The Effect of Three Autumn Storms on a Foredune

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Abstract

Storms contribute to the shape of a beach-dune system, but few studies describe specific effects of storms on a foredune environment. Our team studied the changes that two autumn storms caused to a foredune. The data collected came from on-site anemometers, a wind vane, erosion pins, sand samples for grain size analysis, GPS data entry, photographs, observations, and storm data from the National Weather Service, National Oceanic, and Atmospheric Administration. Our field research took place in a three week period, beginning October 24 and ending November 6, 2013. We recorded three storms, each with high wind speeds and wave heights causing erosion and deposition on the foredune and beach area.

Introduction

Autumn storms pose a potential threat to the health of coastal Michigan foredunes. Research predicts more intense autumn storms in the future [1].The study focused on erosion and deposition in an area influenced by waves, precipitation, and wind caused by storms.

Objectives

1. Analyze storm characteristics
2. Monitor effects of wave run-up on beach and foredune
3. Map erosion and deposition on the foredune

Study Area

Our study location was a beach-foredune system in P.J. Hoffmaster State Park (Fig. 1).

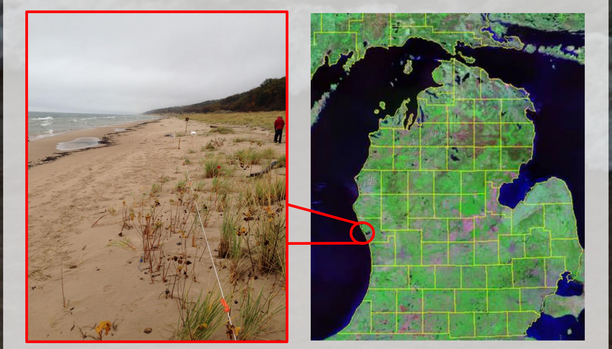

Figure 1: Study location was at a beach and foredune area at P.J. Hoffmaster State Park.

Methods

Data was collected from October 24, 2013 to November 7, 2013. Wave height was collected from the National Oceanic and Atmospheric Administration website [2]. Erosion pin height was measured to record surface change. The wrack line was tracked with a Juno Trimble GPS and analyzed with the ArcGIS program. Wind speed and direction was recorded at 2m using an anemometer.

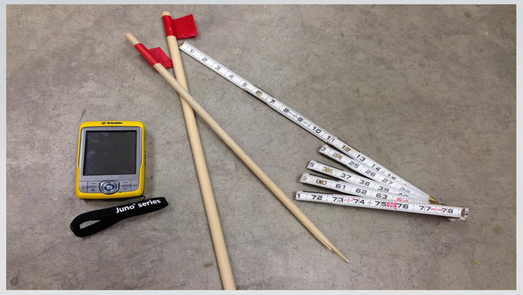

Figure 2: Juno Trimble GPS, erosion pins, and folding ruler.

Results

During our study, three autumn storms occurred (Fig. 3). Storm 1 (Oct. 26) had the greatest wave height and wind speed but no precipitation. Storm 2 (Nov. 1) had lower wave height and wind speeds along with precipitation. Storm 3 (Nov. 6) had the lowest wave height but high wind and precipitation (Table 1).

Results show significant erosion and deposition activity on beach; variation decreases inland. Deposition occurred on rows 1-4 and erosion on rows 5-7 (Fig. 4).

During storm 1, waves came up 20.02m while storm 3 came up 24m. Storm 2's wrack line was not visible when we made our measurements. Week 2's 3.06m wrack line shows the interstorm period after storm 1.

	Storm 1	Storm 2	Storm 3
Average Wave Height	2.8m	1.8m	1.5m
Average Wind Speed	7.68m/s	6.18m/s	7.62m/s

Table 1: Average wave height and wind speed for the three recorded storms.

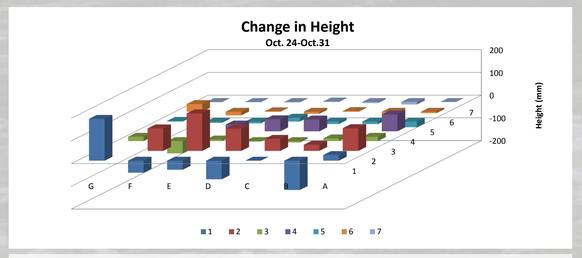

Figure 4a: Graph shows significant deposition (positive values) and erosion (positive values) for week one.

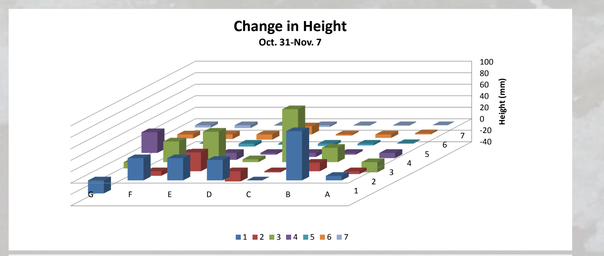

Figure 4b: Graph shows significant deposition (positive values) and erosion (positive values) for week two.

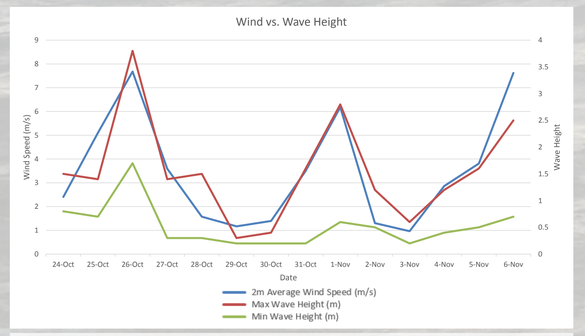

Figure 3: Wind speed and wave height during the study period.

Figure 5: Image shows wrack lines during storm and interstorm periods. Week 1: 6.2 m (teal); week 2: 3.06m (purple) and 20.02m (pink); week 3: 24m (orange).

Discussion

Erosion and deposition of the foredune were caused by wind and wave run-up, tracked by the changing wrack line (Fig. 6). The waves deposited sand at the base of the foredune causing a deposition area. The wind moved sand farther up on the windward face of the foredune. Our study results confirm other studies that show foredune activity increases with increasing wave sizes [3].

Figure 6: Wave run-up was indicated by a wrack line (line of debris).

Conclusions

Our study documented three storms that contributed to erosion and deposition on a Lake Michigan beach and foredune. The study also showed that wave run-up and sand transport had significant effects on foredune topography.

Acknowledgments

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References

[1] Angel, James R., Scott A. Isard. 1998 "The Frequency and Intensity of Great Lakes Cyclones." *Journal of Climate* 11: 61-71.
[2] NOAA. 2013. "National Data Buoy Center." Accessed November 13. http://www.ndbc.noaa.gov/
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