Characteristics of a Lake Michigan Blowout

Peter N. Duimstra, Nathan E. Hilbrands, Rachel K. Hubka, and Allison M. Lee

Calvin College 1876

Abstract

The relationship between wind and topography has been studied in recent scientific literature. Our research question is "what are the patterns of sand movement, wind speed/direction, and topography in a blowout?" The objectives of the study were to study the changes in wind speed and direction in different parts of the blowout, measure differences in erosion from week to week by using erosion pins, and measure the topography with a total station. Results indicated an increase in erosion in the deflation zone and deposition on the slip face as shown by erosion pin measurements, anemometer data, and information gathered using the total station.

Introduction

Previous research has examined the relationship between wind and topography on dunes [1]. This study looks to examine the characteristics of a blowout by looking at the relationships between wind velocity, the topography, and sand transport within a blowout, and by looking for resulting patterns.

The study's objectives were to:

- Map dune blowout topography
- Measure blowout wind speed and direction
- Record erosion/deposition rates in different areas of the blowout

Study Area

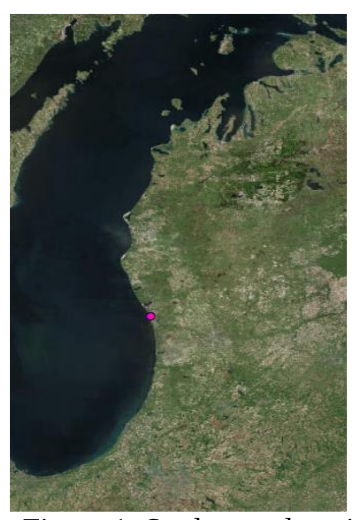

Figure 1: Study area location

This study took place within PJ Hoffmaster State Park in Michigan (Fig. 1). All of our testing took place within a small blowout along the dune ridge just inland from the foredune [2].

Methods

We used the following methods to measure processes and characteristics of our blowout (Fig. 2):

- Total station survey to map topography (Fig. 3)
- Wind vanes and anemometers to measure wind velocity in and around blowout
- Transect line and grid of erosion pins to track surface changes
- Sand traps to measure sand transport rate

Figure 2: Blowout

Figure 3: Total station survey

Results

Topography: The saucer blowout was measured to be 10 meters tall, and 16 meters across (Fig. 4). The leeward side of the blowout was steeper than the windward side. The main axis of the blowout is approximately WSW.

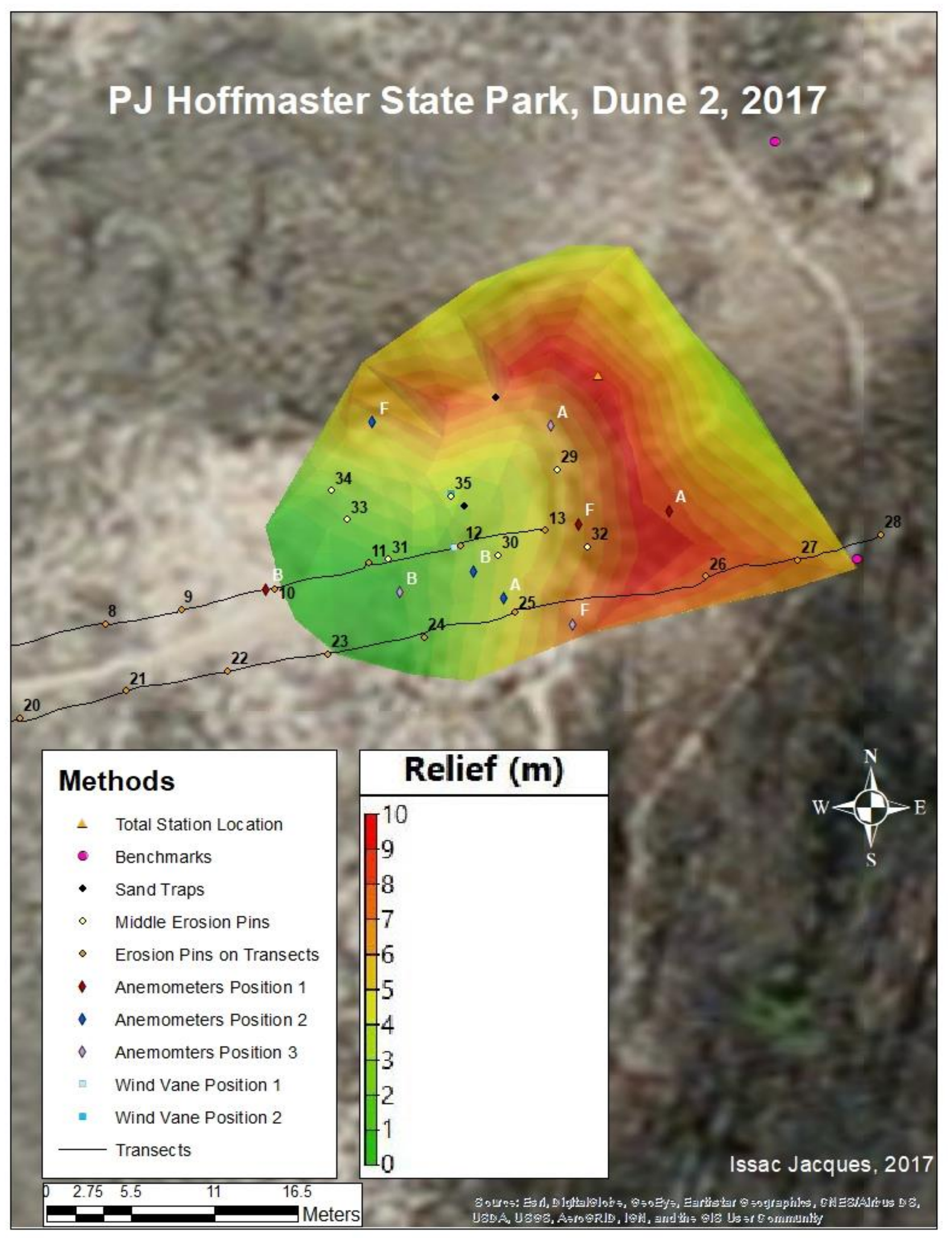

Figure 4: Topographic map of blowout, showing locations of anemometers A, B, and F, wind vane, and erosion pins

Results

Wind speed/direction: The results from our wind measurements showed some noticeable trends. The wind direction clearly followed the topographical contours of the blowout (Fig. 4) as shown in Figure 5. Along with the wind vane measurements, our team also saw that the location of the anemometer significantly impacted the wind speed reading, whether it be on the dune crest or within the saucer of the blowout (Fig. 6).

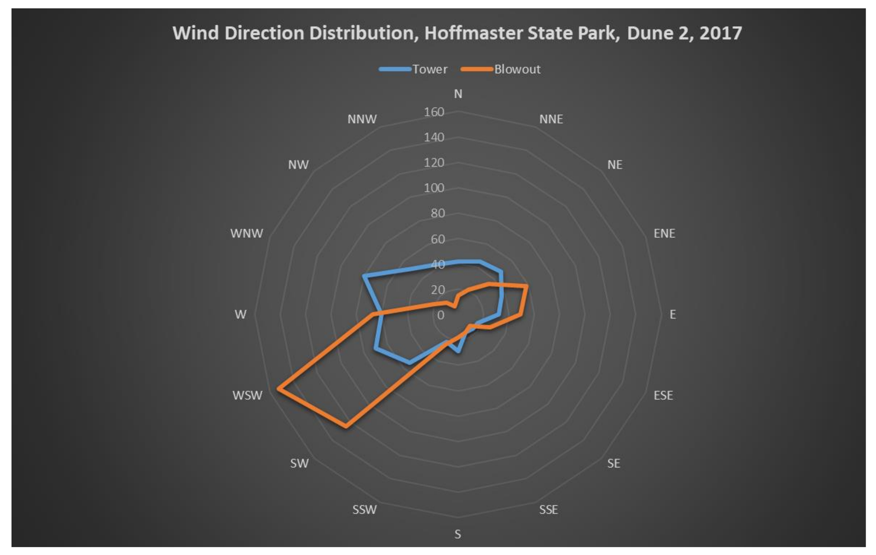

Figure 6: Graph of wind direction distribution

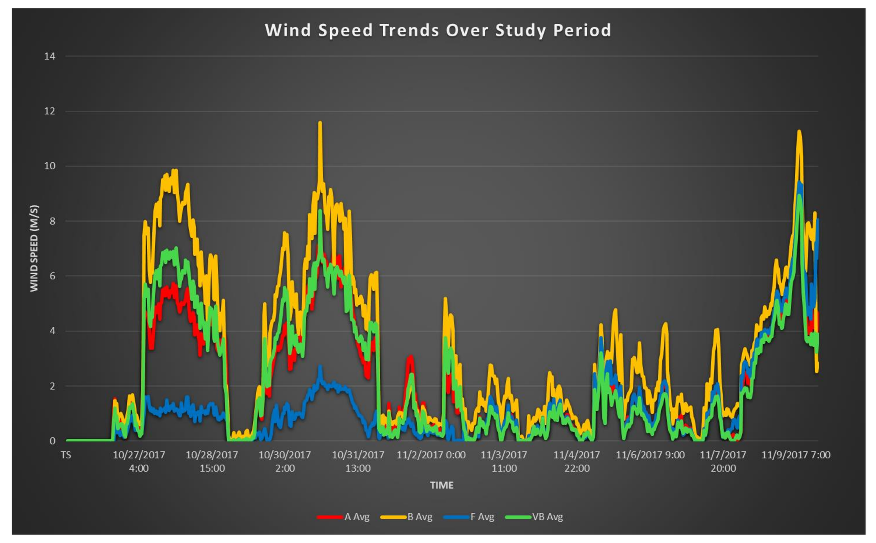

Figure 5: Graph of wind speed

Surface Changes: We were able to see evidence of sand deposition over the course of the two-week study. In locations lower in the blowout, erosion occurred while on the crest more deposition occurred. Fraser *et al.* (1998) also concurs with this finding in similar studies [3]. Just at the peak during lower wind weeks we saw that sand had actually started to erode back into the blowout.

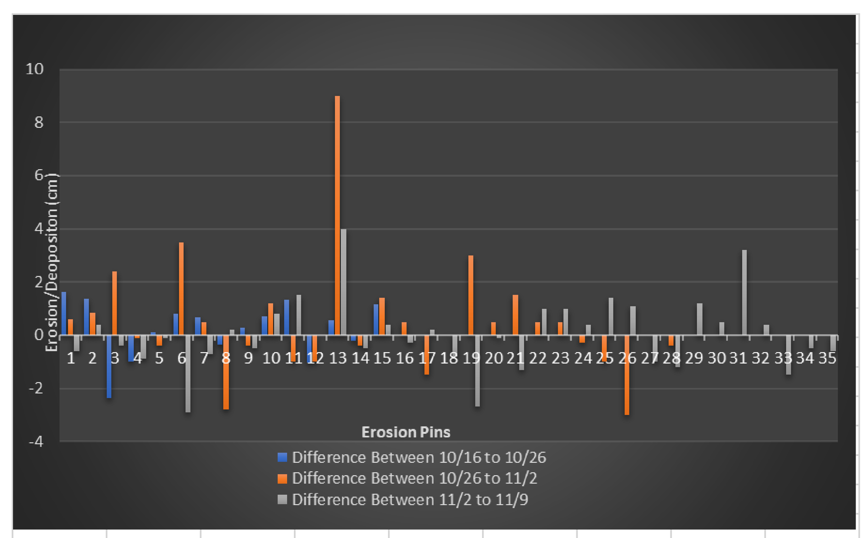

Figure 7: Graph of erosion/deposition

Discussion

The wind direction in the blowout is aligned with the main axis of the blowout which suggests that topography influences wind direction.

Most of the high wind speeds happen at the higher elevation of the blowout. This helps explain higher levels of sand deposition at the crest. We can infer that the blowout will continue to grow under these conditions.

Figure 8: Evidence of deposition on crest

Conclusions

We concluded that the wind was moving faster at the crest of the blowout than in the bowl and the wind direction was being deflected by the blowout. Due to the wind, erosion is occurring in the blowout and deposition is occurring on the crest and leeward side of the dune, causing the dune to advance.

Acknowledgements

We would like to thank PJ Hoffmaster State Park for letting us conduct our research on the property.
A special thanks to Calvin College and the Michigan Space Grant Consortium for funding this project.
Thank you to our Mentor Issac Jacques and to Professor van Dijk.

References

[1] Pease, Patrick, and Paul Gares. 2013. "The influence of topography and approach angles on local deflections of airflow within a coastal blowout." *Earth Surface Processes and Landforms* 38: 1160-69.

[2] van Dijk, Deanna. 2004. "Contemporary geomorphic processes and change on Lake Michigan coastal dunes: an example from Hoffmaster State Park, Michigan." *Michigan Academician* 35: 425-453.

[3] Fraser, Gordon S., Steven W. Bennett, Greg A. Olyphant, Nancy J. Bauch, Victoria Ferguson, Christopher A. Gellasch, Clayton L. Millard, Barbel Mueller, Patrick J. O'Malley, Nathan J. Way, Margaret C. Woodfield. 1998. "Windflow circulation patterns in a coastal dune blowout, south coast of Lake Michigan." *Journal of Coastal Research* 14 (2): 451-463.