Modelling the impact of Climatic Variability and Heat Stress on Olive Productivity in Latakia, Syria

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Introduction

Olive cultivation (Olea europaea) is a vital socio-economic pillar in Latakia Governorate, Syria. However, Mediterranean olive orchards are increasingly threatened by climate change and fluctuating weather patterns. While the biological alternate bearing cycle inherently drives seasonal yield variations, recent shifts introduce non-linear risks to crop development. Specifically, spring heat stress combined with fluctuating spring rainfall severely disrupts flowering and pollination, while shifting autumn precipitation directly impacts fruit oil concentration and harvest quality. Understanding the exact quantitative relationship between these seasonal climate indicators and olive productivity is crucial for developing targeted agricultural adaptation strategies in the region.

Objectives

Conducting a comprehensive econometric analysis of the relationship between climatic variability and olive productivity (Olea europaea) in Latakia Governorate, period (2002-2024)

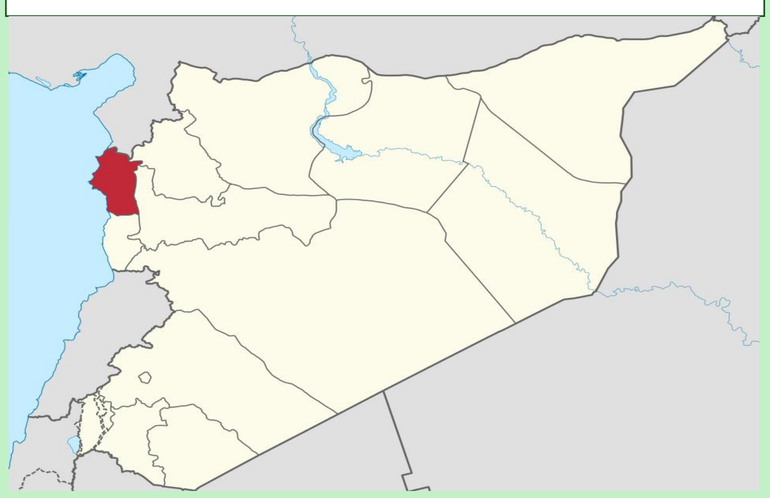

Figure 1: Geographical location and administrative boundaries of the study area (Latakia Governorate, Syria).

Research Materials and Methods:

Research Period: 2002–2024.

Data Sources: Utilizing high-resolution climatic data from the NASA POWER platform integrated with local agricultural records.

Methodology: Employing the Newey-West estimator via Stata software to ensure statistical robustness against autocorrelation and heteroskedasticity when analyzing the impact of specific seasonal climate indicators (Spring/Autumn rainfall and May maximum temperatures) on olive yield and oil concentration.

Justification: This approach effectively addresses autocorrelation and heteroskedasticity inherent in long-term time-series agricultural data.

Figure 2. In-situ observation of olive harvesting practices

Results

Table 1: Newey-West Estimation Results for Olive Yield (YLD)

Variables	Coefficient	P-value	Significance
Spring Rainfall	-0.0046	0.009	Highly Significant (***)
May Max Temp	+0.1052	0.295	Non-Significant
Biological Cycle	+3.5390	0.000	Highly Significant (***)

Model Diagnostics: Obs = 23 | Prob > F = 0.0000 | F (3, 19) = 52.64
Note: *** p < 0.01.

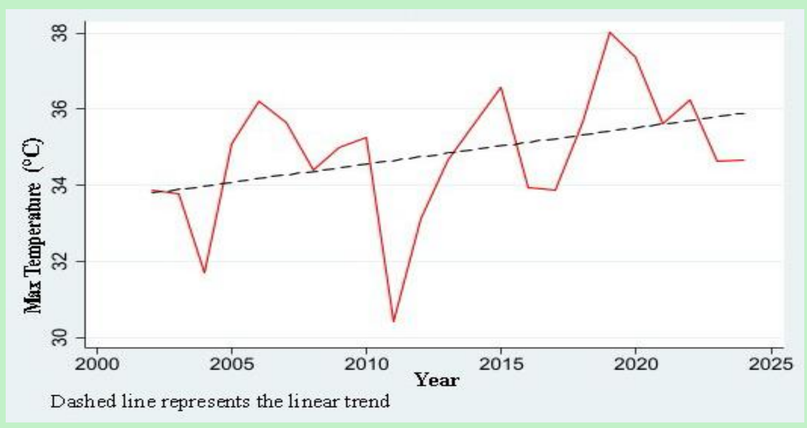

Figure 3. Long-term linear trend of May maximum temperatures in Al-Haffah, Latakia (2002–2024).

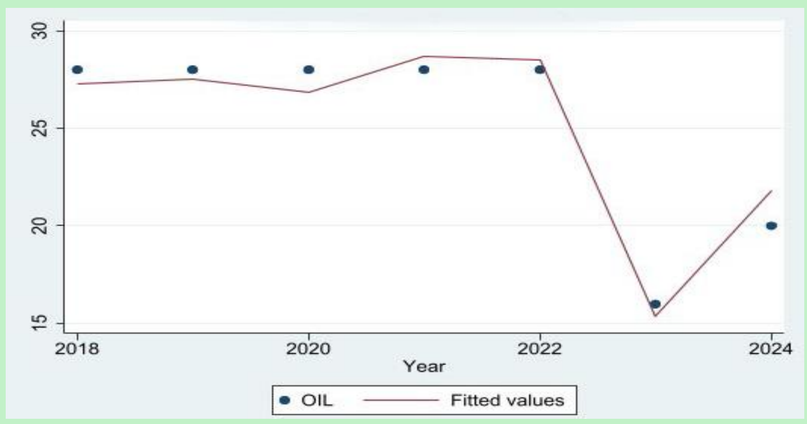

Figure 4. Econometric model validation: Actual vs. fitted values for olive oil concentration

Figure 5. Econometric model validation: Actual vs. fitted values for annual olive yield

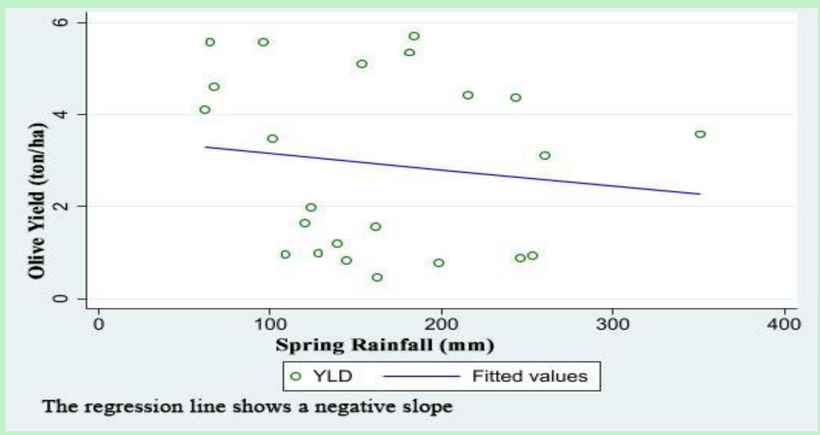

Figure 6. Scatter plot with fitted line showing the negative relationship between spring rainfall and olive productivity (YLD).

Figure 7. Olive production dynamics and maturation in Latakia: (a) High-yield harvest under favorable climate, (b) Fruit ripening indicators to optimize harvest scheduling.

Figure 8. Dehydrated olive fruits reflecting climatic stress in Latakia.

Conclusions

Dominant Biological Driver: The alternate bearing (biological on-off cycle) remains the primary and most significant determinant of annual olive productivity fluctuations.

Spring Rainfall Negative Impact: Spring rainfall exerts a statistically significant negative impact on olive yields, as excessive moisture during flowering and fruit-setting physically interferes with wind pollination and promotes fungal pathogens like Olive Peacock Spot (*Spilocaea oleagina*).

Autumn Rainfall Dilution Effect: Autumn rainfall shows a distinct negative correlation with oil percentage, where late-season precipitation leads to a dilution effect (increasing fruit water content at the expense of oil concentration) and complicates extraction.

Escalating May Heat Stress: A significant long-term upward trend in May maximum temperatures (rising by 0.09 °C per year) signals escalating future risks associated with heat stress during the sensitive reproductive phase.

Recommendations

Establishing integrated early warning systems for spring humidity management and enhancing phytosanitary strategies against fungal diseases. Additionally, it advocates for optimizing harvest timing to adapt to shifting autumn precipitation patterns, ensuring both oil quality and the long-term sustainability of olive production in the Mediterranean coastal region.

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