MONITORING OF WIND AND TOPOGRAPHIC CHANGE OF THE NAKATAJIMA DUNE

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Abstract: The Nakatajima dune is a trangressive dune of approximately 0.6 km wide by 1 km long, with 0.3 to 0.4 mm and moderate to well sorted quartz sand. This dunefield located in the Enshunada coast, Hamamatsu city of Japan. The study area was focused in the east side of the Nakatajima dune where shows a well-developed precipitation ridge. Topography surveys are made using a Topcon GB-500 GPS. SIS V6.3 and Surfer 8 are used to process the data and display the results. So far, 12 times surveys have been carried out from February to November 2007. Detail surveys of the 7,800 m^2 have been done with randomly space measurements in flat smooth topography. From the aerial photograph taken on 27 February 2005 and the GPS measurement on 14 November 2007, the edge of dune was move 18 m forward to the east side. Since the edge of dune was move 3.5 m from February to April and 5 m from February to November. The analysis of the blank grids and volume command results, using the 8 February and 31 October of the Digital Elevation Model (DEM) grids show an increment of 1840 m^3 of sands in the surveyed area (new sand). Field wind data was recorded from 5 February 2007, installed in the dune. Wind sensor positioned at 5 m height above the ground. The dominant (prevailing wind) is clearly WNW. These wind condition are in general agreement with the observations of sand transport.

KEY WORDS: dune; topography; GPS; DEM; sand transport

Introduction

The Nakatajima Dunes are one of the three largest dunes in Japan. The dunes are Spreading 1 kilometers from west to east and 0.6 kilometers from north to south, that is being pushed by the wind from west to east. From winter to spring, the strong westerly winds were increased the sand transported from west to east side of the Nakatajima dune. The study area (Figure 1) was focused in the east side of the Nakatajima dune where shows a well-developed precipitation ridge.

Figure 1. Study area

Method

Because subtraction of 3D surfaces relative to different years and a volume of transported sand into the study area is our goal, we were carried out a topography survey using Geodetic GPS. If we have, for a particular area, two different surfaces relative to different times, we can compare them and analyze the occurred changes. Therefore, the sand transport can be achieved from subtraction of two consecutive dune surfaces. Wind speed and direction is also being recorded in an autonomous station, installed in the dune. Propeller-type anemometer positioned at 5 m height above the ground.

Dune surface measurement

Topography surveys are made using a Topcon GB-500 GPS (Figure 2.(a)). The GPS measurements represent a 3D location and is describes by a north, west and height value (x, y, z) for each point. To improve consistency in the measurements and fastness in the base station set up, the base antenna was mount on a concrete pole, specially built on the east side of a dune, near the monitoring zone. SIS V6.3 and Surfer 8 are used to process the data and display the results. So far, 12 times surveys have been carried out from February to November 2007. Detail surveys of the 7,800 m^2 have been done with randomly space measurements in flat smooth topography. In each survey, the edge of dune was measured. From the aerial photograph taken on 27 February 2005 and the GPS measurement on 14 November 2007, the edge of dune was move 18 m forward to the east side. Since the edge of dune was move 3.5 m from February to April and 5 m from February to November. In order to calculate volume and area of the surfaces, the volume command Surfer 8 was used. The analysis of the blank grids and volume command results, using the 8 February and 31 October of the Digital Elevation Model (DEM) grids (Figure 2.(c)) show an increment of 1840 m^3 of sands in the surveyed area (new sand).

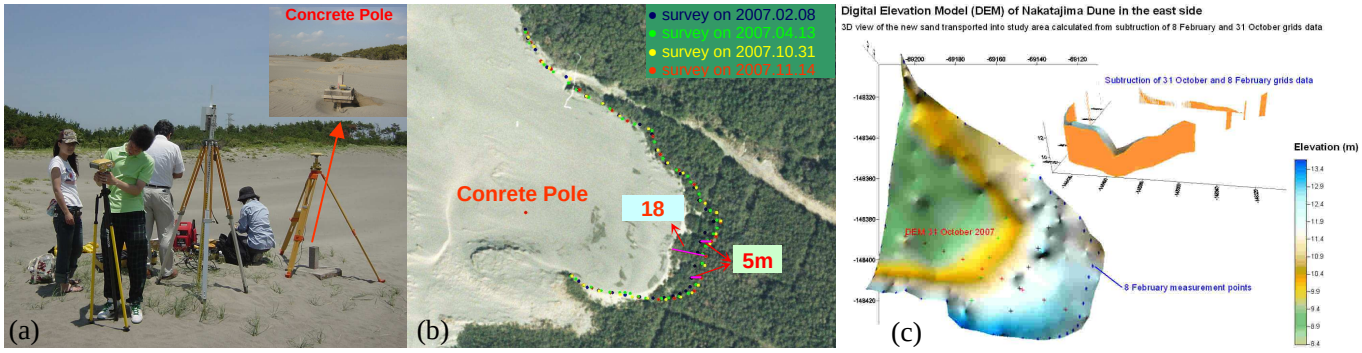

Figure 2.(a) Topography measurements using geodetic GPS;(b) Data analysis using SIS V6.3;(c) DEM result by Surfer 8

Field wind data

Field wind data was recorded from 5 February to 18 October 2007. 10-min wind speed averages were analyzed to get the wind frequency by direction (Figure 3.a) and the scatter plot of wind speed (Figure 3.b). The dominant (prevailing wind) is clearly WNW. Note that the wind are almost from a westerly quadrant during February to April is indicated by the fact that nearly 50% of all observations are either W, WNW, NW. Bagnold (1941) equation is applied in order to calculate the critical shear velocity (u_{*t}). This value is used to calculate the wind speed at the 5 m height above the ground that will initiate sand transport. Only average wind speeds that exceed 722.7 cm/s at the 5 m height above the ground are capable of transporting sand, while wind speeds less than 722.7 cm/s can be ignored in any wind blown sediment transport study at this site.

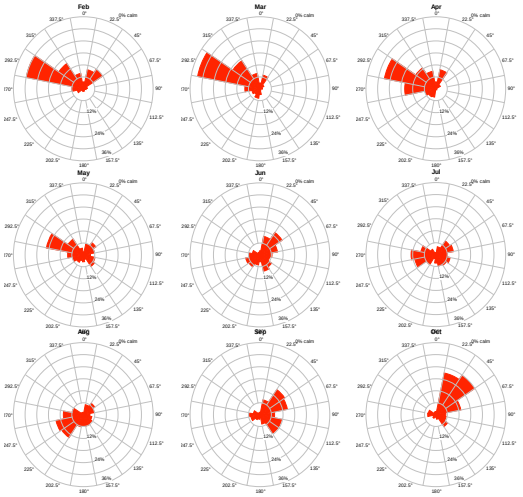

Figure 3. a. Monthly Wind frequency by direction (Feb-Oct, 2007)

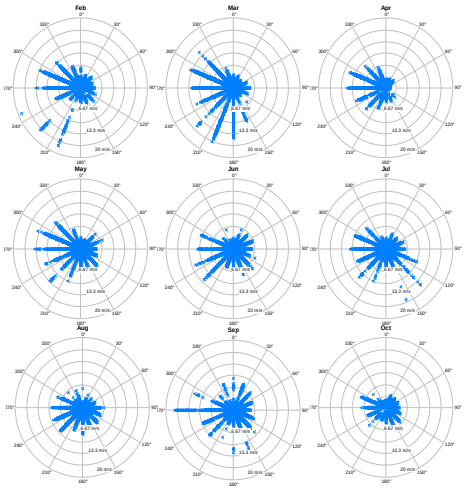

Figure 3. b. Monthly scatter plot of wind speed by direction (Feb-Oct, 2007)

Discussion

The dune surface elevation measurement and the generation of DEMs to calculate the sand movement on the east side of the Nakatajima dune is only one part of the study that is being carried out in this dunefield. Wind speed and direction is also being recorded in an autonomous station, installed in the dune. For future research, these two different approaches to wind and sand transport will allow us to compare the sand movement obtained from wind data to the one measured in the field.

References

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