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Kelsey VanEyl-Godin
Katherine VanZytveld

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PHOTOGRAPHIC MEASUREMENT OF SAND MOVEMENT IN GIGAPIXEL PANORAMAS REVEALS SHORT TERM VARIABILITY IN GEOMORPHICALLY SIMILAR LAKE MICHIGAN DUNES

Kelsey VanEyl-Godin, Katherine VanZytveld, Jason Hunter, and Brian Bodenbender

(1) Geological and Environmental Sciences, Hope College, 35 E 12th St, Holland, MI 49423,(2) Grand Haven High School, 17001 Ferris, Grand Haven, MI 49417

Abstract

We measured sand movement in open-sand environments exposed on the interiors of parallel dunes at two sites along the eastern shoreline of Lake Michigan, at Saugatuck Harbor Natural Area (SHNA) in Saugatuck, Michigan and the Kitchel Lindquist Hartger Dunes (KLH) in Grand Haven, Michigan. Both sites are isolated from the Lake Michigan shoreline. The SHNA site is a blowout of the north dune near the shoreline and consists of low-relief, nearly parallel dunes of 500 to 600 m in length, 1 to 2 m dune height, and 10–20 m wide. The KLH site is more complex in appearance, with large blowouts consistent with a coastal dune complex. Each site has a number of parallel dunes facing north. The KLH site also has a road running through the center of the site that separates the north and south dune areas. The KLH site is more inland than SHNA, with KLH at 100 m from the beach and SHNA at 360 m from the beach. The north dunes, however, have not experienced such deep deflation.

Results

The nearly two years of measurements at Saugatuck Harbor Natural Area from summer 2012 to summer 2014 show a net removal of sand from the open sand areas monitored at 103 photopins. Average erosion across all photopins was 0.67 cm per year. The bulk of this erosion occurred between 2012 and 2013, which saw an average loss of 13.46 cm across all pins. In contrast, from 2013 to 2014 SHNA saw a mean accumulation of sand of 8.63 cm across all photopins.

Discussion

Sand movement responds to a host of variables including vegetation, wind speed, wind direction, fetch, topography, sleepiness, moisture, freezing, and human disturbance. The moderately close association of the two sites, which are separated by 40 km, suggests that some of these variables, if any, are of lesser importance than these factors. All of these factors, however, can vary between the sites at fine scales in response to local conditions—among these, there is an obvious difference in vegetation. KLH is mostly devoid of vegetation, with erosion occurring along the upper reaches of the barn and sand. In contrast, SHNA has the upper slopes along the inner margins of the dunes have been evaluated in recent years—since 2012. KLH may therefore be experiencing greater net erosion whereas SHNA shows a patchy pattern of deflation, including all the presence of dune grass on south slopes that otherwise might be expected to be erosion-resistant. Ultimately, there is no single high-level explanation that local conditions remain within dunes at short-stroke scales, even in regions that show broad geomorphic similarities among landforms.

Locations and Site Characteristics

The two research sites are along the eastern shoreline of Lake Michigan and share several similarities. Both are isolated from the current lakeshore, with SHNA at 360 m from the beach and KLH at 100 m. Both sites are also isolated from the beach by topographic features—such as dune ridge at SHNA and a dune ridge, road, and houses at KLH. SHNA, at a height of 11.5 m above the surrounding ground surface, has a dune axis bearing 75°, whereas KLH reaches 14 m above its surroundings with a dune axis bearing 70°. Both sites have roughly bowl-shaped blowouts with the lowest portion of the surrounding rim on the west side of the region of active sand movement.

The blowout at SHNA is roughly elliptical, with the ellipse having a NNE-SSW trending long axis. It is located at the nose of a stabilized dissected parabolic dune that sits both within topographic expression, although blowouts now notch both arms. The site at KLH is the blowout that sits close to the shoreline at SHNA and has a central thoroughfare. Several notable differences exist between SHNA and KLH. SHNA is more circular than at SHNA and has a central lower area around the upper reaches of the bare sand area. In contrast, at KLH, dunes have been evaluated in recent years—since 2012. KLH may therefore be experiencing greater net erosion whereas SHNA shows a patchy pattern of deflation, including all the presence of dune grass on south slopes that otherwise might be expected to be erosion-resistant. Ultimately, there is no single high-level explanation that local conditions remain within dunes at short-stroke scales, even in regions that show broad geomorphic similarities among landforms.

References


