



Introductio

Mediterranean ecosystems are among the most fire-prone biomes globally due to a combination of dry summers, mild wet winters, and diverse terrain. In recent decades, the North African Mediterranean region has experienced accelerated warming—approximately 20 % higher than the global average—and a shift toward more erratic precipitation patterns and prolonged droughts. These climatic shifts can amplify wildfire risk by altering vegetation moisture, fuel availability, and ignition conditions. Understanding how climate variability interacts with vegetation dynamics and fire regimes in Tlemcen Province is crucial for developing adaptive management strategies that enhance ecosystem resilience and protect community livelihoods.

Objetives

1. Analyze trends in climate, vegetation, and fire activity;
2. Assess links between vegetation health and climate variables;
3. Investigate forest-to-shrubland changes and related fire patterns;
4. Develop a model of climate–vegetation–fire interactions;
5. Propose fire management and climate adaptation strategies.

Study Area

Location: Tlemcen Province, northwestern Algeria; spans coastal plains to Tell Atlas Mountains (0–1,800 m elevation), total ~9,017 km².

Ecological significance: Mediterranean forests (Aleppo pine, cork oak) interspersed with shrublands, high biodiversity, key watershed services.

Climate: Hot, dry summers; mild, wet winters; increasing temperature and variable precipitation patterns.

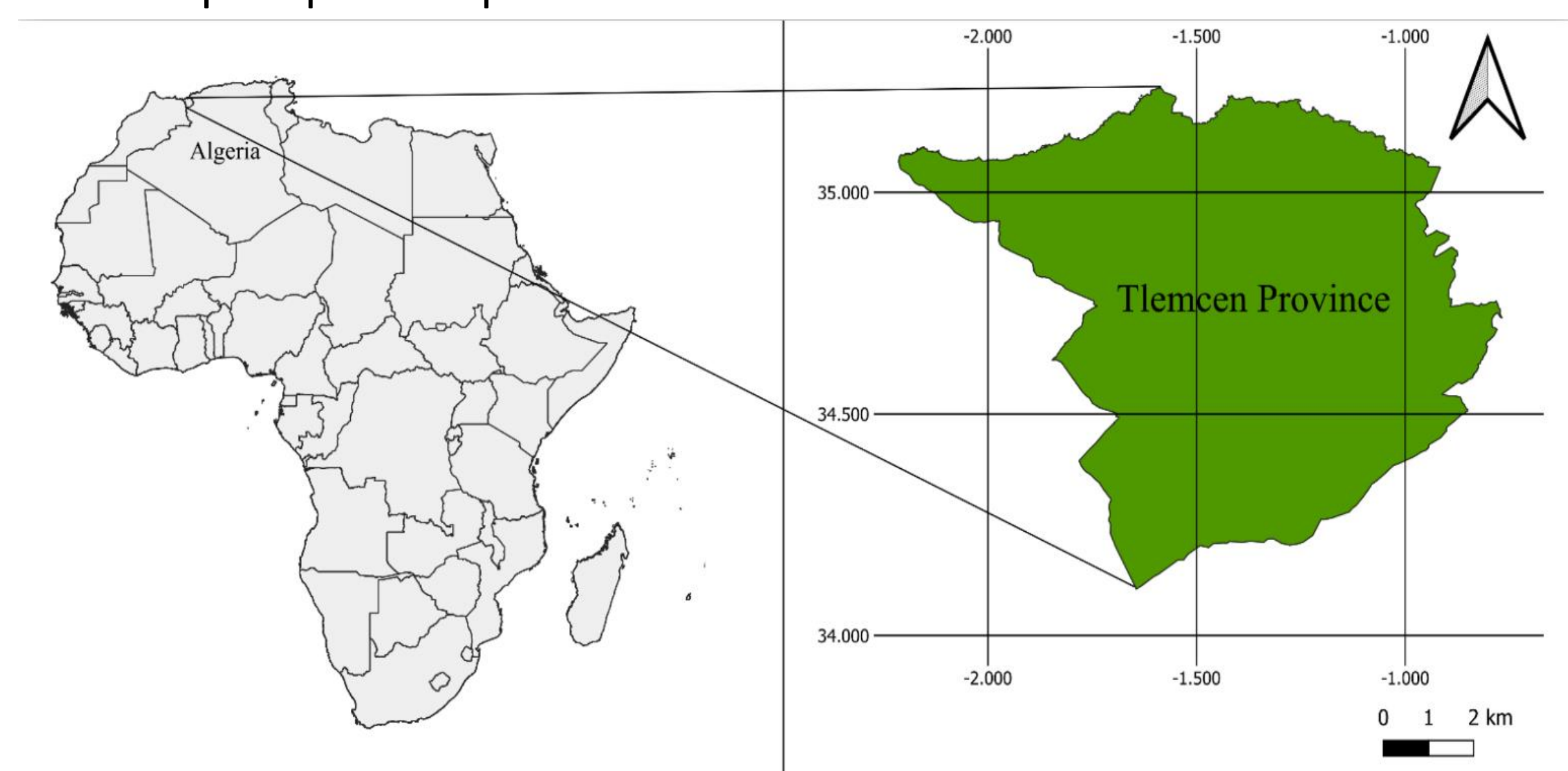


Figure 1: Geographic Location of the Tlemcen province in Northwestern Algeria

Methodology

The study focused on Tlemcen Province, extracted via QGIS, and used satellite and climate data from four 5-year periods (2000–2019), downloaded through Google Earth Engine. Datasets included MODIS NDVI, EVI, pre-fire NBR (from NIR), CHIRPS precipitation, and CHLSA temperature. In QGIS, rasters were reprojected, organized by period, and analyzed using Raster Calculator and zonal statistics. NDVI change and pre-fire NBR were used to identify vegetation stress, while temporal trends and correlations between climate, vegetation indices, and burned area were assessed.

Bibliography

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Results

Climate Trends:

- Precipitation shows a strong negative trend (−0.83), indicating a shift toward drier conditions.
- Temperature exhibits a slight increase (0.0018), suggesting weak warming.

Vegetation Health:

- NDVI shows a declining trend (−0.43), signaling vegetation degradation or stress.
- EVI shows a positive trend (+0.54), possibly reflecting adaptation of specific vegetation types with structural complexity.

Burned Area and Correlations:

- Burned surface area decreased by ~30% despite drier conditions.
- Strong negative correlations were observed between NDVI/EVI and burned area, indicating that healthier vegetation is linked to reduced fire spread.
- The correlation matrix shows complex interdependencies, with precipitation positively linked to vegetation indices and temperature inversely related to precipitation. NDVI and EVI are strongly intercorrelated.

Land Cover Change:

- Forest declined by ~23,000 ha, while shrubland expanded by ~47,000 ha, implying a shift to more drought- and fire-tolerant landscapes.

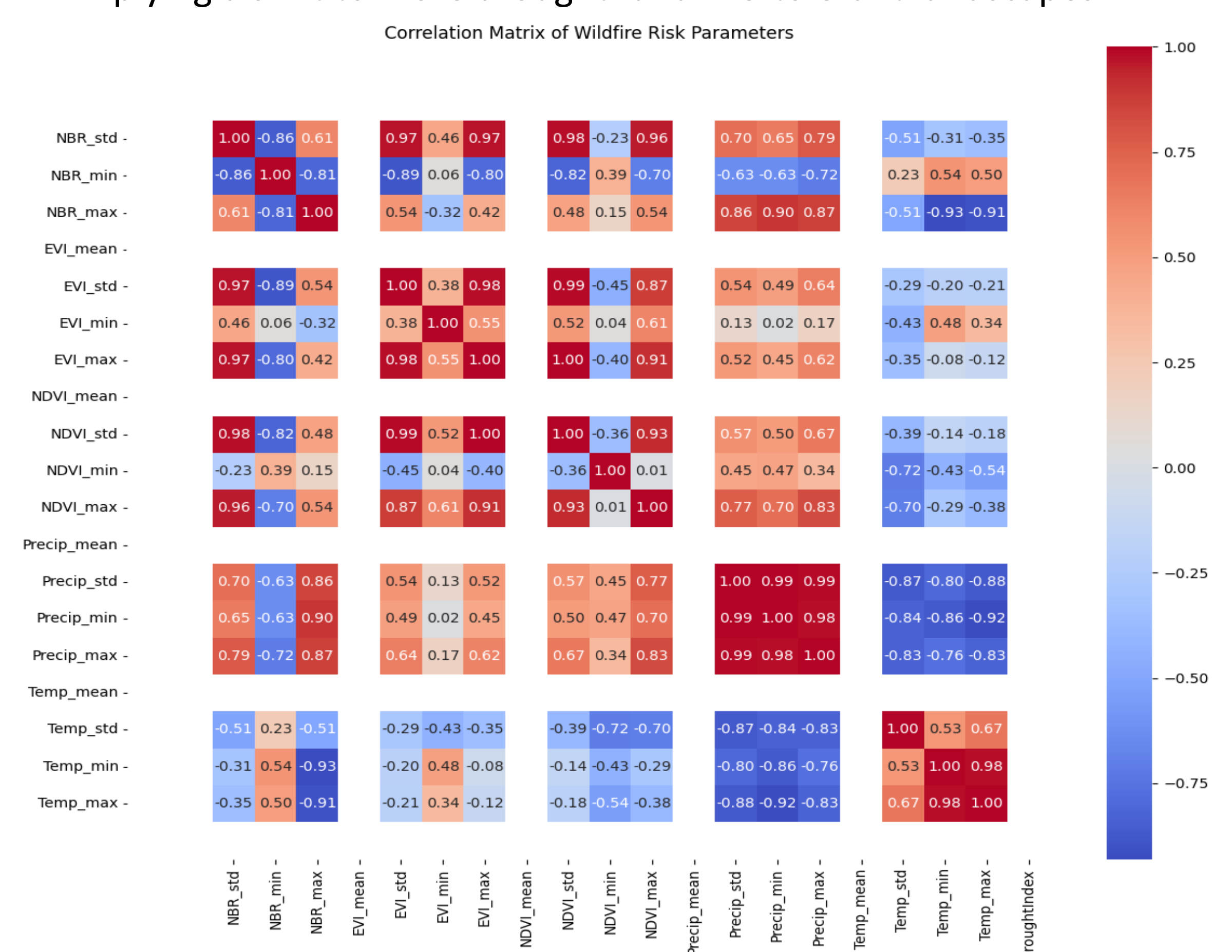


Figure 2: Correlation Matrix of Climate Variables, Vegetation Indices, and Burned Area (2000–2019)

Discussion and Conclusion

The analysis confirms that Tlemcen Province is undergoing a transition toward drier conditions, primarily driven by a marked decrease in precipitation. While temperature increases are modest, vegetation health—reflected in NDVI—has declined, indicating stress. However, EVI's increase suggests that structurally resilient vegetation is adapting. The decline in burned area may be tied to fuel discontinuity, natural suppression mechanisms, or shifts in vegetation type rather than climate relief. Vegetation health appears to be a stronger control on wildfire spread than climate variables alone. Management strategies must prioritize conserving resilient forest areas, diversifying land cover, and enhancing ecological buffers to counteract wildfire risk in an era of accelerating climate stress.