Forecasting of rainfall in Malaysia using time series analysis

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Abstract

Rainfall forecasting is a persistent challenge in hydrology, particularly in Malaysia, where intense and highly variable rainfall often leads to floods with severe social, economic, and environmental consequences. Rapid urbanisation and land-use changes have further increased the vulnerability of flood-prone areas, underscoring the urgent need for accurate and reliable rainfall predictions. Improved rainfall forecasting enhances disaster risk reduction and early warning systems, strengthens sustainable water resource planning, supports climate adaptation, and advances the development of resilient infrastructure. This study aims to forecast monthly rainfall in three regions in Malaysia, Alor Setar, Subang, and Kuantan, representing distinct climatic and flood-prone areas, using the Seasonal-Trend decomposition using Loess (STL) combined with the Autoregressive Integrated Moving Average (STL-ARIMA) and Seasonal ARIMA (SARIMA) models. Monthly rainfall data from 2014 to 2023 were obtained from the Malaysian Meteorological Department and analysed

using Python, with forecast accuracy assessed using standard error metrics. The results show that the SARIMA model is most accurate in forecasting monthly rainfall at Subang and Alor Setar, with mean absolute percentage errors (MAPEs) of 29.71% and 30.46%, respectively, while the STL-ARIMA model performs best in Kuantan, with a MAPE of 57.63%. Forecasts indicate that rainfall in Subang and Alor Setar will continue to exhibit strong seasonal fluctuations. In contrast, Kuantan is likely to experience continued variability in the coming months, suggesting an increased risk of flooding. These findings underscore the importance of accurate, region-specific rainfall forecasting to strengthen disaster preparedness, improve water resource management, and enhance resilience to climate change. Thus, the study directly contributes to achieving the Sustainable Development Goals (SDG) 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities).

Author keywords

Flood risk reduction; Rainfall forecasting; SARIMA; SDG 11; SDG 6; STL-ARIMA; Water resource management

Indexed keywords

MeSH

Climate Change; Floods; Forecasting; Malaysia; Rain; Seasons

Engineering controlled terms

Climate change; Disaster prevention; Disasters; Flood control; Floods; Rain; Risk assessment; Sustainable development; Sustainable development goals; Weather forecasting

EMTREE drug terms

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(STL) combined with the autoregressive integrated moving average; Auto-regressive; Flood risk reduction; Malaysia; Moving averages; Rainfall forecasting; Seasonal ARIMA; Sustainable development goal 11; Sustainable development goal 6; Water resources management

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