Labef

Laboratoire de Biomathématiques &
d'Estimations Forestières

Annual Report 2022

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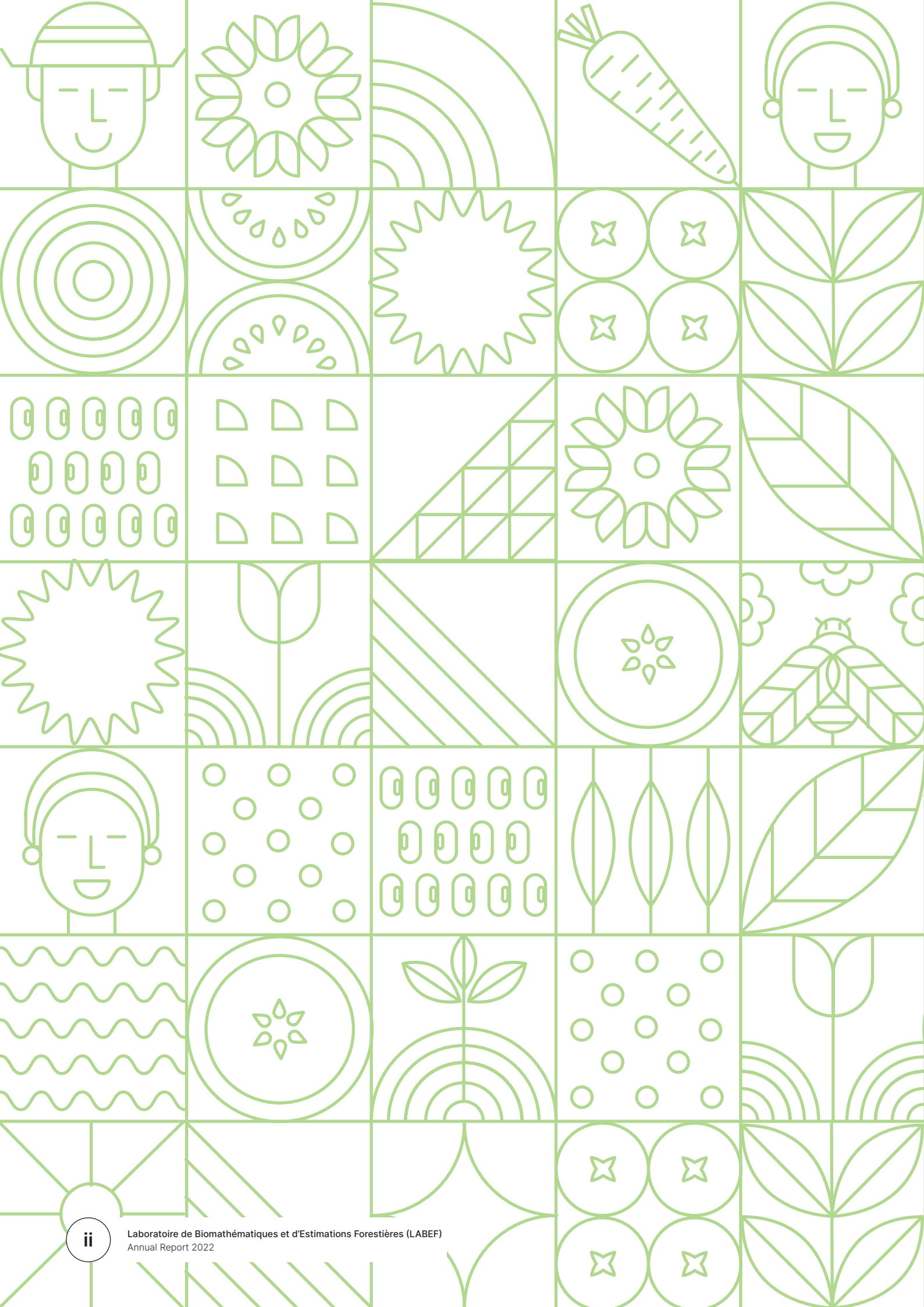


Acknowledgements

This annual report was written under the supervision of Professor Romain Glèlè Kakaï, Head of the “Laboratoire de Biomathématiques et d’Estimations Forestières (LABEF)”. The report was drafted by the scientific coordination with the full commitment of all the other research units of the Laboratory. Gratitude to all members who completed the individual annual report form. We are grateful to all LABEF members for their contributions in framing, editing, and proofreading early drafts of this report. We are hugely thankful for the continued technical and financial support of our partners, which made the highlighted achievements possible.

Abbreviations & Acronyms

AGNES	African German Network of Excellence in Science
EDCTP	European and Developing Countries Clinical Trials Partnership ()
FSA	Faculty of Agronomic Sciences (in English)
HRH	Humboldt Research Hub
IF	Impact factor
INRAB	Institut National de la Recherche Agricole du Bénin (National Institute of Agricultural Research of Benin)
LABEF	Laboratoire de Biomathématiques et d'Estimations Forestières
MSc	Master of Sciences
Ph.D.	Doctor of Philosophy
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
UAC	University of Abomey-Calavi
UNA	Université Nationale d'Agriculture
UP	University of Parakou
WIF	Without Impact Factor

Statement of the head of the Lab

Dear colleagues and friends,

I am delighted, as usual, to introduce the 2022 annual report of the “Laboratoire de Biomathématiques et d’Estimations Forestières” (LABEF).

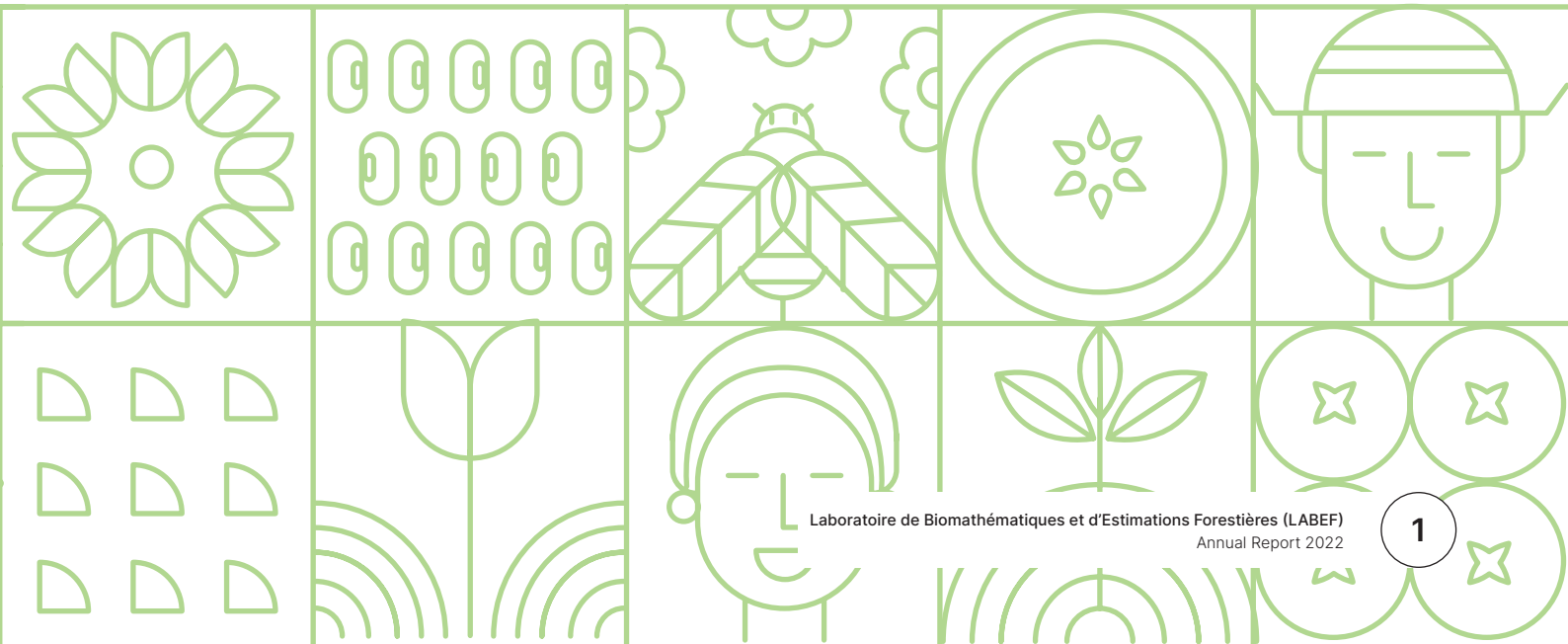
The global pandemic of COVID-19 has continued in 2022 but has been less challenging than in 2021. There has been significant progress of team members, and we have attracted several post-docs and students in our research units.

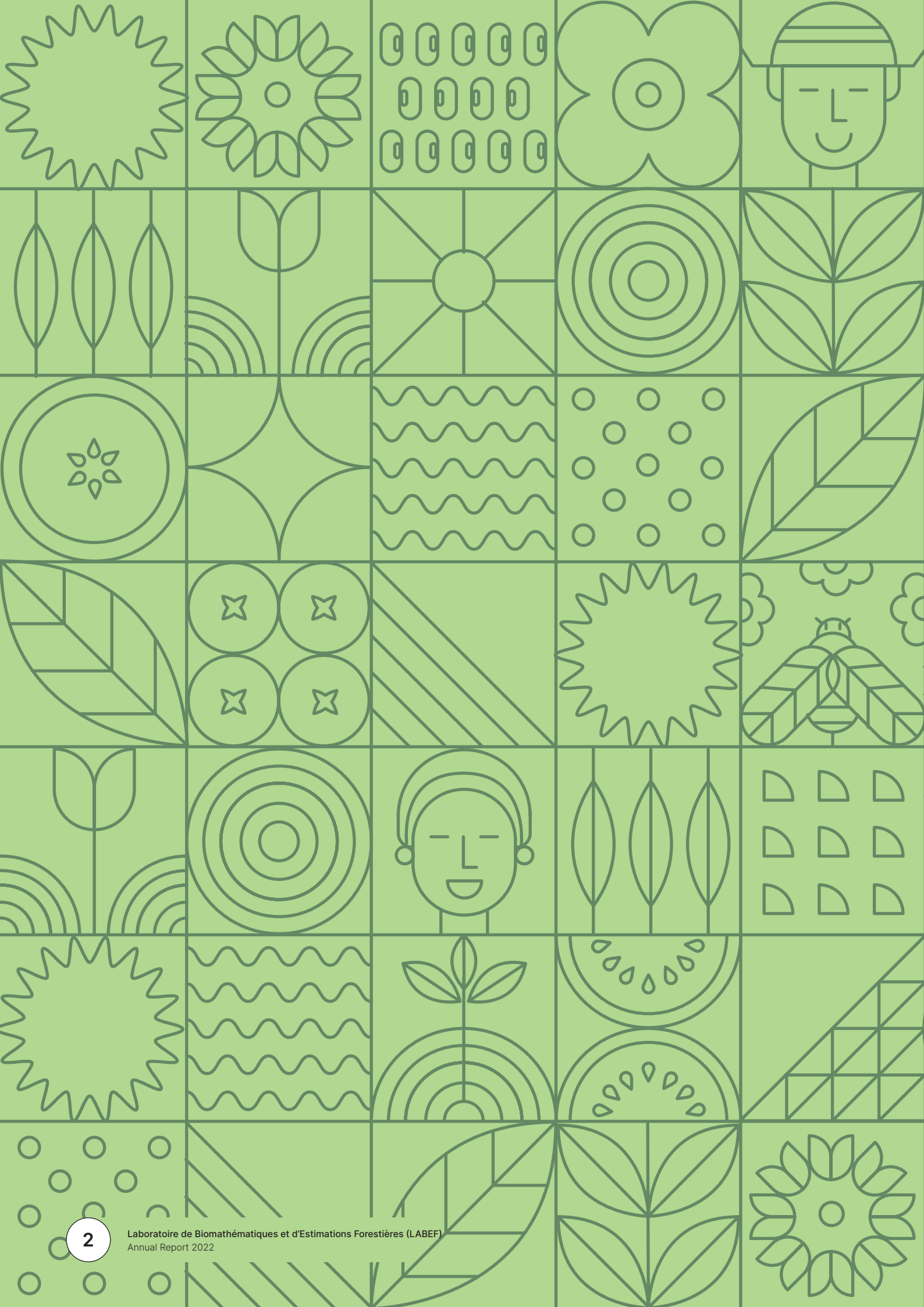
Thanks to the commitment of our members, we have sustained our standards in terms of scientific research. Although we still have room for improvement, I would like to take this opportunity to congratulate all the members for their efforts and contributions to increasing the visibility of the laboratory through the quality of our research and its relevance to society.

LABEF will continue to make climate change and biodiversity conservation a priority of its research themes to inform and guide stakeholders. Mathematical modelling in Forestry has remained a priority of our research agenda, and this is being extended to the field of Epidemiology. Furthermore, Precision Agriculture is now part of LABEF›s research portfolio.

Enjoy reading this report, and I look forward to sharing with you the future progress of LABEF.

Prof. Romain Glèlè Kakaï
Head of LABEF





CHAPTER 1

LABEF: Overview and Team

1.1. Mission, vision, and objectives of LABEF

Created on 27th May 2014 by Romain Glèlè Kakaï, Professor in biometry and forest estimations, the "Laboratoire de Biomathématiques et d'Estimations Forestières", is part of the "Ecole d'Aménagement et Gestion de l'Environnement", Faculty of Agronomic Sciences, University of Abomey-Calavi.

The Laboratory aims to:

- raise awareness of the importance of Mathematics, particularly Statistics in Biological Sciences;
- analyze the applicability of mathematical tools in life sciences with a particular focus on understanding the interactions between ecological processes, anthropogenic factors, and terrestrial ecosystems› structure to deliver clear management actions and policies.

The mission of LABEF is to enhance understanding of biological systems through the effective use of biomathematics.

Its vision is to be, by 2030, a leading institution in developing mathematical tools for biologists and supporting decision-makers in forestry for a better society.

1.2. Organization of LABEF

LABEF is organized into four departments, including the (i) fundraising department, (ii) social life department, (iii) administrative department, and (iv) research department. The research department now includes three units, namely: Unit of Biomathematics (UBM), Unit of Artificial Intelligence and Machine Learning (UAIML), and Unit of Forest Estimations (UFE).

- **The Unit of Biomathematics (UBM)** deals with biology and mathematics and is interested in applications of mathematics in biology. This unit is interested in the use of mathematical theories in biology and especially in publishing scientific notes describing the application of different mathematical tools in life sciences.
- **The Unit of Forest Estimations (UFE)** falls into the overall perspective of assessing wood resources, biomass, and carbon stock available in forest ecosystems. The Unit is interested in developing accurate and robust methods and models for estimating forest resources. It is equally interested in understanding ecological processes and patterns and developing clear and applicable management policies for forest managers and decision-makers. The unit also investigates forest governance approaches, effectiveness, replicability, socio-economic and ecological outcomes, decision-making process, and benefit-sharing.
- **The Unit of Artificial Intelligence and Machine Learning (UAIML)** aims to operationalize and develop machine learning (ML) and artificial intelligence (AI) methods to assist innovation in the field of biology, particularly Forestry and Agriculture.

1.3. Research topic covered at LABEF

The ecosystem of research topics covered at LABEF is diverse and illustrated in figure 1.

Figure 1 *View of research topics covered at LABEF*

1.4. The core management team of LABEF in 2022

Prof Romain Glèlè Kakaï

Prof Romain Glèlè Kakaï is the head of LABEF. He is a Full Professor in Biometry and Forestry, researcher, and lecturer at the Faculty of Agronomic Sciences. Prof Glèlè Kakaï is the chairman of the scientific council of agronomic sciences, chairman of the Scientific Council of the National Institute of Agricultural Research of Benin (INRAB), and chairman of the African German Network of Excellence in Science (AGNES). He is also coordinating the Doctoral program 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 Jonas Doumate

Dr Jonas Doumate is the deputy head of LABEF and head of the Biomathematics research unit. He is Assistant Professor of Mathematics. His research areas include Applied mathematics – Analysis - Mathematical Statistics - Series Analysis – and Financial Mathematics.

Dr Emile Agbangba

Dr Emile Agbangba is the head of the Artificial Intelligence and Machine Learning research unit. His research areas include Machine Learning – Statistical Probability - Climate Science - Linear and nonlinear mixed models.

Dr Kolawolé Valère Salako

Dr Kolawolé Valère Salako is the scientific coordinator and head of the research unit in Forest estimations. He is a lecturer and researcher in Forestry and Biometry. His research areas include population and community ecology – Forest Biometrics – agroforestry systems analysis – multivariate methods in community ecology.

Dr Marcel Donou

Dr Marcel Donou is the head of the social life department. He is also the Teaching manager of the Master Program: Major Biostatistics. His research areas include population Ethnobiology - Conservation Biology – Forest Biometrics.

Carl AKOTO

Carl AKOTO is leading the administrative department. He is in charge of the administration and all related tasks. He assists the coordinator of the master program in statistics major Biostatistics for students' day-to-day management. He ensures that students have their timetable, receive their lectures, submit their homework, and sit their exams on time.

CHAPTER 2

RESEARCH: Milestones & Highlights

2.1. Scientific publications in 2022

2.1.1. Publications Milestones

In 2022, LABEF produced a total of 52 scientific documents. Among these documents (figure 2), 96.23% were scientific publications in peer-review journals (51 published papers), and 3.77% were books and book chapters (1 document).

2.1.2. Diversity of Journals and scientific disciplines covered by publications of LABEF in 2022

In 2022, the scientific articles were published in 41 journals as summarized in table 1. Several research domains were covered. Among the fourteen research domains covered, natural resources management (21 published papers), biostatistics (7 published papers), climate change and Biodiversity (5 published papers), crop sciences (5 published papers), quantitative ethnobotany (3 published papers), climate change and crop sciences (2 published papers), and plant conservation biology (2 published papers) were the most investigated (figure 3).

Scientific documents produced by LABEF in 2022

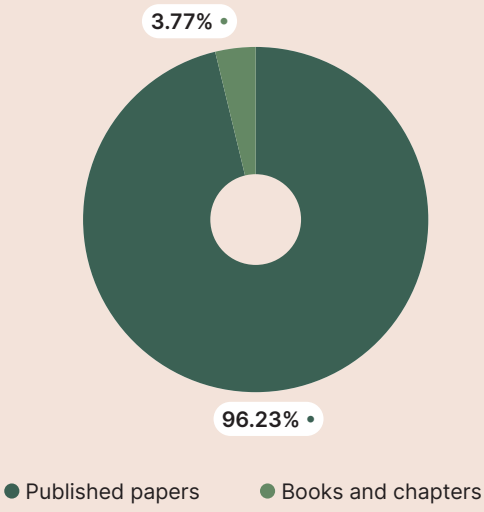


Figure 2 *Scientific documents produced by LABEF in 2022*

Journals	Type of journals	Impact factor (IF)	Number of papers
African Journal of Ecology	IF	0.875	1
Biological Conservation	IF	7.497	1
Biotechnology, Agronomy, Society and Environment	IF	1.087	1
BMC Public Health	IF	4.135	2
Bois et Forêts des Tropiques	IF	0.941	3
Environment, Development and Sustainability	IF	4.08	1
Food Security	IF	7.141	1
Genetic Resources and Crop Evolution	IF	1.876	2
Journal of Arid Environments	IF	2.759	1
Journal of Coastal Research	IF	1.11	1
Journal of Differential Equations	IF	2.615	1
Journal of ethnobiology and ethnomedicine	IF	3.404	1
Land	IF	3.905	2
Scientific reports	IF	4.996	1

Journals	Type of journals	Impact factor (IF)	Number of papers
South African Journal of Botany	IF	3.111	1
Statistics	IF	2.346	1
Sustainability	IF	3.889	1
Trees	IF	2.888	2
Tropical Ecology	IF	1.394	1
Wetlands	IF	2.074	1
Wetlands Ecology and Management	IF	2.134	1
African Crop Science Journal	WIF	-	2
African Journal of Applied Statistics	WIF	-	1
African Journal of Food, Agriculture, Nutrition and Development	WIF	-	1
African Journal of Marine Science	WIF	-	1
Afrique SCIENCE	WIF	-	1
Annales de l'Université de Parakou-Série Sciences Naturelles et Agronomie	WIF	-	1
Bulletin de la Recherche Agronomique du Bénin (BRAB)	WIF	-	1
Environmental Sciences Proceedings	WIF	-	1
Frontiers in Conservation Science	WIF	-	1
GSC Biological and Pharmaceutical Sciences	WIF	-	1
Heliyon	WIF	-	1
International Journal of Biodiversity and Conservation	WIF	-	1
International Journal of Biological and Chemical Sciences	WIF	-	1
International Journal of Fisheries and Aquaculture	WIF	-	1
Journal of Applied Biosciences	WIF	-	1
Makerere University Journal of Agricultural and Environmental Sciences	WIF	-	1
Modeling Earth Systems and Environment	WIF	-	2
Scientific African	WIF	-	1
SSRG International Journal of Agriculture and Environmental Science	WIF	-	1
Trees, Forests and People	WIF	-	3

IF = Impact factored journals, WIF = Without impact factor journals

Table 1 *Diversity of journals for published, in press, and under review papers*

Diversity of research domains for published papers by LABEF in 2022

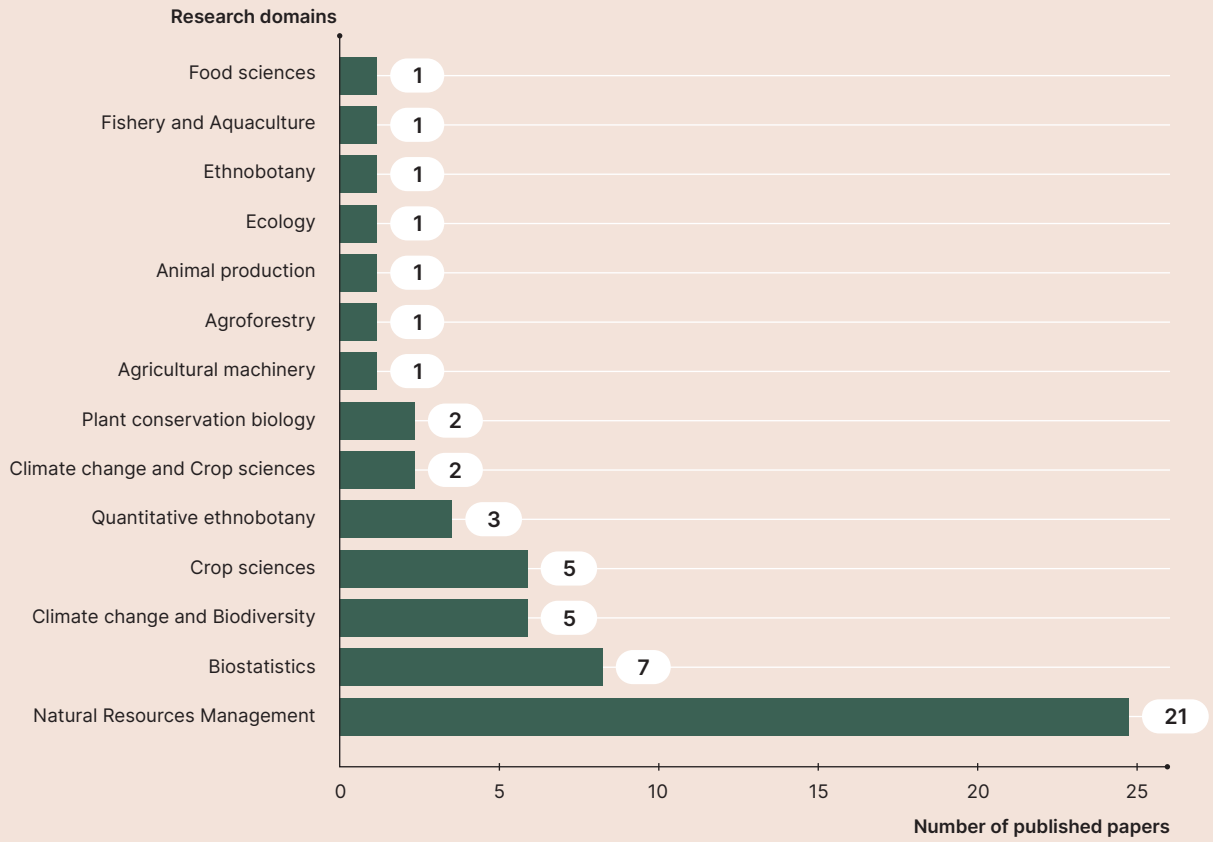


Figure 3 *Diversity of research domains for published papers by LABEF in 2022*

2.1.3. Performance and highlights in publication

LABEF produced slightly more scientific articles in 2022 than in 2021, and the trend has been increasing since 2014 (figure 4a). Among the 51 scientific publications in peer-review journals of 2022, 27 publications (52.94%) were in published in journals with an impact factor (figure 4b).

Trends in annual publications from 2014 (a), and quality of publications (b).

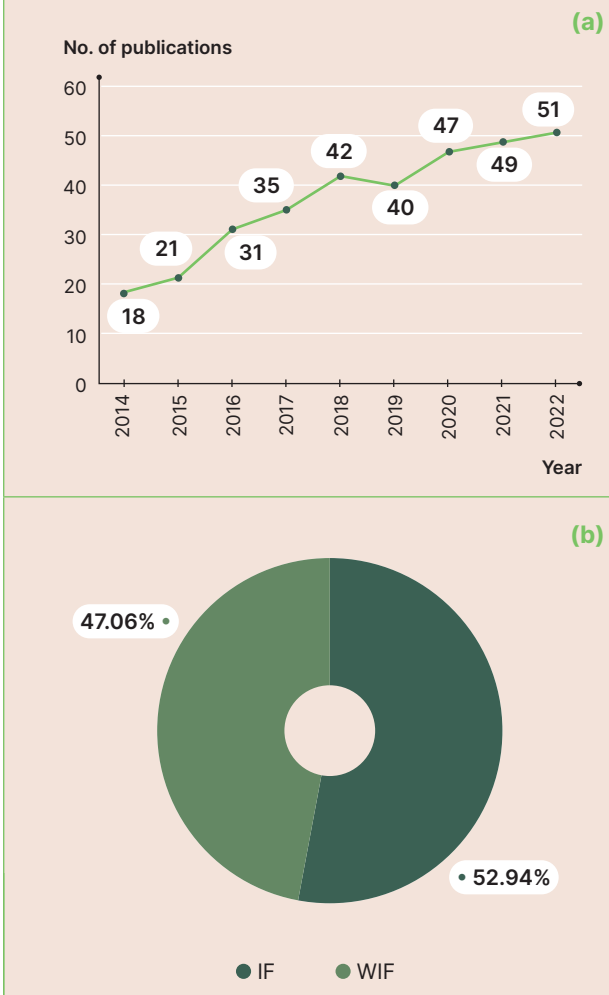


Figure 4 *Trends in annual publications from 2014 (a), and quality of publications (b).*

IF = Impact factored journals, WIF = Without impact factor journals

Among the papers published in peer-review journals with an impact factor in 2022, 7.41% were in journals with an impact factor above 5, 59.26% in journals with an impact factor between 2 and 5, and 18.52% % in journals with an impact factor between 1 and 2 (figure 6).

Range of impact factor of published papers

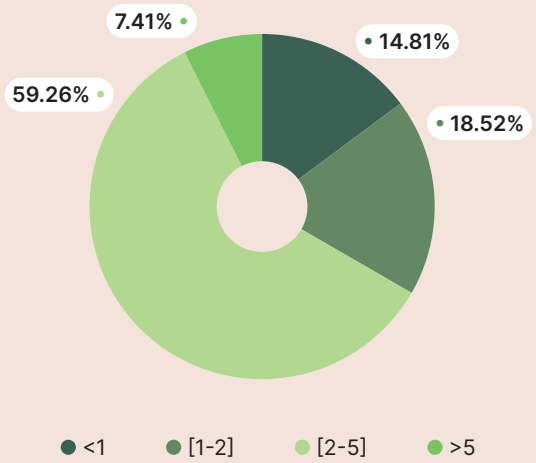


Figure 5 *Range of impact factor of published papers*

2.1.4. Authorship and leadership position in publications in 2021 and 2022

For the 51 scientific papers published in 2022, members of LABEF have occupied variable positions. Members of the lab were exclusively the first author in six published papers (11.76%). In one of the published papers, members of LABEF were among the first three authors (figure 7). The leadership (last) position was occupied by members of the lab in 5.88% of the published papers, while in 37.25% of the papers, the last as well as the first positions were ruled by LABEF's members.

(Co-) Authorship position of LABEF members in publications in 2022

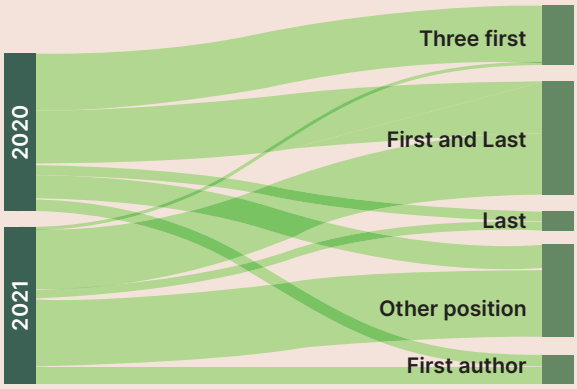


Figure 6 *(Co-) Authorship position of LABEF members in publications in 2022*

2.2. Research projects in 2022

The research projects implemented by LABEF in 2022 included, as usual small (less than USD 25000), medium (USD 25 000-200 000), and large (more than USD 200 000) grants. Six individual small grants were implemented by members of LABEF in 2022 (see table 2).

N°	Funder	Recipient	Topic/subject
1	International Foundation for Science	MENSAH Sylvanus	Assessing the effects of abiotic and biotic factors on the relationship between tree diversity and aboveground tree carbon in West African forests and tree savannas
2	British Ecological Society	MENSAH Sylvanus	Quantifying tree species diversity effects on aboveground tree carbon stock in mixed forest stands in Benin
3	International Foundation for Science	LOKONON E. Bruno	Rural communities-based approach for the sustainable conservation of Caesalpinia bonduc (L.) Roxb in Central and Northern Benin
4	International Tropical Timber Organization	LOKONON E. Bruno	Technical Document Preparation on the Impact of COVID-19 on Sustainable Forest Management in West Africa: cases of Benin, Ivory Coast and Ghana.
5	Artificial Intelligence for Development — AI4D Africa	TAHI Souand	Optimisation of machine learning techniques performances in the prediction of yield of maize cultures under several controlled weather and fertilization patterns
6	Artificial Intelligence for Development — AI4D Africa	HOUETOHOSSOU Ariane	Architectural and parametric optimization of pre-trained Deep Learning algorithms for stress detection on tomato plants under climate and infection based stimulated environment.
7	AGNES-BAYER	HOUNSOU-DINDIN Guillaume	Estimates of Fruit and seed production of Balanites aegyptiaca and Ricinodendron heudelotii in Benin
8	IDEA WILD	AGOUNDE Gafarou	Diversity, socio-economic importance and potential impact of climate change on future distribution of alien invasive plants in Benin: a baseline study to engage conservation NGOs
10	West African Climate Leadership Program (WAfriCLP)	DOGBO Sèdoami Flora	Women in decision-making power in agroforestry systems in Benin

Table 2 *Individual small research grants in LABEF in 2022*

Two medium and five large research projects are being implemented in LABEF in 2022 (Table 3). In the frame of these projects, LABEF partnered with several institutions from diverse countries in Africa (Mali; Burkina Faso; Niger), Europe (Belgium, Denmark), and America (Costa Rica). For more details on these projects, please visit our website: www.labef-uac.org

N°	Project title	Project type	Partner countries	Funding institution	Period
1	Scaling up African baobab food products valuation through enhancement of their safety and value chains for food and nutritional security in Benin (West Africa)	Medium	Benin	Mastercard Foundation & The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)	2018-2022
2	Restauration, conservation et gestion durable des zones humides côtières du Costa Rica face au changement climatique	Medium	Costa Rica ; Benin	French Facility for Global Environment (FFEM)	2018-2022
3	"In-Country/In-Region Scholarship Programme" for Master in Statistics (Major Biostatistics) & Doctorate in Biometrics	Large	Africa	Deutscher Akademischer Austauschdienst German Academic Exchange Service (DAAD)	2019-2022
4	Training epidemiologists and biostatisticians for enhanced response to disease outbreak and epidemic in west Africa – TEBWA	Large	Benin, United Kingdom	European and Developing Countries Clinical Trials Partnership (EDCTP2 / European Union)	2021-2023
5	Humboldt Research Hub Socio-Ecological Modeling of COVID-19 dynamics in Africa (HRH-SEMCA)	Large	Benin, Germany	Humboldt Foundation	2021-2024
6	DELTAS Africa II. Sub-Saharan Africa Consortium for Advanced Biostatistics training. Role: coordinator in Benin (SSACAB)	Large	South Africa, Tanzanie, Malawi, DRC, Benin, Ghana, etc.	African Union	2021-2025
7	Accelerating inclusive green growth through Agri-based Digital Innovations in West Africa (AGriDI)	Large	West Africa	Agropolis fondation	2022-2025

Table 3 *Ongoing medium and large research projects in LABEF in 2022*

2.3. Master, and Ph.D. degree dissertations in 2022

Eleven (11) MSc students (3 females and 8 males) completed their MSc degree at LABEF (figure 7a). Among them, 8 were completed in biostatistics and 3 in natural resources management (figure 7b).

Gender balance (a) and fields of research (b) for Master theses

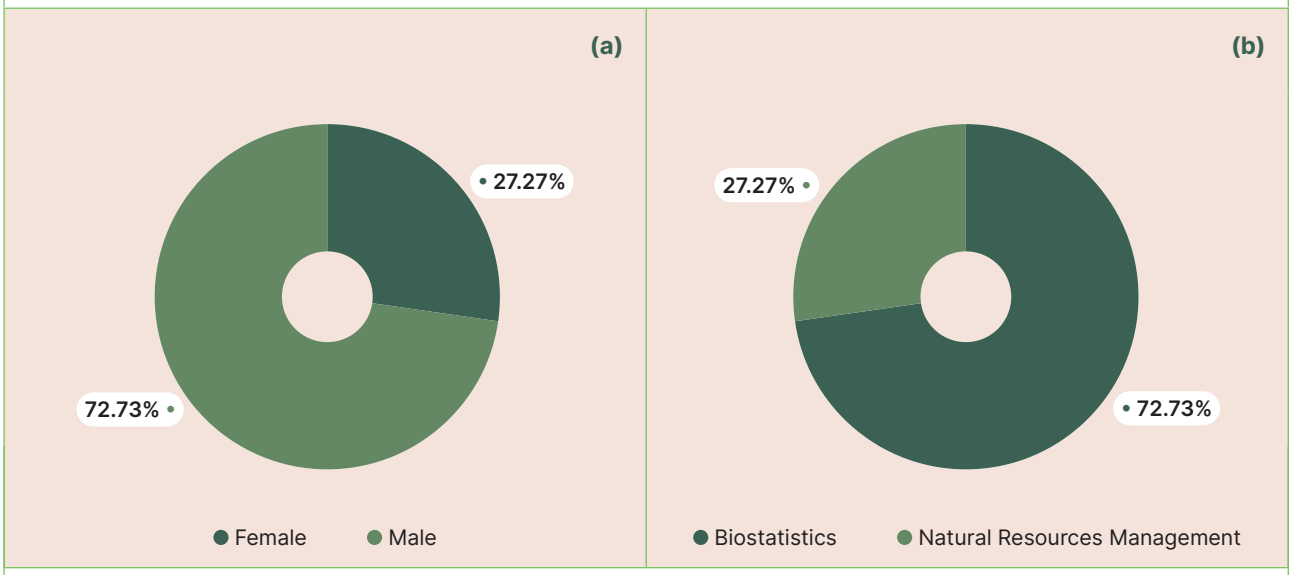


Figure 7 *Gender balance (a) and fields of research (b) for Master theses*

As far as Ph.D. students were concerned in 2022, two students defended their theses in Natural Resources Management. Twenty-seven Ph.D. initiatives are ongoing (9 females and 18 males). These Ph.D. initiatives covered several research domains, with, biometry being the most investigated discipline (22 initiatives, see figure 8a). Moreover, 40.74% of the Ph.D. students are in their first year, while 3.70% are respectively in their fifth and sixth years in 2022 (figure 8b).

Fields of research (a) and stages of ongoing Ph.D. theses in 2022

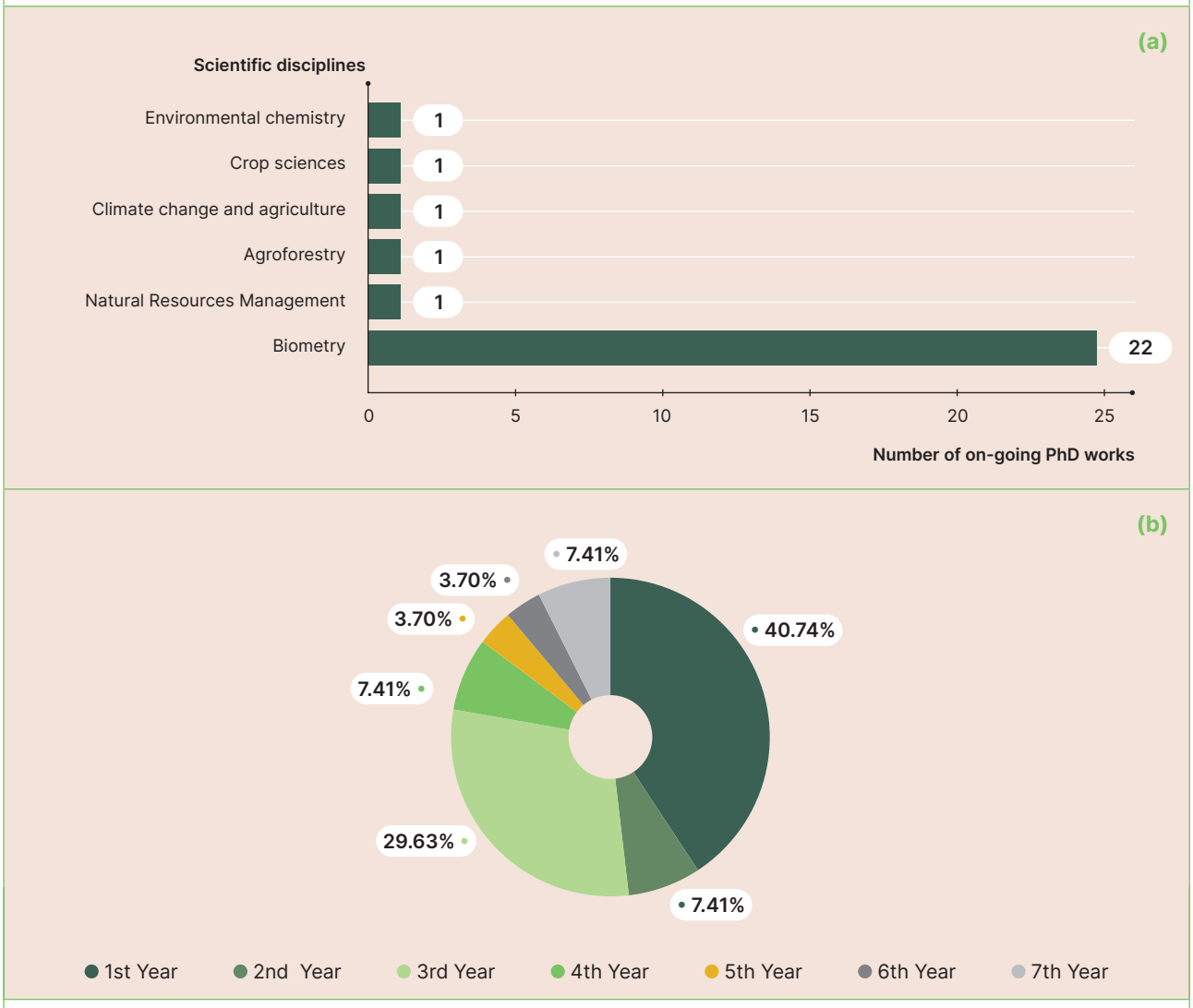


Figure 8 *Fields of research (a) and stages of ongoing Ph.D. theses in 2022*

2.4. Documentary

One documentary was realised in LABEF in 2022 by the PhD student Dogbo Flora on "Agroforestry systems: women's decision-making power in Benin" accessible here: https://www.facebook.com/permalink.php?story_fbid=pfbid02DP8TRisyB2udfDgcoC4PdJirLnvkChN6kxfLB8eHFmpyWd8z1ZyGFJqajcseQrB3l&id=100071811219616

CHAPTER 3

RESEARCH: Connection, share, and networking

3.1. Collaboration for publication in 2022

Collaboration for publications was done with researchers from several countries. In 2022, LABEF members collaborated with researchers from 24 countries, national collaborations being the most dominant (58%, figure 10a). The most represented continent for these collaborations was Africa more than 86%, followed by Europe more than 10% (figure 10b).

Countries (a) and world regions (b) of co-authors of publications of LABEF in 2022

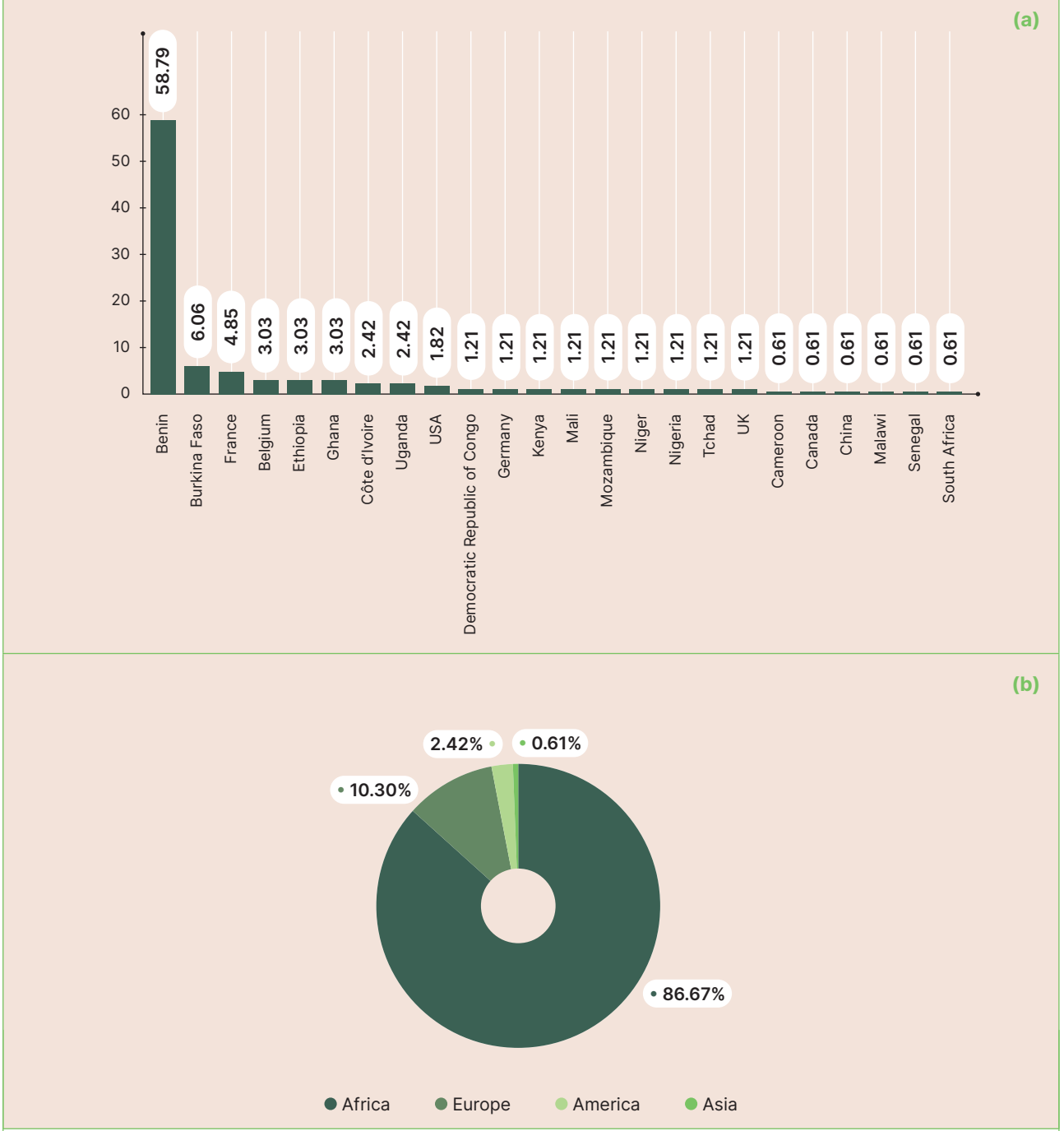
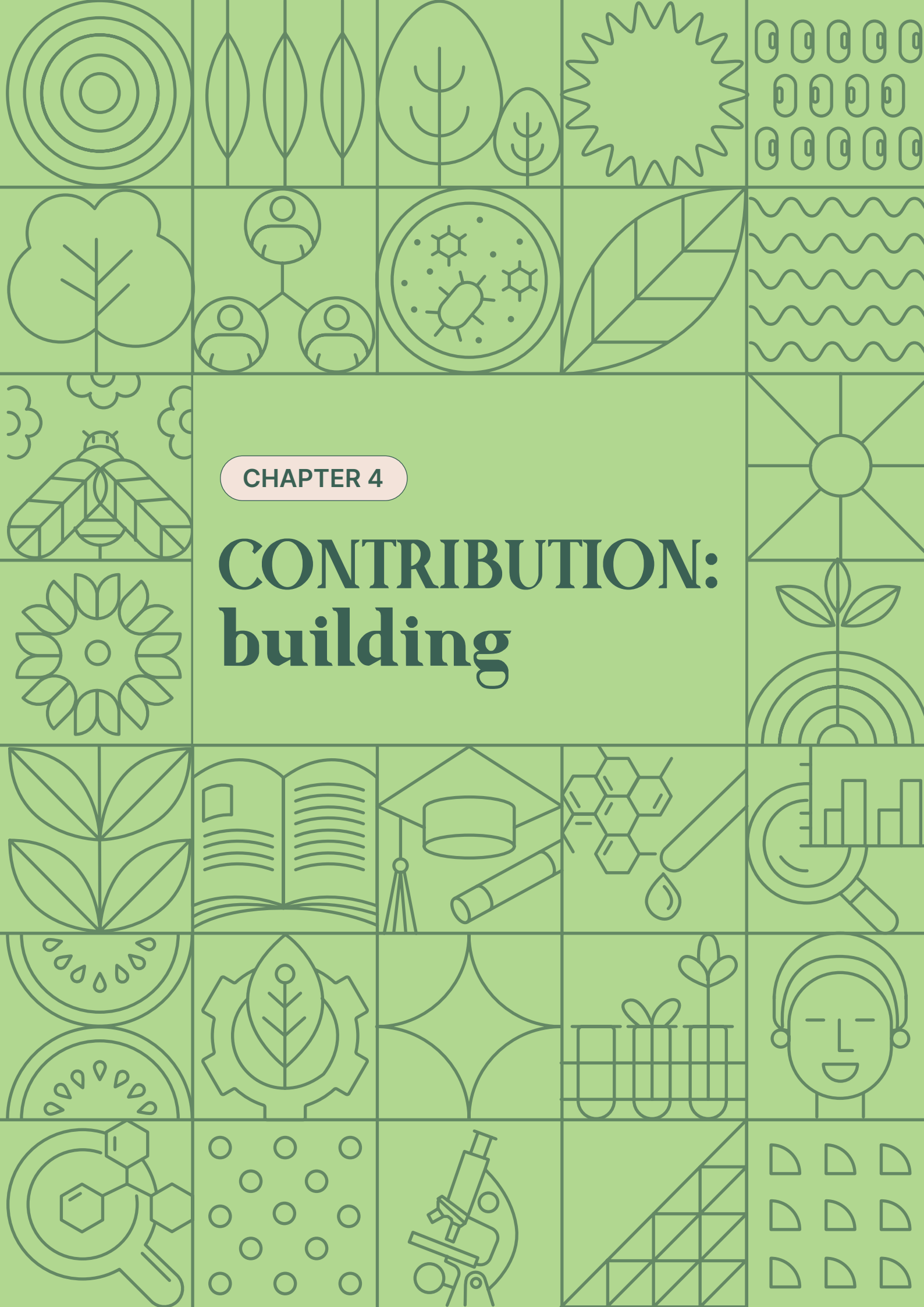


Figure 9 *Countries (a) and world regions (b) of co-authors of publications of LABEF in 2022*

3.2. Visitors to LABEF in 2022

In 2022, LABEF received four international post-Doctoral researchers and one PhD student from two countries (Burkina-Faso, and USA) for visiting research.

N°	Name	Sex	Level	Research topic	Funder	Country	Supervisor(s)	Period
1	Zerbo Issouf	M	Post-Doc	Impact of climate, land use and overexploitation on the conservation of Bombax costatum Pellegr. et Vuillet: a threatened useful woody species from Burkina Faso (West Africa)	DAAD ClimapAfrica	Burkina-Faso	Prof. Romain Glèlè Kakaï & Dr Valère Salako	October to November 2022
2	Tiétiambou Fanta	F	Post-Doc	Combining local perception and ecological niche modelling to understand vulnerability to climate change of priority crops and native woody food species used during the period of food shortage in Burkina Faso	DAAD ClimapAfrica	Burkina-Faso	Prof. Romain Glèlè Kakaï & Dr Achille Hounkpèvi	March 2022 – February 2023
3	Ganame Moussa	M	Post-Doc	Promoting neglected and underutilized leafy vegetable species as resilient climate change adaptation strategies for the local population in Burkina Faso	DAAD ClimapAfrica	Burkina-Faso	Prof. Romain Glèlè Kakaï & Dr (MA) Rodrigue Idohou	September 2022
4	Ouédraogo Hadji Adama	M	PhD Student	Effect of farmers' concern for the environment on the intensity of adoption of agroecological soil conservation technologies	National Research Fund	Burkina-Faso	Dr Valère Salako	August 2022
5	Lynch Lauren	F	Post-Doc	Impacts of Urbanization on Bees and Pollination Services in Abomey-Calavi	Fullbribgt Fellowship	USA	Prof. Romain Glèlè Kakaï & Dr Gbedomon Castro & Dr Valère Salako	Sept 22 – June 23



CHAPTER 4

CONTRIBUTION: building

4.1. Graduate program in Biostatistics and Doctoral program in Biometry

4.1.1. Graduate program in Biostatistics (MBIOST)

4.1.1.1. Presentation of the MBIOST

Since its creation in May 2014, LABEF has been running an international graduate program in Biostatistics. This master's program offers extensive and unique training in recent statistical methods and tools for their applications in Life sciences. At the end of the training, graduated students can easily go into professional life as Biostatisticians or engage in research in Biostatistics by integrating into a doctoral school. This training is open to Bachelor's 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, management, and analysis. The Master in Biostatistics has fully trained and released seven batches of professional biostatisticians and data analysts. The 9th batch of students started in September 2022 and enrolled 29 students from 06 countries (Benin, Burundi, Democratic Republic of Congo, Nigeria, South Sudan, and Uganda). To date, 151 students were trained or are completing their degree in the program. The program is supported by an Intra-ACP Academic Mobility Program (AGREEMENT NUMBER 2013-4177/001-001), RUFORUM, the German Federal Ministry of Education and Research through DAAD In-Country/In Region Program, and the African Excellence Center for Mathematics Sciences and Application (ACE-MSA, through World Bank Group fund).

4.1.1.2. Aims of the MBIOST

The MBIOST program 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, talented Biostatisticians and data analysts. The abilities this training gives in data collection, data management, statistical analysis, and valorization allow graduates to practice the job of Biostatisticians in charge of Statistical Studies in various sectors. Our alumni work as data scientists and Statisticians in multiple institutions (e.g., AfricaRice, MTN, Global Fund TB, Benin National Institute of Agricultural Research, University of Malawi, University of Abomey-Calavi) and PhD-students or post-docs in Africa, Europe, Asia, and America.

4.1.1.3. 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 program, located at the Laboratoire de Biomathématiques et d'Estimations Forestières. Please visit the webpage of the Master for detailed information (http://labef-uac.org/en/master/).

4.1.2. Doctoral program in Biometry

In addition, since 2017-2018, the doctoral school of agronomic sciences and water resources has been offering a Ph.D. program in Biometry under the coordination of Prof Romain Glèlè Kakaï (the head of LABEF and coordinator of the master's program in Biostatistics). Seven new members of LABEF who graduated from the Master's program in Biostatistics are currently enrolled in the PhD program. Thus, to date, 13 students are enrolled in the Ph.D. program, and some are close to their thesis defence and 08 graduated.

CHAPTER 5

Services to society

5.1. Management Forest Inventory for 10 forest reserves of Benin for the project "Projet Forêt Classées du Bénin" (PFC – Bénin)

In 2022, LABEF led a consortium of three institutions, namely the LABEF, the Laboratory of Ecology, Botany and Plant Biology (LEB) of Faculty of Agronomy - University of Parakou, Benin, and the Benin National Herbarium to carry out the Management Forest Inventory for 10 forest reserves of Benin for the project "Projet Forêt Classées du Bénin" (PFC – Bénin). This project is funded by the World Bank with the aim to (i) Improve the integrated management of Forest reserves, (ii) Facilitate access to the main consumption centers for wood-energy produced in a sustainable way and, (iii) promote the value chain of Non-Timber Forest Products. The management forest inventory aims to gather appropriate data on the woody resources essential for planning the sustainable forest management and efficient monitoring of biodiversity. The targeted forest reserves (FR) were: Agoua FR, Dan FR, Logozohe FR, Trois rivières FR, Alibori supérieur FR, Kétou FR, Ouémé Supérieur Ndali FR, Ouémé Boukou FR, Ouenou Benou FR, and Tchaourou-Toui-Kilibo FR. Results from the study were used to update the participative management plan of the forest reserves for the next ten years.

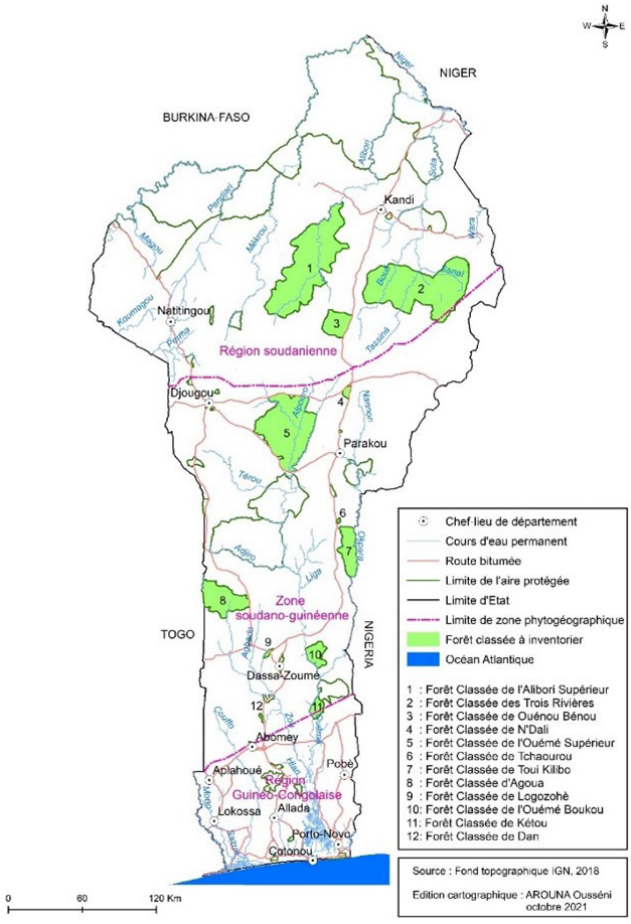


Figure 11 *Map of the ten forest reserves targeted for the study*

Specifically, the study aimed to:

- inventory the woody species of the forest reserves;
- determine the diversity of the forest reserves;
- determine the structural parameters of adult stands and regeneration to better characterize the plant diversity of the forest;
- structurally characterize the main plant communities of the forest reserves;
- identify and geo-reference species and plant communities of major ecological interest to be preserved;
- inventory and quantify the major non-timber forest products to be preserved and enhanced in the forest reserves;
- estimate the annual allowable cut mainly in the production series in the forest reserves; and
- propose follow-up measures and indicators for monitoring the dynamics within the forest reserves.

This study was carried out with the participation of local people, the Direction générale des eaux forêts et chasse of Bénin, local authorities, and researchers from the universities of Benin.

APPENDIX 1

Scientific activities in 2022

A1.1. Defended theses in 2022

Name	Sex	Research topic	Research field
Zanvo Mahoutin Gildas Serge	M	Population structure, dynamics, and ecosystem services of mangroves in southern Benin, West-Africa: implications for sustainable management	Natural Resources Management
Hounsou-Dindin Guillaume	M	Biodiversity and ecological status of wild oil plants implication for conservation and domestication in Benin	Natural Resources Management

A1.2. On-going theses in 2022

N°	Name	Sex	Level	Topic	Field of research
1	ZINZINHEDO Mahoukpégo Luc	M	1st year	Combined approach of Machine Learning and spatiotemporal models for cassava (Manihot esculenta C.) yield prediction in Benin under pathogen infestation conditions.	Biometry
2	GUEDEZOUME Behanzin Marthe Paulette	F	1st year	Using machine learning techniques to predict soil fertility in Benin	Biometry
3	TRAORE Kassifou	M	1st year	A mathematical model for the analysis of malaria incidence and mortality in sub-Saharan Africa: Accounting for population opinion of modern and traditional treatments and prevention methods.	Biometry
4	ODOUNFA Mireille Gloria F.	F	1st year	Using deep learning techniques for early detection of chili (Capsicum spp, Tailor and Francis) diseases under constraints of limited sample image, climate variations, and pests.	Biometry
5	Dereje Gebeyehu Ababu	M	1st year	Cointegration of Markets and Their Impact on Income and Productivity of Cereal Crops Producing Households: The Case of Ethiopia	Biometry
6	Romuald BEH MBA	M	1st year	Empirical performance of Generalized linear mixed model for point-referenced spatial data with Application to epidemiological data: Disease Mapping	Biometry
7	DETE Houénafa Clarisse	F	1st year	Relative performance of model selection criteria based on Kullback's symmetric Divergence in survival analysis with application in animal production	Biometry
8	ANTENEH Leul Mekonnen	M	1st year	Modeling of Cholera Epidemics in Ethiopia	Biometry
9	MONTCHO Yvette	F	1st year	Socio-Ecological and spatio-temporal Modeling of COVID-19 dynamics in Africa	Biometry

N°	Name	Sex	Level	Topic	Field of research
10	ADEOTI Olaiya Mathilde	M	1st year	Bayesian nonlinear modelling for correlated epidemic data using flexible distribution: A Casablanca study with COVID-19 data	Biometry
11	AKIN Y. Yanik	M	1st year	Phylogenetic diversity, perturbation and transient dynamic of tropical fuelwood tree	Biometry
12	AGBANGBA Codjo Emile	M	2nd year	Experimental designs and data analysis with linear model in the presence of spatial autocorrelation with applications in soil sciences	Biometry
13	OROUNLA Bissilimou Rachidatou	F	2nd year	Interplay between personal characteristics, Socio-economic determinants, environmental changes and diseases through Causal Modeling and Structural Equation Modeling	Biometry
14	TABOE Hemaho Beaugard	M	3rd year	Mathematical meta-population models of emerging and re-emerging communicable diseases' dynamic patterns in developing countries: Application to COVID-19 pandemic and Lassa Fever virus outbreak in West Africa.	Biometry
15	TAHI Souand Peace Gloria	F	3rd year	Artificial Intelligence-based problem-solving in agricultural yield prediction: Optimization of Ensemble Learning techniques performances and ability of base regressors in the prediction of yield of maize cultures under several controlled weather and fertilization patterns	Biometry
16	MUSHAGALUSA Ciza Arsène	M	3rd year	Practical use of Random Forest regression for count response data and diseases' vectors abundance prediction: application to ticks (Rhipicephalus appendiculatus) abundance in grazed permanent pastures	Biometry
17	HOUETOHOSSOU Ariane	F	3rd year	Architectural and parametric optimization of pre-trained Convolutional Neural Network (CNN) application on stress detection on tomato plants under climate and infection based simulated environments	Biometry
18	EHNON Gongnet Emmanuel	M	3rd year	Empirical assessment of Bayesian Maximum Entropy (BME) robustness in spatial estimation application on soil data	Biometry
19	BOUROBOU Judie Armel	M	3rd year	Inhomogeneous Poisson Process and its extensions for species distribution analysis: Accounting for sampling bias, imperfect detection, non-linear effect and spatial dependence.	Biometry

N°	Name	Sex	Level	Topic	Field of research
20	MUGUMAARHAHAMA Yannick	M	3rd year	Spatial point process model for analysis of presence-only data: accounting for species characteristics and uncertainties in data	Biometry
21	DAH-DOVONON Virgile-Marx	M	3rd year	Evaluation des stratégies innovantes d'adaptation et apport de l'information climatique dans la Gestion des risques climatiques dans les exploitations agricoles au Bénin	Climate change and agriculture
22	KAKPO Dolou Angeline Reine	F	4th year	Uses, fertilizing power, populations dynamic and conservation of some agroforestry species high soil fertilizing potential in Benin.	Agroforestry
24	DONHOUEDE Janine	F	4th year	Morphological variation, genetic diversity and proximate composition in Annona senegalensis in Western and Southern Africa	Natural Resources Management
23	AHLONSOU Biowa Ceptime Galilée	M	5th year	Empirical performance of Distance functions for farm efficiency analysis application on organic cotton farming systems in Benin	Biometry
25	AMAGNIDE Aubin	M	6th year	Empirical studies of plotless sampling techniques in vegetation studies	Biometry
26	WABI Moudjahid Akorédé	M	7th year	Variabilités climatiques et riziculture au Bénin : cas des communes de Malanville, Glazoué et Tanguiéta	Crop sciences
27	ECLOU Innocent Sènandé Benjamin	M	7th year	Assessing the potential of organic cotton production to improve the livelihoods of millions of poor households in Sub-Saharan Africa (SSA)	Environmental chemistry

A1.3. Completed Master in 2022

N°	Name	Sex	Topic	Supervisor(s)	Field of research
1	Gai Alier John MAKUEI	M	Assessing the effectiveness of combining species' distribution modelling and geostatistical approaches in ecology	Prof. Glèlè Kakai Romain Dr. Vihotogbé Romaric	Biostatistics
2	Nalwanga ROBINAH	F	Assessing the impact of vaccination on the dynamics of COVID-19 in Africa: a mathematical modeling study	Prof. Glèlè Kakai Romain Dr. Doumatè Jonas	Biostatistics
3	Hubert Azonvidé DOSSA	M	Performance of variables selection in logistic regression: A comparison of LASSO, PLS, Information criterion and Significance base procedures	Prof. Glèlè Kakai Romain Dr. Gbemavo D. S. J. Charlemagne	Biostatistics
4	Judicaël LALY	M	Predictive performance of mixed-effects Cox regression and learning neural network model with application in agriculture	Prof. Glèlè Kakai Romain Dr. Gbemavo D. S. J. Charlemagne	Biostatistics
5	Roland Christel SONOUNAMETO	M	A Regression Approach to Assess the Effectiveness of Non-Pharmaceutical Interventions on COVID-19 Epidemic Dynamics in Africa	Prof. Glèlè Kakai Romain Dr. Doumatè Jonas	Biostatistics
6	Sidoine Aude Sèdami Dako	M	Assessing the effects of non-pharmaceutical interventions on the transmission of SARS-CoV-2 across Africa: a compartmental modeling study	Prof. Glèlè Kakai Romain Dr. Doumatè Jonas	Biostatistics
7	Alain KANGELA MATAZI	M	"On the relative performance of five spatial prediction models in Digital soil mapping"	Prof. Glèlè Kakai Romain Dr. Doumatè Jonas	Biostatistics
8	Paustella Gantonho AZOKPOTA	F	Assessing the dynamics of COVID-19 in the face of vaccination in African countries	Prof. Glèlè Kakai Romain Dr. Doumatè Jonas	Biostatistics
9	Aurel Babatoundé Fridolin HANSINON	M	Implications de l'utilisation des traits fonctionnels des bases de données globales sur la relation entre la diversité fonctionnelle et le fonctionnement des écosystèmes	Prof Romain GLELE KAKAÏ	Natural Resources Management
10	Renaud Kévin HOUINATO	M	Estimation de la biomasse aérienne des forêts d'Afrique de l'Ouest : analyse de la précision d'estimation des modèles pantropicaux	Prof Romain GLELE KAKAÏ	Natural Resources Management
11	Surya Nondome Ludmila HAMIDE	F	Analyse de l'effet de la taille d'échantillonnage sur la précision d'estimation de la biomasse des modèles spécifiques et multi-spécifiques	Prof Romain GLELE KAKAÏ	Natural Resources Management

A1.4. Scientific papers published in peer-review journals IF in 2022

N°	Discipline	Authors' Names	Title of the article	Journals	IF
1	Climate change	Amoussou B.E.N., Idohou R., Glèlè Kakaï R., Dauby G., Couvreur T.L.	Impact of end-of-century climate change on priority non-timber forest product species across tropical Africa	African Journal of Ecology	0.875
2	Natural Resources Management	El Hadj Issa A., Gbedomon R.C., Gbemavo D.S.J.C., Mensah G.A., Salako K.V., Sinsin B.	Avantages et bénéfices socio-économiques tirés par les ménages riverains de la Réserve de biosphère transfrontalière W du Bénin (RBTWB)	Bois et Forêts des Tropiques	0.941
3	Natural Resources Management	Atindehou M.M.L., Avakoudjo H.G.G., Idohou R., Azihou F.A., Assogbadjo A.E., Adomou A.C., Sinsin B.	Old Sacred Trees as Memories of the Cultural Landscapes of Southern Benin (West Africa)	Land	3.905
4	Natural Resources Management	Gebremedhn H.H., Kelkay T.Z., Tesfay Y., Tuffa S., Dejene S.W., Mensah S., Devenish A.J.M., Egeru A.	Carbon Stock and Change Rate under Different Grazing Management Practices in Semiarid Pastoral Ecosystem of Eastern Ethiopia	Land	3.905
5	Biostatistics	Doumatè J.T., Salako R.B.	Asymptotic behavior of solutions of an ODE-PDE hybrid competition system	Journal of Differential Equations	2.615
6	Climate change and Crop sciences	Coulibaly M., Idohou R., Akohoue F., Peterson A.T., Sawadogo M., Achigan-Dako E.G.	Coupling genetic structure analysis and ecological-niche modeling in Kersting's groundnut in West Africa	Scientific reports	4.996
7	Natural Resources Management	Gnansounou S.C., Abdul-Kareem R., Gbedomon R.C., Salako, K.V., Mensah G.A., Glèlè Kakaï R.	Impact of Covid-19 on Coastal Fishing and Stakeholders' Response Strategies in Benin, West Africa	Journal of Coastal Research	1.11
8	Natural Resources Management	Ganka G., Salako K.V., Fandohan A.B.	Importance des cultes dans la préservation des espèces d'arbre, le cas du samba (Triplochiton scleroxylon K. Schum.) au Bénin	Bois et Forêts des Tropiques	0.941
9	Natural Resources Management	Avakoudjo H.G.G., Mensah S., Idohou R., Koné M.W., Assogbadjo A.E.	Effects of climate and protection status on growth and fruit yield of Strychnos spinosa Lam., a tropical wild fruit tree in West Africa	Trees	2.888
10	Quantitative ethnobotany	Donhouedé J.C., Salako, K.V., Gandji K., Idohou R., Tohoun R., Hounkpèvi A., Ribeiro N., Ribeiro-Barros A.I., Glèlè Kakaï R., Assogbadjo A.E.	Food and medicinal uses of Annona senegalensis Pers.: a country-wide assessment of traditional theoretical knowledge and actual uses in Benin, West Africa	Journal of ethnobiology and ethnomedicine	3.404

N°	Discipline	Authors' Names	Title of the article	Journals	IF
11	Climate change and Biodiversity	Assogba D., Idohou R., Chirwa P., Assogbadjo A.E.	On opportunities and challenges to conserve the African baobab under present and future climates in Benin (West Africa)	Journal of Arid Environments	2.759
12	Crop sciences	Lokossou J.C., Affognon H.D., Singbo A., Vabi M.B., Ogunbayo A., Tanzubil P., Segnon A.C., Muricho G., Desmae H., Ajeigbe H.	Welfare impacts of improved groundnut varieties adoption and food security implications in the semi-arid areas of West Africa	Food Security	7.141
13	Biostatistics	Damien B.G., Sode A.I., Bocossa D., Elanga-Ndille E., Aguemon B., Corbel V., Henry M., Glèlè Kakaï R., Remoué F.	Bayesian spatial modelling of malaria burden in two contrasted eco-epidemiological facies in Benin (West Africa): call for localized interventions	BMC Public Health	4.135
14	Natural Resources Management	Sinsin L.C.B., Salako K.V., Tohoun R.J., Glèlè Kakaï R.	Survival, Growth, and Productivity of Rhizophora racemosa Transplanted in Natural Ecosystems: Implications for Mangrove Restoration	Wetlands	2.074
15	Biostatistics	Tovissodé C.F., Glèlè Kakaï R.	A generalized stochastic condensation mechanism for inducing underdispersion in count models	Statistics	2.346
16	Natural Resources Management	Gnansounou S.C., Sagoe A.A., Mattah P.A.D., Salako K.V., Aheto D.W., Glèlè Kakaï R.	The co-management approach has positive impacts on mangrove conservation: evidence from the mono transboundary biosphere reserve (Togo-Benin), West Africa	Wetlands Ecology and Management	2.134
17	Biostatistics	Gaffan N., Kpozèhouen A., Dégbey C., Glèlè Ahanhanzo Y., Glèlè Kakaï R., Salamon R.	Household access to basic drinking water, sanitation and hygiene facilities: secondary analysis of data from the demographic and health survey V, 2017–2018	BMC Public Health	4.135
18	Ecology	Hounsou-Dindin G., Idohou R., Donou Hounsode M.T., Adomou A.C., Assogbadjo A.E., Glèlè Kakaï R.	Distribution and structural characterization of Balanites aegyptiaca (L.) Delile and Ricinodendron heudelotii (Bail.) Pierre among phytodistricts and land use types in Benin (West Africa)	Tropical Ecology	1.394
19	Natural Resources Management	Janssens I., Bisthoven L.J., Rochette A., Glèlè Kakaï R., Akpona T.J.D., Dahdouh-Guebas F., Hugé J.	Conservation conflict following a management shift in Pendjari National Park (Benin)	Biological Conservation	7.497

APPENDIX 1 Scientific activities in 2022

N°	Discipline	Authors' Names	Title of the article	Journals	IF
20	Ethnobotany	Sabo P., Salako K.V., Stephen J., Glèlè Kakaï R., Ouédraogo A.	Current knowledge and conservation perspectives of Boswellia dalzielii Hutch., an African frankincense tree	Genetic Resources and Crop Evolution	1.876
21	Natural Resources Management	Sabo P., Salako K.V., Glèlè Kakaï R., Ouédraogo A.	Combined effects of tree size and tapping techniques on resin production of Boswellia dalzielii Hutch., an African frankincense tree	Trees	2.888
22	Natural Resources Management	Gnansounou S.C., Salako K.V., Sagoe A.A., Mattah P.A.D., Aheto D.W., Glèlè Kakaï R.	Mangrove ecosystem services, associated threats and implications for wellbeing in the mono transboundary biosphere reserve (Togo-Benin), West-Africa	Sustainability	3.889
23	Plant conservation biology	Goudegnon E.O., Salako K.V., Teka O., Gouwakinnou G.N., Gandji K., Tohoun R., Oumorou M., Sinsin B.	Effect of seed maturity and morphotype traits on seed germination of Lannea microcarpa in the dry Sudanian region of Benin	Bois et Forêts des Tropiques	0.941
24	Natural Resources Management	Vihotogbé R., Avocèvou-Ayisso C., Djikpo R., Teka O., Sinsin B., Glèlè Kakaï R.	Folk taxonomical distinction between Irvingia gabonensis and I. wombolu (Irvingiaceae) in the Volta Forest region, West Africa	Biotechnology, Agronomy, Society and Environment	1.087
25	Natural Resources Management	Daï E.H., Houndonougbo J.S.H., Idohou R., Assogbadjo A.E., Glèlè Kakaï R.	Current knowledge and future prospects on the declining Uvaria chamae P. Beauv in sub-Saharan Africa: A global systematic review for its sustainable management	South African Journal of Botany	1.087
26	Plant conservation biology	Houehanou T.D., Prinz K., Koua D., Hellwig F., Ebou A., Gouwakinnou G., Assogbadjo A.E., Glele Kakaï R., Zézé A.	Genetic diversity and population structure of a threatened tree species Afzelia africana Sm. ex Pers. among climatic zones for conservation challenges in Benin (West Africa)	Genetic Resources and Crop Evolution	1.876
27	Agroforestry	Compaoré S., Hounkpèvi A., Zerbo I., Belemnaba L., Salako K.V., Gbèmavo C., Ouedraogo S., Thiombiano A.	Impact of vegetation types on the floristic diversity, the availability and the ecological characteristics of five woody species stands used in the management of hypertension and diabetes in southern Burkina Faso	Environment, Development and Sustainability	4.080

A1.5. Scientific papers published in peer-review indexed journals WIF in 2022

N°	Disciplines	Authors' Names	Title of the article	Journals
1	Climate change and Biodiversity	Chérif A.A., Sodé A.I., Houndonougbo J.S.H., Idohou R., Fandohan A.B., Glèlè Kakaï R. Assogbadjo A.E.	Habitat suitability modeling for the conservation and cultivation of the multipurpose fruit tree, Balanites aegyptiaca L., in the Republic of Chad, Sahel	Modeling Earth Systems and Environment
2	Natural Resources Management	Boton D.M., Mensah S., Egeru A., Yamungu A.B.B., Houedegnon P., Namara B.	Performance of collaborative forest management on forest status and contribution to adjacent community livelihoods in Uganda	Makerere University Journal of Agricultural and Environmental Sciences
3	Biostatistics	Honfo S.H., Taboe H.B., Glèlè Kakaï R.	Modeling COVID-19 dynamics in the sixteen West African countries	Scientific African
4	Natural Resources Management	Montcho S.A., Salako K.V., Chadare F.J., Gnansounou S.C., Sohou Z., Failler P., Glèlè Kakaï R., Assogbadjo A.E.	Characteristics and sociocultural impacts of small pelagic fishing by migrant fishers in Benin, West Africa	African Journal of Marine Science
5	Climate change and Crop sciences	Manda L., Idohou R., Assogbadjo A.E., Agbangla C.	Climate Change Reveals Contractions and Expansions in the Distribution of Suitable Habitats for the Neglected Crop Wild Relatives of the Genus Vigna (Savi) in Benin	Frontiers in Conservation Science
6	Biostatistics	Mugumaarhahama Y., Fandohan A.B., Mushagalusa A.C., Sode A.I., Glèlè Kakaï R.	Inhomogeneous Poisson point process for species distribution modelling: relative performance of methods accounting for sampling bias and imperfect detection	Modeling Earth Systems and Environment
7	Natural Resources Management	Lokonon B.E., Gbemavo D.S.J.C., Sodote F.E., Manda L., Glèlè Kakaï R., Sinsin B.	Effect of provenance on population structure and regeneration of six multiple-use tree species along Ouémé catchment in Benin: Implications for conservation	Trees, Forests and People
8	Natural Resources Management	Hounsou-Dindin G., Idohou R., Akakpo A.D., Adome N., Adomou A.C., Assogbadjo A.E., Glèlè Kakaï R.	Assessment of wild oil plants diversity and prioritization for valorization in Benin (West Africa): A multivariate approach	Trees, Forests and People
9	Climate change and Biodiversity	Wouyou H.G., Lokonon B.E., Idohou R., Zossou-Akete A.G., Assogbadjo A.E., Glèlè Kakaï R.	Predicting the potential impacts of climate change on the endangered Caesalpinia bonduc (L.) Roxb in Benin (West Africa)	Heliyon
10	Crop sciences	Katé S., Hounmenou C.G., Déguénon D.D.S.M., Sinsin B.	Study of the Probabilistic Decadal Rainfall Regimes in the Agro-Pastoral Zone of Cotton Production	SSRG International Journal of Agriculture and Environmental Science

APPENDIX 1 Scientific activities in 2022

N°	Disciplines	Authors' Names	Title of the article	Journals
11	Quantitative ethnobotany	Hounsou-Dindin G., Gbedomon R.C., Salako K.V., Adomou A.C., Assogbadjo A.E., Glèlè Kakaï R.	Use and socio-economic values of Ricinodendron heudelotii (Bail.) Pierre, a wild oil species in Benin	International Journal of Biodiversity and Conservation
12	Crop sciences	Gongnet E.E., Agbangba C.E., Affossogbe S.A.T., Glèlè Kakaï R.	Predicting spatial variation in soil nitrogen for sustainable agricultural management in Benin	African Crop Science Journal
13	Agricultural machinery	Dahou N.M., Zokpodo B.K.L., Glèlè Kakaï R.	Impacts du labour motorisé sur le sol et le rendement des cultures : revue critique	Afrique SCIENCE
14	Fishery and Aquaculture	Montcho S.A., Gnansounou C.S., Chadare F.J., Salako K.V., Sohou Z., Failler P., Assogbadjo A.E.	Socio-economic characteristics of the fishing fleets operating in Benin, West Africa	International Journal of Fisheries and Aquaculture
15	Animal production	Behingan M.B., Mama A., Houndonougbo P.V., Koudande D.O., Glèlè Kakaï R., Chrysostome C.A.A.M.	Spatial distribution of goat breeds bred in Benin. International Journal of Biological and Chemical Sciences	International Journal of Biological and Chemical Sciences
16	Natural Resources Management	Gnangle C.P., Abdou N., Zanvo M.S., Amagnidé G.A.Y.G., Kpindjo F., Mama V.J., Agbahungba G.A., Glèlè Kakaï R.	Assessment of the biodiversity of sacred forests in the Atlantic department in Southern Benin	GSC Biological and Pharmaceutical Sciences
17	Crop sciences	Ahlonsou C., Sodinou E., Glèlè Kakaï R.	Distance function approaches for efficiency analysis of organic production units: a critical review	Journal of Applied Biosciences
18	Crop sciences	Ahomondji E.S., Agoyi E., Lokonon B.E., Agbahoungba S., Djanta M.K.A., Assogbadjo A.E., Sinsin B.	Multi Environmental Evaluation of Vegetable Soybean for Adaptation and Stability in Benin	African Crop Science Journal
19	Biostatistics	Gongnet E.E., Agbangba C.E., Affossogbe S.A.T., Glèlè Kakaï R.	Spatial prediction of soil organic matter in Adingnigon (Benin) using Bayesian Maximum Entropy (BME)	African Journal of Applied Statistics
20	Climate change and Biodiversity	Idohou R., Dassou H., Agounde G., Hounsou-Dindin G., Adomou A.C.	Potential Geography and Conservation of Ipomoea beninensis, an Endangered Plant Species for Benin (West Africa)	Environmental Sciences Proceedings
21	Quantitative ethnobotany	Zerbo I., Salako K.V., Hounkpèvi A., Zozoda D., Glèlè Kakaï R., Thiombiano A.	Ethnobotanical knowledge and conservation of Bombax costatum Pellegr. and Vuillet: an overexploited savanna tree species	Trees, Forests and People
22	Food sciences	Koukou E., Amoussa-Hounkpatin W., Savy M., Ntandou-Bouzitou G.D., Mitchodigni M.I., Bodjrènou F.S.U., Tovissode C.F., Termote C.	Contribution of local agrobiodiversity to complementary foods for 6 to 23 months old children in southern rural Benin	African Journal of Food, Agriculture, Nutrition and Development

A1.6. Scientific papers published in non-indexed peer-review journals in 2022

N°	Disciplines	Authors' Names	Title of the article	Journals
1	Natural Resources Management	El Hadj Issa A., Gbemavo D.S.J.C., Hounkpèvi A., Mensah G.A., Sinsin B.	Pressions anthropiques et dynamique des habitats naturels de la Réserve Transfrontalière de Biosphère du W-Bénin	Annales de l'Université de Parakou-Série Sciences Naturelles et Agronomie
2	Natural Resources Management	Padonou E.A., Totin E., Akakpo B.A., Gbenontin E., Kolawole M.A.	Déterminants de l'abandon des foyers améliorés dans les systèmes de production du sel à Djègbadji, au Sud-Bénin	Bulletin de la Recherche Agronomique du Bénin (BRAB)

A1.7. Books and book chapters in 2022

N°	Field of research	Authors' Name	Title	References
1	Natural Resources Management	Salako K.V., Zanvo M.G.S., Sinsin B.C., Gnansounou S.C., Adomou C.A., Glèlè Kakaï R.	Atlas des espèces végétales de la mangrove du Bénin : Diversité, Usages, et Conservation	Salako K.V., Zanvo M.G.S., Sinsin B.C., Gnansounou S.C., Adomou C.A., Glèlè Kakaï R. (2022). Atlas des espèces végétales de la mangrove du Bénin : Diversité, Usages, et Conservation. Laboratoire de Biomathématiques et d'Estimations Forestières. 61p.

A1.8. Participation to conferences/seminars/workshops in 2022

N°	Title, Place and periode of the conference/seminar	Type of Presentation (oral, poster, ..)	Attendee
1	Diversity and prioritization of socio-economically important wild oil plants for valorization in Benin: a multicriteria analysis approach, The XV World Forestry Congress (online), Republic of Korea, 02 - 06 May 2022	Poster	Guillaume Hounsou-Dindin
2	Sustainable Natural Resource Management Summer School, Session II at the Makerere University, Uganda, 13 - 25 June 2022	Oral	Guillaume Hounsou-Dindin
3	A critical review on statistical designs and data analysis in soil science and physico-chemical soil paramaters driving spatial variability in response variables, Institut des Sciences Biomédicales Appliquées (ISBA/CBRSI), Cotonou, Bénin	Oral	
4	La marche vers une agriculture de précision : principales étapes et défis, Laboratoire de Biomathématiques et d'Estimations Forestières, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Bénin	Oral	
5	Association for Tropical Biology (ATBC) Grant writing workshop, United States of America, March 2022	Oral	

APPENDIX 1 Scientific activities in 2022

N°	Title, Place and periode of the conference/seminar	Type of Presentation (oral, poster, ..)	Attendee
6	Multilingual Graduate Student Writers Workshop series, United States of America, March - April 2022	Oral	
7	ACM conference on Equity and Access in Algorithms, Mechanisms, and Optimization (EAAMO'22), Arlington, 6 September 2022	Poster	Souand P.G. TAHI
8	Journée scientifique internationale (JSIL 2022), Togo, 17 - 22 October 2022	Oral	Souand P.G. TAHI
9	Women in Machine Learning (WiLM), event, 5 December 2022	Oral	Souand P.G. TAHI
10	Benin workshop in AI, 19 - 20 December 2022	Oral	Souand P.G. TAHI
11	Young Researchers Overseas Day, Belgique, 12 December 2022	Oral	
12	WASCAL climate days, Togo, 21 au 23 November 2022	Oral	
13	AI4D Africa Summer School/Phd, Kenya, 12 – 16 December, 2022	Oral	
14	Atelier pratique conjoint WASCAL-ICTP sur la technologie HPC pour les sciences du climat, Burkina-Faso, 03 – 13 May 2022	Oral	
15	Wetlands and Disaster Risk Reduction, Webinar conducted by experts from the United Nations Environment Programme (UNEP), Ramsar Regional Center - East Asia (RRC-EA), Ramsar Secretariat, and Wetlands International (WI), 15 December 2022	Oral	
16	Réduction des risques de sécheresse dans la GIRE, Online training, 04 – 22 April 2022	Oral	
17	Deep Learning Indaba, Tunise	Poster	
18	Seminaire scientifique Intelligence Artificielle & Agriculture de Précision, Benin, 25 December 2022	Oral	

APPENDIX 2

Abstracts of published scientific papers in peer-review journals in 2022

Impact of end-of-century climate change on priority non-timber forest product species across tropical Africa

Amoussou B.E.N., Idohou R., Glèlè Kakaï R., Dauby G., Couvreur T.L.

African Journal of Ecology, 60(4), 1120-1132 I **Impact Factor** $_{2021}$: 0.875

DOI : https://doi.org/10.1111/aje.13034

Plant species providing Non-Timber Forest Products (NTFP) are economically important across Africa. How this heterogeneous and understudied resource will respond to ongoing climate change remains understudied. Here, we modelled the impact of end-of-the-century climate change on the distribution of 40 NTFP plant species distributed across tropical Africa. Occurrence data were extracted from a taxonomically verified database and three different ecological niche modelling algorithms were used. Species distributions were modelled under two end-of-century (2085) climate change models (RCP4.5 and RCP8.5) and two dispersal scenarios (limited and expanded). We show that for the 40 NTFP plant species studied here, different responses are modelled with some species gaining in suitable habitats (47.5%–65% under RCP4.5), whereas others will lose in suitable habitats (35%–52.5% under RCP4.5). Nevertheless, we also show that our results vary between the different methods used, such as modelling algorithms, dispersal scenarios and general circulation models. Overall, our results suggest that the response of NTFP species to climate change depends on their distribution, ecology and dispersal ability.

Keywords: Dispersal, NTFP, representative concentration pathways, species distribution modelling

Avantages et bénéfices socio-économiques tirés par les ménages riverains de la Réserve de biosphère transfrontalière W du Bénin (RBTWB)

El Hadj Issa A., Gbedomon R.C., Gbemavo D.S.J.C., Mensah G.A., Salako K.V., Sinsin B.

Bois et Forêts des Tropiques, 352, 13-30 I **Impact Factor** $_{2021}$: 0.941

DOI : https://doi.org/10.19182/bft2022.352.a36373

This study investigated the socio-economic benefits and the relationships in terms of dependence or resources between the W Transboundary Biosphere Reserve (WTBR) in Benin and adjacent communities, over the period from 2000 to 2017. The methodological approach included a survey of opinions and incomes conducted among 340 households. The statistical analyses included logistic regressions and covariance analysis to assess the relationships between residents and the WTBR and their variation over time and space, followed by generalized linear regressions to assess the monetary and non-monetary contributions of the WTBR to the incomes of resident households. The results revealed their dependence on the reserve, particularly for agricultural and grazing land. These relationships varied significantly according to geographical locations (municipality, distance) and were sometimes strong even for households living at a considerable distance from the WTBR. The contribution of the reserve to annual household incomes (from May of year n-1 to April of year n) and cash flows decreased over time to only 3.02% for the 2016-2017 crop year. Furthermore, the results highlight land tenure (agricultural land) and transhumance (rangelands) as issues common to all residents regardless of their geographical location. In the current context of weakening ties and poor economic incentives, households living in or near the WTBR may, at best, lose their motivations to counter internal and external threats to conservation and, at worst, become a threat to conservation themselves. Keywords: income, dependence, W Transboundary Biosphere Reserve (WTBR), protected area, governance, Benin.

Keywords: revenus, dépendance, réserve de biosphère W (RBTWB), aire protégée, gouvernance, Bénin

Habitat suitability modeling for the conservation and cultivation of the multipurpose fruit tree, *Balanites aegyptiaca* L., in the Republic of Chad, Sahel

Chérif A.A., Sodé A.I., Houndonougbo J.S.H., Idohou R., Fandohan A.B., Glèlè Kakaï R., Assogbadjo A.E.

Modeling Earth Systems and Environment, 1-11

DOI : https://doi.org/10.1007/s40808-022-01416-4

Balanites aegyptiaca, a key agroforestry species, is being overexploited in the Sahel due to increasing market demand for its derived products. The present study aims to model the potential current distribution of *B. aegyptiaca* and to assess the potential impact of the future climate (at 2055 and 2085 time horizons) on the species distribution in Chad to identify suitable areas for its further domestication. The principle of maximum entropy (MaxEnt) was used. Species occurrence data combined with bioclimatic data from the AFRICLIM database resulted in ten reduced general circulation models (GCMs) using five regional climate models (RCMs) under the RCP8.5 scenario. The results showed that the rainiest month (BIO13) and the number of dry months (dm) contributed the most to the models' prediction. GCM and RCM models predicted a slight decrease (22.8%) by 2055 and a significant increase (92%) by 2085 in the extent of suitable areas for B. aegyptiaca cultivation. Thereafter, a slight decrease (27.8%) by 2055 and a relatively large extension (56.40%) by 2085 in the extent of suitable areas for its conservation through protected areas were noted. Our findings revealed the conversion of parts of unsuitable areas for the species cultivation and conservation into very suitable areas by 2085. This suggests that further domestication of B. aegyptiaca will be possible over a large part of Chad (46%) in the context of changing climates. These findings should support policy-makers in making reliable decisions toward sustainable management of desert date in the Sahel.

Keywords: Balanites aegyptiaca, Maxent, Climate change, Suitable habitats, Sustainable conservation, Sahel

Old Sacred Trees as Memories of the Cultural Landscapes of Southern Benin (West Africa)

Atindehou M.M.L., Avakoudjo H.G.G., Idohou R., Azihou F.A., Assogbadjo A.E., Adomou A.C., Sinsin B.

Land, 478 I **Impact Factor** $_{2021}$: 3.905

DOI : https://doi.org/10.3390/land11040478

Large old trees (LOTs) are emblematic elements of the cultural landscape and can live for hundreds of years. They represent an intermediate aspect of cultural heritage, linking spirits and humans. They can also provide a range of ecosystem services. In spite of their importance, declining numbers have been reported. This study examined the diversity of LOTs and the impact of anthropogenic threats on their preservation in three districts of southern Benin: Ketou and Abomey, which represent historical districts with royal courts, and Lokossa, which does not have a tradition as a dynastic seat. Semi-structured interviews focused on ethnobotanical aspects and storytelling were conducted with a total of 150 community leaders and traditional practitioners; these were coupled with an inventory of LOTs to demonstrate their importance in maintaining the heritage and providing ecosystem services in cultural landscapes. Diversity, cultural importance, and ethnobotanical indices were calculated to compare positive and negative attitudes towards LOTs by the local people of the study areas. A total of 270 LOT individuals belonging to 14 species were recorded. The most common species was Adansonia digitata (70 individuals), followed by Milicia excelsa (47 individuals), Ceiba pentandra (37 individuals), and Blighia sapida (25 individuals). Sacred forests and the royal palaces (ten for Abomey and three for Kétou), which are protected by a traditional veto, had the highest number of LOTs (145 individuals) belonging to nine species. Details of 79 specific uses were documented for each plant part of LOTs. The most frequently reported were related to medicinal (80.64%), cultic (16.65%), and craft uses (2.6%). Based on a standard area of 100 km2, mean Shannon diversity (H') and evenness (J) were lower in the cultural landscape of Ketou (H' = 0.26 ± 0.42; J = 0.23 ± 0.37) compared to Lokossa (H' = 0.27 ± 0.32; J = 0.21 ± 0.24) and Abomey (H' = 0.42 ± 0.37; J = 0.35 ± 0.31). The threat patterns suggest that, irrespective of the species involved, certain determining factors (urbanization (35%), the timber trade (18%), and decisions made during the Marxist–Leninist revolution in Benin in 1972 (11%)) have affected and continue to affect LOT abundance and diversity. For better management of LOTs, there is a need to promote decision-making strategies that better align human cultural values and ecological objectives.

Keywords: veteran trees, cognitive perception, cultural heritage, state of conservation, Benin

Carbon Stock and Change Rate under Different Grazing Management Practices in Semiarid Pastoral Ecosystem of Eastern Ethiopia

Gebremedhn H.H., Kelkay T.Z., Tesfay Y., Tuffa S., Dejene S.W., Mensah S., Devenish A.J.M., Egeru A.

Land, 639 I **Impact Factor** $_{2021}$: 3.905

DOI : https://doi.org/10.3390/land11050639

Grazing management strategies tend to have different effects on rangeland plant production. Changes in grazing management can, therefore, affect the carbon stock potential of rangelands. Despite rangeland ecosystems being important global sinks for carbon, we know relatively little about the effect of traditional grazing management practices on their potential to store carbon. In this study, we evaluated the carbon stock and change rate of rangelands using three traditional grazing management practices in the semiarid pastoral ecosystem of eastern Ethiopia. By comparing data on vegetation and soil carbon stocks, we found that there was a strong significant difference ($p < 0.001$) between these different management practices. In particular, the establishment of enclosures was associated with an annual increase in carbon stocks of soil (3%) and woody (11.9%) and herbaceous (57.6%) biomass, when compared to communal open lands. Both enclosure and browsing management practices were found to have the highest levels of soil organic carbon stocks, differing only in terms of the amount of woody and herbaceous biomass. Thus, modest changes in traditional grazing management practices can play an important role in carbon storage and sequestration. Further research is required on a wider range of traditional pastoral management practices across space and time, as understanding these processes is key to combating global climate change.

Keywords: open grazing, enclosure, browsing area, climate change mitigation, rangeland ecosystem services, carbon stock

Asymptotic behavior of solutions of an ODE-PDE hybrid competition system

Doumatè J.T., Salako R.B.

Journal of Differential Equations, 216-255 I **Impact Factor** $_{2021}$: 2.615

DOI : https://doi.org/10.1016/j.jde.2022.06.014

We study the large-time behavior of a two-species competition model in a spatially heterogeneous environment and investigate the influence of dispersal strategy on the competition. In particular, we allow one species to exhibit a random dispersal movement while the second species is constrained to a non-spatial movement dynamic. We show that there is a nonnegative threshold number (possibly equal to infinity and determined by both species' local intrinsic growth rates) such that the species adopting the random dispersal strategy persists uniformly in space if its diffusion rate is kept below this number while it goes extinct if its diffusion rate is greater than this number. Furthermore, in the critical case that the diffusing species' movement rate equals this number, exactly two scenarios are possible: the non-diffusing species wins the competition if it has a sink area; otherwise, both species coexist.

Keywords: Competition systems, Reaction-diffusion systems, Asymptotic behavior, Stability

Coupling genetic structure analysis and ecological-niche modeling in Kersting's groundnut in West Africa

Coulibaly M., Idohou R., Akohoue F., Peterson A.T., Sawadogo M., Achigan-Dako E.G.

Scientific reports, 1-18 I **Impact Factor** $_{2021}$: 4.996

DOI : https://doi.org/10.1038/s41598-022-09153-5

Orphan legume crops play an important role in smallholder farmers' food systems. Though less documented, they have the potential to contribute to adequate nutrition in vulnerable communities. Unfortunately, data are scarce about the potential of those crops to withstand current and future climate variations. Using *Macrotyloma geocarpum* as an example, we used ecological niche modeling to explore the role of ecology on the current and future distributions of genetic populations of Kersting's groundnut. Our findings showed that: (1) the models had good predictive power, indicating that *M. geocarpum's* distribution was correlated with both climatic and soil layers; (2) identity and similarity tests revealed that the two genetic groups have identical and similar environmental niches; (3) by integrating the genetic information in niche modeling, niches projections show divergence in the response of the species and genetic populations to ongoing climate change. This study highlights the importance of incorporating genetic data into Ecological Niche Modeling (ENM) approaches to obtain a finer information of species' future distribution, and explores the implications for agricultural adaptation, with a particular focus on identifying priority actions in orphan crops conservation and breeding.

Keywords: Climate sciences, Ecology, Evolution, Genetics, Molecular biology, Plant sciences

Impact of Covid-19 on Coastal Fishing and Stakeholders' Response Strategies in Benin, West Africa

Gnansounou S.C., Abdul-Kareem R., Gbedomon R.C., Salako, K.V., Mensah G.A., Glèlè Kakaï R.

Journal of Coastal Research, 38(2), 279-288 I **Impact Factor** $_{2021}$: 1.11

DOI : https://doi.org/10.2112/JCOASTRES-D-21-00048.1

Coastal fishing is of immense importance in Benin in terms of livelihoods and seafood provision. Yet it is a vulnerable sector that can quickly become unstable, particularly in the presence of external shocks. This study focused on the impact of Covid-19 outbreak on coastal fishing in two coastal communities in Benin and examined the effectiveness of the response strategies put in place by stakeholders. Data were collected following the exploratory sequential mixed method. The approach included in-depth interviews (n = 16) and quantitative surveys (n = 200). The weekly frequencies of fish collection before and during the pandemic were collected and analysed as count data using a Generalized Linear Model with Poisson error distribution. Information on stakeholders' responses and their alternative livelihoods were also collected and analysed using simple likelihood of probability. Findings showed a large disruption of fish collection due to the pandemic, with less educated fisherfolks and those with underlying health conditions more affected ($p = 0.030$ and $p < 0.001$, respectively). More than half (60%) of the surveyed fisherfolks declared that they do not have any alternative livelihoods to sustain their lives in the wake of the pandemic, whereas 15% were engaged in Cyperus articulatus collection, 12% in commercial motorbike riding, 8% in fuel-wood collection, and 5% in agriculture-related activities. Furthermore, 88% of the respondents indicated that they received no help from any stakeholder, whereas 12% agreed that they received face masks. This study provides baseline information to trigger research and field actions to strengthen the fishery industry in Benin in order to withstand disasters like Covid-19. It also makes some suggestions to be considered for small-scale fishery sustainability following the current and future pandemics.

Keywords: Alternative livelihood, Coastal zone, Small-scale fisheries

Effect of provenance on population structure and regeneration of six multiple-use tree species along Ouémé catchment in Benin: Implications for conservation

Lokonon B.E., Gbemavo D.S.J.C., Sodote F.E., Manda L., Glèlè Kakaï R., Sinsin B.

Trees, Forests and People, 7, 100206

DOI : https://doi.org/10.1016/j.tfp.2022.100206

Parkia biglobosa (Jacq.) G. Don, *Pterocarpus erinaceus Poir, Milicia excelsa* (Welw.) C. C. Berg, *Prosopis africana* (Guill., Perrot. and Rich.) Taub., *Afzelia africana* Sm. and *Khaya senegalensis* (Desv.) A. Juss. are the most highly valued indigenous tree species in the agroforestry systems of the Ouémé catchment area. However, information on the population structure of these species is lacking, thus limiting the development of their sustainable conservation, utilization and restoration strategies. This study addressed this gap. It assessed the population structures and regeneration status of the six species from Don, Tan-Houègbo, Atchabita, Bétékoukou, Glazoué, Tchaorou, Zagnanado, Tévèdji, Sinaou and Bétérou along the catchment. Data were collected from 78 permanent rectangular plots (50 × 30 m) randomly installed within 10 provenances. Dendrometric data including diameter at breast height (dbh) of adult trees (dbh ≥ 10 cm), collar diameter, total height of seedlings and saplings, number of individuals per species according to adult, sapling and seedling were recorded. The population structure was described using ecological and dendrometric parameters (relative frequency, importance value index (IVI), mean densities, basal area, mean height), and diameter size-class distributions. Seedling:sapling and sapling:adult ratios were also computed and analyzed for determining regeneration patterns. Based on IVI, Parkia biglobosa (95.85%) and Khaya senegalensis (65.92%) were the most represented species in the catchment area. The analysis of variances showed that dendrometric parameters of the six species varied significantly between provenances. Seedling:sapling and sapling:adult ratios were < 1 for the six species in quasi-totality of the provenances, indicating discontinuous regeneration patterns and low recruitments. All the species showed unhealthy population structures with the predominance of high diameter size-class individuals. To promote conservation and sustainable use of these highly valued species, initiatives aiming introducing juvenile individuals and raising awareness for seedling protection are required in the agroforestry systems of the Ouémé catchment.

Keywords: Multipurpose tree species, Population structure, Regeneration, Agroforestry systems, Sustainable use

Assessment of wild oil plants diversity and prioritization for valorization in Benin (West Africa): A multivariate approach

Hounsou-Dindin G., Idohou R., Akakpo A.D., Adome N., Adomou A.C., Assogbadjo A.E., Glèlè Kakaï R.

Trees, Forests and People, 7, 100210

DOI : https://doi.org/10.1016/j.tfp.2022.100210

Wild oil plants (WOP) are species used for food, cosmetics, nutraceutical, and medicine. In Benin, their importance is still poorly documented. This study investigated the diversity of WOPs and identified priority species for valorization in Benin. Literature synthesis was used to gather data on a list of WOP species. This was completed by ethnobotanical surveys involving users (traditional healers, farmers, fishers, traders, and resource persons), actors in the three biogeographical zones of Benin (Guineo-Congolian, Sudano-Guinean, and Sudanian zones). In addition, field visits to the species habitats were conducted with the help of local populations to assess the true presence of species mentioned during the survey and their availability. Data were collected on the identity of informants, WOPs used or known, ethnobotanical, nutritional and economic values, valorization level, their national distribution and threat status. Data were analysed using the Chi-square test and Principal Component Analysis (PCA). Findings showed that oils extracted from these WOP seeds serve for medicinal (49.25%), food (29.85%), cosmetic (17.91%), and fuel (2.99%) purposes, and neither gender nor the main occupation defined knowledge of WOP diversity. A total of 36 WOPs belonging to 25 botanical families were identified. The top five priority species to be valorized across the country were: *Balanites aegyptiaca* (L.) Delile, *Ricinodendron heudelotii* (Bail.) Pierre, *Lophira lanceolata* Tiegh. ex Keay, *Sesamum indicum* L., and *Cleome gynandra* L. These species were identified as important resources for alleviating poverty and food insecurity in the communities and as potential candidates for the development of the oilseed sector in Benin. Further studies are needed to document the indigenous knowledge associated with those species, existing processing techniques, and exploitable capital to ensure their sustainable management.

Keywords: Wild oil plants, Multivariate analysis, Biogeographical zone, West Africa

Predicting the potential impacts of climate change on the endangered *Caesalpinia bonduc* (L.) Roxb in Benin (West Africa)

Wouyou H.G., Lokonon B.E., Idohou R., Zossou-Akete A.G., Assogbadjo A.E., Glèlè Kakaï R.

Heliyon, e09022

DOI : https://doi.org/10.1016/j.heliyon.2022

Caesalpinia bonduc (L.) Roxb is a medicinal plant with high therapeutic values but declared extinct in the wild in Benin. This study explored the potential distribution and climatic suitability of the species under the present-day and future conditions in Benin, based on two Representative Concentration Pathways (RCP4.5 and RCP8.5) at the 2055-time horizon. The occurrence data were recorded in the distribution area of the species in Benin. These data were supplemented with those from the Global Biodiversity Information Facility (GBIF, www.gbif.org) website and the literature. A total of 23 environmental variables (15 bioclimatic data and 8 biophysical data) were used. The Bioclimatic variables for temperature and humidity were downloaded from Africlim site at 1 km resolution. The biophysical variables concern population, elevation, slope, landcover, wetland, distance to river, soil and distance to dwellings data that are downloaded respectively from DIVA-GIS, ISRIC and SEDAC website at different resolution. A correlation test has been applied to eliminate the highly correlated variables ($r \geq 0.9$) using Pearson correlation coefficient. Species distribution modelling data were processed using five algorithms namely Random Forest (RF), Boosted Regression Trees (BRT), Maximum entropy (MAXENT), Generalized Linear Models (GLM) and Generalized Additive Models (GAM). The results showed that all models performed well with the area under the curve (AUC) values greater than 0.9. The RF, GLM, and GAM models predicted an increase in the suitable areas for the cultivation of the species. BRT and MaxEnt showed a substantial decrease in the suitable areas based on the two scenarios but this reduction is more observed with the MaxEnt model. These results show that climate change and human pressures will have significant effects on the distribution of *C. bonduc* throughout Benin. Sustainable management measures are necessary for *C. bonduc* and should be integrated in development policies to preserve the population of the species from total extinction in Benin.

Keywords: Conservation, Cultivation, Modelling, Endangered species, West Africa

Study of the Probabilistic Decadal Rainfall Regimes in the Agro-Pastoral Zone of Cotton Production

Katé S., Hounmenou C.G., Déguénon D.D.S.M., Sinsin B.

SSRG International Journal of Agriculture and Environmental Science, 9(1), 12-18

DOI : https://doi.org/10.14445/23942568/IJAES-V9I1P103

The study of probabilistic regimes of decadal rainfall in Banikoara commune revealed the existence of stochastic dependence, which was analyzed on the basis of Markov chains applied to two sub-periods (1971-1990) compared to (1991-2010). The results revealed (i) low rainfall variability characterized by a 5% increase in rainfall heights from the first sub-period to the second, a weak distribution of rainfall heights in the two sub-periods, and a lengthening of the wet period by 6 more decades from 1921 to 1973, (ii) the marginal probability of dry decades (58%) is higher than the marginal probability of wet decades (42%) for both sub-periods, leading to a succession of dry states from the first sub-period to the second, without lengthening the dry period; (iii) the drought is recurrent for two or even three decades in a row (93%); the probability of having one wet decade after another wet decade and the probability of having a wet decade after two successive wet decades are high, i.e. 95%; the probability of transition from one dry to another wet decade (6%) and the probability of the opposite transition (4%) are both low. In addition, there is a lengthening of the wet period, a weak distribution of rainfall heights and an alternation of deficit, average and surplus years that are modified by the annual rainfall regime. This expression of climate change is not without consequences on agricultural activities in agro-pastoral zones, particularly on agricultural calendars, sowing periods and therefore on agricultural yields. Thus, it is important to conduct research in relation to the integration of climate change adaptation measures and to develop new agricultural calendars for the use of farmers so that optimal sowing periods for the crops being developed can be determined.

Keywords: *Probabilistic regimes, Decadal rains, Markov chain, Dry decades, Agro-pastoral zone*

Importance des cultes dans la préservation des espèces d'arbre, le cas du samba (*Triplochiton scleroxylon* K. Schum.) au Bénin

Ganka G., Salako K.V., Fandohan A.B.

Bois et Forêts des Tropiques, 351 : 53-65 I **Impact Factor** $_{2021}$: 0.941

DOI : https://doi.org/10.19182/bft2022.351.a36866

Triplochiton scleroxylon K. Schum. est l'une des espèces vénérées des écosystèmes sacrés du Bénin qui revêt une importance socioculturelle. Toutefois, les peuplements naturels de l'espèce sont en déclin et les informations sur ses usages sont quasi non documentées. Cette étude évalue les connaissances locales sur les usages de l'espèce et la distribution desdites connaissances entre groupes ethnolinguistiques, culturels et cultuels au Bénin. Des enquêtes ethnobotaniques individuelles ont été réalisées auprès de 411 adeptes des divinités liées à la conservation de l'espèce au Bénin. Les indices ethnobotaniques tels que la fréquence relative de citation (FRC), la valeur d'usages (VU) total et par organe, et l'indice d'importance culturelle (IC) ont été utilisés pour quantifier la popularité, l'utilisation et l'importance socioculturelle de *T. scleroxylon,* respectivement. Un modèle linéaire généralisé avec la distribution de la binomiale négative a été réalisé pour examiner la variation de la VU entre groupes ethnolinguistiques, culturels et cultuels. Au total, 36 usages spécifiques catégorisés en neuf types d'usages ont été rapportés. Les usages cultuels, médicinaux, artisanaux et comme bois d'œuvre sont les plus cités. Toutes les parties de la plante sont prisées dans la tradition du culte Oro. Les feuilles, racines et écorces sont les organes utilisés pour traiter diverses affections dont les plus populaires sont les affections digestives et gynécologiques. Les connaissances et les usages de l'espèce varient significativement entre les groupes ethnolinguistiques et cultuels. Une singularité des connaissances de *T. scleroxylon* a été observée chez les adeptes du culte Oro. La disparition de cette espèce pourrait avoir des conséquences majeures sur l'identité et la stabilité culturelle et cultuelle des peuples pratiquant cette tradition. Les usages médicinaux populaires rapportés offrent aussi des perspectives pour la valorisation médicinale de l'espèce.

Keywords: Triplochiton scleroxylon, samba, connaissances traditionnelles, valeur d'usage, importance culturelle, forêts sacrées, Bénin

Effects of climate and protection status on growth and fruit yield of *Strychnos spinosa* Lam., a tropical wild fruit tree in West Africa

Avakoudjo H.G.G., Mensah S., Idohou R., Koné M.W., Assogbadjo A.E.

Trees, 1-13 I **Impact Factor** $_{2021}$: 2.888

DOI : https://doi.org/10.1007/s00468-022-02276-2

Abiotic and biotic mechanisms (e.g. climate, human perturbations) are presumed to shape tree growth and reproductive performances. Using the wild fruit tree Strychnos spinosa Lam., as a case study in Benin, we tested whether (and how) tree growth and fruit production were influenced by protection status (non-protected vs. protected sites), climatic zones (Sudanian vs. Sudano-Guinean zones) and size classes (tree diameter < 15 cm; 15–20 cm and > 20 cm). We also tested which climatic variables were important in predicting tree growth/fruit production. Tree growth was only influenced by size class, with higher growth rate in smaller than bigger size classes. Unlike tree growth, fruit production varied significantly with climate and protection status (higher fruit production in Sudano-Guinean than in sudanian zone, and on protected sites than non-protected sites). Fruit production also increased with tree size, and more so on protected sites than non-protected sites. The effect of protection status on fruit production also varied with climatic zones, with protected trees having more fruits than non-protected trees in Sudano-Guinean zone, while both protected and non-protected trees showed similar fruit production in the Sudanian zone. There was a trade-off mechanism between fruit production and growth, which was more pronounced on protected sites. Our study showed that both climate and protection status were considerably important for fruit production, in significant positive (resp. negative) effects of temperature and relative humidity, via mediation by tree size in protected (resp. non-protected) sites. These underlying drivers should be taken into account when predicting scenario for fruit yield under future climate.

Keywords: Tropical plant growth, Fruit yield, Protected area, West Africa, Wild edible plant

Pressions anthropiques et dynamique des habitats naturels de la Réserve Transfrontalière de Biosphère du W-Bénin

El Hadj Issa A., Gbemavo D.S.J.C., Hounkpèvi A., Mensah G.A., Sinsin B.

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Les pressions anthropiques ont accéléré la dégradation des aires protégées surtout dans les pays en voie de développement où les populations dépendent fortement des ressources forestières. La présente étude vise à évaluer l'impact de la gouvernance induite par les différents projets / programmes connus par la Réserve Transfrontalière de Biosphère du W du Bénin (RTBW/B) entre 2000 et 2017 sur son intégrité écologique. De façon spécifique, elle vise à (i) analyser la variation spatio-temporelle des unités d'occupation des terres dans la RTBW/B entre 1990 et 2020 ; et (ii) évaluer la dynamique des indicateurs de pression (défrichement, braconnage, transhumance, pêche illégale, exploitation forestière illégale) sur la réserve de 1990 à 2020. Pour cela, une classification supervisée a été faite sur des images Landsat 4 pour l'année 1990, Landsat 7 pour 2000 et Landsat 8 pour 2020. De plus, une analyse de la tendance des indicateurs de pression a été faite. Les résultats ont montré que le paysage de la RTBW/B s'est fortement dégradé entre 1990 et 2000 avec des taux annuels de changement, certes, relativement bas (entre -0,002 et 0,336 %) mais traduisant une dynamique homogène du paysage. Par contre, entre 2000 et 2020, une nette amélioration du couvert végétal est observée et ceci se traduit notamment par le fait que les mosaïques de champs et jachères ont fortement régressé (ΔS<0 et Tc = -0,822%). De plus, une tendance régressive est globalement notée pour les indicateurs de pression sur la période. Tout ceci pourrait traduire un impact positif des actions des différents projets/programmes mis en œuvre entre 2000 et 2017. Toutefois, il est important de disposer de données sur de longues périodes sur les aires protégées bénéficiaires afin de mieux appréhender les impacts des multiples projets et programmes sur leur intégrité écologique des aires protégées.

Keywords: Aires protégées, pressions anthropiques, Réserve Transfrontalière de Biosphère du W, Landsat, Bénin

Food and medicinal uses of Annona senegalensis Pers.: a country-wide assessment of traditional theoretical knowledge and actual uses in Benin, West Africa

Donhouedé J.C., Salako, K.V., Gandji K., Idohou R., Tohoun R., Hounkpèvi A., Ribeiro N., Ribeiro-Barros A.I., Glèlè Kakaï R., Assogbadjo A.E.

Journal of ethnobiology and ethnomedicine, 18(1), 1-15 I **Impact Factor** $_{2021}$: 3.404

DOI : https://doi.org/10.1186/s13002-022-00510-2

Background. The growing interest for more natural products in food and health industries has led to increasing research on traditional knowledge related to plants. While theoretical knowledge (TK) on the uses of a species informs on the wide spectrum of potential uses of that species, actual uses (AU) highlight their potential being actually used. Distinguishing between the two is important when reporting ethnobotanical studies. However, studies often equated AU and TK, sometimes misleading conclusions, and decision-making. This study assessed TK, AU, and difference between TK and AU of Annona senegalensis and how each is related to factors such as age, sex, sociolinguistic group, and main activity in Benin republic.

Methods. Data were collected through semi-structured individual interviews (n = 755) and analyzed using among others, relative frequency of citation (RFC), and use-value (UV).

Results. A total of 168 theoretical uses were recorded but only 92 were "actually" practiced, of which four were food and 88 medicinal uses. TK and AU were positively correlated. As expected, TK was also significantly higher than AU, indicating that some potential uses of the species are still not valued. Sociolinguistic group and main activity, not age and sex, were the main factors influencing TK, AU, and difference between TK and AU. The highest TK was found with Bariba sociolinguistic group and the highest AU with Otamari. Fruits (100%) and flowers (10%) were the most used organs for food, while leaves (40%) and roots (7%) were mostly used for medicinal purposes. The most common food uses were consumption of the ripe fruits (100%), and food seasoning with flowers (10%). The most cited diseases were malaria (28%) and intestinal worms (8%).

Conclusions. The study illustrated the importance of differentiating between TK and AU. It documented the wide range of the uses of A. senegalensis, while highlighting its most common uses, and the need to better valorize and sustainably manage the species.

Keywords: Use patterns, Knowledge gap, Sociolinguistic groups, Socio-demographic factors, Annona senegalensis

On opportunities and challenges to conserve the African baobab under present and future climates in Benin (West Africa)

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Journal of Arid Environments, 198, 104692 I **Impact Factor** $_{2021}$: 2.759

DOI : https://doi.org/10.1016/j.jaridenv.2021.104692

African baobab *(Adansonia digitata)* is an agroforestry species used by local people for many purposes such as food, medicine, craft, etc. It is uncertain how climate change will impact the suitability of the habitat for the species in Benin. This study aimed to assess the present-day distribution and forecast the probable impact of future climate, and provide sustainable management strategies for the species in Benin. Records of the species were gathered both from fieldwork and through available databases. Environmental data comprised both climatic and soil layers. We transferred the present-day models into future climates under two scenarios (RCP 4.5 and RCP 8.5) using Maxent software. Our results showed high suitability of the Benin territory for African baobab in the present. In addition, high stability of suitable areas was observed for the species in the future across Benin. However, some protected areas are predicted not to effectively conserve the species in the future. We believe that both ex-situ and in-situ conservation measures will help to maintain the African baobab population in the future.

Keywords: Baobab, Habitat suitability, Modeling, Conservation

Performance of collaborative forest management on forest status and contribution to adjacent community livelihoods in Uganda

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It is prominently claimed that including the local community in forest management by adopting Collaborative Forest Management (CFM) approach could help for sustainable forest management. Therefore, information on its effectiveness is still needed for better planning in forest conservation. This study assessed the effectiveness of CFM on both forest status conditions and local community livelihoods in Mabira Central Forest Reserve (MCFR) in Uganda. A floristic survey was conducted to collect data on the species composition in the sites under CFM and Non-CFM. Also, interviews and focus group discussions were used to collect data on the socio-economic aspect of the adjacent local community. Forest species composition status was assessed using common alpha diversity indices (Species richness, Shannon Weiner index, and Simpson index), beta diversity (Jaccard Coefficient), structural vegetation parameters (tree density and basal area) and species Importance Value Index (IVI). Further, size class distribution was established for the two sites (CFM and Non-CFM). Regarding local community livelihood, descriptive and inferential statistics were used. Results revealed that the two sites have low similarity with the CFM site having low species diversity compared to Non-CFM site. The size class distribution of the site under CFM shows stable vegetation, suggesting good regeneration and recruitment potential. In contrary, the adjacent community livelihoods seemed to not be improved after the implementation of the CFM approach. Their income has considerably decreased because most of their activities were based on forest resources. We, therefore, argue that CFM approach should be updated and mixed with a top-down approach to improving forest status and local community livelihoods.

Keywords: Collaborative Forest Management, forest conditions, livelihoods, local community, species diversity

Use and socio-economic values of *Ricinodendron heudelotii* (Bail.) Pierre, a wild oil species in Benin

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International Journal of Biodiversity and Conservation, 14(1), 14-25

DOI : https://doi.org/10.5897/IJBC2021.1526

Ricinodendron heudelotii is a wild oil tree species native to sub-Saharan Africa. It is also found in Benin. Its oil is rich in the essential fatty acids (Omega 3, 6), fat-soluble vitamins (A, D, E and K) and trace elements, essential for human health. Currently, few people know about this oil, likely explaining its almost total absence in rural markets in Benin. The species is also neglected, as little scientific data is available on it in Benin, particularly regarding knowledge on its uses where it occurs. With the aim of filling this gap, ethnobotanical surveys were undertaken to assess the uses of the species, identify factors explaining the variation of its ethnobotanical value, and determine its availability and accessibility for local people. Data were analysed using the relative frequency of citation and generalised linear models. In total, eight uses were enumerated, of which six were for medicinal uses and one for cosmetic and handcraft respectively, and mainly based on its stem. The stem of R. heudelotii was mainly used for handcraft by Nagot and Holli socio-linguistic groups and mainly by men from the Pobe phytodistrict. Although individuals of *R. heudelotii* were absent in southern Benin, its kernel is mainly used for cosmetics and medicine by people from the Fon socio-linguistic group in this region. Field data suggest that the kernels and oil of *R. heudelotii* in this region mainly come from Cameroon and Côte d'Ivoire. The distance travelled to access the species at the time of this study is two times higher than 30 years before and positively correlated with the use-value (r=0.66, P-value<0.001). Our findings suggest that R. heudelotii is marginally used in Benin, and this might be a threat for its conservation and related knowledge.

Keywords: Commercial value, ethnobotanical value, phytodistrict, seed oil, kernel, use-value, West Africa

Welfare impacts of improved groundnut varieties adoption and food security implications in the semi-arid areas of West Africa

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Food Security, 1-20 I **Impact Factor** $_{2021}$: 7.141

DOI : https://doi.org/10.1007/s12571-022-01255-2

This paper investigates the welfare impacts of improved groundnut adoption in Ghana, Mali, and Nigeria using three-year balanced panel data collected from 2,868 households. We apply the Cragg double hurdle model to understand the adoption process and a fixed-effects instrumental variable approach to estimate the impact on gross margins, household income, per capita income, food security, and poverty. The results show that a 10% increase in the area planted with improved groundnut varieties is associated with a 25.6%, 14.8%, 6.9%, and 23.6% increase in groundnut gross margins, household income, per capita income, and food consumption score, respectively. Likewise, this leads to a 3.6% poverty reduction. The highest average impact is found in Nigeria, followed by Ghana and Mali. Furthermore, disaggregating the impacts by adoption history reveals that households that continuously adopted the improved groundnut varieties benefited more than other categories of adopters. They enjoy a 6.6% poverty reduction compared to 1.9% for households that cultivated improved groundnut varieties for a single year. We conclude that improved groundnut varieties' adoption is a promising pathway for rural poverty alleviation and food security improvement. Hence, encouraging households to adopt improved groundnut varieties for consecutive years could help capitalize on income gains and contribute to raising households above the poverty threshold.

Keywords: Poverty, Food consumption score, Panel data, Technology adoption, Ghana, Mali, Nigeria

Modeling COVID-19 dynamics in the sixteen West African countries

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Scientific African, 18, *e01408*

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The COVID-19 pandemic is currently causing several damages to the world, especially in the public health sector. Due to identifiability problems in parameters' estimation of complex compartmental models, this study considered a simple deterministic susceptible–infectious–recovered (SIR)-type model to characterize the first wave and predict the future course of the pandemic in the West African countries. We estimated some specific characteristics of the disease's dynamics, such as its initial conditions, reproduction numbers, true peak and peak of the reported cases, with their corresponding times, final epidemic size and time-varying attack ratio. Our findings revealed a relatively low proportion of susceptible individuals in the region and the different countries (1.2% across West Africa). The detection rate of the disease was also relatively low (0.9% for West Africa as a whole) and <2% for most countries, except for Gambia (12.5 %), Cape-Verde (9.5%), Mauritania (5.9%) and Ghana (4.4%). The reproduction number varied between 1.15 (Burkina-Faso) and 4.45 (Niger), and most countries' peak time of the first wave of the pandemic was between June and July. Generally, the peak time of the reported cases came a week (7-8 days) after the true peak time. The model predicted for the first wave, 222,100 actual active cases in the region at the peak time, while the final epidemic size accounted for 0.6% of the West African population (2,526,700 individuals). The results showed that COVID-19 has not severely affected West Africa as in other regions. However, current control measures and standard operating procedures should be maintained over time to accelerate a decline in the observed trends of the pandemic.

Keywords: SARS-CoV-2 Detection rate, Peak time and size, Final epidemic size, Attack ratio Africa

Bayesian spatial modelling of malaria burden in two contrasted eco-epidemiological facies in Benin (West Africa): call for localized interventions

Damien B.G., Sode A.I., Bocossa D., Elanga-Ndille E., Aguemon B., Corbel V., Henry M., Glèlè Kakaï R., Remoué F.

BMC Public Health, 22, 1754 | **Impact Factor** $_{2021}$: 4.135

DOI : https://doi.org/10.1186/s12889-022-14032-9

Despite a global decrease in malaria burden worldwide, malaria remains a major public health concern, especially in Benin children, the most vulnerable group. A better understanding of malaria's spatial and age-dependent characteristics can help provide durable disease control and elimination. This study aimed to analyze the spatial distribution of *Plasmodium falciparum* malaria infection and disease among children under five years of age in Benin, West Africa. A cross-sectional epidemiological and clinical survey was conducted using parasitological examination and rapid diagnostic tests (RDT) in Benin. Interviews were done with 10,367 children from 72 villages across two health districts in Benin. The prevalence of infection and clinical cases was estimated according to age. A Bayesian spatial binomial model was used to estimate the prevalence of malaria infection, and clinical cases were adjusted for environmental and demographic covariates. It was implemented in R using Integrated Nested Laplace Approximations (INLA) and Stochastic Partial Differentiation Equations (SPDE) techniques. The prevalence of P. falciparum infection was moderate in the south (34.6%) of Benin and high in the northern region (77.5%). In the south, the prevalence of *P. falciparum* infection and clinical malaria cases were similar according to age. In northern Benin children under six months of age were less frequently infected than children aged 6–11, 12–23, 24–60 months, ($p < 0.0001$) and had the lowest risk of malaria cases compared to the other age groups (6–12), (13–23) and (24–60): OR = 3.66 [2.21–6.05], OR = 3.66 [2.21–6.04], and OR = 2.83 [1.77–4.54] respectively ($p < 0.0001$). Spatial model prediction showed more heterogeneity in the south than in the north but a higher risk of malaria infection and clinical cases in the north than in the south. Integrated and periodic risk mapping of Plasmodium falciparum infection and clinical cases will make interventions more evidence-based by showing progress or a lack in malaria control.

Keywords: Malaria, Risk mapping, *Plasmodium falciparum*, Decision making, INLA

Survival, Growth, and Productivity of *Rhizophora racemosa* Transplanted in Natural Ecosystems: Implications for Mangrove Restoration

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Wetlands, 42 (61) | **Impact Factor** $_{2021}$: 2.074

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Mangroves are coastal wetland ecosystems of tropical and subtropical regions. Water and substrate salinities are important drivers of their development and trajectories. Therefore, understanding how main mangrove species respond to salinity gradient when transplanted in natural environment is essential for their restoration. This study assessed the survival, growth, and productivity of *Rhizophora racemosa* seedlings in response to gradient of salinity. Seedlings were grown in nursery under low (3–5 psu) and medium (15–17 psu) water salinities for thirty days and transplanted to three mangrove sites with various salinities (4.6, 11.41, and 18.27 psu). Seedling survival and growth were monitored monthly for 6 months. At the end of month 6, total biomass was harvested and partitioned among plant parts. Results showed that growth, survival, and productivity of *R. racemosa* were mainly influenced not by the salinity under which the seedlings were raised in nursery but rather by site. Survival was higher (88.33%) at the site with the highest salinity. Total plant biomass was similar across sites, but root biomass and root weight ratio were higher on sites with higher salinity. Biomass was disproportionately higher in stems (45–54%) than in roots (28–37%), and leaves (15–18%). We suggest that restoration is done in appropriate period, ideally one month before the start of rainy season. This will not only allow seedlings to well establish their rooting system before rains start but also favour seedling growth, because of substrate salinity dilution by fresh water from rains and flows from uplands.

Keywords: Red mangrove, Restoration, Salinity, Nursery, Growth, Biomass

Predicting spatial variation in soil nitrogen for sustainable agricultural management in Benin

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African Crop Science Journal, 30(4), 539-545

DOI : https://doi.org/10.4314/acsj.v30i4.11

Nitrogen plays an important role in plant nutrition and sustainable agriculture. The objective of this study was to assess the distribution pattern of nitrogen in arable land of Benin. A Bayesian Maximum Entropy (BME) method was used for spatial mapping. Hard data consisted of a total of 305 sampled locations of nitrogen collected at 20 cm depth across the country. Soft data were generated from environmental variables using geographical weight regression (GWR) technique. The study revealed very low (<0.03%) N concentrations across the country. The N concentrations ranged from 0 to 0.8.10-6 %, with higher concentrations in the north and low concentrations beginning from the centre toward the south. In general, low prediction errors (around 0.005) were observed across the country (0.005 to 0.04). The maximum values around 0.035 were due to low sampling density observed at the boundary. These results are important for rational management of nitrogen in fertilisation programmes in Benin.

Keywords: Bayesian Maximum Entropy, Geographical Weight Regression

A generalized stochastic condensation mechanism for inducing underdispersion in count models

Tovissodé C.F., Glèlè Kakaï R.

Statistics, 56 (4), 823-843 | **Impact Factor** $_{2021}$: 2.346

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It is quite easy to stochastically distort an original count variable to obtain a new count variable with relatively more variability than in the original variable. Many popular overdispersion models (variance greater than mean) can indeed be obtained by mixtures, compounding or randomly stopped sums. This work proposes a stochastic mechanism, termed generalized condensation, for the construction of underdispersed count variables (variance less than mean), starting from an original count distribution of interest. For illustrative purposes, we developed the generalized condensed Poisson distribution, which allows for both under- and equidispersion. An application on a dataset demonstrates the potential of the proposal to accommodate underdispersion in the analysis of real count data.

Keywords: Morse-Jewel distribution, condensed Poisson distribution, distribution functions, algebraic moments, Poisson remainder distribution

The co-management approach has positive impacts on mangrove conservation: evidence from the mono transboundary biosphere reserve (Togo-Benin), West Africa

Gnansounou S.C., Sagoe A.A., Mattah P.A.D., Salako K.V., Aheto D.W., Glèlè Kakaï R.

Wetlands Ecology and Management, 30 (6), 1245–1259 | **Impact Factor** $_{2021}$: 2.134

DOI : https://doi.org/10.1007/s11273-022-09894-0

Literature on conservation science has documented the increasing use of the co management approach to effectively conserve natural resources. Although some studies found the co-management approach as highly effective, others also reported some uncertainties associated with the use of this conservation approach. Using the mono transboundary biosphere reserve (MTBR) as a case study, this work assessed the effectiveness of the co-management approach for mangrove conservation in West Africa. Data was collected in two protected sites of the reserve (one in Togo and the other in Benin). Exploratory sequential mixed method via in-depth interviews (n = 17), focus group discussions (n = 14), household surveys (n = 274) and expert-based surveys (n = 10) were carried out, and data was analyzed using the InVEST-based Habitat Risk Assessment (HRA) model, chi-square tests and simple probability of likelihood. Findings showed that the co-management approach has lowered anthropogenic stressors to mangroves in the reserve. Under the co-management approach, all the mangroves located in the Benin side of the reserve are identified as under low risk whereas 42% of the mangrove cover are considered under low risk and 58% under medium risk in Togo. Local perception also portrayed the reduction of mangrove degradation in the study sites following the adoption of the co-management approach in the two countries. However, there are some challenges such as the financial support provision and regular community engagement which need to be thoroughly researched and addressed to achieve the sustainability of the positive impacts of the co-management in the MTBR.

Keywords: Co-management, Habitat, Risk, Assessment, Mangroves, Mono transboundary biosphere reserve, West Africa

Characteristics and sociocultural impacts of small pelagic fishing by migrant fishers in Benin, West Africa

Montcho S.A., Salako K.V., Chadare F.J., Gnansounou S.C., Sohou Z., Failler P., Glèlè Kakaï R., Assogbadjo A.E.

African Journal of Marine Science, 44(3), 215-225

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Small pelagic fish species contribute substantially to the food security and livelihoods of local communities in developing countries. In West Africa, and particularly in Benin, small pelagic fisheries attract many migrant fishers who are key actors in the sector. This study assessed the characteristics and sociocultural impacts of the small pelagic fishery in Benin using qualitative approaches, including focus group discussions (n = 9), in-depth interviews (n = 35), a literature review, direct observations, and secondary data. The findings showed that indigenous fishers from Benin and foreign fishers from Ghana are the two major groups of migrant fishers involved in small pelagic fishing in Benin. These fishers mostly use three categories of fishing gear: gillnets, seine nets, and hooks and lines. Over the period 2014–2018 the annual catch fluctuated between 1 123 and 2 040 tonnes, with the peak catch recorded in 2018, with a commercial value of €3 030 587. Apart from migrant fishers, fishmongers constitute another important pillar of the value chain. Conflicts among migrant fishers in the sector in Benin are related to landing fees and fishing gears. We discuss the urgent need to give attention to the sector through quantitative research and law enforcement to ensure its sustainability.

Keywords: coastal artisanal fishing, fishing gear, fishmongers, focus group discussions, Ghanaian fishers, small-scale fishing, value chain

Impacts du labour motorisé sur le sol et le rendement des cultures : revue critique

Dahou N.M., Zokpodo B.K.L., Glèlè Kakaï R.

Afrique SCIENCE, 14(5), 378-389
ISSN 1813-548X, http://www.afriquescience.net

Impacts of motorized plowing on soil and crop yield: critical review This study deals with the consequences of the adoption of motorized plowing on the physical, chemical and biological properties of tropical soils and the development of crops. The methodology focuses on documentary research around key words: motorized tillage, tillage, soil degradation, soil conservation, Africa. Thirty-four scientific publications obtained from the journals published from 2000 to 2017 permit to summarize and compare the results. The results show that conventional tillage makes the soil less dense, less resistant to rooting and increases its porosity better than minimum tillage and direct seeding. The conventional technique effectively controls weeds but contributes to the decrease of chemical fertility and the low structural stability of the soil by reducing the rate of organic matter than other cultivation techniques. The results also indicate that plowing at a depth of between 15 cm and 20 cm allows optimal cereals yield. This review is useful for the choice of motorized tools and adequate plowing depths that maintain soil fertility and increase crops yields.

Keywords: depth, plowing, tropical soils, fertility, yield

Household access to basic drinking water, sanitation and hygiene facilities: secondary analysis of data from the demographic and health survey V, 2017–2018

Gaffan N., Kpozèhouen A., Dégbey C., Glèlè Ahanhanzo Y., Glèlè Kakaï R., Salamon R.

BMC Public Health, 22, 1345 | **Impact Factor** $_{2021}$: 4.135

DOI : https://doi.org/10.1186/s12889-022-13665-0

In Benin, access to water, sanitation and hygiene (WASH) remains an issue. This study aims to provide an overview of household access to basic WASH services based on nationally representative data. Secondary analyses were run using the 'HOUSEHOLD' dataset of the fifth Demographic and Health Survey 2017–2018. The dependent variables were household access to individual and combined basic WASH services. The characteristics of the household head and those related to the composition, wealth and environment of the household were independent variables. After a descriptive analysis of all study variables, multivariate logistic regression was performed to identify predictors of outcome variables. The study included 14,156 households. Of these, 63.98% (95% CI = 61.63–66.26), 13.28% (95% CI = 12.10–14.57) and 10.11% (95% CI = 9.19–11.11) had access to individual basic water, sanitation and hygiene facilities, respectively. Also, 3% (95% CI = 2.53–3.56) of households had access to combined basic WASH services. Overall, the richest households and few, and those headed by people aged 30 and over, female and with higher levels of education, were the most likely to have access to individual and combined basic WASH services. In addition, disparities based on the department of residence were observed. The authors suggest a multifactorial approach that addresses the identified determinants.

Keywords: Determinant, Logistic regression, Household, Access, Water, Sanitation, Hygiene, Map, National data, Benin

Distribution and structural characterization of *Balanites aegyptiaca* (L.) Delile and *Ricinodendron heudelotii* (Bail.) Pierre among phytodistricts and land use types in Benin (West Africa)

Hounsou-Dindin G., Idohou R., Donou Hounsode M.T., Adomou A.C., Assogbadjo A.E., Glèlè Kakaï R.

Tropical Ecology, (2022), 1-19 | **Impact Factor** $_{2021}$: 1.394

DOI : https://doi.org/10.1007/s42965-022-00244-y

Balanites aegyptiaca (L.) Delile and *Ricinodendron heudelotii* (Bail.) Pierre are multipurpose wild oil plants (WOP) with high socio-economic and ethnoecological importance. Both WOPs remained neglected and underutilized at the national or regional level. In this study, their geographic distribution and structural characteristics were assessed in Benin. Inventory surveys were carried out along 170 linear transects for both species and 488 and 64 circular plots for *B. aegyptiaca* and *R. heudelotii,* respectively. The *dendrometric*, density, and diversity parameters were collected to characterize the stand structure of the species using linear and generalized linear models, Pearson pairwise correlation, Weibull distribution and the Importance Value Index. Adults of *B. aegyptiaca* were exclusively found in the semi-arid zone of Benin. The tree-density increased northward with high value in East Mekrou-Pendjari phytodistrict. The highest value for recruitment was obtained in the Atacora chain and West Mekrou-Pendjari phytodistricts in gallery forest and wooded savannah. As for *R. heudelotii,* adults were found in sub-humid and humid zones with an aggregated spatial distribution. The tree-density of *R. heudelotii* was not significantly affected by phytodistricts and land use types. The recruitment rate was high in South Borgou and West Plateau phytodistricts in the forest. The dendrometric characteristics were high in North Borgou and East Mekrou-Pendjari phytodistricts in farm/parkland for *B. aegyptiaca* and South Borgou and Pobe phytodistricts in gallery forest and forest for *R. heudelotii.* The demographic pattern of these species revealed a low potential for regeneration and recruitment of individuals from low to high diameter classes as a result of anthropogenic pressures. These results demonstrate the need to intensify the domestication or assisted natural regeneration of these species in degraded areas to promote and ensure their sustainable exploitation.

Keywords: Dendrometric characteristic, Ecology, Land use type, Phytodistrict, Tree density, Spatial distribution

Conservation conflict following a management shift in Pendjari National Park (Benin)

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Biological Conservation, 272, 109598 | **Impact Factor** $_{2021}$: 7.497

DOI : https://doi.org/10.1016/j.biocon.2022.109598

A common strategy to counteract global biodiversity loss is sustainable management of protected areas. However, as protection of nature sometimes conflicts with human livelihoods and involves stakeholders with different interests, conservation conflict is globally on the rise. These conflicts can hamper sustainable development, social equity and effective biodiversity conservation. Understanding perceptions of different stakeholders and mapping discourses is key in this respect. In this study, we investigated conservation conflict in the Pendjari National Park in Benin, West Africa. The conservation conflict was fueled in part by a shift from state-led collaborative management to a public-private partnership. Pendjari is the largest remaining savannah ecosystem in West Africa and home to several threatened megafauna species. Using Q methodology, we identified two distinct discourses among stakeholders. The first discourse, supported mainly by formally educated people with non-agricultural jobs, focuses on the limitation of anthropogenic activities in favor of biodiversity conservation. The second discourse is mostly supported by people with a lower education level and a direct dependency on the land. They agree there is a need for conservation but even more so for viable alternatives to ensure people's livelihoods. The identification of these discourses and their underlying drivers can be included into future decision-making processes and management of the Pendjari National Park.

Keywords: West Africa, Stakeholder perception, Participatory management, Public-private partnership, Q methodology, Collaborative governance

Climate Change Reveals Contractions and Expansions in the Distribution of Suitable Habitats for the Neglected Crop Wild Relatives of the Genus Vigna (Savi) in Benin

Manda L., Idohou R., Assogbadjo A.E., Agbangla C.

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Sustainable conservation of crop wild relatives is one of the pathways to securing global food security amid climate change threats to biodiversity. However, their conservation is partly limited by spatio-temporal distribution knowledge gaps mostly because they are not morphologically charismatic species to attract conservation attention. Therefore, to contribute to the conservation planning of crop wild relatives, this study assessed the present-day distribution and predicted the potential effect of climate change on the distribution of 15 Vigna crop wild relative taxa in Benin under two future climate change scenarios (RCP 4.5 and RCP 8.5) at the 2055-time horizon. MaxEnt model, species occurrence records, and a combination of climate- and soil-related variables were used. The model performed well (AUC, mean = 0.957; TSS, mean = 0.774). The model showed that (i) precipitation of the driest quarter and isothermality were the dominant environmental variables influencing the distribution of the 15 wild Vigna species in Benin; (ii) about half of the total land area of Benin was potentially a suitable habitat of the studied species under the present climate; (iii) nearly one-third of the species may shift their potentially suitable habitat ranges northwards and about half of the species may lose their suitable habitats by 5 to 40% by 2055 due to climate change; and (iv) the existing protected area network in Benin was ineffective in conserving wild Vigna under the current or future climatic conditions, as it covered only about 10% of the total potentially suitable habitat of the studied species. The study concludes that climate change will have both negative and positive effects on the habitat suitability distribution of Vigna crop wild relatives in Benin such that the use of the existing protected areas alone may not be the only best option to conserve the wild Vigna diversity. Integrating multiple in situ and ex situ conservation approaches taking into account “other effective area-based conservation measures” is recommended. This study provides a crucial step towards the development of sustainable conservation strategies for Vigna crop wild relatives in Benin and West Africa.

Keywords: crop wild relatives, conservation biases, climate change, in situ conservation, biodiversity conservation

Socio-economic characteristics of the fishing fleets operating in Benin, West Africa

Montcho S.A., Gnansounou C.S., Chadare F.J., Salako K.V., Sohou Z., Failler P., Assogbadjo A.E.

International Journal of Fisheries and Aquaculture, 14(1), 1-14

DOI : https://doi.org/10.5897/IJFA2021.0751

The fishery industry plays a paramount role in poverty alleviation, food security and job creation in Sub-Saharan Africa. Scientific attempts to characterize the sector are however limited. This study used primary and secondary data from 2014 to 2018 to characterize fishing fleets and the diversity of fish species landed in Benin. Primary data were collected via face-to-face interviews and focus group discussions with informants identified using snowball and purposive sampling techniques. Secondary data on the landing statistics for five years (2014-2018) were additionally obtained from the Direction of Halieutic Production (DHP). Findings showed that five fishing fleets are currently operating in Benin, including the Artisanal National Continental Fleet (ANCF), Artisanal National Maritime Fleet (ANMF), Artisanal Foreign Maritime Fleet (AFMF), National Industrial Fleet (NIF) and Foreign Industrial Fleet (FIF). The mean annual volume from all the fishing fleets for the study period was 52,997 plusmn; 12,269 tons, with an average commercial value of 82,194,096 plusmn; 17,618,162 euros per year. Also, 48 species were recorded for the ANMF, 36 families of freshwater species for the ANCF, 43 species for AFMF, and 40 species for FIF. The catch volumes and their associated commercial values showed significant difference across the fishing fleets (ANOVA, plt; 0.05). This study highlights the paramount importance of the Artisanal National Continental Fleet in Benin and provides useful information for regional and global assessment of the fishery industry in the country

Keywords: Fisheries, fleets, short-term assessment, West Africa.

Inhomogeneous Poisson point process for species distribution modelling: relative performance of methods accounting for sampling bias and imperfect detection

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Modeling Earth Systems and Environment, 8, 5419–5432

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Species distribution models (SDMs) have become tools of great importance in ecology, as advanced knowledge of suitable species habitat is required for the process of global biodiversity conservation. Presence-only data are the more abundant and readily available data widely used in SDM applications. These data should be treated as a thinned Poisson process to account for detection errors related to sampling bias and imperfect detection that arise in them. Failure to do so could be detrimental to SDM's predictions. This study assesses the effects of the species abundance, the variation in detection probability, and the number of sites visited in planned surveys on the performance of SDMs accounting for detection errors using simulated data. The results show that the accuracy and precision of estimates differ depending on models and species abundance. Their main difference lies in their ability to estimate β0, the model intercept. The lower the species abundance, the higher the bias and variance of β0^. Furthermore, the lower the detection probability, the higher the bias and variance of β0^. However, β1, the slope parameter, is estimated with almost high accuracy and precision for all models. This study demonstrates the low efficiency of accounting for sampling bias and imperfect detection based on presence-only data alone. Analysing presence-only data in conjunction with point-count outperformed the other approaches, whatever the species abundance, as long as the detection probability is at least 0.25 with average values of detectability covariates. The acceptable accuracy and precision, the minimum number of sites to consider vary depending on species abundance. At least 200 sites are required for the rare species, whereas 50 sites can suffice for the abundant species. Since collecting high-quality data are very expensive, this study emphasizes the need to promote initiatives such as citizen science programs that aim to collect species occurrence data with as little bias as possible.

Keywords: Integrated Species distribution models, Hierarchical models, Maximum likelihood estimates, Data quality, Presence-only data, Point-count, Site-occupancy.

Current knowledge and conservation perspectives of Boswellia dalzielii Hutch., an African frankincense tree

Sabo P., Salako K.V., Stephen J., Glèlè Kakaï R., Ouédraogo A.

Genetic Resources and Crop Evolution, 69, 2261–2278 | **Impact Factor** $_{2021}$: 1.876

DOI : https://doi.org/10.1007/s10722-022-01408-4

Boswellia dalzielii Hutch. is a valuable West African native frankincense tree species. The stem bark has a high traditional medicinal value throughout its range. The resin has great economic potential even though it is little exploited in West Africa, making it one of the neglected and underutilized species. Current anthropogenic pressure on natural habitats coupled with climate change are serious threats to the species. As such, gathering and synthesizing existing information on the species are necessary for its sustainable management. Thus, this study aims to synthesize existing knowledge on *B. dalzielii* and to identify priorities for future research. Articles were searched in Google Scholar, Web of Science, Scopus, and Open-Thesis. One hundred and eight (108) publications were recorded and analyzed. Results showed that more than half (51%) of the studies were conducted in the last four years (2017–2020). The majority (57%) of the studies focused on medicinal properties and 20% specifically on phytochemistry, with a wide variety of therapeutic properties and traditional medicinal uses identified. The species is widely distributed throughout sub-Sahel and Sudanian regions of Africa, typically occurring in low-density stands with populations concentrated in Burkina Faso, Cameroon, and Nigeria. However, natural regeneration is often limited, with poor seed fertility and reduced seedling recruitment in stands. Given the socioeconomic value and regeneration concerns, research is urgently needed on the species population biology and ecology, its population genetics, effective propagation methods, and sustainable resin harvesting practices and management.

Keywords: Boswellia, Non-timber forest products, Medicinal species, Review, Propagation, Semi-arid area

Combined effects of tree size and tapping techniques on resin production of *Boswellia dalzielii* Hutch., an African frankincense tree

Sabo P., Salako K.V., Glèlè Kakaï R., Ouédraogo A.

Trees, 36, 1697–1710 | **Impact Factor** $_{2021}$: 2.888

DOI : https://doi.org/10.1007/s00468-022-02320-1

Boswellia dalzielii Hutch. is an African frankincense tree species with high medicinal and economic values mostly derived from its resin. In Burkina Faso, it has potentials to be the source of significant income for local communities, but it is currently neglected and underutilized. This study aims to assess the species resin production in relationship to tree size, tapping technique, season, intensity, and frequency of harvesting in natural stands of Sudano-Sahelian zone of Burkina Faso. Two independent experiments were conducted on resin yield: (i) experiment 1 combined the tapping technique (six techniques) and tree stem-diameter (10–20 vs. 20–30 cm) using 120 trees; (ii) experiment 2 used the slant incisure tapping technique (best from the first experiment) and combined five tapping intensities (number of grooves: 2, 4, 6, 8 and 10), period of tapping (cold vs. hot dry season), and tree stem-diameter (10–20, 20–30, and > 30 cm), using 90 trees. For each experiment, resin production was collected every 2 weeks for 12 weeks. Analysis of variance and linear mixed model on longitudinal data were used for data analyses. All trees had exudated resin and the average resin yield per tree was 36.28 ± 8.62 g (experiment 1) and 40.43 ± 3.82 g (experiment 2). Tapping techniques and intensity, and tree stem-diameter had significant ($P < 0.001$) effect on resin yield. Slant incisure tapping yielded the highest resin production, followed by tapping in E-shape cut, V-shape cut and circular tape (intermediate yield production), whereas thin deep vertical incisure and node tape gave the lowest resin production. Larger trees exuded higher quantity of resin. Higher tapping intensity and frequency (wound renewal) also gave higher resin production. Trees tapped during hot dry season produced 1.23 times higher quantity of resin (44.58 ± 7.51 g) than in cold dry season. The findings of this research could help design better harvesting strategies for the sustainable management of *B. dalzielii* resources in West Africa.

Keywords: Non-wood forest products, Tapping techniques, Seasonality, Yield, Burkina Faso

Mangrove ecosystem services, associated threats and implications for wellbeing in the mono transboundary biosphere reserve (Togo-Benin), West-Africa

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Sustainability, 14(4), 2438 | **Impact Factor** $_{2021}$: 3.889

DOI : https://doi.org/10.3390/su14042438

Mangroves are important coastal ecosystems, which deliver diverse and crucial services to humans. This study explored the diversity of mangrove ecosystem services, their associated threats as well as their contribution to livelihoods and wellbeing of coastal communities in the Mono Transboundary Biosphere Reserve (MTBR) located between Benin and Togo. Data were collected using the exploratory sequential mixed method. The approach included field reconnaissance, focus group discussions (n = 14), in-depth interviews (n = 17), household survey (n = 274) and direct observations. A total of 21 services and 7 associated threats were recorded in the entire reserve. Provisioning services were the most important service for mangroves in the reserve followed by supporting services, regulating services and cultural services. Change in water salinity, mangrove overharvesting and illegal, unreported and unregulated fishing were the three major threats to mangrove ecosystem services in the reserve. Most of the respondents indicated that the current flow of provisioning services, regulating services and cultural services does not sustain their wellbeing and livelihoods. However, the perception varied significantly across respondents' gender, ethnical groups, educational background and country. Our study showed some similarities between the two countries but also highlighted important differences which can assist the sustainable management of mangroves in the MTBR.

Keywords: wellbeing; mangroves; ecosystem services; mono transboundary biosphere reserve; West-Africa

Spatial distribution of goat breeds bred in Benin. International Journal of Biological and Chemical Science

Behingan M.B., Mama A., Houndonougbo P.V., Koudande D.O., Glèlè Kakaï R., Chrysostome C.A.A.M.

International Journal of Biological and Chemical Sciences, 16(2): 543-554

DOI : https://dx.doi.org/10.4314/ijbcs.v16i2.3

Characterization of local goat breeds is an important step for the development of its breeding. This characterization cannot be done without knowing the size and the spatial distribution of the existing breeds. Thus, this work was carried out to study the spatial distribution of goat breeds bred in Benin. To achieve this, 498 breeders spread across the three climate zone of Benin were subjected to semi-structured individual interviews. The data collected were the socio-demographic characteristics of breeders, the number of breeds bred and the size of the herd per breed. Descriptive statistics, and the generalized linear model of Poisson family were used for data analysis. Results showed that breeders were mainly male (54.02%), married (88.15%) with a high rate of non-education (65.26%). The number of breeds bred by breeders in Guinean zone was 3 (West African Dwarf (WAD), Sahelian and Maradi goat) but 4 Soudanian and Soudano-Guinean zone (WAD, Sahelian, Maradi goat and Saanen). Despite the diversity of this breeds in the climate zone, only WAD breed was bred by more than 80% of breeders with a livestock size of 6133.

Keywords: Goat breeds, spatial diversity, Benin.

Assessment of the biodiversity of sacred forests in the Atlantic department in Southern Benin

Gnangle C.P., Abdou N., Zanvo M.S., Amagnidé G.A.Y.G., Kpindjo F., Mama V.J., Agbahungba G.A., Glèlè Kakaï R.

GSC Biological and Pharmaceutical Sciences, 21(02), 255-262

DOI : https://doi.org/10.30574/gscbps.2022.21.2.0205

In Benin, the sacred forests constitute vestiges of heavily anthropized primary forests. In order to assess the importance of plant biodiversity in the sacred forests of the Atlantic department in South Benin, a forest inventory was carried out in five islands of sacred forests (Hêkpazoun : 25 ha ; Avogbézoun, Sindomè, Ahouansêzoun et Assanmeyzoun : 10 ha each). Structural parameters were compared between forests with analysis of variance tests. The results obtained show that the specific richness of the woody plants varies from 6 species (sacred forest of Hêkpazoun) to 20 species (sacred forest of Avogbézoun) with good distribution of trees between the different species regardless of the sacred forest considered (diversity index of Shannon varying between 3.17 and 4.11). Regarding the dendrometric parameters, only the mean diameter varied significantly (Prob. <0.05) from one sacred forest to another. The largest trees were observed in the sacred forests of Avogbézoun (60.75 cm) and Ahouansêzoun (58.96 cm) while the smaller trees were observed in the sacred forests of Assanmeyzoun (32.03 cm) and Sindomè (42.50 cm). *C. mildbraedii, F. thonningii, T. prieurianna, D. guineense, V. doniana* and *T. scleroxylon* were the main characteristic species of sacred forests. Although the structural features do not indicate an alarming degradation of these ecosystems, measures must be taken for their conservation.

Keywords: Sacred forests, Forest inventory, Specific richness, Dendrometric parameters, Benin

Distance function approaches for efficiency analysis of organic production units: a critical review

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Journal of Applied Biosciences, 173(1), 17963-17976

DOI : https://doi.org/ 10.35759/JABs.173.4

Objectives: This review aims to make a comprehensive synthesis of distance function methods for the efficiency analysis of organic production units.

Methodology and Results: The study reviewed and summarized the different approaches of distance functions applied in organic farming systems to assess performance. Original articles covering ten years, from 2010 to 2020 were identified through keyword searching using web search engines. After careful reading of the abstracts, 20 papers were finally retained. The selected papers were categorized based on study purpose and findings. Results showed a gap between the development of distance function methods and their usage in organic farming efficiency analysis. Four distance function methods were identified, and the most used in organic farming efficiency analysis were output distance function (40%) and directional output distance function (25%).

Conclusion and application of findings: Results indicate that distance functions are powerful tools in modelling multi-input and multi-output production technology for assessing organic farming efficiency. Future research should focus on these methods to deepen their understanding and applications.

Keywords: Distance function, efficiency analysis, literature review, organic farming

Multi Environmental Evaluation of Vegetable Soybean for Adaptation and Stability in Benin

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African Crop Science Journal, 30(3), 313 - 330

DOI : https://dx.doi.org/10.4314/acsj.v30i3.4

Vegetable soybean (*Glycine max* L. Merr.) is a highly nutritious crop in Africa whose attributes make it a product of choice to formulate diets with numerous human health benefits. The crop is still novel in West Africa, but is making inroads in many countries of the region. The objective of this study was to evaluate selected vegetable soybean varieties for agronomic performance and stability for fresh pod yield across Benin. Thirty-five vegetable soybean varieties were planted at three locations, namely Calavi, Grand-Popo and Sèmè, for two seasons. There was a significant variation ($P < 0.05$; $P< 0.01$ and $P < 0.001$) among genotypes for most quantitative traits; with highly significant environmental ($P < 0.001$) and GEI effects on fresh pod yield ($P < 0.001$). *Genotype Maksoy 3N* (15.9 t ha-1) had the highest fresh pod yield; while genotype AGS466 was the most stable across environments. Based on GGE, Sèmè-2 was the ideal environment for growing vegetable soybean in Benin. The study confirmed that vegetable soybean is well adapted to be grown in Benin and varieties *AGS466, AGS346* and *Ashorowase* are candidates for wide cultivation in the country. Also, grain soybean varieties *(S10796-7 and Maksoy 3N)* are well suited to produce vegetable soybean in Benin.

Keywords: *Edamame, Glycine max, Maksoy,* stability

Spatial prediction of soil organic matter in Adingnigon (Benin) using Bayesian Maximum Entropy (BME)

Gongnet E.E., Agbangba C.E., Affossogbe S.A.T., Glèlè Kakaï R.

African Journal of Applied Statistics, 9(1), 1279-1295

DOI : https://doi.org/ 10.16929/ajas/2022.1279.268

Demographic pressure and climate change have heavily affected soil fertility. Proper soil management requires the understanding of the spatial variation of soil properties. In this study, Bayesian maximum Entropy (BME) was used to explore the variation of soil pH and soil organic matter (SOM) at Adingningon (Benin) using 106 soil samples. The predicting maps indicated a lower concentration (0.6 to 0.8g/kg) of SOM toward the center and pH mostly around 5.8 to 6.5 with lower error variance, suggesting an acidic soil. These results provide useful information for managing soil fertility to improve crop yields.

Keywords: spatial distribution, Bayesian maximum entropy, pH, organic matter, geostatistics

Effect of seed maturity and morphotype traits on seed germination of *Lannea microcarpa* in the dry Sudanian region of Benin

Goudegnon E.O., Salako K.V., Teka O., Gouwakinnou G.N., Gandji K., Tohoun R., Oumorou M., Sinsin B.

Bois et Forêts des Tropiques, 352, 3-12 I **Impact Factor** $_{2021}$: 0.941

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Understanding the effect of seed size and maturity level on their germination capacity is essential to propagate a species effectively. This study assessed variations in seed germination of the indigenous fruit tree species *Lannea macrocarpa* in relation to seed maturity levels and morphotype traits. Three fruit maturity levels (green, green-red, and red-purple fruit) and four morphotypes determined according to fruit and seed morphological characteristics (fruit diameter, fruit mass, seed thickness, seed width and seed weight) were considered. The experimental design was a randomized complete block with three replicates. Germination rate and time to the first germination were computed and analyzed using linear mixed-effect and quasi-Poisson generalized linear models, respectively. The results gave the highest germination rate (82.78 ± 5.2%, 45 days after sowing) for morphotype 2 (medium sized seed) and the lowest (33.90 ± 1.49%, 45 days after sowing) for morphotype 3 (larger seeds). The shortest time to the first germination was recorded for morphotype 2 (6.89 ± 1.08 days after sowing) and the longest (9.96 ± 3.2 days after sowing) for morphotype 1 (smaller seeds). Seeds from green fruits had a better germination rate than seeds from green-red and red-purple fruits. Considerable variation was also observed between individual trees, which suggests a potential genotype driving-force in seed germination capacity. Our findings suggest that seeds of intermediate size collected from green fruits perform best as regards germination.

Keywords: *Lannea macrocarpa,* seed germination, maturity levels, morphological characteristics, morphotypes, Benin

Potential Geography and Conservation of *Ipomoea beninensis*, an Endangered Plant Species for Benin (West Africa)

Idohou R., Dassou H., Agounde G., Hounsou-Dindin G., Adomou A.C.

Environmental Sciences Proceedings, 22(1), 59

DOI : https://doi.org/10.3390/IECF2022-13345

The endemic plant of Benin, *Ipomoea beninensis* Akoègn, Lisowski and Sinsin, is threatened in its natural habitats. This study assesses the suitability of the current and future habitat for its conservation countrywide. Maxent models were run using records added to environmental variables under present and two climates. The results showed that the most suitable areas for I. *beninensis* will be mainly in the phytodistrict of southern and northern Borgou. The species could lose 9% and 13.6% of its suitable habitats under RCP4.5 and RCP8.5, respectively. Urgent and timely strategies are needed to save the remaining population of the species.

Keywords: conservation, climate changes, threatened taxa, West Africa

Déterminants de l'abandon des foyers améliorés dans les systèmes de production du sel à Djègbadji, au Sud-Bénin

Padonou E.A., Totin E., Akakpo B.A., Gbenontin E., Kolawole M.A.

Bulletin de la Recherche Agronomique du Bénin (BRAB), 32(01), 255-262

Website: http://www.slire.net; on line ISSN: 1840-7099

La production du sel est l'une des activités principales des femmes dans l'arrondissement de Djègbadji, commune de Ouidah au Benin. Elle contribue à l'utilisation massive de la mangrove de la localité. La promotion des foyers améliorés à faible consommation de bois énergie par le gouvernement du Bénin en collaboration avec des ONG et des Partenaires Techniques et Financiers, a été un échec du fait de non adoption de ces foyers par les producteurs. La présente étude a pour objectif d'identifier les principaux déterminants de l'abandon des foyers améliorés par les producteurs de sel, dans l'arrondissement de Djègbadji. Les données ont été collectées à partir des enquêtes et des essais de quantification des besoins en bois de chauffe pour la production de sel avec les différents foyers. Les résultats ont montré une différence significative entre les foyers et que les foyers traditionnels ont un temps de cuisson plus court. Ils peuvent aussi être trois fois plus économiques en termes de consommation en bois. La durée de cuisson, le groupe sociolinguistique, le sexe, l'âge et la résistance des matériaux de construction peuvent être considérés comme les déterminants majeurs qui influencent l'adoption des foyers de sel dans l'arrondissement de Djègbadji. Ces résultats doivent donc être pris en compte pour une amélioration et un succès des projets d'introduction des foyers de production du sel dans le milieu d'étude.

Keywords: Foyers améliorés, adoption locale, production de sel, Djègbadji, Bénin

Ethnobotanical knowledge and conservation of *Bombax costatum* Pellegr. and Vuillet: an overexploited savanna tree species

Zerbo I., Salako K.V., Hounkpèvi A., Zozoda D., Glèlè Kakaï R., Thiombiano A.

Trees, Forests and People, 10, 100356

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In regions dominated by savannahs, multipurpose tree species are key resources considering the diversity of services they offer. Such species are proned to overexploitation and improper management that may threaten their survival. Understanding local perception on their uses and conservation is essential to engage local communities in their sustainable management. This study presents the case-study of *Bombax costatum* in the semi-arid region of Burkina Faso. Specifically, the study (i) assesses the diversity of uses of *B. costatum*; (ii) analyse the effect of socio-demographic characteristics of local population on its uses and examine their perceptions of the threats and conservation solutions for *B. costatum*. Individual semi-structured interviews were conducted with 309 local people in Burkina Faso. Data were gathered on informants' sociodemographic characteristics, use categories, plant parts used and perceived conservation concerns. Descriptive statistics, Principal Components Analysis, and Non-parametric models were used for data analysis. Ten plant parts of the species are used for nine use categories. Food (44.52%), medicine (19.99%), fodder (15.16%) and handicrafts (14 .33%) were the most cited use categories. The most used plant parts were leaves (30.83%), flowers (25.03%), trunk (16.62%) and bark (14.70%). Leaves, flowers, twig bark and petioles were used as food and fodder. Trunk bark, root and resin were used in medicine. Trunk and whole plant were used in handicraft, construction, culture, honey production and spirituality. The harvest of *B. costatum* plant parts for food uses varied cyclically. Ethnicity, age, education level and main activity were the most influencing sociodemographic factors for the species uses. Furthermore, local population shared the same opinion (Sorensen index > 0.50) on the areas of abundance, threat factors and conservation solutions. They reported the species as abundant in agrosystems (47.08 %), forests (29.57 %) and rocky and granite hills (22.00 %). The main threat factors were tree cutting (32.5 %) and pruning (15.51 %). For its conservation, local people recommended mostly domestication (39.29 %) and strengthening of conservation measures (14.84 ± 2.99 %). This study reveals the importance of *B. costatum* while also highlighting essential aspects to consider to successfully engage farmers for its sustainable management.

Keywords: Local knowledge, Agroforestry, Threaten factor, Conservation solutions

Folk taxonomical distinction between *Irvingia gabonensis* and *I. wombolu* (Irvingiaceae) in the Volta Forest region, West Africa

Vihotogbé R., Avocèvou-Ayisso C., Djikpo R., Teka O., Sinsin B., Glèlè Kakaï R.

Biotechnology, Agronomy, Society and Environment, 27(1), 1-14 | **Impact Factor** $_{2021}$: 1.087

DOI: https://doi.org/10.25518/1780-4507.20096

Description of the subject. *Irvingia gabonensis* and *I. wombolu* produce edible kernels, with their fruit pulp tasting sweet and bitter, respectively. The overlap of their morphological and ecological traits creates taxonomic uncertainty.

Objectives. This study assessed the efficiency of folk classification system for the separation between *I. gabonensis* and *I. wombolu*, in the Volta Forest region (Togo), where both species co-occur.

Method. Interviews were conducted with 114 respondents of the five main sociolinguistic groups in the Volta Forest region, in order to identify distinctive traits between both species. Field reconnaissance and confirmation test were used to identify *I. gabonensis* and *I. wombolu* trees, which were evaluated against ecological features in folk classification system.

Results. Variations existed within each species but were not botanically delimited. The folk classification system was mostly based on fruit pulp taste and some ecological traits. Old local residents only trusted fruit taste to separate these species. Only young Akposso men additionally considered ecology and leaf shape in classification. The reconnaissance survey confirmed the consistency of their folk classification system. Dendrometric parameters of *I. gabonensis* depended on environmental factors, while land use system and soil geomorphology significantly influenced the occurrence of *I. wombolu*.

Conclusions. Fruit pulp taste and flowering seasons were widely used to distinguish between species, while young men used ecological and botanical features. This demonstrates their recent contact with these taxa. It is also likely that domestication is narrowing differences between *I. gabonensis* and *I. wombolu*.

Keywords: Domestication, taxonomy, species diversity, Indigenous Peoples' knowledge, biodiversity conservation

Impact of vegetation types on the floristic diversity, the availability and the ecological characteristics of five woody species stands used in the management of hypertension and diabetes in southern Burkina Faso

Compaoré S., Hounkpèvi A., Zerbo I., Belemnaba L., Salako K.V., Gbèmavo C., Ouedraogo S., Thiombiano A.

Environment, Development and Sustainability, 24(1), 683-700 | **Impact Factor** $_{2021}$: 4.080

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The use of modern drugs to manage hypertension and diabetes is enough expensive and requires constant monitoring of the patient due to the chronicity and complications of these diseases. Thus, the populations of southern Burkina Faso have opted for the use of plants, including *Parkia biglobosa* (Jacq.) R.Br. ex G. Don, *Sclerocarya birrea* (A. Rich.) Hochst, *Lannea acida* A. Rich, *Lannea microcarpa* Engl. & K. Krause and *Balanites aegyptiaca* (L.) Delile. To better contribute to preserving these five target species, the present study analyses the floristic diversity of the different vegetation types in which they occur, assesses their availability and determines the health status of their stands. To achieve this, a floristic inventory was conducted in 109 plots, including 26 plots of 500 m2 in riparian forests, 22 of 2500 m2 in fallows 31, 18 and 12 of 1000 m2 in tree savannahs, shrub savannahs and fenced areas, respectively. The diameter at breast height (dbh) of each individual of the target species was measured in each plot and its health status assessed. Results showed that species diversity varied significantly among vegetation types. According to the Shannon index, riparian forests were the most diversified ($H = 2.62 \pm 0.02$ bits). *Lannea microcarpa, Lannea acida, Sclerocarya birrea,* and *Balanites aegyptiaca* were very frequent ($Ri \leq 60$) to moderately frequent ($60 < Ri < 80$) within vegetation types. The vitality of their stands was independent of vegetation types. However, their individuals were weakly attacked in the fenced areas indicating that local people control these ecosystems. Fenced areas strategies appear to be alternative solutions to preserve stands of species that are a mostly high priority for populations.

Keywords: Woody vegetation, Sustainable preservation, Hypertension, Diabetes

Genetic diversity and population structure of a threatened tree species *Afzelia africana* Sm. ex Pers. among climatic zones for conservation challenges in Benin (West Africa)

Houehanou T.D., Prinz K., Koua D., Hellwig F., Ebou A., Gouwakinnou G., Assogbadjo A.E., Glele Kakaï R., Zézé A.

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Afzelia africana Sm. ex Pers. is an African endangered tree species whose natural populations are declining severely because of human pressure through logging, fodder, and fuel harvesting. Despite the importance of molecular ecology in these decades, no information regarding population genetics is available to motivate the conservation of this tree species in Benin. This study was then carried out to assess the genetic diversity and population structure of *A. afrcana* from different zones by SSR markers analysis to infer conservation implications. Two hundred sixty-four split into twenty-six populations were sampled in the three climatic zones and genotyped at 11 SSR loci measuring genetic diversity and population structure analysis. High levels of genetic diversity were found over the three zones. Mean values of observed/expected heterozygosities ranged from 0.81 to 0.88 and from 0.75 to 0.77, respectively. The pattern of population structure revealed by SSR loci indicated three gene pools in North-West, North-East, and South Benin. The population of the Sudano-Guinean zone exchanges gene with the other zones. We observed a weak but statistically significant genetic differentiation among geographical zones regarding the values of Fst (Value = 0.028; p = 0.001). Significant isolation by distance was obtained with the Mantel test. The observed pattern of population and genetic diversity by SSR loci offers useful insights to guide sustainable management and conservation decision of *A. africana* populations in different climatic zones of Benin.

Keywords: Conservation genetics, Afzelia Africana, SSR, Sustainable management, Benin

Current knowledge and future prospects on the declining *Uvaria chamae* P. Beauv in sub-Saharan Africa: A global systematic review for its sustainable management

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Uvaria chamae P. Beauv is known as a key shrub species providing several goods and services for sustaining livelihoods in Sub-Saharan Africa. Despite its great medicinal importance for local communities, little is known about its conservation status and sustainable management strategies regarding the current overexploitation of the species' fruits through traditional agroforestry systems. Here, we addressed a global systematic review of the current state of knowledge on several aspects of research of *U. chamae* for setting further breeding programmes and conservation initiatives. A total of 744 publications were identified based on the extensive bibliometric review of its sustainable management and conservation status over the last three decades (1991-2021) through existing online databases. Only 257 publications were finally included in the current review after deep scrutinization which were in line with several aspects of the conservation ecology and management of *U. chamae* in Africa. All retained papers came globally from the five sub-regions, and particularly 13 countries in Africa. Most of them were recorded in West Africa (n = 245) compared to the other sub-regions where few studies exist on this intensively harvested shrub species. Approximately 89% of the retained publications came from five of West African countries including Nigeria (n = 151), Benin (n = 30), Côte d'Ivoire (n = 18), Guinea (n = 16), and Togo (n = 14). In-depth bibliometric analysis revealed critical knowledge gaps on *U. chamae* in terms of its geographic distribution; conservation status; tree growth, productivity and propagation; morphological diversity; molecular genetic diversity; reproductive biology; ecophysiological performances; socio-economic importance; biochemical analysis; and structural characterization. The current review paves the way for developing further long-term management programs of *U. chamae* in Africa.

Keywords: Plant genetic resources, Domestication, Neglected and underutilized, Wild medicines, Sustainability

Contribution of local agrobiodiversity to complementary foods for 6 to 23 months old children in southern rural Benin

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In rural Benin, malnutrition, especially micronutrient deficiencies, contrasts with a rich agrobiodiversity that abounds in cultivated or wild foods that are potential sources of micronutrients. This paradox leads us to examine the role of local agrobiodiversity in the diet of children living in two agroecological zones of southern Benin. This study involved 1,263 children aged 6-23 months from 17 randomly selected villages in Southern Benin. A multiple-pass 24-h recall method on two non-consecutive days with the estimation of the consumed portions was used to collect dietary intake data. Semistructured questionnaires were used to collect socioeconomic and demographic data to explore factors driving agrobiodiversity food consumption, especially wild foods. Nonparametric analyses based on gamma distribution were performed to establish the effect of wild food consumption on vitamin A, calcium, iron, and zinc intakes. Conditional inference tree-classification models were performed to identify factors driving wild food consumption. Among a total of 48 local foods that were reported as consumed by children, 11 were from wild species. The contributions of total local agrobiodiversity to nutrient intake of complementary foods was between 49% (calcium) and 98% (vitamin A). Cultivated species contributed to local agrobiodiversity foods for 57% (calcium) and 96 % (zinc). The semi-domesticated species have a contribution of between 2% (zinc) and 35% (calcium) to nutrient intake. Wild species contribution to nutrient intake was between 1% (zinc) and 9% for vitamin C. Wild foods consumption correlated significantly and positively with calcium and vitamin A intakes among children. Sociolinguistic factors such as ethnicity and religion of the household head were determinants of wild food consumption. These findings suggest that sensitization on the nutritional importance of the wild foods including socio-linguistic factors may be necessary to promote wild foods' consumption. This could be a good strategy to promote healthy diets in local communities.

Keywords: agroecological zone, micronutrients, local biodiversity, wild food, healthy diets, Benin

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