THE POTENTIAL EFFECTS OF TEMPERATURE AND RAINFALL VARIATIONS ON TOURISM IN MANGOCHI

ERIC MPHANDAZAOLA

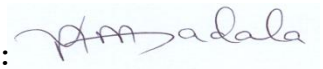
Thyolo, Malawi

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JULY, 2021

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ABSTRACT

The solely aim of this research was to discuss potential implications of temperature and rainfall variations on tourism that Mangochi district has to anticipate, since it was noted by the researcher that despite the understanding of local weather by tourism operators there was still lack of knowledge and awareness of upcoming weather and climate scenarios and its significance to the tourism business in the district. The study used a quantitative approach, whereby historic data of temperature and rainfall from Mangochi was collected from the DCCMS and online climate models were run. The researcher analyzed both the temperature and rainfall data by plotting time series using Excel Microsoft 2016, performed trend analysis using Mann-Kendall test by RStudio version 1.4.1106.0 and produced models of temperature and rainfall. Based on the results found it has been observed that both the annual maximum and minimum temperature trends were making a very significant increase. On the other hand, rainfall showed a great variations and a tendency of decreasing though not significant on annual basis. The models projected an increase and decrease in temperature and rainfall respectively. These means that the district has to anticipate high temperatures which will bring discomfort among tourists and heat related hazards and while on the other hand rainfall patterns will continue with its tendency of variation and decrease in amount which will affect food supply for hospitality businesses. This will affect the choice of the district and period of stay for tourism activities. Therefore, anticipatory measures such as: provision of more shaded areas with a natural air flows and design hotels and lodges that will offer cool places were suggested. The study recommended that weather and climate information needs to be made available to the tourism business operators for planning purposes and further studies on how tourism does also contribute to climate change.

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ACRONYMS/ABBREVIATIONS

°C……Degree Celsius

mm……. millimetres

DCCMS…. Department of Climate Change and Meteorological Services

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CHAPTER ONE: INTRODUCTION

1.1. Background

Tourism is one of the most important economic sectors in the country, whereby it contributes to the growth of the country's economy. In Malawi, tourism industry is one of the sectors which is currently expanding its business. According to Zhong and Chen (2019), states that the tourism industry, particularly nature-based tourism activities are considered sensitive to forecasted climate impacts, which also makes tourism dependent communities vulnerable to climate change and its impacts. Climate determines largely destination and time tourism takes in a place, where by tourists are not attracted to areas which are highly exposed to bad weather conditions (Steyn & Spenser, 2012). According to Steyn and Spencer (2012) there are climates that limits and other climate that favour tourists' activities. Weather and climate can have both the positive and negative impacts on the tourism business in a such way that some conditions might favour some of the tourist activities and other conditions might not be favorable to tourism activities. Therefore, climate acts as a facilitator that makes tourisms activities more enjoyable and possible (Rayamajhi, 2012). In Malawi, Mangochi is one of the district in which tourism businesses do take place. the district is located at the southern end of lake Malawi and it has Lake Malawi national park, hotels and lodges which makes it a suitable destination for tourism activities in the country. Therefore, with the current temperature projections and variations in rainfall patterns, this study tried to discuss the future possibilities and challenges that the tourism industry need to expect in regards to temperature changes and rainfall variations in the district.

1.2. Problem statement

Geographically, Mangochi is low lying area (low altitude) and flat in some parts. The district is known to be a hot area and this is because of its geographical factor of being a

low lying area and the flatness of the area poses a risk of flooding in the district in case of more frequent and high intense rainfall and drought when rains are insufficient.

According to Steyn and Spencer (2012), the current temperature projections states that surface temperature will increase by 1.8 to 4.0°C by the end of the of the 21st Century, which might mean that the district's temperatures will be getting hotter and hotter and that might have negative impact on people whereby making life uncomfortable and stress to the environment.

Despite a better understanding of local weather conditions by tourism operators, the researcher also noted that there was lack of enough knowledge and awareness of the upcoming weather and climate conditions by the tourism business operators and the district at large, possibilities and challenges it might bring to the tourism business and lack of well-structured measures which will help to check the challenges. According to Sifolo and Henama (2017), states that climate is an influence in the tourism industry and plays a crucial role as a motivating factor to the tourist and the tourism destination.

Therefore, with these geographical factors, the lack of knowledge and awareness of the upcoming weather and climate conditions and the challenges it might bring to the tourism business, the study tried to discuss what temperature and rainfall patterns should the district anticipate and what implications will these conditions bring to the tourism business in the district.

1.3. Main and specific objectives

The main goal of the study was to discuss potential effects of temperature and rainfall variations on tourism in Mangochi.

1.3.1 specific objectives

i. To establish the temperature patterns of Mangochi district by analyzing temperature data.

ii. To characterize the variations in rainfall trends in Mangochi district by analyzing rainfall data.
iii. To suggest what will be the possibilities and challenges to tourism business in the district based on the outcomes of the established trends of temperature and rainfall.

1.4. Research questions

The following were the research questions which would help to achieve the specific objectives:

i. What are the expected possibilities and challenges in regards to the changes in temperature and rainfall patterns in the district?
ii. What influence will these anticipated possibilities and challenges from temperature and rainfall variations have on the tourism business in the district?

1.5. Significance of study

This study was of great importance to the district and the country at large in a sense that economic growth of the country partially also depends on the tourism business for its growth. Therefore, the study creates awareness and knowledge of the upcoming scenarios of temperature and rainfall trends, whereby such knowledge and awareness will help those in authority at the tourism department and tourism business owners to fully prepare for the upcoming challenges of changes in temperature and variations in rainfall patterns. The preparation may involve developing well-structured control measures that will help to control the implications for the betterment, profitability and sustainability of the natural business for the growth of the country's economy and bearing in mind that tourism has the role to play in poverty reduction through the employment and business opportunities it provides to communities.

CHAPTER TWO: LITERATURE REVEW

2.1. Introduction

Tourism is a climate-based industry (Huynh, Piracha, & Saul, 2019). Tourism requires and uses a geographical space, this space has a physical and biological element such as weather and climate, geology, topography, flora and fauna and the combination of all these elements creates environments which are considered attractive and or not attractive to the tourists (Steyn and Spencer, 2012). Many people travel for the purposes of enjoying fresh environments and warm temperatures, as such temperature is an important indicator in determining of a place where tourism activities should take place and the changes in temperature can have a strong effect on the coming of tourists in a country (Huynh, Piracha, & Saul, 2019).

2.2. The relationship between weather and climate and tourism

Tourism is a highly climate dependent industry (Huynh, Piracha, & Saul, 2019). Climate influence the environmental resource that are the foundation for tourism, recreation, the length and quality of tourism and recreation seasons, the health of tourists, and the quality of tourism experiences (Rayamajhi, 2012). Tourism is one of the largest and fastest growing economic sectors, it is therefore surprising that the tourism literature pays little attention to climate and climate change and it is equally surprising that the climate change impact literature pays little attention to tourism (Hamilton & Tol, 2014). According to Huynh, Piracha, and Saul (2019), there are gaps in the current knowledge about how to undertake climate change adaptation and mitigation strategies in the developing countries because the connections of tourism and climate change are less understood in developing countries than in the developed countries. Rainfall is also an important weather variable in determining participation in activities, whereby the timing of rain events is also considered influential when making travel choices (Aylem et al., 2014). People need to make plans of travel to specific destination and period of stay in corresponding to the weather or climate forecast of that particular place or region in order to avoid being disturbed by the incoming weather events which are not tourism

friendly. Climate and weather are important factors in tourist's decision-making and also influences the successful operation of tourism business (Becken, 2010). Tourist's respond differently to weather and climate, whilst decision making for tourism is dependent on climate information, recreationists and day visitors are more weather dependent (Aylem, 2014). Therefore, climate is either the main tourism resource or it act as a facilitator that makes tourism activities possible and more enjoyable (Rayamajhi, 2012).

2.3. Weather and climate impacts on tourism

The effects of climate change on coastal areas are more complicated, they include increase of mean air temperature and sunshine duration or warmer temperatures and more frequent and severe extreme weather events (Huynh, Piracha, & Saul, 2019). According to (Huynh, Piracha, and Saul) 2019 global warming is also increasing the length of summer on beach sites in subtropical areas, however, the negative side of climate change could outweigh the positive impacts. The effects of climate change on the tourism business can be man fold, and be both negative and positive, if there is not enough preparation an organization may suffer from the negative effects, while being unable to benefit from possible positive effects (http//: eu-macs.eu/outputs) accessed on 12th April, 2021. According to Murray (2011), climate change will have an impact on the operating costs of tourism operators, such as insurance, heating and cooling costs, pest's management, and the need to augment the supply for drinking and irrigation needs. According to Becken (2010), warmer temperatures and reduced precipitation result into altered seasonality, heat stress for tourists' cooling costs, infectious diseases ranges and water shortages. Therefore, according to Uchegbu and Kanu (2015), changing climate and weather patterns at tourists' destinations can significantly affect the tourist's comfort and their travel decisions and also have impact on tourism businesses and surrounding communities.

2.4. Conclusion

from the literature review it has showed that weather and climate has a strong connection with tourism and the extremities in weather and climate can have negative implications to the tourism business.

CHAPTER THREE: METHODOLOGY

This section discussed methods and tools which were used in this study, which includes: research design, data collection methods and data analysis.

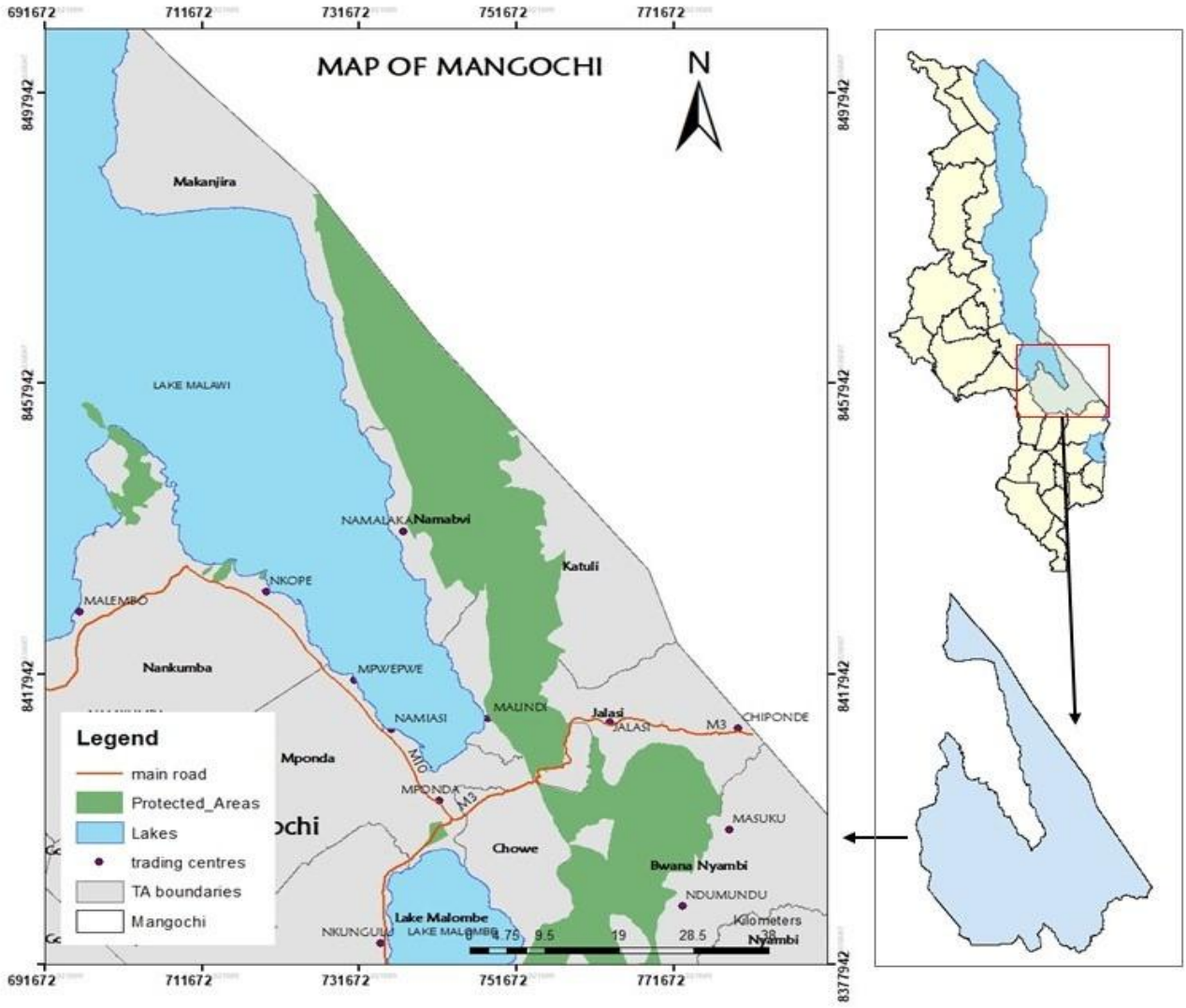
3.1. Research design

The solely aim of this research was to discuss what scenarios of air temperature and rainfall trends the district of Mangochi has to expect and what future influence will these scenarios have on tourism business in the district. The research made use of a quantitative method, whereby the researcher had to collect secondary historic meteorological data of air temperature and rainfall of Mangochi district from the Department of Climate Change and Meteorological Services (DCCMS) and online climate models were run. The collected data was from the year 2000 to 2020. The researcher analyzed the meteorological data by plotting time series, bar graph and pie chart using Excel Microsoft 2016 and performed trend analysis using Mann-Kendall test using Rstudio version 1.4.1106.0 to detect whether there was an increase or decrease significant trend. The study also produced climate models of both maximum and minimum temperature and rainfall showing future scenarios.

3.2. Study area

This study was conducted in Mangochi district. Mangochi is one of the lakeshore districts in Malawi and is located in the southern region of the country, at southern end of lake Malawi in particular. The main economic activities in the district are farming which is mostly done by the smallholder farmers, fishing and tourism activities. Mangochi borders with Machinga to the south-east, Ntcheu, Dedza and Balaka to the south-west, Salima to the north-east and international border with Mozambique to the east.

The figure 1.0 map of Malawi depicting Mangochi district



3.3. Data collection and management

The data was collected from historic observations of air temperature and rainfall made by Department of Climate Change and Meteorological Services in Mangochi. The data was made up of monthly rainfall observations and mean monthly maximum and minimum temperature readings from the year 2000 to 2020.

3.4. Data validation and quality control

data validation and quality control are the process whereby data is thoroughly checked in order to detect missing values and remove errors. The data was collected from DCCMS, therefore, the validation and quality control was already done by the department. Data validation and quality control was performed by plotting cumulative graphs of both maximum and minimum temperature and rainfall in order to test for homogeneity in the data.

3.5. Data analysis

This section made the analysis in respective to the research objectives. This stage made use of different statistical software packages namely: Microsoft Excel 2016 and Rstudio version 1.4.1106.0, to analyze quantitative data of temperature and rainfall.

3.5.1 Time series analysis

The first step in the data analysis was to establish the trends pattern of air temperature, rainfall in Mangochi by producing time series. Time series are simply graphs of different parameters being analyzed against time. These time series helped to demonstrate the trend of how temperature and rainfall were behaving as time progresses using a trendine. These time series were performed by Microsoft Excel 2016. In this time series analysis, linear graphs, bar graph and pie chart were plotted. The times series included both maximum and minimum temperature seasonal and annual changes and seasonal and annual rainfall variations.

3.5.2 Trend analysis

The trend analysis used Mann-Kendall test, whereby the null hypothesis states that there is no significant trend and the alternative hypothesis opposes the null hypothesis by stating that there is significant trend which can be a positive or a negative significant trend, where by positive and negative meant that the trend was increasing and decreasing respectively. The Mann-Kendall test statistics, S, var(S) and the Zmk (standard test statistic) mathematically are calculated a below (Pohlet, 2020):

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \operatorname{sgn}(X_j - X_k) \quad (1)$$

$$\operatorname{sgn}(x) = \begin{cases} 1 & \text{if} \quad x > 0 \\ 0 & \text{if} \quad x = 0 \\ -1 & \text{if} \quad x < 0 \end{cases}$$

$$\sigma^2 = \left\{ n(n-1)(2n+5) - \sum_{j=1}^{p} t_j (t_j - 1)(2t_j + 5) \right\} /18 \quad (2)$$

(3)

$$Z = \begin{cases} \frac{S-1}{\sigma} & \text{if} \quad S > 0 \\ 0 & \text{if} \quad S = 0 \\ \frac{S+1}{\sigma} & \text{if} \quad S > 0 \end{cases} \quad (4)$$

This study used the P-value 0.05 of the significance level (alpha) of 1.96, this meant that if Zmk values were within the range of (-1.96≤Zmk≤1.96) there is no significant trend though it might have shown increase or decrease. But if the Zmk values were greater than or less than the range indicated above that meant that the trend was increasing or decreasing significantly, where by P-values were not supposed to exceed 0.05. The Mann-Kendall test made analysis of monthly, seasonal and annual trend analysis of rainfall variations and seasonal and annual of both maximum and minimum temperature.

3.5.3. climate model analysis

Climate models were run online on https://climexp.knmi.ni/ whereby there is selection of the type of the model, location, variables, range of years and the output type.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

Before the data was analysed it was checked for quality and correctness. The data validation was performed by plotting cumulative graphs to test for homogeneity. The graphs below were the results of data validation and all were straight line except the annual rainfall which indicated some irregularities but were minimal.

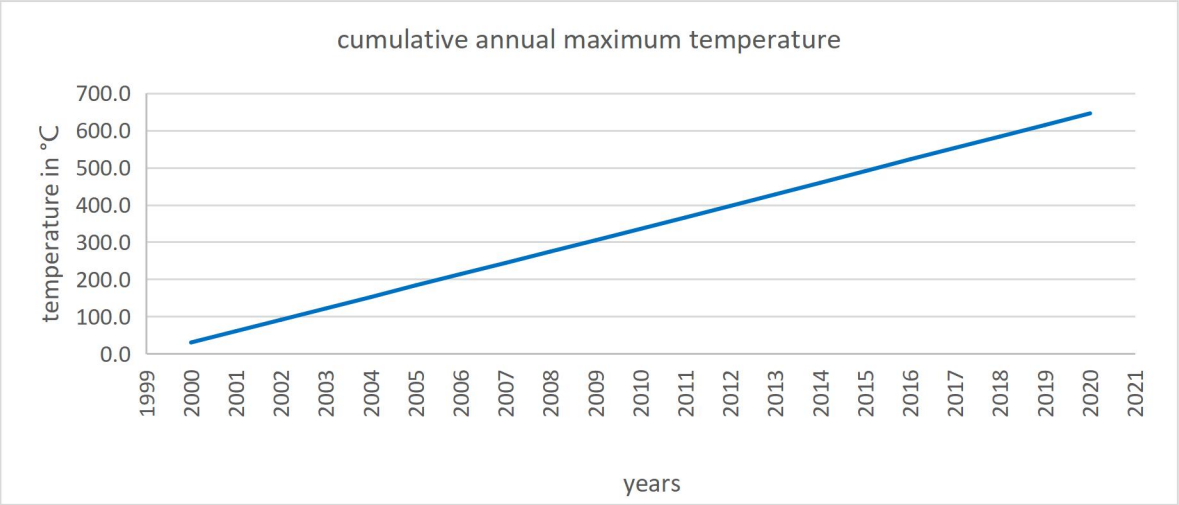


Figure 2: cumulative annual maximum temperature

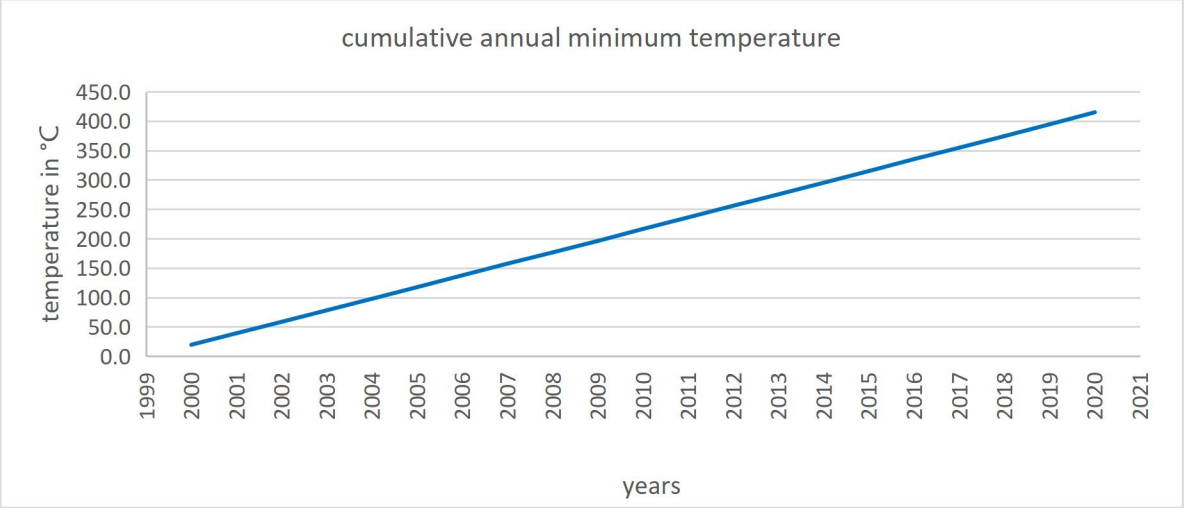


Figure 3: cumulative annual minimum temperature

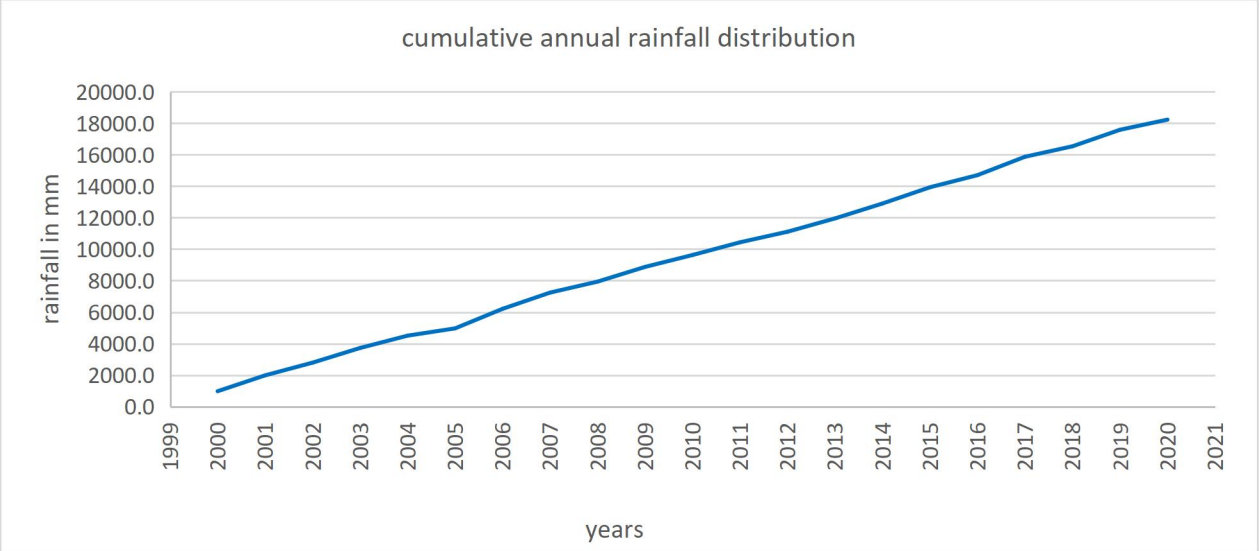


Figure 4: cumulative annual rainfall distribution

4.1. Results from the time series of maximum and minimum temperature

This section shows the time series results of seasonal and annual maximum and minimum temperature changes after data was analyzed.

4.1.1. seasonal maximum temperature

The figures 5, 6 and 7 below were summaries of the seasonal maximum temperature changes after data analysis.

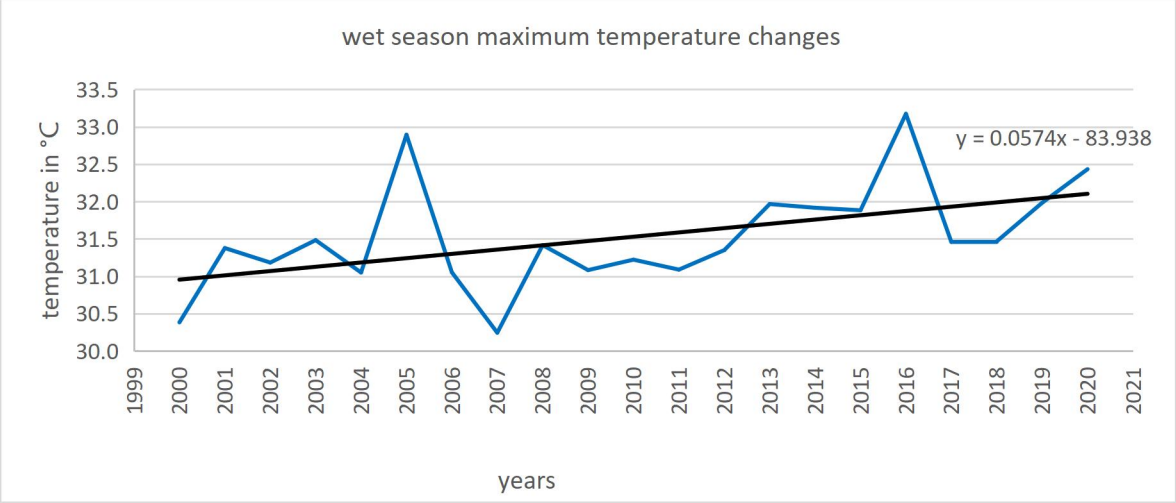


Figure 5: the wet season maximum temperature changes

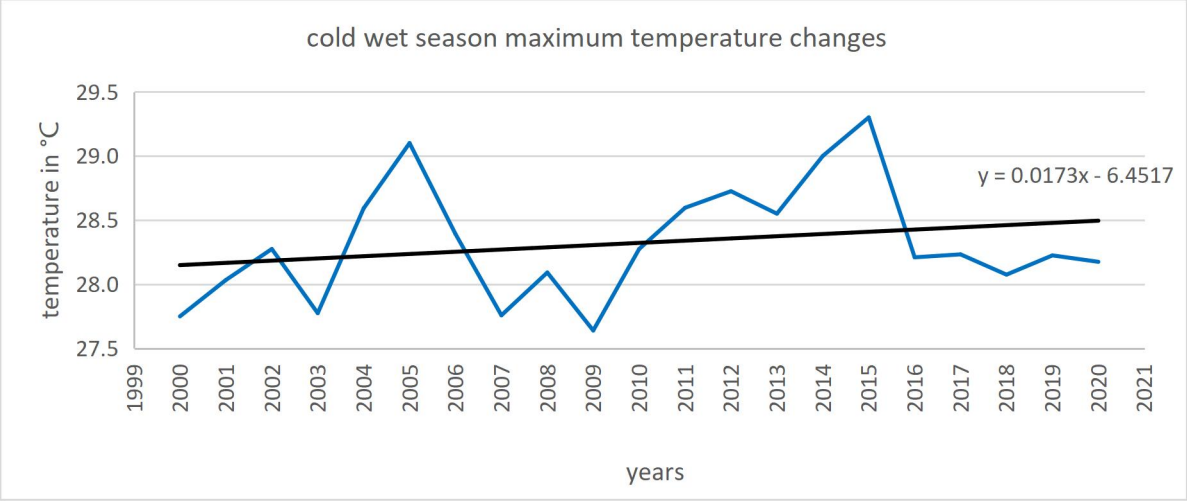


Figure 6: cold-wet maximum temperature changes

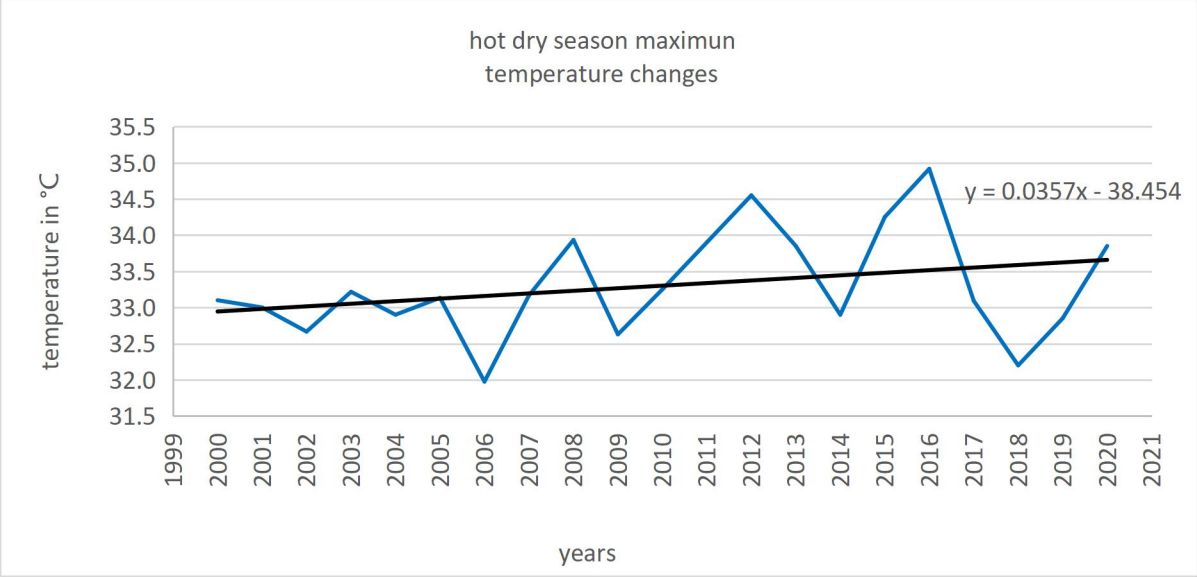


Figure 7: the hot dry maximum temperature

In the seasonal maximum temperature of Mangochi district, three seasons namely: wet, cold-wet and hot-dry season maximum temperature data was analysed. These seasons covers a range from November to April, May to August and September to October respectively. Upon data analysis all the three seasons indicated an increase in the trend line of maximum temperature with the progress of time despite some variations. In the wet season the temperature is increasing with a rate of 0.06°C per year and the highest maximum temperature and the lowest maximum temperature readings recorded in the

year 2016 with a reading of 33.2°C and 2007 with a reading of 30.3°C respectively. In the cold-wet season temperature is increasing at the rate of 0.02°C per year and the highest and lowest temperatures recorded in 2015 and 2009 with readings of 29.3°C and 27.6°C respectively. Lastly was the hot-dry season, where its temperature is increasing at 0.04°C per year and highest and lowest temperature recorded in 2016 and 2006 with 35°C and 32.9°C respectively. Based on the rate of increase it is in the wet season that demonstrated a rapid increase followed by hot-dry season and lastly the cold-wet season.

4.1.2. Annual maximum temperature

The figure below summarizes the trend of annual maximum temperature trend;

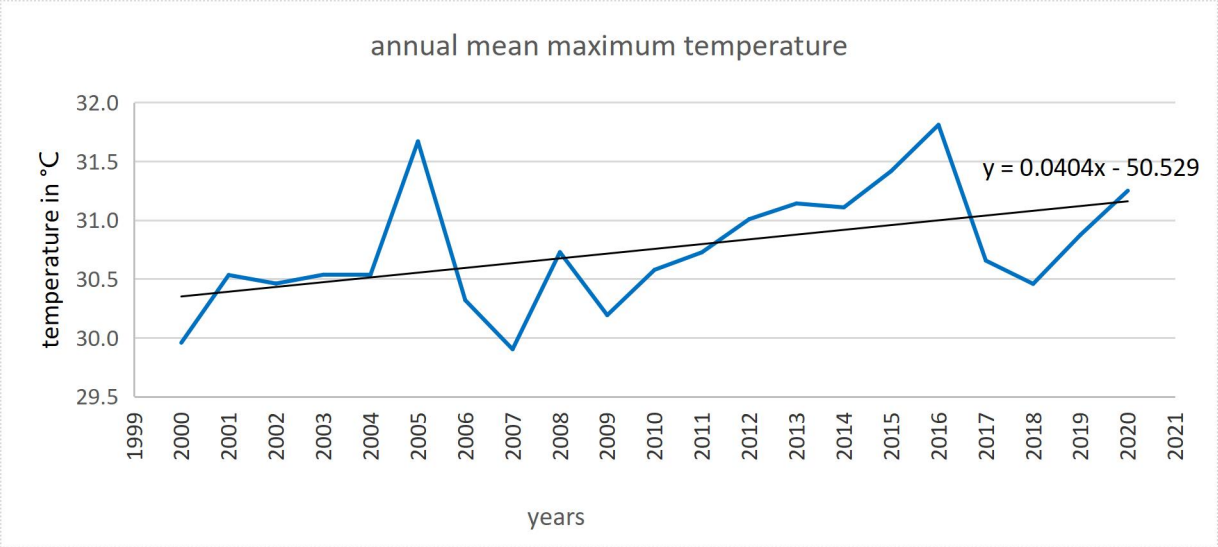


Figure 8: Annual maximum temperature changes

From the graph above, despite the variations, the trend line indicated an increase of inter-annual maximum temperature for the twenty-one years and it is increasing at the rate about 0.04°C. The graph is also indicating highest temperatures recorded in 2016 with approximately 31.7°C and lowest temperature observed in 2007 with approximation of 29.9°C.

4.1.3. seasonal minimum temperature

The figures below are the results of the seasonal minimum temperatures of the three seasons namely: wet, cool-dry and hot-dry season.

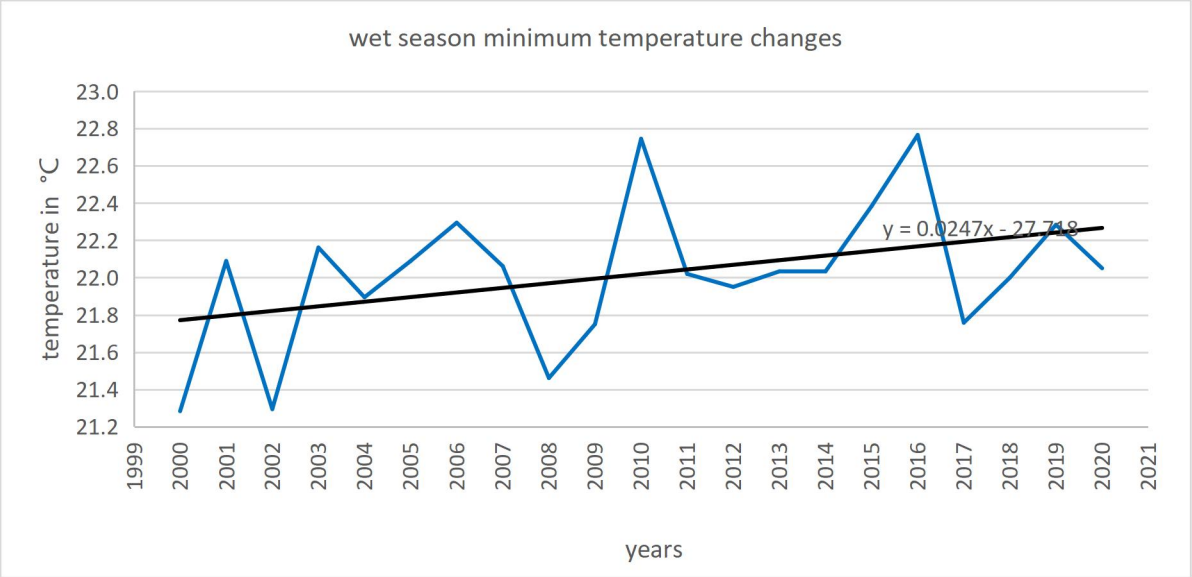


Figure 9: wet season minimum temperature changes

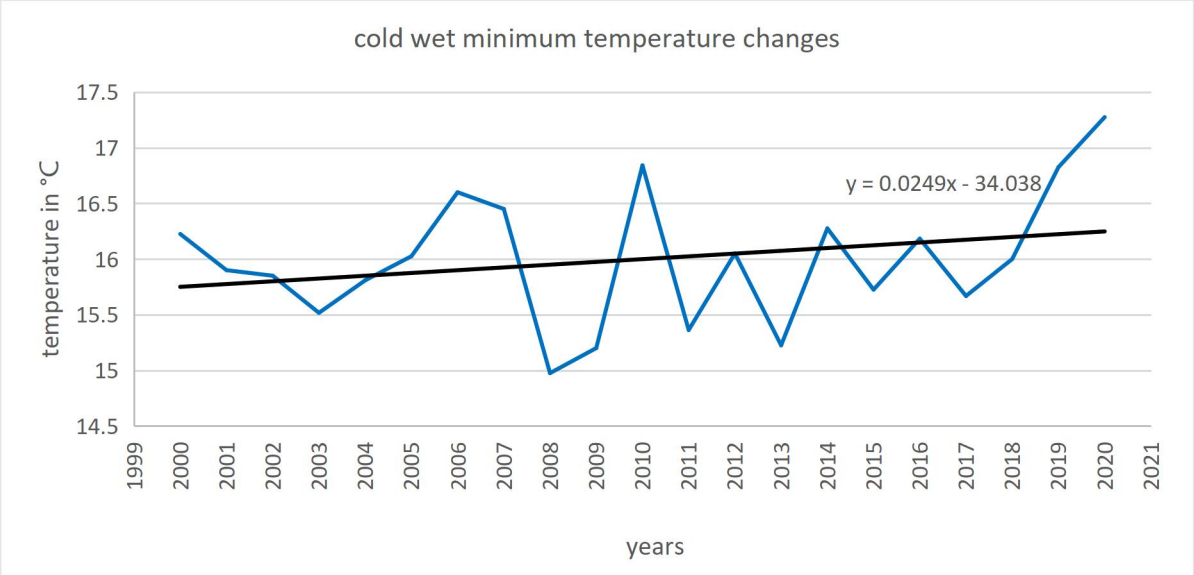


Figure 10: Cold-wet minimum temperature changes

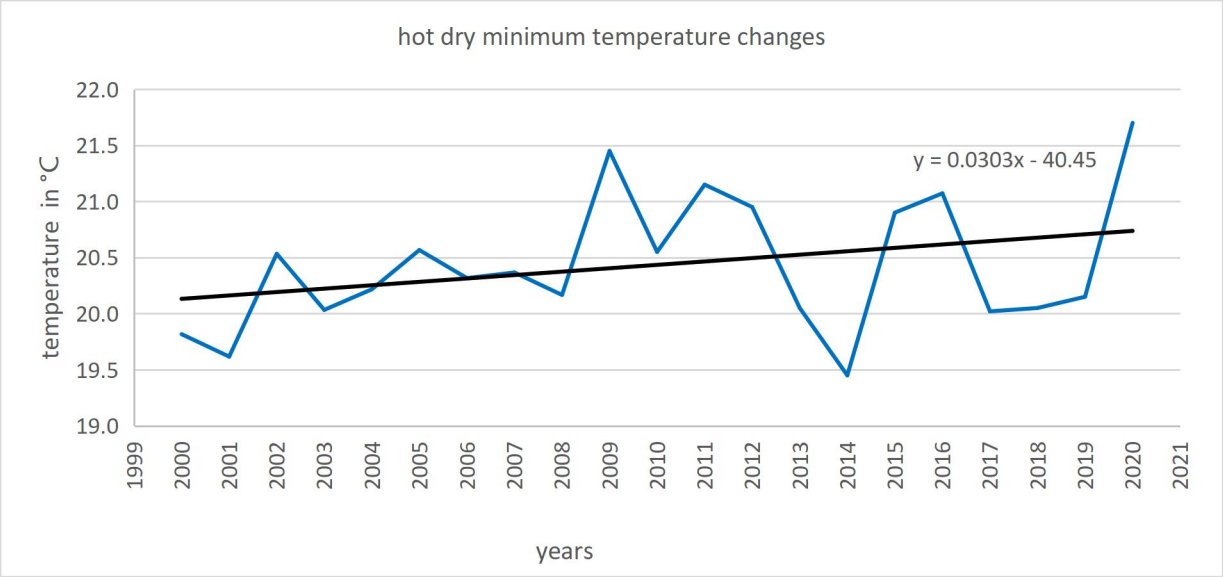


Figure 11: hot-dry minimum temperature changes

All the three seasons based on the graphs above indicated an increasing trend line in the minimum temperature in the district, whereby the highest rate of increase has been observed in the hot-dry season which is indicating 0.03°C while the wet and cold-wet season showed a similar increasing rate of 0.02°C.

4.1.4. annual minimum temperature

The annual minimum temperature indicated an increase on the trend for the past twenty years. The highest temperature was observed in 2010 and 2020 while the lowest was observed in 2008 and the trend is increasing with a rate of 0.03°C. the graph below summarises the changes in the inter-annual minimum temperature trend.

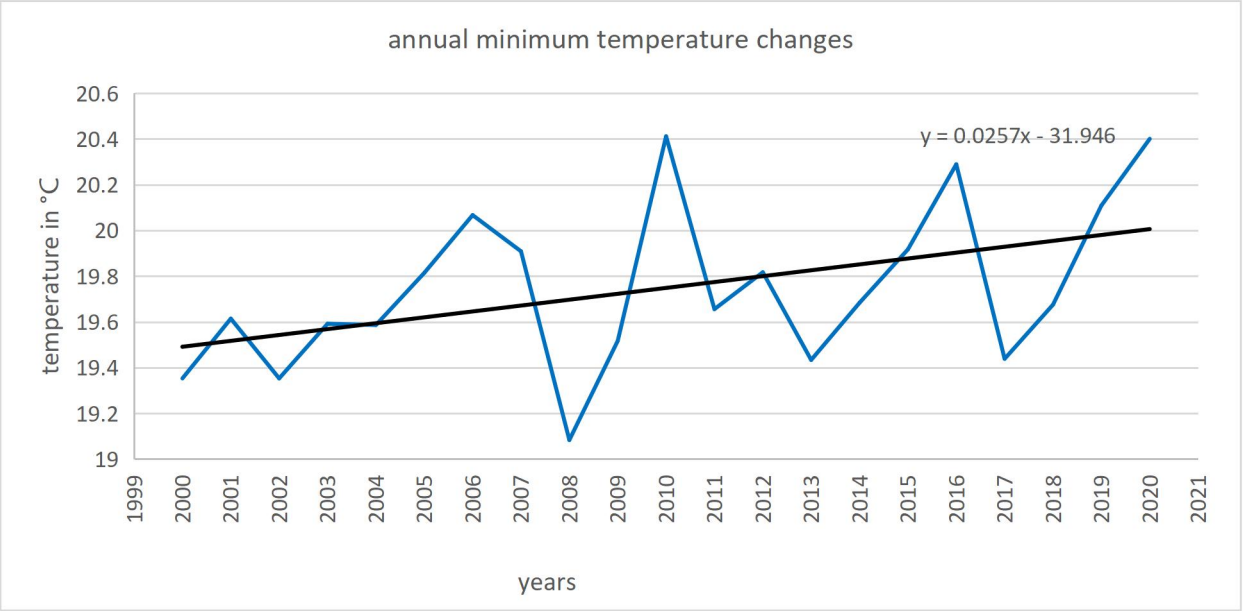


Figure 12: annual minimum temperature changes

4.2. Results from rainfall time series

this section shows the results of time series of mean monthly, seasonal and annual rainfall distribution

4.2.1. mean monthly rainfall distribution

The figure below indicates the summary of the mean monthly rainfall distribution;

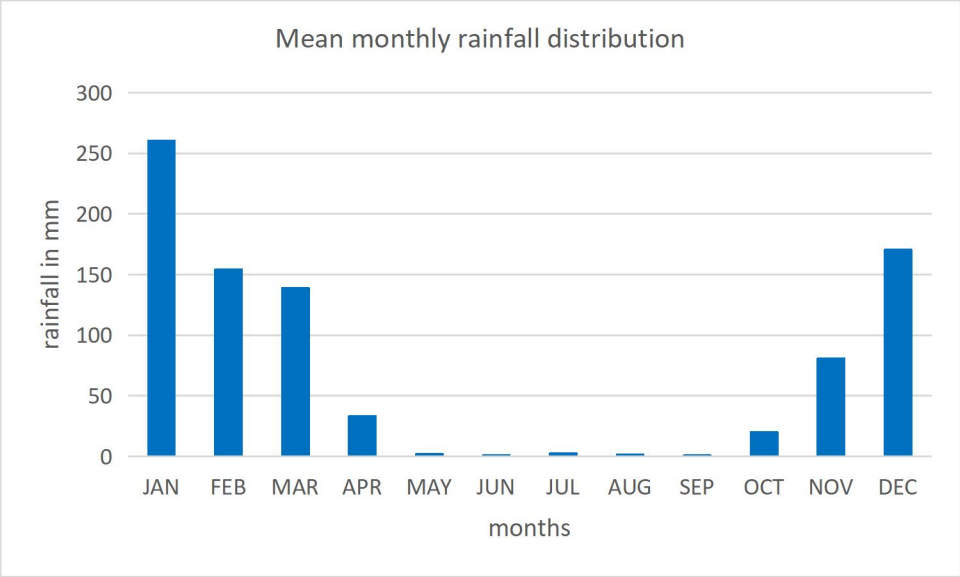


Figure 13: mean monthly rainfall distribution

Based on the figure 13 above in Mangochi rain covers a period of seven months from October to April, with highest amount of monthly mean rainfall recorded in the month of January and the lowest in the month of October. The months of June and July indicated very little amount of rainfall.

4.2.2. seasonal rainfall variation

The following graphs summarise the variations in the main three seasons in the district.

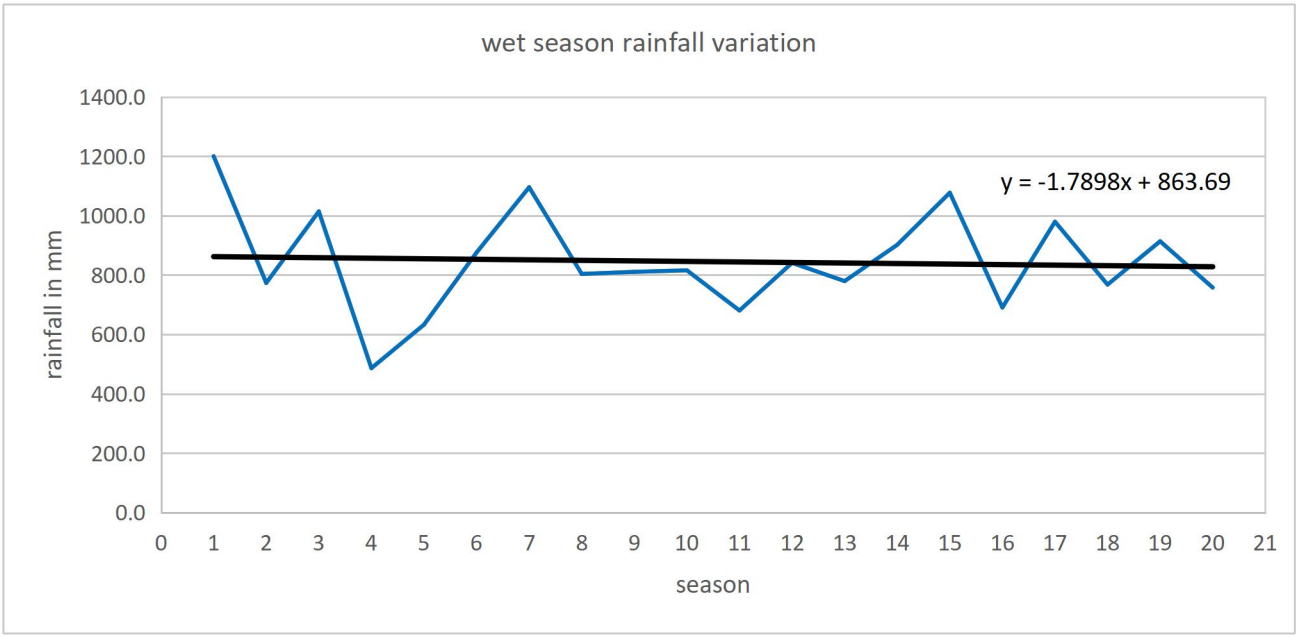


Figure 14: wet season rainfall variation

Note: wet season ranges from November to April, in this case 1 represents 2000/01 season and so on.

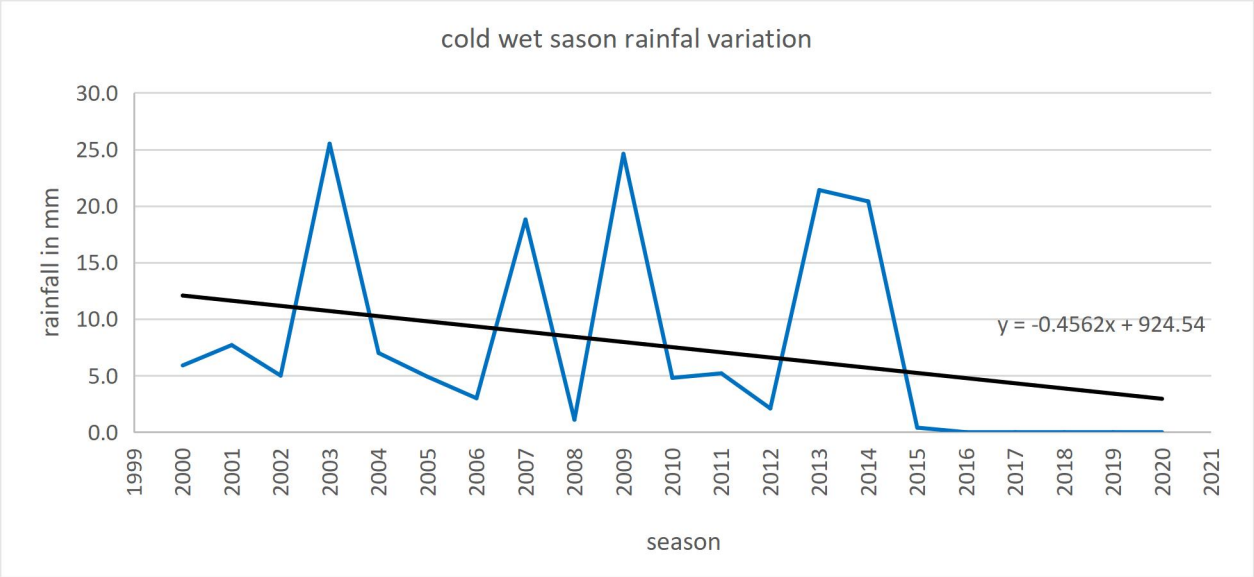


Figure 15: cold wet season rainfall variation

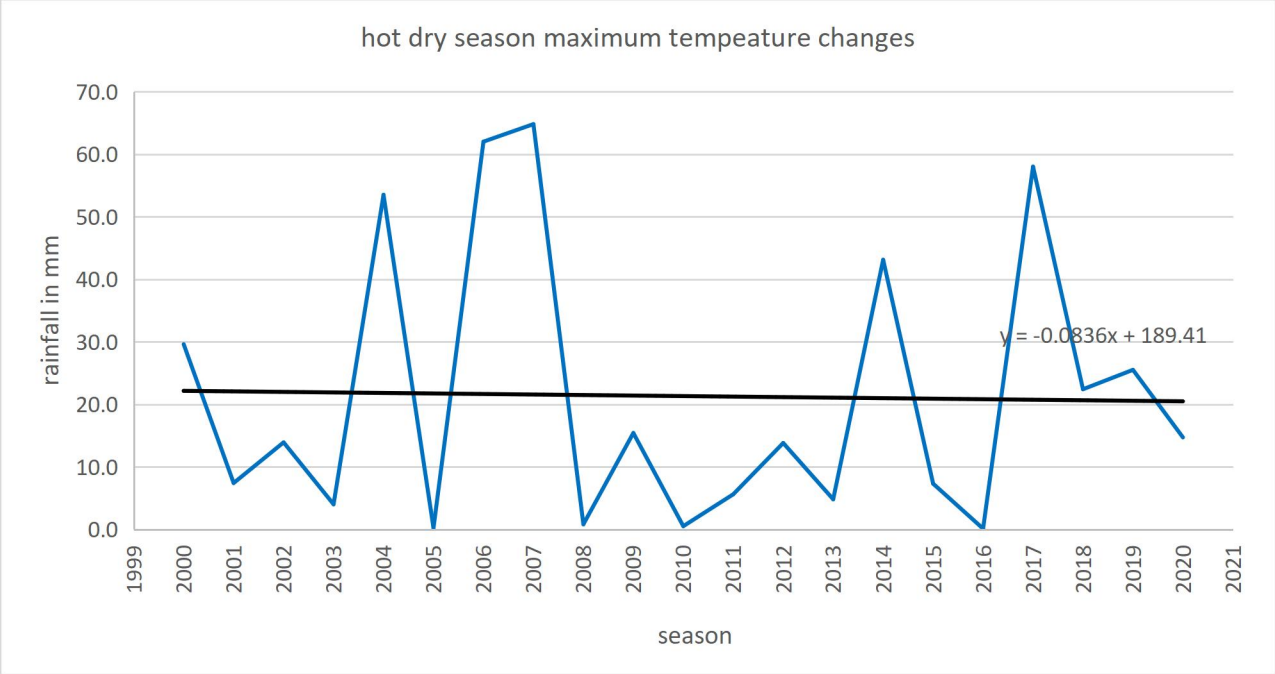


Figure 16: hot dry season rainfall variation

Based on graphs above the trends indicated a decrease in the seasonal rainfall distribution. The decrease is varying from one season to another and within the season itself it has also indicated variation. The decrease is much shown in the wet season as compared to other season where by the decrease rate is about 1.8 mm per year whereby cold-wet and hot-dry are showing a decrease of 0.46 and 0.08 mm per year.

The figure 17 below indicated that more rainfall is in the wet season with the mean 97%, then in the hot dry with the mean of 2% and lastly in the cold wet season with the mean of 1%.

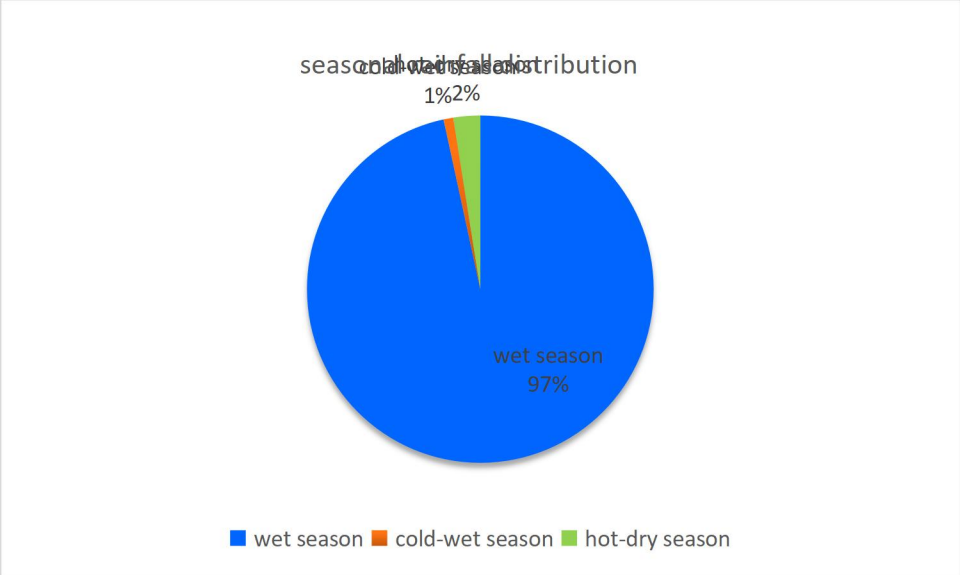


Figure 17: mean season rainfall distribution

4.2.3. annual rainfall variation

The inter-annual rainfall variation indicated a decrease in the graph with a rate about 2.03 mm per year. The figure 14. Below shows the inter-annual rainfall variation. In the trend below rainfall has shown a variation across the years and from the trend line the decrease is not that steep that it is almost a straight horizontal trend line.

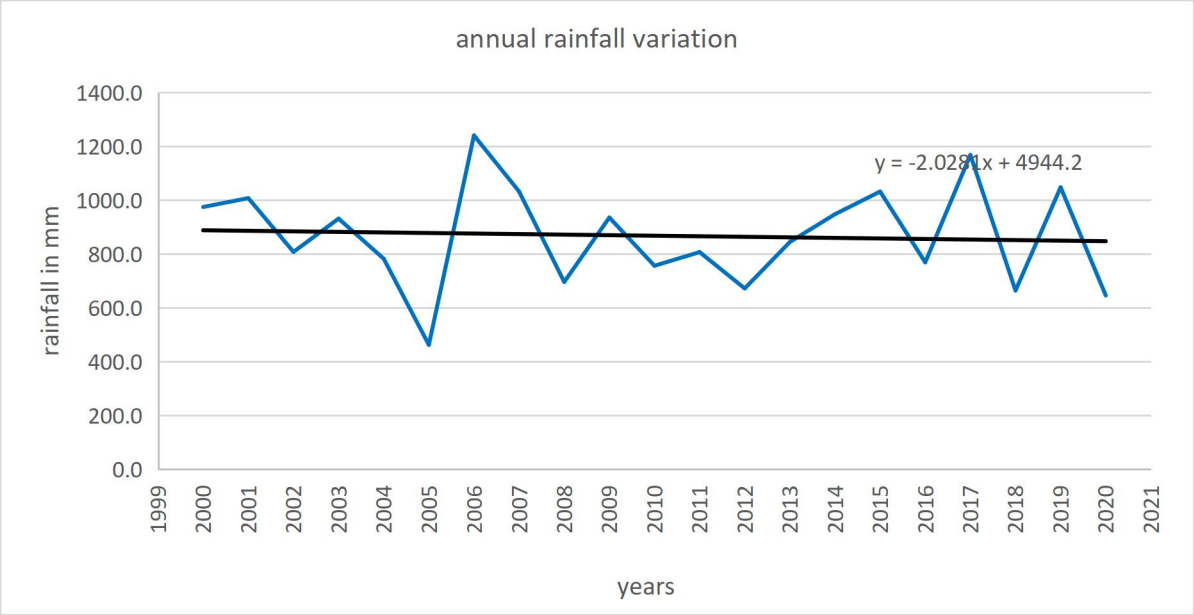


Figure 18: annual rainfall variation

4.3. Results from trend analysis

In this section Mann Kendall test was used to make analysis of the trends in order to determine whether the trend under the analysis was making an increase or decrease significant trend or there was no any significant trend.

4.3.1. monthly rainfall trend analysis

The table 1 below summarises the monthly rainfall trend analysis;

Table 1. monthly rainfall trend analysis

Variable	Z	S	Var(S)	P-value	Kendall tau	Alpha	Comments
JAN	0.88	30	1096.67	0.381	0.14	0.05	Increasing but not significant
FEB	-0.82	28	1096.67	0.415	-0.31	0.05	Decreasing but not significant
MAR	0.27	10	1096.67	0.786	0.05	0.05	Increasing but not significant
APR	-0.42	-15	1095.67	0.672	-0.07	0.05	Decreasing but not significant
MAY	-1.22	-36	828.00	0.224	-0.23	0.05	Decreasing but not significant
JUN	-1.63	-48	828.00	0.102	-0.29	0.05	Decreasing but not significant

JUL	-2.05	-60	828.00	0.040	-0.36	0.05	Decreasing significantly
AUG	-0.77	-23	827.00	0.444	-0.14	0.05	Decreasing but not significant
SEP	-1.48	-46	930.67	0.140	-0.26	0.05	Decreasing but not significant
OCT	0.42	15	1093.00	0.672	0.07	0.05	Increasing but not significant
NOV	0.46	16	1096.67	0.651	0.65	0.05	Increasing but not significant
DEC	-1.36	-46	1096.67	0.174	-0.22	0.05	Decreasing but not significant

From the table above most trends indicated both the increase and decrease in the trends but with no any significant change except in July where the trend indicated a decrease significant trend since it has a P-value of 0.04 which is less than the alpha (0.05) that alone indicated a significant trend, and from the value of Z it indicated -2.05 which shows a negative meaning a decrease and the Z value was out of the range (from -196 to 196) which defined it as a significant trend.

4.3.2. seasonal rainfall trend analysis

Table 2. seasonal rainfall trend analysis

Variable	Z	S	Var(S)	P-value	Kendall tau	Alpha	Comments
Wet season	-0.70	-24	1096.67	0.487	-0.114	0.05	Decreasing but not significant
Cold-wet season	-3.01	-100	1080	0.003	-0.488	0.05	Decreasing significantly
Hot-dry season	0.09	4	1096.67	0.928	0.019	0.05	increasing but not significant

In the seasonal trend analysis, only the cold wet season indicated a significant decrease trend shown by p-value which was 0.003 less than 0.05 and Z value which was -3.01 while wet season and the hot-dry season indicated a decrease and an increase of the trend but not significant.

4.3.3. Annual rainfall trend analysis

Table 3. annual rainfall trend analysis

variable	Z	S	Var(S)	P-value	Kendall tau	Alpha	Comments
Annual rainfall	-0.57	-18	1096.67	0.608	-0.086	0.05	Decreasing but not significant

The annual rainfall trend indicated a decrease but not significant trend.

4.3.4. Seasonal and annual maximum and minimum temperature trend analysis

Table 4. seasonal and annual maximum temperature trend analysis

Variable	Z	S	Var(S)	P-value	Kendall tau	Alpha	Comments
Wet season	2.68	89	1077.67	0.007	0.44	0.05	Increasing significantly
Cold wet season	0.94	32	1078.67	0.35	0.16	0.05	Increasing but not significant
Hot dry season	1.34	45	1079.67	0.18	0.22	0.05	Increasing but not significant
Annual	2.78	92	1075.33	0.005	0.45	0.05	Increasing significantly

The seasonal and annual maximum temperature trend showed a positive significant trend in wet season and on annual maximum temperature while in the cold wet and the hot dry indicated an increase but not significant trend. The significant was shown in p-values of wet season and annual maximum temperatures which were less than the significance level (alpha).

Table 5. seasonal and annual minimum temperature

Variable	Z	S	Var(S)	P-value	Kendall tau	Alpha	Comments
Wet season	1.35	45	1068.33	0.178	0.26	0.05	Increasing but not significant
Cold wet season	0.88	30	1096.67	0.381	0.14	0.05	Increasing but not significant
Hot dry season	1.36	46	1096	0.173	0.22	0.05	Increasing but not significant
Annual	2.18	73	1095.67	0.030	0.35	0.05	Increasing significantly

Based on the table above, significant increase trend is being showed on annual minimum temperature trend while all the three seasons indicated an increase but not significant trend.

4.4. Model output

Figures below are the results after running climate models of temperature and rainfall.

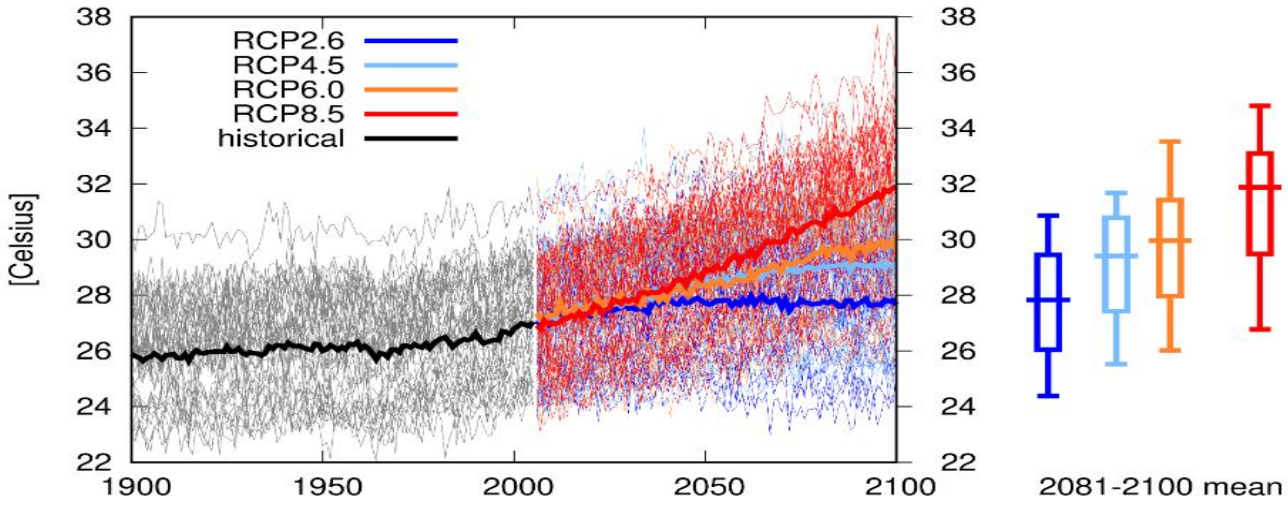


Figure 19: Maximum temperature scenario

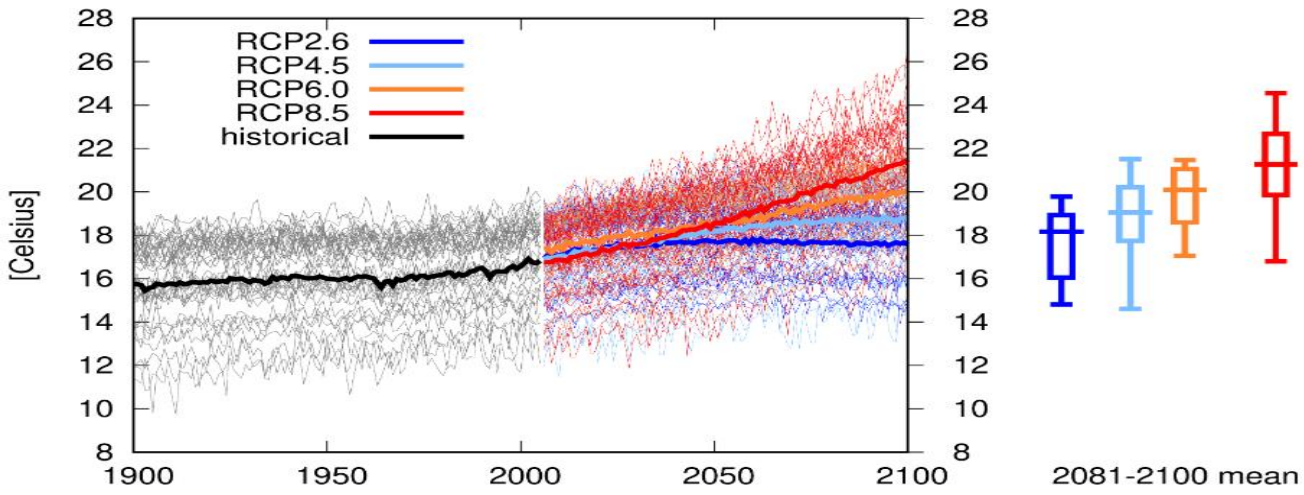


Figure 20: minimum temperature scenario

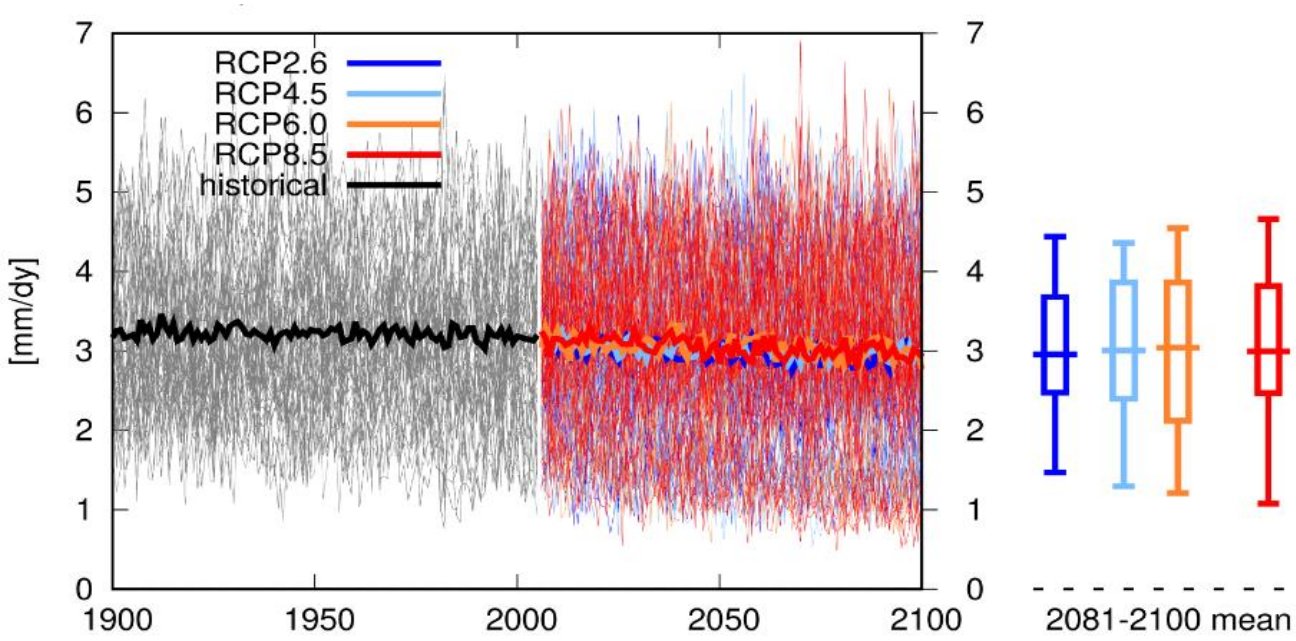


Figure 21: rainfall scenario

The maximum and minimum temperatures projected an increase on the annual basis while rainfall demonstrated a decrease.

4.4. Discussion

Based on the results found it has been observed that both the annual maximum and minimum temperatures were making a very significant increase trend on annual basis and increase though not significant on seasonal basis except maximum temperature for wet season which demonstrated a significant increase. These trends indicating that temperature in the district is increasing at a very important rate. The time series have also shown that both the maximum and minimum temperatures are increasing at a rate about 0.04 and 0.03° C per year respectively and that accounts for 0.4 and 0.3°C respectively on average after a decade. On rainfall patterns the district has shown a variation on the annual amount of rainfall received in a such way that some years the district was receiving more and less amount of rains in other years, but on average it has indicated a decreasing tendency though not significant. The rainfall was decreasing at the rate of 2.03 mm per year and that means after a decade it will account for 20.3 mm. The climate model output indicated that if the current conditions remain the same and that the emission of greenhouse gases are not checked the temperature will continue to rise and the rainfall will be decreasing.

According to the results of both the temperature and rainfall trends and the model output and that if these trends are followed through it means that the temperature of the district will be increasing each passing year and the district will be getting hotter and hotter with passage of time. Therefore, the district has to anticipate higher temperatures and variations in rainfall patterns with a decreasing tendency in the near future. According to the interviews with the tourism business operators in the district, temperature is of great worry to their business because it brings discomfort among the tourists which affects cooling costs. These conditions will have an influence on the tourism business because it is a weather and climate dependent business. According to Huynh, Piracha, and Saul (2019), states that climate conditions have a significant impact to recreation and maintaining tourism resources, such that any change in climate conditions may led to a change in resources as well as tourism demand and season.

Therefore, for weather and climate being the main driver of most tourism activities like choice of destination, period of stay and some outdoor activities, so with this increase in temperature and rainfall variations it means it will affect the choice of the district as a tourism destination because most tourism activities prefer places with cool temperatures hence reduced number of arrivals. This will also increase the expenses made by the tourism business operators for example, paying for power supply for cooling purposes and other expenses payed for food supply in case of drought. As a result, this will affect the country's economy since there will be less foreign exchange and tax collected, tourism business companies which will be realizing less profits thereby affecting the sustainability of the tourism business and the livelihood of the different stakeholders involved in the business to make a daily living.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the evidences from the paper, analysis of past climate variables (temperature and rainfall) and running of climate models is of great importance to the district because it has helped in the understanding and awareness of the changes which are taking place in climate variables in the sense that trends indicate a point of origin and the direction it is heading to while climate models predicts future scenario of specific variables. The analysis indicated both the increase and decrease in rainfall patterns and increase in temperature trends. Over all on annual basis there was a tendency of decreasing trend in rainfall patterns though not significant which indicates that rainfall amount received is gradually decreasing. On the other hand, temperature (maximum and minimum) indicated a significant increasing trend on annual basis and on seasonal basis it also indicated an increase in the trends although of less significant.

These indicated that temperature is making an important increase in the district and this means that the district has to anticipate high temperatures which will bring discomfort among tourists and heat related hazards and while on the other hand rainfall patterns will continue with its tendency of variation and decrease in amount which will affect food supply for tourism hospitality businesses. All these challenges will affect the number of arrivals for tourism activities in the district in a way that the number will be reduced. As a result, affecting sustainability of the tourism business.

5.2. Recommendations

This type of study must be encouraged so that there is enough knowledge, understanding and awareness of the science related to weather and climate so that those in authority can be advised to make good decisions and policy that will help to sustain climate sensitive activities, in this case tourism business.

There is also a great need of providing weather and climate information in forms of monthly and seasonal forecasts to the tourism business operators so that in case of

extreme weather and climate events response must be ready to contain such unfavourable events.

The study also recommends anticipatory adaptive measures which may help to check the challenges such as: provision of more shaded areas with a natural air flows, energy efficient systems, design hotels and lodges that will offer cool places, having enough emergency water and food needs to be put into place to sustain the natural business.

Due to some limitation factors this research used data for twenty-one years, this encourages further studies to use data of 30 years and more than that to get a clear picture of how the climate is evolving. Apart from negative impacts of climate change to tourism industry, it has also some positive impacts to the sector, therefore, further studies on the positive impacts of climate change on tourism business and how tourism has accelerated climate change are also encouraged.

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