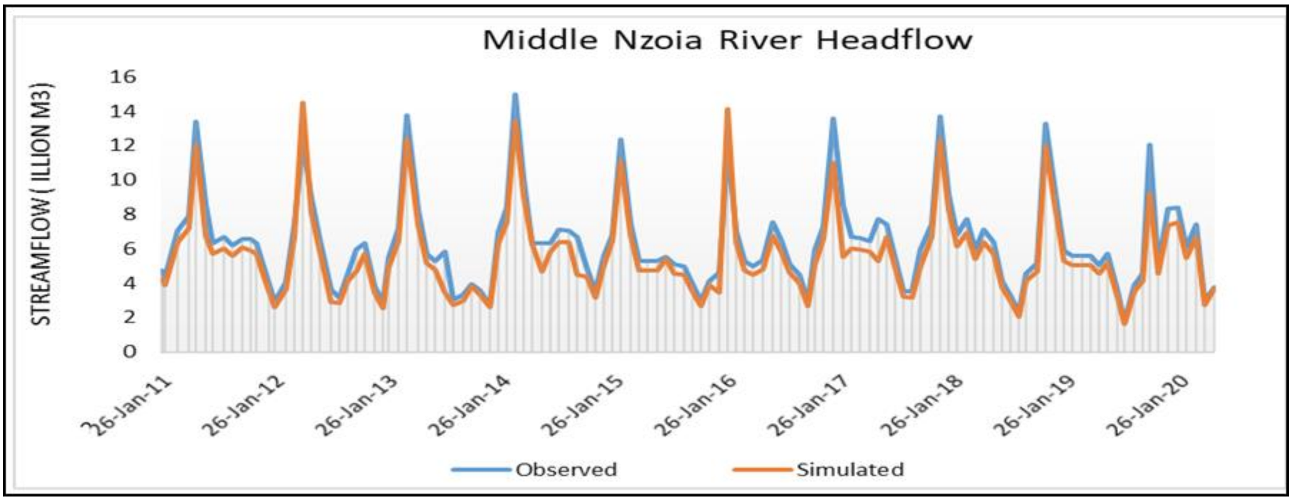

Figure 5 Validation results showing observed and simulated monthly streamflows at selected stations in the Middle Nzoia Catchment (2011-2020) (Source: Researcher (2025))

The above figure shows a time series plot of streamflow for the Middle River Nzoia Headflow. The y-axis represents streamflow (in Million cubic meters, M^3), and the x-axis represents the time period from 26-Jan-2011 to 26-Jan-2020. Two datasets are compared: Observed streamflow (blue line); Simulated streamflow (orange line).

The streamflow shows strong seasonal peaks almost every year, likely corresponding to rainy seasons in the catchment area. Peaks occur roughly once or twice a year, with values reaching 12×10^6 m³ to 15×10^6 m³. Dry-season flows drop significantly, sometimes below 4×10^6 m³.

The Middle Nzoia River streamflow has strong seasonal variability driven by rainfall cycles. The hydrological model simulates the streamflow quite well, matching observed data closely over the 2011-2020 period. Minor discrepancies exist at extreme flows, but overall, the simulation is reliable for hydrological and water management applications.

Summary of annual and monthly fit statistics for the simulated validation data generated by the WEAP model and the observed streamflow data at selected gauging stations in the Middle Nzoia River Basin is presented in Table 2. The statistics cover the validation period from January 2011 to December 2020, and they provide a quantitative evaluation of the model's performance in simulating streamflows using independent data not applied during calibration.

The calibration and validation results affirm the robustness and predictive reliability of the WEAP model in simulating hydrological processes within the Middle Nzoia Catchment. During the calibration phase (2001-2010), the model exhibited strong hydrological fidelity, with statistical indices such as the Nash—Sutcliffe Efficiency (NSE = 0.712), coefficient of determination (R^2 = 0.757), and index of agreement (IA = 0.913) indicating a high degree of correspondence between simulated and observed streamflow data. The validation phase (2011- 2020) yielded even stronger performance metrics, with NSE = 0.807, R2 = 0.821, and Pearson's correlation coefficient (r = 0.888), suggesting that the calibrated model structure and parameters are transferable and generalizable under varying hydroclimatic conditions.

The low values of Mean Absolute Error (MAE = 5.886 m³/s) and Root Mean Square Error (RMSE = 11.991 m³/s) during validation further reinforce the model's capability in minimizing predictive uncertainty. The model's skill in reproducing both temporal dynamics and magnitude of observed flows across sub-catchments supports its applicability for scenario analysis, future water demand forecasting, and integrated water resource management. The performance metrics meet accepted hydrological modelling thresholds, validating the WEAP model as a reliable decision-support tool for simulating surface water availability and allocation under dynamic climatic influences within the basin.