). Significant correlations were found between chemical composition and *in vitro* fermentation characteristics. The *in vitro* gas production method appears to be a suitable technique for the evaluation of the nutritive value of forages in developing countries.

**Key Words:** Grass, Legume, *In vitro* Gas Production, Nutritive Value, Degradability

## 13. Forest Degradation and Invasive Species synergistically impact *Mimusops andongensis* (Sapotaceae) in Lama Forest Reserve, Benin

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*Biotropica* (Published)

### ABSTRACT

Harvesting of Non-Timber Forest Products (NTFPs) can threaten target species, especially those with limited distribution and density. Exploited species also face threats from habitat fragmentation, fire, and invasive species. We assessed the impact of human disturbances and invasive species on the population of a key multipurpose NTFP species, *Mimusops andongensis*, in Lama Forest reserve (Benin). The densities of adult trees and regenerative stems decreased with increasing degradation. *M. andongensis* contributed less to total tree density with increasing human disturbance. There were significantly fewer *M. andongensis* recruits with increasing cover of invasive *Chromolaena odorata*. Smaller diameter individuals predominated in non-degraded and moderately degraded sites while in degraded sites, the structure showed a negative exponential trend with the density of small diameter individuals being less than 2 trees/ha. Larger individuals were also rare in degraded sites. The low density of both mature trees and seedlings in degraded sites may undermine the long-term viability of *M. andongensis*, despite existing protection against NTFP harvesting and other anthropogenic pressures. Management should emphasize facilitating recruitment subsidies and limiting the presence of *C. odorata*.

**Keywords:** anthropogenic pressure; biological invasion; demographic structure; diameter class distribution; Non-Timber Forest Products (NTFP).

## 14. Unpacking Pandora's Box: Understanding and Categorising Ecosystem Disservices for Environmental Management and Human Wellbeing

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*Ecosystems* (Published)

### ABSTRACT

Research into the benefits that ecosystems contribute to human wellbeing has multiplied over the last few years following from the seminal contributions of the international Millennium Ecosystem Assessment. In comparison, the fact that some ecosystem goods and services undermine or harm human wellbeing has been seriously overlooked. These negative impacts have become known as ecosystem disservices. The neglect of ecosystem disservices is problematic because investments into the management or reduction of ecosystem disservices may yield better outcomes for human wellbeing, or at a lower investment, than management of ecosystem services. Additionally, management to optimise specific ecosystem services may simultaneously exacerbate associated disservices. We posit that one reason for the neglect of ecosystem disservices from the discourse and policy debates around ecosystems and human wellbeing is because there is no widely accepted definition or typology of ecosystem disservices. Here, we briefly examine current understandings of the term ecosystem disservices and offer a definition and a working typology to help generate debate, policy and management options around ecosystem disservices. We differentiate ecosystem disservices from natural hazards and social hazards, consider some of their inherent properties and then classify them into six categories. A variety of examples are used to illustrate the different types of, and management strategies to, ecosystem disservices.

**Keywords:** definition; ecosystems disservices; management; typology.

## 15. Latitudinal variation in the woody species diversity of *Afzelia Africana* Sm. habitats in West Africa

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*Tropical Ecology* (published)

### ABSTRACT

This study assessed the woody flora composition of *Afzelia africana* Sm. Habitats along a latitudinal gradient, from the northern limit of the species distribution to the Guinean littoral forest. Data were collected from 201 sample units located in different vegetation types that span four bioclimatic zones: Guinean, Sudano-Guinean, Sudanian and Sahelo-Sudanian zones. The woody flora diversity was described by computing the estimated species richness and the Shannon diversity index within EstimateS 9.1, based on the observed species richness. A sample-based randomization procedure with 95 % confidence intervals was used to compare the patterns of plant richness between vegetation stands. A Non Metric Multidimensional Scaling was performed on presence-absence data matrix to explore the patterns of woody species composition in natural stands. A Canonical Correspondence Analysis was further applied to correlate the patterns of habitat differentiation with climatic variables (temperature, precipitation) and altitude. A total of 165 woody species were recorded, with the highest species richness in Sahelo- Sudanian zone. There was no significant difference in richness between samples from Guinean, Sudano-Guinean and Sudanian zones. Plots in the Sudanian and Sudano-Guinean zones were similar but distinct from those of Guinean and Sahelo-Sudanian zones, a pattern that is supported by precipitation and temperature distributions. Results also suggest important co-occurring species characteristic of each habitat as inferred from the Important Value Index (IVI). It is recommended that habitats of *A. africana* in Sudanian and Sudano-Guinean zones receive similar management and conservation plans while the Guinean and the Sahelo- Sudanian zones can be treated separately.

**Key words:** Climatic gradient, conservation ecology, floristic composition, importance value index, multidimensional scaling.

## 16. Efficacité des aires protégées dans la conservation d'habitats favorables prioritaires de ligneux de valeur au Bénin

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Bois et Forêts des tropiques (publié)

### RESUME

L'objectif de cette étude est d'évaluer au Bénin l'efficacité du réseau des aires protégées dans la conservation des habitats favorables et prioritaires de certaines espèces ligneuses d'importance socio-économique. Il s'agit de *Afzelia africana*, *Anogeissus leiocarpa*, *Burkea africana*, *Daniellia oliveri*, *Detarium microcarpum*, *Prosopis africana* et *Khaya senegalensis*. Les techniques basées sur le principe d'entropie maximale (Maxent) combinées avec les SIG ont été utilisées pour projeter les habitats favorables de ces sept espèces ; le logiciel Zonation a été utilisé pour la modélisation des habitats prioritaires. Les points de présence des espèces ont été collectés et associés aux variables bioclimatiques dérivées de la température mensuelle et de la pluviométrie obtenues à partir de la base de données en ligne de AfriClim, ainsi qu'à la variable édaphique (sol). En terme de déterminisme environnemental, les variables bioclimatiques telles que l'écart diurne moyen de la température (Bio2), les précipitations annuelles moyennes (Bio12), l'évapotranspiration potentielle (ETP) et la variable biophysique sol, sont prédictives pour les distributions des sept espèces. Les habitats protégés plus favorables aux sept essences dans la zone guinéenne commencent aux limites de la forêt classée de Kétou ( $7^{\circ}43'N$ ), dans la zone soudano-guinéenne, à partir de la latitude de la forêt classée d'Agoua ( $8^{\circ}30'N$ ), et dans la zone soudanienne à partir de la latitude de la Pendjari ( $10^{\circ}35'N$ ). Pour la conservation des habitats prioritaires, l'étude de représentation révèle que, dans les zones soudanaises ( $9^{\circ}75'-12^{\circ}27'N$ ), guinéenne ( $6^{\circ}50'-7^{\circ}40'N$ ) et soudano-guinéenne, les aires protégées sont respectivement efficaces, peu efficaces et non efficaces.

**Mots-clés :** habitats favorables, déterminisme environnemental, aires protégées, habitats prioritaires, Bénin.

## 17. Quantitative assessment of palm oil wastes generated by mills in Southern Benin

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### ABSTRACT

While waste management is given more care for protecting the environment and human health, agro industrial wastes are still a concern, in developing countries. This study quantitatively assesses the palm oil wastes generated by mills and describes their management in Southern Benin. Twenty four out of 335 regional palm oil mills were randomly selected and assessed for waste quantities generated during the oil production season. From 1 ton (t) of full fruit bunches (FFB), each palm oil mill produces an average of 712.1 kg of fruits, 254.7 kg of empty fruit bunches (EFB), and 399.8 kg of palm kernel cake, 114.9 kg of fibre, 240.4 L of palm oil mills effluents (POME) and 152.3 L of crude palm oil. Numeric classification analyses resulted in four groups of palm oil mills following production factors and wastes quantities generated: small, medium, large and very large mills. These groups produced yearly on average respectively 12.4, 31.3, 132.7, and 800.7 t of EFB; 5.6, 13.6, 135.2, and 637 t of fibre and 15.1, 40.9, 233.4, and 572.6 t of POME. They differed in nature, plantations size, and capacity to employ people. About 80% are small producers. The use of all POME generated depend on waste quantity produced.

**Keywords:** Palm oil mills, wastes, system production.

## **18. The Effect of seasonal variations, covariations with minerals and forage value on Itchgrass' foliar silicification from Sudanian Benin**

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### **ABSTRACT**

Silica ( $\text{SiO}_2$ ) in forage grasses has been found in reducing cell-wall digestibility. This study investigates whether: (i) the seasonal variability affects the silica and minerals accumulation and forage values of leaves of *R. cochinchinensis* and (ii) silica concentration is correlated with minerals and fodder value. In an Itchgrass population selected in the W Biosphere Reserve, leaves were collected on 90 marked plants from May to October 2003 and 2004, at 15 days intervals except May, June and October. Some 300 g of fresh blades from the 3rd most recently expanded leaves were oven dried and analyzed for dry mass,  $\text{SiO}_2$ , ash, N, Na, Ca, P, K, Mg. Digestible Nitrogen Matter (DNM) and Fodder Energetic Value (FEV) were calculated using Demarquilly formula. Apart from  $\text{SiO}_2$ , Ash and forage value, data were log-transformed to restore homoscedasticity before Statistical analyses.  $\text{SiO}_2$  ranges from 5.69 % to 9.95 %, i.e. varying 1.4 fold between May and October, reaching 1.75 fold at mid-September.  $\text{SiO}_2$  positively related to Ca but negatively to K, P, N, DNM and FEV. The negative correlations suggest that  $\text{SiO}_2$  concentration in *R. cochinchinensis* could be reduced with a significant increase in energy and accumulation of important nutrients such as N, P and K. Therefore, leaf silicification and nutritive value relationship should be conclusive in the case of Itchgrass.

**Keywords** - *Rottboellia cochinchinensis*, Silicification, Minerals, Seasonal variations, Forage value, Covariations, Sudanian Benin

## **19. Potentiel de régénération des chantiers de production du charbon de bois au Centre-Bénin**

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### **RESUME**

Le présent travail a pour objectif d'étudier le potentiel d'émission des rejets des souches des arbres coupés pour la production du charbon de bois. L'inventaire des espèces exploitées a été réalisé dans 24 chantiers de production de charbon répartis dans trois Communes du Département des Collines au Bénin. Au total, 17 essences forestières ont été inventoriées dans les 24 chantiers prospectés. Deux groupes de chantiers ont été formés : le groupe des chantiers sur lesquels une large gamme d'espèces sont exploitées et le groupe assemblant les chantiers quasi-monospécifiques. Les espèces les plus exploitées sont : *Burkea africana*, *Prosopis africana*, *Anogeissus leiocarpa*, *Pterocarpus erinaceus*, *Vitellaria paradoxa* et *Pseudocedrela kotschy*. Dans ce lot, deux catégories d'espèces ont été identifiées en matière de régénération des souches: celle des espèces dont la survie des souches est assurée à environ 100% quels que soient l'âge et les dimensions des souches et celle des espèces dont la survie est assujettie aux variations de l'âge et les dimensions des souches. Somme toute, les stratégies de conservation urgentes ont été proposées pour mieux assurer l'utilisation durable de toutes les espèces qui sont devenues la proie de la production du charbon au Bénin.

**Mots clés** : Régénération, rejet de souche, survie des souches, production de charbon, Bénin.

# Articles published in peer-review journal without IF in 2016

## 1. Analyse de quelques paramètres d'élevage du rat roussard (*Arvicanthis niloticus*, Desmarest, 1822) en captivité étroite à Kétou au sud-est du Bénin

B. A. Djossa, P. M. S. Agonglanon, A. Afanou et G. A. Mensah

### RESUME

Un essai d'élevage des rats roussards (*Arvicanthis niloticus*) a été conduit à Kétou dans le département du Plateau au sud-est du Bénin afin d'asseoir les bases de la domestication à terme de ces petits mammifères rongeurs assez consommés dans diverses localités du pays. Un groupe de sept individus dont cinq femelles et deux mâles capturés dans la nature ont été élevés en claustration étroite pendant sept mois en 2014 dans un enclos parallélépipédique en maçonnerie de 3,0 m de long, 1,0 m de large et 0,9 m de haut fermé avec un couvercle grillagé. Les animaux ont été nourris avec des fourrages, des céréales, des tubercules et des fruits cueillis dans le milieu. Les données collectées ont été le poids vif corporel pris hebdomadairement, l'actogramme, la consommation alimentaire et la reproduction. Les résultats ont montré que *Panicum maximum* (fourrage), *Zea mays* (céréale), *Manihot esculenta* (tubercule) et *Elaeis guineensis* (fruit) ont été les aliments les plus appétés. Le poids vif corporel des animaux élevés a régulièrement augmenté pour atteindre 183 g chez une femelle contre 208 g chez un mâle. Une mise bas d'une portée de 5 petits a été obtenue au bout de trois mois d'élevage et ces ratons ont eu une croissance pondérale assez rapide passant de 04-05 g à 73 g pour trois femelles et à 83 g pour le seul mâle au bout de 70 j d'élevage. Les rats roussards avaient des activités diurnes et crépusculaires. Somme toute, le succès de ce premier essai élucide les premiers pas vers la domestication de ce petit mammifère rongeur au Bénin. Toutefois, une répétition des essais avec un cheptel d'au moins une cinquantaine de têtes dont au moins une trentaine de femelles s'avère indispensable afin d'élaborer le référentiel technico-socio-économique viable de l'élevage des rats roussards calqué sur le modèle de l'aulacodiculture au Bénin.

**Mots clés :** Bénin, rat du Nil, conduite d'élevage, performances zootechniques, domestication

## 2. Approches méthodologiques synthétisées des études d'ethnobotanique quantitative en milieu tropical

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### RESUME

Le souci de rendre comparable et reproductible les résultats en ethnobotanique par des inférences, a entraîné l'apparition de beaucoup d'outils quantitatifs dans les recherches en ethnobotanique quantitative ces deux dernières décennies. Ce travail de synthèse bibliographique vise à identifier les approches méthodologiques les plus utilisées en ethnobotanique quantitative à travers (i) les questions de recherche (ii) les techniques d'échantillonnage et de collecte de données et (iii) les outils quantitatifs d'analyse de donnée. La démarche méthodologique a consisté à utiliser des mots clés dans le moteur de recherche Google scholar afin de sélectionner les articles qui ont fait une synthèse bibliographique et/ou ceux qui ont fait des analyses critiques d'approches méthodologiques en ethnobotanique quantitative. Cette investigation a été faite de décembre 2014 à Janvier 2015. Trois catégories de questions de recherche ont été les plus investiguées en ethnobotanique quantitative : les questions de recherche des études ethnobotaniques descriptives, des études ethnobotaniques de causalité et des études ethnobotanique de diagnostic. Bien que l'échantillonnage n'a pas été considéré de façon prioritaire dans beaucoup d'études ethnobotaniques, d'autres ont commencé par accorder d'importance à la technique d'échantillonnage aléatoire avec une estimation de la taille de l'échantillon. Cinq indices ethnobotaniques ont été repérés comme étant les plus utilisés dans les études ethnobotaniques quantitatives : le Facteur Consensuel de l'Informateur (FCI), le Niveau de Fidélité (NF), l'Indice Relatif d'Importance (IR), la Valeur d'Usage (VU), l'Indice Culturel d'Importance (IC). Cette synthèse d'approches méthodologiques des études ethnobotaniques quantitatives, est un outil d'aide pour les étudiants et jeunes chercheurs des pays d'Afrique francophone.

**Mots clés :** Ethnobotanique, Méthodes, Indice, Biodiversité, Afrique francophone

### **3. Méthodes d'estimation objective du recouvrement de la végétation et de la biomasse herbacées**

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#### RÉSUMÉ

L'estimation du recouvrement de la végétation herbacée peut être obtenue en utilisant la méthode de point d'interception. L'échantillonnage des données a lieu dans les points de grilles dans un quadrat. A chaque position, une tige est abaissée verticalement sur le sol et la première interception avec une espèce de plante est enregistrée. Le recouvrement d'une espèce végétale est défini comme la fréquence relative du nombre de fois que la tige touche l'espèce dans la grille. Le recouvrement est calculé pour chaque espèce. Ce nombre est multiplié par 100 pour obtenir le recouvrement en pourcentage. Dans la savane herbeuse, six quadrats de 0,5 sur 0,5 m sont suffisants pour obtenir une bonne description de la végétation. La biomasse aérienne d'une espèce végétale peut aussi être estimée de façon non destructive en utilisant une modification du procédé de point d'interception. Au lieu d'enregistrer seulement la première interception de la tige et l'espèce de plante, chaque contact entre la tige et la plante est enregistrée. La méthode de point d'interception est rarement utilisée dans les systèmes savanicoles mais constitue une alternative par rapport aux méthodes destructives.

**Mots clés :** Méthode de point d'interception ; points-quadrats ; méthode pin-point ; estimation du recouvrement de la végétation herbacée ; estimation de la biomasse herbacée.

### **4. Méthodes de calcul de la biomasse et du carbone des arbres en afrique de l'ouest**

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#### RÉSUMÉ

Le présent chapitre aborde les méthodes de calcul de la biomasse et du carbone des arbres. Les différentes étapes de ce calcul sont dans un premier temps le choix de l'approche à utiliser (utilisation des équations allométriques ou générales), ensuite la détermination de la densité du bois de chaque espèce d'arbre et la définition des réservoirs de carbone à considérer. Il faut ensuite calculer la moyenne de la biomasse vivante et morte de chaque strate au sein des placettes, supposer la fraction de carbone dans les arbres puis calculer le carbone à partir de la biomasse, calculer également l'incertitude et enfin convertir le carbone en dioxyde de carbone. L'estimation de la biomasse et du carbone a pris une importance croissante dans le monde. L'augmentation de la quantité du carbone au niveau des forêts va permettre l'établissement des petites exploitations agroforestières et des projets REDD +.

**Mot clés :** Biomasse ; carbone ; équation allométrique et générale; incertitude

### **5. Méthodes statistiques multivariées utilisées en écologie**

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#### RÉSUMÉ

Cet article aborde les méthodes statistiques multivariées telles que les méthodes d'ordination et les méthodes de classification qui font partie des méthodes multivariées couramment utilisées en écologie. Les méthodes d'ordination constituent un groupe qui résume l'information contenue dans la matrice de données en minimisant la déperdition. Il s'agit de l'analyse en composantes principales ; de l'analyse en coordonnées principales; de l'analyse factorielle des correspondances simples ; de l'analyse factorielle des correspondances multiples; de l'analyse factorielle des correspondances redressées; de l'analyse canonique de redondance; de l'analyse canonique des correspondances ; du positionnement multidimensionnel non métrique

; et de l'analyse factorielle discriminante. Les méthodes de classification ont pour objectif de constituer des groupes d'individus aussi similaires que possible. Ces méthodes sont entre autre la classification agglomérative (encore appelée classification hiérarchique ascendante) ; l'analyse typologique ; l'analyse discriminante décisionnelle; et de l'analyse de la variance multivariée (MANOVA). Ces méthodes ont l'avantage de permettre de tirer la principale information contenue dans une matrice à plusieurs variables.

**Mots clés :** méthodes statistiques multivariées ; méthodes d'ordination ; méthodes de classification.

## **6. Caractérisation de quelques peuplements naturels de Baobab (*Adansonia digitata L.*) et des pressions subies dans les différentes zones chorologiques du Bénin**

Dossa K., Toni H., Azonanhoun P., Djossa A.B.

### RÉSUMÉ

**Objectif :** Le Baobab est une espèce utilisée à diverses fins par les populations locales au Bénin. Cependant, l'état des peuplements de l'espèce reste peu connu dans plusieurs localités du pays. Cette étude a permis de caractériser les peuplements de baobab dans les communes de Dassa, Matéri et Comè situées dans les trois zones chorologiques du Bénin

**Méthodologie et Résultats :** Six cent soixante six (666) pieds de baobab ont été recensés et étudiés dans les 3 communes afin de mesurer des paramètres dendrométriques comme le DBH, la hauteur et le diamètre du houppier des arbres des peuplements et d'établir le type de distribution spatiale des individus au sein de chaque peuplement. Une enquête auprès de 300 personnes au sein des communautés riveraines des peuplements étudiés a permis de recenser les diverses pressions anthropiques auxquelles l'espèce est soumise. Les résultats ont révélé que les peuplements de baobab étudiés sont globalement dominés par des individus de grande taille (hauteur : 15-20 m et DBH : 100-150 cm avec de larges houppiers (5-10 m) et une faible représentation des individus de la régénération (DBH @ 50 cm). La structure spatiale épouse une distribution globalement aléatoire. La faible régénération est surtout rapportée dans les jeunes jachères et les champs. Les formes et l'intensité des pressions anthropiques qui pèsent sur l'espèce varient d'une commune à l'autre, mais l'agriculture extensive constitue la principale menace rapportée.

**Conclusion et application :** La survie à long terme des peuplements de baobab étudiés est compromise, si la tendance de la faible régénération observée se maintient. Des efforts doivent donc être fournis pour lever les diverses pressions qui pèsent sur l'espèce et surtout favoriser la régénération. Les résultats de ces travaux préliminaires, posent les bases pour des études ultérieures de suivi régulier de ces peuplements afin d'analyser leur évolution dans le contexte actuel des pressions anthropiques encourues et de proposer des stratégies pour une meilleure conservation de cette importante ressource au Bénin.

**Mots clés :** Baobab, structure de population, distribution spatiale, conservation, Bénin.

## **7. Biogéographie du néré (*Parkia biglobosa* (Jack.) R. Br. ex. Don.) sous les conditions environnementales actuelles et futures au Bénin**

E. B. Ayihouenou, A. B. Fandohan, A. I. Sodé, N. G. Gouwakinnou et A. B. Djossa

### RESUME

*Parkia biglobosa* est l'une des espèces agroforestières à grande importance socio-économique non seulement au Bénin mais dans toute la région Ouest Africaine. Cependant, sa conservation et sa domestication pour la diversification de la production agricole dépend de sa capacité à s'adapter aux changements climatiques. Ainsi, 492 points d'occurrence combinées avec des variables bioclimatiques ont été utilisés pour modéliser l'impact des conditions environnementales actuelles et futures sur l'étendue des habitats favorables à *P. biglobosa*, suivant l'approche du principe d'entropie maximum (MaxEnt). Les aires favorables à la culture et à la conservation du *P. biglobosa* sur l'étendue du territoire du Bénin, ont varié dans le temps en fonction des quatre scénarios climatiques utilisés (RCP2.6, RCP 4.5, RCP 6.0 et RCP8.5) et des conditions pédologiques. Dans les conditions environnementales actuelles, 59% du territoire Béninois et 32% de la superficie des aires protégées se sont avérés très favorables respectivement à la culture et à la conservation du néré. Cependant, tous les scénarios climatiques ont projeté à l'horizon 2050 une réduction significative de l'étendue des habitats très favorables à la culture du néré (22 à 31%) au profit des habitats moyennement ou faiblement favorables et une légère extension des aires favorables à sa conservation (6 à 11%). Les aires protégées à l'horizon 2050 peuvent peut-être toujours garantir des habitats favorables à la conservation de l'espèce. Les résultats obtenus suggèrent que malgré les dynamiques spatiotemporelles projetées, liées aux changements climatiques, les conditions environnementales au Bénin peuvent demeurer favorables à la culture et la conservation de *P. biglobosa* à l'horizon 2050. La prise en compte de ces résultats dans les politiques officielles de développement devrait contribuer à garantir une conservation et une utilisation durable du néré au Bénin.

**Mots clés :** Aire de répartition, changements climatiques, MaxEnt, habitat favorable, scénario d'émission RCP, Bénin.

## **8. Potential climate change favored expansion of a range limited species, *Haematostaphis barteri* Hook f.**

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### **ABSTRACT**

Understanding impact of climate change on range breadth of rare species can improve the ability to anticipate their decline or expansion and take appropriate conservation measures. *Haematostaphis barteri* is an agroforestry species of the Sudanian centre of endemism in Africa. We investigated impact of climate change on range of suitable habitats for this species in Benin, using the Maximum Entropy algorithm under R software. Five environmental variables were used with the regional climate model under the new Representation Concentration Pathways (RCP). Moisture Index of the Moist Quarter and Slope variability had the greatest predictive importance for the range of suitable habitats for *H. barteri*. Its Potential breadth was found to be currently limited to the Atacora Mountain Chain (AMC) and covers 0.51% of national territory. Climate change was projected to favor a slight expansion of suitable habitats for *H. barteri* by 0.12% and 0.05%, respectively for the RCP4.5 and RCP8.5. These habitats were however mostly out of the local protected areas network. Observed protection gaps suggest need for integrating this species into formal in situ, on-farm or ex situ conservation schemes.

**Keywords:** Species Distribution Modeling; *Haematostaphis barteri*; climate change; Benin.

## **9. Agro-Ecology, the Solution to Food Insecurity in Climate Change Context in Africa**

### **ABSTRACT**

Climate change is making random food production in the world in general, and particularly in Africa where agriculture remains dominantly rain fed. In a context of rapid population growth and high rates of undernourishment and malnutrition, Africa must opt for a form of sustainable agriculture, resilient, productive, which gives more food while maintaining the ecological balance and preserving public health. From the literature review and a critical reflection, the article identified as a solution, agro-ecology which it analysis before making proposals for its widespread adoption by farmers. Thus, the paper suggests that small farms be privileged and that positive discrimination policies be elaborated and implemented for the agro-ecological products.

**Keywords:** Agro-ecology, Climate Change, Small farms, Differential pricing, Africa.

## **10. Typologie, productivité, capacité de charge et valeur pastorale des pâturages des parcours transhumants au Nord Est de la République du Bénin**

Paolo Lesse, Marcel Houinato, Fortuné Azihou, Jonas Djenontin, Brice Sinsin

International Journal of Innovation and Applied Studies, 14: 132 – 150.

### **ABSTRACT**

The Departments of Borgou and Alibori alone hold approximately 60% of Benin's cattle herd is estimated at 2.166 million heads. The power of these animals is exclusively based on natural pastures, it is important to have an idea of the characteristics of the latter to take decisions. The study took place in the North East part of Benin and aims to characterize the pastures of this region. In total 60 phytosociological surveys were conducted, 40 plots of productivity and 40 linear measurements were made. Surveys were treated with CAP software and identified the types of pasture. Four (04) vegetable grouping were identified. The higher biomass was obtained in the pasture to *Ficus glomosa* and *Hyparrhenia involucrata* (5.7 t DM / ha). The biologic spectrum analysis shows an abundance and a predominance of the phanerophytes (55 %) and the therophytes (35%). As far as the phytogeographic kinds are concerned, the species of the soudanian (58 %) element predomains in the groups. The highest pastoral value was observed in the vegetable grouping *Cochlospermum tinctorium* and *Tephrosia pedicellata* (32.6). It follows from this study that the study of pastures are degraded environment, have low productivity and low pastoral value. Knowledge of these parameters allows to have an idea of the pressure that undergoes the country.

**Keywords:** Characteristics, pasture, Breeding, transhumance, Benin.

## 11. Caractérisation de la répartition spatiale des arbres de *Parkia biglobosa* (Jacq.) R. BR. au Bénin

Oyélèyè Fafunkè Titilayo Dotchamou, Gilbert Atindogbé, Akomian Fortuné Azihou,  
Houédougbe Noël Fonton

Revue CAMES - Science de la vie, de la terre et agronomie, 4 : 59 – 67.

### ABSTRACT

The spatial structure of a forest stand is important in its functioning because the stucture determines the local environment around each tree component. This study was conducted to contribute to modeling the distribution of *Parkia biglobosa* for the sustainable management on the species in Benin. The Ripley equation was used to analyze the data. The data were collected from 12 plots of 4 ha each in six townships and involve individuals with a diameter at 1.3 m above ground  $\geq 5$  cm. The results show a species richness ranging between 10 and 40. The Shannon diversity index and Pielou evenness vary between 2.64 and 4.74 bits and 0.56 and 0.94 respectively. The density varies from 28 to 236 stems / ha. The univariate structure of *P. biglobosa* and dominants species has an aggregative distribution and the bivariate level shows interspecific repulsions of radius varying between 1 m and 13 m. The repulsion of 1 m to 8 m is observed between the size classes of *P. biglobosa* and suggests that the adult proximity affects the survival of young plants. On the basic of the behavior of *P. biglobosa*, the study suggests a minimum distance of 1 m between seedlings and 8 m in case of enrichment parklands.

**Keywords:** Modeling, *Parkia biglobosa*, forest stand, interspecific repulsions, spatial structure.

## 12. Facteurs socioéconomiques influençant l'usage des raphias au Benin (Afrique de l'Ouest)

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CAMES Science de la vie, de la terre et agronomie (publié)

### RESUME

L'objectif de la présente étude était de déterminer les facteurs socioéconomiques qui influencent l'exploitation des raphias et le niveau de connaissance des usages au Bénin. Ainsi, des données sur les caractéristiques socioéconomiques des enquêtés et les usages des raphias ont été collectées lors d'une enquête menée sur toute l'étendue du territoire béninois au moyen d'un questionnaire semi-structuré. Une régression logistique binaire et de Poisson a été réalisée sur les données afin d'identifier les facteurs socioéconomiques affectant l'exploitation des raphias au Bénin. Il ressort des travaux que les facteurs socioéconomiques tels que l'âge, le sexe, le niveau d'instruction, le type d'exploitant et l'activité principale sont ceux déterminant le niveau de connaissance des usages des raphias au Bénin. Ces facteurs socioéconomiques diffèrent selon les espèces de raphia. **R. hookeri** : Plus le niveau d'instruction est élevé, plus le niveau de connaissance des usages de *R. hookeri* est élevé. Il en ait de même pour l'âge des enquêtés. Les transformateurs ont un niveau de connaissance des usages plus élevé que les cueilleurs. **R. sudanica** : les non exploitants, les hommes comme les femmes, les non instruits et les activités principales pris individuellement, contribuent, avec le temps, à une diminution du niveau de connaissance des usages contrairement aux transformateurs et aux personnes instruites. Les cueilleurs, avec le temps, acquièrent un niveau de connaissance des usages stable, qui ne dépassera pas l'unité. En conclusion, l'évaluation des valeurs ethnobotaniques et économiques des raphias doit tenir compte de ces facteurs.

**Mots clés :** Raphia, Valeur d'Usage Rapporté, facteurs socioéconomiques, Bénin.

## 13. Valuing the Potential of Non-timber Forest Products in Financial Valuation of Savannah Formation in Sudanian Region

### RESUME

This study assesses the financial value of one hectare of savannah vegetation in Sudanian region of West Africa based on the potential extraction of Non-Timber Forest Products (NTFPs). Our methodology provides multiple estimations of NTFPs production from each species for two years and also takes into account variation in NTFPs prices. Given the regeneration

capacity of harvested species for some NTFPs such as bark or root, we presented the annual financial value of revenue from NTFPs in contrary to some studies which determined their net present value. Results showed that the Net Annual Value of NTFPs collection is US\$368 ha<sup>-1</sup> and would justify the interest of sustainable use of these resources. The most valuable products of the Pendjari Biosphere Reserve savannah were species leaves (US\$164 ha<sup>-1</sup>) followed by fruits (US\$89 ha<sup>-1</sup>) and roots (US\$78 ha<sup>-1</sup>). However, the Net Annual Value determined here is the potential value of the Sudanian savannah in NTFPs. The NTFPs financial valuation made in this study provided useful details for comparing alternative land use practices. In view of the sustainable use of natural resources, a NTFP focused management system could be considered economically viable management option. However, they cannot be sustainability harvested in absence of careful species selection, yield studies, monitoring of regeneration and harvesting adjustments. Therefore, there is a need to know more about useful species availability, biology and reaction to harvesting impact, especially for those exploited for their roots, flowers or fruits.

**Keywords** Land Use Option, NTFP, Financial Valuation, Savannah Vegetation, West Africa

#### 14. In vitro gas production and nutritive value of sixteen multi-purpose cowpea haulms varieties (*Vigna unguiculata L, Walp*) cultivated in Benin

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#### ABSTRACT

**Objective:** In vitro gas production and nutritive value of 16 new multi-purpose cowpea haulms varieties developed by International Institute of Tropical Agriculture (IITA) was evaluated for their valorisation in the feed for ruminants in Benin. **Methodology and results:** Chemical composition, digestibility, net energy values and nitrogen values of the haulms were evaluated. Crude protein content varied significantly ( $p<0,001$ ) from 8.3 to 16.9 %. They were very rich in fibre (ADF = 58.4 %). Incubation in syringes revealed a short lag time (0.84 hours) and very high gas production (FV = 213.6 ml/gDM). Digestibility (60 %) and net energy values in French Unit System were high (0.78 UFL and 0.71 UFV/kg DM). Ration protein and energy (MAD/UFL) were higher than 120 g for 5 varieties (IT06K-91-1, IT07K-187-55, IT89KD-288, IT06K-108, IT06K-123-1).

**Conclusion and applications of the results:** Theoretically, the nutritive value of all varieties of the cowpea haulms can ensure maintenance (energy and nitrogen) and a gain than 50 g/day for sheep weighing 30 kg. However, a feeding experiment with these cowpea haulms as feed supplements must be carried out by farmers's in order to evaluate the real performances that these cowpea haulms in ruminants.

**Keywords:** Cowpea haulms, Chemical composition, gas-test, digestibility, energy, Benin.

#### 15. Effet de la pâture des ovins sur le rendement en grains de maïs et de fourrage et les propriétés du sol dans le système d'association de cultures maïs-*Lablab purpureus* au Bénin

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#### RESUME

Une expérimentation a été conduite pendant trois ans successifs (2010 à 2012) pour évaluer l'effet de la pâture sur les rendements de fourrage, de grain de maïs et les propriétés chimiques de sol ainsi que sur La croissance pondérale des ovins dans un système d'association de cultures. Le dispositif expérimental était un split plot avec comme parcelle principale, le type d'association de cultures : maïs-*Lablab purpureus* (Lablab) ou maïs pure, et comme sous parcelle, le type de pâture : la pâture et la non pâture avec les ovins. Le rendement de maïs grain a varié de 1.461 à 2.955 kg/ha. Ce rendement était similaire ( $p>0.05$ ) pour les types d'association de cultures. Les parcelles pâturées ont donné des rendements de maïs grain

plus élevés que les mêmes types de parcelle non pâturee. Le rendement en fourrage était plus élevé ( $p<0,001$ ) sur la parcelle d'association maïs-Lablab. La teneur en matières azotées totales de Lablab (20,59% MS) était meilleure avec une production de fourrage de bonne qualité pour la parcelle d'association maïs-lablab. La pâture a amélioré sensiblement le Ph (H<sub>2</sub>O) du sol comparé au sol non pâtré. Le gain de poids vif moyen quotidien des ovins était meilleur sur la parcelle d'association maïs-lablab (40-60,7 g/j) que sur celle de maïs pure (31-33,6 g/j). La technologie de l'intégration de la pâture à l'association maïs-Lablab est une option viable et peut aider à améliorer le bien-être des producteurs.

**Mots clés :** Caractéristique du sol, légumineuse, association de cultures, aliment, élevage.

## Articles in press in peer-review journal with IF in 2016

### 1. Do flying foxes limit flower abortion in African baobab (*Adansonia digitata*)? Case study in Benin, West Africa

Bruno Agossou Djossa, Hermann Cyr Toni, Ibrahim Dende Adekanmbi, Florida K. Tognon and Brice Augustin Sinsin

#### ABSTRACT

**Introduction.** The plant baobab (*Adansonia digitata* L.) is a multipurpose tree in Sub-Saharan Africa. This study investigates the role of bat-induced pollination in baobab fruiting. **Materials and methods.** The tree was studied in three different climatic regions in Benin Republic: Matéri, Dassa-Zoume and Come-Houéyogbé, representing the Northern, Central and Southern parts of the country, respectively. Tree size (diameter at breast height, height, crown diameter) and flower size (sepals and petals length and width) were measured from each of the trees in the study areas and flower visitation by bats was monitored. Bats' contribution to pollination success was also evaluated by monitoring caged and free flowers. **Results and discussion.** There were significant differences in tree and flower sizes among the three regions. Significant differences were also observed in the mean number of bat visits per tree and pollination success among tree populations, but, fruit set per tree was not significantly different among baobab populations, at least in the first 8 weeks. In all populations, flower abortion was significantly elevated in caged flowers. **Conclusion.** Based on findings of this study, it can be concluded that bat-pollination increases the fruit set rate, making it an important factor for *in situ* regeneration of baobab trees in the country.

**Keywords:** Benin / baobab / *Adansonia digitata* / flying fox / bat pollination / fruiting

### 2. Utilisations de *Bombax costatum* (Malvaceae) dans les terroirs riverains de la Réserve de Biosphère de la Pendjari, République du Bénin

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*In press : Bois et Forêts des Tropiques*

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#### ABSTRACT

The red kapok tree, *Bombax costatum* is a common tree species found in the sudanian zone of Africa. It is poorly studied and probably underutilized. This paper assessed knowledge on the uses of *B. costatum* among different socio-cultural groups, age and gender categories. Data were collected in the Biosphere Reserve of Pendjari over one hundred and eighteen informants that were surveyed using individual semi-structured interview and direct observations. Ethnobotanical indices such the relative frequency of citation (RFC), reported use value; reported use value of organs and cultural importance index were computed. 46 uses were recorded and grouped in eight categories of use (food, handicraft, wood, worship ritual, ecological assets, material, medicine and socio-culture). Food (RFC=0.90), medicine (RFC=0.87), material (RFC=0.28) and cultural (RFC=0.24) were the main reported use categories. Leaves, bark, seeds and roots were the most used organs for food, medicinal, and cultural purposes. There were differences among socio-cultural groups, but neither according to gender nor among age categories. *Berba* et *Gourmantché* groups where the most knowledgeable as compared to *Waama*, *Natimba* and *Peulh*, and mainly use *B. costatum* for food. Promoting food uses of this species could be considered and serve as a starting point for a broader valorization. However, future studies should focus on the nutritional value, the profitability as well as effective propagation methods of the species to ensure sustainable domestication strategy.

**Keywords:** *Bombax costatum*, Socio-cultural importance, uses, radar chart, Red kapok tree

### **3. Application of site-specific biomass models to quantify spatial distribution of biomass stocks and historical emissions from deforestation in a tropical forest ecosystem in West Africa**

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#### **ABSTRACT**

The allometric equations developed for the Lama forest, located in southern Benin, were applied to estimate the carbon stocks of the three vegetation types including undisturbed forest, degraded forest and fallow of Lama. The carbon stock of the undisturbed part of Lama was 2.7 and 3.4 times higher than the stock in the degraded forest and fallow respectively. The structure of the forest suggests that the individuals were in general concentrated in lower diameter classes. The carbon stock was positively correlated to the basal area and negatively related to the tree density suggesting that trees in higher diameter classes contributed significantly to the carbon stock. The study demonstrated that big trees constitute an important component to include in the sampling approach to achieve accurate carbon quantification in forestry. Historical emissions from deforestation that converted more than 30 per cent of Lama into cropland between the years 1946 and 1987 amounted to 260563.17 tons of carbon per year (t CO<sub>2</sub>/year) for the biomass pool only. The study explained the application of biomass models and ground truth data to estimate reference carbon stock of forests.

**Keywords:** site-specific biomass model, reference level, spatial distribution of biomass, tropical forest ecosystem.

### **4. Local perceptions of elephant-*Borassus aethiopum* (Arecaceae) interactions in the Pendjari National Park in Benin**

Juliano Houndonougbo<sup>1,2\*</sup>, Valère K. Salako<sup>1</sup>, Rodrigue Idohou<sup>1,2</sup>, Fortuné A. Azihou<sup>1,2</sup> and Romain Glèle Kakaï<sup>1</sup>

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#### **ABSTRACT**

Elephants are reported to have a dramatic impact on woody vegetation in protected areas. As such, careful control of elephant populations is crucial for biodiversity management in such ecosystem. The perceptions of local people and protected areas managers are of key importance for sustainable management of the reserve. This study assessed the perceptions of managers and local people on the causes, damages, consequences and management options of elephant pressure on the dioecious palm *Borassus aethiopum* in the Pendjari National Park. Semi-structured interviews were conducted with 53 informants belonging to three socio-professional categories: administrators, ecoguards, and Local Professional Hunters. Relative frequency of citation and Pearson correlation were used to assess consensus and concordance of informants' perceptions. Informants reported a strong increase of the number of elephants in the Pendjari National Park. This increase was attributed to high elephant migration from transboundary parks where poaching activities were perceived as high. This has resulted in high pressure on tree plant species of which *B. aethiopum*. Despite the professional differences, consensual and concordant opinions were noted among administrators, ecoguards, and Local Professional Hunters on the relationship between *B. aethiopum* and elephants. A regional approach that aims at securing elephants (low poaching) in the W-Arly-Pendjari complex and other neighboring reserves were suggested to limit elephant migration.

**Keywords:** African fan palm, elephant, pressure, reserve managers, savanna, West Africa.

## **5. Population structure of *Pterocarpus erinaceus* and *Anogeissus leiocarpa* in woodlands of W National Park in Niger (West Africa) assessed by structural and ecological indicators**

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South African Journal of botany

### **ABSTRACT**

This study aims to assess population structure and ecological indicators of woodland vegetation dominated by *Pterocarpus erinaceus* and *Anogeissus leiocarpa* as a basis for sustainable conservation strategies. We sampled 34 plots each of 30 m × 30 m in W National Park in Niger and analyzed structural parameters (tree density, basal area, Lorey's mean height and size class distribution) and ecological indicators (species richness, Shannon diversity index, Pielou evenness index and Importance Value Index) of woodland in general and the two key species. The result show that mean density of tree and basal area were respectively 1139 stems/ha and 833 m<sup>2</sup>/ha in the woodlands including 242 stems/ha and 479 m<sup>2</sup>/ha for *A. leiocarpa* and 63 stems/ha and 24.3 m<sup>2</sup>/ha for *P. erinaceus*. The mean diameter of both species was higher (24 cm and 47 cm for *A. leiocarpa* and *P. erinaceus* respectively) than the mean diameter in woodlands (16 cm). A “reverse J” shape distribution was found for woodland in general and for *A. leiocarpa* but *P. erinaceus* showed a left dissymmetric distribution. The woodland was composed of 59 tree species belonging to 34 genera and 17 families. *A. leiocarpa* had the highest IVI value (0.93), whereas *P. erinaceus* was among species with the lowest IVI value (0.03). Findings of this study showed that urgent actions are needed for sustainable conservation of some key species especially *P. erinaceus*.

**Keywords:** Forest inventory, regeneration, size class distribution, woody vegetation.

## **6. Impact of land use practices on traits and production of shea butter tree (*Vitellaria paradoxa* C.F. Gaertn.) in Pendjari Biosphere Reserve in Benin**

T. J. D. Akpona, H. A. Akpona, B. A. Djossa, M. K. Savi, K. Daïnou . B. Ayihouenou . R. Glèlè Kakaï

### **ABSTRACT**

Dendrometric parameters such as tree DBH, height, crown diameter and size characteristics of leaves and fruit production collected from *Vitellaria paradoxa* subsp. growing in three land use types in Pendjari Biosphere Reserve (PBR) were analyzed. A total of 36 circular plots of 15 m diameter were randomly set in the three main land use sites of the PBR. Thus, Shea butter production was estimated from 90 trees (30 trees in each site) selected randomly. Our results revealed a significant difference in trees traits which increase from the park and hunting zone to the farmlands. The highest production of the selected Shea trees was reported from the farmland. Thus, there is high variability between leaf sizes of trees within the sites while for the fruits the greatest variability is between fruits from same tree. The findings of this study showed that the morphological traits and the production of Shea butter trees could be affected by land use systems.

**Keywords:** Production, Dendrometric parameters, Parks, *Vitellaria paradoxa*, Benin

# Articles in press in peer-review journal without IF in 2016

## 1. Nutritional Value of Cereal and Legume Crop Residues Fed to Ruminant in Republic of Benin

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Journal of Nutritional Ecology and Food Research (In press)

### ABSTRACT

In sub-Saharan Africa, farmers use crop residues as livestock feeding strategy in small-scale-farms during the dry season. Due to the ignorance of the nutritional potential of the residues, the amounts of residues used are low and the operation remains rudimentary. The nutritive value of crop residues (cereal and legume) commonly used in ruminant feeding in Benin was determined to provide recommendation for their enhanced. The samples, collected in two agro-ecological regions areas of the country, were screened for their chemical composition and energy content, as well as for their in vitro fermentation characteristics (i.e., gas and volatile fatty acid production, organic matter degradability). Compared to legume residues, cereal residues showed lower energy (5.86 vs. 10.89 MJ/kg DM) and crude protein (4.16 vs. 11.77% DM) level and higher cell wall content (NDF: 84.98 vs. 56.12% DM), respectively. For both cereal and legume residues, the in vitro fermentation parameters were highly ( $P < 0.01$ ) influenced by the residue type, while the study area significantly affected mainly cereal residues. Organic matter degradability ranged between 55.4 and 57.5% in cereal whereas between 53.2 and 89.6% in legume. The in vitro method utilized was helpful to evaluate the nutritive value and describe the fermentation kinetics of crop residues studied.

**Keywords:** Degradability, Fermentation Kinetics, In Vitro Gas Production, Volatile Fatty Acids.

## 2. Facies of vegetation and pastoral characterization of agrosystems dominated by oil palm tree (*Elaeis guineensis*) in Ze, Allada and Toffo' perimeter in Southern Benin

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International Journal of Biological and Chemical Sciences (in press)

### ABSTRACT

This study has been carried out in southern Benin over agro systems of Zè, Allada, and Toffo, three townships from Atlantic department. The overall objective was to assess forage agro systems importance in those townships. Specific objectives were as follow: (i) Zè-Toffo and Allada's perimeter mapping; (ii) identifying of grazing value of vegetal species; (iii) estimating grazing value. Three townships were first zoning in two areas, this area was mapped and surveys have been made closed to shepherds to make a list of consumed species.

Result showed that land owners are essentially men (83.3 %) and women (16.7 %) from 55 age average. Legacy is the main process to access land (46 % of household survey). 171 plant species distributed above 63 botanic families was listed. Euphorbiaceae are the most dominant and diversified family (16 species) followed by Fabaceae and Poaceae (12 species). *Panicum maximum* is the dominant species. Its Contact Specific Contribution averages 77% and the grazing value 43.13%.

**Keywords:** Facies of vegetation, Specific Indice of Quality, Grazing value.

# Articles under review in peer-review journal with IF in 2016

## 1. Usages traditionnelles et valeur économique de *Synsepalum dulcificum* (Schumach. & Thonn.) Daniell

Adandé Belarmain Fandohan<sup>abc</sup>, Flora Josiane Chadare<sup>d</sup>, Nounagnon Gerard Gouwakinnou<sup>be</sup>, Chénangnon Frédéric Tovissode<sup>c</sup>, Alice Bonou<sup>bf</sup>, Frejus S. Djonlonkou<sup>b</sup>, Loetitia F.H. Houndelo<sup>b</sup>, Corine Laurenda B. Sinsin<sup>b</sup>, Achille Ephrem Assogbadjo<sup>bc</sup>

*Under review : Bois et Forêts des Tropiques*

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### ABSTRACT

*Synsepalum dulcificum* (Schumach. & Thonn. Daniell) is a shrub from West Africa. Its importance for Benin local people is still little documented. This study takes up this issue and has been carried out to assess local knowledge, use value and economic importance of the species for local people. Ethnobotanical and economic surveys have been led with 606 respondents from 13 socio-cultural groups of southern Benin. Ethnobotanical and economic indices were computed and their significance tested through statistical tests. Results showed that *S. dulcificum* was well known by local people of southern Benin (100 % of respondents) who mostly grew it in home gardens. All plant parts were used mostly for medicinal, food and magic purposes. Knowledge and use value of the shrub varied between socio-cultural groups, decreasing from south eastern to south western. Knowledge and use value were also gender, age and activity dependent, being concentrated within men, adults, olds, and traditional healers. Economic data showed a short marketing chain. The low average income generated by fruit selling (about \$USD 27,74 yearly) reveals the low economic value of the species which remains a declining subsistence resource. The optimal conservation and valorization of the species requires (i) phytochemical, phenological, morphological and genetic investigations, (ii) the development of a silviculture, (iii) the integration of the species in formal conservation policies and (iv) the development of a chain value through the establishment of an actual spinneret.

**Keywords:** miracle berry, ethnobiology, survey, questionary, income, republic of Benin

## 2. Variation in soil organic carbon along soil profile and across three vegetation types in a tropical forest in West Africa

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### ABSTRACT

Soil organic carbon (SOC), in addition to biomass and dead organic matter, is required to quantify the carbon budget of forest ecosystems. In this study, SOC was derived from direct measurements of organic matter (OM) content in soil. Six hundred seventy five soil samples were collected along 30 cm soil profile and across three vegetation types including undisturbed forest, degraded forest and fallow in a semi-deciduous tropical forest in West Africa. The samples were analysed for bulk densities and for soil OM using loss-on-ignition method. Between 12 and 21 per cent OM per mass was found in all layers, 0-10, 10-20 and 20-30 cm, suggesting that the soil in Lama forest was organic soil. OM and C contents and SOC were higher in the upper soil layer and decreased with depth. The slightly higher values of these parameters were detected in undisturbed forest. The low variation of these parameters within each vegetation type and their fairly homogeneous spatial distribution across vegetation types confirmed that soils in degraded forest and fallow have reached equilibrium, considering undisturbed forest as reference. The lowest bulk density (BD) was found in the top 10 cm layer of the soil profile. There were no significant differences between the mean values of BD observed at the same horizon across vegetation types.

**Keywords:** Bulk density, soil organic carbon, soil profile, spatial variation of carbon, tropical forest.

### **3. Local Knowledge on the Uses, Habitat and Change in Abundance of Multipurpose *Mimusops* Species in Benin**

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*Economic Botany* (Under review)

#### **ABSTRACT**

Multipurpose NTFP species typically experience higher harvest demand because of their multiple uses, which, when combined with unsustainable land use practices may threaten population viability. We assessed local knowledge on the uses, habitat and population status of *Mimusops andongensis* and *Mimusops kummel*, both multipurpose NTFP species in Benin, to promote their valorization and conservation, and thus sustain local knowledge on their uses for domestication issues. One hundred households were randomly selected for structured interviews for *M. andongensis* and 500 for *M. Kummel*. The relationship between age, sex and ethnic groups and the species uses was assessed using comparison and correspondence analyses. Nearly all organs of the species were used. Both species were mainly exploited for medicinal purposes but also in construction and as firewood. We found similarities in some uses of the species organs, although the species occur in different ecological zones and are used by different ethnic groups. This result should be considered for the valorization of the species. Most informants reported that populations of *M. andongensis* were decreasing, although some felt that they were increasing, whereas less than one-third said that *M. kummel* was decreasing. There were strong relationships between gender, age and ethnic affiliation of the users and the exploited organs of both species. Potential uses exist based on both the past and current uses of the species and in comparison to other countries where they are exploited. Local ethno-ecological knowledge and practices will help to valorize and conserve the species. However, further research on the species seeds germination and propagation ability are also necessary.

**Keywords:** Non-Timber Forest Products, local knowledge, ethnobotany, ethnoecology, medicinal plants, *Mimusops andongensis*, *Mimusops kummel*

### **4. Reproductive phenology of two *Mimusops* species in relation to climate, tree diameter and canopy position in Benin (West Africa)**

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*African Journal of Ecology* (Under review)

#### **ABSTRACT**

Assessing species phenology adds useful understanding about their autecology, for management strategies. We monitored the reproductive phenology of *Mimusops andongensis* and *Mimusops kummel* during 12 months and the relationship with climate, tree diameter and canopy position across climatic zones in Benin. Flowering was evident from the dry season to the beginning of the rainy season, but peaked in the dry season. Fruiting occurred in the rainy season and peaked during the wettest period, for both species. Flowering was positively correlated with temperature. Conversely, fruiting was negatively correlated with temperature and positively with rainfall, in the Guineo-Sudanian zone. For *M. andongensis*, both flowering and fruiting prevalence was positively linked to diameter, while only flowering was significantly related to canopy position. For *M. kummel*, the relationship with diameter was significant for flowering prevalence only and in the Guineo-Sudanian zone. Our results suggest that *Mimusops* species phenology is mainly restricted by phylogenetic membership. Flowering and fruiting of both species are influenced by climate and climate change might shift their patterns and affect the species population and, other organisms and services related to them. Long-term investigations, considering flower and fruit abortion, will help to better understand the species phenology and perhaps predict demographic dynamics.

**Keywords:** Flowering, Fruiting, Tree sizes, Climatic conditions, *Mimusops andongensis*, *Mimusops kummel*

## **5. Efficiency of conservation areas to protect orchid species in Benin, West Africa**

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### **ABSTRACT**

The role of protected areas in the prevention of extinction of species has been much debated. This study was carried out in the protected of the Biosphere Reserve of Pendjari and unprotected areas to assess the effectiveness of the reserve in the conservation of the orchid species. Diversity index were used to assess the orchid diversity in the two zones (Protected and unprotected areas). The independent t test of Student was first performed to examine at global stand, whether the conservation status of a study area influence the density of the overall orchids species. Two-way ANOVA were performed to assess an existing combined effect of vegetation type and the conservation status of study area on the density of orchid species and the importance of the protected area in the conservation of *Nervilia kotschy* (Rchb.f.) Schltr. and *Eulophia guineensis* Lindl. The importance value index (IVI) was used to measure how dominant an orchid species is in a given zone according to its conservation status (Protected and unprotected zone). Only three epiphytic orchids (*Calyptrochilum christyanum* (Rchb.f.), *Cyrtorchis arcuata* (Lindl.) Schltr. and *Plectrelminthus caudatus* (Lindl.) Summerh.) were inventoried and all in gallery forest of unprotected area. Indeed, 67% and 58% of the orchid species were respectively only recorded in unprotected area and gallery forest. There is no significant difference between the density of all recorded orchids in protected and unprotected area. The conservation status of the studied zone had a significant effect on *N. kotschy* and *E. guineensis* density ( $p = 1.08e-06$ ). The highest IVI of *N. kostchi* was observed in protected area whereas the one of *E. guineensis* was in unprotected. The conservation status effect with clear differentiation between habitat of protected and unprotected area appeared more with the canonical correspondence analysis results. Orchids characterised by woodland with average tree cover were more conserved in the protected area. However, a gap of conservation can be assumed to most of epiphytic orchid only recorded in the gallery forests of unprotected area. Our results have broad implications for conservation biology and the redefinition of protective zones for some orchid species.

**Keywords:** Orchid, Biosphere Reserve of Pendjari, gap analysis, habitat.

## **6. Profitability of Commercial Thinning in Natural Black Spruce Forests in Quebec**

### **RESUME**

Commercial thinning is a silvicultural treatment that is attracting much interest in the context of limited wood supplies. Further, this interest is increased by the fact that many planted or pre-commercially thinned stands are now becoming available for the treatment. To study this treatment profitability, data used came from 35 pairs of permanent plots (control vs thinned) that were established in operational thinnings and surveyed over ten years post-treatment, in natural black spruce stands. Wood production values and harvest costs were used to determine stand Net Future Values (NFV) ten years after thinning. Using stepwise multiple regressions, thinning intensity and pre-thinning merchantable basal area were selected as the two most important variables, which explained 66.7% of the variation in stand NFV. With 9% annual discount rate, NFV was significantly higher in commercially thinned stands (\$21325/ha) compared to controls (\$18382/ha). Thus, commercial thinning could increase black spruce stand profitability in Quebec in stands with a high initial basal area or when high thinning intensities are used. In these conditions, treatment profitability would result from an earlier income, reinvested at a high interest rate. Although the study results confirm MFFPQ recommendations, there is a need to pay more attention to the market value of thinning products to make commercial thinning profitable.

**Keywords:** Thinning effects, profitability, Net Future Values, black spruce, Quebec

## 7. Mapping land use land cover change and prediction of future extension of *bowé* in West Africa (Benin)

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Land use policy

### ABSTRACT

Desertification and land degradation are worldwide problems affecting soil, vegetation and thereby livelihood of the rural population. *Bowal* (plural *bowé*) is a particular form of degraded land that occurred in tropical region and leads to ferricrete exposure unusable for farming. *Bowé* are more frequent in farmland and degraded savanna. Land use land cover change analysis was used to map the land cover of 1975, 1990 and 2010. The changes observed during these periods (1975-1990, 1990-2010 and 1975-2010) were considered to predict occurrence of *bowé* towards 2050 with the Markovian chain. The results showed considerable change in land use land cover maps of the three periods (1975, 1990 and 2010). The land cover on which *bowé* occur (farmland and degraded savanna) have persisted, and increased at the rate of 0.0542 ha/year, 0.0952 ha/year during the periods 1975-1990, 1990-2010 respectively; while the natural vegetation (forest, woodland and tree savanna) have decreased at the same rate. The future scenarios also predict the same trend. A total of 26% (1286346 ha) and 31% (1293693 ha) of the area cover with natural vegetation would be converted to farmland and degraded savanna towards 2050 if we assume the dynamic recorded respectively from 1975-1990 and 1990-2010. Thus *bowalization* would persist and increase towards 2050. Promotion of the best practices developed by the farmers to prevent and cope with *bowalization* would help to refrain land degradation in this zone.

**Keywords:** Land use/cover change, natural vegetation, *bowé*, ferricrete, West Africa.

## 8. Tree density, diversity and decline in Senegalese farmlands

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Agroforestry system

### ABSTRACT

Trees are rapidly disappearing from agrarian landscapes in many tropical countries, a severe problem to rural populations, who depend on wood and non-timber forest products for their livelihoods. The aim of this study is to determine woody diversity, biomass and carbon stock and to gain insight in the socio-economic determinants of woody vegetation in farmlands in Senegal. A total of 235.5 ha were investigated in 15 sampling plots of 15.7 ha each. In total, 25 tree species were recorded with an average density of 1.6 tree ha<sup>-1</sup> and a canopy cover of 1%. The average above ground biomass (AGB) was 8.9 ton ha<sup>-1</sup> corresponding to 4.45 t carbon ha<sup>-1</sup>. A single species, *Cordyla pinnata*, accounted for 50% of all the trees censured. We developed an allometric model to estimate AGB based on satellite measurements of canopy cover. Satellite images showed considerable change in tree density during the investigated periods (2004, 2009 and 2013). The tree density has decreased at the rate of 3% per year<sup>-1</sup> and 6.4% per year<sup>-1</sup> from 2004-2009 and 2009-2013, respectively. All the trees would be lost towards 30 years (from 2009) and 16 years (from 2013) if this trend continues. Tree planting was not considered an option by the landowners, since livestock damage on young trees was too big and fencing not an option without support from outside. Informants were generally interested in increasing the number of fruit trees. On average, they were willing to allocate 19% of their land for planting of new trees.

**Keywords :** Africa, forest resources, deforestation, local management, woody biomass.

# Articles under review in peer-review journal without IF in 2016

## 1. Prioritization of Non timber Forest Products for economic valorization in Benin (West Africa) using an innovative approach

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### ABSTRACT

Species prioritization is a crucial step towards setting sound valorization strategy, especially for Non timber Forest Products (NTFP). This study aimed at setting priority among NTFP for a successful economic valorization. Data were collected through semi-structured survey conducted with local communities completed by literature review. Eight prioritization criteria and different prioritization systems were used. The top 50NTFP species obtained by each system were identified and tenNTFPof highest priority occurring as priority across methods were selected. These 10NTFPwere: *Vitellaria paradoxa* C.F.Gaertn. ssp. *paradoxa*, *Parkia biglobosa* (Jacq.) G. Don, *Adansonia digitata* L., *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill., *Blighia sapida* Koenig, *Tamarindus indica* L., *Dialium guineense* Willd., *Vitex doniana* Sweet, *Borassus aethiopum* Mart. and *Garcinia kola* Heckel. Due to the economic potential and the regional importance of these priority species, appropriate incentives for their valorization are needed and should be reflected in forest policies in Benin.

**Keywords:** Biodiversity, prioritization scheme, Non timber Forest Products, valorization.

## 2. Local perception on the habitat and uses of *Lippia multiflora* Moldenke in Benin (West Africa)

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### Agronomie Africaine

### ABSTRACT

The present study aims at assessing the ethnobotanical knowledge of *Lippia multiflora* in order to identify its habitats and uses. An ethnobotanical survey was conducted with 180 household distributed in four sociocultural groups in the Sudano-Guinean (Mahi, Bariba, Peuhl) and the Sudanian zones (Boo, Peuhl) in Benin. The habitats of the species were identified with the frequencies of citation. Pearson Chi-square Test was used to analyze the frequency of uses of the species. Correspondence Analysis was used to assess the relationship between organs used and sociocultural groups. The results revealed that *L. multiflora* was abundant in fallow and savanna. A total of 62% of the informants in the study area used the inflorescences of the plant for food, 32% used the leaves for health care and 6% used the stems for artisanal activities. The sociocultural group of Mahi used highly the leaves of the plant species for health care, while Boo and Peuhl used highly the inflorescences for food. The group of Bariba used highly the stems for artisanal purpose. The diseases treated by the species were: stomach ache, fever and malaria, toothache, heart illness, hypertension, wound, physical weakness of baby and itch body.

**Keywords:** *L. multiflora*, local knowledge, bioclimatic zones, sociocultural groups

# Completed Doctorate thesis in 2016

## 1. Tree-ring anatomy, age structures, dynamic in carbon budget and demography of West African tree-populations undergoing selective timber logging and repeated forest fires

MSc. Franck SINSIN

### ABSTRACT

Discipline is needed to provide dendro-ecological data on West African tree-populations for the sustainable management of their habitats. With regards to that purpose, six chapters were developed in this thesis. The first one introduces elementary bases as well as the history and fundamental principles on which, dendrochronology is based. Chapter 2 analyzes anatomical structures of eleven valued commercial timber, focusing mainly on wood density, arrangement and size of vessels and parenchyma. This section demonstrates how wood anatomy could be an instrument of its identification and species recognition. In Chapter 3, the age structure of tree populations was investigated in four different protected areas from 478 wood cores coming from 239 living trees and five species to build 15 age structures and 14 radial growth models. Key findings of this chapter disclosed several categories and various grades of stress on species in protected areas. In chapter 4, the history of bush fires was reconstituted to more than a centenary from charcoal scars observed in tree rings of studied woods and it was proven that fire is controlling the savanna-woodland structure. Based on 120 stem discs collected along a 12 km route, the history of fires in the Wari-Marо Forest ( $09^{\circ}10'0\text{ N}-02^{\circ}10'0\text{ E}$ ) over the past century in savanna woodland and dry forest was reconstituted. By analyzing tree rings, 246 fire scars were identified. The scars were observed to be caused by 51 fire years, occurring at a mean interval of 2.23 years. In chapter 5, a three-dimensional methodology was used based on a diachronic analysis to establish half-decade changes in floristic diversity and carbon budget. Data on tree and stump density, diameter at breast height, tree heights and crown diameter were collected from all trees whose diameters equal or exceed 10 cm at the breast height. These were investigated from a permanent plot of 1 ha set up in savanna-woodland vegetation. Key outcomes of this research revealed that from 2009 to 2014, the woody average species' richness of the investigated area dropped from 15 to 14 species per hectare. The Shannon & Wiener diversity index and the equitability index of Pielou were almost invariable. Conversely, considerable changes were observed with regards to tree density, basal area, crown cover and carbon pool. Finally, the last chapter was oriented towards the social organization which makes possible the illegal timber logging in Wari-Marо Forest Reserve. This chapter also informs us of operating cash, the sale price of the beams and the variation in financial gains by stakeholder groups.

## 2. Functioning of grasslands ecosystem : dynamics, spatial distribution and nutrients contents of tropical grasses fodders

MSc. Myrène AHOUDJI

### SUMMARY

Due to the rapid increase in population demography, lands cover change. In this situation, the management approach adopted by most African developing countries for biodiversity conservation was the development of protected areas. But these areas were located where poverty and insufficient employment opportunities determine population's needs and activities. In this context, protected areas vulnerability increased. Thereby, this study focused on understanding factors that structure grasslands plants community's composition inside the W Biosphere Reserve (WBR) in Benin during these last decades and on the establishment of dominant grasses species repartition and their chemical composition. It aims: (i) to identify the effects of land cover change on rangeland vegetation composition in WBR, Benin Republic (West Africa); (ii) to assess the perceptions of Fulani herders on rangeland degradation in areas bordering W Biosphere Reserve (WBR) in northern Benin; (iii) to assess change in plant communities' composition, diversity indicators and structure in the last decade in the hunting zone of Djona (WBR-Benin); (iv) to establish current floristic composition, life form and productivity of the grasslands in the hunting Zone of Djona (Benin); (v) to predict the spatial distribution of herbaceous fodders using bioclimatic variables in the W Biosphere Reserve of Benin (WBR) and (vi) to assess the seasonal dynamic of aboveground biomass production and macro-mineral composition of tropical grasses species.

**Chapter 1** concerns the general introduction and the **chapter 2** describes the W Biosphere Reserve of Benin, the study area, where all field works of scientific investigations that form the main body of this thesis were done.

In **chapter 3**, three serial times of maps, taken in 1989, 2000 and 2013 were interpreted using the software ArcGis 10.1. Dynamics areas proportions values were calculated and Transition matrices were elaborated. We remark that land cover has changed considerably and these changes were mostly observed in the periphery of the hunting zone where settlements, farms and fallows were noticed and in high proportions in 2013 than in 1989 and 2000. Concerning natural vegetations, savannas increased from 1989 to 2000 and were the most represented land cover type in 2013 while dense forests, gallery forests and woodlands decreased in the same period. Our results highlight the necessity to study dynamic in floristic composition of this

area in order to assess changes in floristic composition and to redefine with actors the best management practices which will allow the protected areas to assume their main role of biodiversity conservation.

**Chapter 4** focused on Fulani's perception on the degradation of rangeland vegetation. Structured and semi structured interviews were conducted. Perceptions of change in rangeland vegetation were assessed and citation frequency of perceived causes of changes and consequences was estimated. Six groups were defined based on informants' age and activities: young agro pastoralists; young pastoralists; adults agro pastoralists; adults pastoralists; old agro pastoralists and old pastoralists. ANOVAs and SSK were used to test the homogeneity of the perception of informants groups and their livestock units. Besides, we performed a Factorial Correspondence Analysis (FCA) to test the dependency between the perception of the groups' and the mentioned causes, consequences and coping strategies. All statistical analysis was done using the software R. Results showed that rangeland changed in the areas surrounding the W National Park. Factors inducing changes and consequences on rangelands vegetation perception depended on the age and activities of Fulanis' people. But strategies depended only on informants' activities. Adaptation strategies were used to reduce the effect of rangeland changes. Mitigation activities were not taken by the Fulanis.

In **chapter 5**, floristic composition of plants communities and ecological indicators were used to understand the changes in the vegetation since 2000. 32 permanent plots installed in 2000 and 60 plots installed in 2013 were considered and "phytosociological relevés" were carried out to established plants communities. Occurrence frequency and mean cover were used to evaluate changes in floristic composition of plants communities within the two years. Alpha diversity indices (specific richness, Shannon's index and Pielou evenness) were calculated to characterize each of these plants communities and β diversity indicator was used to establish similarity and/or dissimilarity between plants communities of the two periods. Life forms' and chorotypes spectrum were also considered to assess changes in the vegetation. Our results showed two plants communities for the two years, one of herbaceous savannas and the second of woody, trees and shrubs savannas. Diversity indicators showed significant differences in floristic composition of the two years. Life forms and chorotypes spectrum in 2000 indicated a relatively undisturbed plants communities in Sudanian region contrary to 2013 where we observed a high level of degradation in plants communities.

**Chapter 6** assessed the temporal changes in floristic composition, plant communities' structures and productivity of grasslands. 30 plots of 900 m<sup>2</sup> were used and "phytosociological relevés" were done following ecological uniformity, floristic homogeneity and samples representativeness to established plants communities. For biomass estimation, 30 plots of 100 m<sup>2</sup> were used. Results showed that the greatest productivity value is about  $8320 \pm 0.21$  kg DM/ha. The identified life forms and chorological types showed an evolution of the post farming pastures to woodlands and savannas vegetation, which explained the current floristic composition of the area. Moreover, it will be possible to model the impact of grasslands exploitation on the viability of the protected area particularly in the context of climate change and for this, it is important to undertake a long-term study in order to take into account variations and causes of these variations.

Chapter 3 to 6 dealt with the dynamic of plants communities in the WBR of Benin. Chapter 7 and 8 concerned tropical grasses spatial distribution and mineral content. Indeed, **Chapter 7** focused on current and future spatial distributions of *Andropogon gayanus*, *Loxodera ledermanii* and *Alysicarpus ovalifolius* regarding bioclimatic variables in the Sudanian zone of Benin, particularly in the W Biosphere Reserve (WBR). These species were selected according to the changes in their natural spatial distribution induced by environmental pressures. A MaxEnt (Maximum Entropy) method was used to identify all climatic factors which determined the spatial distribution of the three species. On the horizon of 2050, spatial distribution showed for *Andropogon gayanus*, a regression of high area distribution in detriment of low and moderate areas. The same trend was observed for *Loxodera ledermannii* and for *Alysicarpus ovalifolius*, currently area with moderate and low distribution were the most represented but map showed in 2050 that area with high distribution increased. We can deduce that without bioclimatic variables, other factors such as: biotic interactions, dispersion constraints, anthropic pressure, human activities and another biological factor determined spatial distribution of species.

**Chapter 8** concerned the minerals contents of some tropical species: *Loxodera ledermannii*, *Andropogon gayanus* and *Tephrosia pedicellata*. Temporal trend on aboveground biomass and nutrients content in biomass and soils at different stages of development of these species were determined. The trend of Carbone/Nitrogen (C/N), Calcium (Ca), Magnesium (Mg), Sodium (Na) and Potassium (K) elements were represented for each species. Comparison was made between species biomass and nutrient content with ANOVA test. Relations between nutrients variation in soils and in biomass at the beginning and at the end of harvesting were showed with Principal Component Analysis (PCA). Results showed that biomass production of perennial grasses (*Andropogon gayanus*, *Loxodera ledermannii*) was higher than legume (*Tephrosia pedicellata*). Contrarily to C/N report, *Tephrosia pedicellata* content in Ca, Mg, Na and K is higher than *Andropogon gayanus* and *Loxodera ledermannii* content in the same nutrients. Nutrients content in soils and biomass are inversely correlated. At the beginning of vegetative cycle of species nutrient content in biomass is higher and lower in soils. And at the end of vegetative cycle of species biomass nutrients content is lower and higher in soils. It will be judicious to investigate on what is the real feedback process between plant and soils nutrients when senescence began.

The last section of this work discussed the major findings and their relevance to literature, implications for conservation and perspectives for future researches.

### **3. Gestion et modélisation de la dynamique des parcours de transhumance dans un contexte de variabilités climatiques au nord-est du Bénin**

MSC. Paolo LESSE

#### **RESUME**

La transhumance est un système d'élevage qui occupe une place importante dans la sous-région et au Bénin en particulier. La présente étude a été conduite au Nord-Est du Bénin qui est une zone de préférence des éleveurs. L'objectif du travail est de contribuer à une gestion durable des parcours de transhumance au Nord-Est du Bénin. Les parcours naturels ont été caractérisés à partir de relevés linéaires, de coupe rase pour la quantification de la biomasse et des relevés phytosociologiques. Le système d'élevage quant à lui a été étudié suivant l'approche système. La matrice de sensibilité a été utilisée pour mieux appréhender le degré de vulnérabilité des transhumants aux variabilités hydro-climatiques. L'évolution future des extrêmes pluviométriques et thermométriques dans le bassin a été analysée grâce aux données du modèle climatique régional REMO. Le « Land Change Modeler (LCM) » d'IDRISI Selva a été utilisé pour prédire l'état de l'occupation du sol en 2050. L'étude a permis de ressortir les contraintes de ce système. Il s'agit des problèmes d'alimentation, de variabilités climatiques, des textes réglementaires, de conflits et de disponibilités des infrastructures pastorales. Au total cent soixante-deux (162) infrastructures pouvant servir d'abreuvement dans la zone d'étude ont été identifiées mais elles sont soit non fonctionnelles, soit mal entretenues. La zone est caractérisée par l'inexistence de voies d'accès aux points d'eau, la présence d'abondants végétaux flottant à la surface des eaux d'abreuvement et les problèmes de fonctionnement des mécanismes de gestion mis en place. Quatre types de pâturage ayant des productivités variées entre 3,46 à 5,7 t MS/ha ont été identifiés. Le pâturage à *Prosopis africana* et *Eragrostis atrovirens* a montré la plus grande valeur alimentaire au niveau des graminées alors qu'au niveau légumineuses, c'est le pâturage à *Piliostigma thonningii* et *Stylosanthes fruticosa*. Douze axes de transhumance tous orientées vers les cours d'eau et les aires protégées ont été répertoriés et cartographiés dans la zone d'étude. Concernant les paramètres démographiques, le taux moyen de croît annuel est de  $1,068 \pm 0,05$  et le taux de production moyen est faible ( $0,155 \pm 0,02$ ). A l'horizon 2050, une évolution très contrastée des régimes pluviométriques dans le Nord-Est du Bénin quel que soit le scénario choisi a été prédit et un réchauffement de 1°C en moyenne est attendu d'ici 2050. Sur la base des probabilités de transition, la modélisation prédictive réalisée sur l'occupation du sol à l'horizon 2050 présage que les savanes arborées et arbustives occuperont 49,89 % de la superficie totale des parcours naturels du Nord Est de la république du Bénin. La variabilité observée se traduit par le retard du démarrage des pluies, la mauvaise répartition et l'arrêt précoce des pluies, les vents violents. L'analyse de la vulnérabilité a permis de remarquer que l'élevage est le plus vulnérable et que les éleveurs craignent plus les sécheresses et les inondations que les baisses de la pluviométrie.

**Mots clés :** système d'élevage, productivité, vulnérabilité, parcours naturels, Variabilités climatiques, Bénin.

### **4. Ethnobotanique, écologie et distribution géographique des plantes utilisées dans le traitement traditionnel de l'hypertension artérielle en République du Bénin (Afrique de l'Ouest)**

MSC. Anselme BIO

#### **RESUME**

L'hypertension artérielle (HTA) est l'une des maladies cardiovasculaires les plus redoutables du monde actuel. Dans les pays en voie de développement, le faible pouvoir d'achat des populations ne leur permet pas de faire face au coût financier de la thérapie de cette pathologie en médecine moderne. La présente thèse a pour objectifs (i) de recenser les connaissances de la médecine traditionnelle liées à l'HTA au Bénin, (ii) d'inventorier les plantes utilisées dans le traitement traditionnel de l'HTA au Bénin, (iii) de déterminer les caractéristiques écologiques des plantes antihypertensives de grande importance, (iv) d'évaluer les différentes menaces exercées sur ces plantes et (v) d'étudier leur distribution géographique en vue de proposer une stratégie pour leur gestion durable au Bénin.

Pour réaliser les objectifs (i) et (ii) une enquête ethnobotanique a été menée à l'aide d'un questionnaire individuel auprès de 801 tradithérapeutes sélectionnés sur toute l'étendue du territoire béninois. Les résultats de cette étude ont fait ressortir 8 principaux facteurs de risque à l'HTA et 221 plantes antihypertensives. L'obésité (60,55 %) et l'hérédité (49,81 %) ont été les facteurs de risque les plus cités. *Heliotropium indicum* (20,22 %), *Parkia biglobosa* (19,6 %), *Citrus aurantifolia* (12,1 %), *Persea americana* (10,11%), *Allium sativum* (8,98 %), *Carissa edulis* (8,36 %) et *Morinda lucida* (7,36 %) ont été les plantes les plus rapportées. Le test Chi-2 de Pearson et l'Analyse Factorielle des Correspondances appliqués aux fréquences de citation des facteurs de risque et des plantes antihypertensives ont montré que les connaissances liées à ces deux variables sont dépendantes des caractéristiques socioculturelles des enquêtés et de leur zone bioclimatique. L'étude des caractéristiques écologiques des plantes antihypertensives de grande importance (iii) a été possible grâce à l'installation des placeaux dans les habitats de chacune de ces plantes. Les relevés phytosociologiques obtenus ont permis d'identifier les groupements végétaux abritant chacune de ces espèces. Certaines de ces plantes sont introduites dans les plantations (*Gmelina arborea*), d'autres sont à l'état sauvage et sont aussi plantées par endroit (*Morinda lucida*, *Crateva adansonii* et *Heliotropium indicum*) et d'autres sont uniquement à l'état sauvage (*Carissa edulis*). Pour cerner les différentes menaces sur ces plantes (iv), une autre

enquête ethnobotanique a été menée auprès de 458 habitants toutes catégories socioprofessionnelles confondues. Les résultats de cette étude ont signalé que l'utilisation à des fins médicinales constitue la principale menace pour la survie de la quasi-totalité des plantes antihypertensives de grande importance. L'étude de la distribution des plantes antihypertensives de grande importance (v) a fait appel à des techniques de modélisation de la niche climatique de ces espèces en combinaison avec le système d'information géographique (SIG). La simulation des aires de distribution potentielle présente et future (2050) de ces espèces a indiqué une diminution de l'étendue de leurs habitats potentiels quel que soit le modèle utilisé. Il est alors urgent que des mesures idoines soient prises pour la conservation durable de ces plantes.

**Mots clés :** Bénin, ethnobotanique, hypertension artérielle, niche climatique, plante antihypertensive, conservation durable.

## 5. Eleveurs, bovins de race Borgou et prédition de la valeur nutritive des ligneux fourrager les plus appétés du Nord-Bénin

MSc. Habirou SIDI IMOROU

### RESUME

Au Bénin, les productions animales et halieutiques contribuent à l'amélioration des conditions de vie des populations. Les systèmes d'élevage des ruminants sont basés sur l'utilisation excessive des pâturages naturels. Le cheptel bovin du Bénin est dominé par la race Borgou et les parcours naturels constituent l'essentiel de leur alimentation. Les études du comportement alimentaire des taurillons Borgou sur ces parcours ont permis de constater qu'en moyenne 67,0 % du temps passé au pâturage est consacré au broutage. Le reste du temps est réparti entre les activités de déplacement (10,6 %), de repos-rumination (15,7 %) et d'abreuvement (6,7 %). Les changements climatiques de ces dernières décennies ont amené les éleveurs du Nord-Est du Bénin à adopter des comportements leur permettant de conserver l'intégrité de leur cheptel. Ces comportements entraînent parfois des conflits avec certains acteurs (les agriculteurs et les exploitants forestiers) qui exploitent les ressources de cette zone. Le diagnostic participatif réalisé auprès des éleveurs sur les connaissances endogènes des ligneux a permis d'identifier sur la base de critères de disponibilité, d'accèsibilité et d'appétibilité 26 espèces de ligneux consommées pendant la période de soudure par les ruminants au Nord-Est du Bénin. Toutefois, peu d'informations sont actuellement disponibles sur la valeur nutritive et sur des équations fiables de prédition de celles-ci. Les modèles d'équations développées et utilisées sont ceux des milieux tempérés. Le problème de ces approches nécessite une connaissance précise de la description botanique des fourrages afin de sélectionner le type de modèle d'équation à utiliser. En effet, en milieu tropical, les systèmes de production animale utilisent plusieurs types de fourrages aux valeurs nutritives très variables. Il est pourtant fondamental de proposer des modèles d'équations qui prennent en compte cette variabilité. La méthode idéale de détermination de la qualité nutritionnelle des aliments est la mesure de la digestibilité *in vivo* ne pouvant pas être appliquée pour des fourrages comme les ligneux ou les pailles. Afin de contourner ces difficultés, plusieurs méthodes de prédition des valeurs nutritives ont été développées par les nutritionnistes. Au cours de cette étude, les paramètres de composition chimique des ligneux, la dégradabilité enzymatique et la fermentescibilité *in vitro* (gaz-test) en présence de jus de rumen ont été expérimentés. Les ligneux comme *Acacia sieberiana*, *Afzelia africana*, *Daniellia oliveri*, *Flueggea virosa*, *Gardenia erubescens*, *Lonchocarpus laxiflorus*, *Pterocarpus erinaceus*, *Swartzia madagascariensis* et *Xeroderris stuhlmannii*, étaient les plus intéressants en alimentation des ruminants ( $UFL = 0,63 / kgMS$  et  $MAD/UFL = 195 g$ ). La composition chimique et la dégradabilité enzymatique n'étaient pas les meilleures prédictrices de la valeur nutritive des ligneux. Par contre, le taux fractionnel de production de gaz à 4 h ( $\mu 4$ ) et le volume de gaz à 72 h ( $V 72 h$ ) ont été les meilleurs prédicteurs. L'introduction des matières azotées totales (MAT) et de la cellulose brute (CB) dans les modèles d'équations améliore la précision de la prédition. Le gaz-test apparaît comme la meilleure méthode de prédition de la valeur nutritive de ces ligneux.

**Mots-clés :** arbres et arbustes, valeur nutritive, bovins, comportement alimentaire, dégradabilité enzymatique, gaz-test, prédition, Bénin.

## 6. Biologie de la conservation des plantes ligneuses médicinales au Bénin: Diversité, Vulnérabilité et Priorisation

MSc. Alain YAOITCHA

### RESUME

Les plantes ligneuses constituent l'une des principales sources de constituants médicinaux, dont dépendent les êtres vivants pour leur bien-être. Cette situation constitue une pression qui pèse sur ces espèces et des stratégies idoines pour leur conservation doivent être définies. Compte tenu des ressources financières limitées caractéristiques des pays en développement comme le Bénin, il est important de sélectionner les plantes ligneuses les plus importantes du point de vue culturelle, socio-économique et écologique pour leur conservation. Ainsi, l'objectif principal de la présente thèse est de renforcer la prise de décision pour la conservation des plantes ligneuses médicinales au Bénin. Les investigations à travers la synthèse bibliographique, des enquêtes ethnobotaniques et des relevés de végétation ont permis d'évaluer respectivement la

diversité, les types d'usages médicinaux et la disponibilité des plantes ligneuses médicinales au Bénin. Les matrices de données portant sur les indices ethnobotaniques et les paramètres écologiques de ces espèces ont été soumises aux analyses multivariées et aux tests non paramétriques. La synthèse bibliographique a permis d'enregistrer au Bénin environ 263 espèces appartenant à 193 genres et 59 familles. Ces espèces sont utilisées pour 146 besoins médicaux catégorisés en 17 groupes, dont les maladies du système digestif, les maladies du système cardiovasculaire, les maladies de peau, le paludisme et les maladies associées pour lesquelles un nombre très important d'espèces est sollicité. L'indice d'importance relative a permis d'identifier 27 espèces ligneuses médicinales importantes parmi lesquelles certaines (*Zanthoxylum zanthoxyloides*, *Morinda lucida*, *Pentadesma butyracea*, *Securidaca longepedunculata*, *Bridelia ferruginea*) ont été recommandées pour la conservation. L'analyse de la répartition des maladies traitées à travers les zones phytogéographiques a révélé que le traitement des maladies telles que les hémorroïdes, le diabète, la paralysie, la folie, l'hypertension et les maladies gynécologiques est plus rapporté dans la zone guinéo-congolaise tandis que le traitement des maladies dermatologiques, les faiblesses sexuelles, les maladies musculo-squelettiques, la toux et les maux de ventre est principalement rapporté dans la zone soudanienne. Parmi les maladies largement traitées base des plantes, le paludisme est la maladie la plus commune et récurrente. Parmi les plantes utilisées pour son traitement, les espèces fréquemment rapportées telles que *Lannea acida*, *Pterocarpus erinaceus*, *Anogeissus leiocarpa* et *Opilia amentacea* sont toutes d'origine soudanienne. En raison de la forte utilisation de leurs écorces et racines, ces espèces se sont révélées vulnérables. Ainsi, nous recommandons que ces espèces soient prises en compte dans les stratégies de conservation de la biodiversité. L'espèce *Z. zanthoxyloides* est l'une des plantes ligneuses médicinales les plus importantes et menacées de disparition. La modélisation de sa distribution spatiale a montré que les changements climatiques auront très peu d'impact sur les zones actuellement favorables de l'espèce au Bénin. Il n'y a donc presque pas de défi en termes de changements climatiques pour sa conservation. Pour une utilisation rationnelle des moyens rares alloués aux stratégies de conservation de la biodiversité, nous avons suggéré la poursuite d'autres investigations sur les impacts des utilisations des terres et des utilisations médicinales. Des investigations menées sur les impacts écologiques des utilisations des plantes ligneuses médicinales les plus commercialisées au Bénin telles que *Z. zanthoxyloides* et *M. lucida*, il a été constaté que la véritable cause de leur vulnérabilité est beaucoup plus la production d'ananas que l'usage médicinal longtemps soupçonné. Les actions de conservation s'avèrent donc nécessaires sur le plateau d'Allada où l'ananas est fortement produit. Les pistes de recherche en la matière ont été aussi suggérées. Dans le but d'identifier les plantes ligneuses médicinales prioritaires pour la restauration de la Réserve de forêt de Wari-Maro, l'une des Réserves de forêts fortement dégradées de la zone soudano-guinéenne qui concentrent plusieurs plantes médicinales commercialisées au Sud-Bénin, une étude de la priorisation a été faite. Ainsi, 12 espèces ligneuses médicinales ont été déterminées. Parmi elles, les plus importantes sont *Afzelia africana*, *Khaya senegalensis*, *Milicia excelsa* et *Pterocarpus erinaceus*. Les actions d'enrichissement et de régénération assistée ont été proposées comme mesures de conservation urgentes à prendre. En somme, les espèces vulnérables identifiées sont prioritaires pour la conservation et ont été systématiquement recommandées pour leur prise en compte dans les plans de conservation. Parmi ces espèces prioritaires identifiées celles qui n'ont pas encore bénéficiées des actions de conservation telles que *Morinda lucida*, *Sarcocephalus latifolius*, *Bridelia ferruginea* et *Securidaca longepedunculata*, constituent de potentiels cibles pour des études futures de domestication et de valorisation.

## 7. Genetic diversity, ecology and Potential expansion of *Rhamphicarpa fistulosa* (Horchst) Benth., hemiparasitic weed of rice in Sahel and Sudanian zones

Ir. Sèsédè Houéfa Norliette ZOSSOU-KOUDERIN

### ABSTRACT

*Rhamphicarpa fistulosa* belongs to the Orobanchaceae and is found in Africa and Australia. It is a hemiparasitic weed of lowland rice genotypes and causes losses of 40–100% of rice grain yield. *R. fistulosa* is a widespread species. The management of parasitic weeds requires knowledge of their ecology, biology, and genetic diversity. Our research studied part of the ecology and genetic diversity of the parasite. In this context, our study addresses the genetic diversity of *Rhamphicarpa fistulosa* in Benin and Senegal, the ecological parameters and indicator species that underlined the presence of *R. fistulosa* in lowland rice production in these two countries and the potential expansion of the parasite in the context of climate change in West-Africa.

We studied the genetic diversity of *Rhamphicarpa fistulosa* accessions using amplified fragment length polymorphisms. Our results show substantial genetic differentiation exists among infested inland valleys within agroecological areas in Benin and Senegal. Several different genetic strains of *R. fistulosa* were introduced into different agroecological areas, and they then could self-pollinate. Our studies showed that, there is a genetic differentiation between the populations of Benin and Senegal. The high genetic diversity of *Rhamphicarpa fistulosa* in Benin and Senegal presents a challenge for the development of resistant rice germplasm.

Ten study areas were identified following the agroecological areas to study the ecological parameters and indicator species that underlined the presence of *R. fistulosa* in rice production in Benin. We used the method of Braun Blanquet to collect cover / abundance scale data. The software PC ORD had been used to analyze these data. Our results showed that *Tephrosia pedicellata*, *Eclipta prostrata*, *Spermacoce verticillata* and the ecological variable such as the pH are indicators of the presence of *R. fistulosa*. *Rhamphicarpa fistulosa* is following rice production in the colonization of new habits. This study permitted us to know more about the kind of strategy that will be used in the management of *R. fistulosa* in lowland rice in Benin. Three agroecological areas were identified following the main lowland rice production to study the ecological parameters and indicator species that underlined the presence of *R. fistulosa* in rice production in Senegal. The results showed that *Alternanthera sessilis* and *Ipomea aquatic* are indicator species of *R. fistulosa* in rice fields. There was no indicator

species of this parasite in natural vegetation in Senegal. All of these species associated with the ecological variables such as the pH the presence of the host (rice crops) and the bare soil are indicators of the presence of *R. fistulosa*. It was also appeared that *R. fistulosa* is following rice production in the colonization of new habits. Habits occupied by *R. fistulosa* should be recognized as relict and critically endangered sites where special protection measures must be used. They should be included in environmental monitoring program with local active protection.

We used Maxent modeling to determine the maximum range distribution for the parasite and to predict the future distribution of *R. fistulosa* in West-Africa under Intergovernmental Panel on Climate Change (IPCC) climate change scenarios. Maxent modelling results' were imported into ArcGIS 9.3 software to map the current geographic distribution of suitable habitat for the species and those of the future (2050 and 2070) different tested RCP scenarios in West Africa. The extent of each habitat (area and percentage) was estimated using the "spatial analyst" tool of ArcGIS 9.3 software. The proportions of habitats currently very suitable and unsuitable likely to become in the future and vice versa have also been estimated for each RCP scenarios. The results showed that, the hemiparasitic weed, *Rhamphicarpa fistulosa* will gain more suitable habitats for its expansion in a context of changing climate by 2050 and 2070. The main result in agriculture will be the stunded growth of rice and yields losses.

**Keys words:** *Rhamphicarpa*, rice, lowland, genetic, diversity, indicator species, modelling, climate change.

## Abstract of conference/seminar in LEA

### 8. Integral ecology framework: application to agro-pastoral dams ecosystem services management in Northern Benin

KPERA G. N.

#### ABSTRACT

Given the major problems of our society today, the world is becoming more complex because of the involvement of different actors with diverse frames of reference, different prior knowledge at different levels (global/national/local), and different interests. Solution building to deal with the complexity that we experience in our daily lives is compromised without a framework with a global vision that contains various perspectives in a way that links, leverages, correlates, and aligns these perspectives. Integral Ecology (IE) provides a comprehensive framework for considering multiple approaches to ecological and environmental phenomena. In order to arrive at the best possible solutions to environmental problems and conflicts, IE takes into account all pertinent perspectives. Integral ecology theory is based on four irreducible perspectives (objective, interobjective, subjective, and intersubjective) which must be considered when one is attempting to understand and remedy environmental problems. Agro-pastoral dams (APDs) – water reservoirs constructed in Benin to provide water for livestock and for agricultural development – face several conflicts including human-crocodile conflicts. The study sheds light on the multi-purpose and multi-stakeholder use/management of APD ecosystem services in northern Benin with the aim to determine the optimal use and management of APD ecosystem services for the benefit of all the stakeholders involved including crocodiles. Using the integral ecology framework as lens, the research helped to develop an integral understanding taking into account institutional, technical, socio-economic, and environmental dimensions of APD's problems. Several technical and institutional constraints hamper the use and the management of APDs. The involvement of human and non-human stakeholders (crocodiles and livestock) makes an APD a complex system, impeding agreement on common rules for their management. Because of the fear that crocodiles engender and crocodiles' negative effects on local livelihoods and people's tranquillity, all stakeholders frame the presence of crocodiles as problematic. At the same time, the APDs' water quality is problematic because of significantly ( $P<0.01$ ) high levels of nitrite, nitrate, iron, and chemical oxygen demand and the contamination of waters with harmful bacteria such as: *Enterococcus faecalis*, *Escherichia coli*, spore of *Clostridium*, *Salmonella typhi*, *Campylobacter jejuni*, and so forth. The low diversity of fish is attributed to damage caused by agricultural practices, selective fishing (large size fish), and crocodile predation on fish. The research suggests that an innovation platform should be established in which all stakeholders can participate to intensively discuss changes that should be collectively developed and realized, resulting in peaceful living with crocodiles, crocodile conservation and sustainable APD ecosystem services use and management.

**Keywords:** multi-stakeholder, conflicts, crocodile, complexity, water pollution integral ecology, watershed management, institutional changes, innovation system

## **9. Drones and conservation**

MSc. Abdelaziz LAWANI

### **ABSTRACT**

Also referred to as Unmanned Aircraft System (UAS), Unmanned Aerial Vehicle (UAV), or a Remotely Piloted Aircraft (RPA), drones are well known for their military uses. While their use in the military conflicts continue to face many criticisms, during the last few years, the public perception of drones has switched because of their potential to be used for good. This talk will present the many ways drones are used for good. It will discuss their application in agriculture, humanitarian response, e-commerce, 3-D mapping, territorial surveillance, natural resource management with an emphasis on conservation.

The presentation will be given by Abdelaziz Lawani, lecturer and researcher at the University of Kentucky (USA). Abdelaziz Lawani is a graduate from the Faculte des Sciences Agronomiques (FSA) of the University of Abomey-Calavi, and of North Carolina State University (NCSU). His research interest covers, Agricultural and Environmental Economics, Trade, Spatial Econometrics, and Drones Application. Abdelaziz Lawani is also a very active serial social entrepreneur.

## **10. Tree-ring anatomy, age structures, dynamic in carbon budget and demography of West African tree-populations undergoing selective timber logging and repeated forest fires**

MSc. Franck SINSIN

### **ABSTRACT**

Discipline is needed to provide dendro-ecological data on West African tree-populations for the sustainable management of their habitats. With regards to that purpose, six chapters were developed in this thesis. The first one introduces elementary bases as well as the history and fundamental principles on which, dendrochronology is based. Chapter 2 analyzes anatomical structures of eleven valued commercial timber, focusing mainly on wood density, arrangement and size of vessels and parenchyma. This section demonstrates how wood anatomy could be an instrument of its identification and species recognition. In Chapter 3, the age structure of tree populations was investigated in four different protected areas from 478 wood cores coming from 239 living trees and five species to build 15 age structures and 14 radial growth models. Key findings of this chapter disclosed several categories and various grades of stress on species in protected areas. In chapter 4, the history of bush fires was reconstituted to more than a centenary from charcoal scars observed in tree rings of studied woods and it was proven that fire is controlling the savanna-woodland structure. Based on 120 stem discs collected along a 12 km route, the history of fires in the Wari-Maré Forest (09°10'0 N-02°10'0 E) over the past century in savanna woodland and dry forest was reconstituted. By analyzing tree rings, 246 fire scars were identified. The scars were observed to be caused by 51 fire years, occurring at a mean interval of 2.23 years. In chapter 5, a three-dimensional methodology was used based on a diachronic analysis to establish half-decade changes in floristic diversity and carbon budget. Data on tree and stump density, diameter at breast height, tree heights and crown diameter were collected from all trees whose diameters equal or exceed 10 cm at the breast height. These were investigated from a permanent plot of 1 ha set up in savanna-woodland vegetation. Key outcomes of this research revealed that from 2009 to 2014, the woody average species' richness of the investigated area dropped from 15 to 14 species per hectare. The Shannon & Wiener diversity index and the equitability index of Pielou were almost invariable. Conversely, considerable changes were observed with regards to tree density, basal area, crown cover and carbon pool. Finally, the last chapter was oriented towards the social organization which makes possible the illegal timber logging in Wari-Maré Forest Reserve. This chapter also informs us of operating cash, the sale price of the beams and the variation in financial gains by stakeholder groups.

## **11. FUNCTIONING OF GRASSLANDS ECOSYSTEM: DYNAMICS, SPATIAL DISTRIBUTION AND NUTRIENTS CONTENTS OF TROPICAL GRASSES FODDERS**

MSc. Myrène AHOUDJI

### **SUMMARY**

Due to the rapid increase in population demography, lands cover change. In this situation, the management approach adopted by most African developing countries for biodiversity conservation was the development of protected areas. But these areas were located where poverty and insufficient employment opportunities determine population's needs and activities. In this context, protected areas vulnerability increased. Thereby, this study focused on understanding factors that structure grasslands plants community's composition inside the W Biosphere Reserve (WBR) in Benin during these last decades and on the establishment of dominant grasses species repartition and their chemical composition. It aims: (i) to identify the effects

of land cover change on rangeland vegetation composition in WBR, Benin Republic (West Africa); (ii) to assess the perceptions of Fulani herders on rangeland degradation in areas bordering W Biosphere Reserve (WBR) in northern Benin; (iii) to assess change in plant communities' composition, diversity indicators and structure in the last decade in the hunting zone of Djona (WBR-Benin); (iv) to establish current floristic composition, life form and productivity of the grasslands in the hunting Zone of Djona (Benin); (v) to predict the spatial distribution of herbaceous fodders using bioclimatic variables in the W Biosphere Reserve of Benin (WBR) and (vi) to assess the seasonal dynamic of aboveground biomass production and macro-mineral composition of tropical grasses species.

**Chapter 1** concerns the general introduction and the **chapter 2** describes the W Biosphere Reserve of Benin, the study area, where all field works of scientific investigations that form the main body of this thesis were done.

In **chapter 3**, three serial times of maps, taken in 1989, 2000 and 2013 were interpreted using the software ArcGis 10.1. Dynamics areas proportions values were calculated and Transition matrices were elaborated. We remark that land cover has changed considerably and these changes were mostly observed in the periphery of the hunting zone where settlements, farms and fallows were noticed and in high proportions in 2013 than in 1989 and 2000. Concerning natural vegetations, savannas increased from 1989 to 2000 and were the most represented land cover type in 2013 while dense forests, gallery forests and woodlands decreased in the same period. Our results highlight the necessity to study dynamic in floristic composition of this area in order to assess changes in floristic composition and to redefine with actors the best management practices which will allow the protected areas to assume their main role of biodiversity conservation.

**Chapter 4** focused on Fulani's perception on the degradation of rangeland vegetation. Structured and semi structured interviews were conducted. Perceptions of change in rangeland vegetation were assessed and citation frequency of perceived causes of changes and consequences was estimated. Six groups were defined based on informants' age and activities: young agro pastoralists; young pastoralists; adults agro pastoralists; adults pastoralists; old agro pastoralists and old pastoralists. ANOVAs and SSK were used to test the homogeneity of the perception of informants groups and their livestock units. Besides, we performed a Factorial Correspondence Analysis (FCA) to test the dependency between the perception of the groups' and the mentioned causes, consequences and coping strategies. All statistical analysis was done using the software R. Results showed that rangeland changed in the areas surrounding the W National Park. Factors inducing changes and consequences on rangelands vegetation perception depended on the age and activities of Fulanis' people. But strategies depended only on informants' activities. Adaptation strategies were used to reduce the effect of rangeland changes. Mitigation activities were not taken by the Fulanis.

In **chapter 5**, floristic composition of plants communities and ecological indicators were used to understand the changes in the vegetation since 2000. 32 permanent plots installed in 2000 and 60 plots installed in 2013 were considered and "phytosociological relevés" were carried out to established plants communities. Occurrence frequency and mean cover were used to evaluate changes in floristic composition of plants communities within the two years. Alpha diversity indices (specific richness, Shannon's index and Pielou evenness) were calculated to characterize each of these plants communities and β diversity indicator was used to establish similarity and/or dissimilarity between plants communities of the two periods. Life forms' and chorotypes spectrum were also considered to assess changes in the vegetation. Our results showed two plants communities for the two years, one of herbaceous savannas and the second of woody, trees and shrubs savannas. Diversity indicators showed significant differences in floristic composition of the two years. Life forms and chorotypes spectrum in 2000 indicated a relatively undisturbed plants communities in Sudanian region contrary to 2013 where we observed a high level of degradation in plants communities.

**Chapter 6** assessed the temporal changes in floristic composition, plant communities' structures and productivity of grasslands. 30 plots of 900m<sup>2</sup> were used and "phytosociological relevés" were done following ecological uniformity, floristic homogeneity and samples representativeness to established plants communities. For biomass estimation, 30 plots of 100 m<sup>2</sup> were used. Results showed that the greatest productivity value is about  $8320 \pm 0.21$  kg DM/ha. The identified life forms and chorological types showed an evolution of the post farming pastures to woodlands and savannas vegetation, which explained the current floristic composition of the area. Moreover, it will be possible to model the impact of grasslands exploitation on the viability of the protected area particularly in the context of climate change and for this, it is important to undertake a long-term study in order to take into account variations and causes of these variations.

Chapter 3 to 6 dealt with the dynamic of plants communities in the WBR of Benin. Chapter 7 and 8 concerned tropical grasses spatial distribution and mineral content. Indeed, **Chapter 7** focused on current and future spatial distributions of *Andropogon gayanus*, *Loxodera ledermanii* and *Alysicarpus ovalifolius* regarding bioclimatic variables in the Sudanian zone of Benin, particularly in the W Biosphere Reserve (WBR). These species were selected according to the changes in their natural spatial distribution induced by environmental pressures. A MaxEnt (Maximum Entropy) method was used to identify all climatic factors which determined the spatial distribution of the three species. On the horizon of 2050, spatial distribution showed for *Andropogon gayanus*, a regression of high area distribution in detriment of low and moderate areas. The same trend was observed for *Loxodera ledermanii* and for *Alysicarpus ovalifolius*, currently area with moderate and low distribution were the most represented but map showed in 2050 that area with high distribution increased. We can deduce that without bioclimatic variables, others factors such as: biotic interactions, dispersion constraints, anthropic pressure, human activities and another biological factor determined spatial distribution of species.

**Chapter 8** concerned the minerals contents of some tropical species: *Loxodera ledermanii*, *Andropogon gayanus* and *Tephrosia pedicellata*. Temporal trend on aboveground biomass and nutrients content in biomass and soils at different stages of development of these species were determined. The trend of Carbone/Nitrogen (C/N), Calcium (Ca), Magnesium (Mg), Sodium (Na) and Potassium (K) elements were represented for each species. Comparison was made between species biomass and nutrient content with ANOVA test. Relations between nutrients variation in soils and in biomass at the beginning and at the end of harvesting were showed with Principal Component Analysis (PCA). Results showed that biomass production of perennial grasses (*Andropogon gayanus*, *Loxodera ledermanii*) was higher than legume (*Tephrosia pedicellata*). Contrarily to C/N report, *Tephrosia pedicellata* content in Ca, Mg, Na and K is higher than *Andropogon gayanus* and *Loxodera ledermanii* content in the same nutrients. Nutrients content in soils and biomass are inversely correlated. At the beginning of

vegetative cycle of species nutrient content in biomass is higher and lower in soils. And at the end of vegetative cycle of species biomass nutrients content is lower and higher in soils. It will be judicious to investigate on what is the real feedback process between plant and soils nutrients when senescence began.

The last section of this work discussed the major findings and their relevance to literature, implications for conservation and perspectives for future researches.

## 12. Isotope stable ecology in mammalian herbivore assemblage from West African savanna: what have we done so far and what next?

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### ABSTRACT

Numerous methods exist to delineate dietary patterns of wild animal populations, all with certain strengths and limitations. Stable isotope analysis is a more recent, yet by now common tool for studying the feeding ecology of wildlife, which has the advantage of providing comparable data for multiple populations over various space and time scales. Most of these researches have focused on East and southern African savannas with little emphasis placed on savannas in West Africa. Since 2013 some studies have been implemented by the Laboratory of Applied Ecology. Our first study was related to the stable carbon isotope analysis of the diets of West African bovids in Pendjari Biosphere Reserve (Northern Benin). This study shows that animals in the better-studied Eastern and Southern African savannas do not exhibit the full range of possible dietary adaptations and African bovid species intended to make the point that studying a little-known region such as West Africa can change our overall picture of bovid isotopic ecology. Secondary, we studied an assemblage of eleven bovid species in Pendjari Biosphere Reserve, West Africa. Our findings have shown numerous patterns in resource partitioning amongst the 11 bovid species studied, suggesting that different species used dietary resources in contrasting ways. In practice, actual resource competition between bovid species is difficult to demonstrate, but there exists much overlap in diet along the stable carbon isotope axis for most of the studied species. We conclude that in our study area, especially in the wet season, niche breadth and diet overlap remain large. However regarding the fact that individual ungulates within the population may often adjust their diet when food availability varies over time. We do think that assessing the isotopic variation in diet of individuals has to be considered when investigating the impacts of food resource abundance on both distribution and dietary niches of ungulate. Based on the time series data from the dentine we can work to understand the individual change of isotopic niches in west African ungulates assemblage. Also the stable isotope variation in the west African savanna vegetation need to be understood to solve the problem of high variation in West African stable isotope niche of ungulates. Given the discrepancies in % C4 in the diets of bovids from PBR compared with literature for other parts of Africa, it is clear that there is spatio-temporal dietary flux in many bovid species. Bovid diets understanding and niche structure at the continent level can give a global picture of bovid isotopic ecology.

**Key words:** diet breadth, body mass, browser, grazer, competition, coexisting

## 13. Domestication et stratégie paysanne de gestion des arbres à grands potentiel agroforestier du Bassin du Congo

AVANA-TIENTCHEU MLA

### RESUME

L'importance écologique, économique et socioculturelle des espèces forestières a été largement documentée depuis le sommet de Rio de Janeiro en 1992. Sous les effets conjugués de la dégradation de leurs habitats, de la surexploitation des produits et du changement climatique, la disponibilité de ces espèces et l'accès à leurs produits et services sont de plus en plus compromis, contraignant ainsi les conditions de vie des populations qui en dépendent. Leur domestication a été proposée afin de créer des sources alternatives d'approvisionnement, réduire la pression sur les ressources naturelles, améliorer quantitativement et qualitativement leurs produits et générer des revenus pour les populations locales. Le programme de domestication participative des espèces forestières implique : l'évaluation écologique et socioéconomique des espèces et de leurs produits et services, la mise au point des méthodes génératives et végétatives de multiplication et une caractérisation des systèmes de production agroforestiers favorables à l'intégration des espèces en cours de domestication. Notre programme de recherche doctorale et postdoctorale sur la domestication des espèces fruitières et médicinales d'intérêt socio-économique est structuré autour de ces trois thématiques avec pour terrain d'étude le Cameroun, la République Démocratique du Congo et le Tchad. *Prunus africana* (Rosaceae), un arbre à multiples usages en médecine traditionnelle et vétérinaire, en artisanat, menuiserie lourde et surtout pharmaceutique est utilisé comme cas d'étude. Cependant l'approche développée a été appliquée à d'autres espèces fruitières et médicinales parmi lesquelles *Afrostyrax lepidophyllus*, *Canarium schweinfurthii*, *Dacryodes edulis*, *Monodora myristica*, *Milletia laurentii*, *Pericopsis elata* et *Vitellaria paradoxa*.

**Mots clés :** arbres forestiers, diversité génétique et phénotypique, évaluation écologique et ethnobotanique, multiplication végétative, technologie et physiologie des semences, systèmes agroforestiers

## **14. Gestion et modélisation de la dynamique des parcours de transhumance dans un contexte de variabilités climatiques au nord-est du Bénin**

MSc. Paolo LESSE

### **RESUME**

La transhumance est un système d'élevage qui occupe une place importante dans la sous-région et au Bénin en particulier. La présente étude a été conduite au Nord-Est du Bénin qui est une zone de prédilection des éleveurs. L'objectif du travail est de contribuer à une gestion durable des parcours de transhumance au Nord-Est du Bénin. Les parcours naturels ont été caractérisés à partir de relevés linéaires, de coupe rase pour la quantification de la biomasse et des relevés phytosociologiques. Le système d'élevage quant à lui a été étudié suivant l'approche système. La matrice de sensibilité a été utilisée pour mieux appréhender le degré de vulnérabilité des transhumants aux variabilités hydro-climatiques. L'évolution future des extrêmes pluviométriques et thermométriques dans le bassin a été analysée grâce aux données du modèle climatique régional REMO. Le « Land Change Modeler (LCM) ». d'IDRISI Selva a été utilisé pour prédire l'état de l'occupation du sol en 2050. L'étude a permis de ressortir les contraintes de ce système. Il s'agit des problèmes d'alimentation, de variabilités climatiques, des textes réglementaires, de conflits et de disponibilités des infrastructures pastorales. Au total cent soixante-deux (162) infrastructures pouvant servir d'abreuvement dans la zone d'étude ont été identifiées mais elles sont soit non fonctionnelles, soit mal entretenues. La zone est caractérisée par l'inexistence de voies d'accès aux points d'eau, la présence d'abondants végétaux flottant à la surface des eaux d'abreuvement et les problèmes de fonctionnement des mécanismes de gestion mis en place. Quatre types de pâturage ayant des productivités variantes entre 3,46 à 5,7 t MS/ha ont été identifiés. Le pâturage à *Prosopis africana* et *Eragrostis atrovirens* a montré la plus grande valeur alimentaire au niveau des graminées alors qu'au niveau légumineuses, c'est le pâturage à *Piliostigma thonningii* et *Stylosanthes fruticosa*. Douze axes de transhumance tous orientées vers les cours d'eau et les aires protégées ont été répertoriés et cartographiés dans la zone d'étude. Concernant les paramètres démographiques, le taux moyen de croît annuel est de  $1,068 \pm 0,05$  et le taux de production moyen est faible ( $0,155 \pm 0,02$ ). A l'horizon 2050, une évolution très contrastée des régimes pluviométriques dans le Nord-Est du Bénin quel que soit le scénario choisi a été prédit et un réchauffement de 1°C en moyenne est attendu d'ici 2050. Sur la base des probabilités de transition, la modélisation prédictive réalisée sur l'occupation du sol à l'horizon 2050 présage que les savanes arborées et arbustives occuperont 49,89 % de la superficie totale des parcours naturels du Nord Est de la république du Bénin. La variabilité observée se traduit par le retard du démarrage des pluies, la mauvaise répartition et l'arrêt précoce des pluies, les vents violents. L'analyse de la vulnérabilité a permis de remarquer que l'élevage est le plus vulnérable et que les éleveurs craignent plus les sécheresses et les inondations que les baisses de la pluviométrie.

**Mots clés :** système d'élevage, productivité, vulnérabilité, parcours naturels, Variabilités climatiques, Bénin.

## **15. Ethnobotanique, écologie et distribution géographique des plantes utilisées dans le traitement traditionnel de l'hypertension artérielle en République du Bénin (Afrique de l'Ouest)**

MSc. Anselme BIO

### **RESUME**

L'hypertension artérielle (HTA) est l'une des maladies cardiovasculaires les plus redoutables du monde actuel. Dans les pays en voie de développement, le faible pouvoir d'achat des populations ne leur permet pas de faire face au coût financier de la thérapie de cette pathologie en médecine moderne. La présente thèse a pour objectifs (i) de recenser les connaissances de la médecine traditionnelle liées à l'HTA au Bénin, (ii) d'inventorier les plantes utilisées dans le traitement traditionnel de l'HTA au Bénin, (iii) de déterminer les caractéristiques écologiques des plantes antihypertensives de grande importance, (iv) d'évaluer les différentes menaces exercées sur ces plantes et (v) d'étudier leur distribution géographique en vue de proposer une stratégie pour leur gestion durable au Bénin.

Pour réaliser les objectifs (i) et (ii) une enquête ethnobotanique a été menée à l'aide d'un questionnaire individuel auprès de 801 tradithérapeutes sélectionnés sur toute l'étendue du territoire béninois. Les résultats de cette étude ont fait ressortir 8 principaux facteurs de risque à l'HTA et 221 plantes antihypertensives. L'obésité (60,55 %) et l'hérédité (49,81 %) ont été les facteurs de risque les plus cités. *Heliotropium indicum* (20,22 %), *Parkia biglobosa* (19,6 %), *Citrus aurantifolia* (12,1 %), *Persea americana* (10,11%), *Allium sativum* (8,98 %), *Carissa edulis* (8,36 %) et *Morinda lucida* (7,36 %) ont été les plantes les plus rapportées. Le test Chi-2 de Pearson et l'Analyse Factorielle des Correspondances appliqués aux fréquences de citation des facteurs de risque et des plantes antihypertensives ont montré que les connaissances liées à ces deux variables sont dépendantes des caractéristiques socioculturelles des enquêtés et de leur zone bioclimatique. L'étude des caractéristiques écologiques des plantes antihypertensives de grande importance (iii) a été possible grâce à l'installation des placeaux dans les habitats de chacune de ces plantes. Les relevés phytosociologiques obtenus ont permis d'identifier les groupements végétaux abritant chacune de ces espèces. Certaines de ces plantes sont introduites dans les plantations (*Gmelina arborea*), d'autres sont à l'état sauvage et sont aussi plantées par endroit (*Morinda lucida*, *Crateva adansonii* et *Heliotropium indicum*) et d'autres sont uniquement à l'état sauvage (*Carissa edulis*). Pour cerner les différentes menaces sur ces plantes (iv), une autre enquête ethnobotanique a été menée auprès de 458 habitants toutes catégories socioprofessionnelles confondues. Les résultats

de cette étude ont signalé que l'utilisation à des fins médicinales constitue la principale menace pour la survie de la quasi-totalité des plantes antihypertensives de grande importance. L'étude de la distribution des plantes antihypertensives de grande importance (v) a fait appel à des techniques de modélisation de la niche climatique de ces espèces en combinaison avec le système d'information géographique (SIG). La simulation des aires de distribution potentielle présente et future (2050) de ces espèces a indiqué une diminution de l'étendue de leurs habitats potentiels quel que soit le modèle utilisé. Il est alors urgent que des mesures idoines soient prises pour la conservation durable de ces plantes.

**Mots clés :** Bénin, ethnobotanique, hypertension artérielle, niche climatique, plante antihypertensive, conservation durable.

## 16. Eleveurs, bovins de race Borgou et prédition de la valeur nutritive des ligneux fourragers les plus appétés du Nord-Bénin

MSc. Habirou SIDI IMOROU

### RESUME

Au Bénin, les productions animales et halieutiques contribuent à l'amélioration des conditions de vie des populations. Les systèmes d'élevage des ruminants sont basés sur l'utilisation excessive des pâturages naturels. Le cheptel bovin du Bénin est dominé par la race Borgou et les parcours naturels constituent l'essentiel de leur alimentation. Les études du comportement alimentaire des taurillons Borgou sur ces parcours ont permis de constater qu'en moyenne 67,0 % du temps passé au pâturage est consacré au broutage. Le reste du temps est réparti entre les activités de déplacement (10,6 %), de repos-rumination (15,7 %) et d'abreuvement (6,7 %). Les changements climatiques de ces dernières décennies ont amené les éleveurs du Nord-Est du Bénin à adopter des comportements leur permettant de conserver l'intégrité de leur cheptel. Ces comportements entraînent parfois des conflits avec certains acteurs (les agriculteurs et les exploitants forestiers) qui exploitent les ressources de cette zone. Le diagnostic participatif réalisé auprès des éleveurs sur les connaissances endogènes des ligneux a permis d'identifier sur la base de critères de disponibilité, d'accèsibilité et d'appétibilité 26 espèces de ligneux consommées pendant la période de soudure par les ruminants au Nord-Est du Bénin. Toutefois, peu d'informations sont actuellement disponibles sur la valeur nutritive et sur des équations fiables de prédition de celles-ci. Les modèles d'équations développées et utilisées sont ceux des milieux tempérés. Le problème de ces approches nécessite une connaissance précise de la description botanique des fourrages afin de sélectionner le type de modèle d'équation à utiliser. En effet, en milieu tropical, les systèmes de production animale utilisent plusieurs types de fourrages aux valeurs nutritives très variables. Il est pourtant fondamental de proposer des modèles d'équations qui prennent en compte cette variabilité. La méthode idéale de détermination de la qualité nutritionnelle des aliments est la mesure de la digestibilité *in vivo* ne pouvant pas être appliquée pour des fourrages comme les ligneux ou les pailles. Afin de contourner ces difficultés, plusieurs méthodes de prédition des valeurs nutritives ont été développées par les nutritionnistes. Au cours de cette étude, les paramètres de composition chimique des ligneux, la dégradabilité enzymatique et la fermentescibilité *in vitro* (gaz-test) en présence de jus de rumen ont été expérimentés. Les ligneux comme *Acacia sieberiana*, *Afzelia africana*, *Danielia oliveri*, *Flueggea virosa*, *Gardenia erubescens*, *Lonchocarpus laxiflorus*, *Pterocarpus erinaceus*, *Swartzia madagascariensis* et *Xeroderris stuhlmannii*, étaient les plus intéressants en alimentation des ruminants ( $UFL = 0,63 / \text{kgMS}$  et  $MAD/UFL = 195 \text{ g}$ ). La composition chimique et la dégradabilité enzymatique n'étaient pas les meilleures prédictrices de la valeur nutritive des ligneux. Par contre, le taux fractionnel de production de gaz à 4 h ( $\mu\text{g}$ ) et le volume de gaz à 72 h ( $V 72 \text{ h}$ ) ont été les meilleurs prédicteurs. L'introduction des matières azotées totales (MAT) et de la cellulose brute (CB) dans les modèles d'équations améliore la précision de la prédition. Le gaz-test apparaît comme la meilleure méthode de prédition de la valeur nutritive de ces ligneux.

**Mots clés :** arbres et arbustes, valeur nutritive, bovins, comportement alimentaire, dégradabilité enzymatique, gaz-test, prédition, Bénin.

## 17. Biologie de la conservation des plantes ligneuses médicinales au Bénin: Diversité, Vulnérabilité et Priorisation

MSc. Alain YAOITCHA

### RESUME

Les plantes ligneuses constituent l'une des principales sources de constituants médicinaux, dont dépendent les êtres vivants pour leur bien-être. Cette situation constitue une pression qui pèse sur ces espèces et des stratégies idoines pour leur conservation doivent être définies. Compte tenu des ressources financières limitées caractéristiques des pays en développement comme le Bénin, il est important de sélectionner les plantes ligneuses les plus importantes du point de vue culturelle, socio-économique et écologique pour leur conservation. Ainsi, l'objectif principal de la présente thèse est de renforcer la prise de décision pour la conservation des plantes ligneuses médicinales au Bénin. Les investigations à travers la synthèse bibliographique, des enquêtes ethnobotaniques et des relevés de végétation ont permis d'évaluer respectivement la diversité, les types d'usages médicinaux et la disponibilité des plantes ligneuses médicinales au Bénin. Les matrices de données portant sur les indices ethnobotaniques et les paramètres écologiques de ces espèces ont été soumises aux analyses

multivariées et aux tests non paramétriques. La synthèse bibliographique a permis d'enregistrer au Bénin environ 263 espèces appartenant à 193 genres et 59 familles. Ces espèces sont utilisées pour 146 besoins médicinaux catégorisés en 17 groupes, dont les maladies du système digestif, les maladies du système cardiovasculaire, les maladies de peau, le paludisme et les maladies associées pour lesquelles un nombre très important d'espèces est sollicité. L'indice d'importance relative a permis d'identifier 27 espèces ligneuses médicinales importantes parmi lesquelles certaines (*Zanthoxylum zanthoxyloides*, *Morinda lucida*, *Pentadesma butyracea*, *Securidaca longepedunculata*, *Bridelia ferruginea*) ont été recommandées pour la conservation. L'analyse de la répartition des maladies traitées à travers les zones phytogéographiques a révélé que le traitement des maladies telles que les hémorroïdes, le diabète, la paralysie, la folie, l'hypertension et les maladies gynécologiques est plus rapporté dans la zone guinéo-congolaise tandis que le traitement des maladies dermatologiques, les faiblesses sexuelles, les maladies musculo-squelettiques, la toux et les maux de ventre est principalement rapporté dans la zone soudanienne. Parmi les maladies largement traitées base des plantes, le paludisme est la maladie la plus commune et récurrente. Parmi les plantes utilisées pour son traitement, les espèces fréquemment rapportées telles que *Lannea acida*, *Pterocarpus erinaceus*, *Anogeissus leiocarpa* et *Opilia amentacea* sont toutes d'origine soudanienne. En raison de la forte utilisation de leurs écorces et racines, ces espèces se sont révélées vulnérables. Ainsi, nous recommandons que ces espèces soient prises en compte dans les stratégies de conservation de la biodiversité. L'espèce *Z. zanthoxyloides* est l'une des plantes ligneuses médicinales les plus importantes et menacées de disparition. La modélisation de sa distribution spatiale a montré que les changements climatiques auront très peu d'impact sur les zones actuellement favorables de l'espèce au Bénin. Il n'y a donc presque pas de défi en termes de changements climatiques pour sa conservation. Pour une utilisation rationnelle des moyens rares alloués aux stratégies de conservation de la biodiversité, nous avons suggéré la poursuite d'autres investigations sur les impacts des utilisations des terres et des utilisations médicinales. Des investigations menées sur les impacts écologiques des utilisations des plantes ligneuses médicinales les plus commercialisées au Bénin telles que *Z. zanthoxyloides* et *M. lucida*, il a été constaté que la véritable cause de leur vulnérabilité est beaucoup plus la production d'ananas que l'usage médicinal longtemps soupçonné. Les actions de conservation s'avèrent donc nécessaires sur le plateau d'Allada où l'ananas est fortement produit. Les pistes de recherche en la matière ont été aussi suggérées. Dans le but d'identifier les plantes ligneuses médicinales prioritaires pour la restauration de la Réserve de forêt de Wari-Maro, l'une des Réserves de forêts fortement dégradées de la zone soudano-guinéenne qui concentrent plusieurs plantes médicinales commercialisées au Sud-Bénin, une étude de la priorisation a été faite. Ainsi, 12 espèces ligneuses médicinales ont été déterminées. Parmi elles, les plus importantes sont *Afzelia africana*, *Khaya senegalensis*, *Milicia excelsa* et *Pterocarpus erinaceus*. Les actions d'enrichissement et de régénération assistée ont été proposées comme mesures de conservation urgentes à prendre. En somme, les espèces vulnérables identifiées sont prioritaires pour la conservation et ont été systématiquement recommandées pour leur prise en compte dans les plans de conservation. Parmi ces espèces prioritaires identifiées celles qui n'ont pas encore bénéficiées des actions de conservation telles que *Morinda lucida*, *Sarcocephalus latifolius*, *Bridelia ferruginea* et *Securidaca longepedunculata*, constituent de potentiels cibles pour des études futures de domestication et de valorisation.

## 18. Genetic diversity, ecology and Potential expansion of *Rhamphicarpa fistulosa* (Horchst) Benth., hemiparasitic weed of rice in Sahel and Sudanian zones

Ir. Sèsédè Houéfa Norliette ZOSSOU-KOUDERIN

### ABSTRACT

*Rhamphicarpa fistulosa* belongs to the Orobanchaceae and is found in Africa and Australia. It is a hemiparasitic weed of lowland rice genotypes and causes losses of 40–100% of rice grain yield. *R. fistulosa* is a widespread species. The management of parasitic weeds requires knowledge of their ecology, biology, and genetic diversity. Our research studied part of the ecology and genetic diversity of the parasite. In this context, our study addresses the genetic diversity of *Rhamphicarpa fistulosa* in Benin and Senegal, the ecological parameters and indicator species that underlined the presence of *R. fistulosa* in lowland rice production in these two countries and the potential expansion of the parasite in the context of climate change in West-Africa.

We studied the genetic diversity of *Rhamphicarpa fistulosa* accessions using amplified fragment length polymorphisms. Our results show substantial genetic differentiation exists among infested inland valleys within agroecological areas in Benin and Senegal. Several different genetic strains of *R. fistulosa* were introduced into different agroecological areas, and they then could self-pollinate. Our studies showed that, there is a genetic differentiation between the populations of Benin and Senegal. The high genetic diversity of *Rhamphicarpa fistulosa* in Benin and Senegal presents a challenge for the development of resistant rice germplasm.

Ten study areas were identified following the agroecological areas to study the ecological parameters and indicator species that underlined the presence of *R. fistulosa* in rice production in Benin. We used the method of Braun Blanquet to collect cover / abundance scale data. The software PC ORD had been used to analyze these data. Our results showed that *Tephrosia pedicellata*, *Eclipta prostrata*, *Spermacoce verticillata* and the ecological variable such as the pH are indicators of the presence of *R. fistulosa*. *Rhamphicarpa fistulosa* is following rice production in the colonization of new habitats. This study permitted us to know more about the kind of strategy that will be used in the management of *R. fistulosa* in lowland rice in Benin. Three agroecological areas were identified following the main lowland rice production to study the ecological parameters and indicator species that underlined the presence of *R. fistulosa* in rice production in Senegal. The results showed that *Alternanthera sessilis* and *Ipomea aquatic* are indicator species of *R. fistulosa* in rice fields. There was no indicator species of this parasite in natural vegetation in Senegal. All of these species associated with the ecological variables such as the pH the presence of the host (rice crops) and the bare soil are indicators of the presence of *R. fistulosa*. It was also

appeared that *R. fistulosa* is following rice production in the colonization of new habits. Habits occupied by *R. fistulosa* should be recognized as relict and critically endangered sites where special protection measures must be used. They should be included in environmental monitoring program with local active protection.

We used Maxent modeling to determine the maximum range distribution for the parasite and to predict the future distribution of *R. fistulosa* in West-Africa under Intergovernmental Panel on Climate Change (IPCC) climate change scenarios. Maxent modelling results' were imported into ArcGIS 9.3 software to map the current geographic distribution of suitable habitat for the species and those of the future (2050 and 2070) different tested RCP scenarios in West Africa. The extent of each habitat (area and percentage) was estimated using the "spatial analyst" tool of ArcGIS 9.3 software. The proportions of habitats currently very suitable and unsuitable likely to become in the future and vice versa have also been estimated for each RCP scenarios. The results showed that, the hemiparasitic weed, *Rhamphicarpa fistulosa* will gain more suitable habitats for its expansion in a context of changing climate by 2050 and 2070. The main result in agriculture will be the stunded growth of rice and yields losses.

**Keywords:** Rhamphicarpa, rice, lowland, genetic, diversity, indicator species, modelling, climate change.

## Social events in LEA



**Photo 1.** Dr. Sylvestre DJAGOUN and Prof Nicole WRAGE-MOENNIG, showing buffalo teeth to be prepared for time series sampling and Carbone and Nitrogen analysis at stable isotope laboratory from the University of Rostock, Germany.



**Photo 2.** Dr Ivan KOURA feeding his animals



**Photo 3.** Dr Emile HOUNGBO visiting an experimental site on rice in Gogounou (Benin)



**Photo 4.** System of plantain storing by semi-wholesaler in Ouagadougou (Burkina Faso)



**Photo 5.** *Parkia biglobosa* seeds on market



**Photo 6.** Marketing actors buying *Vittellaria paradoxa* and *Parkia biglobosa* seeds on market



**Photo 7.** Raising awareness of local communities in conservation of mangroves in South Benin



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