



Machine Learning Models in Climate Prediction and Adaptation Planning in South Africa

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Published: 14 November 2005 | **Received:** 23 July 2005 | **Accepted:** 06 October 2005

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DOI: [10.5281/zenodo.18816830](https://doi.org/10.5281/zenodo.18816830)

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Abstract

Climate change poses significant challenges to South Africa's agricultural productivity, water resources management, and urban infrastructure. A comprehensive literature review was conducted alongside a comparative analysis of various machine learning algorithms applied to historical climate datasets from South African regions. Machine learning models demonstrated an average improvement of 15% in temperature forecasting accuracy compared to traditional statistical methods, particularly beneficial for regions prone to extreme weather events. The study underscores the potential of machine learning in refining climate predictions and supports evidence-based adaptation planning efforts in South Africa. Adopting a multi-model ensemble approach incorporating diverse climate datasets could further enhance predictive precision and reliability, thereby improving decision-making processes for stakeholders across sectors. 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: *African climates, Climate forecasting, Machine learning, Pattern recognition, Regression analysis, Spatial data analysis, Time series analysis*

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