Annals of R.S.C.B., ISSN:1583-6258, Vol. 20, Issue 2, 2016, Pages. 35 - 41
Received 08 October 2016; Accepted 15 December 2016.

Hydrological Modelling Analysis on Impacts of Climate Variability and Land use Change with of at Approach

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ABSTRACT

Earth's surface is home to a vast amount of water, one of the planet's most important natural resources. Global water resources are expected to be approximately 43,750 km3 / year, according to the Food and Agriculture Organization (FAO 2003). America contains the most freshwater on the continent, accounting for 45 percent of the total, followed by Asia (28 percent), Europe (15.5 percent), and Africa (9 percent). Farming (69 percent) is followed by industries (19 percent) and municipalities (10 percent) in terms of water consumption worldwide (12 percent). In terms of agricultural water consumption, Asia is the second-largest continent after North America. India is a developing country in Asia, and as the population grows, so will the need for water and food to meet the country's agricultural and food production needs. For the Murappanadu and A.P.Puram stations, yearly streamflow increased by 10.2 percent and 20.3 percent, respectively, due to climate variability and land use change. Additional data showed that in the Murappanadu and A.P.Puram stations, the percentage (percentage) of the share for land use change alone was -0.1% and 0.1%, respectively, while for climate change alone was 10.3% and 20.2%. Compared to land use change, the SWAT simulation findings show that hydrological processes and water balance components respond significantly to climatic variability.

1. INTRODUCTION

High population increase, fast industrialization, and urbanisation, in addition to the effects of climate change, are the most pressing issues facing our world today. Environmental factors such as shifts in land use/cover and climate variability can modify the hydrological basin cycles, which in turn can affect infiltration of surface and subsurface water, evaporation, and transpiration. Researchers at the regional, subregional, and local levels must consider the impact of changing land use/land cover dynamics and climatic variables on the basin's hydrological response. It is vital to examine the basin-scale impacts of climate change and land use change on water resources in order to make predictions about the future and develop strategies based on those predictions. Climate variability, Land Use/Land Cover (LU/LC) mapping, change detection, and hydrologic modelling with OFAT technique are covered in this chapter. A look into previous and current studies is also included.

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1.1 CLIMATE CHANGE

Overview of Climate Change

There are five components to a climate system: the atmosphere; oceans; the cryosphere; ice caps; land; and the biosphere. The term "climate change" refers to a long-term, significant shift in climate variables like temperature and precipitation (IPCC 2001). "Global warming" and "climate change" are often used interchangeably. Long-term increases in the Earth's surface temperature are thought to be a factor in the variability of the planet's climate pattern. Temperature increases on the Earth's surface are only one component of climate change.

Human activity contributes to the rise in greenhouse gas concentrations. Since the 1950s, the amount of carbon dioxide (CO2) in the atmosphere has risen. The hydrological cycle is affected by precipitation, evapotranspiration, and soil moisture as a result of climate change caused by rising temperatures. A rise in global temperatures of 1.8 to 4.0°C is forecast by the end of this century, according to IPCC (2007). Climate change has the potential to alter water resources, agriculture productivity, and the natural ecology. Climate change is anticipated to have a detrimental influence on water supplies in the majority of the world's countries. However, the impact's intensity and characteristics vary by place, necessitating regional or local research. Hydrometeorological factors must be thoroughly understood in terms of their interseasonal and seasonal fluctuation as well.

2. LITERATURE REVIEW

For all human activity, land serves both a stage and a resource. There are several ways to characterise human activity on land, and the phrase 'land use' is used most commonly. For instance, rural to urban conversion and agriculture (rainfed to irrigated). According to Turner et al. (1995), land use "includes both the way in which the bio-physical properties of the land are changed and the aim underlying that manipulation – the purpose for which the land is utilised". Either a shift in the mix and pattern of land uses in a region, or a modification to an existing land use, can be considered a land use change (Briassoulis 2000).

Water, plant, soil, and man-made structures all contribute to the land's physical and biological cover (Ellis 2007). Changing land cover because to the demand for necessary commodities such as food, water, and shelter has led to changes in land use. Because of this, the term "Land Use and Land Cover" (LULC) is often used to describe the activities that take place on the planet.

Despite the fact that land cover serves as a resource basis, it has been difficult to analyse the current and future effects of the changes on land use because of a lack of relevant data. Satellite remote sensing, with its high temporal resolution, was one promising tool for monitoring land cover change. LC/LU change and earth surface conditions related to climatology, hydrology, oceanography, and land cover monitoring have been repeatedly measured using this historical framework (Kostmayer 1989; Jensen & Cowen 1999).

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Different fields such as agriculture, geology, hydrology, and ecology rely on changes in land use and land cover. Remote sensing has a critical role in hydrological science because of its ability to offer long-term land use change data and to assess hydrological variables, which are not achievable through traditional techniques (Santillan et al. 2011).

Various hydrological models have been used to study the impact of land use/land cover change on water balance in various parts of the world (JoorabianShooshtari et al. 2017). Numerous research projects have used remote sensing and GIS to examine the impact of land use/land cover on future hydrologic responses (Welde&Gebremariam 2017).

Few studies have examined how a watershed's hydrologic response varies as a result of land use changes in the past, present, and future (Rajib&Merwade 2017). Watershed management techniques, such as water resource planning and conservation measures, must therefore include an assessment of the influence of land use/land cover changes on hydrology.

3. METHODOLOGY

Its primary goal is to examine the effects of climate change and land use change on the hydrology of the Thamirabarani river basin. These are the specific steps to take in order to accomplish this goal in detail (Figure 3.1).

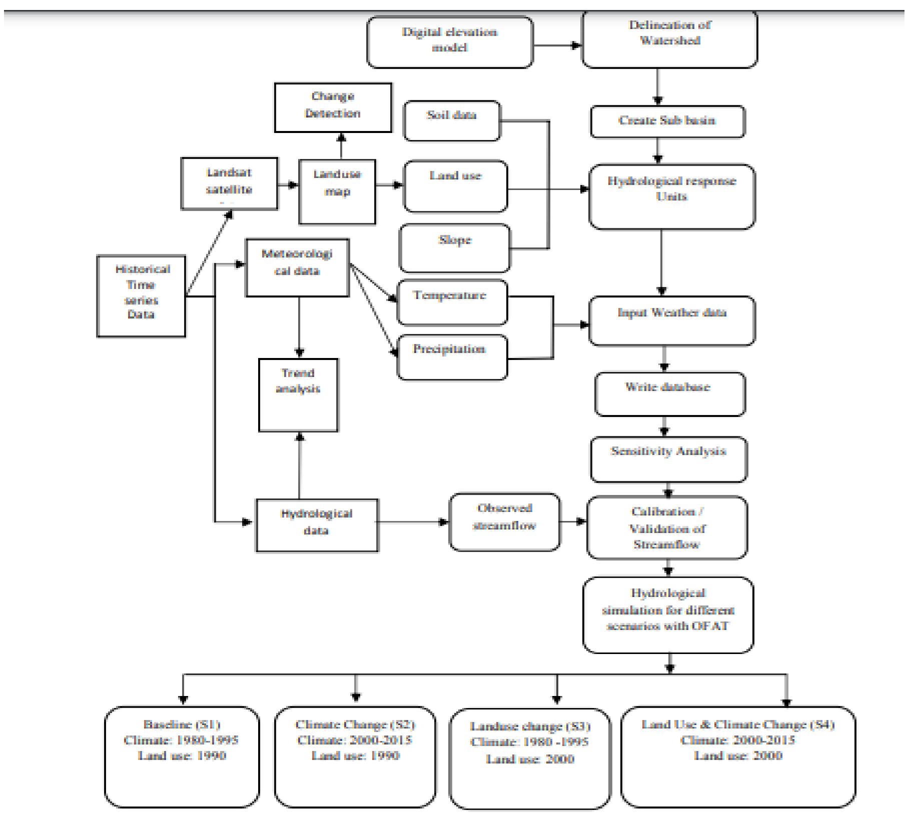

Figure 3.61Methodological Flow Chart

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3.1 Trend Detection in Hydro-Meteorological

Data The hydro-meteorological data set was subjected to two kinds of statistical scrutiny. For starters, the presence of monotonically growing or declining trends was detected using the widely-used non-parametric MannKendall test (Mann 1945; Kendall 1975). To determine a linear trend's slope, Hirsch et al. used Hirsch's nonparametric Sen's slope technique, which was developed by Sen himself (1982).

3.2 Non-parametric Mann-Kendall test

The Mann-Kendall test has the advantage of not requiring a specific distribution match for the time series data input. Another advantage of the test is its low susceptibility to abrupt breakdowns caused by non-homogeneous hydrometeorological time series (Gocic&Trajkovic 2013). If the observations xi of a meteorological time series data are expected to follow the model in Equation (3.1), then the Mann-Kendall test is appropriate.

$$x_i = f(t) + \varepsilon_i \qquad (3.1)$$

It can be assumed that the residuals I can be derived from a comparable distribution with a mean value of zero by taking f(t) as a continuous monotonic upward or downward linear function of time. Since the variance of the distribution is supposed to remain constant over time, it is (t). A lack of trend is assumed in the null hypothesis (H0) used in this statistical test. There is no monotonic trend in the time series (xi) contradicting the alternative hypothesis (H1), which states that there is.

If n is at least 10, the conventional approximation test is used. This statistic is derived using Equation (3.2) (Partal&Kahya 2006) if n is less than 10, however.

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \operatorname{sgn}(x_j - x_k) \qquad (3.2)$$

data values (monthly or seasonal or annual values in years j and k), n is the record length of the time series data set (i.e., time series data), and xj and xk are the sequential time series data values.

$$\operatorname{sgn}(x_j - x_k) = \begin{cases} +1, & if\ (x_j - x_k) > 0 \\ 0, & if\ (x_j - x_k) = 0 \\ -1, & if\ (x_j - x_k) < 0 \end{cases} \qquad (3.3)$$

Assuming that n > 9, the theoretical distribution of S is used as a basis for comparison of S's absolute value. There are four alternative significance levels of = 0.1, 0.05, 0.01, 0.001 for the

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two-tailed test. Null hypothesis H0 is rejected for alternative hypothesis H1 when the absolute S is greater than or equal to a specific value of S/2, where /2 is smaller than or equal to the chance of S2 showing in case of no trend, and H1 is accepted at this probability level. Positively skewed values of S imply an upward trend, whereas downward-skewed values indicate an upward trend. It is possible that we will be wrong in rejecting the null hypothesis H0, that there is no trend in the data, because of the significance level of = 0.001, which means there is a 0.1% chance that the observations in the time series are from a random distribution

4. HYDROMETEOROLOGICAL TREND DETECTION ANALYSIS

4.1 GENERAL

Many environmental issues can be solved by better understanding the precipitation and other hydrological processes. This includes agricultural and natural disasters like floods and drought. Climate change and variability are viewed as a severe environmental and ecological hazard by many countries throughout the world, threatening food production, water supply, and a way of life. In addition, developing countries in the tropical regions of the world are expected to have a greater impact on the global climate.

4.2 BASIC ANALYSIS IN PRECIPITATION TIME SERIES DATA

The average yearly rainfall in the study area is 1244 millimetres. Figure 4.1 illustrates the 35-year interannual variability in watershed average annual rainfall recorded from 1980 to 2015. Recent years have seen a lack of rain, on average. Winter (January-February), Summer (March-May), South West Monsoon (June-September), and North East Monsoon (October-December) are the four major seasons of the year.

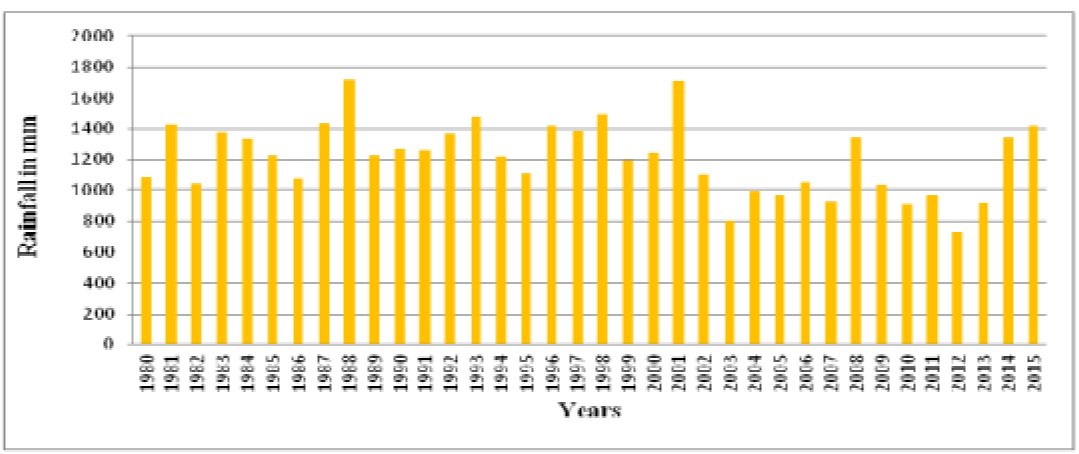

Figure 4.1 Annual rainfall (1980-2015)

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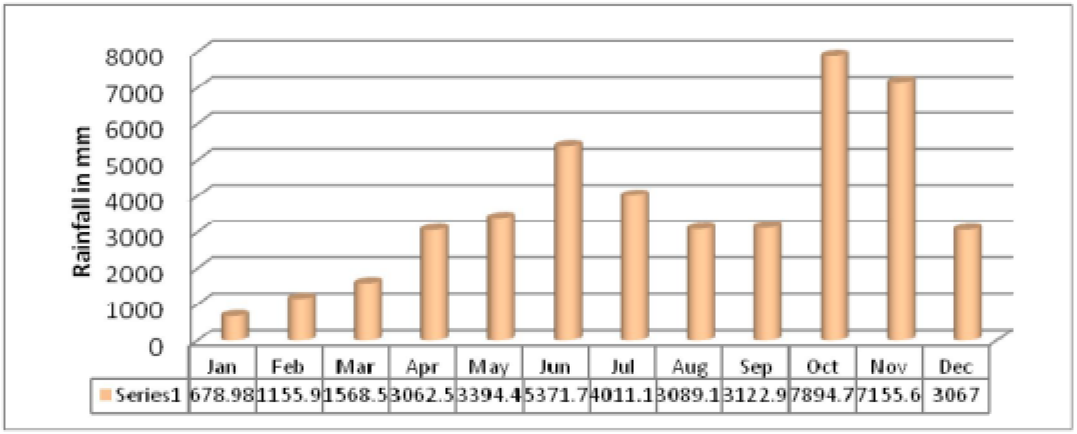

Figure 4.2 Monthly rainfall distributions (1980--2015)

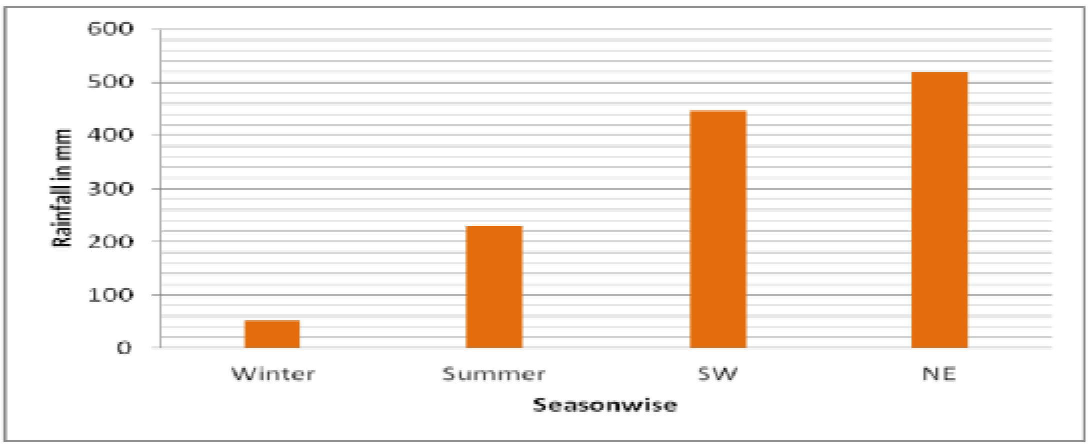

Figure 4.3 Rainfall distributions in different season (1980-2015)

Figure 4.2 and Figure 4.3 shows the monthly and seasonal distribution of catchment average rainfall between 1980 & 2015. The region receives peak rainfall during North-east monsoon (October and November) and followed by the south-west monsoon. From the Figure 4.3, it is clear that high quantum of rainfall is received in the north-east monsoon compared to the other season, which indicated that this basin receives rainfall in both northeast monsoon and the south-west monsoon.

CONCLUSION

As a result of the combined effects of climate variability and land use change, yearly streamflow at Murappanadu Station increased by 10.2 percent and at A.P.Puram Station increased by 20.3 percent, respectively. For the Murappanadu station and A.P.Puram station, the simulation results showed that the percentage (percent) of the share was -0.1% and 0.01% for land use change alone, and 10.3% and 20.2% for climate change alone. Compared to land use change, the SWAT

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REFERENCES

1. Abbaspour, KC 2014, SWAT-CUP 2012: SWAT Calibration and Uncertainty Programs – A User Manual, Swiss Federal Institute of Aquatic Science and Technology.
2. Abbaspour, KC, Faramarzi, M, Ghasemi, SS & Hong Yang, 2009, 'Assessing the impact of climate change on water resources in Iran,' Water resources research, vol. 45, pp. 1-16.
3. Abebe, BA 2014, 'Modeling the Effect of Climate and Land Use Change on the Water Resources in Northern Ethiopia: the case of Suluh River Basin,' PhD Thesis, Freie Universität, Berlin.
4. Abeysingha, NS, Man Singh, Adlul Islam & Sehgal, VK 2016, 'Climate change impacts on irrigated rice and wheat production in Gomti River basin of India: a case study', Springer plus, vol. 5, pp. 1-20.
5. Abhinav, W, Srimuruganandam, B & Pavan Kumar, K 2017, 'Streamflow non-source pollutant analysis using swat modelling,' International Journal of Civil Engineering and Technology, vol. 8, no. 7, pp. 283-294.
6. AbinehTilahun&BogaleTeferie 2015, 'Accuracy Assessment of Land Use Land Cover Classification using Google Earth', American Journal of Environmental Protection, vol. 4, no. 4, pp. 193-198.
7. Aggarwal, PK & Swaroopa Rani, DN 2009, 'Assessments on climate change impacts on wheat production in India,' In: Aggarwal PK (ed.) Global climate change and Indian agriculture case studies from ICAR network project, ICAR, New Delhi, pp. 5í12.
8. Ahmadaali, J, Gholam-Abbas Barani, Qaderi K &Hessari, B 2018, 'Analysis of the Effects of Water Management Strategies and Climate Change on the Environmental and Agricultural Sustainability of Urmia Lake Basin, Iran,' Water, vol. 10, no. 160. pp. 1-20.
9. Ahn, KH &Merwade, V 2014, 'Quantifying the relative impact of climate and human activities on streamflow,' Journal of Hydrology, vol. 515, pp. 257-266.
10. Akhtar, M, Ahmad, N &Booij, MJ 2008, 'The impact of climate change on the water resources of Hindukush Karakorum–Himalaya region under different glacier coverage scenarios,' Journal of Hydrology, vol. 355, pp. 148–163.