ANNUAL REPORT
2018

Laboratoire de Biomathématiques et d'Estimations Forestières
University of Abomey-Calavi

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Our gratitude

This report was prepared thanks to a core team led by the Forest & People Livelihood research unit of the Laboratoire de Biomathématiques & d'Estimations Forestières, under the supervision of its Director, Professor Glèlè Kakaï Romain. The production of the report has received support and contributions from all other departments and research units of the Laboratory. Special thanks go to all colleagues.

The Laboratoire de Biomathématiques et d'Estimations Forestières would like to acknowledge with thanks, the technical and financial supports of its partners along the academic year 2018. The accomplishments highlighted in this report would not be possible without your support.

Abbreviations & acronyms

AEC-MSA	:	African Excellence Center in Mathematical Sciences and Applications
AGNES	:	African German Network of Excellence in Science
BSc	:	Bachelor
CAMES	:	Conseil africain et malgache pour l'enseignement supérieur
DEA	:	Diplôme d'Etudes Approfondies
IF	:	Impact Factor
IFS	:	International Foundation for Science
IRD	:	Institut de recherche pour le développement
LABEF	:	Laboratoire de Biomathématiques et d'Estimations Forestières
MSc	:	Master of Science
PhD	:	Doctor of Philosophy
RUFORUM	:	Regional Universities Forum for Capacity Building in Agriculture

Content

Director's statement

Prof Romain Glèlè Kakaï
Director of Labef

Dear colleagues and friends,

I am pleased to present the 2018 Annual Report from The Laboratoire de Biomathématiques et d'Estimations Forestières (LABEF). The academic year 2018 was one of sustained and continued growth for the Lab, knowledge generation with exciting advances in science underpinned by a solid capacity development. Above all, LABEF distinguished itself as a leader of collaborative efforts to propel excellence in sciences forward and to translate research advances into practical knowledge to inform decision making process in forest management.

At LABEF, we are empowering biomathematics and Forest sciences through our fundamental and applied research projects, our collaboration with local, national and international research institutions and practitioners, and through scientific education programs and capacities development that reach in 2018 a continental audience with the organization of the African Mathematical School.

Our early-career members are also hitting their stride, securing significant funding and support for their research and garnering recognition as rising stars in the international scientific community.
As we look ahead, I am more enthusiastic and optimistic than ever about LABEF's potential to make easier the use of mathematical tools in life science and to transform forest research. I am confident that we have the right strategy and plans in place and I look forward to sharing our continued progress with you.

Prof Romain Glèlè Kakaï
Director of Labef

LABEF

OVERVIEW AND TEAM

Mission, vision and Goals

In spite of being a fundamental tool in understanding, modelling and prediction, mathematics in general and biostatistics in particular has received little attention in biological sciences and particularly forestry in Africa. To address this issue, the Laboratoire de Biomathématiques et d'Estimations Forestières (LABEF) was created on May 27th 2014 by Prof Romain Glèlè Kakaï, Professor of Biometry and Forestry.

LABEF is part of the school of Environment Planning and Management, Faculty of Agronomic Sciences, University of Abomey-Calavi. The Laboratory works on the development and popularization of innovative statistical methods in life sciences, and particularly in forestry, for the optimal delivery of their multiple contribution to people's quality of life.

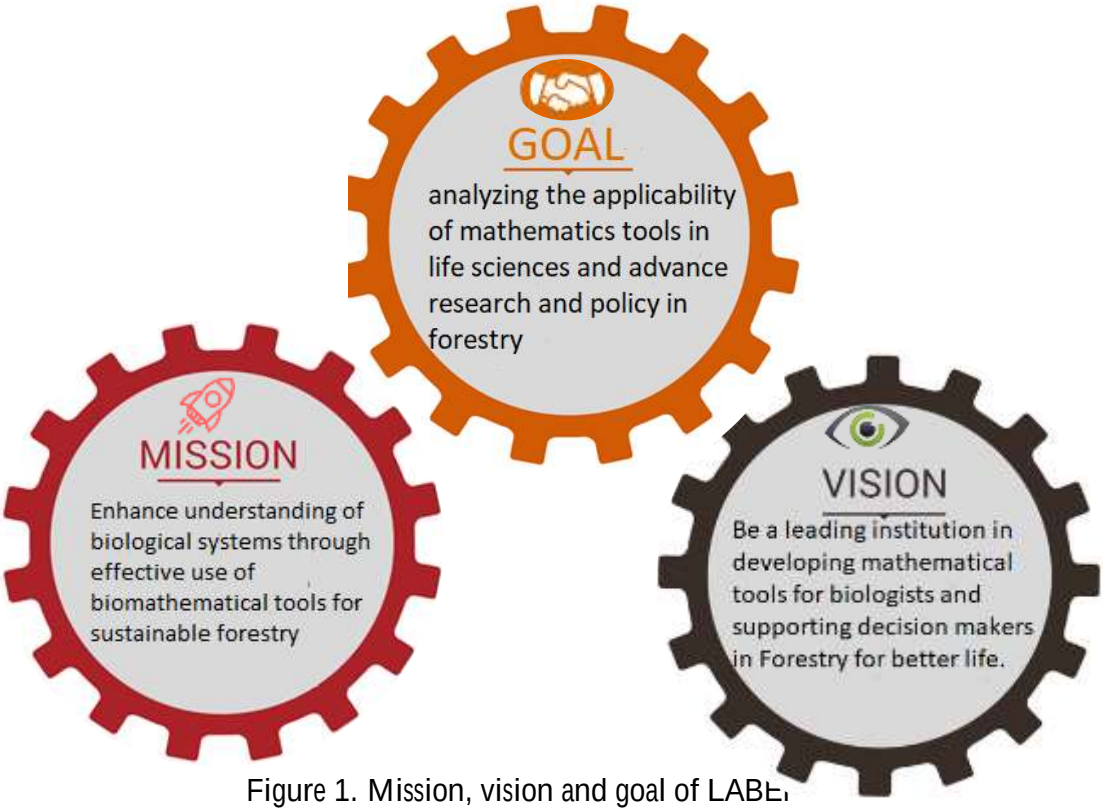


Figure 1. Mission, vision and goal of LABEF

Organization of Labef

LABEF is organized in 4 departments including fundraising department, social life department, administrative department, and research department. The research department includes four interrelated units namely: Unit of Biomathematics and Applied statistics; Unit of Forest Methods; Unit of Forest Ecology and Management and the Unit of Forest and People.

➔ **The research unit on biomathematics and applied statistics** falls into biology and mathematics and are interested in applications of mathematics in the field of biology. This unit is interested not only in the use of mathematical theories in biology but especially publishing scientific notes describing the application of different mathematical tools in life sciences.

➔ **The Forest Methods research unit** falls thus into the overall perspective of assessing the wood resources, biomass and carbon stock available in forest ecosystems. Hence, it provides the development of accurate and essential information for policy planning and forest resources management of the development of accurate and robust methods for estimating forest resources.

➔ **The Forest Ecology and Management** research unit is intended to understand ecological processes and patterns (forest ecosystems and forest ecosystem services, patterns and processes that govern the ecology of species and the system of which these species are parts, seed ecology) and to develop accordingly clear and applicable management policies for forest managers and decision makers.

➔ **The Forest & People research unit** undertakes investigations on forest governance approaches, their effectiveness and replicability, their socio-economic and ecological outcomes, decision making process, benefit sharing etc.

The core Management team of Labef in 2018

Prof Romain Glèlè Kakaï is the head of LABEF. He is full professor in biometry and Forestry, researcher and lecturer at the faculty of agricultural sciences. Prof Glèlè Kakaï is chairman of the scientific council of agronomic sciences, chairman of the Scientific council of the National Institute of Agricultural research of Benin, Chairman of the African German Network of Excellence in Science. He is also coordinating the Doctoral programme in Biometry at the University of Abomey-Calavi. His research areas include: Linear and nonlinear mixed models – Generalized linear models – Multiblock data analysis –Forest estimations – Forest management

Dr Valère Kolawole Salako is the scientific coordinator of LABEF. His research deals with population and community ecology, agroforestry, system analysis, conservation and biostatistics. His academic performance has been recognized internationally with several prizes and distinctions. He is member of multiple scholars' societies and welcomes collaborative researches and grants that involves multiple complementary disciplines. Valère attended several local, national and international trainings, workshops and conferences.

Dr Charlemagne Gbemavo is the head of the research unit on biomathematics and applied statistics of LABEF. His research deals with Population Ecology, Forest Estimation and Spatial Modeling. He teaches Biostatistics and Forest Estimations at the National Universities of Benin and takes the role of Biostatistician in several national or regional research projects.

Dr Rodrigue Castro Gbedomon is leading the research unit of Forest and People livelihood of LABEF. Castro's research concerns the social dimensions of biodiversity conservation, or, focus on how people perceive, use and interact with forest resources in a context of global changes. He is interested in advancing knowledge and practices on nature conservation, with a focus on topics such as ecosystem services, urban forestry, forest economics and governance etc.

Dr Rodrigue Idohou is coordinating the Forest Methods research unit of LABEF. Rodrigue research focuses on aspects of the distribution and geography of wild species, impact of human-induced factors on wild species conservation, spatial prioritization, planning, and wild species propagation. His work is collaborative in nature, and usually involves geographers, computer scientists, and biologists. He also took parts in several outstanding local, national and international trainings, workshops and conferences.

Dr Jean Didier Akpona is heading the Forest Ecology and Management research unit of LABEF. Jean Didier's research interests include Forest Ecology and management, Seeds Ecology and Biodiversity conservation, Pollination and Ecosystem services, Plant and Wildlife interaction and GIS and Remote Sensing

Dr Marcel Donou is in charge of the social life department of LABEF. Biostatistics and forest modeling. His PhD research focused on conservation biology with a special focus on wild palms conservation. His research interests include Forest inventory, Ethnobotany, Beekeeping.

Afia Ombada, Bsc obtained her Bachelor degree at Sheffield Hallam University in England in 2012. She has a good communication skill and speaks fluently English which is simple to communicate with English speaking collaborators. She is in charge of the administration and all related tasks. She mostly helps the coordinator of the master program in statistics major Biostatistics for students day to day management. She makes sure that students have their timetable, receive their lecture, submit with their homework and sit their exams on time. She also does everything students need for the good continuation of their stay throughout the program.

RESEARCH

MILESTONES AND HIGHLIGTHS

Scientific publications in 2018

Publications milestones

In 2018, LABEF and its members produced 64 knowledge products including 62 manuscripts from which about 77.5% was already published (appendix 1) and 02 technical reports.

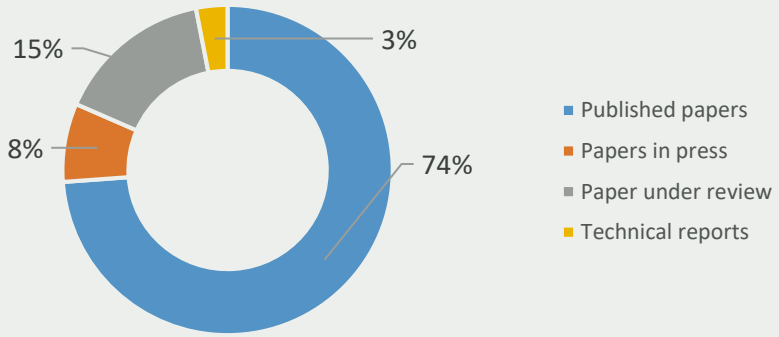


Figure 2. Publications in LABEF in 2017

Although the global knowledge production very similar to that of the last two years, there is a significant increase in scientific publication (41.17%) which reached a total of 48 articles in 2018, representing a release of 6 articles per academic month. While LABEF members did not contribute to book editing in 2018, they produced two technical reports.

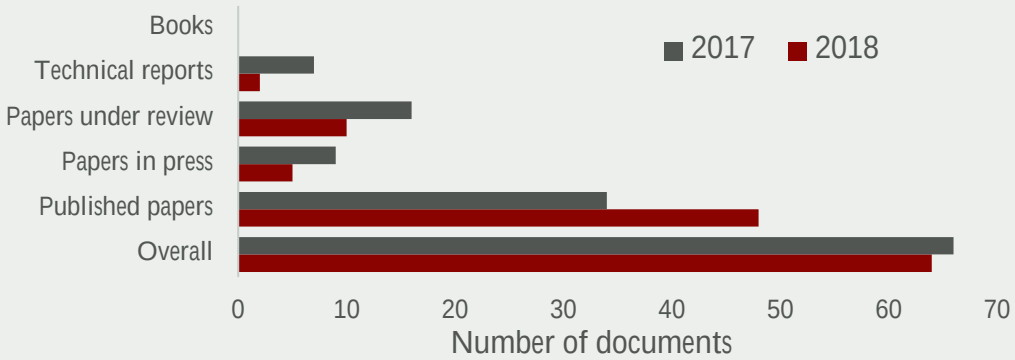


Figure 3. Publications of LABEF in 2017 and 2018

Diversity of journals

In 2018, knowledge products from LABEF were published, nearly published or in process for publication in 35 journals (Table 1). The Top five journals are Agroforestry systems, Journal of Ethnobiology and Ethnomedicine, African Crop Science Journal, Annales des Sciences Agronomiques, Environment, Development and Sustainability, and Modeling Earth Systems and Environment.

Table 1. Journals considered for publication in 2018

Journal	Nb	Journal	Nb
Agroforestry Systems	6	Energy, Ecology and Environment	1
Journal of Ethnobiology and Ethnomedicine	4	Environmental Research Letter.	1
African Crop Science Journal	2	Ethnobiology Letters	1
Annales des sciences agronomiques	2	Food Security	1
Environment Development and Sustainability	2	Forest Ecology and Management	1
Modeling Earth Systems and Environment	2	Genetic Resources and Crop Evolution	1
Science et technique, Revue burkinabè de la recherche, Sciences naturelles et appliquées	2	International Journal of Applied Mathematics and Statistics	1
African Journal of Applied Statistics	1	International Journal of Biological and Chemical Sciences	1
African Journal of Ecology	1	International Journal of Engineering and Future Technology	1
Afrique SCIENCE	1	International Journal of Engineering, Science and techn	1
Agro-Science	1	Journal of Animal & Plant Sciences,	1
American Journal of Environmental Science and Engineering	1	Journal of Forestry Research	1
Biomass and Bioenergy	1	Journal of Insects as Food and Feed	1
Biotechnologie Agronomie,	1	Larhyss journal	1
Bois et Forêt des Tropiques	1	Oecologia	1
EcoHealth	1	Tropical Conservation Science	1
Economic Botany	1	Tropical Ecology	1

Diversity of research domains

The research in LABEF in 2018 dealt with a diversity of issues covering different disciplines (Table 2). Forestry and related sciences, Conservation, Ethnobotany, Statistics and related sciences and Agroforestry were the most investigated fields (9 Table 2).

Table 2. Domains of research in 2018

Domain of research	Nb	Domain of research	Nb
Ethnobiology	12	Water Resources	2
Ecology	10	Animal production	1
Agroforestry	4	Biodiversity conservation	1
Agronomy	4	Climate change	1
Biostatistics	4	Crop sciences	1
Ecological modelling	2	Forestry	1
Food security	2	Spatial ecology	1
Tropical Forestry	2		

Performance and highlights

➔ *International quality standards and Impact factor*

The overall scientific quality of article produced in LABEF increased significantly in 2018. About 81.25 % of the scientific production were published, in press or under review in international standards journals. About 66.67 % of the published or nearly published (in press) papers in 2018 was done in journal with impact factor. In addition, about 77.78% of papers under review are processing in journal with impact factor. In comparison to 2017, LABEF kept the trend in high quality publications in 2018 (Figures 4). The number of publications in journal with impact factor increased steadily (40 %).

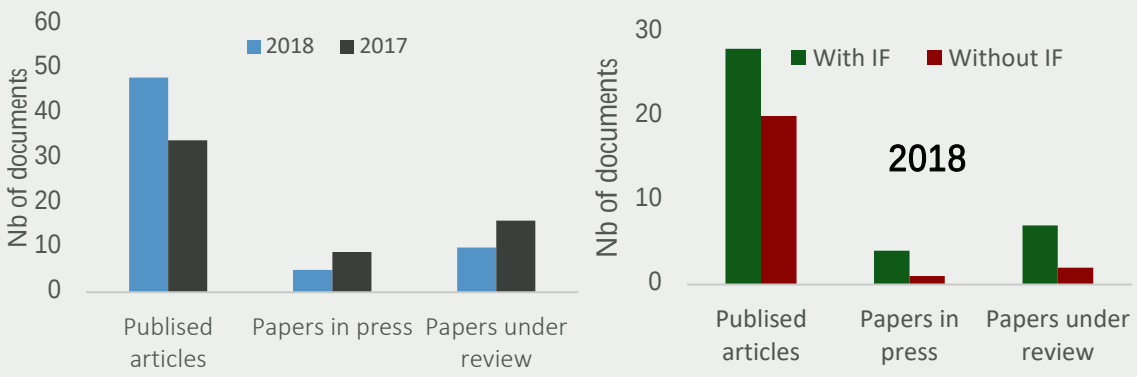


Figure 4. Trends and quality in publications

Apart from the number of publications, the cumulative impact factor for published and nearly published increased (31.6 %) and suggest a remarkable work toward better quality of publications. The cumulative impact factor in 2018 was 49.553 representing an increase of about 10 points on the performance of 2017 (total IF =

39.94) for papers published or nearly published (In press) and 06.005 for papers under review.

About half of our published papers was in journal with at least one point for impact factor (Figure 5, Appendix 1.4-1.5). About quarter of our publications were with at least 2 points for impact factor (Figure 5). The publications (including those in press or nearly accepted) with highest impact factors were in Environmental Research Letter (4.541), Biomass and Bioenergy (3.2), Oecologia (3.127), and Forest Ecology and Management (3.064), EcoHealth (2.649), Journal of Ethnobiology and Ethnomedicine (2.181)

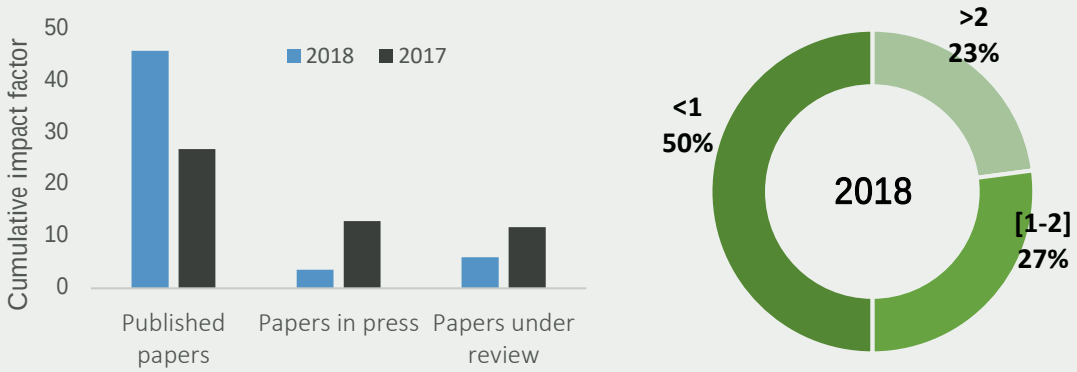


Figure 5. Ranges of impact factor of LABEF's publications in 2017

Authorship and leadership in publications

LABEF was strongly involved and kept a leadership on publications in 2018. We first authored about one third while being among the three first authors of about two thirds of the publications. We assumed leadership position (Last authors) in about 40 % of the publications. This trend evidences the strong involvement of LABEF and its members in research conception, implementation and publications in one way, and in another our capacity to partner with others institutions for transdisciplinary and larger research.

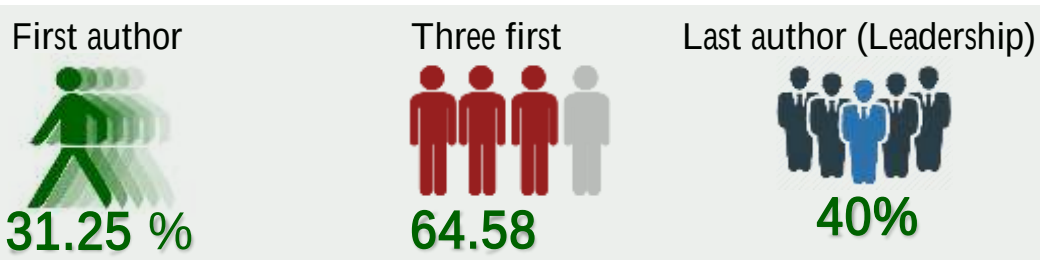


Figure 6. Authorship and leadership in publications of LABEF in 2018

Prizes, awards & recognitions

Prizes, Awards and recognitions

In 2018, our researchers have been celebrated for their excellence in Science. They received four prestigious Prizes and awards:

- Nomination of Prof Romain Glèlè Kakaï as the chairman of the Scientific council of the National Institute of Agricultural research of Benin; For more information about INRAB: https://inrab.org/
- Nomination of Prof Romain Glèlè Kakaï as the chairman of the African German Network of Excellence in Science (AGNES). For more information about AGNES: www.agnes-h.org
- Appointment of Dr Emile Agbangba as assistant Professor at EPAC, University of Abomey-Calavi; For more information about EPAC: https://epac.uac.bj/

Research projects

Research activities in LABEF were supported by both national and international institutions. In 2018, LABEF extended its partnership, led or co-led different research projects. Its portfolio of projects included small, medium and large research projects.

Small projects involved individual researchers of the Lab for up to $10 000. In 2018, the Lab housed 17 small projects from which 12 were new grants. The small grants dealt with different research issues and include:

- 07 research grants from the International Foundation for Sciences (IFS);
- 03 research grants from Rufford;
- 02 research grant from the African Excellence Center in Mathematical Sciences and Applications (AEC-MSA);
- 01 research grant from the France Embassy;
- 01 research grant from the International Tropical Timber Organization;
- 01 research grant from Sud Expert Plants (SEP2D);
- 01 research grant from the Swiss Government;
- 01 research grant from African Leadership School of Business.

For the medium and large research projects, LABEF partnered with others national and international institutions. In 2018, LABEF hosted 09 medium and large projects from which 2 were new projects. The medium and large projects include:

- A project on mangroves management by Fonds national de la recherche scientifique et de l'innovation technologique (FNRSIT) (Medium);
- A project on mangrove funded by the French Facility for Global Environment (FFEM) (medium);
- A project on Baobab value chain funded by The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) (Large);
- A project on wild fruits funded by Agropolis (Large);
- A project on forest monitoring funded by the The French Research Institute for Development (IRD) (medium);
- A project on agriculture funded by the Danish International Development Agency (DANIDA) (large);
- A project on ecosystem services funded by the European Union (large);
- A project on genetic diversity of mangroves trees funded by ARES (medium).

Overall in 2018, LABEF partnered with a dozen of institutions from Burkina Faso, Mali, Togo, Denmark, Belgium, France and Costa Rica. Details about small research projects are available upon request to grantee (See Appendices 1.12 and 1.13). Details about medium and large research projects are available on our website http://labef-uac.org/en/ongoing-projects/

Master and PhD theses in 2018

In 2018, nineteen master research projects were completed in LABEF spanning different research topics in Biostatistics and Natural resources management (Figure 7b; Appendix 1.3). About 16% were conducted by women (Figure 7a)

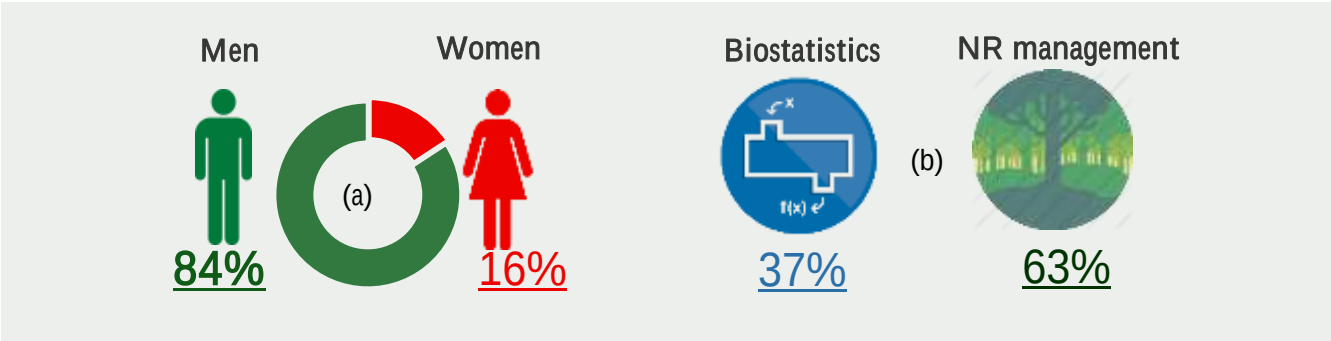


Figure 7. Gender balance and fields of research for Master theses

During the academic year 2018, a PhD research project was defended (See appendix 1.1). Eighteen others PhD research projects were under supervision or co-supervision in LABEF at different stages of research. More than half of the research projects was at their inception. About one third was at inception (first year of enrollment) while more than half (55%) was at second year of research. Two PhD research (See appendix 1.2) are about to complete with tentative defense in 2019. PhD research projects were dominated by biometry (38.89%) while the other PhD research topics deal with natural resources and forestry, agronomy, climate change (Figure 8). Only two PhD research projects were being conducted by women.

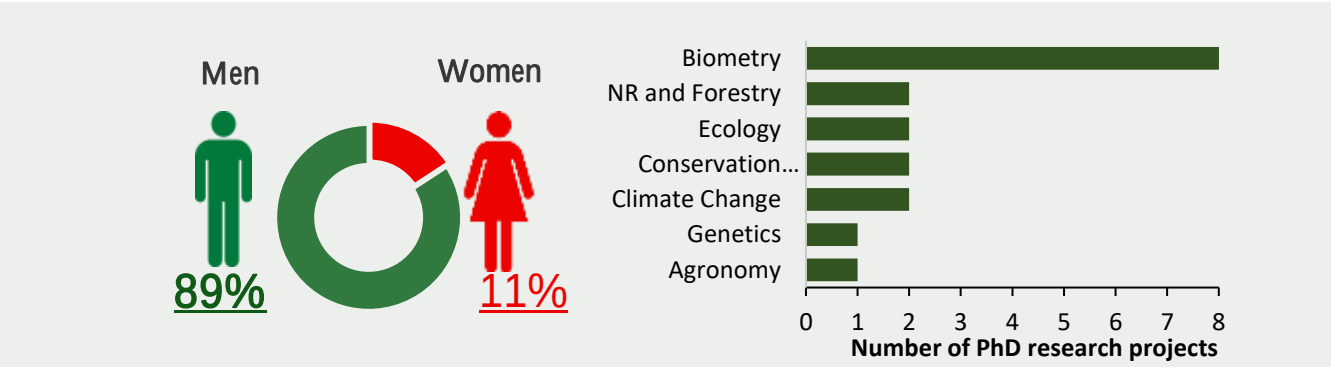
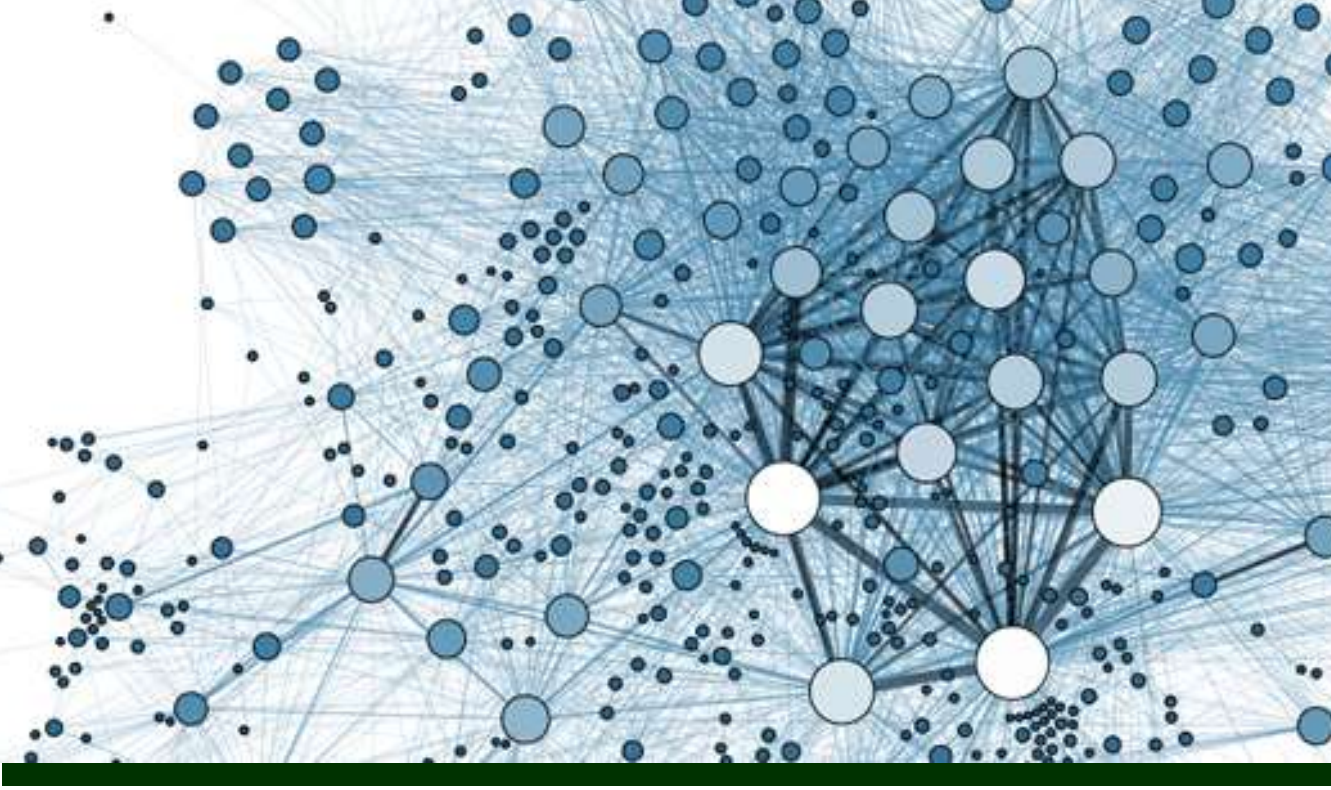


Figure 8. Gender balance and fields of research for PhD theses



RESEARCH

CONNECTIONS

Collaboration in publication

LABEF works with a wide range of both local and international partners for research. In 2018 the LABEF collaborates with researchers from 29 countries (Figure 9) across the world (Figure 10b). At country level, most of the collaboration for publication were realized researchers from different institutions in Benin (47%). About half of the scientific production by LABEF involved international collaboration. About 80% of the collaboration for publication in 2018 were realized among key countries (Figure 10a) with which the Lab has traditional relationships.

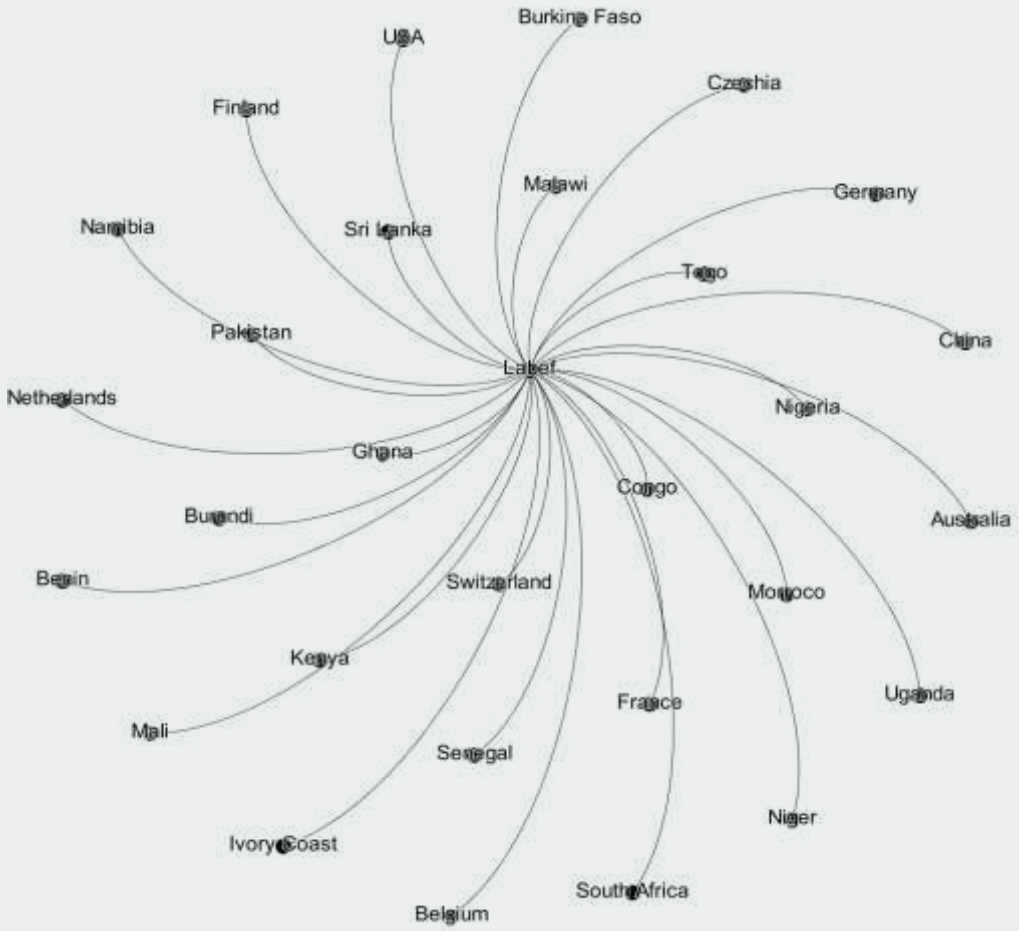


Figure 9. Countries which collaborate for publication with LABEF in 2018

However, new and fruitful collaborations were established with scientists from regional, pan-African and international institutions. At the continent level, most of the publications were produced in collaboration with researchers from Africa (81%; Figure 10b). Others collaborators are from Europe, Asia, Oceania and America.

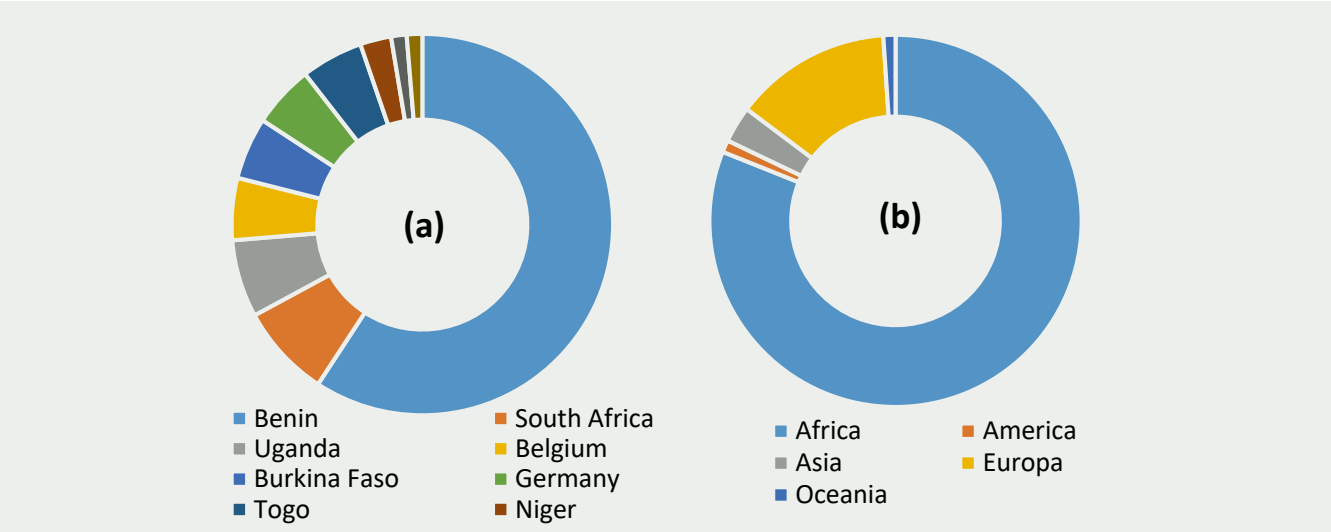


Figure 10. Countries (a) and world regions (b) of co-authors of publications of LABEF in 2018

Apart from collaboration for publication, we received in 2018 visitors (Table 3) including three students and four senior researchers for various scientific activities (See appendix 1):

Table 3. List of visitors in 2018

Students	Seniors researchers
Iliana Janssens (VUB-Belgique)	Prof Jean Hugé (Belgium)
Devone Goad (VUB-Belgique)	Prof MONTY Arnaud (Belgium)
Anton De Ryck (KU-Leuven, Belgique)	Prof CROS David (Cameroon)
	Prof Saliou DIOUF (Senegal)

Participation in scientific meetings in 2018

Researchers form LABEF have taken part as in speaker, poster presenter or simple participants in 27 International conferences/workshops around the world (Figure 11). As of December 2018, participation in international conferences and workshop increased steadily (285%) indicating quality and performance of our researchers. About half conferences and workshops attended were in Africa (56%) mostly in Benin (22 %). The remaining conferences were held in Europe (Belgium, France, Italy) and in Asia (Israel and Japan). The researchers attended these events as participants (37%), oral presenters (37%), or poster presenters (19%) or both oral and poster presenters (07%). The conferences and workshops dealt with different issues in statistics, biodiversity conservation, ecology, forestry and agriculture.

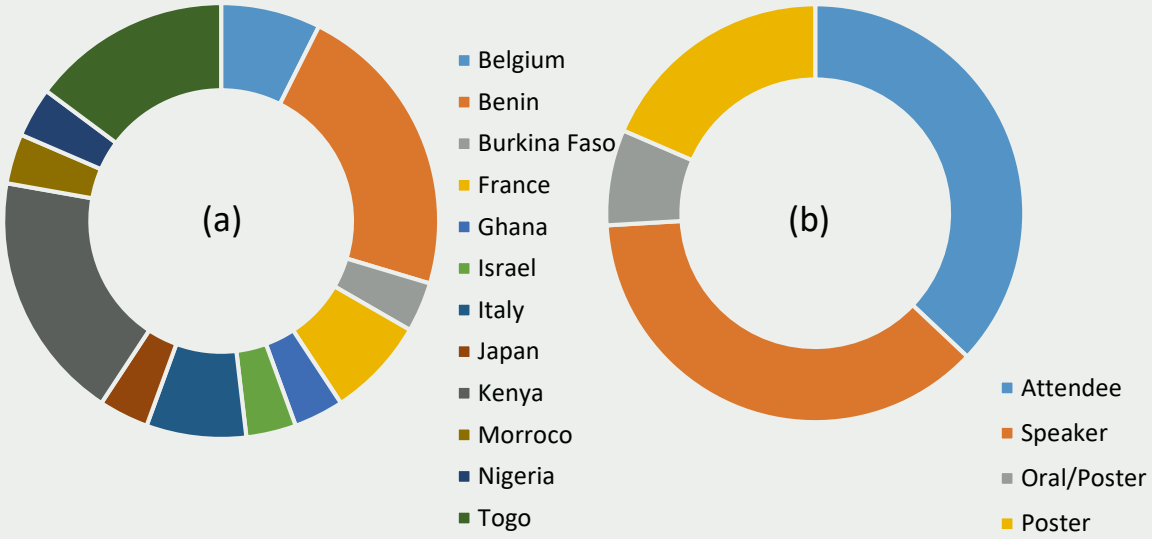


Figure 11. Host countries of conferences attended by LABEF members in 2018 (a) and status of participants (b)

CONTRIBUTION

to capacity building

Graduate program in Biostatistics and Post graduate program in Biometry

The PhD programme in Biometry

Since the academic year 2017-2018, the doctoral school of agronomic sciences and water resources is offering a PhD programme in Biometry. The programme is coordinated by Prof Glèlè Kakaï Romain with support of the Laboratoire de Biomathématiques et d'Estimations Forestières. Six members of LABEF who graduated from the Master programme in Biostatistics are currently enrolled in the PhD programme (Tovissodé Frederic, Honfo Sewade Hermann, Amagnidé Aubin and Lokonon Bruno, Essomanda Tchandao Mangamana and ahlonsou Ceptime).

The Master programme in Biostatistics

The Master programme in Statistics with major in Biostatistics offers an extensive and unique training in recent statistical methods and tools toward their applications in Life sciences. At the end of the training, graduated students can easily go into professional life as Biostatistician or engage in research in Biostatistics by integrating a doctoral school. This training is open to Bachelor Degree holders in Life Sciences domains (agronomy, health, biology, environment, etc.), or in Mathematics/Statistics or Master Degree holders wishing to acquire knowledge and know-how in the field of data collection and analysis. The Master in Biostatistics has fully trained and released three batch of professional biostatisticians and data analysts. The 6th batch of students started in September 2018 and enrolled 21 students from two countries (Benin, Cameroon). As for date, 109 students were trained or are mastering in the programme. They are from fourteen countries, covering four out the five Africa regions including West, East, Centre and South regions (Figure 12). The women participation has increased steadily since the inception of the Master, and reached a ratio of more than 1 woman for 4 men (25% of student enrollment since two batches). The programme is supported by an Intra-ACP Academic Mobility Programme (AGREEMENT NUMBER 2013-4177/001-001), RUFORMUM and the African Excellence Center for Mathematics Sciences and Application (ACE-MSA) with support of the World Bank Group.

➔ What the Master aims to?

The field of Biostatistics is expanding. It deals with various sectors. The abilities this training gives in data collection, management, statistical analysis and valorization allow graduates to practice job of Biostatisticians in charge of Statistical Studies in various sectors. This programmes aims to provide Food Enterprises, Projects, Health Sector (Units of Clinical research), Department of Medical Information, etc.), Public and Private Research Institutions, Non-Governmental Organizations (NGO), International Organization (FAO, UNDP, World Bank, etc.) Education and International Research Institutions, with talented Biostatisticians and data analysts.

➔ How to apply?

Visit the website www.labef-uac.org and fill in the online application form (http://labef-uac.org/application). Candidates from Benin could submit their applications to the secretary of the programme, located at the Laboratory of Biomathematics and Forests Estimations. Please visit the webpage of the Master for detailed information (http://labef-uac.org/en/master/).

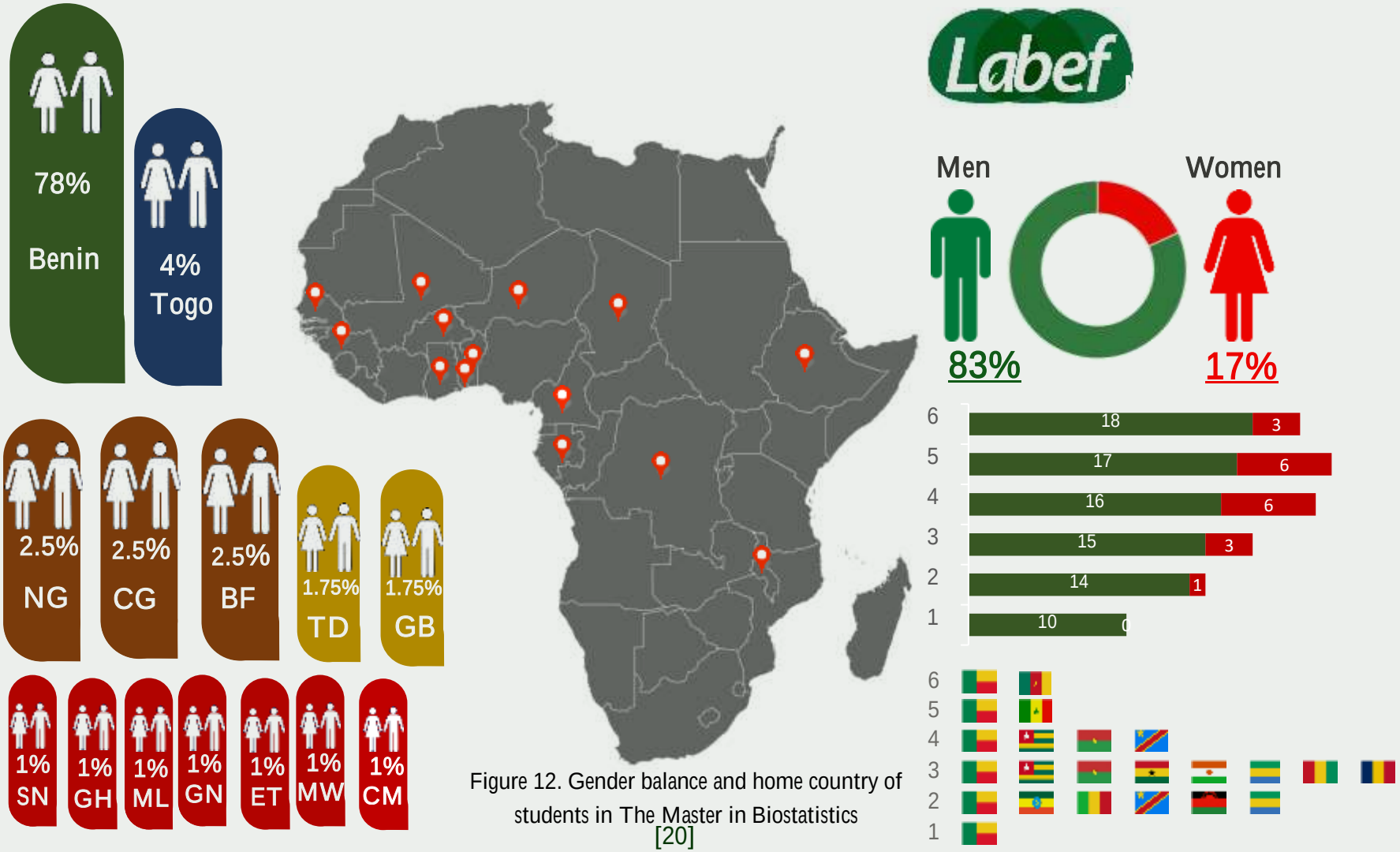


Figure 12. Gender balance and home country of students in The Master in Biostatistics [20]

NG: Niger; CG: Congo; BF: Burkina Faso; CM: Cameroon; MW: Malawi; ET: Ethiopia; GN: Conakry Guinea: ML: Mali; GB: Gabon; SN: Senegal; GH: Ghana; TD: Tchad

The Internship Programme

The Laboratoire de Biomathématiques et d'Estimations Forestières commits to build capacity of African scientists' community and professional in statistics. In addition to the Master in Biostatistics which develops long term capacities, the LABEF offers two internship programmes.

- An academic internship programme that welcomes BSc and MSc for a period of 3 to 8 months. Interns are introduced to basic statistics, R statistical software, thematic trainings, participate to training sessions and contribute to research activities in the Lab. In 2018, we received 11 BSc students from the University of Abomey-Calavi, the National University of Agriculture of Porto Novo and the University of Parakou.
- A professional and regional internship programme that welcomes PhD student, early career researchers and others practitioners in biology, ecology and conservation and epidemiology. The internship is fit to each profile and includes introduction to basic statistics, R statistical software, data mining and analyses, etc. In 2018, we received 02 PhD students from the University of Felix Houphouet Boigny (Ivory Coast), Institut des Sciences de la Sante (Burkina Faso), and 02 early career researcher from the University Ouaga I Prof Joseph Ki-Zerbo.

Figure 13. Origin and genre distribution of interns in 2018

We hope to welcome more interns in future. For details, requirement and condition for participating in the internship programmes of LABEF, please contact the Lab (contact.labef@gmail.com)

Conferences and seminars held in Labef in 2018

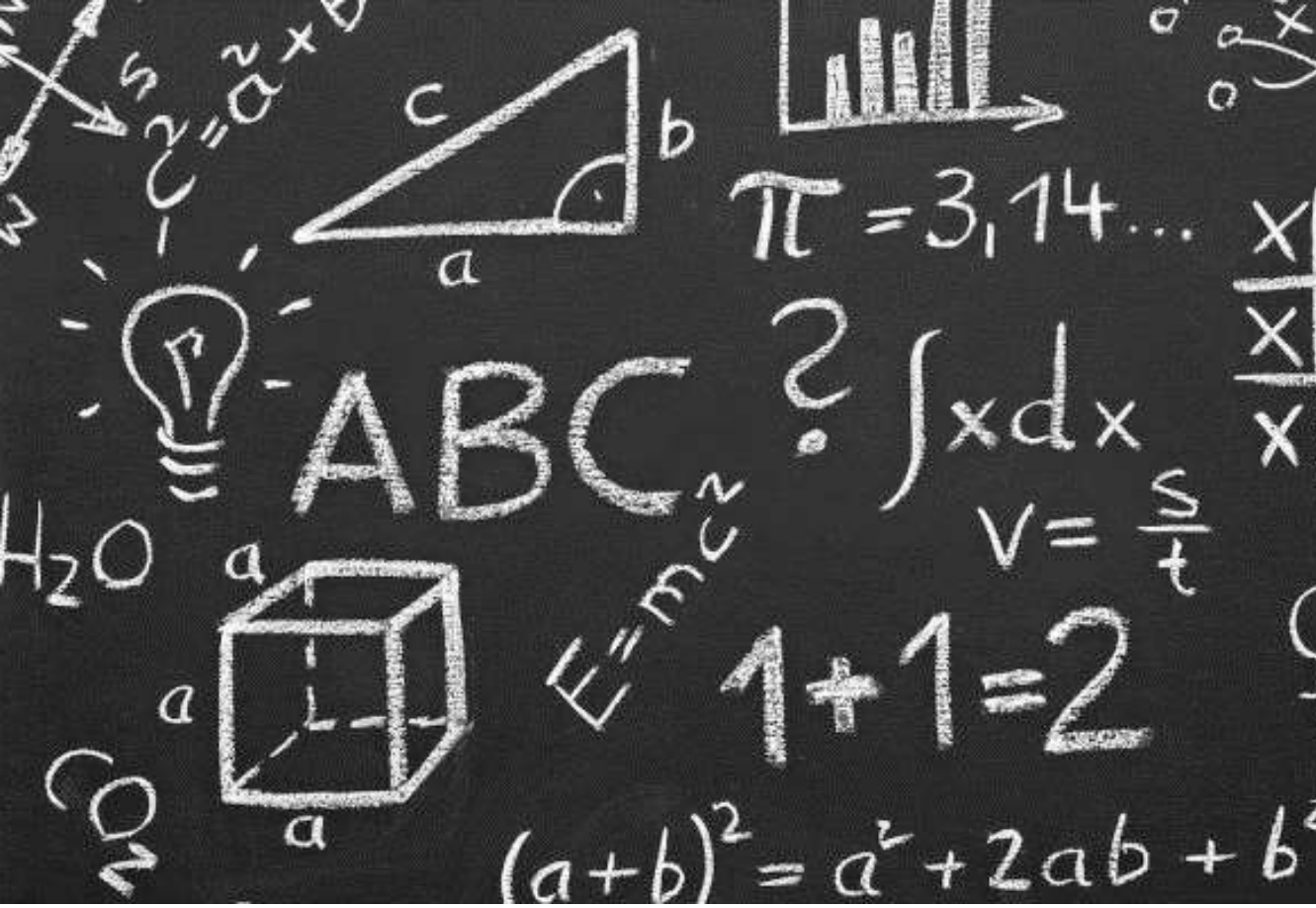
Six free-of-charge scientific seminars took place at LABEF during the year 2017, covering different issues and disciplines. Participants including Experts, researchers, practitioners and policy makers attended and share experiences on the following topics:

- Le Protocole de Nagoya sur l'accès aux ressources génétiques et le partage juste et équitable des avantages découlant de leur utilisation et les implications pour la recherche au Bénin ;
- What if forest resources were managed differently? 30 years of experiences and learned lessons from multi-stakeholders' participative model;
- La théorie des valeurs extrêmes ;
- Etudier les systèmes socio-écologiques : vers une démarche systématique et réfléchie ;
- Analysis of sensory data: internal and external mapping.

For details about the conference and seminars in 2018, see Appendix 6 and our website (www.labef-uac.org) .

In 2018, the Lab held also two internal events:

- The African Mathematical School (AMS) organized the African mathematical school that welcomed about 40 participants from Benin, Togo, Ghana, du Nigeria, Niger, Gabon, Burkina Faso, Congo, Conakry Guinea and United States of America. The event was funded by The Centre International de Mathématiques Pures et Appliquées (CIMPA) with support of the Centre d'Excellence Africain en Sciences Mathématiques et Applications (CEA-SMA).
- A regional workshop on ecosystem services in protected areas. The event took place at Natitingou in September 2018 and welcomed participants from Benin and Belgium. It was funded the Capacities for Biodiversity and sustainable development (CEBIOS).



APPENDICES

Appendix 1.
Scientific activities of the Labef

Appendix 1.1. Completed PhD thesis in 2018

N°	Student full name	Research topics	Field of Research
1	Kisito Gandji	Modelling ethnobotanical patterns of *Moringa oleifera* Lam. in Benin (West Africa)	*Etnobotany and agroforestry*

Appendix 1.2. Ongoing PhD thesis

N°	Student full name	Level	Research topics	Field of Research
1	Eclou Innocent	3rd year	Assessment and analysis of agro-ecological aspects of cotton farming systems for a sustainable cotton production in Benin.	*Environmental chemistry*
2	Atanasso A. Justin	3rd year	Effects of abiotic and biotic factors on the early recruitment of the threatened *Afzelia africana* Sm. ex Pers. (Fabaceae-Ceasalpinioideae) in the Pendjari Biosphere Reserve (Benin, West Africa)	*Conservation biology*
3	Gnonlonfoun Isidore	2st year	Dynamics of savanna plants: effects of trophic interactions between elephants and woody plants in Pendjari Biosphere Reserve in Benin, West Africa	*Ecology*
4	Houndonougbo Juliano	2st year	Ecology, conservation and domestication of the African locust bean tree *Parkia biglobosa* (Jack.) R. Br. (Mimosaceae) in Benin, West Africa	*Conservation biology*
5	Amagnide Aubin	2nd year	Empirical comparison of plotless sampling techniques in vegetation studies	*Biometry*
6	Hounmenou Castro	2nd year	Global optimization in multilayer perceptron neuronal networks	*Biomettry*
7	Lokonon Bruno	2nd year	Empirical comparison of parameter estimation methods used in generalized linear mixed model (GLMM) with applications on ecological data	*Biometry*
8	Honfo Hermann	2nd year	Linear mixed effects models for fitting multivariate longitudinal data: application to natural regeneration of *Adansonia digitata* L.	*Biometry*
9	Tovissode Frederick	1st year	Performance of Generalized Linear and Nonlinear Mixed Models under flexible semi-non parametric and parametric distributions: applications to plant-plant interactions and gene dispersal in *Afzelia africana*	*Biometry*
10	Savi Merveille	2nd year	Advanced system dynamic analysis approach to enhance the control of malaria in West Africa	*Biometry*
11	Kafoutchoni Medard	1st	Genetics of yield and yield components in Kersting's groundnut [Macrotyloma geocarpum (Harms) Maréchal & Baudet]	Genetics

12	Zanvo Serge	1st year	Population structure, dynamics, and ecosystem services of mangroves in southern Benin, West-Africa: implications for sustainable management	Natural Resources Management
13	Sinsin Corine	1st year	Resilience and vulnerability of mangroves to climate change in Benin, West Africa	Climate change and biodiversity
14	Donhouede Janine	1st year	Morphological variation, genetic diversity and proximate composition in Annona senegalensis in western and southern Africa.	Forestry ressources
16	Ahlonsou Ceptime	1st year	Study of error rate in discriminant analysis on functional data	Biometry
17	Amoussou Eldys	2nd	Evaluation et Prédiction de l'impact des changements climatiques sur les PFNLs d'Afrique tropicale : Conséquences sur la distribution des espèces et implications économiques.	Climate change
18	Tchandao Mangamana Essomada		Multiple data tables analysis: new developments around ComDim	Biometry

Appendix 1.3. Completed Master in 2018

N°	Student full name	Research topics	Field of Research
1	Agbohessou Mariette	Comparative analysis of the performances of cuttings, grafting and aerial marcotting to propagate baobab	Natural Resources Management
2	Houenon Hurgues	Stand structure and farmers' management of health issues in the bush mango tree in agrarian systems of Southern Benin (West Africa)	Natural Resources Management
3	Sabo Prospère	Stand structure, ethnobotany, distribution and vulnerability of Boswellia dalzielii hutch in the Boucle du Mouhoun region (Burkina Faso)	Natural Resources Management
4	Agounde Gafarou	Potential impacts of climate change on 13 food tree of elephant in the W-Arly-Pendjari-Oti-Keran ecosystem, West-Africa: insights from dispersal constraints.	Natural Resources Management
5	Dahodo Médard	Analyse des facteurs technico-socio-économiques de l'adoption des espèces à croissance rapide comme stratégie de lutte contre la surexploitation des espèces de mangroves au Bénin	Natural Resources Management
6	Assongba Gnonwado Macaire	Les mangroves plantées du sud-Bénin : structure des peuplements, caractéristiques morphologiques et perceptions des acteurs sur les facteurs de réussite	Natural Resources Management
7	Houenou Ezechiel	Study of potential and socio-cultural importance of Wild Edible Fruit Trees (WEFT) in the Monts Koiuffe gazette forest in Benin	Natural Resources Management
8	Tahi Peace Gloria	Competing Risks Models: simulation and application with HIV data in Benin.	Biostatistics
9	Yacouba Biba	Relative performance of penalized methods of variables selection in linear mixed effects models.	Biostatistics
10	Laouali Inoussa	Linear mixed model analysis of environmental and genetic effects on Calving interval in Azawak cows at Toukounouss stage ranch of Niger.	Biostatistics
11	HouetohossoU S. C. Ariane	Using multivariate longitudinal data analysis to assess growth patterns of maize (Zea mays L.) in Benin.	Biostatistics
12	Mugumaarhahama Yannick	Poisson point process models for analysis of Presence-only data: Relative performance of methods accounting for sampling bias and imperfect detection	Biostatistics
13	Behingan Milognon Boris	Empirical evaluation of the robustness of imputation method combined to back propagation algorithm in context of non-linear multiple regression.	Biostatistics

14	Karimou Zhoul-Korneni A. A.	Effect of phenotypic variance covariance matrix structure and sample size on the precision of heritability of milk yield though random regression model.	Biostatistics
15	Tohoun Roméo	Optimal configuration of the characteristics of a multilayer perceptron neural network (MLPNN) in non-linear regression.	Biostatistics
16	Akin Yanik	On the performance of two distance sampling techniques in plant communities: Ordered distance versus variable area transect.	Biostatistics
17	Viayinon Jean Hénock Sèmèvo	Breiman Random Forest Classifier: Effect of hyper parameters on the performances for standard and high dimensional feature space and application to telecom churn and credit risk detection.	Biostatistics
18	Mushagalusa ciza Arsène	Effect of data types on the performance of random forest method: Application on pig population prediction in Benin.	Biostatistics
19	Sacla Edmond	Mixture Optimization through desirability modeling: comparison of linear regression and beta inflated mean regression methods and application to food formulation data.	Biostatistics

Appendix 1.4. Articles published in peer-review journal with IF in 2018

Disciplines	N°	Authors' Names	Title of the article	Journals	IF
Plant ecology	01	Hounkpèvi, A., Kouassi, K. E. & Glèlè Kakaï, R	Effects of climatic variability and local environment patterns on the ecology and population structure of the multipurpose plant species, *Vitex doniana* Sweet (Lamiaceae) in Benin	Tropical Ecology	1.13
Tropical Forestry	02	Assogba GA, Fandohan AB, Gandji K, Salako KV, Assogbadjo AE	*Bombax costatum* (Malvaceae): state of knowns, unknowns and prospects in West Africa	Biotechnologie Agronomie, and Environment	0.7
Ethnobiology	03	Kafoutchoni K.M., Idohou R., Egeru A., Salako K.V., Agbangla C., Adomou A.C., Assogbadjo A.E.	Species richness, cultural importance and prioritization of wild spices for conservation in the Sudano-Guinean Zone of Benin (West Africa).	Journal of Ethnobiology and Ethnomedicine	2.181
Forest Ecology and Management	04	Banla T., Houehanou T.D., Savi M.K., Idohou R., Glèlè Kakaï R., Kokou K.	Population structure of *Pterocarpus erinaceus* Poir. across a protection gradient in Sudanian savannahs of Togo, West Africa.	African Journal of Ecology	0.797
Agroforestry	05	Vihotogbé R., Idohou R., Gebauer J, Sinsin B, Peterson A.T.	Estimation of cultivable areas of Irvingia gabonensis and I. wombolu (Irvingiaceae) in West Africa.	Agroforestry systems	1.201
Biodiversity conservation	06	Rochette A-J, Akpona JDT, Akpona H.A., Akouehou G.S., Kwezi M.B., Djagoun C.A.M.S, Habonimana B., Idohou R., Legba IS, Nzigidahera B, Matilo AO, Taleb MS, Bamoninga B.T., ivory S., Janssens DE Bisthoven L, Vanhove M P.M.	Developing policy-relevant biodiversity indicators: lessons learnt from case studies in Africa.	Environmental Research Letter.	4.541
Ethnobotany	07	Gandji K., Salako V.K., Fandohan B.A., Assogbadjo A.E., Glèlè Kakaï R.L.	Factors determining the use and cultivation of Moringa oleifera Lam. in Republic of Benin.	Economic Botany	1.582

Disciplines	N°	Authors' Names	Title of the article	Journals	IF
Ethnobiology	08	Salako, K. V., Moreira, F., Gbedomon, R. C., Tovissodé, F., Assogbadjo, A. E., & Glèlè Kakaï, R. L.	Traditional knowledge and cultural importance of *Borassus aethiopum* Mart. in Benin: Interacting effects of socio-demographic attributes and multi-scale abundance	Journal of Ethnobiology and Ethnomedicine	2.181
Agroforestry	09	Lokonon E. B., Tchandao Mangamana E., Gnonlonfoun I., Akpona J. D., Assogbadjo A., Glèlè Kakaï R. and Sinsin B.	Knowledge, valuation and prioritization of 46 woody species for conservation in agroforestry systems along Ouémé catchment in Bénin (West Africa).	Environment, Development and Sustainability	1.379
Food security	10	Chadare, F.J., Fogny, N.F., Madode, Y.E., Ayosso, J.O.G., Honfo, S.H., Kayodé, F.P.P., Linnemann, A.R. and Hounhouigan, D.J.,	Local agro-ecological condition-based food resources to promote infant food security: a case study from Benin	*Food Security*	2.970
Agroforestry, Conservation Ecology	11	Salako V.K., Vihotogbé R., Houéhanou T., Sodé I.A., Glèlè Kakaï.	Predicting the potential impact of climate change on the declining agroforestry species Borassus aethiopum Mart. in Benin: a mixture of geostatistical and SDM approach.	*Agroforestry systems*	1,2
Plant ecology	12	Savi M.K., Noumonvi R., Chadaré F.J., Daïnou K., Salako V.K., Idohou R., Assogbadjo A.E., Glèlè Kakaï R.	Synergy between traditional knowledge of use and tree population structure for sustainability of *Cola nitida* (Vent.) Schott. & Endl in Benin (West Africa).	*Environment Development and Sustainability*	1.379
Spatial ecology	13	Salako V.K., Kénou C., Dainou K., Assogbadjo A.E., Glèlè Kakaï R.	Impacts of land use types on spatial patterns and neighbourhood distance of the agroforestry palm Borassus aethiopum Mart. in two climatic regions in Benin, West Africa	*Agroforestry Systems.*	1.201
Ethnobiology	14	Rashid N., Gbedomon R.C., Ahmad M., Salako V.K., Zafar M., Malik K.	Traditional knowledge on herbal drinks among indigenous communities in Azad Jammu and Kashmir, Pakistan.	*Journal of Ethnobiology and Ethnomedicine*	2.181

Disciplines	N°	Authors' Names	Title of the article	Journals	IF
Plant ecology	15	Mensah S., Salako V.K., Assogbadjo A.E., Glèlè Kakaï R.	Differential Responses of Taxonomic, Structural, and Functional Diversity to Local-Scale Environmental Variation in Afromontane Forests in South Africa.	*Tropical Conservation Science*	1.149
Ethnobiology	16	Agbani P.O., Kafoutchoni K.M., Salako V.K., Gbedomon R.C., Kégbé A.M., Karen H., Sinsin B.	Traditional ecological knowledge based assessment of threatened woody species and their potential substitutes in the Atakora mountain chain, a threatened hotspot of biodiversity in Northwestern Benin, West Africa.	*Journal of Ethnobiology and Ethnomedicine.*	2.181
Agroforestry	17	Senarathne, S. H., Atapattu, A. J., Raveendra, T., Mensah, S., & Dassanayake, K. B.	Biomass allocation and growth performance of Tithonia diversifolia (Hemsl.) A. Gray in coconut plantations in Sri Lanka.,	*Agroforestry Systems*	1.201
Forestry	18	Mensah, S., Egeru, A., Assogbadjo, A. E., & Glèlè Kakaï, R.	Vegetation structure, dominance patterns and height growth in an Afromontane forest, Southern Africa.	*Journal of Forestry Research*	0.748
Ecology	19	Dimobe, K., Mensah, S., Goetze, D., Ouédraogo, A., Kuyah, S., Porembski, S., & Thiombiano, A.	Aboveground biomass partitioning and additive models for Combretum glutinosum and *Terminalia laxiflora* in West Africa.	*Biomass and Bioenergy*	3.358
Ecology	20	Mensah, S., du Toit, B., & Seifert, T.	Diversity–biomass relationship across forest layers: implications for niche complementarity and selection effects.	*Oecologia*	3.127
Ecology	21	Mensah, S., Pienaar, O. L., Kunneke, A., du Toit, B., Seydack, A., Uhl, E., … & Seifert, T.	Height–Diameter allometry in South Africa's indigenous high forests: Assessing generic models performance and function forms.	*Forest Ecology and Management*	3.169
Agronomy	22	Gbaguidi, A. A., Dansi, A., Dossou-Aminon, I., Gbemavo, D. S. J. C., Orobiyi, A., Sanoussi, F., & Yedomonhan, H.	Agromorphological diversity of local Bambara groundnut (Vigna subterranea (L.) Verdc.) collected in Benin.	*Genetic Resources and Crop Evolution*	1.130
Ecology	23	Dimobe, K., Goetze, D., Ouédraogo, A., Mensah, S., Akpagana, K., Porembski, S., & Thiombiano, A.	Aboveground biomass allometric equations and carbon content of the shea butter tree (Vitellaria paradoxa CF	*Agroforestry Systems*	1.201

Disciplines	N°	Authors' Names	Title of the article	Journals	IF
			Gaertn., Sapotaceae) components in Sudanian savannas (West Africa).		
Ecology	24	Adehan, S. B., Adakal, H., Gbinwoua, D., Zoungrana, S., Toé, P., Ouedraogo, M., … & Glèlè Kakaï, R.	West African Cattle Farmers' Perception of Tick-Borne Diseases	*EcoHealth*	2.649
Ethnobotany	26	Goudégnon, E. O. A., Vodouhê, F. G., Gouwakinnou, G. N., Salako, V. K., & Oumorou, M.	Ethnic and generational differences in traditional knowledge and the cultural importance of Lannea microcarpa Engl. & K. Krause in the Sudanian savannah of Benin.	*Bois et Forêt des Tropiques*	0.283
Animal production	27	Pomalégni, S. C. B., Gbemavo, D. S. J. C., Gnanglè, P. C., Djossou, S. R., Kenis, M., Babatoundé, S., L. R. Glèlè Kakaï & Mensah, G. A.	Seed cake of Jatropha curcas (L.), potential substrate to produce maggots as feed for reared monogastric animals.	*Journal of Animal & Plant Sciences,*	0.407
Agronomy	28	Heita, H. T., Ham, H., & Mensah, S. (2018).	Effects of seed viability and pre-treatments on seed germination of two indigenous species—Strychnos cocculoides Baker and Guibourtia coleosperma (Benth.) Leonard in Namibia.	*Agroforestry Systems*	1.201

Appendix 1.5. Articles published in peer-review journal without IF in 2018

Disciplines	N°	Authors' Names	Title of the article	Journals
Ecological modelling	01	Guidigan MLG, Azihou F, Idohou R, Okhimanhe AA, Fandohan AB, Sinsin B. and Adet L.	Modelling the current and future distribution of *Kigelia africana* under climate change in Benin, West Africa	*Modeling Earth Systems and Environment*
Tropical Forestry	02	Lawin IF, Fandohan AB, Gandji K, Assogbadjo AE, Ouinsavi CAIN	Cola millenii K. Schum : Etat des connaissances et perspectives de recherche	*International Journal of Biological and Chemical Sciences*
Ecological modelling	03	Agbo R.I.. Idohou R., Vihotogbe R., Missihoun a.a., Dagba R.A., Assogbadjo A.E., Agbangla C.	Spatio-temporal dynamics of suitable habitats for Detarium microcarpum Guill. & Perr. (Caesalpiniaceae), a priority food tree species in Benin (West Africa).	*Modeling Earth Systems and Environment.*
Ethnobiology	04	Gandji K., Chadare F.J., Idohou R., Salako V.K., Assogbadjo A.E. Glèlè KakaÏ R.L.	Status and utilisation of Moringa oleifera Lam: a review.	*African Crop Science Journal*
Water Resources	05	Zandagba J. E. B., Adandedji F. M., Lokonon B. E., Chabi A., Dan O., Mama D.	Application Use of Water Quality Index (WQI) and Multivariate Analysis for Nokoue Lake Water Quality Assessment.	*American Journal of Environmental Science and Engineering*
Statistics	06	Lokonon B E., Beh MbaR., Gbeha Mand Glèlè Kakaï R.	Parameters Estimation Methods in Generalized Linear Mixed Models Applied in Ecology: A Critical Review	*International Journal of Engineering and Future Technology*
Water Resources	07	Nounangnonhou T. C., Fifatin F-X. N., Lokonon E. B., Acakpovi A., Sanya E. A.	Modelling and Prediction of Ouémé (Bénin) River Flows by 2040 Based on GR2M Approach.	*Larhyss journal*
Changement Climatique **Agriculture**	08	S. C. Atidegla et C. Hounmenou	Adaptation des producteurs à la variabilité climatique au sud-Bénin : cas de la plaine inondable de gbessou houékèkomè	*Annales des sciences agronomiques*

Disciplines	N°	Authors' Names	Title of the article	Journals
Ethnobotany	09	Adjahossou S. G. C., **Houehanou D. T.**, Toyi M., Tente B., Houinato M., Sinsin B.	Degré de pression et perception endogène de multiplication et de conservation du genre *Isoberlinia* au Moyen-Bénin (Afrique de l'Ouest).	*Science et technique, Revue burkinabè de la recherche, Sciences naturelles et appliquées,*
Conservation ethnobotany	10	Ahoyo C.C., Mama Sambo Imorou I., Houehanou D.T., Yaoitcha S.A., Houinato R.B.M., Sinsin A. B.	De l'ethnomédecine à l'ethnopharmacologie vétérinaire et la conservation d'espèces ligneuses au Bénin : application raisonnée d'outils quantitatifs.	*Science et technique, Revue burkinabè de la recherche, Sciences naturelles et appliquées,*
Crop sciences	11	Moussa, A. A., Salako, V. K., Gbemavo, D. C., Zaman-Allah, M., Glèlè Kakaï, R., & Bakasso, Y.	Performances agro-morphologiques des varietes locales et ameliorees de maïs au sud-ouest du Niger.	*African Crop Science Journal*
Agroforestry	12	Dotchamou, t., Atindogbe, g., Houmenou, c., Fonton, N.	Modélisation de la productivité fruitière de *Parkia biglobosa* en zone soudanienne et zone soudano-guinéenne du Bénin	*Afrique SCIENCE*
Ethnobiology	13	Sankara, F., Pousga, S., Dao, N.C.A., Gbemavo, D.S.J.C., Clottey, V.A., Coulibaly, K., Nacoulma, J.P., Ouedraogo, S. and Kenis, M.	Indigenous knowledge and potential of termites as poultry feed in Burkina Faso	*Journal of Insects as Food and Feed*
Food security	14	Diop, B. M., Gueye, M. C., Agbangba, C. E., Cisse, N., Deu, M., Diack, O., … & Ngom, A.	Fonio (Digitaria exilis (Kippist) Stapf): A Socially Embedded Cereal for Food and Nutrition Security in Senegal.	*Ethnobiology Letters*
Statistics	15	Lazaro, M., 1;2, Gbeha, M. and Romain Glèlè Kakaï	Influence of Missing Value Imputations on the Performance of Canonical Correspondence Analysis: Ecological Applications.	*African Journal of Applied Statistics*
Agronomy	16	Dayou, E. D., Zokpodo, K. L. B., & Glèlè Kakaï, L. G. (2018)	Assessment of the physical and mechanical properties of the soils in the different agroecological zones of Benin	Agro-Science

Disciplines	N°	Authors' Names	Title of the article	Journals
Ethnobotany	17	Sèwadé, C., Lokonon, B.E., Azihou, A.F., Akouèhou, G.S., Mensah, G.A., Glèlè Kakaï, R., & Houinato, M.R.B. (2018).	Use diversity and farmer's preference of 48 local multipurpose fodder trees: a comparative analysis of three sociolinguistic groups of Benin	Annales des sciences agronomiques
Ecology	18	Houdanon, R. D., Mensah, S., Gnanglè, C., Yorou, N. S., & Houinato, M. (2018).	Ecosystem services and biomass stock from bamboo stands in central and southern Benin, West Africa.	Energy, Ecology and Environment
Agronomy	19	Dayou, E. D., Zokpodo, K. L. B., & Kakaï, A. G.	Evaluation of the physical, mechanical and kinetic properties of some cereals and leguminous seeds in Benin republic.	International Journal of Engineering, Science and Technology
Statistics	20	Amagnide A., Gbeha M., Glèlè Kakaï R. (2018).	Fitting an optimal variance-covariance structure for longitudinal data under Linear Mixed Effects Models framework: simulation-based analysis.	African Journal of Applied Statistics
Biostatistics	21	Lokonon E. B. and Glèlè Kakaï R.	Effect of overdispersion and sample size on the performance of Poisson model and its extensions in frame of Generalized Linear Models (GLMs)	International Journal of Applied Mathematics and Statistics

Appendix 1.6. Articles in press in peer-review journal with IF 2018

Disciplines	N°	Authors' Names	Title of the article	Journals	IF
Ethnobotany	1	Adjahossou S. G. C., Houehanou D. T., Toyi M.	, Salako V. K., Ahoyo C.C., Lesse P., Tente B., Houinato M. R. B.	Ethnobotany	1
Conservation ecology	2	Thierry D. Houehanou, Kathleen Prinz, Frank Hellwig, Achille E. Assogbadjo, Jens Gebauer, Romain L. Glele Kakaï, Brice Sinsin	Morphological trait variation and relationships of Afzelia africana Sm. shifted by climatic conditions and anthropogenic disturbance in Benin (West Africa)	Genetic Resources and Crop Evolution	1.13
Conservation Genetics	3	Thierry D. Houehanou, Kathleen Prinz & Frank Hellwig	Characterization of 15 nuclear microsatellite markers for Afzelia africana Sm. (Fabaceae) and related species	Applications in Plant Sciences	1.18
Ethnobiology	4	Iboukoun Fidèle lawin, Towanou Houètchégnon, Adandé Belarmain Fandohan, Valère Kolawolé salako Achille Ephrem assogbadjo, Christine Adjokè Ifètayo Nougbodé ouinsavi	Connaissances et usages de *Cola millenii* K. Schum (Malvaceae) en zones guinéenne et soudano-guinéenne au Bénin	*Bois et Forêt des Tropiques*	0.283

Appendix 1.7. Articles in press in peer-review journals without IF in 2018

Disciplines	N°	Authors' Names	Title of the article	Journals
Ethnobotany	1	Gandji K., Gbedomon R. C., Chadare F. J., Moshobane C. M., Salako V. K., Assogbadjo A. E., Glèlè Kakaï R. L	Factors influencing the specific uses of *Moringa oleifera* Lam. in Benin (West Africa)	*Annales des Sciences Agronomiques*

Appendix 1.8. Articles under review in peer-review journal with IF in 2018

Disciplines	N°	Authors' Names	Title of the article	Journals	IF
Plant morphology	1	Achille Hounkpèvi, Valère Kolawolé Salako, Janine Conforte Fifonssi Donhouédé, Emilienne Houévo Daï, Frédéric Tovissodé, Romain Glèlè Kakaï, Achille Ephrem Assogbadjo	Intraspecific trait variation patterns of the wild soursop Annona senegalensis (Annonaceae) along a climatic gradient in Benin, West Africa	Plant Ecology and Evolution	1.012
Ethnobotany	2	Assogbadjo Bidossèssi Eliane Juliette, Hounkpèvi Achille, Barima Yao Sadaiou Sabas, Akabassi Ghislain Comlan, Assogbadjo Achille Ephrem, Glèlè Kakaï Romain Lucas	Connaissances endogènes des populations sur les plantes médicinales et / ou fruitières sauvages comestibles conservées dans les systèmes agroforestiers de la zone périphérique de la Forêt Classée de la Lama au Bénin	Bois et Forêts des Tropiques	0.283
Wild edible fruits domestication	3	G.A. Assogba, K.V. Salako, A.B. Fandohan, A. Egeru, R. Glèlè Kakaï, and A.E. Assogbadjo.	Local preferences of the red kapok tree and calyx production in the sub-humid and semi-arid regions of Benin, West Africa	FRUITS	0.644
Plant Ecology	4	Goudegnon Eude, Salako Valère, Gouwakinnou Gérard, Mensah Sylvanus, Oumorou Madjidou	Land use impact on the sex ratio, sex-specific population structure and distance to neighbor of the dioecious *Lannea microcarpa*, Engl. & K. Krause (Anacradiaceae) in Benin	*Tropical Conservation Science*	1.149
Wild edible fruits domestication	5	Goudegnon Oré Adédiran Eude, Salako Valère Kolawolé, Gouwakinnou N. Gérard, Oumorou Madjidou	Morphological variation in trees, fruits and seeds traits of *Lannea microcarpa* in the Sudanian zone of Benin, West Africa: implication for its domestication	*FRUITS*	0.644
Wild edible fruits domestication	6	Salako VK, Kégbé AM, Chadaré F, Kafoutchoni KM, Amagnidé A, Gbedomon RC, Assogbadjo A, Agbangla C, Glèlè Kakaï R	Potential for domestication of *Borassus aethiopum* Mart., a wild multipurpose palm species in Sub-Saharan Africa	*Genetic Resources and Crop Evolution*	1.130
Agriculture	7	Agoyi, E.E., Kafoutchoni, K.M., Sossou, H.S., Allagbé, A., Hounguèvou, M., Assogbadjo, A.E., Sinsin, B. (2018).	Leguminous Vegetables Production and marketing in southern Benin. Agriculture & Food Security (in review)	*Agriculture and Food security*	1.143

Appendix 1.9. Articles under review in peer-review journal without IF in 2018

Disciplines	N°	Authors' Names	Title of the article	Journals
Agriculture	1	Agoyi, E., N'Danikou, S., Kafoutchoni, K., Ayenan, M., Sodedji, F., Agbahoungba, S., Sossou, H., Vodouhè, R., Assogbadjo, A.	Kersting's groundnut [macrotyloma geocarpum (harms) maréchal & baudet] crop attracts more field pests and diseases than reported before.	Heliyon
Ecology	2	Kafoutchoni, K.M., Idohou, R., Salako, K.V., Agbangla, C., Adomou, A.C., Agoyi, E.E., Assogbadjo, A.E.	What Determine the Distribution and Richness of Wild Spices in the Sudano-Guinean zone of Benin, West Africa?	African Journal of Rural Development

Appendix 1.10. Technical Reports and books in 2018

Field of research	N°	Authors' Name	Title	References
Ecosystem services	01	Tèwogbadé Jean Didier Akpona, Rodrigue Castro Gbedomon, Anne-Julie Rochette, Luc Janssens de Bisthoven, Jean Hugé, Maarten P.M. Vanhove, Romain Glèlè Kakaï	A systematic review of ecosystem services research on the Pendjari Biosphere Reserve: current state and the way forward	Akpona T.J.D., Gbedomon R.C., Rochette A-J., de Bisthoven L.J., Hugé J., Vanhove M.P.M., Glele Kakaï R. 2018. A systematic review of ecosystem services research on the Pendjari Biosphere Reserve: current state and the way forward. Book of Abstract-LABEF, 24p
Ecosystem services	02	Rochette, A.J., Hugé, J., Akpona T.J.D., Gbedomon R.C., Vanderhaegen, K., Verbist, B., Glèlè Kakaï R., Janssens, I., Goad D., Janssens de Bisthoven, L.	Les services écosystémiques dans la Réserve de Biosphère de la Pendjari	Rochette, A.J., Hugé, J., Akpona T.J.D., Gbedomon R.C., Vanderhaegen, K., Verbist, B., Glegle Kakaï R. , Janssens, I., Goad D., Janssens de Bisthoven, L. 2018. Les services écosystémiques dans la Réserve de Biosphère de la Pendjari. Policy Brief, CEBIOS, 4p

Appendix 1.11. Participation to workshops/conferences in 2018

N°	Title and period	Type of presentation	Country	Participant
1	Training on the topic : << International R&D Courses : Research and Development in Agricultural Engineering Technologies >>,	Attendee	Israel	Amagnide Aubin
2	Sixth African Higher Education Week	Oral	Kenya	Zanvo Serge
3	RUFORUM Biennial Conference 2018	Attendee	Kenya	Zanvo Serge
4	Sixth International conference of the University of Lome		Togo	Zanvo Serge
5	Metrics of climate change adaptation	Oral	Morroco	Sinsin Corine
6	Regional workshop on validation of various climate change related training compendiums for African forestry March 12 - 16, 2018,	Attendee	Burkina Faso	Gbedomon Rodrigue Castro
7	Regional training workshop on climate change modelling and scenario development with applications to forestry sector. April 9-13 2018, Osun State,.	Attendee	Nigeria	Gbedomon Rodrigue Castro Idohou Rodrigue
8	Towards Achieving Sustainable Development Goals in West Africa: The Footprint of WASCAL". Accra, Ghana, August 15-16, 2018.	Poster	Ghana	Hounkpevi Achille
9	Ecosystem services assessment, Natitingou	Attendee	Benin	Idohou Rodrigue Gbedomon Castro
10	50è Journées de Statistique organisées par la Société Française de Statistique à EDF Lab Paris-Sacley, 28 mai au 1er juin 2018	Poster	France	Tchandao
11	The Sixth African Higher Education Week: Aligning African Universities to accelerate attainment of Africa Agenda 2063, Monday, 22-26 October 2018	Poster	Kenya	Tovissode Frederic
12	First data science school in Benin: from data to value and knowledge, 6-14 December 2018	Attendee	Benin	Lokonon Bruno
13	Tropentag 2018, Global food security and food safety: the role of universities, *Conference organized by Ghent University, Ghent, Belgium,* 17-19 September	oral	Belgium	Lokonon Bruno

14	CIMPA Lomé 2018, Togo, 3-15 September 2018 on 'Statistique des durées de vie et statistique spatiale : Applications aux essais thérapeutiques, à la fiabilité industrielle, à l'épidémiologie et au changement climatique	Attendee	Togo	Lokonon Bruno
15	African Higher Education week and Sixth RUFORUM Biennial Conference (22-26 October, 2018)	Oral	Kenya	Honfo Sèwanou Hermann
16	Research school : "Statistiques des durées de vie et Statistiques spatiales: Applications aux essays thérapeutiques, à la fiabilité industrielle, à l'épidémiologie et au changement climatique" (3-15 September, 2018)	-	Togo	Honfo Sèwanou Hermann
17	Robust estimation in multivariate nonlinear regression with multilayer perceptron neural networks (September 2018)	Oral	Togo	Hounmenou G. Castro
18	European Conference of Tropical Ecology, "Challenges in tropical ecology and conservation - global perspectives" March 26 – 29, 2018, Université Pierre-Marie Curie and Muséum National d'Histoire Naturelle, Paris, France	Oral/Poster	France	Houehouanou Thierry
19	Quatrième Colloque Scientifique Interrrational de L'Université de Parakou. Thème : La recherche scientifique, pilier essentiel de la responsabilité sociale des Universités. 28 – 30 Novembre 2018, Campus Universitaire de Parakou, Parakou, Benin.	Oral	Benin	Salako Valère
20	Science and Technology in Society (STS) Forum , 5 to 9th October, 2018	Attendee	Japan	Salako Valère
21	Second TWAS Young Affiliates Network (TYAN) meeting, 26 November 2018	Poster	Italy	Salako Valère
22	TWAS 14th General Conference & 28th General Meeting, 27-29 November 2018	Oral	Italy	Salako Valère
23	Quasi Experiment Design, 27-29 December	Attendee	Benin	Salako Valère
24	Data science school	Attendee	Benin	Salako Valère
25	4ème Colloque Scientifique International de l'Université de Parakou, Parakou, Benin, 28 – 30 November 2018.	Oral	Benin	Kafoutchoni Medard
26	Sixth African Higher Education Week and Ruforum Biennial Conference, Nairobi, Kenya, 18 – 27 October 2018.	Oral/Poster	Kenya	Kafoutchoni Medard
27	Annual interdisciplinary conference on research in tropical and subtropical agriculture, natural resource management and rural development (TROPENTAG) 2018, Ghent, Belgium, 17 – 19 September 2018.	Poster	Belgium	Kafoutchoni Medard

Appendix 1.12. Research projects of LABEF in 2018

N°	Title	Funding	Objectives	Period
1	Restauration, conservation et gestion durable des zones humides côtières du Costa Rica face au changement climatique (COSTA RICA, BENIN)	Fond Français pour l'environnement Mondiale	Le projet vise à développer la restauration, la conservation et la gestion communautaire durable des zones humides côtières (notamment les mangroves) du Costa Rica, contribuant à l'atténuation et l'adaptation au changement climatique, à travers le renforcement de politiques publiques et la mise en œuvre d'actions de terrain qui associent les communautés locales, avec l'objectif de se répliquer au niveau international en un projet pilote au Bénin.	2018-2022
2	Scaling up African baobab food products valuation through enhancement of their safety and value chains for food and nutritional security in Benin (West-Africa)	RUFORUM	this project aims to develop a sustainable and competitive baobab VC in Benin. The project is built around six work-packages and will facilitate university-TVET and community linkages to upgrade baobab products VC while contributing to improve farmers' livelihoods and baobab conservation.	2018-2021
3	Vers une gestion durable des mangroves au Bénin : dynamique spatio-temporelle, biodiversité, usages et gestion locale, capacité de séquestration de carbone et impacts des changements climatiques.	FNRSIT	(i) Caractériser la dynamique spatio-temporelle des mangroves du Bénin ; (ii) estimer la biodiversité des mangroves du Bénin ; (iii) évaluer les usages des mangroves ainsi que les pratiques locales de gestion des mangroves ; (iv) évaluer la capacité de séquestration de carbone et l'effet des changements climatiques sur l'étendue des mangroves du Bénin	2017-2019
4	Setting up a system of evaluation of the land use dynamics and follow up indicators of the	Observation spatiale des forêts d'Afrique	Le projet vise donc à développer des méthodes rentables, respectueuses de l'environnement et permettant la production durable de feuilles de baobab pour assurer la sécurité alimentaire des petits producteurs dans les trois zones climatiques en république du Bénin.	2017-2019

N°	Title	Funding	Objectives	Period
	transboundry biosphere reserve of the Mono	Centrale et de l'Ouest/IRD		
5	Enhancing nutritious food availability through promotion of native edible tree/shrub species in Sub-Saharan Africa (TREEFOOD)	Agropolis Fondation – Fondazione Cariplo and Fondation Daniel et Nina Carasso	The project aims at supporting so-called farmer-led innovation platforms in improving collection, production, processing and marketing of products from edible tree/shrub species, whereas field schools will be established to disseminate technologies.	**2017-2019**
6	Project SCOPA (Sustainability of Cotton Production in Africa)	DANIDA	The overall aim of the project is to increase knowledge about the sustainability of cotton production in SSA, where we will particularly focus on organic cotton production.	2015-2018
7	Payments for ecosystem services: an assessment of existing and possible reward mechanisms for ecosystem services in the Pendjari Biosphere Reserve, Benin'	MAB UNESCO	EVAMAB stands for "Economic valuation of ecosystem services in Man and Biosphere reserves: testing effective rapid assessment methods in selected African MABs". The project addresses the evaluation of the economic value of ecosystem services (ES) in UNESCO-MAB sites from a regional perspective (Africa) and focuses on sites from 4 countries: Benin, Ethiopia, Tanzania, Uganda.	
8	« Morpho-physiological adaptation and genetic diversity of keystone mangrove tree species in response to human disturbance regimes in Benin: implications for mangrove conservation »	Académie de Recherche et d'Enseignement Superieur (ARES)	assess the morpho-physiological adaptation of *Rhizophora racemosa* and *Avicennia germinans* to human disturbances across a gradient of water salinity and, assess the impact of disturbance regimes on the population genetics of *Rhizophora racemosa* and *Avicennia germinans*	2018

Appendix 1.13 Research Grants in 2018

N°	Title of Grant	Beneficiaries	Status
1	International Foundation for Science (IFS) Individual Research Grant	Ahuéfa M. Kegbe	Ongoing
2	International Foundation for Science (IFS) Individual Research Grant	Frederic Tovissode	Ongoing
3	Centre d'Excellence Africain en Sciences Mathématiques et Applications (CEA-SMA)	Bruno Lokonon	Ongoing
4	Rufford second Grants	Merveille Koissi Savi	Ongoing
5	International Foundation for Science (IFS) Individual Research Grant	Honfo Sèwanou Hermann	Ongoing
6	International Tropical Timber Organization	Valère SALAKO	Ongoing
7	Sud Expert Plantes Développement Durable (SEP2D) research grant	Valère. SALAKO	Ongoing
8	Rufford Grant	Charlemagne GBEMAVO	Ongoing
9	Ambasssade de france au Benin	AMOUSSOU B. Eldys	Ongoing
10	International Foundation for Science (IFS) Individual Research Grant	Zanvo Serge	Ongoing
11	Rufford small grant	Sinsin Corine	Ongoing
12	CEA-SMA scholarship	Essomanda TCHANDAO MANGAMANA	Ongoing
13	International Foundation for Sciences (IFS)	Akpona Tèwogbadé Jean Didier	Ongoing
14	African Leadership School of Business full scholarship	Akpona Tèwogbadé Jean Didier	Ongoing
15	IFS travel grant	Bruno Lokonon	Ongoing
16	Individual IFS renewal grant	Bruno Lokonon	Ongoing
17	Swiss Government Excellence Scholarship	Gbedomon Rodrigue Castro	Ongoing

Appendix 1.14. List of interns/trainees received in 2018

	Full name	Highest degree	Institution of origin	Country
1	Fanta TIETIAMBOU	Dr.	Laboratoire de Biologie & Ecologie Végétales, Université Ouaga I Pr Joseph Ki-Zerbo	Burkina Faso
2	Issouf ZERBO	Dr.	Laboratoire de Biologie & Ecologie Végétales, Université Ouaga I Pr Joseph Ki-Zerbo	Burkina Faso
3	Souleymane COMPAORE	PhD student	Institut de Recherche en Sciences de Santé	Burkina Faso
4	Milène Nadège KOUTOUAN	PhD student	Ecole doctorale WASCAL Biodiversité, Université Felix Houphouët Boigny	Ivory Coast
5	BANKA ALIOU Saoudatou	B.Sc. student	Cours SONOU	Benin
6	AGOSSOUKPE Abel	B.Sc. student	Faculty of Agricultural Sciences, University of Abomey-Calavi	Benin
7	David Abiola AKODEKOU	B.Sc. student	Faculty of Agricultural Sciences, University of Abomey-Calavi	Benin
8	Sandra Sènan BOKOSSA	B.Sc. student	Faculty of Agricultural Sciences, University of Abomey-Calavi	Benin
9	Marcel Machreal EGAH	B.Sc. student	Licence en agronomie, Ecole d'Horticulture et Aménagement des Espaces Verts, UNA	Benin
10	Mirabelle GANDJI	B.Sc. student	Faculty of Agricultural Sciences, University of Abomey-Calavi	Benin
11	Wilfried GBONGBOUI	B.Sc. student	Faculty of Agricultural Sciences, University of Abomey-Calavi	Benin
12	Moustapha KOLAWOLE	B.Sc. student	Faculty of Agronomy, University of Parakou	Benin
13	Abiola OGNONKITON	B.Sc. student	Faculty of Agronomy, University of Parakou	Benin
14	Renaud SINSIN	B.Sc. student	Polytechnic School of the University of Abomey-Calavi	Benin
15	Maellyx ZANOU	B.Sc. student	FSA/UAC	Benin

Appendix 1.15. Visitors received in 2018

N°	Full names of visitors	Provenance	Responsible	Topics
01	Student : Iliana Janssens	VUB-Belgique	Jean Didier Akpona	Q Methodology in conservation Mapping stakeholder perspectives on management in Pendjari National Park
02	Student : Devone Goad	VUB-Belgique	Jean Didier Akpona	La 'nominal group technique': une approche permettant d'identifier les services écosystémiques de la Pendjari
03	Student : Anton De Ryck	KU-Leuven, Belgique	Jean Didier Akpona	Payments for ecosystem services: an assessment of existing and possible reward mechanisms for ecosystem services in the Pendjari Biosphere Reserve, Benin
04	Prof Jean Hugé	Belgique	Jean Didier Akpona	**LABEF-Séminar** : Etudier les systèmes socio-écologiques: vers une démarche systématique et réfléchie
05	MONTY Arnaud	Belgium	AGO Expédit & SALAKO Valère	Les expérimentations en conditions contrôlées ou semi-contrôlées : intérêts et applications en écologie végétale
06	CROS David	Cameroon	GLELE KAKAI Romain	Application of mixed model analysis for crop improvement: prediction of genetic values with BLUP and Bayesian methods
07	Saliou DIOUF	Senegal	GLELE KAKAI Romain	La théorie des valeurs extrêmes

Appendix 2.

Abstracts of the publications in Labef in 2018

1. Biomass allocation and growth performance of *Tithonia diversifolia* (Hemsl.) A. Gray in coconut plantations in Sri Lanka

Senarathne, S.H., Atapattu, A.J., Raveendra, T., Mensah, S. and Dassanayake, K.B.

Agroforestry Systems
https://link.springer.com/article/10.1007/s10457-018-0290-y

Abstract

Coconut is a popular plantation crop with a growth habit requiring wide space between palms. With the amount of sunlight that reaches coconut understory, the between-palms space can be used to grow other beneficial plants. Growing fertilizing shrubs within coconut rows can contribute to effective and sustainable use of coconut plantation soil. In the long term, sustainable coconut plantation systems will require shrubs that sprout quickly after periodic cutting to provide sufficient plant nutrients. Here, we report the results of a 4-year experiment on *Tithonia diversifolia* (Hemsl.) A. Gray biomass allocation and growth performance in coconut plantations in Sri Lanka. Effects of growing T. diversifolia, pruning frequency and its green manure application on soil properties, moisture, organic matter, bulk density and microbial activity were assessed in two agro-ecological research stations. Results revealed increasing dry foliage and wood biomass overtime. At higher pruning frequencies, foliage biomass increased while wood biomass decreased. Inversely, at lower pruning frequencies, wood biomass increased while foliage biomass declined. Growing *T. diversifolia* in coconut plantations had little effect on soil moisture content especially in humid area. In the long run, mulching reduced bulk density, improved soil nutrient, organic matter and microbial activity and palm leaf macronutrient levels. This study shows that *T. diversifolia*, when used as green manure crop in coconut plantations, has a great fertilizing capacity and potential to improve in the long term, not only the soil properties, but also the nutrient levels in the palm organs.

Key words : Agroforestry, Biomass production, Green manure, Pruning frequency, Soil fertility

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2. Parameters Estimation Methods in Generalized Linear Mixed Models (GLMMs) Applied in Ecology: A Critical Review

Bruno E. Lokonon, Romuald Beh Mba, Micheline Gbeha, Romain Glèlè Kakaï

International journal of engineering and future technology

http://www.ceser.in/ceserp/index.php/IJEFT/article/view/5746

Abstract

The use of GLMMs is widespread in ecology since last decades. However, GLMMs likelihood function is analytically intractable. As a result, various approximation methods have been introduced with different degrees of accuracy. This study assesses the frequency of usage of different GLMMs estimation methods in ecology and makes a comprehensive discussion of these methods to deepen the understanding of users. Original articles in ecology from 2007 to 2016 were identified via keywords searching using web search engines. A total of 802 articles were selected. The usage of GLMMs increases exponentially from 2007 to 2016. Thereafter, 297 papers were sampled through careful reading of their abstracts. Ten estimation methods were reported and the most used were penalized quasi-likelihood (35.02 %) and Laplace Approximation (28.28 %). Useful expected information from GLMMs was not notified in several articles. Random components were not described in 220 articles (74.07%). Overdispersion was evaluated in only 23.23 % of the articles. It is important that users of GLMMs check elementary statistical conditions and report appropriate information from their findings.

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3. Vegetation structure, dominance patterns and height growth in an Afromontane forest, Southern Africa

Sylvanus Mensah, Anthony Egeru, Achille Ephrem Assogbadjo, Romain Glèlè Kakaï

Journal of Forestry Research

https://link.springer.com/article/10.1007/s11676-018-0801-8

Abstract

Information on forest structure is fundamentally important to track successional vegetation dynamics for efficient forest management. This study reports on vegetation characteristics, dominance patterns and species height growth in a northern mistbelt forest type in South Africa. Common alpha-diversity indices (species richness and Shannon–Weiner diversity), structural vegetation parameters (tree density and basal area), and species importance value index were used. Size class distribution and height–diameter allometry were further examined for the overall stand and most important species. Stem densities (472.0 ± 43.5 and 605.3 ± 28.1 trees ha−1 for ≥ 5 cm to < 10 cm and ≥ 10 cm dbh (diameter at breast height) classes, respectively) and basal area values (1.99 ± 0.19 and 48.07 ± 3.46 m2 ha−1, respectively) are comparable to other Afromontane forests in East Africa. The overall stand showed an inverted-J shaped distribution pattern which is a typical feature of stand size class distribution in most natural forests. Most ecologically important species also exhibited an inverted-J shaped distribution pattern, suggesting good regeneration and recruitment potential. There were significant differences in species on height, reflecting species-specific height growth patterns, possibly a result of intrinsic growth potential and competitive interactions. The present study suggests that conservation and management policies, including protection of surrounding land uses against fire, contribute to maintaining a

successful recovery of these forests. However, it should be noted that these forests may be experiencing relatively slow dynamic flux as a result of the over-mature state of some trees with several years under relatively strict protection.

Keywords: Diversity, Population structure, Species composition, Size class distribution.

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4. *Cola millenii* K. Schum : Etat des connaissances et perspectives de recherche

Iboukoun Fidèle LAWIN, Adandé Belarmain FANDOHAN, Kisito GANDJI, Achille Ephrem ASSOGBADJO et Christine Adjokè Ifètayo Nougbodé OUINSAVI1

International Journal of Biological and Chemical Sciences
https://www.ajol.info/index.php/ijbcs

Abstract

Cola millenii est un fruitier sauvage comestible peu connu, négligé et sous utilisé en Afrique de l'Ouest. La présente synthèse littéraire a pour objectif de faire le point des connaissances sur l'espèce et de relever les axes de recherche-développement. Les moteurs de recherche Google Scholar et Science Direct ont été utilisés pour la recherche de littérature sur l'espèce avec des mots-clés pertinents. Des publications évaluées par les pairs, livres, thèses et mémoires obtenus dans diverses bibliothèques ont été également consultés. Il ressort de l'analyse de la littérature que *C. millenii* est une plante à usages multiples qui est retrouvée dans plusieurs pays. Elle renferme beaucoup d'éléments minéraux et de la vitamine C nécessaires aux besoins nutritionnels de la population ainsi que des composés chimiques tels qu'alcaloïdes, tannins, saponines, glycosides cardiaques, glucides, stérols, résine et terpènes responsables de son action pharmacologique. En vue
de sa conservation et domestication, des travaux complémentaires méritent d'être entrepris sur les variations des usages, l'écologie, la morphologie, la caractérisation biochimique et la phénologie de l'espèce.

Keywords: *Cola millenii*, fruitiers sauvages comestibles, produits forestiers non ligneux, plante médicinale

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5. Modélisation de la productivité fruitière de *Parkia biglobosa* en zone soudanienne et zone soudano-guinéenne du Bénin

Titilayo Oyélèyè Fafunkè DOTCHAMOU, Gilbert ATINDOGBE, Castro HOUMENOU, Noël Houédougbé FONTON1

Afrique SCIENCE;
http://www.afriquescience.net/numero3_vol_14.html#

Abstract

Modéliser la production en fruits, c'est concevoir un modèle théorique disponible pour estimer la production à partir de certains paramètres collectés. Cette étude vise à modéliser la production en fruits de 60 arbres de Parkia biglobosa afin de mieux connaître ses potentialités pour une gestion durable. Les poids des fruits ont été déterminés en fonction des paramètres dendrométriques de l'arbre et des paramètres morphologiques des fruits. La production moyenne en fruits par arbre est respectivement de 110 ± 19,90 kg en zone soudano guinéenne et de 80,9 ±20,56 kg en zone soudanienne. Les caractéristiques dendrométriques et de production sont significativement identiques dans les deux zones climatiques d'après le test t de Student. En ce qui concerne la morphologie des fruits, les différentes formes de fruits identifiées ne dépendent pas des zones climatiques (Prob.> 0,05). Toutefois, il est à noter une fréquence plus élevée des «fruits longs-larges» par rapport aux fruits longs-minces et courtes-larges, quelle que soit la zone climatique. La forme « courte-mince » n'est observée que dans la zone soudano-guinéenne et ne représente que 13,79 %. Les fruits longs-larges sont pour la plupart observés chez les arbres ayant un diamètre > 40 cm avec une fréquence de 63,64 % (58,85 ± 1,41 cm de diamètre en moyenne) dans la zone soudanienne. A partir de cette étude, il est possible de prédire le potentiel de production de *P. biglobosa* à partir des paramètres dendrométriques et environnementaux.

Key words: Parkia biglobosa, paramètres dendrométriques, production, fruits, zone climatique.

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6. Indigenous knowledge and potential of termites as poultry feed in Burkina Faso

Sankara, F., S. Pousga, N. C. A. Dao, D. S. J. C. Gbemavo, V. A. Clottey, K. Coulibaly, J. P. Nacoulma, S. Ouedraogo, and M. Kenis.

Journal of Insects as Food and Feed

https://www.wageningenacademic.com/doi/abs/10.3920/JIFF2017.0070

Abstract

The purpose of this study, carried out in eight regions in Burkina Faso, West Africa, was to assess the use and knowledge of termites in poultry nutrition in Burkina Faso and to analyse the factors influencing this use. Household surveys were conducted to collect data on the socio-demographic characteristics of poultry farmers and the use of termites in poultry feed. These surveys involved 1,100 farmers in 32 villages. Poultry farmers mostly raise chicken and guinea fowls and these two species are also those that receive termites as supplementary feed. 78% of the surveyed farmers use termites to feed their poultry, but the rate strongly varied among regions and provinces. Several reasons were given for not using termites, the most common being the unavailability of termites followed by the lack of time and not being aware of the technique. Farmers were aware of termite species they consider as toxic in feeding

chicks. Understanding the link between the use and availability of termites in poultry nutrition in West Africa is an important step towards the improvement of poultry production.

Keywords: Burkina Faso, insects as feed, poultry, termite use

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7. Population structure of *Pterocarpus erinaceus* Poir. across a protection gradient in Sudanian savannahs of Togo, West Africa

Tèkondo Banla, Thierry D. Houehanou, Merveille Koissi Savi, Rodrigue Idohou, Romain Glèlè Kakaï, Kouami Kokou

Journal of Applied Biosciences

https://www.ajol.info/index.php/jab/article/view/163475

Abstract

Human-modified systems come as innovative ones necessary to be more understood to attain biodiversity conservation goals. This study aimed to assess the effect of human disturbance on the population structure of *Pterocarpus erinaceus* in different land use types (Highly protected area, Moderately protected area and Non-protected area) in Sudanian savannahs of Togo. Data were collected in forty randomly set plots (50 m × 30 m) within each land use type. Population structure parameters and leaf and leaflet morphological traits were evaluated and compared among the land use types by performing different statistical analyses. Results showed an adverse effect of human disturbance on adult and juveniles densities as well as the total height (significant difference between highly protected and non-protected areas; $p < 0.001$). Diameter class structures revealed in the three land use types an inverted J-shape indicating the predominance of young individuals. Significantly greater ($p < 0.001$) values of leaflet length were observed in the non-protected area compared to highly protected one. The human-mediated area impacted the diameter-height relation and the one among assessed leaf and leaflet traits. These findings are tools to be incorporated in new policy development for the future management of this tree species population.

Keywords: conventional tillage, direct sowing, soil fertility, conservation agriculture.

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8. Factors Determining the Use and Cultivation of Moringa oleifera Lam. in the Republic of Benin

Gandji, K., Salako, V.K., Fandohan, A.B., Assogbadjo, A.E. and Kakaï, R. Glele Kakaï

Economic Botany

https://link.springer.com/article/10.1007/s12231-018-9424-4

Abstract

Despite its nutritious leaves and considerable economic importance, the agroforestry species Moringa oleifera Lam. is still considered a neglected and underutilized species. To contribute to the development of an effective valorization strategy for M. oleifera, this study identified factors driving its use and cultivation in Benin. To this end, an ethnobotanical survey through individual interviews (n = 801) was performed in 46 localities across biogeographical zones in Benin. Conditional inference tree–based classification models allowed us to identify factors that mostly influence the use, cultivation, and cultivation system of M. oleifera. Awareness, knowledge of the plant biology, gender, cultivation system, and age are factors influencing the use of M. oleifera. Cultivation systems are driven by ethnicity, knowledge of the plant's biology, and the main socio-professional activity. Effective valorization of M. oleifera requires awareness rising on its usefulness while providing knowledge on the plant biology.

Keywords: Africa, agroforestry system, driving factors, Moringa oleifera L. use

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9. Fonio (*Digitaria exilis* (Kippist) Stapf): A Socially Embedded Cereal for Food and Nutrition Security in Senegal

Diop, B.M., Gueye, M.C., Agbangba, C.E., Cisse, N., Deu, M., Diack, O., Fofana, A., Kane, N.A., Ndir, K.N., Ndoye, I. and Ngom, A.,

Etnobiology letters
https://ojs.ethnobiology.org/index.php/ebl/article/view/1072

Abstract

Agricultural diversification with neglected and underutilized species is a viable way to sustainably increase the productivity of agrosystems. Understanding the social, cultural, and ecological roles of these species is crucial for their promotion. White fonio (*Digitaria exilis*), a neglected cereal endemic to West African Sahelian countries, is recognized as a crop for the future due to its cultural, nutritional, and economic values. In this study, we described fonio farming systems in Senegal through an ethnobotanical approach. As expected in family farming systems, farmers largely practiced diversified subsistence agriculture on small plots and relied on local seed exchange networks. The importance of fonio varied among agroecological zones, ethnic groups, and gender. In the Groundnut Basin, where agriculture is more mechanized, late-maturing landraces of fonio are cultivated as a cash crop rather than a staple crop. However, in southern Senegal, where food shortages are recurrent, fonio is more widespread and the cultivation of both early- and late-maturing landraces contributes to local food security. These differences also reflect the cultural status of fonio: different among ethnic groups and more important for women than for men. Finally, the regressive dynamics of fonio cultivation in most regions emphasizes the need to develop integrated conservation and

promotion strategies that take into account the diversity of social and agronomical roles of the plant.

Keywords: Family farming system; Neglected and underutilized species; Cereals; Agricultural diversification; Ethnobotany

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10. Modelling the current and future distribution of *Kigelia africana* under climate change in Benin, West Africa

Guidigan, M. L. G., Azihou, F., Idohou, R., Okhimamhe, A. A., Fandohan, A. B., Sinsin, B., & Adet, L.

Modeling Earth Systems and Environment
https://link.springer.com/article/10.1007/s40808-018-0491-4

Abstract

Kigelia africana (Bignoniaceae), is an indigenous species widely recognised for its medicinal, magic uses and therapeutic virtue used throughout Africa and especially in Benin Republic. Distribution of the species coincides with that of the intermediate hosts as determined by environmental factors. This study aimed to model the present-day and future distribution of Kigelia africana in Benin. Maximum Entropy (MaxEnt) modelling technique was used to predict the distribution of suitable habitats of Kigelia africana using presence data combined with two future forescats: CNRM-CM5and HadGEM2-ES. Results showed that Annual Temperature range, precipitation seasonality, soil, temperature seasonality, maximum temperature of the warmest month were most significant variables. Which mean that the excellent of the model. Likewise, must of the distribution of the species will be find mostly stable. The different model used identified different areas as highest conservation priority although the highest priority areas keeping most of Kigelia africana species are located in the Guineo-Congolian and Sudano-Guinean region. Additional analyses could help to have more information about the distribution and population and cultivation of Kigelia africana species, which in future will help us to improve operative conservation strategies for this medicinal species. MaxEnt model is robust in Kigelia africana species habitat modelling.

Keywords: *Kigelia africana*, Biodiversity, Climate change, Representative concentration pathways, Ecological niche, GIS

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11. Effect of overdispersion and sample size on the performance of Poisson model and its extensions in frame of Generalized Linear models

Lokonon, B. E., and R. Glele Kakaï.

International journal of applied mathematics & statistics,

http://www.ceser.in/ceserp/index.php/ijamas/article/view/5700

Abstract

Mean equal variance assumption in Poisson model is constantly violated in real life count data leading to overdispersion. This study assessed empirically, the performance of Poisson Model and its extensions under varying overdispersion and sample size using R software. Increased values of overdispersion (=2, 4, 8, 12, 20) have been introduced in count data following Poisson distribution with parameter and various samples (=25, 50, 100, 500, 1000) have been extracted. Poisson, quasi-Poisson, negative binomial and zero inflated Poisson models were fitted on the sampled data and the results were compared to the outcomes from linear regression after a log-transformation. The results showed that overdispersion and sample size impact the performance of the Poisson model and its extensions. Negative binomial model is better than the other models for all combinations of with the large samples (=500 and 1000). However, for small samples (=25, 50), there was no model performing better in all combinations. The outputs also revealed that log-transformation of count data by using linear regression performs well only for some small samples.

Keywords: Poisson model and extensions, simulation, overdispersion, sample size, performance.

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12. Influence of Missing Value Imputations on the Performance of Canonical Correspondence Analysis: Ecological Applications

Matthews Lazaro, Micheline Gbeha and Romain Glèlè Kakaï

African Journal of Applied Statistics

http://www.statpas.org/ajas/admin/articles/pdfs/ajas_2018_01_02_def.pdf

Abstract

This paper assessed the influence of four imputation methods of missing values on the performance of canonical correspondence analysis (CCA). Missingness was introduced in complete multivariate normal data sets under three missing mechanisms: MCAR, MAR and NMAR. Results showed that mean imputation recorded the best performance under MCAR and MAR while for NMAR, median imputation was the best.

Keywords: Complete Data; Missingness; Simulation, Accuracy Criteria; Imputation Methods

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13. Assessment of the physical and mechanical properties of the soils in the different agroecological zones of Benin

E.D. Dayou, K.L.B. Zokpodo, L.R. Glèlè Kakaï
Agro-Science
https://www.ajol.info/index.php/as/article/view/173259

Abstract

The physical properties of soils are important for proper monitoring of soil functions. In order to evaluate soil resistance to agricultural equipment, a study was carried out on the four main soil types (ferralitic, ferruginous, hydromorphic and vertisol) in the eight agroecological zones of Benin. The objective of this work was to determine the physical and mechanical parameters of the soils. A sampling of soil types by agroecological zone was carried out in 36 localities in Benin to record vertical and horizontal soil strengths using a compactometer and a penetrometer. These data were complemented by measurements of texture, density and water content of the soil samples. An analysis of variance, polynomial regressions and Pearson correlation were performed between the parameters studied. It is noted that majority of soils assessed were sandy loam. The high sand content in most soils would be due to the depth considered (20 cm). The bulk densities range from 1.21 to 1.73gcm-3 and water contents from 4.9 to 35.11%. Vertical resistances range from 3.89 to 16.36 kg cm-2 and horizontal resistances from 1.03 to 4.44 kg cm-2. Strong soil resistances (vertical and horizontal) are recorded in the northern part of Benin where large proportions of the gravels were observed in the samples taken. A positive correlation was observed between vertical resistance and horizontal soil resistance. It can be concluded that soil resistance in Benin vary from one agro-ecological zone to another, but the linking of soil properties is less significant between zones.

Key-words : *Synsepalum dulcificum*, baie miraculeuse, enquête ethnobotanique, groupe socioculturel, phytothérapie, valeur d'usage, République du Bénin.

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14. Predicting the potential impact of climate change on the declining agroforestry species *Borassus aethiopum* Mart. in Benin: a mixture of geostatistical and SDM approach

Salako, V.K., Vihotogbé, R., Houéhanou, T., Sodé, I.A. and R. Glèlè Kakaï
Agroforestry Systems
https://link.springer.com/article/10.1007/s10457-018-0262-2

Abstract

Predicted effects of climate change (CC) on plant species distribution have raised concerns on their conservation and domestication. Appropriate stand density may enhance species ability to adapt to CC. Therefore, combining species distribution modeling (SDM) and spatial pattern of density should provide insightful information for setting conservation actions. We combined geostatistical and SDM techniques to assess (1) current tree density spatial pattern and its relationship with bioclimatic zone (humid, sub-humid, and semi-arid), land-use type (protected areas vs. agrosystems), and soil type (eight types), and (2) present-

day and future distributions of suitable habitats under low-RCP4.5 and high-RCP8.5 emissions scenarios for Borassus aethiopum, a declining agroforestry palm in Benin. Data were obtained from 2880 one-ha plots. Semivariogram and kriging were used to model spatial patterns of density while Maximum Entropy was used for SDM. Tree density followed an isotropic spatial model with a range of 2.15 km, indicating extremely fragmented density pattern. Tree density was 8-times higher in protected areas (PAs, 68.6 ± 5.09 trees ha−1) than in agrosystems (8.4 ± 0.31 trees ha−1) and greater on ferruginous soils. Though 80% of the country was currently highly suitable with similar trend for PAs and agrosystems, future predictions showed major habitat loss (20–61%), particularly under RCP8.5. While changes were similar between PAs and agrosystems, the decrease in habitat suitability was pronounced in the semi-arid zone where the species is currently widely-distributed with higher abundance. Very weak link was found between present-day abundance and present-day and future distribution. It is concluded that B. aethiopum has a fragmented density pattern and will be sensitive to CC. In-situ and circa-situ conservations or orchards establishment were suggested depending on the projected changes and the bioclimatic zone. The approach used here is exemplary for other agroforestry tree species.
Keywords : SDM Geostatistics MaxEnt Underutilized species Palm Agroforestry

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15. Performances agro-morphologiques des variétés locales et améliorées de maïs au sud-ouest du Niger

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African Crop Science Journal
https://www.ajol.info/index.php/acsj/article/view/172234

Abstract

Le maïs (Zea mays L.) joue un rôle important dans la sécurité alimentaire des populations du Niger. Toutefois, sa culture est en baisse, ce qui constitue une menace à la sécurité alimentaire et aux ressources phytogénétiques du maïs. L'objectif général de cette étude était d'évaluer les performances agro-morphologiques des variétés locales et améliorées du maïs au Sud-Ouest du Niger afin d'identifier les variétés prometteuses sur la base de leurs performances agronomiques. Au total, vingt-cinq variétés de maïs dont deux variétés locales et vingt-trois variétés améliorées produites par le Centre International d'Amélioration du Maïs et du Blé du Zimbabwe (CIMMYT/Zimbabwe) ont été évaluées à la station expérimentale de Tara (Gaya/ Niger). Treize caractères agro-morphologiques dont la compacité de l'épi, la forme du grain, le taux d'émergence, le nombre de jours à 50% floraison mâle et femelle, la hauteur de la plante, la longueur de l'épi, le diamètre de l'épi, le nombre d'épis à la récolte, le poids des épis à la récolte, le poids des grains, le poids de 100 grains et le poids du fourrage sec ont été utilisés. L'analyse de variance a montré des différences significatives entre les variétés pour les différents caractères agro-morphologiques. La classification hiérarchique ascendante (CHA) a révélé que cette variabilité est structurée en 4 groupes. Les groupes 1 et 2 regroupent les

variétés plus précoces, plus productives avec un fort taux d'émergence. Les groupes 3 et 4 regroupent les variétés moins précoces, moins productives et avec un faible taux d'émergence. Sept variétés prometteuses appartenant aux groupes 1 et 2 ont été identifiées. Il s'agit toutes des variétés améliorées (CZH132163, CZH132194, CZH1262, CZH132150, CZH132139, CZH1155 et CZH1261). Ces résultats peuvent être directement utilisés pour un programme d'amélioration de la productivité du maïs au Sud-Ouest du Niger.

Mots clés : *Niger, sécurité alimentaire, variété prometteuse, Zea mays L.*

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16. Traditional knowledge and cultural importance of *Borassus aethiopum* Mart. in Benin: interacting effects of socio-demographic attributes and multi-scale abundance

Salako, K.V., Moreira, F., Gbedomon, R.C., Tovissodé, F., Assogbadjo, A.E. and R. Glele Kakaï,

Journal of Ethnobiology and Ethnomedicine

https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0233-8

Abstract

Background

Eliciting factors affecting distribution of traditional knowledge (TK) and cultural importance of plant resources is central in ethnobiology. Socio-demographic attributes and ecological apparency hypothesis (EAH) have been widely documented as drivers of TK distribution, but their synergistic effect is poorly documented. Here, we focused on Borassus aethiopum, a socio-economic important agroforestry palm in Africa, analyzing relationships between the number of use-reports and cultural importance on one hand, and informant socio-demographic attributes (age category and gender) on the other hand, considering the EAH at multi-scale contexts. Our hypothesis is that effects of socio-demographic attributes on use-reports and cultural importance are shaped by both local (village level) and regional (chorological region level) apparency of study species. We expected so because distribution of knowledge on a resource in a community correlates to the versatility in the resource utilization but also connections among communities within a region.

Methods

Nine hundred ninety-two face-to-face individual semi-structured interviews were conducted in six villages of low versus high local abundance of B. aethiopum spanning three chorological regions (humid, sub-humid and semi-arid) also underlying a gradient of increasing distribution and abundance of B. aethiopum. Number of use-reports and score of importance of uses of B. aethiopum were recorded in six use-categories including medicine, food, handcraft, construction, firewood, and ceremonies and rituals. Data were analyzed using Poisson and ordered logistic models.

Results

Informants listed 121 uses for B. aethiopum: medicine (66 uses), handcraft (16 uses), food (16 uses), construction (12 uses), firewood (6 uses), and ceremonies and rituals (5 uses); but food use was the most culturally important use (2.45 ± 0.03), followed by construction (0.61 ± 0.03), medicinal (0.57 ± 0.03) and handcraft (0.56 ± 0.03), firewood (0.29 ± 0.02), and ceremonies and rituals (0.03 ± 0.01). Food use was the most important for women who were specialized in hypocotyls and fruits collection for commercialization. Men valued more the species for handcrafting, construction, and medicine. The number of use-reports was significantly dependent on age category and gender, and differences between age categories (young, adult, and old) in particular were dependent upon local and regional apparency. In particular, discrepancies among age categories were higher in areas of low abundance and distribution, which may be linked to different speed in the process of knowledge acquisition. In areas of low abundance, the species past abundance was also found instrumental in understanding current knowledge distribution.

Conclusion

Findings suggest that studies aiming at understanding relationship between current TK and cultural importance of a resource on one hand and socio-demographic attributes on the other hand should consider the resource current local and regional apparency but further its local past abundance. The study also confirms that B. aethiopum is a socio-economic important species in Benin.

Key words: Ethnobotany, Knowledge distribution, Wild palm Conservation, *Borassus aethiopum* Mart. Benin

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17. Effects of climatic variability and local environment patterns on the ecology and population structure of the multipurpose plant species, *Vitex doniana* Sweet

Hounkpevi, A., Kouassi, E.K. and R. Glèlè Kakaï, R.G.,

Tropical Ecology,
http://bft.cirad.fr/cd/BFT_333_5-16.pdf

Abstract

We assessed impacts of climatic variability, land cover and proximity of river on the ecology and population structure of Vitex doniana Sweet in Benin (West Africa) in order to provide relevant information for its sustainable management and conservation in the context of global change. Numbers of contacts and numbers of adult individuals per contact of the species along transects revealed through negative binomial model that even though the species is present in all climatic zones, it does not show preference to a particular zone, but it is more frequent in mosaics of croplands and fallows (MCF) and in areas at less than 500 m to river. Analyses of floristic composition, suggested that V. doniana occurs globally in different woody plant communities regarding climatic zones, land cover types and distance to the closest river. Significant interaction effects of climatic zone and land cover type were noted

on structural parameters (mean diameter and basal area) of V. doniana with the highest values in the Sudanian MCF (46.11±23.83 cm and 3.35±3.07 m2 ha−1). Moreover, diameter structures revealed globally a predominance of relatively young individuals (dbh ≤ 20 cm) of the species. Although studied environmental factors do not have significant effect on densities of the species (adult and regeneration), the relatively low values recorded may lead to a rapid decline of its populations in future. Sustainable management practices should be thought to favour and preserve the regeneration of the species for it conservation.

Keywords : Agroforestry species, conservation, global change, plant ecology, population patterns, Vitex doniana, wild fruiting trees.

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18. Aboveground biomass partitioning and additive models for Combretum glutinosum and Terminalia laxiflora in West Africa.

Dimobe, K., Mensah, S., Goetze, D., Ouédraogo, A., Kuyah, S., Porembski, S. and Thiombiano, A.,

Biomass and Bioenergy
https://www.sciencedirect.com/science/article/pii/S0961953418301119

Abstract

Accurate estimates of aboveground biomass (AGB) strongly depend on the suitability and precision of allometric models. Although additive allometric equations are expected to reduce uncertainties due to additivity property between biomass of tree components, methods for developing biomass equations do not comply with the additivity property. This study aimed to evaluate biomass allocation patterns within tree components, and to develop additive allometric equations for *Combretum* glutinosum and *Terminalia laxiflora* in West Africa. Sixty trees were destructively sampled and measured for stem, branch and leaf biomass in Sudanian savannas of Burkina Faso. Biomass allocation to stem, branch and leaf was assessed by calculating the biomass fractions for each component. Bivariate relationships between biomass fraction and diameter at beast height (dbh) were further examined. For each biomass component we tested three non-linear allometric equations based on dbh alone, and dbh in combination with height and/or crown diameter as independent variables. Seemingly Unrelated Regressions were used to fit a system of additive biomass allometric equations. Branch biomass accounted for between 60 and 70% of the AGB. Branch mass fraction increased with increasing stem diameter while a reverse trend was observed for leaf and stem mass fractions. The decline in the mass fraction was more pronounced for the leaf than the stem. Additive biomass models developed for the two species exhibited good model fit and performance, with explained variance of 68–89%. The models developed in this study provide a robust estimation of tree biomass components and can be used in Sudanian savannas of West Africa.

Keywords: Allometric equations, Biomass allocation, Carbon sequestration, Multivariate regression, Sudanian savanna

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19. Diversity–biomass relationship across forest layers: implications for niche complementarity and selection effects

Mensah, S., du Toit, B. and Seifert, T.,

Oecologia
https://link.springer.com/content/pdf/10.1007/s00442-018-4144-0.pdf

Abstract

Forest stratifcation plays a crucial role in light interception and plant photosynthetic activities. However, despite the increased number of studies on biodiversity–ecosystem function, we still lack information on how stratifcation in tropical forests modulates biodiversity efects. Moreover, there is less investigation and argument on the role of species and functional traits in forest layers. Here, we analysed from a perspective of forest layer (sub-canopy, canopy and emergent species layers), the relationship between diversity and aboveground biomass (AGB), focusing on functional diversity and dominance, and underlying mechanisms such as niche complementarity and selection. The sub-canopy layer had the highest species richness and diversity, while the emergent layer had the highest AGB. Species richness–AGB relationship was positive for each forest layer, but stronger for sub-canopy layer than for canopy and emergent layers. Total AGB was strongly correlated with functional diversity, leaf and wood traits of species in the sub-canopy and canopy layers. This suggests that sub-canopy and canopy species are major drivers of stand diversity–AGB relationship, and that resource fltering by canopy or emergent trees may not reduce the strength of diversity–AGB relationship in the sub-canopy layer. We argue that complementary resource use by sub-canopy species that supports niche complementarity, is a key mechanism driving AGB in natural forests. Selection efects are most evident in emergent species and niche complementarity efects for sub-canopy and canopy species, supporting arguments that AGB is afected by sub-canopy species' efcient use of limited resources despite competition from emergent species.

Keywords: Ecosystem function · Functional diversity · Forest strata · Species coexistence · Structural equation modelling

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20. Knowledge, valuation and prioritization of 46 woody species for conservation in agroforestry systems along Ouémé catchment in Benin (West Africa)

Lokonon, B.E., Mangamana, E.T., Gnonlonfoun, I., Akpona, T.J.D., Assogbadjo, A.E., R.G. Glèlè Kakaï, and Sinsin, B.,
Environment, Development and Sustainability
https://link.springer.com/article/10.1007/s10668-018-0142-y

Abstract

The Ouémé catchment abounds an important diversity of woody plant species. However, harvesting pressure on these species seems to lead to threats of their sustainability. Despite this fact, few published studies concerning their conservation have been undertaken. In this regard, our study focused on (1) assessment of impact of socio-demographic factors and climatic zones on knowledge and use of the woody plant species; (2) assessment of the use status of each of these species and (3) ranking within each climatic zone these species according to their priority for conservation. A total of 411 randomly selected informants were interviewed through a semi-structured survey followed by a field survey in 69 random plots of 0.15 ha. Data from available literature were used to complete the surveys. Ecological and ethnobotanical parameters were computed, and the highest priority species for conservation were identified. The results showed significant difference in plant use between women and men, ethnic groups and climatic zones. However, age was not a determinant of plant knowledge. The findings also revealed that more than 50% of native species in the study area are underutilized or widely used by few people. Moreover, six species were identified as priorities and need high conservation efforts in the two climatic zones, namely: Parkia biglobosa, Pterocarpus erinaceus, Milicia excelsa, Prosopis africana, Afzelia africana and Khaya senegalensis. Non-governmental organizations, governments and agroforestry research institutions are entreated to incorporate these species in local development strategies aiming at sustainable management and long-term conservation of native species.

Key words: Woody plant Local people Knowledge and use Conservation priorities Ouémé catchment Benin

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21. Impacts of land use types on spatial patterns and neighbourhood distance of the agroforestry palm *Borassus aethiopum* Mart. in two climatic regions in Benin, West Africa

Salako, V.K., Kénou, C., Dainou, K., Assogbadjo, A.E. and R.G. Glèlè Kakaï
Agroforestry Systems
https://link.springer.com/article/10.1007/s10457-018-0205-y

Abstract

Spatial pattern (SP) and neighbourhood distance (ND) of trees are crucial for pollination services, in particular for dioecious species. However, land use types through human disturbances may affect the natural SP and ND and possibly have a negative effect on pollination services. Though several studies have focused on the effect of land use types on

SP of trees, few have reported on ND. In this study, we compared SP and ND of the dioecious Borassus aethiopum Mart. between two land use types (protected areas vs farmlands) in two contrasting climatic regions (semi-arid vs sub-humid) in Benin. Trees were mapped in twelve plots from six populations. Pair-correlation function was used to generate univariate and bivariate SP and ND. Next, ANOVA was used to compare ND. While supporting the overall trend towards a less aggregated pattern along plant life-cycle, the study showed that the SP of B. aethiopum was altered from aggregated and spatial association in protected areas toward random and independence patterns in farmlands with increased ND among individuals, particularly between adult males and females. In addition, differences in ND between land use types varied across climatic regions, the differences being higher in the drier semi-arid region, thus suggesting more intense human activities in this region and climatic region-specific management. Management actions should mainly aim at reducing or not further increasing ND, particularly between female and male adult populations in farmlands in the semi-arid region through planting new individuals of B. aethiopum trees or limiting their removal but at the same time account for other tree species to maximise diversity of farmlands' functions and services. Further studies should examine whether the observed increased ND due to human-disturbances in farmlands is detrimental for the species pollination services, fruit production and whether it affects the species spatio-temporal population genetic structuring.

Key words: Climatic conditions Anthropogenic pressure Impacts Spatial pattern Point pattern process

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22. Height – Diameter allometry in South Africa's indigenous high forests: Assessing generic models performance and function forms

Mensah, S., Pienaar, O.L., Kunneke, A., du Toit, B., Seydack, A., Uhl, E., Pretzsch, H. and Seifert, T.

Forest Ecology and Management
https://www.sciencedirect.com/science/article/pii/S0378112717317425

Abstract

Height-diameter equations are essential to understand forest dynamics and estimate forest biomass and carbon stocks. Most existing large-scale height-diameter equations in Africa are based on data from rain forests, and their application to species from southern and eastern parts of Africa can result in large estimation error. Using a dataset of 1130 trees measured for their diameter and height from four forest sites with varying environmental characteristics across South Africa, we (1) evaluated the deviations in height estimated from existing generalized height-diameter equations; (2) compared the predictive ability of eight function forms applied to develop height-diameter models; (3) tested for sites and species effects on tree height-diameter allometries; and (4) developed country scale and site-specific height-diameter models in South Africa natural forests. The existing continental height-diameter

equations significantly overestimated tree height in South Africa. The deviations associated with these equations, though varied with sites, remained substantially large and increased with increasing tree diameter. The power function outperformed the other theoretical functions forms and proved to be the most suitable for height-diameter allometry at country scale. As expected, forest sites and species respectively had significant effects on height-diameter allometry, suggesting further need for site and functional groups-specific height-diameter relationships. The effect of site was shown by higher scaling allometric exponents at warmer and wetter sites. On the other hand, species potentially occupying same canopy niche seem to have similar allometric relationships. Our results reveal that tree height in South Africa is more accurately predicted using locally developed models. Site-specific and country scale allometric models were thus documented for future use.

Keywords : Allometric equation, Estimation error, Height growth model, Power law

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23. Estimation of cultivable areas for *Irvingia gabonensis* and I. wombolu (Irvingiaceae) in Dahomey-Gap (West Africa)

Vihotogbé, R., Idohou, R., Gebauer, J., Sinsin, B. and Peterson, A.T.,

Agroforestry Systems
http://www.ingentaconnect.com/content/ista/sst/2017/00000045/00000002/art00002

Abstract

Cultivation of priority plant species ensures their sustainable management. African bush mango trees (Irvingia gabonensis and I. wombolu) are the most exploited Irvingiaceae species. Experts disagree on the status of these very similar taxa, as taste remains the only character by which they can be distinguished in the field. We combined occurrences and environment data in ecological niche models to assess suitable areas for the two species. Irvingia gabonensis presented a wider occurrence area due to cultivation across contrasting ecological areas. Irvingia wombolu does not appear to be cultivated and only occurred in southwestern Togo. These differences in range is likely determined by phenological limitations of I. wombolu, reinforced by differences in local management systems, thus confirming the failure of market development to impact useful plant species' conservation significantly. Highly suitable areas for I. wombolu were in the Volta Forest, where I. gabonensis saw low suitability, while out of this inverse situation was observed, as regard environmental suitability. These differences are significant, implying different ecological adaptation. However, anthropogenic influences, related to domestication history, are also important. Therefore, updated genetic investigations and field trials in contrasting ecological areas are required for understanding the origin of differences between these two forms.

Keywords: Bush mango Cultivation Ecological niche modelling Non-timber forest products

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24. Agromorphological diversity of local Bambara groundnut (Vigna subterranea (L.) Verdc.) collected in Benin

Gbaguidi, A.A., Dansi, A., Dossou-Aminon, I., Gbemavo, D.S.J.C., Orobiyi, A., Sanoussi, F. and Yedomonhan, H

Genetic Resources and Crop Evolution
https://link.springer.com/article/10.1007/s10722-017-0603-4

Abstract

Bambara groundnut (Vigna subterranea (L.) Verdc.) is a neglected and less exploited species in Benin. However, the rational use of the different landraces available involves an appropriate knowledge of their characteristics. This study examined the characteristics of 52 local landraces of Bambara groundnut traditionally cultivated in Benin based on 12 qualitative and 11 quantitative variables, in order to expose those of good qualities. After a classification based on the morphological variables of the seeds, the experimental field was installed in a completely randomized device of blocks repeated three times. The collected data was analyzed with Statistica 7.1 and NTSYS PC 2.2. softwares using qualitative characteristics (Growth's type, Stem's hairiness, Flower's colour, Leave's shape etc.). As result, the number of morphotypes increased from 18 (out of classification) to 47. Therefore, it appears that the Benin collection of Bambara groundnut is broad in morphological variability. The analysis of the principal component of the quantitative variables revealed three specific classes within the collection. The most efficient variety which belonged to the second class, had a high field yield per hectare (> 1 t/ha). The Souhouloumankpa variety yielded the earliest (103 days after sowing) in addition to the high field yield. The study also showed a positive relationship between 100 seed's weight, their length, the number of seeds per plant and the seed's field yield in kg/ha. For a sustainable preservation and an improvement of the available resources, a molecular characterization of the Bambara groundnut landraces in Benin Republic needs to be done.

Keywords: Bambara groundnut, Benin, Diversity Landraces, Vigna subterranea ,Yield

25. Synergy between traditional knowledge of use and tree population structure for sustainability of *Cola nitida* (Vent.) Schott. & Endl in Benin (West Africa)

Savi, M.K., Noumonvi, R., Chadaré, F.J., Daïnou, K., Salako, V.K., Idohou, R., Assogbadjo, A.E. and Romain Glèlè Kakaï

Environment, Development and Sustainability
https://link.springer.com/article/10.1007/s10668-018-0091-5

Abstract

Cola nitida is a West African tree, commonly used for pharmaceutical purposes. In Benin, the species is used for many purposes ranging from traditional rituals to domestic consumption. Nowadays, the species, as well as its offspring, are hardly encountered. So far, research on the species focused on a single domain such as ethnobotany and phytochemistry. The current paper used a holistic approach to explain the species scarcity in the natural habitats using (1) the rural knowledge pattern on *C. nitida* and (2) the tree population structure. Semi-structured interviews (n = 170 respondents) were conducted and combined with ecological inventory (n = 38 plots) in the phyto-geographical districts of Coast and Pobè in southern Benin. The indices of diversity, equitability, and consensus quantified the range, the evenness, and the relative reliability of rural communities' knowledge. Moreover, the plant part index gave the most used part of the tree. The knowledge on the species was unevenly distributed according to the gender, while the cofactor age did not have a statistically significant effect (P = 0.902) on the pattern. In addition, seeds represented the most used plant part (PPI = 0.59). *C. nitida* tree demographic structure showed a low density of seedling and sapling (1.05 ± 0.47 trees ha-1). Diameter size fitted with a two-parameter Weibull distribution indicated a threat of species extinction. The multiple uses of *C. nitida* seeds do not allow natural regeneration of the species. The domestication of *C. nitida* tree and the establishment of Cola garden/orchard in the surveyed districts are suggested for sustainable use of the species.

Keywords: Benin, *Cola nitida*, Quantitative ethnobotany, Tree demographic structure, Wild edible plant.

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26. Adaptation des producteurs à la variabilité climatique au sud Bénin: cas de la plaine inondable de gbessou houékèkomè

S. C. ATIDEGLA* & C. HOUNMENOU

Annales des sciences agronomiques

Abstract

Le Sud-Bénin est l'une des régions du pays où la variabilité climatique est très perceptible par le monde rural. C'est dans ce contexte que la présente étude est menée afin d'analyser les stratégies d'adaptation développées dans la plaine inondable de Gbessou Houékèkomè ainsi que les corrélations entre ces stratégies et les différentes catégories de producteurs. La méthodologie utilisée est basée sur l'enquête auprès de 68 exploitations agricoles et de l'application des tests statistiques. Les résultats de cette recherche ont montré que les producteurs perçoivent entre autres une diminution et une irrégularité croissante des pluies, une plus grande fréquence de poches de sécheresse avec un réchauffement très prononcé au cours de ces deux dernières décennies. En réponse à ces changements, les producteurs selon leurs catégories d'âge ([20-50] ans ou [>50 ans]) et en fonction des superficies emblavées (≤

1 ha ou > 1 ha) développent différemment six stratégies d'adaptation. Ainsi, sur 47 jeunes producteurs (JP) enquêtés, 74% ont adopté la diversification des sources de revenus (DSR) contre 72 % pour l'agriculture de contre saison (ACS) et la modification de la date de semis, 68 % pour l'irrigation des parcelles et cultures (IPC) et la diversification des cultures (DC). En effet, la diversification des sources de revenus (DSR) se révèle pertinente et permet de discriminer les différents types de producteurs (P < 0,15) lorsque l'âge est considéré. Par contre, les producteurs emblavant une petite superficie (PS) ou une grande superficie (GS) trouvent plus pertinente, la diversification des cultures (DC) comme stratégie d'adaptation. Enfin, eu égard au constat selon lequel l'adaptation est limitée par des contraintes matérielles, financières et techniques et d'accès à l'information, il urge que des mesures d'accompagnement (formation, encadrement, financement) soient prises pour améliorer les stratégies et faciliter l'adaptation.

Mots clés : monde rural, irrégularité des pluies, âge, superficies emblavées, stratégies d'adaptation, diversification des cultures

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27. Use diversity and farmer's preference of 48 local multipurpose fodder trees: a comparative analysis of three sociolinguistic groups of Benin

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Annales des sciences agronomiques

Abstract

Les espèces végétales contribuent de manière significative aux besoins quotidiens des humains et des animaux, dans les pays en développement. Cette étude a été conduite dans la zone de transition Guineo-Congolaise/Soudanienne du Bénin auprès des populations riveraines des forêts classées des Monts Kouffé, de Wari-Maro et de l'Ouémé supérieur. Elle vise à (i) analyser l'impact de l'âge, du sexe et des groupes socio-culturels sur la perception de la valeur d'usage des espèces ligneuses fourragères ; (ii) identifier les préférences d'usage pastoral des ligneux suivant les groupes socio-culturels et (iii) identifier les ligneux surexploités ou sous-utilisés suivant les groupes socio-culturels. Un échantillon de 220 personnes appartenant à trois groupes socio-culturels majoritaires (Bariba, Nago et Peulh) a été interviewé au moyen d'une enquête semi-structurée. Les différentes catégories d'usages à l'échelle de la zone d'étude et sur le plan international ont été définies et utilisées pour calculer les taux d'usage. Les résultats montrent que les préférences des espèces fourragères varient suivant les groupes socio-culturels. Six catégories d'usage ont été notées : aliment, médicine traditionnelle, construction, combustible, vétérinaire et fourrage. Afzelia Africana, Khaya senegalensis et *Pterocarpus erinaceus* sont les espèces les plus utilisées dans l'alimentation des animaux chez les Peulhs et les Baribas alors qu'au niveau des Nagos, Mangifera indica vient en tête suivie de loin par Ficus umbellata, Ficus platyphylla et Pterocarpus erinaceus. Suivant les différentes catégories d'usage, les espèces surexploitées ou sous-utilisées varie selon les groupes

socioculturels. Mais globalement, A. Africana, K. senegalensis, P. erinaceus et Mangifera indica sont des espèces surexploitées alors que Ficus sycomorus, Combretum micranthum, Combretum molle, Balanites aegyptiaca, Crossopteryx febrifuga, Sarcocephalus latifolius sont sous-utilisées. Pour une exploitation rationnelle des ligneux fourragers, nous suggérons : (i) une évaluation de la disponibilité des espèces surexploitées et (ii) leur utilisation dans les plans d'aménagement des parcours naturels au cours des activités d'afforestation/reforestation et de reboisement

Mots clés Biodiversité, Ethnobotanique, groupe socio-culturel, ligneux fourragers, usages.

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28. Aboveground biomass allometric equations and carbon content of the shea butter tree (*Vitellaria paradoxa* C.F. Gaertn., Sapotaceae) components in Sudanian savannas (West Africa)

Dimobe, K., Goetze, D., Ouédraogo, A., Mensah, S., Akpagana, K., Porembski, S. and Thiombiano, A.,
Agroforestry Systems
http://scialert.net/abstract/?doi=je.2017.24.32

Abstract

Vitellaria paradoxa is one of the most economically important trees in West Africa. Although being a key component of most sub-Sahara agroforestry systems, little information and argument exist regarding its biomass and carbon potential. Here, we developed biomass equations for V. paradoxa tree components in Sudanian savannas. A destructive sampling approach was applied, which was based on measuring stem, branch and foliage biomass of thirty individual trees selected from a wide spectrum of diameter at breast height (dbh) and tree height (h). Basal diameter (d20), dbh, h and crown diameter (cd) were measured and used as predictors in biomass equations. Carbon content was estimated using the ash method. Variance explained in biomass allometric equations ranged from 81 to 98%, and was lower for foliage than for branch and stem biomass models, suggesting that leaf allometries are less responsive to tree size than branch and stem allometries. Stem biomass was best predicted by d20, branch biomass by dbh, and leaf biomass by crown diameter. For aboveground biomass, adding height to dbh as compound variable (dbh2 × h) did not make any significant change, as compared with model based on dbh alone. However, adding crown diameter to dbh and height reduced the error by 15% and improved model fits. Carbon contents in V. paradoxa foliage, branch and stem were 55.29, 55.37 and 55.82%, respectively, and higher than reference value suggested by the IPCC. Established allometric equations can be used to accurately predict aboveground biomass of the species in the Sudanian savannas of West Africa.

Key words: Allometry Biomass, uncertainty, Crown diameter, Destructive sampling, Estimation error, Semi-arid area

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29. Traditional knowledge on herbal drinks among indigenous communities in Azad Jammu and Kashmir, Pakistan

Rashid, N., Gbedomon, R.C., Ahmad, M., Salako, V.K., Zafar, M. and Malik, K.,

Journal of Ethnobiology and Ethnomedicine
https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0217-8

Abstract

Background

Traditional knowledge about the use of medicinal plants for herbal drinks (HDs) is not well documented in the Azad Kashmir region despite their widespread use. This study highlights the taxonomic diversity and traditional knowledge on medicinal plants used for HDs while examining the diversity of diseases treated with HDs in the study area.

Methods

Individual discussions were conducted with 255 informants (84 women and 171 men). Data gathered included (i) informant age and gender, (ii) HD species and respective plant parts used, (iii) health disorders treated, and (iv) mode of preparation and utilizations. Quantitative ethnobotanical indices including relative frequency of citation (RFC), informant consensus factor (ICF), and use value (UV) were used for data analyses.

Results

Altogether, 73 medicinal plants belonging to 40 families and 66 genera were reported to be used in HD preparations, with Asteraceae being the richest family. The average number of HD species cited was 9.09 ± 0.17 per informant and did not vary either by age or gender. In addition, men and women, and adults and the young used the same pool of species (dissimilarity nearly zero). The most used plant parts were leaves (20.00%), roots (17.25%), and fruits (16.47%). Based on UV, the top five most used species were *Valeriana jatamansi*, *Isodon rugosus*, *Onopordum acanthium*, *Acacia nilotica*, and *Viola canescens*; and the UV was similar among gender and age categories too. The most utilized herbal preparation forms included decoctions, infusions, and tea. One hundred and eleven diseases grouped into 13 ailment categories were reported to be cured using HDs. The main category of disease treated with HDs was gastrointestinal (GIT) disorders (RFC = 17.43%). Relatively few species were used by a large proportion of informants for each category of ailment (ICF ≥ 0.60). Only one species was used for "glandular disorders" and "eye diseases" (ICF = 1). A novelty of about 22% (16 species) was recorded for HD species in the present work.

Conclusion

The diversity of medicinal plant species used as HDs and the associated traditional knowledge are of considerable value to the indigenous communities of the Azad Kashmir region. Therefore, there is a need for conservation and preservation of medicinal HD species as well as the wealth of indigenous knowledge. The conservation effort should be high for species in the ailment's categories glandular disorders and eye diseases. The therapeutic uses of HDs have provided basic data for further research focused on phytochemical and pharmacological studies and conservation of the most important species.

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30. Status and utilisation of Moringa oleifera Lam: A review

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African Crop Science Journal
https://www.ajol.info/index.php/acsj/article/view/167532

Abstract

Moringa oleifera (Moringaceae) is a medium-size agroforestry tree that originated from south Asia, but has become naturalised in many countries globally. Moringa oleifera has gained importance due to its multipurpose uses and good adaptability to both humid and dry climates. Almost all parts of the plant are used. The species is considered as a neglected and underutilised as its potential is still not well economically known and valued. This review presents the status and factors responsible for underutilisation of this, otherwise important crop as a basis for formulation of viable development strategies of knowledge on taxonomy, distribution, diverse utilisations, nutritional value, socioeconomic importance, morphological and genetic diversity, domestication, propagation and management of M. oleifera. Knowledge gaps, and research and development avenues are suggested and discussed for improved valorisation. To that purpose, articles were searched in Google Scholar, Web of Science and BioMed Central database with relevant keywords on M. oleifera. All the articles found, including reviews and peer-reviewed articles were critically read and analysed for inclusion in this review. Findings revealed that the species is one of the most studied and used species with various uses stretching from food and medicinal uses to water purification, biopesticide and production of biodiesel. Findings also highlight high morphological and genetic diversity of the species, which may become a resource for the conservation and the selection of germplasm. However, many aspects of the species are still waiting for further research.

Keywords: Domestication, economy, genetic resources, Moringa oleifera, nutrition value

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31. Differential Responses of Taxonomic, Structural, and Functional Diversity to Local-Scale Environmental Variation in Afromontane Forests in South Africa

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Tropical Conservation Science

https://journals.sagepub.com/doi/abs/10.1177/1940082918762372

Abstract

Exploring taxonomic, functional, and structural diversity can provide additional insights into our understanding of diversity responses to environment. Using altitude, slope, and relative radiation index as well as floristic and functional data from a South Africa Afromontane forest, we examined how taxonomic, structural, and functional diversity varied with local environmental variation. Taxonomic and structural diversity were quantified through species richness- and diameter class-based Shannon index and evenness, respectively. Skewness and coefficient of variation of diameter distribution were additionally computed for structural diversity. As for functional diversity, we used functional richness, evenness, divergence, and dispersion based on functional traits. Data were analyzed using multimodel inference and subset regression. We found little evidence of environmental effects on local-scale taxonomic diversity patterns. In contrast, structural and functional diversity metrics varied significantly along environmental gradients. Accordingly, diameter class-based Shannon evenness declined with increasing slope while skewness and coefficient of variation of diameter distribution increased with increasing slope. Functional evenness and divergence decreased with increasing altitude and radiation, respectively, while functional richness and dispersion increased with increasing slope. The results showed that taxonomic diversity patterns were less responsive to local-scale topographical variation than structural and functional diversity. Lower functional diversity on lower slope sites suggests weak environmental filtering effect promoting competitive exclusion and dominance of species with acquisitive traits. On higher slope sites, environmental filtering associated with slope gradient seems to favor coexistence of species with conservative traits and adapted to harsh conditions.

Key words: diversity patterns, environmental filtering, radiation index, species coexistence, slope

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32. Ecosystem services and biomass stock from bamboo stands in central and southern Benin, West Africa

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Energy, Ecology and Environment

http://www.wageningenacademic.com/doi/abs/10.3920/JIFF2016.0061

Abstract

Bamboo is a multi-purpose woody grass with international and national interests accentuated by the promotion of green energy. In Asia, bamboo plantations are being successfully promoted and constitute important carbon sinks, while in Africa, they remain unimproved despite their potential service supply. In this study, we assessed ecosystem services (ESs) and biomass stock from bamboo stands in central and southern Benin. First, we interviewed 264 informants across seven sociolinguistic groups from 10 municipalities to analyse ESs importance across gender and multi-linguistic group spaces and determine trade-offs and synergies between services. Second, we used field plots to quantify biomass stocks in selected bamboo stands. Seven ESs (building material, handicraft material, medicine, firewood, support for agriculture, biological control and cultural dance) were mentioned, with provisioning ESs being the most important. ESs were equally mentioned by women and men, except for firewood and medicine which showed slightly different patterns. Handicraft material, firewood and cultural dance were mostly mentioned by Nago and Fon, whereas biological control and support for agriculture were cited by Toffin and Weme. Handicraft material, firewood and cultural dance were synergistically mentioned, but negatively associated with citations of biological control and support for agriculture, suggesting trade-offs. The estimated biomass density was remarkably low, ranging from 0.54 to 29.7 t/ha, with an average value of 11.1 t/ha. These results show a need for participative management integrating sociolinguistic groups into decision-making processes while promoting extensive bamboo plantations and bamboo carbon farming.

Keywords: Biomass, Cultural valuation, Gender, Local perception, Sociocultural group.

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33. West African Cattle Farmers' Perception of Tick-Borne Diseases

Adehan, S.B., Adakal, H., Gbinwoua, D., Zoungrana, S., Toé, P., Ouedraogo, M., Gbaguidi, A.M., Adoligbé, C., Fandohan, A.B., Hounmanou, G. and R. Glèlè Kakaï,

EcoHealth
https://link.springer.com/article/10.1007/s10393-018-1323-8

Abstract

Worldwide, cattle production is struggling to face the negative impacts caused by ticks and Rhipicephalus (Boophilus) microplus is one of the most harmful ticks for livestock. Most of the people in West Africa depend on cattle farming and subsistence agriculture. The presence of ticks on cattle is a major problem faced by smallholder farmers who fight for their livelihood. National and regional tick control programs could assist these rural communities in protecting their livelihoods against ticks and tick-borne diseases, but only if they take into account the targeted herders and their perception on cattle management and tick control.

This paper aims to provide a better insight in the socio-economic characteristics of Beninese cattle farmers, and their perception on tick burden, as well as to document common tick control strategies. Different tick species and their seasonality are well understood by cattle herders. For tick control, many still use manual tick removal, especially in the north of the country. The high cost of acaricides, the lack of financial means of African farmers, and of the local stockbreeders in particular, limits the use of acaricides in livestock breeding in Benin. While aiming to increase the meat or milk production of their animals, stockbreeders who can afford it sometimes turn to an abusive use of acaricides, which might in time lead to an increase in tick resistance. This study remains one of the rare studies to report extensively on the perceptions of West African cattle herders.

Keywords: Ticks, Tick control, Cattle herders, Perception Survey

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34. Traditional ecological knowledge-based assessment of threatened woody species and their potential substitutes in the Atakora mountain chain, a threatened hotspot of biodiversity in Northwestern Benin, West Africa

Agbani, P.O., Kafoutchoni, K.M., Salako, K.V., Gbedomon, R.C., Kégbé, A.M., Karen, H. and Sinsin, B.,

Journal of Ethnobiology and Ethnomedicine

https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0219-6

Abstract

Background

Atakora mountains in Benin are a unique but fragile ecosystem, harboring many endemic plant species. The ecosystem is undergoing degradation, and the woody vegetation is dramatically declining due to high anthropogenic actions and recurrent drought. This study aimed to (i) assess the diversity of threatened woody species and (ii) identify their potential substitutes in the three regions of the Atakora mountains namely East Atakora, Central Atakora, and West Atakora.

Methods

The data were collected during expeditions on surveyed localities through semi-structured individual interviews. Free-listing was used to record threatened woody species and which were important and why. Alpha-diversity indices were used to assess diversity of threatened and important threatened woody species. A correspondence analysis was used to determine the reason supporting their importance. Differences in species composition were assessed using analysis of similarities. A number of potential substitutes were compared among species using generalized linear models.

Results

A total of 117 woody species (37 families and 92 genera) were identified. The most prominent families were Fabaceae (19.66%), Combretaceae (12.82%), and Moraceae (10.26%), and the richest genera were Ficus (10 species), Combretum (6), and Terminalia (5). Most threatened species differed across regions (East Atakora, Central Atakora, and West Atakora) and included *Afzelia africana*, *Anogeissus leiocarpa*, *Borassus aethiopum*, *Diospyros mespiliformis*, *Khaya senegalensis*, *Milicia excelsa*, and *Pterocarpus erinaceus*. Most socio-economically important species (*K. senegalensis*, *Parkia biglobosa*, *Vitellaria paradoxa*, and *V. doniana*) were used mainly for food, timber, and fuelwood purposes. Old and adult people, and Dendi and Fulfulde sociolinguistic groups had greater knowledge of threatened woody plant species. High intercultural differentiations in species composition were detected between Bariba-Berba and Bariba-Natimba. Knowledge of substitutes also differed across regions with *P. erinaceus*, *Isoberlinia*spp., and *A. africana* being the most cited substitutes.

Conclusion

Basic data was provided here to inform decision and guide efficient management of woody resources. There was evidence that immediate conservation measures are required for some high economic value woody taxa which were critically threatened. Ex-situ conservation of these species while promoting their integration into agroforestry-based systems were recommended. Besides, community-based management programs and community-led initiatives involving knowledgeable people from different horizons will lead to a long-lasting conservation of these threatened resources.

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35. Différence entre les générations et groupes ethniques des connaissances traditionnelles et de l'importance culturelle de *Lannea microcarpa* Engl. & K. Krause en savane soudanienne au Bénin

Goudégnon, E.O.A., Vodouhê, F.G., Gouwakinnou, G.N., Salako, V.K. and Oumorou, M.,

BOIS & FORETS DES TROPIQUES

http://revues.cirad.fr/index.php/BFT/article/view/ID-BFT-170309

Abstract

Connaître l'importance socioculturelle des arbres fruitiers autochtones et des facteurs qui la déterminent est un préalable indispensable àleur valorisation et aux décisions sur leur mode de gestion. La présente étude s'est attachée à documenter les connaissances traditionnelles (CT) et l'importance culturelle (IC) de Lannea microcarpa, arbre fruitier autochtone peu connu et sous-utilisé de la zone soudanienne au Bénin. L'étude s'est également penchée sur les éventuelles variations en termes de CT et de IC selon les groupes ethniques et les générations. Nous avons recueilli des informations sur les utilisations et l'importance de l'essence auprès de 262 personnes sélectionnées de manière aléatoire dans la zone de distribution de l'arbre, à l'aide de listes libres et d'un système de notation. Vingt-huit utilisations réparties en huit catégories d'usages ont été recensées, dont 21 médicinales, deux

commerciales et une chacune pour l'alimentation humaine, le fourrage, le bois de feu, la construction, l'emballage et les cure dents. Contrairement au cas des autres catégories d'utilisation, les connaissances traditionnelles liées aux usages pour l'alimentation n'ont pasvarié selon les générations ou les groupes ethniques. De plus, les utilisations alimentaires sont culturellement les plus importantes, suivies par les utilisations médicinales. Globalement, le fruit est la partie préférée de l'arbre, et la plus souvent commercialisée. Les problèmes de santé traités à l'aide de L. microcarpa comprennent l'anémie, la diarrhée, la toux, les ulcères, les maux d'estomac et les hémorragies suite aux accouchements. Nos résultats indiquent que la domestication de L. microcarpa devra privilégier le fruit, la partie de l'arbre la plus appréciée. D'autres études pourront ainsi se pencher sur les possibilités de domestication de L. microcarpa en privilégiant ses caractéristiques fruitières et l'amélioration de la production de fruits.

Keywords: Lannea microcarpa, connaissances traditionnelles, valorisation des essences fruitières, zone soudanienne, Bénin

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36. *Bombax costatum* (Malvaceae): state of knowns, unknowns and prospects in West Africa

Assogba, G.A., Fandohan, A.B., Gandji, K., Salako, V.K. and Assogbadjo, A.E.,

BOIS & FORETS DES TROPIQUES
https://popups.uliege.be/1780-4507/index.php?id=16652

Abstract

Introduction.
The red kapok tree, Bombax costatum is a tree species native to West Africa. Most of its organs or plant parts are of medicinal, food, and economic importance.
Literature.
The species is widely used for food and medicinal purposes and as timber. Yet B. costatum is poorly studied and declining across its distribution range. So far, little has been achieved on this species'conservation status, genetic diversity, breeding and domestication. With the aim of synthesizing current knowledge and gaps, and suggesting future research, articles were searched in Google Scholar and Web of Science databases with relevant keywords on B. costatum. All articles found were critically read and analyzed for inclusion in the present review.
Conclusions. The current state of knowledge on taxonomy, distribution, ecology, botanical description, structural characteristics, uses, nutritional and phytochemical properties, socioeconomic importance, propagation, growth and development, threats and conservation of B. costatum have been reviewed. Knowledge gaps were identified and research and development avenues were suggested and discussed for conservation of this species.
Keywords. Bombax costatum, taxonomy, ecology, ethnobotany, nature conservation.

37. Species richness, cultural importance, and prioritization of wild spices for conservation in the Sudano-Guinean zone of Benin (West Africa)

Kafoutchoni, K.M., Idohou, R., Egeru, A., Salako, K.V., Agbangla, C., Adomou, A.C. and Assogbadjo, A.E.,

Journal of Ethnobiology and Ethnomedicine
https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0267-y

Abstract

Background

Spices have always been used for their flavor-enhancement characteristics and for their medicinal properties. In Benin, scientific research on spices is scarce, despite their importance in the local population's daily needs. This study investigated the diversity of wild spices and documented the associated traditional knowledge that can be used for their valuation, domestication, and sustainable management in the Sudano-Guinean Zone of Benin.

Methods

Data were collected during field expeditions using semi-structured interviews in ten localities across the three phytodistricts of the zone. Species richness and Shannon's diversity index were estimated using species accumulation curves. Use report (UR), cultural importance, use value (UV) index, and informant consensus factor (F_{ic}) were used to assess traditional knowledge on wild species, their local importance, and informants' agreement among sociolinguistic groups. Priority wild spices were finally identified using an approach combining eight criteria (native status, economic value, ethnobotanical value, global distribution, national distribution, in-situ and ex-situ conservation status, legislation, and threats assessment) in four prioritization methods (point scoring procedure, point scoring procedure with weighting, compound ranking system, and binomial ranking system).

Results

A total of 14 species, belonging to 12 genera and 9 families, were inventoried. The most prominent families were Zingiberaceae (21.43%), Annonaceae (21.43%), and Rutaceae (14.29%). More than 200 specific uses were reported, with the Tchabè people holding the greatest level of knowledge (70 uses; UR = 5.70 ± 0.33). The culturally most important spices differed among sociolinguistic groups. Most of the informants agree on the use of the species among (F_{ic} = 0.72–0.98) and across the considered use categories (F_{ic} = 0.88–0.99). The highest UV were registered for *Aframomum alboviolaceum* (UV = 0.93), *Lippia multiflora* (UV = 0.76), and *Aframomum angustifolium* (UV = 0.18). Overall, people perceived wild spices as declining due to agriculture, grazing, and drought. Five species, *A. alboviolaceum*, *L. multiflora*, *Monodora tenuifolia*, *Xylopia aethiopica*, and *Z. zanthoxyloides*, were the most prioritized for conservation.

Conclusions

This study provides information relevant for the implementation of conservation and domestication actions of wild spices in Benin. Priority species could be integrated into traditional agroforestry systems (e.g., home gardens). However, for this to be effective, further research should be undertaken on morphological and genetic diversity and propagation methods of priority wild spices.

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38. Spatio-temporal dynamics of suitable habitats for *Detarium microcarpum* Guill. & Perr. (Caesalpiniaceae), a priority food tree species in Benin (West Africa)

Agbo, R.I., Idohou, R., Vihotogbé, R., Missihoun, A.A., Dagba, R.A., Assogbadjo, A.E. and Agbangla, C.

Modeling Earth Systems and Environment
https://link.springer.com/article/10.1007/s40808-018-0550-x

Abstract

Detarium microcarpum (Caesalpiniaceae) is a priority, multipurpose, and indigenous food tree species in West Africa. However, data related to its efficient conservation and sustainable use, through changing ecological environments, are still lacking. Thus, species occurrence records were combined with climatic and soil data in Maximum Entropy (Maxent), a species distribution modelling algorithm, to evaluate the impacts of future environmental conditions (under CNRM-CM5 and HadGEM2-ES) on the species' potential distribution in Benin. Results indicated that the species' present potential distribution range was mainly found in the Sudanian and Sudano-Guinean ecological regions. Some extensions and retractions of the present-day distribution (lowly, moderately and highly suitable habitats) were noted under future climates based on the two scenarios. Introduction of *D. microcarpum* in suitable habitats are required for its efficient conservation in West Africa.

Keywords: Benin Climate change Sustainable management *Detarium microcarpum* Ecological niche modelling

39. Evaluation of the physical, mechanical and kinetic properties of some cereals and leguminous seeds in Benin republic

E.D. Dayou, K.L.B. Zokpodo, A.L.R. Glele Kakaï.

International Journal of Engineering, Science and Technology
https://www.ajol.info/index.php/ijest/article/view/180459

Abstract

In order to design a seeder for direct sowing, a seed characterization study was conducted. The objective was to assess the physical, mechanical and kinetic properties of the most cultivated cereals and leguminous in Benin. Two varieties of Zea mays, four varieties of Vigna unguiculata, one variety of Arachis hypogea, one variety of Cajanus cajan and two varieties of Glycine maxwere studied. It was noticeda variation in physical parameters not only between species but also between varieties of the same species. All sphericity coefficients are greater than 0.7 with C. cajan which is more spherical (0.91±0.03) against the DMR ESR-W/QPM and 85 TZSR-W varieties of Z. mays which are the least spherical with 0.72±0.10 and 0.71±0.11 respectively. The rupture force generally increased from 14 to 720 N. Vigna TVX 32-36 is the most resistant with 633.3±75.72 N against 16.0±2.0 N for Arachis TS32-1 the least resistant. Overall, the falling speed decreased from 1.67 to 0 m/s on the rigid PVC, from 1.36 to 0 m/s on the black plate and from 1.67 to 0 m/s on the transparent hose when the angle of inclination increases from 20° to 70° relative to vertical. These parameters are essential for good sizing of the distribution system and the seed descent channels for a seeder. They can also be used for grains calibration and other use in agricultural engineering and food processing.

Keywords: Seeds, physical properties, mechanical properties, kinetic properties, Benin

40. Seed cake of *Jatropha curcas* (l.), potential substrate to produce maggots as feed for reared monogastric animals

Pomalégni, S.C.B., Gbemavo, D.S.J.C., Gnanglè, P.C., Djossou, S.R., Kenis, M., Babatoundé, S., Glèlè Kakai, L.R. and Mensah, G.A.,

Journal of Animal & Plant Sciences

Abstract

Seeds of jatropha (*Jatropha curcas*) are used worldwide to produce biodiesel and the oil extraction generates a high amount of waste called seed cake. Jatropha seed cake has high protein content but its valorization, for example as animal feed, is hampered by its toxicity and antiâ€"nutritional properties. This study, carried out in Benin, West Africa, aimed to determine the capacity of jatropha seed cake to produce fly larvae for animal feed and assess the nutritional quality of the larvae. Three types of substrates were exposed to naturally occurring house flies: jatropha seed cake alone, the same seed cake enriched with earthworms to help detoxifying and decomposing the cake, and corn bran, a substrate commonly used in the region to produce fly larvae. All three substrates produced larvae of similar sizes. The yield obtained with corn bran was significantly higher (55.6 g per kg of dry substrate) than those with pure seed cake (44.5 g) and seed cake with earthworms (50.1 g). However, the larvae produced with jatropha seed cake contained more proteins and other important nutrients than those produced with corn bran. These results show that jatropha seed cake can be

valorized by producing fly larvae but it remains to be seen whether the fly larvae produced on jatropha seed cake are not toxic for animals.

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41. Effects of seed viability and pre-treatments on seed germination of two indigenous species—Strychnos cocculoides Baker and Guibourtia coleosperma (Benth.) Leonard in Namibia

Heita, H.T., Ham, H. and Mensah, S.,

Agroforestry Systems
https://link.springer.com/article/10.1007/s10457-018-0333-4

Abstract

Strychnos cocculoides Baker (Monkey orange) and *Guibourtia coleosperma* (Benth.) Leonard (False mopane) are two socio-economically important indigenous species for rural communities in the northern regions of Namibia. The exploitation of these indigenous species is causing rapid declines in the goods and services produced. In addition, nursery experiments to assist the germination of these indigenous woodland trees are limited. This study aimed at investigating the effects of six pre-treatments [control, cold water (15 °C), warm water (50 °C), hot water (90 °C), scarification and chemical with 32% HCl] on the seed germination of both species. Prior to the pre-treatments, sample seeds were tested for viability using the tetrazolium and rag doll tests. This was conducted to determine whether the seeds used in this study were viable and had a germination potential. For both species, over 80% seeds were viable with the tetrazolium test. Germination results indicated a significant difference between the six pre-treatments, which was more pronounced for *S. cocculoides* than for *G. coleosperma*. For *S. cocculoides* seeds, warm water (80%), cold water (70%) and control (untreated seeds) (63%) yielded greater percentages of germination than hot water (40%), scarification (3%) and HCl-chemical (0%) after 7 weeks of germination. For *G. coleosperma* seeds, warm water (83%), cold water (80%), control (80%) and hot water (70%) produced the highest percentage of germination, compared to chemical (67%) and scarification (67%) pre-treatments. The control, cold and warm water pre-treatments showed germination of *S. cocculoides* seeds within 3 weeks of sowing, while for other treatments, seeds only germinated 4 weeks after sowing. *Guibourtia coleosperma* untreated and warm water-treated seeds germinated earlier (week 2) compared to the other pre-treatments, for which germination only occurred during week 3. Therefore, the study recommends warm water as an ideal pre-treatment to promote germination in *S. cocculoides* and *G. coleosperma* species. Potential future studies could investigate effect of different temperatures and photoperiods on the germination percentage of the two species.

Keywords: *Strychnos cocculoides*, *Guibourtia coleosperma*, Pre-treatment Viability Tetrazolium Germination

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42. Developing policy-relevant biodiversity indicators: lessons learnt from case studies in Africa

Rochette, A.J., Akpona, J.D.T., Akpona, H.A., Akouehou, G.S., Mayundo, B.K., Djagoun, C.A.M.S., Habonimana, B., Idohou, R., Legba, I.S., Nzigidahera, B. and Matilo, A.O.,

Environmental Research Letters
https://iopscience.iop.org/article/10.1088/1748-9326/aaf495/meta

Abstract

There is an increasing need for monitoring schemes that help understand the evolution of the global biodiversity crisis and propose solutions for the future. Indicators, including temporal baselines, are crucial to measure the change in biodiversity over time, to evaluate progress towards its conservation and sustainable use and to set conservation priorities. They help design and monitor national and regional policies on biodiversity; they also feed into national reporting on international agreements such as the Convention on Biological Diversity and the Sustainable Development Goals. We analyse the methodological approach of five small African projects resulting from a call to promote indicator development, improve monitoring capacity and strengthen the science-policy interface in the field of biodiversity. We compared their approach to existing guidance provided by the international community, specifically the Biodiversity Indicators Partnership. To this end, we assess whether internationally recommended steps are effectively applied to national/local biodiversity monitoring in selected developing countries. We also present lessons learnt from workshop interactions between partners involved in these projects. Through our pilot projects we identified data availability and data accessibility, together with the involvement of stakeholders, as critical steps in indicator development. Moreover, there is a need for a better awareness and a wider application of the indicator concept itself. Hence, training of key actors both in the policy and science spheres is needed to operationalize indicators and ensure their continuity and sustainability. We hope that these case studies and lessons learnt can stimulate and support countries in the Global South to formulate policy-relevant biodiversity indicators.

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43. Fitting an optimal variance-covariance structure for longitudinal data under Linear Mixed Effects Models framework: simulation based analysis

Aubin Amagnide, Micheline Gbeha and Romain Glele Kakai

African Journal of Applied Statistics

Abstract

In this study, we (i) assessed the performance of 5 fit statistics (AIC, BIC, HQIC, CAIC and AICC) to determine the cor-rect within-subject covariance structure (WSCS) in longitudinal data analysis and (ii) investigated the consequence of misspecification of WSCS. Firstly, a simulation study was achieved in 192 cases taking into account six characteristics of the data

sample (sample size, measurement periods, magnitude of growth parameter, size of G matrices, covariance structure and distribution of the within-subject error). For each combination of these parameters, 500 replications were generated using Monte Carlo procedure and the hit rate of each of the 5 search statistics is computed and help to compare their performance. At a second step, based on 32 restricted simulation conditions, the effect of misspecification in WSCS was assessed by computing the mean relative bias and mean relative errors of the coefficients of fixed effects and random components. Results showed an overall best performance of the HQIC, BIC and CAIC for searching first order auto-regressive [AR(1)] and first order moving average [MA(1)] covariance structures.

Key words: Repeated measurements; within-subject covariance structure; fit statistics; misspecification; Monte Carlo experiments

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44. Modelling and Prediction of Ouémé (Bénin) River Flows by 2040 Based on GR2M Approach.

Nounangnonhou, T.C., FIFATIN, F., Lokonon, B.E., Acakpovi, A. and Sanya, E.A.,
LARHYSS Journal
http://larhyss.net/ojs/index.php/larhyss/article/download/567/579

Abstract

The study described in this paper has consisted of simulating the real future behaviour of the Ouémé river basin's water flow by 2040. The approach of the Rural Engineering model, with two variables, at a monthly time step named GR2M has been adopted owing to its robustness. This model is an indispensable tool for studying the evolution of water resources in the medium and long term. For our approach, the projected data, from 2016 to 2040, were generated using the Auto-Regressive Integrated Moving Average model. Observed data were then used for the calibration and the validation of the GR2M model. The results obtained showed that the GR2M model is a very satisfactory tool for simulating the transformation of rainfall data into flows on the one hand and an impact of future climate change resulting in a decrease in annual average flows between 11.90% and 46.37% by 2040 on the other hand. The quality parameters revealed very interesting values obtained from the model on the three representative sites of the Ouémé basin with Nash-Sutcliffe more than 70% and determination coefficient more than 0.75.

Keywords: rainfall-runoff modeling, GR2M, simulation, forecasts, Oueme river basin.

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45. Application Use of Water Quality Index (WQI) and Multivariate Analysis for Nokoué Lake Water Quality Assessment

Josué Esdras Babadjidé Zandagba, *, Firmin Mahoutin Adandedji, Bruno Enagnon Lokonon, Amédée Chabi, Oswald Dan, Daouda Mama

Abstract

Due to its location and multiple uses, Nokoué Lake, is subject to multiple attacks impairing water quality. The present work aims at assessing the water quality index (WQI) on this surface water, by monitoring twenty sampling locations for a period of rainy and dry season in 2016. For calculating the WQI, seven parameters, namely, pH, dissolved oxygen, turbidity, electrical conductivity, Biochemical oxygen demand, nitrite and nitrate were considered. Statistical tests and conclusions were made on the basis of a multiparametric model. Thus, to evaluate significant differences among the sites for all water quality variables, data was analyzed using one-way analysis of variance (ANOVA) at 0.05% level of significance. Multivariate analysis of the water quality data sets was performed using Hierarchical Cluster analysis (HCA) and Principal Component Analysis (PCA). The results showed that WQI values ranged from 93.96 (good water quality) in rainy season to 100.73 (bad water quality) in dry season. The values of physicochemical parameters significantly increased from rainy to dry season. Water quality of Nokoué Lake can be categorized into "Good water" during the rainy season to "Poor water" during the dry season. Application of the WQI is suggested as a very helpful tool that enables decision makers to evaluate water quality.

Keywords: Lake, Water Quality, WQI, Multivariate Analysis

Appendix 3:

Abstracts of ongoing doctoral research in Labef in 2018

1. *Assessment and analysis of agronomic and ecological aspects of cotton farming systems for a sustainable cotton production in Benin (West Africa)*

Eclou, S.I.

Cotton is the main cash-crop in Sub-Saharan Africa whose estimated population of 856 million in 2010, is projected to exceed two billion shortly after 2050. It plays a very important role in the economy of several African countries, including Benin Republic. However, most current cotton production systems are not sustainable and this could become a significant obstacle to the future development of these countries. Particularly in Benin Republic (West Africa), the massive use of pesticides and other agrochemicals in conventional cotton production methods results in severe environmental and health problems. But No study was conducted in Benin Republic on persistence and degradation of pesticide residues in soils under cotton cultivation. Yet we know that Organic cotton which by definition is cotton produced without chemicals, appears as a solution. However, low productivities observed in biological or organic cotton production systems are an obstacle to the adoption by farmers of these cropping systems. Nevertheless, the existence of biological or organic cotton shows that it is possible to produce cotton without using chemicals. It is in this context this study intends to evaluate and analyse the agro-ecological impacts not only of conventional and organic cotton production systems currently used in Benin but also some innovative cotton production methods which could give good yields and protect more environment and human health. This doctoral thesis study seeks to: (i) review the existing literature on cotton production in Africa, (ii) analyse effects of different cotton production practices on its agronomical performances, (iii) analyse effects of different cotton practices on soil fertility characteristics, (iv) assess pesticide residues impacts following different cotton farming systems, (v) Quantify pyrethroid and organophosphate pesticide residues in soils from cotton production area and (vi) analyse pyrethroid and organophosphate pesticides persistence and degradation in incubation study. This study is being conducted in two different cotton agro-ecological zones of Benin Republic. This research project is funded by the Kingdom of Denmark.

Keywords: *Organic cotton*, agronomical performances, pyrothroid and organophosphate pesticides, Benin.

2. *Empirical comparison of plotless sampling techniques in vegetation studies*

Amagnide, G.A.

Sampling consists in selecting a sample from a large population with procedures for efficient and accurate estimating of parameters of that entire population from measurements made on the sample. To overcome problems of quadrat pattern (size, shape, etc.) in vegetation studies, distance methods or plotless sampling techniques (PST) were developed. This research will (i) analytically improve density estimators from PST by accounting for imperfect detection, measurement errors on distances and spatial pattern of plants and (ii) empirically compare PST in density estimation.

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3. *Performance of Generalized Linear and Nonlinear Mixed Models under flexible semi-nonparametric and parametric distributions: applications to plant-plant interactions and gene dispersal in Afzelia africana*

Tovissode, F.

Generalized Linear Mixed Models (GLMMs) and Nonlinear Mixed Models (NLMMs) have now become part of tools commonly used by researchers in all applied sciences. Traditionally built on the normality assumption, these modelling devices have been shown to suffer distributional restrictions, what may substantially bias estimations and mislead decision making. Numerous proposals have thus emerged to tackle some aspects of this problem, essentially by introducing flexibility (skewness and/or kurtosis) in distributions. The new models generally bear more computational challenges than their normal counterplea. This has led to the development of many estimation procedures which have problem-dependent performances. The present dissertation aims at exploring flexible distribution based GLMMs and NLMMs in order to provide a benchmark for practitioners facing the miscellaneous of approaches relaxed. We consider a very large and flexible class of parametric distributions (skew scale mixture of normals) and an equally flexible semi-nonparametric class of distributions. The advantage of these distributions resides in their ability to represent a large range of skewness and kurtosis and the possibility to recover the normal distribution when the data does not support departure from normality. Specifically, our goals are to (1) develop and assess the performance of a Generalized Linear Mixed Model for binary outcome under skew scale mixture of normal random effects; (2) develop and assess the performance of a Generalized Linear Mixed Model for count data under skew scale mixture of normal random effects; (3) assess and compare the performances of Semi-Nonparametric and Parametric Nonlinear Mixed Models; and (4) survey the performance of two deterministic and four stochastic algorithms in fitting Nonlinear and Generalized Linear Mixed Models under Semi-Nonparametric and skew scale mixture of normal distributions. Our objectives will be achieved through development of unified models and simulations studies meant to reveal which model is best suited for a dataset given sample features as sample size, cluster size

(number of pseudo-replications) and correlation among predictors; and which algorithm is the most appropriate given sample characteristics (e.g. missingness and importance of noise) and specific model features (e.g. presence of random intercept, random slopes). The results of simulation studies will be used to provide tutorials demonstrating on *Afzelia africana* survival, growth and spatial genetic structure data, the advantages of the proposed approaches over existing ones.

Key words: Flexible links, extradispersion, skew scale mixture of normals, semi-nonparametric distribution, bridge-logistic distribution, Poisson-Tweedie mixtures

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4. *Linear mixed effects models for fitting multivariate longitudinal data: application to natural regeneration of Adansonia digitata L.*

Honfo, S.H

Research experiments in applied sciences such as agriculture, management of natural resources sciences and medicine are often complex and characterized by multiple observations on several variables measured repeatedly over the time (plant growth, study on species' regeneration, climate change, and epidemiology studies). For analyzing such data, the most appropriate method when there is significant correlation between variables of interest is the multivariate linear mixed effects model (MLMM). Various MLMM approaches have been developed and are available. Though, these MLMMs methods present some computational problems due to either the dimension of the joint covariance matrix of the random effects or the number of variables and/or the number of used random effects per variable. How do these methods really perform according to the above computational factors? Which method can be considered as the best one, or which methods are better for which situations? Does the time spacing considered for collecting data influence the performance of MLMMs? These are various fundamental research questions that need to be addressed. Therefore, the present PhD thesis aims at bringing an added value to multivariate linear mixed effects models methods for fitting longitudinal data through (i) the assessment of the performance of MLMM methods according to computational factors; (ii) the assessment of the effect of the variation of time spacing on the precision of parameters' estimation using MLMMs; (iii) the assessment of the effects of biotic and abiotic factors on the regeneration potential of Adansonia digitata L. in Benin using longitudinal data in MLMM framework.

Keywords: multivariate linear mixed effect model, longitudinal data, Adansonia digitata, regeneration

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5. *Global optimization in multilayer perceptron neuronal networks*

Hounmenou G.C.

Modeling empirical data for forecasting purposes is a difficult statistical task because of the relationships that underlie the measurements that can be strongly non-linear, non- univocal,

noisy, and of dynamic nature. For this purpose, the standard statistical methods used such as regression models, time series for the treatment of these types of data give mostly unsatisfactory results. It is therefore necessary to explore alternative approaches to develop better models. Thus, new tools and methodologies have been increasingly developed and are able to process increasingly complex data. These include: boltz machine, machine-supported vectors, artificial neural networks (ANN). These are inspired by neurobiology and perform calculations similar to those of the human brain. Attractiveness for ANNs comes from the processing of characteristic information such as nonlinearity, parallelism, noise tolerance, learning ability and of generalization. They are applied in various fields including the field of statistic, physics agriculture, environment, industry, medicine, communication, computer science, electronics, mechanics, insurance automotive, chemistry, biology, air transport, automatic etc. They encompass several types of models, among of them the multilayer perceptron (MLP), have demonstrated their effectiveness in prevision and prediction of empirical data. Often, these data have a high proportion of contaminated observations with errors whose magnitude and structure can be arbitrary. Thus, the problem of global optimization of learning algorithms used in RNA arises. In addition, although neural networks have demonstrated their ability to obtain excellent predictive and estimated performance, the problem of the choice of hyper-parameters is very critical for these networks because the size of the search space increases significantly of exponential way with the number of intermediate layers. The objectives of this thesis are to: (i) define new models and learning algorithms for PMCs that correct the explanatory variables and explain "at best" so as to find the "real" relationship that binds them. This first objective aims at studying the problem of the class convex nonlinear optimization (ii) determine the optimal structure of the PMCs about of the choice of hyper-parameters and sampling size; (iii) analyze their behavior in the face of missing data, and at last, (iv) propose of the cases of applications of non-linear regression using MLP.

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6. *Comparison of parameter estimation methods used in generalized linear mixed model (GLMM) with applications on ecological data.*

Lokonon, B.

The use of Generalized Linear Mixed Models (GLMMs) is widespread in ecology last decades since it is a more flexible approach for analyzing non-normal data when random effects are present. This popularity has led to a lot of methodological research. Despite the availability of accurate methods for estimating GLMM parameters in simple cases, complex GLMMs are challenging to fit. As a result, various approximation methods have been introduced in the literature with different degrees of accuracy. Tthe main problem in parameters estimation with GLMMs is that, in contrast to linear mixed models, likelihood function of GLMMs is analytically intractable. To tackle the intractability, different estimation methods and packages have been proposed. Specific research questions we address in this situation are: Do differences exist in term of robustness among the estimation methods in terms of parameter

bias of fixed effects and variances of the random effects? What are the performances of the R packages involved in each estimation method? Through my PhD thesis, I plan to assess, analytically and empirically, the robustness of the existing estimation methods and packages in order to contribute to an accurate use of these methods.

Keywords: GLMM, estimation methods, simulations, packages, performance, ecology.

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7. *Effects of elephants on the dynamic of savanna plants in Pendjari Biosphere Reserve in Benin, West Africa*

Gnonlonfoun, I.

Evolutionary processes between animals and plants are the key motors of woody trees dynamic and related ecosystem services delivery in natural stands. Mammalian herbivory can lead to decline and or extirpation of trees species in savannas ecosystems and then influence the food web at multiple trophic levels (Dublin 1991, van der Waal et al. 2016). In West Africa, mega-herbivores are impacting the dynamic of plants species and their related ecosystem services. The main objective of this study is to contribute to sustainable conservation of native biodiversity and sustainable maintaining of ecosystems services delivery in Pendjari Biosphere Reserve in Benin.

Keywords: Trees' strategies, Mammalian herbivory, Plant defense, Ecosystem services, Elephants feeding behavior, Pendjari Biosphere Reserve.

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8. *Effects of abiotic and biotic factors on the early recruitment of the threatened Afzelia africana Sm. (Fabaceae-Ceasalpinioideae) in the Pendjari biosphere reserve (Benin, West Africa)*

Atanasso, J.

Afzelia africana is a threatened woody plant species which population recruitment suffers a real bottleneck in its natural habitats even in protected areas so that very weak potential of regeneration has often been reported. For the understanding of this plant dynamic in natural stands, knowledges of the key abiotic and biotic factors and their interactive effect on *A. africana* regeneration are particular interests. The current research aims to understand the effects of abiotic and biotic factors on the early recruitment of the threatened *Afzelia africana* Sm. (Fabaceae-Ceasalpinioideae) in the Pendjari biosphere reserve (Benin, West Africa). Planning into chapters, the study aims more specifically to: (1) set a revew on the biotic and abiotic factors influencing the natural regeneration of *A. africana* in West Africa, (2) identify the abiotic factors affecting *A. africana* occurrence, density and structures in the Pendjari Biosphere Reserve of Benin (West Africa), (3) determine the spatial structure of *A. africana*

in relationship with its conspecific and heterospecific tree species in the Pendjari Biosphere Reserve (PBR) in Benin, (4) assess the interactive effects of abiotic and biotic factors on *A. africana* sm. early recruitment in the Pendjari Biosphere Reserve in Benin (West Africa) and (5) analyse the abiotic and biotic effects on recruitment dynamics of the early stages of *A. africana* in Benin (West Africa).

Key words: *Afzelia africana*, Biotic and abiotic factors, early recruitment, regeneration, Benin

Appendix 4:
Abstracts of the scientific seminars organized in Labef in 2018

1. *Le Protocole de Nagoya sur l'accès aux ressources génétiques et le partage juste et équitable des avantages découlant de leur utilisation et les implications pour la recherche au Bénin*

Melkior KOUCHADE & Hugues AKPONA & Bienvenu BOSSOU
National Forest and wildlife, Republic of Benin

Resumé

La Convention sur la diversité biologique de Rio de Janeiro 1992, entrée en vigueur le 29 décembre 1993, est le seul instrument international complet sur la diversité biologique. Cette Convention a trois objectifs : (1) la conservation de la diversité biologique, (2) l'utilisation durable de ses éléments constitutifs et (3) le partage juste et équitable des avantages découlant de l'utilisation des ressources génétiques. Environs 10 ans plus tard, le sommet mondial sur le développement durable (Johannesburg, septembre 2002) a réclamé la négociation, dans le cadre de la Convention, d'un régime international pour la promotion et la protection du partage juste et équitable des avantages découlant de l'utilisation des ressources génétiques, afin d'assurer l'avancement du 3ème objectif. Le Protocole de Nagoya sur l'accès aux ressources génétiques et le partage juste et équitable des avantages découlant de leur utilisation relative à la Convention sur la diversité biologique qui est une réponse à cette requête a été adopté à la dixième réunion de la Conférence des Parties, le 29 octobre 2010, à Nagoya, au Japon, après six ans de négociations. Ce Protocole fait progresser considérablement le 3ème objectif de la Convention en assurant une plus grande certitude juridique et une transparence accrue pour les fournisseurs et les utilisateurs de ressources génétiques. Les obligations particulières visant à assurer la conformité aux lois ou aux réglementations nationales de la Partie fournissant les ressources génétiques et les obligations contractuelles précisées dans les dispositions convenues d'un commun accord sont d'importantes innovations du Protocole. Les dispositions sur la conformité, ainsi que celles établissant des conditions plus prévisibles d'accès aux ressources génétiques, contribueront à assurer le partage des avantages lorsque les ressources génétiques quittent la Partie fournissant ces ressources. De plus, les dispositions du Protocole sur l'accès aux connaissances traditionnelles associées aux ressources génétiques détenues par les communautés autochtones et locales amélioreront la capacité de ces communautés à profiter de l'utilisation de leurs connaissances, de leurs innovations et de leurs pratiques. Ainsi, en encourageant l'utilisation des ressources génétiques et des connaissances traditionnelles associées à celles-ci, et en consolidant les occasions de partage juste et équitable des avantages découlant de leur utilisation, le Protocole contribuera à stimuler la conservation de la diversité biologique, l'utilisation durable de ses éléments constitutifs, et à accroitre la contribution de la diversité biologique au développement durable et au bien-être humain. Ce

protocole a été ratifié par la république du Bénin en Janvier 2014, devenant ainsi le 66ème membre dudit protocole. D'autres dispositions réglementaires ont suivi pour opérationnaliser la mise en œuvre dudit protocole. Au cours de ce séminaire, les conférenciers présenteront le contenu du protocole et ses implications pour la recherche scientifique, les dispositions réglementaires en vigueur en république du Bénin en la matière, et les procédures administratives nécessaires pour se conformer auxdites dispositions.

Mots clés : Biodiversité, Valorisation, Gestion durable, Equité, Règlementations

2. *Etudier les systèmes socio-écologiques: vers une démarche systématique et réfléchie*

Jean Hugé
VUB, Biology Department, Ecology & Biodiversity; ULB, Systems Ecology & Resource Management ; Ghent University, Centre for Sustainable Development
Hasselt University, Centre for Environmental Science

3. *What if forest resources were managed differently? 30 years of experiences and learned lessons from multi-stakeholders' participative model*

Karin ORTEGA

conservationist, President of the FONDATION TOBE

Abstract

Benin is among the countries wherein both customary and statutory rights drive the governance of forest resources. In the protected area (out of gazetted area), customary right has taken precedence over the statutory one, providing families and communities with legitimacy and extended rights over large agroforestry lands and forests. These ecosystems, generally fall under the tragedy of the common goods, and therefore are under strong human pressure. Over the last decades, non-governmental organizations and specialized agencies of decentralized states have been interested in the integrated and sustainable management of these ecosystems, as a way to stimulate their contribution to local development. This presentation will focus on the Tobé-Kpobidon community forest where a multi-stakeholder's participative model for forest governance is being implemented for 30 years. The presentation will describe the structure and functioning of the governance model, as well as its socio-economic and ecologic outcomes over the 30 years of implementation. The presentation will take an additional step to discuss the learned lessons and explore improvements for increased socio-economic and ecological impact of the model. The model has already inspired some forest management projects in Benin and in West Africa.

Key words: Participative management, forest, Tobé-Kpobidon, Benin

4. Analysis of sensory data: internal and external mapping

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Laboratoire de Biomathématiques et d'Estimations Forestières, LABEF/FSA/UAC),

Institut National des Recherches Agricoles du Bénin, programme

Abstract

Sensory analysis is a set of methods for measuring sensory perceptions (sight, hearing, smell, taste, touch). The first use of sensory analysis was for food products and the aim was to analyze/study/compare a set of products using sensory descriptors. The particularity of sensory analysis is that the measuring instrument is the human. Sensory analysis is a fast-growing discipline in domains such food, cosmetics, automobile, and other industries. For example, to assess the sensory characteristics and preference of different types of bread (bread made from 100% wheat flour, bread made from 50% wheat flour and 50% cassava flour and bread manufactured from 50% wheat flour and 5% corn flour), sensory analysis methods are used. The sensory evaluation aims at characterizing the products both from the point of view of their sensorial properties and from the point of view of the preferences of the consumers. As a result, it is at the crossroads between research, development and marketing. The lecturer will present the main statistical methodologies used in sensory analysis from planning, data collection, to statistical data processing. He will end up with a case study.

Keywords: Planning sensory experiences - Product characterization - Building a product space - Mapping preferences