

# **Passive Dewatering**

## **A soft way to extend the life of beach nourishments**

**FSBPA Technical Conference  
for PDF print**

**February 6, 2015**

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# Presentation

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**Groundwater and erosion**

**Passive dewatering/PEM**

**International projects**

**Hillsboro Beach, Florida**

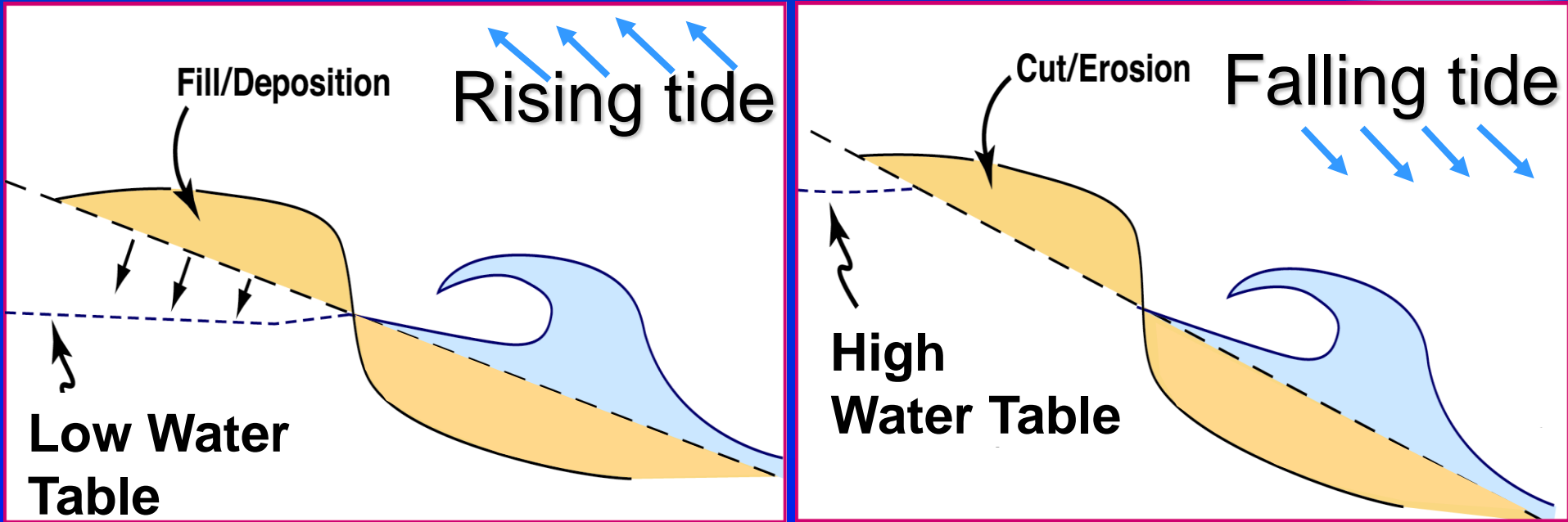
**Site evaluation - Pilot Study**

**Pros and Cons**

## **Introduction**

- **First PEM installation 1997**
- **US patent in 2003**
- **More than 30 projects**
  - **Europe, Asia, Africa**
  - **USA Feb. 2008**

# Groundwater and Erosion



**Dry Beach = Accretion**

**Wet Beach = Erosion**

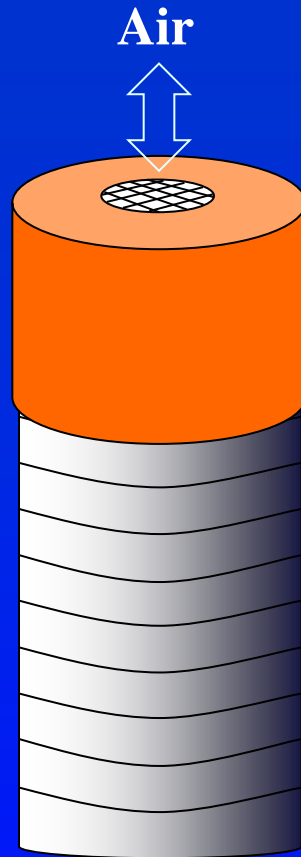
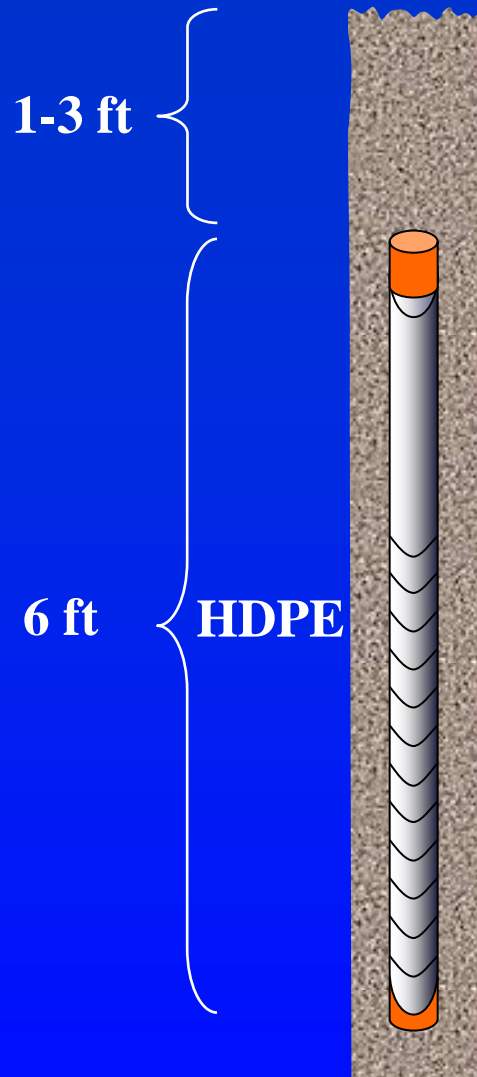
Semi-permeable and impermeable layers in a beach result  
in poor drainage → wet beach → erosion

”In a qualitative sense, the role of elevated beach groundwater in promoting beach face erosion and lower beach water table in promoting onshore accretion, is now well established”

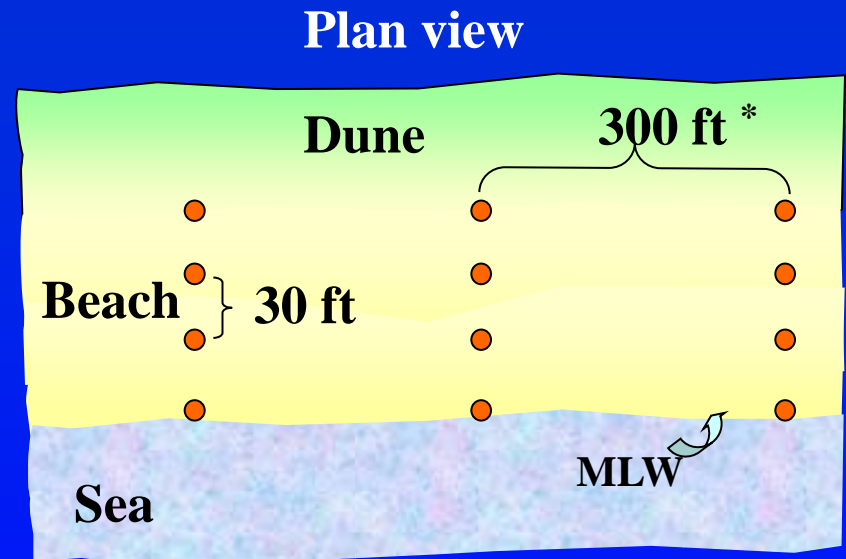
**Turner and Leatherman, 1997,**

Beach Dewatering as a ‘Soft’ Engineering Solution to Coastal Erosion  
– A History and Critical Review. *Journal of Coastal Research*, 13 (4) , 1050-1063

# PEM System



PEM is patented and designed to improve drainage of the beach



**NO PUMPS – NO POWER USED**

\* Every installation is tailor made

Diameter 2.5 inches



# PEM Function



# Poor drainage

A thin layer of impermeable clay is the most likely the culprit

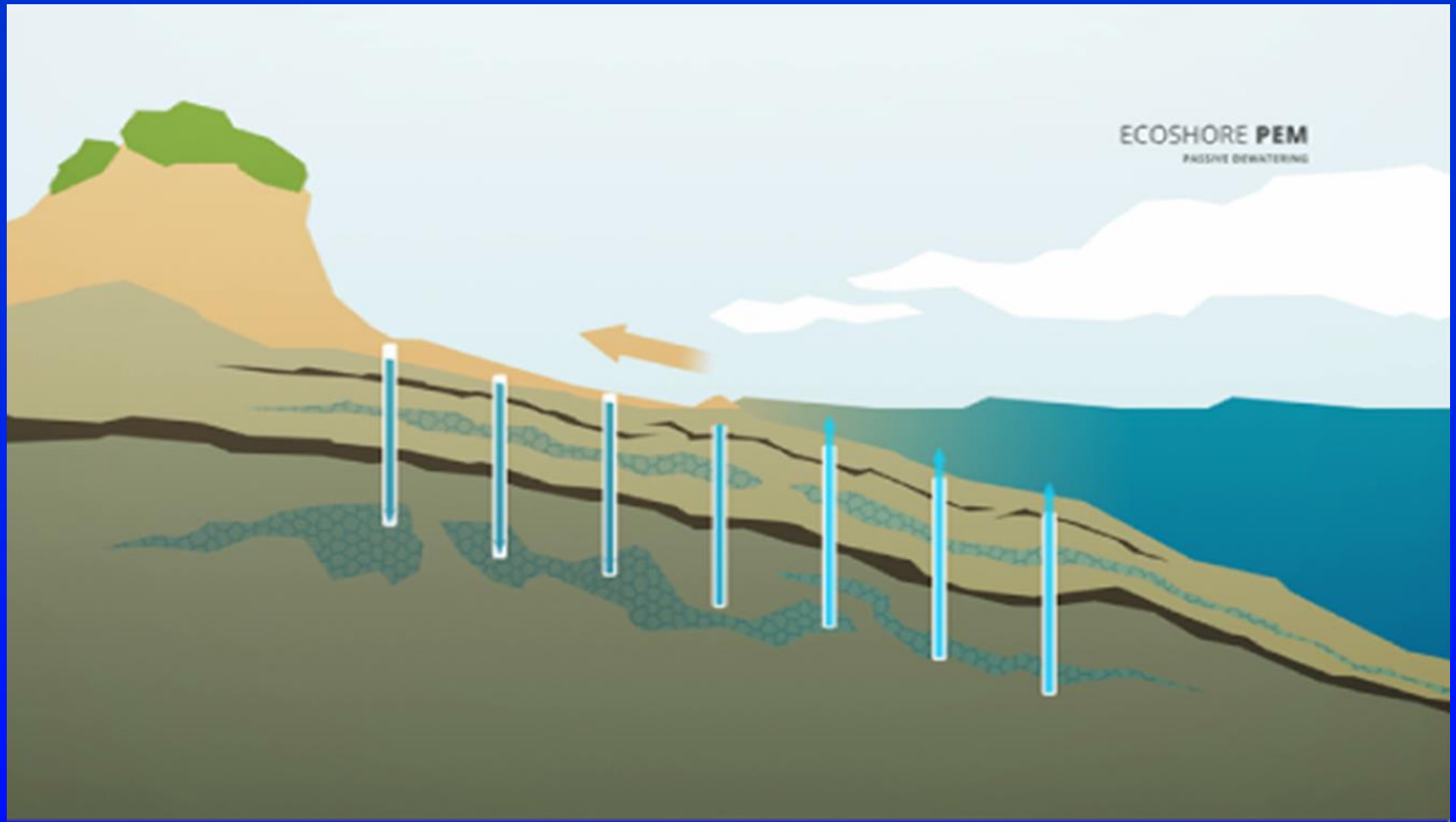


**Holgate, NJ**



**Beach Stratification in New Jersey**

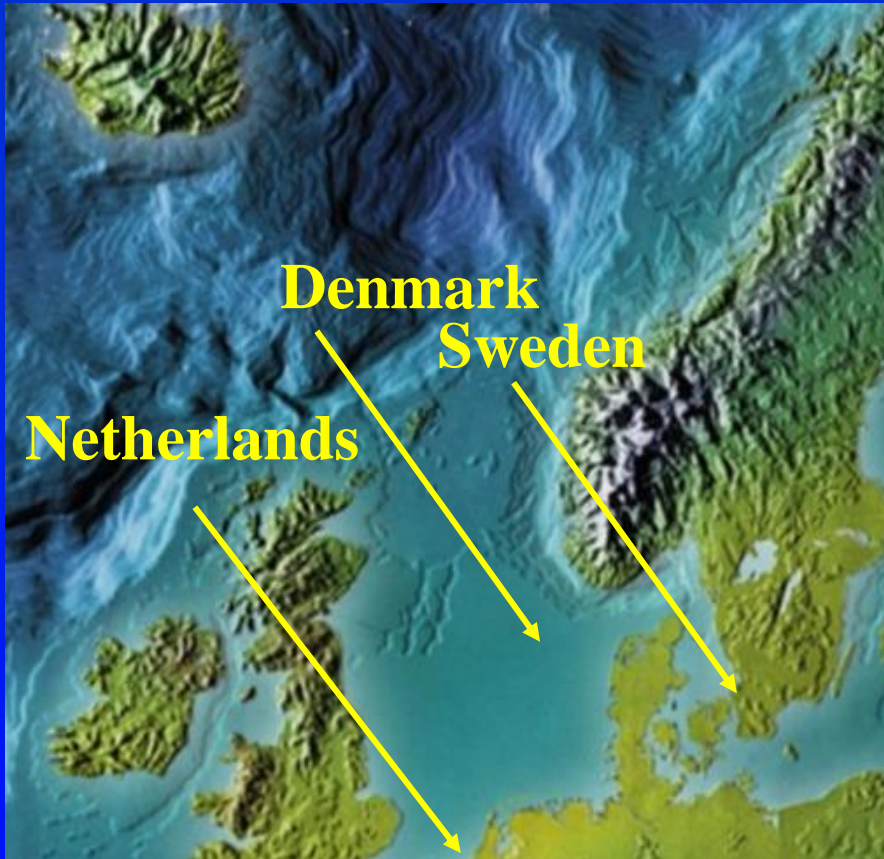




For animation see [www.ecoshore.com](http://www.ecoshore.com)



# Projects



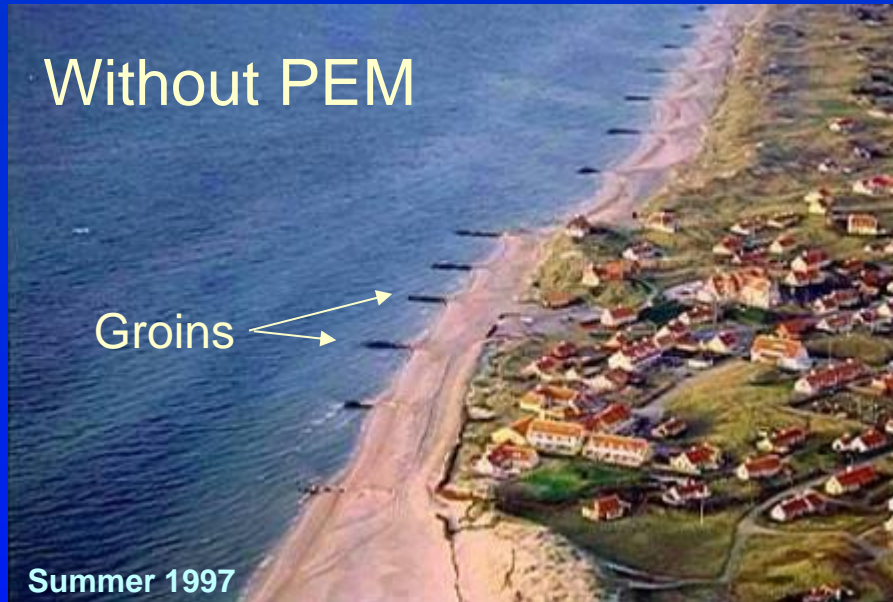
**Teluk  
Chempedak  
Malaysia**



**Hillsboro  
Beach  
Florida  
USA**

# Old Skagen North 1998-2001

PEM as stand alone and placed near groins



**Before PEM  
installation**



**18 months after  
PEM installation**

**Erosion on Danish West coast 2 x 2.5 million cubic yards/year**



# Old Skagen North 1998-2001

PEM as stand alone and placed near groins

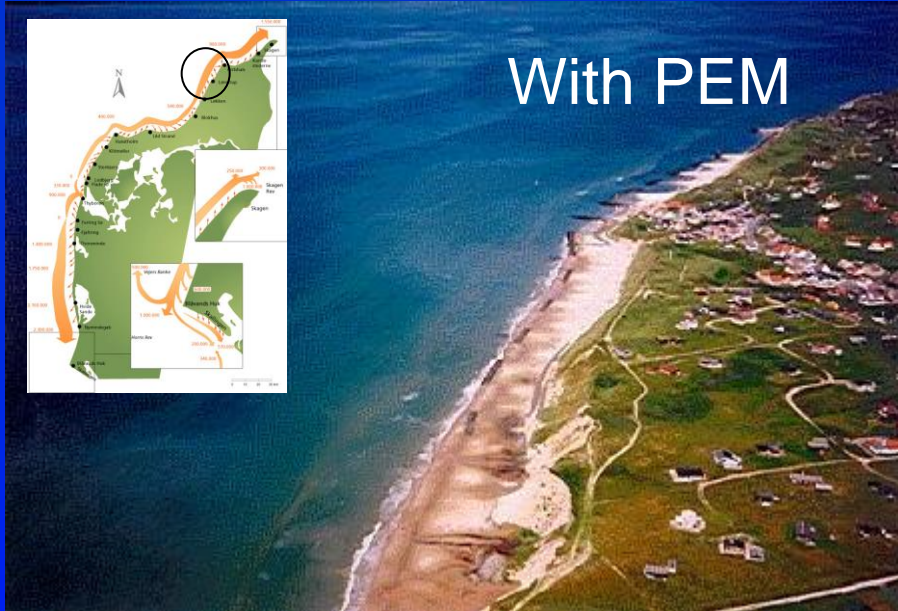


**July 2002**

**8 months after removal of the PEMs**

# Lønstrup, Denmark

## PEM placed near breakwaters



**PEM installed April 1999**  
**Photo summer 1999**

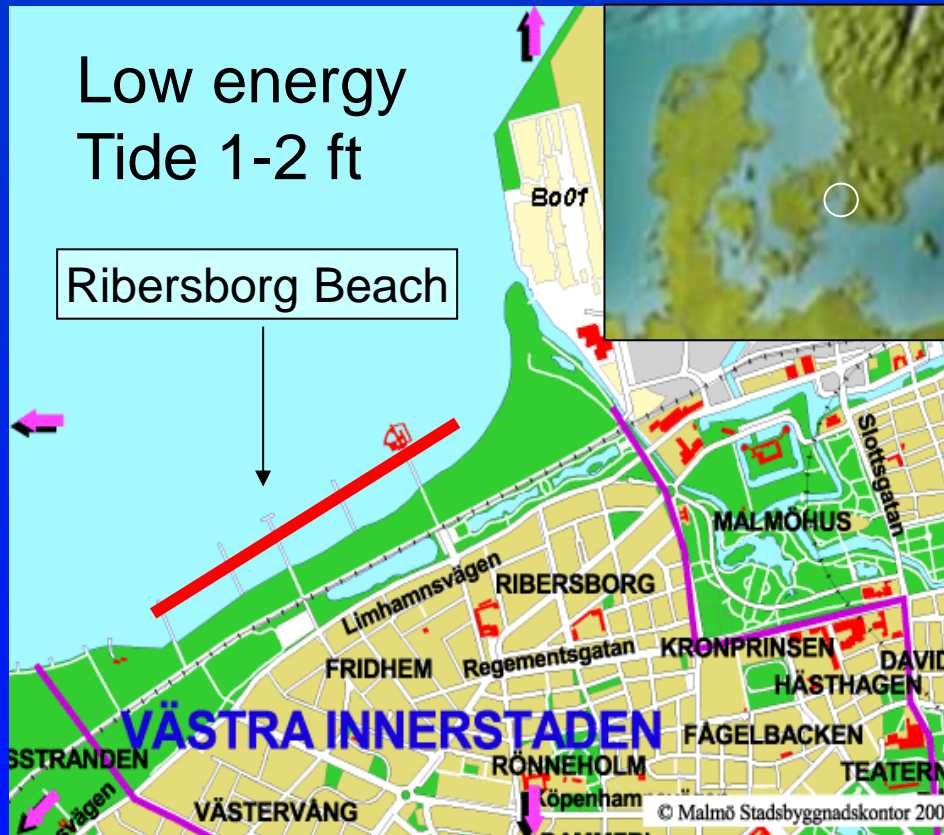


**PEM removed August 1999**  
**Photo summer 2002**



# Ribersborg Beach, Sweden

## PEM and Beach Nourishment – constructed beach



## Commercial installation on artificial beach

### Purpose:

Avoid having to fetch sand  
every spring

### Installed:

Oct 2001

### Status:

Stopped having to fetch sand.  
Contract renewed

# Ribersborg Beach, Sweden



# Egmond aan Zee, Netherlands

## 6 km stand alone PEM project

- Project by The Royal BAM Group (25,000 empl. \$10Billion)
- Four year Study from 2006 to 2010 and Master Thesis



### Main findings after 4 years

- On historically eroding PEM beach: avg. beach elevation +2 ft
- PEM and control beaches gained sand during the study
- Sediment on PEM beach had fewer very fine particles and drained better
- Increase in dune volume on PEM beach
- Steeper beach slope on PEM beach which results in a more robust beach
- Lowered water table on PEM beach
- PEM beach lost less sand during storm and built up faster

### Trust the PEM Technology

Royal BAM Offered the Danish State a 70 miles PEM installation leased over 5 years on the Danish west coast

Source:

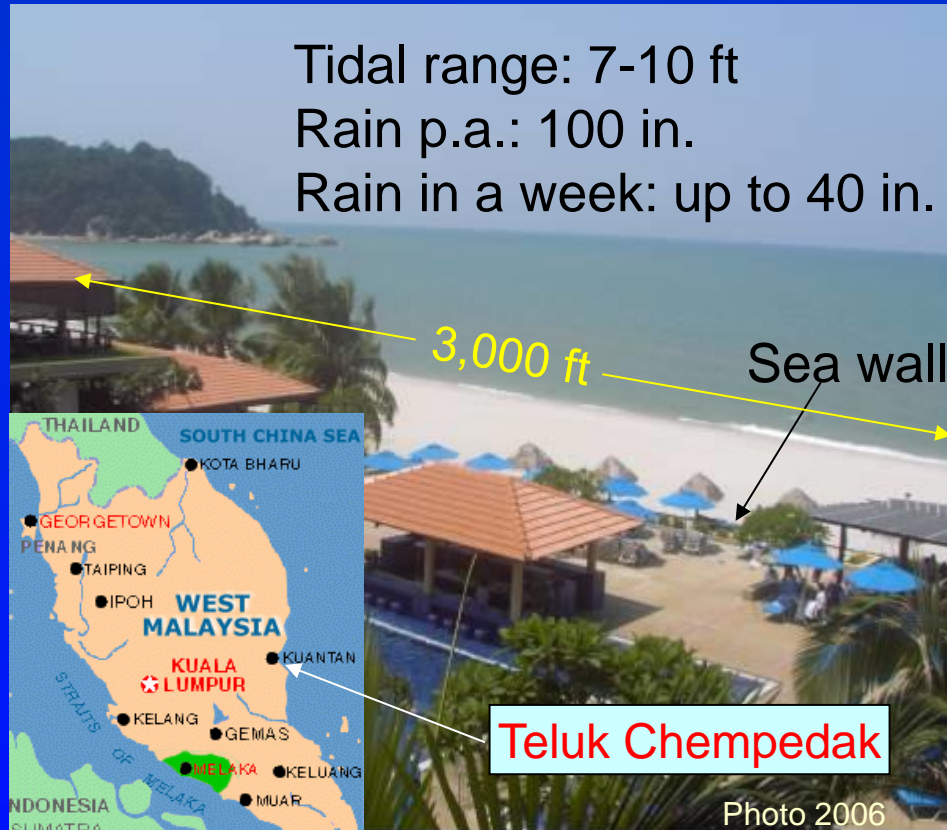
*Drainage tubes versus sediment, Effects of vertical drainage tubes on the sedimentology and beach processes at the intertidal beach zone, MSc Thesis, Ekkelenkamp, 2011.*

# Teluk Chempedak, Malaysia

## PEM combined with Beach Nourishment

### Double layer of PEM

Tidal range: 7-10 ft  
Rain p.a.: 100 in.  
Rain in a week: up to 40 in.



### Purpose:

Prolong the lifespan of beach nourishment (normal life 3-4 yrs)

### Installed:

PEM #1: First set July 2003

Nourishm. 230,000cy.: May-July 2004

PEM #2: Second set Aug 2004

### Status:

2007: Beach is stable

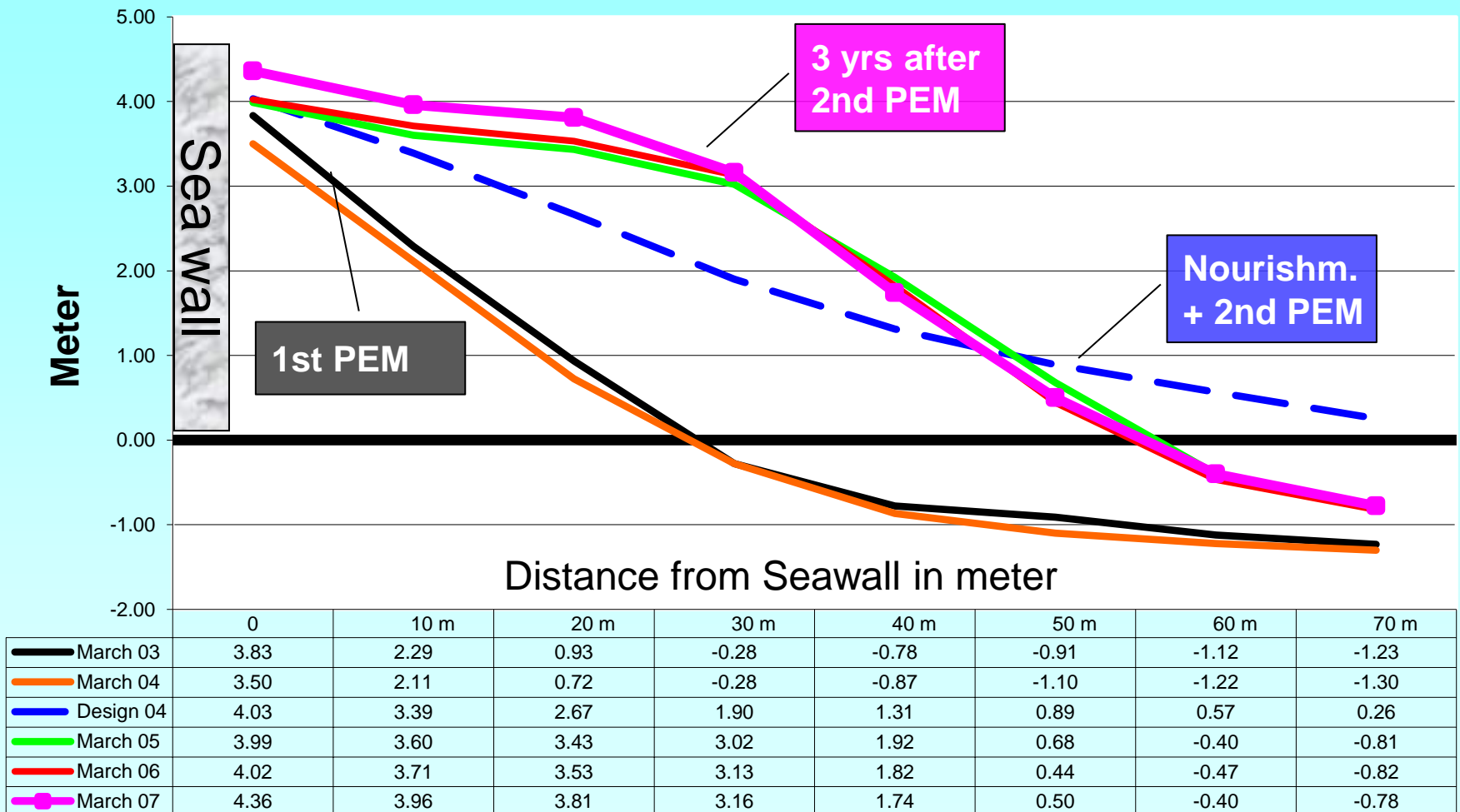
Expected lifetime: >10 years



# Teluk Chempedak, Malaysia

## PEM combined with Beach Nourishment

## Double layer of PEM



# Hyatt, Teluk Chempedak, Malaysia

## PEM in combination with beach nourishment



**2003**

**Pre-  
Nourishment**



**2007**

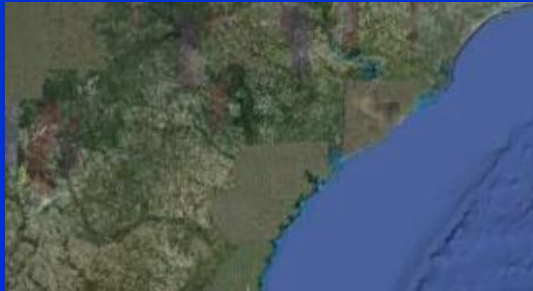
**Post-  
Nourishment**



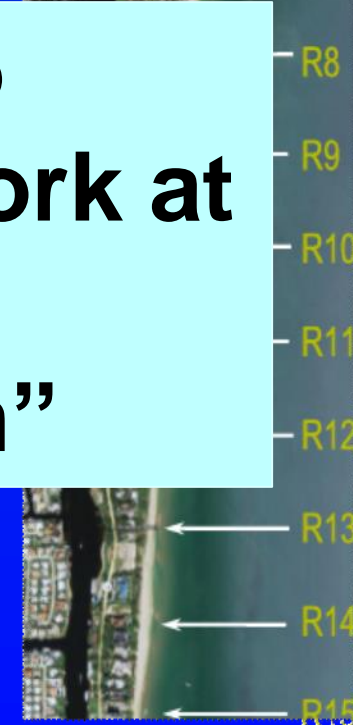
**July 2013**

**Elevated convex beach. This project demonstrates  
how to prolong the life of beach nourishments.**

# Hillsboro Beach, Florida



**The FDEP.....“knew of no technology that would work at the exact location due to groins at Deerfield Beach”**



Study Area

# Hillsboro Beach, 2001-07 annual change to DOC \*

**North control + 1.9 cy/ft**

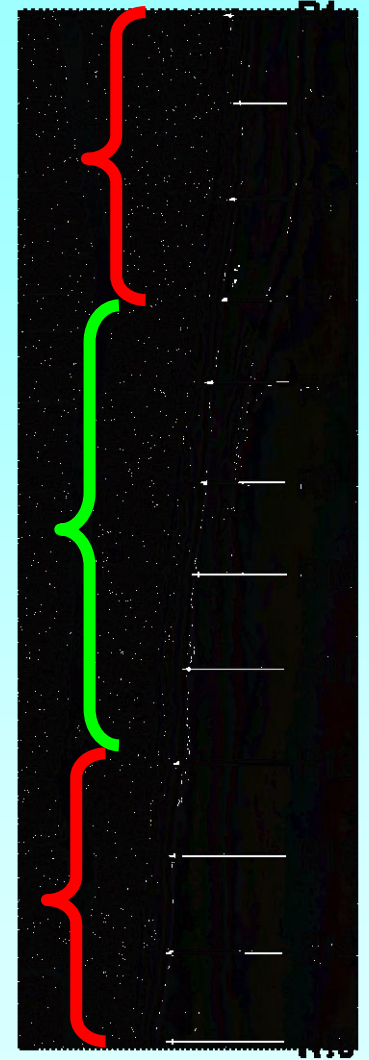
**Project area - 3.9 cy/ft**

**South Control + 1.2 cy/ft**

North  
Control  
0.5 mile

Project  
Area  
1.0 mile

South  
Control  
0.5 mile



\* Olsen and Ass. 2008



# Installation & Removal



## Pre-PEM installation February 2008

- **Validate physics: Installed water wells/PEMs**
  - Very high groundwater level



## PEM Installation in February 2008

- **Installation completed in 2 weeks**
- **90 PEMs installed with drill**
- **Very poor beach condition**
- **>50% of PEMs were reduced in size**



- **After 18 mths PEM had met success criteria**
- **Client pays. No-cure no-pay contract**
- **Client decides to have trad. nourishment**
- **Monitoring continues**
  - 24 months (2010) and 36 months (2011)
- **2/3 of PEMs found and removed in 2011**

1210 Hillsboro Mile  
Hillsboro Beach, FL 33062



Phone (954) 427-4011  
Fax (954) 427-4834



We confirm that, based on the evaluation and reports of our consultant, Coastal Engineering Consultants, Inc., the PEM system has benefited the Town and has met the success criteria set out in the contract between the Town and EcoShore. Further, the installation of PEMs did not cause any harmful effects to other sites, to the environment, or to visitors on the beach.

Re: PEM installation at Hillsboro Beach, Florida

In 2006, the Town of Hillsboro Beach and EcoShore Int'l, Inc. entered into a contract to install a PEM system (pressure equalizing modules) for beach erosion control at the critically eroding Hillsboro Beach.

The system was installed in February 2008.

We confirm that, based on the evaluation and reports of our consultant, Coastal Engineering Consultants, Inc., the PEM system has benefited the Town and has met the success criteria set out in the contract between the Town and EcoShore. Further, the installation of PEMs did not cause any harmful effects to other sites, to the environment, or to visitors on the beach.

The PEM system was installed at a time when the beach was very narrow due to storms. Recently, the Town has decided to acquire a new, wide beach, and plans to do a beach nourishment project which necessitates the termination of the PEM project.

The collaboration between the Town administration and EcoShore has been smooth during the entire project.

Sincerely,

# Hillsboro Beach 3-year results \*

Average Beach Elevation At Each Dewatering Tube Row (ft)

	Installation	Removal	Change
Row A (MLW)	-2.26	-0.08	2.18
Row B	0.21	1.83	1.62
Row C	4.46	4.25	-0.21
Row D	4.80	5.45	0.65

+1 ft

## Volume data in PEM area to DOC (surveyed 1 month after removal)

- Accumulated sand to depth of closure (DOC): 47,000 cy
- Sand placed in test area during 2008 / 2009 (truck hauls): 8,500 cy
- In total, the test area added  $(47,000 - 8,500) = 38,500$  cy in 3 years
- The same area historically lost an average 21,000 cy annually = -63,000 cy in 3 years

## Shoreline data in PEM area (surveyed 1 month after removal)

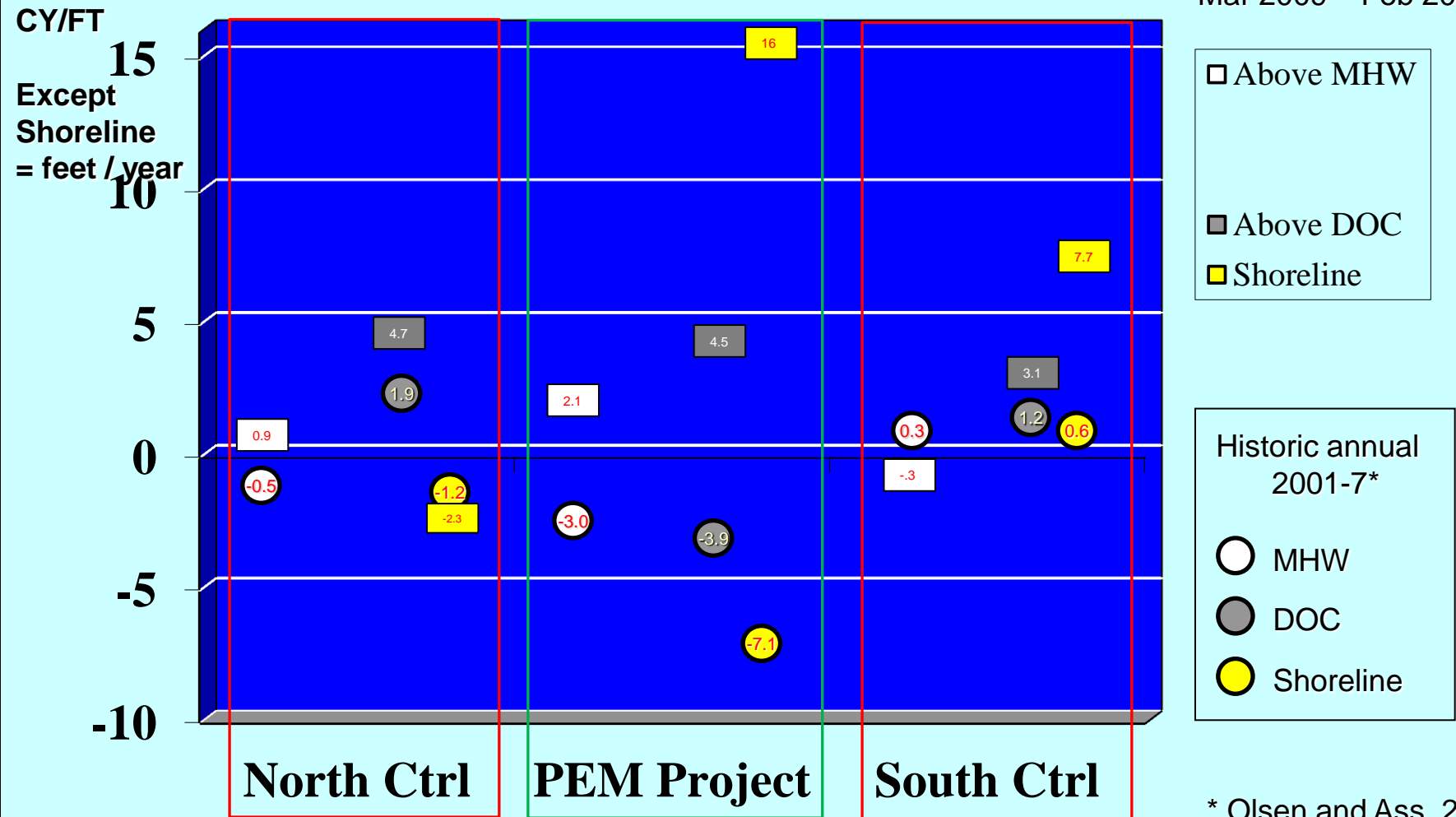
- Shoreline advanced an average 26.9 ft
- Shoreline was expected to retreat by 25.2 ft

**Neither of the controls were negatively affected as both North and South controls gained volume in line with the norm**

\*All Hillsboro Beach PEM project data were obtained by SEA Diversified Inc, a Certified Florida Surveying and Mapping Company

# 2<sup>nd</sup> year. No Nourishments. No storms.

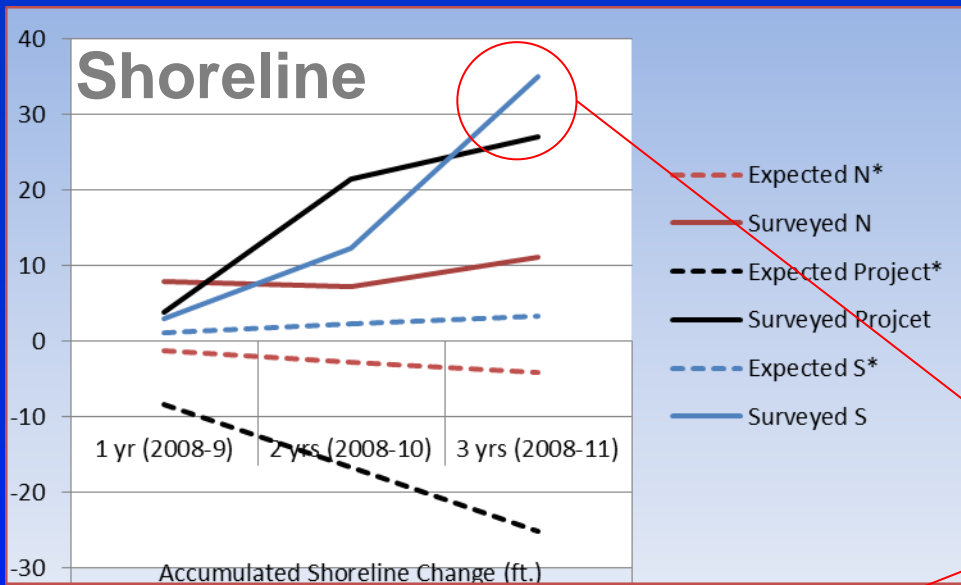
Mar 2009 – Feb 2010



\* Olsen and Ass. 2008



# Hillsboro Beach – comparative results

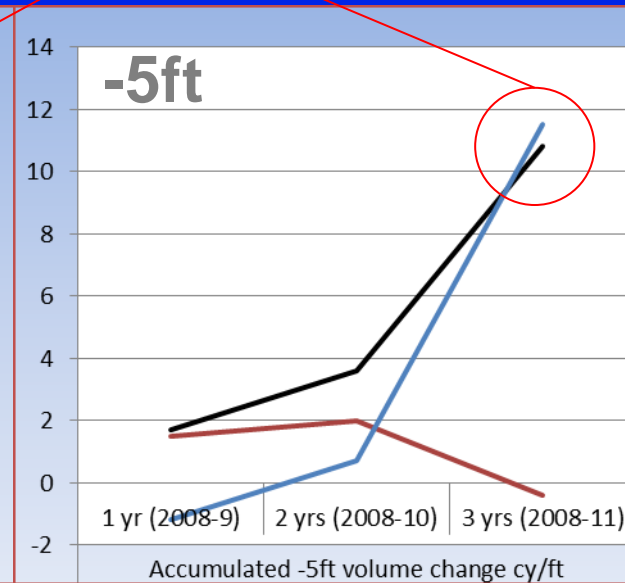
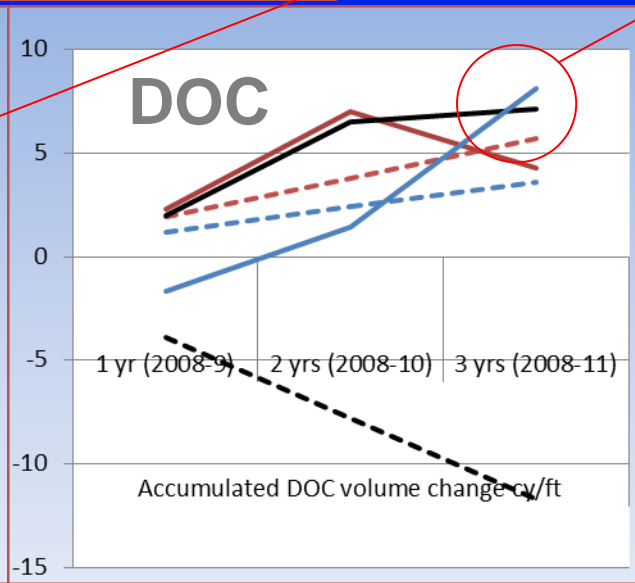
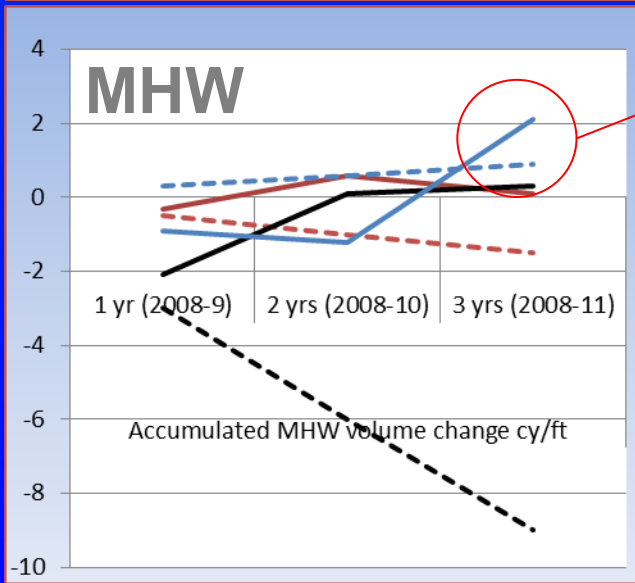


**Accumulated 3 year  
Comparative Results**

**How did the test areas expected  
performance\* compare to the surveyed  
results?**

**\*Sep 2001 - April 2007. Olsen and Ass. 2008**

**No down-drift erosion**



# Hillsboro Beach 3-year photo comparison

Photo location looking south

R-7 in February 2008

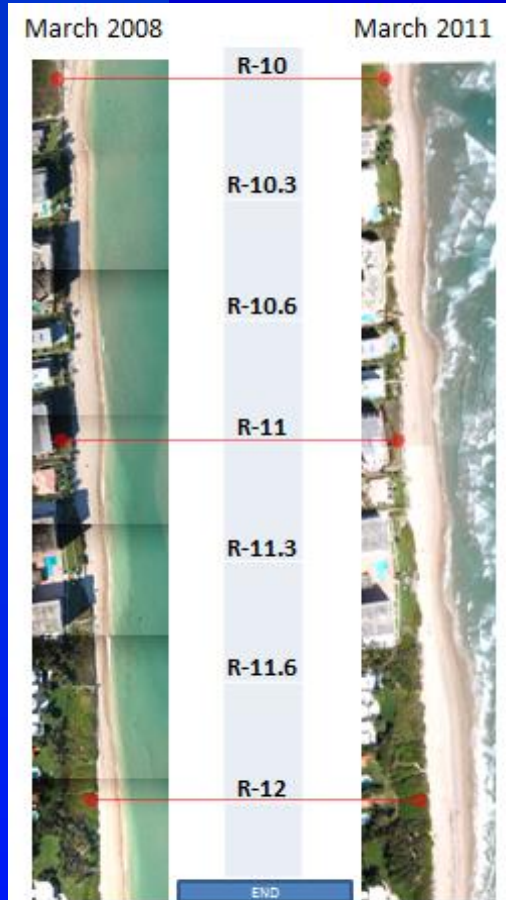


Photo comparison  
at low tide.

March 2011 was shot 1  
month after PEM removal.  
By then the sand had  
started to wash away

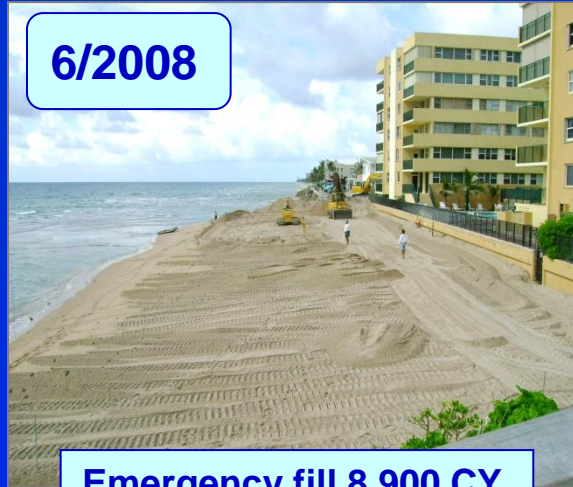
# Hillsboro Beach – Timeline 2008 - 2014

**2/2008**



**Project starts. PEM installed from R7 - R12**

**6/2008**



**Emergency fill 8,900 CY at R7, on top of PEM**

**2/2009**



**PEM is stabilizing the emergency fill at R7**

**1/2011**



**Project ends. PEMs are removed. The beach is wide**

**3/2011**



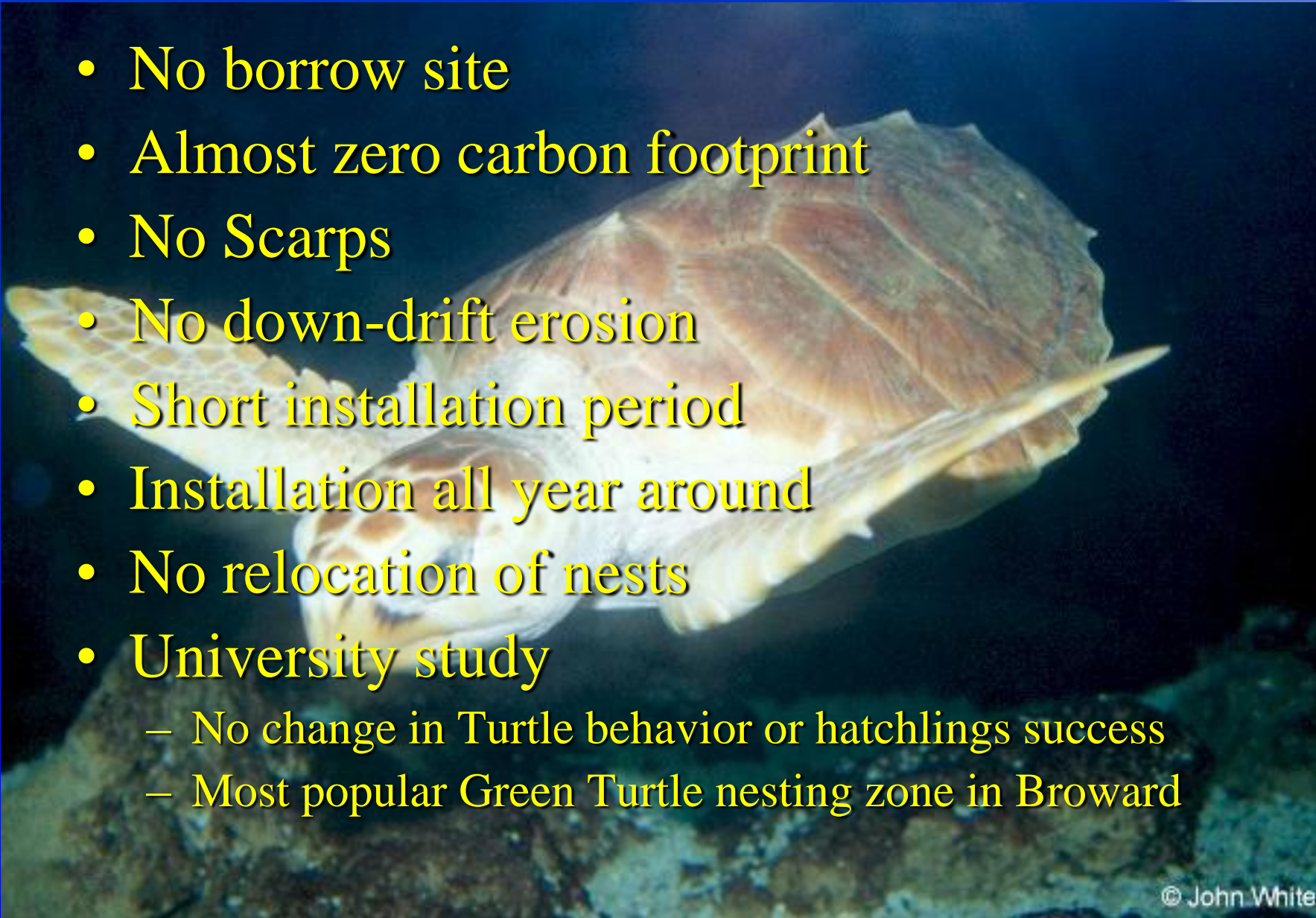
**Beach nourishment 340,000 CY from R6 - 12**

**2/2014**



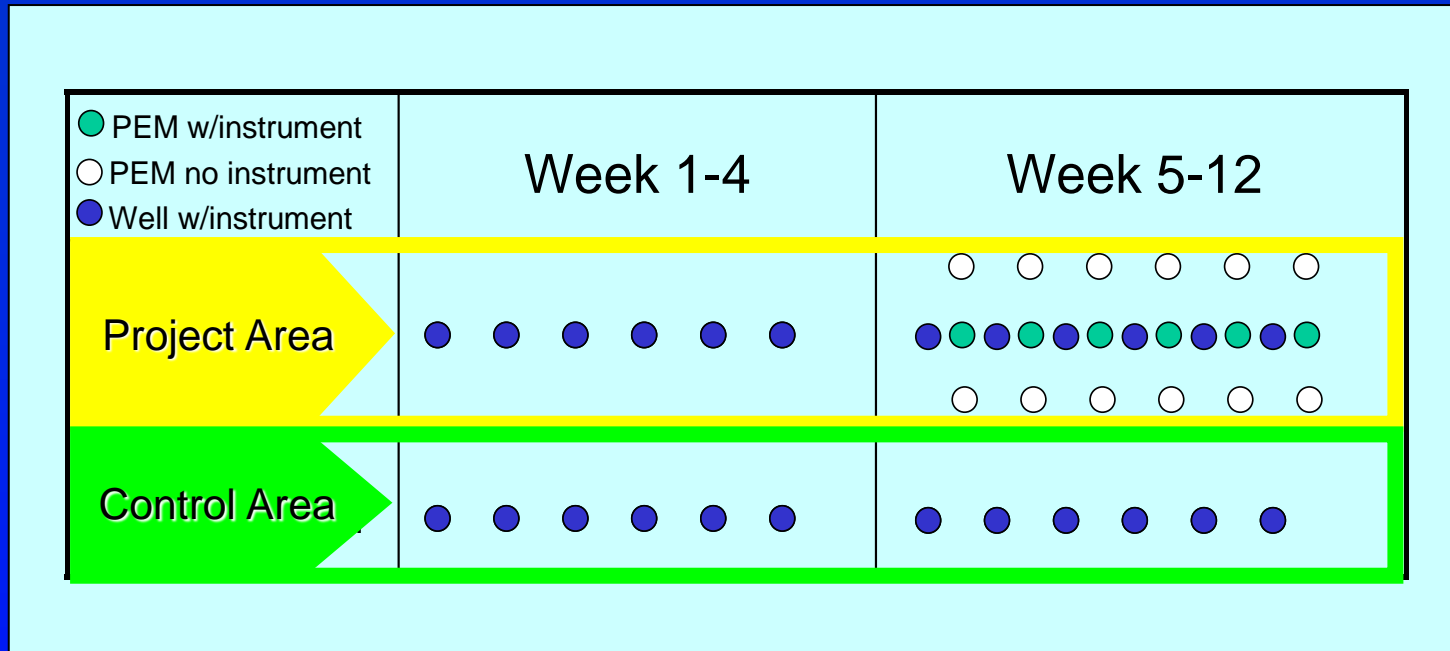
**Sand has washed away and beach is back to 2008-level**



- 
- A photograph of a Green Turtle swimming underwater. The turtle is seen from a side profile, moving towards the left. Its carapace is a mottled brown and tan color, and its flippers are visible. The background is a dark, deep blue, suggesting an underwater environment.
- No borrow site
  - Almost zero carbon footprint
  - No Scarps
  - No down-drift erosion
  - Short installation period
  - Installation all year around
  - No relocation of nests
  - University study
    - No change in Turtle behavior or hatchlings success
    - Most popular Green Turtle nesting zone in Broward

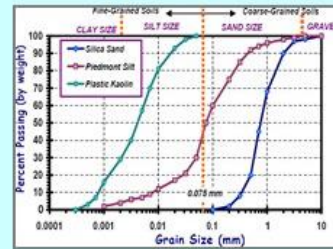
# Will PEM work at a specific beach?

## Pilot study – Controlled test



**Pilot Study performed on 2 segments of the beach  
300 ft apart during 2 time periods  
Duration: 3 months**

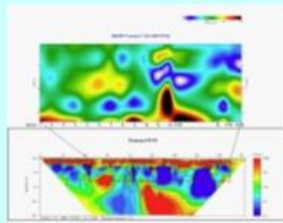
## GRAIN SIZE



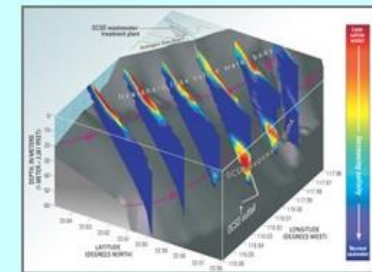
## CORES



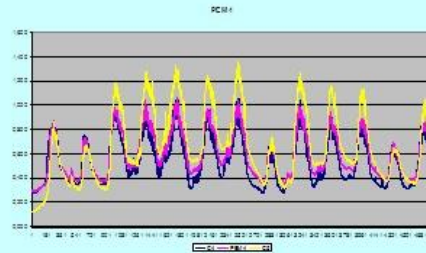
## MASW



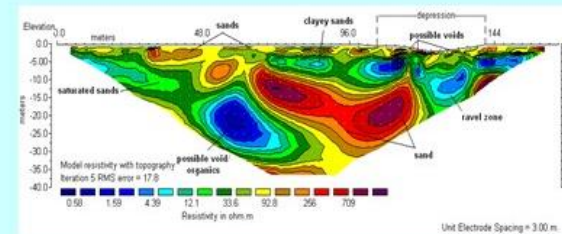
## SALINITY



## TESTS



## PRESSURE TRANSDUCER



## 2D MER

**Pilot Study: What is causing the erosion?**

**How is the groundwater and beach affected by the PEMs?**

**Which PEM configuration to be used if full scale?**



# Pros and Cons of Passive Dewatering

## Pros

Highly cost-effective at suitable sites
Keeps sand on beach and adds from sea
Turtle and environmentally friendly
Invisible to beach visitor
No down-drift erosion
No scarps
Storm protection and fast beach buildup
Prolong the life of beach replenishment

## Cons

Requires minimum 6-8 ft depth of sand
Requires tide variations
Beach cleaner must know PEM location
After storms PEMs may become exposed, especially likely at project start. Reported by beach raker or a visitor via free call to computer. Marked and later repositioned below the sand by local staff
<b>It takes time to gain sand !</b>



A photograph of a coastal landscape featuring sand dunes and grass. The dunes are covered in patches of yellowish-brown grass and sand. In the background, a sandy beach leads to the ocean under a cloudy sky. The text "Thank you for listening" is overlaid in a white, cursive font.

*Thank you  
for listening*

PEMs installed for 8 years

[www.ecoshore.com](http://www.ecoshore.com)