EXTENDED ABSTRACT

ANALYSIS OF PRECIPITATION ANOMALY INDICES FOR EXTREME RAINFALL OVER THE IRANAIMADU TANK IN SRI LANKA

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Abstract

The extreme rainfall events leading Kilinochchi district which has *Iranaimadu* tank is a major water source, to droughts and floods prone. The objective of this study is to analyse temporal variation of extreme rainfall events over the *Iranaimadu* tank. This study used thirty years (1984 – 2018) of monthly rainfall data. The study used Precipitation Anomaly Index (PAI) to identify extreme rainfall events. The extreme events showed drought events ($PAI \leq 1$) and flood events ($PAI \geq 1$). The data analysis done by descriptive analytical technique. Results revealed that annual extreme events were noted 23 events (76.7 %) including 15 drought events and 08 flood events. Seasonal extreme events were noted 86 events (71.7 %) such as 48 seasonal drought events and 38 flood seasonal events. High monthly drought events recorded in June and flood events noted in November. Droughts are a significant extreme events. Hence decision makers should give priority to drought mitigation.

Keywords: Anomaly, extreme, flood, precipitation.

1. Introduction

Sri Lanka is an island situated close to the equator. Due to its geographical position, the climate of the country has tropical climatic pattern (Piratheeparajah, 2015). It is influenced by two monsoons and weather system based on Inter-Tropical Convection Zone (ITCZ). Sri Lanka's weather is highly dynamic during the South West Monsoon and North East Monsoon (Domros, 1998). Rainfall patterns in Sri Lanka have multiple origins and these patterns are influenced by monsoon winds of the Indian Ocean and Bay of Bengal (Rekha, 2012).The country is vulnerable to extreme rainfall event leading to droughts and floods (Thevakaran, 2019). The Northern region predominantly has climatic features pertaining to the dry zone (Piratheeparajah, 2015). Northern Region of Sri Lanka has suffered a lot due to droughts and floods (Kandiah, 2014). Rainfall is the most significant hydrological variable which can be used to identify extreme events. Kilinochchi district is one of the droughts and floods prone district in Sri Lanka. Iranaimadu tank is a major water source to this district especially farmers. Detailed knowledge of extreme events are essential for proper water management practices. Thus, understanding the variations in rainfall both spatially and temporally and improving the ability of forecasting rainfall may help in planning crop cultivation as well as in designing water storages, planning drainage channels for flood mitigation (Jayawardene, 2005). Decision making for developing projects based on Iranaimadu tank encounters constraints related to

limited and unreliable rainfall and high variability in rainfall patterns, therefore, it is necessary to understand extreme rainfall events. The main objective of this study was to examine the temporal variation (monthly, annually and seasonal) of the extreme rainfall events over the Iranaimadu tank. Identification of the extreme rainfall events intensity will be much useful to the Iranaimadu tank management and future irrigation plans.

2. Methodology

This research conducted using the thirty years (1984-2018) monthly rainfall data collected from the Iranaimadu tank weather station. Limitation of the study was from 2004 to 2010 rainfall data was not used to this study. From 2004 to 2010 daily rainfall data was not collected from Iranaimadu irrigation tank because of the civil war. The data analysis done by descriptive analytical techniques such as bar and line charts using the MS Excel. Precipitation Anomaly Index (PAI), an index used to explain annual rainfall inconsistency (Rooy, 1965). The PAI considers two anomalies, as positive anomaly (flood) and negative anomaly (drought). First, the precipitation data are arranged in descending order. The ten highest values are averaged to form a threshold for positive anomaly and the ten lowest values are averaged to form a threshold for negative anomaly. The PAI is used to describe rainfall variability and is calculated for both positive and negative anomalies as:

$$PAI = \pm 3 \text{ x } ((YP - AP)/(A10 - AP))$$

where YP = actual rainfall for individual years; AP = average rainfall; and A10 = Average 10 extreme rainfall values(highest and lowest) observed during the study period.

Table 1. Precipitation Anomaly Index

Classification	Precipitation Anomaly Index (10)
Extremely flood	More than 3
Very flood	2.00 to 2.99
Moderately flood	1.00 to 1.99
Near normal	0.99 to -0.99
Moderately drought	-1.00 to -1.99
Very drought	-2.00 to -2.99
Extremely drought	Less than -3

Source: Rooy, 1965.

3. Results and Discussion

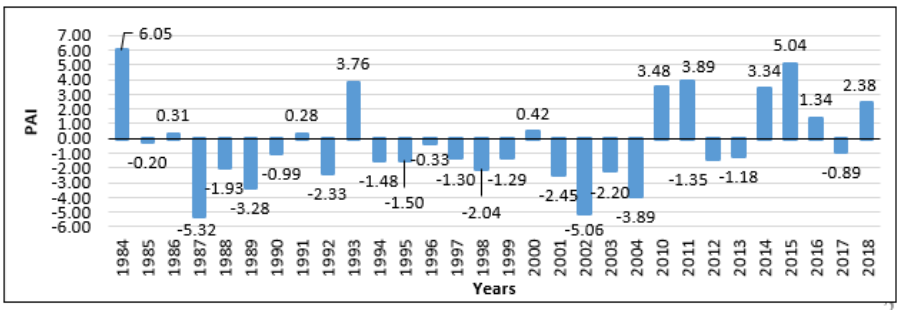

Figure 1. Annual Precipitation Anomaly Index from 1984 – 2018

Table 2. Annual Precipitation Anomaly Index from 1984 – 2018

Category	PAI Value	Frequency	Percentage (%)
Extremely wet	More than 3	06	20
Very wet	2.00 to 2.99	01	3.3
Moderately wet	1.00 to 1.99	01	3.3
Near normal	0.99 to -0.99	07	23.3
Moderately dry	-1.00 to -1.99	07	23.3
Very dry	-2.00 to -2.99	04	13.3
Extremely dry	Less than -3	04	13.3

Figure 01 shows annual PAI values from 1984 – 2018. PAI value negative (-) which means drought and PAI value negative (+) which means flood. 07 years out of 30 years categories as near normal (PAI value 0.99 to -0.99). This indicates 23.3% of time period as near normal and other 74.7% as extreme event years. 15 annual drought events recorded during the past 30 years. This had 07 annual events were moderate drought, 04 annual events were very drought and 04 extreme drought events. Therefore 50% annual drought events were extreme events. Then 26.7% annual flood events noted as extreme events in which one is annual moderate flood, one annual very flood and 06 annual extreme floods (20%). Hence drought noted as high annual extreme events (15 events) at the same time 08 annual events also noted in the study area during the study period (Table 02). Piratheeparajah (2015) revealed three floods and four droughts occurred as floods occurred in 1975, 1984 (Extreme flood) and 2010 while droughts occurred in 1974 (Severe drought) 1987, 2008 and 2009 (Extreme drought) through the Standard Precipitation Index(SPI) in Iranaimadu during 1972 to 2012. These finding supporting to this results.

Table 3. Monthly Precipitation Anomaly Index for 30 years (1984-2018)

	Classification of Precipitation Anomaly Index						
Months	Extremely wet	Very wet	Moderately normal	Near dry	Moderately dry	Very dry	Extremely dry
January	03	03	04	05	03	06	06
February	03	01	01	08	02	08	07
March	02	03	03	05	05	04	08
April	04	04	01	07	04	05	05
May	02	02	01	06	06	08	05
June	03	02	01	04	05	04	11
July	04	03	03	06	03	01	10
August	05	01	00	09	04	05	06
September	04	02	04	09	03	02	06
October	05	01	03	10	04	01	06
November	04	01	06	06	04	06	03
December	05	01	03	07	04	06	04
Total	44	24	30	82	47	56	77

All 12 months show high monthly events were noted near normal (Table 3). High monthly drought events recorded in June (20 events) and high monthly flood events noted in November (11 events). Lathiscumar (2020) examined the highest monthly rainfall was recorded in November. Further, month of June recorded less than 50 mm of mean monthly rainfall. That research finding supported to this result.A majority of the extreme drought events recorded in June (11 events) and July (10 events). Very drought events were high in May and February (08 events). High moderate events were recorded in May (06 events). Six Moderate flood events were recorded in November, very flood events were in April and Extreme flood events were in October and December as high in monthly extreme events. Hence high monthly drought events recorded in June and high monthly flood events noted in November. So 77.2% of monthly extreme events occurred as drought (50%) and flood (27.2%) in the study period.

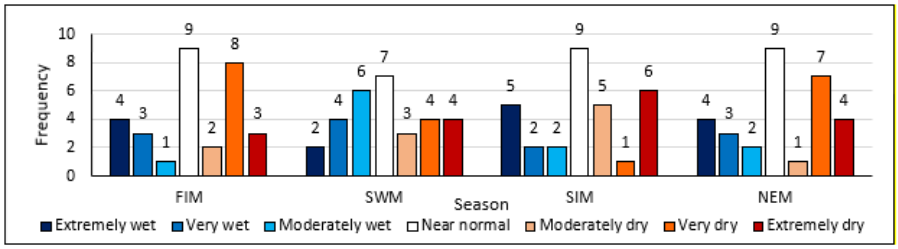

Figure 2. Seasonal Precipitation Anomaly Index from 1984 – 2018

Figure 02 shows seasonal PAI value from 1984 – 2018. All four seasons show high seasonal value between 1 to -1 as near normal. 34 out of 120 seasonal events (28.3%) were noted near normal. The extreme events were recorded 86 events as 71.7%. Those are drought events (40%) and flood events (28.3%). First Inter Monsoon (FIM) had 08 floods events and 13 drought events. South West Monsoon (SWM) had 12 flood events and 11 drought events. Second Inter Monsoon (SIM) had 09 flood events and 12 drought events. North East Monsoon (NEM) had 09 flood events and 12 drought events. High number of extreme drought events recorded in SIM as 06 drought events. Similarly high very drought seasonal events in FIM, moderate drought events in SIM. Very flood and moderate flood seasonal events were high recorded in SWM. 05 extreme flood events noted in SIM as high seasonal events. Hence droughts noted as high seasonal extreme events in this area.

4. Conclusion

PAI was calculated at different scales, but the extreme events showed drought events ($PAI \leq 1$) and flood events ($PAI \geq 1$). Annual extreme events were noted 23 events (76.7%) such as drought events were 15 events and flood events were 08 events. Seasonal extreme events were noted 86 events (71.7%) such as 48 seasonal drought events (40%) and 38 flood seasonal events (31.7%). High monthly drought events recorded in June (20 events) and high monthly flood events noted in November (11 events). According to PAI analysis, drought is a significant extreme events in over the Iranaimadu tank. Therefore decision makers should give priority to drought mitigation and drought resilience practice to beneficiaries who obtains water from this tank and at the same time should create action plan to flood control measures in month of November. This study was used only 30 years data, further studies needs with the long term historical rainfall data for find out highly precious interpretation.

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