The Potential Fate of Taro (*Colocasia esculenta*) Under RCP4.5

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Introduction

Taro (*Colocasia esculenta*) is part of the Araceae family, which comprises about 3750 known species spread across the world, but the vast majority - 90% - are found within the tropics. A root vegetable popular especially in South-East Asia, Africa and Oceania, *C. esculenta* is a perennial tropical plant that flourishes in climates with high temperatures and adequate amount of rainfall (Cabrera et al., 2008; Kodis et al., 2018). Thought to have originated in Southern India, taro's range has steadily increased with time to northern Australia, across the Pacific islands to South America, throughout Africa and several Mediterannean nations as well as the southern United States.

With the Representative Concentration Pathway (RCP) for greenhouse concentrations currently on track to exceed the 2.6 scenario and more likely to hit the 4.5 level of modelling, it is expected that this would have a range of effects on the planet and the environment. One of the species that may be affected is taro, whose wide range and reliance on high temperatures and rainfall could lead to a change in global distribution (Lebot et al., 2017). A species Distribution Model (SDM) will be created based off of a range of data collected to determine what could be the potential fate of *C. esculenta* under RCP4.5.

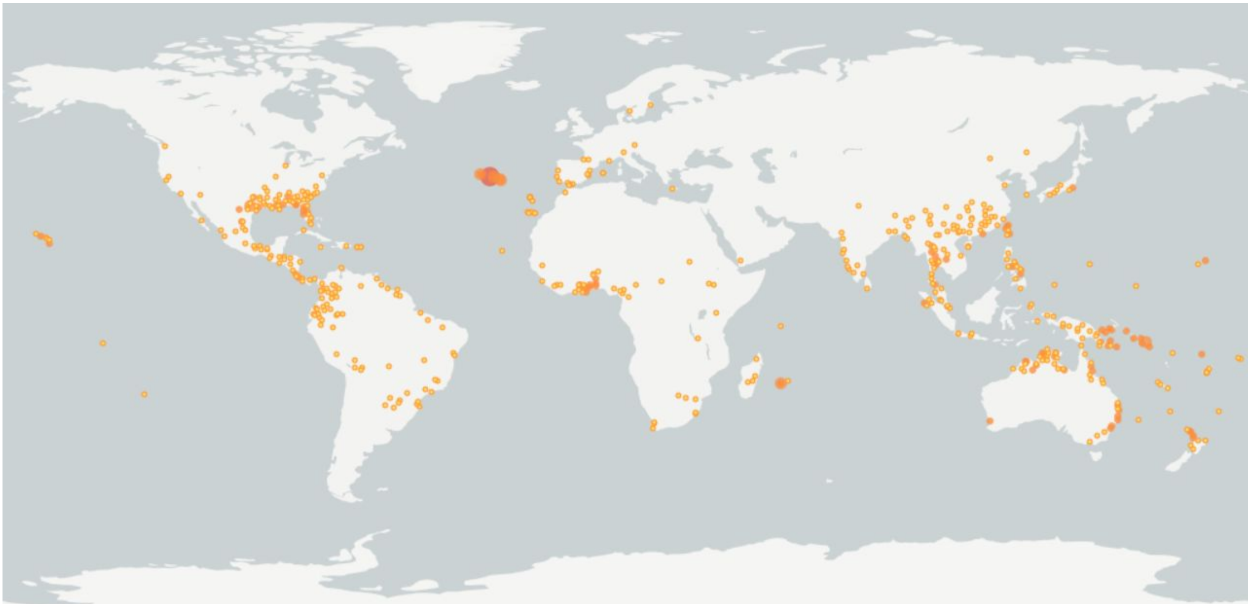

Figure 1.0: Global occurences of C. esculenta as presented by GBIF

Research question

How will *C. esculenta*'s distribution be affected by the RCP4.5 scenario?

Hypothesis

Due to the higher temperatures and shifting weather patterns associated with RCP4.5, *C. esculenta*'s range will increase.

Methodology

Occurence data for *C. esculenta* and their associated locations was obtained from GBIF prior to being cleaned in Excel to leave only the decimal longitude and latitude of each recorded unit. The cleaned data was then inserted into ArcGIS where it was analysed to delete any points that were deemed inaccurate - eg: in the ocean or away from its recorded distribution range. As such 82 points were removed from the occurrence data set, or roughly 1.1% of the total occurrences recorded on GBIF.

Bioclimatic data was then retrieved from WorldClim for current conditions (1960-1990) as well as those expected under RCP4.5 (2050) on 5 arc minutes. Both of these datasets were then run through R-Studio prior to MaxEnt, where it was replicated 5 times to produce an SDM. Three main variables were identified in the literature as having a significant effect on taro range and distribution: Bio3 (Isothermality), Bio4 (Temperature Seasonality) and Bio12 (Annual Precipitation). These variables had a Variation Inflation Factor (VIF) value of 6.6, 6.5 and 1.5 respectively and were the ones used for modelling.

Results

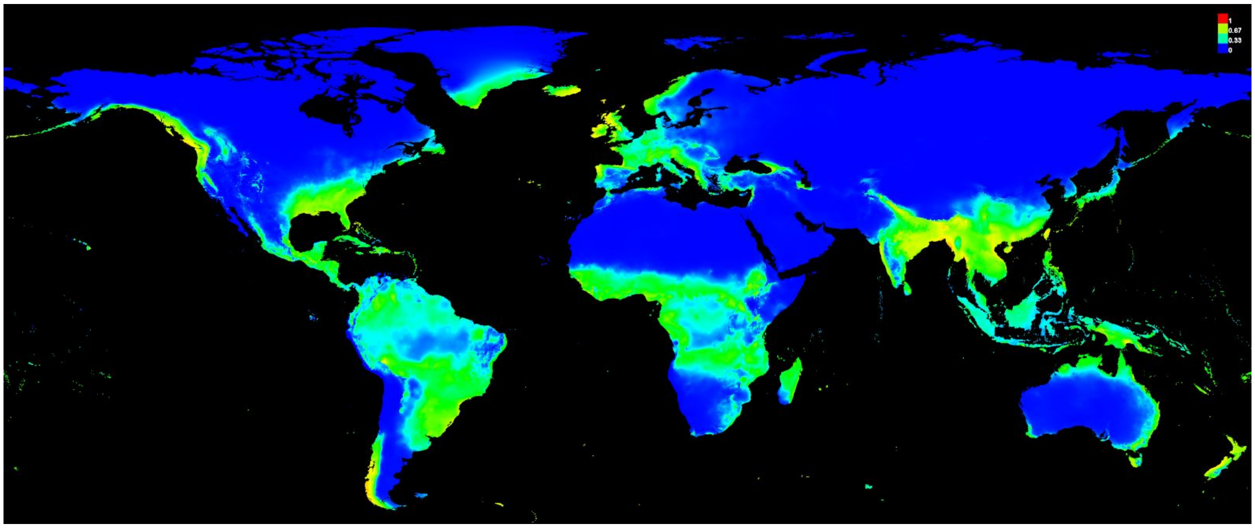

Figure 2.0: Present suitable habitats for *C. esculenta*

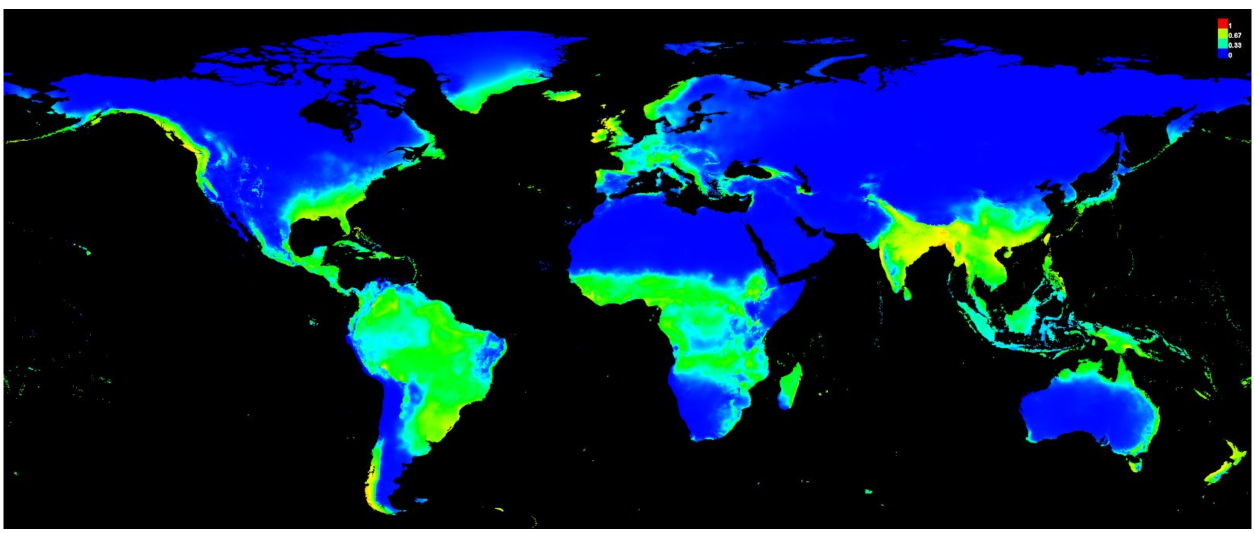

Figure 2.1: Future projections of suitable habitats for *C. esculenta* under RCP4.5

Variable	Percent contribution	Permutation importance
_Bio12	77.4	64.2
_Bio04	17.2	24.9
_Bio03	5.4	10.9

Figure 2.2: Percent contribution of climatic variables

The MaxEnt outputs illustrating current and future predictions showed a more noticeable change than its R-Studio counterpart. This model is very reliable as its AUC score (Figure 2.3) is 0.837, and has a standard deviation of 0.005. Figure 2.2 (inset) describes the percent contribution of each climatic variable on the model. Corroborating the suggestion by the previous VIF score that Bio12 (Annual Precipitation) was the most important variable, MaxEnt identified Bio12 as the most influential of the three (Figure 2.4).

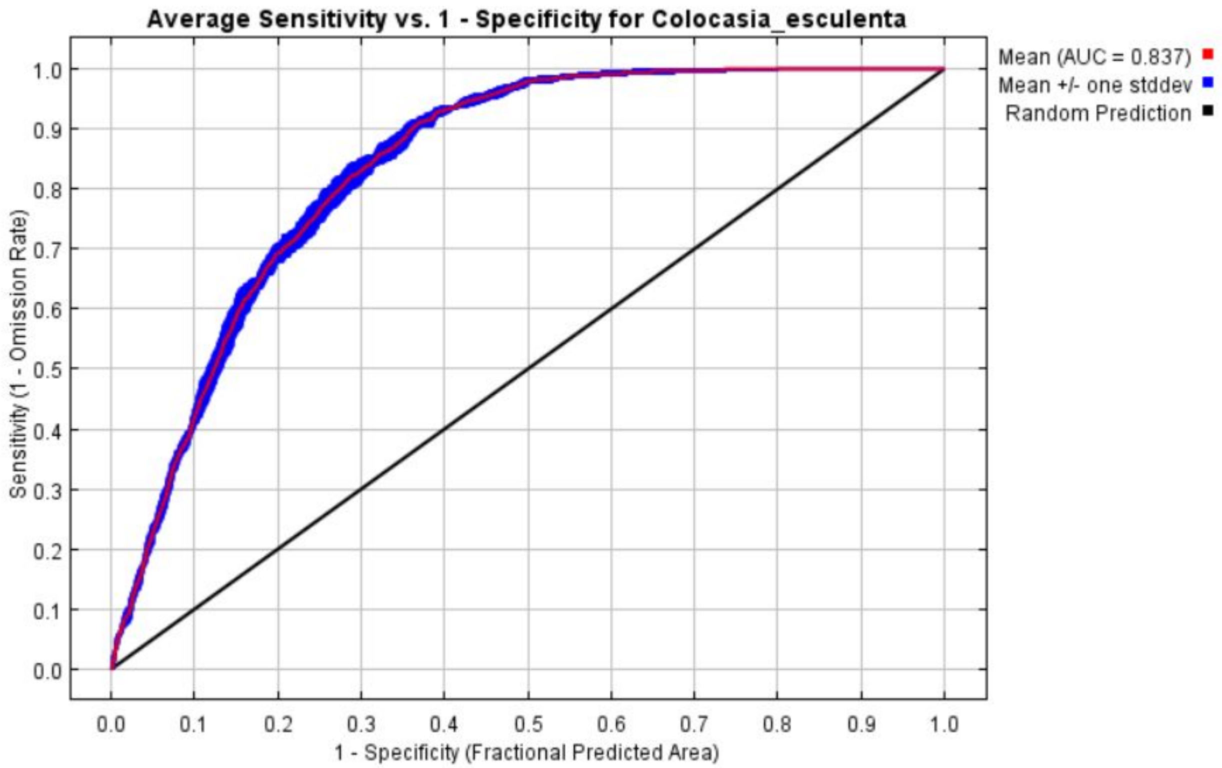

Figure 2.3: Area Under Curve (AUC) graph for the model

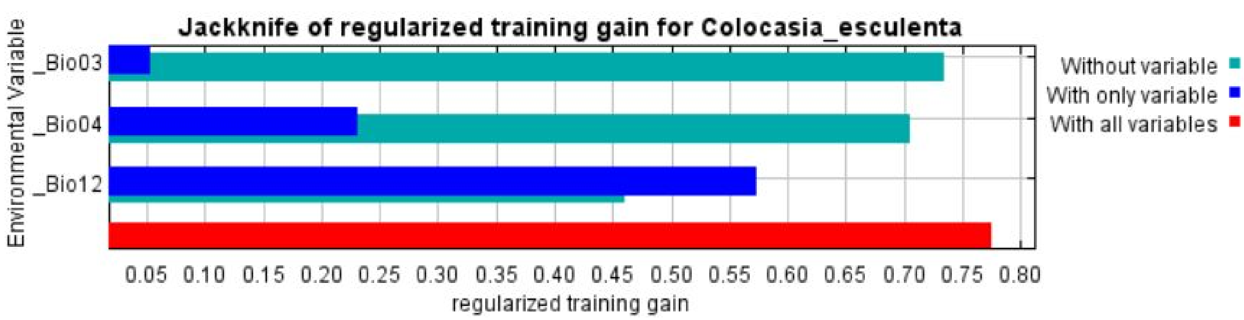

Figure 2.4: Jacknife of regularized training gain for *C. esculenta*

Discussion

Figure 2.1 shows a global change in geographical range for *C. esculenta*. Under RCP4.5 projections South America, Africa and South-East Asia all see a fairly large increase in suitability, likely owing to warmer temperatures and higher rainfall that would be expected under that scenario (Collins et al., 2013). However, habitat suitability decreases slightly in North America and Europe, which corroborates earlier IPCC report models outlining how European and North American temperatures would change at lower rates while becoming drier, challenging potential habitat suitability for *C. esculenta*.

Overall, taro is expected to continue to thrive around the equator and become less likely to expand its range into more temperate regions. This corroborates current literature's consensus that *C. esculenta* is set to become an important crop in tropical regions, but will be more constrained to those climates as a result of climate change. Additionally, this also validates the hypothesis set out at the beginning of this report which predicted an increase in *C. esculenta*'s distribution under an RCP4.5 scenario.

References

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