THE IDIOSYNCRASIES OF NAMIBIAN RAINFALL

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INTRODUCTION

It is probably safe to say that the rainfall of any country or region as its own idiosyncrasies. It is necessary that all persons involved in agriculture should take cognizance of the character of rainfall and its idiosyncrasies so that their actions are in harmony with these characteristics. During the past year the Ministry of Agriculture, Water and Rural Development (MAWRD) has commissioned a study of the rainfall distribution in Namibia and the results of this study has brought forward many of the characteristics of Namibian rainfall. This study has also added greatly to the database of rainfall being kept within the Agro-Ecological Zoning (AEZ) programme. This paper looks at various interesting aspects of annual and monthly rainfall in Namibia.

ANNUAL RAINFALL

Namibia is an arid country, probably the driest country in Africa south of the Sahara. It also has deserts on its eastern (Kalahari) and western edges (Namib). The Namib is a true desert with mean annual rainfall less than 20mm in places and mostly below 50mm. The Kalahari stretches over three southern African countries, i.e. Namibia, Botswana and South Africa and is actually not a true desert but a semi-desert with mean annual rainfall in the 150-350mm range. The mean annual rainfall for Namibia is about 270mm and ranges from less than 20mm in the Namib Desert to more than 700mm at Katima Mulilo in the Caprivi strip. The distribution of land area receiving different categories of rainfall is as follows:

Rainfall (mm)	Land Surface (%)
<100	22
100-300	33
300-500	37
>500	8

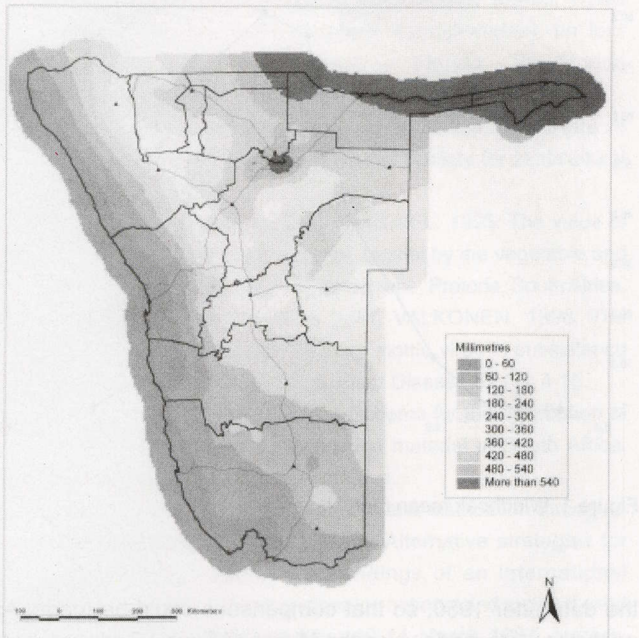
These are the figures that are usually quoted when describing Namibian rainfall in general. These figures are not disputed by the latest study, but this is too general to be of any use to anyone except those that need only a cursory knowledge of Namibian rainfall.

During the last five years I have tried to educate farmers and other role players in agriculture to use the median rainfall rather that the mean as a measure of the rainfall to expect at any place. (The median value is that value that can be expected at least 50% of the time.) This is because rainfall is statistically skewed and a few large falls tend to inflate the mean values. Maps 1 to 3 show the distribution of mean and median rainfall as well as the amount by which the mean is higher that the median (as a percentage of the median). The mean/median increases from the southwest to the northeast with a secondary maximum in the so-called maize triangle (Tsumeb-Grootfontein-Otavi). The difference between mean and median is negatively correlated with the median value and reaches a maximum at the coast near Swakopmund. The coefficient of variation of annual rainfall is usually more than 30% and may even reach more than 90%, especially in the drier parts of Namibia. The distribution is shown in Map 4. The coefficient of variation for the annual rainfall is much less than that for the individual months, but the actual values of the standard deviation are quite large and mean that the year-to-year variation can be considerable. In a recent paper (Du Pisani, 1999b) I used the deviation and variation as an indicator of drought vulnerability. The larger the year-to-year variation, the greater the vulnerability of a place is to drought occurrence. The management of the farmer and his bank balance also determines vulnerability. Management determines the effect of below normal on the productivity and profit of any farming enterprise.

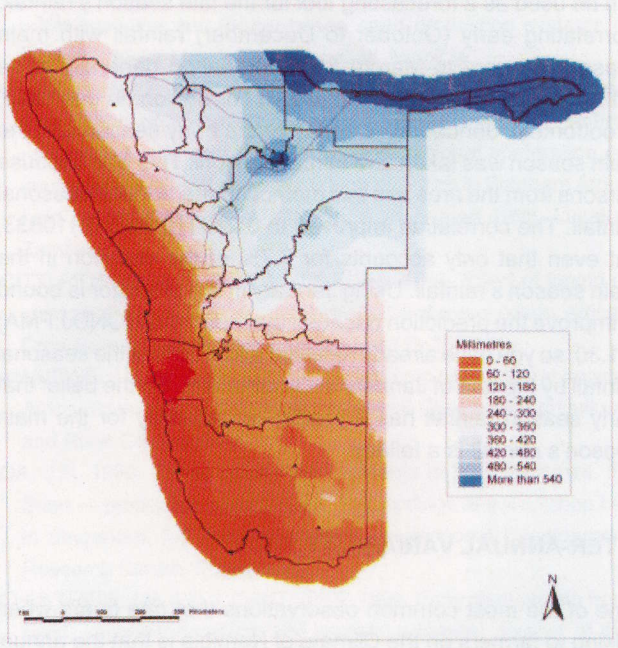
Another factor that might influence the vulnerability is the trend of annual rainfall over time. Because I have been told repeatedly during the last five years that Namibia s rainfall has been decreasing, I used the opportunity of having the most data available yet to find out if this is indeed true (Du Pisani, 1999a). Contrary to expectations, the trend over the last half century has not been all negative. There are quite large areas where it has been positive. Another fact, which surfaced during this study, was that the trend might have been negative at many places during the last 50 years, but if you take the whole century, there was virtually no trend at all. This shows that annual rainfall does vary considerably from year-to-year, but over a period of a century, what has been around comes around in some form or the other.

MONTHLY AND SEASONAL RAINFALL

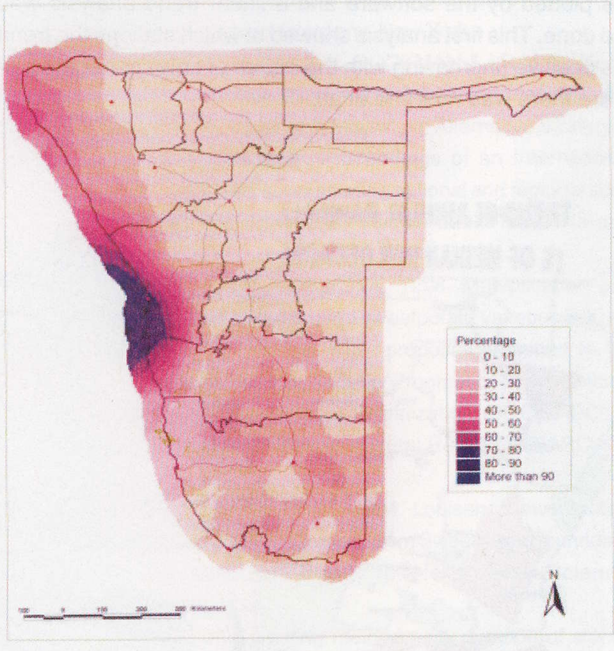
Namibia is predominantly a summer rainfall area (Map 5). Only a small portion of the southwestern part of the country receives a majority of its rainfall in winter. This area is adjacent to the winter rainfall area of the Cape and the few post frontal air mass surges which reach Namibia during winter also brings rainfall to this very dry part of Namibia. In exceptional years they might also bring rain to other parts of Namibia, but it has a negligible influence on the total rainfall in the major portion of Namibia. The three months of January, February and March are the 'heart' of the rainy season in Namibia. In some years the contributions of December and April rainfall can also be considerable, but this is the exception rather than the rule. I found Namibians talking of the short and long rains ('Kleine Regenzeit' and 'Grosse Regenzeit'). This is a term used mostly in East Africa where they have a definite short rains in March-



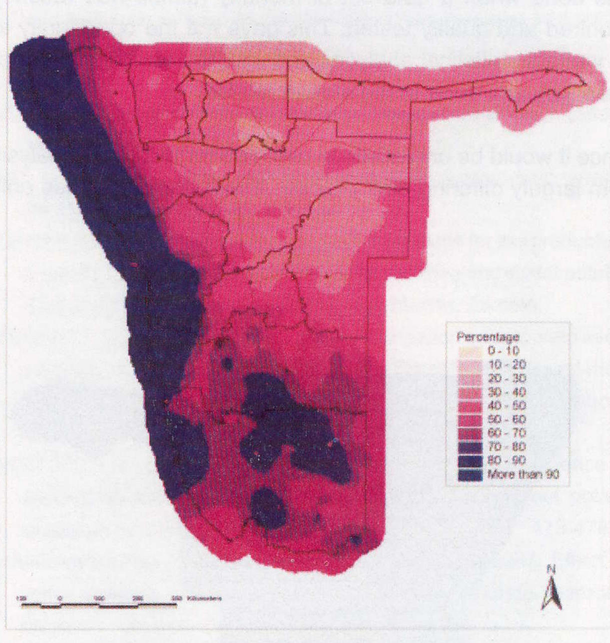
Map 1. Average annual rainfall.



Map 2. Median annual rainfall.



Map 3. Difference between average and median rainfall as percentage of median.



Map 4. Coefficient of variation of annual rainfall.

April and then a break in rainfall before the long rains from June to September fall. Implicit in this concept is two rainy seasons with a definite break between them. Looking at Namibian data, there is no definite break. It is simply the short rains blending into the long rains of January to March. The figure for Windhoek gives an indication that there is no definite break between two rainy seasons, but only one season which starts rather slowly in September and peaks in January to March and then falls away sharply again (Figure 1).

Another belief that I picked up is that the early season s rainfall can be used as a forecasting tool for the late season s rainfall. Correlating early (October to December) rainfall with main season (January to March) finds correlation generally to be 0.1 or less, which means virtually no correlation. In one case, Grootfontein, January was added to the early season and the main season was taken as February to April. This was because persons from the area use this method to predict total seasonal rainfall. The correlation improved to 0.278110 from 0.110833, but even that only accounts for 7.7% of the variation in the main season s rainfall. Using January in the predictor is bound to improve the prediction because the mean ratio (ONDJ:FMA) is 1.30, so you have already received about 60% of the seasonal rainfall by the end of January in Grootfontein. So the belief that early season rainfall has a predictive capability for the main season's rainfall is a fallacy.

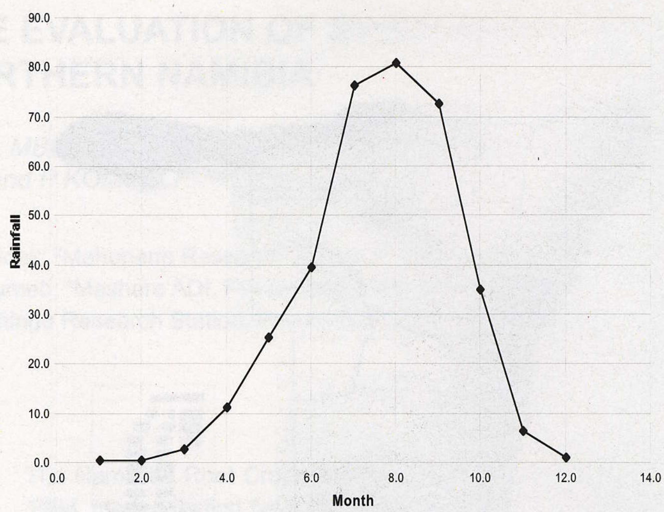


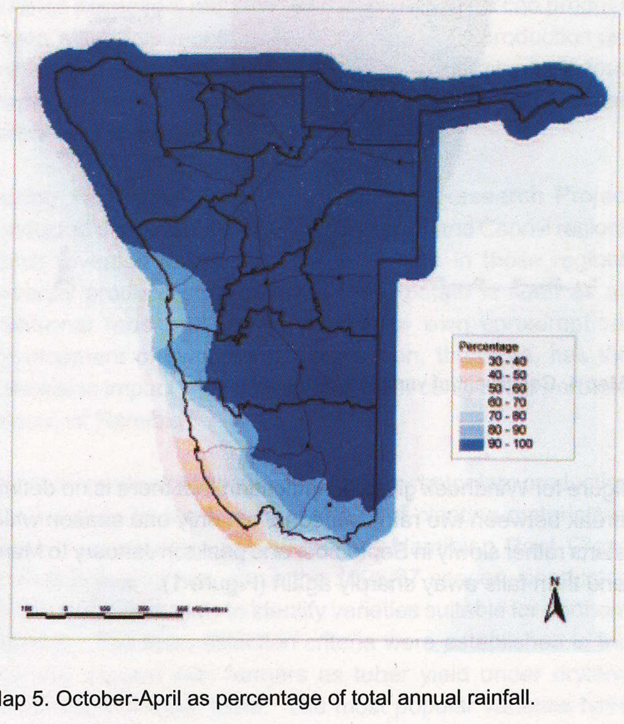
Figure 1. Windhoek mean monthly rainfall.

INTER-ANNUAL VARIABILITY

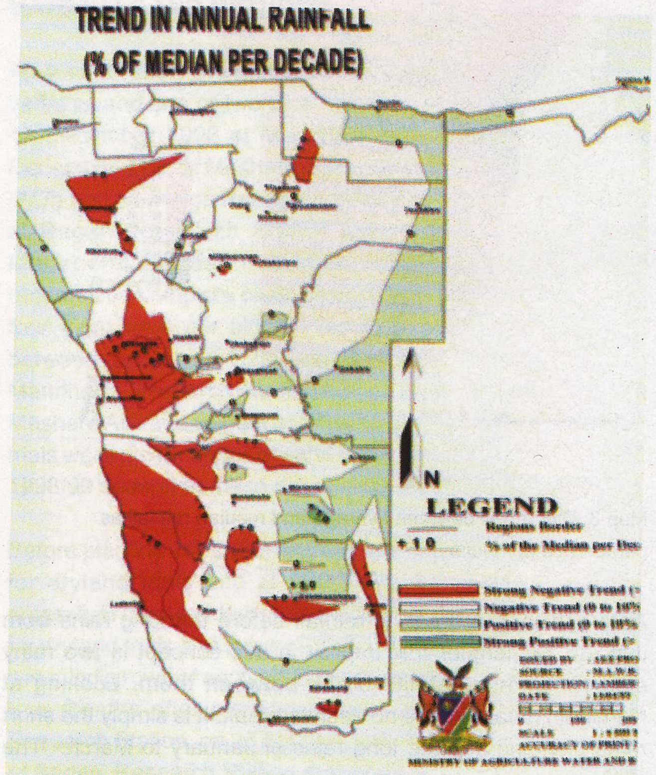
One of the most common observations that one hears when talking to farmers on the Climate of Namibia is that the annual rainfall has declined in the recent past. The only way to prove or disprove this observation is by actually making a study of the annual rainfall at as many places as possible and then to determine whether there has been any discernible trend. This was done when a data set of monthly rainfall was recently acquired and quality tested. This gave me the opportunity to do various statistical analyses and also to determine whether there was any trend to the annual rainfall.

Since it would be unrealistic to use data for this trend analysis from largely differing time periods, it was decided to use only the data after 1950, so that comparisons could be made. All analyses were made using the Microsoft Excel 97 spreadsheet software package, which includes many statistical analyses and also has the ability to do trend analyses.

Trend analysis was done on the march of annual rainfall that was plotted by the software and a linear trend analysis was also done. This first analysis showed at which stations the trend was positive (increasing with the march of time) or negative or where there was no trend at all.



Map 5. October-April as percentage of total annual rainfall.



Map 6. Trend in annual rainfall (% of median per decade).

Table 1. Trends of annual rainfall for Namibian Rainfall Stations

Number Stations with Negative trend	Number of Stations with Positive trend	Number of Stations with Zero trend
201	80	5

These positive and negative values were plotted on a map of Namibia that showed whether there was any spatial coherence to the trend. This showed some coherence but did not give a good idea of the steepness of the trend and did not lend itself to spatial analysis. Further analysis was done on the plotted graphs whereby the values of annual rainfall were read off at relevant decadal values (say 1960 and 1990) and then the slope of the line was calculated in mm of rainfall per decade (positive or negative). Expressing this slope as a percentage of the median rainfall for the station followed. This was done to be able to make valid comparisons between rainfall stations. A trend of 10.0mm per decade might not mean much at a place like Katima Mulilo with a median annual rainfall of 625.2mm but might be considerable for Swakopmund with a median annual rainfall of 7.6mm.

Table 1 shows that in the **majority** of cases the **annual rainfall did show a negative trend**, i.e. the **perception that the rainfall has decreased is true**. It is impossible to reproduce the whole table of all the rainfall stations and the trends detected because of its sheer size. A map has been prepared, which shows the areas with positive and negative trend (Map 6). Another fact that arose from this study is that the period used for the study has a profound effect on the result. Not many places have more than half a century's data, but Windhoek has more than a century's record. The trend over the last fifty years is definitely negative, but using the total length of record found zero trend.

Another aspect of rainfall is an area's vulnerability to drought. Drought vulnerability is caused by many factors such as management and other socioeconomic factors. The inter-annual variability of rainfall as well as the intra-seasonal variability usually causes vulnerability to drought due to the rainfall regime. The variability from year to year effects all farming enterprises, while the within season variability usually plays havoc with dryland crop production since a relatively short dry period during a particularly vulnerable growth period might wipe out an entire crop while the total seasonal rainfall might be above-normal.

To illustrate the range in inter-annual variability, and thus vulnerability, let us look at the actual variability for selected rainfall stations in Namibia (Table 2). These were selected to be examples for different rainfall regimes in Namibia. Namibia's rainfall generally decreases from the Northeast to the Southwest.

The standard deviation steadily increases with increasing mean annual rainfall, while the coefficient of variation (CV) in turn steadily decreases. The CV values stay high (30% or more) except for Outjo and Rundu. A map of the coefficient of variation can indicate the spatial variation in this parameter. According to this map the western and southern portion of Namibia is much more vulnerable to droughts than the Northeast. On general, the lower the annual rainfall, the greater the vulnerability. Of course, it is not only the coefficient of variation

Table 2. Actual variability for selected rainfall stations in Namibia

Station	Latitude	Longitude	Mean Annual Rain (mm)	Median Annual Rain (mm)	SD (mm)	CV (%)
Diaz Point	26°38'S	15°06'E	18.1	14.0	15.6	85.9
Aus	26°41'S	16°19'E	91.1	85.5	54.2	59.5
Keetmanshoop	26°32'S	18°07'E	159.6	150.8	97.7	61.2
Aroab	26°47'S	19°39'E	167.8	47.5	99.2	59.1
Mariental	24°37'S	17°58'E	202.0	184.5	113.4	55.2
Aranos	24°08'S	19°07'E	205.3	198.5	125.5	62.1
Rohrbeck	24°08'S	18°28'E	206.1	166.3	113.0	54.8
Tsumis	23°43'S	17°12'E	217.6	188.9	141.6	65.1
Beenbreck	23°28'S	17°56'E	255.7	243.9	125.8	49.2
Abochaibis	22°39'S	16°18'E	279.0	265.0	120.1	43.0
Dordabis	22°56'S	17°41'E	310.9	300.2	125.0	40.2
Windhoek	22°34'S	17°06'E	353.5	325.6	143.4	40.6
Hochfeld	21°39'S	17°52'E	405.8	395.0	153.4	37.8
Omatjenne	20°24'S	16°29'E	429.7	399.9	154.9	36.0
Outjo	20°07'S	16°09'E	427.2	424.2	127.4	29.8
Otjiwarongo	20°27'S	16°40'E	457.1	446.9	188.7	41.3
Otavi	19°38'S	17°20'E	528.1	501.6	164.3	31.1
Grootfontein	19°36'S	18°08'E	542.5	515.0	175.9	32.4
Rundu	17°55'S	19°46'E	573.7	594.6	163.1	28.4
Katima Mulilo	17°28'S	24°15'E	669.1	625.2	220.7	33.0

that effects vulnerability, but also the absolute values of the deviations, which tend to grow larger as the rainfall increases. This makes even the rainier parts of Namibia still vulnerable to droughts, especially since the crop growing areas, both commercial and subsistence, is situated in these parts of Namibia. The monthly variations are much larger than the annual variations and during the rainiest months of January to March, Rundu, which has an annual coefficient of variation below 30%, has coefficients of variation of 55.7, 59.2 and 68.8 percent, respectively.

Another way of illustrating the vulnerability (variation) is to plot the annual rainfall against time. The annual rainfall for Rundu against time is plotted in Figure 2. This figure shows us how the year-to-year fluctuations have varied during the past. During the 1950's to the early 1960's the variation was quite small but after 1963 the varying looks quite alarming. During the 1970's, which are reckoned as good years, the annual variation was quite large and only damped during the 1980's with larger variations again during the 1990's. The trend line was also drawn in and it is obvious that the high rainfall during the late 1960's and 1970's tends to make it negative for the whole period.

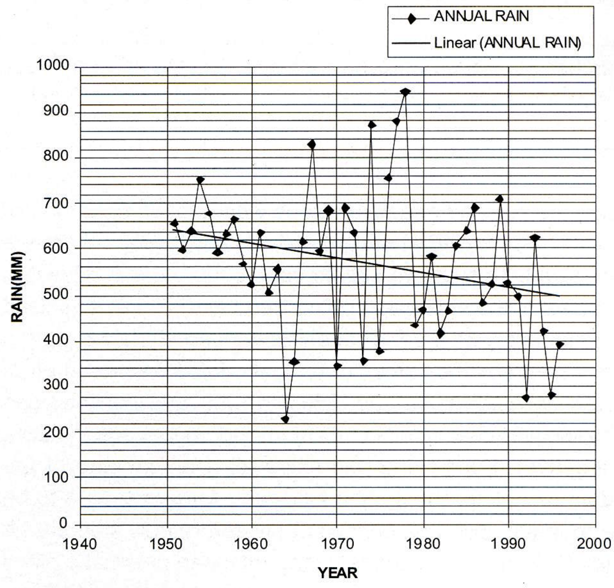


Figure 2. Annual rainfall (mm) for Rundu plotted over time.

CONCLUSION

This paper has illustrated that Namibian rainfall might be low, but that it has definite idiosyncrasies that should be taken into account when planning or managing any agricultural activity. I hope that certain beliefs or myths have been demystified and put into perspective. This paper shows that the study of rainfall has many facets and should be actively pursued to make agricultural activities more scientific, effective and efficient.

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