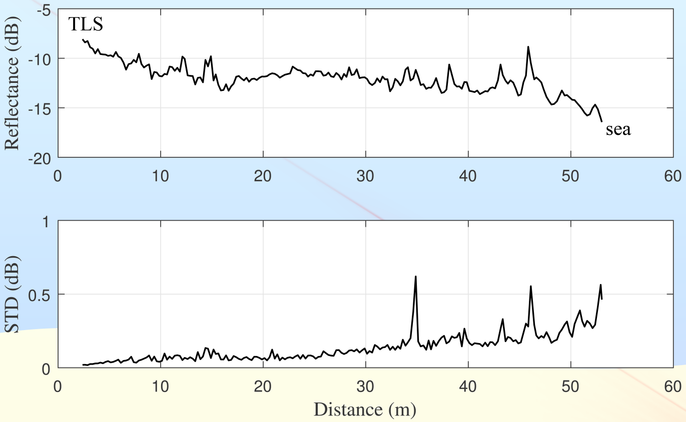
MEASURING THE SPATIAL VARIATION IN SURFACE MOISTURE ON A COASTAL BEACH WITH AN INFRA-RED TERRESTRIAL LASER SCANNER

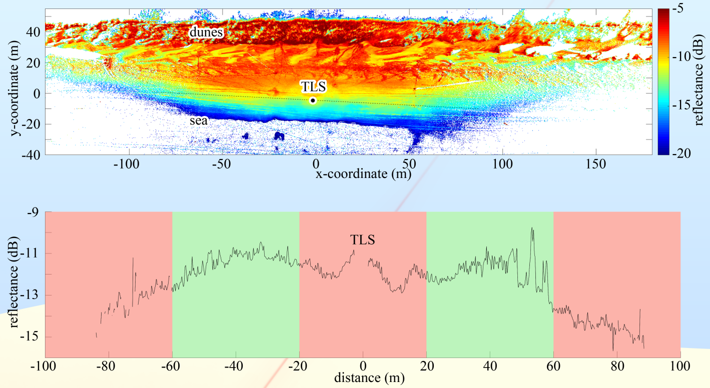
Yvonne Smit (y.smit@uu.nl), J. J. A. Donker and B. G. Ruessink, Utrecht University

1.

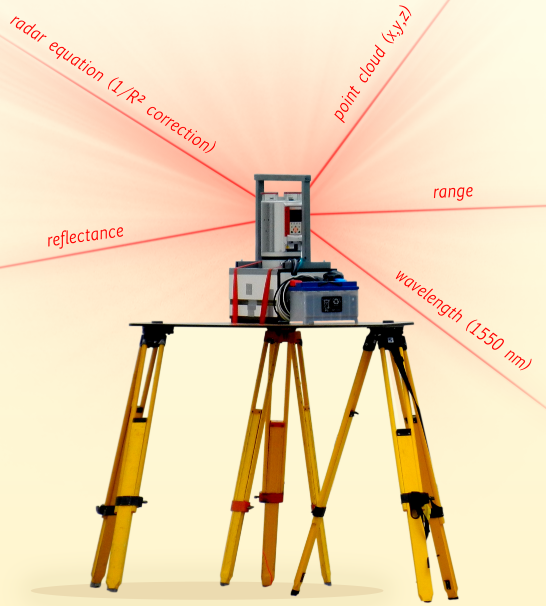


Average line scan calculated with ~ 1200 line scans in the cross-shore direction.
The TLS is located at the high water line, 55 m from the sea.
Reflectance varies between -6 dB and -16 dB, with -6 dB meaning dry sand and -16 dB saturated sand.
The maximum standard deviation of the line scan is 0.6 dB over a range of 10 dB. Thus, significantly small.

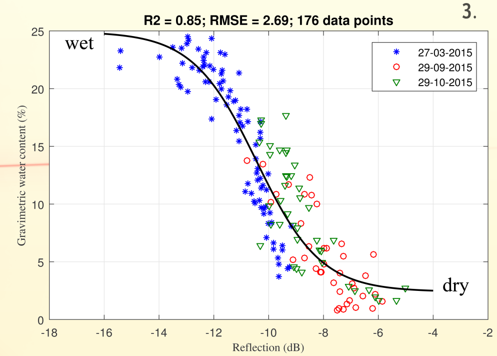
2.



A panoramic scan of the reflectance output (dB) made by the TLS. Where there is a clear gradient visible from the dunes (dry, -5 dB) towards the swash zone (wet, -20 dB).
The TLS is situated at the high water line and an along shore transect is used to study the influence of distance on reflectance, assuming surface moisture is relatively constant.
Reflectance decreases within the first 20 meters from the TLS.
Between a distance of 20 m and 60 m reflectance stays approximately stable.
After 60 m reflectance decreases and data gaps occur.
Multiple panoramic scans showed the same result.



3.



Calibration curve of reflection versus gravimetric surface moisture content. The curve has a range of 2% until 25% soil moisture with a corresponding range of -4 dB to -16 dB, respectively. The calibration curve consists of 176 data points with a RMSE of 2.69 and an R-square of 0.85

INTRODUCTION

Coastal sand dunes provide essential protection against marine flooding. Nowadays there is growing awareness that advanced knowledge on dune recovery and growth is needed to predict future dune development. For this reason, aeolian sand transport from the beach into the dunes has to be investigated thoroughly. (Arens et al., 2013)

Surface moisture is a major factor limiting aeolian transport on sandy beaches. By increasing the velocity threshold for sediment entrainment, pick-up rates reduce and the fetch length increases. (Bauer & Davidson-Arnott, 2002)

Conventional measurement techniques (e.g. impedance probes, gravimetric method, brightness method) cannot adequately characterize the spatial and temporal distribution of surface moisture content required to study the effects on aeolian transport.

Here we present a new method for detecting surface moisture at high temporal and spatial resolution using the RIEGL VZ-400 terrestrial laser scanner (TLS).

RESEARCH QUESTIONS

1. How robust and accurate are the reflectance measurements?
2. What is the dependence of reflectance on distance?
3. What is the relationship between reflectance and surface moisture?

METHODS

1. Line scans
2. Panoramic scans
3. Gravimetric surface moisture samples

CONCLUSIONS

1. Reflectance is proven to be a robust and accurate parameter to measure surface moisture
2. Reflectance can be used to measure surface moisture between a distance of ~20 m - 60 m
3. TLS (rmse = 2.7) can measure surface moisture over its full range (0% - 20%) on a large spatial and temporal scale in contrary to impedance probes (rmse = 1.5 - 2)

Department of Physical Geography, Faculty of Geosciences,
Utrecht University, PO Box 80.115, 3508 TC Utrecht, The Netherlands