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Study and analyse temperature and rainfall data effecting to climate change in Shimoga district

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Abstract: Any technique that will lessen the effects of climate change is referred to as a climate adaption strategy. In order to influence anticipated climatic changes, adaptation entails reducing risk from climate change. The goal of this study is to offer adaptation strategy for implementing district-level, sustainable responses to climate change. Additionally, mitigation is typically accomplished at the national and state levels. The effects of climate change differ depending on the local physiography.
The current analysis identifies the physiographic regions that are both severely and less affected. Solutions for implementing adaption policies and plans should be provided by the inquiry. The functions that villages and grama panchayats play in society's adaptation to climate change should be included in a district-level plan. Whether we take action or not, humans will adapt to the effects of climate change. We can decide to adapt in a way that safeguards our most priceless resources by taking action. We run the risk of losing or harming some of our most precious resources if we do nothing.
To stop climate change, mitigation involves lowering greenhouse gas emissions. Even if significant mitigating efforts are quickly put in place, adaptation to the effects, such as higher average temperatures and greater rainfall unpredictability, will be necessary. According to this investigation, while adjusting to the current climate's variability may help us prepare to some extent for future climate change, doing so will not be enough on its own.

Keywords: Climate adaptation strategy, Physiographic regions, temperature, rainfall.

I. INTRODUCTION

Climate change is defined as a long-term shift in meteorological characteristics such as temperature, precipitation, or humidity that may be identified in the mean and variability of its properties. Climate change is caused by both natural and man-made factors. Changes in the Earth's climate have been catalysed by human activities since the dawn of the industrial period. According to the IPCC's fifth assessment of the working group 2nd, water scarcity, variations in food production, and consequences on human health would occur in many parts of Asia due to a lack of adaptation techniques to floods, droughts, cyclones, and glacier melts. Integration of adaptation and mitigation might result in gradual modifications that lessen impacts while maintaining benefits. The insertion of people can help with adaptation to the consequences of climate change. Planned adaptation makes it easier for living beings to adapt to their surroundings. Although the adaption processes are self-contained, the most valuable natural resources can be safeguarded by taking prudent steps. Risk factors and vulnerabilities must be clearly specified in order to indicate the need for adaptation and thus aid in the development of capacity. Experts with extensive experience can identify the requirement and address the issues using a variety of techniques. Various adaptation solutions are available, but they may or may not match the adaption requirements. It is impossible to adapt with all of the resources and implementation techniques available, but with the right resources and modern technologies, adaptation can be accomplished on par with natural system preservation. Reducing greenhouse gas emissions in many energy sectors can help to mitigate the effects of climate change. The policies adopted by a number of developed and developing countries around the world, as well as their implementation, can help to bring about change and solve the problem.

II. LITERATURE REVIEW

Following papers highlight about the Effects on climatic change, Study on physiographic region,and Evaluation of parameters (Rainfall & Temperature).

A. Thankam Theresa Paul (2021)

This paper names climate change as the primary strain affecting the small-scale fishing (SSF). Additionally, there is a noticeably decreased rate in the manufacture of the primary component of SSF (Small Scale Fisheries), and this lower rate is attributed to climate variation caused by changes in temperature and precipitation. Also, as the best adaptation

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method for bringing back the lowered rate of fishing in an area, present a plan that is compatible with lower payment fishery technology.

B. **Kai Xu (2020)**

This article bases its evaluation method on the idea of vulnerability proposed by the Intergovernmental Panel on Climate Change. Using moisture indices that incorporate factors related to climate change, such as temperature and rainfall, one can define the status of being detrimental to future climates without protection. Based on global climatic indicators as well as improved vulnerability identification, quantification, and prioritisation, the method offers a variety of comprehensive vulnerability evaluation options that are later tested on a large spatial scale to serve as a guide for ecosystem conservation efforts.

C. **Karen E. Mc Namara (2019)**

In this paper, vulnerability is discussed as a key component of the discussion of climate change and is frequently seen as a concept that is affected by non-living, social, and economic elements that have an impact on a system's resiliency and capacity for adaptation. Aims to provide more knowledge on climate change vulnerability and to make available the usage of a foundation for vulnerability that is harder to assess. The limited number in terms of the indirect indicator utilised, and as a result, offer guidance to the future studies that explore in depth a large range of the factors that influence exposure, sensitivity, and adaptive capacity.

D. James D. Ford (2018)

In this paper, the distinctive trait that is associated to the use of vulnerability techniques in learning of climate change is recognised, described, and evaluated. We discovered an advantage and the applicability of using vulnerability techniques since the limited learning opportunities appealed to the many lacks of fulfilment of the vulnerability. Based on fictitious concepts, vulnerability understanding is typically quite advanced, even though it still requires more conceptual understanding of how vulnerability is created and evolves over time. However, empirical research is typically not very far along in terms of developing a more general understanding of present or future exposure, sensitivity, and adaptive capacity.

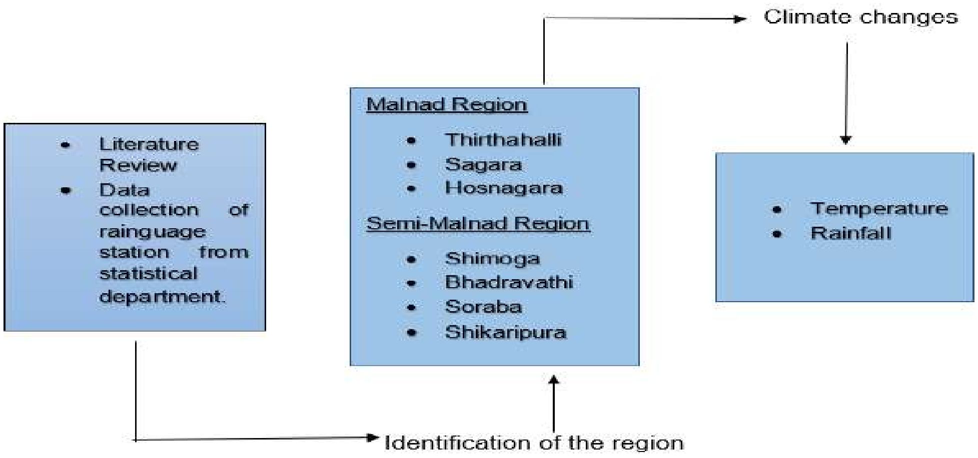
E. Thuc D. Phan (2018)

A dynamic modelling approach was used in this work to analyse the susceptibility of the coastline freshwater organisation, aspirational flow failure, and social economic development. An insignificant effect that suggests that there is sufficient freshwater on hand to satisfy home, industrial, and agricultural needs. presents a system dynamics assessment that simulates the proper balancing of the quantity and aesthetic aspects of a freshwater seaside system. The design access and allegations from this application may be appropriate for developing and growing seashore communities where the water supply authority is at risk of working with social and economic advancement and climatic change.

III. OBJECTIVES OF THE STUDY

To assess the region's climate change levels.
To create rainfall map for the district's various region.

IV. METHODOLOGY



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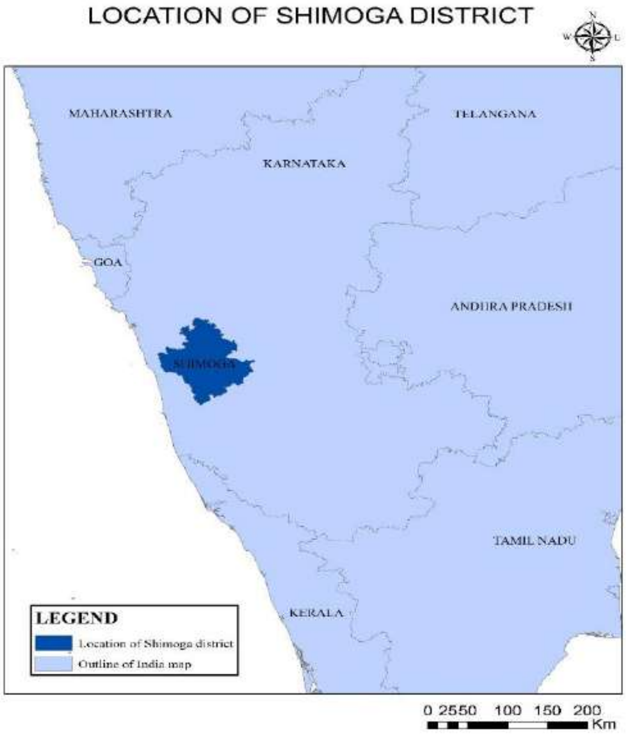
V. OVERVIEW OF THE STUDY

Shimoga district is located in Karnataka's mid-southwestern region. Shimoga, Bhadravathi, Thirthahalli, Soraba, Shikaripura, Hosanagar, and Sagara are the seven taluks that make up the district, with a total of 1540 villages. The purpose of this study is to identify high-climate-change regions in order to achieve long-term goals. The rainfall and temperature of the region, which is separated into Malnad (Western side of the district) and Semi-Malnad, are used to assess climate change (Eastern side of the district).

A. Physiography

Shimoga district is located in the mid-southwestern section of Karnataka, between 13°27′ and 14°39′ N and 74°37′ and 75°52′ E. It has a geographical area of 8477 sq. km. Based on the physiography of the area, Shimoga district is separated into Malnad and Semi-Malnad. The Malnad region, which is part of the Western Ghats and is located in the western section of the district, has heavy rainfall, continuous hills, and is rich in biodiversity. The Semi Malnad region consists of broad plains with low and rising hillocks and sparse vegetation. The physiography of the location can be used to divide the taluks. Semi-Malnad taluks include Shimoga, Bhadravathi, Soraba, and Shikaripura, whereas Malnad taluks include Thirthahalli, Sagara, and Hosanagar. The primary rivers that travel through the district include the Tunga, Bhadra, Sharavathi, Kumudvathi, and Vara. Shimoga district has a diverse flora and fauna, as well as evergreen and semi-evergreen forest.



B. Calculation of average rainfall of the district by Thiessen Polygon Method.

The Thiessen Polygon Method (weighted mean method) is used to compute average rainfall. The amount of rain that falls in a basin or catchment is constant, but the intensity and duration of the rain vary from place to place. As a result, the rainfall reported at each rain gauge station in the area is taken into account.

Methodology

On a graph sheet, the Shimoga district's area jurisdiction map is drawn, along with the position of rainguage in the area.

- Rainguage locations are connected to form a triangle network.
- Perpendicular bisectors are drawn around the triangles, forming polygons surrounding the stations
- The polygons are outlined, and their areas are calculated by dividing them into small geometric shapes.
- The formula for calculating average rainfall is as follows:

$$P_{avg} = \frac{P_1*A_1+P_2*A_2+P_3*A_3+P_4*A_4+P_5*A_5}{A_1+A_2+A_3+A_4+A_5}$$

P_{avg}=Average precipitation in mm/day

P1=Rainfall in the region in millimeters per day

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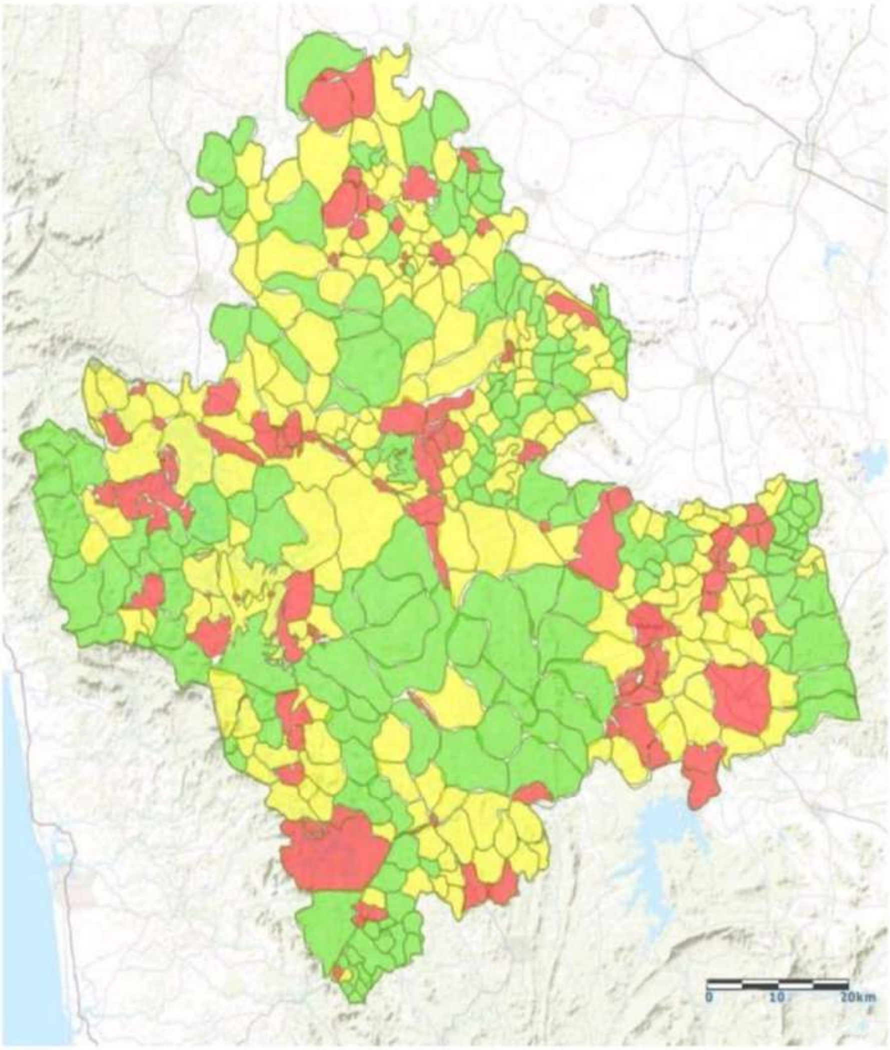
A1=Area of the region in square kilometers

Data which is collected from statistical department concludes that,
low mean rainfall of 10.943 mm (2007)
High mean rainfall of 18.657 inches (2015) &
District's average rainfall is 16.057 mm/day.

Shimoga district receives an average of 16.057mm of rain each day. The combined trend of all the stations suggests that rainfall in the district is increasing. As a result, significant cloud cover might result in poor radiation, resulting in lower crop productivity in Shimoga area. According to the projection, yields would be lower in the kharif season. Farmers can mitigate the effects of climate change on their crops by employing crop management practices such as greater water, fertilizer, and soil moisture conservation, appropriate drainage, and the use of climate-tolerant cultivars.



5.3 Rainfall mapping in Shimoga district

VI. RESULT AND DISCUSSION

6.1 CLIMATE VARIABILITY AND PROJECTIONS

Climate change is evaluated using data from the last 20 years. For the Shimoga district study, the climate trend of five rain gauge stations is examined from 2000 to 2020. Precipitation and temperature for the individual rain gauge stations are among the variables. Shimoga district has a tropical climate and is influenced by the south west monsoons. The changing patterns of the variables in the monsoon, pre-monsoon, and post-monsoon seasons are also included in the analysis.

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Fig 6.1 Location of Shimoga rainguage stations

6.2 Bhadra River Project

The reservoir of the Bhadra river benefits the Bhadra river project, which is located in the district's southernmost corner. Irrigation, hydroelectric power generation, and water delivery are all made easier by the reservoir. The region's catchment area is 1960 square kilometres. The region is also home to the Bhadra Tiger Reserve, which is rich in flora and animals. The rain gauge stations are located at 13°42 latitude and 75°3820 longitude.

Months	Monsoon	Average rainfall in mm	Observed trend mm/day
January	Pre	3.1	22.904
February	Pre	3.19	
March	Pre	9.2	
April	Pre	39.37	
May	Pre	59.66	
June	SWM	160.14	194.022
July	SWM	283.33	
August	SWM	229.9	
September	SWM	102.72	
October	NEM	140.45	68.873
November	NEM	57.55	
December	NEM	8.62	
Annual Rainfall			285.799

Table 6.1 BRP Monsoon rainfall variation of previous 20 years

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According to the above analysis, changes in rainfall intensity can have severe effects on agricultural productivity and cause livelihood concerns in the region. The variability is very high during the pre-monsoon seasons, with a 10% increase in annual rainfall during monsoon from 2000 to 2020, causing likely increases in floods in the Bhadra reservoir.

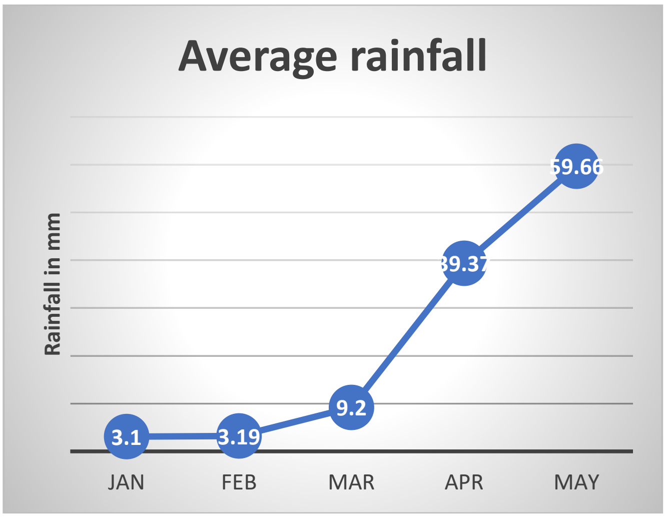

Fig 6.2 BRP Pre-monsoon

The graph above depicts rainfall variations over the previous 20 years. The rainfall is increasing in the Pre-Monsoon (January to May).

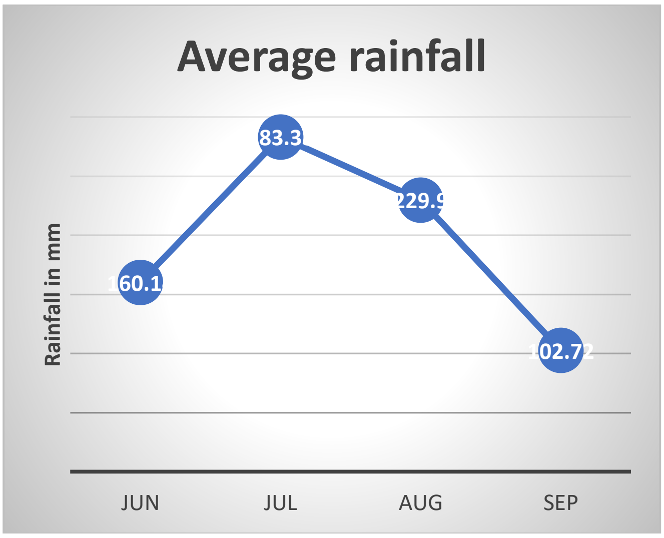

Fig 6.3 BRP South West-monsoon

From the above graph, we can conclude that rainfall is varying month to month that is from June to September which is known as South West Monsoon.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

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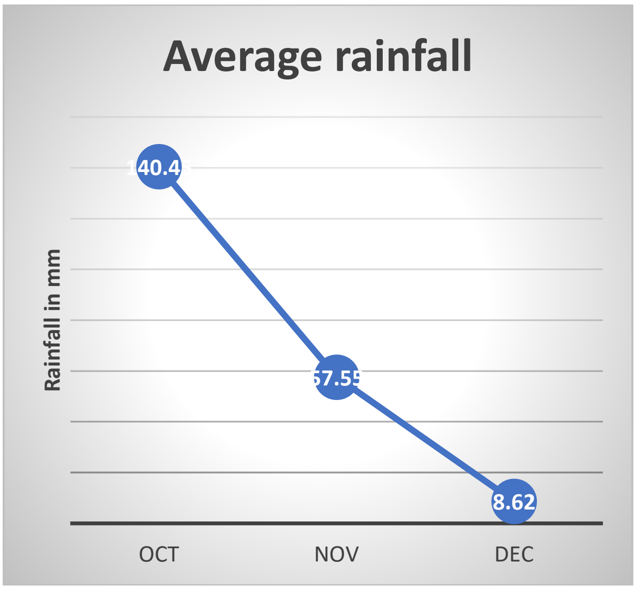

Fig 6.4 BRP North East-monsoon

The above graph shows that rainfall is decreasing in North East Monsoon from the month October to December. This could be owing to the region's forest area shrinking at an alarming rate. During the monsoon, a reduction in relative humidity in the area might lead to a rise in maximum temperature.

6.3 Shimoga taluks

Shimoga taluks is located in the eastern part of the district and consists of 39-gram panchayat parts. The taluks are the district's administrative region as well as the region's industrial hub. With ecological hotspots like Shettyhalli wildlife and Mandagadde bird sanctuary, the region is well connected to other parts of the state. The region is part of the semi-malnad, and the majority of it is flat ground.

Months	Monsoon	Average rainfall in mm	Observed trend mm/day
January	Pre	1.039	24.191
February	Pre	1.78	
March	Pre	2.36	
April	Pre	44.8	
May	Pre	70.98	
June	SWM	139.56	162.4
July	SWM	179.68	
August	SWM	191.86	
September	SWM	138.5	
October	NEM	114.56	52.536
November	NEM	30.63	
December	NEM	12.42	
Annual Rainfall			239.127

Table 6.2 Shimoga Monsoon rainfall variation of previous 20 years

International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified ⁘ Impact Factor 7.105 ⁘ Vol. 9, Issue 7, July 2022
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Rainfall increases climatologically during the pre-monsoon and South West Monsoon, as seen by the above chart. An increase in the number of rainy days can generate floods, affecting rice and arecanut agriculture.

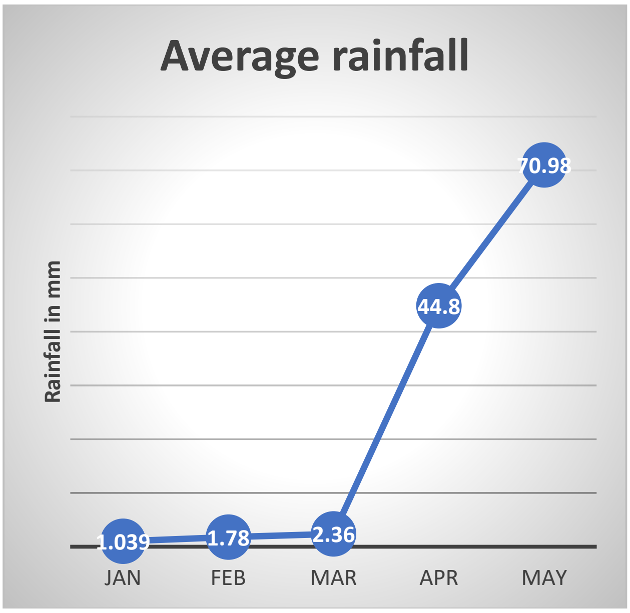

Fig 6.5 Shimoga Pre-monsoon

The graph above depicts the change in rainfall over a 20-year period. The average rainfall in Shimoga taluk is increasing, according to this trend (Pre-Monsoon).

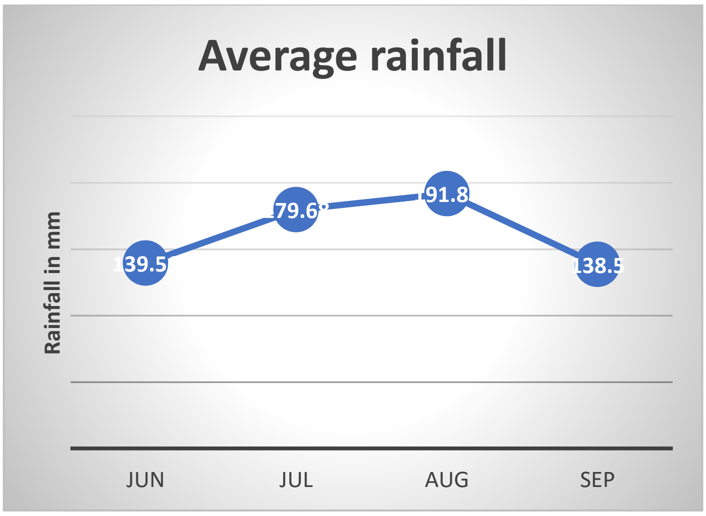

Fig 6.6 Shimoga South West-monsoon

In the above graph during the South West Monsoons, the trend shows a increase in rainfall.

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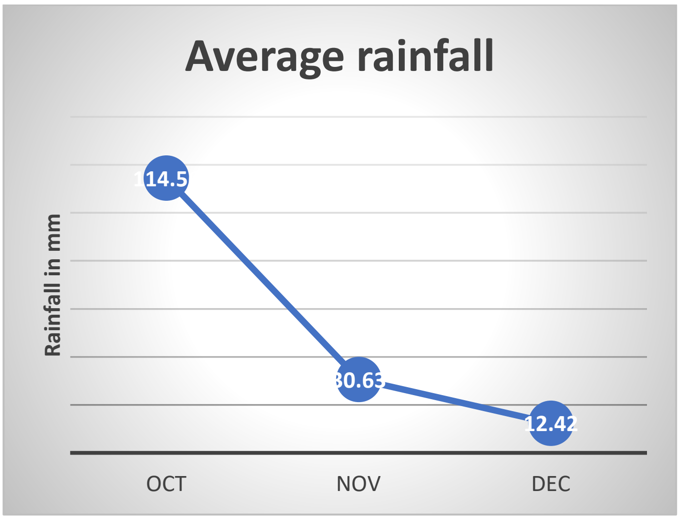

Fig 6.7 Shimoga North East-monsoon

The above graph depicts that rainfall decreases from the month October to December in the North East Monsoon.

6.4 Kutrahalli

Kutrahalli is a small village in the Shimoga district's shikaripura taluk. It is situated in the district's north-eastern corner. It belongs to Bangalore Division. Located 55 kilometres north of Shimoga, the district administrative centre.

Months	Monsoon	Average rainfall in mm	Observed trend mm/day
January	Pre	2.29	24.548
February	Pre	4.46	
March	Pre	10.87	
April	Pre	49.89	
May	Pre	55.23	
June	SWM	151.87	173.12
July	SWM	250.96	
August	SWM	177.46	
September	SWM	112.19	
October	NEM	137.72	59.786
November	NEM	35.59	
December	NEM	6.05	
Annual Rainfall			257.454

Table 6.3 Kutrahalli Monsoon rainfall variation of previous 20 years

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

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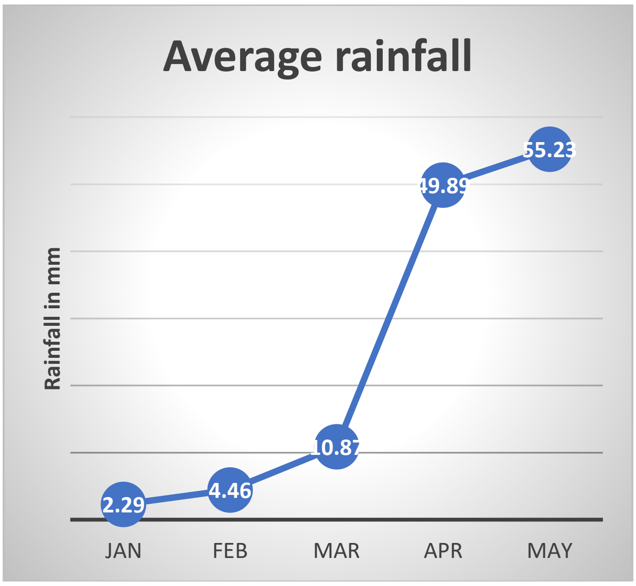

Fig 6.8 Kutrahalli Pre-monsoon

The graph above shows how rainfall have changed over the last 20 years. kutrahalli's typical rainfall rate indicating an increasing tendency in Pre-Monsoon.

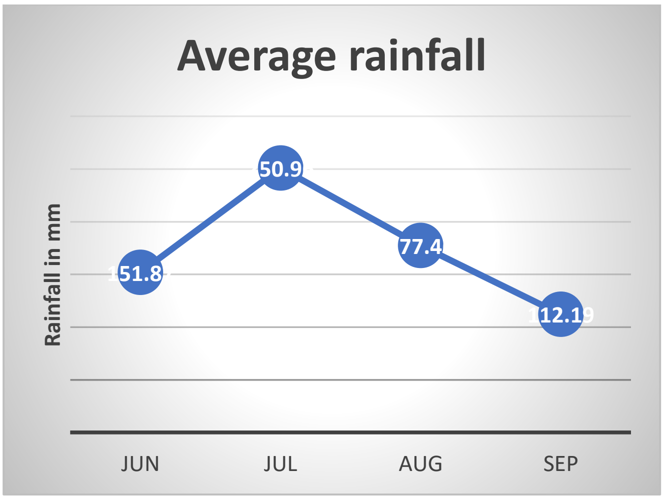

Fig 6.9 Kutrahalli South West-monsoon

From the above graph, the average precipitation during the North East Monsoon increasing month to month.

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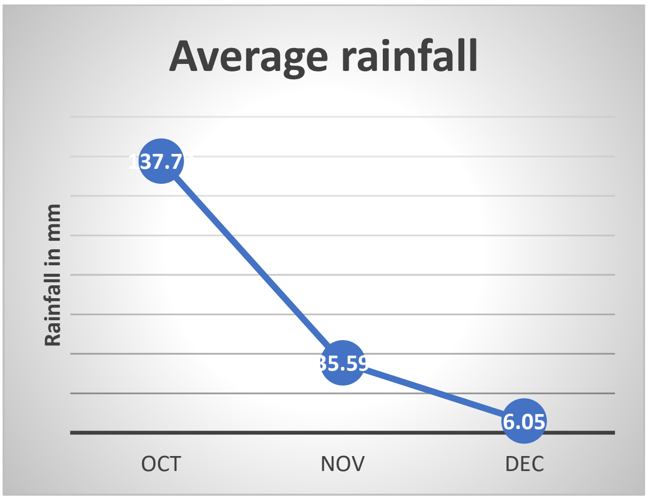

Fig 6.10 Kutrahalli North East-monsoon

The above graph depicts that rainfall decreases during North East Monsoon (October to December).

6.5 Agumbe

Agumbe is a small settlement in the Shimoga district's south western corner. It's dubbed as the "Cheerapunji of the South" since it has some of the country's heaviest rainfall. The location of 13º50′87″ N and 75º09′59″ E represents heavy evergreen rains with abundant biodiversity. In the Agumbe jungle, endangered animals such as the lion-tailed Macaque and the King cobra can be found.

Months	Monsoon	Average rainfall in mm	Observed trend
January	Pre	3.62	62.154
February	Pre	2.73	
March	Pre	17.66	
April	Pre	60.36	
May	Pre	226.4	
June	SWM	1744.5	1836.03
July	SWM	2650.62	
August	SWM	2139.13	
September	SWM	809.87	
October	NEM	382.96	169.8
November	NEM	118.62	
December	NEM	7.82	
Annual Rainfall			2067.984

Table 6.4 Agumbe Monsoon rainfall variation of previous 20 years

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

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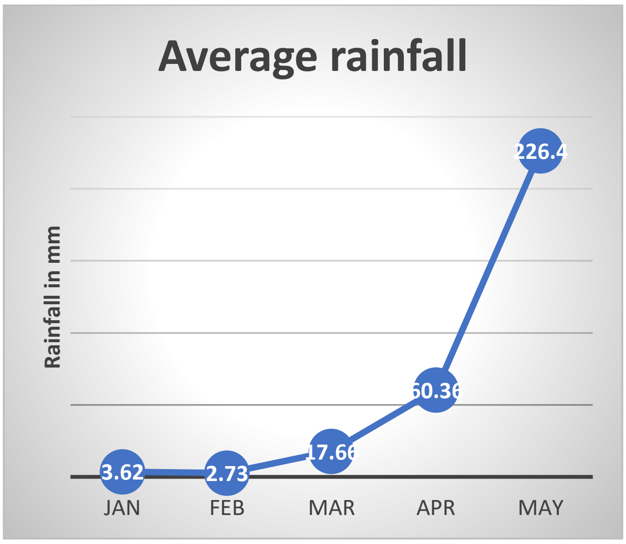

Fig 6.11 Agumbe Pre-monsoon

The graph above depicts the rainfall variance over a 20-year period. The precipitation is increasing in the Pre-Monsoon. Seasonal fluctuations of precipitation are investigated in order to gain a better understanding of the rainfall in Agumbe.

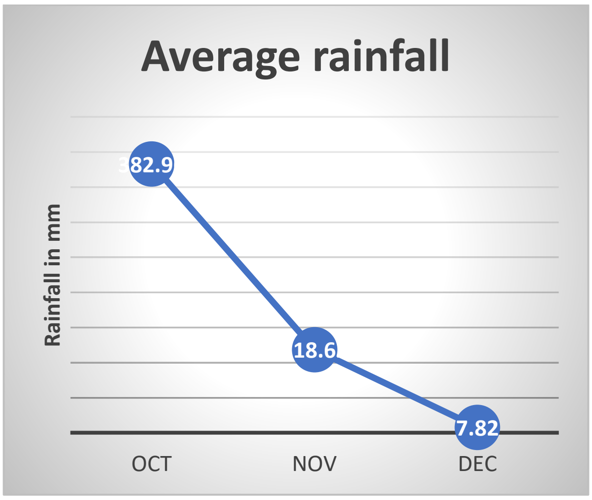

Fig 6.12 Agumbe South West-monsoon

From the above graph, we can conclude that during South West Monsoon the rainfall increases with respect to months.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

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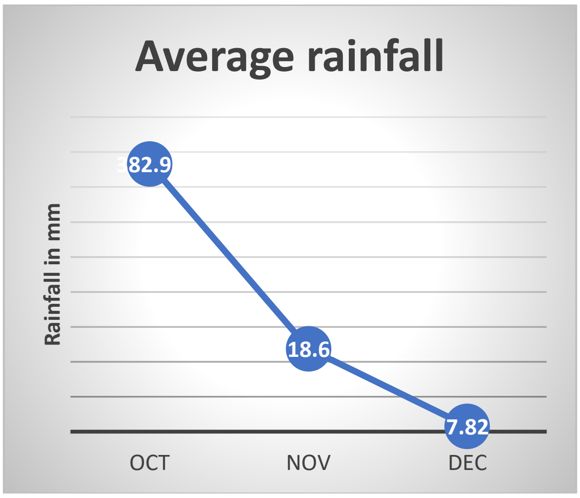

Fig 6.13 Agumbe North East-monsoon

The above graph says that rainfall decreases with the respect to months in North East Monsoon.

6.6 Linganamakki

The Shimoga district's Sagara taluk is where Linqanamakki is situated. In the western portion of the district, at coordinates 15.17558ºN and 74.84627ºE, is the Sharavathi reservoir. Saira Varghese Kidangan claims that the reservoir was built with a 4368 million cubic litre water storage capacity over a 300 square kilometre area.

Months	Monsoon	Average rainfall in mm	Observed trend mm/day
January	Pre	5.64	25.188
February	Pre	1.18	
March	Pre	7.8	
April	Pre	36.3	
May	Pre	75.02	
June	SWM	1146.38	951.435
July	SWM	1369.4	
August	SWM	934.75	
September	SWM	355.21	
October	NEM	156.24	69.3
November	NEM	44.96	
December	NEM	6.59	
Annual Rainfall			1045.923

Table 6.5 Linganamakki Monsoon rainfall variation of previous 20 years

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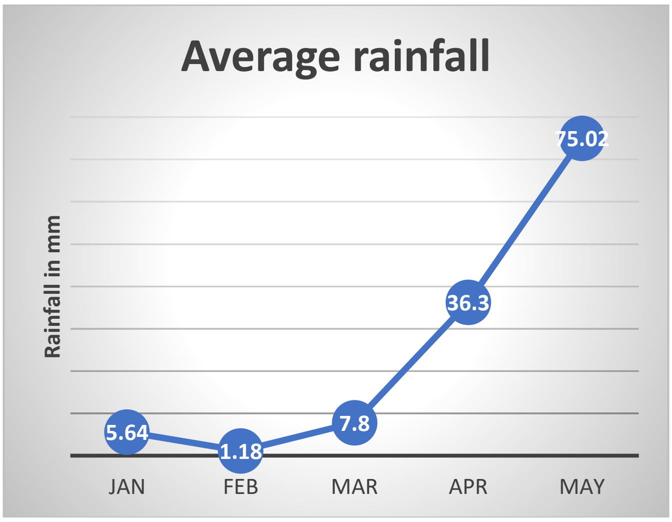

Fig 6.14 Linganamakki Pre-monsoon

The graph above depicts the rainfall variance over a 20-year period. Rainfall increasing in the Pre- Monsoon displays a trend study of Linganamakki's daily rainfall in millimetres (January to May).

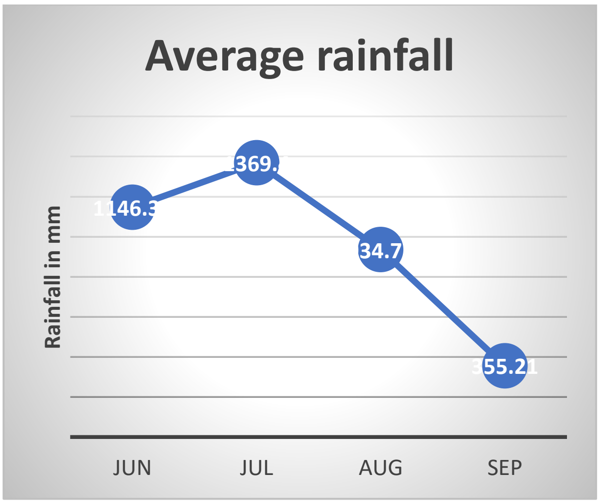

Fig 6.15 Linganamakki South West-monsoon

The graph above depicts the typical rainfall in Linganamakki during the North East Monsoon season (June to September).

DOI: 10.17148/IARJSET.2022.9715

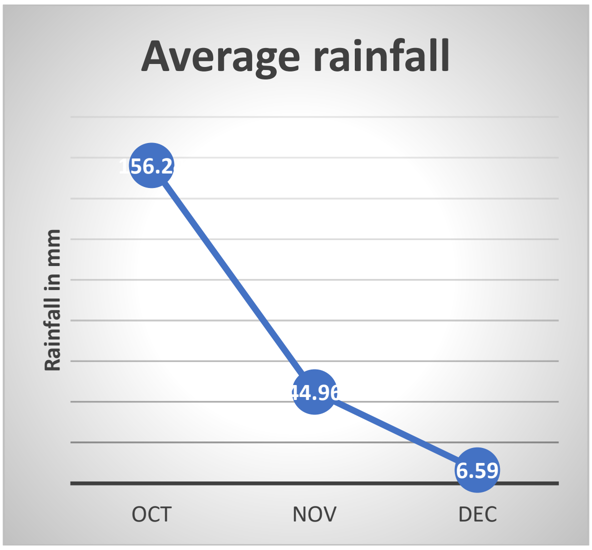

Fig 6.16 Linganamakki North East-monsoon

From the above graph, we can conclude that in the North East Monsoon rainfall decreases typically with respect to months

Here, we take into account data from the last 20 years for all five rain gauge stations monsoon rainfall variance. We may deduce that the highest annual rainfall in the region is 2067.984 in Agumbe, the lowest annual rainfall is 239.127 in Shimoga and the medium annual rainfall is 1045.923 in the region (Linganamakki).

VII. CONCLUSION

- The Shimoga district was taken into consideration when examining climate change on a regional level.
- Temperature and rainfall were taken into consideration as analytical criteria.
- To determine the change in the parameters, trends in the 20 years of data were analysed.
- Maps show the district's peak rainfall rate (18.657mm/day), lowest rainfall rate (10.943mm/day), and average rainfall rate (16.057mm/day).
- Based on the three types of monsoons—Pre-monsoon, South West monsoon, and North East monsoon—the variation in average rainfall is displayed by a graph, which illustrates how temperature has been impacted.
- The yearly variations in monsoon rainfall and temperature can cause catastrophic occurrences like floods, which reduce agricultural production. Fertilizer, soil moisture conservation, proper drainage, and the use of climate-tolerant cultivars can all help to increase agricultural production.

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