SPATIOTEMPORAL SURFACE MOISTURE VARIATIONS OVER A TIDAL CYCLE

Yvonne Smit (y.smit@uu.nl), and Gerben Ruessink, Utrecht University

INTRODUCTION

Coastal sand dunes provide essential protection against marine flooding. 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 and therefore important to measure *(Bauer and Davidson-Arnott, 2002)*. A new method has been developed to measure surface moisture content accurately with a near-infrared Terrestrial Laser Scanner *(Smit et al, 2017)*.

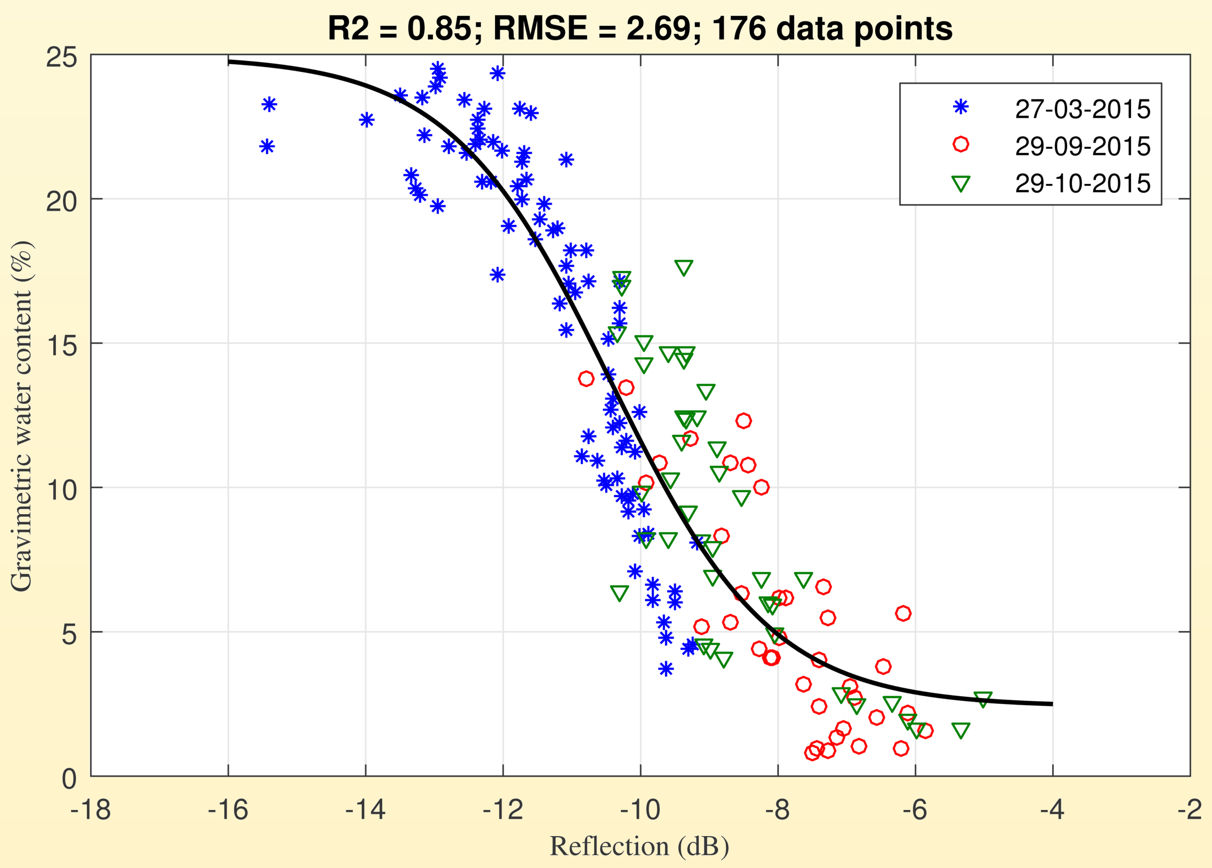
Here we present high-resolution surface moisture maps and a description of how surface moisture content varies spatiotemporally over a tidal cycle.

RESEARCH QUESTIONS

1. How does surface moisture fluctuate spatially?
2. How does surface moisture fluctuate temporally?
   a. falling tide   b. rising tide

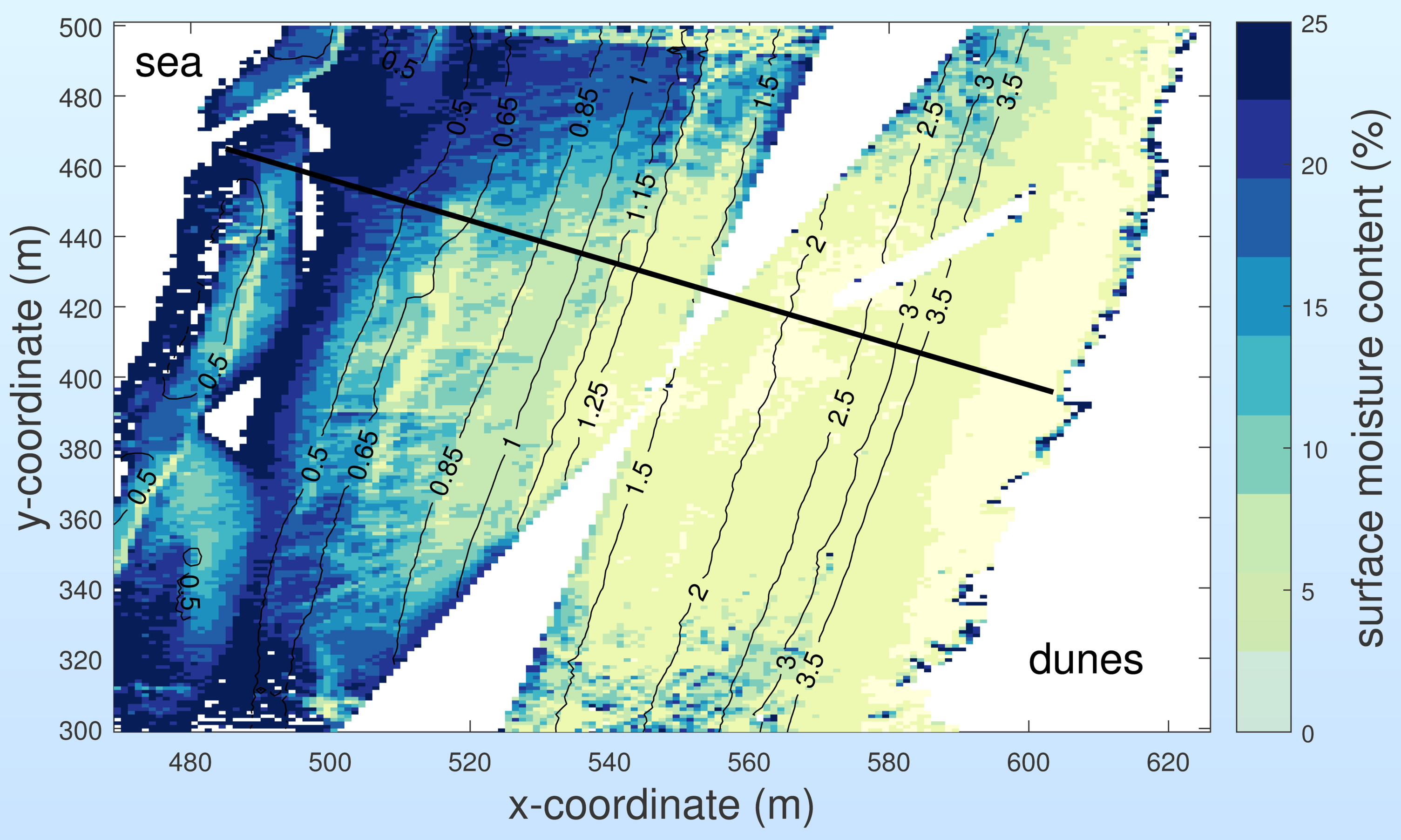
METHODS

Measurements were performed on the barred Egmond beach, The Netherlands, where the tidal range is about 1.5 m. Panoramic scans of reflectance were taken from high towards low tide with a RIEGL VZ-400 TLS and translated into surface moisture maps.
Additionally, cross-shore surface moisture transects were extracted from surface moisture maps.

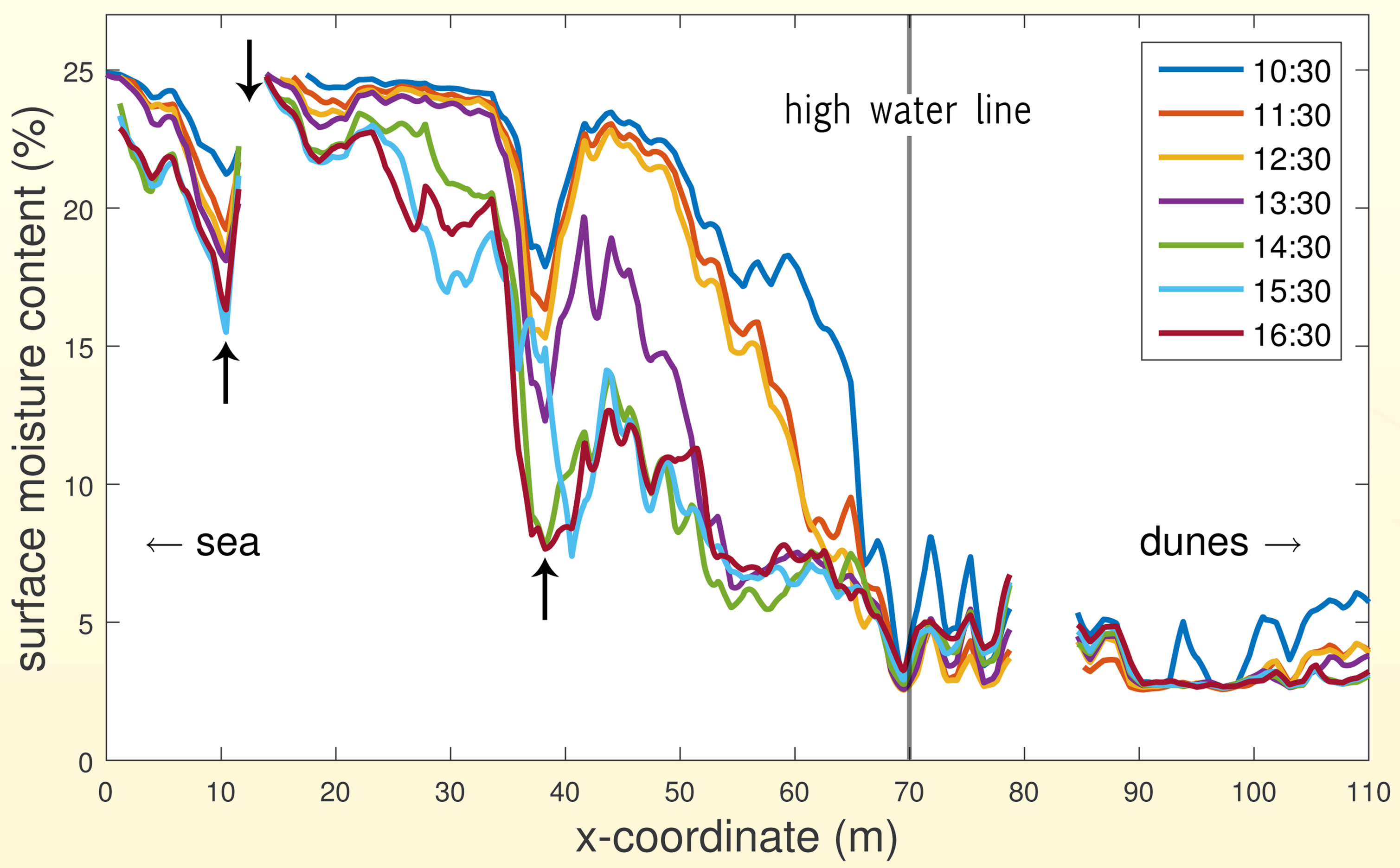


Calibration curve of reflection versus gravimetric surface moisture content. The curve has a range of 2% until 25% soil moisture with a corresponding range of -4 dB to -16 dB, respectively. The calibration curve consists of 176 data points with a RMSE of 2.69% and an R-square of 0.85

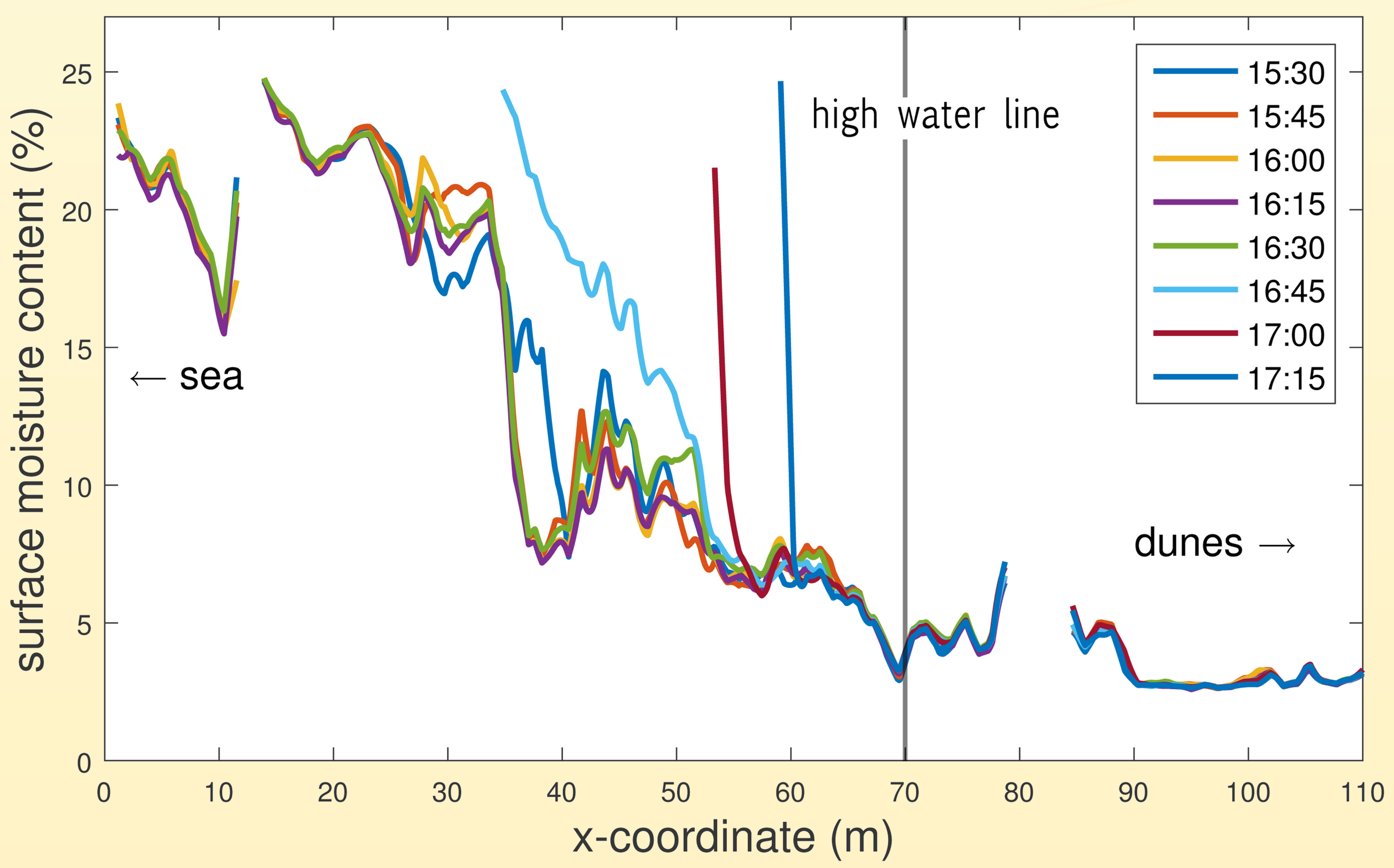
RESULTS



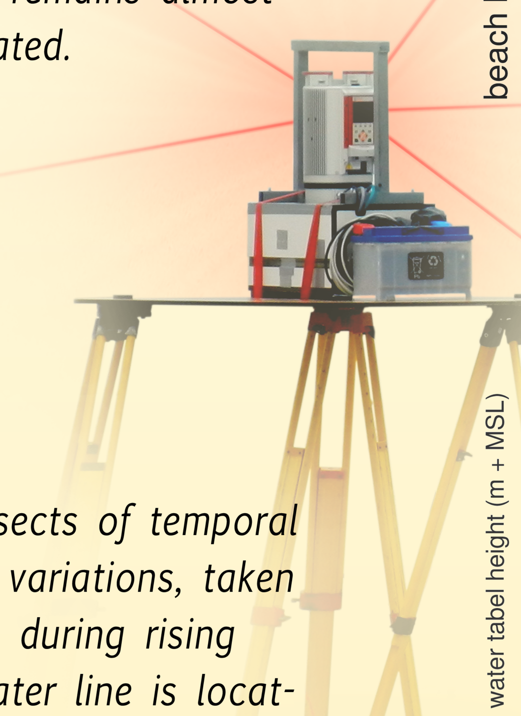
Surface moisture contents during low tide. At the back beach (yellow colors) above the high water line (the 1-m contour) surface moisture varies spatially from 0% until 8%. In the intertidal zone (green colors) it varies spatially from 10% towards complete saturation of 25% (blue colors). No data points are visible in the trough since it is inundated by water. In contrast, the sandbar shows lower moisture contents than its surroundings. Some unnatural features are visible like tire tracks, which appear drier than their surroundings as well.



Cross-shore transects of temporal surface moisture variations during falling tide. Above the high water surface moisture content remains relatively stable around 3%. Below the high water line, between x=25 m and x=70 m, on the intertidal beach large surface moisture variations are visible, where surface moisture can decrease with a maximum of 8% per one hour and 14.5% in total. Near the swash zone between x=0 m and x=25 m, the soil remains almost completely saturated.



Cross-shore transects of temporal surface moisture variations, taken every 15 minutes during rising tide. The high water line is located at x = 70 m. During rising tide hardly any surface moisture dynamics are visible over the entire beach. Only some variations generated by swash waves are visible on the intertidal beach.



CONCLUSION

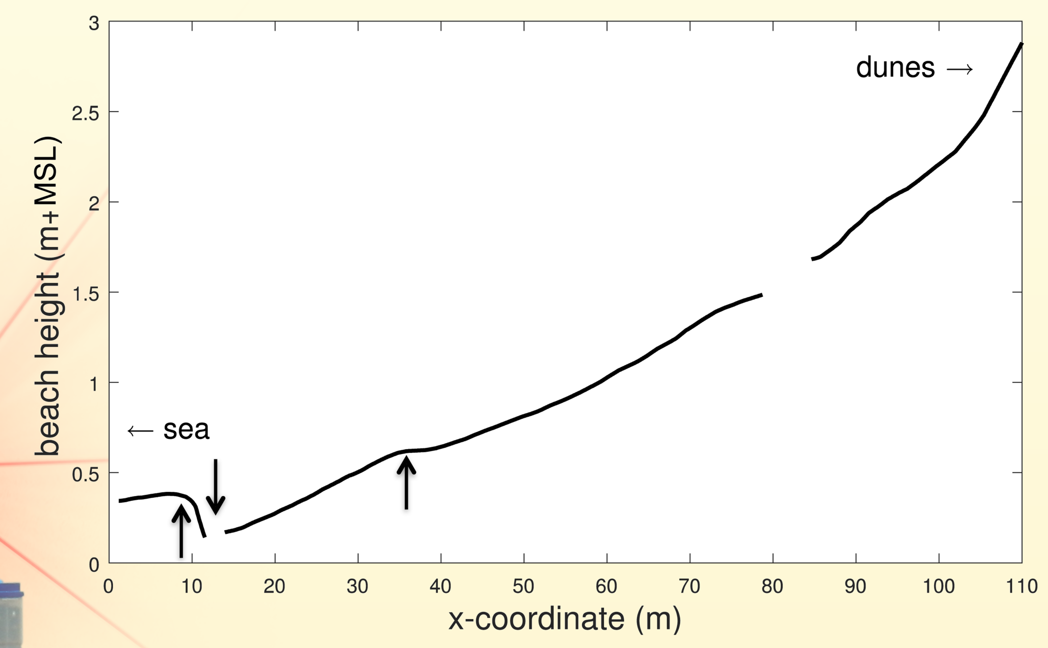
The beach can be divided into 3 distinct surface moisture areas:

1. The swash zone, with small surface moisture fluctuations around 23% near saturation.
2. The intertidal beach, with high surface moisture fluctuations, varying between 3% - 25%, and reducing during falling tide.
3. The back beach were surface moisture content remains very stable and low around 3%.

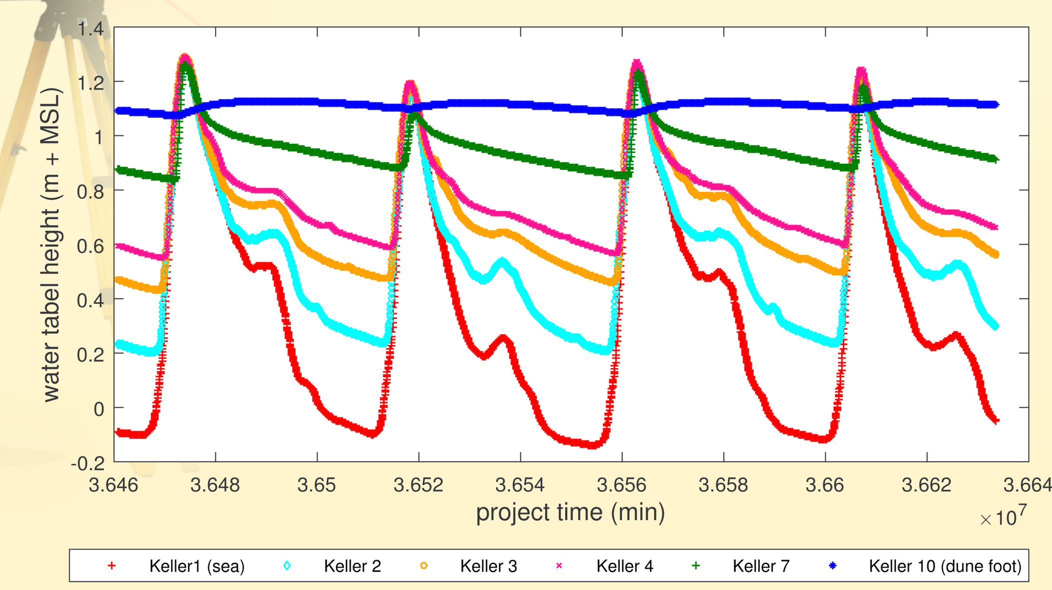
Morphological features like the sandbar and trough cannot be ascribed to a specific zone but have their own characteristics. The sandbar can dry out to surface moisture contents of 15% and the trough is always completely saturated 25%.

DISCUSSION

Our next step will be to investigate the key factors that control surface moisture variations. Preliminary results reveal that groundwater depth plays an important role in predicting surface moisture content variations.



Cross-shore transect with a pronounced bar-trough morphology



Groundwater fluctuations, where Keller 1 (sea) shows large fluctuations and Keller 10 (dune foot) small fluctuations

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