# Impact of climate change on coffee agrosystems and potential of adaptation measures

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## 1. Background

- Coffee is one of the most economically important agri-food systems globally, and is the main source of income for many rural households in several countries.
- Climate change may have negative impacts on coffee production, such as reducing yields and increasing instability from year to year.
- To address these challenges, it's important to evaluate potential adaptation measures and agronomic practices.
- Process-based models are well suited to study the effects of such modifications.

## 2. Materials and Methods

- We used the biophysical model DynACof, developed specifically to simulate coffee agrosystems. We validated modelled yields with data available from previous studies in different countries.
- We developed a tool called G-DynACof, to spatialize the model at continental scale using extensive climatic projections and soil geodatasets (Fig.1).
- G-DynACof was used to simulate coffee yields in Latin America and Africa using an ensemble of statistically downscaled and biased corrected climate models for the period 1985-2014 and for 2036-2065 under two emission scenarios.
- We tested the efficacy of increasing shade tree density on mitigating the negative effects of climate changes on coffee yield.

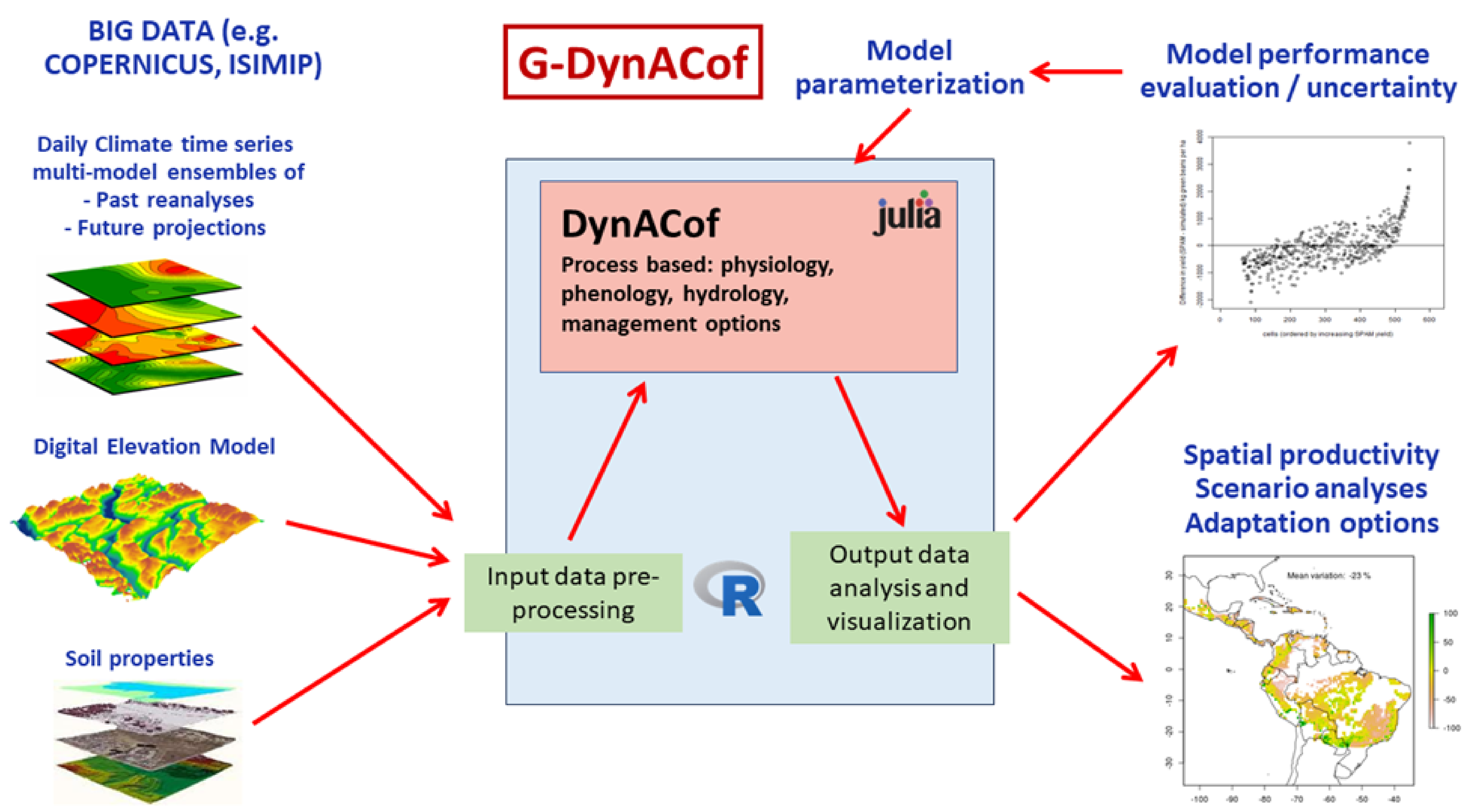


Fig. 1. Schematic representation of the workflow within our tool G-DynACof.

## 3. Predicted yield decrease

- Our results indicate that crop yields are likely to decrease between 29% and 35% in Latin America and between 16% and 21% in Africa, depending on the scenario considered (Fig. 2).
- Spatialized simulations predict a strong negative impact on most areas, but still, some lower latitudes and higher elevation areas presented higher predicted yield compared to the baseline (Fig. 3).

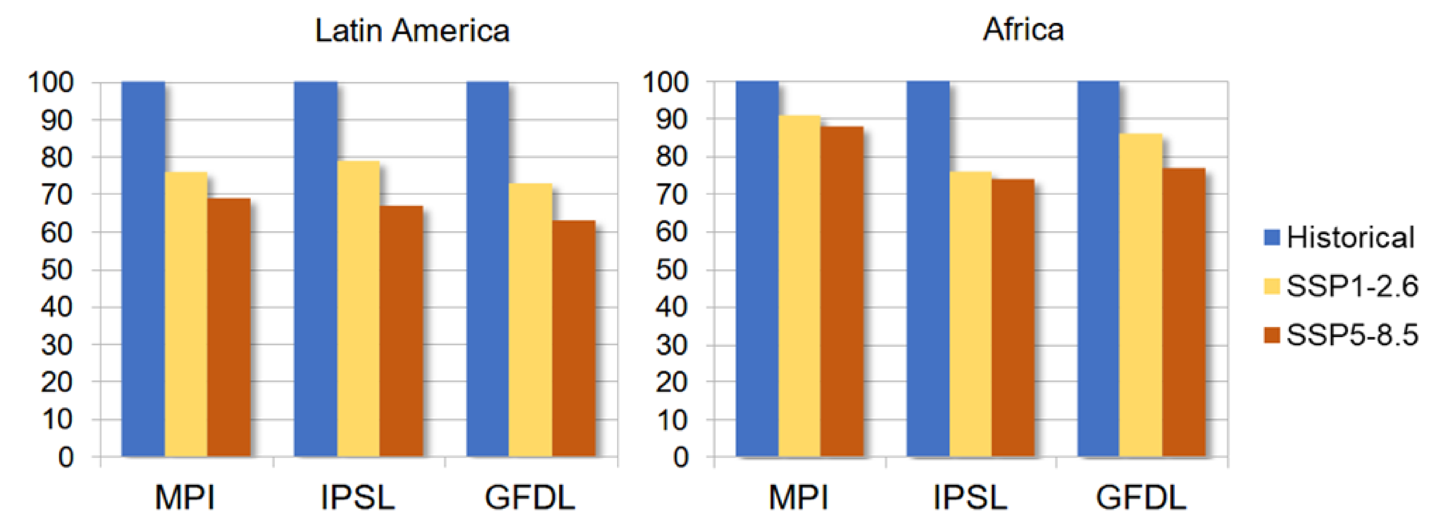


Fig. 2. Normalized average annual potential yield, climate projections (2036-2065) vs. historical climate (1985-2014), where yield under historical climate is set to 100. Climate models: MPI=Max Plank Institute; IPSL =Institute Pierre Simon Laplace; GFDL = NOAA Geophysical Fluid Dynamics Laboratory. Shared Socioeconomic Pathways: SSP1-2.6 = Sustainability with low GHG emissions (expected radiative forcing of 2.6 W/m$^2$); SSP5-8.5 = Fossil-fuelled Development with very high GHG emissions (expected radiative forcing of 8.5 W/m$^2$).

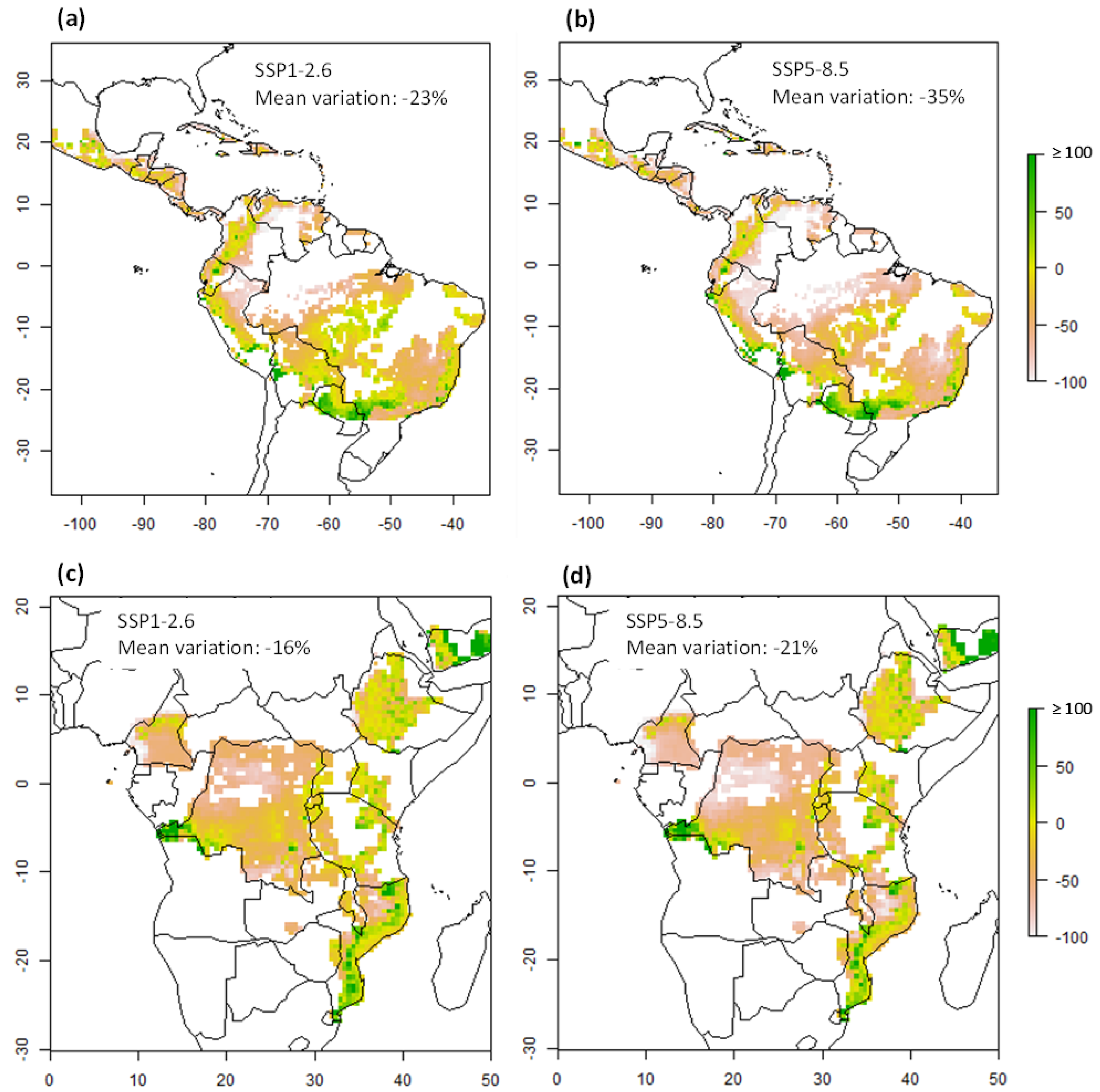


Fig. 3. Predicted variation of potential yield in Latin America and Africa, climate projection (2036-2065) vs. historical climate (1985-2014). Multi-model average for SSP1-2.6 (a, c) and SSP5-8.5 (b, d).

## 4. Effect of adaptation measures

- In our simulations, enhanced agroforestry mitigated the negative impact of climate changes on 20% of Latin American production areas, reducing yield loss by 2 percent points on average, while on 74% of the area it further reduced yield (Fig. 4).

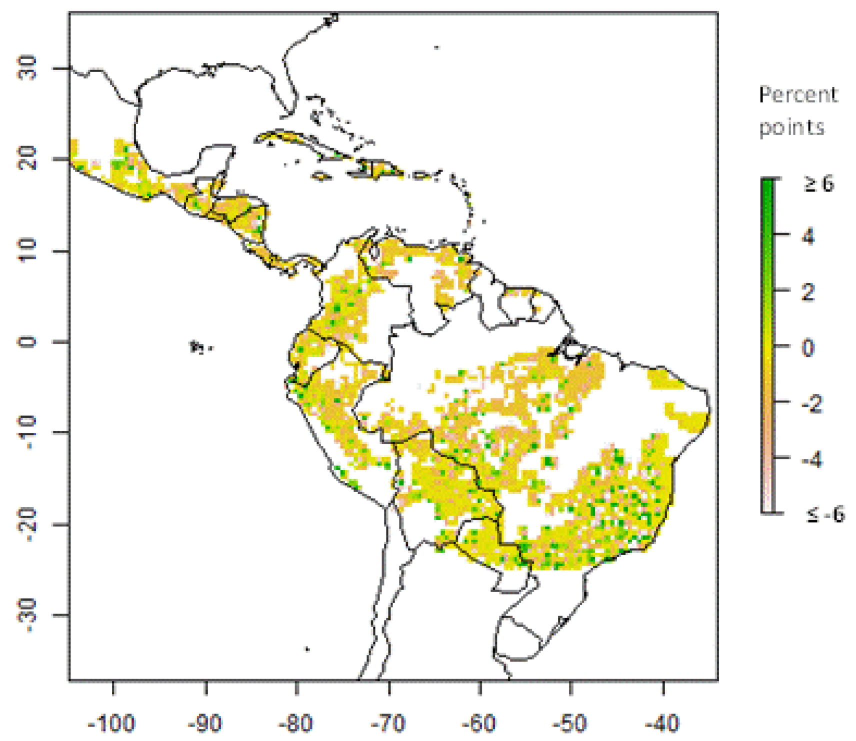


Fig. 4. Difference in coffee yield (percent points) between scenario "enhanced agroforestry" (50% increase of shade trees density) vs. baseline, under SSP1-2.6.

## 5. Conclusions

- Our simulations with the newly-developed tool G-DynACof predicted an **overall coffee yield decrease** by 2050 under all considered emission scenarios.
- Yield is predicted to decrease **more in Latin America** than in Africa, possibly due to climatic conditions.
- Areas at **lower latitudes** (e.g. Southern Brazil) and **higher altitudes** will be **less impacted**, and may present yield increase.
- **Production may shift** towards these areas, posing problems related to deforestation and loss of biodiversity.
- Increasing **shade trees** density may counteract the negative impacts of climate change on some specific areas, but it would not be sufficient to reverse the overall trend.

## References & acknowledgements

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We are grateful to researchers that made available field data to allow model validation: Marcel van Oijen; staff at CATIE (Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica), in particular Elias De Melo; Antoine Libert; Mattia Guglielmi.