Durability of vehicle tracks on three Namib Desert substrates

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Vehicle tracks were made on three Namib Desert substrates by five types of vehicles in common use. The windward slopes of the dunes and the hard, calcrete interdune valleys are least vulnerable to long-term substrate damage. In contrast, the sandy interdune valleys and dune bases are extremely vulnerable.
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Voertuigspore is op drie Namibwoestyn-substrate gemaak deur vyf tipes voertuie wat algemeen gebruik word. Die loefwaarste hellings van die duine en die harde, kalkagtige interduin-valleie is die minste kwesbaar vir langtermyn substraatskade. In teenstelling hiermee is die sanderige interduin-valleie en duinbasisse uiters kwesbaar.
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The upsurge in recreational vehicular traffic in the deserts of southern California and Arizona has resulted in extensive destruction of plant and animal life and an unsightly appearance (Davis 1974, Stebbins 1974). Namib Desert sand dunes are a potential recreation area for vehicular traffic, especially along the coast near Swakopmund and Walvis Bay, and the destructive process is under way. This report identifies the fragility of certain Namib Desert dune environments and suggests some ways of avoiding irreversible damage.

Area and Methods

Dunes near the Desert Ecological Research Unit at Gobabeb were selected as a test site. Five commonly used off-road vehicles (Table 1) made grids of tracks on experimental plots on three types of surface: the relatively hard windward slope of a sand dune (Fig. 1) where research vehicles usually travel; a patch of fine gravel-covered sand in the interdune valley; and a hard calcrete rubble plain, also in the interdune valley.

The grid in Fig. 2 shows how four tracks were made by each vehicle on each plot of the surfaces. To evaluate the

Table 1 Vehicles used in experimental grid of tracks

Vehicle type and mass	Seating capacity	Tyre type and inflation pressure	Power distribution
Land Rover 1 497 kg	6 persons	Sand tyres 103 kPa	4 wheel drive
Ford truck 2 175 kg	3 persons	Road tyres 90 kPa	4 wheel drive
Mercedes Benz Unimog 3 200 kg	2 persons	Road tyres 83 kPa	4 wheel drive
Heald Tryke three-wheeler 200 kg	1 person	24 kPa	Power to rear wheels
Honda three-wheeler 70 kg	1 person	7 kPa	Power to rear wheels

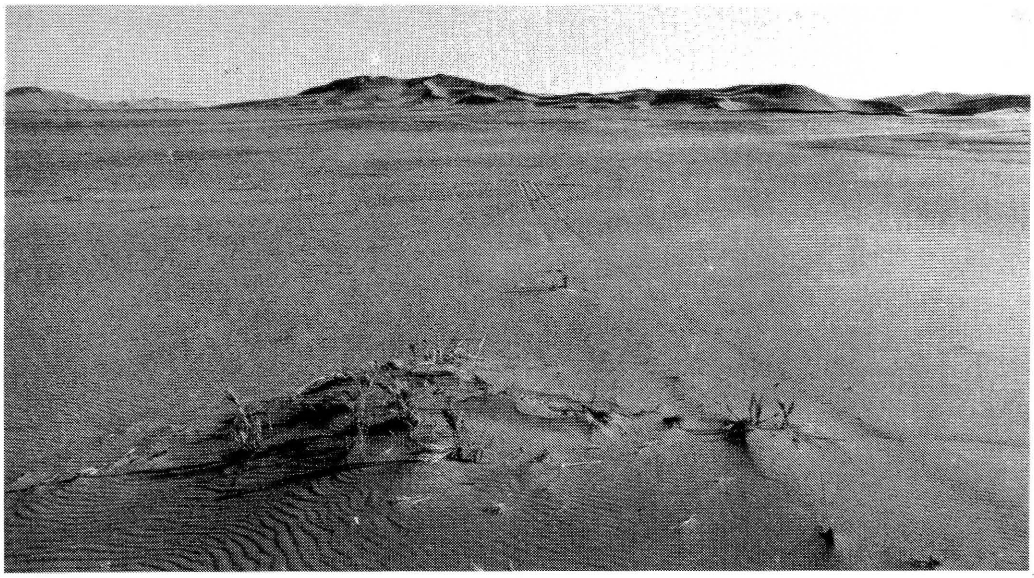

Fig. 1 Tracks on sand dune photographed on the day tracks were made, following afternoon wind. These tracks disappeared within one week.

effect of repeated traffic the Land Rover and the three-wheeled cycles were driven ten times over the same tracks. On the gravel-covered sand the Land Rover was also driven ten times along the shoulder of the same track, returning along the opposite shoulder. This manoeuvre is believed by some drivers to leave shallower imprints, improving traction and reducing substrate damage.

Results

SAND DUNES On the same day wind had erased all tracks on the upslope half of both dune plots except a faint track that remained where the Land Rover had been driven ten times over the same tracks. Downslope the tracks were progressively clearer towards the bottom of the slope. The most clearly visible tracks were related to vehicle mass and number of traverses (Table 2).

GRAVEL-COVERED SAND On the same day all tracks made in all directions were clearly visible at dusk (Fig. 3a). A comparison of the depth of the tracks gave the ranking order: Land Rover, 10 × same track; Land Rover, 10 × shoulders of track; Unimog, once; Ford, once; Land Rover, once; Heald Tryke, 10 ×; Honda, 10 ×; footprint, once; Heald Tryke, once; and Honda, once.

Table 2 Tracks visible on windward slope of sand dune after 5–7 hours

Mean length of track	Vehicle	Number of traverses
50 m	Land Rover	10
25 m	Mercedes Unimog	1
18 m	Heald Tryke	10
10 m	Land Rover	1
8 m	Honda three-wheeler	10
5 m	Footprint, human	
4 m	Heald Tryke	1
0 m	Honda three-wheeler	1

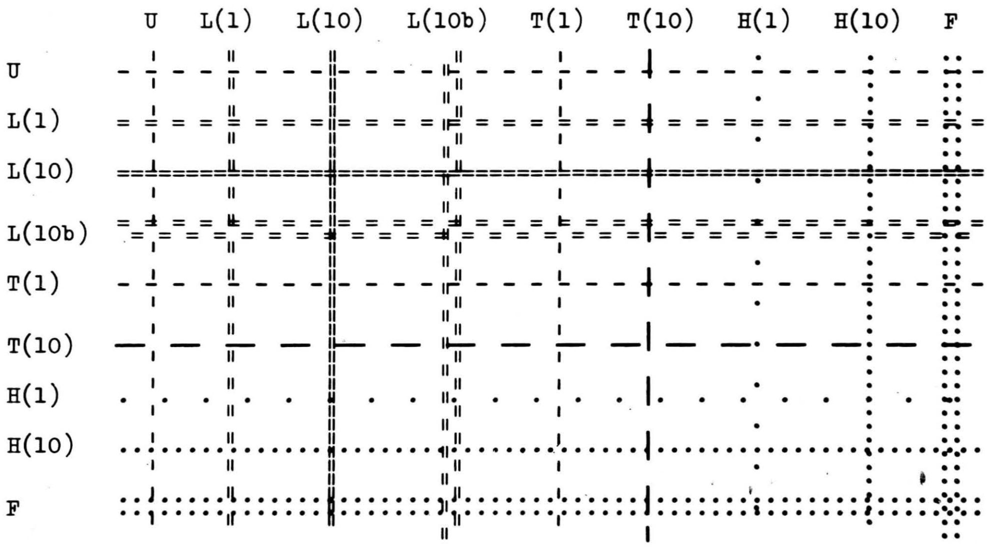

Fig. 2 The grid arrangement of the experimental plots. U - Unimog, L - Land Rover, T - Heald 'Tryke' three-wheeler, H - Honda three-wheeler, F - Ford truck.

Fig. 3 (a) Tracks on gravel-covered sand photographed on day tracks were made, following afternoon wind. The tracks on the left were made by the Land Rover driving in the same track ten times, while those on the right were made by the Land Rover driving on the shoulders of the track ten times. (b) The same tracks four months later.

CALCRETE RUBBLE By the evening of the same day we could not relocate the three-wheeled cycle tracks, but the tracks made by driving the Land Rover ten times over the same tracks were still faintly visible.

After one week all signs of tracks on the sand dune had disappeared, all tracks were clearly visible on the gravel-covered sand, and the calcrete substrate showed evidence of the passage of the heavier vehicles. Three months later the situation had changed. There had been several heavy rain showers with resulting growth of grass. On the gravel-covered sand all tracks were still visible (Figs. 3b and 4b), those of the light three-wheeled vehicles being least obvious, and those where a vehicle had cornered at speed being most obvious. Grass did not grow as profusely in the tracks as on the undisturbed ground. On the calcrete the tracks of the heavy vehicles were discernible only because no grass grew in part of the tracks. One year later the situation had not changed much except that all the tracks were less obvious than before.

Discussion

The dunes are composed of sand grains averaging 0,15 mm in diameter, which are easily moved by the daily wind of up to approximately 30 km/h.

Calcrete rubble surfaces consist mainly of rocky material covered by a thin, mobile sheet of sand and some lag gravel. Rearrangement of the sand cover rapidly eliminates traces of vehicle tracks and this surface is thus highly resistant to damage by vehicular traffic.

In contrast, the sandy interdune valleys and dune bases are extremely vulnerable. The surface cover ranges from fine lag gravel (diameter 2 mm) to pebbles (diameter 50 mm) which is driven into the underlying sand or displaced sideways when a vehicle passes over it, and the

Fig 4. (a) Effect of cornering on gravel-covered sand (one month after the tracks were made). (b) The same tracks four months later after rain and the resultant growth of vegetation.

sand thus exposed is blown away. Tracks made on this kind of surface may last for years.

In addition to the grids of tracks made for this experiment, existing tracks in the vicinity which had been made in the course of earlier mining and water exploration and research activities were also observed. The vehicles which had made these tracks and the dates when they were made were known. In several square kilometres of interdune valleys near Gobabeb traces persisted of tracks made six years earlier, and did not support growth of grass as did the surrounding area.

An unexpected result of vehicular traffic was observed on the vegetated dunes east of the experimental area (Fig. 5). Following unusually heavy rains in late summer, annual grasses developed preferentially along old, hitherto invisible vehicle tracks on the sand surface. According to Liddle & Grieg-Smith (1975a, b) compaction of the sand in vehicle tracks causes an increase in soil water content on coastal dunes in England, and presumably a similar mechanism operates in the Namib dunes. Such tracks are, however, temporary and disappear when the ephemeral vegetation dries up and blows away.

Recommendations

The results of this investigation point to several ways in which drivers of vehicles can minimize the effect of their vehicles on desert substrates. These include (but are not limited to) the following:

Choice of route Whenever possible vehicles should be driven on the dunes rather than on the interdune valley floor. The dune base is often gravel-covered and should be avoided, but between this level and the first slipfaces on the windward side of the dunes there is a region of relatively hard sand which provided an excellent track for all vehicles in this study.

To cross an interdune gravel plain the route should be

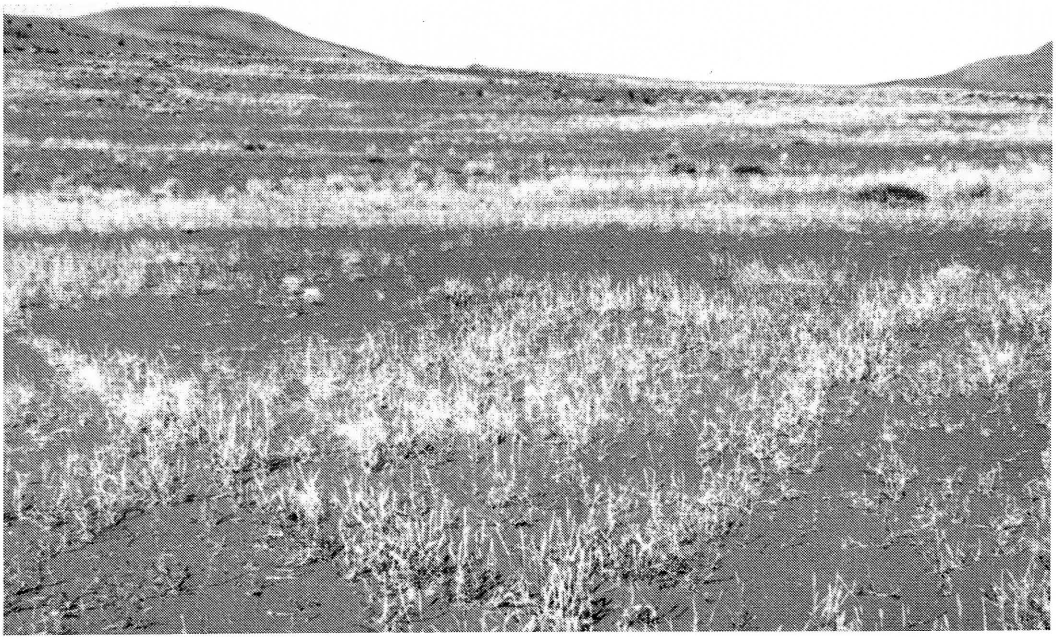

Fig. 5 Tracks on vegetated dunes east of the experimental area after heavy rains.

kept to the hardest substrate available. Crossings should be kept to a minimum. On substrates where frequent traffic occurs the appearance of the environment will be best preserved if a single track is followed. When following existing tracks it may be possible to minimize track depth by driving on the shoulder of existing tracks.

DRIVING SPEED This does not materially affect the impact on the substrate except that cornering at speed scores deep and lasting gashes (Figs. 4a and b). On soft sand high speed need not be maintained if tyres are properly deflated.

TYRES Tyre pressure should be as low as possible, compatible with satisfactory tyre life, and whenever possible sand tyres should be used.

These recommendations are based on experiments carried out in the central Namib Desert dunes, but they may well apply to the desert and sandy areas throughout southern Africa which generally have fragile substrates.

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