DROUGHT ASSESSMENT OF KIRINDI OYA AND KELANI RIVER BASINS IN SRI LANKA UNDER CLIMATE CHANGE IMPACTS

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ABSTRACT

Drought Assessment of Kirindi Oya and Kelani River Basins in Sri Lanka under Climate Change Impacts

Drought is a natural phenomenon that occurs because of climate change. Droughts are localized events influenced by climatic variables such as precipitation, evapotranspiration, and temperature. As a result, the characteristics and implications of drought differ depending on the climatic administrations in various regions around the world. Drought is one of the maximum significant intervals in Sri Lanka. Sri Lanka is very sensitive to the effects of climate change. Drought is an extremely considerable interval in Sri Lanka in terms of people concerned and helps provided, and the country also serves as a recent example for drought interval and risk assessment in tropical regions.

This research investigates the probable use of drought indices at Kirindi Oya and Kelani River basins and provides drought assessment for future climatic scenarios. This research was directed to perceive the changes in drought, their consistencies according to seasonal analysis in the Kirindi Oya and Kelani River basin in Sri Lanka using normalized difference vegetation index (NDVI), standardized precipitation index (SPI), and streamflow drought index (SDI) for future climate change RCP 8.5 which is one of the worst scenarios according to 5th assessment report of the intergovernmental panel on climate change (IPCC). The drought assessment has been divided into three-time intervals such as observed period (1985-2015), mid-century (2040-2059), and end-century (2080-2099). Further, future climate rainfall data has been forecasted by bias correction monthly factor of historical climate rainfall and observed rainfall data using linear scaling.

The NDVI has been calculated by using Landsat images near-infrared (NIR) and RED bands in GIS 10.3. Initially, SPI and SDI have been calculated for observed rainfall and streamflow data respectively. Hydrological model HEC-HMS was set up and calibrated (2002-2006) with a root mean square error standard deviation ratio (RMSE std dev) value of 0.6, nash sutcliffe (NSE) value of 0.59, and percent bias (PBIAS) of 7.63%. The model was validated from 2010 to 2014 with an RMSE std dev value of 0.7, NSE value of 0.51, and PBIAS of 3.22% for Kirindi Oya basin. Further, for the Kelani basin. the HEC-HMS was set up and calibrated (1990-1995) with an RMSE std dev value of 0.6, NSE value of 0.64, and PBIAS of 0.64% and validated (2007-2011) with RMSE std dev value of 0.7, NSE value of 0.56 and Percent Bias of -3.27% for Kelani basin. Thereafter, mid and end-century SPI and SDI have been calculated for future bias-corrected rainfall data and future simulated streamflow, respectively.

To achieve the objectives of this research work, The rate of recurrence of drought occurrences was determined using a combined SPI and SDI evaluation which identified 1989, 1990, 1992, 2001, and 2004 as a severe drought-affected year in the Kirindi Oya river basin in this observed interval. For the Kelani River basin, severe drought has been identified during 1990, 2001, 2012, 2013, and 2014 in the observed interval.

According to seasonal analysis, the probability of occurrence of extreme drought according to SPI values in Kirindi Oya basin is decreasing 25% for mid and 50% end-century, in the Kelani basin 93.75% for mid and 68.75% in end-century. According to SDI values in the Kirindi Oya basin is decreasing 25% for mid and 25% end-century, in the Kelani basin 93.75% for mid and 50% in end-century. First inter monsoon has been found more severe to drought for both SPI and SDI combination in Kirindi Oya river basin, the northeast monsoon period is the driest season for the Kelani River basin which is situated in wet zone in Sri Lanka.

Keywords: Drought indices, Normalized difference vegetation index (NDVI), Standardized precipitation index (SPI), Streamflow drought index (SDI)

DEDICATION

By the grace of Almighty Allah.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CMIP5	-	Coupled Model Intercomparison Project Phase 5
DEM	-	Digital Elevation Model
FDC	-	Flow Duration Curve
FIM	-	First Inter Monsoon
HEC	-	Hydrologic Engineering Center
HMS	-	Hydrologic Modeling System
IPCC	-	Intergovernmental Panel on Climate Change
LULC	-	Land-use Landcover
MIT	-	Minimum Inter-event Time
NEM	-	Northeast Monsoon
NSE	-	Nash Sutcliffe Efficiency
PBIAS	-	Percentage Bias
PVE	-	Percentage Streamflow Volume Error
R10	-	Heavy precipitation days
R20	-	Very heavy precipitation days
RAS	-	River Analysis System
RCP	-	Representative Concentration Pathways
RMSE	-	Root Mean Square Error
RMSE std dev	-	RMSE Observed Standard Deviation Ratio
SCS	-	Soil conservation service
SDI	-	Streamflow Drought Index
SEM	-	Second Inter Monsoon
SM	-	Soil Moisture
SMA	-	Soil Moisture Accounting
SPI	-	Standardized Precipitation Index
SWM	-	Southwest Monsoon