UNIVERSITY OF ABOMEY-CALAVI

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FACULTY OF AGRICULTURAL SCIENCES

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BID-AF2015-0065-NAC PROJECT

“Capacity building and biodiversity data mobilization to address health and food security priorities in Benin (West Africa)”

SPATIAL DISTRIBUTION AND ECOLOGICAL NICHE MODELING OF PRIORITY MEDICINAL PLANTS AND AGROFORESTRY SPECIES IN BENIN

FINAL REPORT ON DATA USE

GBIF Benin

Project Coordinator

Professor GANGLO C. Jean

August 2018

FOREWORDS

We seize this opportunity to thank very much, the European Union (EU) who funded this project. We tell our gratitude to the Secretariat of the Global Biodiversity Information Facility (GBIFS) and to the team of the program for Biodiversity Information for Development (BID) for their supports and solicitude all along the implementation of the project.

As planned in the project, we used data on agroforestry and medicinal plants to achieve their distribution maps at present and in the future under different scenarios of the Intergovernmental Platform for Climate Change (IPCC). We also try to find out the usefulness of the protected areas of Benin as of today and in the future with respect to the conservation of the targeted species. In addition to our workshops during which we raised awareness of decision makers and natural resource managers of Benin on our findings and great achievements, the French version of our reports will be sent to them so as to inform their decisions on biodiversity conservation in Benin.

The capacities that enabled GBIF Benin to use GBIF data to achieve the results presented here were developed thanks to the kind financial supports of JRS Biodiversity Foundation, Global Biodiversity Information Facility, and European Union.

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1-Medicinal plants

1.1-Vulnerability of *Khaya senegalensis* Desr & Juss to climate change and to the invasion of *Hypsipyla robusta* Moore in Benin (West Africa)

Akotchiffor Kévin Géoffroy DJOTAN*[1], Augustin Kossi Nounangnon AOUDJI[1], Sunday Berlioz KAKPO[1], Alain Jaurès GBÈTOHO[1], Kourouma KOURA[1], Jean Cossi GANGLO[1]

[1]***University of Abomey-Calavi, Faculty of Agricultural Sciences, Laboratory of Forestry Sciences, BP 1493 Calavi Benin***

Introduction

Thanks to genetic resources, forests provide humanity with many goods and services (Jeffers *et al*., 2015; Groot *et al*., 2002) without which life would be impossible. Unfortunately, these resources are under pressure of all kinds (Myers *et al*., 2009) including climate change (McClean *et al*., 2005), human pressures (Gaoue & Ticktin, 2016; Glele Kakai and Sinsin, 2009), and forest pests (Sokpon and Ouinsavi, 2004). In Benin, *Khaya senegalensis* is one of the species undergoing the two last threats above (Gaoue & Ticktin, 2016; Glele Kakai and Sinsin, 2009; Sokpon and Ouinsavi, 2004). This species is an urban tree (Orwa *et al*. 2009), a medicinal plant (Sokpon Ouinsavi,) 2002, and a high value wood tree (Sokpon *et al*., 2004). Unfortunately, its wood is often attacked by *Hypsipyla robusta*, which situation deserves special attention.

Objective

This is to inform the resource managers, decision-makers, developers of plantations, and manufacturers of wood based products on the vulnerability of *Khaya senegalensis* to climate change and the invasion of forest pests, and then propose strategies for the conservation and production of a good quality wood. The specific objectives are as follows: assess the impact of climate change on the distribution of *Khaya senegalensis*; estimate the impact of climate change on the distribution of *Hypsipyla robusta*; and identify areas at potential biological attack risk by *Hypsipyla robusta* as well in the current climate as in the future.

Methodology

Khaya senegalensis Desr & Juss (Meliaceae), is a megaphanerophyte (up to 30 m high and 3 m in circumference), preferring light (Sokpon and Ouinsavi, 2002), with a dense crown and a small trunk (Burkill, 2004). *Hypsipyla robusta* Moore (Pyralidae), is apparently restricted in its feeding to Meliaceae in their diet (Griffiths, 2001). It drills the wood and bores the young shoots of *Khaya senegalensis* (Sokpon and Ouinsavi, 2004). West Africa was the study areas with a particular focus on Benin. The MaxEnt modeling algorithm was used (Philips *et al*, 2006). Presence data used are available at http://doi.org/10.15468/dl.is3mds and http://doi.org/10.15468/dl.k0adsn, some were collected in literature. Environmental data of the present climate and the future climate horizon 2055 (4.5 RCP and RCP 8.5) (Platts *et al.*, 2015) were also used. GIS (Geographic Information System) and its tools have been used to process and present the results of the modeling. Areas classified as areas at risk of biological attacks have been identified and corresponded to areas potentially very favorable to both species.

Main results

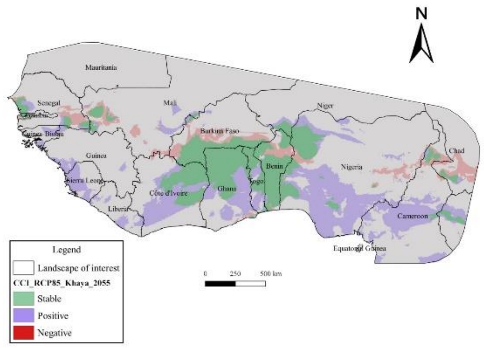
The evolution of the climate turns to have positive, negative and neutral impacts on the potential distribution of *Khaya senegalensis*. Positive climate impact areas represented 3% (RCP4.5) and 2% (RCP8.5) of Benin's total area. The negative climate impact areas represented 15% (RCP4.5) and 16% (RCP8.5). Climate neutral impact areas accounted for 75% (RCP4.5) and 74% (RCP8.5) of the country's area. As for *Hypsipyla robusta*, climate change turns out to have only negative impacts on its potential distribution. Whatever the scenario, the positive impacts of future climate were insignificant on the pest species. The negative climate impact areas represented about 66% of Benin's total area. Climate neutral impact areas were unimportant. Under the current climate, only municipalities of Malanville, Ségbana, Kandi, Gogounou, Kalalé, Nikki, Prèrè, Djougou, Kopargo, Kérou, and Ouaké would guarantee a production of a good quality wood. Under future climate (2055), whatever the scenario, the climate change is against *Hypsipyla robusta* whose favorable areas will decrease enormously, decreasing the biological attacks (regression of the areas of distribution of the insect).

Recommendations

To produce high quality wood, we recommend to promote the reforestation plans of protected areas in areas that are less favorable for *Hypsipyla robusta*, consider the mixed plantations in areas where the parasite is likely to appear, introduce with moderation, parasites of *Hypsipyla robusta* that are not harmful to *Khaya senegalensis*, prioritize the non-favorable areas for *Hypsipyla robusta* in the future (figures 1 and 2).

To deal with climate change, we recommend to promote the reforestation plans of protected areas located in the stable area for the species, consider the reforestation areas positively impacted by climate change, and promote urban and peri urban forestry to plant the tree in its suitable areas, especially alignment plantations in urban areas.

Illustrations



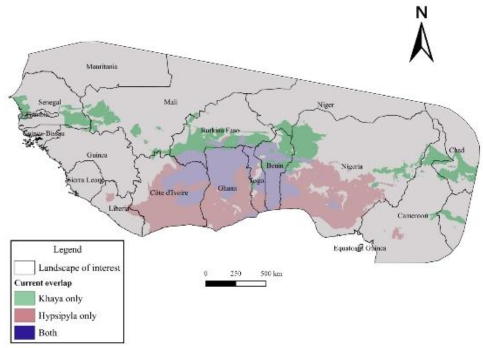
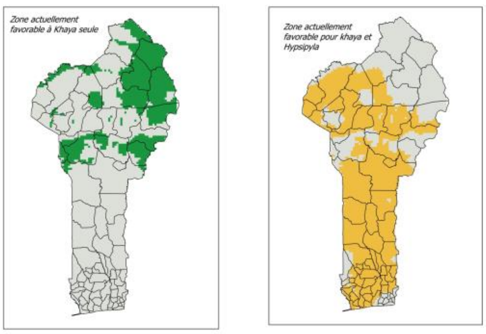


Figure 1a: Influence of climate on the distribution of *Khaya senegalensis* Figure1b: Influence of climate on the distribution of *Hypsipyla robusta*



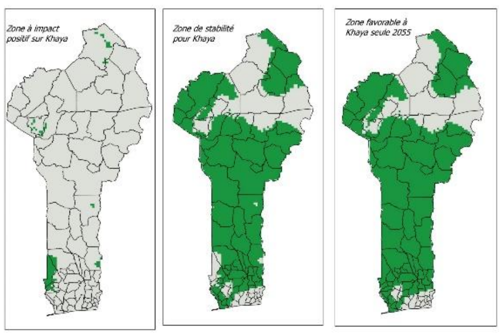


Figure 2a: Climate and risks of biological attack Figure 2b: Climate and risks of biological attack

Key-words: *Khaya senegalensis*, *Hypsipyla robusta*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa.

1.2-Distribution and ecological niche of *Crateva adansonnii* DC. in the context of climate change in Benin.

EDOU Evrardo, GBETOHO Alain Jaures, GANGLO C. Jean

University of Abomey-Calavi, Faculty of Agricultural Sciences, Laboratory of Forestry Sciences, BP 1493 Calavi Benin

Introduction

Forest provide a large number of animal and plant resources that are sources of food, medicinal products, wood energy, and timber for local populations. Increasing pressure on natural resources is a constraint to the preservation of natural habitats and biodiversity and is now leading to profound changes in our environment. Added to this is the spread of invasive species in degraded or non-degraded natural habitats and the global changes that are sources of uncertainty and risks to the sustainable management of natural resources. In this context, the fight against the disappearance of biodiversity and the natural habitats degradation has become an international priority objective, even more in tropical zone where more than a third of the earth's plant species, most of which have medicinal properties, are concentrated. (Scholes and Biggs 2004, Hanski 2005, Souad et al., 2010). Among these, *Crateva adansonii*, a savannah tree species, planted close to home or in home gardens, is full of many medicinal virtues to cure many diseases (**photos 1 and 2**). Through such uses, individuals of the species undergo mutilations and ubiquitous effects that are dangerously threatening their survival so that the species population has almost disappeared in the wild. This is the reason that justifies the present study on the ecological niche distribution of *C. adansonii* in climate change context in Benin in order to contribute to its conservation.

Objectives

The overall objective of this study is to contribute to the conservation and sustainable management of medicinal species of Benin. Specifically, the study aims to: evaluate the current distribution of *C. adansonii*; assess the impact of climate change by 2055 on the distribution of the species, and finally evaluate the effectiveness of protected areas to conserve *C. adansonii*.

Methods

The study was carried out at the level of West Africa and the results were clipped to Benin boundaries. The georeferenced occurrence data of the species have been collected using a Global positioning system (GPS). These data have been completed by the occurrence data downloaded on www.gbif.org, DOI10.15468/dl.r7f1oy). At all, 164 occurrence data have been used (**figure 1**). The climatic data of current and future climate were downloaded from WorldClim and AFRICLIM. After the study of correlation and the application of the Jackniffe test, 5 variables have been retained. The modelling was achieved in MaxEnt. The resulted maps were processed in QGIS. The area have been overlaid to the layer of Benin protected areas for gap analysis.

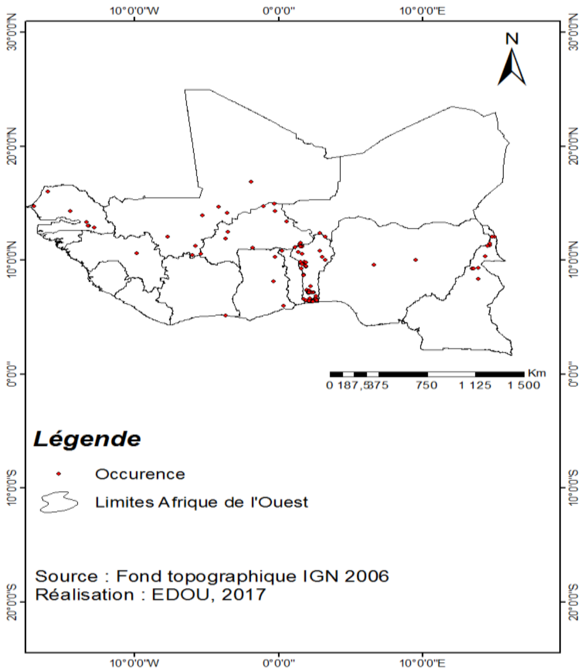


***Figure 1: C. adansonii* occurrence points**

Photo 1: *C. adansonii* leaves

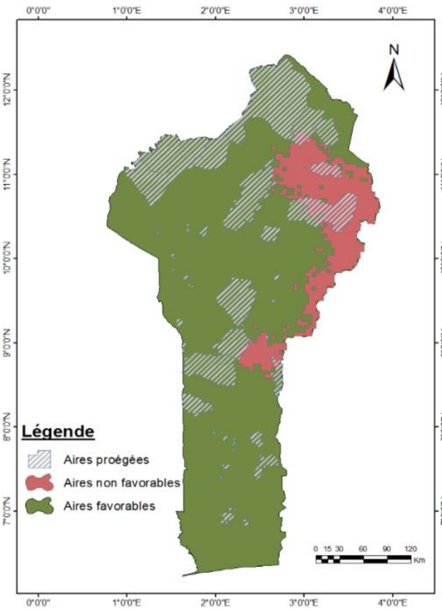
Photo 2: *C. adansonii* flowering

Results

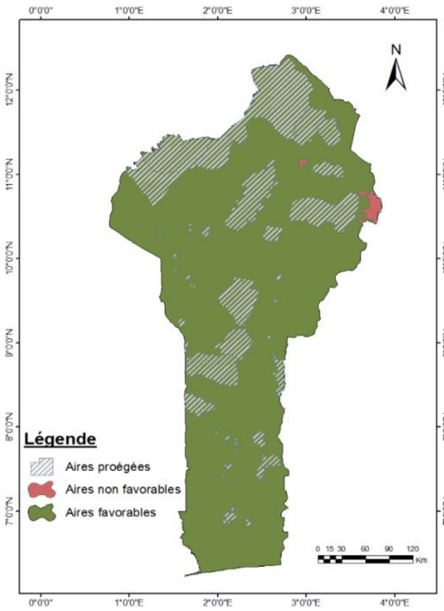
The average value of the AUC was 0.912. This confirms the good performance of the MaxEnt algorithm in capturing variations of environmental data and demonstrates the quality of the model to project the geographical distribution of *C. adansonii.* The variables bio_6 (minimum temperature of the coldest month), bio_12 (annual precipitation) are the factors determining the distribution of the species. From the current distribution and following the scenarios RCP 4.5 and RCP8.5, an increase in habitats favourable to the cultivation and conservation of *C. adansonii* was noted (**figure 2**).

Conclusion and Conservation Strategies

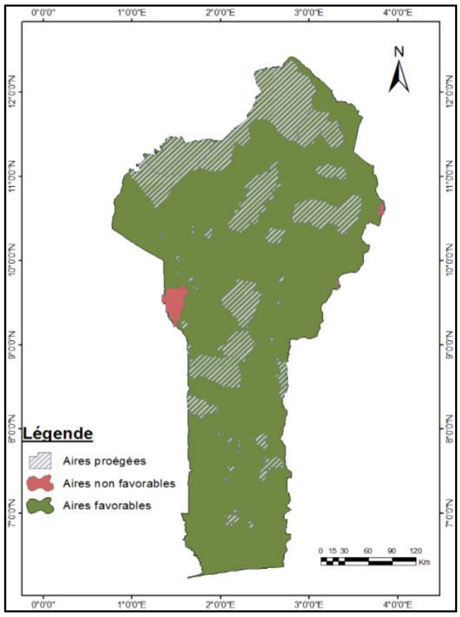
C. adansonii is mostly present in home gardens, farms and fallows and its leaves are extracted by local population for medicinal purpose. The results of the modelling revealed that *C. adansonii* may not be vulnerable to climate change and may be cultivated in protected areas. We suggest that some specimens be conserved in protected areas, as in situ conservation, and botanical gardens as ex situ conservation. It is necessary that the population ensure the reproduction of the species by planting.



Current distribution of suitable areas to *C. adansonii*



Future distribution of suitable areas for *C. adansonii* under RCP4.5 by 2055



Future distribution of suitable areas for *C. adansonii* under RCP8.5 in 2055

<u>Figure 2</u>: C. adansonii range projection under RCP4.5 et RCP8.5 scenarii in Benin

Key-words: *Crateva adansonii*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa.

1.3-Spatial distribution modelling and impact of climate changes on species from the genus *Combretum*

Gbètoho AJ, Kakpo SB, Djotan G, Hounsa M, Kingbo A, Koura K, Gangnibo NC, Aoudji AKN, Akouèhou G, Ganglo JC

University of Abomey-Calavi, Faculty of Agricultural Sciences, Laboratory of Forestry Sciences, BP 1493 Calavi Bénin

Introduction

Climate change is recognized to affect species distribution, negatively most of the time. However, the impact of changes in climate on a group of species depend on their basic ecological requirements and their plasticity. *Combretum* is the largest and most widespread genus of the Combretaceae family. The genus comprises approximately 200-250 species being distributed throughout the tropical and subtropical regions mainly in Africa and Asia. The species of *Combretum* are trees, shrubs, shrublets or woody climbers, very rarely subherbaceous. They belong to the Angiosperms branch, the Magnoliopsida class, the Myrtales order, and the Combretaceae family. It is an interesting group because of the medicinal properties of its species.

Objective

The present work aims at analyzing the effect of climate changes on the distribution of 18 species of Combretum Loefl. found in Benin in order to suggest their management strategies.

Methods

Species occurrence data were downloaded from www.gbif.org (DOI: 10.15468/dll.siyygq). After the data cleaning, the number of occurrence points retained for each species vary between 13 (*Combretum conchipetalum*) and 600 (*Combretum collinum*). The variables of WorldClim version1.4 for the current climate and AFRICLIM Ensemble model for the future climate were used. The data were downloaded at a resolution of 150 seconds (a grid of approximately 5 km x 5 km). AFRICLIM was elaborated following two main representative concentration pathways RCP 4.5 and RCP 8.5 also called scenarios; the first being optimistic and the second pessimistic. The modelling was achieved in MaxEnt using the cross validation method: 20% of the presence points were used to test the calibrated model with 80% of the points for each species. The results are presented as maps in which the values of the cells range between 0 (predicted absence) to 1 (probability of presence). Maximum training presence was considered as the threshold to classify the cells of the resulted map to binary map of favourable / unfavourable area to the distribution of *Combretum* species. The maps were overlaid to the map of Benin protected areas. The areas of suitability over Benin and over the protected areas were calculated.

Results

All the models have an AUC value higher than 0.75 which suggest good predictive abilities. The variable Bio 4 contributes more to the models of *C. comosum, C. conchipetalum, C. indicum, C. mucronatum, C. nioroense, C. paniculatum and C. platypterum*. Then for the other eleven species it's the environmental variable Bio 12 which contributes most. The majority of *Combretum* species tested in this study will be positively affected because their ranges will increase in the future (2055) under both scenarios (**tables 1 and 2, figures 1, 2, 3**). Other species of *Combretum* may be vulnerable by losing a part of their favourable distribution areas. *C. collinum*, *C. sericeum* and *C. glutinosum* are the most vulnerable as they may lose 100% of their range at the horizon 2055 in both West Africa and Benin.

Table 1: Current and future area distribution at the horizon 2055 in Benin

Species	Current Area	rcp45, 2055		rcp85, 2055		Impact of CC
C. aculeatum	28978	117603	+306%	117603	+306%	Favourable
C. acutum	88754	117603	+33%	117603	+33%	Favourable
C. adenogonium	111173	8638	-92%	22226	-80%	Vulnerable
C. collinum	112631	0	-100%	0	-100%	Vulnerable
C. comosum	29492	117603	+299%	117603	299%	Favourable
C. conchipetalum	9023	117603	+1203%	117603	1203%	Favourable
C. glutinosum	90319	0	-100%	0	-100%	Vulnerable
C. indicum	64578	117603	+82%	117603	+82%	Favourable
C. micranthum	115910	42845	-63%	104486	-10%	Vulnerable
C. molle	112717	0	-100%	28334	-75%	Vulnerable
C. mucronatum	46596	117603	+152%	117603	+152%	Favourable
C. nigricans	114345	75744	-34%	113809	0%	Favourable
C. nioroense	82967	117603	+42%	117603	+42%	Favourable
C. paniculatum	92634	117603	+27%	117603	+27%	Favourable
C. platypterum	49682	117603	+137%	117603	+137%	Favourable
C. racemosum	103672	114003	+10%	112780	+9%	Favourable
C. sericeum	81746	0	-100%	0	-100%	Vulnerable
C. zenkeri	54161	117603	117%	117603	117%	Favourable

Table 2: Efficiency of current protected areas network of Benin in the conservation of the species

Species	Current	Percentage of Benin	rcp45, 2055	rcp85, 2055	Impact of CC
C. aculeatum	11102	1,111%	28463	28463	Favourable
C. acutum	21325	2,288%	28463	28463	Favourable
C. adenogonium	24605	2,072%	4480	8959	Vulnerable
C. collinum	25291	2,165%	0	0	Vulnerable
C. comosum	2079	0,204%	28463	28463	Favourable
C. conchipetalum	42	0,005%	28463	28463	Favourable
C. glutinosum	27348	3,137%	0	0	Vulnerable
C. indicum	13974	1,706%	28463	28463	Favourable
C. micranthum	28463	1,503%	17168	27970	Vulnerable
C. molle	26426	2,485%	0	6923	Vulnerable
C. mucronatum	6815	0,740%	28463	28463	Favourable
C. nigricans	28291	2,423%	22912	28377	Vulnerable
C. nioroense	25355	1,484%	28463	28463	Favourable
C. paniculatum	18625	1,373%	28463	28463	Favourable
C. platypterum	6558	0,569%	28463	28463	Favourable
C. racemosum	20232	2,031%	25677	24648	Favourable
C. sericeum	16696	2,186%	0	0	Vulnerable
C. zenkeri	7480	0,834%	28463	28463	Favourable

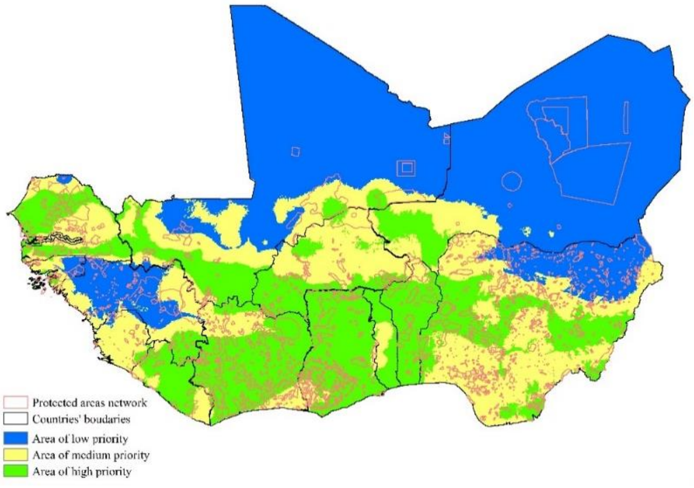


Figure 1: Areas of conservation priority for species of the genus *Combretum* under current climate

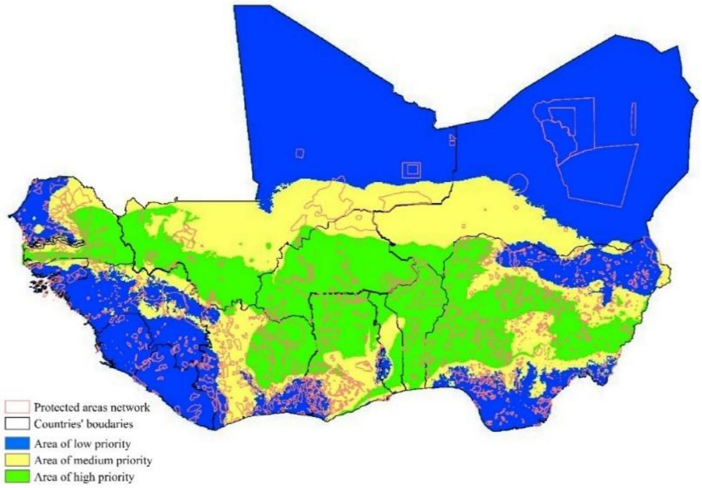


Figure 2: Areas of conservation priority for species of the genus *Combretum* under future climate and rcp4.5

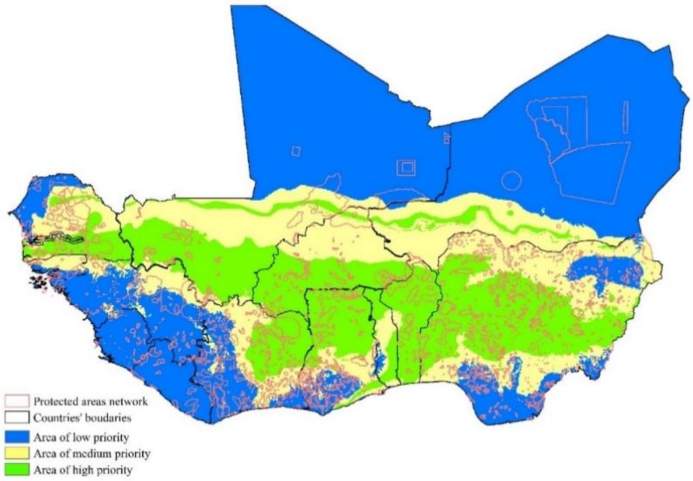


Figure 3: Areas of conservation priority for species of the genus *Combretum* under future climate and rcp8.5

Key-words: *Combretum*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa.

1.4-Potential geographical distribution of *Cissus populnea* Guill. & Perr. in Benin (West Africa)

Sunday B. KAKPO, Gbèdomèdji H. A.HOUENON, Paul H. YEDOMONHAN, Augustin AOUDJI, and Jean C. GANGLO

Laboratoire des Sciences Forestières, Université d'Abomey-Calavi, Faculté des Sciences Agronomiques.

Abstract

This study was carried out in Benin Republic, located between 6°10' and 12°50' N and 1° to 3°40' E in West Africa. In total, 229 occurrence records were downloaded from the Global Biodiversity Information Facility portal (http://doi.org/10.15468/dl.des6nm). Current (1950–2000) climate data were obtained from WorldClim version 1.4 and future climate data were downloaded from AFRICLIM version 3.0. The projections were modeled under representative concentration pathway (RCP) 4.5 and RCP 8.5 for 2055 time horizons. The Maximum Entropy algorithm was used for the habitat suitability modeling. From our main results, at present, *Cissus populnea* is distributed throughout the whole country (**figure 1**). The future projections showed a strong decrease of the suitable areas of the species both under RCP4.5 and RCP8.5 scenarios in Sudanian-Guinean climatic zone.

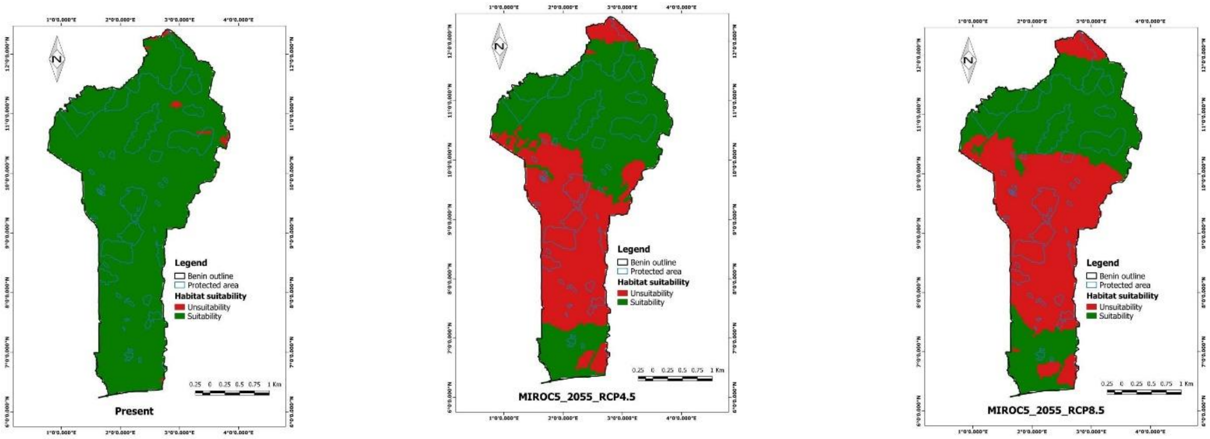


Figure 1: Spatial distribution of *Cissus populnea* in Benin under different scenarios

Key-words: *Cissus populnea*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa

1.5-How broads are the suitable areas of *Sarcocephalius latifolius* Sm. E.A. Bruce to support its conservation despite climate change and use of all of its parts.

A. Kévin Géoffroy DJOTAN* and Jean C. Ganglo

[1]Université d'Abomey-Calavi, Faculté des Sciences Agronomiques. Laboratoire des Sciences Forestières. BP : 1493 Calavi Bénin.

INTRODUCTION

Forests provide us with sufficient resources which our survival depends on (Myers *et al*, 2009). More than 80% of the world's population relies on traditional medicine for their first healthcare needs (Pierangeli, 2009). *Sarcocephalius latifolius* is a well-recognized and well sought species for use in medicine and food (Ademola *et al*., 2007; Gidado *et al*., 2005; South Expert plants, 2010). Leaves, fruit, bark, and roots are used, particularly the roots to treat malaria and stomachaches (Emedje *et al*., 2005; David *et al*., 1992). The collection of bark and roots can hinder the survival of the species (Ticktin, 2004). The potential threats of climate change on plants of Africa (McClean *et al*., 2005) and the removal of all parts of *Sarcocephalius latifolius* were the subject of the present study.

OBJECTIVE

The overall goal is to draw attention of people on non-wood forest products (NWFP) and the conservation of *Sarcocephalius latifolius*. More specifically, our objective was to see if at least the future climate would allow the survival of the species despite the pressures observed on it.

METHODOLOGY

Sarcocephalius latifolius. Sm A.E. (Rubiaceae), is a shrub with many stems per foot. Its former name is *Nauclea latifolia* Sm. The area of interest of this study is Benin but the modeling focused on West Africa. Modeling by MaxEnt algorithm (Philips *et al*, 2006) was preferred. Presence data have been downloaded across West Africa (https://www.gbif.org/occurrence/download/0032212-160910150852091). The environmental data of the present climate, and future climate horizon 2055 (RCP 4.5 and RCP 8.5) (Platts *et al*., 2015) were used. GIS (Geographic Information System) and its tools have been used to process and present the results of the modeling.

MAIN RESULTS

Surprising results have been obtained concerning the impacts of climate change on the species. Only a small portion of Benin, farthest north part of the country was shown unfavorable for the species. Projection on 2055 revealed that future climate would be more favorable to the proliferation of *Sarcocephalius latifolius*. In Benin, the stability zone was shown to be the largest one (**figure 1**).

RECOMMENDATIONS

Based on the results that were obtained, we recommend to reduce pressure on the plant, to control and regulate root collections. The full development of the life cycle of the species must promote sexual reproduction, which event guarantees the genetic variation and then the diversity.

ILLUSTRATIONS

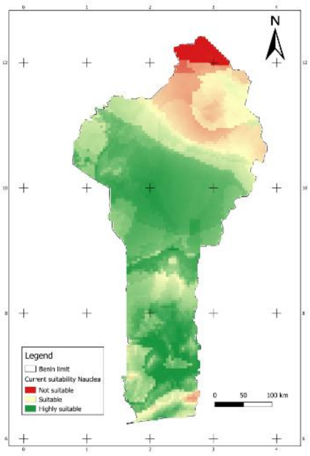


Figure 1a: Potential distribution under current climate

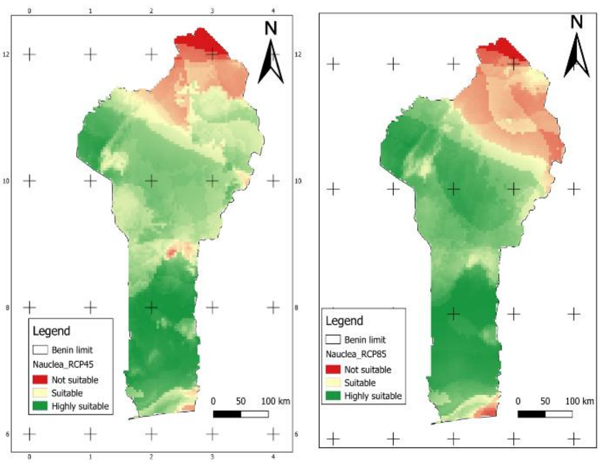


Figure 1b: Potential distribution under future climates

Key-words: *Sarcocephalius latifolius*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa

2-Agrofrestry species

2.1-Distribution and ecological niche modeling of valuable species of Benin under climate changes: case of *Spondias mombin* L.

Yolande TOGNI, Sunday Berlioz KAKPO*, Jean C. GANGLO

Laboratory of Forest Sciences, Faculty of Agricultural Sciences, University of Abomey-Calavi. BP 1493 Calavi, Bénin.
*Corresponding author, E-mail: kakposunday@yahoo.fr

Extended abstract

Climate change is rapidly changing the potential range of plants and is expected to result in changes in forest flora at different scales. Identifying appropriate measures for the conservation of some species of value requires a better understanding of the impact of climate changes on the distribution of these species. Ecological niche modeling provides the information needed to develop these measures. *Spondias mombin* L., from the family of Anacardiaceae, is a plant from Benin flora and heavily used in food and traditional medicine. Ecological niche modeling has been used to study the current and future potential geographic distribution of the species in Benin.

Occurrence data for this species have been downloaded from the Global Biodiversity Information Facility portal (https://doi.org/10.15468/dl.jldlp2). A total of 1069 occurrence have been used for the West African region. The current climate data (1950-2000) comes from Worldclim version 1.4 and those of future by 2055 come from version 3.0 of Africlim. Two bioclimatic variables was added the variable soil. Projections were performed under the RCP (Representative Concentration Pathways) 4.5 and RCP 8.5 scenarios for time horizons 2055. The maximum entropy species distribution model algorithm (MaxEnt, version 3.3.3k) was used to model the adequacy of the habitat.

Our results show that the least correlated variables (Isothermality, Temperature Seasonality, Temperature Annual Range, Annual Precipitation, Soil type) most influence the distribution of the species. Currently, the ecological niche of the species is poorly represented in Benin. The favorable areas of *S. mombin* is shared between the semi-arid and humid zones. The general finding is that all protected areas except a very little area left in semi-arid part are unsuitable to the species (**figure 1**). On the

other hand, the two scenarios of the future show a strong increase of the favorable areas of the species. RCP 8.5 scenario is more optimistic (**figure 1**). Protected areas thus have great potential for the conservation of the species in the future (**figure 1**).

For sustainable management of *S. mombin*, the protection of few protected areas found in the favorable areas of species must now be strengthened. As the climate is favorable for the species' expansion in the future, assisted regeneration of the species in its predicted favorable areas in the future is recommended.

Key-words: *Spondias mombin*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa.

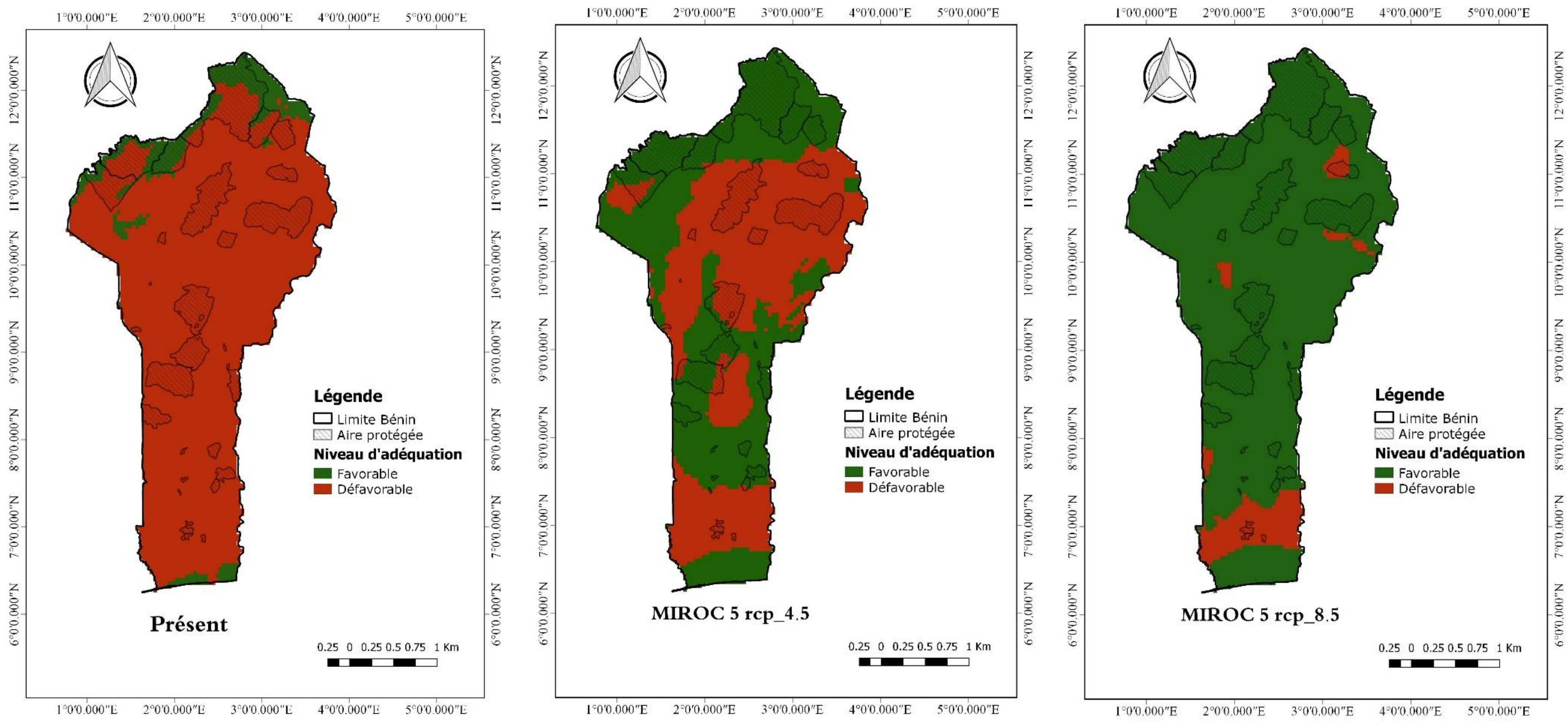


Figure 1: Distribution of *Spondias mombin* L. in Benin at present and in future climatic conditions

2.2-Predicting the Impact of Climate Change on the Distribution of the Iconic African Baobab (*Adansonia digitata* L.) using Ecological Niche Models

Sunday Berlioz KAKPO*[1,2], Larba Hubert BALIMA[1], Charles NELIMOR[1], Dobo Pierre Valence DJE BI[1], Jean Baptiste SOKOUDJOU[1], Abdourhimou AMADOU ISSOUFOU[1], Lazaniriana RANDRANTOARIMBOLA[1], El hadji SOW[1], Edjèdu K. SODJINOU[1], Sarah BABIRYE[1], Keita BAMBA[1], Chamsia IBRAHIM[1], Onyebuchi Patrick AGWU[1], Rémy MANGANI MUZINGA[1], Djenguemtar Josias[1], Jean Cossi GANGLO[2]

[1]Network of African Leaders for Biodiversity Conservation and Environment.
nalbce2017@gmail.com
[2]Laboratory of Forest Sciences, Faculty of Agricultural Sciences, University of Abomey-Calavi. BP 1493 Calavi, Bénin.
*Corresponding author, E-mail: kakposunday@yahoo.fr

Extended abstract

Climate projections suggests significant acceleration in warming and climate related extremes. These changes are expected to exacerbate water stress and negatively influence the composition, structure, and functions of ecosystems. Even though, *Adansonia digitata* is drought loving, the extent and magnitude and of predicted future occurrence is likely to outstrip its threshold for efficient reproduction and survival. Ecological niche modeling was used to study the current and future potential geographic distribution of *Adansonia digitata* in Africa.

The Maximum Entropy species distribution model algorithm (MaxEnt, version 3.3.3k) was used for the habitat suitability modeling. A dataset of 1129 georeferenced records for *A. digitata* presence was downloaded from Global Biodiversity Information Facility portal (https://doi.org/10.15468/dl.n5eabk), Rainbio portal and West African Vegetation Database (**figure 1**). Additional 203 occurrences was gathered from field throughout African continent. After cleaning, 633 occurrences were used for the continent, of which 170 occurrences from field collections. Fifteen climatic variables of current climate data (1970-2000) were downloaded from the WorldClim version 2 at a spatial resolution of 10 minutes (340 km). Future climate conditions were obtained from AfriClim database that encompasses regional climate projections. For projections of

future climatic conditions, we have used the predictions from Ensemble. The projections were run under representative concentration pathway (RCP) 4.5 and RCP 8.5 for the 2055 time horizons.

Model evaluations indicated that the model was robust (AUC = 0.86) and yielded predictions statistically significantly better than random. The AUC ratios were well above 1.0. So, the model showed excellent performance. Our analyses of variable contributions showed that six bioclimatic variables most contributed to the model quality: Precipitation of Wettest Month, Temperature Seasonality (standard deviation *100), Annual Precipitation, Min Temperature of Coldest Month, Max Temperature of Warmest Month and Isothermality. 40.65% of Africa area (5,459,040 Km^2) are currently suitable for *A. digitata*. Species is subservient in all climatic zones in Africa excepted arid and Mediterranean climatic zone. Future projections showed a strong decrease for suitable area of the species from the two RCP scenarios. The model Ensemble predicts under RCP 4.5 a loss of 57.12% of the current suitable habitats and 35.42% under RCP 8.5 by horizon 2055 (**figures 3 and 4**). In West Africa 59.93% of protected areas are currently in suitable zone. But the regression of suitable zone in the future induces a loss of protected areas in the suitable areas of 34.98% and 19.72% respectively for the senarii RCP 4.5 and RCP 8.5.

For sustainable management of the African baobab, it is important to apply *ex situ* conservation in climatic zones that will become unsuitable. These include the dry tropical climate zone and the part of humid tropical climate zone located in southern Africa.

Keywords: *Adansonia digitata*, ecological niche modeling, climate change

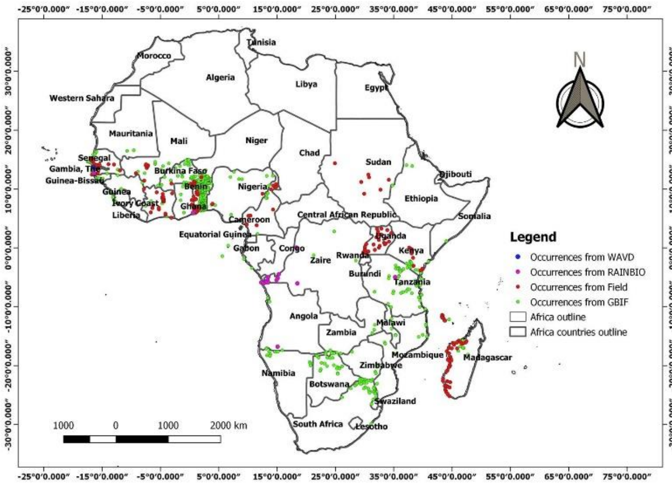


Figure1: *A. digitata* occurrence distribution through Africa

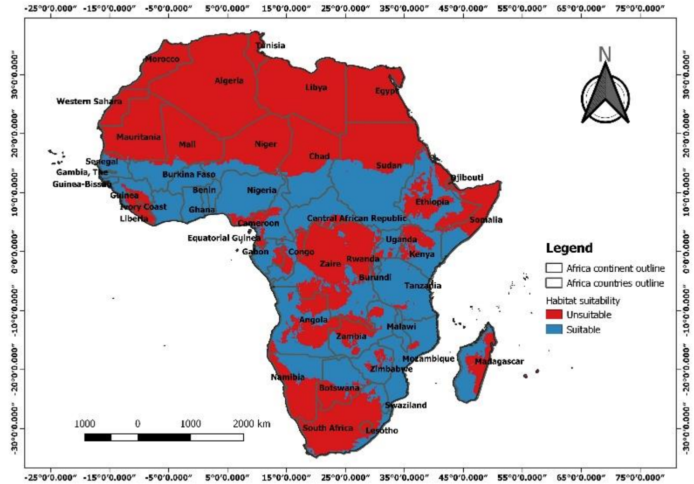


Figure 2: *A. digitata* distribution model at present

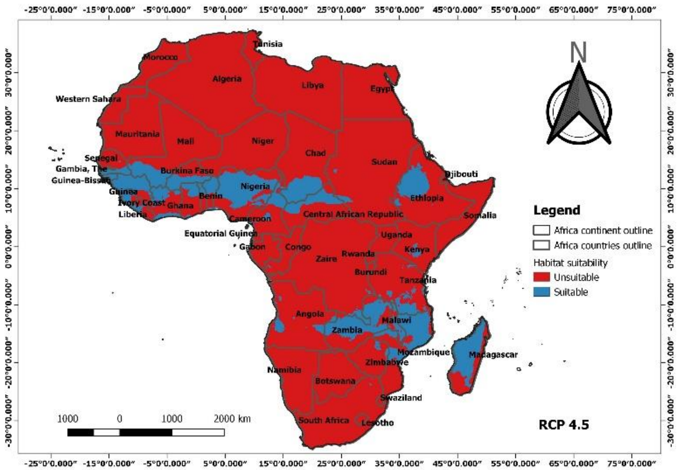


Figure 3: *A. digitata* distribution model mapped under future climatic conditions (RCP 4.5)

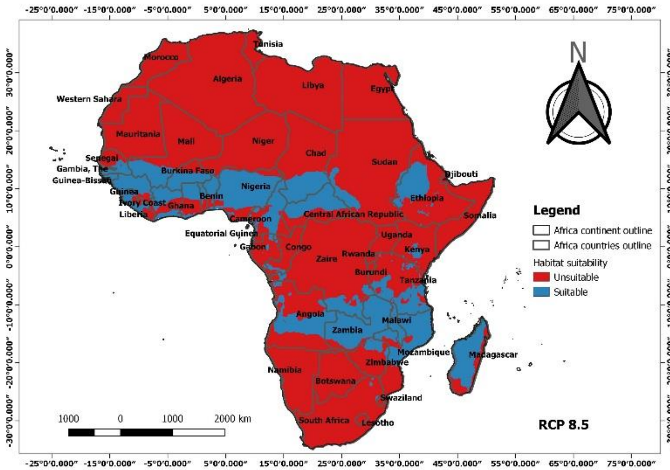


Figure 4: *A. digitata* distribution model mapped under future climatic conditions (RCP 8.5)

2.3-Ecological niche modeling and strategies for the conservation of *Dialium guineense* Willd. (Black velvet) in West Africa

GANGLO C. Jean, DJOTAN K. Geoffroy, AOUDJI K. N. Augustin, KOURA Kourouma, KAKPO S. Berlioz, YÊHOUÉNOU TESSI D. Romaric, GBÈTOHO A. Jaures

University of Abomey-Calavi. Faculty of Agricultural Sciences. Laboratory of Forest Sciences

Extended abstract

Dialium guineense Willd. is a multipurpose species useful in many respects. It is used in agroforestry and is believed to restore soil fertility in fallows. Its leaves are used to cure many diseases such as diarrhea, cough, stomachaches, malaria fever, and the trade of its fruits, firewood, and charcoal is a substantial source of income for rural populations. Despite those high interests of *Dialium guineense* to populations, we don't know much about how its spatial distribution could be impacted by climate change and which strategies to implement for it is sustainable use and conservation. To overcome those challenges, we used MaxEnt to model the ecological niche of *Dialium guineense*, and derived its spatial distribution. We used different decision thresholds to interpret and classify the outputs of MaxEnt. From our main results, we noted that under Africlim rcp 4.5 horizon 2055, the predicted stable areas of the distribution of the species will be about 73% of West Africa (our Landscape of Interest (LOI)) when we considered the threshold of the minimum training presence and will decrease to 12% of our LOI when the threshold of the maximum training sensitivity plus specificity is considered (**figure 1**). Under Africlim 8.5 horizon 2055, the corresponding values we noted for the stable areas of the species are respectively 70% and 8% of the LOI. With respect to our LOI, globally in Benin, *D. guineense* will be less threatened by climate change but, the protected areas of the department of Alibori in the North-East of the country are predicted to be unsuitable for the distribution of *Dialium guineense* whereas the rest of the protected areas of the country are predicted to be partially or totally suitable for the species (**figure 1)**. Among the strategies of the conservation and sustainable use of the species we recommend to grow and introduce it in its favorable areas where it is actually absent or grows at low densities. In order to lighten pressure on the species, it is also important to build capacities for farmers and other users of the species and assist them in growing and planting the species as well as in tending operations to ensure its survival along the successional stages of the vegetation growth.

Key-words: *Dialium guineense*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa.

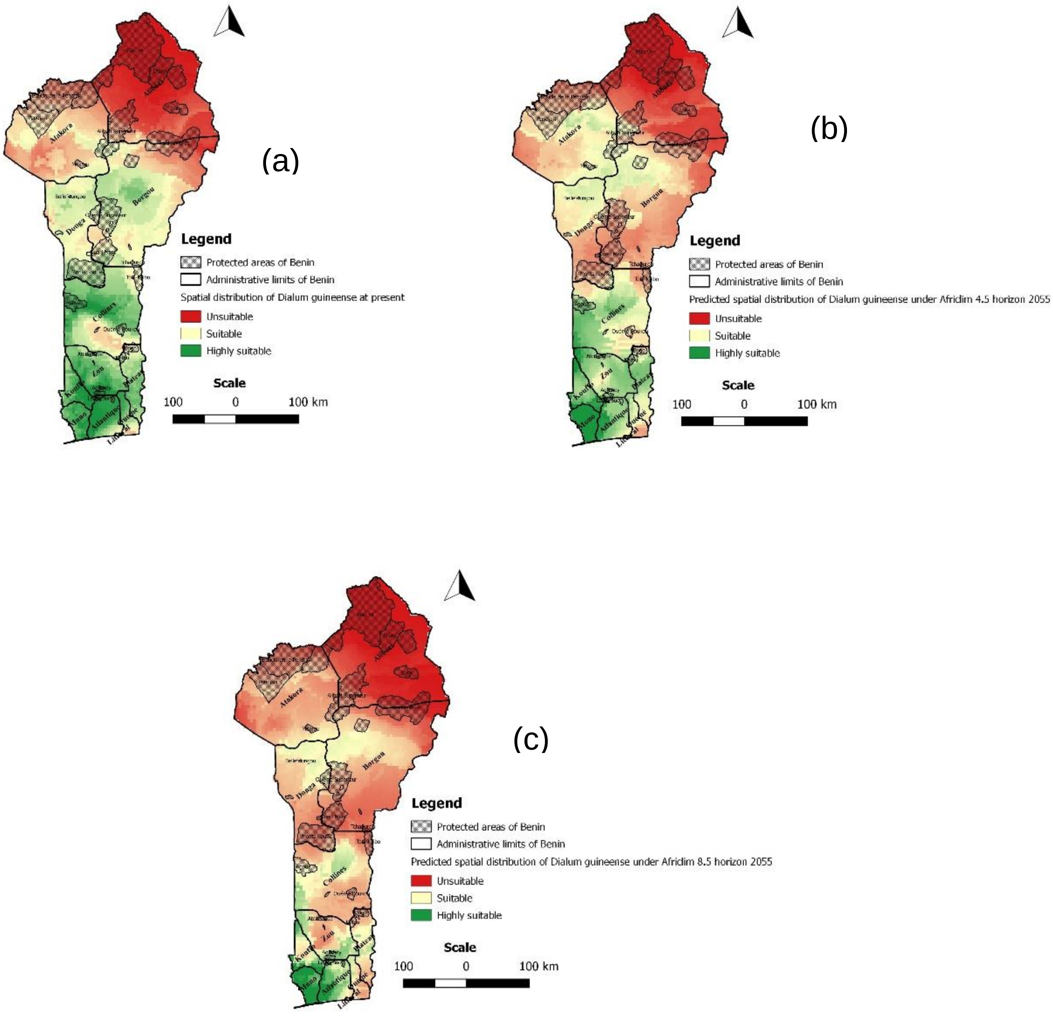


Figure 1: Spatial distribution of *Dialium guineense* in Benin*:* a) at present; b) under Africlim RCP4.5, horizon 2055; c) under Africlim RCP8.5, horizon 2055

2.4-Spatial distribution and strategies for the conservation of *Chrysophyllum albidum* G. Don (white star apple) in Benin

GANGLO C. Jean*, DJOTAN K. Geoffroy, AOUDJI K. N. Augustin, KOURA Kourouma, KAKPO S. Berlioz, YÊHOUÉNOU TESSI D. Romaric, GBÈTOHO A. Jaures

*University of Abomey-Calavi. Faculty of Agricultural Sciences. Laboratory of Forest Sciences

Extended abstract

Despite its importance to the survival of humanity, biodiversity is threatened by habitat fragmentations, overexploitations, invasive alien species, pollutions, and climate change. On vulnerable continents like Africa, threats of climate change to biodiversity must be tackled very seriously to preserve the important ecosystems services to poor populations. Among the components of forest ecosystems to be preserved, *Chrysophyllum albidum* deserves particular attention because of its multipurpose uses by rural and poor populations. It is an agroforestry species and its fruits contain many vitamins and nutrients indispensable in the equilibrium of the diet of rural populations. It is also source of income for rural populations. The objective of our study is to examine the possible impacts of climate change on the distribution of the species and therefore suggest strategies for its conservation. To achieve that purpose, using GBIF plugin in QGIS, we downloaded from GBIF site (www.gbif.org) 231 occurrence points of the species in West Africa. Those occurrence points were further on downloaded (https://doi.org/10.15468/dl.e692qf). The software MaxEnt was used to model the ecological niche of the species both at present and in the future under the scenarios RCP4.5 and RCP8.5 at horizon 2055. From our main results, at present the favorable area for the distribution of the species is a coastal band extending from Côte-d'Ivoire to Cameroun. In Benin, apart from the far most department of Alibori in the North of the country and its protected areas, the rest of the country including the remaining protected areas are favorable to the species distribution (**figure 1**). In the future under the two scenarios taken into account, the favorable areas for the distribution of the species will decrease both in the north and in the south of West African countries including Benin. Among the strategies to conserve the species, we suggest its population assessment in its favorable areas and then an introduction of the species where it is absent or at insufficient densities. Tending operations should be carried out to assist the species throughout its developmental stages to sustain its establishment.

Key-words: *Chrysophyllum albidum*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa.

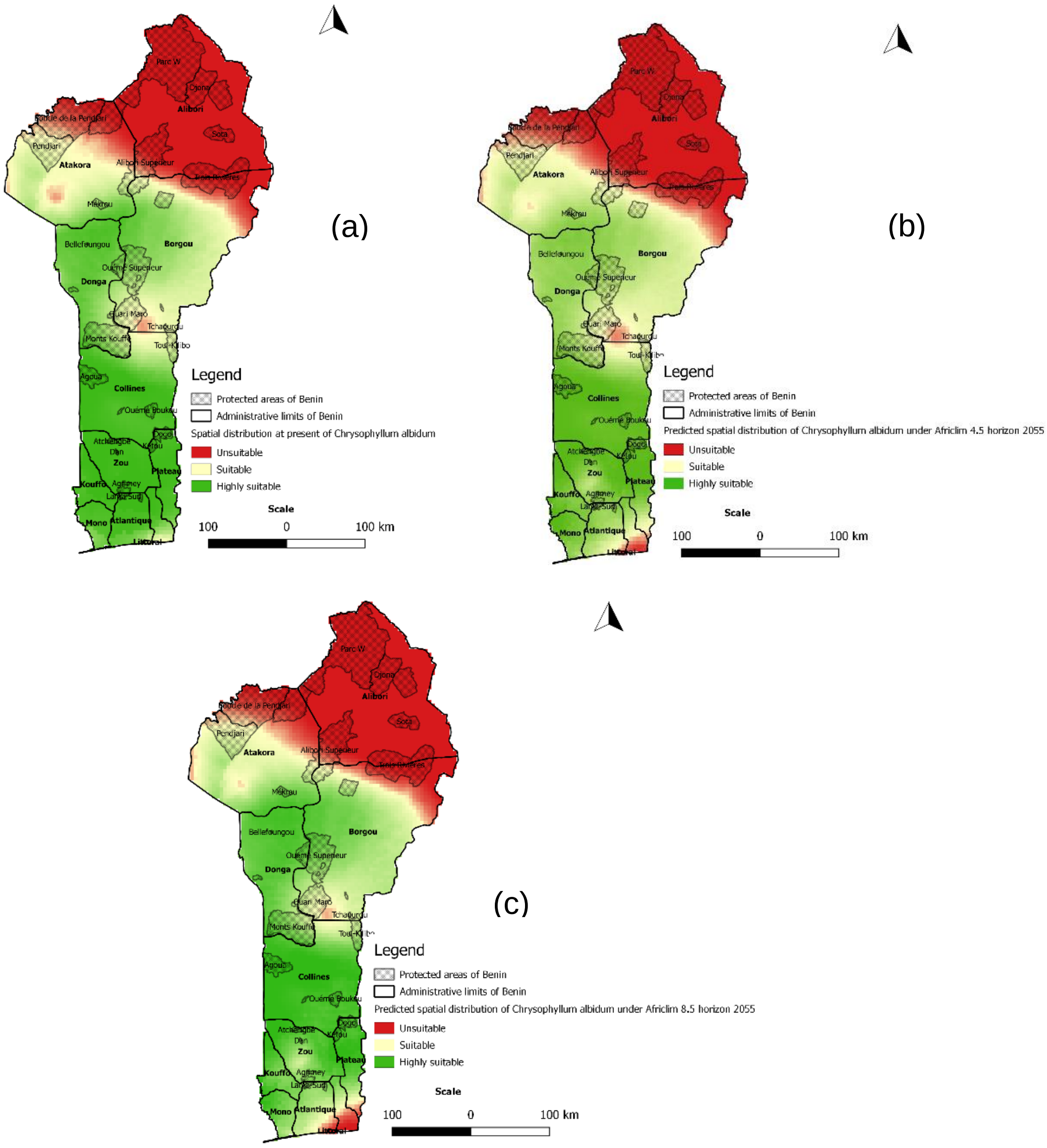


Figure 2: Spatial distribution of *Chrysophyllum albidum* in Benin*:* a) at present; b) under Africlim RCP4.5, horizon 2055; c) under Africlim RCP8.5, horizon 2055

2.5-Modeling the Spatial Distribution of multipurpose forest trees for sustainable conservation and use in the context of Climate Change: Case of *Afzelia Africana* Sm. And *Pterocarpus Erinaceus* Poir., Benin (West Africa)

Donald R. YEHOUENOU TESSI[1*], Sunday B. KAKPO[1], Jaures A. GBETOHO[1], Kevin DJOTAN[1], Augustin AOUDJI[1], Kourama KOURA[1], Jean C. GANGLO[1]

[1]Laboratory of Forest Sciences, University of Abomey-Calavi, BP 1493 Cotonou, Benin

Extended abstract

Despite the important services of biodiversity to human survival, forest resources are still disappearing at a high rate. The high proportion of rural populations in Benin exacerbates pressure on natural resources with the risk of extinction of some important tree species. Our study on species distribution models was implemented by using the method of the Maximum Entropy with the program MaxEnt (version 3.3.3k). We applied this tool to two multiple purposes tropical forests trees that are overexploited: *Afzelia africana* Sm. and *Pterocapus erinaceus* Poir. In order to evaluate the impact of climate change on the spatial distribution of the species, we used the models of climate projections established by the project Couple Model Inter comparison Project Phase – 5 and MIROC5, following the scenarios RPC4.5 and RCP8.5 recently used for some studies on African species in the same study area. We then downloaded all the records from different database sites and essentially on the Global Biodiversity Information Facility (GBIF) site (www.gbif.org; DOI of *P. erinaceus*: http://doi.org/10.15468/dl.6ucyrp ; DOI of *A. africana*: http://doi.org/10.15468/dl.yl7epd).

From the main results, we found out that, under the current conditions, the potential suitable area for both species are at least 85% of the area of Benin (**figures 1 and 2**). With the future predictions, the national parks that were partly unsuitable at present will become more suitable (**figures 1 and 2**).

The suitable areas of both species are located mostly in the Sudanian – Guinean zones and the Sudanian zone. Considering all the models, the only protected areas falling in unsuitable areas are the national parks (parks of Pendjari and Park of W). based on our findings, the strategies of conservation include: (1) implementation of long-term species monitoring; (2) vegetation enrichment by introduction of the species wherever needed in their suitable areas and (3) follow up by cultivation activities (weeding, liana cutting, thinning etc.

Key-words: *Afzelia Africana, Pterocarpus Erinaceus*, ecological niche modeling, spatial distribution, biodiversity conservation, Benin, West Africa

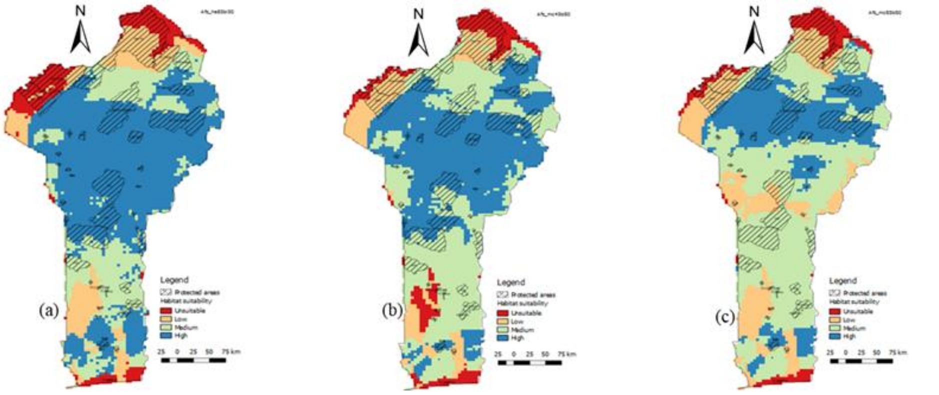


Figure 1: Map showing the suitability area of *P. erinaceus* in Benin: (a) current, (b) MIROC5 RCP4.5, (c) MIROC5 RCP8.5

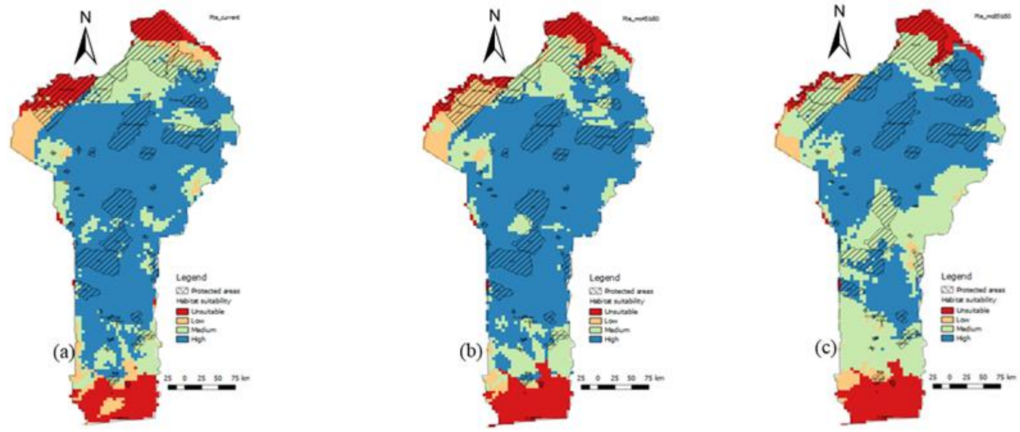


Figure 2: Map showing the suitability area of *A. africana* in Benin: (a) current, (b) MIROC5 RCP4.5, (c) MIROC5 RCP8.5