



Sandy reinforcement Houtribdijk

An NBNF example to:

1. Ensure protection from flooding;
2. Enhance nature values in a lake system;
3. Implement an adaptive management strategy

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Houtribdijk

A primary water defence in the middle of Lake IJssel



Essential for flood risk management

Curbs the water lake Marken and IJssel during extreme events



Storm Houtribdijk Februari 2018



Important road connection Lelystad - Enkhuizen

Also known as the Markerwaarddijk, N307, etc.



Initial part of Zuiderzeewerken

Construction between 1965 - 1975

PLAN VAN AFSLUITING EN DROOGMAKING
DER
ZUIDERZEE.
(ZUIDERZEE-VEREENIGING — STAATSCOMMISSIE)



- VERKLARING:
- Afsluitdijk en Meerdijken.
 - Kanalen met sluizen.
 - Grenzen der Polderafdeelingen.
 - Vult droog bij L.W.
 - Van 0-5 M. diep.
 - Dieper dan 5 M.
 - Klei.
 - Zand.
 - Veem.



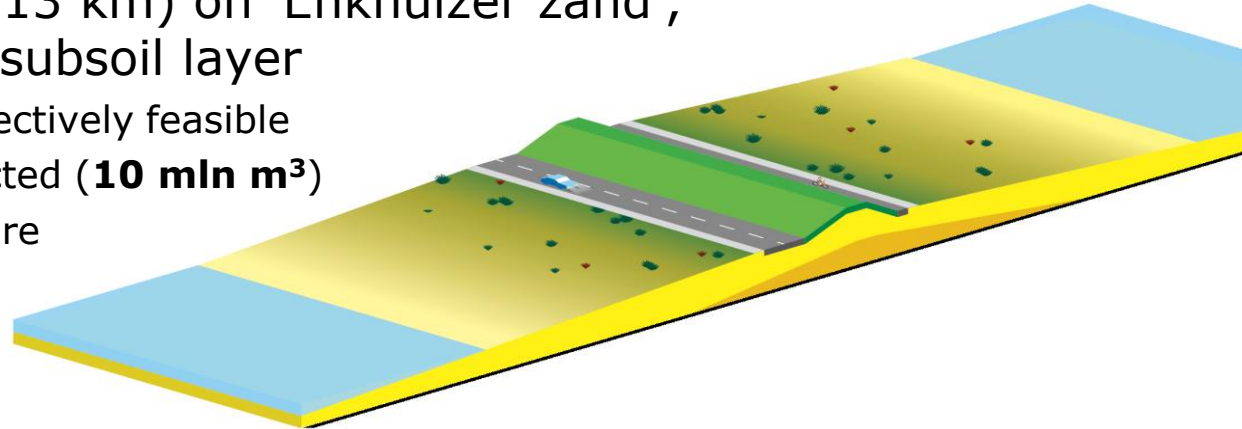
Constructed for inpoldering the Markerwaard

The polder was never constructed (Official political decision in 2003)



Levee Reinforcement

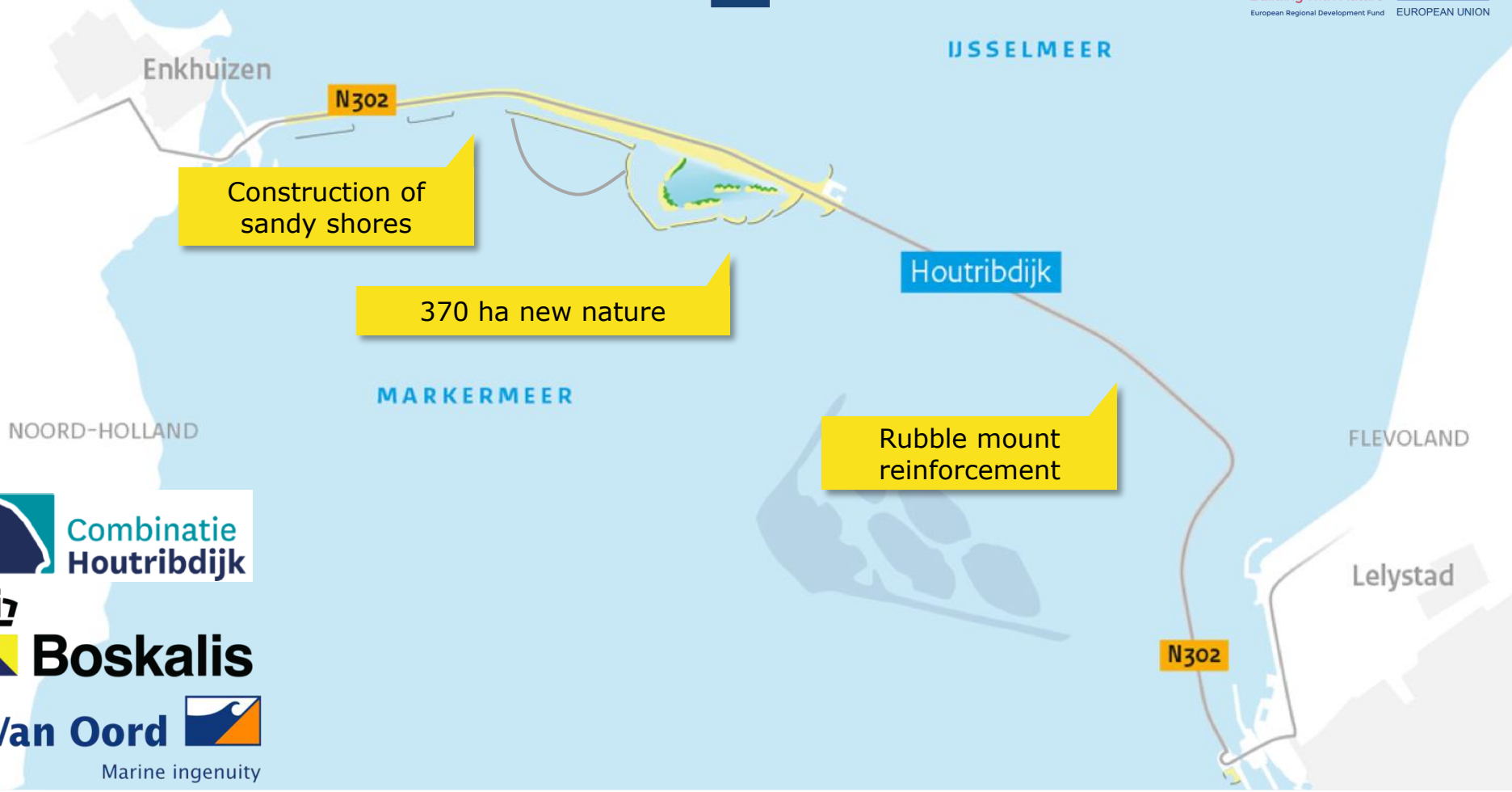
- Levee failed assessment of flood risk protection (standards)
→ Reinforcement needed (obligated by law)
- North-Western part (13 km) on 'Enkhuizer zand', a shallow and sandy subsoil layer
 - NNBF solution cost effectively feasible
 - Sandy shores constructed (**10 mln m³**)
 - Lot of benefits on nature development (flora and fauna)



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NOORD-HOLLAND

MARKERMEER

IJSSELMEER

FLEVOLAND

Lelystad



Marine ingenuity



Acquisition date: 2016-06-05
Sensor: Spot6_7
Resolution: 1.5m



World map changing (prior)

Satellite image May 2016 (www.satellietdataportaal.nl)



Finishing last parts

Additional nature area will
be constructed end of 2019

World map changing (post)

Satellite image March 2019 (www.satellietdataportaal.nl)



Sandy shores and nature area Trintelzand

Enhanced biodiversity in lake IJssel area



Applying a NNBf solution:

- **Needs to be safe at all times! → Intervention level is needed**
- You allow for a dynamic system
 - Introduce a rate of flexibility in the system's state
 - Check the state of the system more regularly
 - Don't panic when intervention level is exceeded locally → assess whether natural forces are able to intervene with material from surrounding areas.
- **Adaptive management is needed and being developed**
 - Unknown rate of morphodynamics (and why)
 - Make use of collaboration on NNBf guideline development with USACE



Research and monitoring program

Rijkswaterstaat in collaboration with TU Delft

4-year program that includes high resolution monitoring of hydraulics and morphodynamics

Monitoring sandy shores Houtribdijk

Rijkswaterstaat reinforces the Houtribdijk partly by constructing sandy shores. The sand will dissipate the energy of the waves before the waves can reach the levee. Making use of sandy shores as a flood risk protection measure in a fresh water inland lake environment is unique. To be able to apply this adaptive, nature-based and ecofriendly measure more often, Rijkswaterstaat and Delft University of Technology set up a research and monitoring programme. Main goal of the programme is to develop knowledge on the maintainability of the sandy shores in lake environment without tides.

www.rijkswaterstaat.nl/houtribdijk/english



Morphodynamics

Over time the sand will form an equilibrium with the incoming wave action. Various measurements will learn us which important processes are driving the deformation of the sand.

Circulating installations

Three locations are being monitored in detail where high frequent wave, velocity and morphodynamic measurements are performed. These locations change over time during the program.

Long term benchmarks

These benchmark installations are active during the entire program. The installations measure offshore wave and velocity conditions in the Markermeer and IJsselmeer.

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NNBF solution for levee reinforcement

- Has lots of advantages, i.e.:
 - More flexibility for future changes
 - Smart maintenance using nature
 - Enhances ecologic values
 - Birds paradise
 - Shelter areas for fish
 - N2000 and EU-WFD
- Disadvantages to overcome, i.e.:
 - No prior experience – no reference -> large uncertainty in design
 - Uncertainty in maintenance during lifespan of solution -> AM!





Rijkswaterstaat
*Ministry of Infrastructure
and Water Management*

For further questions, please do not
hesitate to contact me!



Ministry of Infrastructure
and Water Management

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More information and movies can be found on:

<https://www.rijkswaterstaat.nl/houtribdijk/english>