ANALYSIS OF PRECIPITATION TREND AND STREAMFLOW SENSITIVITY TO PRECIPITATION IN MADURU OYA RIVER BASIN WITH HEC-HMS MODEL SIMULATIONS

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Degree of Master of Science in

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DECLARATION

"I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Analysis of Precipitation Trend and Streamflow Sensitivity to Precipitation in Maduru Oya River Basin with HEC-HMS Model Simulations

ABSTRACT

Water resources management in a basin needs an intensive analysis of historical data in terms of different climate elements and streamflow. Several researchers have examined the influences of climate change over several main basins during the past years. However, no studies have been performed in the Maduru Oya basin and associated sub-catchments. Hence, the main objective of this study was to identify rainfall trends and then to analyze the streamflow elasticity to the climate in the Maduru Oya basin. Widely used non-parametric trend tests such as Mann-Kendall (MK) test, Modified Mann-Kendall (MMK) test and Sen's slope estimator were adopted to perform the trend analysis in annual, seasonal and monthly scales. The results displayed by all three tests were in very good agreement except for very few cases. On an average, a positive trend of annual rainfall was experienced in Maduru Oya basin with 1.05 and 1.103 trends, respectively from MK and MMK tests with the yearly increment of 12.52 mm/year. During cropping seasons, Maha season predominantly exhibited positive trends where Yala season was witnessed mostly with negative trends. Likewise, during rainfall seasons, except for SWM season, remaining FIM, NEM and SIM seasons displayed positive trends. The monthly analysis found out that November and December experienced strong positive trends whereas the highest negative trends were revealed in September.

Further, for Padiyathalawa sub-basin located in the upstream of Maduru Oya river basin, analysis of streamflow elasticity to precipitation, defined as the proportional change in mean annual streamflow divided by the proportional change in mean annual rainfall, was performed on historical data. This part of the study was carried out using a non-parametric estimator and a method proposed by finding the slope of the graph plotted between the proportional variation of annual streamflow and proportional variation of annual precipitation. Both results indicated that the variations in rainfall are magnified in streamflow. The non-parametric method and the graphical method revealed that a 1% change in mean annual rainfall would respectively result in 1.12% and 1.92% change in mean annual streamflow. Moreover, in an attempt to incorporate the impacts of climate change in streamflow variability due to variation in climate elements, a HEC-HMS hydrological model was developed, calibrated and verified for this sub-basin. The model performance was good in both calibration and verification periods with MRAE and Nash-Sutcliffe Efficiency values of 0.433 and 0.665 and 0.559 and 0.642 respectively. Hypothetical climate change scenarios were predicted as future climate change scenarios by modifying the input rainfall and evapotranspiration data. The results indicated that the relationship between rainfall and streamflow is stronger than that between evapotranspiration and streamflow as an increase of 10% in rainfall without any change in evapotranspiration results in 20.42% increase in streamflow while the same amount of increase in evapotranspiration with no variation in rainfall results 6.30% decrease in streamflow.

In conclusion, the analyses revealed positive trends of rainfall in annual scale for the entire Maduru Oya river basin as well as for Padiyathalawa sub-basin while the streamflow elasticity for the sub-basin using the non-parametric estimator was found out to be 1.12 for the data periods considered.

Keywords: Rainfall trend analysis, Streamflow elasticity to precipitation, Non-parametric estimator, Hydrological modelling

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES