Impact of climate change on the geographic range of Indigenous Neglected and Underutilized Species: case study of *Dialium guineense* Willd. in Benin

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OUTLINE

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Background (1/5)

- In Africa, forest ressources and particulary NTFPs are very important contributors to health care, energy, food and the income of local households (Cavendish., 2000; Mahapatra et *al*., 2005).

- However, because of human pressure on biodiversity, many useful plant species are becoming threatened in their natural habitats (Sala et *al*., *2001).*

Background (2/5)

- Beside human-induced threats, climate change is an additional threat which is affecting and will continue to affect these plant populations.

- Since the shifting of climate variables (temperature, rainfall) will affect the range of suitable habitats of species (IPCC, 2007), climate change effect on plant species deserves more attention within the frame of the agricultural diversification .

Background (3/5)

- *Dialium guineense* is one of these plant species which is neglected and underutilized despite its potential to contribute to local population livelihood improvement in Benin (Lokonon, 2008; Dogble, 2012).

Main Objective

Provide pratical tools of decision-making for sustainable managment of *Dialium guineense* under a changing climate in Benin

Specific objectives

- Identify the current suitable range for propagation and conservation of *D. guineense*;
- Assess the impact of climate change on this suitable range under two climate models in 2050 ;
- Assess the effectiveness of protected areas network in the current and future conservation of the species;

Materials and methods (1/6)

Study species

Dialium guinnense, black velvet, Ceasalpinioïdeae

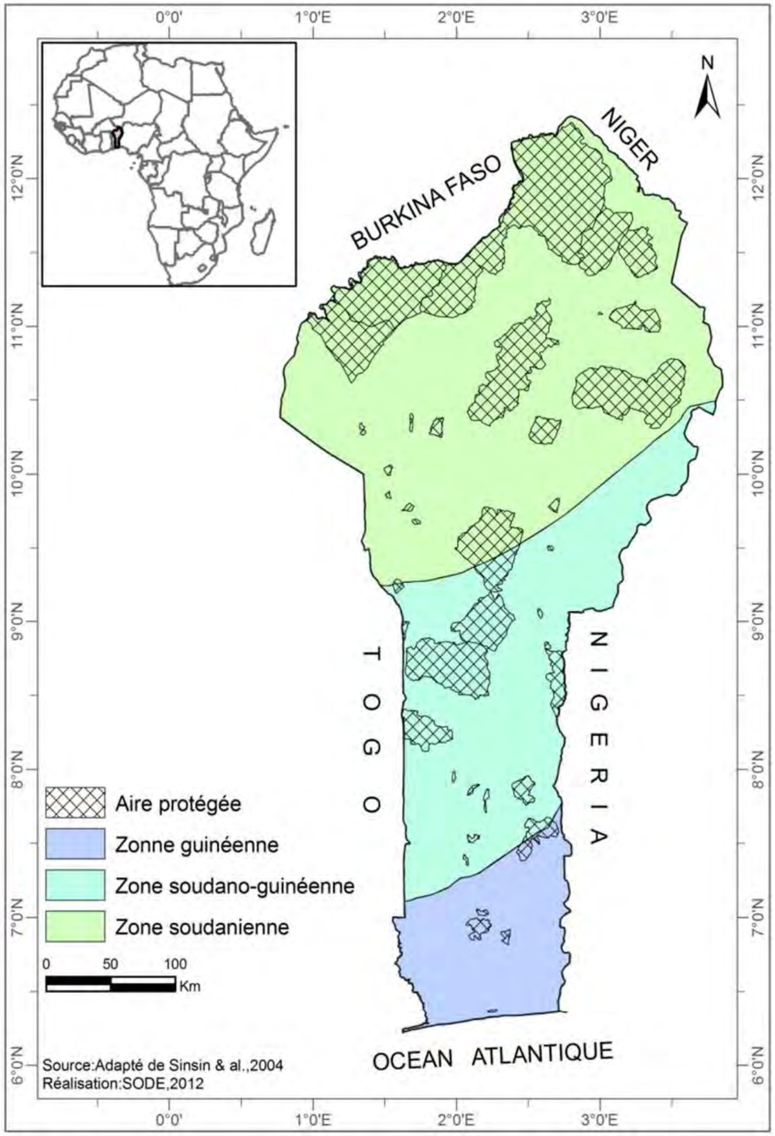
Dry and wet dense forests, gelllery forests

Edible fruits sold in local market

Study area

- Benin, located between 6°30’ & 12°30’ lat North and 1° and 3°40’ long East

- **Guinean zone**: Wet subequatorial climate, rainfall: 1200 mm/year
- **Soudano- guinean Zone**: tropical Climate; rainfall 900-1110 mm/year
- **Soudanian zone:** Dry tropical climate; 900-1100mm/year;



Materials and methods (2/6)

- Species Distribution Modeling (SDM) combined with Geographical Information System (GIS)
- Data required:

  - Occurrence data (geographic cordinates of *D. guinense*)

  - Environnemental layers (current and future bioclimatic variables and other biophysic variables such as: soil, maximal available soil moisture, landcover and SRTM)

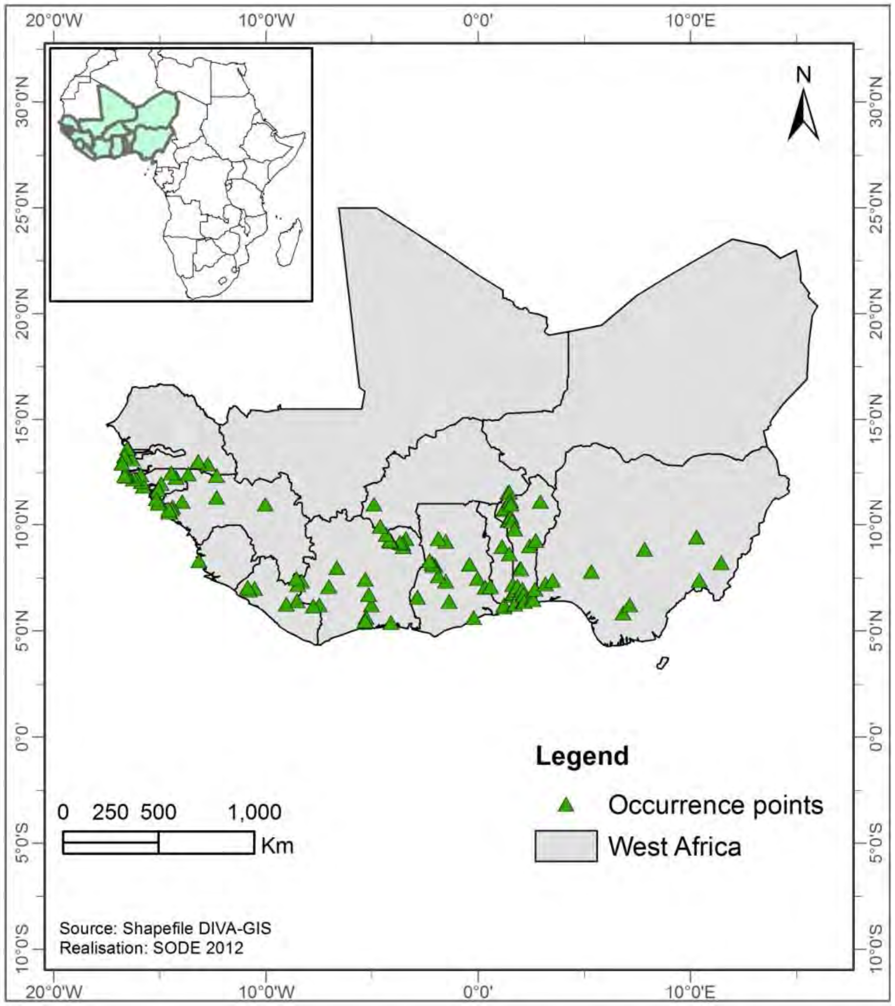
  - Shapefiles (West Africa, Benin and national protected areas network)

Materials and methods (3/6)

Data collection

- ***Occurrence data***

124 records without duplicate in grids all over the range of the species in West Africa were collected(Fieldwork, GBIF, published literature)



Materials and methods (4/6)

- ***Environmental data***

  - The current climatic variables were obtained from Worldclim (www.worldclim.org) and the future one from CCAFS (www.ccafs-climate.org) with 2.5 arcmin resolution;
  - Future projetions based on 2 climate models, **CCCMA** (Canadian Center for Climate Modeling and Analysis) and **CSIRO** (Commonwealth Scientific and Industrial Research Organisation) under A2 scenario of IPCC and their final results were averaged for further discussion;

- **Shapefiles:** West Africa and Benin (www.givagis.org), and national protected areas network (www.protectedplanet.net)

Materials and methods (5/6)

Distribution modelling and Validation

- Pearson correlation test (Paired comparison) on climatic variables with ''ENMTools_1.3''(Warren et *al*. 2010).
- Models run with Maxent 3.3.3k (Phillips et *al*., 2006); this is a modelling program based on presence only data.
- Jackknife Test enabled to assess predictors contribution to the model predictions.

Materials and methods (6/6)

Mapping and spatial analysis

- With spatial analysis tools, the extent of each suitable habitat type is estimated in order to assess the gain or loss in the current suitable habitats.
- For assessment of protected area effectiveness, a spatial Gap analysis was done by overlaying the national PAN with the curent and future suitable ranges.
- Mapping were performed using ArcGIS9.3

Results & discussion (1/6)

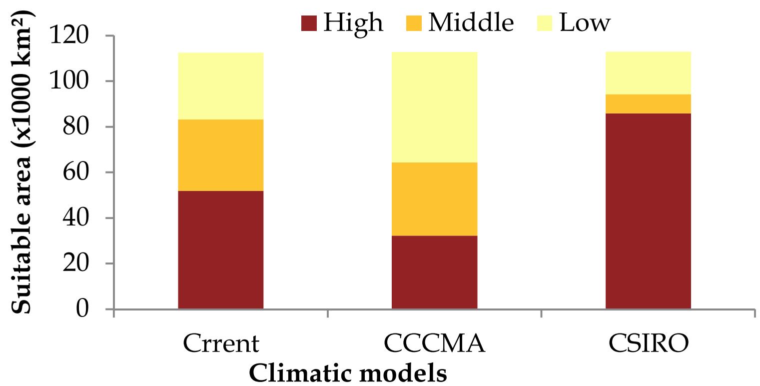
Variables contribution and model validation

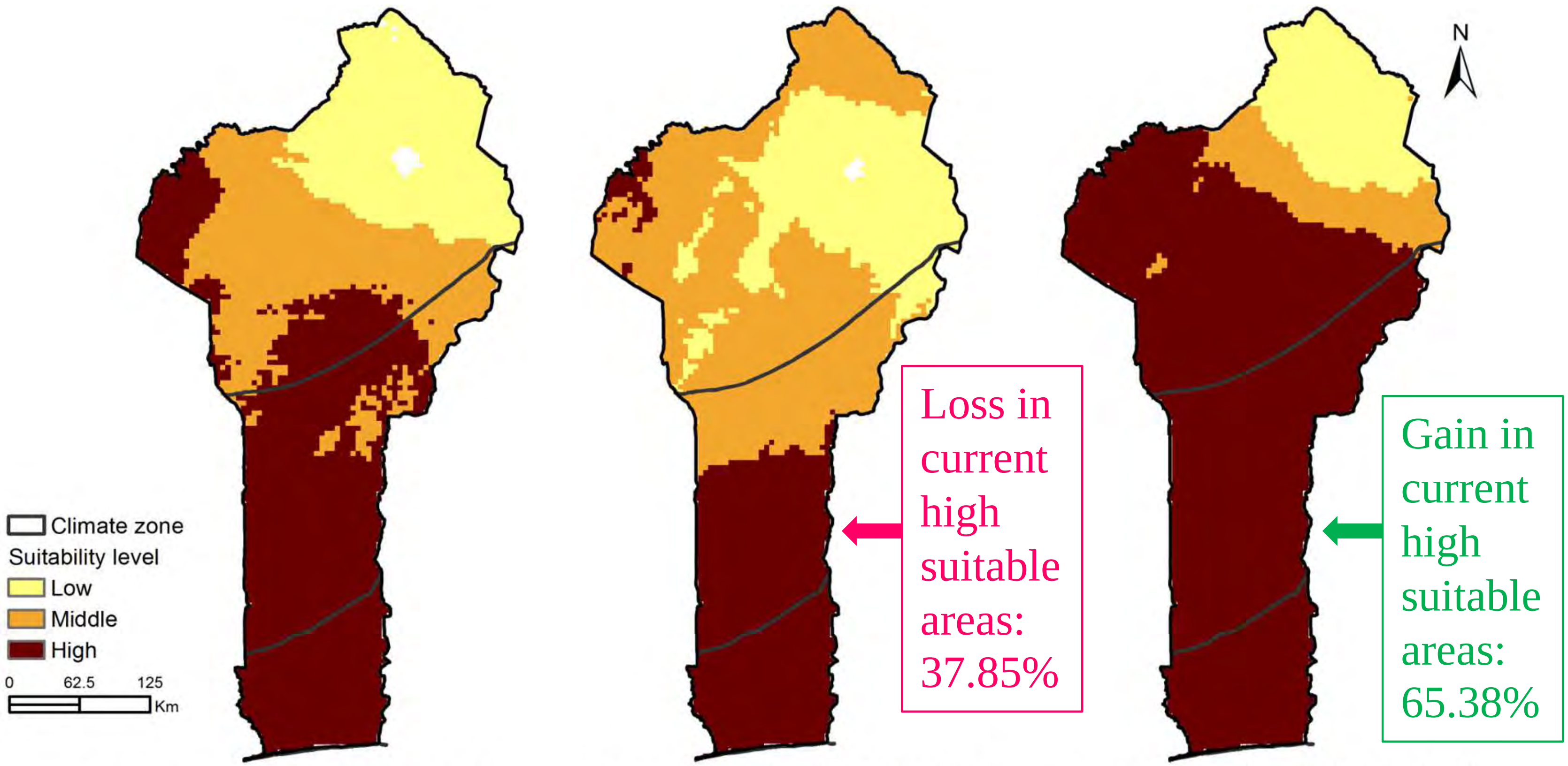
Variables code	Variables meaning	Variables contribution (%)
Bio1	Annual Mean Temperature	0.1
Bio2	Mean Monthly Temperature Range (max-min)	5.3
Bio4	Temperature Seasonality (STD * 100)	85.4
Bio8	Mean Temperature of Wettest Quarter	0.1
Bio9	Mean Temperature of Driest Quarter	2.5
Bio10	Mean Temperature of Warmest Quarter	1.3
Bio11	Mean Temperature of Coldest Quarter	2.5
Bio13	Precipitation of Wettest Month	0
Bio14	Precipitation of Driest Month	2.7
Bio15	Precipitation Seasonality (CV)	0
Bio19	Precipitation of Coldest Quarter	0
MASM	Maximal available soil moisture	0
Landcover		0
SRTM		0
Soil		0

AUC average value is 0.91 → Very good model quality.

Results and discussion (2/6)

Current and future range of suitable habitats for propagation of *D.guineense*





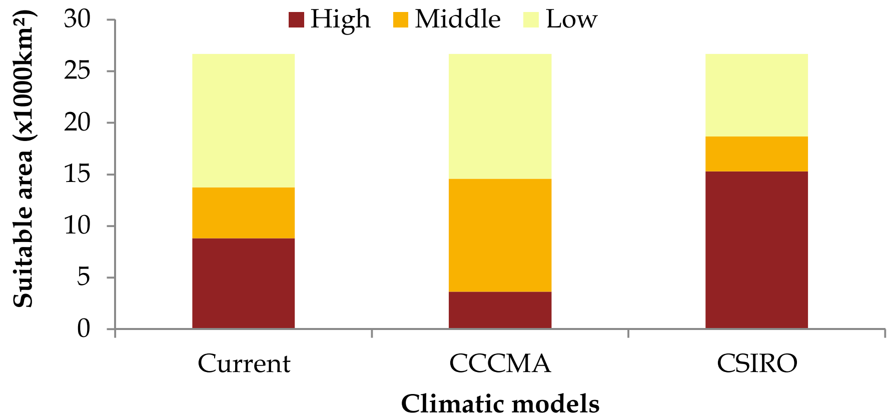
Current suitable habitat distribution

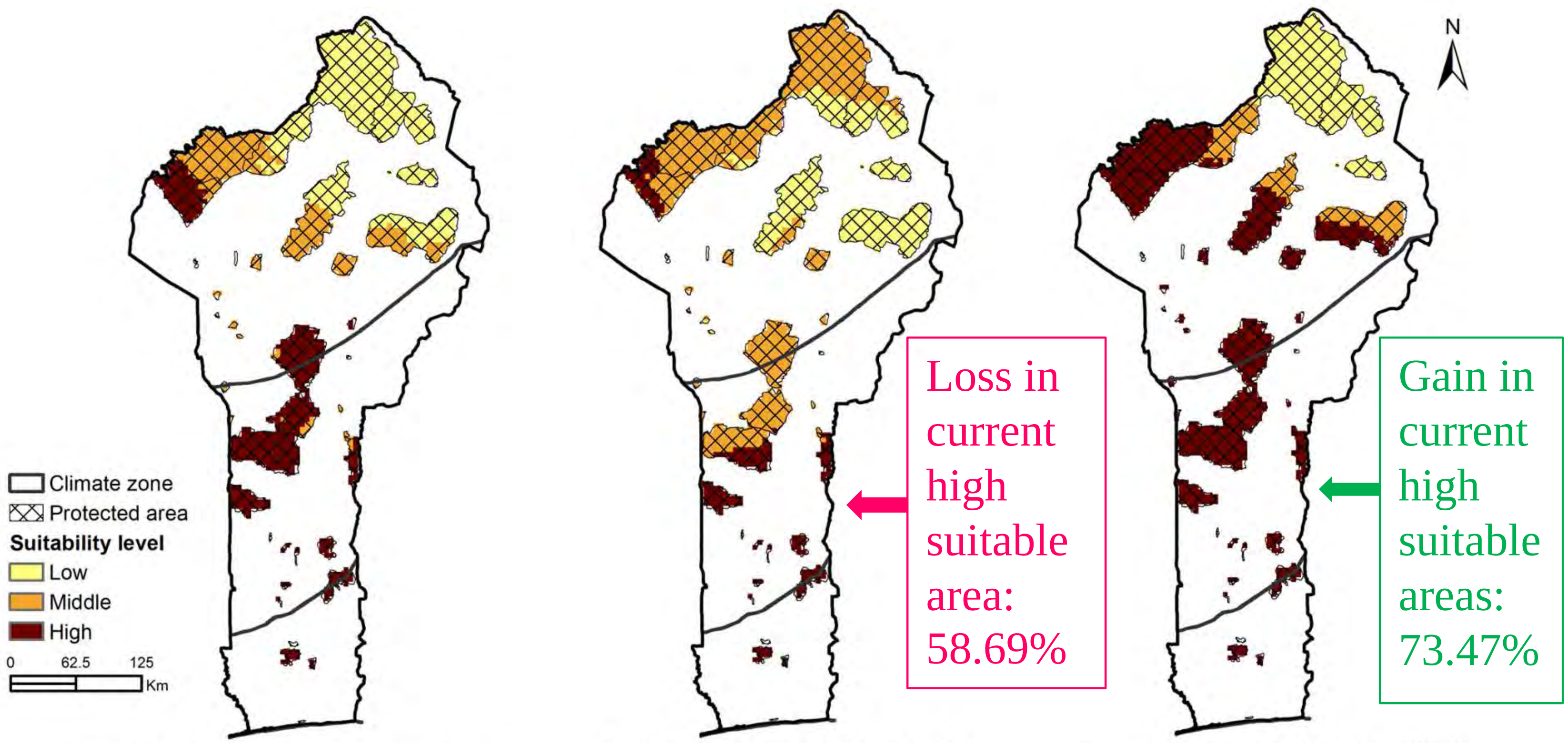
Projection under CCCMA in 2050

Projection under CSIRO in 2050

Results and discussion (3/6)

Models predictions and conservation of *D.guineense* in protected areas





Current suitable habitat distribution

Projection under CCCMA in 2050

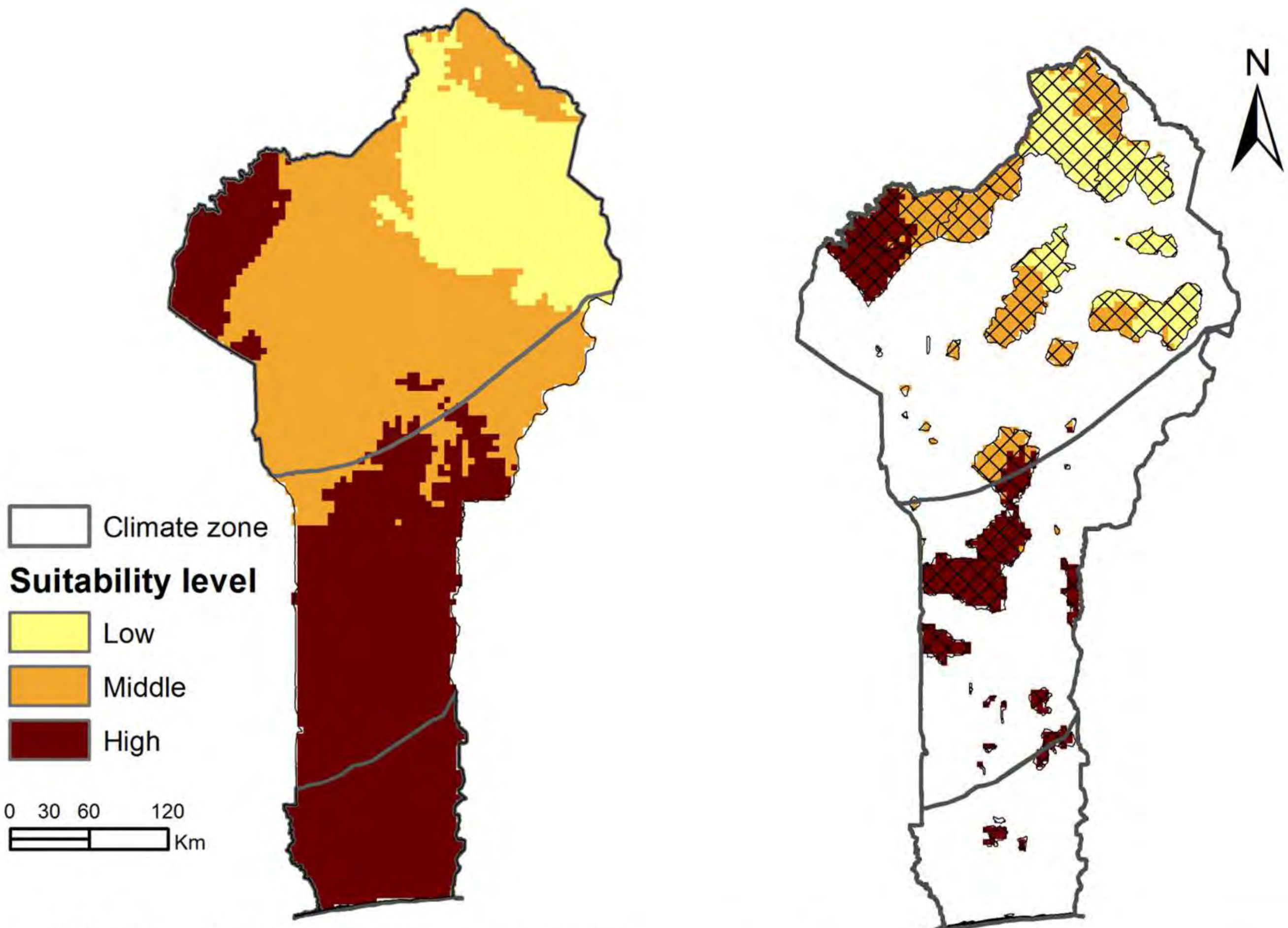
Projection under CSIRO in 2050

Results & discussion (4/6)

- This difference in projections is similar to that obtained on *Sclerocarya birrea*, sub-species *birrea* (Gouwakinnou, 2011) and *Tamarindus indica* (Fandohan et *al*., 2013) in Benin under the same scenario.
- These results confirm that, though models used are GCM the most recommanded, they have difference on rainfall projections in West Africa (IPCC, 2007).
- So, difference in rainfall projections by models may explain variations observed in projections (Christensen et *al*., 2007).

Results and discussion (5/6)

Average result for CCCMA and CSIRO model projections



CCCMA and CSIRO models mean in 2050

CCCMA and CSIRO models mean in 2050

Results and discussion (6/6)

- According to the models, Guinean zone and soudano-guinean zone and related protected area would remain suitable to *D. guinense* in the future (2050 horizon).
- So within the frame of species domestication, priority should be given to these zones,
- Given that *D. guinense* has a high potential for agroforestry, its integration in agroforestry system would contribute to ecosystem services enhancement and income generation for local households.

Conclusion and perspectives (1/2)

- Climate change is likely to modify the suitable habitats of *Dialium guineense* .
- The guinean and soudano-guinean zones and related protected areas appear as the best prioritization areas for propagation and conservation of *D. guineense* in the future.
- However, although their integration in the model is not currently possible, other factors such as biotic interactions, dispersal and genetic adaptation capacity of the species may improve the results of model.

Conclusion and perspectives (2/2)

- Knowledge of species genetic variability in terms of drought adaptation and fruit production could enable to ensure good integration of species in production system;

- Study of climate change based on physiological and taxonomical difference of *D. guinnense* should be important for idenfying specific strategy of species conservation.

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