current accounts to identify significant deviations from the baseline conditions. This comparison allowed for the identification of potential issues, such as water shortages or quality degradation, and highlighted critical trends or risks that may arise under different future scenarios.

3.1.5 Model calibration and validation

The WEAP (Water Evaluation and Planning) model was calibrated and validated to ensure it accurately simulated the hydrological and water use dynamics of the Middle Nzoia River Catchment. Calibration and validation were critical steps to confirm the reliability of the model before applying it to future water demand and allocation scenarios.

3.1.6 Calibration of the WEAP model

The objective of the calibration process was to align the model's simulated outputs with observed historical data, thereby ensuring that WEAP could reliably represent the catchment's water system behavior under past conditions. The calibration was conducted using a 10-year dataset covering the period 2001 to 2010.

3.1.7 Calibration process

1) Data Integration: Historical hydrological data—including river discharge measurements, rainfall records, and climate data—were integrated into the WEAP model. This data formed the basis for simulating water availability and distribution in the catchment.

2) Parameter Adjustment: Model parameters, particularly those related to surface runoff, infiltration, evapotranspiration, and sectoral water demand, were iteratively adjusted. Parameters such as runoff coefficients, root zone conductivity, and demand per capita were fine-tuned to achieve realistic simulations.

3) Historical Data Comparison: Simulated streamflow outputs were compared against observed discharge data from key gauging stations within the catchment. Discrepancies between simulated and observed data were addressed through continued refinement of model inputs and assumptions.

4) Sensitivity Analysis: Sensitivity analysis was carried out to identify which model parameters had the greatest influence on output accuracy. This step helped prioritize parameters for adjustment and improved model efficiency.

5) Calibration Metrics: The performance of the calibration process was evaluated using statistical indicators such as Nash-Sutcliffe Efficiency (NSE), Mean Absolute Error (MAE), and Root Mean Square Error (RMSE).

These metrics quantified how closely the simulated results matched observed data and provided confidence in the model's reliability.

3.1.8 Validation process

1) Independent Data Collection: Observed hydrological data for the validation period— including river flows and other relevant catchment characteristics—were used to test the model. These datasets were independent of those used during calibration.

2) Simulation of Validation Period: The model was run using the calibrated parameters to simulate catchment behavior over the 2011–2020 period. No further parameter adjustments were made during this stage.

3) Performance Evaluation: The accuracy of the validation simulations was assessed using the same statistical metrics applied during calibration (NSE, MAE, and RMSE). High levels of agreement between observed and simulated data during this period further confirmed the model's predictive capacity.

4) Model Robustness Testing: The model's performance was evaluated under various conditions to test its stability. This included testing across wet and dry years to ensure the model's applicability under variable hydrological conditions.