

AEOLIAN DEPOSITS AT HENTIES BAY, CENTRAL NAMIB COAST: PROVENANCE AND ENGINEERING IMPLICATIONS

J.D. Ward and B.G. Bulley

ABSTRACT

During the winter months high velocity, low frequency north-easterly Berg winds blow sand-sized fluvial material out of the lower Omaruru River into a discrete sand stream that passes through the northern residential area of Henties Bay, a coastal resort in the central Namib. The resultant sand drift build-up and dune encroachment problems experienced by the residents could be alleviated by the construction of sand trap fences on the north-eastern margin of the development and on the plains where the aeolian sand stream diverges from the main course of the Omaruru River. The local fluvial provenance and the dominance of the Berg wind in maintaining the Henties Bay sand stream contrasts with the more characteristic situation encountered elsewhere on the Namib coast, e.g. Walvis Bay and Lüderitz. In those areas, the south-south-westerly is the major sand-moving wind and the main Namib Sand Sea the principal sediment source. The anomalous situation at Henties Bay is attributed to the coarser grade of aeolian sediment derived from the lower Omaruru River, which would affect the threshold velocity for sand entrainment, and the comparatively low energy of the south-south-westerly wind regime in the central Namib.

1. INTRODUCTION

Development along the South West African/Namibian coast is faced with a number of unusual engineering problems related to the extreme-arid desert climate. In particular, the towns of Walvis Bay and Lüderitz experience continual problems with aeolian sand drift and dune encroachment in developed areas and also on lines of communication (Brink, 1985). In both cases, the main Namib Sand Sea is the major sediment source and aeolian activity is governed principally by the high-energy, south-south-westerly wind which prevails along the Namib coast (summarized in Brink, 1985, Table 16, p. 81).

In contrast to Walvis Bay and Lüderitz, the source of the aeolian sand at Henties Bay, a coastal resort 72 km north of Swakopmund, is not related to any dunefield or sand sea nor to the south-south-westerly wind regime. Instead, the lower Omaruru River is the source of the aeolian sand and the north-easterly Berg wind, which blows mainly in the winter months, is the dominant sand-moving agent.

2. FIELD OBSERVATIONS

Henties Bay is located on the extensive Pleistocene alluvial deposits (fan delta) of the Omaruru River (Korn and Martin, 1955). These cohesive sediments, comprising sands, silts and gravels, form a sea-facing cliff, up to 20 m high, that is partly obscured by an aeolian sand drape which has slopes of up to 30°. The present Omaruru River, a major ephemeral watercourse, follows a south-westerly course that is partly incised into these alluvial sediments for the last 8 km to the Atlantic Ocean. A distributary (or possibly a former main course) runs to the south of the main channel and divides Henties Bay into northern (North Dune) and southern (South Dune) sections (Fig. 1). Flow down this distributary is prevented by a berm wall (Fig. 1).

During the winter of 1987, north-east Berg winds were

particularly strong and persistent in the Henties Bay region. Consequently, the eastern part of the North Dune residential area experienced severe sand drift and dune encroachment problems (Fig. 2). Small barchanoid and parabolic dunes, up to 1,5 m high, formed against and

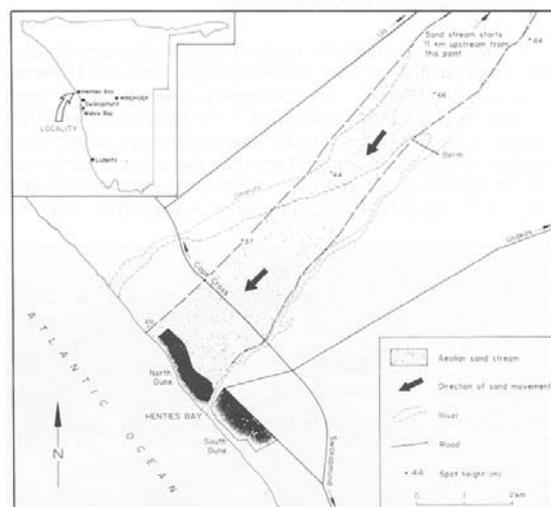


Fig. 1: Map of the Henties Bay area indicating the lower reach of the aeolian sand stream derived from the lower Omaruru River.



Fig. 2: Oblique aerial photograph illustrating dune encroachment and aeolian sand drift accumulation on the eastern margin of North Dune residential area, 3 August 1987.



Fig. 3: Build up of a small parabolic dune over a boundary wall in the North Dune residential area, 2 August 1987.

adjacent to dwellings (Fig. 3). Most of the houses on the eastern edge exerted a self-cleaning or wind scoop effect which prevented the small dunes from banking up against these buildings. However, where slatted concrete fences and low garden walls were present, considerable build-up of sand occurred, resulting in the adjacent yards being inundated to a depth of about 1 m. These deposits ranged from coarse- to fine-grained, with an apparent dominance of medium-grade material. Significantly, the build-up of aeolian deposits on South Dune was considerably less than on North Dune.

From field observations made during a strong north-east Berg wind in August 1987, it was obvious that North Dune lay directly in the path of a south-westerly oriented aeolian sand stream that could be traced back to the lower reaches of the Omaruru River (Figs 1 and 4). The persistence of this sand stream, which starts some 21 km from the coast, is confirmed by the remote sensing record provided by aerial photographs (e.g. Job 760 of 1976) and Landsat imagery (WRS: 193-75). Several other smaller aeolian sand streams were identified farther upstream, but these do not appear to affect Henties Bay.

The megaripples in coarse- to granule-grade sand on the flood plain and river bank south of the Omaruru in the vicinity of the berm wall are oriented to the north-easterly wind and not to the south-south-westerly. These aeolian bedforms testify to the high velocities



Fig. 4: Oblique aerial photograph of the aeolian sand stream from the exit out of the lower Omaruru River towards the North Dune section of Henties Bay, 3 August 1987.

attained by the Berg winds. In addition, the shadow and coppice dunes associated with the dwarf shrubs (mostly *Arthroerua leubnitziae*) on the plains between the Omaruru River and Henties Bay have a persistent south-westerly alignment and consist mainly of coarse- to medium-grade sand.

The aeolian sand that forms a drape over the sea-facing cliff, which is particularly well developed on North Dune, is also derived largely from the Omaruru River. The south-south-westerly wind mostly redistributes these sands northwards, in places forming small (0,5 m high) climbing dunes along the crest of the cliff. At times, however, sand movement on the sea-facing cliff is retarded because fog-derived moisture in the surficial layer of the aeolian drape temporarily stabilizes the surface.

3. GEOMORPHOLOGICAL CONSIDERATIONS

The aeolian deposits on North Dune are derived from the lower Omaruru River some 21 km inland from the coast and exit from this broad, shallowly-incised course some 6 km inland in a well-defined sand stream under the influence of high velocity, low frequency north-east Berg winds. Sand movement along, and out of, the lower Omaruru River is facilitated by the sparse cover of riparian vegetation and dwarf shrubs which occur on the plains between the river and Henties Bay.

This inland, local provenance therefore differs from the large-scale sediment movement associated with the sand seas and coastal dunefields in the rest of the Namib. For example, the Orange River is the major source of sediment for the main Namib Sand Sea and the south-south-westerly wind regime and the northward longshore drift are the dominant interacting geomorphic processes (Rogers, 1977; Lancaster, 1983; Lancaster and Ollier, 1983). Similar processes, operating on a littoral-derived sand supply, are responsible for the development of the Skeleton Coast dunefield (Lancaster, 1982), the Bai dos Tigres-Curoca Sand Sea (Torquato, 1972) and probably the Engo-Kunene Sand Sea.

The orientation and persistence of the sand stream from the lower Omaruru River south-westwards to Henties Bay suggests that the north-easterly is a more important sandmoving wind than the south-south-westerly in this section of the Namib. The strength of the south-south-westerly wind decreases from the southern to the central Namib. This is reflected in the sand drift potential, calculated from wind data, which decreases from 2823 vector units (VU) at Pomona in the Sperrgebiet to 518 VU at Pelican Point, Walvis Bay (Fryberger, 1979). Lancaster (1988) also demonstrated the decrease in the potential sand transport rate from Kolmanskop (Sperrgebiet) to the Kuiseb River, which forms most of the northern boundary of the main Namib Sand Sea. Resultant drift potentials calculated for stations on the north bank of the lower Kuiseb indicate a theoretical westerly to south-westerly net movement for this reach

where the linear dunes front onto the river (Breed *et al.*, 1979; Harmse, 1982; Lancaster, 1988).

However, monitoring of dune movement along the lower Kuiseb River proves that the linear dunes are moving northwards (Ward and Von Brunn, 1985). This net northerly movement thus emphasizes the importance of the more frequent, but lower energy, south-south-westerly wind in this area. Significantly, these linear dunes consist mainly of fine- (crest) to medium-grained (plinth) sands (Lancaster, 1981), whereas the aeolian sediments derived from the lower Omaruru River are generally coarser. Therefore, the threshold velocity for sand entrainment in the Henties Bay aeolian sand stream is likely to be higher than that required for the linear dunes of the northern main Namib Sand Sea. Thus the high velocity, albeit low frequency, north-easterly Berg wind is the dominant sand-moving wind in the Henties Bay area. In those stretches of the Namib where the south-south-westerly wind is only marginally high energy, i.e. 400 VU (Fryberger, 1979), grain size of the aeolian sediments may be the most important factor determining the geomorphologically effective winds.

Moreover, the south-westerly aligned lower Omaruru Valley funnels the Berg winds, thereby enhancing their transporting capacity, an effect that has also been noted in the Kuiseb (Ward and Von Brunn, 1985) and Tsauchab (Lancaster, 1988) valleys farther south.

4. ENGINEERING IMPLICATIONS

The sand stream has important implications for development in the North Dune area and future undertakings should recognize the problems involved and take appropriate measures. Several methods of dune control have been tried with varying degrees of success in the Walvis Bay area (Brink, 1985). One of the more effective methods has been the erection of sand-trap fences across the path of the sand-moving winds. These fences are, however, unsightly and require regular cleaning and maintenance. Therefore, consideration could be given to the establishment of windbreaks formed by indigenous dwarf shrubs, such as *Arthroa leubnitziae*. These would form effective, aesthetically pleasing sand-traps that could be strategically located on the north-eastern fringe of the North Dune residential area and on the southern bank of the Omaruru River where the aeolian sand stream diverges from the main channel (Figs 1 and 4).

Appropriate design of buildings can also assist in reducing sand accumulation. Free flow of wind around the building, resulting in a self-cleaning effect, is beneficial, whereas obstacles such as courtyards, wing walls, etc. aligned across wind result in considerable sand deposition. Boundary fences, particularly concrete walls and slatted fences, also promote the accumulation of aeolian sands.

Control of sand movement in Henties Bay will, however, disrupt the natural process of deposition and

aggradation of the aeolian drape on the sea-facing cliff. From preliminary field observations, it appears that replenishment of this aeolian drape may partly balance the marine erosion of this cliff. Therefore it is recommended that any sand removed from the developed areas, or any future sand-trap fences, be dumped over the sea cliff to counteract erosion.

5. CONCLUSIONS

The lower Omaruru River provides sand-sized sediment that is readily transported by the high velocity, low frequency north-east Berg winds into Henties Bay, particularly North Dune. The coarse grade of these aeolian deposits, notably those associated with the shadow and coppice dunes and the megaripples, illustrate the importance of grain size on the threshold velocity of geomorphologically effective winds in this region. Consequently, the normally important role played by the south-south-westerly wind along the Namib coast is overprinted by the north-easterly Berg wind in the Henties Bay region. The influx of aeolian sand into the North Dune residential area of Henties Bay could be reduced considerably by the construction of aesthetic sand trap fences at strategic intervals in the sand stream between the Omaruru River and North Dune. However, the sand removed from these fences during cleaning operations should be dumped over the sea-facing cliff to retard coastal erosion.

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