

Vulnerability of cocoa-based agroforestry systems to climate change in West Africa

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AIM & OBJECTIVES

Aim: Characterize the environmental suitability of cocoa and common shade tree species in West Africa and their vulnerability to climate change at medium and long term. The general objective will be developed through three specific objectives:

Objectives:

1. To analyze the drivers of current habitat suitability of cocoa and associated shade tree species.
2. To predict current and future suitable habitat distribution of cocoa and associated shade tree species under projected future climate changes (2040 and 2060).
3. To identify current and future priority areas for cocoa-based agroforestry systems in West Africa.



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INTRODUCTION



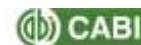
Source: Rolando Cerda, CATIE



Mondelēz
International



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MATERIALS AND METHODS

I. PRESENCE LOCATION POINTS

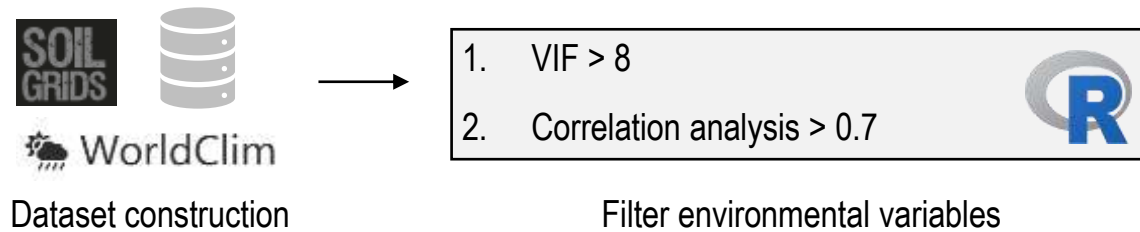


1. Correct coordinates
2. Valid sources
3. Records (1969 - 2020)
4. Reduce sampling bias
5. $N > 60$ records
6. Climatic outliers



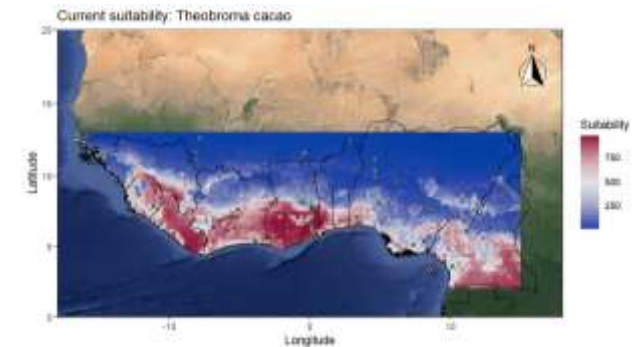
37 shade tree species + cocoa
14,769 occurrences

II. ENVIRONMENTAL VARIABLES

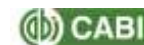


INPUTS

1. Run Species Distribution Models
2. Models evaluation
3. Ensemble model
4. Forecast (7 GCM, 2 SSP)



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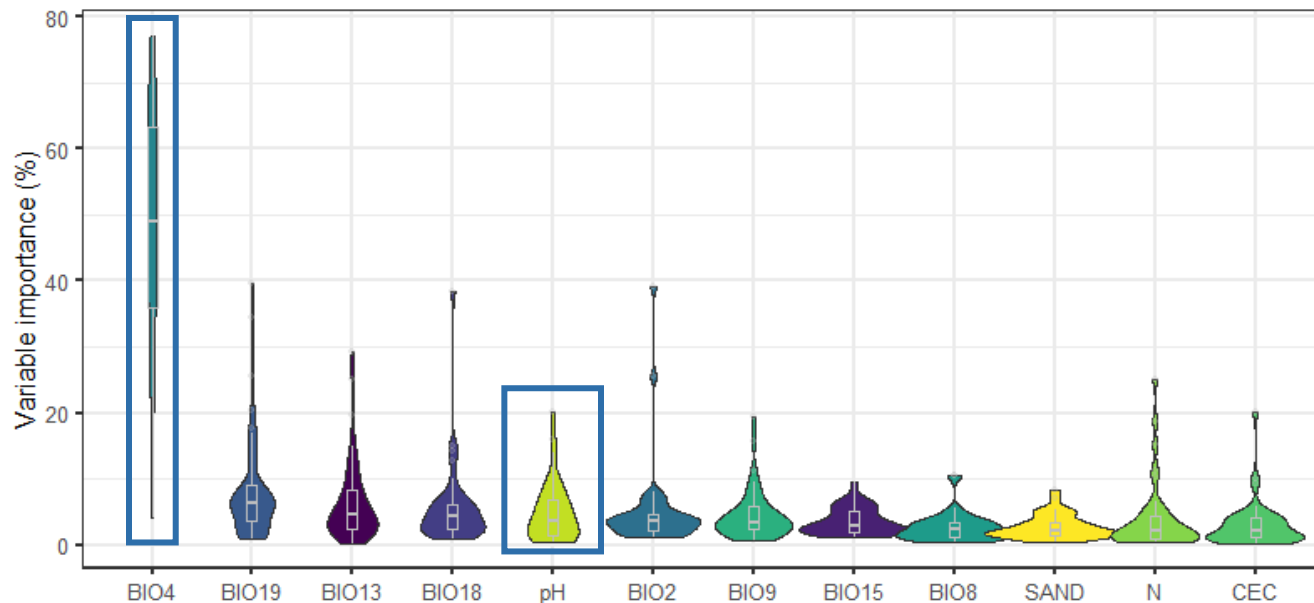
RESULTS

Environmental predictors

- ❑ The highest scores were related to temperature seasonality (standard deviation of annual temperature).
- ❑ Within the edaphic variables, pH was also relatively strong predictor of species occurrence.
- ❑ The sum of the contribution rate of the 8 climatic variables reached 85% and that of the 4 soil factors reached 15%.

Theobroma cacao:

- ❑ The sum of the contribution rate of temperature seasonality and the precipitation of warmest quarter reached 65%.



RESULTS

Changes in habitat suitability

Current



Theobroma cacao

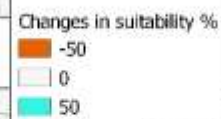
- ❑ Increase of suitable area by 2040 ranging from 3.9% for the low emissions scenario and 4.8% for the high emissions scenario.
- ❑ By 2060, the increase will be of 0.2% (high emissions) and 6.7% (low emissions).

2021 - 2040

SSP 126



SSP 585



2041 - 2060

SSP 126



SSP 585



- ❑ Increase in suitability in the central part of Côte d'Ivoire and south-eastern Nigeria.
- ❑ Reduction in habitat suitability of the currently highly suitable areas of cocoa in Guinea, Sierra Leone, and Liberia.

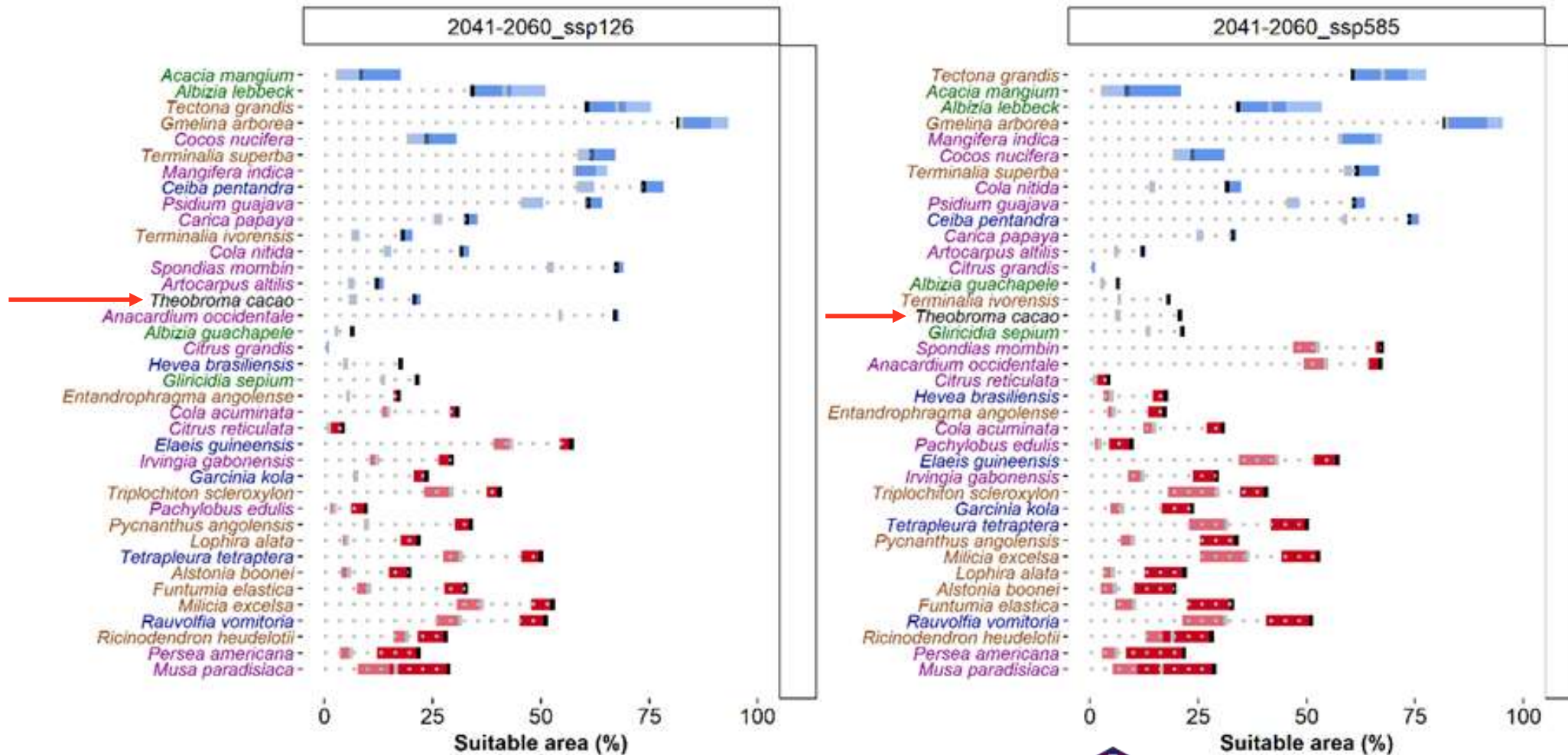


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RESULTS

Changes in habitat suitability

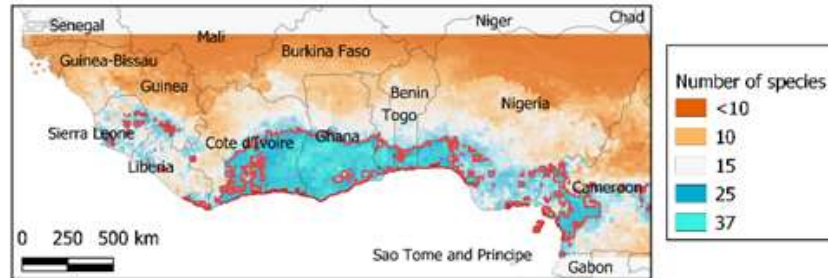


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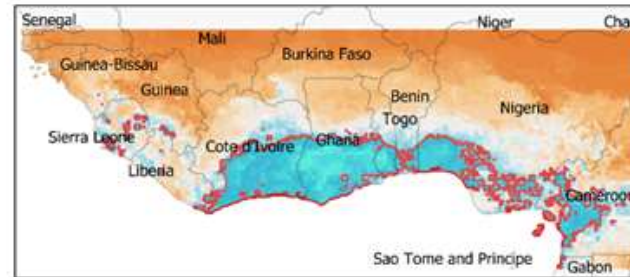
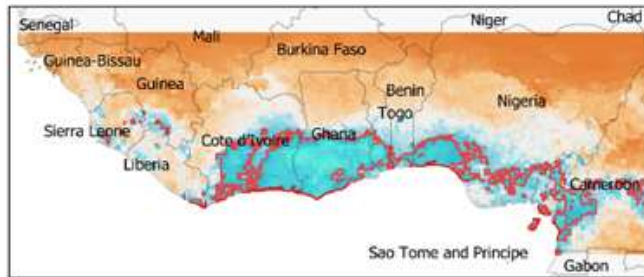


RESULTS

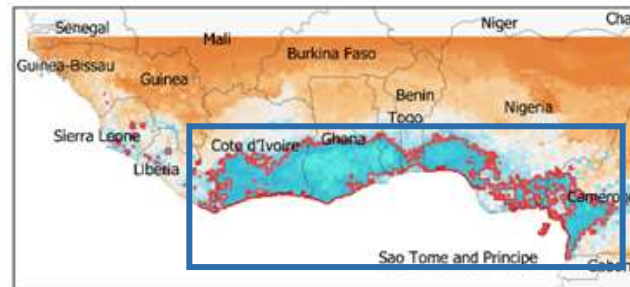
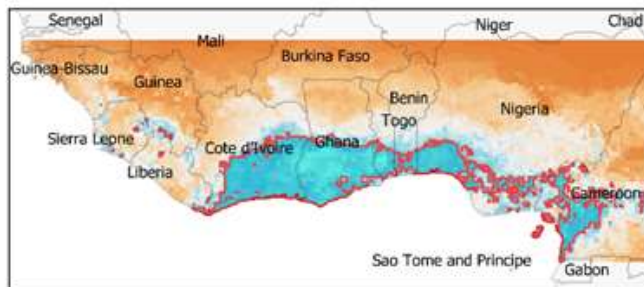
Current



2021 - 2040



2041 - 2060



Species richness

- ❑ Currently, bioclimatic habitat of ~ 25 shade tree species overlaps with that of *Theobroma cacao* L. in the coastal zones of West Africa.
- ❑ By 2060, ~ 70% of the cocoa distribution areas would be suitable for more than 25 shade tree species.
- ❑ All cocoa producing areas will at least keep more than 10 species under environmental suitable conditions.



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CONCLUSIONS

1. Maximum temperatures during the dry season in the future West Africa are projected to locally approach the limits of tolerance of *Theobroma cacao* L. reported in the literature, but this effect will sometimes be offset by a slight increase in precipitation.
2. The potential habitat suitability for *Theobroma cacao* L. in West Africa would remain constant or slightly increase in the next decades.
3. Approximately half of the shade tree species showed a decrease in suitable area across the region for the expected climate scenarios in 2040 and 2060.
4. The most negative effects are projected in the coastal areas of Guinea, Sierra Leone and Liberia.
5. Data-based transforming agroforestry systems by changing tree species composition may be the best approach to adapt most of the cocoa production areas in West Africa, maximizing the performance of cocoa plantations and improving farmers' livelihoods.



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EVALUACIÓN Y RESTAURACIÓN DE
SISTEMAS AGRÍCOLAS Y FORESTALES



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