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CLIMATE SCENARIOS AND AGROCLIMATIC SUITABILITY FOR THE CULTIVATION OF ROBUSTA COFFEE (*COFFEE CANEPHORA*) AND ARABICA COFFEE (*COFFEA ARABICA* L) IN THE REPUBLIC OF ANGOLA

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OBJECTIVES

All sectors of society are being affected by the meteorological anomaly. Among these, agriculture is the most affected by current climate change scenarios and their variations, such as decreasing productivity and increasing pest and disease infestations. All climate change models use mainly temperature values ,however, high precipitation variations or the lack of reasonable values are associated with increased drought periods and even flooding. Therefore, the combined analysis of thermal and water anomalies becomes an important factor in better adapting plant development conditions to the current climate and potential scenarios that may arise. This study seeks to quantify the adaptability Arabica and Robusta coffee varieties in the Republic of Angola.

METHODOLOGY

The Republic of Angola has always been recognized as a major coffee producer, especially of the Robusta and Arabica varieties. This study aims to demonstrate the agroclimatic suitability of these species under the current climate scenario and under potential scenarios as indicated by the IPPC 2021/2022. The ideal temperature for growing the Arabica variety is between 18°C and 23°C, and temperatures above 30°C can impair plant development, especially during the flowering phase. Annual rainfall should range between 1,200 mm and 1,800 mm, distributed evenly, with a well-defined dry period, which helps induce flowering. The robusta coffee plant has specific climatic requirements for optimal development, such as average annual temperatures between 22°C and 26°C and annual rainfall between 1,200 mm and 1,800 mm. Ideal conditions include a tropical climate, lower altitudes (up to 900 m), and preferably a dry winter and spring followed by a humid summer. In this regard, a study was developed considering climatic conditions based on the work of Melo & Abreu, 2001, and the proposed methodology for crop adaptation based on the work of Camargo et al. (1973). The study considered possible climate scenarios, with patterns based on the climatological normal, establishing warming patterns of 2 to 4°C and variation in total annual precipitation of plus or minus 20%.

CLIMATE REQUIREMENTS

1 - ARABICA COFFEE

It is a crop with low tolerance to frost and even high temperatures. Annual temperatures between 18°C and 22°C are fully favorable, while temperatures between 18 and 20°C may present restrictions closer to 18°C due to delayed vegetative cycle and ripening. Temperatures below 18°C may be considered unfavorable due to the increased risk of frost. Annual temperatures between 22°C and 24°C indicate a range at risk of high maximum temperatures. The closer to 24°C, the more appropriate agronomic techniques should be used. Regarding rainfall distribution, although the crop requires a dry period for fruit maturation and harvesting, the resulting rest period and pre-induction of flowering can be quantified by annual water deficit. Regions with zero annual water deficit cause problems with maturation, harvesting, and plant health. On the other hand, an annual water deficit between 160 and 240 mm may indicate regions where supplemental irrigation is necessary. With annual water deficits above 240 mm, irrigation is essential.

2 - ROBUSTA COFFEE

The upper thermal limits of coffee plants are quite different from those of Arabica. For this species, an average annual temperature between 22 and 26°C indicates suitable areas for cultivation, especially if the maximum temperatures in the upper limit are not frequent, with values above 34°C. In temperature ranges between 18 and 22°C, regions are considered marginal to unsuitable due to thermal insufficiency, and 18°C is the limit below which thermal insufficiency is limiting. The water limits for this crop can be considered similar to those for Arabica, with an annual water deficit greater than 240 mm being unfavorable for the crop. The ideal conditions include a tropical climate, lower altitude (up to 900 m) and preferably a dry winter and spring, followed by a humid summer. In this aspect, a study was developed considering the climatic conditions based on the work Melo & Abreu,2001. The climatic requirements or demands were established based on the work of Camargo et al, 1973, as indicated in the table for those crops are below.

Agroclimatic limits and crop development					
Thermal limits and agroclimatic suitability				Water limits and agroclimatic suitability	
t	**t_cafe arabica**	t_café robusta		**Water Deficiency**	**Arabica coffee, Robusta coffee**
17-18	Inapta	inapta		< 200mm	Apta	Apta
18-19	Inapta	inapta		200 a 240mm	Marginal	Apta
19-20	Marginal	inapta		240 a 300mm	Inapta	Apta
20-21	Apta	Marginal		300 a 400mm	Inapta	Marginal
21-22	Apta	Marginal		400 a 600mm	Inapta	Inapta
22-23	Apta	Marginal		600 a 800mm	Inapta	Inapta
23-24	Marginal	Apta		> 800mm	Inapta	Inapta
>24	Inapta	Apta				
t+2	**t_cafe arabica**	t_café robusta				
19-20	Marginal	Inapta				
20-21	Apta	Marginal				
21-22	Apta	Marginal				
22-23	Apta	Marginal				
23-24	Apta com restrições	Apta				
24-25	Inapta	Apta				
25-26	Inapta	Apta				
>26	Inapta	Marginal				

RESULTS

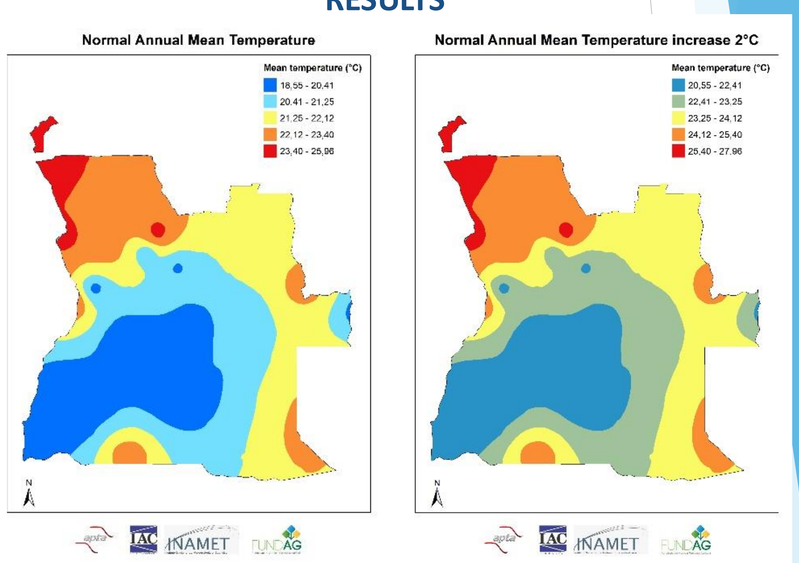

Figure 1. Mean annual air temperature-Actual and with 2º increase.

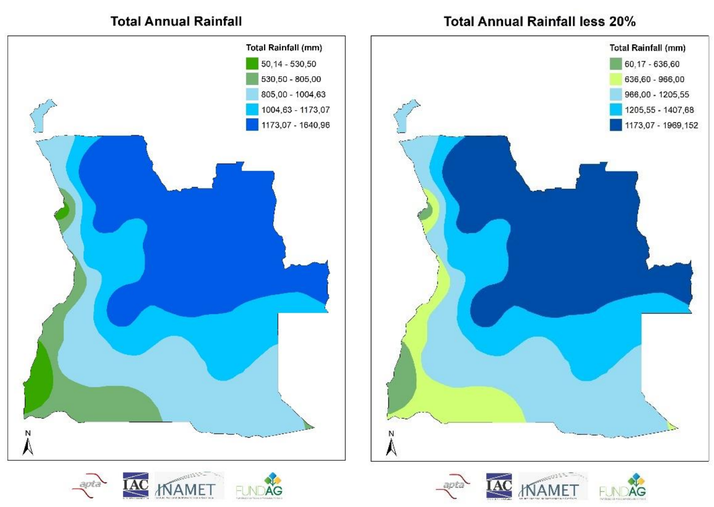

Figure 2. Annual rainfall-actual and reduction 20%.

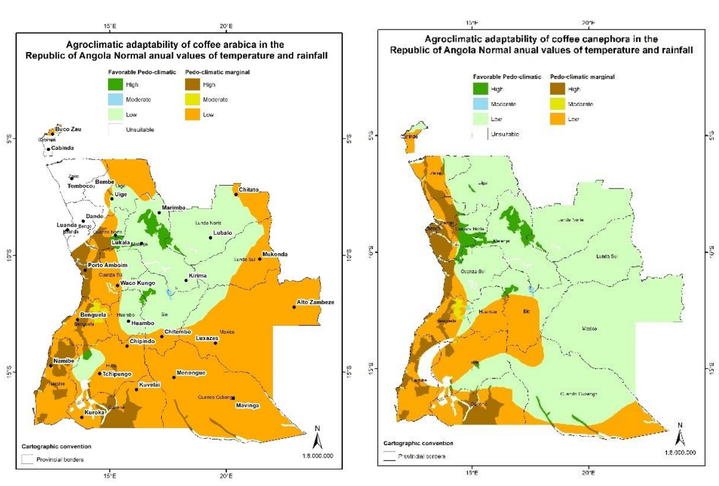

Figure 3. Bioclimatic zones for arabica and robusta coffee at normal scenarios.

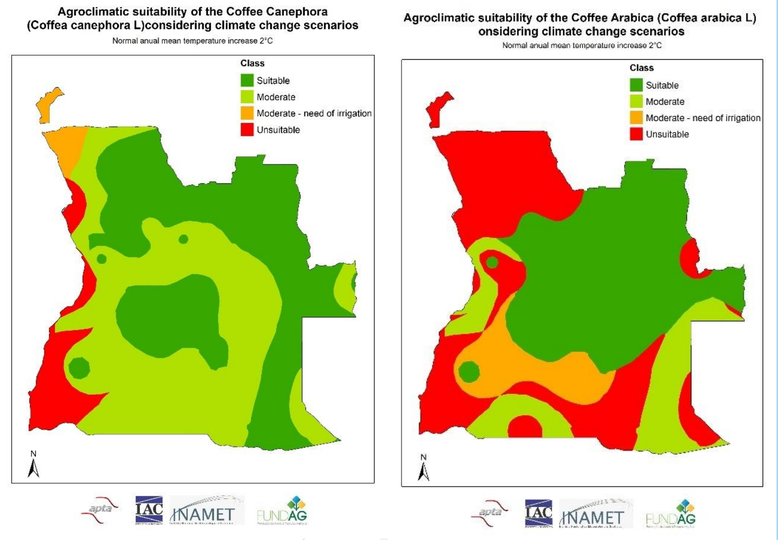

Figure 4. Thermal suitability of robust a and arabica coffee with 2ºC Increase.

FINAL CONSIDERATIONS

The results indicate that in relation to the current climate scenario, the potential agroclimatic area in the Republic remains high. However, compared to the scenarios established with an increase of 4°C even with the increase in rainfall, there is a significant reduction in the suitable area for both species and vey high for the Arabic specie. In the scenario of warming of 2°C, maintaining the current rainfall regime even with a 20% increase in rainfall, the suitable areas remain high. However, if there is a 20% reduction in the total rainfall, the area suitable for cultivation is significantly reduced, in special fot the Arabic variety. It is therefore concluded that the thermal regime of +4°C poses serious restrictions to these crops, requiring genetic adaptations and reducing precipitation is a crucial factor for crop management.

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