Ranfall analysis in Uma Oya basin, Sri Lanka

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RAINFALL ANALYSIS IN UMA OYA BASIN, SRI LANKA

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ABSTRACT

Climate change is believed to be a critical issue and there is enough evidence to identify the impact of climate change. Sri Lanka is expected to be one of the most affected countries from adverse impact of climate change. Various climatic models propose a rise of rainfall intensity to south Asian region while the number of rainy days are to be reduced. Therefore, the necessity is raised to find the clear trends in climatic factors in the region. However, a very few research work was carried out to see the climatic changes over the last few decades in Sri Lanka. Temporal variation of precipitation (rainfall) can be a good indicator to identify the trends in climate. In addition, these rainfall variations are used in many engineering aspects, including design of massive civil engineering structures like dams, design of water supply networks, etc. Furthermore, the rainfall variations are not only important in engineering aspects but also heavily in agriculture. Therefore, this research paper presents an analysis of temporal variation of rainfall in Uma Oya basin, Sri Lanka. Initial results show some interesting trends in rainfall over a period of 24 years. Furthermore, research is being conducted using advanced statistical data analysis techniques to present comprehensive trends in rainfall in Uma Oya basin.

Key words: Annual rainfall, patterns and trends, temporal variation, Uma Oya basin-Sri Lanka

1. INTRODUCTION

Temporal and spatial variation of rainfall can produce extreme events, like droughts or floods in populated areas [1, 2]. Therefore, the analysis of temporal and spatial variations of rainfall is an important topic for designers, planners and obviously for general public. Rainfall variations, therefore, are the best interests in applications of hydrology, agriculture and ecology. This has an additional importance when it comes to the tropical countries like Sri Lanka, Nepal and countries in south Asian sub-continent. Most of these tropical countries are affected in the fields of agriculture and hydropower generation due to the extreme events of rainfall [3]. South Asian counties experience monsoon rainfalls. Asian monsoon plays an important role to the global climate and importantly the region covers roughly a half of the world’s population [4, 5]. Asian monsoon systems is believed to be developed in the beginning of the Neogene and related to the Himalayan uplift [6, 7]. Monsoons are much noticeable in south and east Asia.

The global circulation of precipitation is heavily important to maintain the balance of the earth system. This circulation transports heat from warm regions to the higher latitudes [8]. However, this balance is believed to be unbalanced due to global warming. Global warming is one of the most challenging scenarios of climate change. There is some evidence to show that the climate change is a natural phenomenon; however, this is challenged by many researchers around the world in the context of the 20^{th} century. They believe the human activities have overreacted the natural causes to make this earth a warmer place [8]. Precipitation is one of the most important climatic parameter. Therefore, it is essential to understand the precipitation patterns to analyze the past and present climate changes and then, to predict the future changes [9].

Literature shows many previous research articles to present the interest of analyzing the rainfall patterns both in spatially and temporally [10–13]. However, there is little research on this along the line of Sri Lanka.

Uma Oya basin in Sri Lanka has taken much attention due to the Uma Oya development program. There are enough critics to the development program due to the proposed diversion of water to the down south of Sri Lanka. Therefore, it is better to conduct an engineered research to find the water availability of the region if there is a crisis developed due to this diversion. Therefore, daily rainfall data for 24 years from rain gauges in Uma Oya basin have taken into consideration to have the draft conclusions from the study.

2. METHODOLOGY

The catchment for Uma Oya basin was developed using Google Earth tool. The catchment is being drawn over the real scanned topographical maps. The developed catchment is given in Figure 1. The black colored line shows the Uma Oya catchment and the purple lines show the creeks in Uma Oya.

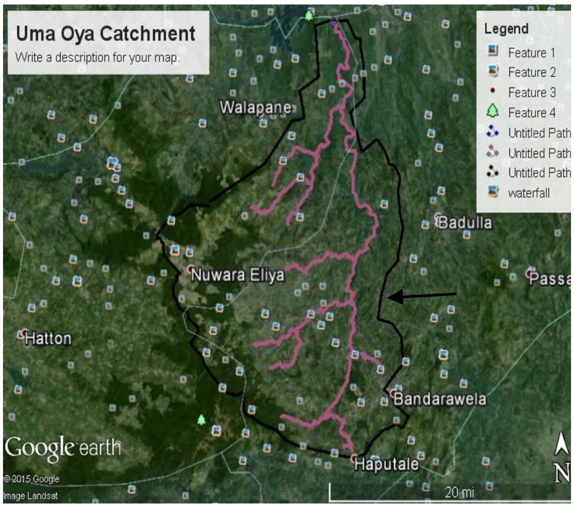


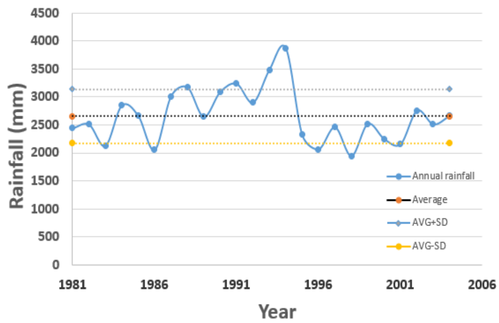
Figure 1: Developed Uma Oya catchment map (←catchment line)

Daily rainfall data for two rain gauge stations in Uma Oya basin were considered in this research. They are in Narangala, Badulla (7.05 ^{0}N, 81.00 ^{0}E) and Debedda, Badulla (6.96 ^{0}N, 81.12 ^{0}E). Daily rainfall data for 24 years (from 1981 to 2004) were statistically analyzed from Narangala rain gauge, whereas it was 16 years daily rainfall data (from 1989 to 2005) for Debedda rain gauge. However, further research is being carried out for many other rain gauge stations.

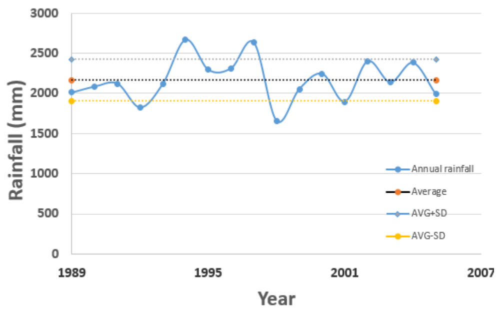
3. RESULTS

Figures 2(a) and 2(b) present the variation of annual rainfall of both rain gauges. The average rainfall (AVG) among the differences in average to standard deviations (SD) are also plotted ($AVG \pm SD$).

A sinusoidal annual rainfall pattern can be seen in both rain gauge stations. In other words, peaks and troughs can be clearly seen from Figures 2(a) and 2(b). As it was earlier mentioned, to identify the extreme events, differences to the average with standard deviations are plotted in above figures. Year 1994 was an extreme year to receive heavy rainfalls to the Narangala area. The annual rainfall is well above the average rainfall (roughly = *AVG*+(2**SD*)). A similar observation can be seen in Figure 2(b). In addition, a significant high rainfall can be observed in year 1993 for Narangala. However, for Debedda it is in the average level. A vice versa observation can be seen in year 1997. Debedda has received a considerable high rainfall whereas Narangala has received an annual rainfall, which is lower than the average value. Year 1998 was a year for an extremely low annual rainfall. This can be seen in both rain gauge stations.



(a)



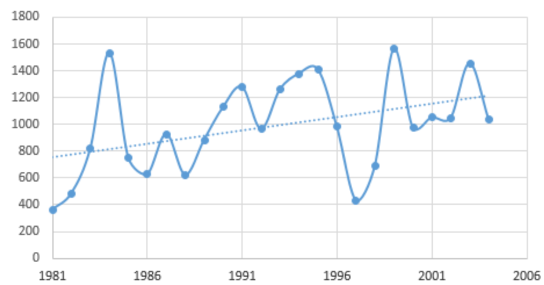
(b)

Figure 2: Annual rainfall variation (a): Narangala; (b): Debedda)

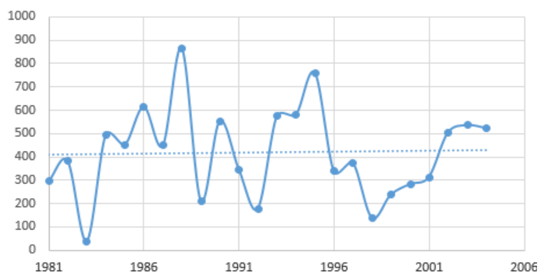
The average rainfall values of these two stations are 2656 mm in Narangala and 2167 mm in Debedda. Therefore, they have averagely a difference of 489 mm (2656-2167 mm) of annual rainfall. Furthermore, they are located by 17 km (straight distance) away each other in the same district. Therefore, the spatial variation of rainfall in these two locations can be visualized.

However, to have a comprehensive analysis, these rainfall data were plotted over the seasons. Figures 3(a) to 3(d) are the plotted rainfall data for Narangala area. The "X" axis gives the time in years while the "Y" axis presents the rainfall per season in millimetres. The usual standards were used to define the corresponding rainfall seasons.

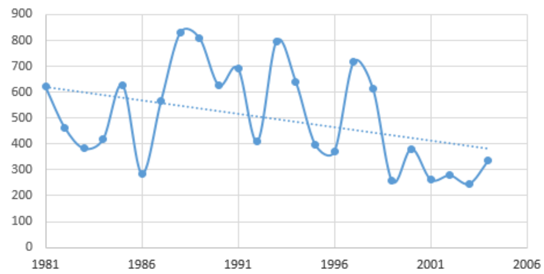
It can be clearly seen from the Figures 3(a) to 3(d) that the seasonal rainfall has a good temporal variation. It was well known that the major rainy season for Oma Oya basin area is North-east monsoon. A clear increasing trend can be seen from Figure 3(a). However, the next rainy season, 2nd inter-monsoon shows a decreasing trends (Figure 3(d)) to the rainfall. In addition, the 1st inter-monsoon shows a neutral trend while the south-west monsoon demonstrations a sharp decreasing trend. Therefore, it can be concluded herein that the dry months in Uma Oya basin are expected to have much drier periods whereas the rainy months will have increased precipitations. Uma Oya basin is well known for its vegetable production and the landscape is mountainous. Therefore, these new climatic (rainfall) trends may lead to more natural disasters, like landslides.



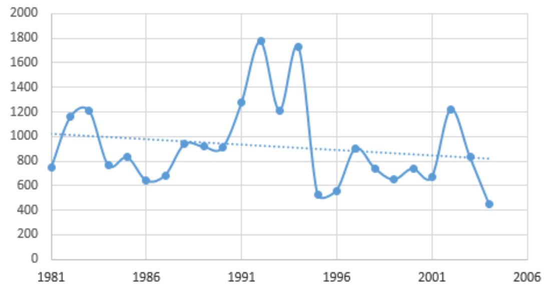
(a) NE monsoon



(b) 1st intermonsoon



(c) SW monsoon



(d) 2nd intermonsoon

Figure 3: Seasonal rainfall in Narangala, Badulla, Sri Lanka

Similar seasonal rainfall trends to Narangala can be observed in Debedda area. North-east monsoon has an increasing trend while the south-west monsoon has a decreasing trends. Unlike the Narangala area, the 1st and 2nd inter-monsoons in Debedda area have increasing rainfall trends, which is interesting. This can be due to the spatial variation of rainfall between the two locations.

4. CONCLUSIONS

Daily rainfall data for two rain gauging stations in Uma Oya basin, Sri Lanka were analyzed to observe the temporal variation of the rainfall and to examine the trends. The results of the analysis show that temporal variations of annual rainfall in both rain gauges are generally constants. In other words, the trends in annual rainfall is overlapping to the average annual rainfall. Therefore, it can be concluded that the climate change has not done a significant impact to the annual rainfall in Uma Oya basin.

However, when it is looked at the micro level some interesting observations can be identified. The major rainy season to Uma Oya basin, north-east monsoon, has an increasing rainfall trend. This observation can be used to derive some predictions to the climate in Uma Oya catchment. Therefore, during the months of December, January and February, Uma Oya area can expect an intensive rainfall. However, the dry season to Uma Oya basin, south-west monsoon, has a decreasing rainfall trend. This means, the area is expected to have some drier months, including months from May to September.

If this seasonal drift can be validate by some more rain gauges in the same area, outcomes of this study can be utilize to enhance the economical, ecological and social environment of the Uma Oya area. Therefore, research is being carried out to analyze the other available rain gauging stations to drive sound conclusions. In addition, the research is being conducted to identify the sound trends using the advanced statistical analysis techniques, like Student T test and Mann-Kendall test.

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