Mangifera indica L. habitat suitability under present and future climate conditions.

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Introduction

Mangifera indica L. is one of the most important tropical crops. It has been domesticated and distributed thousands of years ago (Shapiro, 2017).

Originally found in northeastern India, Burma, and Bangladesh, now it appears to be one of the most widely distributed tropical fruits all over tropical (Fig. 1.) and subtropical countries, as the south of Spain (Shapiro, 2017).

Fig. 1. Distribution map of *M. indica* L. created with ARCGIS with gbif.org data.

The weather preferences of this species are relatively wide. Mangoes grow in frost free climates with a relatively cold dry season and rain during the hot season. Under high temperature and low-humidity the respiration rate is high and the low carbon accumulation leads to a less hability to hold heavy crops. (Bally, 2006).

Methodology

The MAXENT settings selected were Logistic output format, threshold features, to remove the duplicate presence records in case they were some, a random test percentage to 0 and a maximum number of background points 10000. Moreover, setting threshold means that continues values (running from 0 to 1) not have to be converted to discrete values.

The selected scenario was RPC 2.6, which is the only mitigating scenario and lead to very low greenhouse gas concentration levels (van Vuuren et al., 2011), and the climate model NorESM1-M.

Among the 19 variables, I selected Bio1 (Annual mean temperature), Bio12 (Annual mean precipitation) and Bio 15 (Precipitation seasonality) because the temperature and the precipitations are limiting factors for the tree growth and development, as for example low temperature stress is necessary for flowering. Besides, precipitation seasonality is very important because *M. indica* produce best when there is a well defined dry season (Bally, 2006).

Model output

As we can see in Fig. 2. There are not a lot of differences except at the Ecuador and this could be mainly because the selected scenario doesn't induce a big climate change. The species distributions stills tropical and subtropical areas avoiding really dry and cold areas as deserts or high mountains as its shown in the map with Sahara desert and the Andes.

Present: Future:

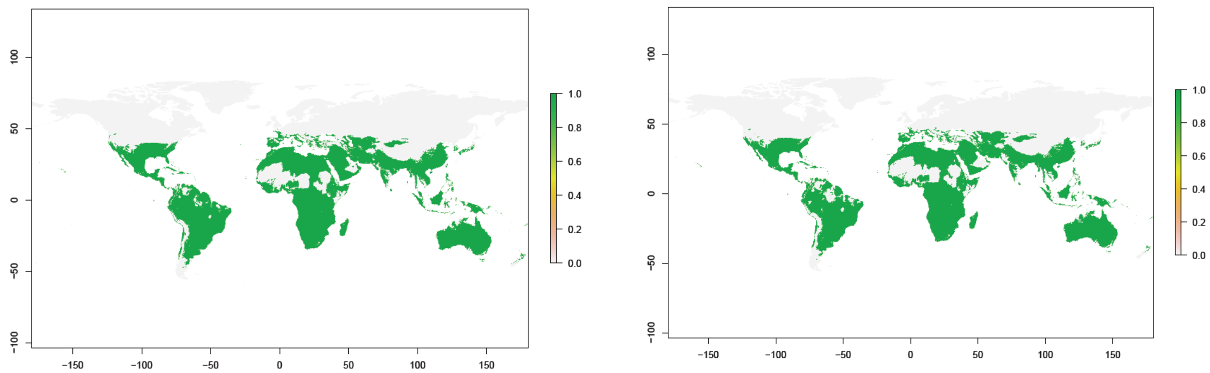

Fig. 2. Present and future distribution maps of *M. indica* under RPC 2.6 scenario

The red line of Fig. 3. shows the fit of the model to the training data. It has an area under the curve (AUC) value greater than 0.7 so the model is reliable; the probability of finding a mango out or within its distribution area is not random.

Fig. 3. AUC plot, it gives the reciver operator curve (ROC) for training data and de AUC value.

Looking at the variable importance table (Table 1.), the annual mean temperature seems to be the main driver of distribution in this model with a 96.6 percent of contribution and in a small part the annual mean precipitations, with a 3.5 percent of contribution (Table 1.). This tells us that in this model the temperature is the limiting factor of mango distribution.

Variable	Percent contribution	Permutation importance
bio1	96.6	87.3
bio12	3.4	12.4
bio15	0	0.3

Table 1. Variable importance table

Response to future scenario

As we saw on Fig. 2. This model doesn't show significant changes for the future scenario. The most important ones are near the Ecuador where we can see distribution diminution on the Amazon rainforest, the Sahara desert and the Arabian Peninsula (Fig. 4.). In this map we can also observe the gain of habitat distribution in the northern coast of Australia that are mainly drive by future temperature changes (Table 1.).

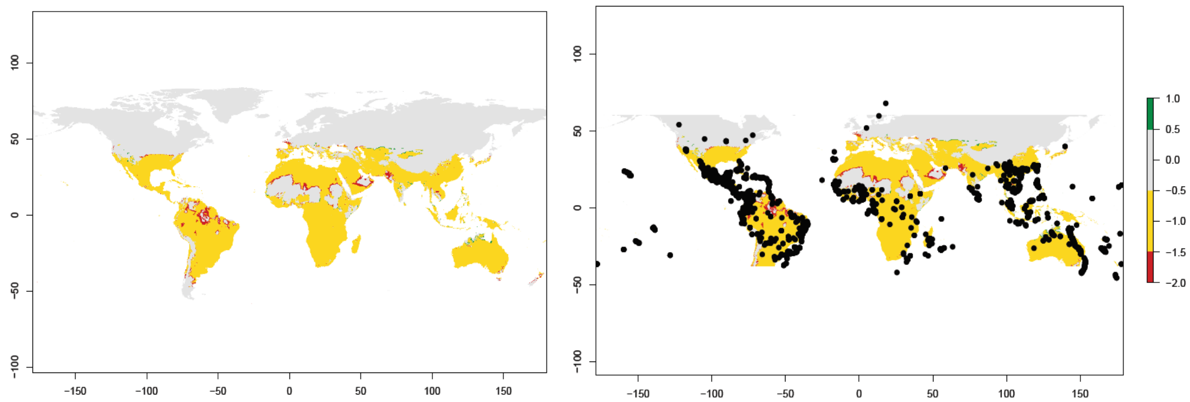

Fig. 1. Future changes map

Biological interpretation

According to this model *M. indica* distribution will change mostly because temperature changes in the planet and the most affected parts will be near the Ecuador. Mango's optimum temperature is 24-27^{o}C (Bally, 2006) so the predicted higher temperatures in those areas won't allow mangoes to grow there.

As temperature has a direct effect on tree and fruit growth rates (Bally, 2006) the development of this plant will be affected. The tree's ability of holding heavy mangoes decrease under dry and hot conditions because of the deficiency of photogenic rate and the high respiration, resulting in low carbon accumulation (Bally, 2006), this would lead to smaller and less productive trees

Although RPC 2.6 scenario is not as dramatic as RPC 8.5 would be it stills showing some effect on mangoes distribution. We can observe that this model is not random because its AUC value higher that 0.7

There is one factor that this model does not care and it is the soil. The pH and salinity of the soil are important drivers of *M. indica* distribution and they are not taken into account.

Bibliography

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