THE WATER PROJECTS OF THE NAMIB DESERT

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SYNOPSIS

The paper accentuates the role of water as a life giving force in a desert environment.

To provide the background for the specific water projects the physiography of the Namib coastal belt is described. Water development in the Namib required a special ingenuity which has been met by those engaged on this problem from the early makeshift days to today's science-aided investigations.

Starting at the Orange River in the south, the paper describes the water projects of the Namib Desert as far as the Cunene River in the north. These projects vary from sea water distillation to natural oases occurrences as well as discovery of large underground water supplies deep below the desert sands capable of supporting modern towns and industries as well as considerable mineral development. The only feature absent is agricultural development but its place is taken by "farming" the desert in its natural state for the visitor and tourist.

The Cunene River presents a classical hydropower form with promise of future development to enrich the Namib in a manner most suited to its natural environment.

THE NAMIB IN GENERAL

WATER is life. When one considers those essential elements which provide the basis for all life forms as we know them here on Earth, then earth and water, air and sunlight come readily to mind. Where a life source occurs in abundance it is not highly valued, but where there is a lack or where it is endangered its value is appreciated. A Hollander prizes the restricted land area which provides him with a home, an inhabitant of the Arctic appreciates sunshine, a Londoner smog-free air, but surely no one appreciates water more than a dweller in the desert where only the presence of a modicum of water can make the difference between life and death. If one can appreciate this approach one can understand why water can make of the Namib Desert a habitat of man and of the lesser life forms and not the equivalent of a moon type environment.

Reaching an average of 120 Km from the Atlantic shoreline to the edge of the escarpment of the South West African Plateau and 1 300 Km between the Orange River in the south and Cunene in the north, the Namib in South West Africa is one of the true deserts of the world. The rainfall varies from nothing, except for occasional years when freak rains occur, to 100 mm at the edge of the escarpment in the semi-desert zone. With pleasant and invigorating winters the summer in the desert can however become unbearably hot. The immediate coastal zone has a character all of its own; washed as it is by the cold Benguella current, its climate is tempered to a degree where winter winds can be biting, while in summer it is bracing and invigorating except on the few occasions when hot land winds blow seawards. The phenomena of a cold current with cold air being drawn inland at low levels results in the formation of a mist belt which generally does not extend more than 10 Km inland but on occasions covers the whole Namib.

Geologically speaking the coastal belt is relatively stable. There have however been geological ages where the sea level has changed relative to the land. Previous to the present, and during a period which apparently coincided with a wetter climatic cycle, the rivers debouching from the interior like the Kuiseb and the Omaruru formed extensive deltas. During the most recent desert stage the prevailing southerly winds, fed with sand from the coastal beaches, has formed the dune belt which is one of the characteristic land forms of the Namib. Where river flow has been strong enough to keep channels open to the sea, the rivers have formed natural barriers to the propagation northwards of the dune formations and north of the

Kuiseb, Hoarisib and the Cunene the winds have swept the immediate area to the north of these rivers comparatively clean of wind borne sand. Nevertheless the present channel of the Kuiseb has been pushed to the northern limit of its delta, while practically the whole delta has been covered with dunes leading to a typical form of ground water occurrence protected from evaporation and transpiration of plants, except along the channel still in use. Other weaker rivers in the extensive dune belt south of the Kuiseb have been completely smothered by sand and their very intermittent flows are swallowed up by the hungry sand sea before they are able to penetrate the dune belt very far. Their original mouths can not be identified today except by the small seeps of brackish water at points along the coast known only to the wanderers of the desert both human and animal.

The Namib rises fairly regularly from the coast to an elevation of 750 to 1 000 m at the foot of the escarpment. With distance from the coast and increase in elevation the rainfall increases and a sparse vegetation of light grasses and succulents with tamarisk and acacia along the better watered river channels becomes possible. Contrary to expectation and except for the dune belt near the coast and in the north, the dunes are reasonably stabilised by hardy dune grasses and some succulent bush capable of withstanding long periods of drought and smothering by sand. It is one of the most impressive sights of the Namib to see the desert bloom after one of its infrequent rain spells particularly when game concentrations are drawn to local green spots.

Apart from ground water associated with tertiary river deposits, the basic rock formations are tight and can be completely neglected as a source of water supply. If water does occur at all it is to be found at the foot of the escarpment or is so weak and saline that it is unfit for consumption.

WATER DEVELOPMENT IN THE NAMIB

Water is an essential element in the realisation of the potential wealth of the Namib and the key to the generation of its economic activity.

The basis of all development problems consists firstly of identifying and evaluating the need for a service on the one hand and the source of supply on the other. Having established the limits of the water equation the next step is to determine the optimum way in which the two can be linked at minimum cost. Here it is that the engineer, as with all engaged on development problems, has to tax his ingenuity and draw on the depth of technology at his disposal to ensure that public funds are spent to best advantage to provide the community with the standard of service it demands. In all this effort he must be constantly aware of the importance of the time element in considerations of growth and change and particularly its impact on cost factors. Money spent needlessly before its time is money down the drain and cost benefit calculations are not simple ratios but must be calculated on a time scale with interest charges brought into account.

While development in developed areas, where elements entering into the calculations can be reasonably established, still bristles with problems, development in the Namib with most factors unknown demands a special ability coupled with a pioneer spirit to meet its challenges. The history of water development in the Namib is speckled with examples of the ingenuity of man surmounting the challenges of a harsh environment. With water the key to unlocking the treasures of the desert and its inhospitable coast, surmount it he did.

In the early years the approach to the Namib was the sea and water supplies were shipborne only. A wreck on the coast away from a river mouth meant certain death, because who could face the unknown of seemingly endless miles of sand dunes. These

shipborne supplies made the cursory exploration of the coastline by the early Portuguese navigators and those who followed possible. The story of the exploitation of the guano islands of Ichaboe and others during the 1840's fall into this category. Later too shipborne supplies played their part in the development of Walvis Bay and Luderitz and the opening up of the interior until in the case of Walvis Bay the first pipeline was laid by the South African Railways in 1922 from Rooibank on the Kuiseb delta to the port and Luderitz developed its first sea water distillation plant in 1897.

With the discovery of diamonds along the Luderitz coastline in 1908 the resourcefulness of the prospectors resulted in the rediscovery of the brackish seeps of water at isolated points along the coast previously known only to game and strandlopers. The "rolbalies" with which they trundled their water over the sand can still be found today when you know where to look for them.

Mainly however the history of water supplies is expressed by the growth of sea water distillation at Luderitz and the development of water supplies from the sand of the Namib rivers. As others will have covered historical aspects of the Namib it is the intention here to deal only with the present state of water development and future prospects.

THE ORANGE RIVER

Because the border between South Africa and South West Africa runs along the high flood line along the north bank of the Orange River, South West Africa has no international right to a share in the waters of the Orange River. Making use of ground water infiltrating into the sands of the north bank of the river near its mouth, South West Africa nevertheless used the Orange River water to supply the diamond mining town of Oranjemund and allow it to develop as a well watered desert township. The diamond workings along the coast to the north of Oranjemund are also served from this source.

The Orange River is also the natural source of supply for the mining development at Rosh Pinah where zinc is produced. A State Water Supply Scheme has recently been completed for the mine and its associated town.

LUDERITZ

With its long record of being the only town in Southern Africa to receive all its water from sea water distillation at the highest price of R1.20 per m^3 paid by any comparable community the people of Luderitz rejoiced when the supply of fresh water from the desert in December, 1968, smashed their previous record and tumbled the price of water to a more genial rate of 32 cents per m^3. The Christmas box was made possible by the discovery of fresh water of high quality 110 Km inland below the desert-stifled course of the Koigab River. While ground water surveys justified the construction of a scheme with a delivery capacity of 700 000 m^3 per annum, the further extent of underground supplies has as yet not been determined. As the original source of the water is from flashy water courses stemming from the already arid mountainous fringe to the east it can reasonably be said that water is being locally mined and is not derived from safe yield. Further supporting evidence can be adduced from age determinations made of water from two boreholes in the zone lying 31 Km apart along the expected underground flow path which revealed that the age upstream was of the order of 6 260 years and downstream 7 330 years leading to a flow rate of roughly 29 m per year.

The most massive dune belt of the Namib starts north of the Koigab and its waterless nature renders it inhospitable to man and his domestic animals but not to the gemsbok and other desert denizens. Until the Kuiseb is reached the only promise of water lies along the snuffed out courses of the Tsauchab and Tsondab. Development of water along the inland fringe of the dune belt offers a chance of stabilising the habitat of the gemsbok during frequent drought years and pre-

venting destruction on adjacent farms. At the same time development of water supplies here will provide tourist and recreational opportunities in an unusual desert environment, thus providing an economic benefit while retaining a natural state.

WALVIS BAY AND ENVIRONS

The Kuiseb River with an estimated mean annual runoff of 16 000 000 m^3 per annum at a point just upstream of its contact with the dune belt, is the largest river in the coastal belt between the Orange and the Cunene. Even then its flow is only one fourhundredth of that of the Cunene which in turn is comparable in size with the Orange excluding its Vaal tributary. The Kuiseb has its source in the Khomas Hochland 30 Km to the west of Windhoek and because its catchment is rugged and consists mainly of relatively impervious mica schists it has a better yield than the adjacent Swakop catchment which, while larger, is more intermittent due to extensive sand deposits and riverine growth along its course which absorb the weaker flows.

The Kuiseb delta is extensive and once its underground flow has extended outside the limit of the northern arm where it is exposed to surface evaporation and transpiration from heavy riverine growth, it is well protected by blanketing sand dunes. The result is that in the dune area there is no visible sign of water. Seismic surveys have shown that a reasonable estimate of the underground water reserves could be placed at 1 500 Mm^3 or 330 000 M gallons or about two thirds the size of Vaal Dam. That this water is continually being replenished by the Kuiseb River is shown by the fact that the water gradient slopes seaward following the natural slope of the river while an age determination has revealed that near the sea the water is still relatively young and of the order of 70 years old.

While Swakopmund used to obtain its water supplies from sand beds near the mouth of the Swakop River, experience soon showed that while the river could yield small supplies, heavier withdrawals led to salt concentrations rendering the water completely unfit for human consumption. This phenomenon is typical of the lower Swakop where lenses of fresh water, fed by intermittent floods, drift above underlying brack water in the surface zone of the sand beds in the river channel and enable vegetable production to take place on a small scale at Palmenhorst and Goanikontes. Consequently Swakopmund has of recent years been supplied by pipeline from the State Water Scheme at Rooibank on the middle delta of the Kuiseb whose prime function is to meet the needs of Walvis Bay.

At Rooibank water is collected by means of specially filtered tube wells sunk into the fine sands, each capable of delivering about 50 m^3 per hour. The wells are well dispersed enabling selective withdrawals to be carried out when individual wells are subjected to underground flows of more saline water. By these means the dissolved solids can be kept in the range of 700 to 900 p.p.m. From the wells the water is pumped to collecting reservoirs from where it is fed by gravity to terminal reservoirs supplying consumers at Walvis Bay and Swakopmund. The water consumption during 1969 of this complex reached the figure of 3 600 000 m^3. At the phenominal rate at which the area is developing the water consumption is doubling itself every 8 years which by comparison with a doubling rate of 15 years of major cities in the Republic must be considered exceptional.

Planning is therefore underway to provide for future growth by means of extensions to the Rooibank system with a view to not only meeting the demands of existing consumers, but also the fresh water requirements of the uranium mining development along the Khan River, a tributary of the Swakop, where, as officially announced, the capital investment will amount to R100 000 000. Investigations are also proceeding on the evaluation and possible use in mining processes of the brack water resources of the lower Swakop

River. These developments are indicative of the vital part played by water in the harvesting of the riches of the barren coastal zone and of the sea in just this one area, the harvest taking the form of commerce, harbour traffic, fishing industries, mining development and recreation and tourism.

THE OMARURU RIVER

Lying 100 Km north of the Swakop the Omaruru River has the characteristics of the Swakop with regard to sand beds along its course and of the Kuiseb with regard to delta formation, except that the delta is not dune covered and is formed on a much smaller scale. The Omaruru State Water Scheme at Neineis some 100 Km from the sea supplies water to the Uis tin mine lying at the foot of the Brandberg and to other developments in this area. This scheme has a capacity of 500 000 m^3 per year and derives its water supply entirely from the sand beds of the river.

The water resources of the Omaruru delta are exploited to supply the growing holiday resort of Henties Bay with its needs and are well located to serve other potential consumers in this area of the Namib. The scheme has a capacity of 150 000 m^3 per year at this stage.

THE SKELETON COAST

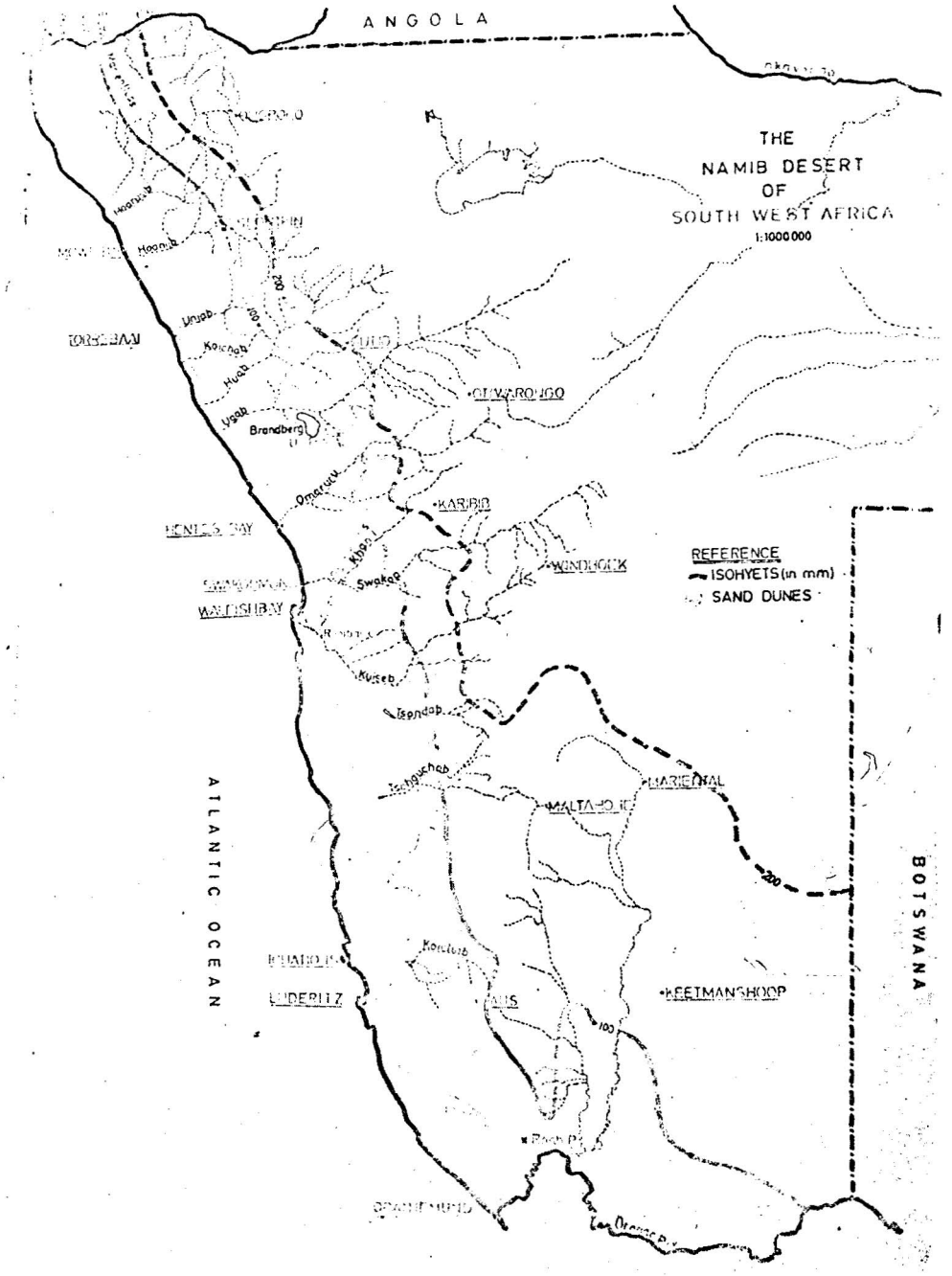
Of the rivers north of the Omaruru the Ugab and the Huab do on occasions reach the sea but their water resources are poor in quality and quantity and have not been put to use to any extent at present. The Koichab and the Unjab are only significant in that they offer opportunities for watering game, though the Unjab may be able to provide sufficient water for visitors at the seasonal holiday resort of Torrebaai.

The Hoanib and the Hoarusib to the north are perhaps the most interesting rivers along this stretch of the coast. The Hoanib has for perhaps a hundred years or more been permanently blocked off to the sea by the flow of sand dunes from the south so that in this section its course can no longer be discerned except by brack seeps on the seaward side of the dunes. The floor of the natural dam upstream of the dunes is covered with silt deposited during the infrequent periods when the river flow is arrested by the dunes. Closer in to the dunes reed and marsh growth is indicative of water close to the surface and this vegetation as well as the tree belt along the course of the river upstream is the lure for a permanent population of gemsbok, springbok and ostriches as well as the occasional rhino and herd of elephants.

Remnants of beds of silt with a well defined upper level still hanging a hundred meters or more above the present bed of the river are indicative of a bygone period when the Hoarusib too was dammed off from the sea by dune belt bridging. Today however the river course in this section is canyon-like with the floor filled with sand but the flanks stark and bare rock. Because of its present regime and similarities with the Omaruru, the Hoarusib is capable of exploitation and will probably be used as the source of supply for the new fishing harbour and factory centre to be built at Möwe Bay which lies between these rivers.

It is hoped that the Skeleton Coast, which properly starts north of the Hoarusib and continues as far as the mouth of the Cunene, will be retained as a natural wilderness area whose exploitation will take the form of untouched enjoyment through the eyes of the visitor and that the sparse vegetation of the desert fringes will remain to support the natural species and not be denuded by the hand of man and his domestic animals. For these tourist uses and for potential mineral development the northern zone must look to the Cunene for its water and for the stage when the demand and the capacity to pay can support the cost of the transmission of water southwards.

The prime economic importance of the waters of the Cunene at this stage however lies in the hydro potential of the Namib zone. Nature has been kind and has pro-


ANGOLA
THE
NAMIB DESERT
OF
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Brandberg
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SWAKOPMUND
WALVISBAY
LÜDERITZ
MARIENTAL
KEETMANSHOOP
ATLANTIC OCEAN
BOTSWANA

vided dam sites for power development in such a way that almost the full fall of the river between the point where the river breaks out of the Baynes mountains and the sea can be utilised. The sites have been named Marienfluss, Hartman, Hombolo and Mcha after local features and between them 750 MW can be powered and 3 500 GWh of energy per annum can be produced at economic rates. Because of its international status the river must be developed jointly with Angolan Portugal, but nevertheless these future very scenic dams and their power benefit can but enhance the beauty and productivity of the northern Namib provided care is taken to pattern the development sympathetically with the natural environment.