ECOBEACH EEN NATUURLIJKE OPLOSSING?

Ministerie van Verkeer en Waterstaat Rijkswaterstaat bam

Ecobeach

Results of the test at Egmond

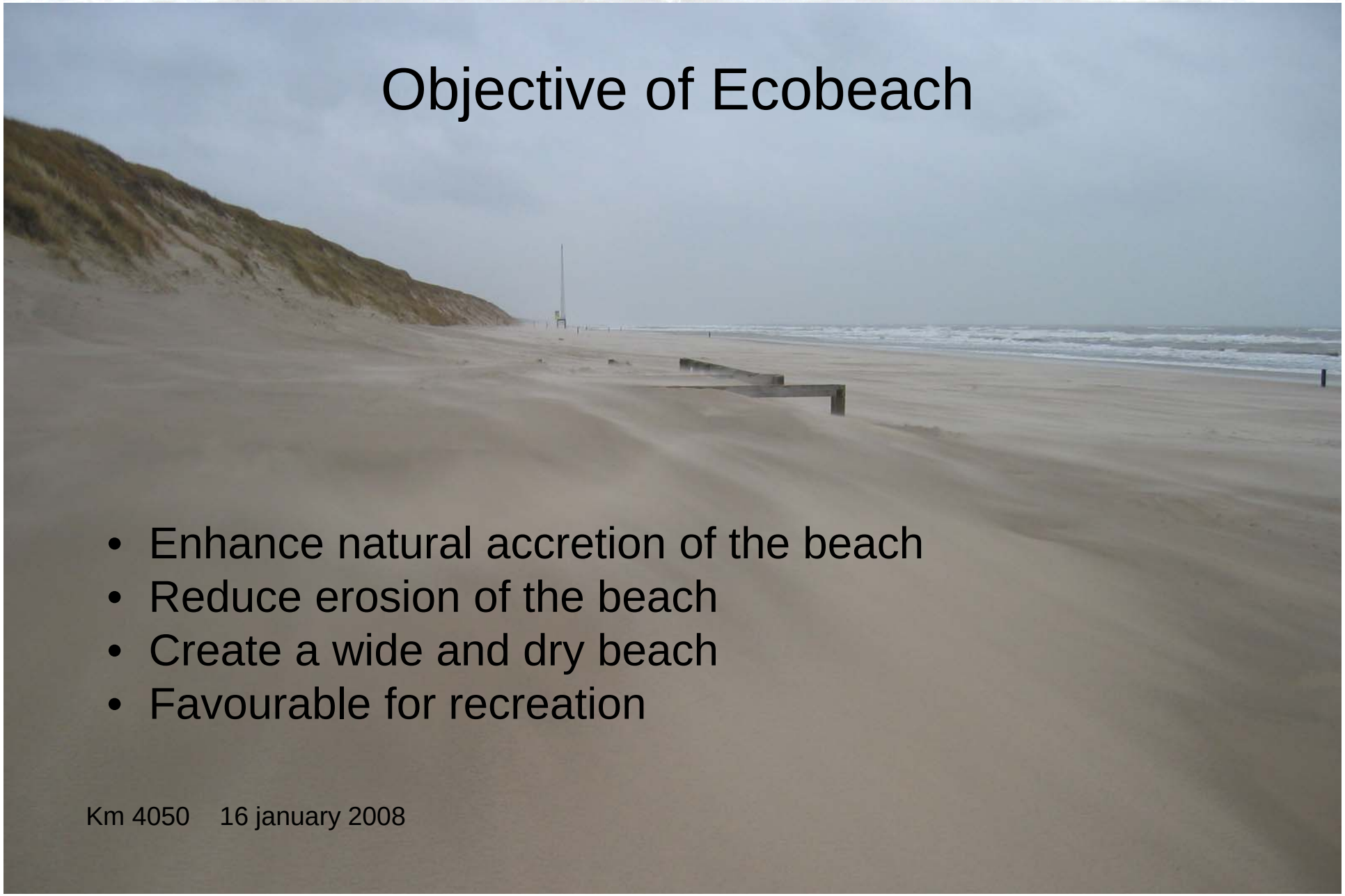
2007 to 2011

What is Ecobeach

- Ecobeach is vertical beach drainage
- Shore perpendicular rows of drainage tubes
- 10 m cross shore distance
- 100 m longshore distance
- Between dune foot and Low Water Level

Ecobeach effect discovered by Poul Jakobsen by accident

Objective of Ecobeach

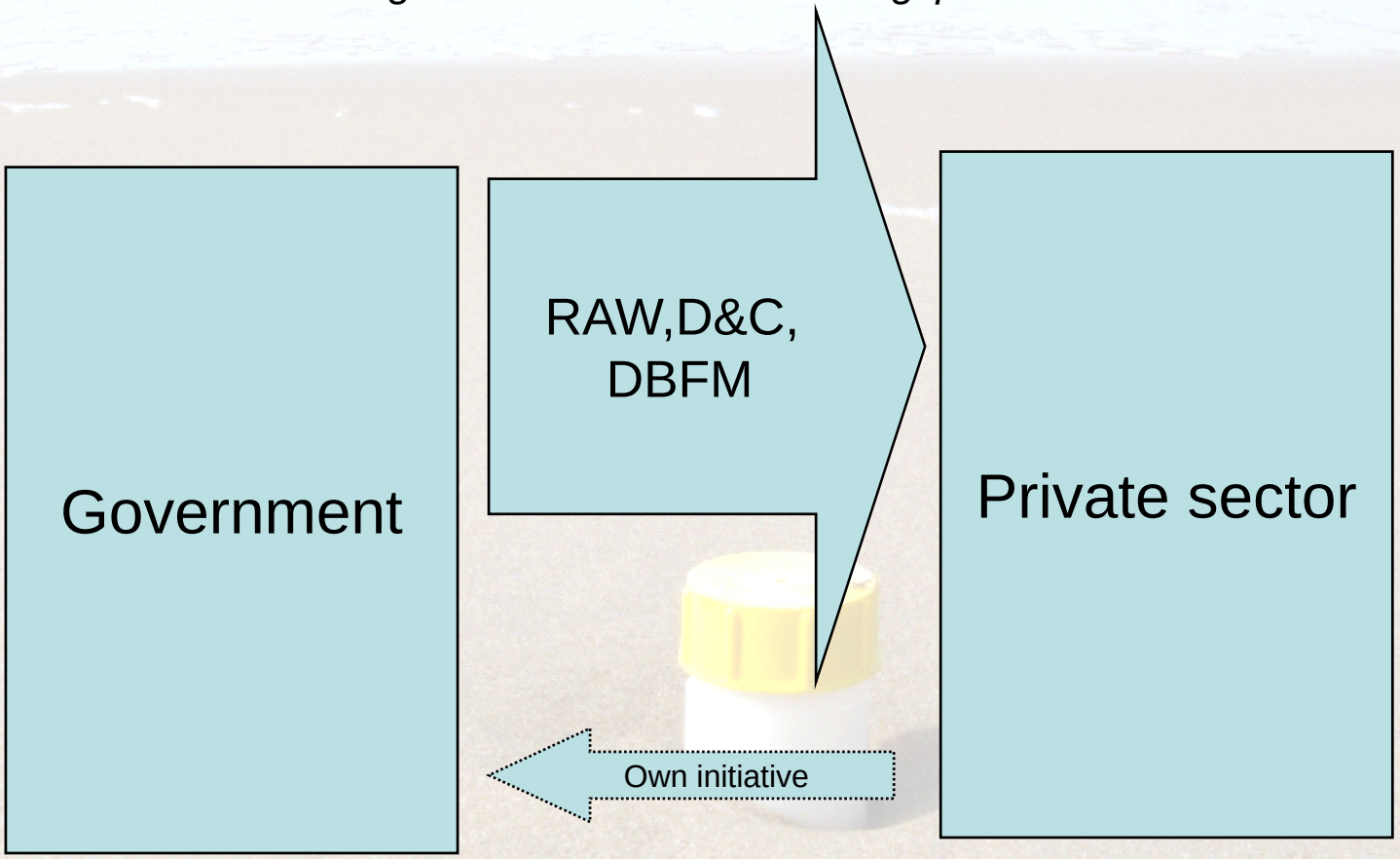


- Enhance natural accretion of the beach
- Reduce erosion of the beach
- Create a wide and dry beach
- Favourable for recreation

Km 4050 16 january 2008

Own initiative by Private Sector

Eigen initiatief in aanbestedingsproces



BAM triggered by Danish projects

Before installation of Ecobeach

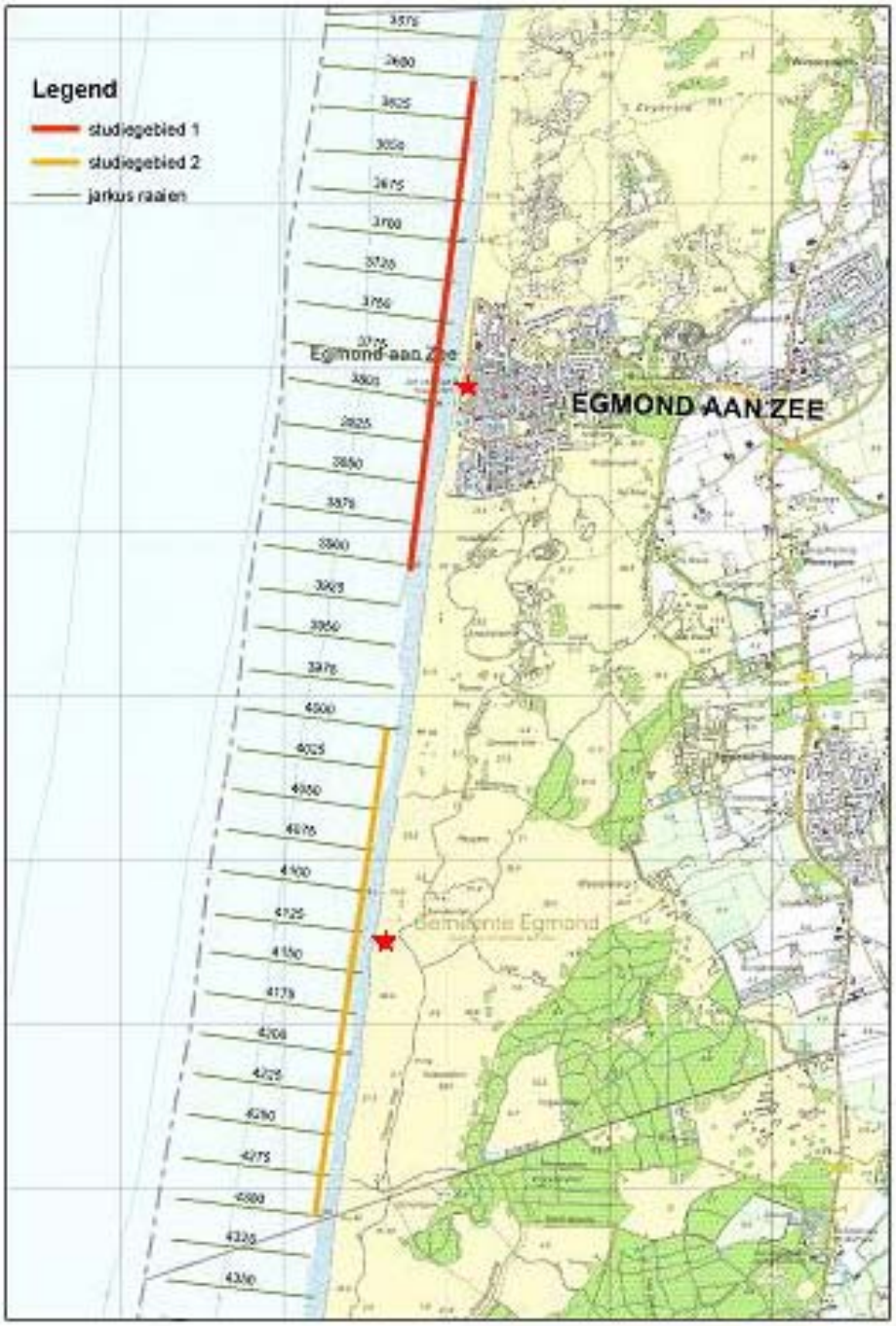
Ecobeach installed

Ecobeach removed

Research Strategy

- Field Experiment (statistical analysis)
- Research on working mechanisms
  Interdisciplinary approach

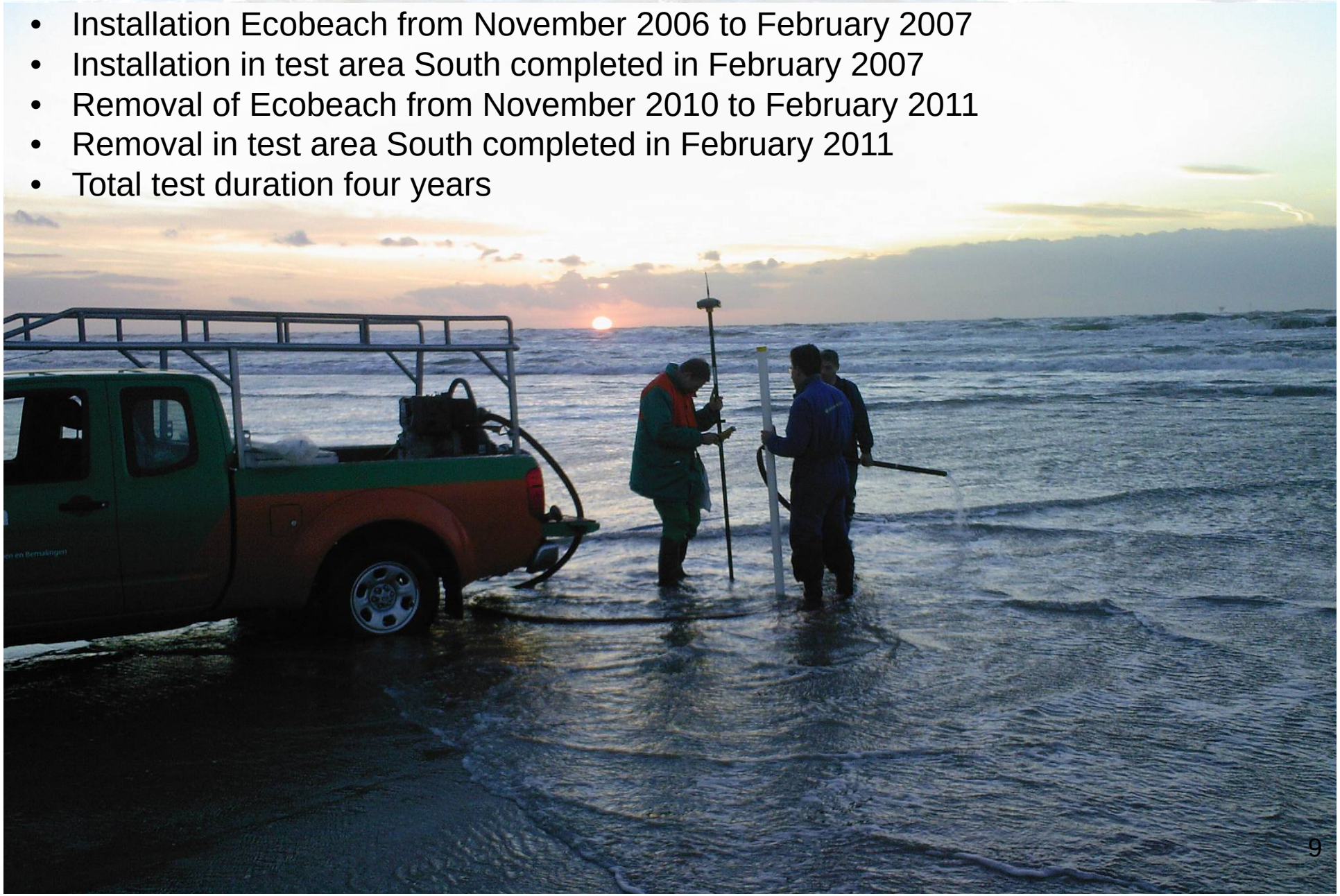
  Possible working mechanisms on the interface of morphology, geology/geotechnical and geo-hydrology
- Evaluation Own Initiative



Test locations Egmond

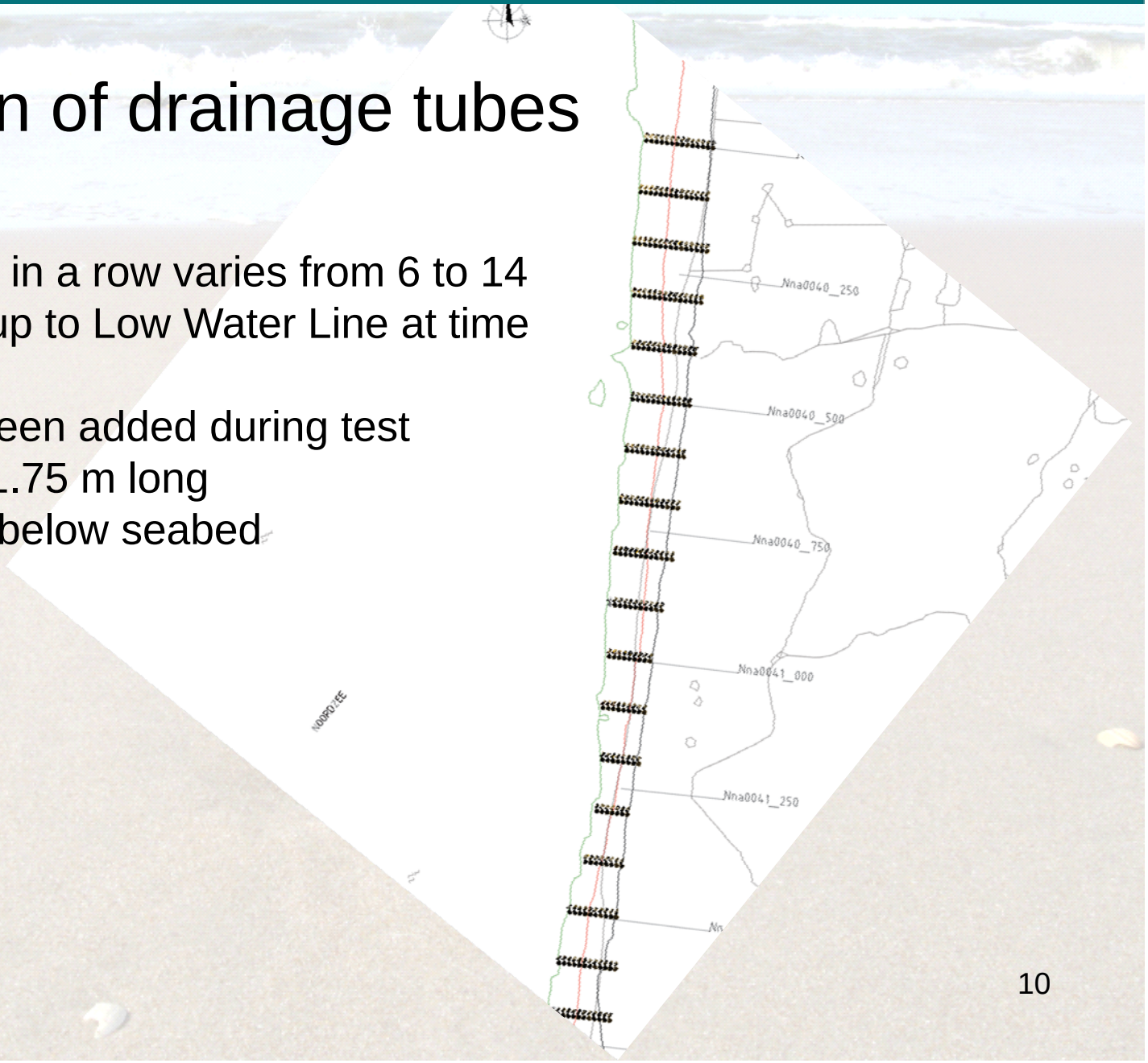
- Two test locations
- Each 3 km long
- Northern site heavily nourished
- Southern site relatively undisturbed
- 1 km in between without Ecobeach
- Argus observation of both areas

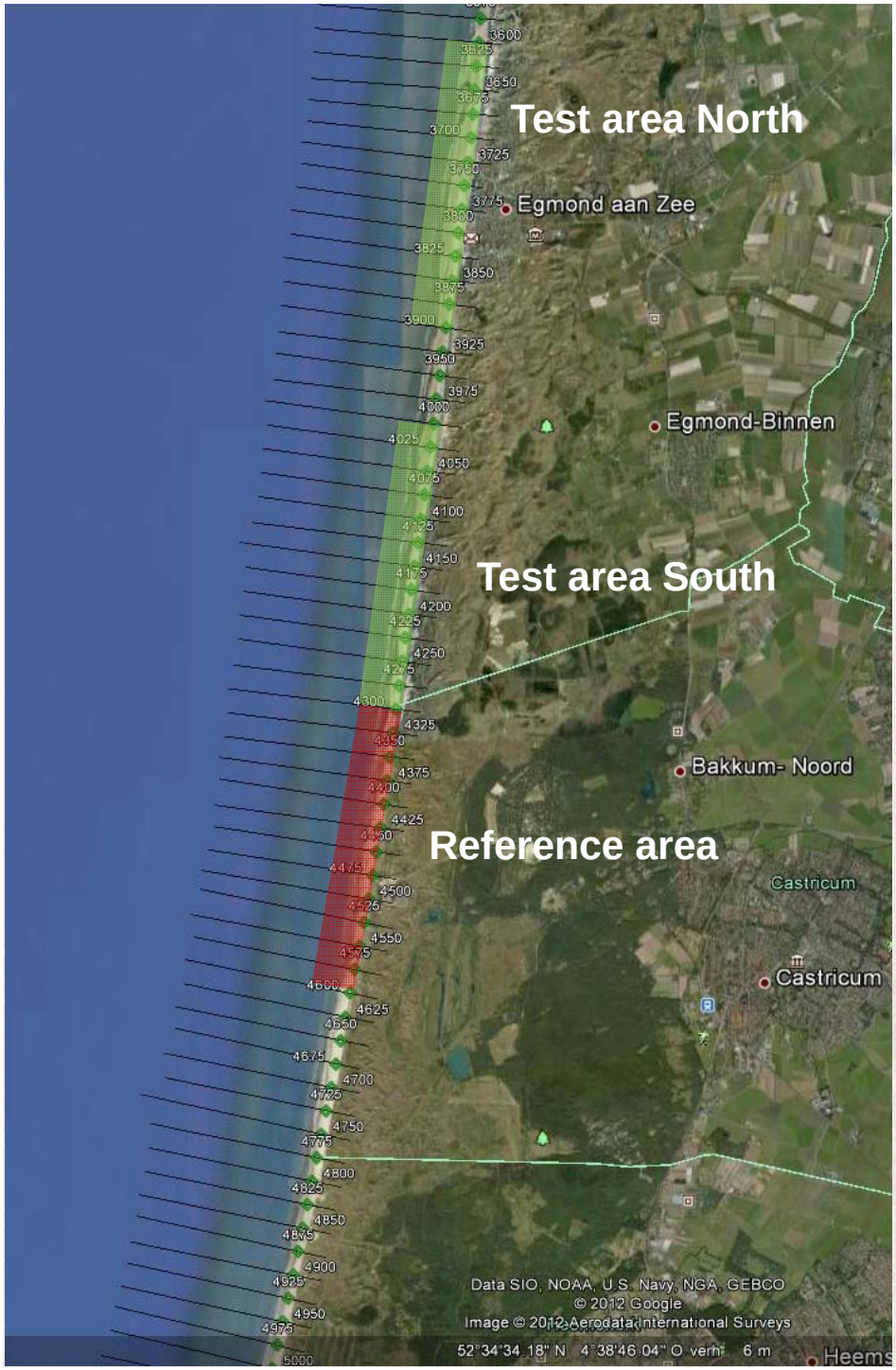
- Installation Ecobeach from November 2006 to February 2007
- Installation in test area South completed in February 2007
- Removal of Ecobeach from November 2010 to February 2011
- Removal in test area South completed in February 2011
- Total test duration four years



Configuration of drainage tubes

- Number of tubes in a row varies from 6 to 14
- Drainage tubes up to Low Water Line at time of installation
- No tubes have been added during test
- Drainage tubes 1.75 m long
- Installed 0.25 m below seabed

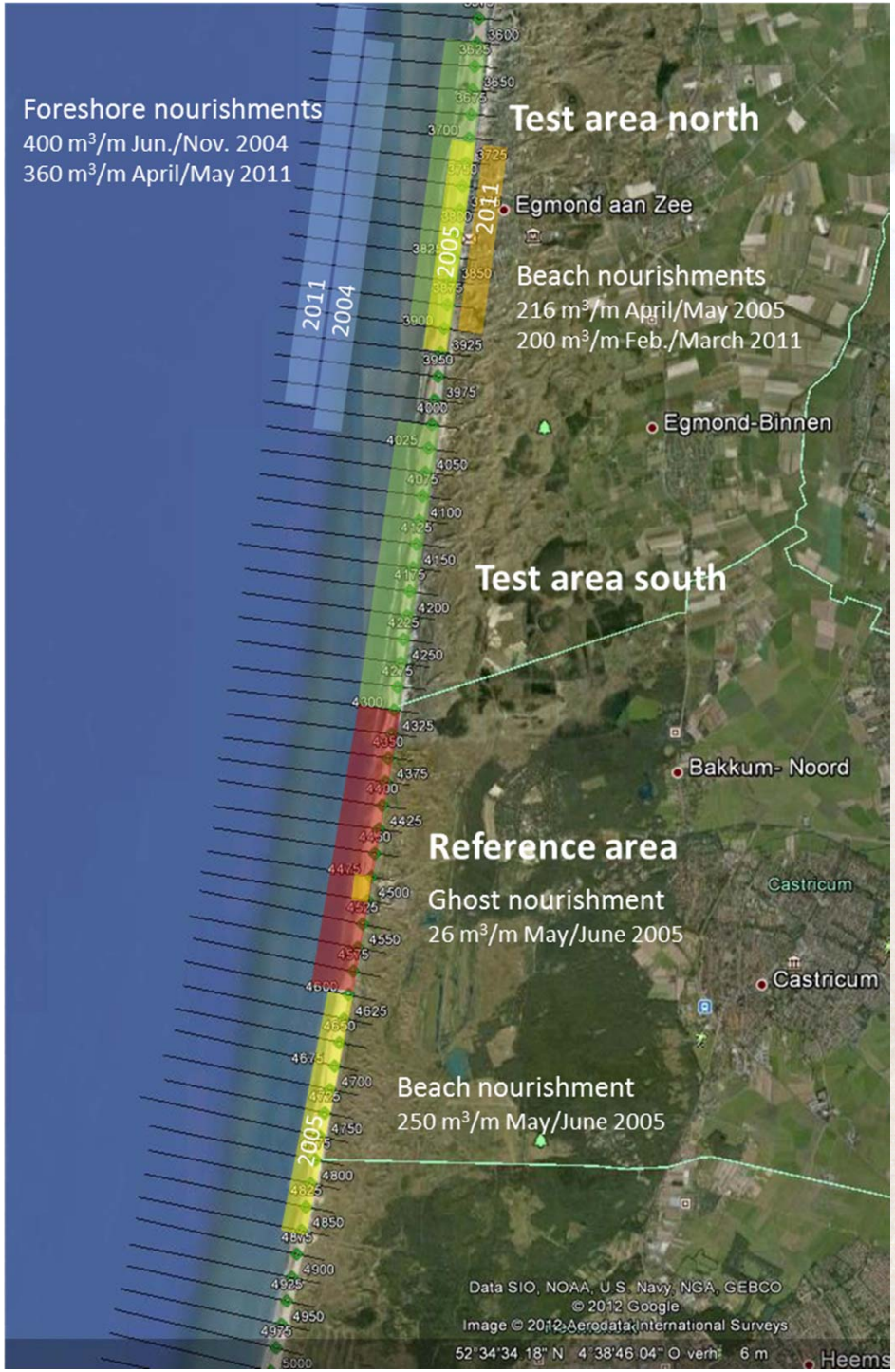




Location of reference area

The location of a reference area was defined in 2006 on the basis that this area was not disturbed by nourishments

It was also considered that the reference area would not be disturbed by the test area because of a net northward longshore transport

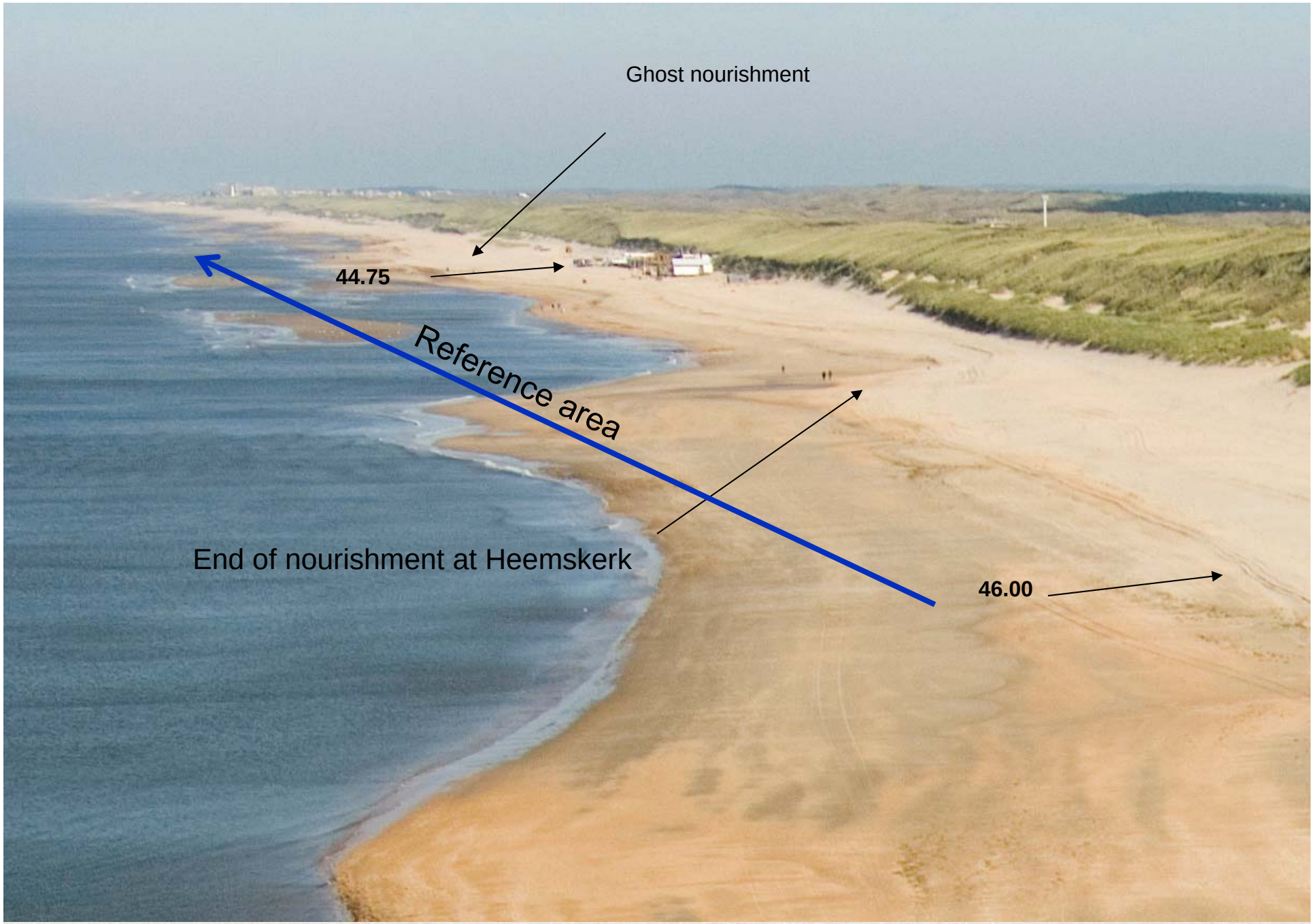


Overview of nourishments

Test area North is a heavily nourished area

In 2010 it became apparent that a beach nourishment was carried out next to and in the reference area in May/June 2005

18 October 2005, northern end of nourishment at Heemskerk



18 October 2005, detail of northern end of nourishment at Heemskerk

Experimental approach

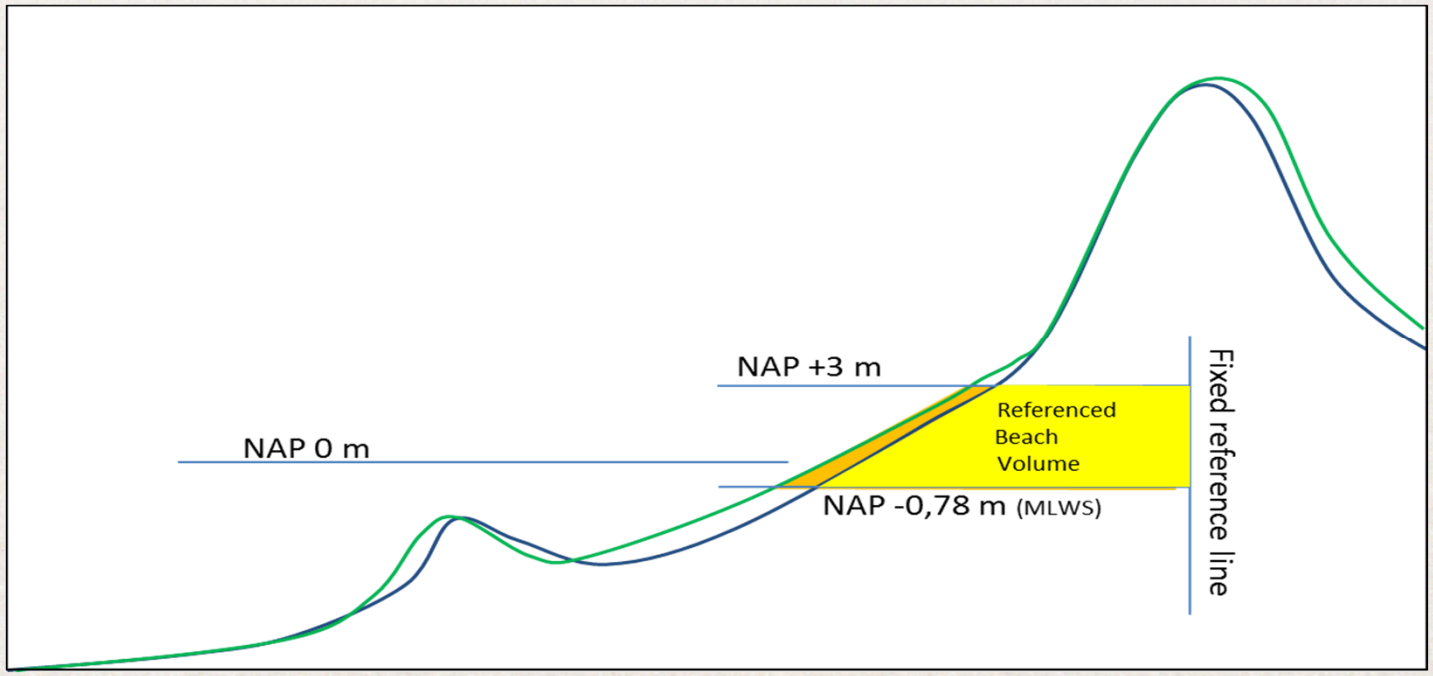
Coastal State Indicators

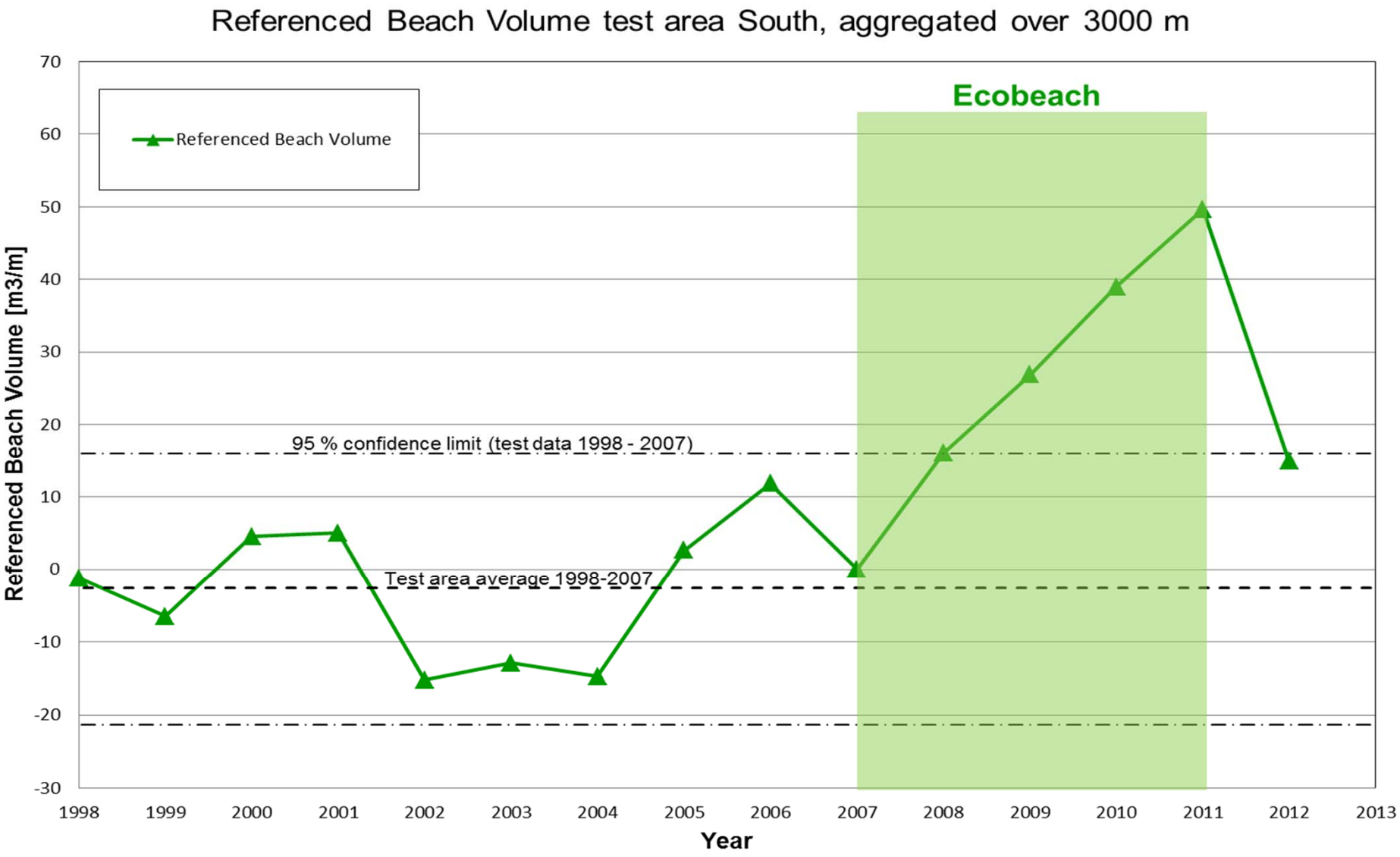
- Referenced Beach Volume +3 to -0.78 m
- Dune Volume +3 to top of dune
- MCL volume, +3 to -4.56 m
- Foreshore Volume -4.56 to -8 m
- **Focus on Referenced Beach Volume**

- JARKUS transects every 250 m
- Using aggregated values over the length of the areas to average variability of individual transects
- Aggregated over 13 or 11 transects (3000 or 2750 m)
- JARKUS data from 1965 to 2012 (nourishments since 1990)

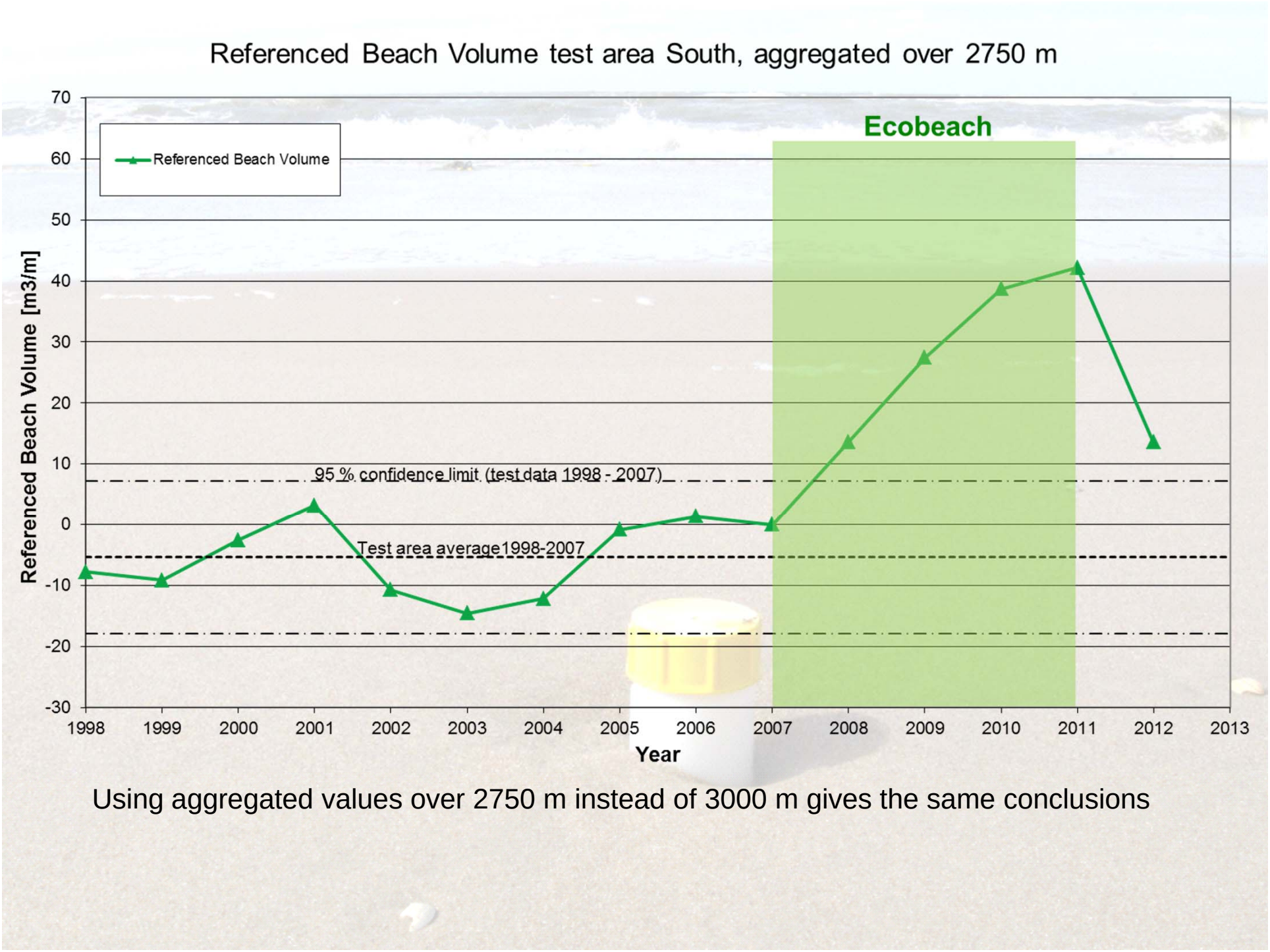
- Determine behaviour of CSI's on the basis of 40 years before the test
- Determine trends and confidence limits
- Check whether CSI data points during test are within or outside band width

Definition of Referenced Beach Volume

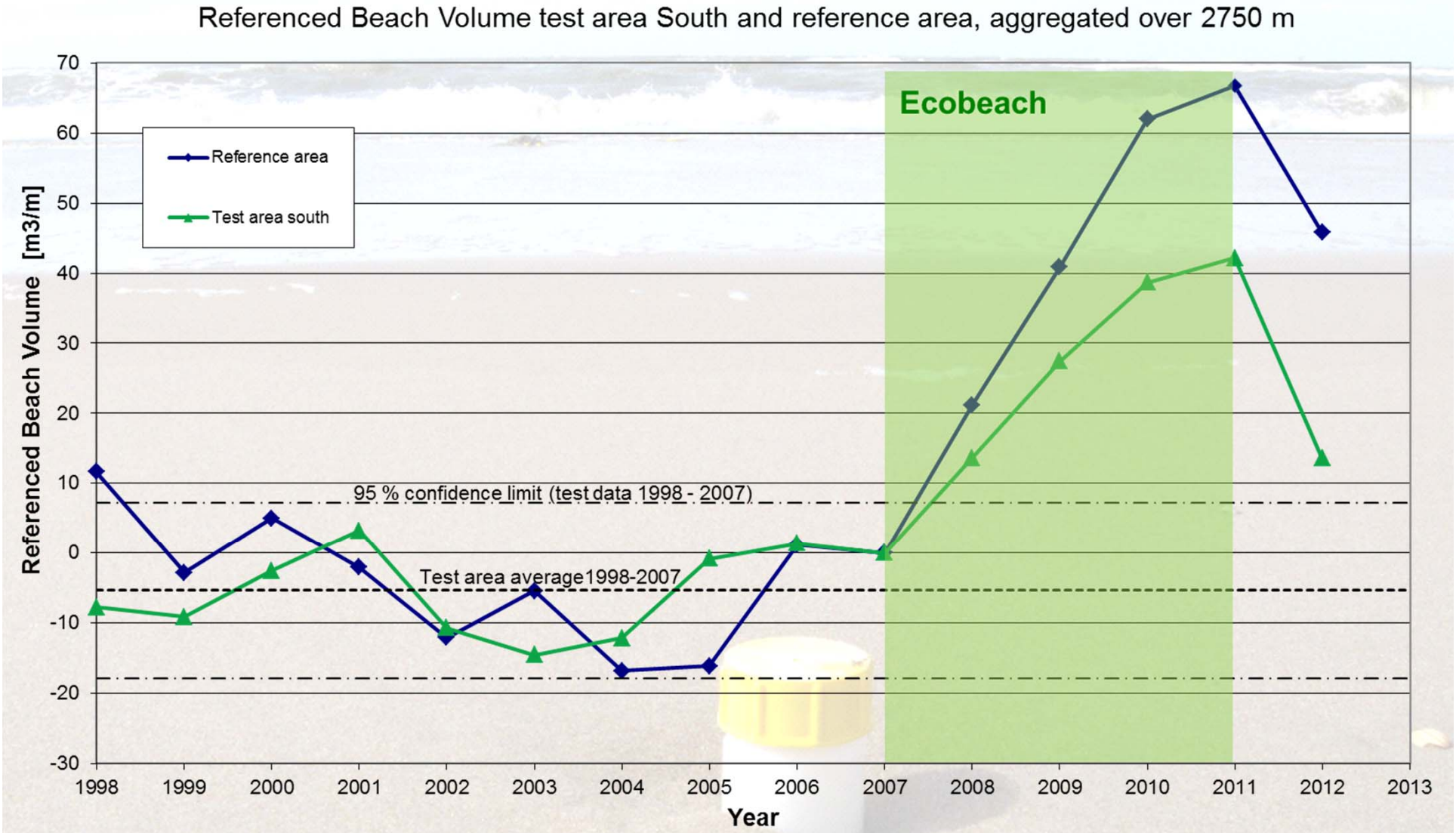




The Referenced Beach Volume in test area South has reached the highest value since 1965 during the test period. Growth in beach volume is significant compared to the natural variability (JARKUS data since 1998 is Lidar data, except for 2002)



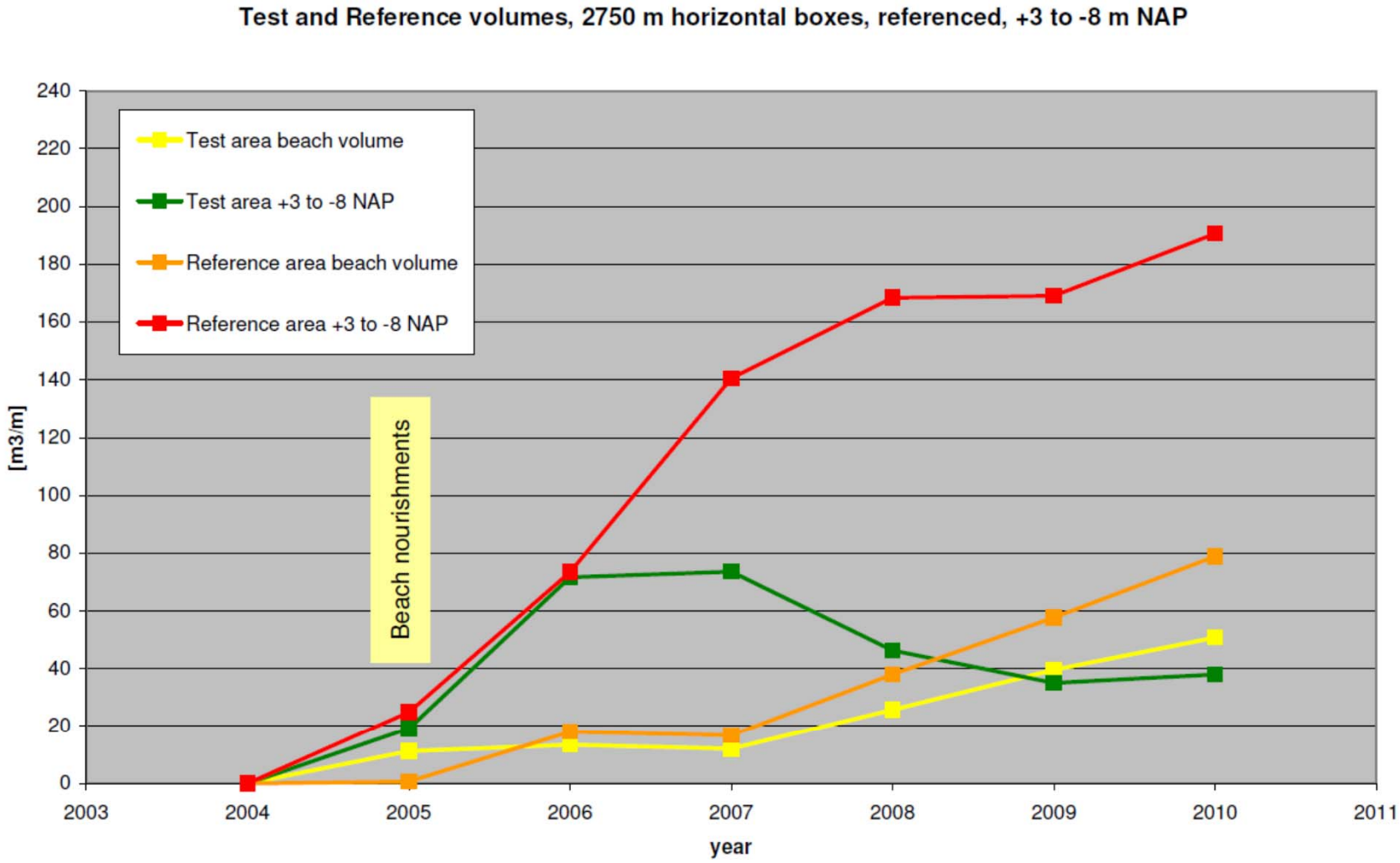
Using aggregated values over 2750 m instead of 3000 m gives the same conclusions



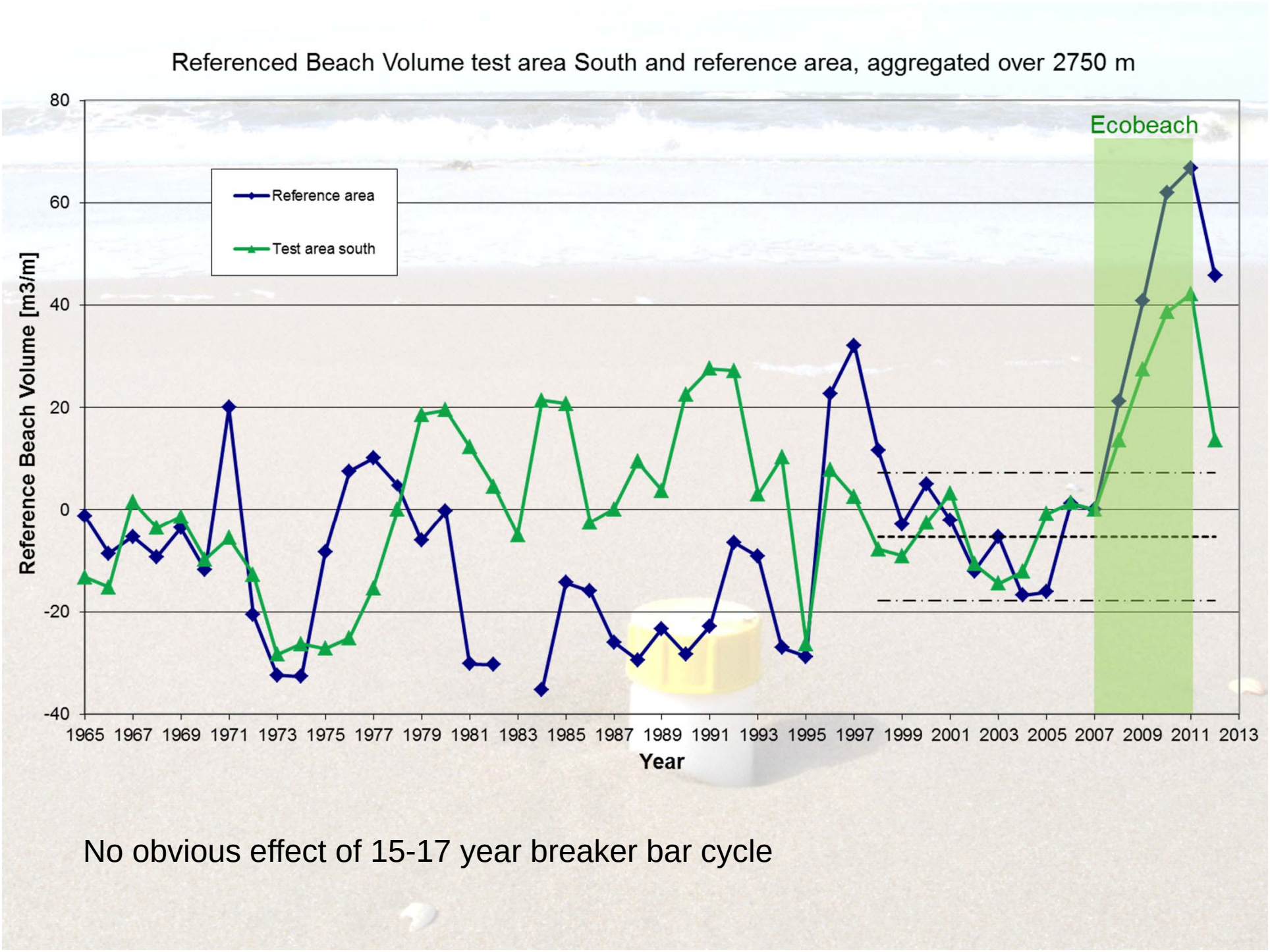
The Referenced Beach Volume in both test area South, and the reference area south of this test area, has grown significantly since the installation of the Ecobeach system

In both areas, the growth in beach volume is significant compared to the natural variability

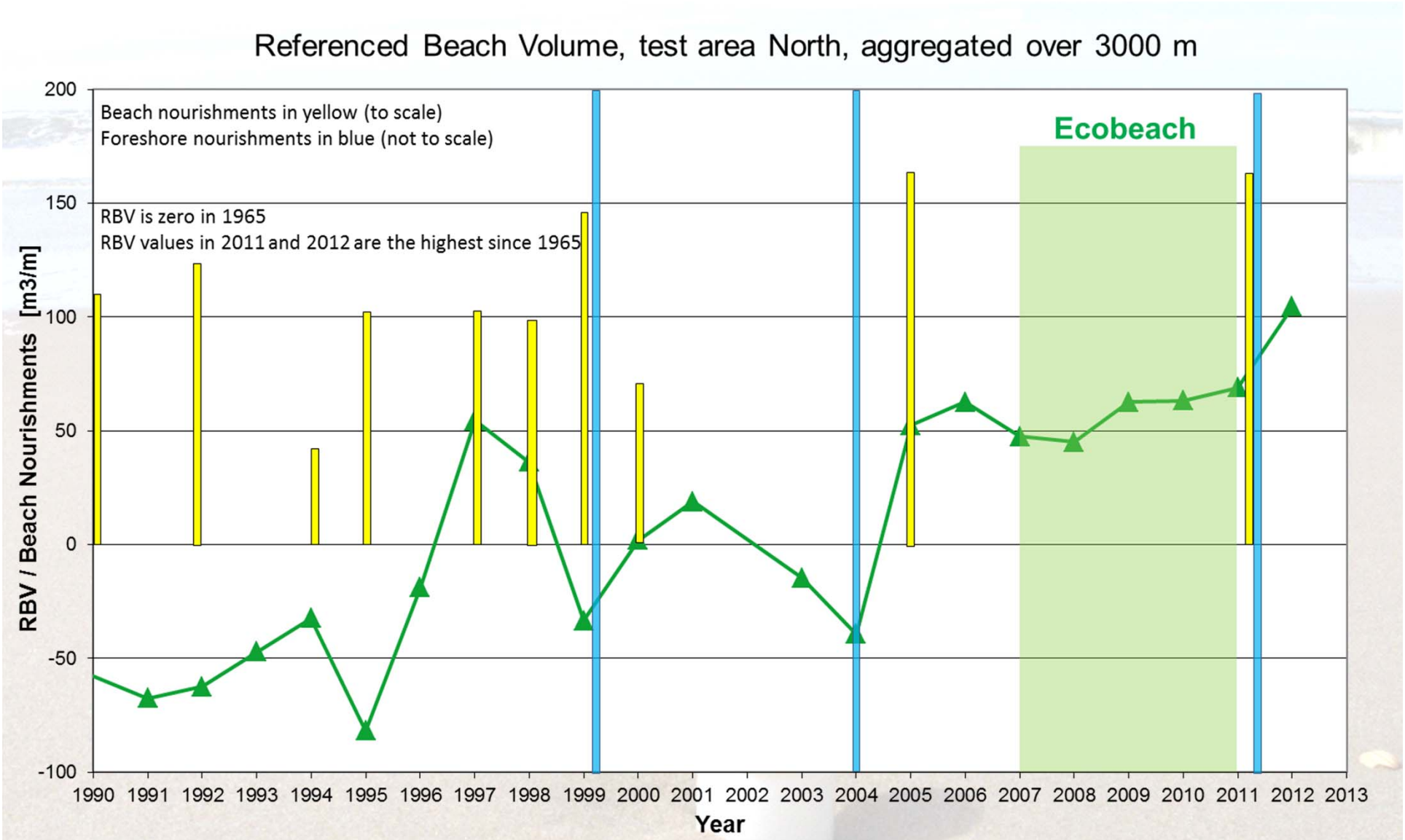
Different behaviour Test and Reference area after 2006



Deltares data, 28 April 2011, Volumes between -8 NAP and dune foot



No obvious effect of 15-17 year breaker bar cycle



The Referenced Beach Volume in the test area North has reached the highest value since 1965 at the end of the test period, 6 years after the last beach nourishment.

Overview scientific research by students

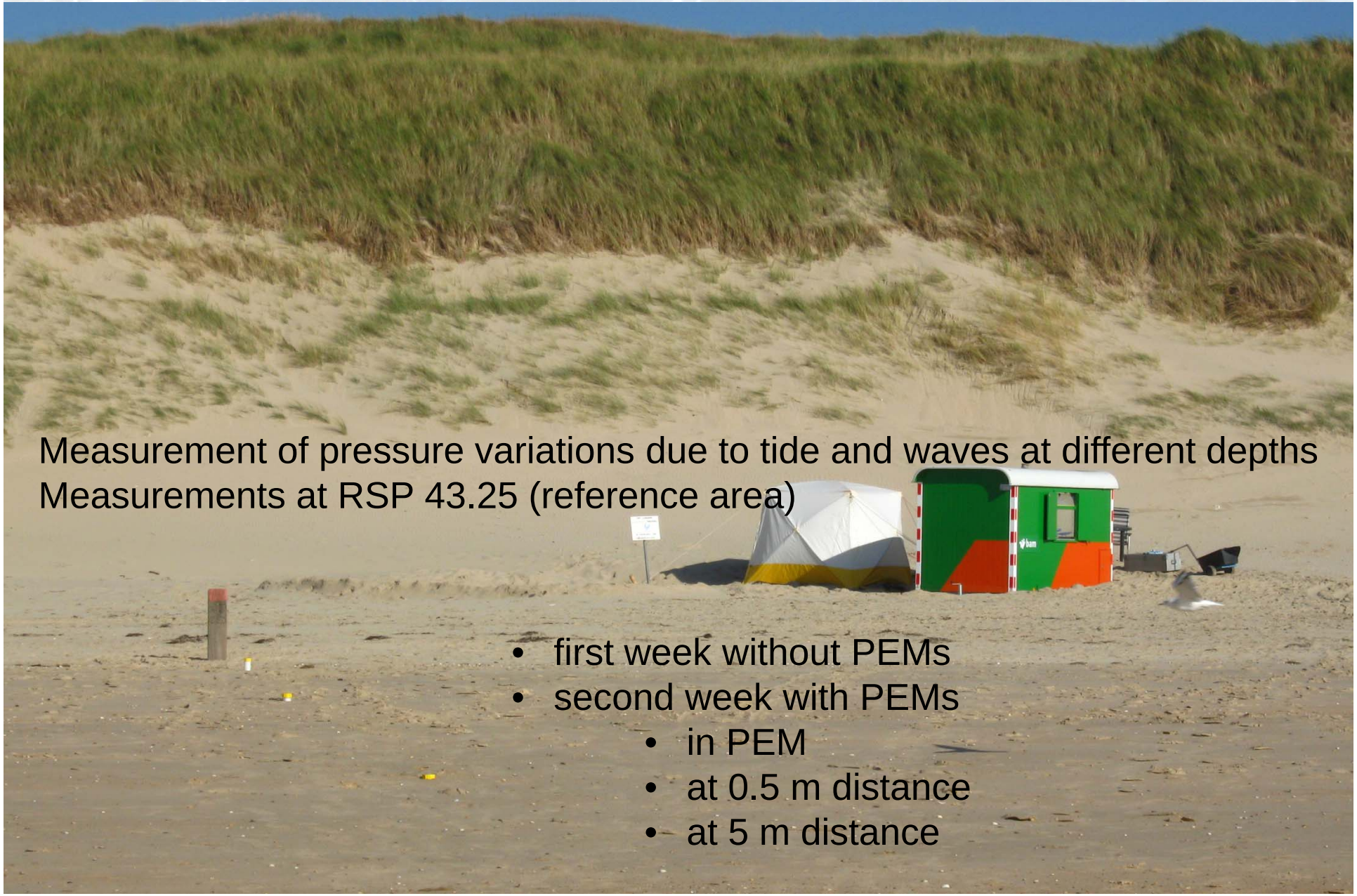
October 2008 – February 2009 (Jelle-Jan Pieterse)
- Initial Ecobeach Research

January 2009 – September 2009 (Pieter Pauw)
- Global groundwater system

April 2009 – October 2009 (Jelle-Jan Pieterse)
- Literature research Egmond area
- Local groundwater system
- Local and global sediment properties

November 2009 – February 2011 (Hugo Ekkelenkamp)
- Literature research sediment
- Global sediment properties

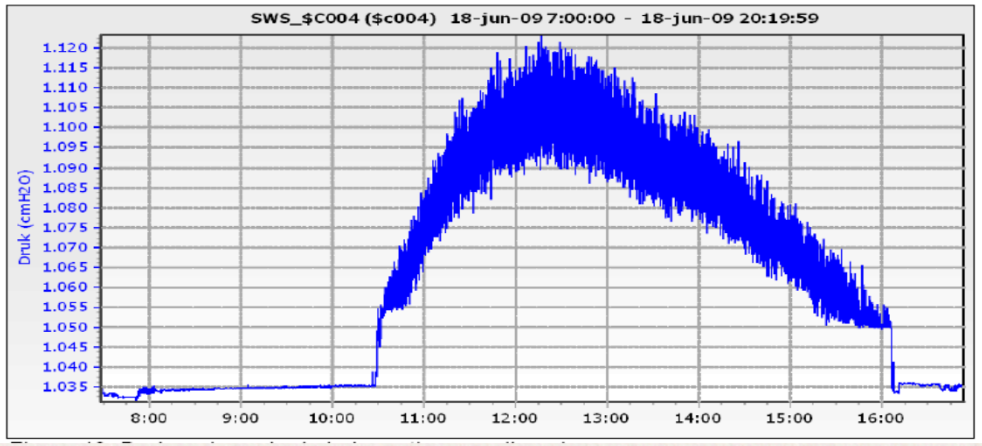
Local groundwater measurements



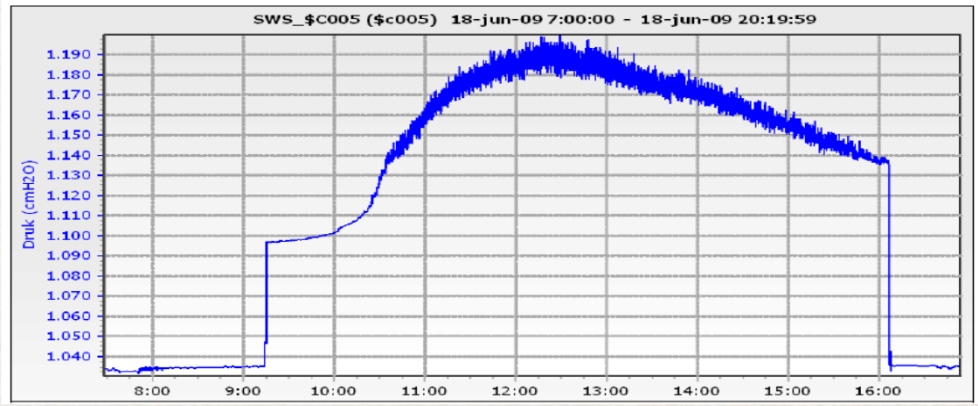
Measurement of pressure variations due to tide and waves at different depths
Measurements at RSP 43.25 (reference area)

- first week without PEMs
- second week with PEMs
  - in PEM
  - at 0.5 m distance
  - at 5 m distance

Groundwater pressure measurements



0.2 m depth

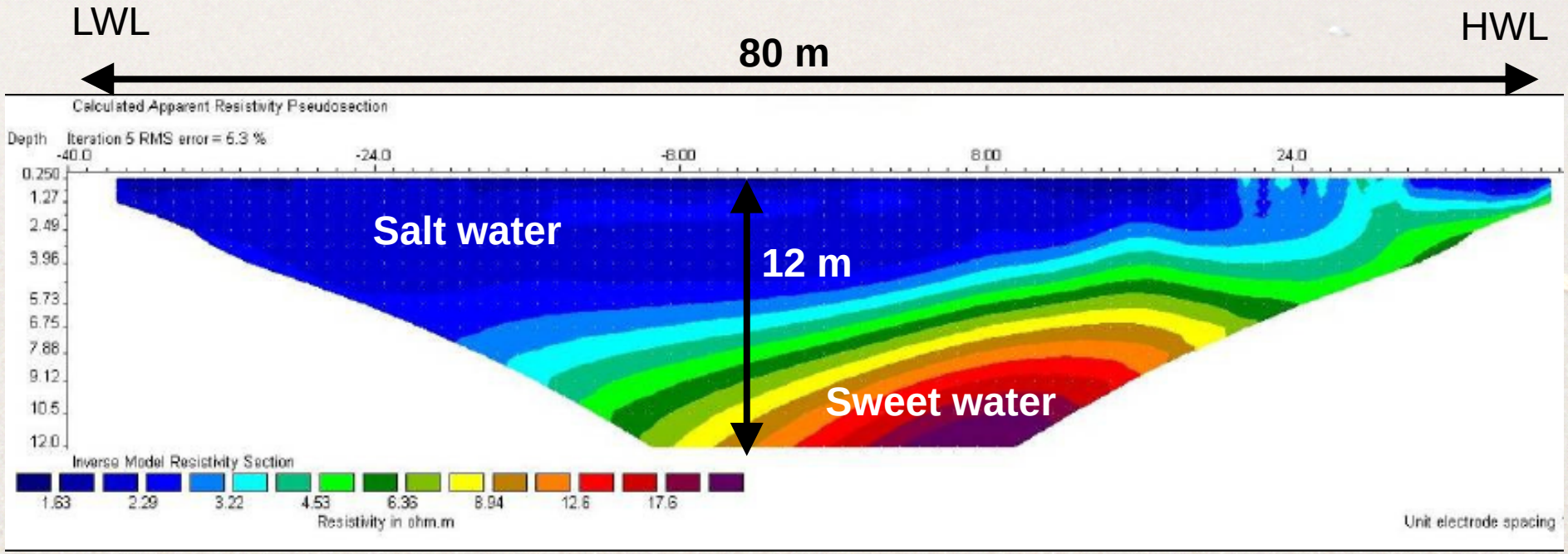


1.0 m depth

Pressure variations due to tide and waves, effect of waves still measurable at 1 m depth

Groundwater resistivity measurements

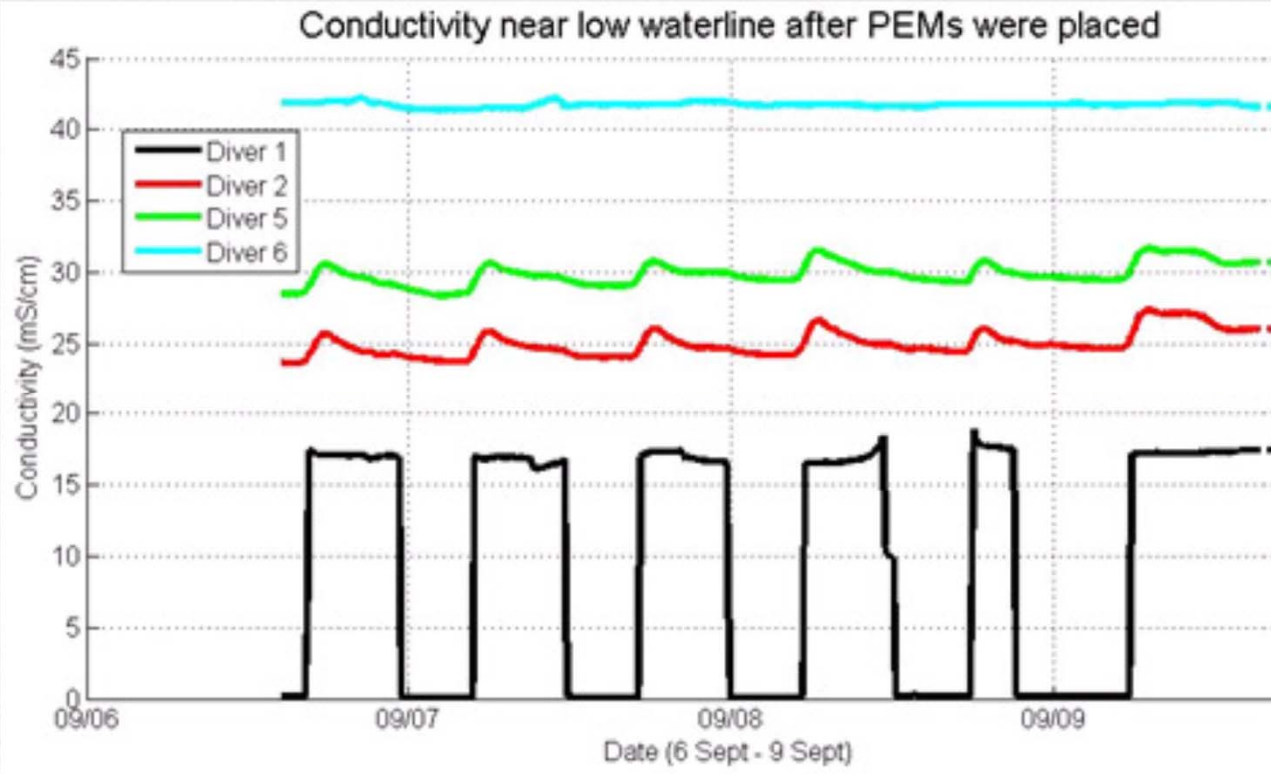
Fresh water at 5 to 10 m below the beach surface



Conductivity near drainage tubes

Effect of drainage tubes measured near Low Water Line
More fresh water found near drainage tubes

Distance to tube:
Diver 1 = 0.0 m
Diver 2 = 0.5 m
Diver 5 = 0.5 m
Diver 6 = 5.0 m



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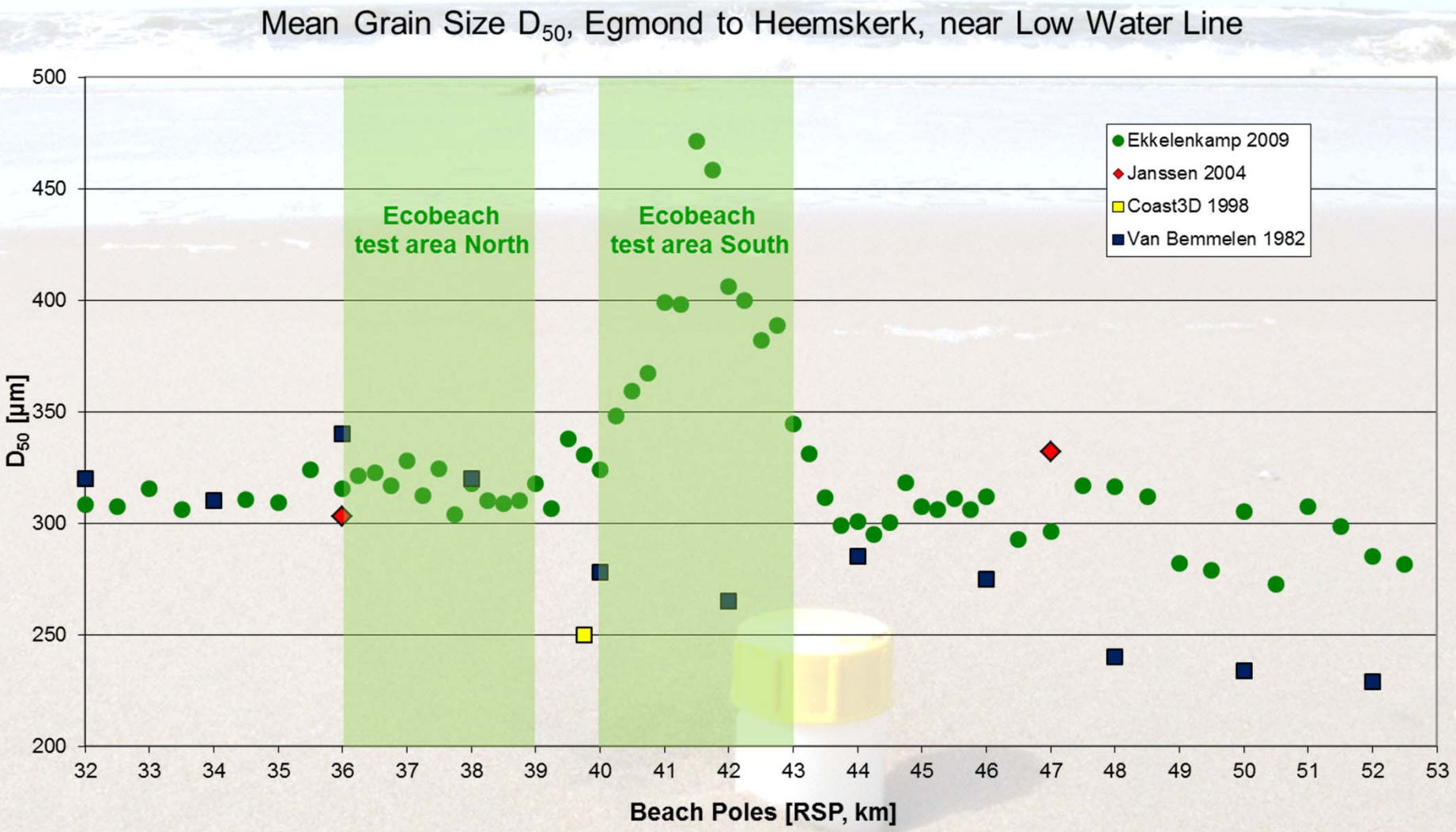
Stormy conditions during research

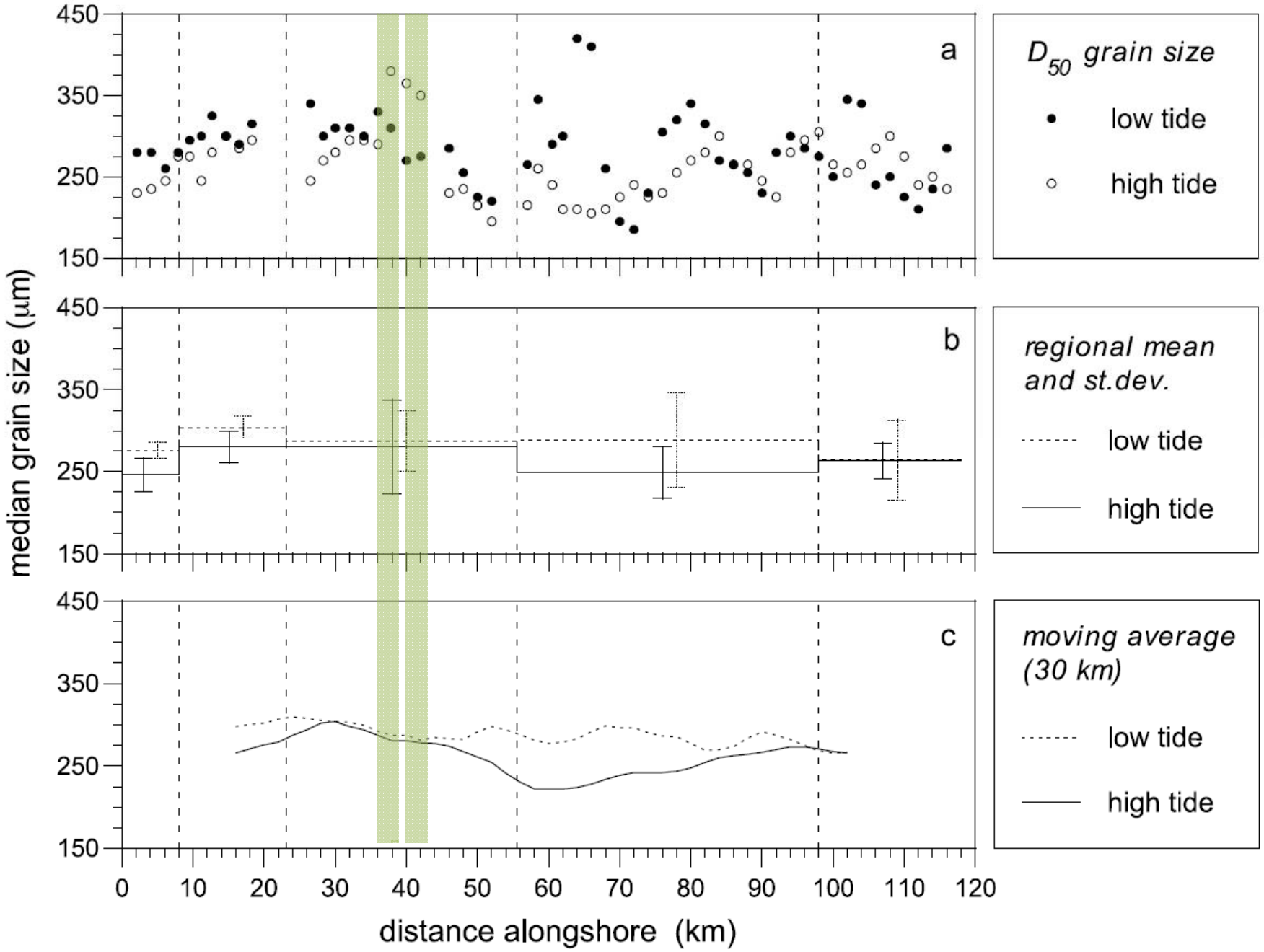
Results of geotechnical survey

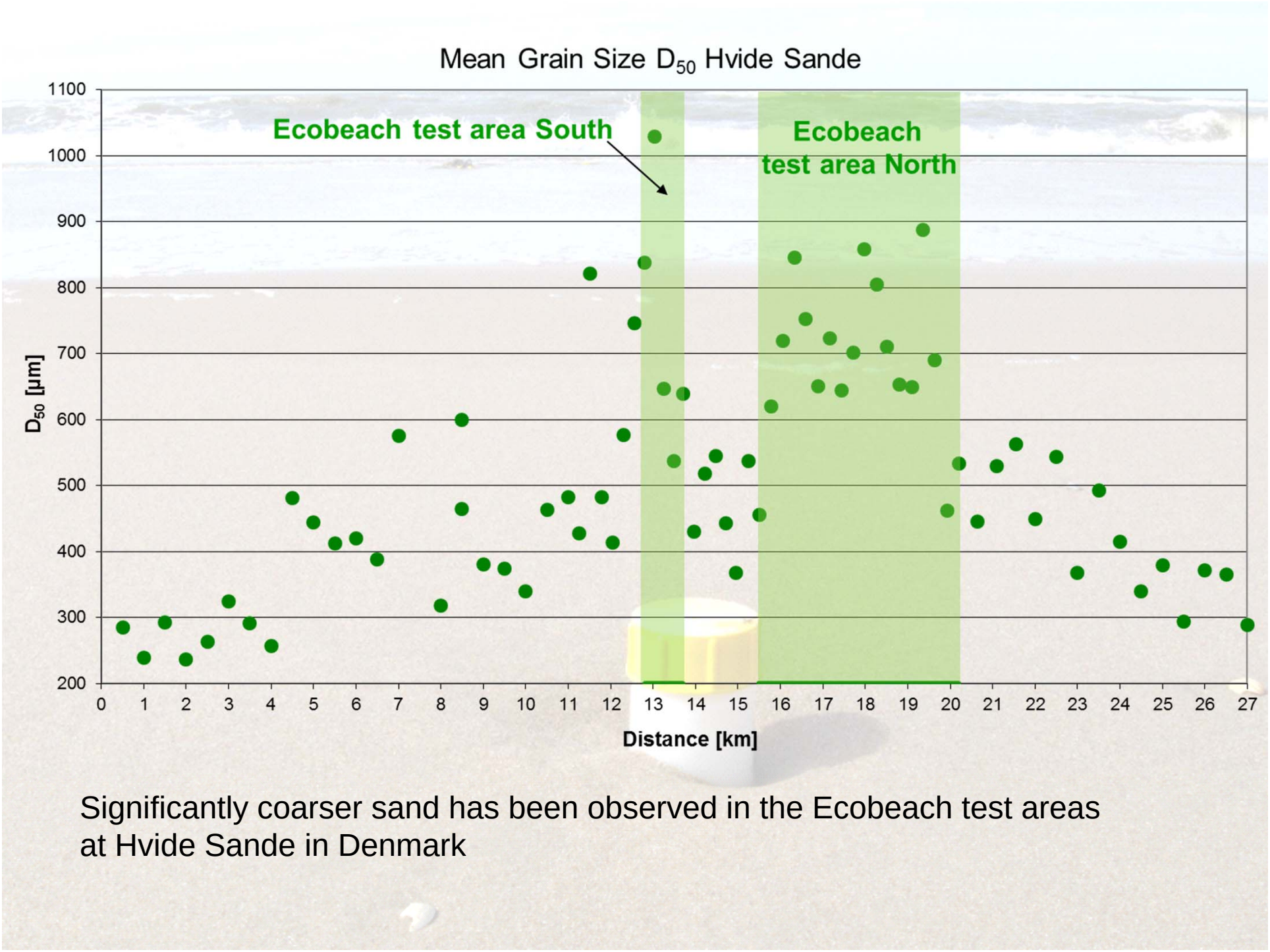
- Coarser sand in southern test area
- Coarser sand only in upper 2 m of beach
- Upper 2 m in southern test area has higher cpt values (cone resistance)

- Coarser sand in test areas at Hvide Sande



Significantly coarser sand has been observed in the upper 2 m of the beach of test area South
The coarser sand has not been found on the beach in previous surveys.
The beach of test area North has been nourished 9 times before the start of the test.


a
b
c
median grain size (μm)
distance alongshore (km)
D_{50} grain size
low tide
high tide
regional mean and st.dev.
low tide
high tide
moving average (30 km)
low tide
high tide



Significantly coarser sand has been observed in the Ecobeach test areas at Hvide Sande in Denmark

What do we see in the field?

Km 4050 6 november 2007 (before storm)

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Km 4050 13 november 2007 (after storm, highest waves ever measured at IJmuiden)

Km 4050 16 january 2008, 2 months after storm

Conclusions

At the end of the Ecobeach test period, both in test area South and North the highest Referenced Beach Volume since 1965 was observed

The growth in beach volume during the test is significant compared to the natural variability before the test. After removal of the Ecobeach system, the RBV in the southern test area has dropped significantly

There is interaction between the nourishment at Heemskerk, the reference area and test area south

Coarser sand has been observed in the upper 2 m of the beach of test area South and in the test areas at Hvide Sande. The coarser sand may be the result of an increase in wind driven transport of fine sand to the dunes because of a dryer beach. Test area North has been nourished extensively in the past which may explain that no significantly coarser sand has been found in this area

The drainage tubes may act as a trigger, leading to coarsening of the beach sand

Conclusions

Outflow of fresh water has been observed in a drainage tube placed near the Low Water Line

The results of the Ecobeach test at Egmond are very promising