Analysis of the combustion characteristics of a spark ignition engine equipped with a variable valve actuation system

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A Case Study of Moving Sand Dunes: The Barchans of the Kharga Oasis

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Abstract: Recently we have proposed the use of the time series of Google Earth to investigate the motion of sand dunes. In this paper we consider a case study, applying the method to some barchans of the Kharga Oasis. To evaluate the motion of these dunes as a function of their size we use Gimp, a GNU image processing software.

Keywords: Google Earth, Dune motion, Satellite images, GIMP, Image processing

1. Introduction

In two recent papers we have discussed the use of the time series of Google Earth to investigate the motion of sand dunes [1,2]. In this paper we consider a case study, applying the method to the dunes of the Kharga Oasis. This oasis is the southernmost of the five western oases of Egypt. Capital of New Valley Governorate, it is located in the Libyan Desert, about 200 km to the west of the Nile valley, and is some 150 km long [3].

As remarked in [4], the sand dune movement is a problem for cultivated lands and houses, irrigation canals and artesian wells of the Egyptian oases. In these oases the sand dunes are of two main types, barchans and linear dunes. Barchans are the dunes having a crescent shape. In [5], the author measured the movement rate for several crescent dunes in the Kharga oasis by comparing two sets of aerial photographs, of 1944 and 1961. The measured rate in average was of 12 m/yr. The rate of dune movement in Kharga was also measured in 1979 using two sets of topographic maps of 1930 and 1961 with a resulting average rate of 9 m/yr [6].

Here, we will see in detail how to apply the time series of Google Earth to investigate the motion of some Kharga Oasis' barchans. By means of such an approach we can investigate the local behavior of specific sets of dunes, monitoring them with a freely available resource.

2. Use of the images

Usually, Google Earth provides a time series of images, that is, for a given location, several satellite images recorder at different times are available. These images are quite interesting, showing variability or changes over time. When Google Earth includes time information, it is possible to use the time slider, to play the series of images as an animation. However, saving each images we can process them, enhancing brightness and contrast if necessary, using for instance GIMP, a GNU image processing software. And with some movie maker, we can create a movie as we like. For instance, at [7] we can see a movie of some barchans. However, when we want to create a movie from the satellite images, it is necessary to choose in them a specific reference point and maintain this point fixed in the image frame, because sometimes the Google Earth images are slightly shifted in respect to each other.

To remove this shift we can use the fact that GIMP allows us to manage the images as layers that we can move and overlap to have a better comparison. For instance, in the figure 1 we can see two images (recorded on 22 September 2003 and 22 December 2011) processed and overlapped. The dunes are numbered. A white segment shows the displacement of the ridge of each numbered dune. The purple segment shows a distance of 1 km, obtained by means of the Google Earth ruler. Therefore, the distances travelled by the dunes can be easily measured.

The time interval of this motion is given by the dates of the images. The speed of then is the ratio of the dune displacement and the time interval between the images.

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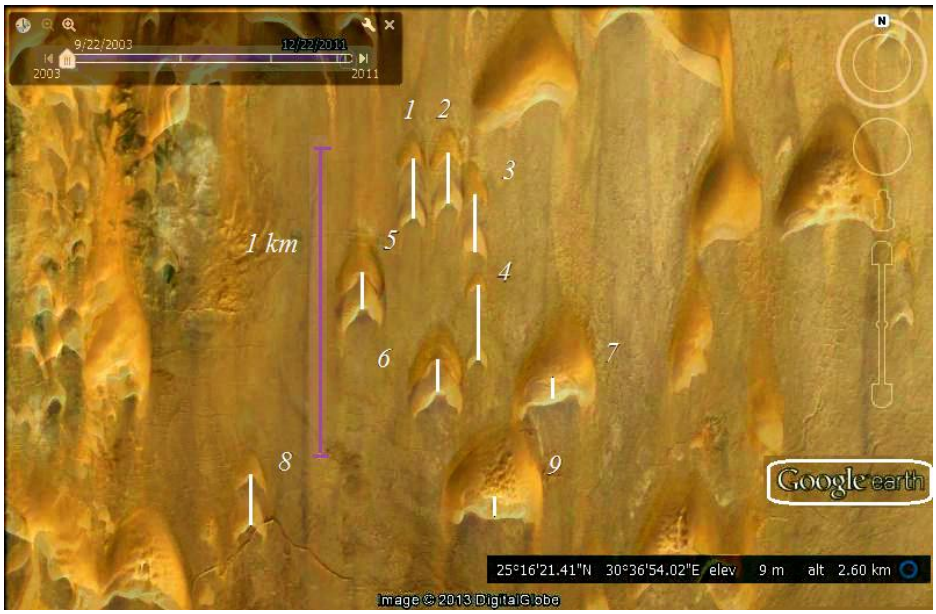

Fig.1 - Two images from Google Earth (recorded on 22 September 2003 and 22 December 2011) have been processed and overlapped using GIMP. The dunes are numbered. The white segment shows the displacement of the ridge of the dune. The purple segment corresponds to a distance of 1 km.

Since small dunes move faster than the large ones, we can try to find a relationship between size and speed [8]. However, from the satellite images we can find quite well the projection of the surface of the dune on the image plane. Let us then try to use this area as an estimation of the size of the dune; to measure it approximately, we can use a grid such as shown in the Figure 2. In this image, the size of each square is of 37.0 m.

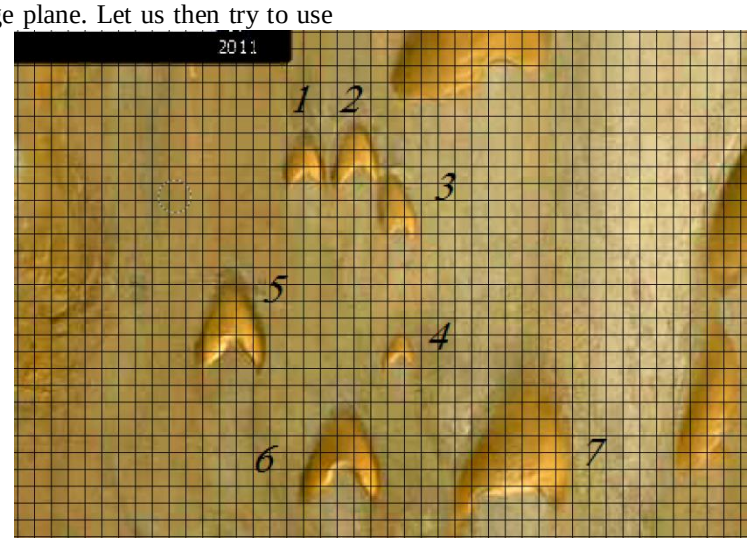

Fig. 2 – GIMP allows overlapping a grid on the image. Therefore, knowing the size of the small square, an approximation of the area covered by the dune is possible.

After measuring the areas occupied in the image by the dunes, we can prepare a plot of their displacement as a function of their areas. This is given in the Figure 3. The displacements have been measured in the Figure 1.

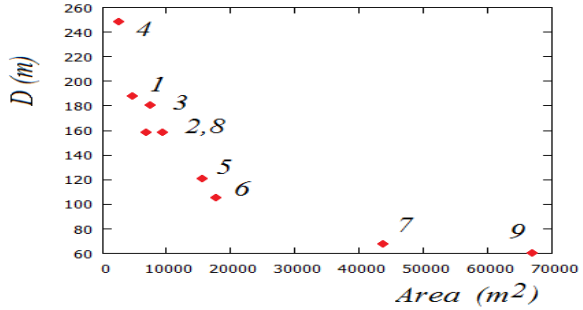

Fig.3 – Displacement in meters of the numbered dunes (Figure 1) as a function of the area they are covering in the same figure. The time interval is of 8.25 years.

The speed, averaged on the nine dunes of the Figure 1, is of about 17.5 m/yr. The time interval between the satellite images was of 8.25 years. It seems larger than the values given in the Refs. 5 and 6. However this is a small set of dunes. Adding two other sets of dunes of the Kharga Oasis, we obtain the plot in Figure 4. The considered time interval is the same as that of the Figure 3. The average speed of all these dunes is 14 m/yr.

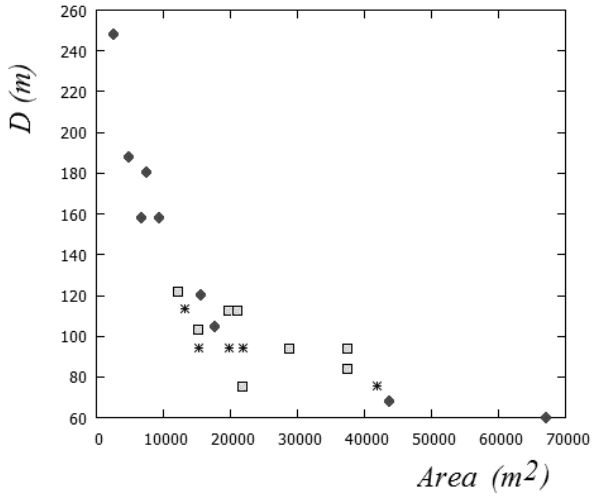

Fig.4 – The same as in the Figure, with the addition of two other sets of dunes. The average speed is 14 m/yr.

3. Conclusions

By means of this approach we could also investigate whether some changes during the last years occurred in the motion of Kharga Oasis' dunes, analyzing in details the same sets of dunes studied in [5] and [6]. In fact, the motion of the sand dunes seems to be strongly connected to the climate change [9,10] and therefore an increase of the speed of these barchans is probable. As told in [2], the Google Earth allows to follow those sets of dunes, the images of which are available in the time series. In this manner, besides some general studies on the climate changes concerning large regions, this free tool can help people in monitoring those dunes which are threatening a specific site. And this fact is quite important for the local economy and ecology of populations.

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