Brandberg climatic considerations

John D.S. Olszewski
P.O. Box 5211, Ausspannplatz, Namibia

Limited information is available on the climate of the Brandberg. Some neighboring stations show congruous detail with previously published information related to the surrounding desert plains and less arid plateau, but have little relevance to the inselberg itself. The presently available information from the mountain itself indicates reliable winter rainfall much further north than what would be expected, and a wet June following the El Niño year of 1983, whereas rainfall usually peaks during the January to March period. The microclimate of the mountain is expected to be unique for its area, with moderate temperatures and a much higher amount of reliable rainfall through orographic effect, which also appears to be borne out by the limited data available. Further interpretation requires more quantitative data.

INTRODUCTION

The extinct volcanic mount forming the Brandberg, with the highest peaks in Namibia (2573 m), is a distinctive feature of the landscape of Namibia. Its nearest geographical neighbours in altitude are the peaks of the Auas Mountains (2479 m), just south and south-east of Windhoek, the Erongo Mountains (2319 m), 110 km to the southeast of the Brandberg and those of the Otjihipa Mountains (2016 m), straddling the Kunene River on the northwestern border of Namibia. These other mountains all rise, however, from the elevated African plateau (over 1200 m above sea level), while the Brandberg stands in lonely splendour on the inland fringe of the Namib desert. The geographical setting alone predicts a unique micro-climate for the area.

The field of micro-climatology is, however, often dogged by the absence of sufficient data, or a complete lack of data, with which to support assumptions. The Brandberg Massif is no exception, as there has never been a perceived need to acquire any form of climatic information from this mountain. Whichever, the climatological background for a project such as reported in this volume requires detail and/or assumptions as are provided below.

The Brandberg predates the split-off and eventual departure of the Brazilian shield from Gondwanaland some 135 million years ago. The breakup of Gondwana left this peak in close proximity to the developing South Atlantic Ocean, at present 80 km to the west, which provided a source of moist air. The onset of the extreme aridity of the Namib Desert at the base of the mountain began some 5-2 million years ago, while the present climate range within this arid environment is presumed to have been fairly stable for the last 20 - 25 000 years (Tyson 1986). Ecological processes should, therefore, have developed in harmony with the mountain's climate over such an extended period.

The greater part of Namibia, in common with the rest of southern Africa, is situated on an elevated plateau at an average altitude of 1000 - 1200 meters. Most of southern Africa also lies within the sub-tropical high-pressure latitudinal belt. The results are cooler summers and limited, but colder winters than at similar latitudes elsewhere. A considerable up-welling of deep, cold water (Benguela current) occurs along the western coast of Namibia. The associated circulation patterns have a major effect on the climate of the entire country (Jury 1999; Jury & Engert 1999), with the result that it has 10 hours of sunshine for 300 days during all but the wettest of years. Namibia is subject to a semi-permanent upper air trough associated with this up-welling. Expected hotter temperatures are, however, modified by altitude above the western escarpment, while the low-altitude, western coastal plain produces the unique phenomenon of a coastal low pressure centre.

The Namibian climate varies from the sub-humid zone of the far north-east, with mean rainfalls on the 500 - 550 mm annual level, to the hyper-arid Namib (Lancaster *et al.* 1984), where fog precipitation is more than the annual average rainfall figure (Nieman *et al.* 1978). A marked summer rainfall maximum regime is prevalent across all of Namibia but the extreme south-west, where the rainfall pattern is orientated to a winter time regime. In contrast to the summer rainfall area, scant winter falls recur reliably in the southwestern extreme of the country. Arid conditions in the country, particularly in summer rainfall areas, are intensified by a very high variability factor in rainfall. Actual measurements at individual stations can vary by hundreds of per cent above the mean figure to absolute zero for a particular month. Such variability is experienced over most of the country.

The main moisture source for most of Namibia is that of the Congo air-mass, which, during the austral summer, can flow southward with a depth of 7 000 m. A weaker moisture input is derived from a much modified Indian Ocean air-mass which sweeps westwards across the sub-continent from the coast of Natal and Mozambique, and before reaching Namibia with a much shallower level of penetration. During winter, the South Atlantic anticyclone migrates northwestwards and moist Atlantic air is introduced over the southern and western parts by recurrent, eastward-sweeping fronts.

The Brandberg is situated in the summer rainfall area. At that latitude, most precipitation is in the form of summer thunderstorms (Gamble 1980; Sharon 1981), but the amount, range and intensity of individual rainfall events (Sharon 1981), may vary considerably from the scant amounts detailed for such an arid climate (Lancaster *et al.* 1984; Nieman *et al* 1978), or as indicated by mean rainfall isohyets. In fact, the only safe assumption regarding rainfall in an arid to semi-arid environment is that any year could be extremely dry.

The base of the Brandberg is very similar in its climatological setting to hyper-arid conditions (Olszewski in prep.). The altitude of the peak and the upper reaches of the mountain will, however, ensure an increase in rainfall as compared to the base and the lowest foothills through orographic effect. The well-known occurrence of advective fog influencing the desert plains (Olivier 1992) may affect the foothills, but is unlikely to have any vertical value.

CLIMATIC DATA

Unfortunately, there is no reliable data available for the upper reaches of the Brandberg. The nearest climatic information available was recorded at Uis Mine 40 km to the east. The information presented by Breunig (1990), from data gathered by Harald Pager between October 1977 and May 1985, does, however, provide some detail where nothing was previously known. Unfortunately, these data are discontinuous and neither altitude nor daily measurements were available for re-analysis. The Uis data set is more accessible, though the duration of this station was brief, being between 1967 - 1980, during the so-called 'wet seventies'. These data can be skewed by this truly wetter range of years, in particular 1972, 1974 and 1976. The Uis temperature and humidity data series (*vide* Appendix) does, however, provide a baseline from which other studies may develop.

This extreme aridity at the base of the Brandberg is shown by current data sets, in particular from

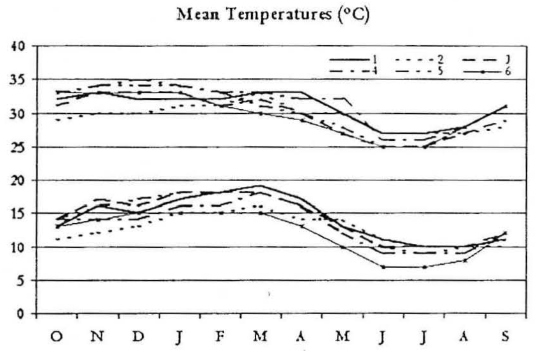

Figure 1. Average monthly maximum and minimum temperatures (°C) for 1. Uis; 2. Gobabeb; 3. Emeritus; 4. Usakos; 5. Karibib; 6. Eremutua.

Gobabeb, a station 200 km to the south (23°34'S, 15°03'S, 407 m. amsl). Though more relevant for the inner Namib Desert, some ranges of data such as temperature and humidity (Figures 1 & 2, Appendix) should be relevant even at that distance from the massif. Other relevant stations are further inland, i.e. Uis (21°13'S, 14°52'E, 800 m. amsl), Emeritus (23°00'S, 15°43'E, 1000 m. amsl), Eremutua (20°54'S, 15°47'E, 1250 m. amsl), Usakos (22°00'S, 15°35'E, 873 m. amsl) and Karibib (21°56'S, 15°51'E, 1170 m. amsl). As coastal detail is modified by the immediate presence of the South Atlantic Ocean, and since this level of modification cannot be expected to extend as far inland as the Brandberg, e.g. as qualified by the Gobabeb data-set (Lancaster *et al.* 1984), data from stations such as Pelican Point, Walvis Bay, Swakopmund and Möwe Bay are not applicable.

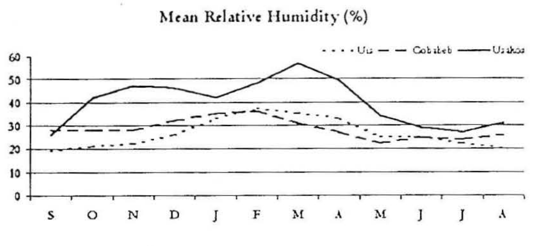

Figure 2. Average monthly relative humidity at 14h00 for Uis, Gobabeb, and Usakos.

Little more can be done in the absence of definitive data, other than to apply general meteorological principles and practical experience to assume the extant conditions and place these in context. The two main parameters that should be examined are rainfall and temperature. Both of these provide the necessary substance to any review of climate.

ASSUMPTIVE CLIMATE

RAINFALL

A massif of this size must be expected to have an individual rainfall regime, which is influenced by the mountain itself (Huschke 1959; Tyson 1986). This regime will have little connection with the general range of conditions at the base and in the northern Namib. Orographic rainfall does not have an automatic increase factor as one ascends the mountain - the prevailing wind pattern will have a distinct influence, determining which side of the mountain is drier or wetter. The prevalent moist airflows during the summer months are from WNW to ENE (Preston-Whyte & Tyson 1988). These faces of the Brandberg would reveal this fact were data available.

Rainfall data recorded at Uis Mine exhibit an average mean of 100 mm. The bulk of this precipitation, some 70%, can be expected during January to March, which is similar to other inland stations (Figure 3). The likely spread of months at higher altitudes on the Brandberg should include the period from November to April, which compares fairly well with figures provided by Breunig (1990). The presence of middle-layer cloud will provide precipitation, even showers, during these and other months. Such precipitation rarely reaches the ground in any substantial amount, but high peaks such as those on the Brandberg, should receive more rain.

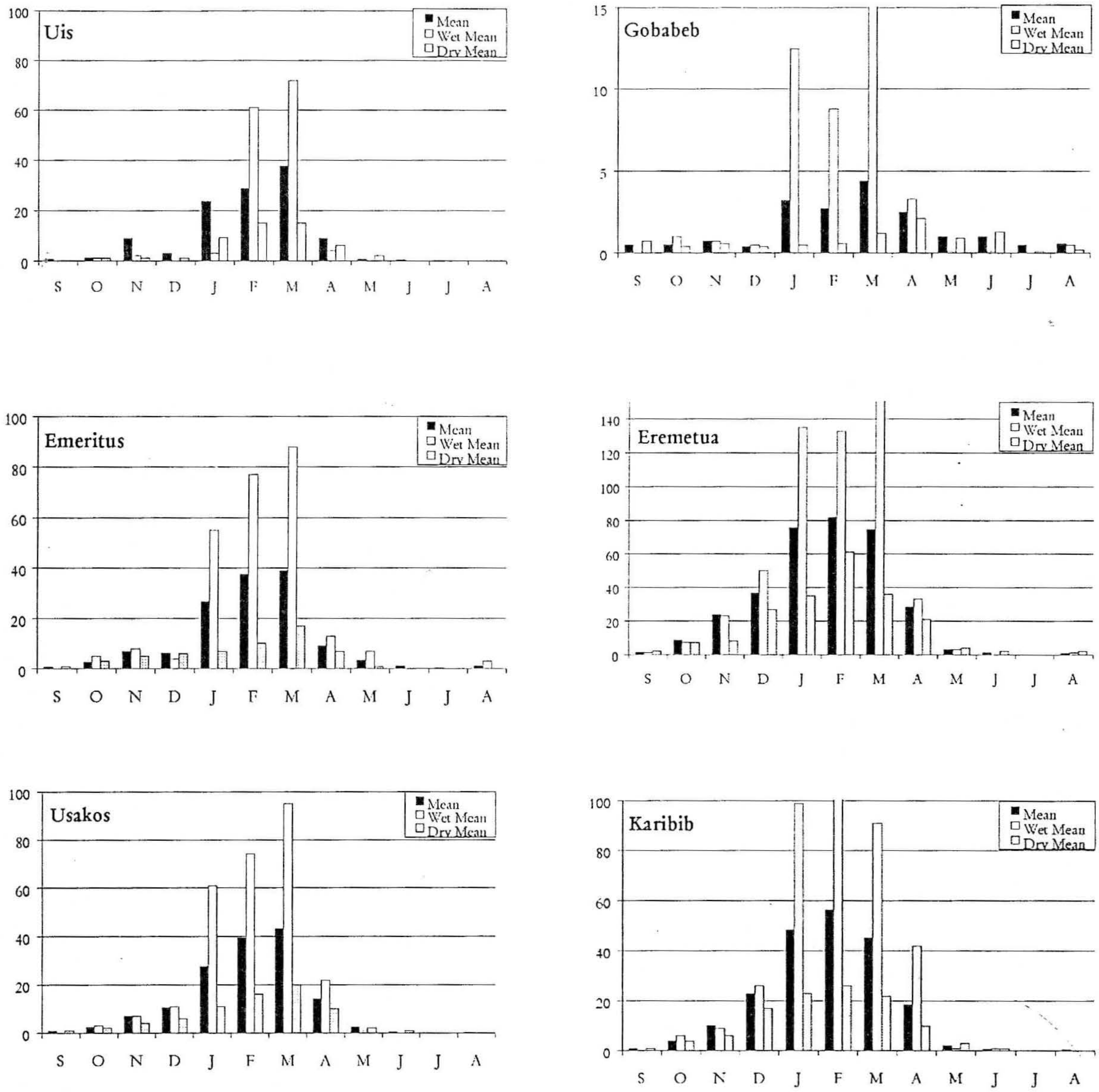

Figure 3. Average monthly rainfall recorded in mm. at Uis, Gobabeb, Emeritus, Eremetua, Usakos, and Karibib for all recorded years, for above average wet years, and for below average dry years.

The paucity of rain from April 1980 to January 1982 as indicated by Breunig's data (Figure 4), not surprisingly, reflects the brunt of the drought-ridden early eighties period. But even in this brief set of data an interesting condition exists. North of the 25th parallel, winter rain is scarce or non-existent, so the occurrence of winter rain, particularly within June and July, over a period of seven full years remains intriguing.

Cold fronts are capable of extending well beyond their expected latitudinal range during winter, resulting first in an induction of air from a northwesterly direction. This flow can produce considerable middle-cloud cover. These alto-clouds are certainly capable of producing virga descending hundreds of metres (Olszewski pers. obs.). Doubtless, these virga result in precipitation on the upper slopes of the Brandberg, particularly on windward slopes. Furthermore, the immediate passage of the front, at the alto-cloud level, will result in a rapid change of the airflow to a southerly component. There will be a drop in temperature and with the moist air already condensed into cloud, a further drop in temperature will cause precipitation to either increase or commence in earnest. Again, the windward slope will benefit substantially and all-round dampening should be the overall result.

That the isolation of the Brandberg would result in such a set of occurrences can be imagined as possible, but unlikely. The records presented by Breunig (1990) prove the imagined to be reality. The percentage of value, or the intensity associated with each distinctive set of events, may be uncertain, but when four out of the 10 wettest months are to be found in June (three) and July (one), there are certainly both amount and intensity of value. An inherent flaw of the cumulative rainfall data is that both value and intensity are unavailable.

In the sub-tropical high-pressure belt the occurrence of winter rain is unusual. In any further studies it would be desirable to obtain detail from both the northerly and the southerly slopes of the Brandberg.

Breunig (1990) noted September as the driest month. Not even the developing El Niño (*vide infra*) of the southern African 1983 wet season altered that statistic, but from November onwards, with January and February falling short, as would be expected, it proved to be the wettest of the brief sequence of years. Furthermore, current research indicates that, following a Pacific El Niño event, there is the possibility of some winter rain, particularly during June. The occasions are often little better than drops of rain, but they do indicate an interesting aftermath to the event. June 1983 was one of the wet Junes on the Brandberg.

An expectancy of above 200 mm a year for the higher altitudes of the Brandberg would not be an unreasonable estimate (Breunig (1990) provides no cumulative annual totals). This is still very low compared to Namibia's interior to the northeast, but compares well to the southern inland parts of Namibia. Given the variable nature of rainfall in an arid climate, there shall be a considerable range of variability to such an estimate, as was indicated in Breunig's (1990) article. Due to the altitude and prominence of the peak, however, there could well be an enhanced consistency to the annual rainfall pattern: the variability factor could be reduced to a level of near-regularity, an unusual condition even in the sub-humid parts of northeastern Namibia.

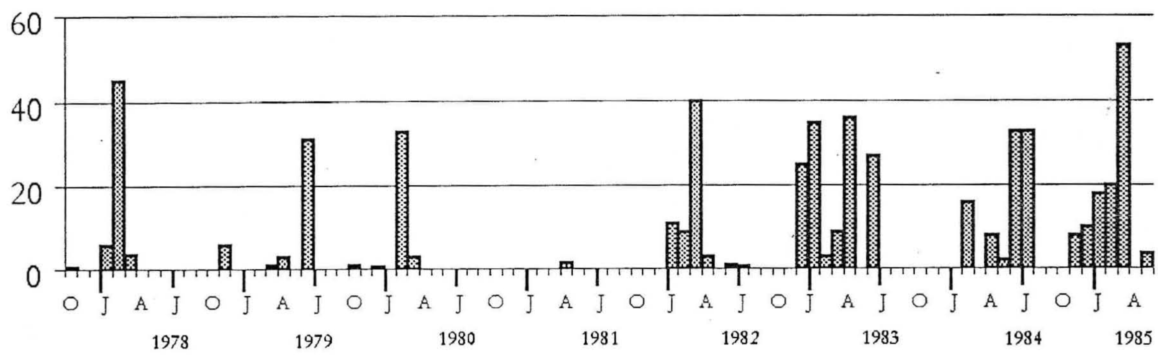

Figure 4. Recorded rainfall in mm. on the Brandberg Massif between October 1977 and May 1985, abbreviation on x-axis for January, April, July, and October (after Breunig 1990)