Dune Surface Change on Perseverance Dune

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Abstract

This study focuses on sediment transport and surface change on Perseverance Dune. The area of research was Perseverance Dune. The goals of this research project were to measure sand movement, wind and weather patterns, and analyze the results. Methods included erosion pins, sand samples, sand traps, and wind anemometers. Erosion pin data caught the largest changes during week one. The sand samples revealed a common decrease in moisture content over the three weeks. The sand trap data shows the most sand collection happened during week three. The wind anemometers revealed the prominent wind direction was SW and the fastest wind occurred in week three. This project is important to conclude the surface movement on Perseverance Dune.

Introduction

Michigan dunes are influenced by wind and precipitation [1,2]. Higher wind velocities create large measurements of sand transportation [3]. Sediment moisture content is dependent on rainfall [3]. This study focuses on how wind and moisture affect Perseverance Dune. Multiple methods were used to obtain data and assess the developing dune and its relationships with weather and sand movement.

Study Objectives

1. To assess the current conditions of the developing dune
2. To measure sand movement and surface changes for three weeks
3. To measure wind and weather patterns for the same three weeks
4. To analyze the results for relationships between wind/weather and sand movement.

Study Area

Field research took place on the Perseverance Dune at Calvin University (Figures 1, 2). The surrounding area of the dune is also considered for the impact it might have on the dune. The dune is on a downward slope of grass.

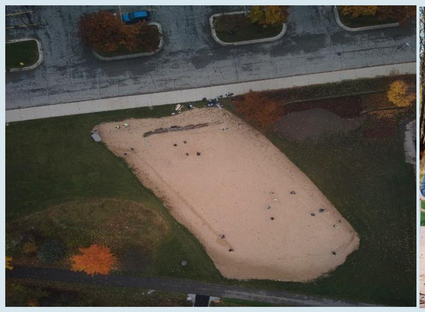

Figure 1: Aerial image captured by drone of Perseverance Dune and its surrounding area

Figure 2: Sand movement researchers from left to right Emma, Hailey, Peter, Michael and Derek

Methods

There were five methods used to complete our research project. We documented current conditions on the dune with taking photos and collecting sand samples for moisture content analysis (Figure 3). We used sand traps to measure sand movement and erosion pins to measure surface changes. We used wind vanes to see how the weather affected the dune during our study.

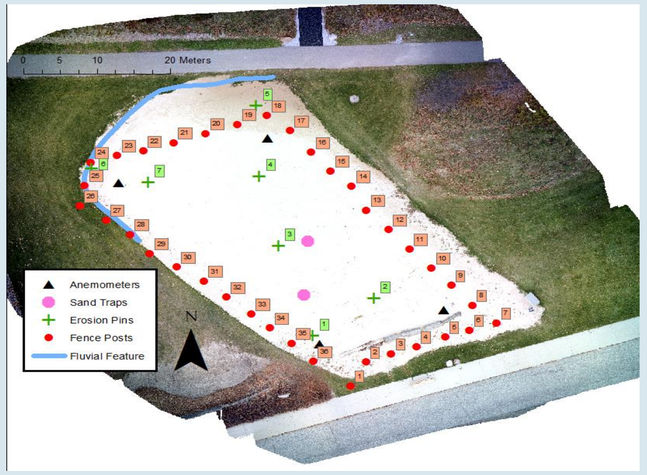

Figure 3: Perseverance Dune with mapped locations of equipment used to collect data.

Results

The sand sample data shows the greatest change in surface moisture occurred at pins E and F located near the bottom of the dune (Figure 4). The data from the sand samples shows that the moisture decreased at each pin over the three weeks, except moisture stayed generally consistent at pin E (Figure 5).

The sand trap data showed that during the third week, the traps collected the most sand (Figure 6).The wind data showed that the prominent direction of wind came from the SW, and the fastest wind gusts occurred during the third week (Figure 7).

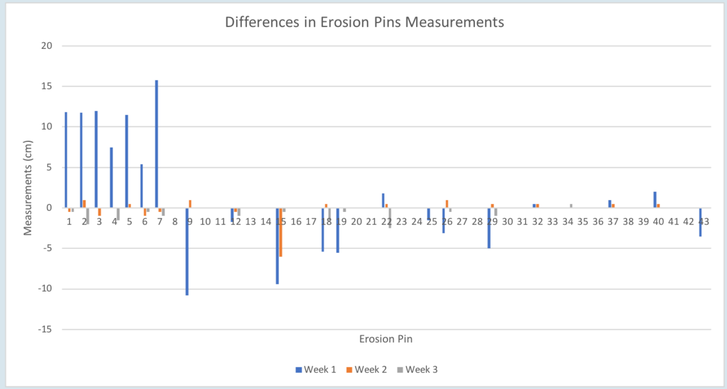

Figure 4: Measurements of erosion pins on Perseverance Dune taken over three weeks.

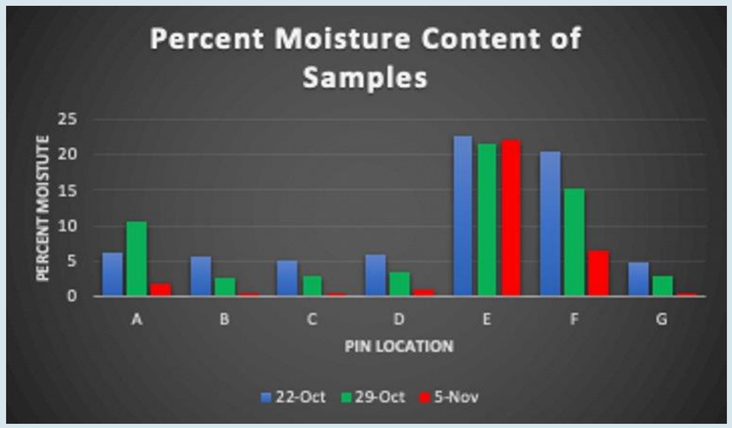

Figure 5: Moisture content of the sand over three weeks of field work.

Location	10/22	10/29	11/5
Southern	0 (g)	0 (g)	580.34 grams 5.04% moisture
Northern	0 (g)	0 (g)	134.93 grams 3.45% moisture

Figure 6: Weight and moisture content of sand collected in sand traps.

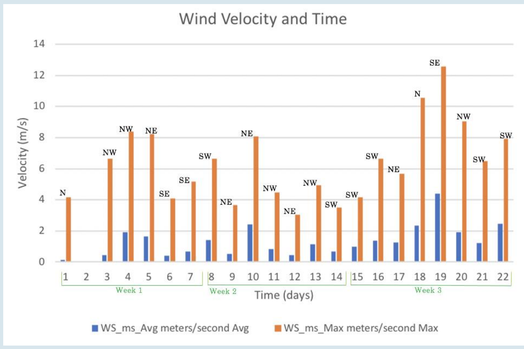

Figure 7: Wind speed and direction recorded by anemometers and vanes.

Discussion

The greatest changes on the erosion pins occurred during week one because this was when it was very rainy and over the next two weeks the sand dried up more. There was deposition because the rain caused the sand to compact which is why the measurements were larger the first week. A major difference in moisture content can be seen at pin E which is located on the north-east part of the dune where a lot of water accumulates.

The sand traps collected the most sand during week three because it was the windiest during this week. The wind picked up on the third week because a storm came through.

Conclusions

Through measuring erosion pins and moisture content it was shown that more erosion and moisture was found near the bottom of the dune. Through weighing the sand in sand traps, it was shown how much the sand was moving during our study. Through measuring wind speed and direction, it was shown that winds pick up around times of a storm. With this new knowledge our data can be used in years to come to observe how Perseverance Dune may or may not be progressing.

Acknowledgements

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Works Cited

[1] Davidson-Arnott, R.G.D., and M.N. Law. 1996. "Measurements and Predictions of Long-Term Sediment Supply to Coastal Foredunes." *Journal of Coastal Research*, 12 (3), pp. 654-63.

[2] Landsberg, H., and A.N. Riley. 1943. "Wind Influences on the Transportation of Sand over a Michigan Sand Dune." *Proceedings of the Second Hydraulics Conference: June 1-4, 1942.* Iowa City: State University of Iowa, pp. 342-52.

[3] Hugenholtz, C.H., and S.A. Wolfe. "Morphodynamics and Climate Controls of Two Aeolian Blowouts on the Northern Great Plains, Canada." *Earth Surface Processes and Landforms*, vol. 31, 17 May 2006, pp. 1540-55.