Y. APPENDICES – OTHER SUBJECTS

Appendix Yb1. De Hoop Vlei - Floods and droughts – From S Butcher's MSc Thesis

4.4. RECORDED EXTREME EVENTS

During the past century De Hoop Vlei is known to have overflowed its southwestern banks and flooded surrounding farmlands on two occasions, namely in December 1906 and August 1957. At the opposite extreme in its water regime most of the vlei was dry, except for the pools formed by some springs, in the years 1903, 1945, 1975 and 1980. These occurrences are referred to as floods and droughts respectively and are discussed further in this section. Published information on these events is limited to a list of the years of their occurrence (Harrison, 1957) and a brief description of the 1957 flood (Uys and MacLeod, 1967). From the average rainfall record for the catchment the years of excessive or deficient rainfall have been extracted and ranked in Table 4-1. In the ensuing discussion the verbal accounts of these events are compared with the information contained in this table and the monthly rainfall record.

4.4.1. Floods

The water level associated with flooding of the surrounding farmlands has never been directly measured. Although the department of Nature Conservation has a record of water levels at De Hoop which covers the period April 1958 to August 1968, it is incomplete and has several inconsistencies, since the gauge was moved or replaced three times during this period. An autographic recorder has been in operation since 1978, during which period water levels have been relatively low. Crucial periods such as the flood of 1957 and the refilling of the vlei after drought in the years 1977 and 1981 are either not covered, or are omitted from this record. It is therefore not possible to utilise these data to determine the dynamics of the De Hoop hydrological system and its response to excessive rainfall.

Table 4-1. RAINFALL EXTREMES, 1882 - 1980

A. Rainfall in excess of 127% M.A.P. (x̄ + 1.s)

Rank	%M.A.P.	Hydrol. year
1	275	1909
2	150	1907
3	144	1902
4	143	1957
5	140	1977
6	138	1951
7	134	1904
8	(131	1888
	(131	1890
	(131	1921

B. Rainfall less than 76% M.A.P. (x̄ - 1.s)

Rank	%M.A.P.	Hydrol. year
1	58	1973
2	60	1928
3	66	1970
4	67	1969
5	(72	1968
	(72	1899
	(72	1906
8	73	1950
9	75	1903

In the absence of any definite measurement of flood levels, the house of Mr Mike Swart has been used as a reference point to determine the peak water levels reached by the major floods of 1906 and 1957. This house is situated in close proximity to the vlei on the farm Melkkamer and was flooded to windowsill height in 1906, and floor level in 1957. By field survey these levels were determined as 11,8 and 11,2 m above MSL respectively.

The first verifiable flood occurred at De Hoop in December 1906. Although the rainfall for the hydrological year ended September 1906 had been very low - a mere 72% of M.A.P., this was distributed in the form of showers at times favourable to the farming pattern of the time, viz. April and June. The Van Breda family diary bears an entry for 30 June 1906 which describes the lambing season as "most prosperous" and the June showers as well timed for the completion of sowing. A cold spell during August resulted in the only known snowfall recorded for this district (see Section 3.1.1). The antecedent moisture conditions were thus unusual, but by no means excessively wet when "a record SE rain ... flooding the local rivers" fell on 15 December 1906 (Van Breda diary). The entry continues: "Reports received of damage in different parts of the district as also in other districts"; and on 16 December: "River impassable". (This refers to the Kars River.)

The catchment rainfall for December 1906 was 188 mm - the highest December rainfall in the 100-year record. This is almost 9 times the average December rainfall and more than double the second highest December figure for the period of record. According to the daily rainfall record for Cape Agulhas (M. van Breda, pers. comm.), 71,6% of this rain fell in the form of heavy showers to steady rain during the 24-hour period ended at 8:30 a.m. on 15 December, and 81,4% during the period 11 - 15 December.

The floodwaters reached a peak level of 11,8 m and must have caused considerable flooding of surrounding farmlands. Judging from the length of time taken for floodwaters to recede after the 1957 flood, and from rainfall records for the period 1906 - 1909, the vlei must have continued to overflow to the southwest for at least three years after the December 1906 flood. Although rainfall was only slightly above average in the hydrological year 1908, the year 1909 was characterised by particularly heavy rainfall. With the exception of April (in which 52,8 mm was recorded), the months March to September were extremely wet, monthly rainfall ranging from 74,4 mm in June to 206,5 mm in September. (All of these monthly amounts exceed $\bar{x}$ + 1.s where monthly means and standard deviations are as in Table 3-2.) It will also be seen from Table 3-2 that the three-month period July to September 1909 is the wettest on record. Yet the year 1909 is not specifically mentioned in connection with flooding at Melkkamer. It is most likely that the period from December 1906 through to 1909 is merged in the memories of local people and remembered as a single event, referred to as 'the 1906 flood'.

It is maintained that this 1906 flood was the first since European occupation of the area, and could therefore possibly be the first ever. A milkwood tree, which according to oral tradition was well over 100 years old and the trunk of which had a diameter equal to that of a large wagon wheel, died shortly after the flood due to waterlogging of the root zone. This tree had stood beside the farmhouse (M. Swart, pers. comm.). The age of this tree could be verified if pieces could be traced - since it is claimed that parts of the trunk were made into furniture.

It was over 50 years before a second major flood occurred at De Hoop. The winter of 1957 was exceptionally wet in several parts of the Cape Province, including the southwestern districts. The Cape newspapers carried reports of severe floods in both the northern Cape and the Cape Peninsula. The rainfall on the catchment of De Hoop during the months of May to July was above average and had resulted in abnormally high water levels at De Hoop. Heavy rains in mid-August cause the water level to rise suddenly and on the weekend of 17 - 18 August water flowed through Mr Mike Swart's house necessitating that the house be evacuated. This was front-page news in Die Burger on Monday 19 August, where it was estimated that 6 688 ha (8 000 morgen) of land to the south and south-west of De Hoop was flooded and that some farm roads in the vicinity were under as much as 8 ft of water. These figures are probably exaggerated, as Mr. C. Burgers (pers. comm.) has estimated the actual flooded area, excluding 'islands' at only 2 980 ha. This latter estimate is based upon a study of the vegetation from aerial photography in 1962.

This water had not markedly receded when a heavy thunderstorm broke over the district on the afternoon of 1

October. The entire southwestern Cape experienced continuous heavy rain and hailstorms for the following two days. Road and rail washaways temporarily isolated the entire Bredasdorp district, where the farmlands were completely under water. Heavy crop losses were sustained and significant amounts of topsoil were lost. It was reported after these rains that soil was up to 30 cm deep in places on the Caledon-Napier road. In the Cape Argus of 2 October the Sout River is described as having been in spate and at its highest level for that year. The peak water level associated with this flood is estimated at approximately 11 m above MSL at De Hoop.

Even though rainfall was close to average in the following two years, it took 2 - 3 years for the floodwaters to visibly recede at Melkkamer (Uys and MacLeod, 1967 p. 235). This could be attributed to the fact that inflow from the Sout River would have compensated for water loss through evaporation and seepage in the downstream regions; and secondly, that waterlogging often occurs on Melkkamer because the limestone is close to the surface and seepage is thus slow.

This temporarily enlarged waterbody attracted large numbers of birds to the area. Although most of the vegetation was submerged, there were several thickets of Acacia cyclops on higher ground which became excellent heronries. Smith (1959) estimated that literally thousands of birds flocked to the area after the 1957 flood. Of particular note is the fact that the greater flamingo (Phoenicopterus ruber) bred at De Hoop during that period. Although the greater flamingo is regularly observed at De Hoop, the main breeding ground for this species is further north, namely in South West Africa and Botswana. The flamingoes were attracted to the many shallow, nutrient-rich pans which were left as the floodwaters receded, and their population size peaked at between four and five thousand individuals in the summer of 1960/1961. An estimated 800 nests with eggs were observed in the Reimerskraal area in that year (Uys and MacLeod, 1967). This is the only large-scale breeding record for the greater flamingo in South Africa (C. Heÿl, pers. comm.).

Besides these major floods there have been instances in which lesser flooding has occurred at Melkkamer. There are two regions on the southwestern bank of the vlei where some spillover used to occur when the vlei was 'full'. There is no specific information regarding these events except that spillover is said to have occurred in the 1920's and in the late 1940's. This flooding was of short duration and did not extend beyond the immediate vicinity of the vlei on these occasions. After the 1957 flood the bank of the vlei was built up to form dykes in these and other low-lying regions, which had been eroded by the floodwaters.

If the dates of the major floods are compared with the rainfall extremes listed in Table 4-1, it will be seen that the hydrological year 1902, which is ranked one place above 1957 as regards excessive annual rainfall, is not accounted for in the verbal account of floods at De Hoop. In 1902 rainfall in excess of 70 mm fell in the months February, August and September, but that for April, May and July was well below average. A similar situation is recorded in 1977 (ranked fifth according to annual rainfall) where the months February, April and May were relatively wet, but the intervening month of March was drier than average. Although the total annual precipitation was similar in the years 1902, 1957 and 1977, the year 1957 differs in that there was a five-month sequence of above average rainfall, in two consecutive months of which over 80 mm of rain was recorded.

It is apparent from this discussion that both major floods occurred in years in which the annual rainfall exceeded 500 mm. Secondly, this excess of almost 150 mm above the mean occurred as a single storm event in 1906, and in consecutive months in 1957. In other years of equally high annual rainfall the excess above the mean was not concentrated over consecutive months and no major flooding occurred at De Hoop.

A third factor which influences flooding is the spatial distribution of storm rainfall. Heavy rainfall over the Bredasdorp district in August 1978 caused local flooding and damage to roads in the Kars River catchment, but, although the Sout River flowed strongly for two to three days afterward, this input was not large enough to cause a significant increase in the water level at De Hoop. It appears that the storm rainfall associated with both of the major floods was widespread, affecting the entire catchment area as well as causing waterlogging in the surrounds of De Hoop Vlei.

4.4.2. Droughts

The absence of water in De Hoop Vlei is less noteworthy than the presence of excessive amounts, and droughts are therefore more difficult to pinpoint than floods in the history of the vlei.

The Marais Commission (1968) distinguishes three types of drought to which South Africa is subject. These are
(a) seasonal droughts, which occur annually; (b) droughts of shorter or longer duration (periodic droughts); and
(c) critical droughts, of three or more years duration. Periodic droughts are a regular occurrence in South Africa, and on average 20 of every 60 years are dry. Critical droughts are less frequent and in the study area these are predicted to occur once in 18 years (Marais Commission, 1968).

In order to clarify the term 'drought' for De Hoop, the known periods (the 'verbal account') of low water levels are compared with the average catchment rainfall record. Harrison (1957) mentions that in the years 1903 and 1945 'the greater part' of the lake bed was exposed, but there is no indication of the actual extent of this exposure. In 1975 and 1980 the entire bed of the vlei was exposed, only the springs being excepted. In the discussion which follows the rainfall record for the periods surrounding the years 1903, 1945 and 1975 is examined and compared with that for the years of low rainfall listed in Table 4-1(B).

Six consecutive years of subnormal rainfall in 1895 - 1900 were followed by good rains in 1901 and 1902. The total rainfall for the year October 1902 to September 1903 was only 275 mm, largely due to deficient winter rains. It could be that the year 1903 is remembered as the lowest water level prior to the 1906 inundation, and was not necessarily a year of critical drought.

The year 1945 is less noteworthy as regards annual rainfall. This year, for which the total rainfall was 364 mm, marked the beginning of a 4-year sequence of sub-average rainfall, but apart from a drier than average summer and wetter than average winter, the rainfall for this year was in no way remarkable.

The average catchment rainfall record shows two other sequences of deficient rainfall to have occurred, namely the five-year dry sequences of 1926 - 1930 and 1933 - 1937. Neither of these is remembered in the verbal account of low water levels at De Hoop.

The most recent dry spell which caused exposure of the entire bed of the vlei, occurred during the period 1968 to 1973. In each of the three consecutive years (1968 - 1970) the annual rainfall was below 76% M.A.P. ($\bar{x}$ - 1.s). If annual rainfall is ranked from lowest to highest, these years rank 5th, 4th and 3rd respectively (see Table 4-1(B)). After a slight recovery in the years 1971 and 1972, the rainfall of 1973 was the lowest on record, namely 214 mm (58% M.A.P.). As a result of this sequence of deficient rainfall the Sout River dried completely, and streamflow was zero at Kykoedie for almost seven years between December 1967 and May 1976. (Some flow was recorded for the periods July 1971 - November 1972 and September - October 1974.)

There was thus virtually no input to De Hoop Vlei from its catchment during this time and the vlei became progressively emptier and more saline until the entire bed of the vlei was exposed in 1975. Until June 1976 the vlei was completely dry and was used as a direct route for nature conservation vehicles travelling between De Hoop and Windhoek.

After rainfall in April and June 1976 the Sout River began to flow again at De Hoop in late June. Good winter rains in 1977 raised the water level still further, but as the inflow from the Sout River declined during 1978 - 1980, the vlei dried rapidly and, apart from a shallow pool near Die Mond, the bed of the vlei was again exposed from the summer of 1979/80 until February 1981.

On the basis of the rainfall record and the length of time for which the vlei was dry, it seems likely that the 1968 - 1973 drought was the most severe in the 100-year period of recorded rainfall. (As the Sout River has only been gauged since 1965, there is no record of the effects on streamflow of previous dry periods.) This recent drought is the only known dry period at De Hoop that is clearly identifiable from the rainfall record.

The dominant aquatic primary producer in De Hoop Vlei is <u>Potamogeton pectinatum</u> (vlotgras). This plant is unable to tolerate salinities in excess of 15 ppt for long periods (C. Heÿl, pers. comm.), and consequently dies off rapidly during a prolonged drought. The salinity of De Hoop Vlei is generally between 5 and 11 ppt, but is known to have reached 50 ppt during the dry period in January 1981 (D. Coetzee, pers. comm.). Since <u>P. pectinatum</u> is the major determinant of the carrying capacity of the vlei for primary consumers such as waterfowl and coot (C. Heÿl, pers. comm.), its absence has obvious repercussions on the ecosystem. It is not known how long it will take for the ecosystem to recover from the extreme depletion of water reserves and the persistence of highly saline conditions which have occurred in the past decade.

It would seem from this comparison of the observed dry periods at De Hoop with the ranked list of years of deficient rainfall, that, besides regular seasonal (summer) droughts, there have been at least six droughts of longer duration and only one verifiable critical drought at De Hoop during the past century.

4.4.3. Conclusion

This discussion has shown that the major floods and the recent drought correspond to years of extremely excessive or deficient rainfall respectively. It is therefore not possible to determine whether the agricultural development of the catchment or the rumoured blockage of the sinkhole have significantly affected the degree of flooding or dessication which has occurred during this century. There are no recorded extreme rainfall events in the pre-1903 period, and it is therefore not possible to ascertain whether similar rainfall input as caused the floods of 1906 and 1957 might have caused less extensive flooding in earlier times. The observed rate of sedimentation would suggest that this might have been the case, irrespective of the alleged impacts of human activities. The relation of rainfall input to basin capacity is therefore of prime importance in flood prediction. Other factors which determine the quantity of rainfall that becomes runoff, i.e. intermediate processes which can be modified by man, are of lesser significance than excessive rainfall in causing floods. The effect of these parameters is explored by means of an hydrological model in the following chapter.