



AI4Chocolate: AI for resilient cocoa farming

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Goal

Using AI/ML tools to predict the land suitability of 4 main African cocoa producing countries under climate change: **Ghana, Cameroon, Nigeria, and Côte d'Ivoire.**

Data and Method

MaxEnt, short for Maximum Entropy, is a modeling approach used in various fields, including land suitability and species distribution. MaxEnt's main advantage is using presence-only data as the lack/absence of data does not reflect reality for many domains. It was a good fit for our data. Figures 1-3 show all the data we used for our analysis.

Cocoa Harvested Area

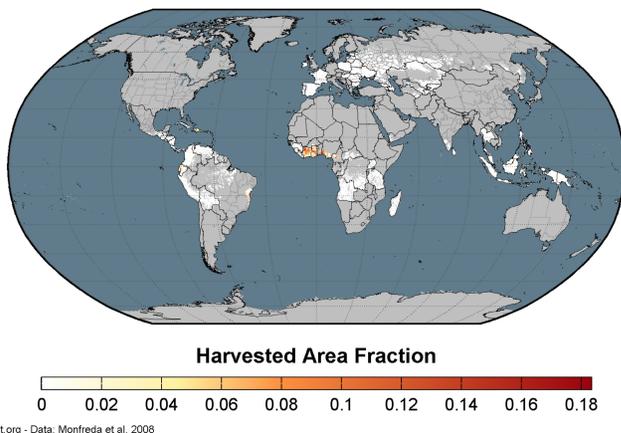


Figure 1. EarthStat (<http://www.earthstat.org/>) which provides global harvested area including 175 kinds of crops. The fraction of cacao-harvested area (FSHA) was used to represent the cacao distribution present points for the areas of interest.

Environmental variable
Mean diurnal range (bio2)
Mean temperature of the wettest quarter (bio8)
Mean temperature of the driest quarter (bio9)
Mean temperature of the warmest quarter (bio10)
Mean temperature of the coldest quarter (bio11)
Precipitation of the wettest quarter (bio16)
Precipitation of the driest quarter (bio17)
Precipitation of the warmest quarter (bio18)
Precipitation of the coldest quarter (bio19)
Elevation

Figure 2. WorldClim (<https://www.worldclim.org/data/index.html>) which provides environmental variable including weather, elevation and some other bioclimate variable.

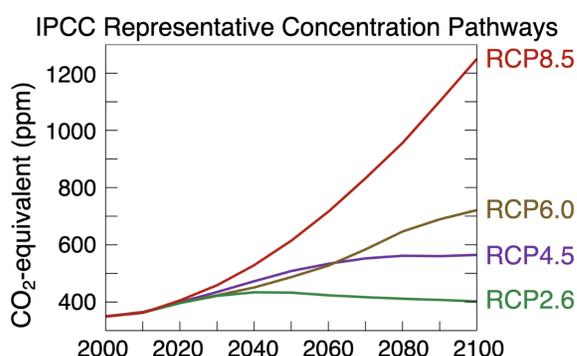


Figure 3. CCAFS (https://www.ccafs-climate.org/data_spatial_downscaling/) which provides future climate data. We need these data to analyse what happens to the land suitability of interested areas if the climate data change according to different models (i.e. bcc_csm1 and cnrm_cm5) under two scenarios RCP2.6 or "low emissions" and RCP8.5 or "very high emissions".

Insights

- The AUC of our best model is 0.81. The higher the AUC, the better the model is at predicting.
- For all models for **highly suitable** areas **bio17 (precipitation of the driest quarter)** and **bio19 (precipitation of the coldest quarter)** have the **highest** contribution.
- But for **(medium) suitable** areas, **bio17** and **bio10 (the temperature of the warmest quarter)** have the highest impact.
- **Bio16 (precipitation of wettest quarter)** has the **least** contribution in all models.
- The prediction under scenario RCP2.6 (Figure 4, top) is better than RCP8.5 (Figure 4, bottom) in both models. This can be attributed to the fact that climate scenario RCP2.6, aims to limit global warming, in contrast to RCP8.5.
- Certain regions show improved suitability in the future, driven by variables like precipitation that strongly influence the model predictions. In both climate scenarios, these specified regions are projected to experience increased rainfall.

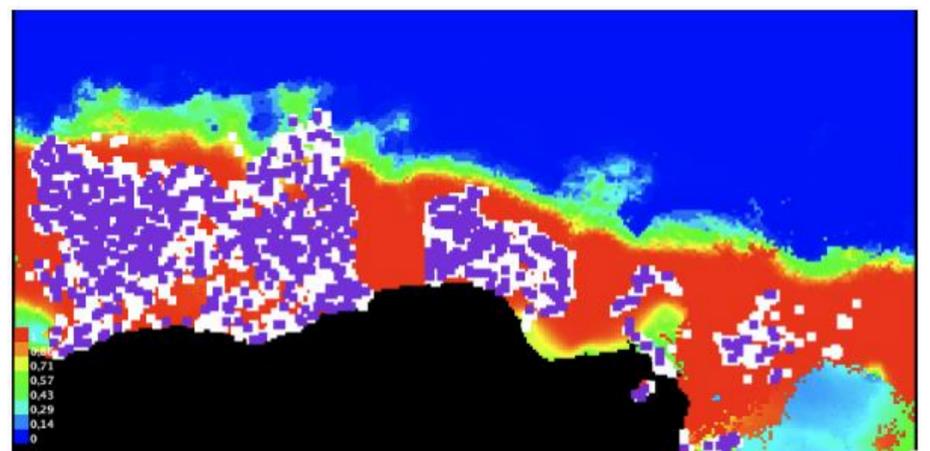
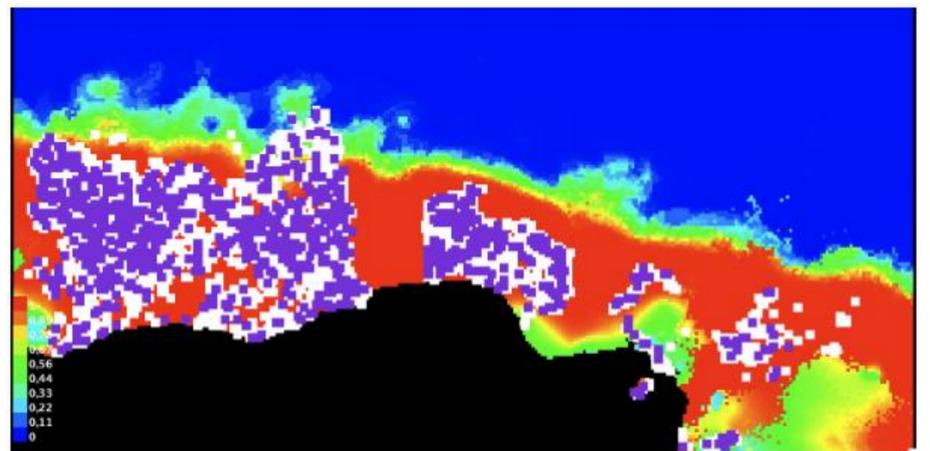


Figure 4. Warmer colors show areas with better predicted conditions. White dots show the presence locations used for training, while violet dots show test locations.

Future Direction

Our project focused solely on analyzing land suitability based on climate change, neglecting other variables that could impact the model predictions. Future work should consider these additional factors for a more comprehensive assessment.

One future goal is to informing the policy makers of possible future scenarios on cacao land suitability. The recommendation can help them to design or change the management policies on the current suitable cacao farms. They can also invest in new farms that would be appropriate for the coming future.

Acknowledgement

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