THE RIVERS OF THE NAMIB AND THEIR DISCHARGE INTO THE ATLANTIC

PART II: OMARURU AND UGAB

DIE RIVIERE DER NAMIB UND IHR ZULAUF ZUM ATLANTIK

II. TEIL: OMARURU UND UGAB

Second contribution to the hydrology of the South West African Namib desert, dealing with the two northern rivers of the central section of the Atlantic run-off area.

By
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(18 figs., 3 plates)
Maps, Diagrams and Sketches

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Introduction

Whereas data and records on rainfall, flows of rivers, etc. have been available in the case of the Swakop and Kuiseb rivers since the earliest times, few documents exist about the Omaruru and Ugab rivers although both also belong to the central runoff area of early European settlement.

Walvis Bay and the mouth of the Kuiseb served as an entrance to the country from the early days. The same can be said of Swakopmund where, of necessity, a harbour was constructed shortly before the turn of the century followed soon afterwards by a railway line into the interior. Many old people of South West still remember the old road, 'der Bay Weg', which connected Walvis Bay and Swakopmund with the hinterland. All the first travellers interested in science followed these routes, making daily observations on the distances travelled, temperatures, etc., which data are still partly available today. Here we think of the journeys of Dove, Schinz, François, Jäger, Waibel, etc. and not to be forgotten is the valuable knowledge collected about the country by the 'Schutztruppe'.

The early records on the Omaruru and Ugab rivers are too vague and inaccurate for publication but even such sparse data of the past is however of great interest and importance.

Both river-beds are filled up with deep sand sediments bearing groundwater, therefore any future development, irrespective of whether takes place near to the rivers or whether the water has to be supplied by pipe lines, will have to rely solely on that store of groundwater.

Fig. 1. The Namib and the central part of the Atlantic drainage area, (1:3,000,000; dotted space: Namib desert).
A. The Central Part of the Catchment Areas to the Atlantic

The biggest part of the Atlantic drainage area covers the river systems of the Kuiseb, Swakop, Omaruru and Ugab. These form — on account of their sandy and groundwater-bearing river-beds — the most densely populated portion of South West Africa, with the exception of Ovamboland (where 45% of the country's total population lives).

In accordance with the rainfall conditions, of this area the most densely populated portion is the highland, with an average rainfall from 300 to 500 mm; then follows the escarpment area, with an average of 50 to 100 mm; and finally the coastal Namib desert (100 to 150 km wide), with a rainfall from 0 to 50 mm.

For a detailed description of this part of the central drainage area, the part I of the present series of articles (dealing with the Swakop and Kuiseb rivers) should be consulted.

The size of the catchment areas, lengths of the rivers, relation of the Namib area to the total catchment area, etc., are tabulated below.

The southern section of the Atlantic run-off area, reaching from the Orange river northwards to the Kuiseb delta, is covered in its entirety by big sandy dunes. Consequently the three local major rivers of this territory, viz. Koichab, Tsauchoh (Sossus) and Tsordab, no longer reach the sea, as their beds are entirely covered by wind-borne sand deposits. Originating in the highlands and the escarpment, they end abruptly in vleis, viz. large, flat, dry lakes which are encircled by big dunes and bordered by scattered Acacia trees.

The central section, which is dealt with in parts I and II of the present article series, consists of the rivers Kuiseb, Swakop (with Khan), Ugab and Omaruru.

The northern section of this run-off area spreads from the Ugab to the Kunene. The rivers crossing this portion of the Namib are all episodic and the major ones bear the names Huab, Khwarib (Hoanib) and Hoarusib. Only the Kunene, forming the border, is a perennial river, with a yearly discharge capacity of about 5x10^6 m^3 water. There are some more dry rivers on the Angolan side of the Namib desert.

Each of these three run-off sections covers approximately an area of 80,000 sq.km.

Supplementary diagram fig. 2 shows the size of the catchment areas of the central section.

---

* Cf. Scientific Papers Namib Desert Research Station, No. 22.
** At present, all these three rivers are apparently funnel-shaped. This, however, does not preclude from forming a delta in years of big sand-bearing floods.

<table>
<thead>
<tr>
<th>River</th>
<th>Size of the catchment area sq.km.</th>
<th>Total length of river km.</th>
<th>Size in the Namib area sq.km.</th>
<th>Namib area in % of the total catchment area</th>
<th>In the Namib area length of the river km.</th>
<th>Mouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuiseb</td>
<td>16,200</td>
<td>440</td>
<td>3,350</td>
<td>20.5</td>
<td>140</td>
<td>Delta</td>
</tr>
<tr>
<td>Swakop with Khan</td>
<td>31,000</td>
<td>420</td>
<td>5,000</td>
<td>16.0</td>
<td>120</td>
<td>funnel** shaped</td>
</tr>
<tr>
<td>Omaruru</td>
<td>14,050</td>
<td>315</td>
<td>3,200</td>
<td>23.0</td>
<td>115</td>
<td>funnel** shaped</td>
</tr>
<tr>
<td>Ugab</td>
<td>15,400</td>
<td>486</td>
<td>2,000</td>
<td>13.0</td>
<td>110</td>
<td>funnel** shaped</td>
</tr>
</tbody>
</table>
Fig. 2. Catchment areas of the central section (about one third of the total surface area contributing to the run-off into the Atlantic, consists of the northern, central and southern run-off areas).

Fig. 3. Altitude of the Omaruru (above) and Ugab (below) areas and rainfall days recorded.
Fig. 4. Altitude of the rivers of the central section, Omaruru and Ugab, and average rainfall of the area.
**Fig. 5.** Altitude of the rivers of the central section, Swakop and Kuiseb, and average rainfall of the area.
B. The Omaruru River

1. The rainfall in the catchment area.

It is generally known that the increase of the rainfall in South West Africa is from south to north and from west to east; precipitation figures therefore increase from the coast towards the highlands.

Fig. 3 shows the relation in altitude and rainfall days of the Omaruru and Ugab areas, while diagrams figs. 4 and 5 indicate the correlation in the increase of altitude and that of rainfall for both these rivers, as well as for the Swakop and Kuiseb rivers.

The following tables explain the rainfall in the river basin of the Omaruru, in relation to various localities situated on different altitudes above sea level, and the floods over a given period of years.

2. The flow of the river to the Atlantic.

The only records on the flows of the Omaruru which reached the Atlantic were given by the people who transport salt. Salt has been mined for years on the coast northwards from Swakopmund to the Ugab river mouth and has been transported along the coast by lorries to the railway station in Swakopmund. This salt transport takes place over the whole of the year and the only obstacles the drivers of these lorries meet are the rivers when carrying water in the rainy season.

<table>
<thead>
<tr>
<th>Observation site</th>
<th>Uis Mine</th>
<th>Okombahe</th>
<th>Omajette</th>
<th>Omaruru</th>
<th>Omburo South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude above sea level, in m</td>
<td>875</td>
<td>945</td>
<td>1250</td>
<td>1211</td>
<td>1400</td>
</tr>
<tr>
<td>Average yearly rainfall, in mm</td>
<td>93.2</td>
<td>169.7</td>
<td>289.5</td>
<td>305.8</td>
<td>310</td>
</tr>
<tr>
<td>Periods in years</td>
<td>5—7</td>
<td>40—42</td>
<td>13—15</td>
<td>31—34</td>
<td>18—21</td>
</tr>
<tr>
<td>Number of days with rain</td>
<td>14.8</td>
<td>24</td>
<td>31.3</td>
<td>33.6</td>
<td>39.7</td>
</tr>
<tr>
<td>Rainfalls when the flow did not reach the Atlantic</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>1944/45</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>145.5</td>
<td>121.6</td>
</tr>
<tr>
<td>1951/52</td>
<td>?</td>
<td>155.3</td>
<td>?</td>
<td>213.2</td>
<td>454.2</td>
</tr>
<tr>
<td>1955/56</td>
<td>?</td>
<td>230.6</td>
<td>281.6</td>
<td>316.0</td>
<td>280.6</td>
</tr>
<tr>
<td>1959/60</td>
<td>?</td>
<td>89.2</td>
<td>149.2</td>
<td>321.1</td>
<td></td>
</tr>
<tr>
<td>1963/64</td>
<td>?</td>
<td>102.5</td>
<td>185.7</td>
<td>222.2</td>
<td>253.7</td>
</tr>
</tbody>
</table>

| Rainfalls when the flow reached the Atlantic | ? | ? | ? | ? | ? |
| 1933/34                   | 761.0 | 720.0 | 841.0 | 745.0 |
| 1949/50                   | 663.0 | 392.0 | 245.6 | —     |
| 1962/63                   | 427.8 | 396.7 | 355.5 | 563.6 |
1965/66 Not in flood.
1966/67 Small streamlets on road; no break-through to the coast; river passable.
1957/58 Like 1956/57.
1958/59 Like 1956/57.
1959/60 Like 1956/57.
1960/61 River flowing a full month without interruption.
1961/62 During Christmas week flowing continuously, but river passable.
1962/63 In flood from middle of January 1963 to the end of April; river flowed in small rivulets up to May.
1963/64 Not in flood.

Diagram fig. 6 is based on the above notes.

With regard to the floods of the rainy season 1962/63, the Omaruru, after abnormally heavy rains in the Black Spitzkopjie area, came down at a width of over one mile, in several strong arms flowing for 1 to 1½ days. During three months of continuous flow, the floods varied so much that from time to time and only for some hours the river was passable on the road to Cape Cross. At a distance of about 150 km (between Okombahe and the road crossing between Swakopmund and Cape Cross) the velocity amounted to 1.8 m/s (altogether 96 hours). This velocity figure, however, may be considered only an average, as the observations on flood took place in Okombahe and were reported to Swakopmund only for the sake of the salt transport.

Some scanty and incomplete information on earlier floods was drawn from old newspapers preserved in the Swakopmund Museum. All these notes refer to the Omaruru; the Ugab is not mentioned:

March 15th, 1931. — (Windhoeker Anzeiger) Omaruru flowed at Omaruru from February 21st to 27th at Okombahe for 14 days; slight damage to gardens at Okombahe.

February 3rd, 1960. — (Deutsch Südwestafrikanischer Anzeiger) Strong rains fell south and north of Tsumeb. The same is reported from Omaruru. It was a very strong rain, like the rain in 1904, when the pasture was excellent. The Omaruru river came down in full flood; the schoolchildren were not allowed to cross the river on the small bridge leading to the school.

February 6th, 1912. — (Deutsch Südwestafrikanischer Anzeiger) Omaruru in heavy flood.

March 5th, 1913. — (Deutsch Südwestafrikanischer Anzeiger) The excessive rains of the last couple of weeks, apart from the fact that the pasture is threatened with the danger of rot, caused several upsets. As, for example, the court session had to be cancelled as the officials were cut off by the Omaruru in flood.

February 11th, 1921. — (Swakopmunder Zeitung und Handelsblatt) In Omaruru the rain was very good during the last few days; the river is flowing.

1923. — Of this year of heavy rains, no mention in the newspapers examined.

February 3rd, 1925. — (Swakopmunder Zeitung und Handelsblatt) Omaruru river in full flood since Thursday (January 29th, 1925). Gardens in the town severely damaged and much valuable garden soil washed away.

January 15th, 1931. — (Swakopmunder Zeitung und Handelsblatt) According to telephonic information, the Omaruru river came down in flood 3 to 4 m high. The river eroded back its northern bank to about 50 m; all the gardens on this side were heavily damaged and *Ana*-trees washed out and swept away.

March 28th, 1931. — (Swakopmunder Zeitung und Handelsblatt) Omaruru flowing in full width.

February 13th, 1934. — Among other items it is reported that one of the bridges near Etio is heavily damaged and the railway bridge at Omaruru is completely destroyed. . .

3. The mouth of the river.

A superficial observer of the mouth of the Omaruru river receives the impression that the mouth forms a funnel. Its discharge directly into the Ocean is checked by the surf, so that the flowing water of the river is deflected in southerly and northerly directions along the coast before it flows over the sand barrier of the shore into the sea (cf. map fig. 8 and diagram fig. 10).

Along these two branches of the mouth Tamarisks have sprung up and drift wood has been deposited. Future heavy floods will probably flow directly into the sea at the mouth, but as the flood decreases the action of the surf will form a new sand barrier which will force the flood water to flow in southerly and northerly directions from the mouth. In such a case the sandy barrier of the shore keeps back a large amount of flood water which forms a big pond fed also by sea waves breaking over the sandy barrier.

As with the Kuseb river in January 1963, a flood of long duration took place in the lower Omaruru, the waves of which caused deep erosion in the riverbed, up to 6 m in depth (cf. plate I, photo A). The sandy plateau of the steep coast is situated about 20 m above level of the river-bed. Towards the interior, this difference in height gradually decreases, and about 6 km inland the river-bed shows a width of about 2 km, but is only 1.5 m deep. About 3 km to the south of the mouth there is a valley-like indentation of the steep sandy coast line, a few hundred metres long, which, further inland, changes into a shallow channel and gradually approaches the river-bed of the Omaruru for some kilometres from the coast. In this valley there is a small swamp with rush, which feeds some shallow wells with freshwater; a few hundred metres north of this site, freshwater springs are situated directly on the beach.

In the same valley, and later also on the sandy plateau, the anglers' village Henties Bay came into
being. At present it consists of about 80 houses, and is frequented by many holiday makers during the summer season (November to March).

In the course of the development of the water supply for this village test borings and investigations for water were undertaken by the South African Council for Scientific and Industrial Research, with the result that a second and smaller underground branch of the Omaruru river mouth was identified. This branch was gradually covered by drifting sand, with the result that, only when the bed of the main river has been raised by sand masses, can episodic floods fill the channel. The exact site of the branching off of the channel has not yet been found, but respective investigations are in progress through further test boreholes and seismic survey.

The preliminary results of these investigations can be gathered from figs. 8 and 10. The map also shows the existing bore sites as well as the test sites investigated by seismic methods; existing clay layers and gravel banks are not shown in the cross sections. The section, which shows two or more deeper channels, indicates clearly that the conclusion that there is a second mouth to the Omaruru, is justified. To test the seismic survey a borehole (close to peg no. 10) on the line B was drilled at a distance of about 3 km. from the coast on the sandy plateau and 1 km. south of the Omaruru. This showed a borehole depth of 20 m. to rock, but at a depth of 14 m. good potable water was discovered.

4. The quality of groundwater in the lower river.

The sandy river-bed of the Omaruru may be considered of good groundwater-bearing capacity. After good rainy seasons with resultant heavy floods, the sand up to the top layer is saturated with water. Here evaporation takes place to such an extent that it causes mineralisation of the water, while the deeper water-layers are of good quality because little evaporation takes place.

The attached sketch of a cross section of the river at Okombhae down to the deepest sand layer at 10 m. (see diagram fig. 11), shows the average TDS content as ± 500 p.p.m. Although the mineral content of the water rises towards the coast, it remains within the limits for potable water.

The TDS content is at Neineis about 687 at a distance of 110 km. from the mouth, at Leeuwwater 1864 and 1020 at about 80 km. from the mouth (see map fig. 9).
For the mouth area itself refer to fig. 6. Here the quality of water is excellent. In section A 1: 374 TDS p.p.m. in the river-bed; B 2: 362 TDS p.p.m. in the river-bed; B 1: 477 TDS p.p.m. in the river-bed, B 10: 436 TDS p.p.m. on the sandy plateau; C: 349 TDS p.p.m. on the sandy plateau.

A number of boreholes drilled in the upper course of the branch to Henties Bay showed qualities from 1440 to 1505 TDS p.p.m. The four boreholes gave a pump capacity during 70 hours of 1990 gal/h to 5605 gal/h (9 m³/h to 25.5 m³/h).

In connection with the water supply development at Henties Bay, already in 1950 Dr. O. Wipplinger pointed out that sufficient and usable water may be expected in the sandy sediments of the Omaruru river. At that time the water drawn from a shallow well surrounded by rush was found to be unsuitable for human consumption; at 940 TDS p.p.m. the fluorine content was 4.5 p.p.m. It is understood, however, that since this time the water quality has been improving, according to the following data:—

Fig. 8. Map of the delta of the Omaruru river (based on the detailed map of Progress Report No. 18 of the C.S.I.R. Regional Laboratory, South West Africa; published with permission from the Director of C.S.I.R.).
SECTION A-A

SECTION C-C

CROSS SECTION AT CAPE CROSS - SWAKOPMUND ROAD

SCALE: HIR 1:10,000

HEIGHTS HAVE NO CONNECTION WITH REST OF PLAN

Fig. 9. Omamuru river. - Cross sections.

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Fig. 11. Omaruru river. — Cross section at Okombahe.
C. The Ugab River

1. The rainfall conditions in the catchment area.

The longest of the four rivers which drain the central part of the Atlantic area is the Ugab, with a length of 486 km.

It has its origin on the flats and mountains slopes near Otavi. The Otavi highlands is one of the highest rainfall areas in South West Africa, with an average rainfall figure of about 500 mm. Also the number of days of rainfall for the upper Ugab area is the highest, viz. 70 days p.a. on an average.

The following tables explain the rainfall in the catchment area of the Ugab, in relation to various localities situated on different altitudes above sea level, and the floods over a given period of years.

It was impossible to register exceptionally heavy rainfalls with a high degree of intensity on account of the great distances existing between the respective observation sites. However, rains falling in the Namib area appear to cause floods in the lower course of the river. Such rains are rare, but it is evident that heavy rains falling on bare ground or on ground with sparse vegetation cause a quick run-off and consequently high floods with large waves*.

* In this connection it may be remembered that the railway bridge at Swakopmund was destroyed by floods caused by heavy rains in the lower Khan area (the Khan river is the biggest tributary of the Swakop). Also a few of the bigger floods that occurred in the lower Omaruru river basin 1962/63 originated from rainfall in the Black Spitzkopje area. Worth mentioning also in this regard are flood data on the Swakop river listed by Dr. R. Seydel in his publication 'Das Schwemmland im Swakopthal, 1915—1943'. In 1916 there occurred in the lower course of the Swakop such a big flood that in many instances garden soil was washed away and installations were damaged at Gomare, Brock and some other sites downstream up to the last settlement close to Swakopmund (Weule) where a windmill was washed away. According to this information (which I owe to Dr. Röng) a cloud burst occurred in the lower Namib near the railway siding Ebony and over Haigamklab, where the Khan enters the Swakop; this cloud burst destroyed a part of the station building and caused a high flood.

<table>
<thead>
<tr>
<th>Observation site</th>
<th>Sorris-Sorris</th>
<th>Outjo</th>
<th>Otavi</th>
<th>Otjikondo</th>
<th>Omatjene</th>
<th>Otjiwarongo</th>
<th>Erundu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude above sea level, in m</td>
<td>540</td>
<td>1262</td>
<td>1420</td>
<td>1300</td>
<td>1381</td>
<td>1455</td>
<td>1444</td>
</tr>
<tr>
<td>Average yearly rainfall, in mm.</td>
<td>79.6</td>
<td>409.4</td>
<td>539.7</td>
<td>350.9</td>
<td>382.8</td>
<td>441.5</td>
<td>429.0</td>
</tr>
<tr>
<td>Period in years</td>
<td>3—5</td>
<td>49/53</td>
<td>38/42</td>
<td>24/26</td>
<td>14/15</td>
<td>33/38</td>
<td>22/24</td>
</tr>
<tr>
<td>Number of days with rain</td>
<td>17.9</td>
<td>39.8</td>
<td>76.6</td>
<td>35.6</td>
<td>40.9</td>
<td>43.7</td>
<td>38.3</td>
</tr>
<tr>
<td>Rainfalls when the flow did not reach the Atlantic (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1953/54</td>
<td>—</td>
<td>597.7</td>
<td>709.1</td>
<td>645.5</td>
<td>389.1</td>
<td>746.0</td>
<td>684.4</td>
</tr>
<tr>
<td>1956/57</td>
<td>—</td>
<td>400.7</td>
<td>628.1</td>
<td>337.2</td>
<td>327.5</td>
<td>354.5</td>
<td>314.9</td>
</tr>
<tr>
<td>1959/60</td>
<td>—</td>
<td>275.0</td>
<td>461.9</td>
<td>171.4</td>
<td>316.7</td>
<td>360.9</td>
<td>323.9</td>
</tr>
<tr>
<td>1963/64</td>
<td>—</td>
<td>365.9</td>
<td>503.3</td>
<td>—</td>
<td>262.7</td>
<td>426.5</td>
<td>337.0</td>
</tr>
<tr>
<td>Rainfalls which caused a flood to the Atlantic (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1933/34</td>
<td>—</td>
<td>1050.0</td>
<td>995.0</td>
<td>840.0</td>
<td>—</td>
<td>660.0</td>
<td>860.0</td>
</tr>
<tr>
<td>1950/51</td>
<td>—</td>
<td>525.9</td>
<td>467.1</td>
<td>615.7</td>
<td>—</td>
<td>582.0</td>
<td>455.1</td>
</tr>
<tr>
<td>1953/54</td>
<td>—</td>
<td>597.7</td>
<td>709.1</td>
<td>645.5</td>
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<td>746.0</td>
<td>684.4</td>
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<tr>
<td>1960/61</td>
<td>—</td>
<td>385.7</td>
<td>472.3</td>
<td>320.0</td>
<td>—</td>
<td>416.8</td>
<td>273.3</td>
</tr>
<tr>
<td>1962/63</td>
<td>—</td>
<td>458.6</td>
<td>692.2</td>
<td>429.8</td>
<td>—</td>
<td>502.1</td>
<td>566.4</td>
</tr>
</tbody>
</table>
Fig. 12. Discharge data on the Ugab river.

*: Small flood reaching the Atlantic.
**: Moderate flood reaching the Atlantic.
***: Big flood reaching the Atlantic.
*: No flood, or no details available.
2. Floods of the Ugab to the Atlantic.

No precise information is available. Of the five years mentioned above, in which the river reached the sea, reliable records exist only for the rainy years 1960/61 and 1962/63. It can be assumed, however, that the river reached the sea also in the years 1933/34, 1953/54 and 1950/51, as this can be proved for the Omururu river; it can furthermore be assumed for 1933/34 (known as the greatest rain and flood year), as was the case with all larger rivers, also the Ugab flowed to the sea.

In the upper course of the river on the farm Petersburg and near Sorris-Sorris, automatic water gauges have now been installed to record the floods on a scientifically exact basis. These records, covering the last four years, have not yet been analyzed and the floods are merely mentioned in the following diagram fig. 12. At the mouth of the Ugab a few salt mines are to be more intensely exploited, so future records can be expected also from this area.

Even less respective information is available about the rivers north of the Ugab. According to a few observations made by a prospector, all small rivers originating in the Namib and draining into the Atlantic came down in flood in 1933/34; from 1934 to 1963 their floods did not reach the sea. The Huab river was impassable on the coastal road in 1962 and 1963; in November 1963 a flood came down to within four miles of the coast. The Hoarusib river reached the sea in November 1963, as did the Hoanib river.

3. The area of the river mouth.

See map fig. 13 and diagrams figs. 14 and 15 at the end of the chapter.

The mouth of the Ugab is seldom visited; only anglers and prospectors pass a few days there once in a while. The entrance into the sea can be clearly seen, as well as a second and smaller branch leading into the sea, which is situated immediately south of the main branch and about 1.5 m above the level of the bottom of the latter. The second branch branches off the southern bank of the main arm about 3 km from the coast; rocky outcrops on the southern bank prevent its deepening and also an eventual expansion of the mouth towards the south.

The northern bank is wide and shallow, rises gradually, becomes a sandy plateau merging into the shifting dunes. It is covered with large masses of drift-wood; from the state of preservation of the latter one may conclude that the deposit, which spreads over kilometres, occurred during an exceptional rainy season. This flood may have been that of 1934, since square, processed pieces of timber are to be found among the drift-wood; they lie so far inland that they could not have been washed up by the sea even during an exceptionally high springtide. But the flood of 1934 is understood to have done so much damage to farms lying along its upper reaches that the timber in question could easily have been washed down from those sites. Further deposits of drift-wood are found also on the strip of land between the two delta branches close to the coast. Farther inland there are some earth mounds, about three-quarters of a meter high, and formed by sedimentary layers of silt and sand; they may indicate remnants of an earlier river-bed which was situated about 3.5 m above the present level of the river-bed.

At the Swakop mouth the high floods of 1934 carrying vast quantities of sand and silt, caused the river to expand its bed into the sea and through the action of the surf the mouth area was raised; the same could have taken place at the mouth of the Ugab during a season of such high floods. Thus it may be assumed that the whole river-bed was raised by sand and silt, while later floods eroded the bed into deep channels; with these conditions extending further inland, the present state of affairs could have developed.

A beach sandbank along the coast forms a lagoon at the mouth of the river, which is fed by waves breaking over this barrier. In the river-bed above the lagoon there is an area of reed intermixed with tobacco plants, which stretches over several kilometres.

4. The groundwater in the lower course of the river.

The Ugab originates on the slopes of the Usib mountains (1918 m) and has a length of 486 km and a gradient of 1:254, from this site to the Atlantic. As the Usib mountains rise like a wall above the Otavi plains, and if we accept the Goab gorge (1400 m) to represent the source of the Ugab, the average gradient of the river is 1:347, including its lower course (cf. fig. 16).

Down-stream to Sorris-Sorris the river is bordered on both sides by farms; here its course forms a terraced landscape of particular beauty. Further down-stream as from the Brandberg West Mine (situated in the steep mountains of the escarpment) the course of river flows through the Namib desert.

For the purpose of investigating the groundwater conditions, two trips were undertaken by the hydrological section of the S.W.A. Water Affairs Branch in July and October, 1962, respectively. The general impression thus gained was very favourable. Open water pools were found in the river, in spite of the fact that the rainy seasons had been poor during preceding years; the same pools were still in existence on the occasion of the second trip, though of lesser extent.

Water samples taken in 1962 from the open water ponds in the river-bed gave the following results which are tabulated below, p. 22:
Fig. 13. Site plan of Ugab River mouth.
Fig. 14. Ugab. — Longitudinal and cross sections (Ugab River Mouth Survey, April 1964).
Fig. 15. Ugab. — Cross sections A, B and C (Ugab River Mouth Survey, April 1964).
The TDS-content of the water rises sharply from Sorris-Sorris to Brackputs and then steadily declines up to the coast. Roughly speaking all the samples taken from shallow wells (waterholes) and also from flowing water on the top of the sandbed had an average TDS p.p.m. of 1800 with the exception of the sites near Brackputs which are situated downstream of the Brandberg West well. The water samples for almost the entire Namib section of the river are therefore still within the limit 2000 TDS p.p.m. and thus suitable for human consumption according to the S.A. Standards.

The only water consumer in the whole area of the lower course is the Brandberg West Mine.

The well of Brandberg West Mine is situated in the middle of the sandy river-bed (see Plate III, photo c). The depth of the river sand is 30 m. at the site of the well. The water is about 8 m. deep and the lowest that the water level has dropped in all the years of its existence was about 2.4 m. from the bottom of the river-bed. The pump capacity is 11.5 l/s. The water consumption is 440 m³ daily; this amounts in a year to 165,000 m³ — a consumption which is far below the capacity of the river.

The management of the mine had undertaken detailed test boring of more than 70 boreholes over a distance of 4.5 km. in 1953; the boreholes are situated more or less in the middle of the river-bed. The quality of the water in the existing well of the mine is 2,326 TDS p.p.m., thus not satisfactory.
Fig. 16. Map of the Lower Ugab river.

(Distances from the mouth of river to:
Brackpüts: 71 km.
Schillpüts: 96 km.
Riet: 116 km.
Sorris-Sorris: 185 km.)

Investigated by S. W. BURGER, S.W.A. Administration – Water Affairs.
Fig. 17. Brandberg West Mine. — Cross section of the Ugab at the pump station (river gradient = 1:310).

Fig. 18. Brandberg West Mine. — Calibration curve of the Ugab at the well of the Mine.
**Summaries**

**Samenvatting**

Die Atlantiesekus van Suidwes-Afrika strek 1,400 km. van Noord na Suid en word in die noorde deur die Kwenenerivier en in die suide deur die Oranjeverviers begrens. Die Kune is aan die Oranje is standhoudende riviere. Dreinering na die Atlanties Oseaan geskied slegs in die sentrale en in die noordelike ge-deelde deur middel van 'n aantal droë riviere. Slegs daardie riviere wat hul oorsprong in die hooggeleë hoëlande het waar die gemiddelde jaarlikse reënval 400—500 mm. is, bereik die Atlanties Oseaan.

Agter die Kuslyn volg die Namib, 'n westyn son-der plantegroei, bedek met sand, klippe en puin, wat tot 100—150 km. binneland strek en wat 'n gemid-delde reënval van 0—50 mm. het. Dan volg die plato-rand met 'n reënval van 50—100 mm. en aansluitend die sentraal geleë hoogland met 300—500 mm. soos alreeds hierbo aangedui.

Die Kuiseb, Swakop, Omaruru en Ugab is die droë riviere van die afloopgebied wat in die Atlanties Oseaan mon. Terwyl daar by die Kuiseb en die Swa-kop riviere heelwat waarnemings beskikbaar was, wat 'n begro oor die reënval en afloop van die rivie-re gee, is die gegevens oor die twee meer noordelik geleë riviere, die Omaruru en die Ugab uitsers skaars.

Deur verskeie tabelle en sketsie is die reënval, wat na die binneland toeneem, as gevolg van die algemene styging van die terrein oor seespieël aangedui.

Min waarnemings oor die toeloop na die kas van die riviere Ugab en Omaruru, is beskikbaar. Slegs uittreksels uit dagboeke van die transporteryers van die souteweggee 'n aanduiding hiervan vir 'n aantal jare.

Outomatiesse meetstasies wat olangs in albei ri-viere opgerig is, sal in die loop van die volgende paar jaar heelwat bykomende noukeurige data oor die waterhoeveeldhede wat afgeloop het en ook oor die tydperke waarin die vloëde voorgekom het, beskikbaar stel.

Oor die grondwater van die Ugab en Omaruru ri-viere, waar hulle deur die Namib vloei, is reeds besonderhede verkry. Die ondersoekde duur nog voort.

Navorsing van die grondwaterrapportiteit en kwaliteit sal vir die komende ontwikkeling van baie groot waarde wees. Vandag is hierdie gebiede nog onbe-woon, eensaam en onaangeroer, maar die moderne wetenskap en tegniek bied ook hier die potensiaal vir ontwikkeling.

**Zusammenfassung**


Von der Küste ausgehend folgt die Namib, eine vegetationlose Sand-, Schutt- und Steinwüste, die sich bis zu 100—150 km ostwärts erstreckt, mit einem Regenfall von 0—50 mm gemittelt. Es folgt die Randstufenlandschaft (Eskarpment) mit einem Regenfall von 50—100 mm und das zentrale Hochland (mit 300—500 mm, wie bereits erwähnt).

Kuiseb, Swakop, Omaruru und Ugab sind die Trockenflüsse des zentral gelegenen Teiles dieser Abluflußzone, welche die Küste erreichen.

Die Riviere des südlichen Teiles dieser atlantischen Abluflußzone liegen unter den Wanderdünen der Na-mib, während im nördlichen Teil des Kaokoveldes wieder einige Trockenflüsse die Küste erreichen.

Während für den Kuiseb und den Swakop verschiedene Beobachtungen und Unterlagen zur Verfügung standen, um für eine Darstellung über die Regenverhältnisse und hauptsächlich über die Wasserführung zu berichten, sind die Unterlagen der beiden nördlichen Riviere, Omaruru und Ugab, sehr spärlich. Durch eine Reihe Tabellen und Figuren ist die zunehmende Regenhöhe nach dem Irland mit der auch zunehmenden Höhe der Landoberfläche über dem Meeresspiegel gezeigt.


Die an beiden Rivieren in letzter Zeit errichteten Meßstationen werden in einigen Jahren genaue Angaben über Wassermenge und Zeitdauer der Wasserführung ergeben.

Auch über die Grundwasserzuführungen der beiden Trockenflüsse Omaruru und Ugab im Bereich der Namib werden einige Untersuchungen mitgeteilt.

Die Erforschung der genauen Grundwasservor-kommen kann für die kommende Entwicklung von großem Wert sein, wenn auch bis heute diese Gebiete noch vollkommen unbewohnt in ihrer Einsamkeit und Unberührtheit daliagen.
Literature and References


4. Information about floods of the Ugab near Brandberg West Mine. Mr. Northing.


6. Extracts from the files of the Water Affairs Branch of South West Africa Administration.


a) The mouth of the Omaruru, viewed from the northern bank, about 1 km off the coast. The indentation in the plateau is about 320 m. wide; the northern bank slopes about 6 m. to the bottom of the river-bed (the deepening of the river-bed took place in February, 1963). In the middle of background: the sea with line of surf.
(H. W. Stengel phot.)

b) The mouth of the Omaruru. — Steep sand and silt bank of washaways. On the left, compact tertiary sand (siltcrete).
(H. W. Stengel phot., Feb., 1964)

c) The mouth of the Ugab. Remnants of silt sediments on the northern bank (behind sediments a portion of the second mouth can be seen). The sediments show clearly that the river used to lie higher, and is constantly being scoured deeper.
(H. W. Stengel phot.)

d) The river-bed of the Omaruru, between Swakopmund—Cape Cross crossing and mouth.
(H. W. Stengel phot.)
PLATE II

a) The mouth of the Ugab. — Lagoon, with the view towards the sea; on the bank, drift wood and tobacco plant. The water of the lagoon is held back by a sandy barrier, but fed by sea water through occasional breakers and spring tides.

(H. W. Stengel phot.)

b) The mouth of the Ugab. — Lagoon, photographed from the same position as in photo 1 but towards up-stream.

(H. W. Stengel phot., Feb., 1964)

c) The mouth of the Ugab. — The northern bank; in the sandy bed deposits of drift wood.

(H. W. Stengel phot., Feb., 1964)

d) The mouth of the Ugab. — The southern bank, about 2 km. from the coast. Note the wide expanse of vegetation (reeds, rushes and tobacco plants).
PLATE III

a) Ugab river, close to Brandberg West Mine.
   (W. Kuhn phot., July, 1964)

b) Ugab river. — Ford across river, close to Brandberg West Mine.
   (W. Kuhn phot., July, 1964)

c) The well of the Brandberg West Mine, situated in the middle of the
   Ugab river-bed.
   (W. Kuhn phot., July, 1964)