CLIMATE CHANGE MULTI-RISK ASSESSMENT FOR MANGO CULTIVATION IN SICILY, ITALY BY USING BAYESIAN NETWORK

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Abstract

Ensuring food security poses a significant challenge for organizations and consultant companies involved in the agriculture industry or responsible for food programs. This challenge is particularly relevant in Sicily, Italy, which has a semi-tropical climate. Given the favourable weather conditions for mango cultivation and other tropical crops, it becomes crucial to consider measures for safeguarding against potential climate change impacts in the future. Climate change is expected to bring changes and increased risks in terms of temperature, extreme events, soil salinity, and irregular rainfall.

Amidst this looming threat, there is a growing demand for a fresh approach and supportive tools to manage risks and mitigate potential damages in policy-making and decision-making circles. In this study, we employ a robust method known as Bayesian Network (BN) to effectively capture and model multiple risks under various future scenarios. By exploring 'what-if' situations, such as the maximum levels of climate-related variables, the projected BN model is trained and validated using spatially resolved data from the Messina region in Sicily. This approach enables us to understand the dynamic variations in local-scale temperature and precipitation, as well as the underlying driving forces, within the timeframe of 2009-2022.

The outputs of the Bayesian Network aid in predicting future trends in temperature and precipitation levels, thereby supporting the prioritization of mango cultivation and conservation efforts. In general, the findings derived from the BN analysis provide valuable support for disaster risk management and mitigation strategies in the face of climate change and extreme events. This tool can further enhance decision-making processes by integrating the spatial results of the developed model into a user-friendly interface such as Geographic Information System (GIS), thereby assisting policymakers and decision-makers in prioritizing Disaster Risk Management and Climate Change Adaptation plans.

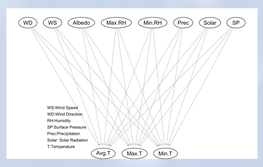
Introduction

1. **Urgency of Food Security**: Climate change threatens food security, particularly in semi-tropical regions like Sicily, which are susceptible to shifts in weather patterns.
2. **Climate Change Realities**: Climate change is no longer abstract; it brings real and increasing risks, including temperature shifts, extreme weather events, soil salinity, and irregular rainfall.
3. **Importance of Bayesian Networks**: The BN approach offers a robust framework to evaluate 'what-if' scenarios, helping to assess climate change impacts on Sicily's agriculture.
4. **Complex Interactions**: Unlike traditional models, BN considers intricate interactions and dependencies among factors, providing a holistic view of climate change impacts.
5. **Local-Scale Analysis**: Spatial data from the Messina region enables localized assessment, identifying areas vulnerable to specific climate-related risks.
6. **Comprehensive Impact Assessment**: BN is used to simulate different climate scenarios, assessing their effects on crop yields, water availability, and pest and disease prevalence.
7. **Informed Decision-Making**: This research aims to empower policymakers and stakeholders with insights for proactive strategies and adaptation measures to safeguard Sicily's food security in the face of climate change.

Methodology

Pre-Processing

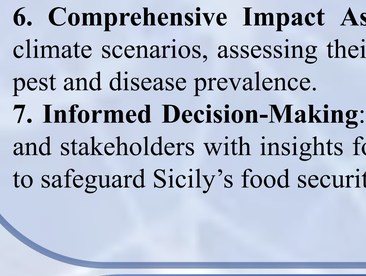
Conceptual Model

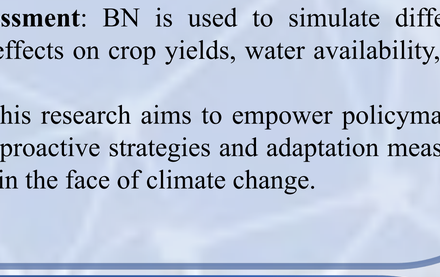


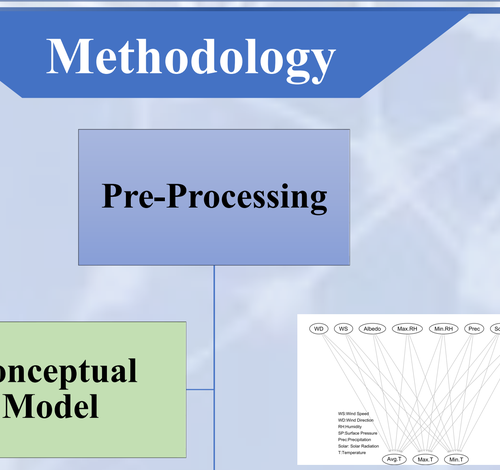
Model Parameterization

Calibration and Validation

Scenario Analysis







Results and discussion

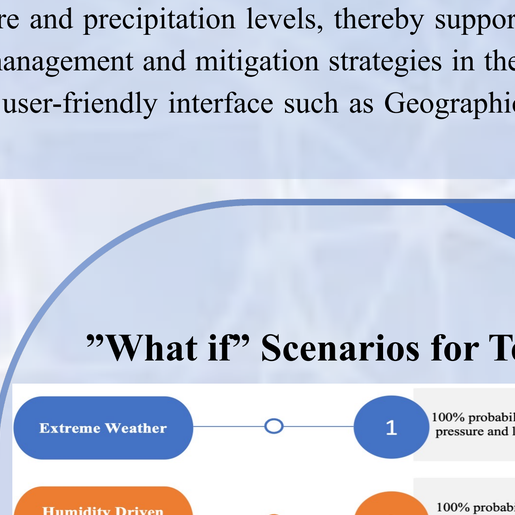
"What if" Scenarios for Temperature

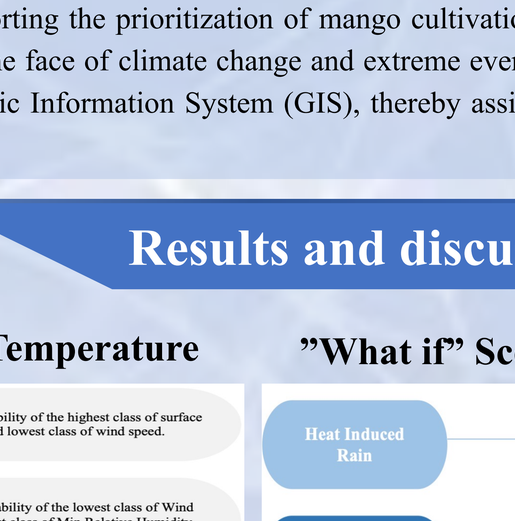
Extreme Weather	1	100% probability of the highest class of surface pressure and lowest class of wind speed.
Humidity Driven Warmth	2	100% probability of the lowest class of Wind Speed, lowest class of Min.Relative Humidity, and highest class of Max.Relative Humidity.
Solar Radiation Surge	3	100% probability of the high class of Solar
Windless Heat	4	100% probability of the lowest wind speed and southern wind direction.
Radiant High Pressure	5	100% probability of the highest solar radiation and lowest Albedo and high surface pressure

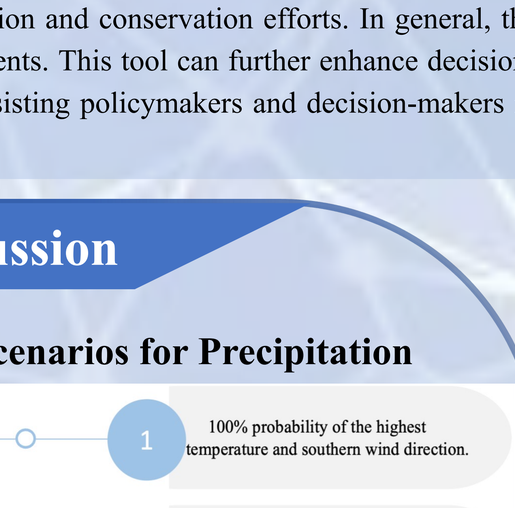
"What if" Scenarios for Precipitation

Heat Induced Rain	1	100% probability of the highest temperature and southern wind direction.
Humid	2	100% probability of the highest temperature and highest classes of max and min relative humidity.
Dry High	3	100% probability of high surface pressure and lowest classes of Albedo and wind speed.

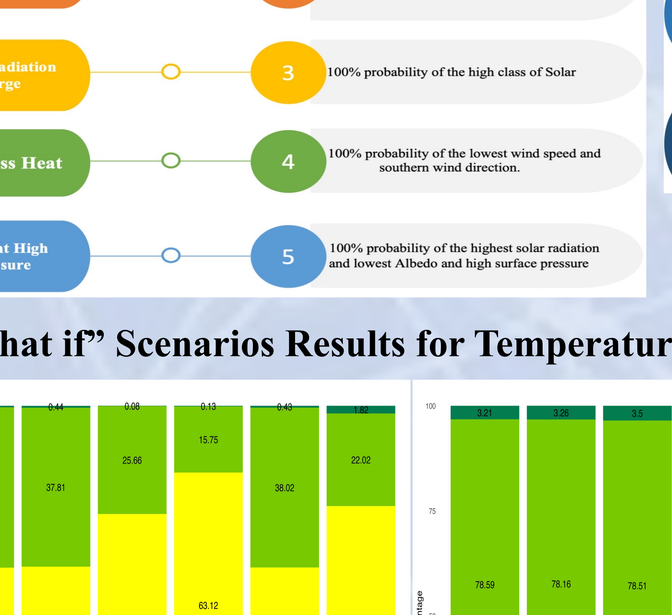
"What if" Scenarios Results for Temperature (Max, Avg, Min)







"What if" Scenarios Results for Precipitation



- Five distinct climatic scenarios were analysed, revealing the sensitivity of temperature predictions to various factors.
- Higher solar radiation, lower albedo, and elevated surface pressure tend to increase temperatures, while lower wind speeds and southern wind directions can also contribute to temperature rise.
- Precipitation scenarios show the influence of temperature and relative humidity on precipitation predictions.
- Scenarios with higher temperatures and humidity levels tend to result in increased precipitation.

Conclusion

- The BN model provides insights into temperature and precipitation variations over time.
- The model's outputs can inform decisions for prioritizing mango cultivation and conservation efforts.
- The BN model demonstrates reasonable accuracy in temperature forecasts.
- Factors like solar radiation, wind speed, and humidity influence temperature and precipitation predictions.
- Decision-makers can use this information to develop adaptive strategies for mango cultivation.
- The integration of spatial results into user-friendly tools like GIS can enhance decision-making.