DUNE MIGRATION - BUSHMANS BEACH CAR PARK AREA

1.0 LOCATION

The 1943 aerial photo – fig. 1 - shows the dune area of the west bank of the Bushmans estuary. Photographs taken in 1965 from the Kenton side showed that bushes had not been planted. The sand dunes were stable (personal knowledge). The 1980 image of the 1:10 000 topographical map – fig.2 shows the area of wattles and bushes on the west. The 2016 image shows the location of the car park and the Bushmans river mouth. The bushes and Port Jackson wattles covering the area were planted in the 1970's and covered an area 400m west of the car park. The wattles at the western side were removed some years back. The exact reason for planting the bushes is not known to the writer. **Wattles are known to control the movement of windblown sand, was this the reason**?

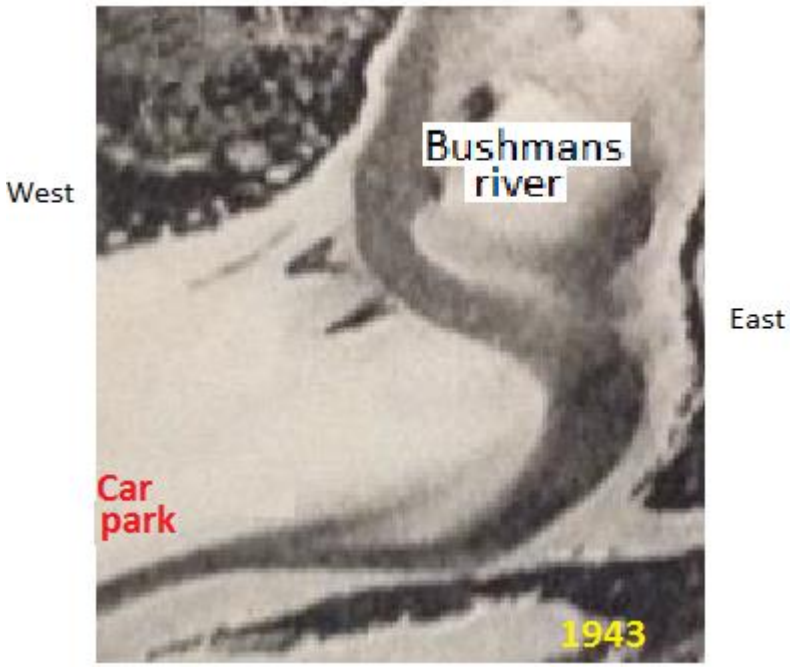


Fig.1

Fig.1 Bushmans river mouth – 1943.

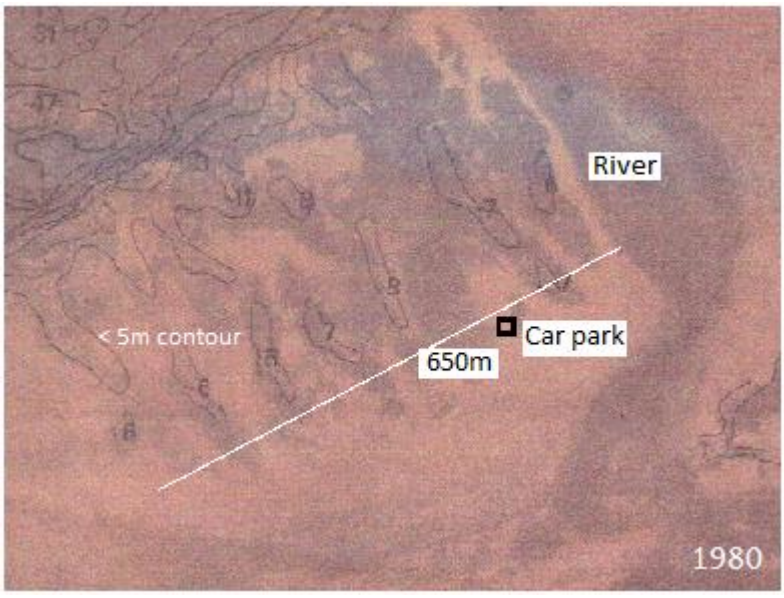


Fig.2

Image of the 1980 1:10 000 topographical map. Areas of planted vegetation are the darker patches.

Fig.3

Fig.3 is the 2016 image of the car park area. It also shows the interpreted limit of the bushes, with the wattles planted on the western side. The western limit of the vegetation is based on the 1980 1:10000 topographical map of the area. The area of the wattles is based on field observations of stumps.

2.0 SAND MOVEMENT

The sand distribution in a strong wind is shown in fig.4

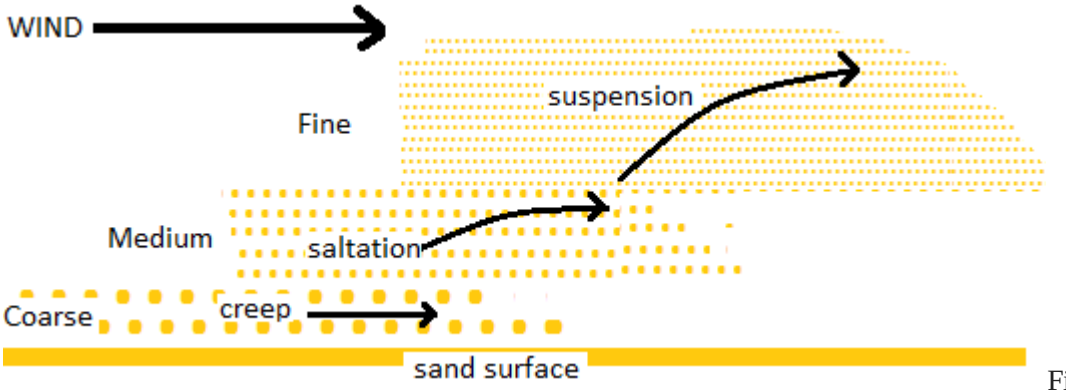


Fig 4

A very noticeable feature in recent months is the high percentage of soft / loose sand on the windward slopes of all the dunes in the area. This is possibly due to present drought conditions. The loose sand results in high migration rates.

3.0 DUNE MIGRATION RATES

These are comparative figures. The rate that dunes will move in a year varies considerably. The high dunes against the Bushman's hills will move at a low rate a year whereas those near the shoreline with greater wind influence and sand availability move at higher rate. Concentrated wind flow – a valley – will lead to higher rates.

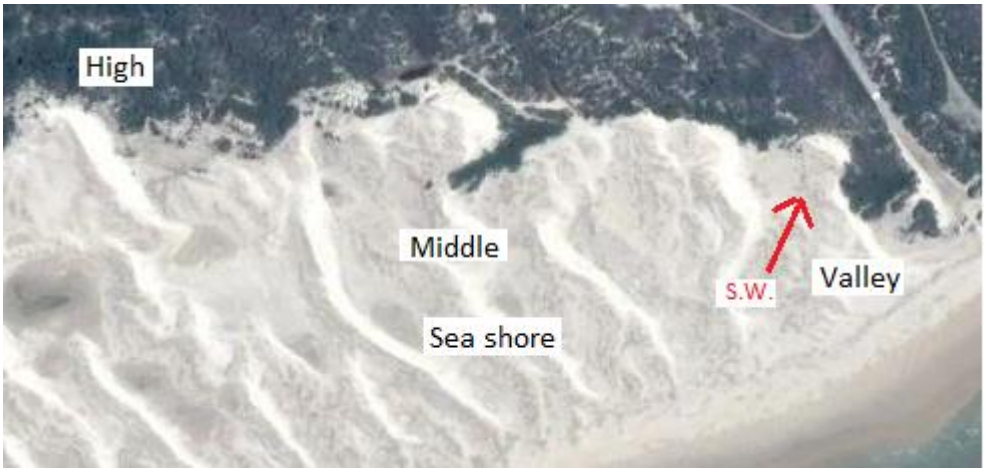


Fig. 5

These figures are from a few sites and give a general idea of annual migration rates: Inland / High ground = 1.5m per year. Middle zone = 3m per year. Shore zone = 7m per year. Valley (concentrated wind flow) = 13m per year.

4.0 BUSHMAN'S DUNE MIGRATION WEST OF CAR PARK. 2003 – 2017

Google images are available from 2003, 2010, 2013 and 02/2016. Measurements were made in June 2017 to update the data. The following Google images show the movement of dunes towards the Bushman's beach car park road. Fig.6 is the 2003 image with the main dune 148m west of the road. Note the bush cover on the sand ridges west of the car park.

Fig 6

Fig.7

By 2010 –fig.7 - the main dune had moved 40m eastwards towards the road, averaging 6m per year. The dune movement is over a wide front extending down to the beach. The bush covered sand hillocks in the southern section west of the car park are good reference points.

Fig.8

In the period from 2010 to 2013 two distinct dunes had developed, A and B – fig 8. The average advance rate increased to 10m per year.

Fig.9

A significant feature is how the shapes of the dunes have changed – fig. 9. In 2013 the crests of the dunes were roughly parallel. By 2016 the crest of the east dune – A - is lower (-) than it was in 2013. The north crest of the west dune – B - is a lot higher (+). Note the change in shape of the west dune. The northern section has advanced 16m whereas the southern section has been cut back some 18m by the west wind moving the sand. The cut back of the western dune has created a distinct valley between the two dunes and channelling the west wind (red arrow) and sand. The leading dune has advanced 33m to the road in 30 months. Note the bush vegetation and the ridge have offered no resistance to the dune progression. The strong west wind period is July to October so further migration can be expected by the end of 2017.

5.0 JUNE 2017 SITUATION

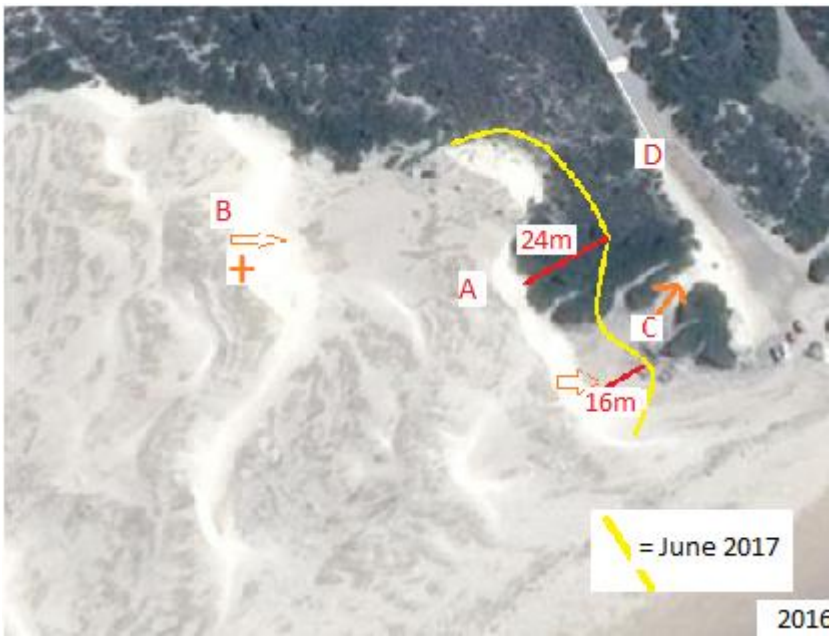


fig.1

Since 02/2016 the dunes west of the car park have moved eastwards as shown by the yellow line being the June position of the dunes – fig.10. In the 16 months since the 02/2016 image the eastern edge of dune A has moved significant distances – 24m and 16m. The dune – B - with the plus sign has increased significantly in height as well as moving eastwards. The area at C is a depression between the bushy hills so that it concentrates the west wind flow.

Therefore, as the dune at C moves eastwards a large quantity of sand will be carried through the gap onto the car park. It is likely that this will occur before the sand reaches the road at D.

6.0 DUNE MIGRATION GRAPH

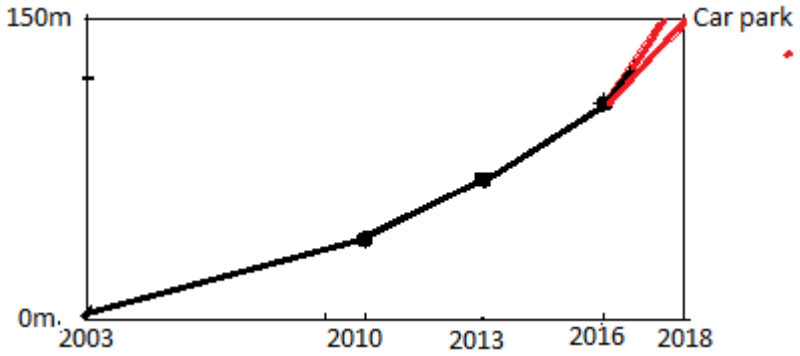
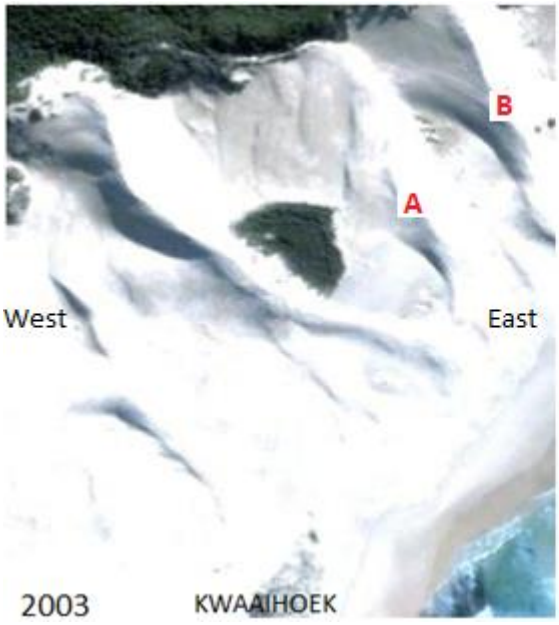


Fig 11

The graph in fig. 11 shows the steady increase in the rate of dune migration. This increase is owing to the narrowing of the leading dunes. There is little doubt that the car park will be closed by the end of 2018.

7.0 KWAAIHOEK AREA

As can be seen in fig.12 that apart from slight changes in shape, there has been virtually no dune movement in the Kwaaihoek area at 1.9 km west of the car park.



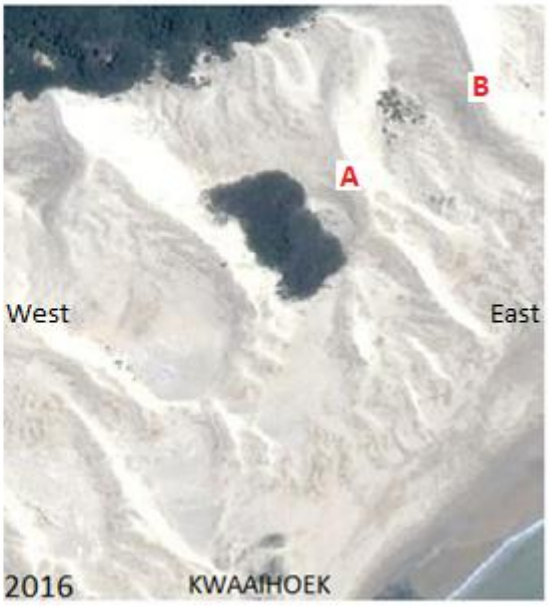


Fig.12.

8.0 THE LOOK- OUT

The "Look-out" is between Kwaaihoek and the car park at 1km west of the car park – fig.13. The dunes in this area have moved 40m from 2003 to 2016.

9.0 LOCATION VARIATIONS IN DUNE.

The dune migration figures over 13 years of 0m at Kwaaihoek, to 40m at Look-out – fig.13- and 115m at the car park area are very significant. The reasons for this difference clearly indicates the influence of the wind and source of

sand. The influence of the west, south –west wind is reduced in the Kwaaihoek area due to the high rocks but further east it reaches maximum velocity over the open sea.

10.0 SOURCE OF THE SAND

It is estimated that approximately 400,000 cu .m. of sand contributed to the increase in dune area and the increased height of the dunes from 2003 to 2017. As the sand did not move laterally from the west (Kwaaihoek) the only source was from the sea.

Fig.13 shows an inshore current that turns seaward at Kwaaihoek to join the dominant offshore current. The presence of the inshore current was evident during the last Bushman's river flood, a +/- 300m zone of muddy water moved along the shore up to Kwaaihoek where it turned seawards into the offshore current. Does the inshore current have an influence on the sand deposited on the beach line?

The shape of the beach is continually changing from the gully situation in fig.13 to a sloping beach with no gullies. With the sloping beach situation waves are breaking and stirring up sand 300 m off shore. This situation and high spring tides and tidal surges result in large quantities of sand being moved up the beach into the "swash" zone. Sand is deposited on the beach and then is moved by the west winds. The "west winds" range from south-west to north-west but are predominantly south- west.

fig 13

11.0 SWASH ZONE

The edited information presented here was obtained from an Australian source and explains the mechanics of the source of the sand:-

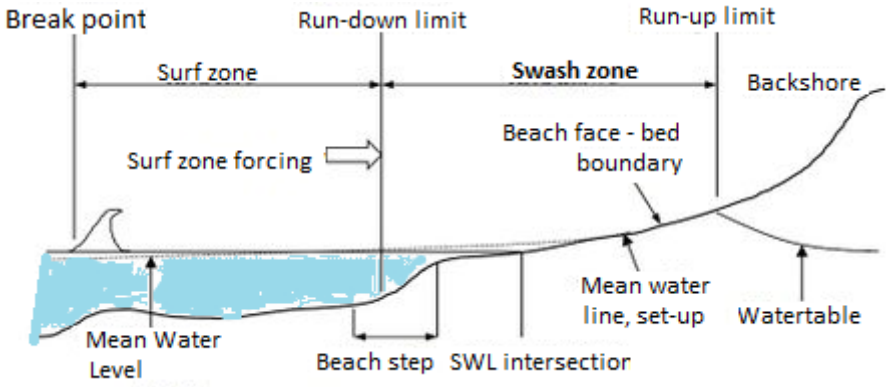


Fig. 14

"The swash zone forms the land-ocean boundary at the landward edge of the surf zone, where waves run up the beach face (figure 13). It is the region of the littoral zone most associated with beach erosion and the impacts of climate change. The landward edge of the swash zone is highly variable in terms of geomorphology, and may terminate in dunes, cliffs, marshes, ephemeral estuaries and a wide variety of sand, gravel, rock or coral barriers. This influences the exchange of sediment between the land and ocean, which ultimately forms the coastline.

In terms of coastal processes and coastal protection, a large part of the littoral sediment transport occurs in the swash zone, both cross-shore and long-shore, which influences beach morphology, and beach erosion and beach recovery during and after storms. Wave run-up is an important factor in the design of coastal protection and also generates hazards for beach users, and is the dominant process leading to the erosion of coastal dunes. Swash hydrodynamics also influence the ecology of the intertidal zone and groundwater levels in sub-aerial littoral beaches and low lying islands, which is often critical for freshwater water supply on islands and atolls ".

Fig. 15

Fig . 15 A turbulent bore containing sand just prior to reaching *the swash* zone. The sand is then washed into the swash zone during the run-up. The difference in elevation between "spring" and "neap" tide means there is a zone of loose sand available for transport by strong winds.

12.0 DISCUSSION

In the period 2003 to 2017 the dunes have moved 120m towards the Car park, 40m at "Look out" and 0m at Kwaaihoek.

What is puzzling is that for years the dunes were basically stationary and in the last 14 years they have moved large distances at an increasing rate. Did the removal of the wattles allow the dunes to start moving to the east? In the long term the dune movement will not stop at the car park but will continue eastwards towards the mouth**,** fig.16. The current high rate of advance of the dunes will decrease as the dunes reform on a wider front on the other side of the car park

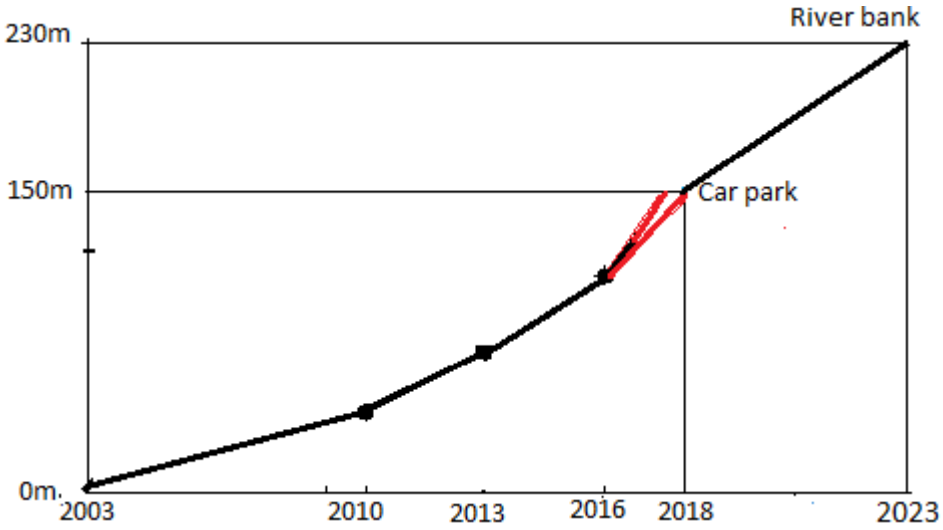


Fig.16

High dunes on the estuary bank will be subjected to tidal erosion with increased silting of the estuary. The recent high spring tide / tidal surge was a good example of sand being carried into the estuary. Fig.s 17 & 18 of different "google images" are used to show the difference in the western banks before a tidal surge – fig 17 and after an event – fig 18, a distance of 85m.

Fig.17

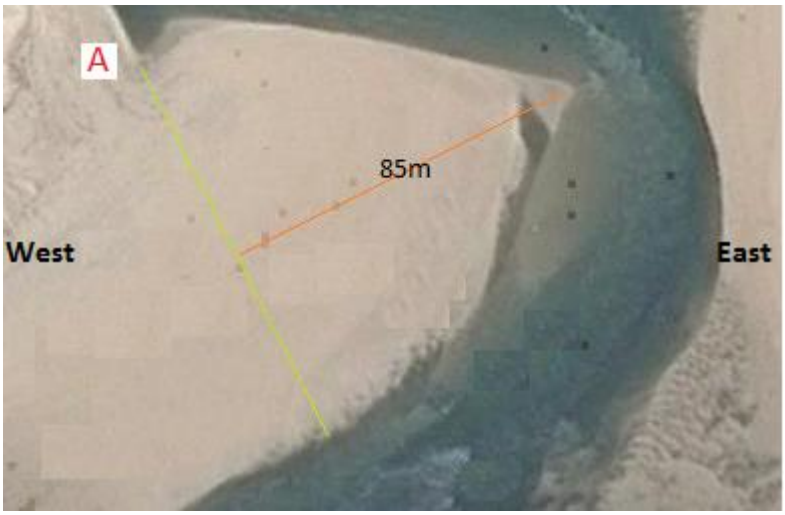


Fig 18

If the drought persists through the dominant west wind period of August / September then higher migration rates can be expected owing to the large areas of loose/soft sand on the windward slopes. Unfortunately, nothing can be done now to stop the migration of the sand onto the road or car park. The situation in the car park is worse now because of the large quantity of sand washed onto the car park by the recent high spring tide.

The migration of the dunes towards the estuary bank is a major problem. Will the planting of 'Port Jackson Willows' – wattles – be the answer??? The area planted must be at least 200m west of the car park. Wattles planted on the windward slope stop sand being moved up the slope and the dune moving forward.

Amatola Water Board, the other question is how does the dune migration affect boreholes providing local water. Already one borehole has been covered by a dune and is out of action. Another borehole is covered but still operates.

This is a serious issue and any additional information and comments to establish the correct facts will be welcome. It is really puzzling is why over hundreds of years Bushmans estuary was functional with a sand western bank and in 74 years the situation has changed dramatically!!!!!!!

D H Laubscher (dennis.laubscher@mweb.co.za) 17/08/2017