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Spatiotemporal analysis of climate variability and smallholder adaptation: Evidence from Chewaka resettlement site, southwest Ethiopia

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Abstract

Understanding spatiotemporal trends of climate variables and farmers' responses is essential for designing effective adaptation strategies. This study examined the spatial and temporal trends and variability of rainfall and temperature across different elevation zones and time periods (1980–2022) in the Chewaka resettlement site, Oromia Regional State, Western Ethiopia. It also assessed farmers' perceptions of climate variability and their adaptation strategies. Historical climate data from CHIRPS-v2 and CHIRTS-ERA5 were analysed using the Mann-Kendall trend test, Sen's slope, coefficient of variation (CV), standard anomalies, and spatial mapping techniques to quantify patterns of change. A structured household survey was conducted to collect data on farmers' perceptions and adaptation responses and analysed using descriptive statistics. Results show a significant increasing trend in mean annual rainfall ($p < 0.001$), increasing by 5.34 mm per year with 9.37 % interannual variability. Seasonal rainfall analysis indicates significant increases during Bega and Belg seasons ($p < 0.05$) with high variability, while changes in Kiremt rainfall were not statistically significant. Spatial analysis revealed highly significant differences in rainfall distribution across elevation zones ($\chi^2 = 117.87$, $p < 0.001$). Both minimum and maximum temperatures showed significant increasing trends ($p < 0.001$), rising by 0.029°C and 0.025°C per year, respectively. The strongest increase in maximum temperature occurred during Belg (0.037°C yr⁻¹), followed by Bega (0.017°C yr⁻¹) and Kiremt (0.016°C yr⁻¹). Tmin also exhibited a consistent upward trend across seasons. Farmers demonstrated strong awareness of climate variability, with 81.6 % reporting rising temperatures and changing rainfall patterns, 79.1 % noting reduced dry-season water availability, 80.7 % observing increased rainfall amounts, and 65.1 % reporting longer dry spells. Common adaptation strategies included crop diversification, soil and water conservation, intercropping, crop rotation, and adjusting planting dates. These strategies are largely low-cost and land-based. The study highlights the value of integrating gridded climate datasets with local knowledge for understanding climate dynamics in data-scarce regions. Findings provide a basis for designing climate-resilient agricultural interventions and sustainable livelihood policies, particularly for vulnerable lowland agroecologies facing population pressure and resource stress.

Keywords: Climate change, rainfall, resettlement, temperature, trend