



Sustainable development of nourished shorelines

*Building with Nature solutions for
improved project design and realisation*

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EcoShape | Building with Nature

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Gijon (Spain), May 2010



Realisation of maritime infrastructure in complex environmental settings

- Continuous growth of market for maritime infrastructure
- Development of large-scale projects characterized by uncertainties and delays

Maasvlakte-2 (NL)





Realisation of maritime infrastructure in complex environmental settings

- Extensive Environmental Management Plans and monitoring requirements
- Sustainable development increasingly important for clients

Port of Melbourne (AUS)



Port of Khalifa (UAE)





“Sustainable development offers opportunities to make the difference”



Innovation is needed to do things differently!



Building with Nature



Building with Nature

- **Dynamics of natural system** as starting point for design and realisation of maritime infrastructure
 - Make optimal use of natural processes
 - Design fits with natural (eco-)system dynamics
 - Explore opportunities to promote nature development
- From defensive (minimize environmental impacts) to **offensive** approach (optimize full economic and environmental potential)
- **Integration** of disciplines: Engineering, Ecology & Governance

“Ecodynamic Design”



Figure courtesy of G.M. Jansen



Building with Nature in the context of Dutch Coastal Zone Management



Holland Coast: Policy context

- Decrease of natural sediment supply owing to
 - Sea level rise
 - Human interventions
- Consequence: Structural erosion
- Solution: Nourishments



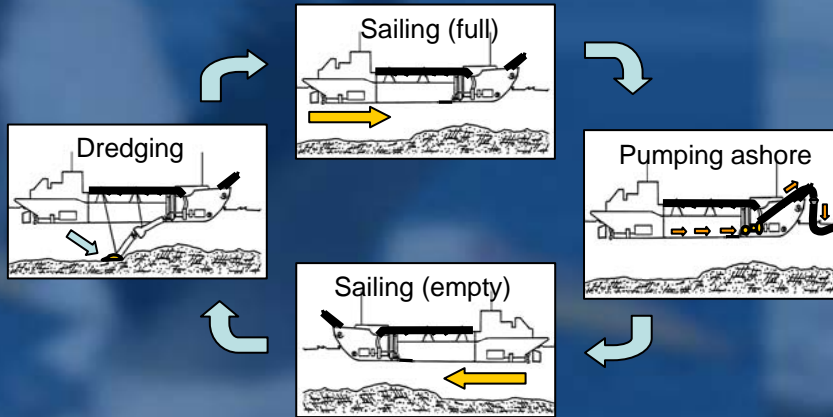
Shoreline retreat Egmond (1679 – 1996)

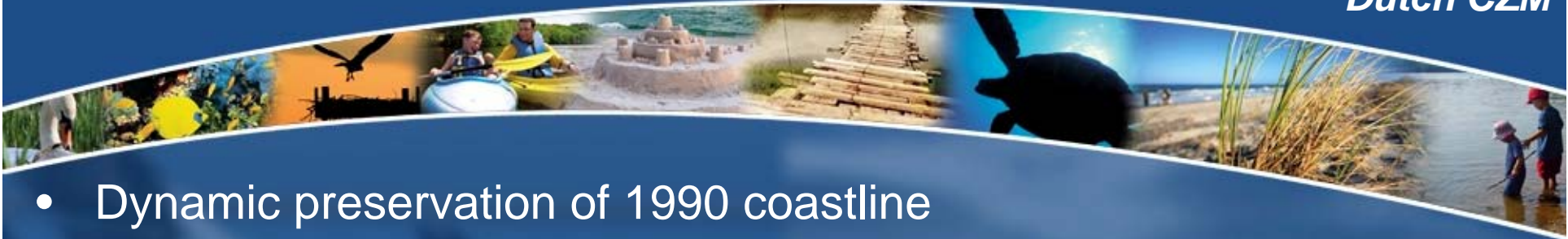




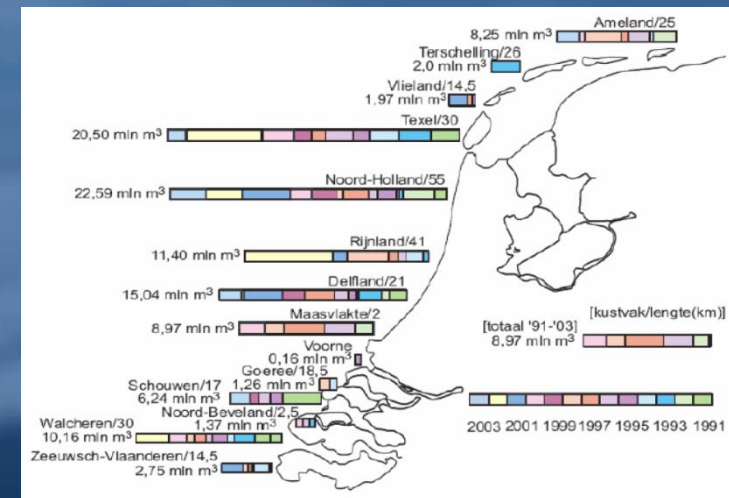
Sand mining & nourishment: Scope & Operations

Dredging cycle





- Dynamic preservation of 1990 coastline
 - Sustainable maintenance of safety and functions & values of dunes
 - Compensate sand losses deeper water
 - Objective not: land reclamation
- Preferred solution: nourishment
- Sand volumes:
 - Since 1990: 6 mln m³/yr
 - Since 2001: 12 mln m³/yr
- Veerman (2008): 40-85 mln m³/yr excl 40 mln m³/yr for reclamation



➔ *Tendency towards larger-scale nourishments*

➔ *Opportunities for Building with Nature*



Opportunities for Building with Nature Innovations in Design and Realisation

Example 1

Mega-nourishments



Pilot Sand Engine Delfland

- Surplus of sand, distributed by tide/waves/wind
- Joint initiative of Ministry of Public Works, Province of South Holland and others
- Ca 100-150 ha, 20 mln m³, 1000 m seaward
- Objectives
 - Long-term: Guarantee coastal safety by promoting dune development
 - Short-term (1): Knowledge development & innovation
 - Short-term (2): Create space for nature / recreation
- Realisation planned 2010-2011

Artist impression
Pilot Sand Engine Delfland

Sand Engine: BwN elements

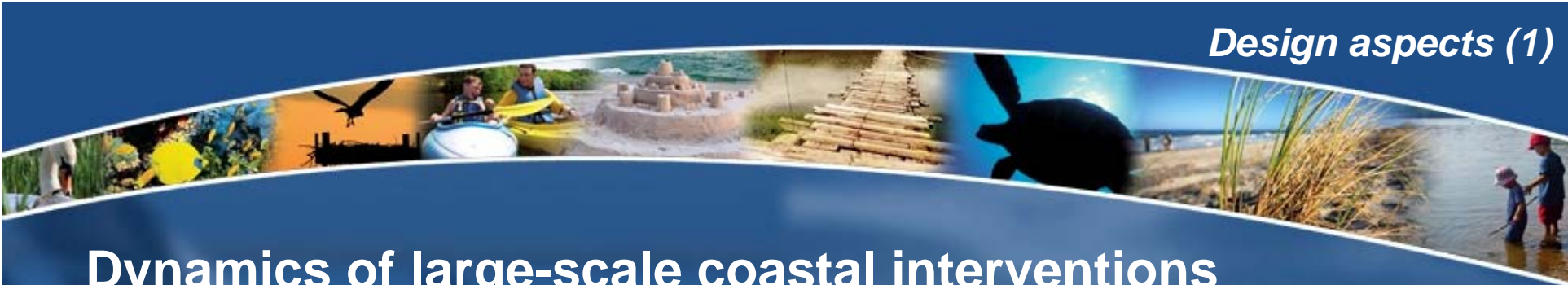
- Integral solution to meet integral objectives
- Use natural processes to distribute sand
- Minimal impacts on ecosystem
- Smart design promotes nature development
- Cost-efficient implementation

Ambitieovereenkomst pilotproject Zandmotor

Natuurlijk werken aan de
Delflandse Kust!

23 april 2008

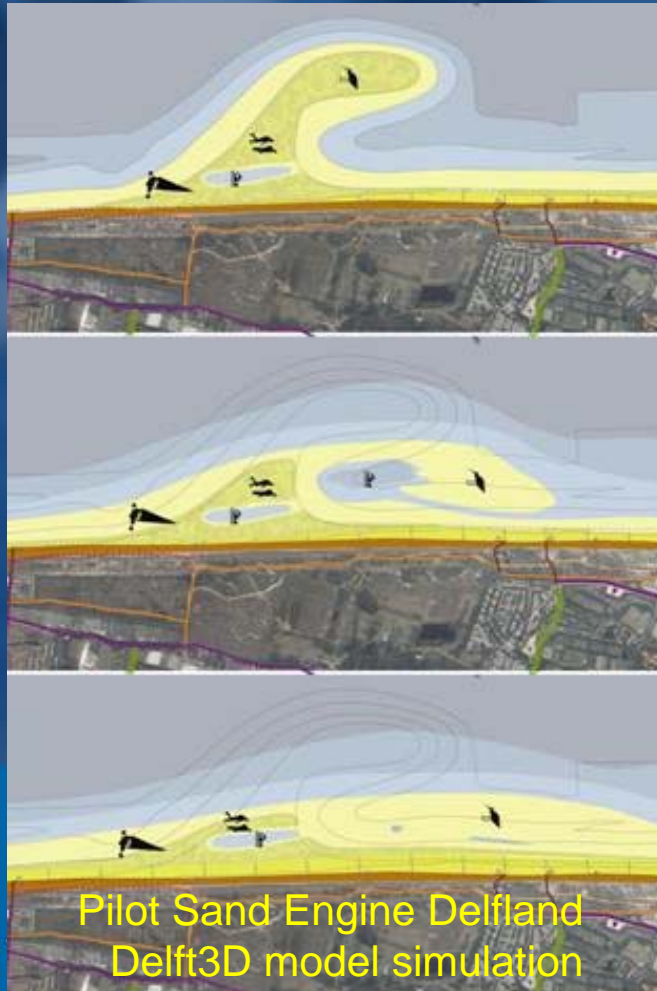




Dynamics of large-scale coastal interventions

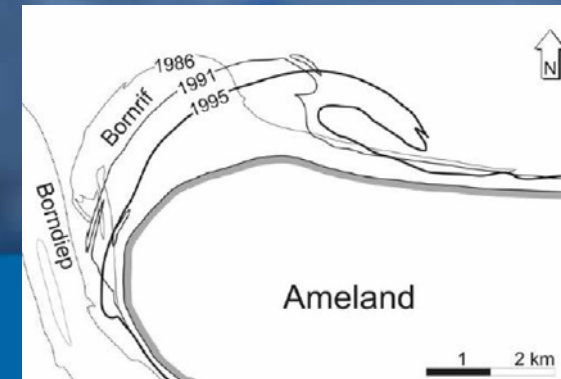
- Formation of meandering channel (analogy with Bornrif Ameland)
- Scale analysis Bornrif / Sand Engine
 - Meander length SE ~ 600 m
 - Meander width SE ~ 70 m
- Accomodate room for this in design!

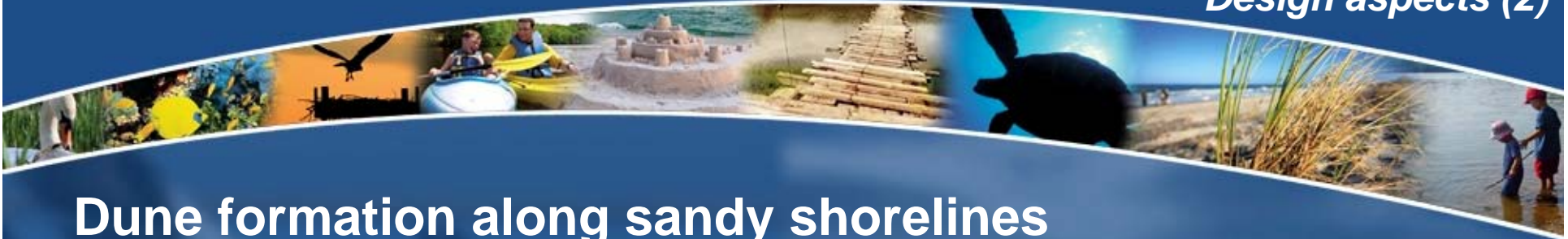
Evolution Sand Engine (ca 10-20 yrs)



Pilot Sand Engine Delfland
Delft3D model simulation

Landfall of tidal bar – Bornrif, Ameland (NL, 1986-2000)



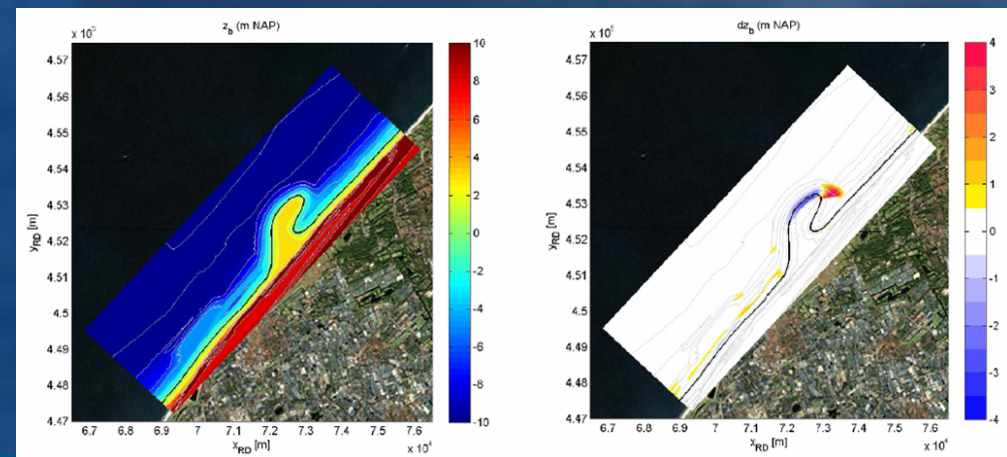
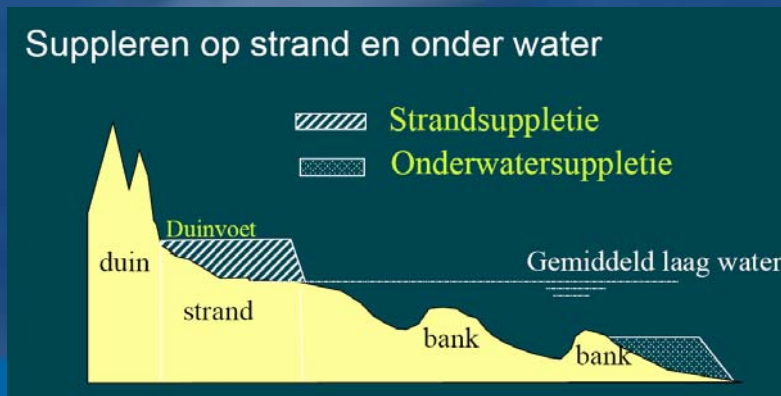


Dune formation along sandy shorelines

- Damsma (2009): Dune growth on time scale 5-25 years dominated by erosion events
- Hypothesis: Dune formation encouraged through appropriate design of beach and shoreface nourishments

Beach or Shoreface nourishment?

Storm simulations with XBeach model





Opportunities for Building with Nature Innovations in Design and Realisation

Example 2

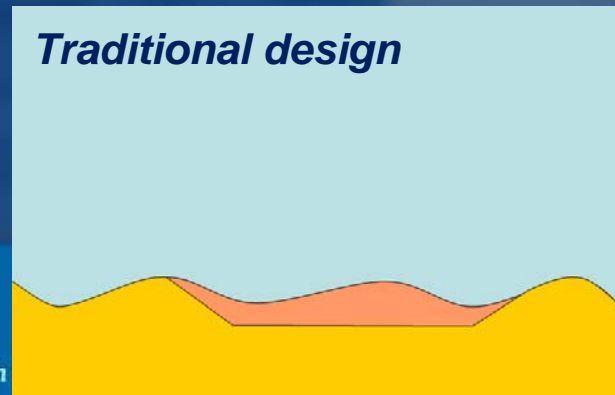
Ecological Mining Pits



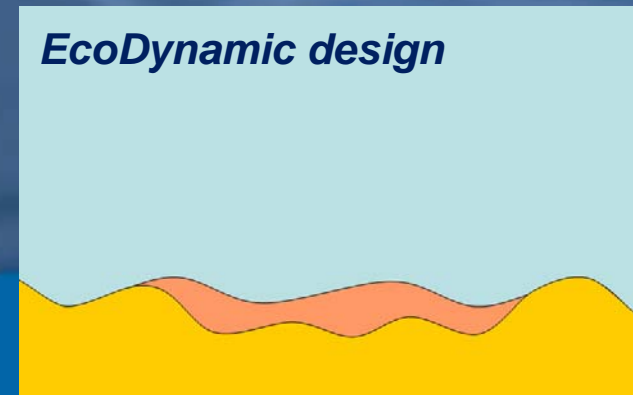
Concept

- Increase of nourishment volumes (NL), hence sand mining
- No clear guidelines on ecology and sand extraction sites
- Ecological landscaping involves realisation of large-scale bed forms in mining pit
- Large potential for ecological development and mutual benefits for stakeholders
 - habitat diversity (benthos) + faster recolonization
 - Positive effect on populations of fish, birds & mammals
 - increase economical value of a dredging area

Traditional design



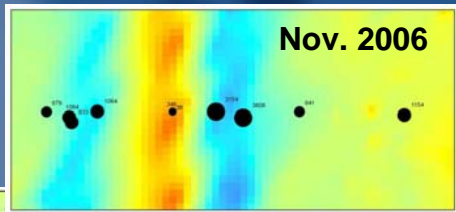
EcoDynamic design



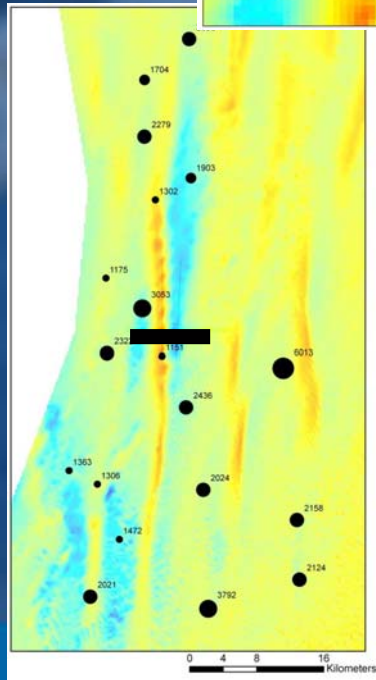


Inspiration for ecological landscaping

Benthos density (m⁻²)

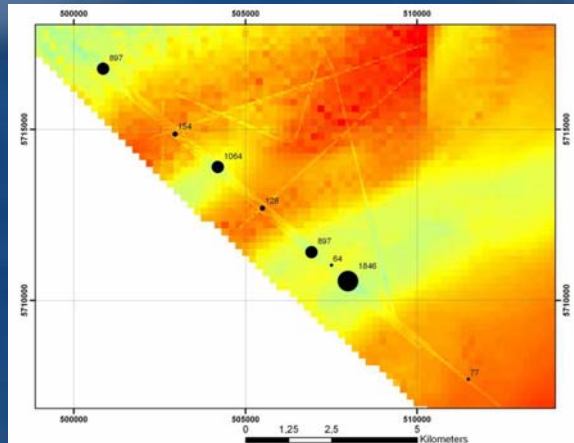


Bruine bank

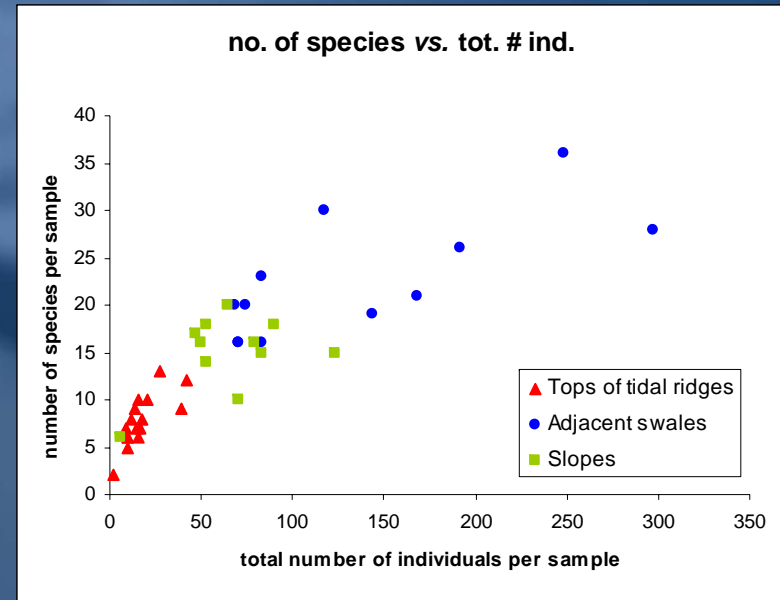


Bruine Bank, Mar-Apr-Jun 1992

Thornton bank



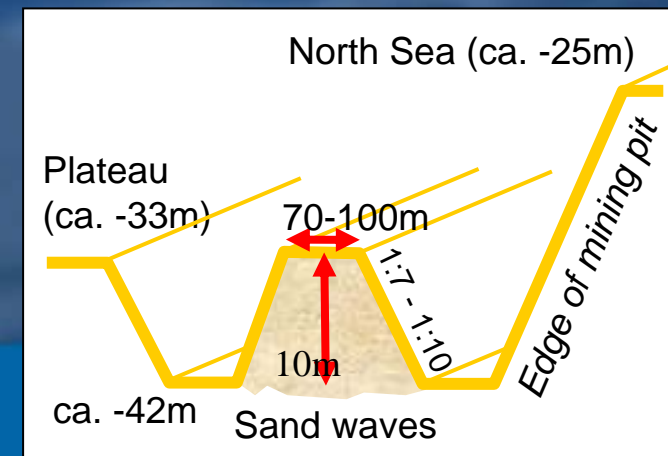
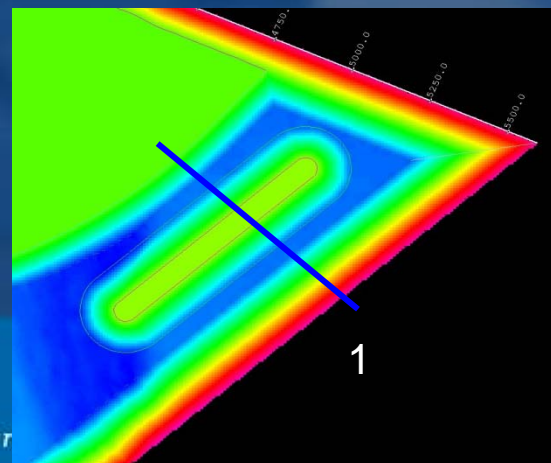
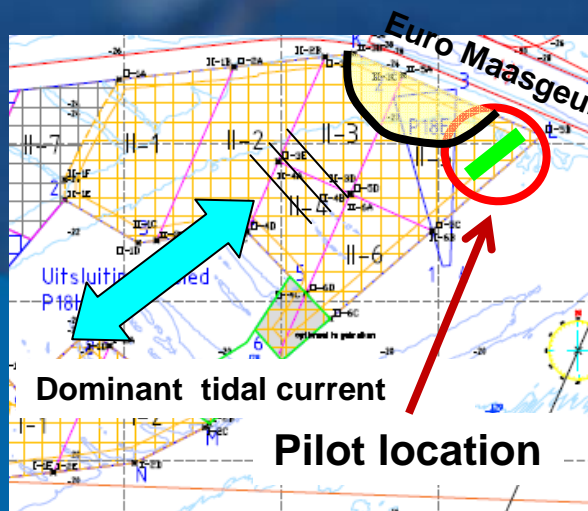
Density and diversity per morphological unit of tidal ridges (both banks)





Pilot Ecological Mining pit (2010)

- Realised as part of sand mining for Maasvlakte-2 project
- Assessment of feasibility within existing permits
- Assessment physical dimensions (L ~ 300-400 m, V > 1-10 Mm³)
- Identification of suitable location
- Design of monitoring strategies (4-6 yrs after realisation)
- Organization of framework for data analysis
- **Permanent liaison with stakeholders** (PoR, RWS, PUMA, ...)





Innovation Program

Building with Nature



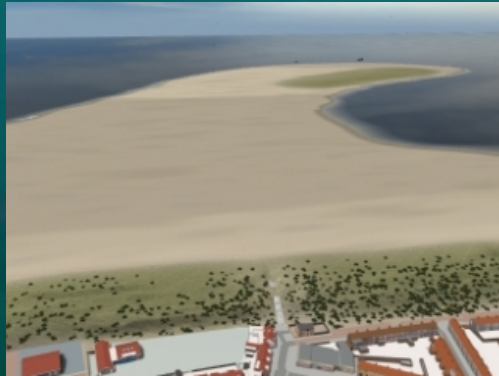
Building with Nature program

- Program duration 2008-2012
- Budget ca 30 mln euro
- Main outcome: Guidelines & tools for Ecodynamic Design
- All Dutch key players involved!
 - Initiative contractors: Boskalis and Van Oord
 - Scientific Institutes: Deltares, Imares, NIOZ
 - Consultants: Witteveen + Bos, DHV, Haskoning, Arcadis
 - Industry: IHC Holland, Vereniging van Waterbouwers
 - Universities: Delft, Wageningen, Twente
 - Port authority: Harbour of Rotterdam
 - Government: RWS-DI, City of Dordrecht





Hollandse Kust



ZW Delta

BwN Cases



Markermeer - IJsselmeer



Singapore



Conclusions

- Sustainable development drives innovations in project design and realisation
- Building with Nature: Dynamics of natural system as starting point for design and realisation of marine infrastructure
- Scale increase in Dutch CZM offers framework for development of sustainable strategies for sand mining and coastal nourishments
- Potential of this approach presently explored on the basis of real-world pilot experiments
- Work carried out as part of Innovation Program Building with Nature



Building with Nature is Building our Future

