Assessing Perceptions of Climate Variability and Change among Farmers in Kyela District: A Quant-qualitative Approach

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Abstract: *The study assed the relationship between perceived and objective climate variability and change in Kyela district, Mbeya Region, Tanzania. The study had two main objectives: one was to assess whether there have occurred any significant shifts in rainfall pattern over the past 47 years. Two was to determine the relationship between perceived climate and objective climate by comparing the physical data with the subjective recall and memory of change in climate from respondents. Data was collected using interviews, focus- group discussions, documentary review and analysis of instrumental records of rainfall. Although there are some degrees of similarities there is a big difference between perceived and objective climate in the study area. While respondents perceive a recent change in rainfall pattern, instrumental records on the other hand clearly show that variability in rainfall has been there throughout the study period. The study concludes that the differences between these sources of information are a result of people recalling on most recent events than the past. Also that rainfall data presented in this study represent a broad picture for the whole district while practically there can be differences between villages even if they are just 10 miles away from each other. Hence a further study to cover similar area coverage for both data sets would be important to address the discrepancy of the findings revealed in this study.*

Key Words: Seasonality, rainfall pattern fluctuations, subsistence farmers, Kyela, Tanzania

INTRODUCTION

The term óclimateô is defined as óthe average meteorological conditions over a specified time, usually at least a month, resulting from interactions among the atmosphere, oceans and land surfaceô (Glantz, 2003:17). Climate change in this study is defined as any change in climate over time, either due to natural variability or as a result of human activity (Alley *et al.,* 2007), or both. The extent to which climate patterns are changing in Tanzania and how such changes are perceived by rural farmers is still complex and scantly explored. This study provides some background data using rainfall records from 1960-2006, as a basis for examining, from an independent perspective, the level and extent of shifts in seasonality, frequency of extreme events and variability of climate in Kyela district. These are all factors which would have significant impacts on farmers. This study had two main objectives; the first objective was to assess whether there have occurred any significant shifts in rainfall pattern over the study period. The second objective was to determine the relationship between perceived climate and objective climate by comparing physical data with subjective recall and memory of change in climate from respondents.

The existing literature suggests that there is no general rule on whether perceptions on climate always tally/do not tally with physical data from instrumental records. A study by Gbetibouo (2009) for example notes that where statistical analysis of climate data indicated an increasing temperature trend over years and rainfall inter-annual variability, people perceived a decreasing rainfall amount, a shortened rainy season and a change in timing of rains. The study therefore suggested that farmers are capable of perceiving changes in climate objectively.

Maddison (2007) concludes that of the 11 African countries he studied only five indicated a relationship between data from instrumental records and peoplesô perceptions, these are Burkina Faso, Ghana, Niger, Senegal and Zambia. Whereas the remaining four namely Kenya, Niger, Senegal and South Africa, there were no relationship between perceive and objective climate data.

In Bangladesh, Kumar and Jalal (2011) compared observations of water levels decline in river Rupsha-Bhairab and local peoplesô perceptions of climate change. Kumar and Jalal (2011) came out with conclusions that peopleǿs perceptions were in line with their observation findings in river Rupsha-Bhairab that the study area was experiencing a trend of scarce rains. A study by Hoang Minh *et al.* (2009) reveals a close relationship between instrumental records of rains and peopleǿs perceptions of climate change in Vietnam.

Goulden (2011) reports that the analysis of temperature records in Mongolia shows that over the last 70 years Mongoliaǿs climate has increased for almost 4 degrees Fahrenheit. Goulden (2011) interviewed Mongolian herders with the objective of establishing whether they were aware of the changing climate and what they perceive to be their future; he concludes that herders are aware that the climate is changing, and they are beginning to worry about their future.

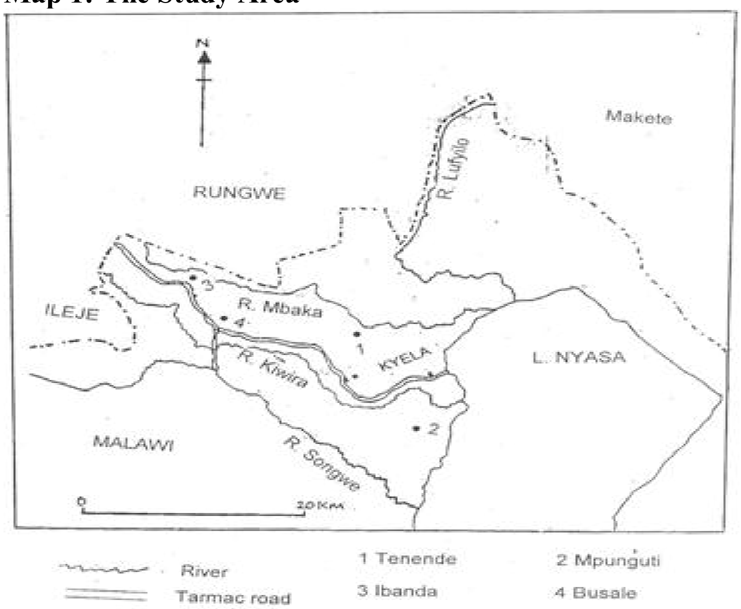
It is evident from the reviewed literature that perceptions of climate change vary with places considerably around the world, and it is therefore difficult to generalise the state of art basing on the available literature. The study by Maddison (2007) is evidence that in order to tap climate change perceptions at specific geographical locations one need to conduct field studies for that specific location.

METHODOLOGY

The Study Area - Kyela District

Kyela district is located in the south eastern corner of Mbeya region in Tanzania (Map 1). It lies within latitudes 9ę 25´ and 9ę40´ South and longitude 33ę40´ and 30ę00´ East. Kyela district borders the districts of Rungwe, Iringa, and Ileje in north and north-east, and east and west respectively. The south and south west of the district forms a border with Malawi. The Livingstone Range forms a prominent feature separating Kyela and Iringa districts. Kyela district was selected for this study based on the known frequent occurrence of extreme weather events in the country, particularly excessive flooding.

Map 1: The Study Area



Source: Land Use Plan Kyela District

The study was undertaken in four villages, namely: Tenende and Mpunguti (Mwaya ward) and Ibanda and Busale (Busale ward). It was not possible to conduct this study in many villages due to time and resource constraints. The four villages were selected purposively. From the upland, accessible villages were picked - two villages with access via the main road from Kyela district to Mbeya town were randomly picked. Studying farms prone to floods was the motivation for selecting the villages in the lowlands - the villages of Tenende along Mbaka and Kiwira rivers; and Mpunguti along the Kiwira and Songwe rivers, were picked randomly. The intention was to compare the nature of perceptions on climate following an assumption that there are different levels of vulnerability between the uplands and the lowlands.

METHODS

Data Collection and Analysis

Data collection techniques involved qualitative interviewing, focus group discussions, a review of texts and documents as well as analysis of rainfall records. Unstructured interviews were conducted in four villages. Targeted people for the interviews were farmers and non farmers who have lived in the study area for over 40 years; these were thought to be the right respondents as they are likely to have accumulated experiences on variability and changes in climate in the study area over the study period (1960-2006). Four focus group discussions were conducted in each of the four villages. The group members were selected randomly.

The researcher asked the village leaders to write down the names of the villagers aged 40-70, female list separated from the male list. Each individual in the list was assigned a number; then the researcher wrote down all the numbers in pieces of papers, folded the papers and picked four papers randomly; then the individuals whose numbers were in the list prepared by the village leaders were included in the focus group discussions. In line with Kruger (1998) each group was composed of four members, two female and two male. The discussions were recorded using an audio recording device to ensure accessibility of the data in its origin form as much as possible. Notes were taken to record any important issue that emerged during the group discussions, following Silverman (2000). Some documents were gathered for documentary analysis, these included rainfall records where Kyela rainfall data for the period from 1960 ï 2006 was collected from Tanzania Metrological Agency.

The study employed several approaches for analysis of data, including thematic data analysis for survey data and content analysis for data from the documents. Simple mathematics were applied to analyse rainfall records - done with the help of excel computer software. In order to understand rainfall fluctuations and variability for the period from 1960-2006 in the study area, different rainfall regime components were considered. They include annual rainfall, annual average rainfall, monthly rainfall and monthly average rainfall, as well as long-term averages, and moving averages.

FINDINGS

Perceptions of Climate

The findings in this study show that people in Kyela view the variability in rainfall pattern as a recent characteristic. They experience inter-annual wetter and drier spells as recent anomalies and thus find it hard to make the predictions necessary for the farming calendar. To them this is the opposite of what they experienced in the past. Respondents explained that they currently experience wet season to start in November or December instead of October as used to be the case in the past. They further explained that the peak rainfall was always in April in the past, unlike the case today when it is more unpredictable and may also occur in February or March.

The researcher quoted three respondents who had the following explanations: ñThe problem is that rain does not start on time, it may set late and end earlyò

(Mughogho, crop researcher, Uyole, April 2008). ñIn the past rains started in October and November but nowadaysô rains start in December, so October and November are getting dryé ò (MO Uyole, April 2008). ñIn the past, rain could come in November; but these years it may be as late as January (Alani Ibanda village subsistence farmer - April 2008).ò

People in Kyela further explained that the start of the dry season has currently shifted to May from August as the case was in the past, and it continues until October. Hence May, June, and July are perceived to have shifted from wet months to dry months. The length of the wet season is perceived to have been getting shorter because of the perception that May, June and July are currently dry whereas in the past they used to be wet. This is explained by one of the respondents as follows: ñWe knew wet season was sometimes up to Augusté ; (today) it may end as early as May (Andrew, Busale Village, April 2008).ò

Respondents further perceive that there is a change in seasonality where currently people cannot predict the distribution of rainfall over the wet season. We quoted some of respondents who had the following to say:

> Last year, (2007) for example, it started raining in November which is not usual actually, it then continued nonstop until Marché Aprilé till May! In the past é in late October it rained a bit then it stopped then rained again a bit and stoppedé it was systematically, in February it was dry é but not today (Julius, lowland - Tendende Focus Group Discussion, April 2008).
>
> Rainfall pattern is so unpredictable, in the past it rained in October just a bit, we cultivated fields, it rained again in December we did sowingé but these years rain comes in a zigzag wayé it may rain too much from the start such that farms can be inundatedé Rainfall fluctuation started in 2000s, before that it was better (Esther lowland - Mpunguti Key Farmer Informant, April 2008).
>
> In the past rainfall pattern was clearly known to farmers, nowadays rainfall is not well predictableé ten years now rainfall have not been predictableé We can say since 1998 or so (Mwampaja, Kyela Agricultural Extension Officer).

Respondents were of the opinion that flooding events are no longer predictableé . currently it can flood even in February whereas in the past floods of high magnitude were expected on the 15th of every April (Table 1). Respondents did not have any recall of specific dry years, rather specific recall on years with severe flooding events which were 1963, 1978, 1980, 1982, 1986, 1988, 1989, 1990, 1998, 2002 and 2008. There had been no clear perceptions of temperature change among respondents. The next section presents the findings on the rainfall pattern in Kyela. Later a comparison is be made to see the relationship between the perceived climate and the climate from the instrumental records of rainfall.

Table1: Perceived timing of floods among respondents in Kyela district in all years covering the study period 1960-2006

Respondent	Months for floods							
	Usual Months		Current Months					
	March	April	Dec	Jan	Feb	March	Apr	You can't tell
Upland	-	✓	-	✓	-	-	-	
Upland	-	-	-	-	-	-	-	✓
Lowland	-	✓	-	-	-	-	-	✓
Lowland	✓	-	✓	-	-	-	-	✓

Source: Field Data

Rainfall Pattern in Kyela: 1960-2006

In Kyela district, annual rainfall for the period from 1960-2006 is highly variable. The average annual rainfall is 2658.8mm (table 2) and the standard deviation is 1021.4mm (Table 2), with a range from a maximum rainfall of 4750.4mm (1989), to a minimum of 358.3mm (1973) (Appendix 1). The high degree variability suggested by the standard deviation can be observed in Figure 1, which shows significant rainfall fluctuations and variability above or below the long-term average. The moving average does not suggest any specific trend in rainfall, and therefore from this data, the future rainfall pattern cannot be predicted.

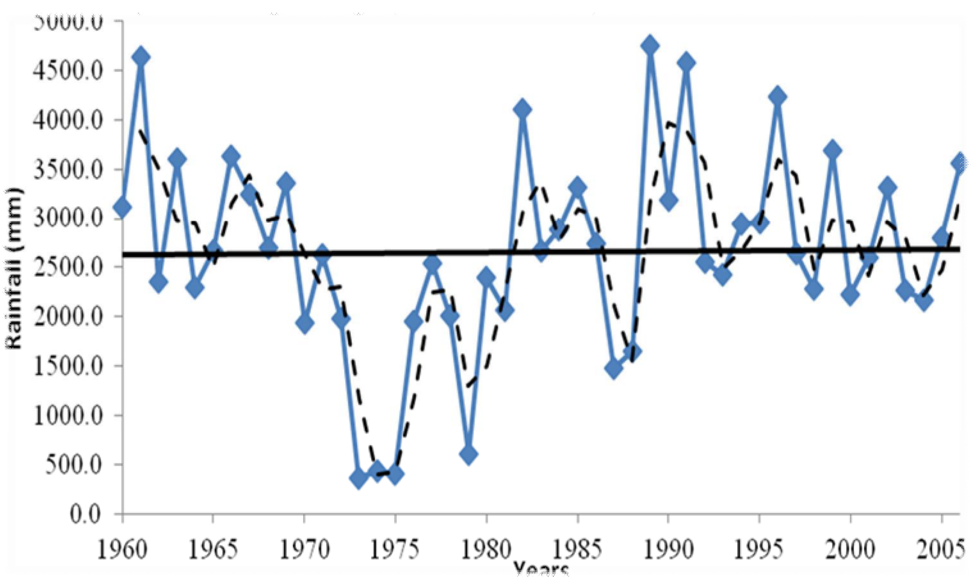


Figure 1: Kyela Average annual rainfall 1969-2006 showing annual rainfall (blue line), long term average (thick blue line), and a five year moving average (black dotted line).

From Figure 1 shows a ten year analysis that the period from 1960 to 1969 was characterized by rainfall above the 1960-2006 long-term average of 2658.8mm and the average for this period was 3162.8mm (Table 2). Over half of the period experienced rainfall above long-term average. 1961 was an especially wet year with a total annual rainfall of 4636.9mm (appendix 1). In the first ten years of the study period rainfall experienced high inter-annual variations with a standard deviation of 2042.5mm.

Table 2: Rainfall Fluctuation 1960-2006 the Long-term Average is 2658.8mm

Period	1960-69	1970 - 78	1980-89	1990-99	2000-06	STD
Average (mm)	3162.8	1486.0	2805.3	3148.7	2705.1	1021.4

Source: Calculated from Rainfall Records for Kyela District (Appendix 1)

The period from 1970 to 1979 was characterized by rainfall below the long-term average; the average during this period was 1486.0mm (Table 2), which is almost half of the long-term average for most of the years with a severe drought in 1973/74/75 (Appendix 1). These three exceptional drought years have an average of only 399.1mm; it is interesting that this extent of drought has never recurred again throughout the study period.

The period from 1970-1979 is characterized as dry since more than half the decade experienced below long-term average rainfall. 1973-75, in fact, has a significant impact on the overall time line average being over 6 times below the overall average for the period 1960-2006 ï an example of extreme meteorological conditions (drought). The standard deviation of 925.0mm, which when compared with its mean of 1486.0, shows that during this period rainfall has lower inter-annual variability with the exception of the three years 1973/74/75. These lower inter-annual variations for this period can be easily observed in Figure 2.

The period from 1980 to 1989 again saw a large number of years above the long term average (Appendix 1) but the years 1987-8 were well below the average with an average of 1563.8mm (calculated from the data in Appendix 1). This was just slightly over half of the long-term average. Again this period show significant variability of the annual rainfall. Indeed it is rare to find two years the same within the past 47 years. This data in itself is a clear demonstration of the term climate variability rather than climate change. Looking for patterns over longer-time periods - for example 10 years, suggests that some decades have been wetter or drier on average than others but again there is no clear trend or evidence of long-term changes in a specific direction (Table 2).

The findings from this study show that monthly rainfall for the period from 1960-2006 varied considerably. While April had the highest average rainfall (847.4mm), September had the minimum average rainfall (8.5mm) (Table 3). In the overall, the dry season starts in June when rainfall declines from 430.9mm in May to 8.5mm in September (Table 3) when the dry season peaks. It will be interesting to see whether farmers notice any changes overtime in this progression. Then rainfall increases gradually from October (14.1mm) and November (114.4mm), the season is however still dry, but rainfall increasing steadily through December (176.3mm) to January (197.2mm) (Table 3).

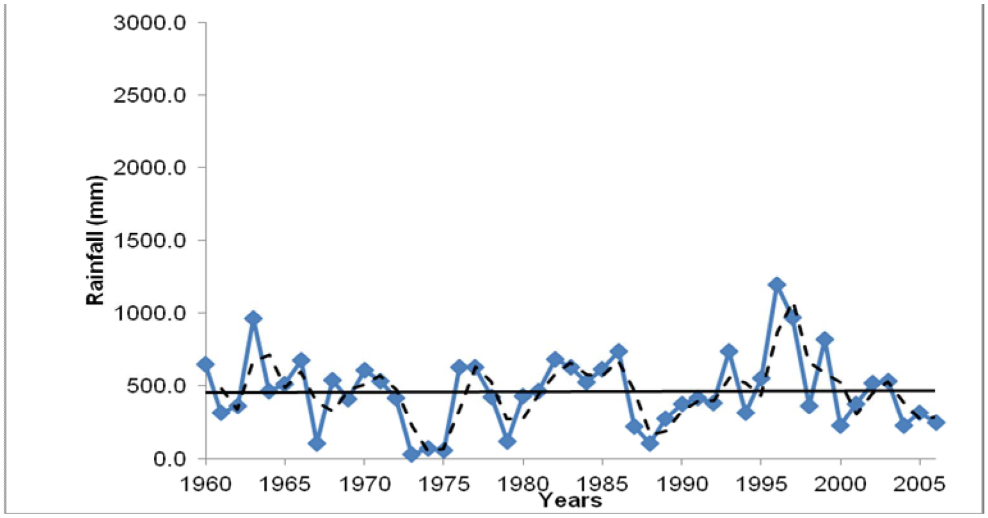


Figure 2: - Observed (blue line) annual rainfall, long term average (thick black line) and 5 years moving average (black dotted line) for March 1960-2006.

The data suggests that in the overall, October rainfall marks the start of the wet season. In February rainfall declines to 159.9mm marked by a dry spell before it picks up again to 463.8mm in March. March, April, and May have annual averages of 463.8mm; 847.4mm; and 430.9mm respectively, with an overall monthly average of 230mm. This suggests that these three months were the wettest months of the wet season in the study area with April at the peak while September (8.5mm) as the driest month (Table 3).

Table 3: Rainfall monthly means (mm) for the period 1969-2006 showing the start of the dry season in June, the start of wet season in November and the peak rains in April

Time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	69-06
Mean	197.2	159.9	463.8	847.4	430.9	132.1	89.8	24.5	8.5	14.1	114.3	176.3	230.0

Source: Calculated from Rainfall Records of Kyela District (Appendix 1)

Based on Figures 2, 3, and 4, rains in March, April and May respectively, show considerable variations. Rainfall pattern in these three months tended to follow the trend pattern of the annual averages as in Figure 1; the graphs are showing an inherent variability within the rainfall pattern for the period from 1969-2006. Figure 2 shows March rainfall with the annual average rainfall pattern showing considerable variation around the mean of 463.8mm (Table 4).

Table 4: Calculated Total, Maximum, minimum, and Mean Rainfall, and the Standard Deviation for March 1960-2006

Variable	Total	Maximum	Minimum	Mean	Std Deviation
Rainfall (mm)	21798.4	1196.5	29.3	463.8	249.2

Source: Calculated from Rainfall Records for Kyela District (Appendix 1)

In the year 1996 March was especially wet at about 1196.5mm (Appendix1), and it experienced the driest condition in 1973 with rainfall of 29.3mm (Appendix 1). Again, it is interesting to see farmers did not refer year 1973 to major drought event.

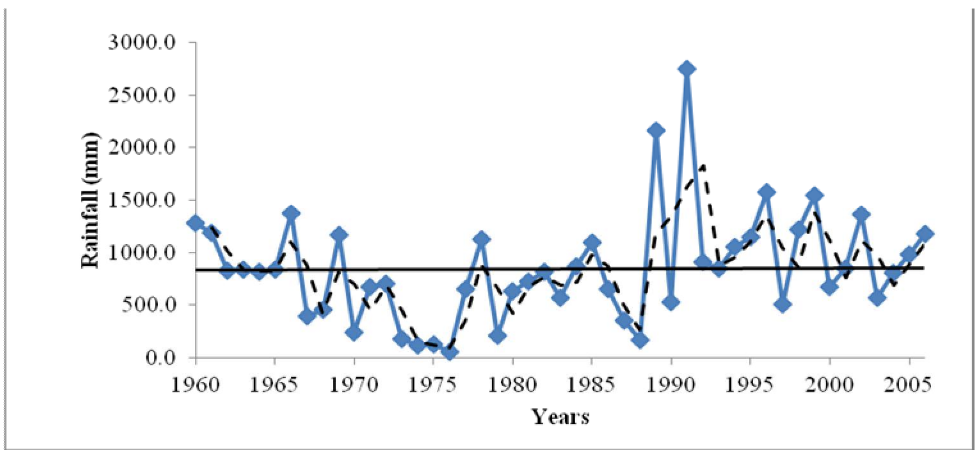


Figure 3:- Observed (blue line) annual rainfall, long term average (thick black line) and two periods moving averages (black dotted line) for April rains 1960-2006.

The April data shows two major spikes in 1989 and 1991, of over 2000m (Figure 3 and Appendix 1); 1991 had the wettest condition with a rainfall of 2744.6mm (Appendix 1). A major dry period occurred in 1976 when there was only 55.5mm of rainfall (Appendix 1) against the long-term mean of 847.4mm (Appendix 1). April rain data show significant monthly variations with a standard deviation of 517.7. In Figure 3 the moving average does not portray any specific rainfall trend for April rains showing that it is difficult to predict the future rainfall pattern for this month.

The data for May shows three spikes at over 1200mm in 1982 (1340.2mm), 1989 (1362.6mm) and 1990 (1393.7mm) (Appendix 1); 1990 had the highest rainfall (1393.7mm) while 1973 had the lowest rainfall (17.3mm) appendix1) in the overall, for the period from 1960-2006, May has an average rainfall of 430mm (Table 5).

The standard deviation of 349.7 (Table 5) tells that rainfall for May (1960-2006) is highly variable and the moving average in Figure 4 shows that future rainfall pattern for this month is unpredictable.

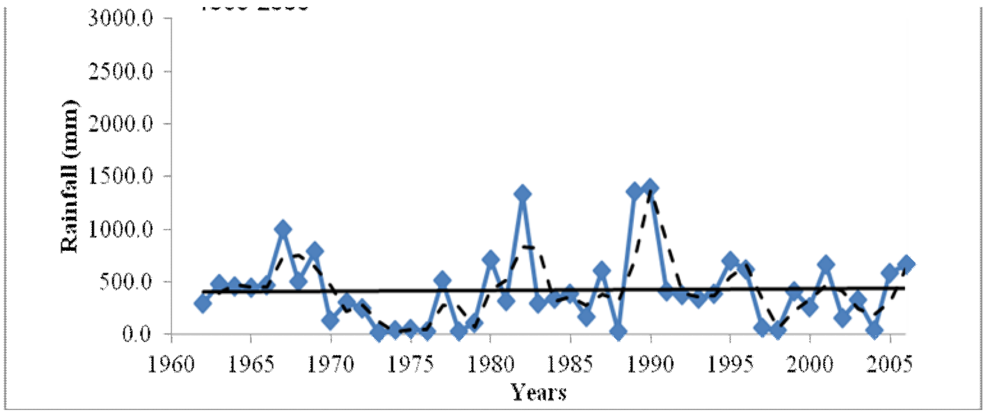


Figure 4:- Observed (blue line) annual rainfall, long-term average (thick black line) and 5 years moving average (black dotted line) for May rains 1960-2006.

Table 5: May rains in Kyela 1960-2006

Variable	Total	Maximum	Minimum	Average	Std Deviation
Rainfall (mm)	20250.9	1393.7	17.3	430	349.7

Source: Calculated from Rainfall Records for Kyela District (Appendix 1)

Although February data reveals the same patterns as in the months of March and April ï many fluctuations and variability with no obvious trend- it was considered important to examine this month (February) because it featured frequently during interviews. It was clearly a month of concern as farmers argued that this month currently shows a wetter condition with the result that customary weeding activities suffered, compared to previous decades. Therefore it is of interest to document whether February is indeed becoming wetter as farmers pointed out during the interviews. According to the meteorological data (appendix 1) there is no clear trend towards wetter Februarys, the data show that there is a slightly wetter trend for years 2004, 2005, and 2006). From figure 5 it is difficult to predict the future rainfall pattern for this month.

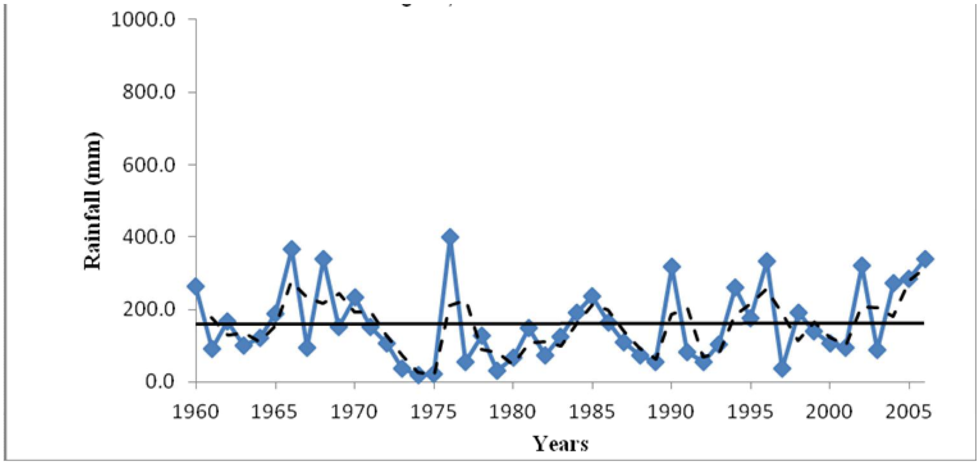


Figure 5: - Observed (blue line) annual rainfall, long term average (thick black line), and moving average (black dotted line) for Kyela February rains 1960-2006. (The scale for Y-axis has been reduced to 1000 to reduce flatness of the figure.

However, as in the case of the other already discussed months (March, April, and May), February rains for the period 1960 ï 2006 experienced significant inter-annual variations and inter-decadal fluctuations (Figure 5). February rainfall in 1960-1969 was above its long-term average of 159.9mm (Table 6) with an average of 188.7mm (Appendix 1). It was followed by a roughly 20 year period (1970-1989) of rainfall below the long-term average.

Table 6: - Calculated Maximum, Minimum, and Long term Average rainfall, as well as the standard deviation for Kyela February Rains 1960-2006

Variable	Maximum	Minimum	Average	Std Deviation
Rainfall (mm)	398	18.7	159.9	103.6

Source: Calculated from Rainfall Records for Kyela District (Appendix 1)

The next 17 years experienced rainfall above the long-term average (Table 7), 2000-2006 being the wettest period. Given the fact that overall this month is the only month that experiences dry spell within the wet season, it will be interesting to find how farmers perceive the variations in rainfall in this month and what impacts these variations have in the farming system.

Table 7: - February Rainfall Inter-decadal Fluctuations above and below the average of 159mm the green fill shows rainfall above average and the yellow fill shows rainfall below average

Period	1960 -69	1970 - 79	1980 - 89	1990-99	2000-06
Rainfall (mm)	188.7	117.8	124.0	170.1	215.4

Source: Developed from rainfall records

Having collated and analysed the available climate data for Kyela, the next section discusses the relationship between the data in this section and peopleôs perceptions of climate as presented in the previous section.

DISCUSSION

Table 8 displays a comparison between the perceive climate in Kyela and data from the instrumental records of rainfall. The overall assessment indicates that there are some levels of agreement, but the two perspectives often differ. Figure 6 presents a conceptual framework for the perceived climate in Kyela based on the data from the interviews and focus group discussions.

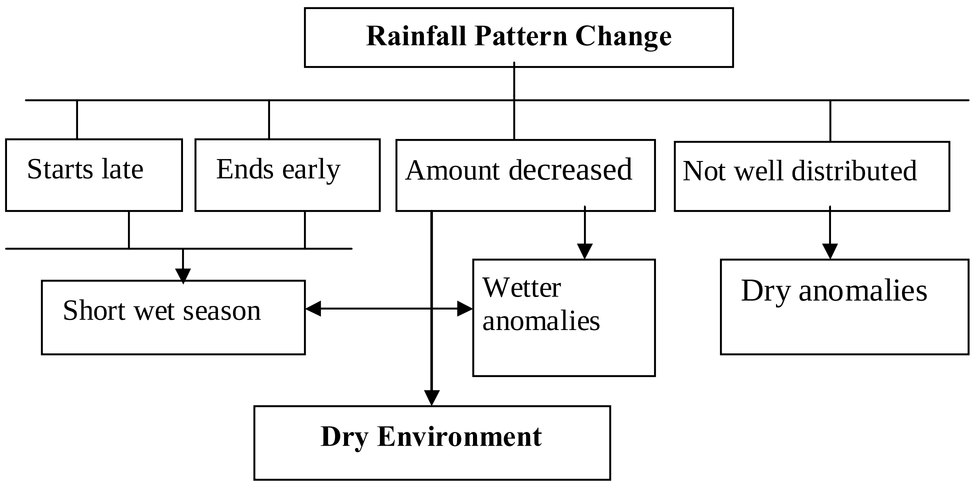


Figure.6: Respondents perceptions and experiences of rainfall change in Kyela
Source: Developed from data analysis

The Figure shows that the overall picture gained from the interview data is that:

(i) Rainfall pattern is highly variable compared to the past;
(ii) Wet season starts late and it ends early;
(iii) The amount of rain has decreased;
(iv) Rainfall is not well distributed;
(v) The region experiences dry and wet anomalies;
(vi) Kyela is heading towards a dry environment.

The interviews further revealed that the variability in the rainfall pattern is a recent phenomenon, where in the ópastô they had had a well-established seasonality whereas currently the rainfall pattern is not predictable. This picture of change of rainfall revealed by the perceptions of people is difficult to match to the patterns of rainfall revealed by the instrumental records over the past 40 years (see Figure 7).

Table 8: Perceived climate data derived from the analysis of interviews and focus group discussions and objective climate data derived from instrumental records showing largely disagreements with few agreements

Perceived climate	Objective climate
Variability in rainfall pattern is a recent characteristic. Inter-annual wetter and drier spells are recent anomalies that cause difficulties in making the predictions necessary for the farming calendar. This is the opposite of experiences in the past.	Highly variable rainfall pattern throughout the period 1960-2006, characterized by inter-annual variations and inter-decadal fluctuations, no specific trend, the future rainfall patterns is unpredictable.
The wet season starts in November or December instead of October as used to be the case in the past. The peak rainfall was always in April in the past, unlike the case today when it is more unpredictable and may also occur in February or March. The start of the dry season is currently shifted from August to May, and it continues until October. Hence May, June, and July have shifted from wet months to dry months	The wet season starts in November as it always has. A slight increase in moisture is observed during October, but it is still a dry month. Rainfall increases in December through January before declining in February. It reaches a peak in April as it always has. In May the weather is still wetter with a very substantial amount (430.9mm) before it declines substantially in June (132.1mm) (which marks the beginning of the dry season). The dry season starts in June and it continues through July, August, September to October
The length of the wet season is perceived to have been getting shorter because of the perception that May, June and July are currently dry whereas in the past they used to be wet.	On average the length of the wet season has always remained the same
Flooding events are no longer predictable, it can flood even in February whereas in the past floods roughly of high magnitude were expected on the 15^{th} of April	The amount of rain in February, March, April, and May have always been highly variable but maintained peak rains in April. The data indicate slight increase in the amount of rain over the last few years. Hence the data indicate that flooding events are more likely to happen in April and they are likely to be of high magnitude.
No recall of specific dry years, rather specific recall on years with severe flooding events which were 1963, 1978, 1980, **1982**, 1986, 1988, **1989**, **1990**, 1998, 2002 and 2008	Periods of above and below long term rainfall average (refer chapter 4) where years **1982**, **1989**, **1990**, 1991, and 1996 had some months of extremely wetter condition and on the other hand years 1973, 1974, and 1975 were extremely dry.
There are no clear perceptions of temperature change among respondents	There is no instrumental records on temperature for Kyela district

Source: Developed from data analysis

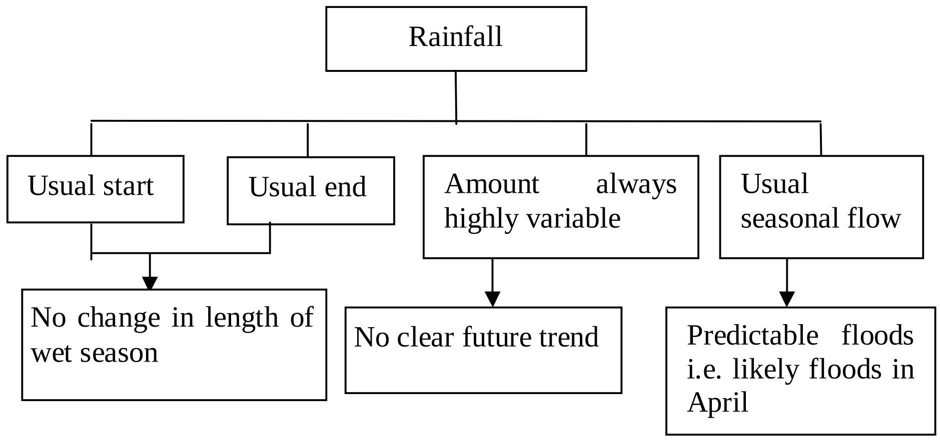


Figure 7: Picture of rainfall pattern from the analysis of instrumental records of rainfall (1960-2006)

Source: Developed from data analysis

Figure 7 is a picture of framework of the rainfall pattern in Kyela revealed from the analysis of instrumental records of rainfall. It shows:

(i) That variability in rainfall is not a new phenomenon;
(ii) No change in the length of the wet season;
(iii) The pattern/distribution of the season is usual; and
(iv) There is no clear pattern for future trend of rains in the study area.

The summary of available rainfall data for Kyela showed that rainfall patterns have remained highly variable and unpredictable over the period 1960-2006, with episodes of above and below long-term average rainfall. The data show high inter-annual and inter-decadal fluctuations, and the moving averages did not reveal any long-term trends.

The two data sets on climate further show differences in terms of the start and end of wet season, the distribution of rainfall and the amount of rainfall. While the objective climate data shows that the wet season had always started in November throughout the period of 1960-2006, respondents on the other hand made an observation that in the past the wet season started in October but currently it starts in either November or December. The rainfall records show that October cannot be categorised as a wet month as the average amount of rainfall in this month (14.1mm) has been negligible throughout the period of 1960-2006 (see Table 3 and Appendix 1 for details on the amount of rainfall in October).

Although respondents held a view that currently peak rains can be in February or March and they generally view that it is hard to predict the distribution of rainfall in any given year, the objective climate shows that the yearly distribution of rainfall has remained consistent for the period of 1960-2006. As Table 8 explains, the wet season had always started in November and the amount of rain had always been increasing in December through January before declining in February, picking up again in March and reaching its peak in April. In May the weather is still wet and it is only by June that the dry season begins. Surprisingly respondents perceived that the kind of rainfall pattern which is revealed by the instrumental rain records only existed in the ÷pastø, and that current rainfall distribution is unpredictable.

Most respondents perceive that the amount of rain has decreased and that the area is heading towards a dry environment. One explanation for this is that respondents are comparing the period of 1990-99 and the period of 2000-06; these two periods both had rainfall above the long-term average (3148.7 & 2705.1mm respectively) (refer to Table 2). The fact that the period from 1990-99, had had higher average rainfall than the later period might have created an impression among respondents that, the amount of rain is decreasing. However the rainfall records show that the amount of rain in 1970-78 (1486mm) was even lower than that of the period from 2000-06. (Refer to Table 2). Hence, contrary to what respondents said, the decrease in the amount of rain in 2000-2006 is not a new phenomenon in the history of the amount of rain in the study area. Further, there is no substantial evidence from the instrumental records of rainfall that the amount of rain is declining to the point that the area is heading towards a dry land.

Respondents perceive that the wet season currently ends in May whereas in the past it usually ended in July and in some years it ended in August. However, the rainfall records for the period from 1960-2006 show that the wet season has always ended in May and that June - August had always been dry (see Appendix 1 for details of the amount of rain in these months). It is not clear why respondents perceive the end of the wet season to be in July in the past. Respondents also held that the length of the wet season is currently shorter whereas the instrumental data show that on average the length of the wet season remained similar for the period from 1960-2006. Although the years 1973, 1974, and 1975 were particularly dry, respondents did not make any recall of drought in these years (or in any other years).

As far as flooding events go, respondents explained that in the past flooding events occurred only in April whereas currently Kyela can flood even in February. Floods are also perceived to be decreasing in frequency but increasing in intensity. There is no substantial evidence from the rainfall records to support the view that flooding events are on a decreasing trend. However, the slight increase in the amount of rain in April for the period 1990-2006 where rain had been above the long-term average (see Figure 3) may be partly consistent with observations that the intensity of floods is increasing. It is more likely however, that factors beyond the immediate region are implicated. Floods in Kyela are a result - both of rainfall within Kyela, and rainfall beyond Kyela, particularly in the Rungwe highlands. Hence in this case floods in February might be a result of rainfall from Rungwe highlands.

Respondents recalled flooding events in years 1963, 1982, 1989, 1990, and 2002; the instrumental records of rainfall are consistent with this respondentsô recalls as they show that these years had average rainfall amounts above the long-term average of 2658mm (300.1; 341.6; 395.9; 490 and 276.5mm respectively (See Appendix 1)). In the years in which rainfall was well below the long term average, namely 1973, 1974 and 1975 there is no suggestion from the respondents for flooding events (Table 8). There were no clear perceptions on temperature among respondents nor are there any temperature records for the study area.

CONCLUSIONS

Three main observations emerge from this comparison. Firstly, the experiences related by respondents regarding changes in the rainfall pattern are consistent. There have been no major differences between responses from the lowlands and that from the uplands and - like-wise, there have been no major differences between farmer respondents against non-farmer respondents. Secondly, although there are some points of consistency, peopleôs collective memories from interviews and discussions are often different from the evidence from the instrumental records of rainfall data. Thirdly, the two data sets are consistent in that floods are likely to be increasing in intensity. However they differ in that while respondents perceive that flooding events are no longer predictable the instrumental records show that the flooding events are more likely to occur in April as the case has always been. The analysis of instrumental records does not show any significant shifts in climate pattern rather higher variability as discussed before.

One possible explanation for these differences is that perceptions of climate and the instrumental record data are likely to be influenced by very recent events in the past few years such as the decrease in the amount of rain for the period of 2000-2006 compared to that of 1990-1999 as already discussed. The fact that people are not able to recall the past in detail or with full accuracy is well known in studies of oral history. **T**his does not mean to deny that the perceptions or experiences are invalid but means that reliance on subjective data should be treated with caution.

In line with Gbetibouo (2009), it could also be the case that the peoplesô experiences are personal and location-specific whereas the instrumental records of rainfall tend to be aggregate broad brush. This being the case then it is hard to conclude that the instrumental records of rainfall are 100% a representation of the rainfall pattern on the ground in the district. Rather, they present a general broad picture of the rainfall pattern for Kyela district. The responses by respondents in Kyela - on the other hand, are likely to be indicators of the existing differences in rainfall pattern in location specific areas as the reviewed literature indicates (see for example Gbetibouo 2009; Maddison 2007; Kumar and Jalal 2011; and Dasgupta *et al*., 2007). But also these peopleôs experiences might be revealing the fact that slight differences in seasonality might be amplified for specific villages whereas such slight changes might not appear in the instrumental records. Thus a further study is required to cover similar area coverage in terms of data sets i.e. instrumental records at very local scales e.g. village level compared to survey data at village level.

References

Archer, D. (2007). *Global Warming: Understanding the Forecast*. Blackwell Publishing Ltd: USA

Claiborne, R. (1970). Climate, Man and History. Angus and Robertson (U.K.) Ltd London Field 2005

Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D. and Jianping Yan, "The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis" (February 1, 2007). World Bank Policy Research Working Paper No. 4136 Available at SSRN: http: //ssrn.com/abstract

Gbetibouo, G. A. (2009). *Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability. The Case of the Limpopo Basin, South Africa*. International Food Policy Research Institute: Pretoria

Glantz, M.H. (2003). *Climate Affairs: A Primer*. Island Press: London

Goulden, C. (2011). Herder Perceptions of Climate Change http://scientistatwork as of 13/03/2012

Justice, C.O., Wilkie D., Putz F.E. and Brunner, J. (2005). Climate Change in Sub-Saharan Africa: Assumptions, Realities, and Future Investments (pp172-181) In Low P.S. *Climate Change and Africa.* Cambridge University Press: Cambridge

Kruger, R.A. (1998). *Analyzing and Reporting Focus groups Results*. Focus Group Kit 6 SAGE Publications Inc. London United Kingdom

Kumar, S. and JalalS. (2011). Local Perceptions of Climate Change In Peri-Urban Areas Of Khulna http://periurbansouthasia./local-perceptions-of-climate-change-in.html as of 15/03/2012

Maddison, D . (2007). *The Perception of and Adaptation to Climate Change in Africa*. The World Bank

Mate, J., Davies, K. and Kanter, D. (2009). The Risks of other Green House Gases, in Starke, L . *The State of the World*. Earthscarn: London

McGregor, D. (2008) Climate Change and Development. In Desai, V. and Potter, R. B. (Eds) *The Companion to Development Studies*. Hodder Education: London

Mungôongôo, C.G. and Yanda, P.Z. (2005). Risk, Livelihoods and vulnerability to flooding in the Songwe River Flood Plain of Kyela District. Accepted for Publication in UTAFITI Journal

OôBrien, K.L. and R.M. Leichenko. (2009). Global Environmental Change, Equity, and Human Security. Chapter 8 in R. A. Matthew, J. Barnett, B. McDonald and K. L. O'Brien (eds.) *Global Environmental Change and Human Security*. Cambridge, MA: MIT Press.

Ochoa, G., Hoffman, J. and Tin, T. (2005). *Climate: The Force that Shapes our World – and the Future on Earth*. Rodale International Ltd: London

Poku, N. & Mdee, A. (2011-forthcoming) Politics in Africa: An Introduction. London: Zed Books

Ribot, J.C., Najam, A. and Watson, G. (2009). Climate Variation, Vulnerability and Sustainable Development in the Semi-Arid Tropics. In Lisa, E., Schipper Fand and Burton, I. (Eds.) *Adaptation to Climate Change*. Earthscarn: London

Seitz, J.L. (2008). *Global Issues: an Introduction*. Blackwell Publishing: Oxford Silverman, D. (2000). *Doing qualitative research: A practical handbook*. Thousand Oaks, CA: Sage.

URT (2007). Local Government Capital Development Grant (LGCDG) System for Kyela District: Progress Review 2005/2006.

Appendix 1: Rainfall Data

Monthly Rainfall (mm) - Kyela (993310)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual	An. Aveg
1960	337.6	263.1	652.0	1275.0	194.3	229.9	55.1	0.0	0.0	0.0	8.9	105.9	3121.8	260.2
1961	158.2	91.4	314.2	1188.9	958.8	604.0	636.0	22.9	6.4	0.0	297.2	358.9	4636.9	386.4
1962	209.6	167.9	366.0	824.7	300.2	13.7	132.8	121.4	0.0	31.0	46.7	134.1	2348.2	195.7
1963	298.0	101.6	961.6	835.7	482.6	113.3	0.0	0.0	0.0	0.0	325.9	485.6	3604.3	300.4
1964	196.3	121.9	465.8	814.7	464.8	30.2	0.0	0.0	0.0	0.0	70.1	135.4	2299.3	191.6
1965	158.5	189.0	515.9	834.4	453.4	14.0	32.3	11.4	0.0	47.8	0.0	415.5	2672.0	222.7
1966	103.9	367.3	676.7	1368.8	467.1	233.2	46.0	0.0	36.8	14.7	177.0	136.1	3627.6	302.3
1967	155.7	95.5	104.4	397.3	1007.1	443.0	269.5	0.0	98.0	8.6	133.1	537.7	3249.9	270.8
1968	269.2	337.3	540.8	456.7	511.3	77.7	68.8	123.7	19.1	80.0	97.8	120.7	2703.0	225.3
1969	207.0	152.4	408.9	1167.1	794.5	162.6	45.7	31.8	0.0	0.0	292.1	102.9	3365.0	280.4
1970	146.1	233.7	605.8	242.1	134.6	208.3	76.2	50.8	0.0	20.3	85.1	130.8	1933.7	161.1
1971	119.4	151.1	535.7	671.8	304.8	88.9	186.7	0.0	29.5	0.0	158.8	382.0	2628.6	219.1
1972	92.8	105.5	420.0	705.0	250.8	68.0	79.0	1.4	0.0	25.0	194.0	41.3	1982.8	165.2
1973	16.8	35.7	29.3	184.3	17.3	34.0	4.6	0.0	0.0	11.5	9.0	15.8	358.3	29.9
1974	91.9	18.7	72.5	121.3	48.5	19.8	17.7	0.0	10.3	0.0	0.0	29.3	430.0	35.8
1975	14.8	22.1	59.4	129.4	58.2	41.8	13.4	7.5	0.0	4.2	10.3	48.0	409.1	34.1
1976	333.0	398.0	629.3	55.5	35.2	143.9	90.4	34.3	0.0	21.0	28.5	191.1	1960.2	163.4

1977	250.5	54.7	629.2	655.5	516.9	18.6	173.9	10.1	0.0	0.0	74.8	156.0	2540.2	211.7
1978	120.2	127.2	425.1	1121.9	34.2	7.3	2.0	10.2	0.0	37.4	63.0	68.1	2016.6	168.1
1979	22.0	31.7	120.1	212.0	118.9	18.2	9.1	5.5	0.0	0.0	14.1	48.6	600.2	50.0
1980	193.3	66.1	431.9	637.6	711.1	18.3	48.3	13.6	8.9	0.0	14.0	257.9	2401.0	200.1
1981	72.5	148.1	467.9	728.1	326.2	48.6	21.7	2.9	3.1	4.8	14.0	228.8	2066.7	172.2
1982	89.4	72.9	684.5	816.3	1340.2	123.1	245.6	85.7	6.1	95.8	375.7	164.0	4099.3	341.6
1983	145.2	124.5	629.5	572.1	301.3	429.7	229.4	25.1	0.0	34.1	0.5	178.1	2669.5	222.5
1984	212.7	191.8	526.2	866.3	341.9	200.9	181.0	0.0	0.0	0.0	108.0	263.4	2892.2	241.0
1985	192.5	234.7	614.6	1093.7	385.8	178.3	49.3	38.9	25.6	0.0	374.4	121.7	3309.5	275.8
1986	332.8	163.6	738.6	648.6	170.5	62.9	4.1	2.6	0.9	0.0	273.3	338.5	2736.4	228.0
1987	115.6	111.0	218.6	356.0	609.2	0.7	3.8	0.0	0.0	0.0	32.4	28.0	1475.3	122.9
1988	783.3	72.5	104.4	175.8	37.9	58.7	112.6	10.6	0.0	8.0	245.8	42.7	1652.3	137.7
1989	171.9	54.3	277.6	2161.5	1362.6	198.3	47.9	189.7	10.2	49.3	180.2	46.9	4750.4	395.9
1990	137.8	318.8	374.8	529.7	1393.7	84.7	10.5	34.9	4.4	34.7	159.0	101.7	3184.7	490.0
1991	179.3	82.4	414.8	2744.6	416.7	18.1	115.9	98.8	8.0	52.4	138.4	308.5	4577.9	381.5
1992	401.4	54.9	380.8	906.6	383.6	76.8	45.4	2.3	0.0	0.0	252.2	52.6	2556.6	213.1
1993	205.7	104.8	738.4	850.0	340.2	98.4	43.8	0.0	0.0	0.0	0.0	42.3	2423.6	372.9
1994	228.9	260.3	314.7	1054.1	396.8	23.2	82.0	0.0	0.0	0.0	207.1	374.9	2942.0	245.2
1995	211.8	175.2	552.3	1142.1	699.6	20.1	53.4	0.0	0.0	0.0	21.0	84.4	2959.9	246.7
1996	165.9	333.6	1196.5	1577.1	624.5	145.6	16.5	1.3	0.0	0.0	0.0	169.7	4230.7	352.6
1997	231.7	38.2	967.5	514.9	73.9	194.3	205.3	2.0	0.0	8.5	22.6	380.6	2639.5	220.0
1998	178.8	192.1	363.2	1222.5	43.5	63.0	112.6	13.6	22.0	0.0	12.3	56.9	2280.5	190.0
1999	172.3	140.4	818.1	1544.5	409.5	70.2	238.9	102.4	9.2	8.8	92.2	85.3	3691.8	307.7
2000	158.9	106.7	228.6	675.7	264.3	296.6	43.7	35.0	4.1	8.9	171.6	236.6	2230.7	185.9

2001	259.5	95.2	378.4	853.0	670.5	167.9	66.0	12.8	0.0	0.0	0.0	96.5	2599.8	216.7
2002	424.7	320.1	522.1	1359.6	166.1	113.5	3.6	20.1	2.3	0.0	258.4	127.5	3318.0	276.5
2003	164.0	88.2	534.0	567.1	331.7	199.4	38.2	16.5	48.2	0.0	6.1	269.2	2262.6	188.6
2004	193.5	273.0	224.3	811.2	43.2	253.6	7.0	13.3	37.4	57.3	75.8	173.3	2162.9	180.2
2005	200.0	284.7	316.4	982.7	587.2	131.3	126.5	0.0	2.4	0.0	0.0	173.0	2804.2	233.7
2006	142.2	340.2	247.0	1172.7	665.6	360.1	129.9	0.0	8.6	0.0	250.7	240.5	3557.5	296.5