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Fuljis: A Discussion

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ABSTRACT

In the late nineteenth century Anne and Wilfrid Blunt described horse-shoe shaped hollows they called fuljis in dunes in the Nafud sandsea of Nejd in Arabia. Since then the term has been sparsely used but investigators have tended to associate these features with coalescing barchans. Examination of images from Google Earth, however, have shown that such hollows are associated with quite a large range of other dune types including star dunes, parabolics, network dunes, and mega-barchanoid ridges. The paper concludes with the suggestion that the term is superfluous, and that such rather neglected features, which deserve further investigation, should simply be called 'interdunal hollows'.

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1. Introduction: Literature review

Lady Anne Blunt, the 15th Baroness Wentworth, and her philandering husband, Wilfrid Scawen Blunt were great breeders of Arab horses and notable explorers of the Middle East. Anne (1837-1917) was a granddaughter of Lord Byron and she married Wilfrid (1840-1922), a poet and diplomat, in 1869. On their journey to the Nejd, in what is now Saudi Arabia, described in Anne's *A Pilgrimage to Nejd, the Cradle of the Arab Race* (1881), they covered some 640 km of stony desert between Damascus and Al-Jawf and then headed south westwards through dune country to Jubba and Ha'il.

Here the Blunts observed dunes with regularly-spaced, crescentic hollows in the An Nafud sandsea (p 158-9):

> The most striking features of the Nefûd are the great horse-hoof hollows which are scattered all over it (Radi calls them *fulj*). These, though varying in size from an acre to a couple of hundred acres, are all precisely alike in shape and direction. They resemble very exactly the track of an unshod horse, that is to say, the toe is sharply cut and perpendicular, while the rim of the hoof tapers gradually to nothing at the heel….. The diameter of some of these fuljes must be at least a quarter of a mile, and the depth of the deepest of them, which we measured to-day, proved to be 230 feet, bringing it down very nearly exactly to the level of the gravelly plain which we crossed yesterday, and which, there can be little doubt, is continued underneath the sand.

They were not sure of their origin, and debated whether they were due to wind or water action.

Wilfrid also wrote a rambling paper on the subject (1880, pp 94-6), in which he stressed their age and stability. As to origin, Wilfrid was not clear. He remarked that 'At first sight I was inclined to fancy that it was due to the action of water, and that each long string of hollows corresponded with an underlying wady, but this can hardly be the case'. 'On the other hand', he said, 'it is equally difficult to seek in the prevailing winds a solution of the mystery.'

Following the writings of the Blunts, there was some interest in this subject. Their work was summarised by Cornish (1897) and led to some discussion at the Royal Geographical Society (RGS) (Bonney *et al*. 1897), in which McMahon (p 306-7) remarked that he had observed them on his 'recent wanderings in the deserts between India and Persia'. Presumably he is referring to Afghanistan. He noted their association with barchans and speculated on the role of lee eddies in their formation. He also noted square varieties. A further discussion at the RGS occurred in 1910 (Strahan *et al*. 1910).

Subsequent references to fuljis are sparse. Aufrere (1931) briefly mentioned them, but employed the term 'bajir', a name that had been used by Hedin (1904 p. 543) working in the Tarim valley in the Taklamakan Desert.

Melton (1940, p. 131) very briefly mentioned fuljis in the context of intersecting transverse dunes in the southern High Plains of the USA:

> The dune form resulting from two series of transverse dunes intersecting at a right angle is quite complex. Even an ideally simple case would probably be beyond the comprehension of a ground observer working without the aid of vertical aerial photographs. The chief characteristics are pointed hummocks of sand and equally numerous basins or pits. It may be described as "peak-and-fulje" topography, using a term long employed in Arabia for the enclosed basins commonly found there.

Bagnold (1941, pp. 214), also very briefly, used the term in the context of migrating barchans, which he sometimes termed 'promiscuous':

> If the dune to windward is low, and has been advancing faster than the one in front, it may have got so close that its wings have joined up with the foot of the leeward dune.

> In this case the hollow formed by its slip-face may be almost circular in shape, and may suggest that it is caused by a rotary swirling action on the part of the wind. But there is no evidence that such large-scale swirls seriously affect the shape of dunes. These inter-dune hollows are known in northern Arabia as *Fuljis*. They occur wherever a string of barchans are pressing closely on one another.

Bagnold (1951) also discussed the fuljis of Arabia, showing a ground image from the Nafud, and also mentioning some from the Rub' al Khali, though no locational details were given. He confirmed his view that they were associated with coalescing barchans.

Beheiry (1967 p. 44) used the term for some dune forms in the Coachella Valley of California and confirmed Bagnold's view on the role of large-scale swirls:

> Like congestion in road traffic, where vehicles are moving slowest and almost bumper to bumper, the dunes are here closely packed with the horns of some dunes joining with the foot of the windward surfaces of the dunes ahead. Later, the slip-faces of adjoining dunes become mere shallow hollows, almost circular in shape….known in north Arabia as fuljis. At first sight, these hollows suggest that they are caused by rotary swirling wind vortexes. But there is no evidence that such large-scale swirls seriously affect the shape of the dune.

Folk (1976 p. 663) also discussed the flow characteristics associated with barchans and fuljis

> High-order transverse (HO-t) flow produces transverse dunes, which gradually migrate as the rollers are 'rolled forward'. In the high-order festoon phase (HO-f) the scallop-like deformation of the roller vortices produces barchans (again feedback means that the dune form and the roller exert a co-operative influence in reinforcing each other), and scours out the deep hollows known as fuljes.

Breed and Grow (1979 p. 282) mentioned that there are examples of fuljis in the eastern Rub' al Khali, White Sands (USA) and the NW Sahara, and in the same volume (Glenn 1979, p. 399) defined a fulji as 'A depression (interdune) between barchans or barchanoid ridges, especially where dunes are pressing closely on one another'.

Finally, Edgell (2006, p. 144-5) confirmed the presence of fuljis in the Nafud and the Rub' al Khali of Arabia.

2. Fuljis on Google Earth

The availability of Google Earth images enables one to try and assess the distribution of fuljis at the global scale, to assess their morphology, and to see their association with various dune types and with ground surface conditions. Discussion of the use of Google Earth in desert geomorphology is provided by Goudie (2023).

It is appropriate first of all to look at the Blunts' classic Nejd site in Arabia (Fig. 1). This view is located c 100 km south east of Jubba and 100 km north of Ha'il. It is clear that these dunes are not all simple, coalescing barchans. Rather they are a mix of complex linear forms (Edgell 2006, fig. 7.21) with some transverse elements, particularly in the west (Fig. 2), so that most definitions of fuljis, involving association with barchans, do not apply to the type site. These dunes are relatively inactive under present wind regimes and Whitney *et al*. (1983) provide a chronology of both the dunes and the deposits of the interdunal hollows.

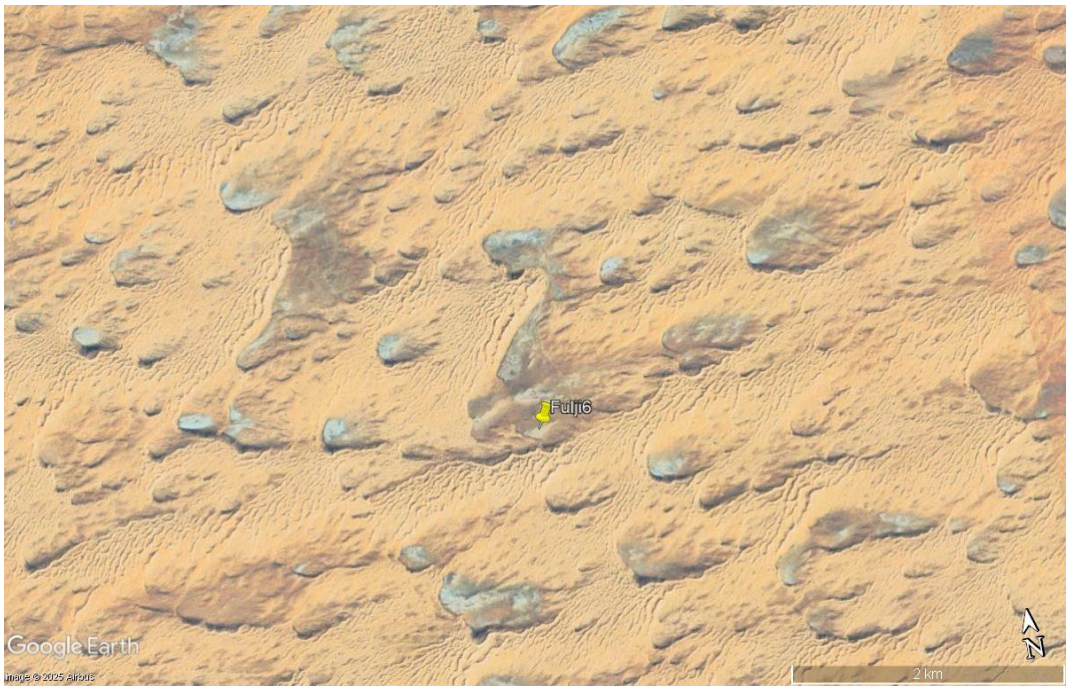

Fig. 1. Saudi Arabia, Nejd. Classic fuljis at the type site. 28°26'16.73"N, 41°52'17.37"E. ©Google Earth, Scale bar = 2 km. The relative relief is generally 20-30 m.

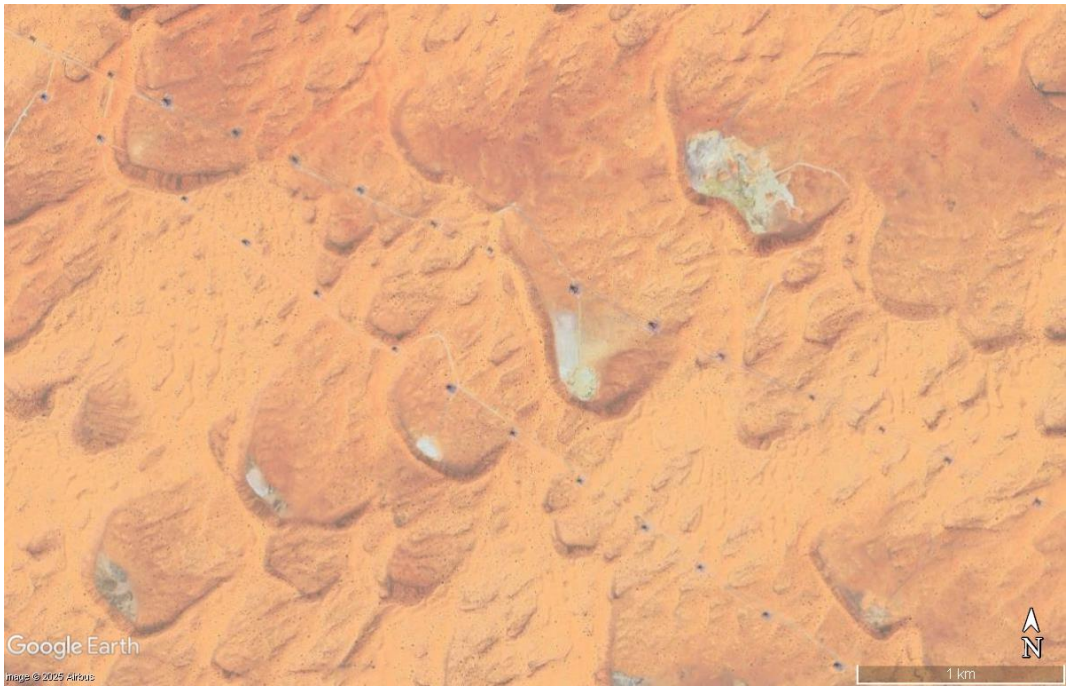

Fig 1.2. Nafud Desert, Saudi Arabia, showing fuljis in lee of barchanoid elements. 27°54'24.68"N, 41°21'30.75"E. ©Google Earth, Scale bar = 1km.

That is not to say, however, that fuljis do not occur in association with barchans. There are many examples where they do. This is the case, for instance, with the barchans of the Kunene and Skeleton Coast ergs in Angola and Namibia. Fig. 3 shows fuljis from the barchan fields on

the Skeleton Coast. However, these are very much smaller than those described from the Nafud.

Rather larger hollows exist in complex barchanoid terrain in the southern Rub' al Khali in Saudi Arabia (Fig. 4), but also in the transverse mega-dunes of the northern parts of the Liwa area in the UAE (Bishop 2013), where the available relief exceeds 100 m.

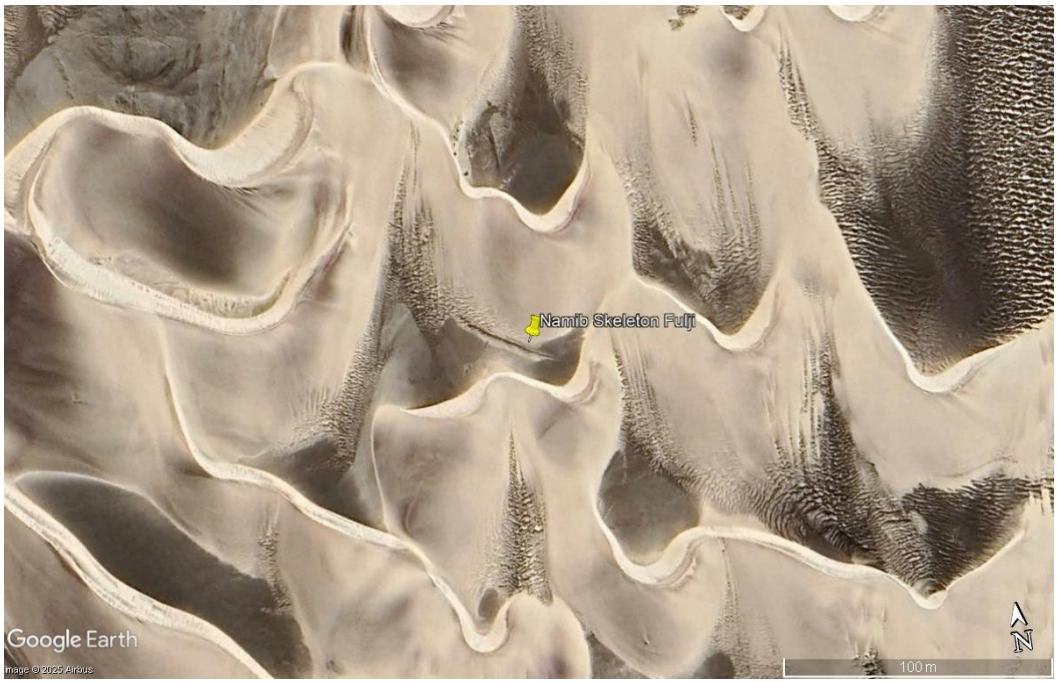

Fig. 3. Namib Skeleton Coast coalescing barchans. 20°20'49.60"S, 13°19'10.26"E. ©Google Earth, Scale bar = 100 m.

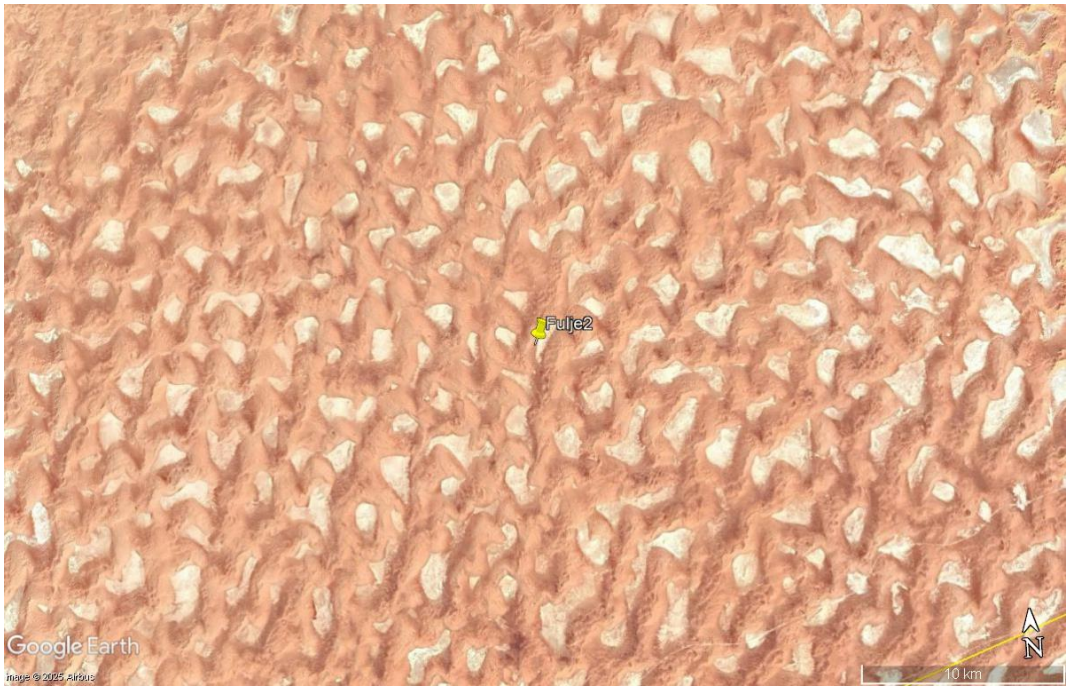

Fig. 4. Saudi Arabia, south Rub' al Khali, hollows in coalesced barchans. 19°28'56.91"N, 52°46'47.27"E. ©Google Earth, Scale bar = 10 km. The relative relief between the dune peaks and the hollows is c 100 m.

Such complex networks of dunes also occur in the Murzuk Sandsea of Libya (Fig. 5). The basins therein do not have a classic hoof-print form, but have a triangular morphology.

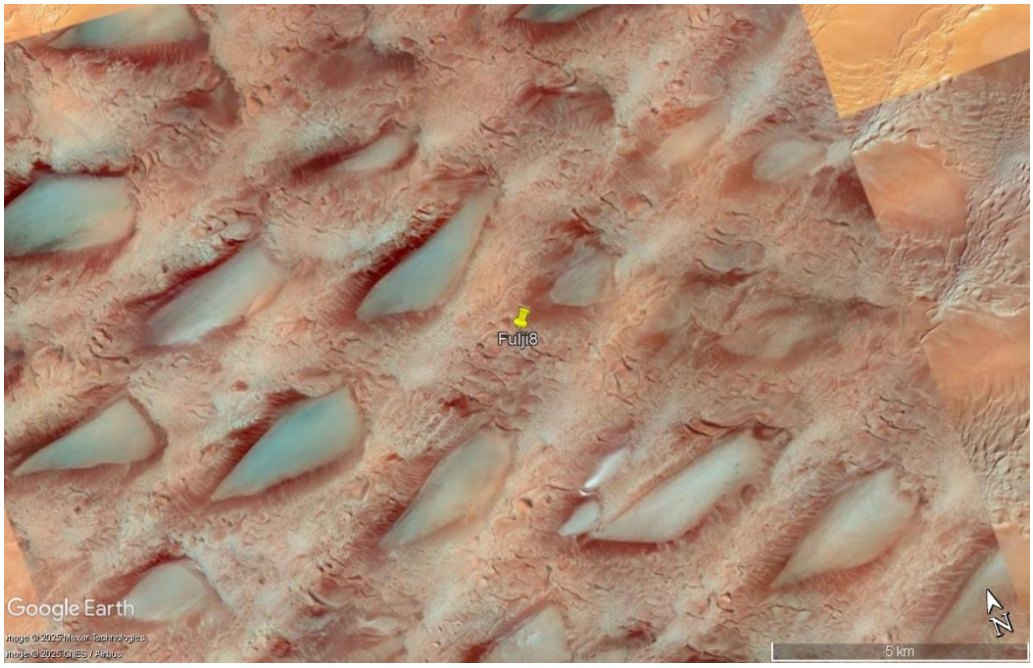

Fig. 5. Libya, Murzuk Sandsea, network dunes, with triangular hollows. 24°28'23.89"N, 12°15'21.00"E. ©Google Earth, Scale bar = 5 km.

One thing that Google Earth indicates is that fulji-like hollows also occur frequently in association with star dunes. This is the case in the eastern Rub' al Khali in Saudi Arabia and Oman (Figs 6, 7, 8) but also in parts of Libya (Fig. 9) and the Erg Iguidi in Algeria (Fig. 10).

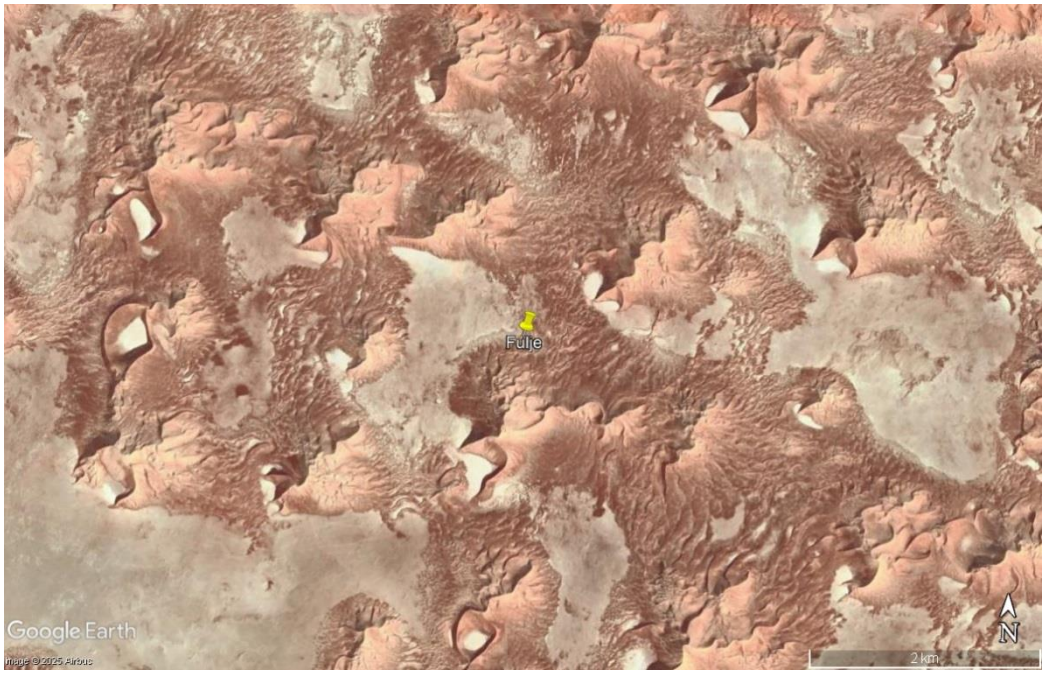

Fig. 6. Oman, South Rub' al Khali. Merged star dunes. 19°27'14.18"N, 53°38'39.30"E.. ©Google Earth, Scale bar = 2km. The difference in altitude between the peaks of the stars and the hollows is c 80 m.

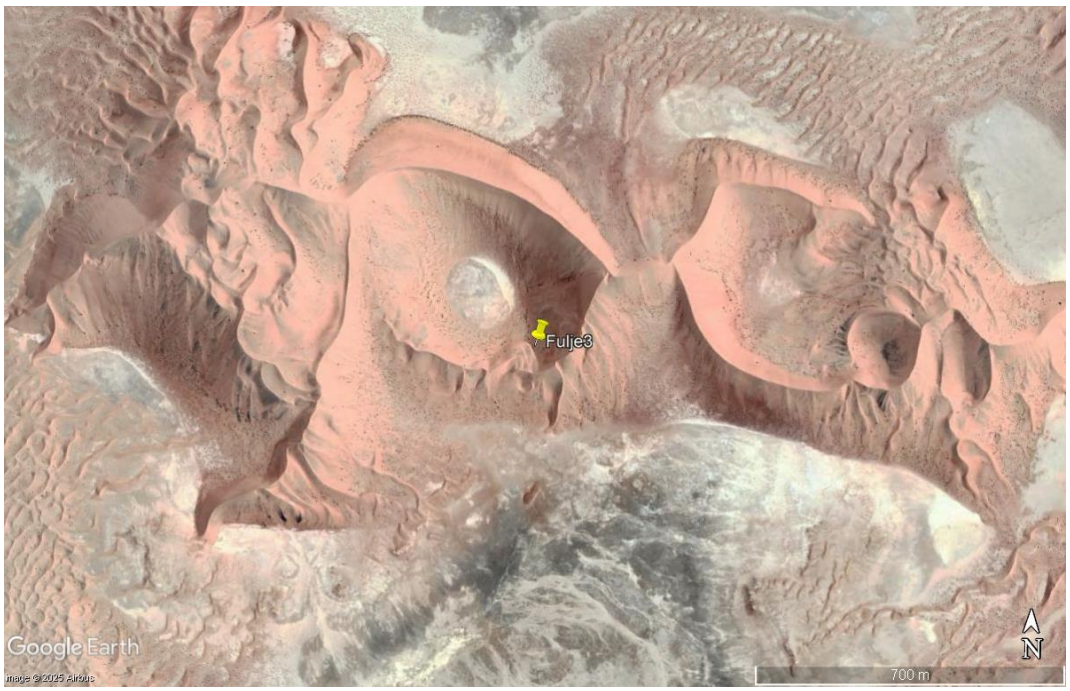

Fig. 7. Saudi Arabia, Rub' al Khali. Cauldron-like hollows in star dunes. 21° 7'13.86"N, 55° 7'42.30"E. ©Google Earth, Scale bar = 700 m. The relative relief here is c 90 m.

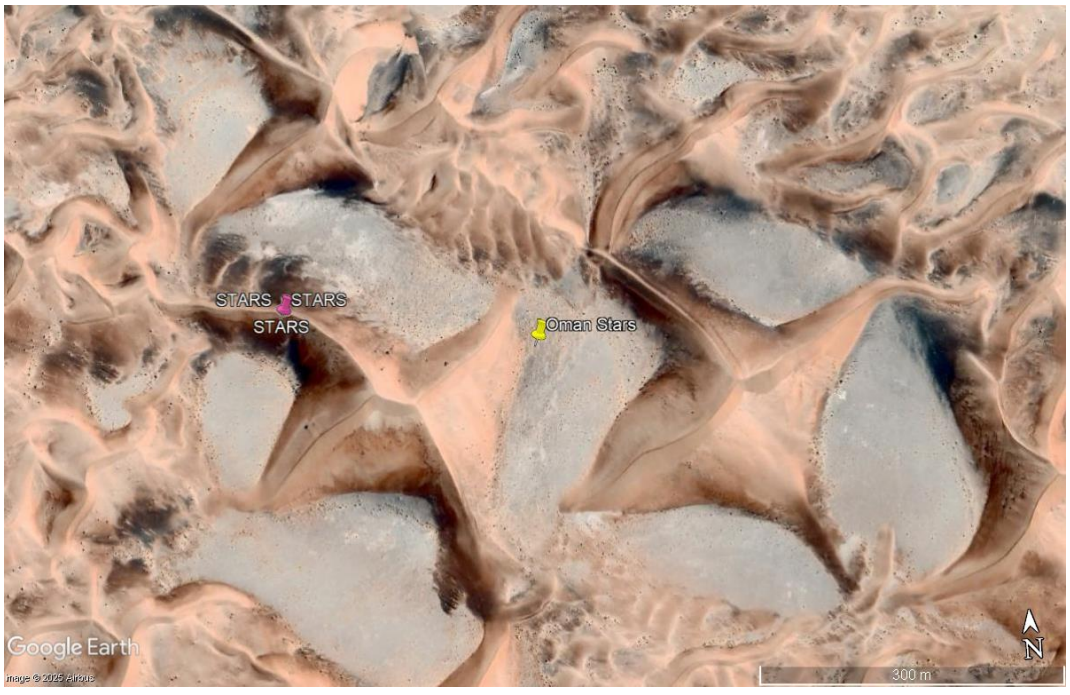

Fig. 8. N.W. Oman. Star dunes with depressions. 23° 5'18.18"N, 55°39'23.92"E. ©Google Earth, Scale bar = 300 m. The relative relief is only c 10 m.

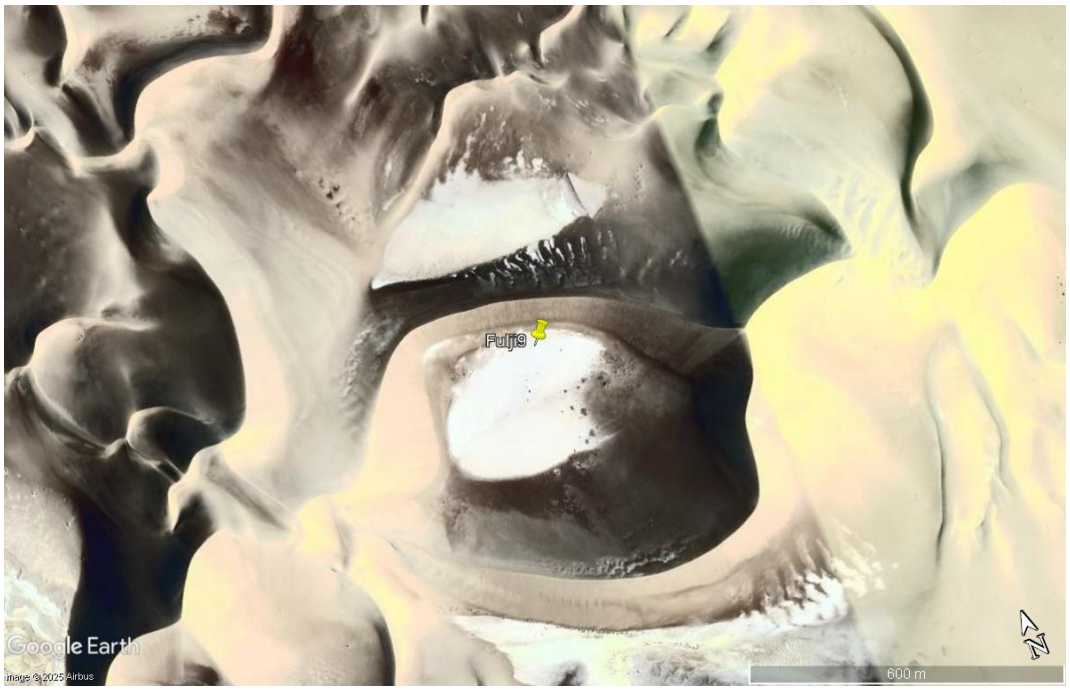

Fig. 9. Central Libya, star dunes with cauldron-like hollows. 28°57'30.85"N, 20°13'56.38"E. ©Google Earth, Scale bar = 600 m. The relative relief is c 40 m.

Fig. 10. S.W. Algeria, Erg Iguidi, star dunes, 27°31'29.69"N, 4°19'11.47"W. ©Google Earth, Scale bar = 500 m. The maximum relative relief is c 40 m.

In the eastern Lut Desert in Iran, there are fuljes on the western margin of the sandsea. These appear to be associated with complex star dunes (Fig. 11).

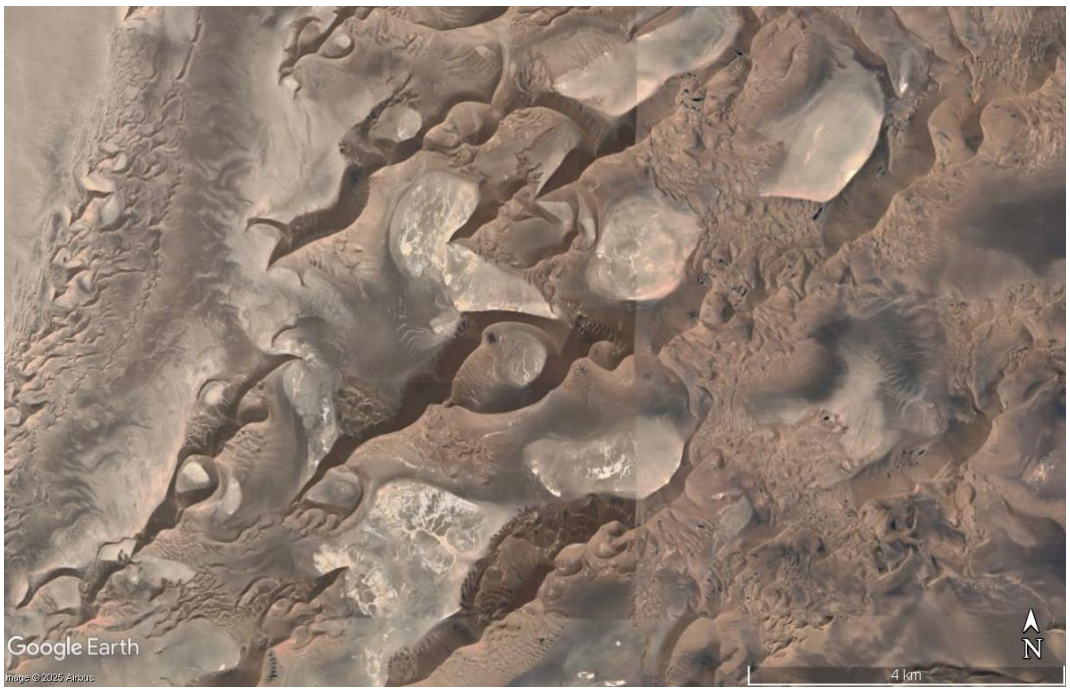

Fig. 11. Iran, Lut Desert. 30° 5'20.33"N, 59°11'21.44"E. ©Google Earth, Scale bar = 4 km.

Fulji-type landforms also appear to have developed in association with transverse mega-dunes. This is the case in the Taklamakan, Badain Jaran and Tengger deserts of China (Figs. 12, 13, 14). Those in the Taklamakan are the *bajirs* of Hedin and lie in close proximity to the Tarim River in an area with high groundwater levels. Those in the Badain Jaran occur amidst some of the highest mega-dunes on Earth and appear to be fed by groundwater (Yang *et al*. 2003).

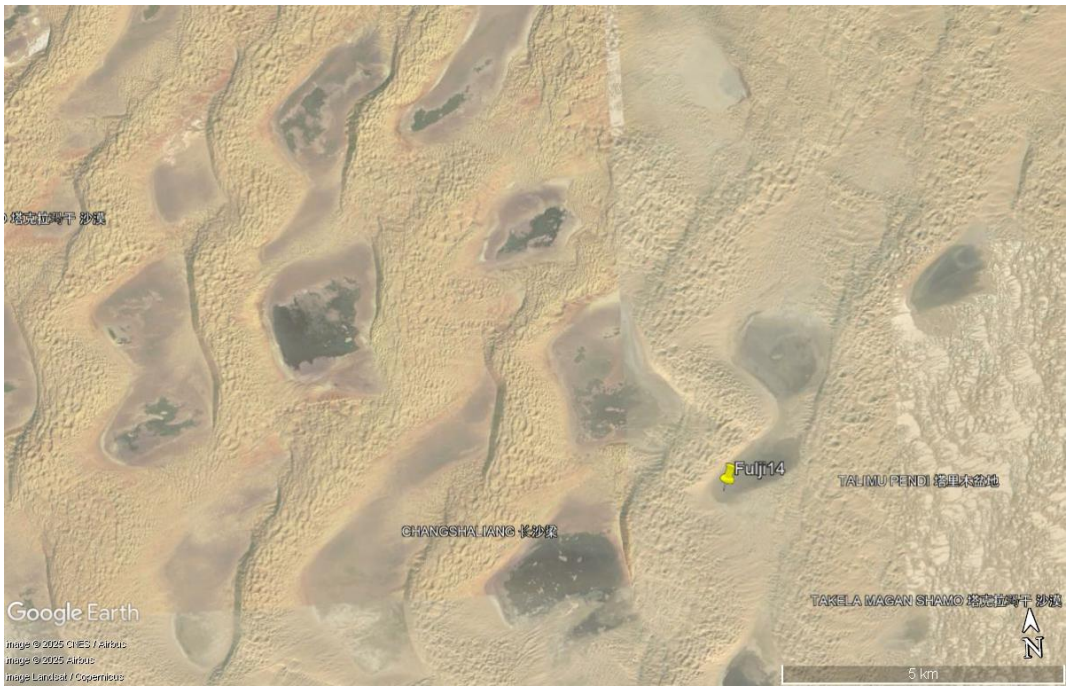

Fig. 12. China, North Taklamakan, transverse mega-dunes. 40°26'1.24"N, 87°20'8.88"E. ©Google Earth, Scale bar = 5 km. The relative relief is c 80 m.

Fig. 13. China, Badain Jaran, 39°48'4.11"N, 102°25'30.58"E. ©Google Earth, Scale bar = 5 km. The relative relief is c 300 m.

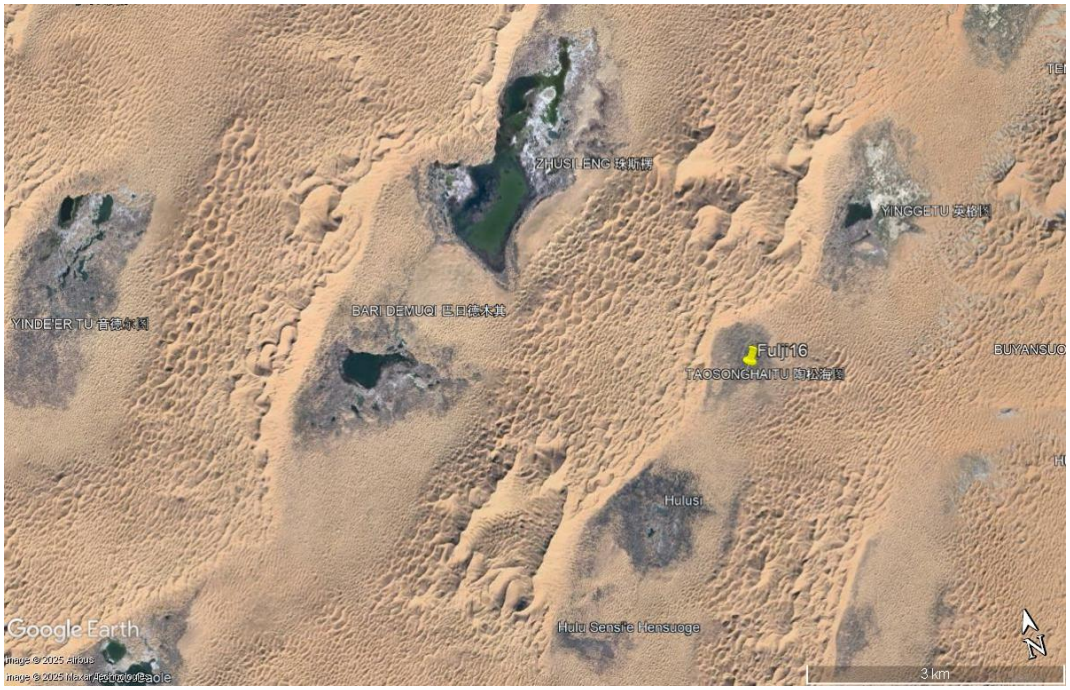

Fig. 14. N.W. China. Tengger Shamo, 38°43'46.90"N, 104°49'31.20"E. ©Google Earth, Scale bar = 3 km. The relative relief is c 120 m.

Large transverse mega-dunes also characterise the Nebraska Sandhills in the USA, and here too there are many interdunal hollows/lakes (Fig. 15) (Warren 1976).

Fig. 15. USA, Nebraska Sandhills, 41°58'59.69"N, 102° 6'26.04"W. ©Google Earth, Scale bar = 4 km. The maximum relative relief is c 60 m.

Finally, interdunal hollows occur in the noses of some parabolic dunes, as is the case with the *dhands* of the western Thar Desert in Pakistan (Fig. 15) (Goudie 2011).

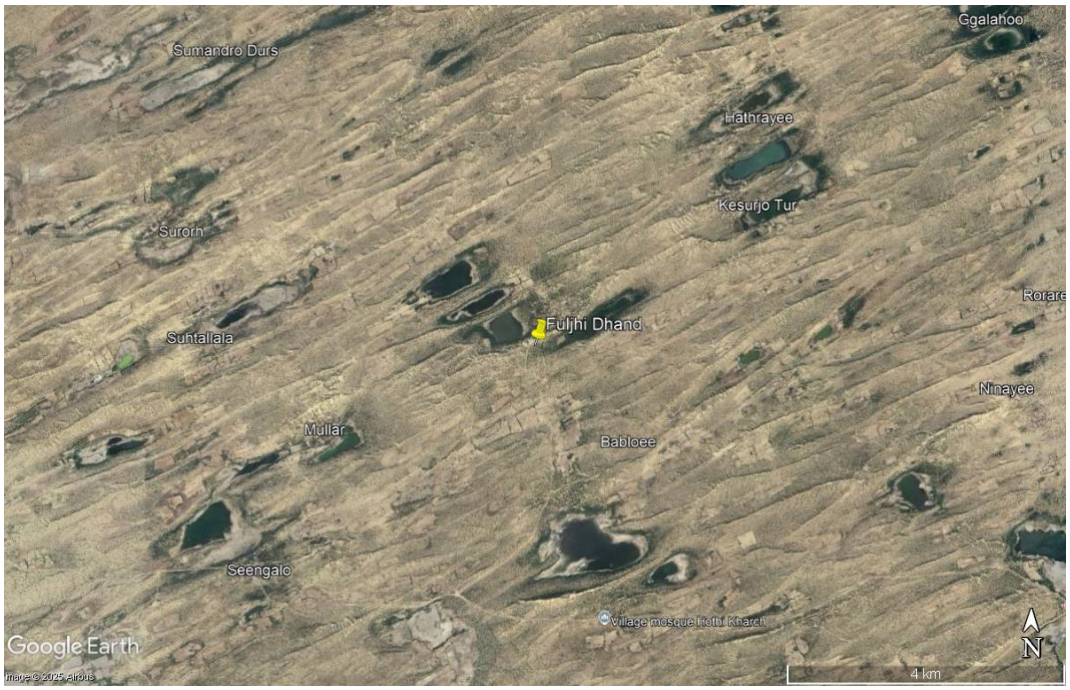

Fig. 16. Dhands in parabolic dunes on the edge of the Indus floodplain in the western Thar Desert of Pakistan. ©Google Earth, Scale bar = 4 km. The relative relief is c 30 m.

3. Conclusions

Since they were first described in the last quarter of the nineteenth century from Arabia, fuljis have received rather sparse attention from geomorphologists, but the availability of Google Earth images has enabled the investigation of these features at a global scale. It is apparent that fuljis can occur in association with coalescing barchans, but that they also can occur in association with a large range of other dune types, including network dunes, star dunes, transverse mega-dunes and parabolic dunes. However, whether or not the term fulji should continue to be used is a moot question. A more appropriate term might simply be 'interdunal hollow'. In any event, such hollows deserve much greater attention than they have received hitherto, for not only are they intriguing landforms, but they are also of some ecological significance. Along with solutional forms (*dayas*) (Goudie 2010) and deflation pans (Goudie and Wells 1995) they add to the diversity of desert landscapes.

Acknowledgement

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