WEATHER PATTERNS AT RUHIJA, BWINDI IMPENETRABLE NATIONAL PARK, SOUTH WEST UGANDA

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I. SUMMARY

This report describes the weather patterns of Bwindi Impenetrable National Park using data collected at ITFC from Ruhija. Two climatic parameters were used to describe the weather patterns at Ruhija and these are rainfall and temperature. The two have been chosen because they have profound influence on the distribution of plants and animals and can easily be interpreted. We used the conventional rain gauge and the maximum-minimum thermometer to measure the two climatic parameters over a 13-year period (1987-1999).

There are two rainfall peaks (March-May and September-November) and two dry season troughs (December-January and June July). The two main wet and dry seasons at Ruhija have been constant over years (at least from 1963-1999). During the 1987-1999 study period, the wettest year was 1988 and 1999 was the driest.

The study shows that there has been a temperature increase since 1983. This was based from the data collected since 1987 to-date and compared with the available climate data from Butynski (1984) and the meteorological data of Kabale since 1918. According to this study, Ruhija has a mean daily maximum of 19^0C and a mean daily minimum of 14^0C. Mean annual temperature is 16.3^0C. These contrasts with the 1963-1987 data for which the mean daily maximum was 20^0C and mean daily minimum 7^0C, and a mean annual temperature of 13^0C.
This study further shows that June and July are the coldest months while September and March are warmest. The two coldest and warmest periods correspond to the two dry season troughs and rainy season peaks respectively.

II. ACKNOWLEDGMENTS

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III. LIST OF ACRONYMS USED

BINP: Bwindi Impenetrable National Park

EMP: Ecological Monitoring Programme

CARE-DTC: Development Through Conservation Project of CARE

ITFC: Institute of Tropical Forest Conservation,

UK : United Kingdom

IV. INTRODUCTION.

Atmospheric components include moisture, solar radiation, temperature, and wind. A product of weather conditions over several years (probably over 30 years) of a particular place is its climate. Climate is combination of rainfall, temperature, humidity and wind of a given place expressed as means or averages (Smith, 1996). Commonly measured climatic components include rainfall, temperature, humidity, wind and solar radiation.

This report covers weather conditions at Ruhija station (altitude 2400m a.s.l), Bwindi Impenetrable National Park (BINP) over a period of 13 years and describes two major climatic parameters (rainfall and temperature). Rainfall is a major source of water for any organisms' metabolic activities while temperature directly affects metabolic processes such as respiration, growth and reproduction. As such, they are crucial variables for climatic data recording.

At Ruhija there has been an ongoing climatic data collection since 1987. However, before 1987, there has been no long-term systematic recording of climatic data in Bwindi. Butynski (1984) provides some information on climate at Ruhija based on the meteorological records taken at the nearby Kabale town (for temperature) over a forty-year period and forest department record (for rainfall) of 1963-1983. There is an ongoing climate data collection at Kabale Meteorological Department in Kabale town and this has been taking place since 1918 (Mushabe Andrew *pers.com*).

Butynski (1984) has reported that Bwindi impenetrable forest has two peaks of rainfall (March-April and September-November), this is a characteristic of most tropical areas close to the equator. Leggat and Osmaston (1961) in Butynski (1984) suggest that owing to the relatively large size of Bwindi Impenetrable forest, it may have an important stabilising effect climatically, especially by its influence on the number of rain days that occur.

Any significant change in the climatic patterns of Bwindi Impenetrable National Park is likely to cause a dramatic change in the species composition and distribution of flora and fauna in the park.
It is therefore imperative to record and document the weather patterns around BINP. Therefore the Institute of Tropical Forest Conservation set up a weather station at Ruhija in 1987 as part of climate monitoring of BINP.

V. STUDY OBJECTIVE

This study aims at recording and documenting the weather patterns at Ruhija station as part of the ecological monitoring programme of Bwindi Impenetrable National Park.

VI. METHODS USED

Various instruments have been designed and used for recording rainfall and temperature. The conventional rain gauge that basically consists of a graduated cylinder and the automated (tipping bucket) rain gauge are commonly used to measure rainfall. A simple maximum-minimum mercury thermometer and an electronic thermometer are commonly used to measure temperature. However, automated climate recording systems (tipping bucket rain gauges and electronic thermometers) are quite expensive to buy and maintain and require a high level of training of personnel. They are therefore considered unsustainable for long term monitoring purposes in Bwindi Impenetrable National Park. In our case we considered simple, non-automated systems as more practical to use since they are relatively cheap, simple and easy to use and they require less training of personnel.

We conducted training sessions on the use of rain gauges and thermometers for ITFC field assistants at Ruhija before weather data collection begun. ITFC field assistants based at Ruhija station made the weather recordings daily between eight and nine o clock in the morning. The rain gauges are located in an open space, free from any obstacles such as forest canopy and buildings while the thermometers are placed under forest canopy. Placing of rain gauges in an open place prevents rain drops from being intercepted by plants and other obstacles while placing the thermometer under forest canopy shields the thermometer from direct sunlight (Brower *et. al*, 1990) Weather recordings of 1987-1998 were obtained from the ITFC records. The information on the climate of Ruhija since 1963 to 1987 was obtained from Butynski (1984) while Kabale town climate data information (from 1918-1996) was obtained from the Department of Meteorology Kabale.

The rainfall data were analysed graphically and presented as averages of mean monthly rainfall, and annual total rainfall. The rainfall distribution from 1987 to 1999 at Ruhija was compared with that of 1963-1983 got from Butynski (1984) and that of Kabale town (1918-1996). Temperature data were analysed graphically and presented as mean daily minimum and maximum temperature and mean annual maximum and minimum temperature.

VII. RESULTS

A. Mean monthly rainfall

The mean monthly rainfall patterns at Ruhija for the period 1987-1999 are shown in Figs 1 and 2. Generally through out the study period, there are two rainfall peaks and two dry season troughs. However, the exact timing varies between years. The only exception is that June, July and August are all the driest months in the different years and have remained relatively constant over the 13-year study period. At some point in 1988 there were heavy rains in July although it was expected to be a dry season. Also during the 1992 and 1999 study periods the mean monthly rainfall distribution almost shows a unimodal distribution instead of the expected bimodal distribution. The March rainfall peaks in 1992 and 1999 are so low that the two wet season peaks characteristic of most tropical areas are not pronounced. There was also considerable interannual variation in the amount of rain for any given month, as shown by the graphs.

Fig.1

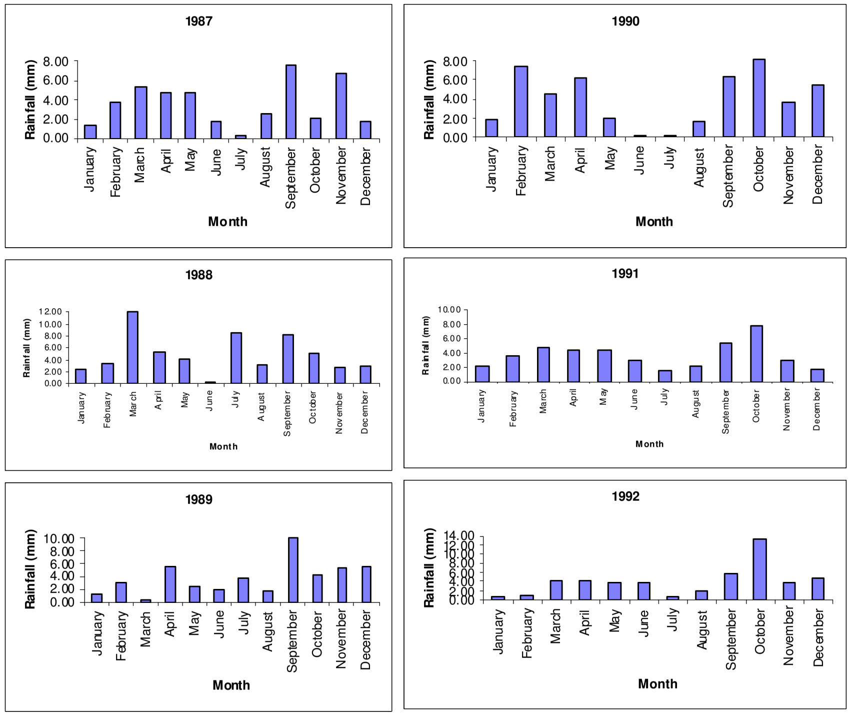

1987
1988
1989
1990
1991
1992
Rainfall (mm)
Month
January
February
March
April
May
June
July
August
September
October
November
December

Fig .2

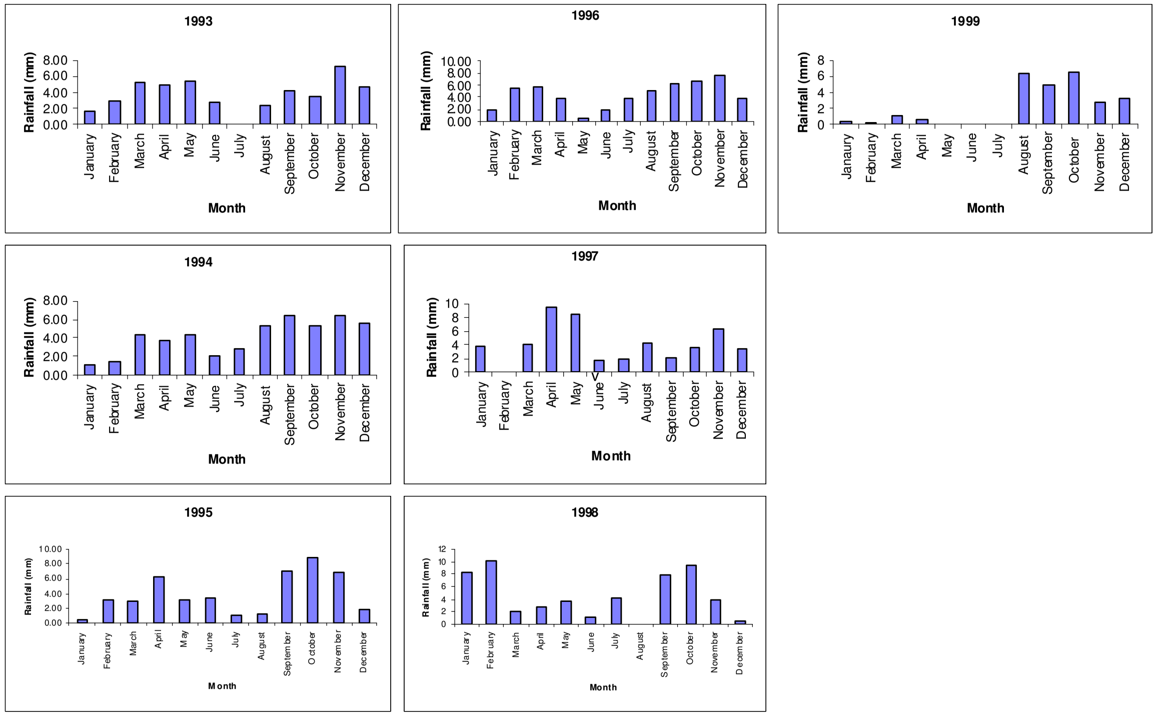


Fig 3: Total annual rainfall at Ruhija, Bwindi Impenetrable National Park

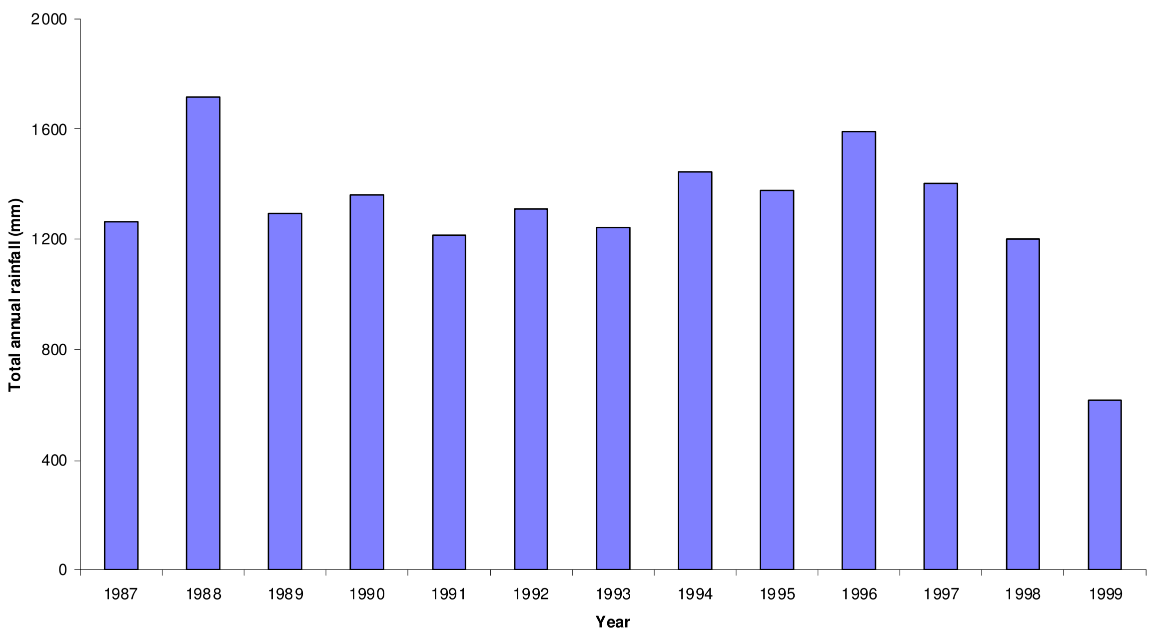
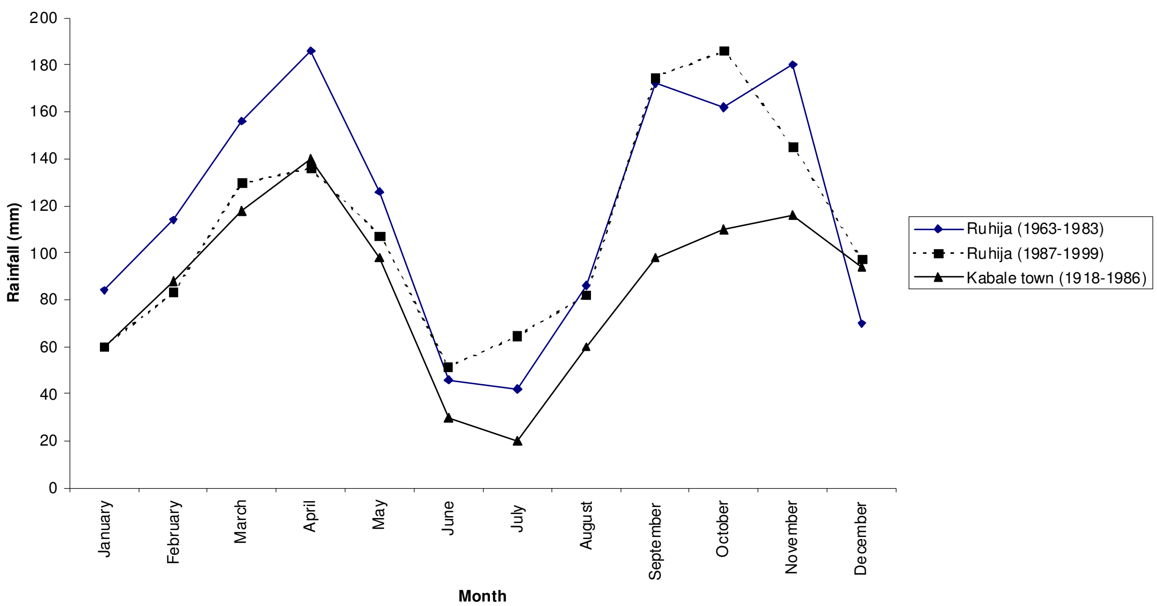
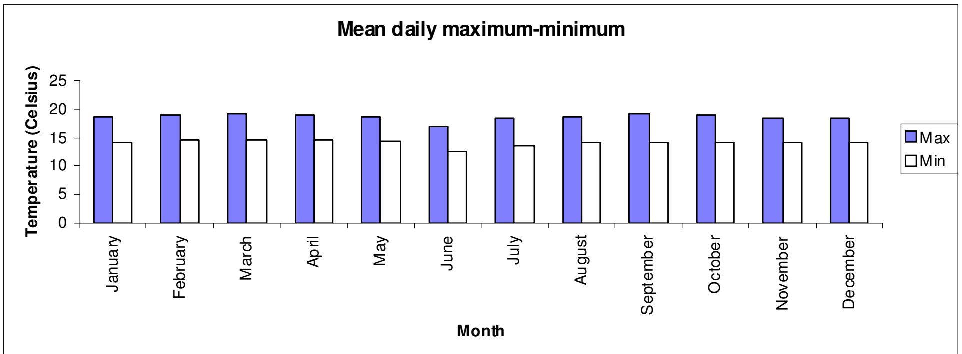


Fig 4: Comparison of monthly mean total rainfall of Ruhija 1963-1983 and 1987-1999, and Kabale town 1918-1996




Mean daily maximum-minimum
Temperature (Celsius)
25
20
15
10
5
0
January
February
March
April
May
June
July
August
September
October
November
December
Month
Max
Min

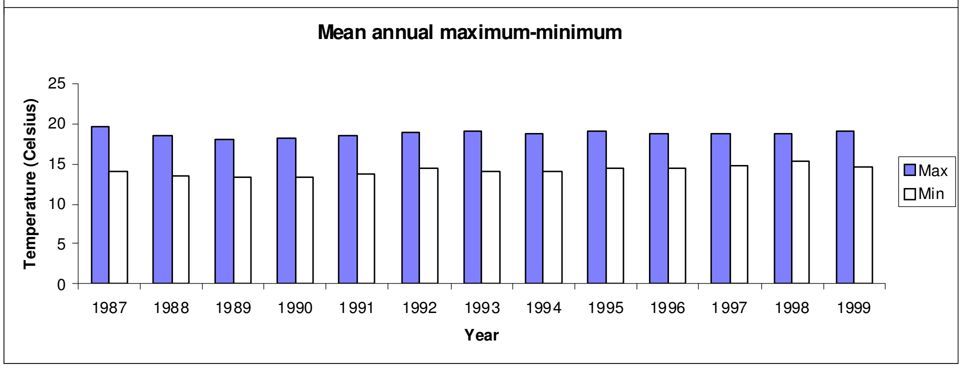
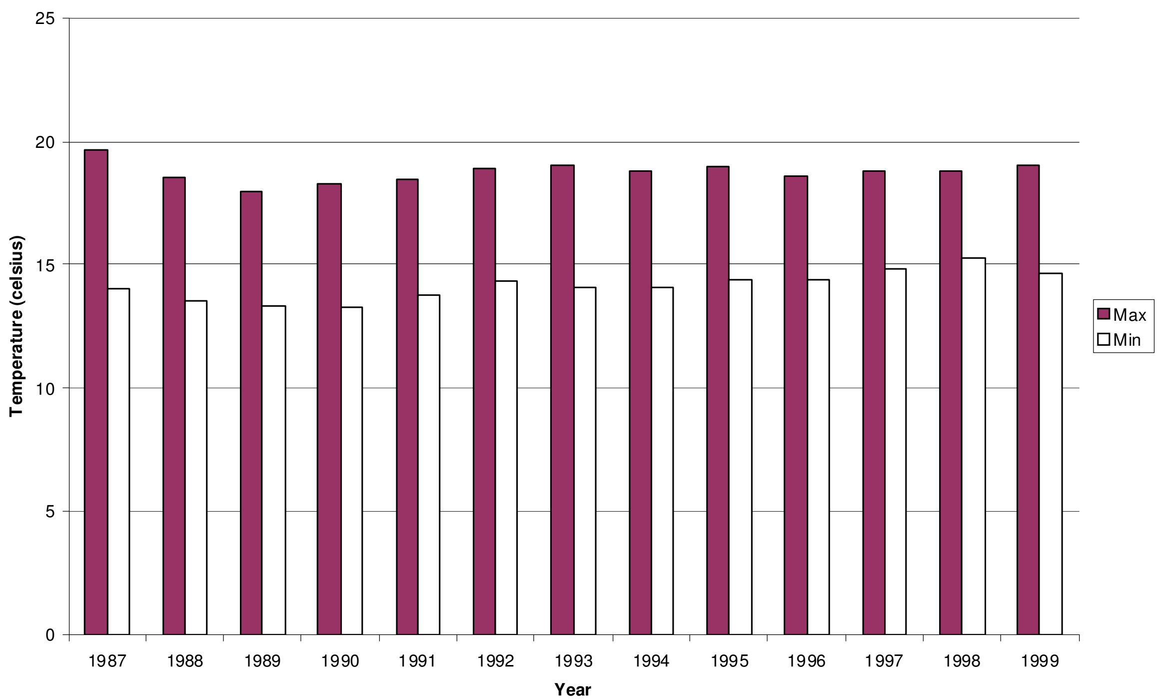

Mean annual maximum-minimum
Temperature (Celsius)
25
20
15
10
5
0
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year
Max
Min

Fig 6: Annual Maximum-Minimum Temperatures at Ruhija, Bwindi Impenetrable National Park



B. Total annual rainfall

Fig. 3 shows the total annual rainfall at Ruhija over the 13-year study period. From the figure, it is evident that the total annual rainfall recorded over the 13-year period varies slightly with an exception of 1999, which received a markedly low rainfall. However, 1988 was the wettest year with a total rainfall of about 1719mm and 1999 the driest with a total rainfall of less than 600mm. The 1999 period was a year when the whole country experienced a prolonged drought (la Nina).

C. Monthly mean total rainfall

Fig 4 is a comparison of the monthly mean total rainfall of 1963-1983 and 1987-1999 at Ruhija and that of 1918-1996 at Kabale town. From the figure it is evident that there are two wet season peaks and two dry season troughs. A comparison of the three graphs shows that the rainfall peaks and the dry season troughs have remained constant over years (since 1918 to-date). The two rainfall peaks are March–April and September–November and the two dry season troughs are December-January and June-July. The figure also shows that Kabale town received less rainfall than Ruhija.

D. Temperature

Fig 5 and Table 1 show the mean daily maximum and minimum temperatures and mean annual maximum and minimum temperature at Ruhija weather station. It is evident from the figure and the table that the interannual variation in temperature for specific months is less pronounced. June and July are the coldest months while September and March are the warmest (Butynski, 1984 also noted this). The two coldest and warmest months correspond to the two dry season and rainy season troughs and peaks respectively as mentioned above. The Fig 5 also shows the mean annual maximum and minimum temperatures at Ruhija. There is slight temperature variation over the years. 1989 and 1990 were the coldest years while 1987 and 1997 were the warmest. The coldest temperature ever recorded at Ruhija during the study period was 11^0C while the warmest was 24^0C.

The mean monthly temperature variation at Ruhija is less than 6^oC. Ruhija also has a mean daily maximum of 19^0C and minimum of 14^0C with a mean annual temperature of 16.3^0C.

Table 1: Mean daily maxima and minima at Ruhija (1987-1999)

Temp (^{o}C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Max	19	19	19	19	19	17	18	19	19	19	18	18	19
Min	14	14	15	15	14	13	14	14	14	14	14	14	14

VIII. DISCUSSION

Plants and animals respond to climatic variations. Plants, in particular, are sensitive indicators of climate (Smith, 1996). Over the long evolutionary history, plants have adapted to the limits of moisture and temperature by assuming certain physical forms, dimensions, and physiological attributes that enable them to cope with climate. At one extreme, where temperatures are hot and precipitation is high tropical forests are developed; at the other extreme of cold temperatures and low precipitation, arctic tundra are developed (Smith, 1996).

Most areas close to the equator have characteristic two peaks of rainfall and two dry season troughs (Pomeroy and Service, 1986). In BINP, this is the case also although during the 1992 and 1999 study period, there was a prolonged drought experienced that almost caused unimodal rainfall distribution. Actually the whole country experienced a prolonged drought. Several areas in the country experienced famine due to the prolonged droughts and there were also several outbreaks of fires in and around BINP that caused considerable damage to the forest (Otim, 1994, Babaasa et al. 1999).

In Kibale forest, the interannual variation in temperature for specific months is less pronounced. The coldest months in Kibale forest are October and November while the warmest month are February and March (Struhsaker, 1997). In BINP also as noted earlier on, there is very little interannual temperature variation over the months.

Between 1963 and 1983 (Butynski, 1984), the mean daily maxima at Ruhija was 20^0C and minima 7^0C with a mean annual temperature of 13^0C. In Kabale town between 1918 and 1996, the mean daily maximum was 23.8^0C and the mean daily minimum was 10.6^0C (Meteorological Department Kabale, 1996). This study shows that there has been a temperature increase from 1983 to-date at Ruhija. The mean daily minimum has doubled from the original 7^0C while the mean annual temperature has increased by 3.3^0C. The mean daily maximum temperature at Ruhija has remained the same. This study covered a 13-year period (1987-1999) and that of Butynski (1984) was based on the statistical abstract of 1974 that covered a 40-year period. It should also be noted that since

1918, Kabale town and its environs have undergone a lot of biophysical changes due to some human activities like swamp drainage and construction of buildings. These activities have most likely led to further increase in temperatures in Kabale town and its environs. The temperature increase in Bwindi Forest can be explained as part of the regional or global warming taking place. Human activities around the forest like swamp drainage may also have contributed to the increase in temperature.

IX. CONCLUSION AND RECOMMENDATIONS

This study shows that the rainfall peaks and dry season peaks have remained constant over years and that there is a slight difference in the amount of rainfall received over years. There is an indication that there has been temperature increase over the past 40 years. Any changes in temperature or precipitation of BINP will most likely have a serious consequence on the distribution of plants and animals and this could affect the status of the highly sensitive plants and animals like the endangered mountain gorilla (*Gorilla gorilla beringei*).

Although this study shows some likely trends of climate at BINP, we are not able to conclude on the climate of BINP as there is need to collect more climate data (probably up to 30 years) and set up a network of climate measuring instruments in and a round BINP. In fact the ITFC-Ecological Monitoring Programme has set up three weather stations at Buhoma (Park headquaters), Rushamba (northern Sector Park out post) and Ruhija (ITFC field station). These three form a network of climate recording instruments around BINP. The three sites were chosen on the basis of altitudinal differences and the presence of personnel to man and record climatic data daily. The altitudinal distribution of rainfall is of ecological importance (Trapnell and Griffiths, 1960) as these are likely to influence the altitudinal zonation of vegetation (Hedberg, 1964).

X. REFERENCE

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CLIMATE RECORDING DATA SHEET

Date:……………………………………….

Location:……………………………………..

DATE	RAINFALL (MM)	TEMP. (^0C)		HUMIDITY (%)	COMMENTS	RECORDER
		MAX	MIN			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
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28						
29						
30						
31						