STUDY ON METHODS AND APPLICATIONS FOR ASSESSING CLIMATE CHANGE VULNERABILITY IN KALU AND KIRINDI OYA RIVER BASINS AND CONSEQUENCES ON SURFACE WATER-GROUNDWATER INTERACTION

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Climate change has influenced long-term rainfall patterns, with wet zones getting wetter and the inverse occurring in the dry zone, posing severe implications in water resource analyses and management. This has become a major issue in dry zone watersheds since baseflow is crucial in maintaining dry period streamflow. The main objective of this research is to identify tools and applications for assessing climate change vulnerability in the Kalu river basin at Ellagawa from the wet zone and the Kirindi Oya river basin at Thanamalwila from the dry zone, as well as to assess the climate change impacts on surface water-groundwater interaction in these zones. Before selecting any modelling tool, a comprehensive study on tools and indicators that are used for climate change vulnerability assessment was carried out. The accessibility, validity, and adaptability of multiple hydrological models were identified, and considering them, HEC-HMS was selected as the runoff modelling tool.

After considering the benefits and drawbacks of several objective functions in runoff modelling, the mean ratio of absolute error (MRAE), R-squared correlation (R^2), and Nash Sutcliff objective function (NASH) were chosen as objective functions. For the Ellagawa sub-basin, the NASH value, R^2 and MRAE were 0.63, 0.85, and 0.18, respectively while for the Thanamalwila sub-basin, the goodness of fit were 0.77, 0.87, and 0.45, respectively in calibration period. In the validation period, for the Ellagawa sub-basin, the NASH value, R^2 and MRAE were 0.67, 0.83, and 0.49, respectively and for the Thanamalwila sub-basin, the values were 0.60, 0.69, and 4.47, respectively. Therefore, objective function values demonstrate that the models perform well in both watersheds. According to the sensitivity analysis of model parameters, impervious percentage, recession constant and ratio to the peak can be considered the most sensitive parameters. When impervious percentage, recession constant and ratio to peak change from -50% to 50%, the MRAE value shows the highest percentages changes as 119%, 131%, and 160%, respectively and the NASH value shows the highest percentages changes as 24%, 21%, and 69%, respectively. Time of concentration and soil percolation can be considered the least sensitive parameters.

To assess the climate change vulnerability of the basins, synthetic climatic change scenarios were considered. Considering all the climate change combinations, change in mean annual streamflow will vary between -42% to 30% and -36% to 32% for the Ellagawa watershed and Thanamalwila watershed, respectively, and mean annual groundwater flow will vary between -56% to 27% and -32% to 62% for Ellagawa watershed and Thanamalwila watershed, respectively for the two selected scenarios. From the results obtained, it can be identified that the wet zone basin is more vulnerable in terms of streamflow changes and less vulnerable in terms of groundwater flow changes than the dry zone basin. For future studies, HEC-HMS can be recommended as a feasible and less complicated modelling tool for runoff simulation.

Keywords: Climate Scenarios, Dry Zone, HEC-HMS Modelling, Wet/Dry Zone

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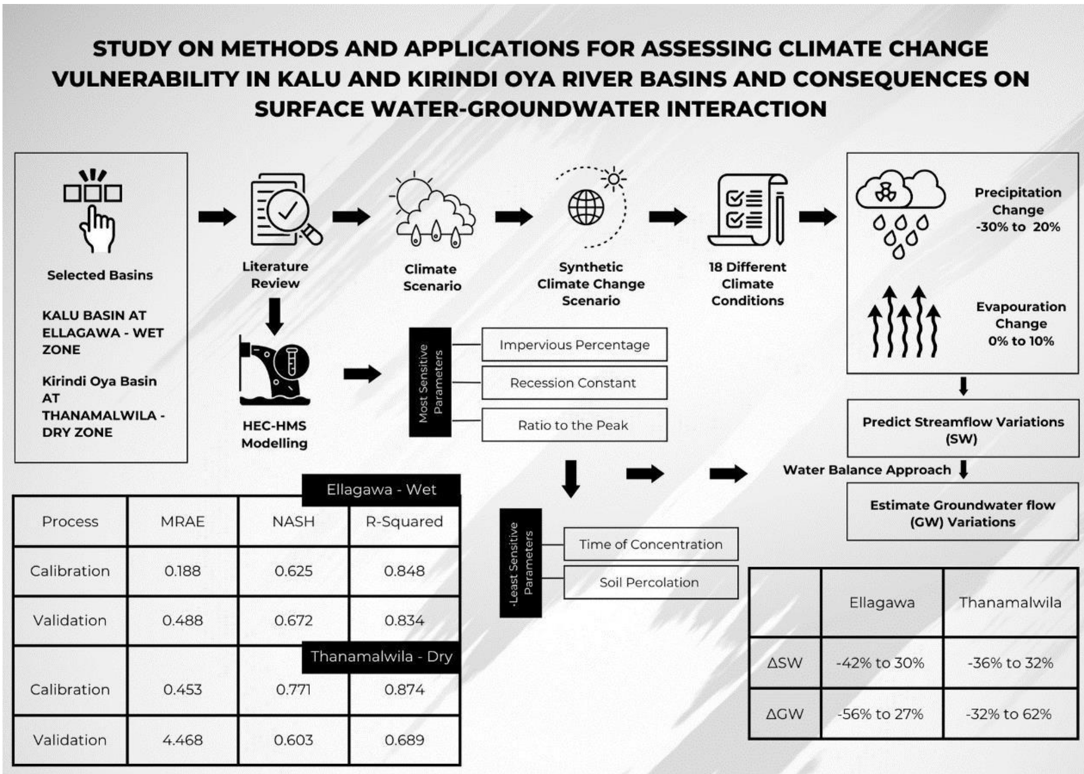
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Selected Basins
KALU BASIN AT ELLAGAWA - WET ZONE
Kirindi Oya Basin AT THANAMALWILA - DRY ZONE
Literature Review
Climate Scenario
Synthetic Climate Change Scenario
18 Different Climate Conditions
Precipitation Change -30% to 20%
Evapouration Change 0% to 10%
HEC-HMS Modelling
Most Sensitive Parameters
Impervious Percentage
Recession Constant
Ratio to the Peak
Predict Streamflow Variations (SW)
Water Balance Approach
Estimate Groundwater flow (GW) Variations
Least Sensitive Parameters
Time of Concentration
Soil Percolation
Ellagawa - Wet
Process | MRAE | NASH | R-Squared
Calibration | 0.188 | 0.625 | 0.848
Validation | 0.488 | 0.672 | 0.834
Thanamalwila - Dry
Calibration | 0.453 | 0.771 | 0.874
Validation | 4.468 | 0.603 | 0.689
| Ellagawa | Thanamalwila
ΔSW | -42% to 30% | -36% to 32%
ΔGW | -56% to 27% | -32% to 62%