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Institution of Civil Engineers

Knowledge

in partnership with Environment Agency

Decision making in Dutch coastal research based on coastal management policy assumptions

Quirijn Lodder
Principal Advisor Coastal Flood Risk Management

ice.org.uk/coastal2019

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Institution of Civil Engineers

Knowledge

Rijkswaterstaat
Ministry of Infrastructure and Water Management

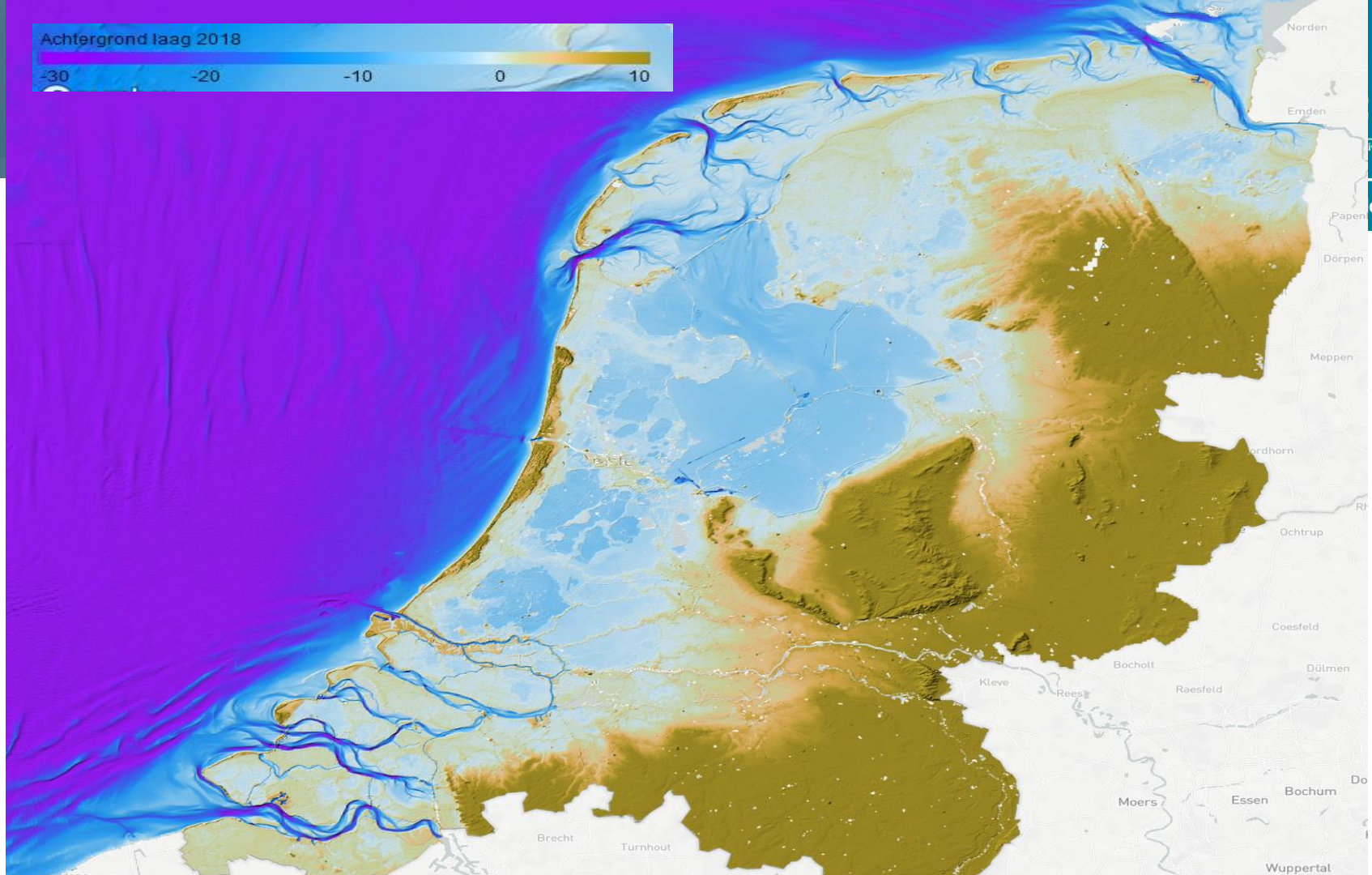
in partnership with
Environment Agency

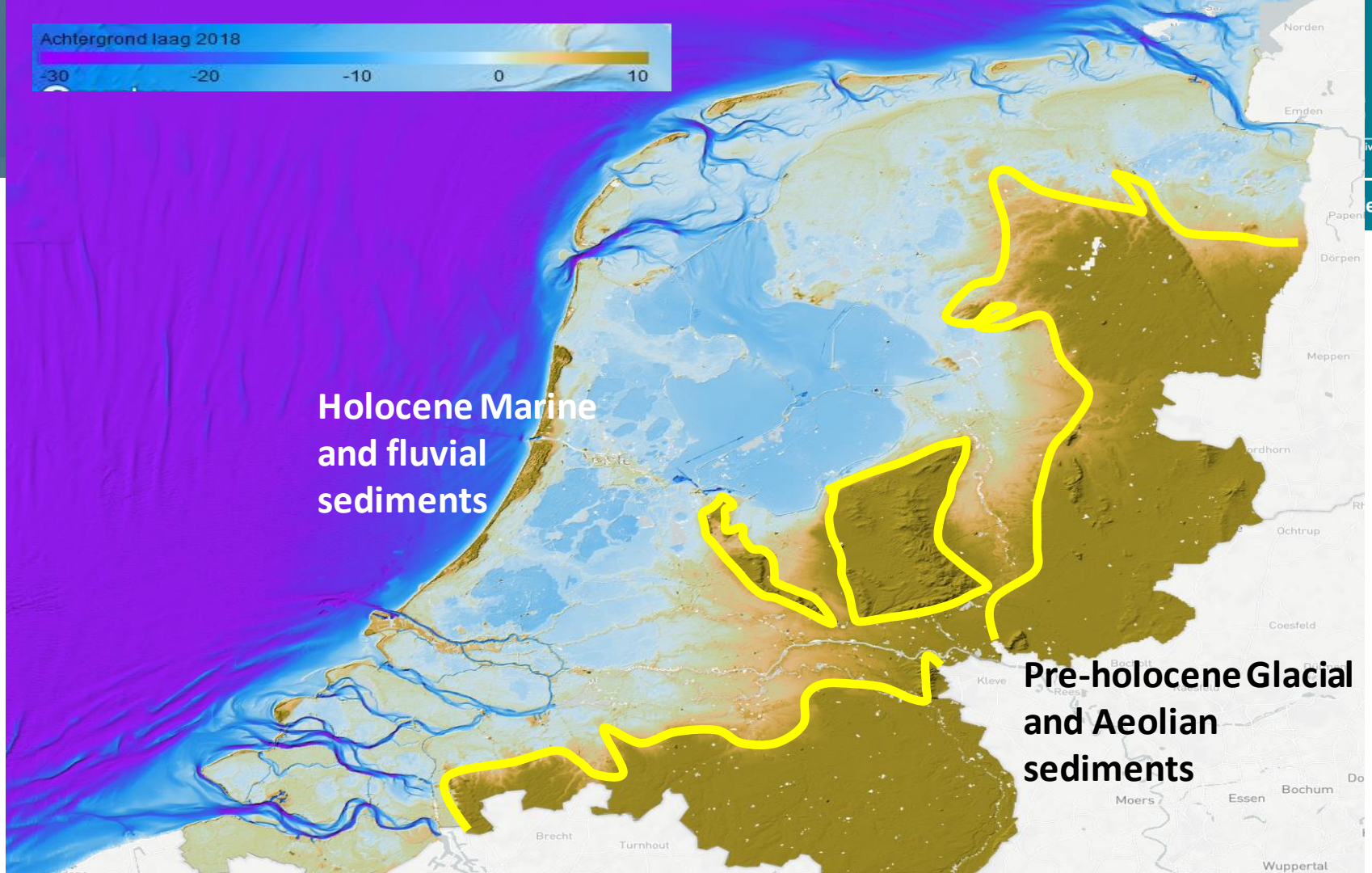
TU Delft

Jill H. Slinger, Delft University of Technology / Rhodes University, South Africa
Zheng Bing Wang, Delft University of Technology / Deltares
Carola van Gelder, Rijkswaterstaat

Interreg North Sea Region
Building with Nature
European Regional Development Fund
EUROPEAN UNION

ice.org.uk/coastal2019


Achtergrond laag 2018
-30
-20
-10
0
10
Norden
Emden
Papen
Dörpen
Meppen
Ochtrup
Coesfeld
Bocholt
Dülmen
Kleve
Rees
Raesfeld
Moers
Essen
Bochum
Brecht
Turnhout
Wuppertal


Achtergrond laag 2018
-30
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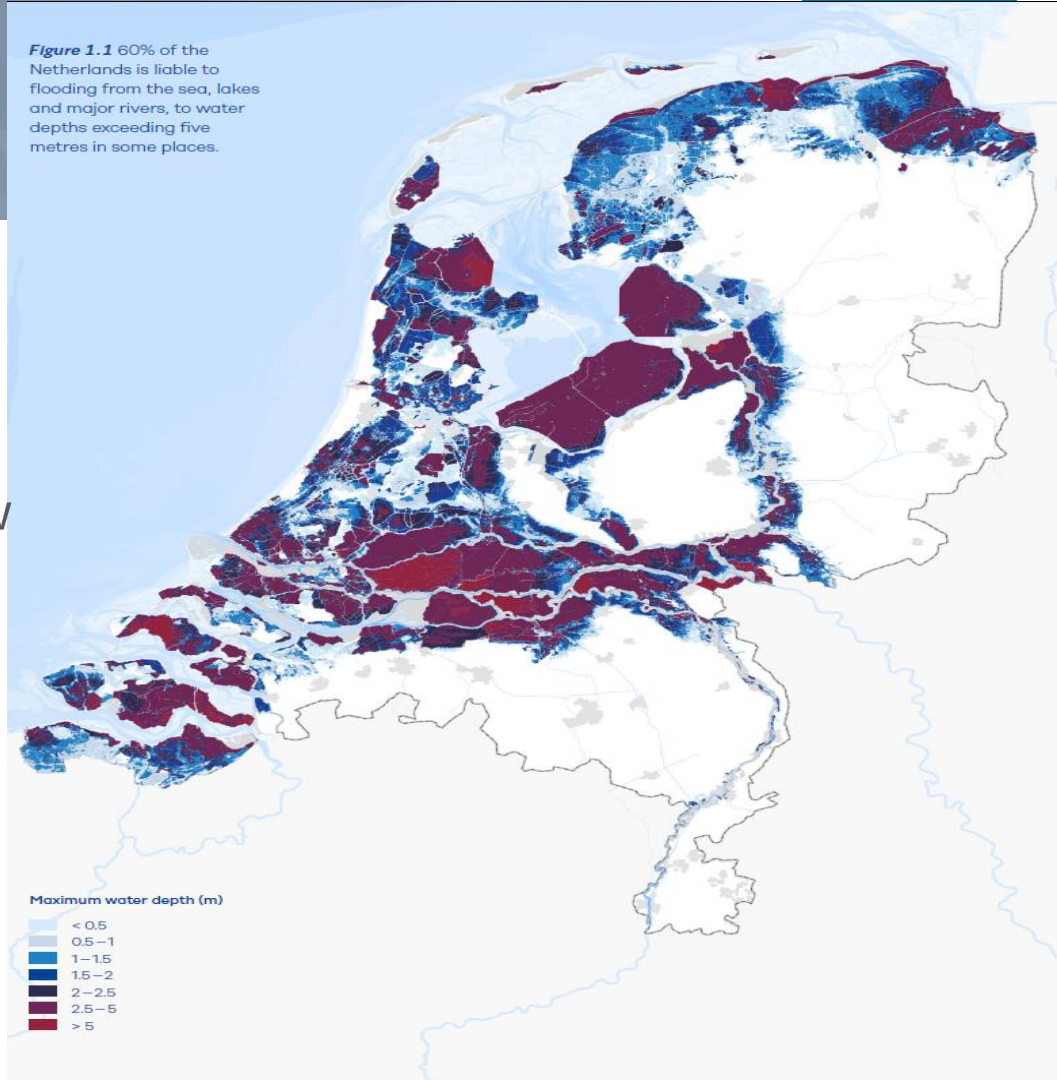
Holocene Marine and fluvial sediments
Pre-holocene Glacial and Aeolian sediments
Norden
Emden
Dörpen
Meppen
Ochtrup
Coesfeld
Kleve
Moers
Essen
Bochum
Wuppertal
Brecht
Turnhout

Flood Prone Netherlands

- 26% below mean sea level
- 55% is susceptible to flooding
- 60% of our population lives below mean sea level
- > 60 % of our economic value is earned in the lowest-parts of the country

- **Strong correlation with sediment origin…**



So in many places it looks like this

So in many places it looks like this

ice
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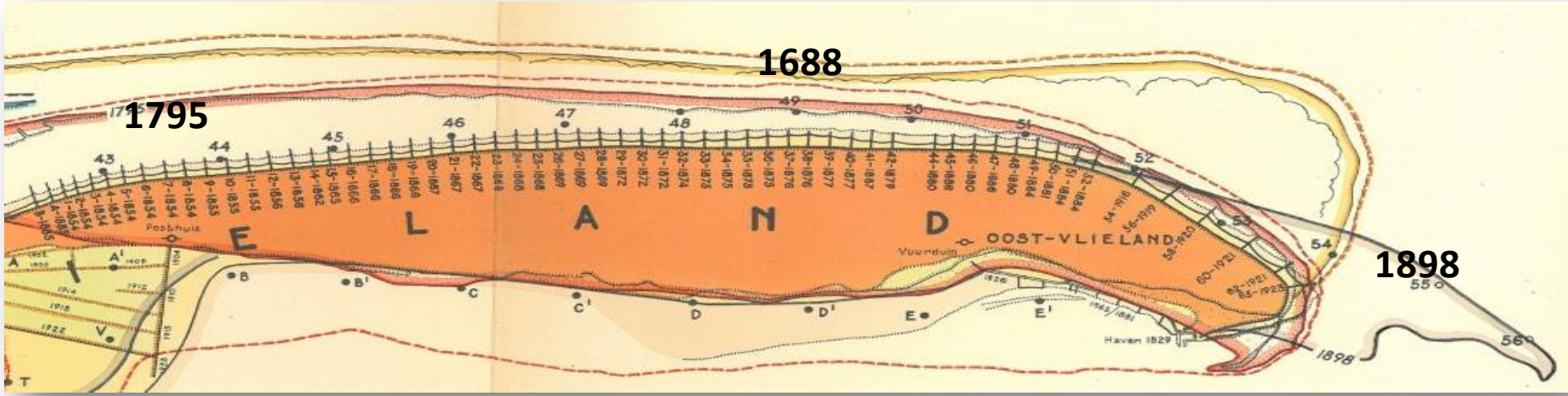
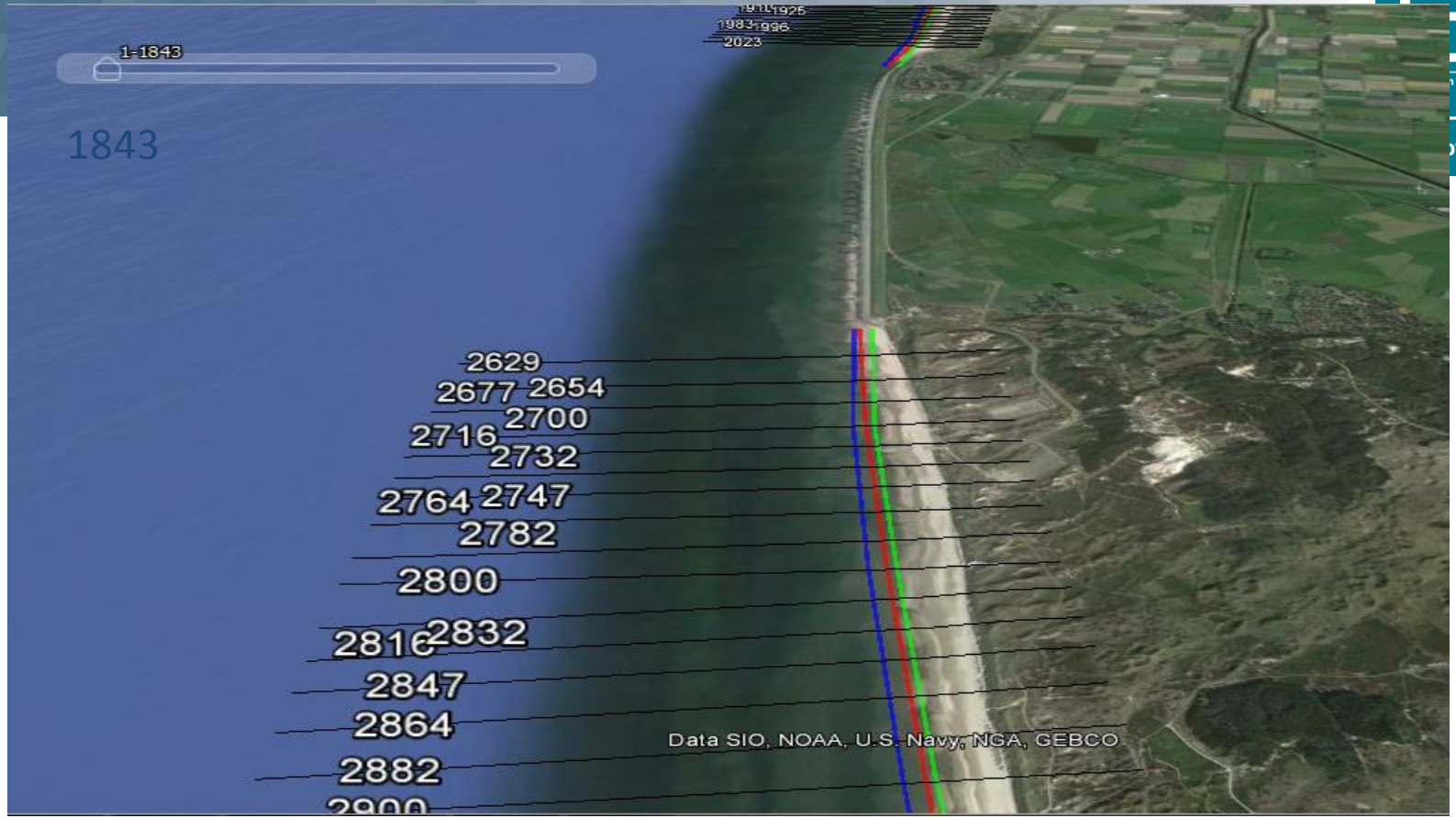
Knowledge

We have an on average eroding coastline




1-1843
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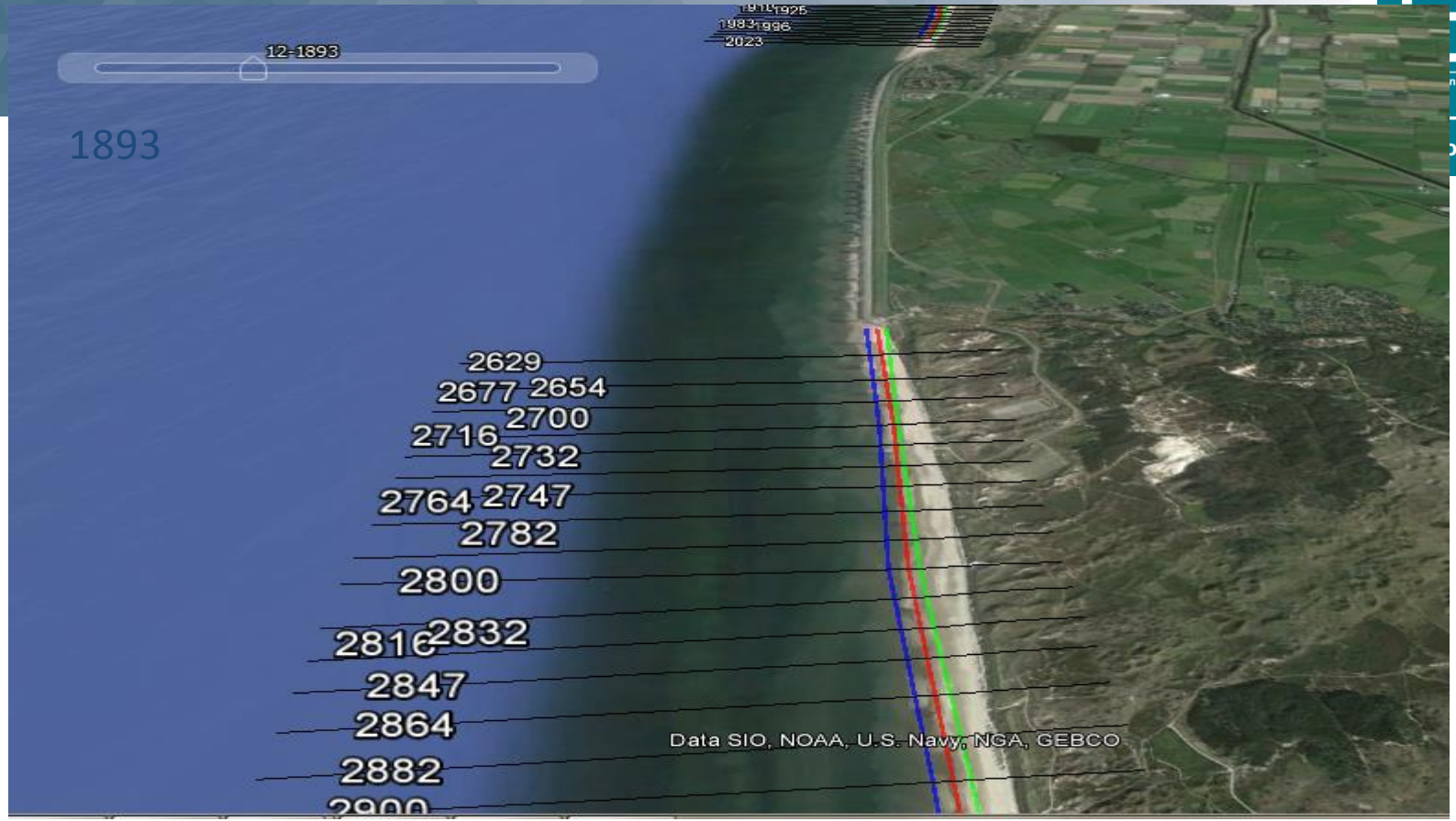
Data SIO, NOAA, U.S. Navy, NGA, GEBCO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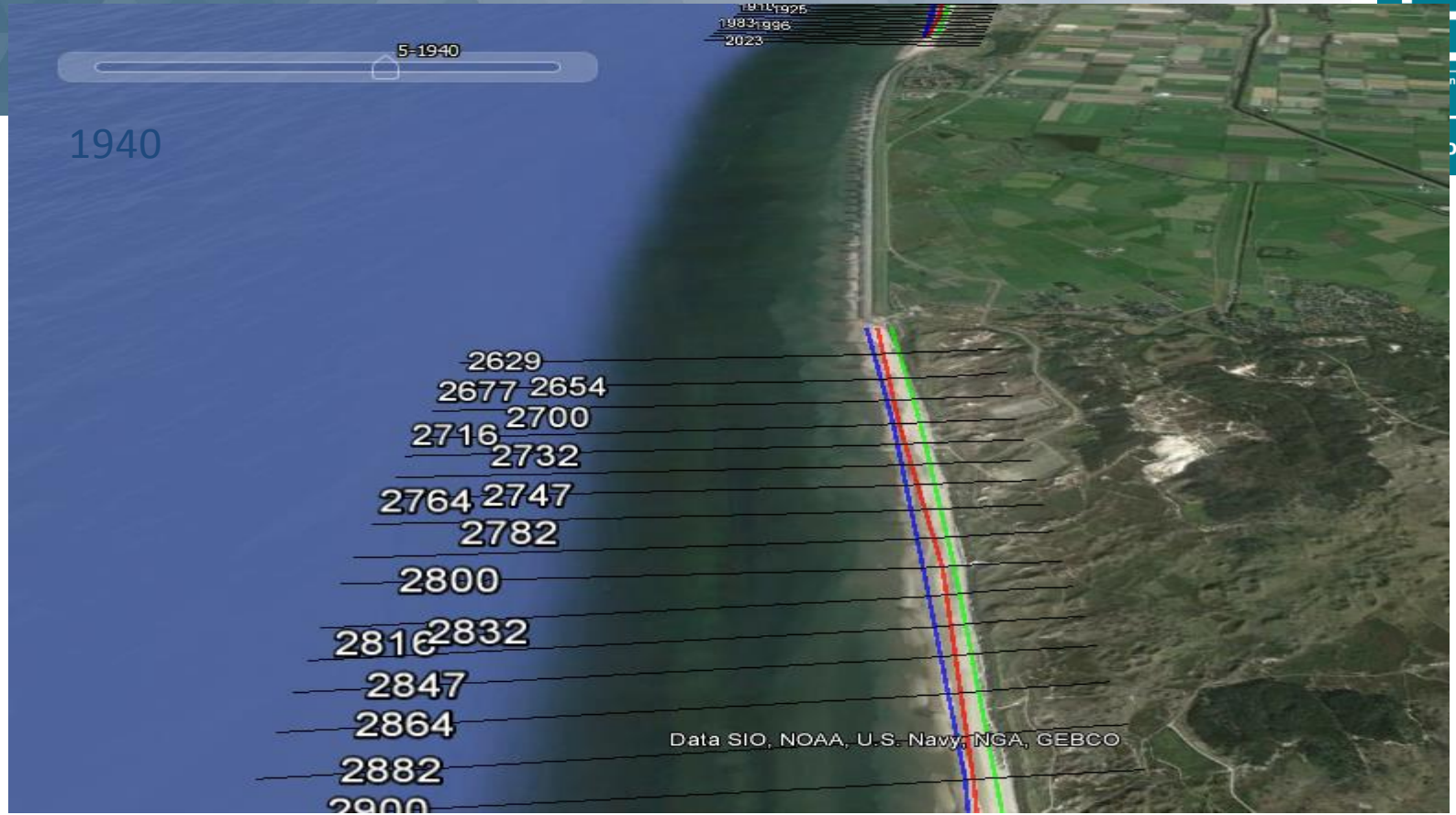
Data SIO, NOAA, U.S. Navy, NGA, GEBCO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Data SIO, NOAA, U.S. Navy, NGA, GEBCO


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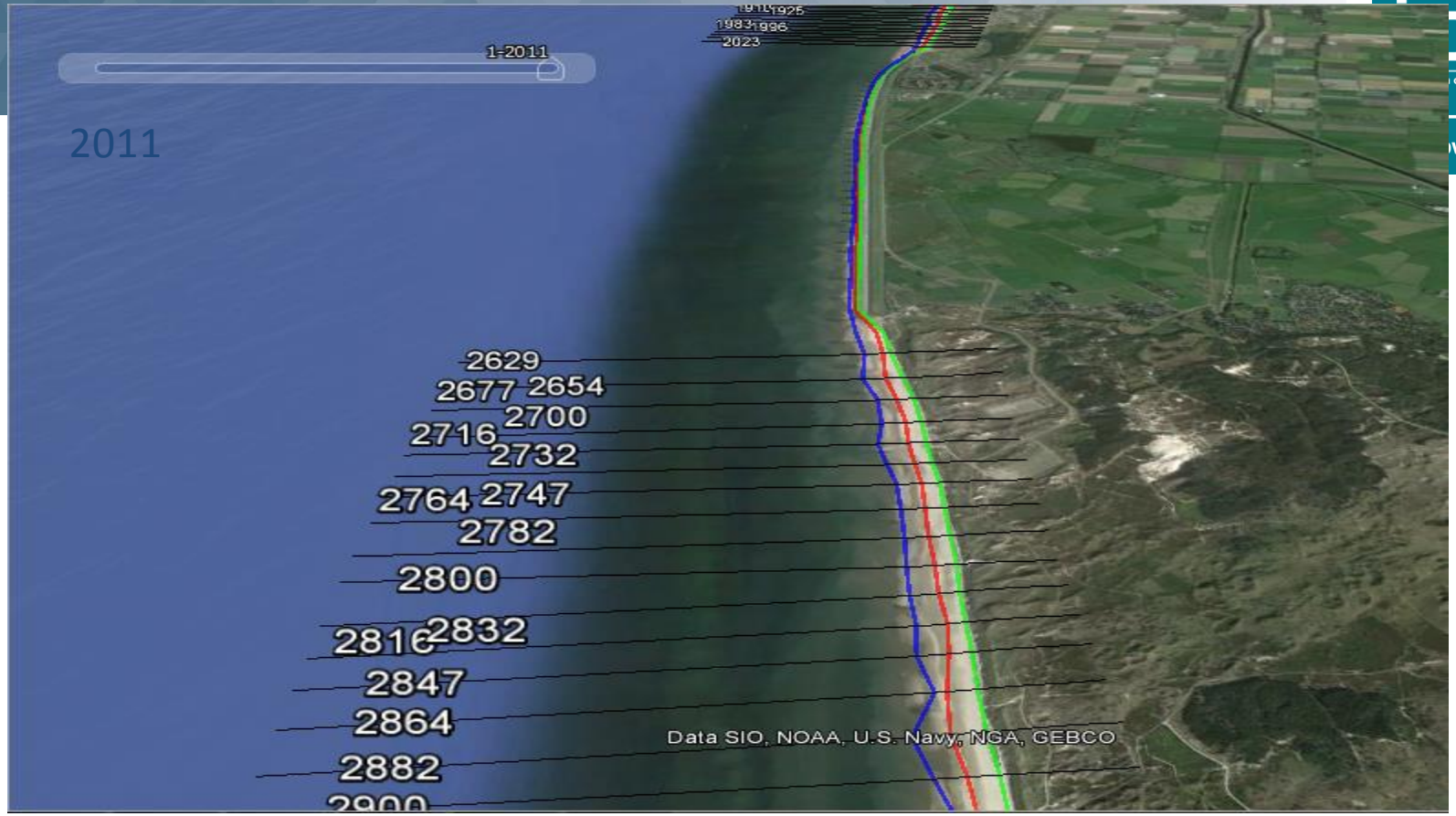
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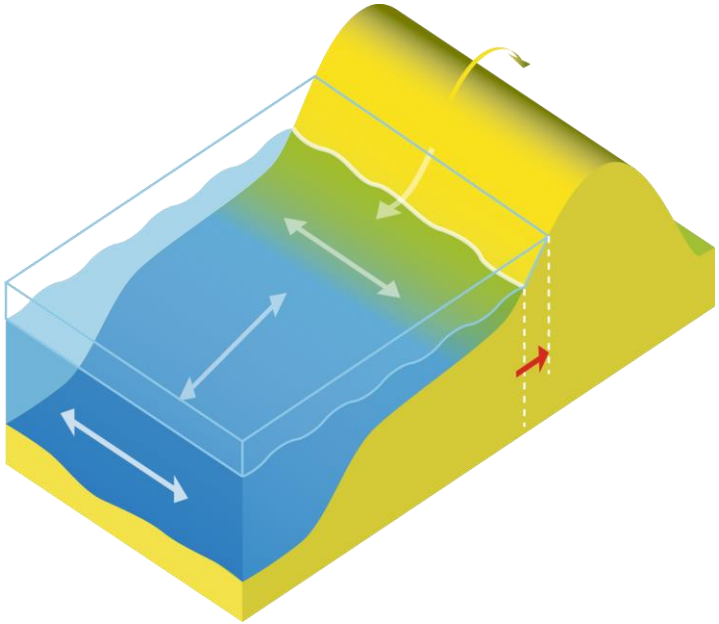
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

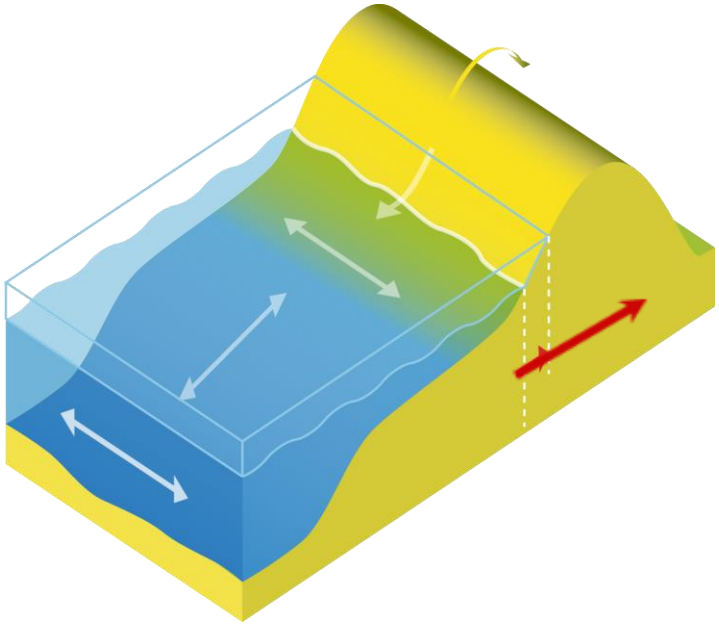
The erosion treatens coastal functions

Coastal Protection with Sediments

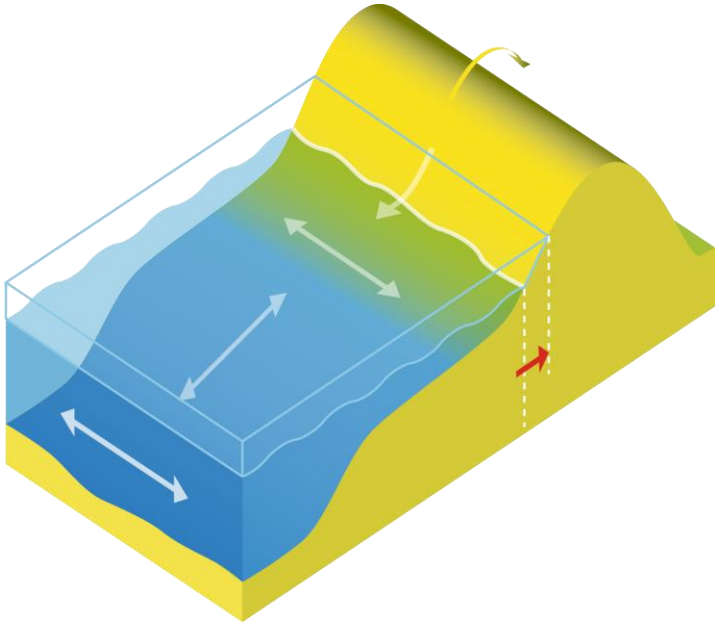
Effect Sea Level Rise

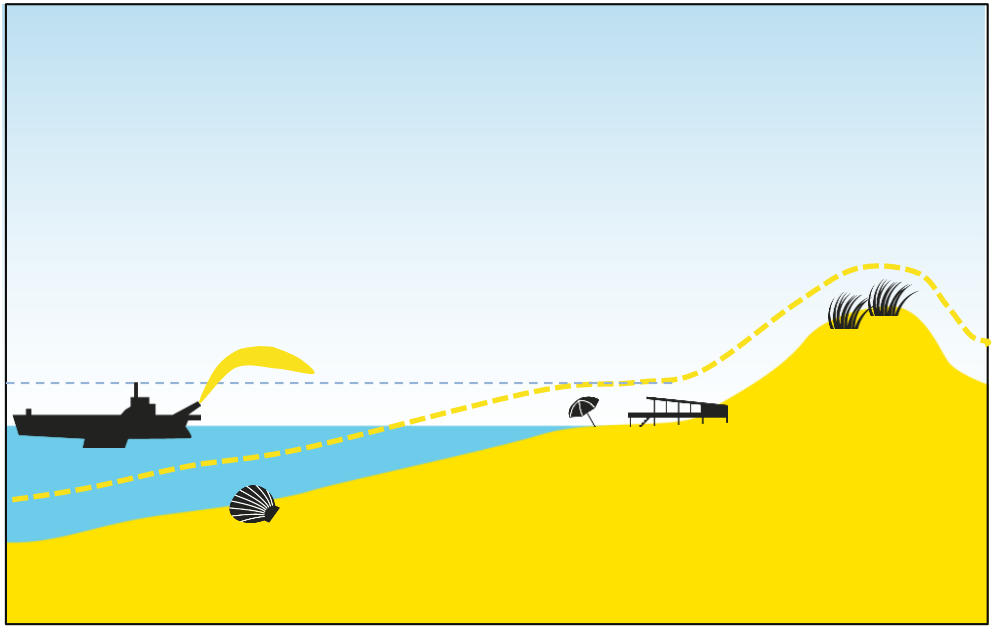


Effect Sea Level Rise

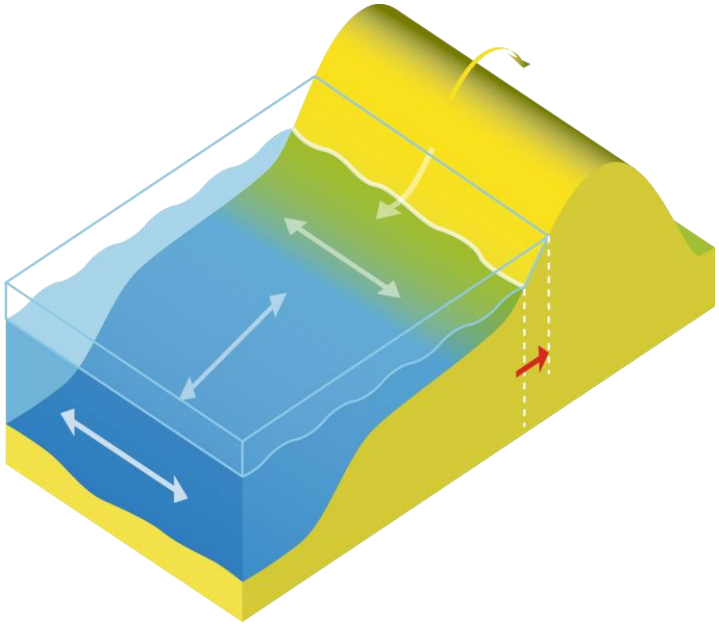


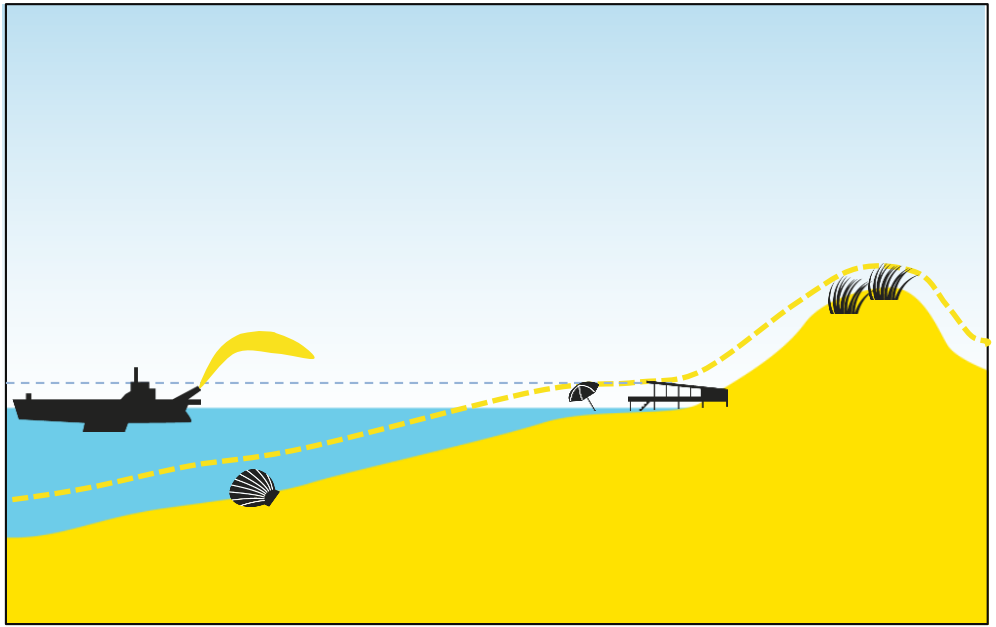
Dutch Strategy: Feed the Coast with Sediments





So it can grow with Sea Level





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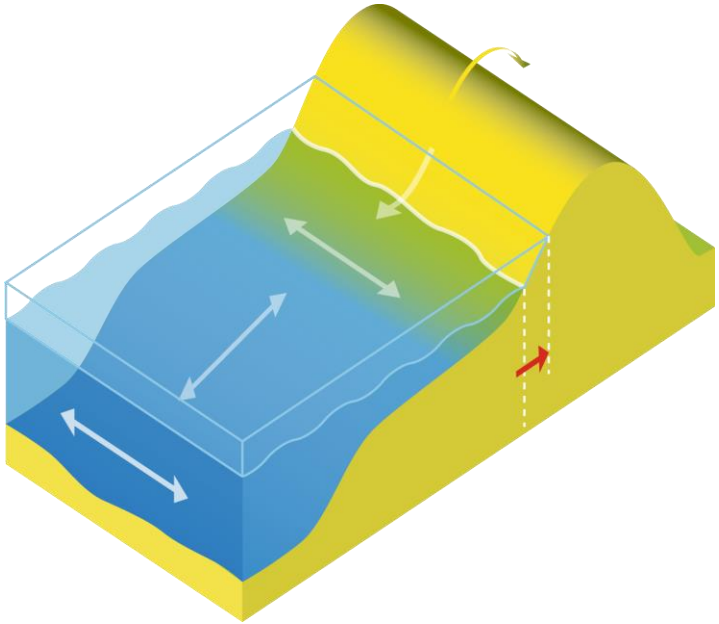
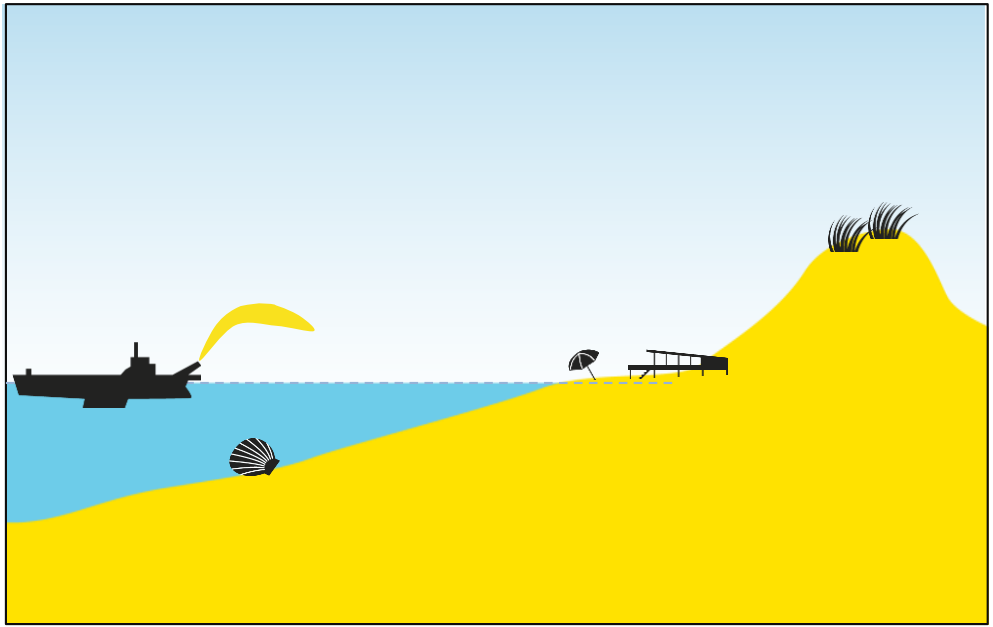
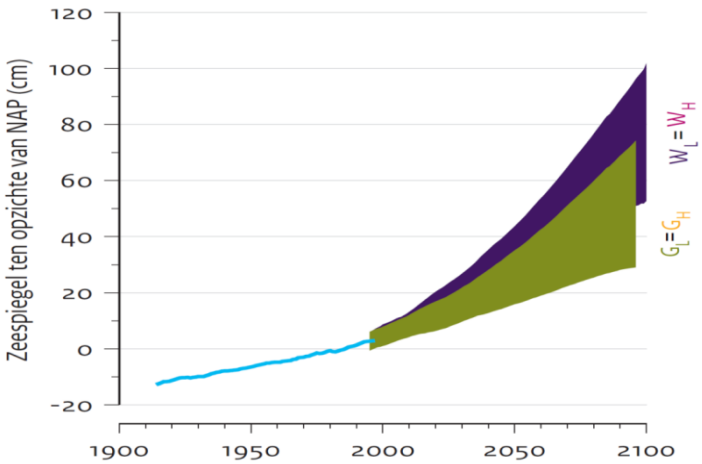
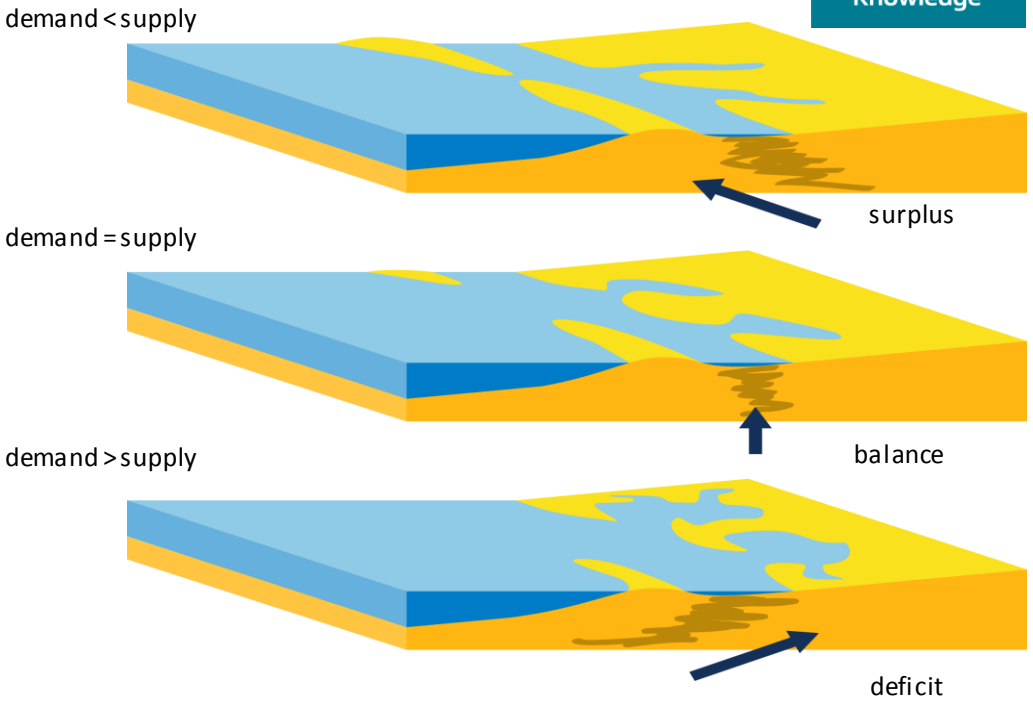




Coastal evolution of sedimentary systems: **net** result of the **sediment budget**



Measured Sea Level Rise
Around 20 cm/century



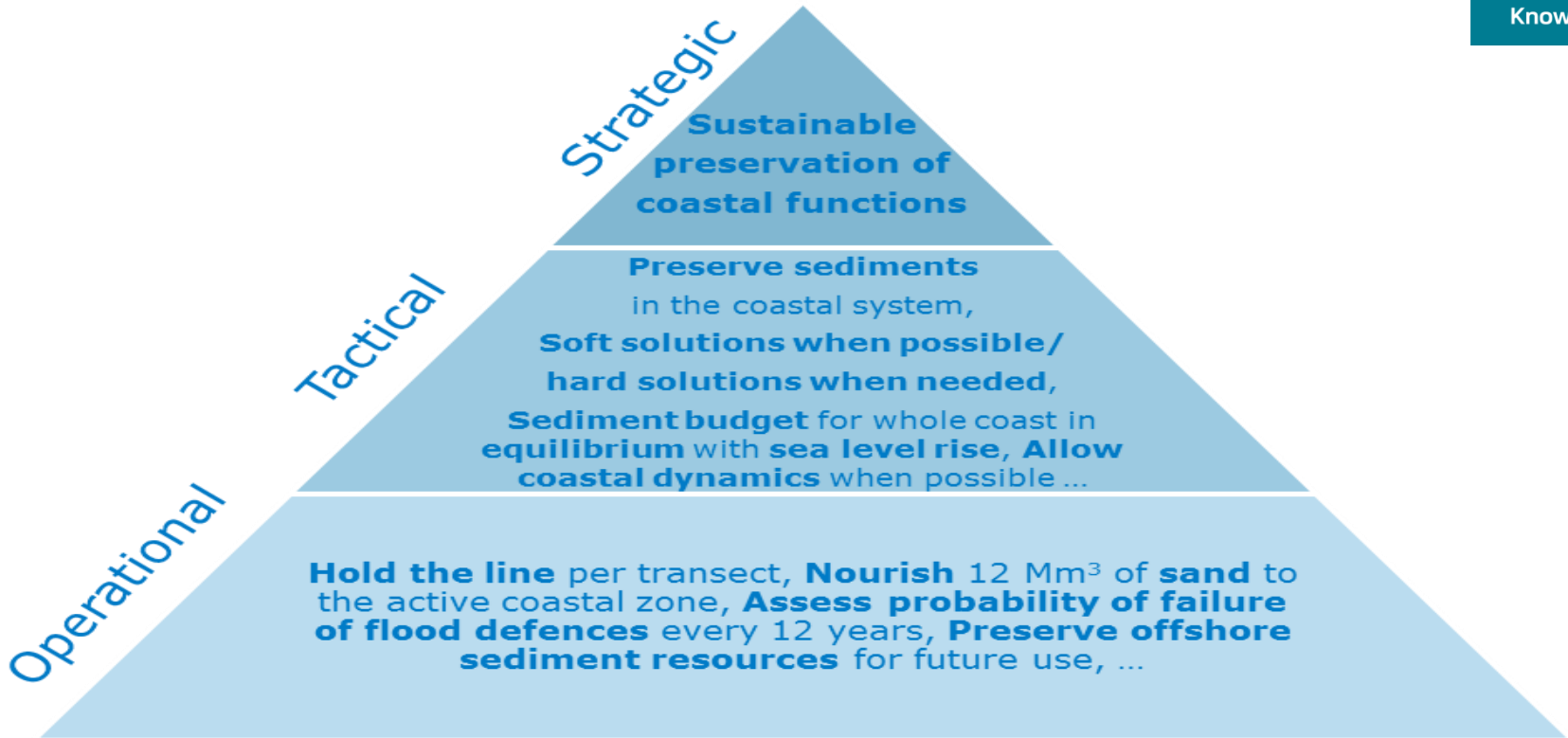
After: Nichols, 1989, marine geology 88 pp 201-209

Strategic objective

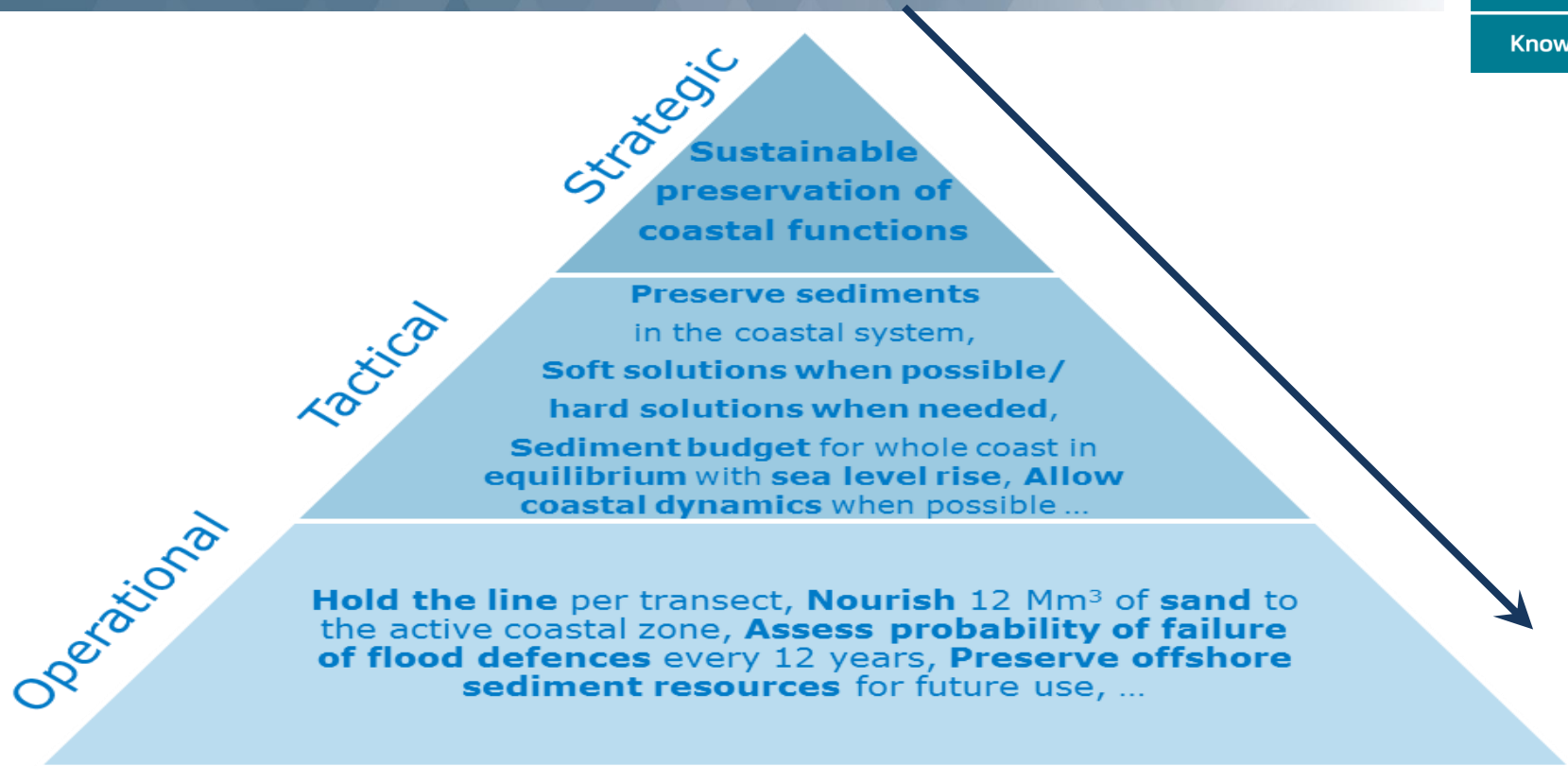
Provide the conditions to **sustainably preserve** the **functions** of the coastal zone including:

- Protection low-lying polders against flooding
- Infrastructure on the dunes
- Dune Habitats
- Recreation
- Fresh water extraction

Strategy


Strategic
Sustainable preservation of coastal functions
Tactical
Preserve sediments in the coastal system, Soft solutions when possible/ hard solutions when needed, Sediment budget for whole coast in equilibrium with sea level rise, Allow coastal dynamics when possible …
Operational
Hold the line per transect, Nourish 12 Mm³ of sand to the active coastal zone, Assess probability of failure of flood defences every 12 years, Preserve offshore sediment resources for future use, …

Strategy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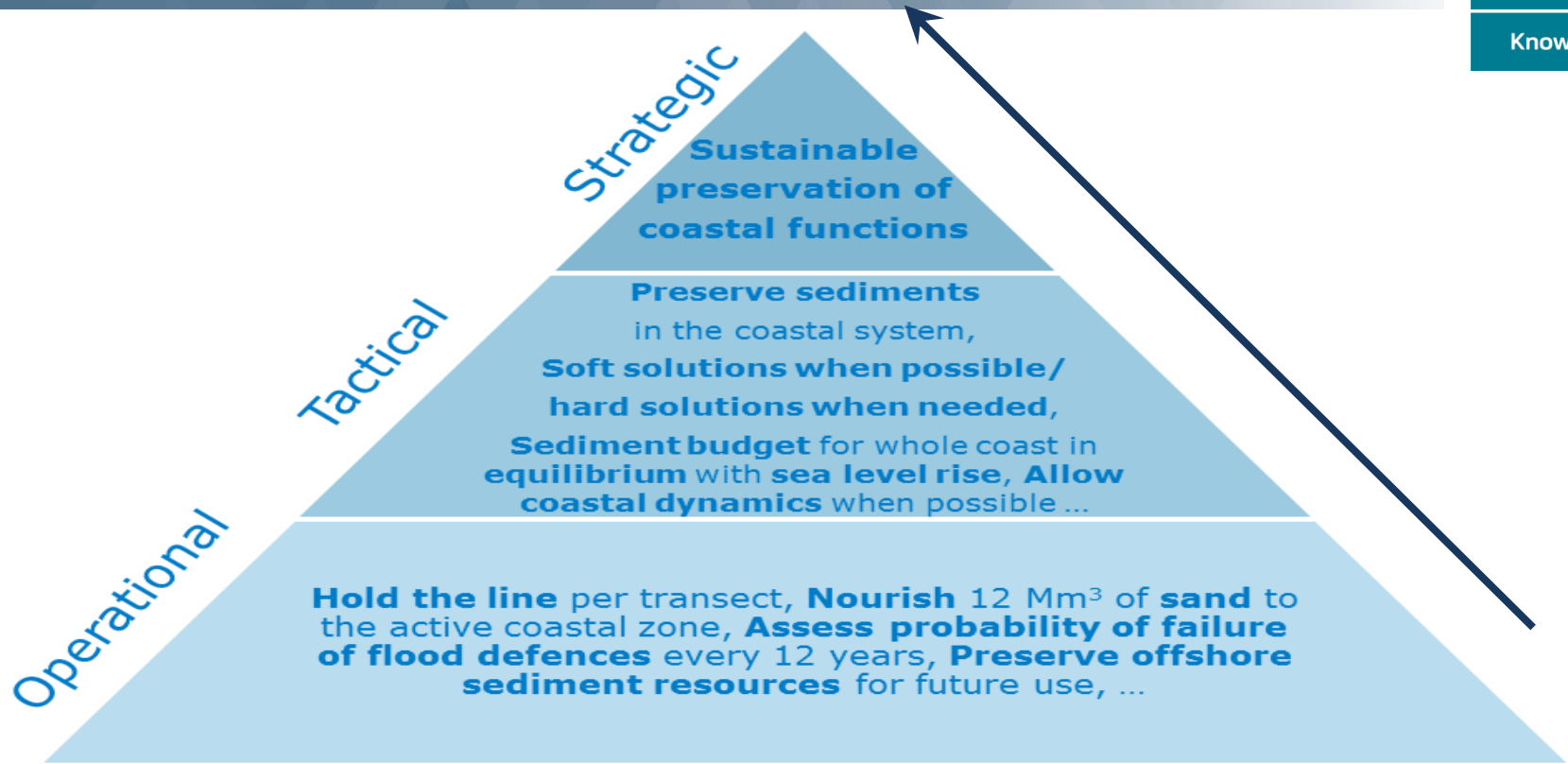
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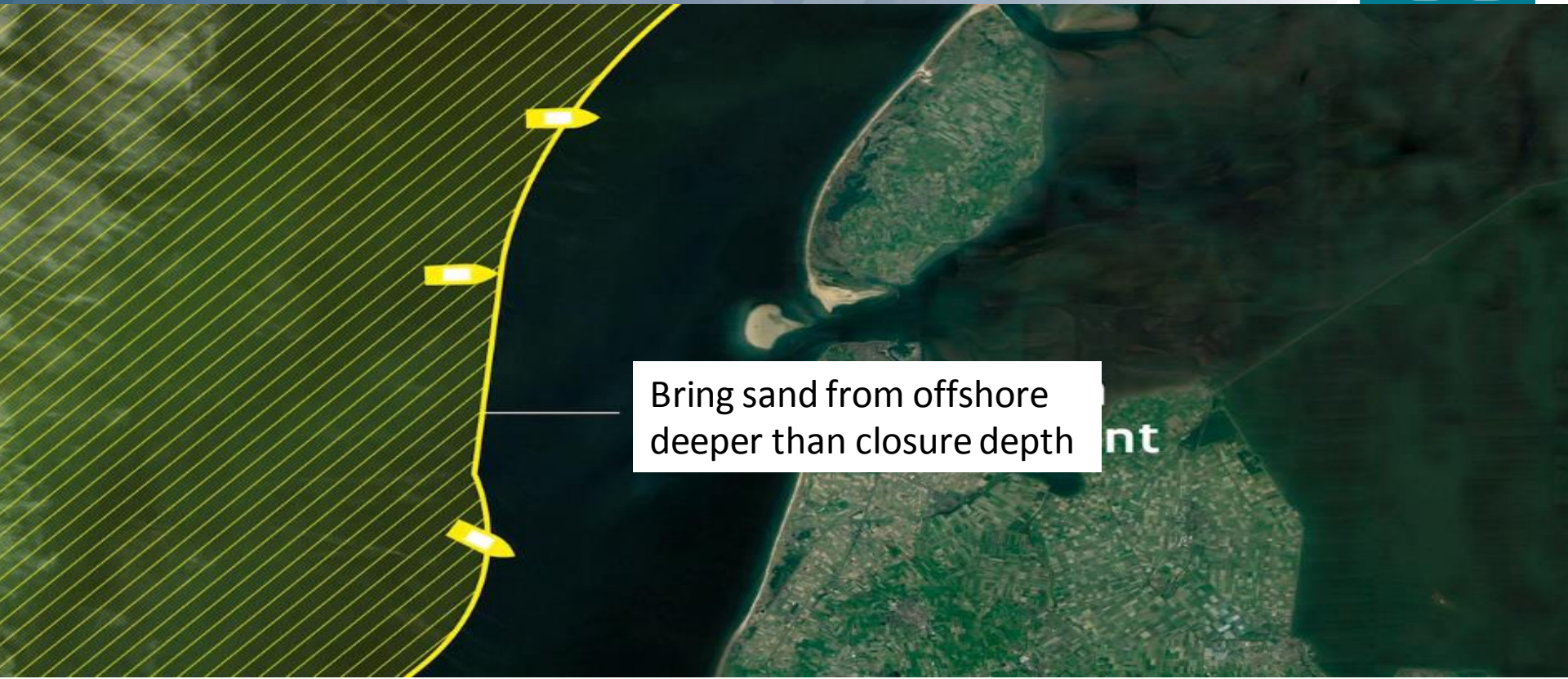
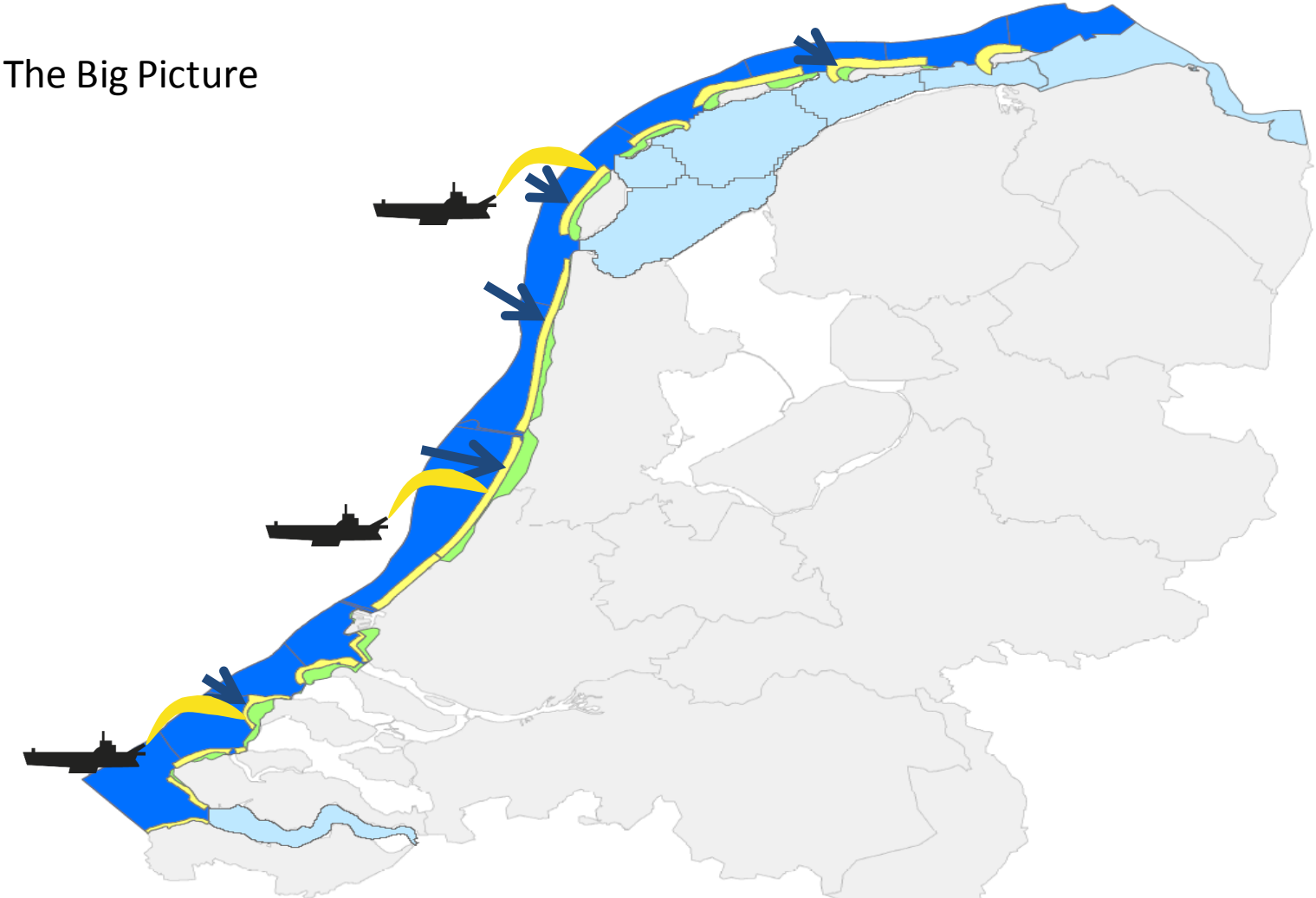

Bring sand from offshore deeper than closure depth

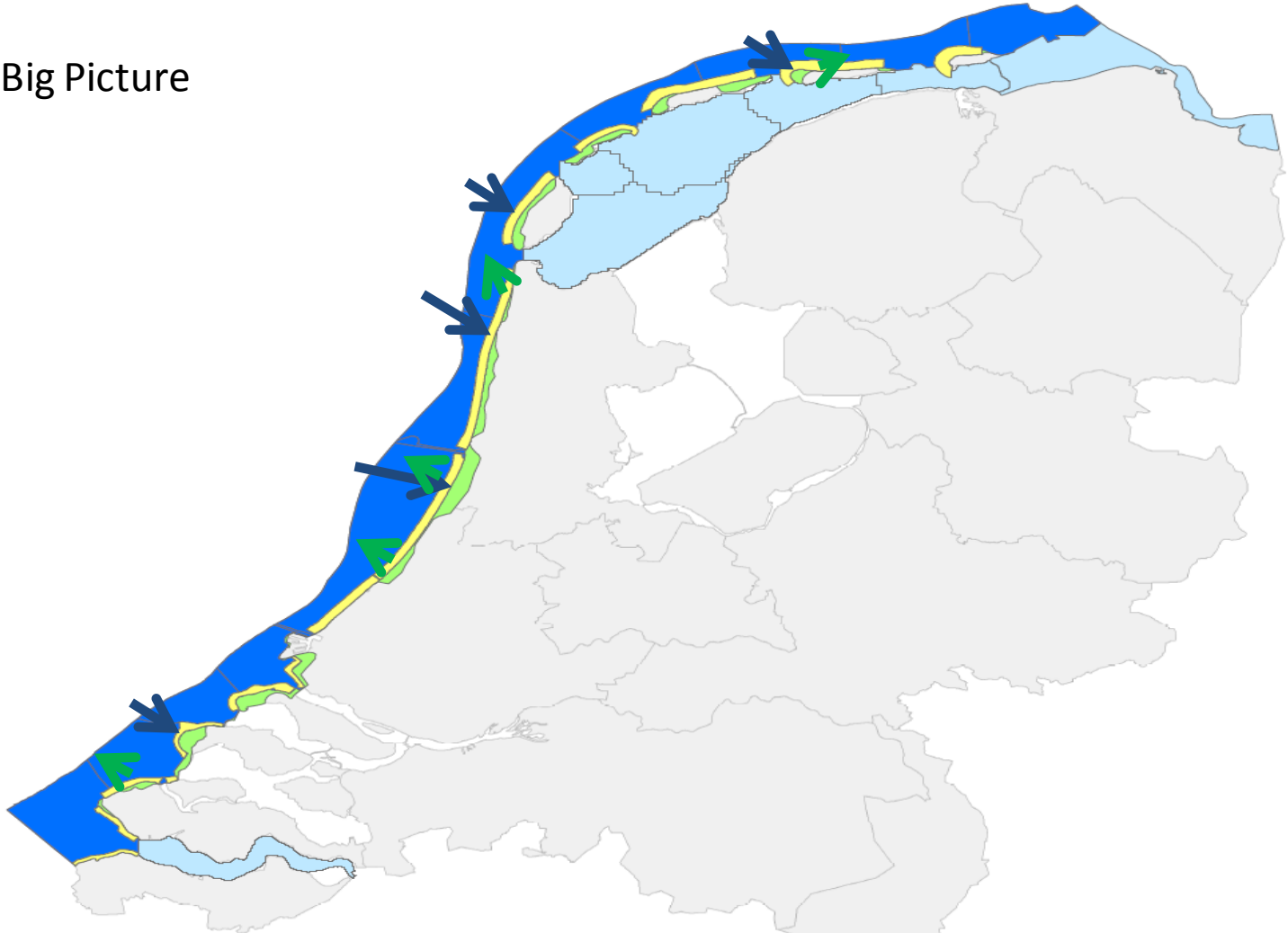

Bring sand from offshore deeper than closure depth


Bring sand from offshore deeper than closure depth

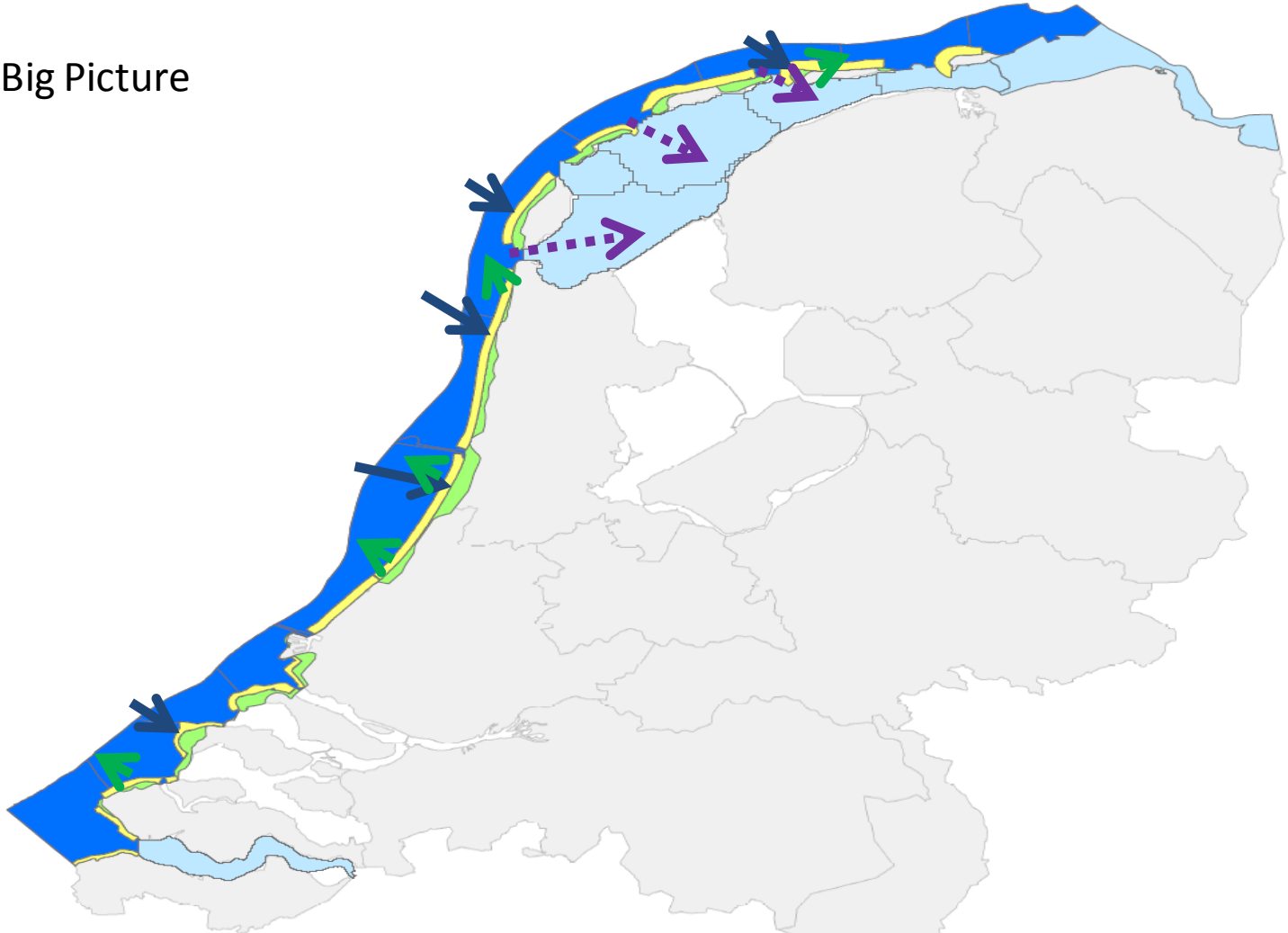
The Big Picture

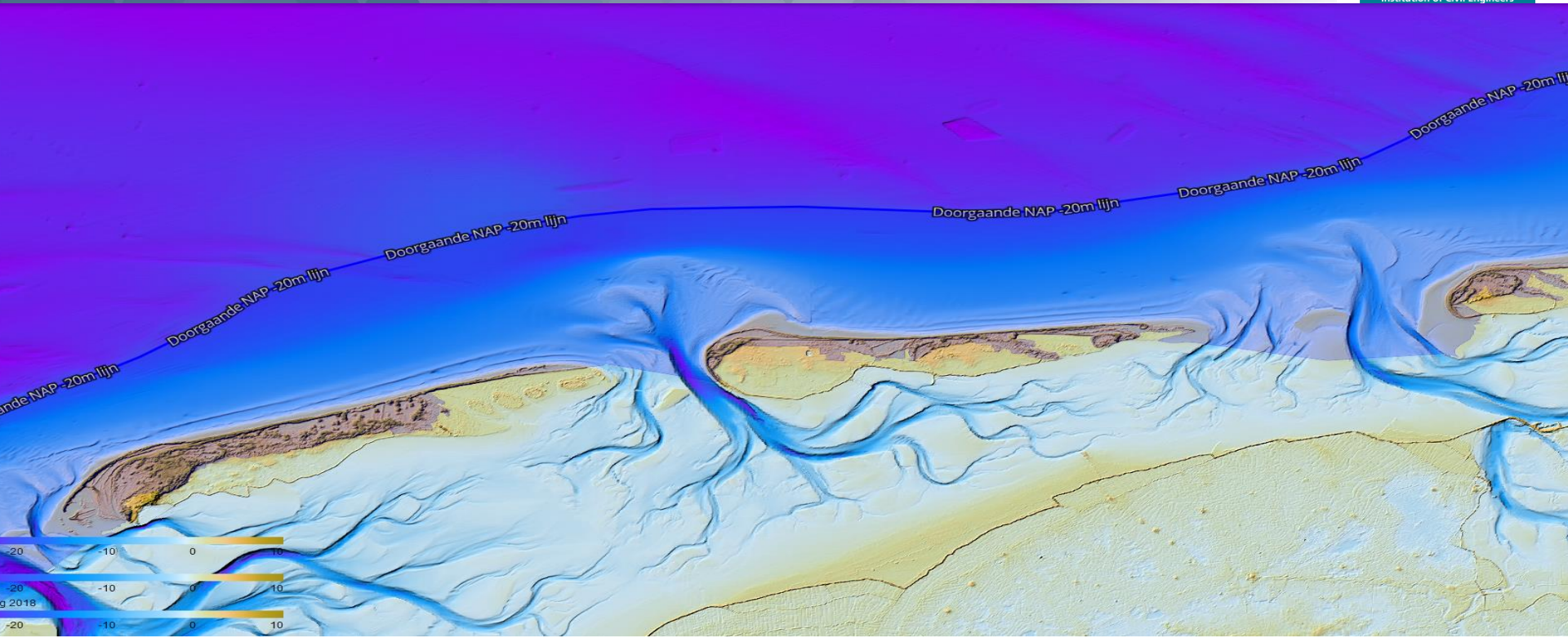


The Big Picture



The Big Picture




Doorgaande NAP -20m lijn
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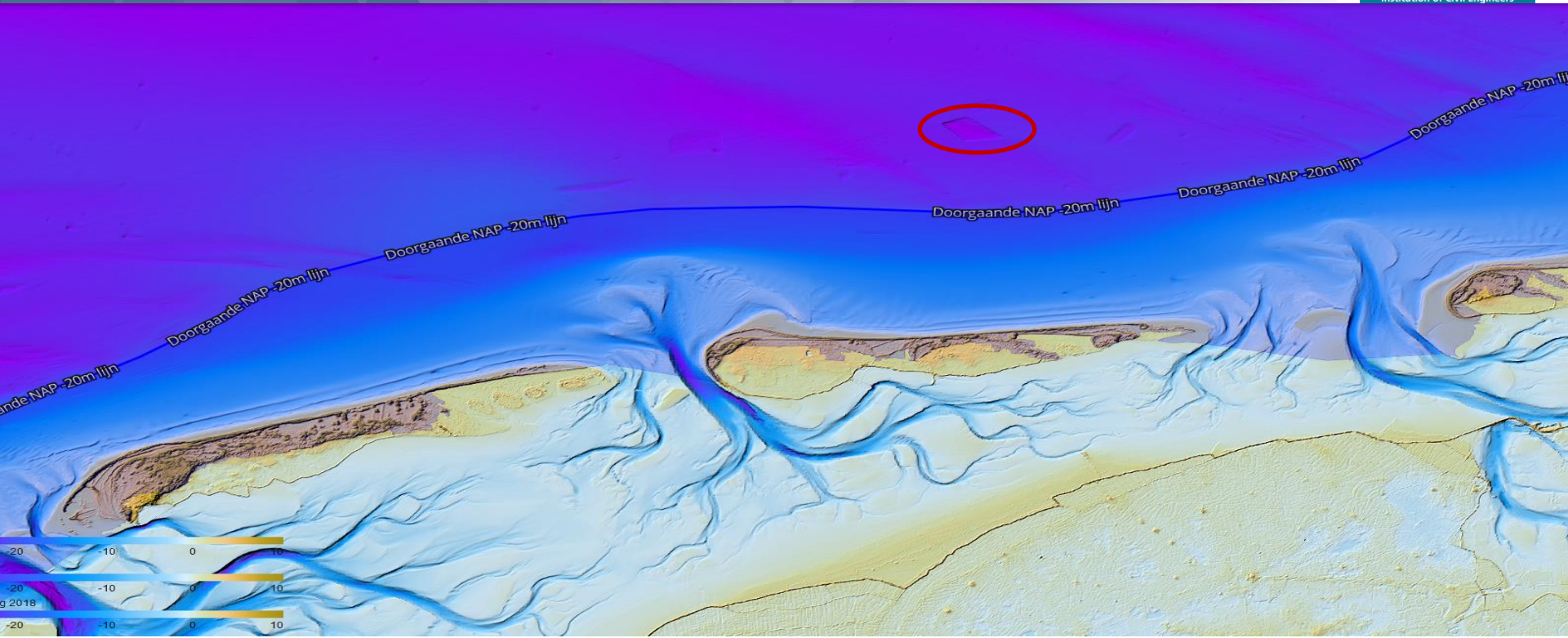
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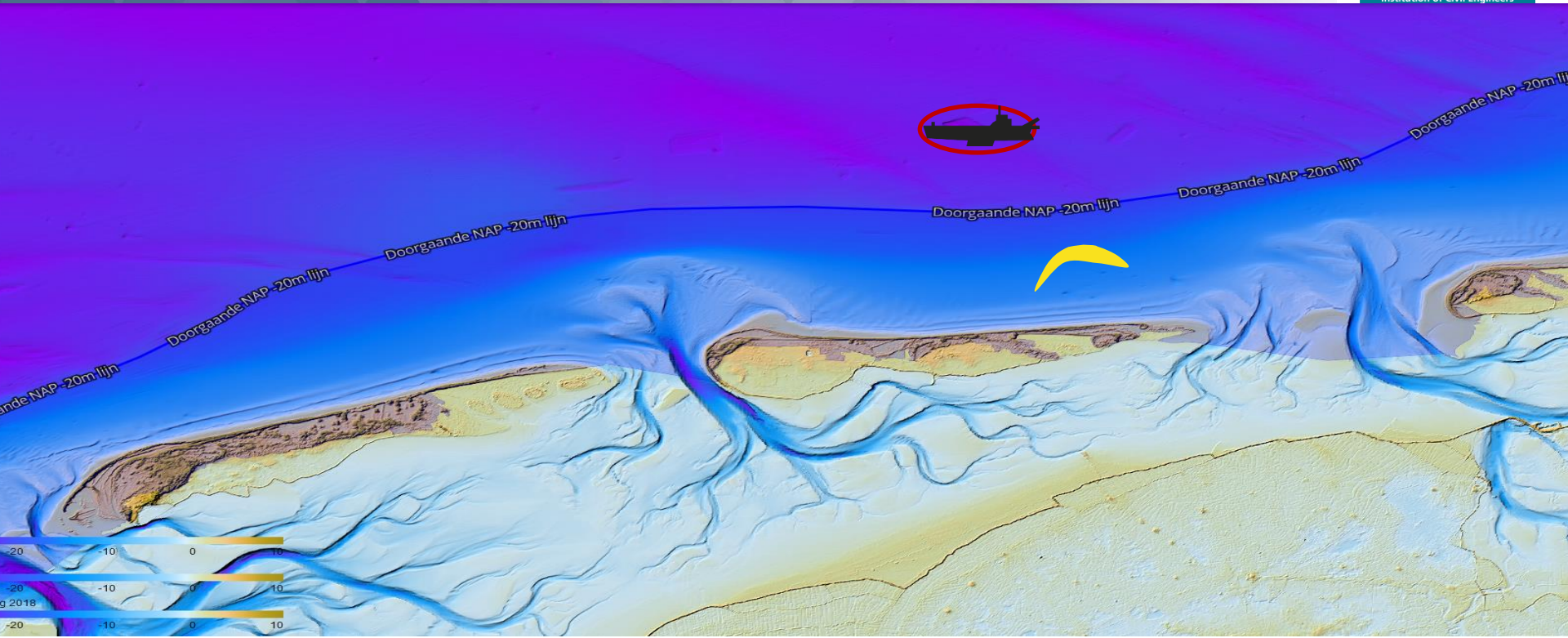
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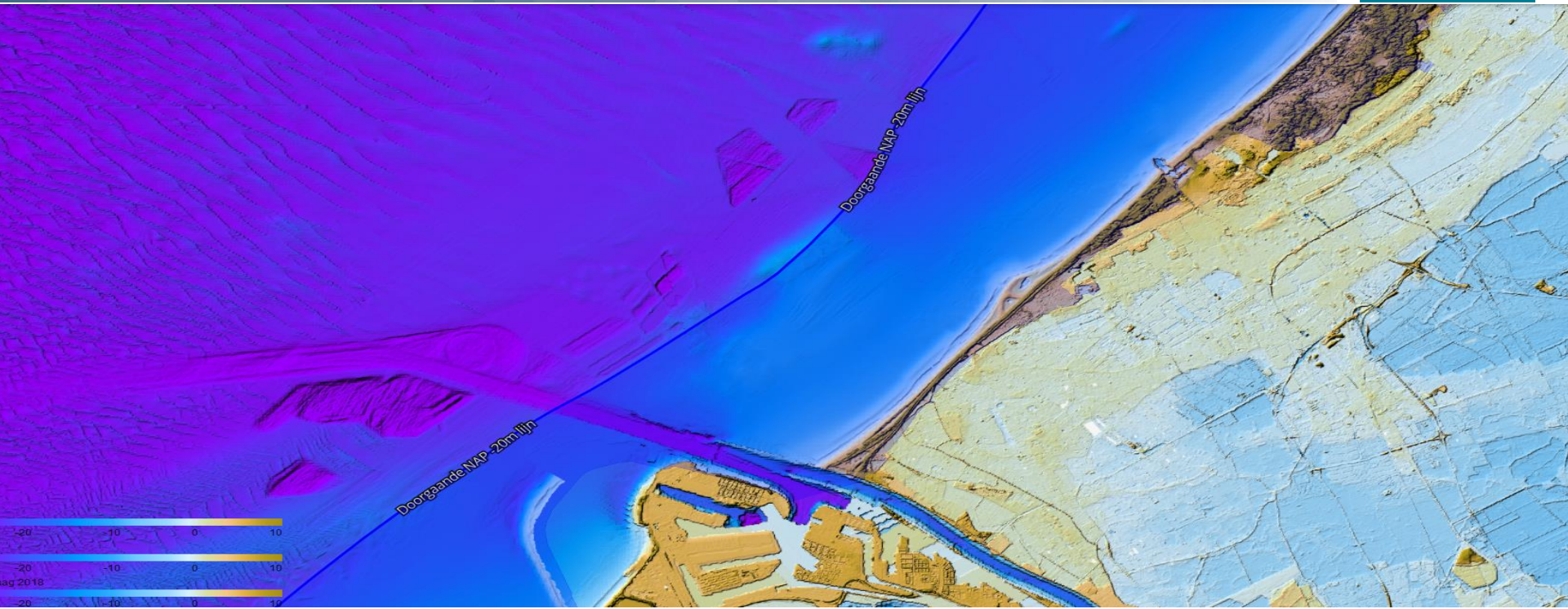
Doorgaande NAP -20m lijn
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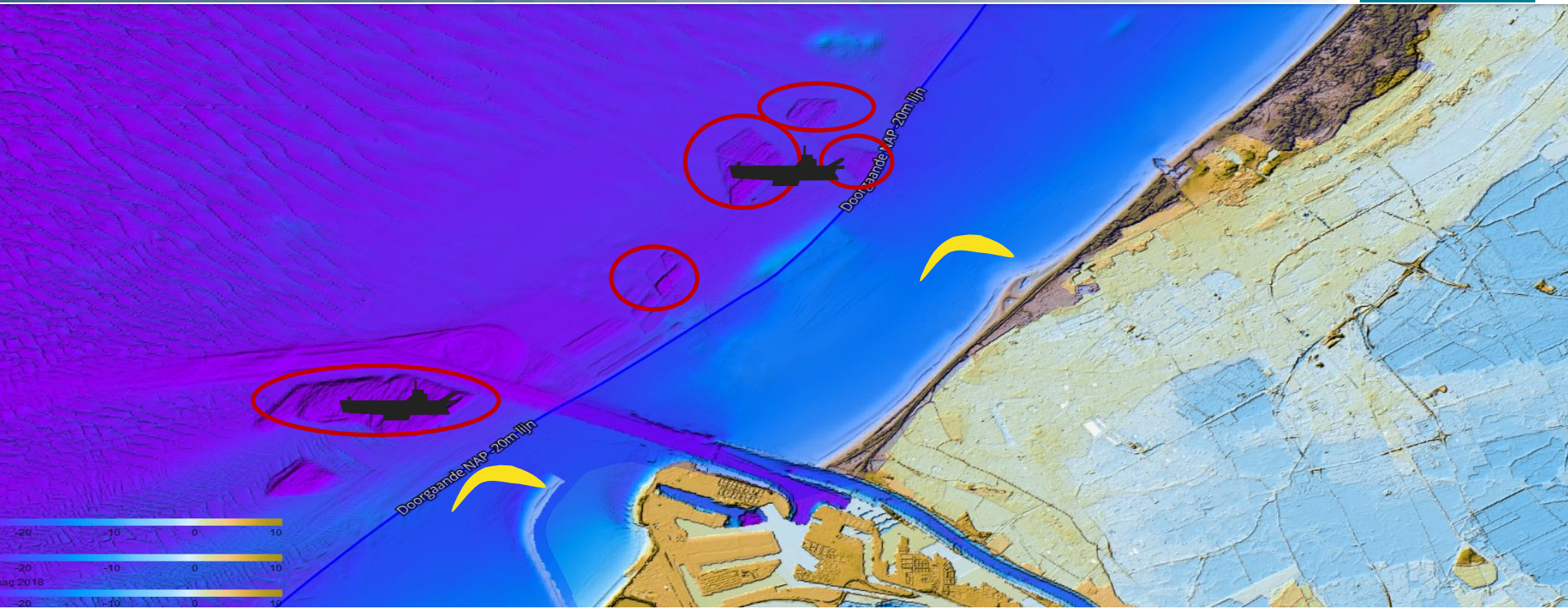
Doorgaande NAP -20m lijn
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Research to improve policy and practice

ice
Institution of Civil Engineers
Knowledge

Kennis op orde

- data management & viewet
- ontsluiting rapporten (wiki;s) papers
- beheer bibliotheek + kombergingstapp
- (beel.) modellen & tools (bijv morphan)
- wie doet wat?

Nieuwe kennis

- meetcampagnes
- modellen ontw.
- data analyse (sediment balans)
- pilots

(hoeft niet het zelfde als anders, alleen beter)

Samenwerken & uitdragen

- partners
- stakeholders


20
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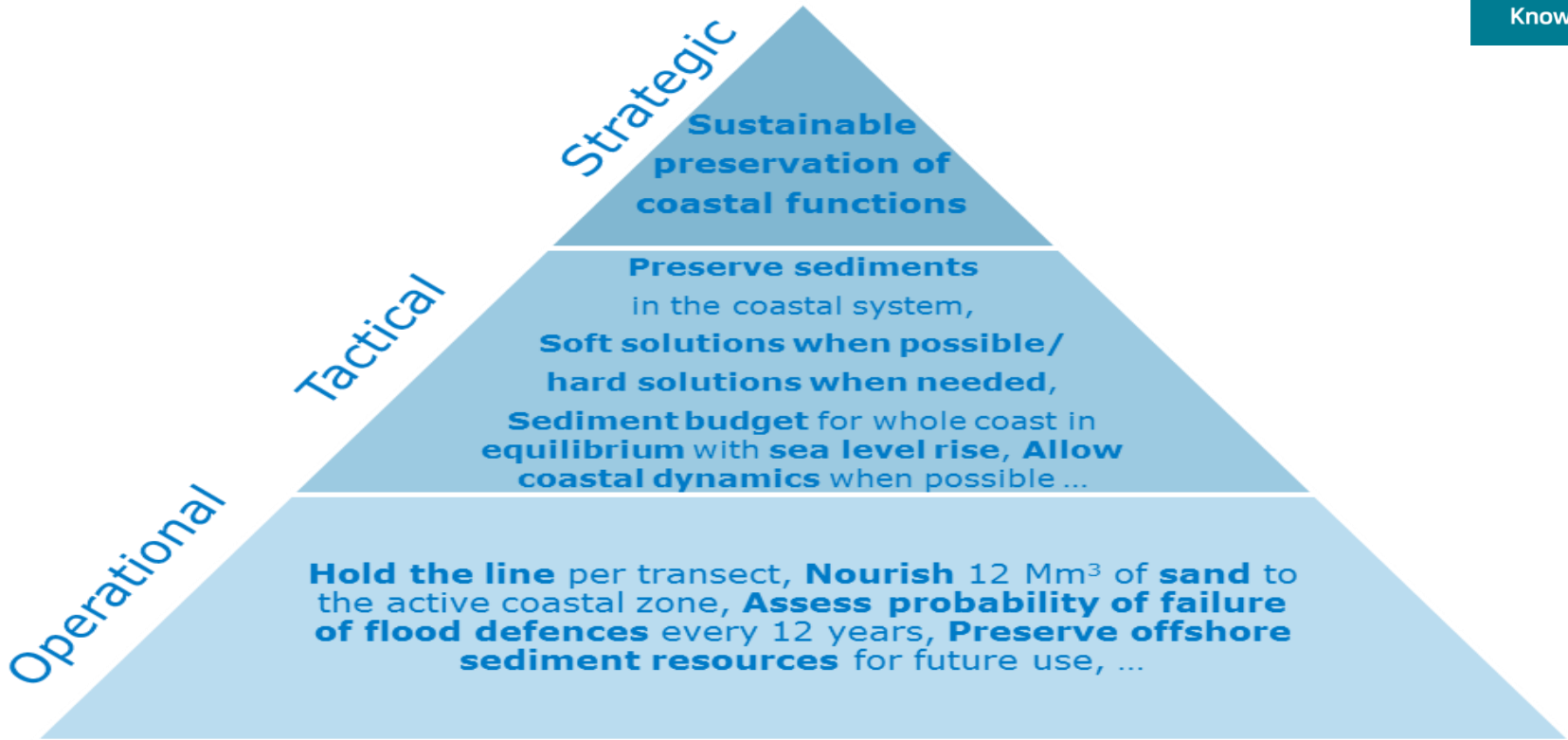
-30
-40
-50
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2017 Google
© 2009 GeoBasis-DE/BKG
Image Landsat / Copernicus
40 km
N
monitoring Vooroever Ameland Terschelling
Combi 3D model + metingen → 1DV model
detailanalyse Boschplaat
Parameters zeegat systemen
kaart dominant kustproces Amelander zeegat
detailanalyse morfologie Friesche zeegat (Zoutkamp/Pinkegat)
Model opti · Randen · Harde lagen · ZS gedrag
Voorspelling Maatregel versterking buitendijkse sedimentatie
ontw. morfologie Voorspelling Autonome ontwikkeling inc. ZSS 2017-18
Overzicht modellen
actualisatie data
model set-up, ... scenario analyse
analyse data
Uitwisseling getijbek & Marsdiep Data + modellen zeegaten grens + detail
Tidal inlet · Sed transp. naar Wadden-zee · Voorspel morfologie
data an... Boschpla... Borndiep ...
monito... zeegat Amel... Terschelling
kombergingen Borndiep verbieden?
cal dynamic ...aarweg ...meland
monitoring pilot ophoging Westgat (Schiermonn.)
Lo BzO Westgat
Implementatieplan monitoring
Meet-campagne interactie water + sed voor modellen
Eems Dollard in alle Lead proj.
zeespiegel monitor
Kust fund (Lange termijn) · Geul Vlieland · L-Ontwikkeling · Regionale verschil · Digi kaart
Morf komberg
morfologische indicatoren
Verbetering Prognose bagger-hoeveelheden
sed-mon-data W. Waddenzee
Spec. Advies (Ad. hoc) → Regionaal op maat → Leni → Wilu: producten
Analyse sed balans Vaddenzee
K RW Slib Koppeling naar Eco → PvA
? goede ontslibbing informatie → wrkb. BzO?
geologie Dis →
invloed ondertouw Vaargeulen + havens → Beoordeling
ontw. slib concentratie
Toestand Vd Kust · beheer bieb · Kustviewer · Syst. kennis
Kustlijn kaarten boek
beheer bibliotheek
beheer bibliotheken
Natuurlijk Verlies · Sibes data · Gevolgen reguler suppl.
Site kustgenese.deltares.nl
SEAWAD
Zorg: synthese & atlas & T. advies
Workshop zeegaten
Workshop 11/2/18
Gezamelijk beeld
Pro-actief Advies + Reactie
CoP Vraag samenwerking Efficiënt CoP's

Strategy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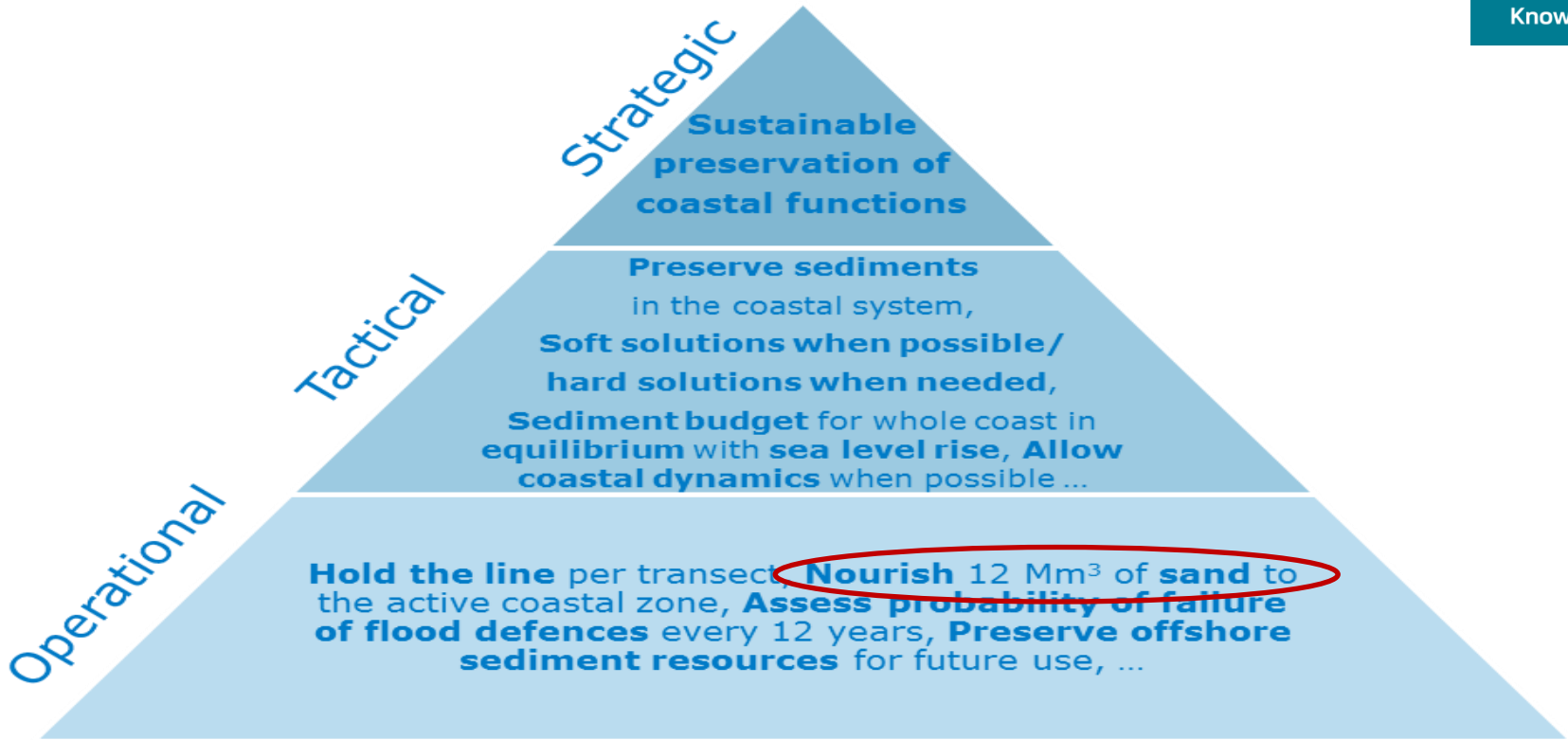
Strategy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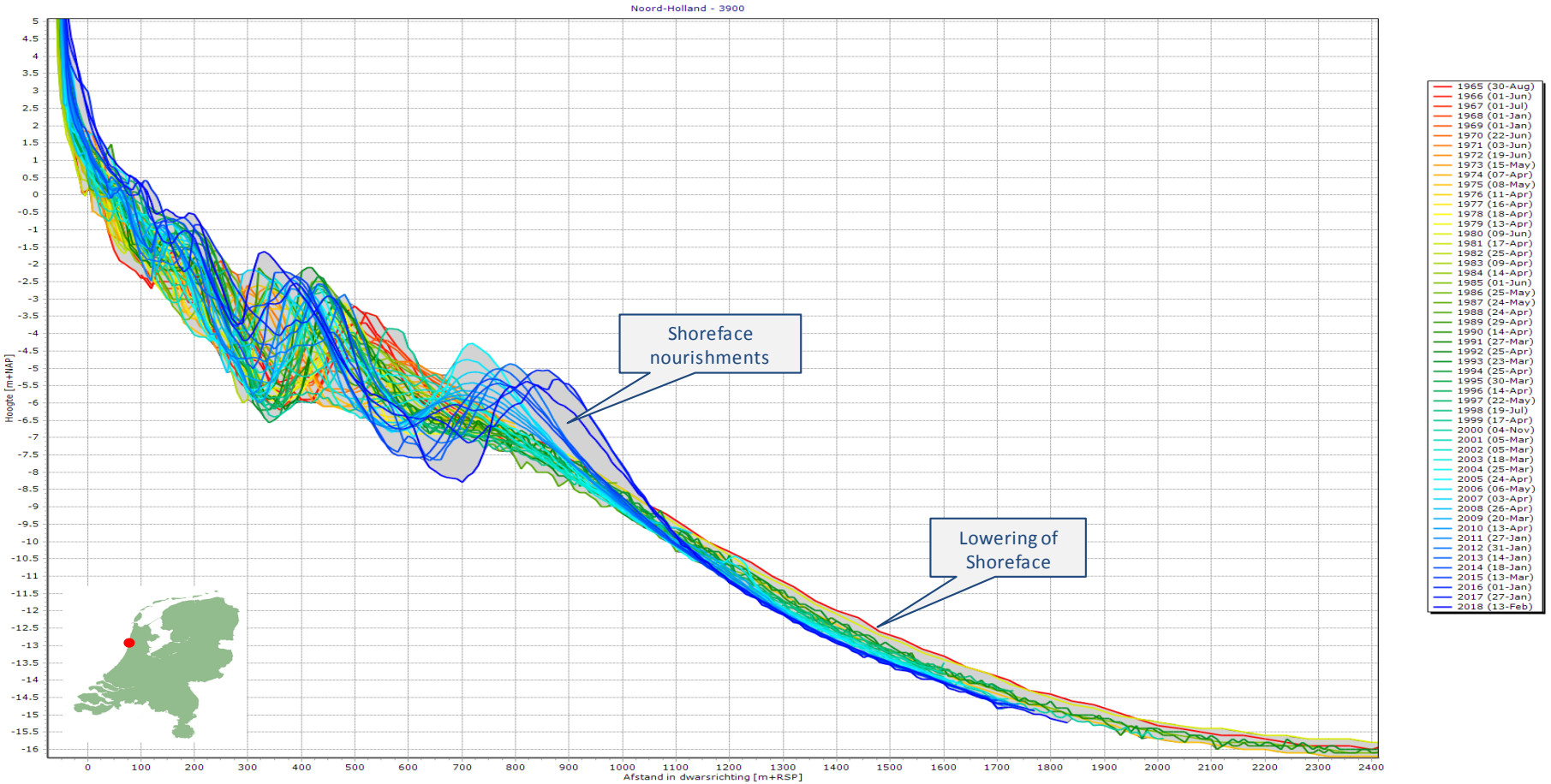
Nourishing 12 Mm3 of Sand annually

Associated assumptions:

- Annual sediment deficit is equal to the area of the active coastal zone times local relative sea level rise (LRSL)
  - Closure depth is at -20m MSL on decadal to centennial timescales
  - Sediment export from open coast to the tidal basins is equal the area of the basin times LRSL
  - The present day relative sea level rise along the Dutch coast is around 2 mm per year. This includes geological subsidence.
  - ….
- Nourished sediments spread naturally over the whole active coastal zone
- …….

Closure depth is at -20m MSL on decadal to centennial timescales


Noord-Holland - 3900
Hoogte [m+NAP]
Afstand in dwarsrichting [m+RSP]
Shoreface nourishments
Lowering of Shoreface
1965 (30-Aug)
1966 (01-Jun)
1967 (01-Jul)
1968 (01-Jan)
1969 (01-Jan)
1970 (22-Jun)
1971 (03-Jun)
1972 (19-Jun)
1973 (15-May)
1974 (07-Apr)
1975 (08-May)
1976 (11-Apr)
1977 (16-Apr)
1978 (18-Apr)
1979 (13-Apr)
1980 (09-Jun)
1981 (17-Apr)
1982 (25-Apr)
1983 (09-Apr)
1984 (14-Apr)
1985 (01-Jun)
1986 (25-May)
1987 (24-May)
1988 (24-Apr)
1989 (29-Apr)
1990 (14-Apr)
1991 (27-Mar)
1992 (25-Apr)
1993 (23-Mar)
1994 (25-Apr)
1995 (30-Mar)
1996 (14-Apr)
1997 (22-May)
1998 (19-Jul)
1999 (17-Apr)
2000 (04-Nov)
2001 (05-Mar)
2002 (05-Mar)
2003 (18-Mar)
2004 (25-Mar)
2005 (24-Apr)
2006 (06-May)
2007 (03-Apr)
2008 (26-Apr)
2009 (20-Mar)
2010 (13-Apr)
2011 (27-Jan)
2012 (31-Jan)
2013 (14-Jan)
2014 (18-Jan)
2015 (13-Mar)
2016 (01-Jan)
2017 (27-Jan)
2018 (13-Feb)

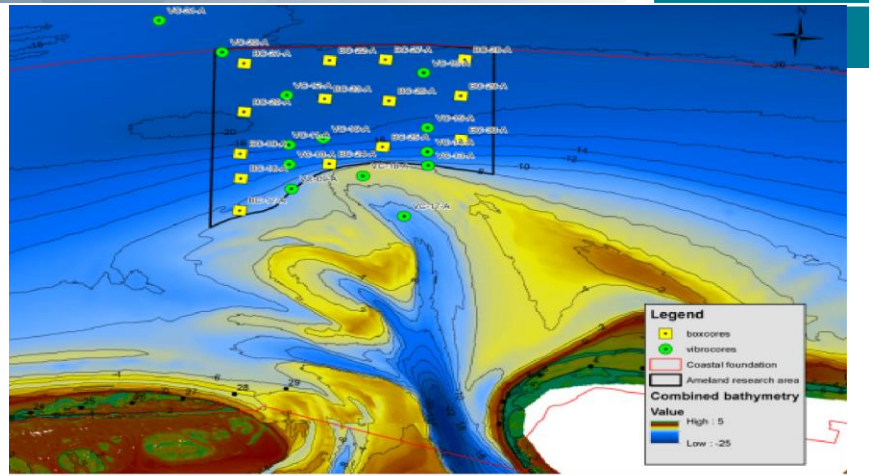
Deeper parts shoreface

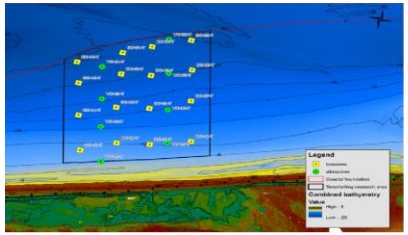
- Focus on short and long term morphodynamics of the deeper shoreface
- Measuring campaign (june 2017 – june 2018)
  - 3 locations: Noordwijk, Terschelling, Ameland
  - Landers: currents, water levels, waves, sediments, ripple shapes etc
  - Topography
  - Geology and sediments

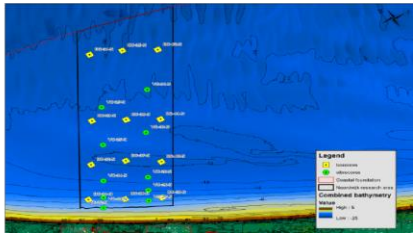
Deeper parts shoreface

- System discription
- Data-analysis: campaign 2017 - 2018
- Modeldevelopment and validation with the campaign data
- Geological and geomorphological atlas

-> Advise on closure depth/off shore boundary for “the coastal foundation” and dredging







Sediment export from open coast to the tidal basins is equal the area of the basin times Sea Level Rise

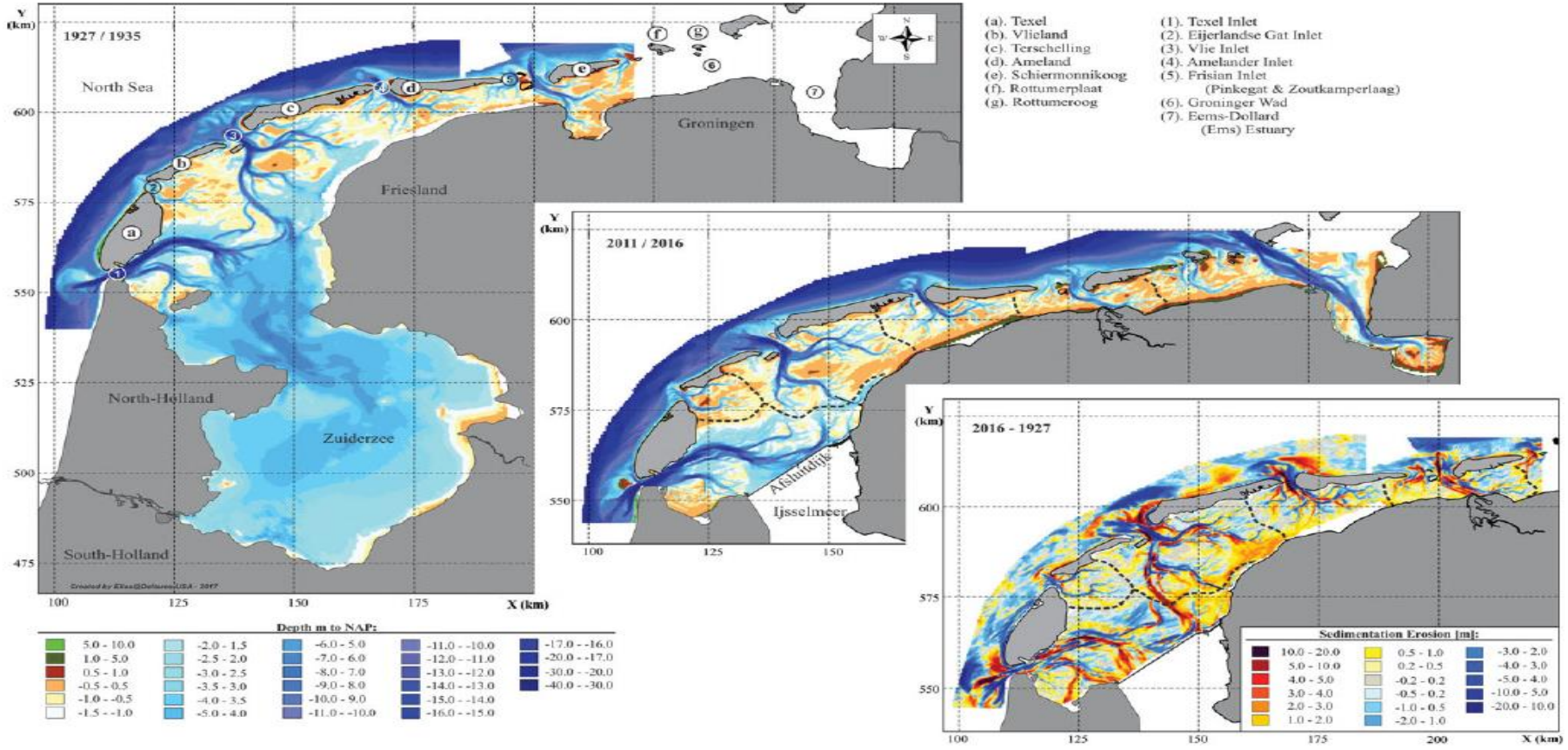
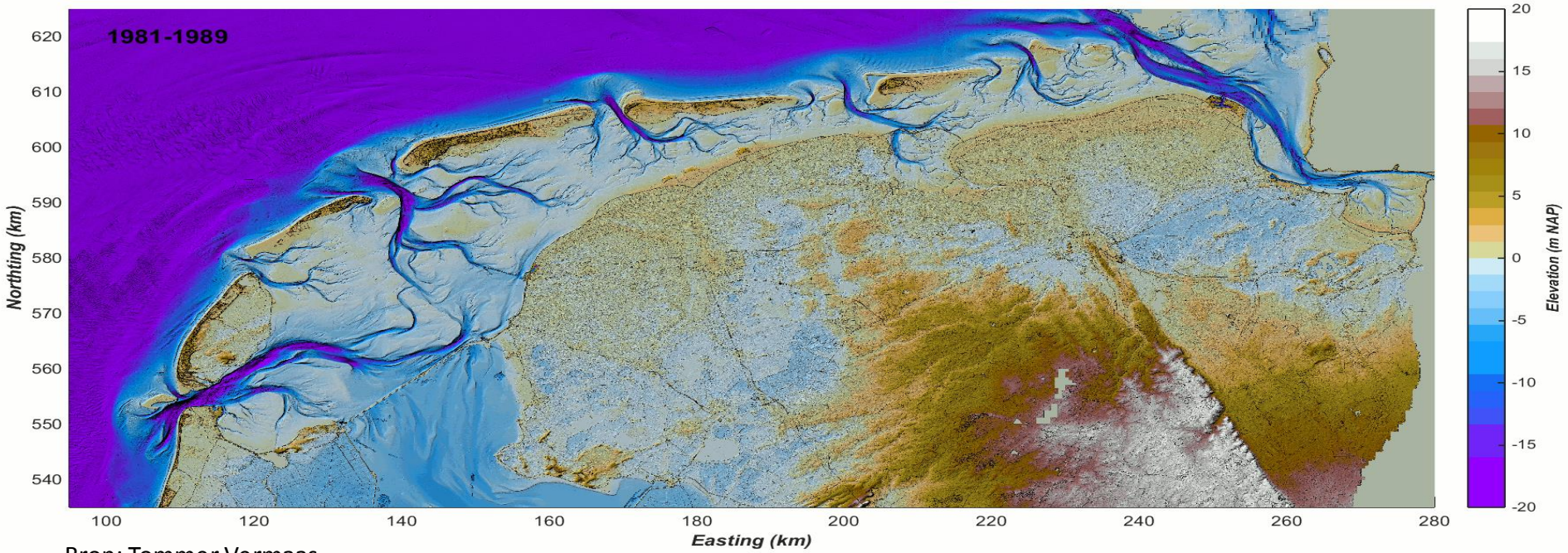


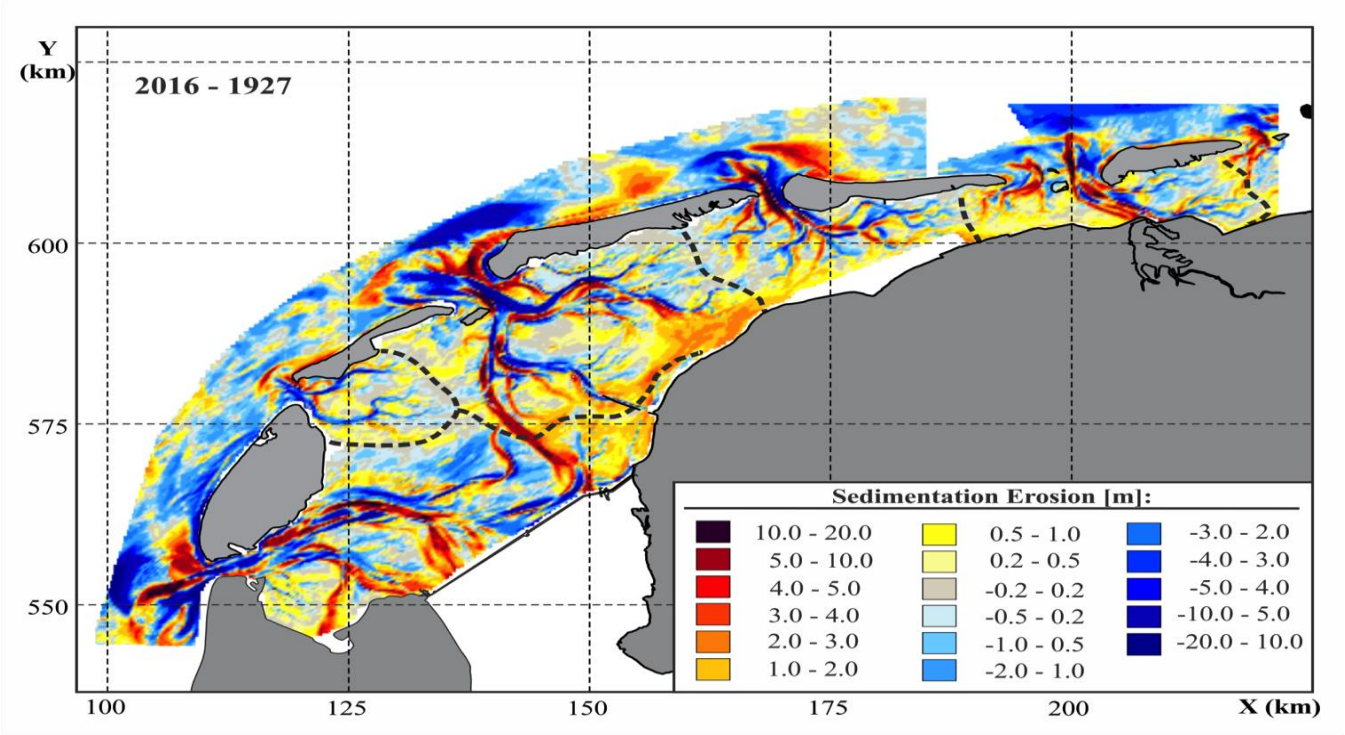
Fig. 2. Changes in channels and shoals in the Dutch Wadden Sea over the period 1927–2016. Upper panel: Bathymetry representative for the 1927–1935 time frame (prior to closure of the Zuiderzee). Middle panel: Recent bathymetry based on surveys over the years 2011–2016. Lower panel: Sedimentation–erosion pattern over the interval 1927–2016.

Morphology Wadden Sea area



Bron: Tommer Vermaas

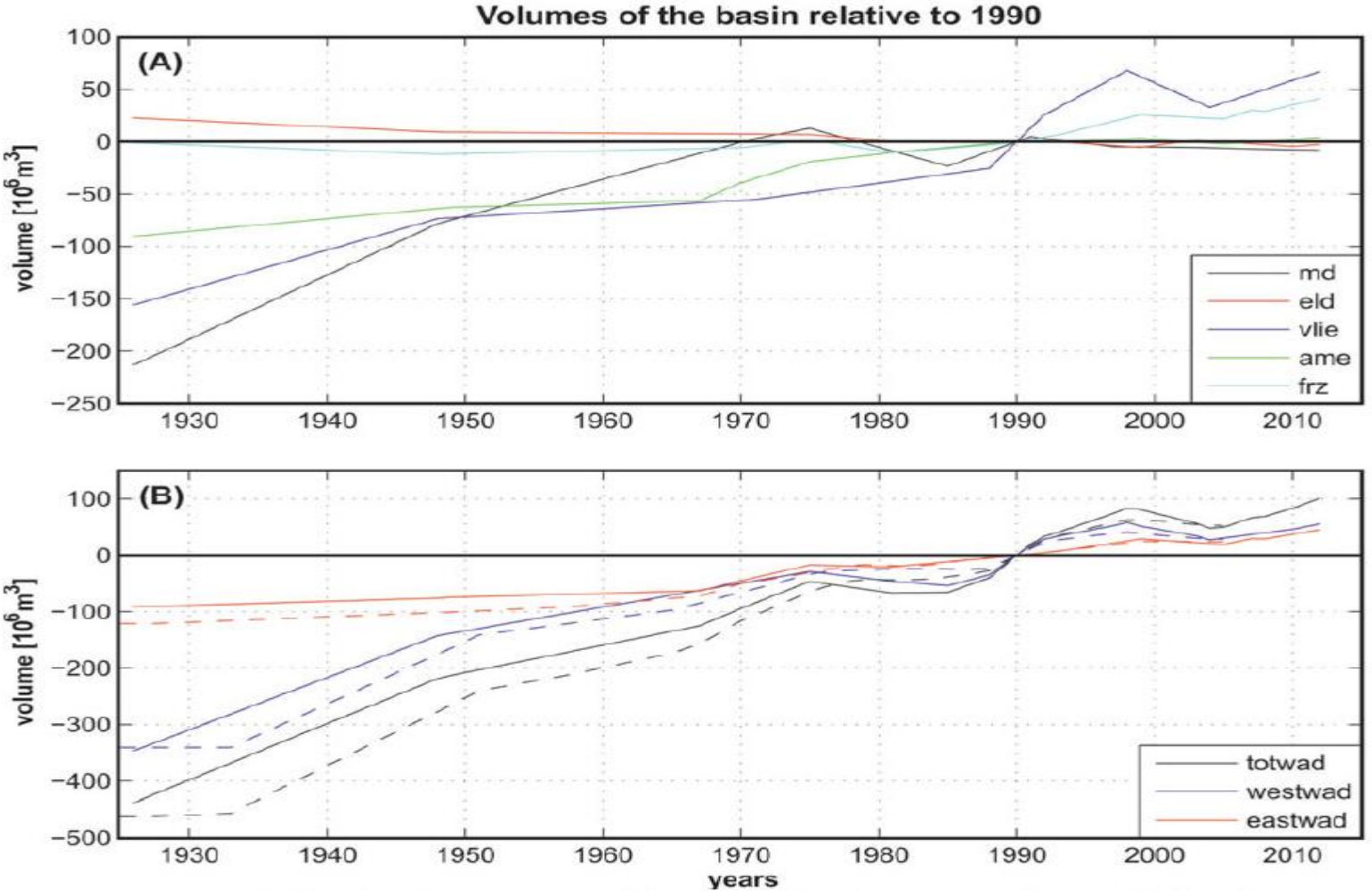
Sedimentbudget Open Coast and Wadden Sea



~1930 - 2016

Wadden Sea:
+ ca. 500 Mm3

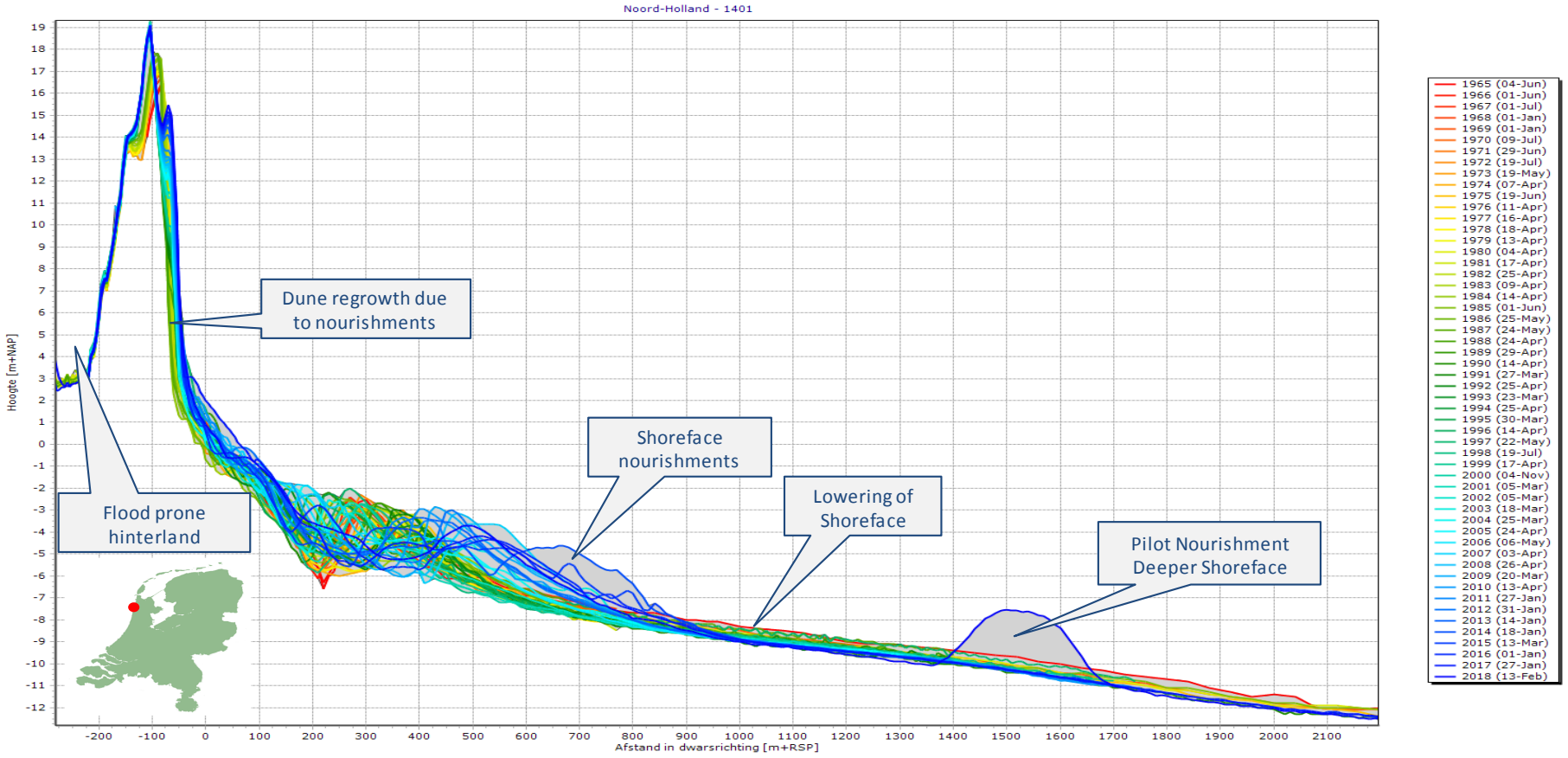
North Sea Coast:
- ca. 600 Mm3

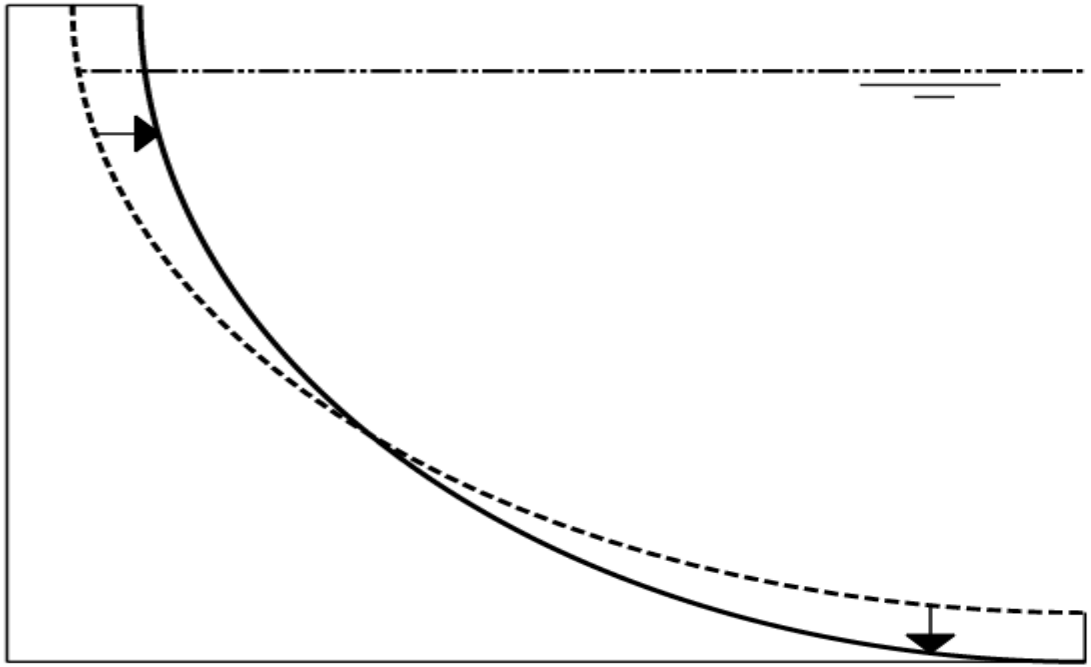

Volumes of the basin relative to 1990
(A)
volume [10^6 m^3]
100
50
0
−50
−100
−150
−200
−250
1930
1940
1950
1960
1970
1980
1990
2000
2010
md
eld
vlie
ame
frz
(B)
volume [10^6 m^3]
100
0
−100
−200
−300
−400
−500
1930
1940
1950
1960
1970
1980
1990
2000
2010
years
totwad
westwad
eastwad

Sediment export from open coast to the tidal basins is equal the area of the basin times Sea Level Rise

- Not true for the Wadden Area.

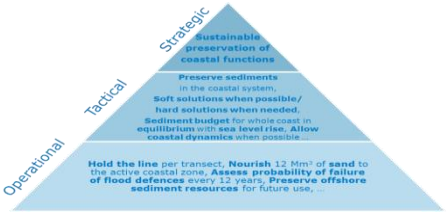
Nourished sediments spread naturally over the whole active coastal zone


Noord-Holland - 1401
Hoogte [m+NAP]
Afstand in dwarsrichting [m+RSP]
Dune regrowth due to nourishments
Flood prone hinterland
Shoreface nourishments
Lowering of Shoreface
Pilot Nourishment Deeper Shoreface
1965 (04-Jun)
1966 (01-Jun)
1967 (01-Jul)
1968 (01-Jan)
1969 (01-Jan)
1970 (09-Jul)
1971 (29-Jun)
1972 (19-Jul)
1973 (19-May)
1974 (07-Apr)
1975 (19-Jun)
1976 (11-Apr)
1977 (16-Apr)
1978 (18-Apr)
1979 (13-Apr)
1980 (04-Apr)
1981 (17-Apr)
1982 (25-Apr)
1983 (09-Apr)
1984 (14-Apr)
1985 (01-Jun)
1986 (25-May)
1987 (24-May)
1988 (24-Apr)
1989 (29-Apr)
1990 (14-Apr)
1991 (27-Mar)
1992 (25-Apr)
1993 (23-Mar)
1994 (25-Apr)
1995 (30-Mar)
1996 (14-Apr)
1997 (22-May)
1998 (19-Jul)
1999 (17-Apr)
2000 (04-Nov)
2001 (05-Mar)
2002 (05-Mar)
2003 (18-Mar)
2004 (25-Mar)
2005 (24-Apr)
2006 (06-May)
2007 (03-Apr)
2008 (26-Apr)
2009 (20-Mar)
2010 (13-Apr)
2011 (27-Jan)
2012 (31-Jan)
2013 (14-Jan)
2014 (18-Jan)
2015 (13-Mar)
2016 (01-Jan)
2017 (27-Jan)
2018 (13-Feb)

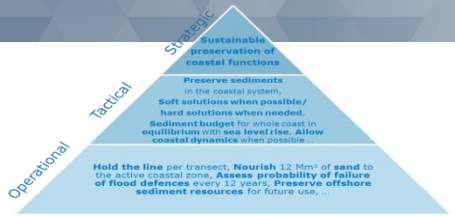


→ Uitbouw door suppleties
↓ Structurele verdieping
------- Oude kustprofiel
—— Versteiling kustprofiel

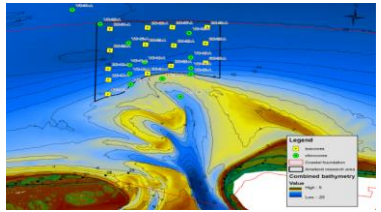
In a loop



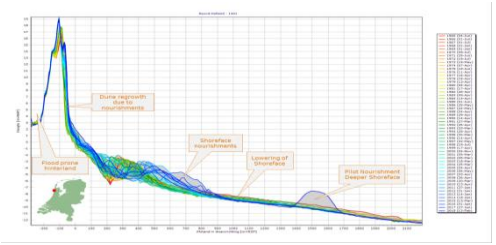
Advise political decision makers on policy adjustments if needed



Deduce assumptions associated with Tactical and operational objectives



Plan and do research based on the most critical assumptions most for the current policy and practice



Adjust pratice, experiment

Contact information

Quirijn Lodder
Principal Advisor Coastal Flood Risk Management

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