Chapter 7

CONCLUSIONS

7.1 General

Climate change causes a detrimental impact on the hydrological cycle, resulting in frequent occurrences of flood and drought events, which pose a severe threat to the availability of water resources. Changes in the pattern and magnitude of climatic extremes are indicators of climate change. Changes in magnitude and pattern of temperature and rainfall are responsible for changes in extreme hydrologic events like droughts due to climate change. This study provides a framework for assessing meteorological drought under observed and changing climate scenarios. The present study evaluated the applicability of globally used drought indices SPI and SPEI at different timescales across the study region for the historical period (1971 to 2018). The drought characteristics are estimated and evaluated based on the severity, duration, and frequency of occurrences at different severity (moderate, severe, and extreme). Drought characteristics are calculated by applying the run theory approach at the threshold of SPI/SPEI≤-1. The patterns of drought intensity, duration, frequency of occurrence, and trend are assessed through various statistical assessments and portrayed through various spatial maps. Station proportion has been used to evaluate the temporal variability of the spatial extent of drought occurrence of different severity (moderate, severe, and extreme).

The drought characteristics estimated using SPI and SPEI were evaluated and compared at different timescales over the observed period. The present evaluation used widely acknowledged scientific methodology to assess the situation and intended to advance our knowledge of meteorological drought jeopardy over Uttar Pradesh, India. The jeopardy increased when climate extremes (dry and wet events) occurred in rapid succession over the study region, as compared to individual climatic extremes. The characteristics of climatic extremes (dry and wet events) are estimated and evaluated based on severity, duration, and intensity, calculated using SPEI at a 1-month timescale. The successive occurrence of climate extremes (dry and wet events) and their rapid transition over the study region amplify the jeopardy with respect to the occurrence caused by single climatic extremes over the study region. The characteristics of climatic extremes (dry and wet events) are estimated and evaluated based on severity, duration,

and intensity, calculated using SPEI at a 1-month timescale. The dry and wet event characteristics and the transition time between the climatic extremes were estimated through various statistical methodologies and portrayed temporally and spatially over Uttar Pradesh (India) for the observed period from 1971 to 2018. The statistical downscaling model (SDSM) tool used to downscale the temperature and precipitation to estimate meteorological drought for the future period under changing climate scenarios RCP 4.5 and RCP 8.5. Observed daily maximum temperature (Tmax), lowest temperature (Tmin), and rainfall data for 18 synoptic stations in Uttar Pradesh, India, from 1971 to 2005 were used in the statistical downscaling method. The NCEP reanalysis data considers 26 atmospheric variables daily for the same period. CanESM2 data from RCP 4.5 and RCP 8.5 scenarios create future scenario climate variables. The projected rainfall and temperature under RCP 4.5 and RCP 8.5 are input variables for estimating the SPEI at various timescales from 2019 to 2050. Climate change impacts on drought events' severity, duration, and frequency were evaluated and compared in the study region using RCP 4.5 and RCP 8.5.

7.2 Concluding Remarks

- The primary goal of this study is to quantify drought characteristics by using two widely used indices and evaluating their applicability over the study area, as climatology significantly varies spatially over DRB, India. Due to the extensive process studies conducted at the district level, its primary scientific implication is increased process understanding.
- This study demonstrates how the incorporation of temperature in calculating drought indices impacts drought characteristics. This will encourage researchers to focus more on providing accurate drought depictions.
- This research demonstrated the methodology for evaluating the occurrence of successive climatic extremes (dry and wet events) in the same region. Climate extremes' concurrent occurrence and interplay are evaluated spatially and temporally. This improves our understanding of the scarcity and excess of regional water resources. This research examines the transition times between climate extremes since such rapid succession challenges emergency planning, event management, and long-term risk reduction and is especially problematic for agriculture.

- This study provides a comprehensive analysis of the variability in trends of different meteorological variables over the observed period. It also investigates the projected changes in precipitation and temperature due to climate change using SDSM, as these variables are crucial in determining the likelihood of drought. The study examines the spatial and temporal characteristics of drought under observed and changing climate scenarios (RCP 4.5 and RCP 8.5) across the DRB of India.

The study research findings are essential information for agriculture management, managers of water resources, and decision-makers as they update current policies and develop new plans for reducing the effects of extreme stream flow events brought on by climate change.

7.3 Future scope of studies

1. It was determined in the present study that the trend pattern of climatic variables is continuously altering; it may be either increasing or decreasing. This changing behavior of climatic variables may be due to increased greenhouse gases, the leading cause of global warming and climate change. So, with the help of scientific experiments. The exact amount of CHGs emissions can be evaluated, and severe attention can be given to the carbon budget dynamics due to anthropogenic activities.

2. The prioritization and identification of climate change were analyzed for the Damodar Basin, which can be caused by climate extremes like floods and drought. The same can be done for farming, agriculture, and the ecosystem.

3. Climate forecasts predict weather averages and other climatic properties from weeks to years in advance. Increasingly, forecasters are using compressive models of Earth's climate system to make such predictions.

4. ArcGIS 10.8 worked well for the assessment of spatio-temporal variation. These techniques can be further used for the same and other applications like hydrological modeling and sediment yield modeling for the provided area.