INTERNATIONAL COFFEE ORGANIZATION

SC 75/17

20 September 2017
Original: English

E

Statistics Committee
13th Meeting
26 September 2017
Yamoussoukro, Côte d'Ivoire

**Advances in coffee economics:
Recent studies on the impact
of climate change on coffee production**

Background

In accordance with Article 34 of the International Coffee Agreement 2007, the International Coffee Organization is required to provide Members with studies and reports on relevant aspects of the coffee sector. This document contains a review on recent studies on the impact of climate change on coffee production.

Action

The Council is requested to take note of this document.

ADVANCES IN COFFEE ECONOMICS:
RECENT STUDIES ON THE IMPACT OF CLIMATE CHANGE ON COFFEE PRODUCTION

Introduction

1. This document contains a review of two recently published studies[1] which add empirical evidence to the literature on modelling the impact of climate change on coffee production. Specifically, the studies investigate how rising temperatures and changing rainfall patterns affect the suitability of land currently used for coffee production globally and at country level. Furthermore, adaptation strategies and mitigating actions, including migration of production, are discussed.

2. Both articles emphasize the importance of coffee production as a livelihood for millions of smallholders around the globe as well as its economic significance as a generator of a large share of export earnings in producing countries. But coffee is also likely to be affected particularly strongly by climate change as the coffee plant has a narrow genetic base and thus grows only in a limited climatic range. As a tree crop with an average lifespan of 30 years, existing coffee plantations are expected to experience rising temperatures and changes in rainfall patterns predicted by the models underlying the assessments of the Intergovernmental Panel on Climate Change (IPCC).

Climate change profile of Arabica and Robusta coffee

3. Bunn et al. (2015) use machine-learning algorithms to project the future climate suitability for production of both Arabica and Robusta. The authors train their models by linking climate data with a database of thousands of geo-referenced coffee farms.

4. The first output of the model comprises a world map indicating the suitability of certain regions for coffee production under current climate conditions. The results of this baseline scenario indicate highly favourable conditions for Arabica in the state of Minas Gerais in Brazil, areas in Central America and the Ethiopian highlands, while other areas in Africa and Asia are considered of intermediate suitability. Areas deemed highly suitable for cultivation of Robusta are in the Brazilian Espirito Santo region, lower-altitude locations of Central America, and mountainous areas in Asia, especially in Vietnam.

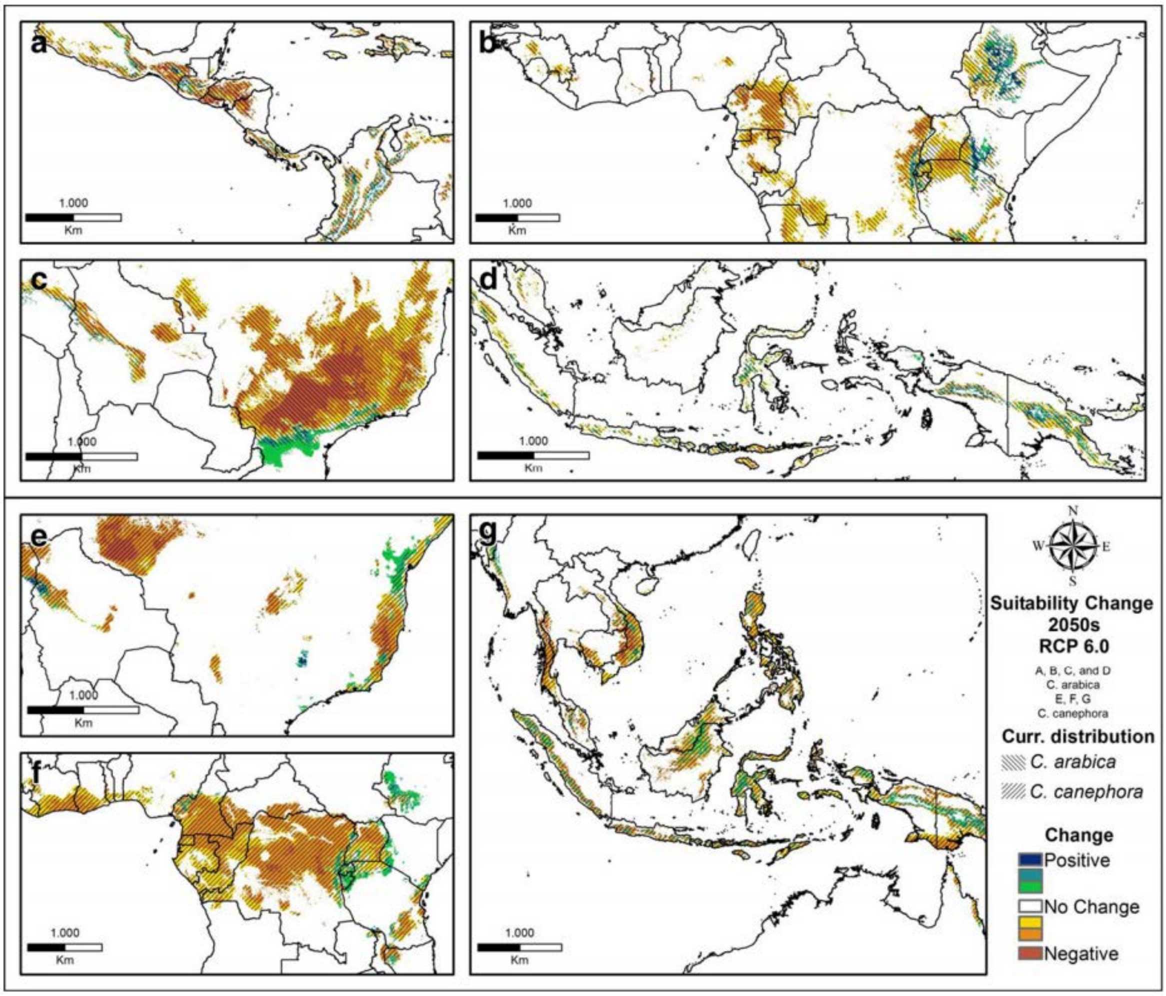
---

[1] ***Bunn, C., P. Läderach, O. Ovalle Rivera, and D. Kirschke (2015).*** *A bitter cup: climate change profile of global production of Arabica and Robusta coffee. Climate Change Vol 129: 89–101*
Moat, J., J. Williams, S. Baena, T. Wilkinson, T. W. Gole, Z. K. Challa, S. Demissew, and A.P. Davis (2017). *Resilience potential of the Ethiopia coffee sector under climate change. Nature Plants Vol. 3 (7)*

5. Building on the baseline scenario, the researchers project the suitability in three commonly used greenhouse gas emission scenarios (low, medium, high) approved by the IPCC in its 5th Assessment[2]. The results are presented separately for Arabica and Robusta.

6. For the medium scenario (RCP 6.0), the authors find that by the year 2050 suitability of the area currently used for Arabica production is greatly reduced across Latin America, Asia, East Africa, the Congo basin and coastal areas of West Africa (Figure 1). An increase in suitability is projected for southern areas in Brazil as well as for the Ethiopian, Ugandan and Kenyan highlands. A southward movement of suitability can also be found for Indonesia and the Philippines. In the case of Robusta, the model predicts severe losses in suitability of land in Brazil, West Africa, and in the most important production regions of South East Asia. On the other hand, suitability for Robusta cultivation is likely to increase at higher altitudes.

Figure 1: Suitability changes by the 2050s in the RCP 6.0 scenario; A-D: Arabica, E-G: Robusta



Source: Bunn et al. (2015)

[2] *The IPCC selected four Representative Concentration Pathways (RCPs) defined by their total radiative forcing (cumulative measure of human emissions of greenhouse gasses from all sources expressed in Watts per square meter) pathway and level by 2100. The RCPs were chosen to represent a broad range of climate outcomes, based on a literature review, and are neither forecasts nor policy recommendations. In their article, the authors use the projections of RPC 2.6, RCP 6.0, and RCP 8.5.*

7. Notably, the most important climate parameter affecting the suitability for Arabica cultivation is the mean temperature of the warmest quarter in a given year. For Robusta, which is known to be more tolerant to high temperatures, the most important climate variables are the annual temperature range as well as precipitation parameters.

8. In sum, the model estimates a reduction in the global area currently used for coffee production by 50% by 2050 across all three emission scenarios. The model also projects new areas to become suitable for cultivation of coffee. Distinguishing land use classes, the losses in suitability are equally distributed between areas with and without forest cover. For example, new areas in East Africa are currently not forested. In contrast, in Asia most of the area that will become increasingly suitable for coffee cultivation is covered by forests at the moment. Hence, the authors note that migrating coffee production could come at the cost of deforestation, resulting in more emissions from changes in land use.

Country specific impacts: Ethiopia

9. The study by Moat et al. (2017) builds on previous work including Bunn et al. (2015), projecting changes in suitability of land for coffee farming under various climate change scenarios. The authors develop a more refined methodological approach to investigate climate change impact on Arabica cultivation in Ethiopia. Their model complements remote-sensing data (e.g. satellite imagery) with on-the-ground validation through research teams, increasing the robustness of projections that cover the period until 2100.

10. The study's first finding is that 39-59% of the area currently used for Arabica cultivation may fall out of production as the agro-climatic conditions deteriorate until the end of the century. Depending on the emission scenario, annual mean temperatures are expected to increase by 1.1-3.1 °C by the 2060s and 1.5-5.1 °C by the 2090s. At the same time rainfall patterns are projected to change, leading to a slight increase in annual rainfall. However, the increase in precipitation will not be sufficient to offset the negative impact of higher temperatures on the coffee plants. Regions negatively affected by climate change include Ethiopia's most famous coffee growing areas such as Bale and Sidamo (including Yirgacheffe).

11. The study's second finding is that vast areas of land where coffee is currently not produced will become increasingly suitable for Arabica cultivation. Due to Ethiopia's topographic profile land at higher elevations brought into production would contribute to a net-gain in area suitable for growing coffee of more than 400% by the end of the century. To realize the fourfold increase, production would have to migrate from increasingly less suitable areas to the highlands.

12. The authors identify both the rising temperatures and the changes in rainfall patterns as main drivers of change. Currently, temperatures in Ethiopia rarely reach levels that negatively affect Arabica plants. However, the combination of higher temperatures and increasingly unfavorable seasonal rainfall patterns are likely to constitute limiting factors in the future.

13. Finally, the authors discuss the impact of compounding negative effects of climate change (e.g. spread of pests and disease) and the beneficial impact of elevated CO2 levels on plant growth. The factors are not explicitly modelled and could alter the results.

Conclusions and policy recommendations

14. The two studies presented in this document point use models to project the impact of climate change on suitability of land for coffee production. The main research and policy implications derived from the research discussed in this document are:

- By the end of this century, climate change will severely impact the spatial distribution of coffee production. Around 50% of the area where coffee is currently produced may be rendered unsuitable by 2050. At the same time new areas, mostly at higher elevation, will become increasingly suitable.
- Climate change has a negative impact on both Arabica and Robusta production, however, albeit via slightly different routes. Arabica is more sensitive to rising mean temperatures while Robusta may be affected by a combination of changing rainfall and temperature patterns during the production season.
- Due to the tree crop nature of coffee, lead times for adaptation measures such as breeding for climate stress tolerance are very long.
- Investments in locally appropriate adaption of coffee production systems, including use of modern varieties, advanced farming techniques and irrigation, can mitigate some of the negative consequences of climate change in today’s coffee growing areas. In view of farmers’ often limited access to finance, the implementation of climate smart agriculture could be supported by international and regional development banks.
- To meet the growing demand for coffee, adaptation measures need to be complemented by migration of coffee production, especially Arabica, to higher elevations. This requires farmers who currently do not produce coffee to develop skills and to undertake investments necessary to profitably grow coffee. Additional value chain infrastructure such as washing stations will be necessary.

- Migration of production could occur without major government intervention as farmers at the frontier realize that coffee production becomes economically viable. However, negative consequences of land use change in currently forested areas need to be considered.

15. Future research could focus on improving the accuracy of projections at the global level as new climate data becomes available. Furthermore, country-level studies covering a wider range of coffee-exporting countries would be desirable in order to enable policy makers to evaluate the impact of climate change on domestic coffee sectors and formulate tailored responses.