

AEOLIAN SEDIMENT TRANSPORT AT A MAN-MADE DUNE SYSTEM

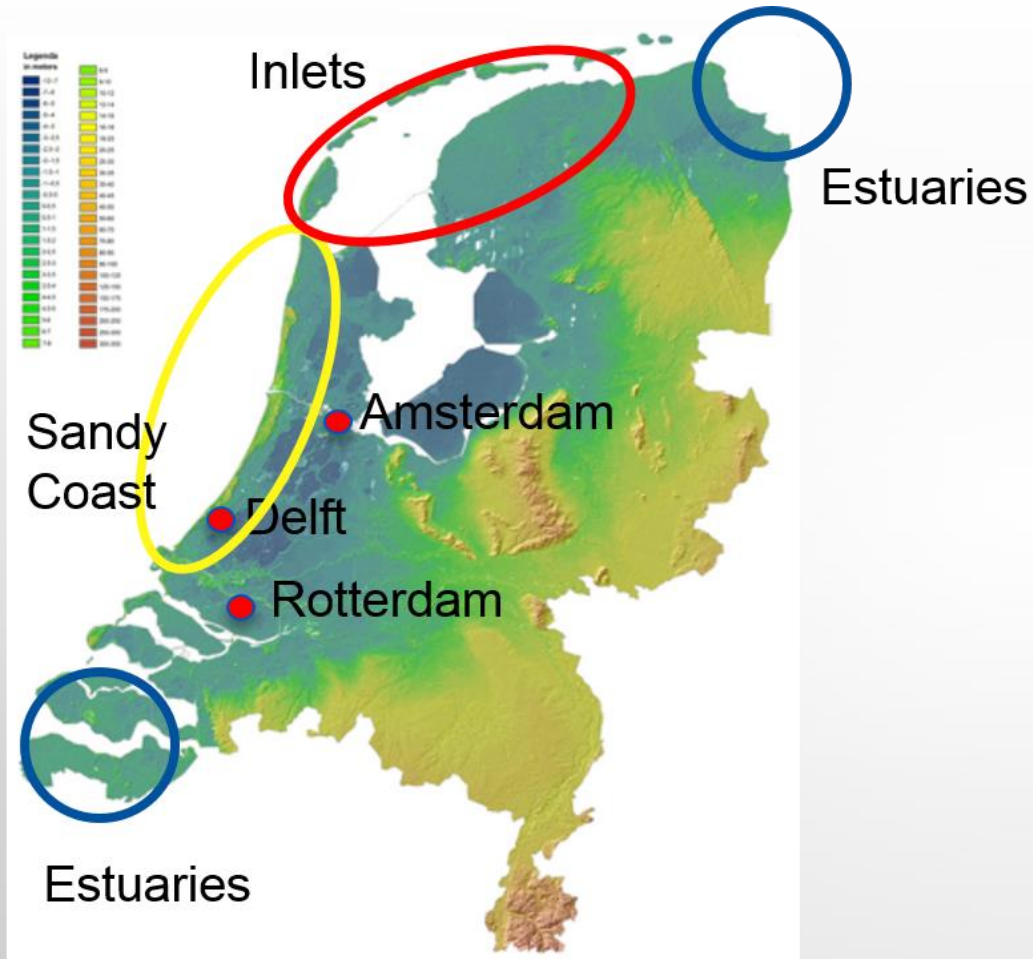
BUILDING WITH NATURE AT THE HONDSBOSSCHE DUNES

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DREDGING PRODUCTION ENGINEER – ROYAL BOSKALIS WESTMINSTER N.V.

ICCE 2018 - BALTIMORE
31 JULY 2018

PROF. DR.IR. S. AARNINKHOF – DELFT UNIVERSITY OF TECHNOLOGY
DR. IR. S. DE VRIES – DELFT UNIVERSITY OF TECHNOLOGY
IR. P. GOESSEN – HOOGHEEMRAADSCHAP HOLLANDS NOORDERKWARTIER

DUTCH COASTLINE



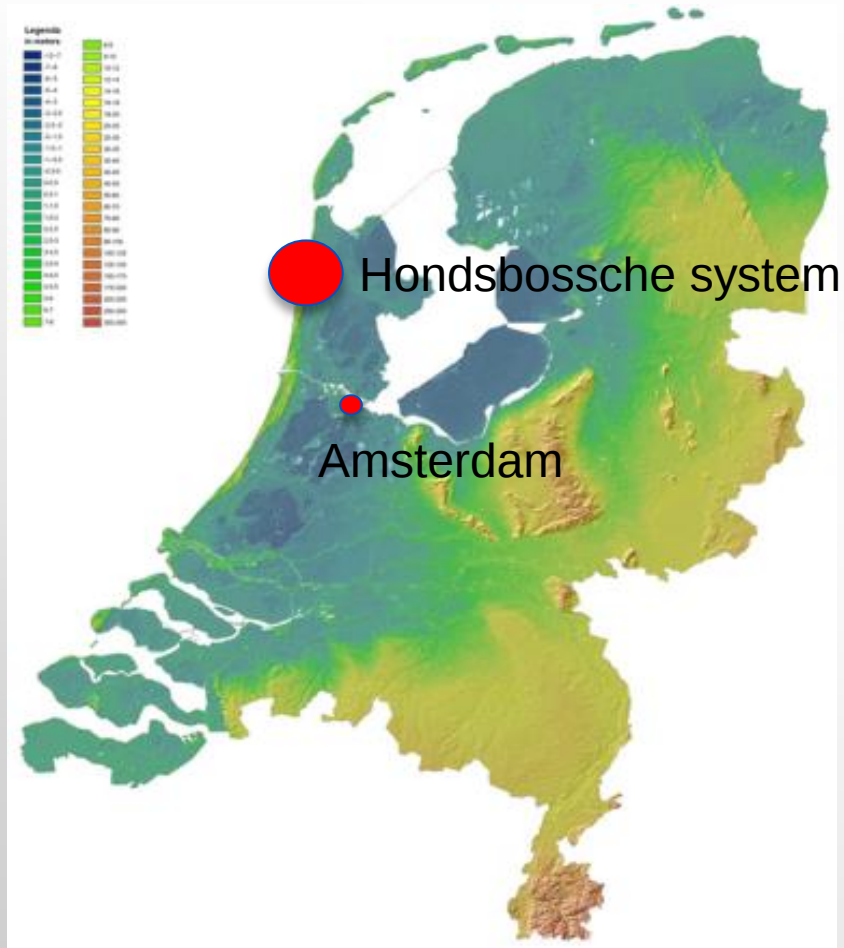
75 % of the Dutch coastline is 'soft'

Since 1990s maintenance by

- Beach nourishments
- Foreshore nourishments



PROJECT LOCATION



PETTEN - CAMPERDUIN

1981 – 2014:
'Hondsbossche & Pettermer' –
Sea Defence (HPZ)

Since April 2015:
Hondsbossche **Dunes (HD)**

PREVIOUS SITUATION

STATIC – HARD SOLUTION

1981 - 2014



PREVIOUS SITUATION

STATIC – HARD SOLUTION

1981 - 2014



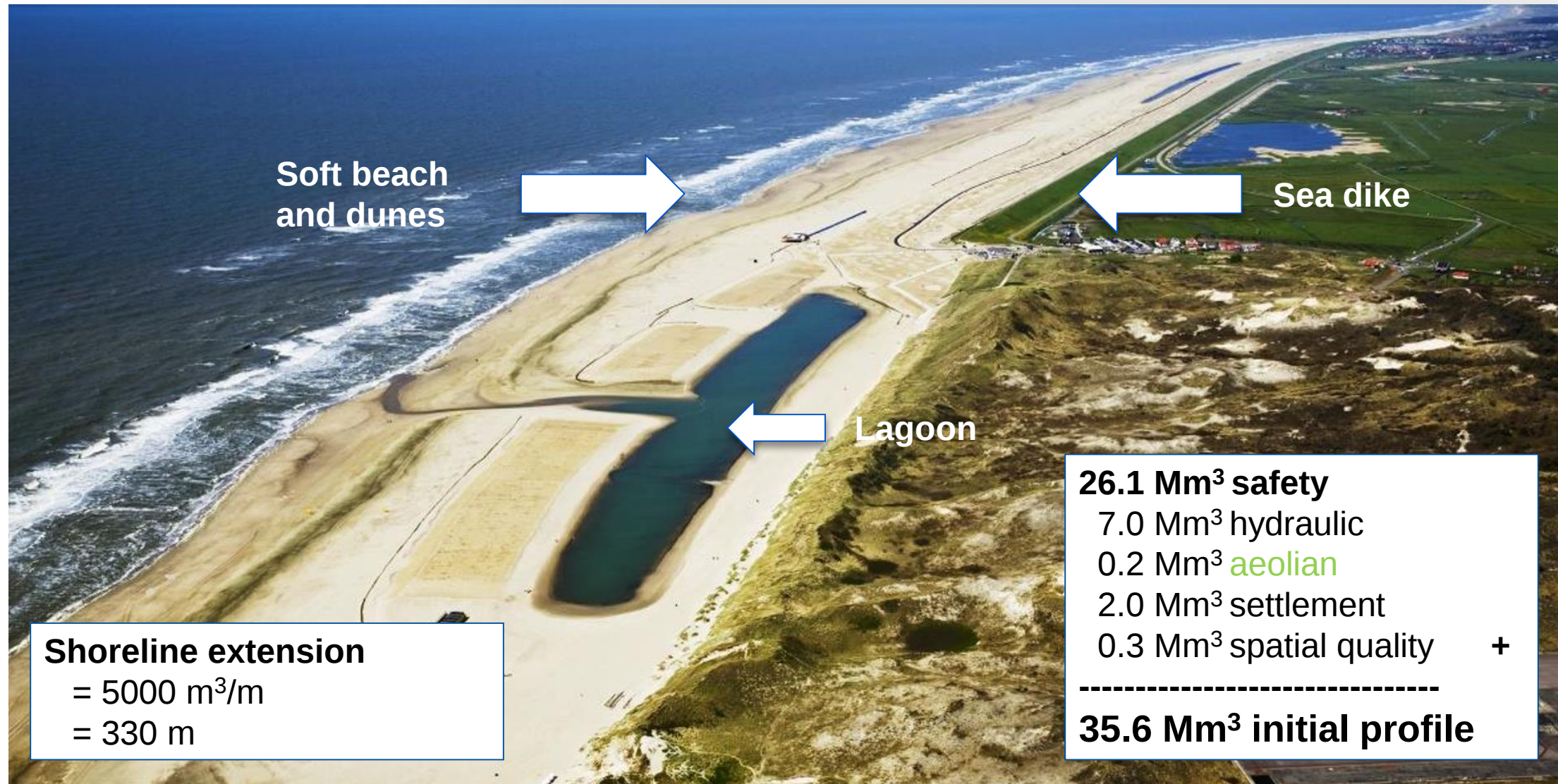
NEW SITUATION

DYNAMIC – SOFT SOLUTION

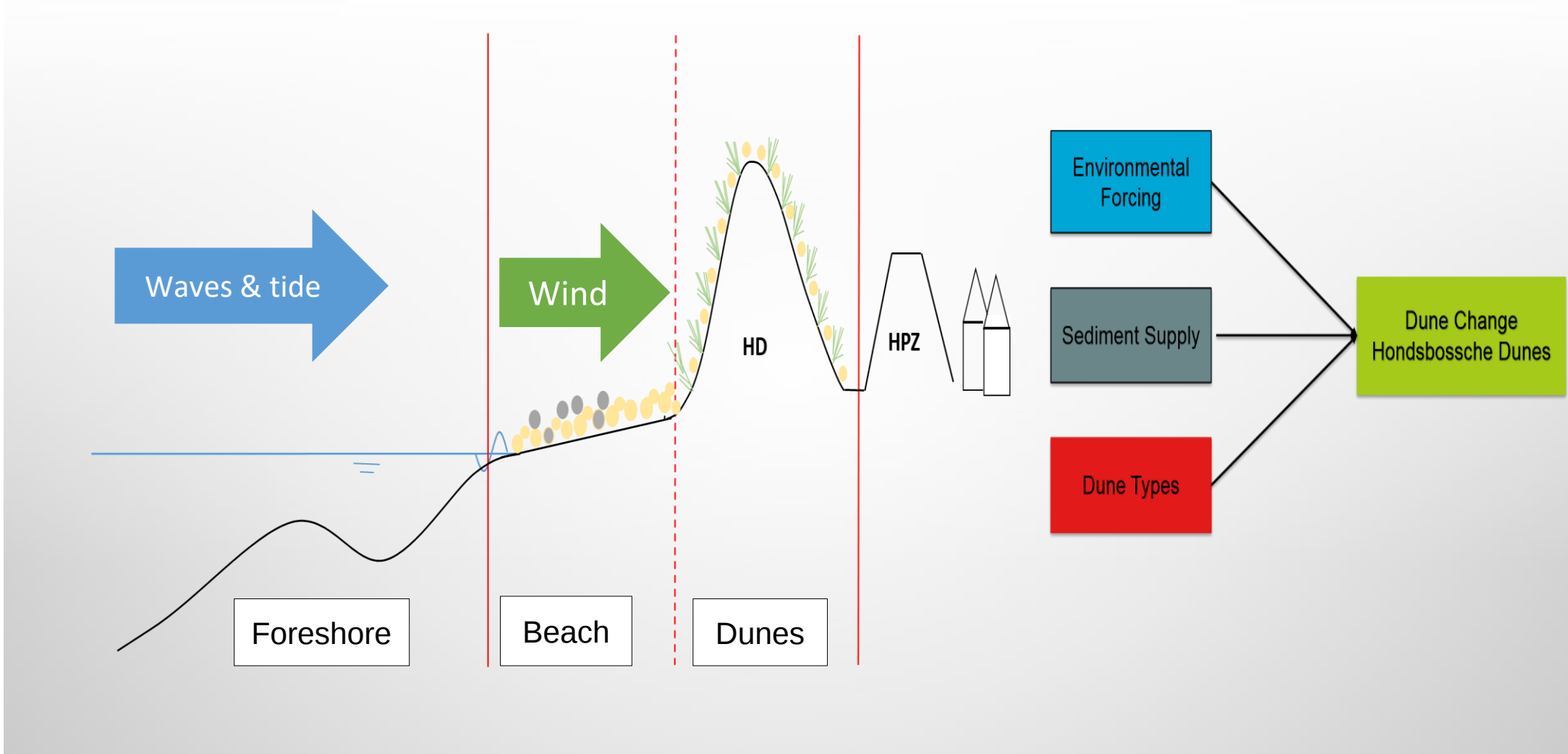
SINCE 2015



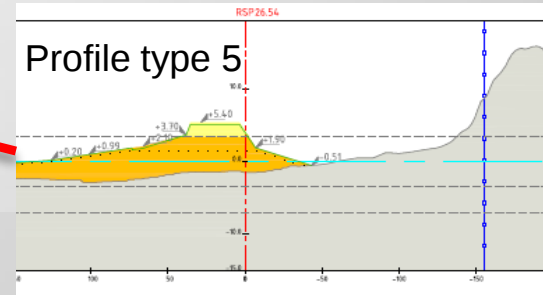
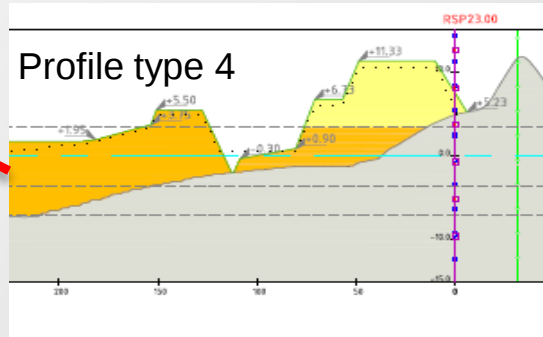
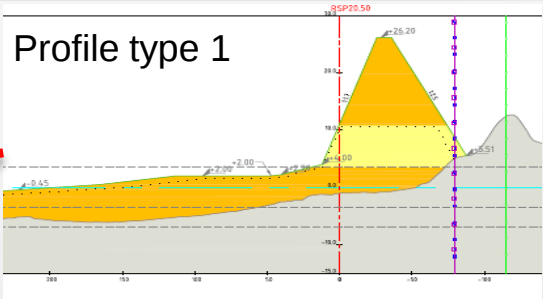
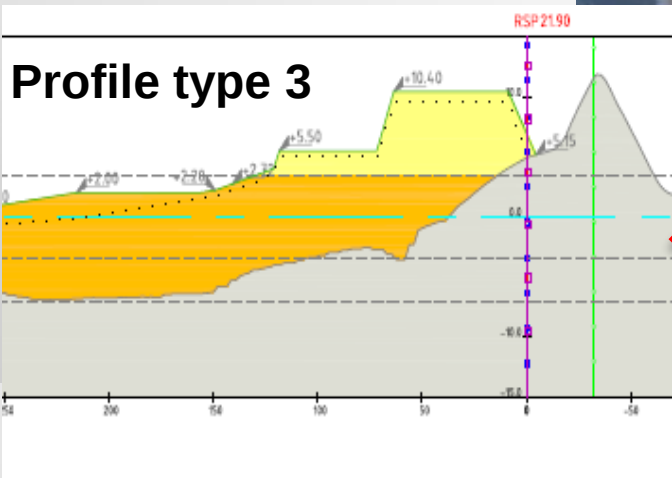
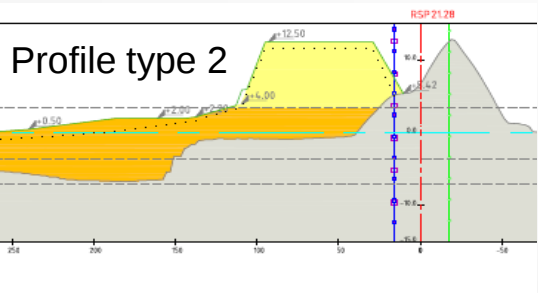
DESIGN, BUILD, MAINTENANCE



HONDSBOSSCHE DUNES

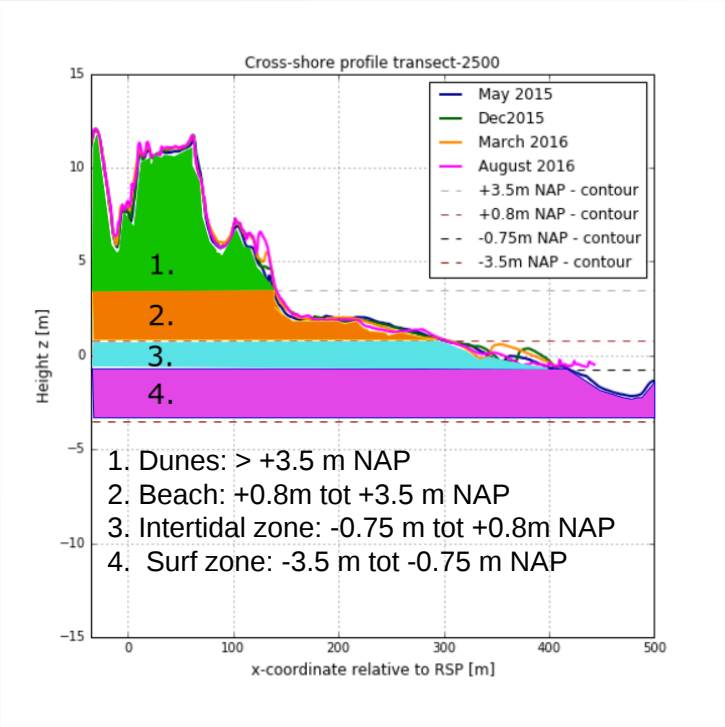


DUNE TYPES

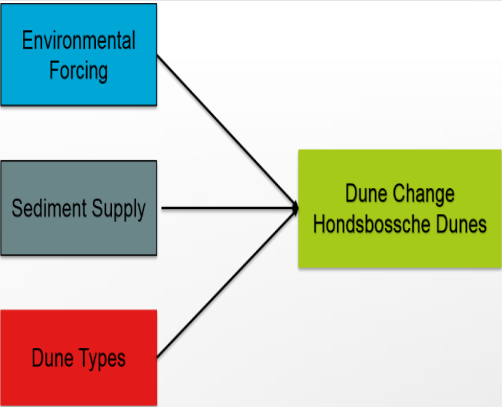
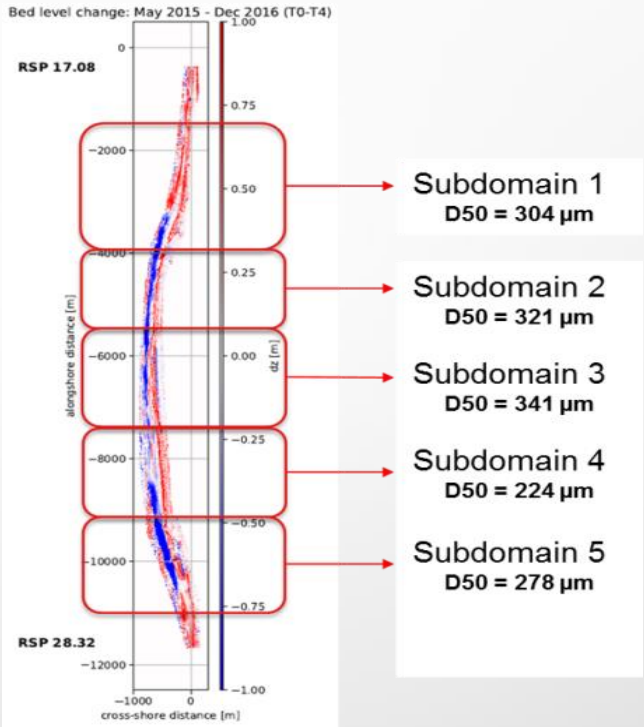


METHODOLOGY

LIDAR DATA



2DH MODEL AEOLIS

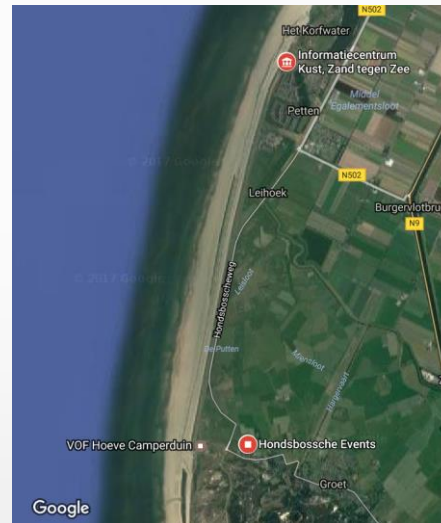


ALONGSHORE DEVELOPMENT



LiDAR: May 2015 – September 2016

CUMULATIVE CHANGES MAY '15 – DEC '16

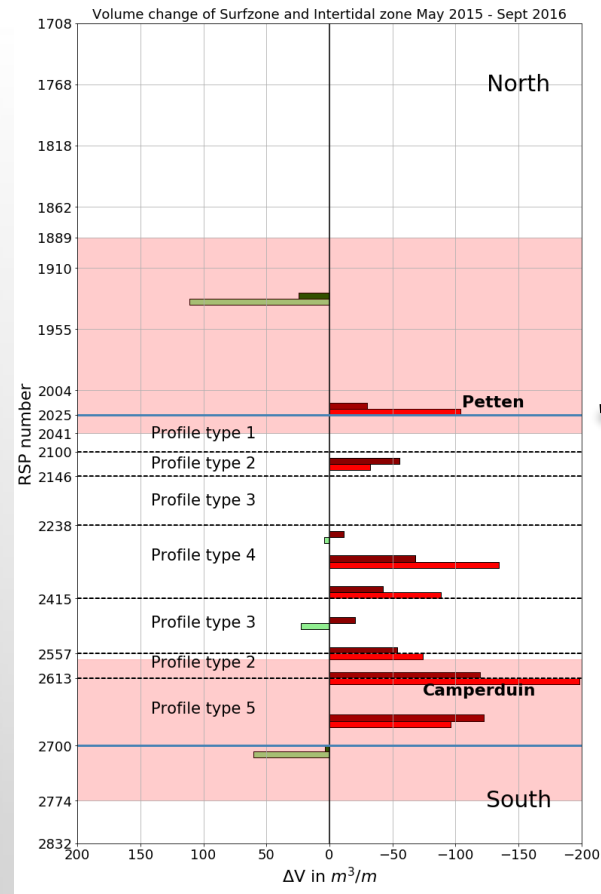


Intertidal zone
Surf zone

Beach

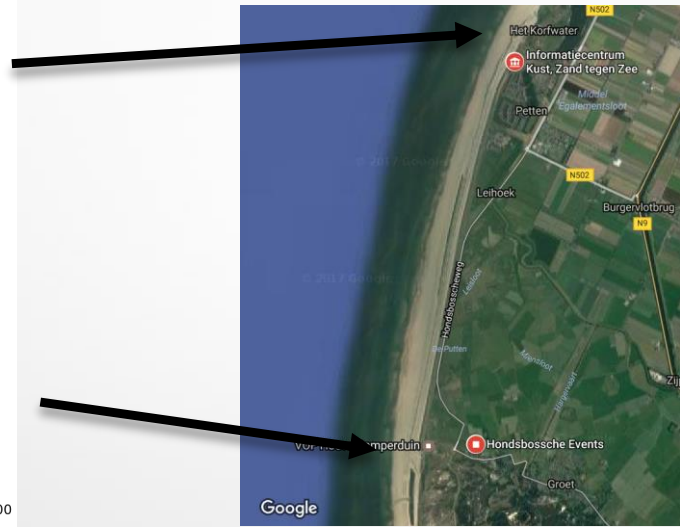
Dunes

CUMULATIVE CHANGES MAY '15 – DEC '16



Intertidal zone
Surf zone
-74 m³/m/y (HD)

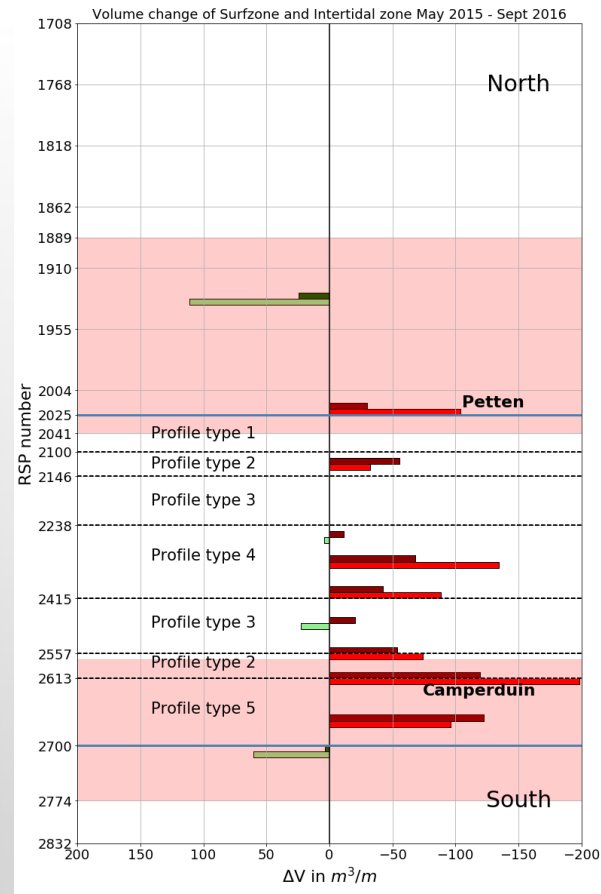
Erosion
Deposition



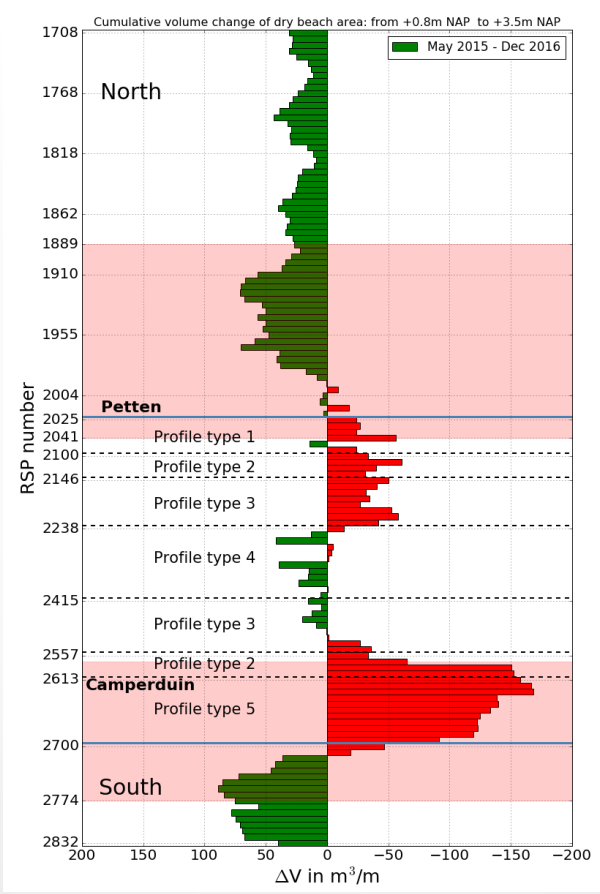
Beach

Dunes

CUMULATIVE CHANGES MAY '15 – DEC '16



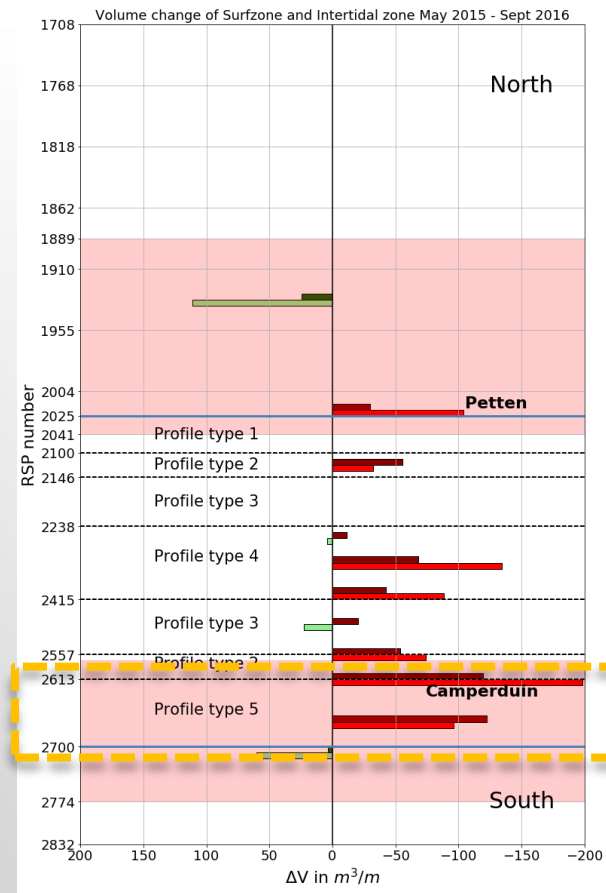
Intertidal zone
Surf zone
-74 $m^3/m/y$ (HD)



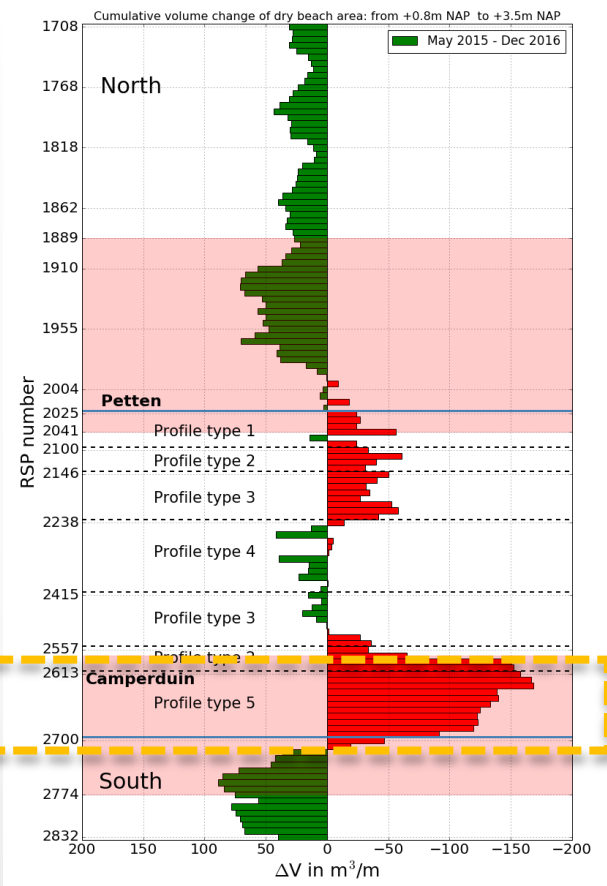
Beach
+2 $m^3/m/y$
-29 $m^3/m/y$ (HD)

Dunes

CUMULATIVE CHANGES MAY '15 – DEC '16



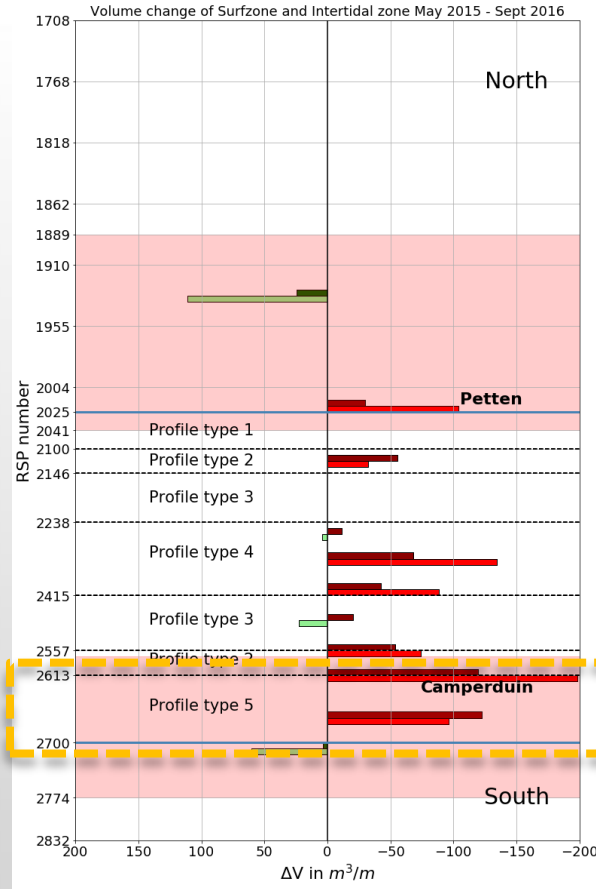
Intertidal zone
Surf zone
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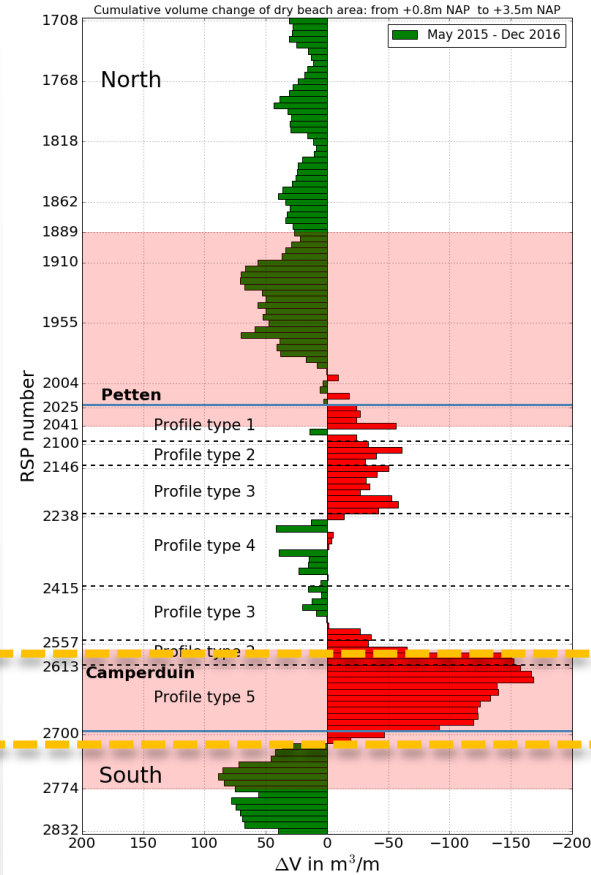
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Dunes

CUMULATIVE CHANGES MAY '15 – DEC '16

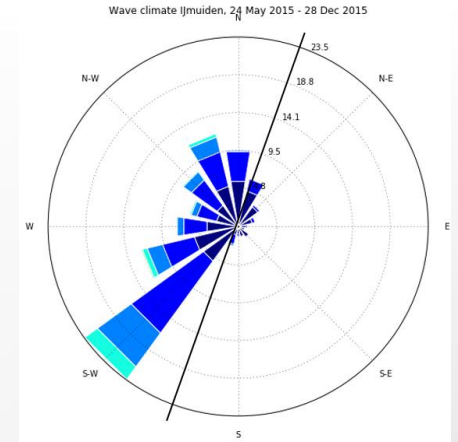


Intertidal zone
Surf zone
-74 m³/m/y (HD)



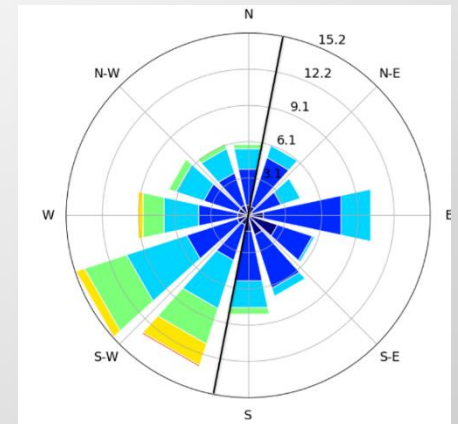
Beach
+2 m³/m/y
-29 m³/m/y (HD)

Waves

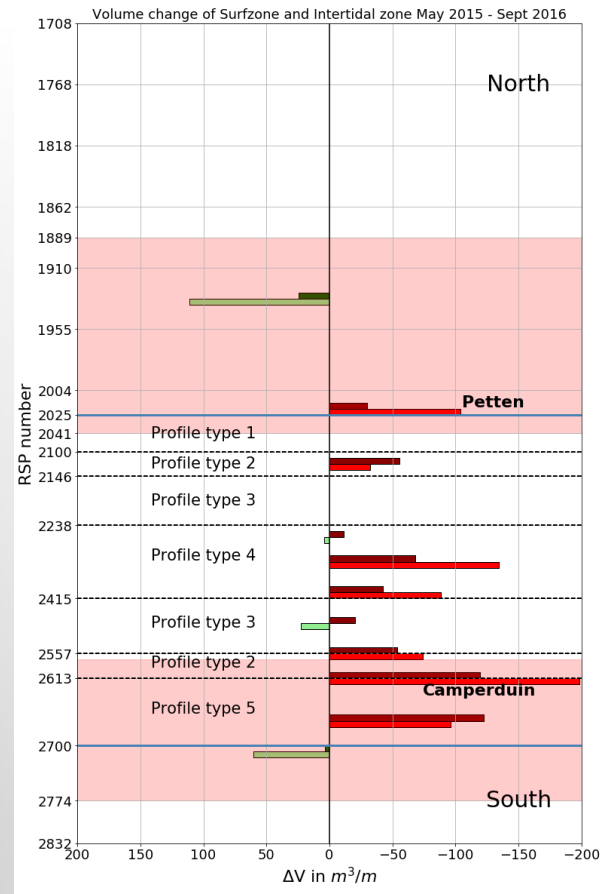


T0-T1

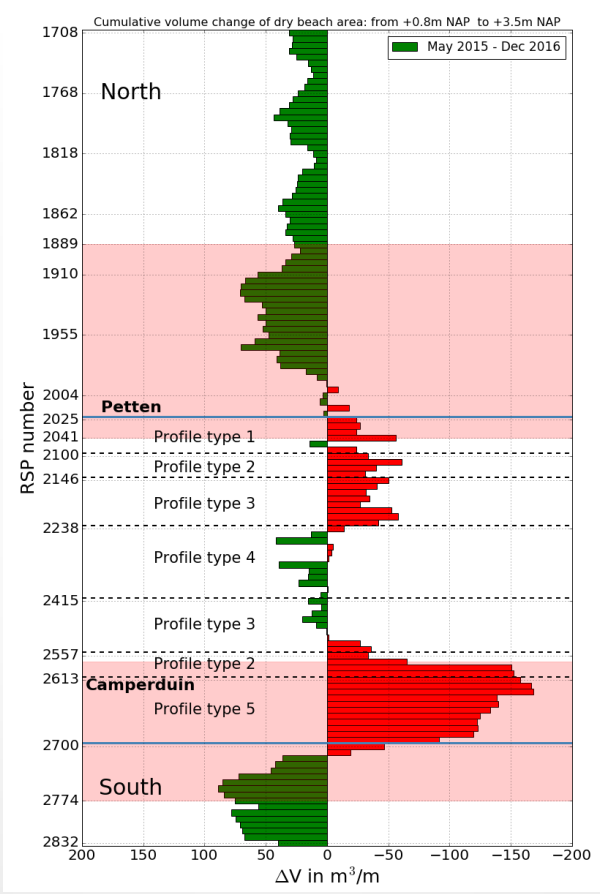
Wind



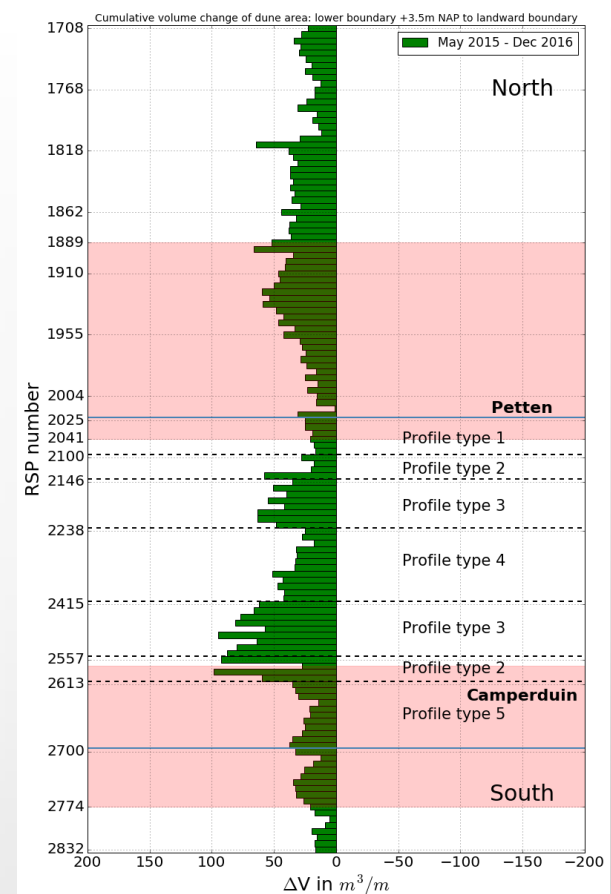
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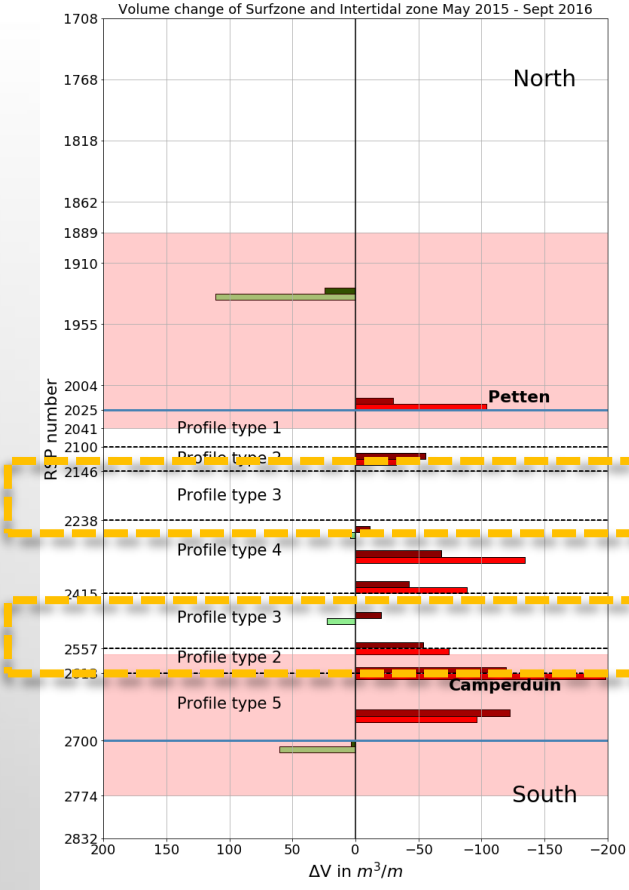


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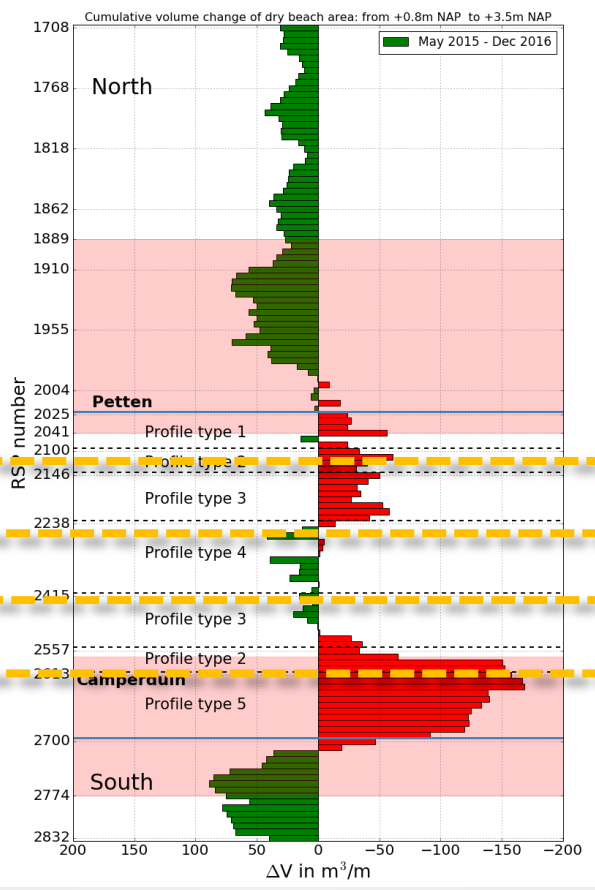


Dunes
+23 m³/m/y
+28 m³/m/y (HD)

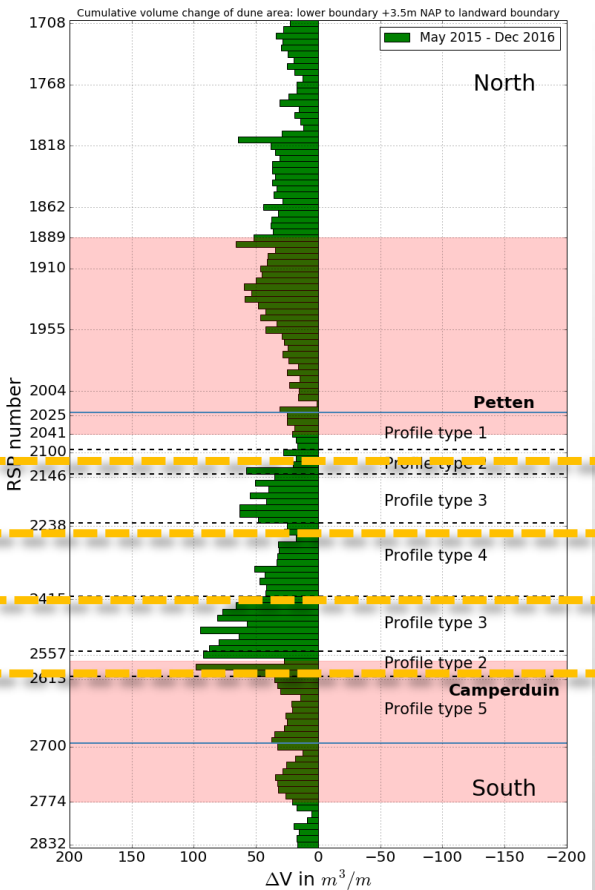
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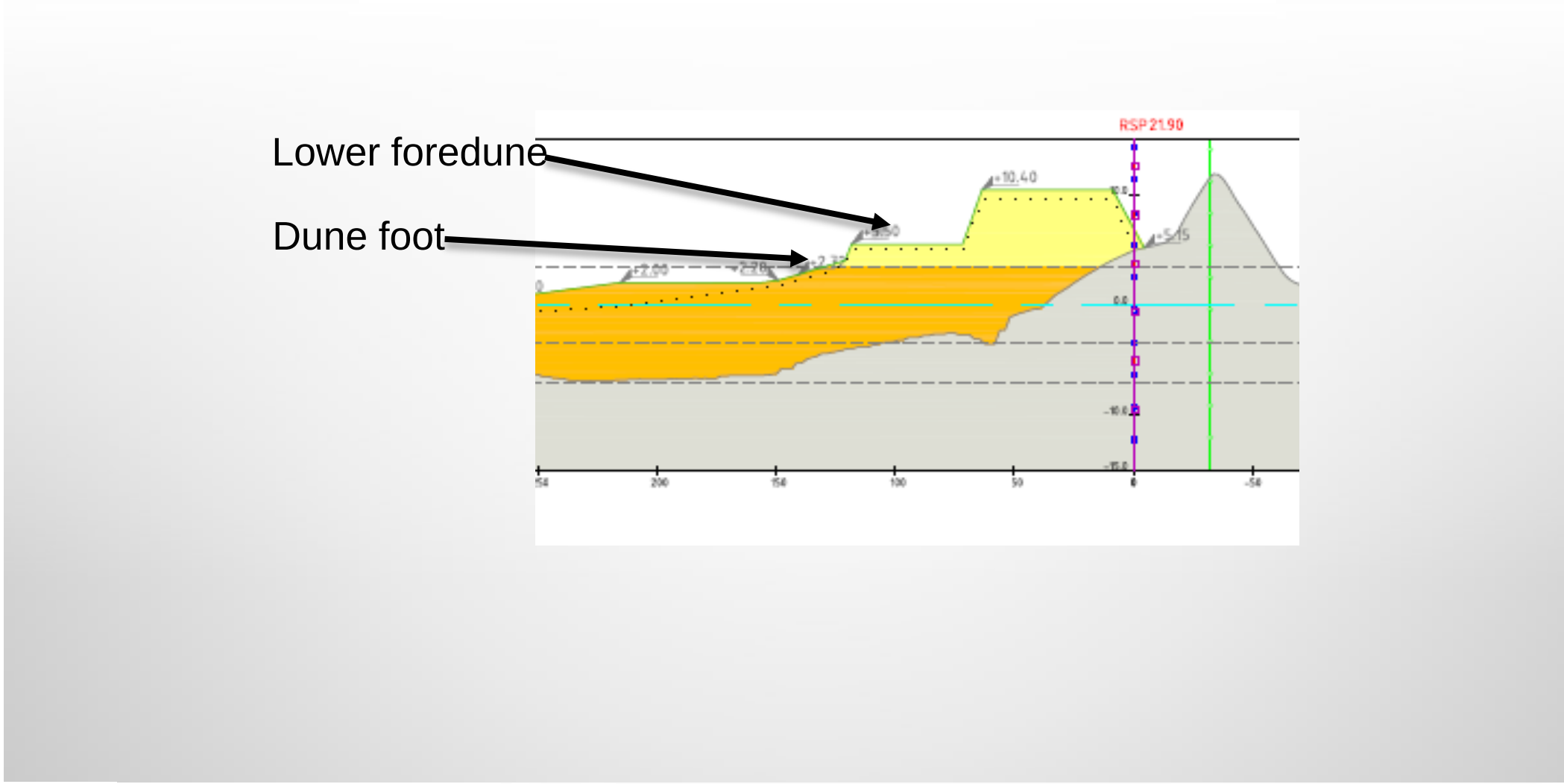


Dunes
+23 $m^3/m/y$
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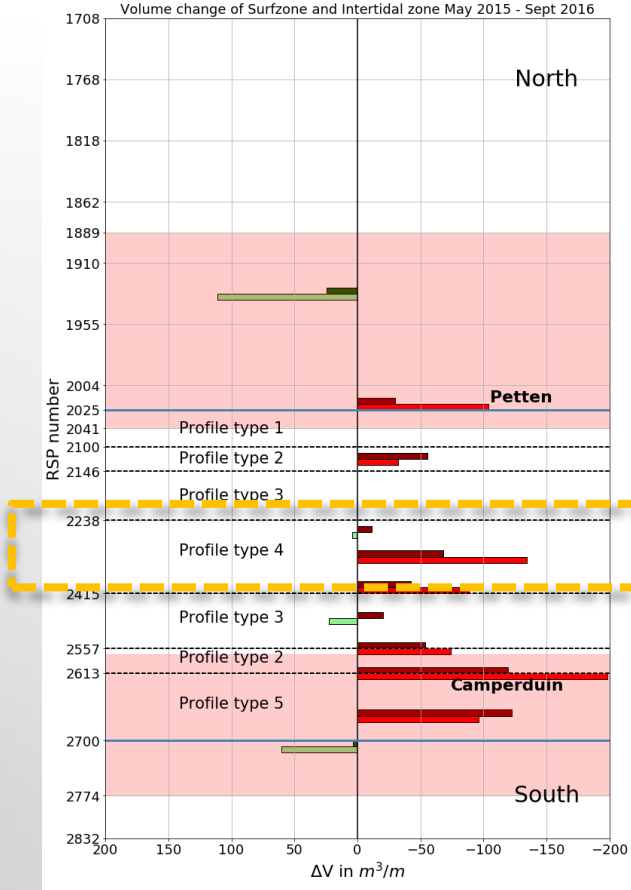
Lower foredune

Dune foot

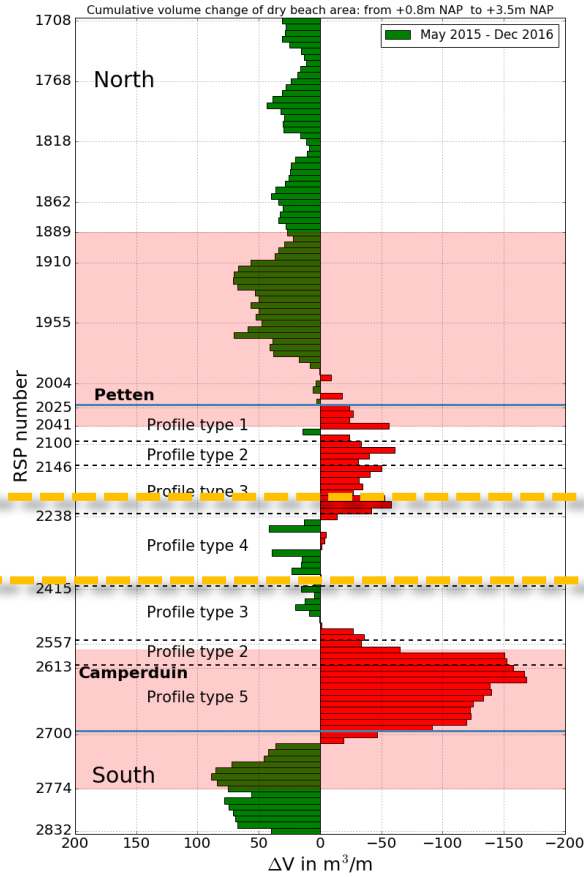
The diagram is a cross-section of a coastal profile. The horizontal axis at the bottom represents distance, with labels 154, 200, 154, 100, 50, 0, and -54. The vertical axis on the right represents elevation, with labels 21.90, 10.40, 5.15, 0.0, -10.0, and -15.0. A vertical green line is positioned at the 0 mark on the horizontal axis. The profile shows a wide, flat area on the left (land) and a steep, sloping area on the right (sea). A yellow-shaded region is located between the 100 and 50 marks on the horizontal axis, representing the dune. A blue-shaded region is located between the 154 and 100 marks on the horizontal axis, representing the lower foredune. A black arrow points from the text 'Lower foredune' to the blue-shaded region. Another black arrow points from the text 'Dune foot' to the boundary between the blue and yellow shaded regions. The top of the profile is marked with a red line and the label 'RSP 21.90'.



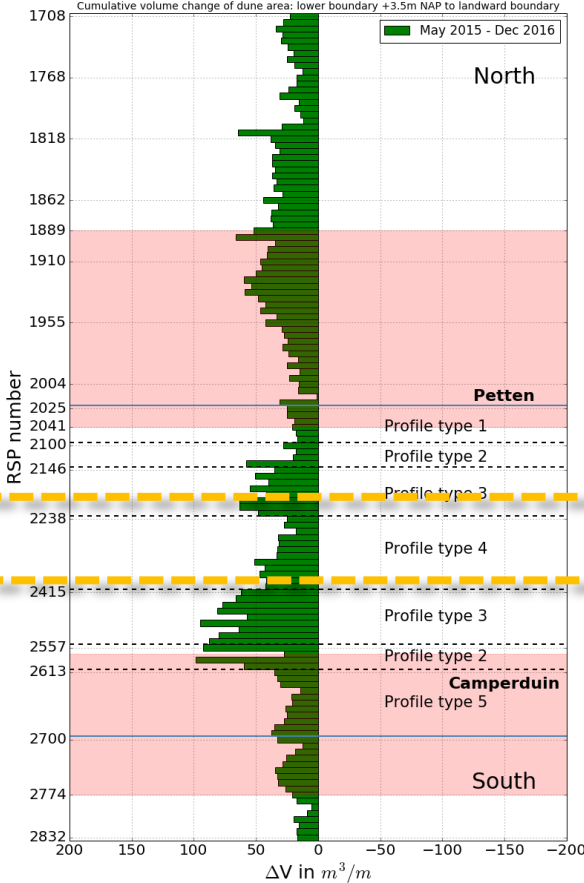
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-74 $m^3/m/y$ (HD)



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+2 $m^3/m/y$
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Dunes
+23 $m^3/m/y$
+28 $m^3/m/y$ (HD)

HINDCAST DUNE GROWTH



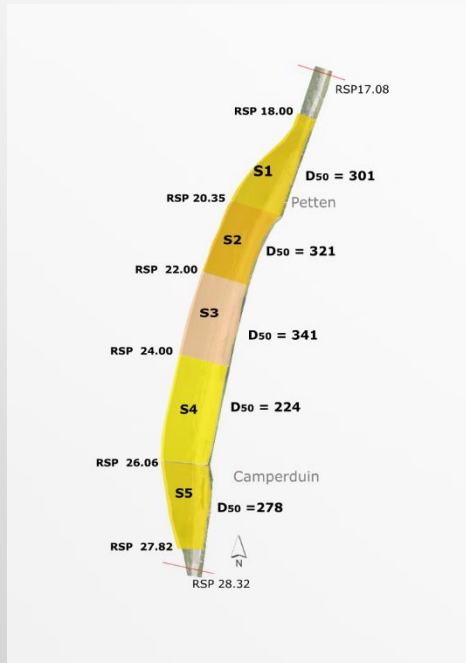
Application of model AeoliS¹ to
Hondsbossche Dunes

¹ Hoonhout, de Vries (2017)

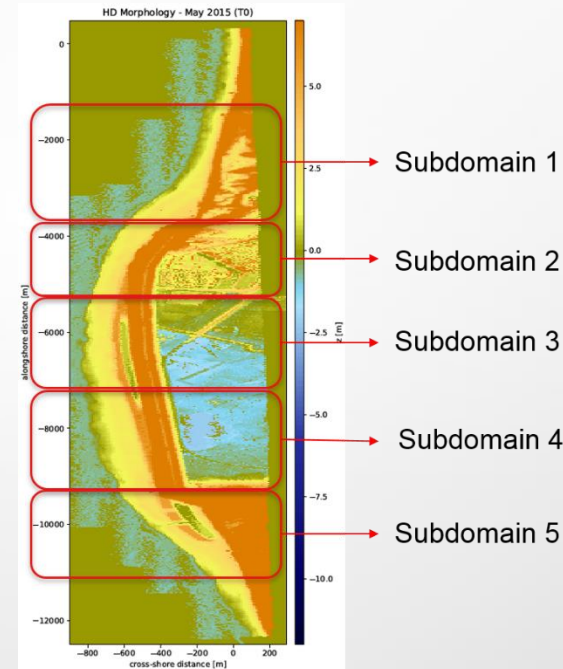
STRENGTH MODEL

Quantification dune growth by taken into account alongshore variation in:

1. Grain size distribution
2. Topography beach

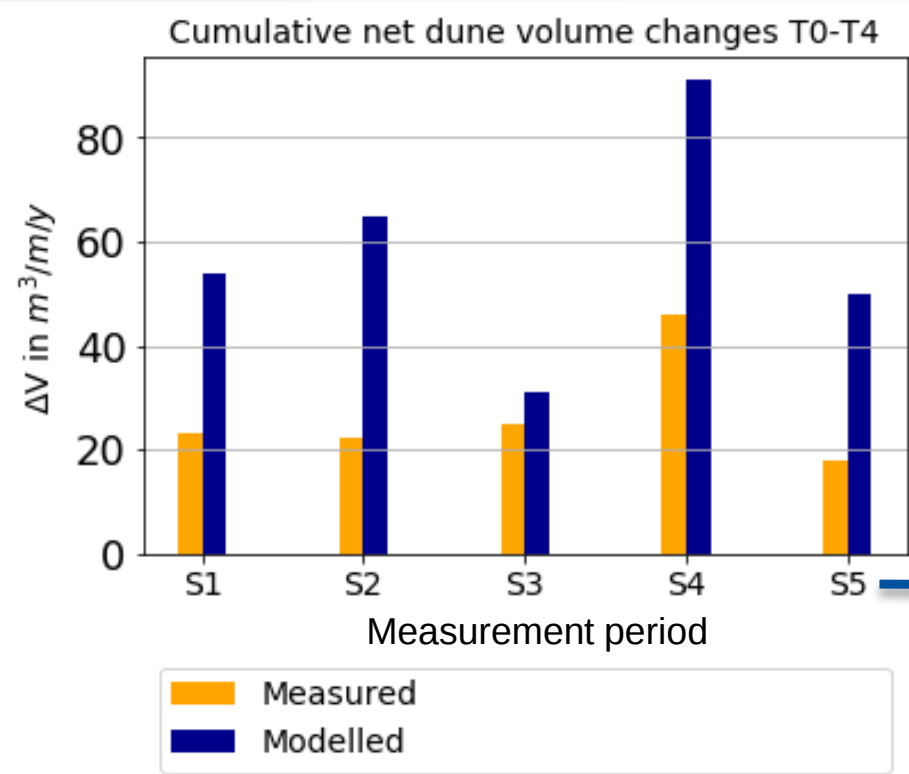


Grain size distribution

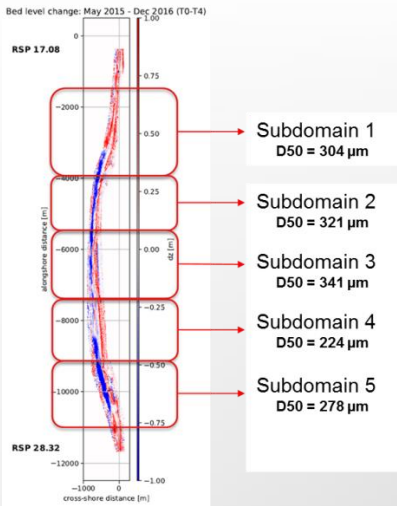


Topography

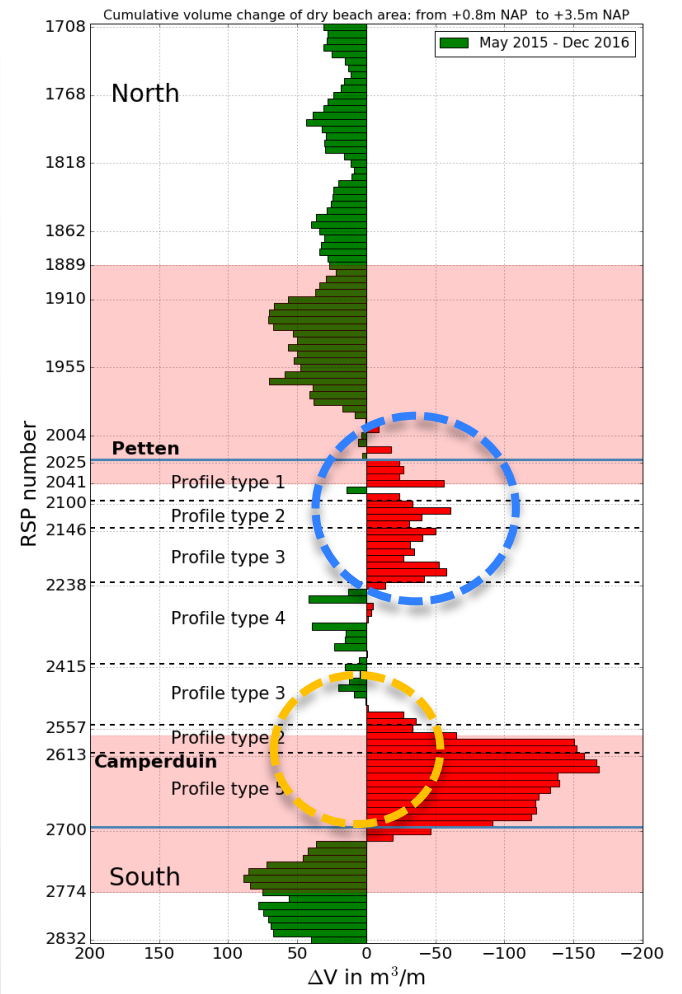
HINDCAST CUMULATIVE DUNE GROWTH



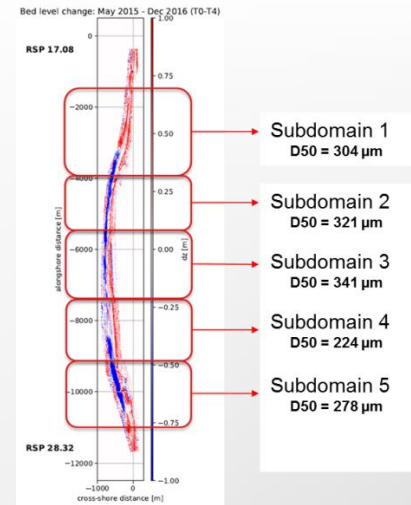
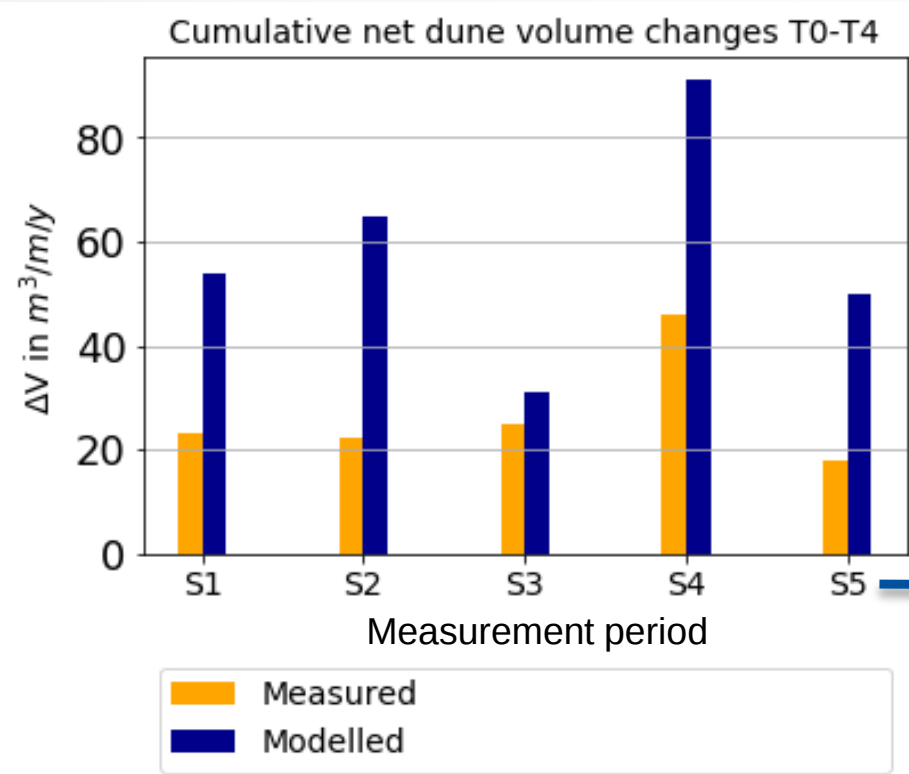
Subdomain	Overestimation by Model
1	2.3
2	3
3	1.2
4	2
5	2.8



DRY BEACH ZONE



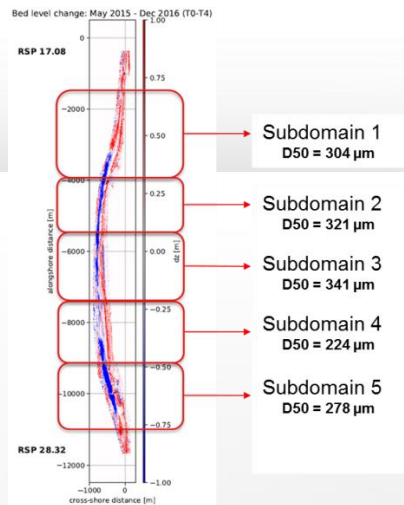
HINDCAST CUMULATIVE DUNE GROWTH



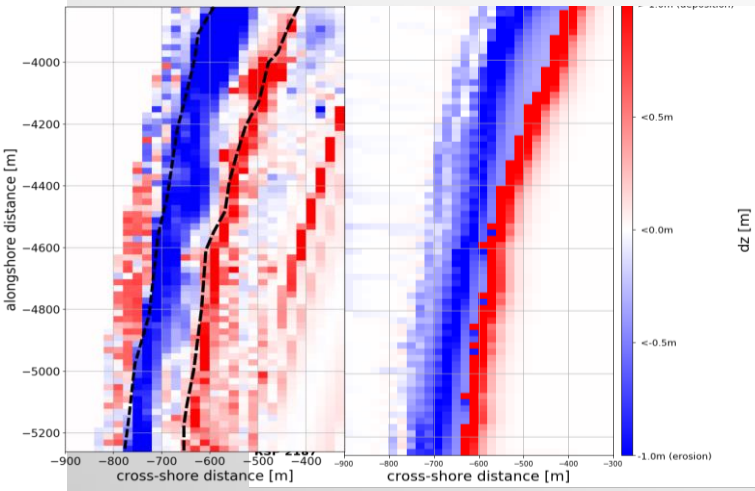
Subdomain	Overestimation by Model
1	2.3
2	3
3	1.2
4	2
5	2.8

MODEL PERFORMANCE

Deposition
Erosion

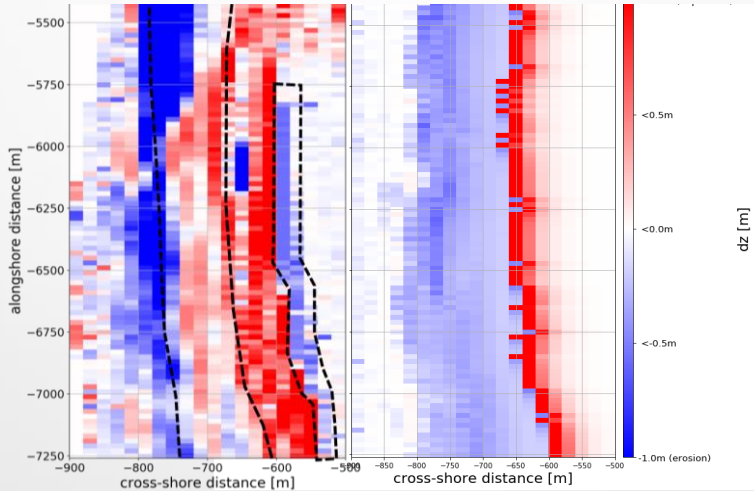


Subdomain 2



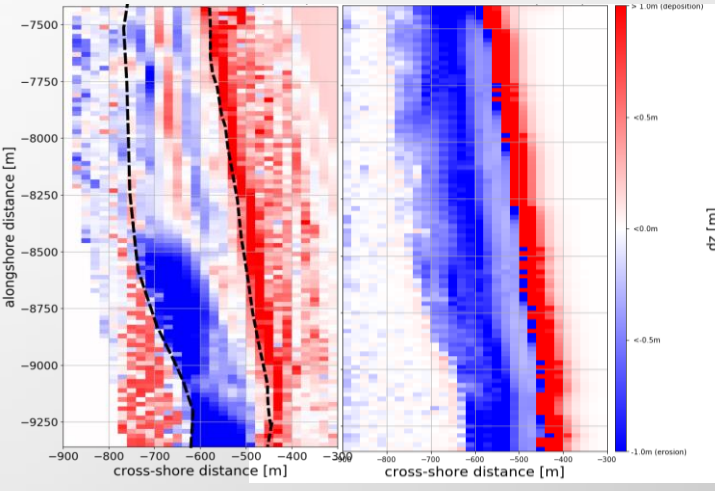
Measurements Model

Subdomain 3



Measurements Model

Subdomain 4



Measurements Model

LESSONS LEARNED

1. **SUCCESSFUL MAN-MADE DUNE DEVELOPMENT!**
2. **DUNE GROWTH IS DETERMINED BY:**
 - b. Temporal and alongshore variability in aeolian sediment supply
 - c. Grain size properties
 - d. Dune geometry
3. **AEOLIAN SEDIMENT TRANSPORT AFFECTS COASTLINE MAINTENANCE**

AEOLIAN SEDIMENT TRANSPORT AT A MAN-MADE DUNE SYSTEM

BUILDING WITH NATURE AT THE HONDSBOSSCHE DUNES

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