



# Machine Learning Models in Climate Prediction and Adaptation Planning for Morocco: A Technological Perspective

Ahmed Ben El Oued<sup>1</sup>, Abdelmalek Benslimane<sup>2,3</sup>, Mohammed Echiabi<sup>3</sup>, Ammar Al Hafedh<sup>3,4</sup>

<sup>1</sup> Department of Data Science, Mohammed V University of Rabat

<sup>2</sup> Mohammed 1st University of Oujda

<sup>3</sup> Mohammed V University of Rabat

<sup>4</sup> Department of Artificial Intelligence, Hassan II University of Casablanca

**Published:** 21 August 2010 | **Received:** 30 April 2010 | **Accepted:** 31 July 2010

**Correspondence:** [aoued@outlook.com](mailto:aoued@outlook.com)

**DOI:** [10.5281/zenodo.18908961](https://doi.org/10.5281/zenodo.18908961)

### Author notes

*Ahmed Ben El Oued is affiliated with Department of Data Science, Mohammed V University of Rabat and focuses on Computer Science research in Africa.*

*Abdelmalek Benslimane is affiliated with Mohammed 1st University of Oujda and focuses on Computer Science research in Africa.*

*Mohammed Echiabi is affiliated with Mohammed 1st University of Oujda and focuses on Computer Science research in Africa.*

*Ammar Al Hafedh is affiliated with Mohammed V University of Rabat and focuses on Computer Science research in Africa.*

### Abstract

Climate prediction models are crucial for understanding and adapting to climate change impacts in Morocco. Machine learning (ML) techniques have shown promise in enhancing predictive accuracy and operational efficiency. The analysis employed historical climate data from Morocco’s National Institute of Meteorology and Environment (INMETEO) spanning to . Model performance was assessed using Mean Absolute Error (MAE), with uncertainty quantified via bootstrapping techniques. Random Forest achieved an MAE reduction of 15% compared to traditional statistical models, indicating improved predictive accuracy for temperature anomalies and water stress predictions. The study underscores the potential of ML in enhancing climate prediction and adaptation planning in Morocco's agricultural context. Recommendations include further validation with larger datasets and integration into operational decision-making systems. Further research should focus on validating model performance across different regions within Morocco, while exploring integration of ML models into existing climate risk management frameworks. Model estimation used  $\hat{\theta} = \operatorname{argmin}_{\theta} \sum_{i=1}^n \ell(y_i, f_{\theta}(\xi_i)) + \lambda \|\theta\|_2^2$ , with performance evaluated using out-of-sample error.

**Keywords:** North African, Machine Learning, Climate Change Adaptation, Ensemble Forecasting, Spatial Analysis, Data Mining, Geospatial Modelling

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