CLIMATE CHANGE IMPACT PROJECTION ON SPATIAL DISTRIBUTION OF *ZANTHOXYLUM ZANTHOXYLOIDES* (LAM.) Z & T. – A THREATENED MEDICINAL PLANT IN BENIN (WEST AFRICA)

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ABSTRACT

Climate change constitutes nowadays another kind of threat for useful plant species in West Africa. This study aims to identify the suitable areas for conservation of *Zanthoxylum zanthoxyloides* under the current and the future climate. The occurrences of *Z. zanthoxyloides* were associated with current and four future scenarios data. Two Species Distribution modeling methods (MaxEnt and MaxLike) were used in R software packages and the results were compared for identifying the most acceptable method. MaxLike method results were more valid than Maxent's giving the latter's uncertainty. With MaxLike's method, about 52% of Beninese territory was detected to be suitable for *Z. zanthoxyloides* production in the current climatic conditions. These areas were localized in southern and central Benin with a good coverage by the included protected areas. The predicted distributions of *Z. zanthoxyloides* in Benin under the four different emissions scenarios have shown a no significant impact of climate change on its current suitable areas. The challenge for conservation of *Z. zanthoxyloides* in climate change conditions is needless. It is suggested further investigations in impacts of land uses and medicinal uses on survival of *Z. zanthoxyloides* for better positioning of the suitable conservation strategies in present situation of limited resources for conservation.

Key words: *Zanthoxylum zanthoxyloides*, Species Distribution Modelling, Uncertainty, Future climate, Suitable areas, Benin.

RESUME

PROJECTION DE L'IMPACT DES CHANGEMENTS CLIMATIQUES SUR LA DISTRIBUTION DE ZANTHOXYLUM ZANTHOXYLOIDES (LAM.) Z & T. – ESPÈCE MÉDICINALE MENACÉE AU BÉNIN (AFRIQUE DE L'OUEST)

Les changements climatiques constituent des nos jours, un autre type de menace pour les espèces végétales utiles en Afrique de l'Ouest. Cette étude vise à identifier les zones appropriées pour la conservation de Zanthoxylum zanthoxloides*. Les points d'occurrence de* Z. zanthoxyloides *ont été combinés aux données bioclimatiques actuelles et futures (quatre scenarios futurs). Deux méthodes de modélisation de la distribution d'espèce (MaxEnt et MaxLike) ont été utilisées dans les logiciels R et les résultats ont été comparés pour identifier la méthode la plus valide. Les résultats de la méthode MaxLike ont été plus valables que ceux de Maxent compte tenu de l'incertitude de ce dernier. Avec la méthode de MaxLike, environ 52% du territoire béninois se sont révélés appropriés pour la production de* Z. zanthoxyloides *dans les conditions climatiques actuelles. Ces zones se retrouvent dans le Sud et le Centre du Bénin dont une bonne partie est*

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couverte par les aires protégées. La modélisation de la distribution de Z. zanthoxyloïdes *sous les quatre scenarii d'émissions différentes a montré que les changements climatiques auront très peu d'impact sur les zones actuellement favorables de* Z. zanthoxyloïdes *au Bénin. Il n'y a donc presque pas de défi en termes de changements climatiques pour sa conservation. Pour une utilisation rationnelle des moyens rares alloués aux stratégies de conservation de la biodiversité, nous suggérons la poursuite d'autres investigations sur les impacts des utilisations des terres et des utilisations médicinales de l'espèce* Z. zanthoxyloïdes.

Mots clés : Zanthoxylum zanthoxyloides*, Modélisation de la Distribution d'Espèce, Incertitude, Climat futur, Aire appropriée, Bénin.*

INTRODUCTION

It is widely agreed upon that climate change is going to affect the phenology of numerous plant species and lead to plant diversity disturbance (Bellard *et al*., 2012; Feeley *et al.*, 2013; Vos *et al.*, 2008). The major challenge of a plant species conservation is to strengthen the conservation planning thought the results of quantitative assessment of the current suitable habitat and projection of how it will experience loss, expansion or stability in the face of global climate change (Balmford & Bond, 2005). Meeting this challenge is fundamental for efficient use of the limited resources dedicated to climate change integrated management strategies of the most vulnerable and local community's livelihood depend plant species (Whitton, 2013).

In Africa, most of poor households find their incomes through the collection and marketing of some useful plant species (Hamilton, 2004; Vodouhè *et al.,* 2008). *Zanthoxylum zanthoxyloides*, a threatened species registered on the IUCN Red List in Benin (Adomou *et al.,* 2011) is one of such species (Vodouhè *et al.,* 2008). Therefore, *Z. zanthoxyloides* is frequently sold in local and international markets perceived as rare by the vendors in Benin (Quiroz *et al*., 2014; Van Andel *et al.*, 2015). Recent studies have proven the anthelminthic effects of this species (Azando *et al.,* 2011; Hounzangbé-Adoté *et al*., 2005a, b; Olounladé *et al*., 2012). This utility can lead to its overexploitation through an eventual production of improved traditional drugs for treatment of animal diseases. Indeed, *Z. zanthoxyloides* is widespread in west tropical Africa, mainly in littoral zones (Akoègninou *et al.*, 2006) and its traditional medicinal uses are well known throughout this region (Schmelzer & Gurib-Fakim, 2008).

The Republic of Benin is a part of the West African region which is the most fragile ecological zone of Africa because of its geographical position combined with the global warming and its rapidly growing population (Boko *et al.,* 2007). Therefore, most of the economic resources of this region are vulnerable to climate change and this vulnerability is exacerbated by its weak adaptive capacity due to poverty and limited access to capital (Arrow *et al*., 2004). It is not excluded that these conditions lead human to over-exploit the natural resources and to increase their vulnerability. Therefore, the perturbation carried by climate change deserves more attention. Recent results from a number assessments of impacts of climate change on species habitats based on global circulation models have indicated substantial reduction in current suitable areas of some useful tree species such as Sclerocarya birrea, Adansonia digitata, Parkia biglobosa, Vitellaria paradoxa, and Tamarindus indica for the future years (2050) in Benin (Fandohan *et al.*, 2013; Gouwakinnou, 2011; Hamilton, 2004). Here, we identify the suitable areas for conservation of the medicinal plant *Z. zanthoxyloïdes*, under the current and the future climate conditions using species distribution models.

One of Species Distribution modelling (SDM) methods widely used in ecology is Maxinum Entropy (MaxEnt) (Phillips *et al.*, 2006). There are many studies that show how well MaxEnt performs, but this method has been recently criticized for the quality of its results (Fitzpatrick *et al.,* 2013; Royle *et al.*, 2012). Thus, comparing two different methods is definitely worthwhile. Accordingly, other methods such as Maximum likelihood (MaxLike) method has been proposed ((Fitzpatrick *et al.,* 2013; Royle *et al*., 2012). With regard to the uncertainty related of SDM, it is important to identify the most valid model between MaxEnt and MaxLike methods through their modelling performance, in order to have relevant tools for decision-making. The objectives of this study are to (i) check the consistency of modelling the distribution of *Z. zanthoxyloides* with two different approaches, MaxEnt and MaxLike and (ii) assess the sensitivity of the current suitable area of *Z. zanthoxyloides* to the future climate in Benin.

MATERIAL AND METHODS

SPECIES OCCURRENCE

Zanthoxylum zanthoxyloides is a Rutaceae presented in the form of a tree or shrub with a trunk bristling with strong thorns (Figure 1). These leaves are very fragrant et the bark of these root has a pungent flavor. The locality points of *Z. zanthoxyloides* were recorded in the field following the central axis from southern to North Benin. The three phytogeographical zones: Guineo-congolian zone in the south, Sudano-guinean zone in the center, and Sudanian zone in the North (2) of Republic of Benin were investigated. But, no locality point of *Z. zanthoxyloides* has been in soudanian zone of Benin. A total of 127 points were recorded using a Global Positioning System (GPS), but 33 were retained after removing the duplicate presence points in a same raster cell (1 degree) in order to reduce sampling bias. These points were collected in field with the help of local guide who knows the distribution of the species in each locality. These localities are Ouidah, Tori-Bossito, Allada, Abomey, Agbangninzoun and Djidja in Guinea-congolian zone and Dassa, Savalou and Savè Sudano-guinean zone. The other 49 locality points were selected from http://www.gbif.org in addition to those obtained in the field. Then, these locality points obtained from internet covered all of the three phytogeographical zones of Benin and many western Africa countries.

Figure 1: Images of plants of Zanthoxylum zanthoxyloïdes.

Images des plants de Zanthoxylum zanthoxyloïdes.

BIOCLIMATIC DATA

The bioclimatic data were downloaded from WorldClim (http://www.worldclim.org). Two kinds of data were obtained: data of current conditions (1950-2000) and the future conditions (2050). Each type was made up of 19 bioclimatic variables generated from total precipitation as well as minimum and maximum monthly temperature (at 2.5' resolution). Concerning the bioclimatic future data, the global climate model developed by MIROC5 (Model for Interdisciplinary Research on Climate) was chosen with the four future scenarios: Representative Concentration Pathways (RCPs) 8.5 (High radiative forcing), 6.0 (Intermediate radiative forcing), 4.5 (Intermediate radiative forcing) and 2.6 (Low radiative forcing). The 19 bioclimatic variables were reduced to three variables (Bio5, Bio18 and Bio19) after removing the correlated pairs of variables and those that exhibited little spatial variability across Benin area. Thus, the least correlated variables (r < 0.7) were retained using the pairwise correlation between the 19 variables and the high variance variables basing on their variances.

SPECIES DISTRIBUTION MODELLING

The occurrence data of *Zanthoxylum zanthoxyloides* were combined with current and future bioclimatic data for a spatial analysis and modelling using R software, (R Core Team, 2013). Maximum likelihood estimator of occurrence probability (MaxLike) and the widely used method based on Maxinum Entropy (MaxEnt) were used to model the distribution of *Z. zanthoxyloides*. MaxEnt and MaxLike were both implemented in 'dismo' package as profile method (Hijmans & Elith, 2013). MaxEnt was fitted using the default settings, as implemented in MaxEnt 3.3.3. To evaluate how well both methods fit the data, the occurrence data of *Z. zanthoxyloides* were partitioned into training data set and tested with remaining data set. Fifty random partitions (without replacement) of this species occurrence data were made to assess the average behavior of each method. Each partition was made of 75% of datasets for model calibration (training) and 25% remained for testing. The goodness of the average predicted probability used for species distribution maps resulting from each method, was appreciated using the area under the receiver-operator curve (AUC) and absolute validation index (AVI): proportion of presence evaluation points falling above some specified threshold of predicted suitability. These statistical values combined to our professional judgment had permitted to choose the most accurate model to make predictions of suitable habitats under the four future climate scenarios.

RESULTS

EVALUATION OF MAXLIKE AND MAXENT METHODS

The current distribution pattern of *Zanthoxylum zanthoxyloides* shown by both methods (MaxLike and MaxEnt) were quite different (Figure 2). The areas of high occurrence probabilities were most important with MaxLike than MaxEnt. In addition, these areas of high probabilities perfectly matched the points, at which the species was recorded in case of MaxLike while MaxEnt underestimated the probabilities of some points where the species were recorded. In sum, the distribution presented with MaxLike's method was in congruence with the area where *Z. zanthoxyloides* was recorded. As for MaxEnt's method, the modelled distribution was evidently more reduced than the current occupancy. The results of evaluation the both methods were showed on Table 1. Therefore, absolute validation index (AVI) which measures the proportion of presence evaluation point fall above 0.5 threshold of predicted suitability area was about 0.95 with MaxLike and 0.60 with MaxEnt. In average, MaxLike has produced comparatively higher probability to location (0.58) than MaxEnt which assigned 0.55. For random background locations, both methods have generated the similar probabilities (0.08). However, they all performed better than random with 0.89 for MaxLike and 0.91 for MaxEnt.

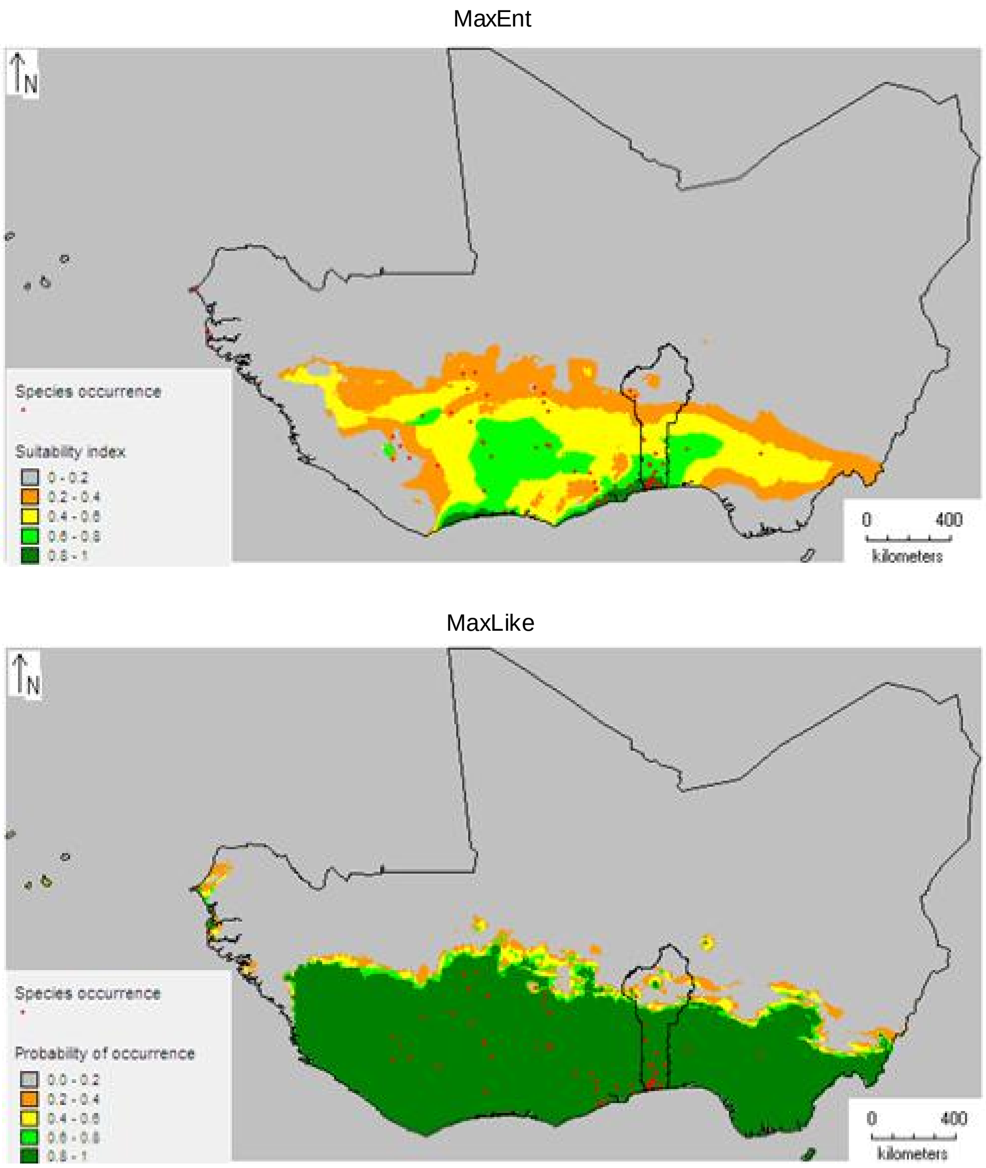

Figure 2: Current distribution modeling of *Zanthoxylum zanthoxyloïdes* in western Africa performed using MaxLike and MaxEnt Methods.

Aire de distribution actuelle de Zanthoxylum zanthoxyloïdes *dans l'Afrique de l'Ouest réalisée selon les méthodes de MaxLike et de MaxEnt.*

Table 1: Evaluation of MaxLike and MaxEnt Methods.

Evaluation des méthodes de MaxLike et de MaxEnt.

Parameters	MaxEnt	MaxLike
Threshold of predicted suitability area (thresh95)	0.012	0.85
Absolute validation index (AVI)	0.60	0.95
Receiver-operator curve (AUC)	0.91	0.89
Probability of location (meanProb)	0.55	0.58
Random background locations (meanBG)	0.08	0.08

CHANGE OF CURRENT SUITABLE HABITAT DISTRIBUTION OF *Z. ZANTHOXYLOIDES* IN BENIN UNDER MAXLIKE AND MAXENT METHODS

When we consider the average of occurrence probabilities obtained from each method as the threshold of predicted suitability, MaxLike method has predicted the most important suitable areas of *Z. zanthoxyloides* in Benin than MaxEnt (Figures 3 and 4).

Indeed, MaxLike has predicted significantly higher suitable area of *Z. zanthoxyloides* in Benin (about 52% of Beninese territory), than did MaxEnt (25% of Beninese territory). These suitable areas were more important in Southern and Central than in Northern of Benin. MaxEnt and MaxLike have both predicted suitable areas in 100% of Guineo-congolian zone of Benin. Following this Guineo-congolian zone of Benin, MaxLike has predicted suitable areas in nearly 100% of Sudano-guinean zone with a total coverage by the included protected areas while MaxEnt has only predicted last than 50% with small coverage by the included protected areas. MaxEnt method did not predict any suitable area in Sudanian zone (Northern) although many presence points of *Z. zanthoxyloides* were recorded in this zone. Only MaxLike has predicted some continuous and island suitable areas in Sudanian zone with a little coverage by the included protected areas. In sum, the current suitable distribution of *Z. zanthoxyloides* predicted in Benin with MaxLike's method seems more congruent with the field reality.

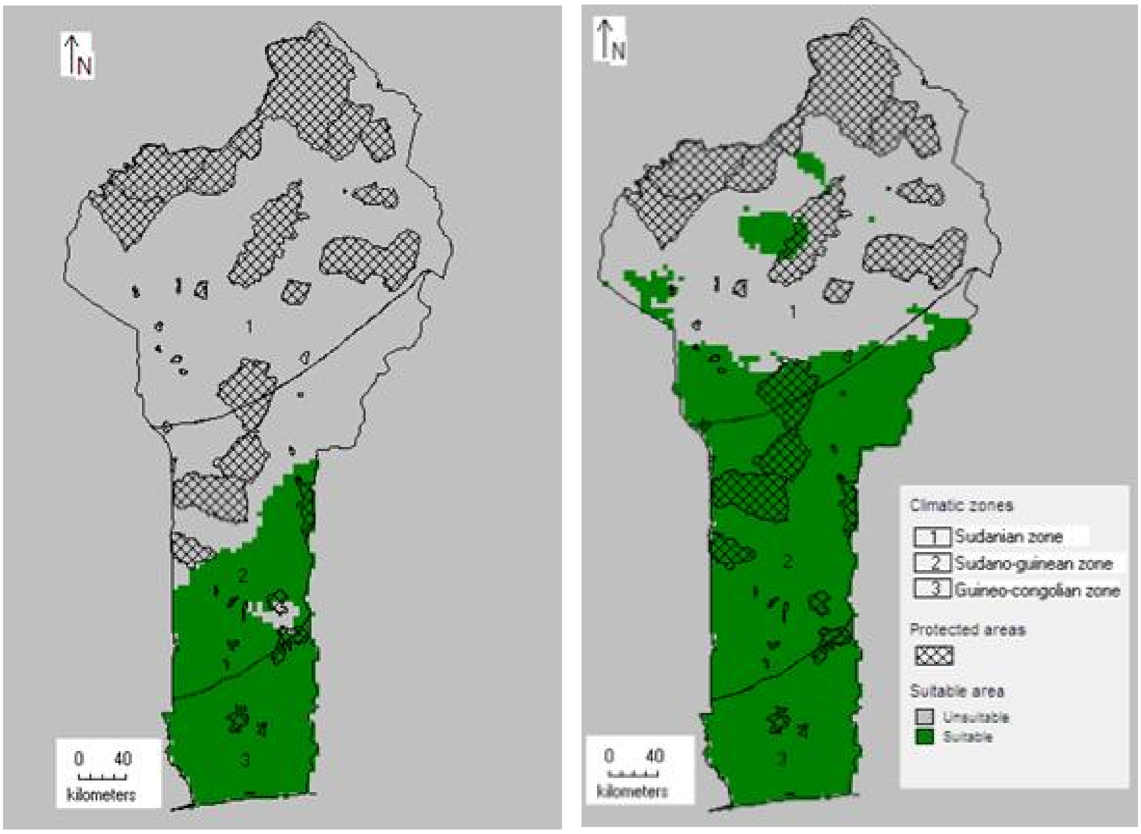

Figure 3: Predicted current suitable distributions of *Zanthoxylum zanthoxyloïdes* in Benin following MaxLike and MaxEnt Methods.

Prédiction des aires de distribution présentes convenables de Zanthoxylum zanthoxyloïdes *sur le territoire du Bénin selon les méthodes de MaxLike et de MaxEnt.*

Threshold (Average of occurrence probabilities of MaxLike and MaxEnt Methods) = 0.565

Le seuil (la probabilité moyenne d'occurrence) = 0,565

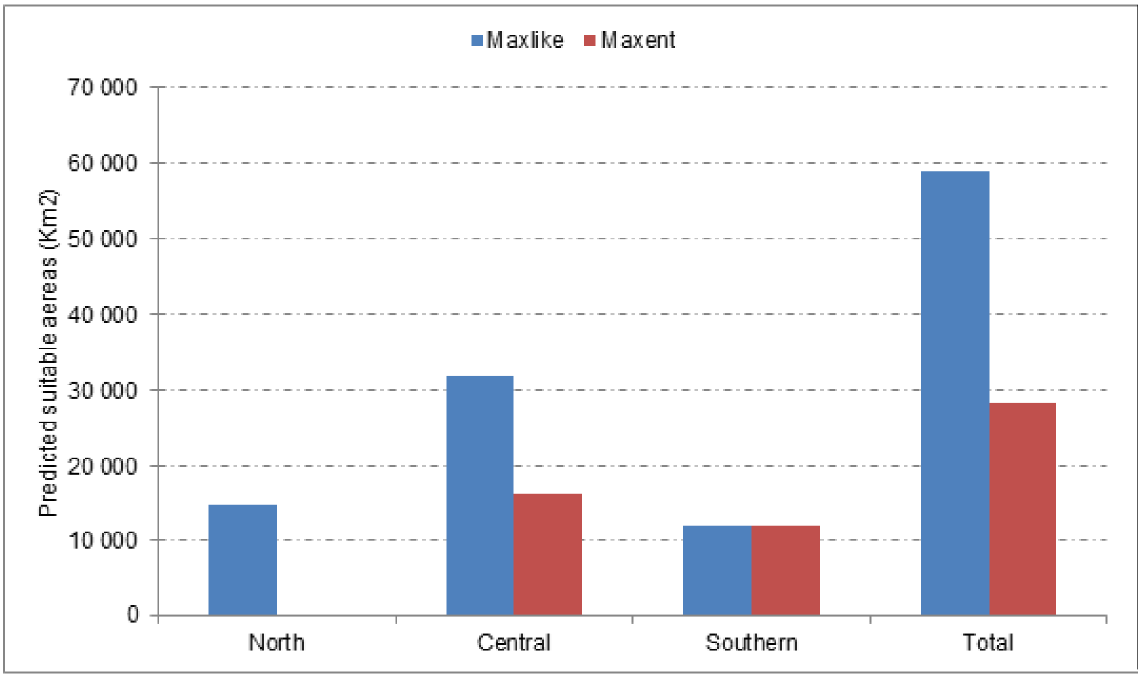

Figure 4: Predicted suitable areas of *Zanthoxylum zanthoxyloïdes* in different zones of Benin following MaxLike and MaxEnt Methods.

Prédiction des aires convenables de Zanthoxylum zanthoxyloïdes *dans les différentes zones du Bénin selon les méthodes de MaxLike et de MaxEnt.*

CHANGE OF FUTURE SUITABLE DISTRIBUTION OF *Z. ZANTHOXYLOIDES* IN BENIN UNDER FUTURE CLIMATE MODELS

The future projections (2050) from the four future RCP (Representative Concentration Pathways: 8.5, 6.0, 4.5 and 2.6) scenarios of MIROC5 (Model for Interdisciplinary Research on Climate) have shown future potential suitable areas of *Zanthoxylum zanthoxyloides* in Benin (Figure 5).

The current suitable areas of the species have been maintained under most of the RCPs in Southern and Central Benin. However, the predicted high (8.5) and two intermediate (6.0 and 4.5) emissions have shown the predictions of remarkable loss of the current suitable areas of *Z. zanthoxyloides* mainly in Sudanian zone (Northern). Most of island current suitable areas of *Z. zanthoxyloides* in Sudanian zone were predicted to make a loss with these high and intermediate predicted emissions. With the predicted low emissions (2.6) on the contrary, there was a stability of all current suitable areas expect a non-remarkable loss and a great gain of suitable areas in this Sudanian zone. Only a little proportion of extreme north zone of Benin was still no suitable for *Z. zanthoxyloides* with the low emissions predictions.

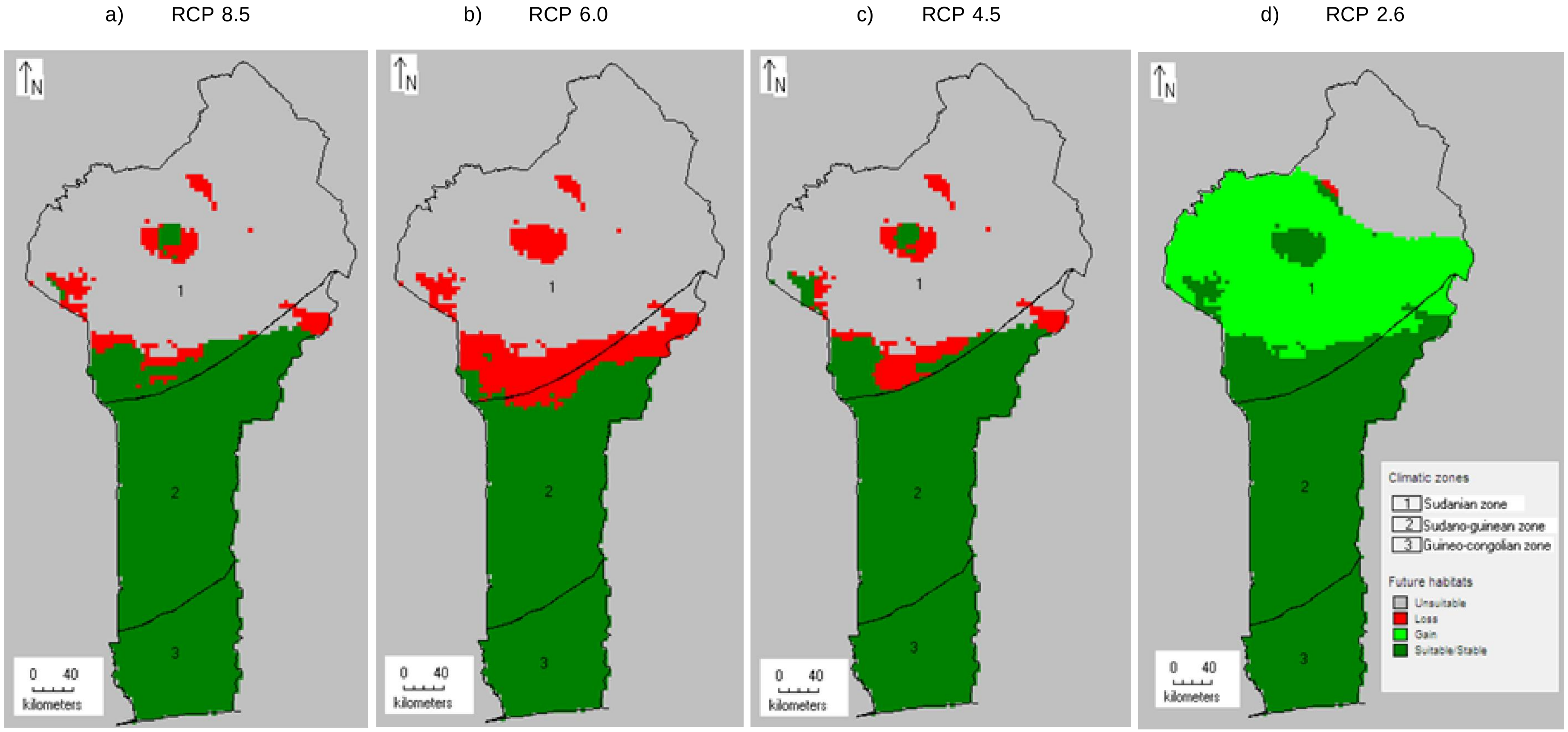

Figure 5: Predicted future distribution of *Zanthoxylum zanthoxyloïdes* in Benin (2050) under the four Representative Concentration Pathways (RCP: 8.5, 6.0, 4.5 and 2.6) of MIROC5 (Model for Interdisciplinary Research on Climate) following MaxLike method.

Prédiction des aires de distribution de Zanthoxylum zanthoxyloïdes *sur le territoire du Bénin sous les quatre scenarii d'émissions différentes (RCP: 8.5, 6.0, 4.5 and 2.6) de MIROC selon la méthode de* MaxLike.

DISCUSSION

MAXENT VERSUS MAXLIKE

The current distribution of *Z. zanthoxyloides* resulted from MaxLike's method was different from that of MaxEnt; although the good values of AUC. The latter parameter was often used to evaluate model performance through the probability that a model scores a random presence site higher than a random background site (Phillips *et al.,* 2009). However, it was criticized for its inadequate use in comparing of the results of two different modelling methods (Jimenez-Valverde, 2012; Lobo *et al.*, 2008). Therefore, one of understandable parameters such as absolute validation index (AVI) expressing the proportion of presence evaluation points falling above some specified threshold of predicted suitability (Boyce *et al.,* 2002; Hirzel *et al.*, 2006) has shown that MaxLike's method result is more acceptable than Maxent's. Indeed, MaxLike has presented 95% of test points that fall above 0.58 threshold while 60% test points were fallen above 0.55 threshold in case of MaxEnt, considering that a model is valid when most of presence-only test data coincide with the high values than with the low value of predicted habitat suitability. These results are in congruence with those of Royle *et al*. (2012) and Fitzpatrick *et al.* (2013) who firstly had detected that MaxEnt has underestimated the probabilities of most points where species were recorded. Therefore, the probabilities of occurrence produced generally by MaxEnt close to 0.5 for most occurrence locations (Phillips & Dudík, 2008) while the probabilities assigned by MaxLike to the points where species were recorded, were substantially high. This explains why the areas of high probabilities of occurrence predicted with MaxLike were larger than those of MaxEnt (Fitzpatrick *et al.*, 2013). But, it is probably difficult to understand why a point of natural occurrence of a given species could fall into an unsuitable area in current conditions. Consequently, MaxLike's result seems more understandable and express better the real distribution mapping of *Z. zanthoxyloides* in Western Africa, since according to its chorology, *Z. zanthoxyloides* is sudano-Guinean species and can be found from Senegal to Nigeria (Akoègninou *et al.,* 2006). Such result of Maxent seems being a false alarm and cannot be useful for policy-makers, especially since the monetary benefits of some products of native plant species could be mapped for providing a benchmark for local policy-makers (Heubes *et al.*, 2012). Therefore, with the assumption that an increased species occurrence probability would result in higher monetary value flows (Heubes *et al.*, 2012), such weak occurrence probabilities of Maxent can underestimate the performance and vitality of species which are not concerned. This can lead us to say that the MaxLike's method is the most pragmatists, despite the fact that every modelling method presents some uncertainty. This would certainly due to this fact that for sensitive subject as monetary mapping of Non-timber forest products (NTFP), Heubes *et al.* (2012), have combined tree different modelling methods: (1) generalized additive models (GAM), (2) generalized boosting models (GBMs) and (3) flexible discriminant analysis (FDA) performed in R software. However, most of recent studies related to medicinal plant conservation continue to use Maxent's method for raison that it was widely used and performed better with small sample size presence-only data in ecology (Khanum *et al.*, 2013; Van Andel *et al.*, 2015).

SENSITIVITY OF *Z. ZANTHOXYLOIDES* TO CLIMATE CHANGE

The predicted future distributions of *Z. zanthoxyloides* in Benin, under the four different scenario emissions have shown a little impact of climate change on its current suitable areas. All the southern and most of central Benin were not concerned by climate change effects, even in the most predicted extreme case of emissions. A similar result was found with Chrysophyllum albidum which was not at all affected by any global climate model such as Hadley Centre for Coupled Model version 3 (HadCM3) and (Commonwealth Scientific and Industrial Research Organization (CSIRO) (Gbesso *et al.*, 2013). The current suitable areas of Z. zanthoxyloides were little affected by future climate in the regions localized in Northern Benin mainly the Sudanian zone. The vegetation survey conducted at the beginning of this study through the Beninese territory has proven that *Z. zanthoxyloides* was not found in sudanian zone. However, the GBIF database (http://www.gbif.org) and Adomou (2005) had revealed the presence of this species in sudanian zone mainly in phytogeographical districts such as «Chaine de l'Atacora» and Mékrou-Pendjari». Most of these occurrence data were recorded during the implementation of Project flora of

Benin since 2005 (Akoègninou *et al.*, 2006). Can we consider the absence of *Z. zanthoxyloides* in sudanian zone after these 10 years as warning sign of predicted climatic effect? Any attempt to answer to this question would be pretentious. Though, we are aware that the field investigations conducted at beginning of this study was superficial and were not fetching into the vegetation along of rivers where *Z. zanthoxyloides* can be found in sudanian zone (Adomou, 2005). In sum, the species will not be affected by any predicted climate change in its current suitable areas. Therefore, little conservation management strategy against future climate change is concerned by *Z. zanthoxyloides*. The attention of the researchers and decision makers can be directed to other domains of threat of this species for efficiency use of scarce funds.

Apart from climate changes, other factors mainly the land uses and medicinal uses can lead to absence of a medicinal plant species such as *Z. zanthoxyloides* into a given region. With regard of the land use dynamic, the finding about the loss of biodiversity would be unequivocal and we can raise the good reason to justify the absence of *Z. zanthoxyloides* in sudanian zone. Such land use dynamic is also observed in central zone of Benin where *Z. zanthoxyloides* was faintly recorded. Therefore, the types of agricultural productions the most destroyers of natural vegetation lands in sudanian and sudano-guinean zones were cotton and yam. These productions lead to the shifting agriculture on large surface of forests and savannas which hold the major of plant diversity. This form of agricultural pressure is non-existent in guineo-congolian zone and could permit to justify the presence of *Z. zanthoxyloides*. Further investigations are needed to better situate the real causes of the vulnerability of *Z. zanthoxyloides* classified on the IUCN Red List in Benin for the establishment suitable strategies for its conservation.

As far as medicinal uses are concerned, numerous studies in Benin (Akpona *et al.*, 2009; Hermans *et al.*, 2004; Hounzangbé-Adoté, 2001) and other countries sharing the same centers of endemism (Gbolade, 2012; Jiofack *et al.*, 2010; Koudouvo *et al.*, 2011; Van Andel *et al.*, 2012) have released the use of *Z. zanthoxyloides* for treatment of diseases and uses such as: Infection, Stomach, ulcer, Strengthen pregnant women, aphrodisiac, malaria, Animal diarrhoea, gastrointestinal infection dental decay, Hypertension, sickle cell disease). With regard of these medicinal properties, *Z. zanthoxyloides* belongs to the list of the most important medicinal tree species (Yaoitcha *et al*., 2015). Concerning the impact of medicinal use on its availability, it has been observed that namely the roots of *Z. zanthoxyloides* were used not only locally but also at international (Adomou *et al.*, 2013; Djego *et al.*, 2011; Quiroz *et al.*, 2014). With regard of to these little threats related to climate change on useful species such as *Z. zanthoxyloides*, conservation arrangements are urgent for guarantee the availability of these species for future generation.

ASSESSING THE METHODOLOGY

The species distribution modelling used in this study has only based on bioclimatic data, knowing that others factors such as soil and plant physiology could be taken account. The considered bioclimatic factors have just permit to view the climate effect on *Z. zanthoxyloides*' realized niche. However, other factors such as human activities, interspecific competition, history, or geophysical barriers, can avoid species occupying all its suitable areas (Araújo & Pearson, 2005).

As for the methods used in species distribution modelling, MaxEnt was fitted using the default settings, as implemented in MaxEnt 3.3.3. The results were underestimated compared to the real niche of species. We supposed that the results could be improved with other features (linear, quadratic, product, threshold, hinge…) chosen basing on accurate ecological assumptions.

CONCLUSION

Absolute validation index (AVI) values, mapping of *Z. zanthoxyloides'* occurrence distribution and current locations covered by this species have shown that MaxLike's method result is more acceptable than Maxent's although the good performance of both methods relieved by area under the received-operator curves (AUC) values in this study. Based on MaxLike's method, about 52% of Beninese territory localized in southern and central Benin was noticed to be suitable for Z. zanthoxyloides production in the current climatic conditions with a good coverage by the included protected areas. As for predicted future climate change, only little proportion of regions localized in Sudanian zone of Benin would be affected, all the southern and most of central zones of Benin were not concerned by climate change effects. It is no use to implement further management strategies for this purpose at the risk of wasting the scarce funds. But, it is possible that other non-climate factors such as land uses and medicinal uses affected the availability of *Z. zanthoxyloides* in Benin in future following the current remarks. For some useful species such as *Z. zanthoxyloides* the non-climatic effects (land uses and medicinal uses) can be more feared than climatic effects. Indeed, the suitable strategies are expressed for their conservation in this way.

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