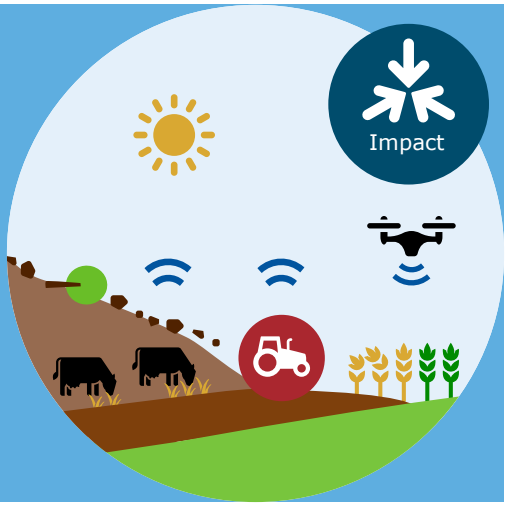
AI4Chocolate

Artificial intelligence for resilient cocoa farming

Emerging DS/AI methods



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Data Driven Discoveries in a changing climate (D3C2)

Objective: 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. For this study, we used two climate models and two climate scenarios to determine the future suitability of these regions by 2080.

Activities

As a result of several meetings and literature reviews, we decided to use MaxEnt for this project. MaxEnt, short for Maximum Entropy, is a modelling approach used in various fields, including land suitability and species distribution. It is used to predict the probability distribution of a set of conditions based on incomplete information. MaxEnt is free to use, uses the presence-only data, incorporating multiple variables, works well with small datasets and is a very common practice.

For the cacao farm dataset, the data was obtained from EARTHSTAT which provides global harvested area and yield data including 175 kinds of crops. The fraction of cacao-harvested area (FSHA) was used to represent the cacao distribution present points. The FSHA value represents the fraction of a grid cell that was harvested with cacao.

We used WorldClim for current bioclimate data and CCAFS for future climate models (bcc_csm1 and cnrm_cm5) under two scenarios (see image 1):

- RCP2.6: 'low emissions' scenario, which aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels.
- RCP8.5: 'very high emissions' scenario, which assumes that no significant mitigation measures are taken.

For the environmental variables, we experimented with different bioclimate variables, and we removed the corelated variables.

Achievement

Various graphs and plots have been generated. The AUC (area under curve) of our best model is 0.81. The higher the AUC, the better the model is at predicting. One interesting result was the variable contribution and importance result. 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 results revealing that more areas are suitable for cacao farming under the current climate conditions. The prediction under scenario RCP2.6 is better than RCP8.5. This can be attributed to the fact that climate scenario RCP2.6, aims to limit global warming, in contrast to RCP8.5, which does not. 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. It is important to note that our project focused solely on analysing 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.

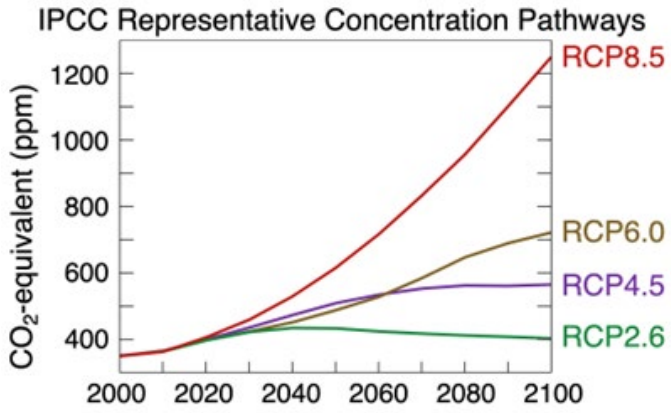

Figure 1 Different RCP scenarios result in different greenhouse gas concenteration.

Environmental variable
Mean duirnal range (bio2)
Mean tempreature of the wettest quarter (bio8)
Mean tempreature of the driest quarter (bio9)
Mean tempreature of the warmest quarter (bio10)
Mean tempreature of the coldest quarter (bio11)
Precitipation of the wettest quarter (bio16)
Precitipation of the driest quarter (bio17)
Precitipation of the warmest quarter (bio18)
Precitipation of the coldest quarter (bio19)
Elevation

Figure 2 Variables used for suitability analysis.

Outlook

One future direction would be 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 invest in new farms that would be appropriate for the coming future. To help policy makers plan better policies, we can also extend our research to include other factors (besides environmental features) like socioeconomics (education, salary, et cetera).

Lessons learned

The process of using MaxEnt is not as straightforward as it may seem. There were several steps required to prepare the present data, such as cacao harvest distribution.

Among all, one important lesson learned was to first classify the dataset to two class highly suitable and suitable. We had to do this to handle the bias (non-uniformness) of the FSHA. The result would have been quite different without this step.

Deliverables

- Jupyter Notebook with all the necessary steps for preparing the data and the results from Maxent can be found: AI4CHOCOLATE.
- Links to all datasets: EARTHSTAT, WorldClim and CCAFS

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