Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Coastal Flood Risk Management in the Netherlands,
policy and practice

The Coastal Technology Policy Study Group, Japan

Quirijn Lodder
Durk Riedstra
Rijkswaterstaat – Water, Traffic and Environment

October 15th, 2021

Rijkswaterstaat – Since 1798

Rijkswaterstaat is the operational agency of the ministry of Infrastructure and Water Management. Rijkswaterstaat is responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. This includes the main road network, the main waterway network and watersystems.

Rijkswaterstaat – Since 1798

Rijkswaterstaat is the operational agency of the ministry of Infrastructure and Water Management. Rijkswaterstaat is responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. This includes the main road network, the main waterway network and watersystems.

Rijkswaterstaat works to ensure:

- Dry feet
- Sufficient clean water
- Smooth and safe traffic flows on the nation's roads and waterways
- Reliable and useful information

All with 8000 employees

Who are we?

- Quirijn Lodder, Principal Advisor Coastal Flood Risk Management
- Durk Riedstra, Senior Advisor Flood Risk Management and consequences

Durk Riedstra
Senior Advisor Flood Risk Management

Rijkswaterstaat - Water, Traffic and Environment
Zuiderwagenplein 2 | 8224 AD Lelystad
PO box 17 | 8200 AA Lelystad

M 06 1011 7755
durk.riedstra@rws.nl
www.rijkswaterstaat.nl

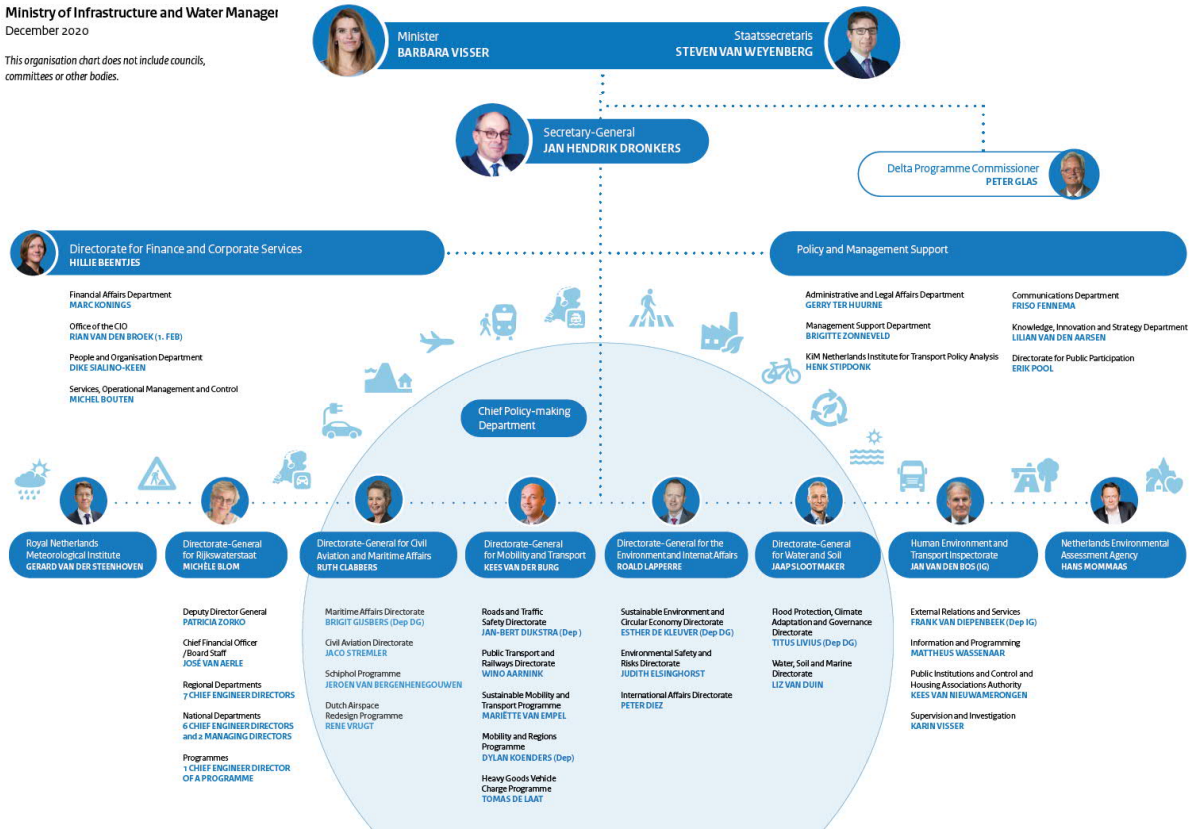
Quirijn Lodder
Principal Advisor Coastal Flood Risk Management

Rijkswaterstaat Water, Verkeer en Leefomgeving
Veiligheid en Watergebruik - Afdeling Hoogwaterveiligheid
Zuiderwagenplein 2 | 8224 AD Lelystad | 4e zuid (flex)
Postbus 24060 | 3502 MB Utrecht

T + 31 (0)6 11 53 42 20
Quirijn.Lodder@rws.nl
www.rijkswaterstaat.nl

Water. Wegen. Werken. Rijkswaterstaat.

Organisation



Ministry of Infrastructure and Water Management

Minister and State Secretary

Elected Officials

Policy directorates	Operational directorates
- **DGWB** (Water and Soil) - DGMO (Mobility and Transport) - DGLM (Civil Aviation and Marine Affairs) - DGMI (Environment and International Affairs)	- **DG RWS** (Rijkswaterstaat) - KNMI (Meteorological Office) - Inspectorate (Auditing Agency) - PBL (Environmental Assessment Agency)

Public Servants

Advice

Policy

Assignment

Operational

Tasks

- Sets policy
- Provides advice to elected decision makers
- Determine assignments and distribute associated funding to operational directorates
- Implementing policy
- Organize and conduct research to support policy development and implementation
- Advising to policy directorates on policy development based on research and implementation experience

The physical system in the Netherlands

The physical system in the Netherlands

The physical system in the Netherlands

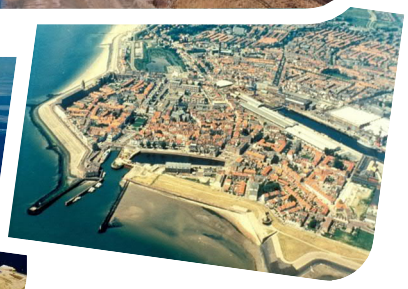
The physical system in the Netherlands

The physical system in the Netherlands

The physical system in the N

Waddensea

Holland coast

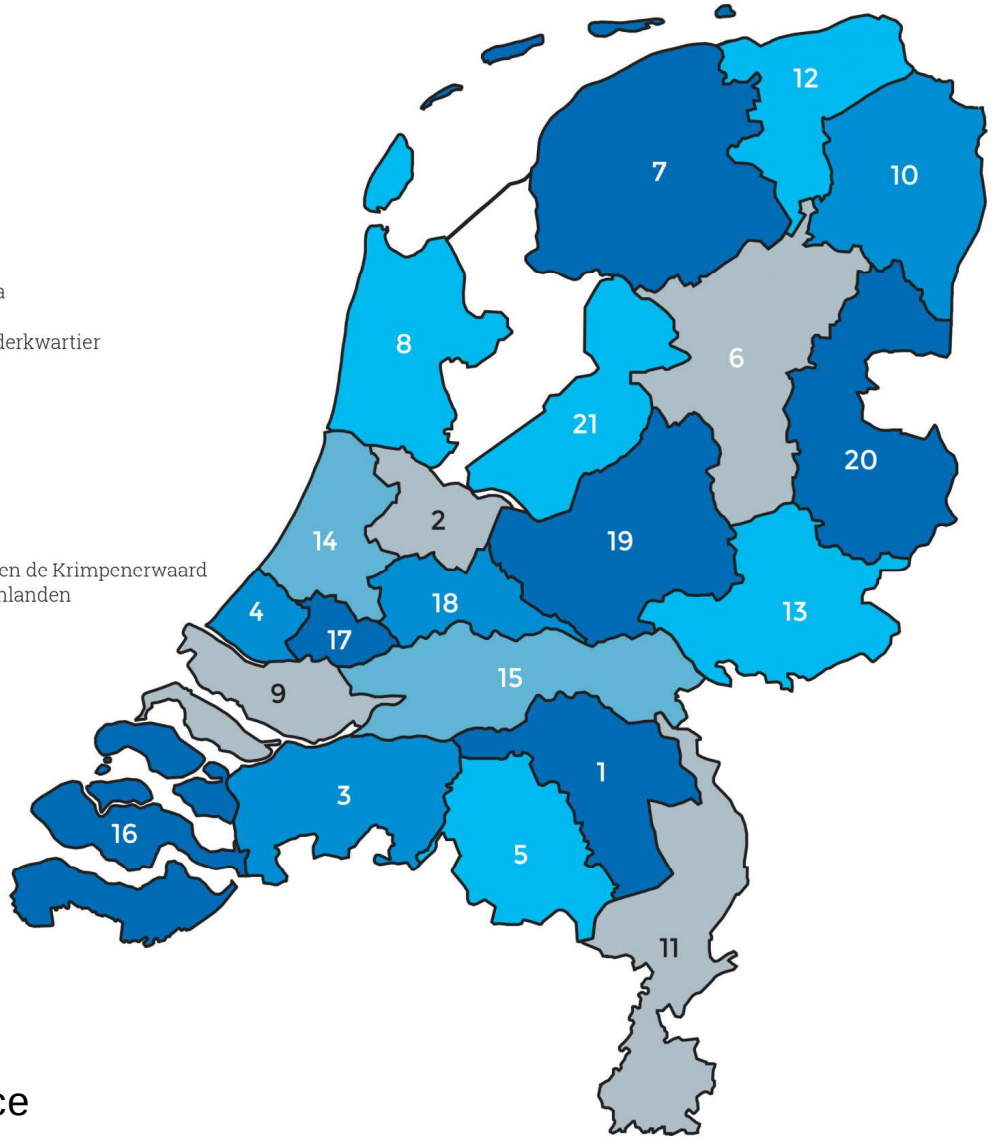


Southwestern Delta

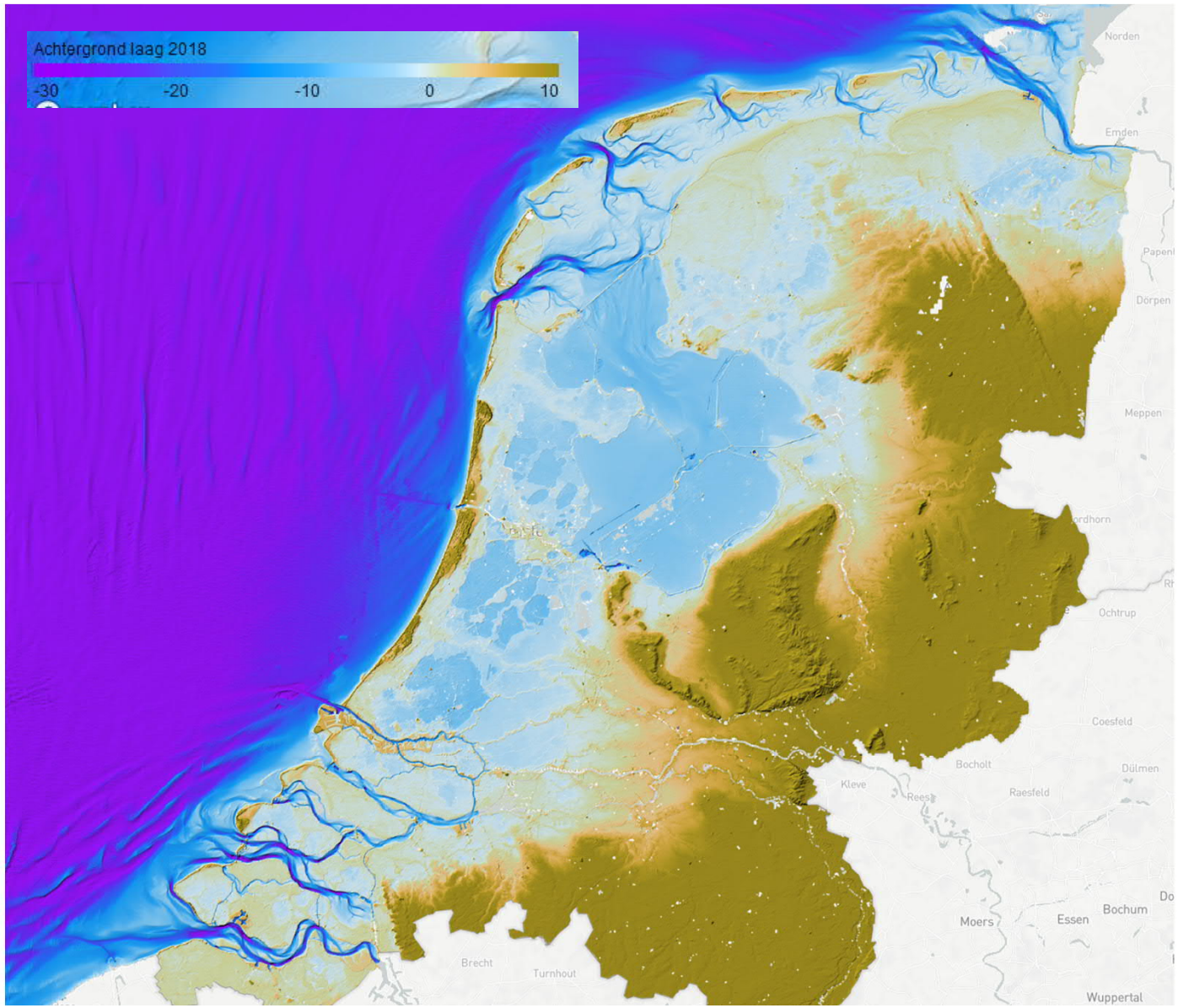
UNIE VAN WATERSCHAPPEN

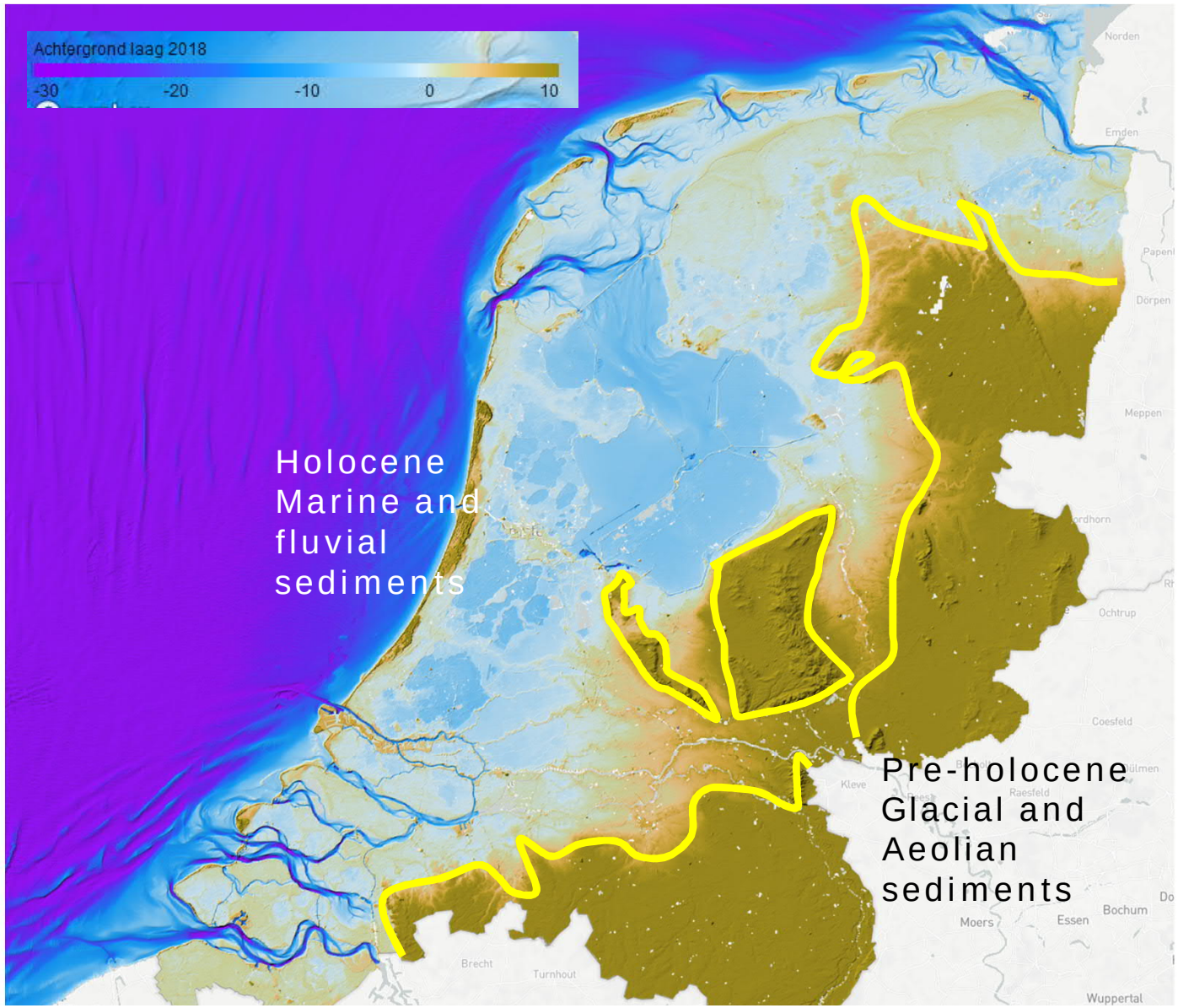
LEGENDA

1. Waterschap Aa en Maas
2. Waterschap Amstel, Gooi en Vecht
3. Waterschap Brabantse Delta
4. Hoogheemraadschap van Delfland
5. Waterschap De Dommel
6. Waterschap Drents Overijsselse Delta
7. Wetterskip Fryslân
8. Hoogheemraadschap Hollands Noorderkwartier
9. Waterschap Hollandse Delta
10. Waterschap Hunze en Aa's
11. Waterschap Limburg
12. Waterschap Noorderzijlvest
13. Waterschap Rijn en IJssel
14. Hoogheemraadschap van Rijnland
15. Waterschap Rivierenland
16. Waterschap Scheldestromen
17. Hoogheemraadschap van Schieland en de Krimpenerwaard
18. Hoogheemraadschap De Stichtse Rijnlanden
19. Waterschap Vallei en Veluwe
20. Waterschap Vechtstromen
21. Waterschap Zuiderzeeland



Water Governance


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


Achtergrond laag 2018
-30
-20
-10
0
10
Holocene
Marine and
fluvial
sediments
Pre-holocene
Glacial and
Aeolian
sediments
Norden
Emden
Meppen
Ochtrup
Coesfeld
Kleve
Raesfeld
Moers
Essen
Bochum
Brecht
Turnhout
Wuppertal

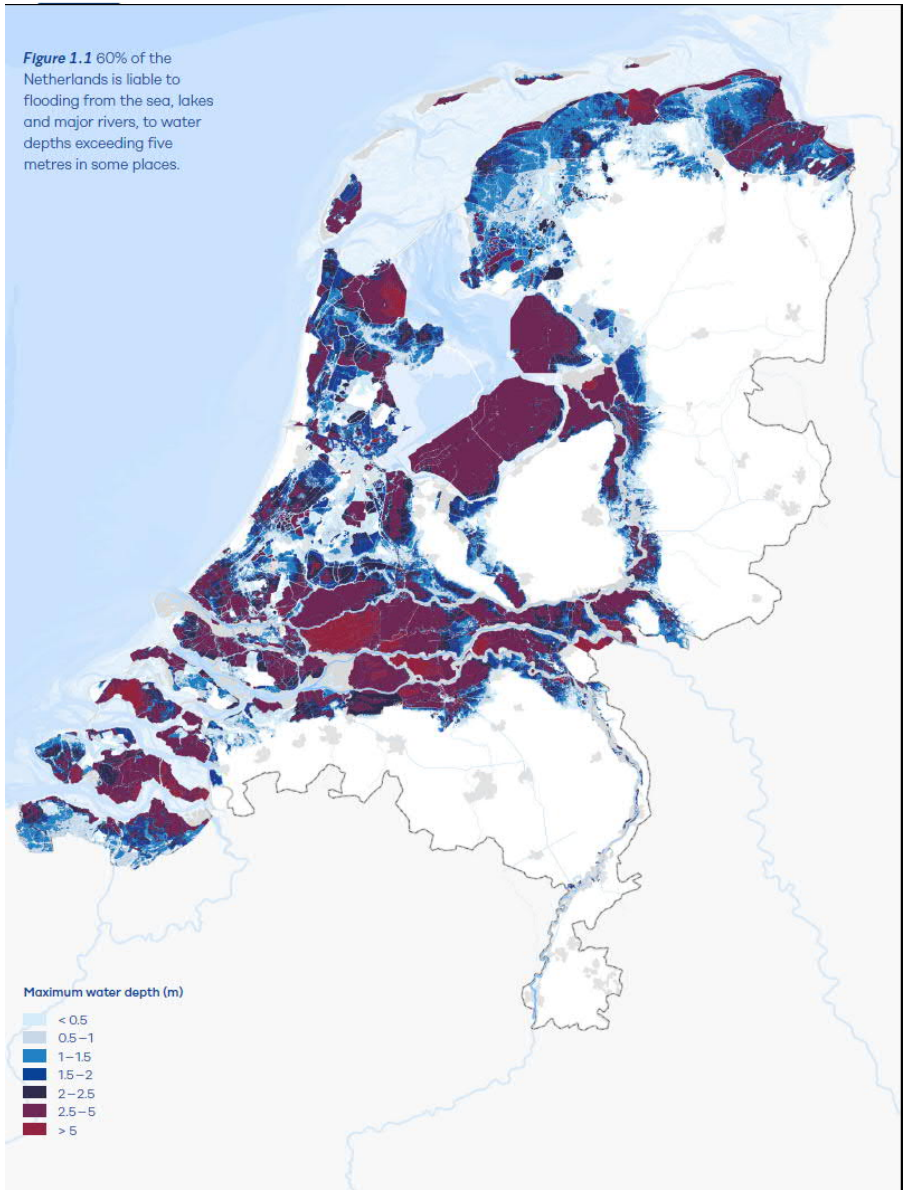
So in many places it looks like this

So in many places it looks like this

Flood Prone Netherlands

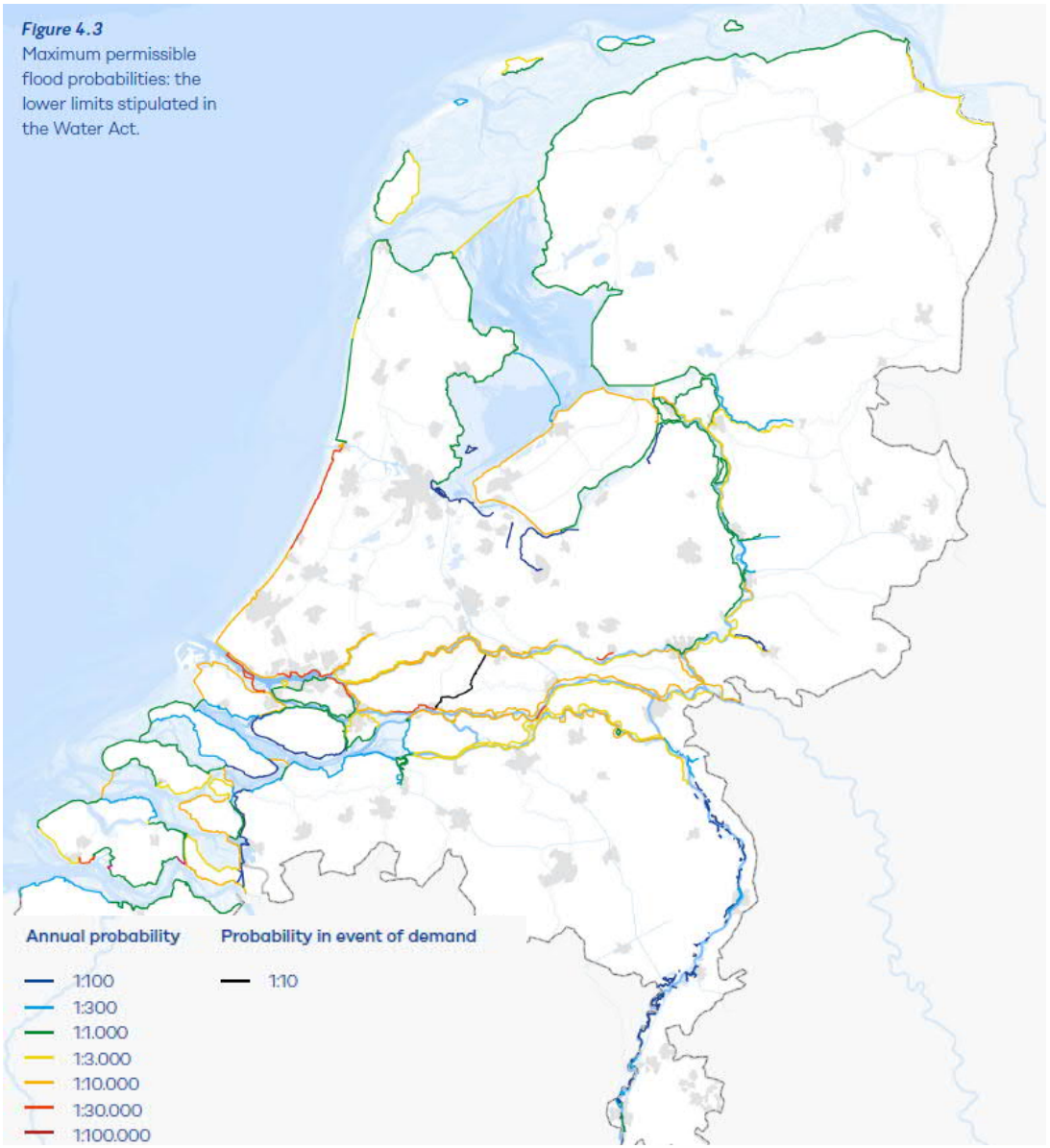
- 26% below mean sea level
- 55% is susceptible to flooding
- 60% of our population lives in flood prone area's
- > 60 % of our economic value is earned in the lowest-parts of the country

- Strong correlation with sediment origin…

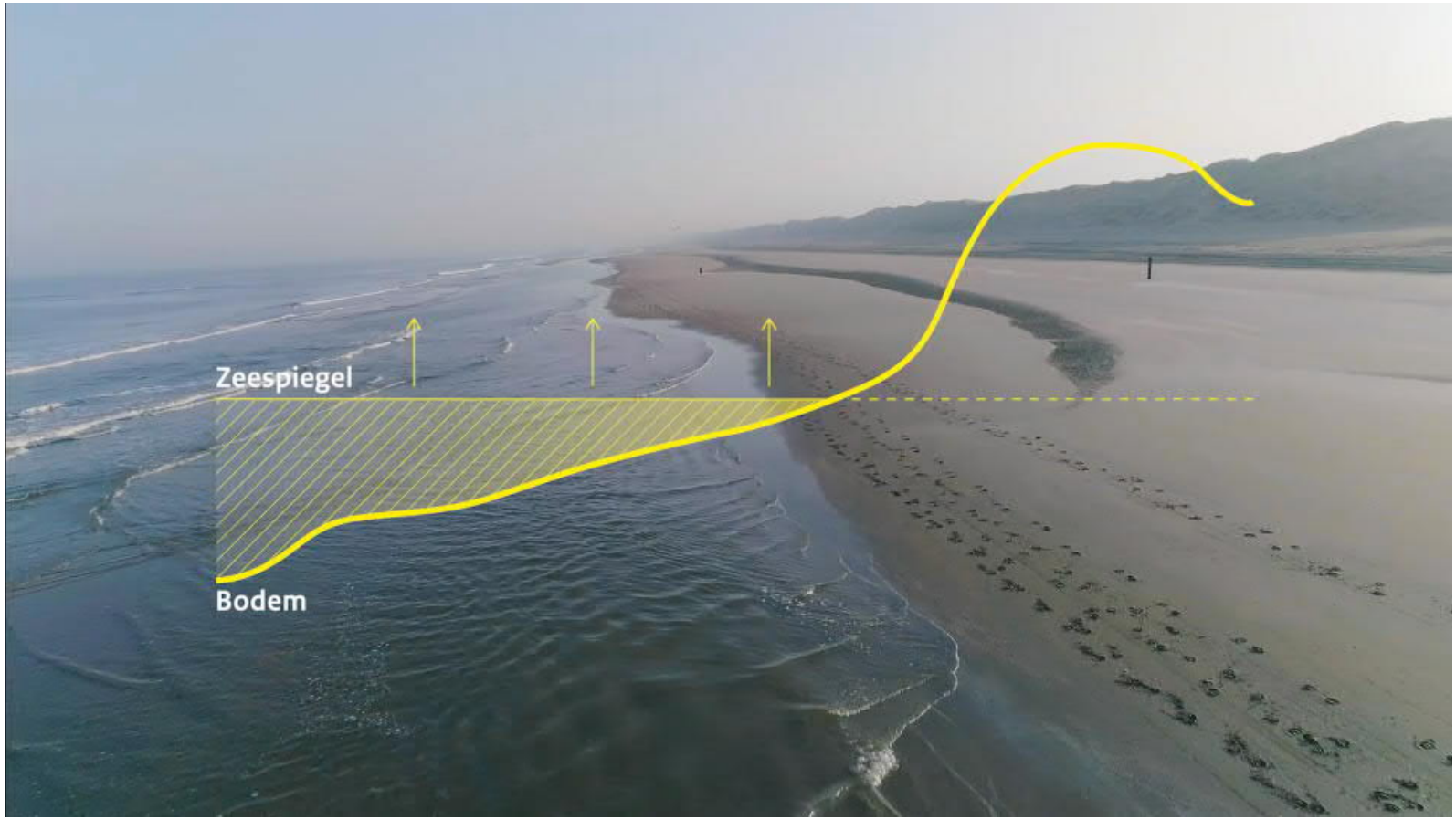


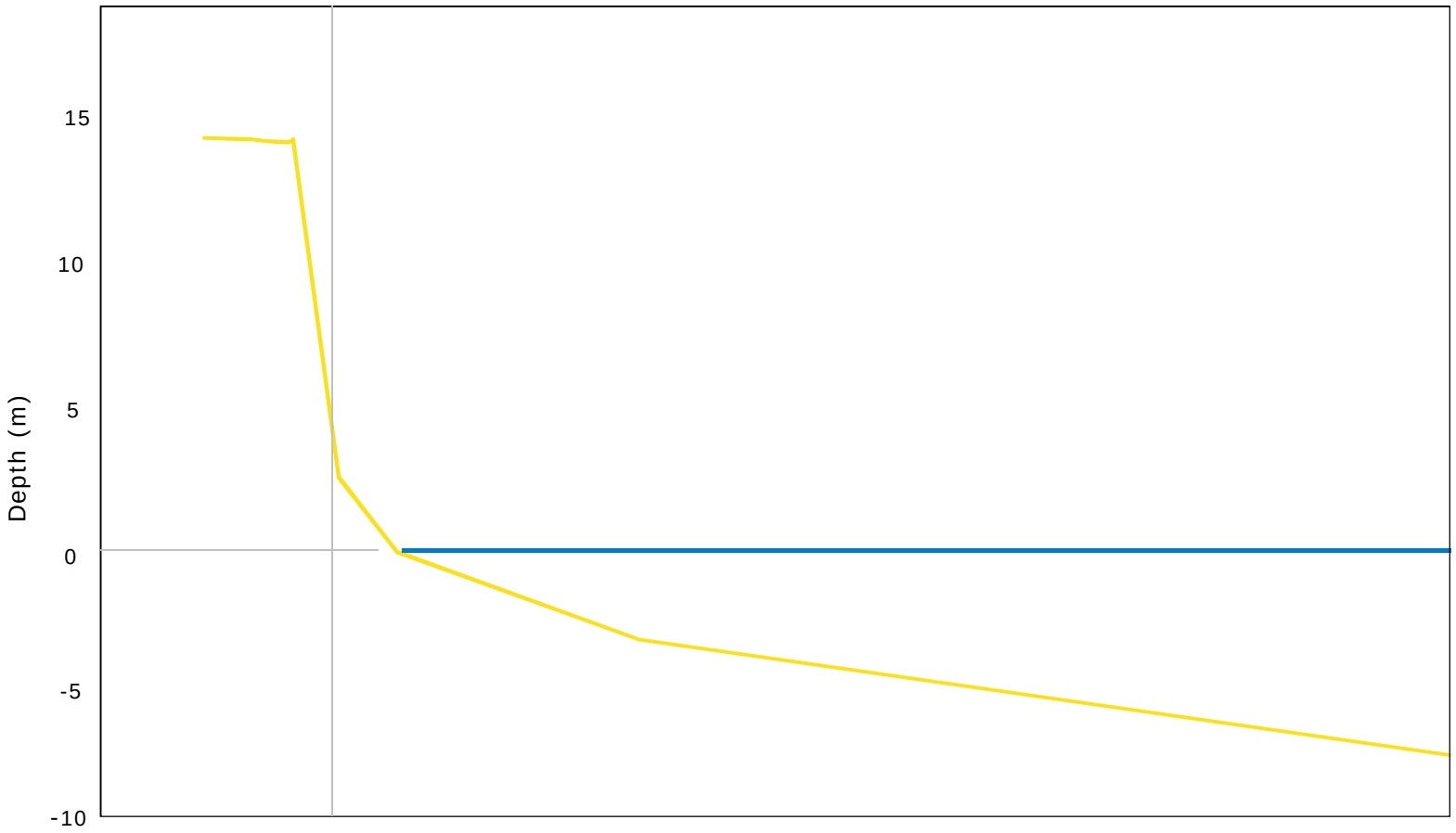
Flood Risk Standards

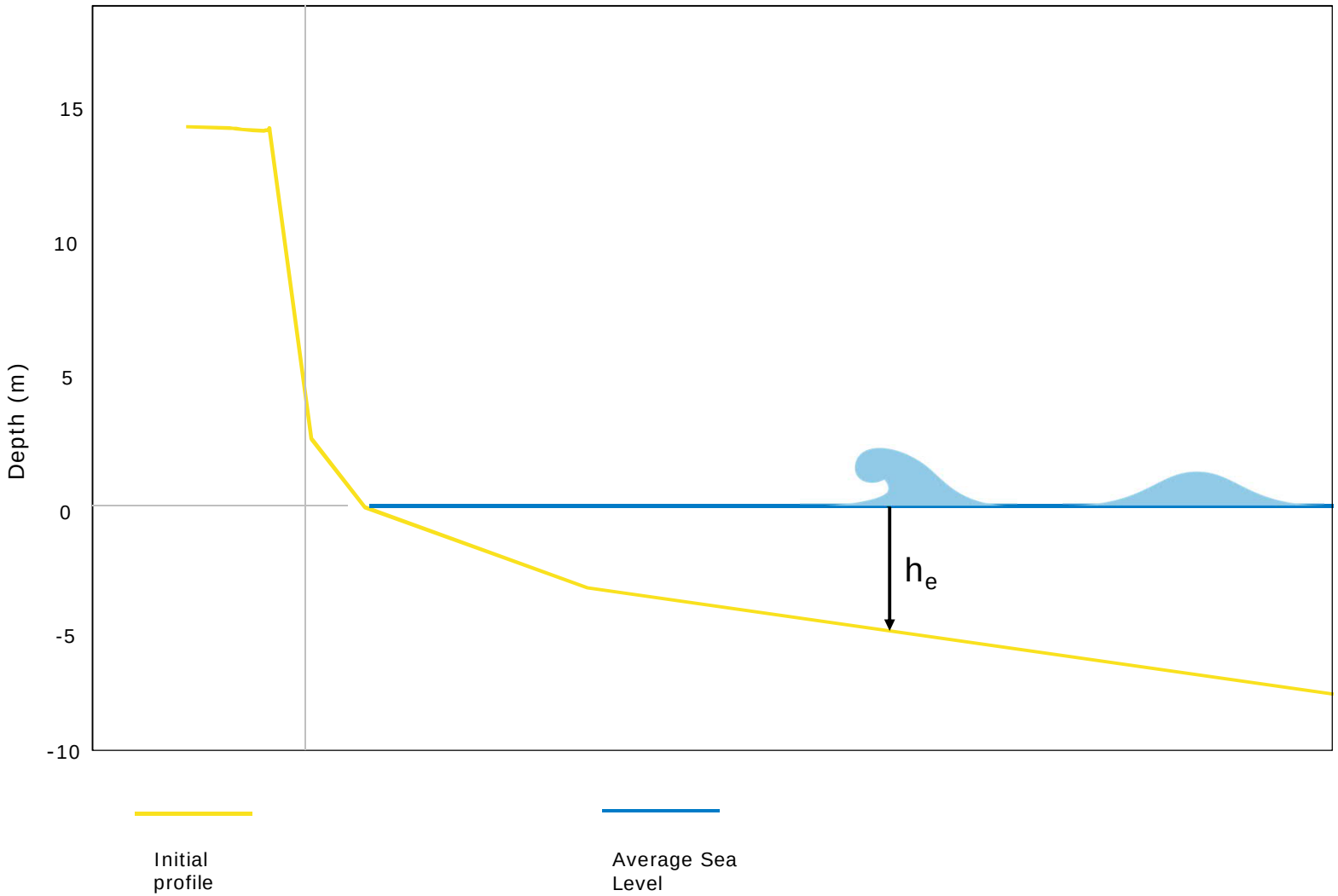
Set in law

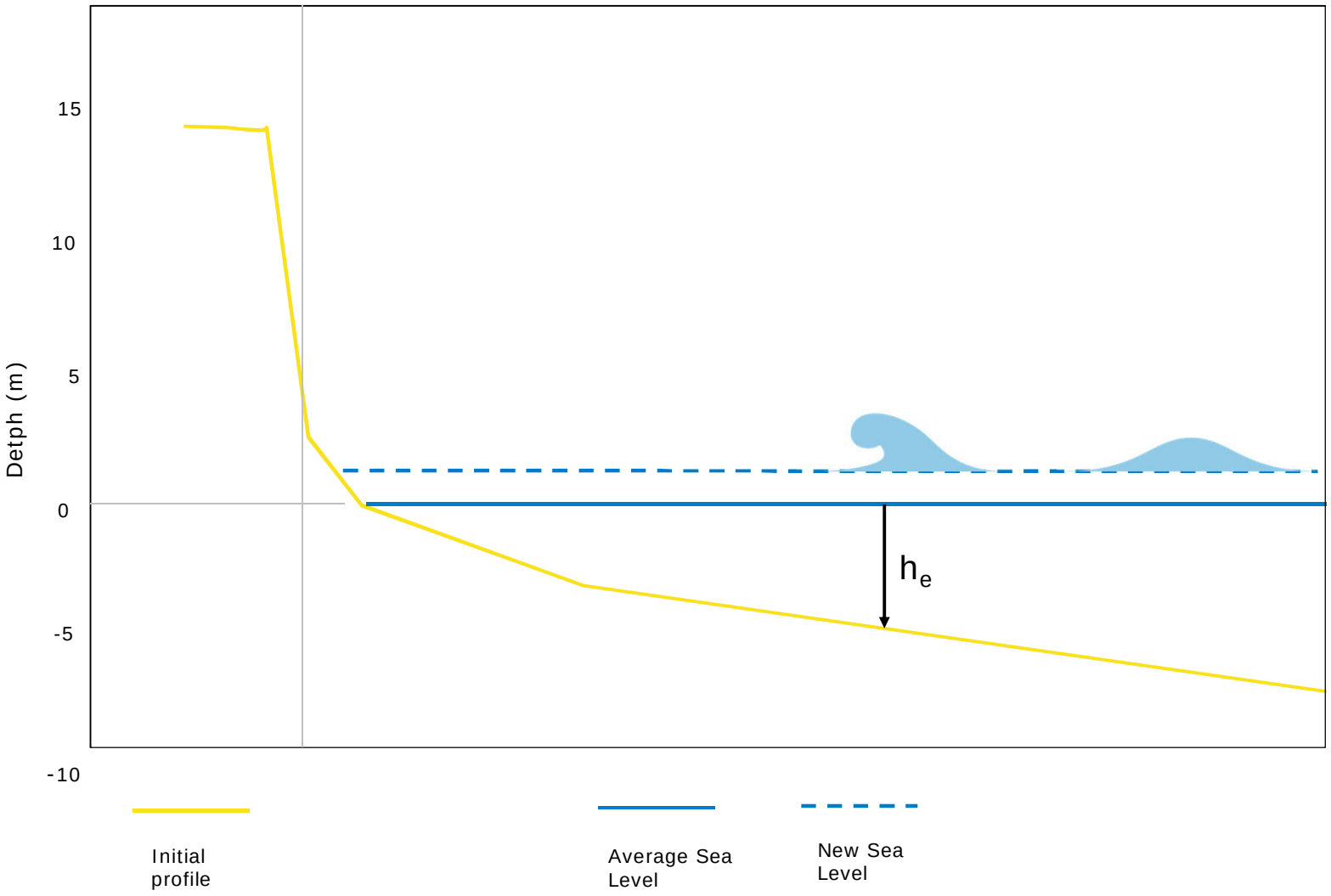


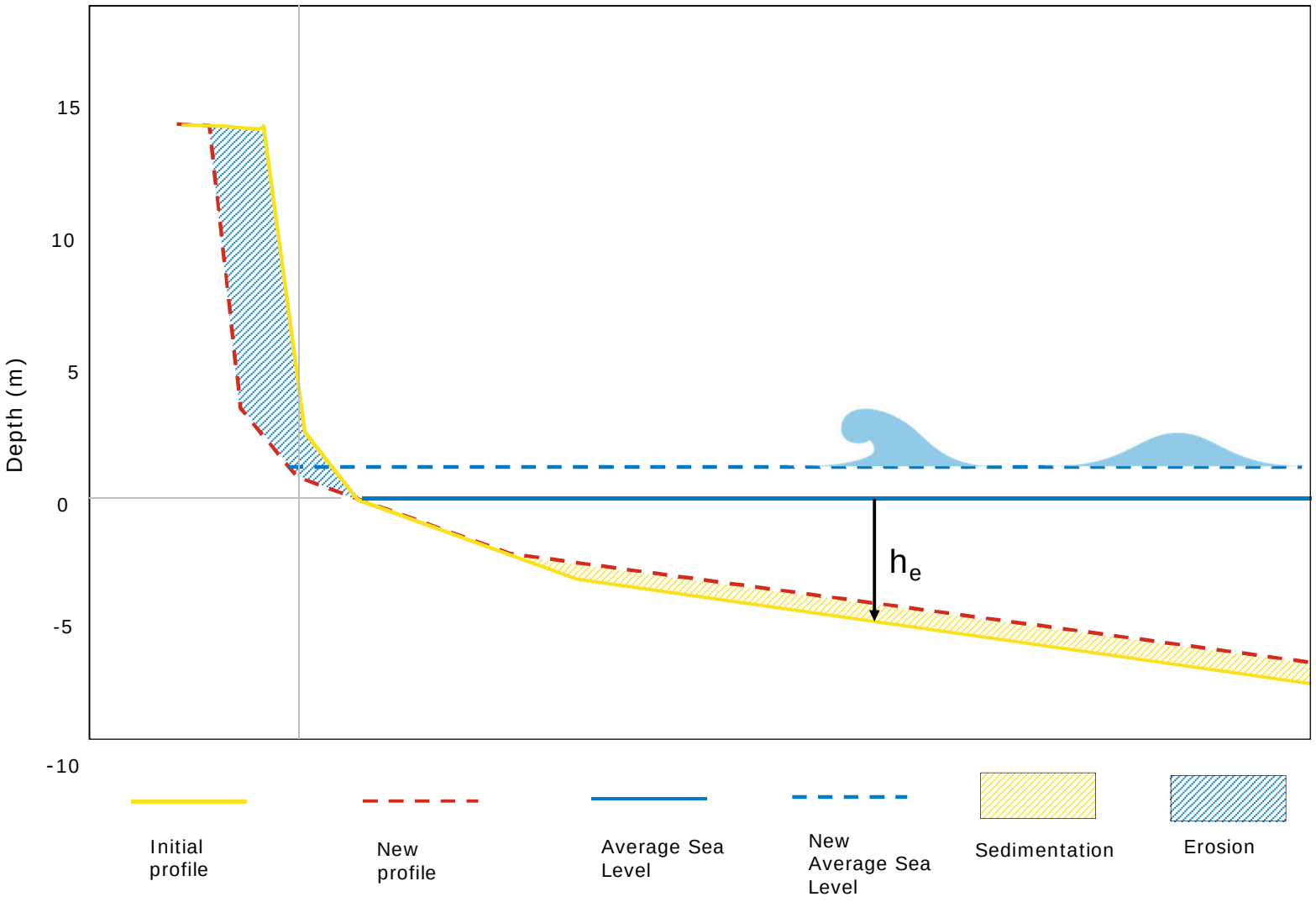

Zeespiegel
Bodem

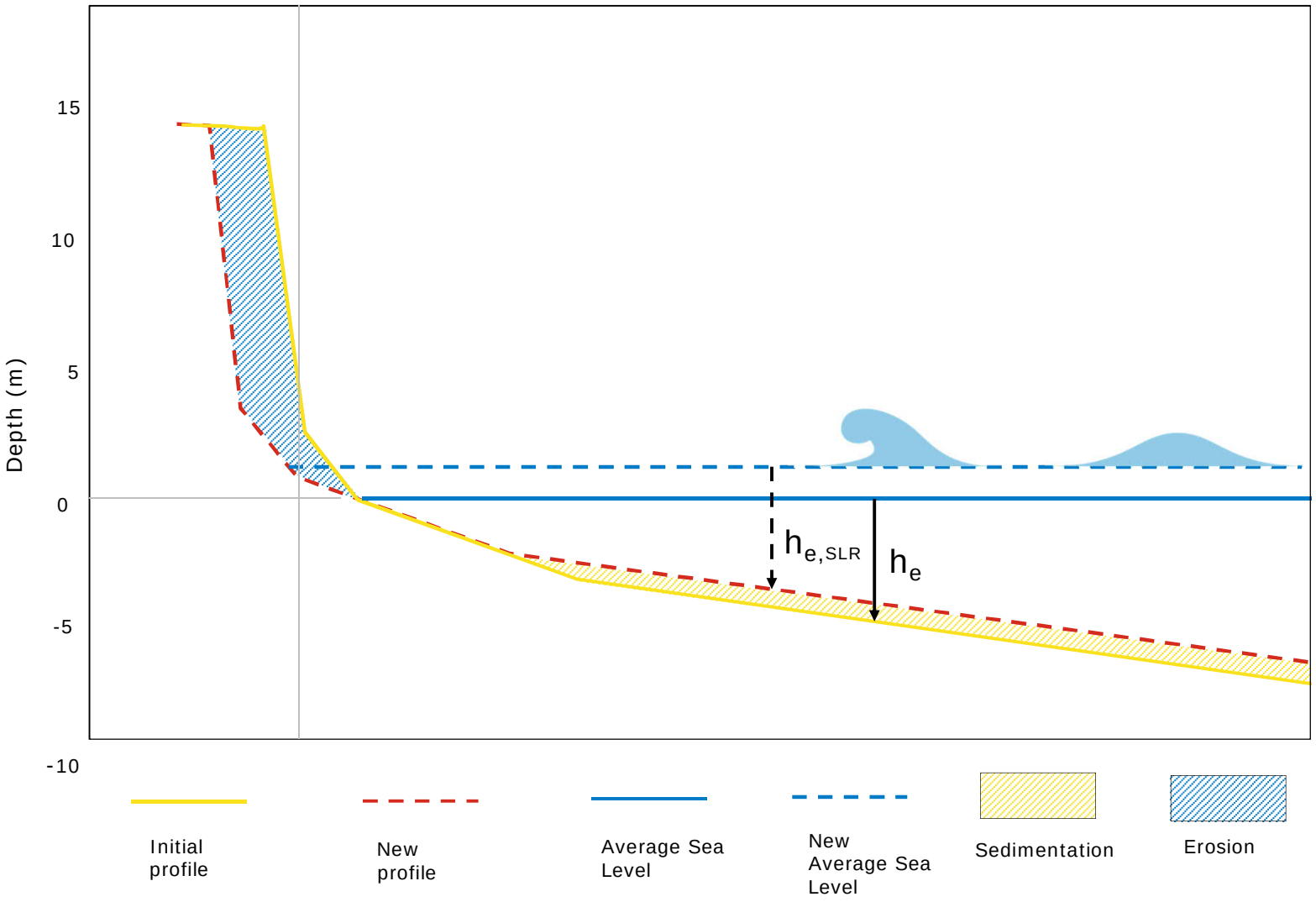

Zeespiegel
Bodem

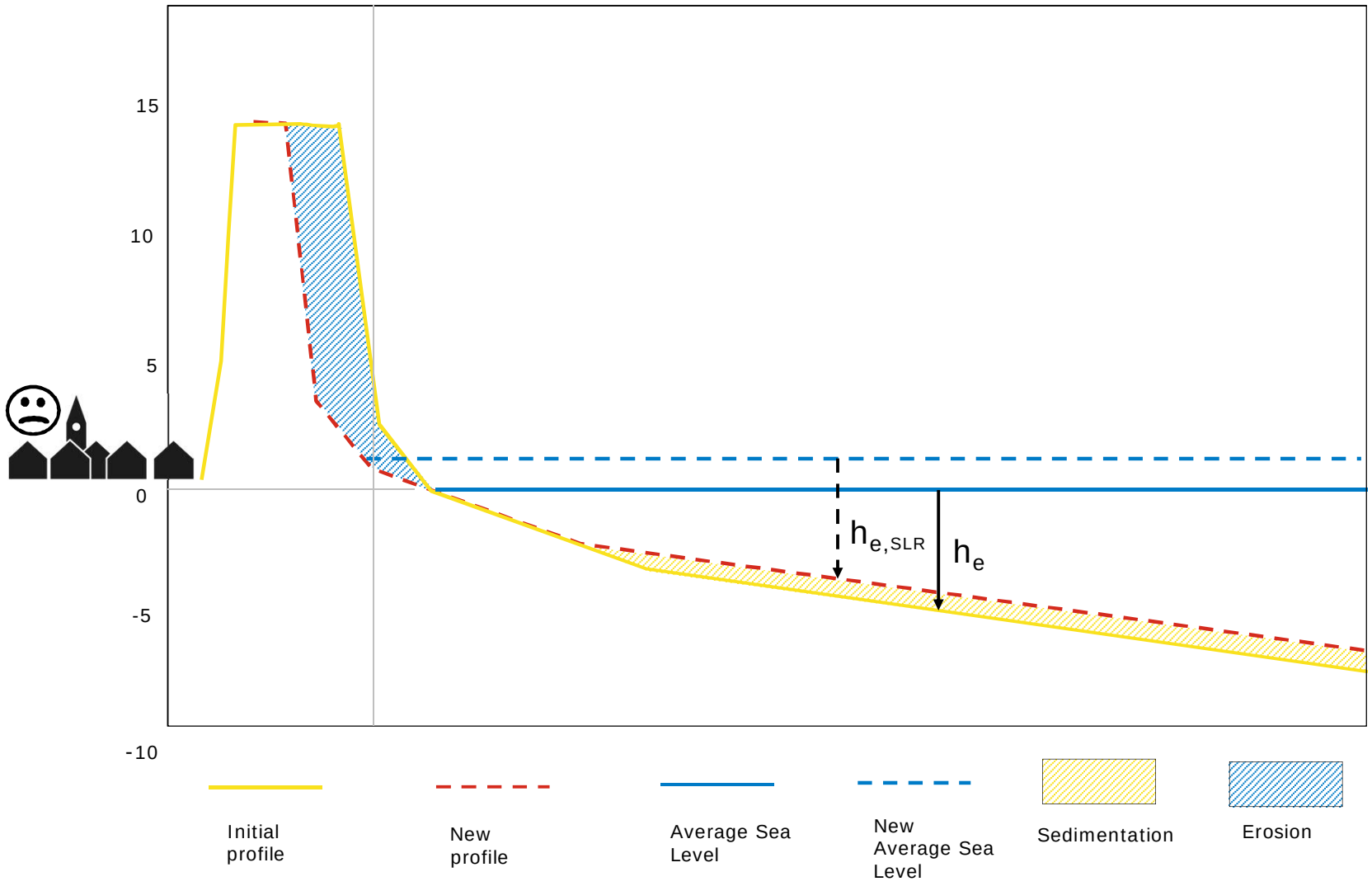

Depth (m)
15
10
5
0
-5
-10

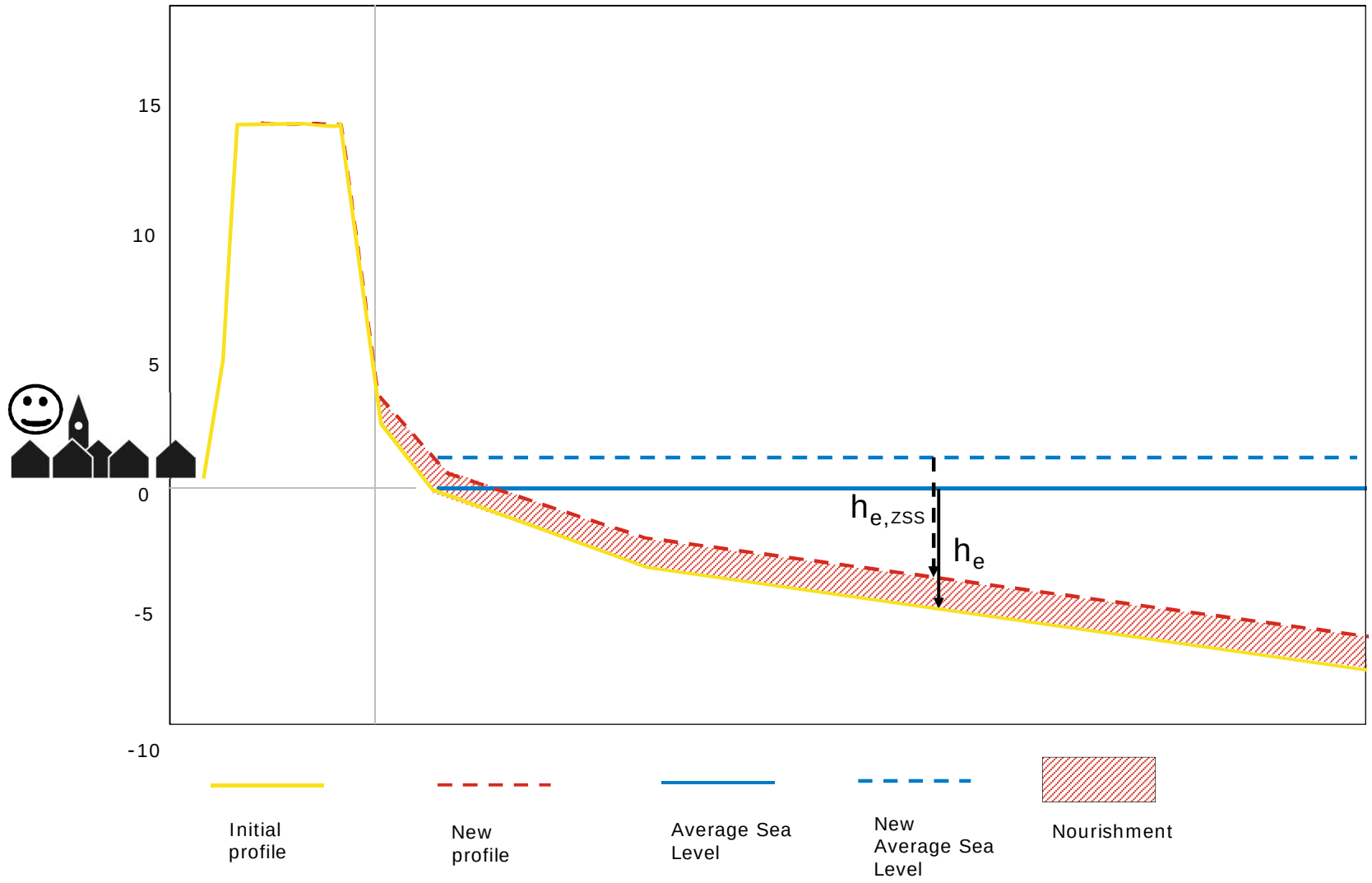

15
10
5
0
-5
-10
Depth (m)
h_e
Initial profile
Average Sea Level

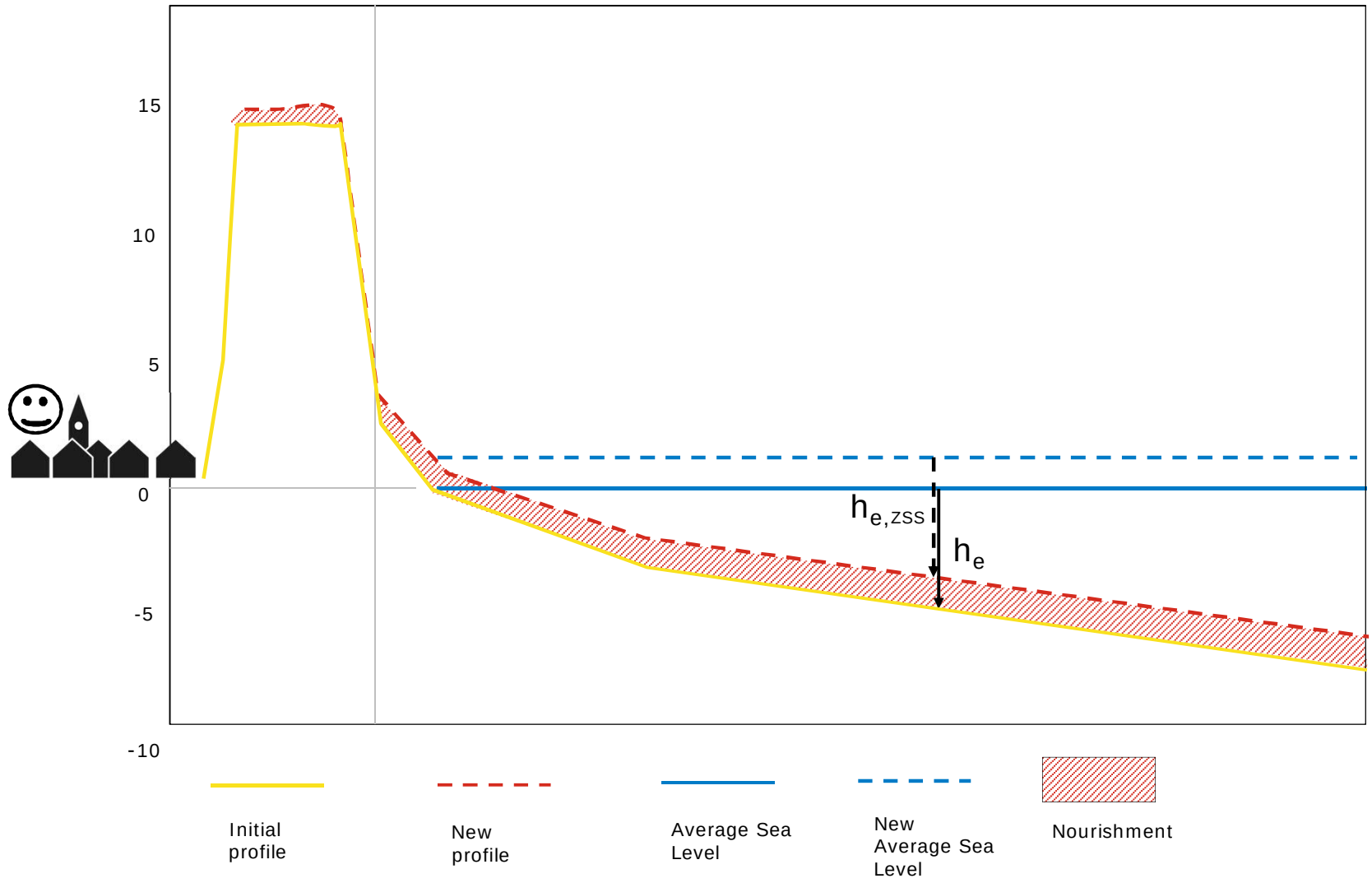

15
10
5
0
-5
-10
Detph (m)
h_e
Initial profile
Average Sea Level
New Sea Level


15
10
5
0
-5
-10
Depth (m)
h_e
Initial profile
New profile
Average Sea Level
New Average Sea Level
Sedimentation
Erosion

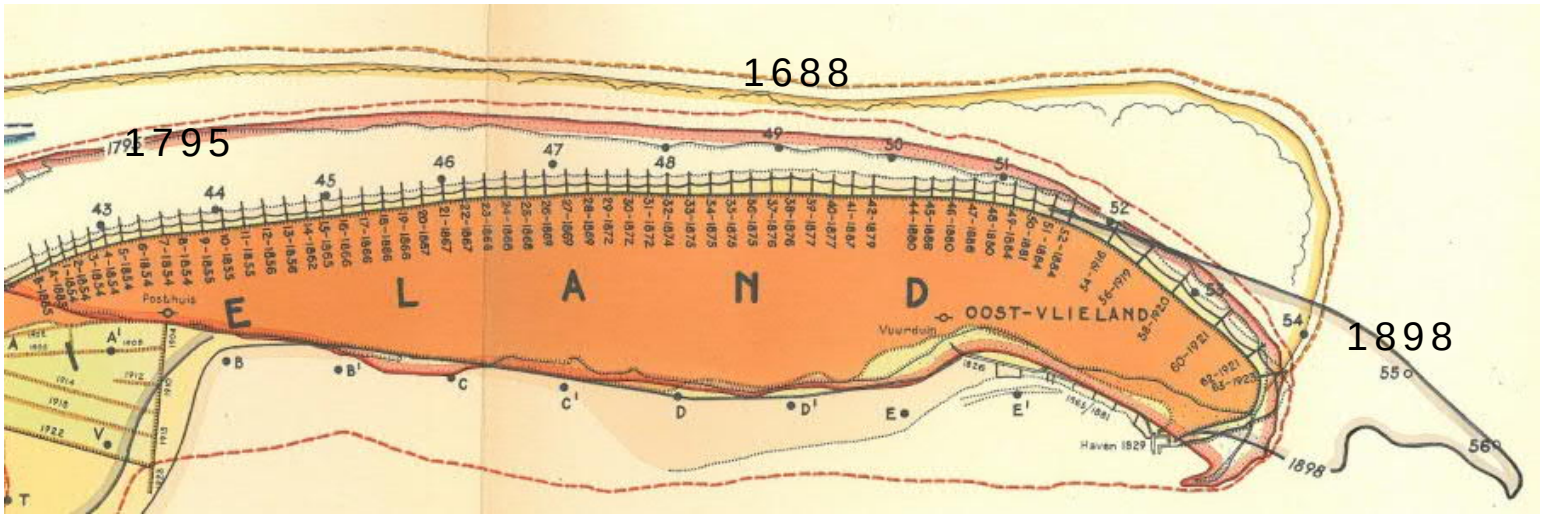

15
10
5
0
-5
-10
Depth (m)
$h_{e,SLR}$
h_e
Initial profile
New profile
Average Sea Level
New Average Sea Level
Sedimentation
Erosion

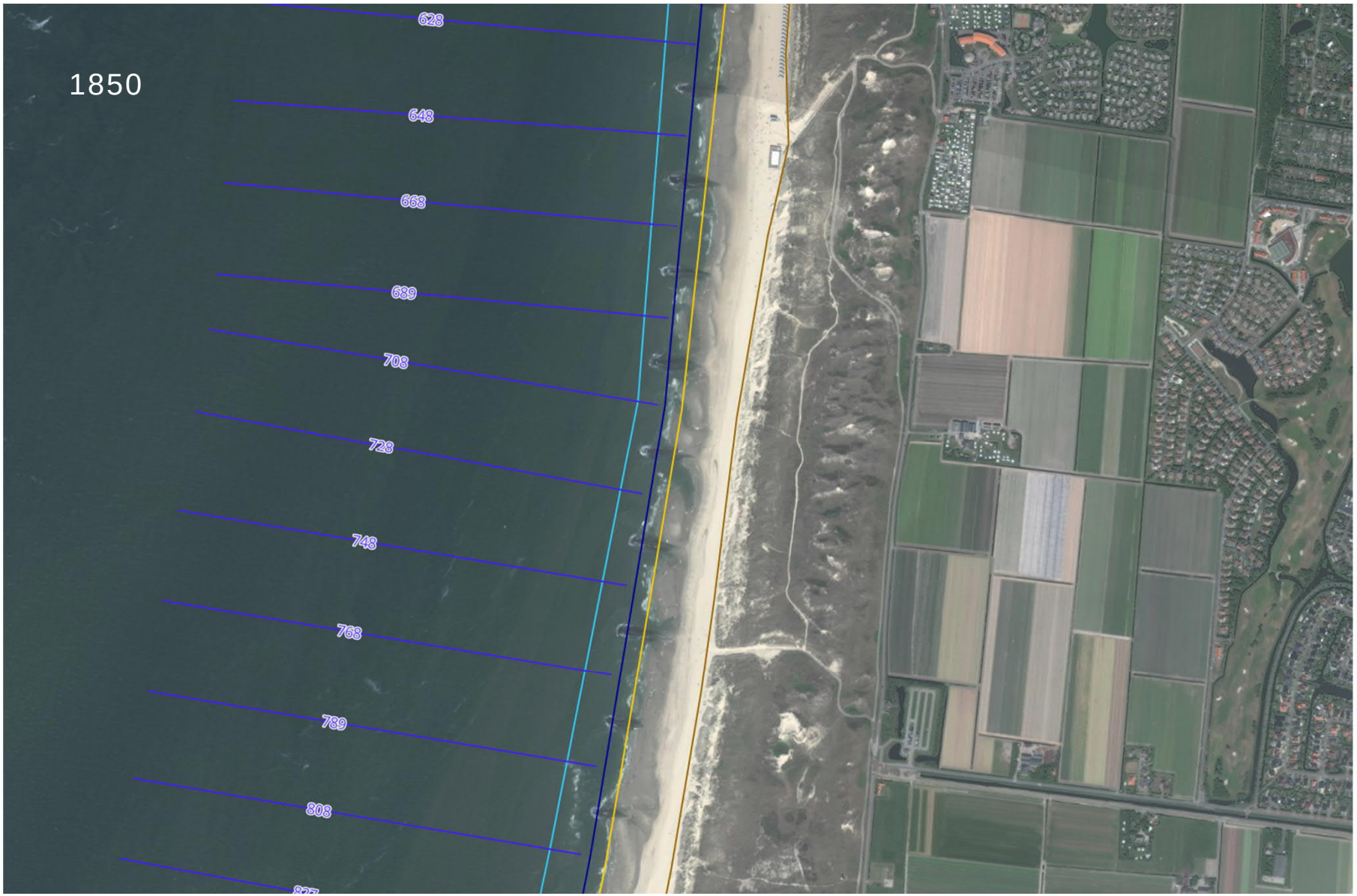

15
10
5
0
-5
-10
$h_{e,SLR}$
h_e
Initial profile
New profile
Average Sea Level
New Average Sea Level
Sedimentation
Erosion

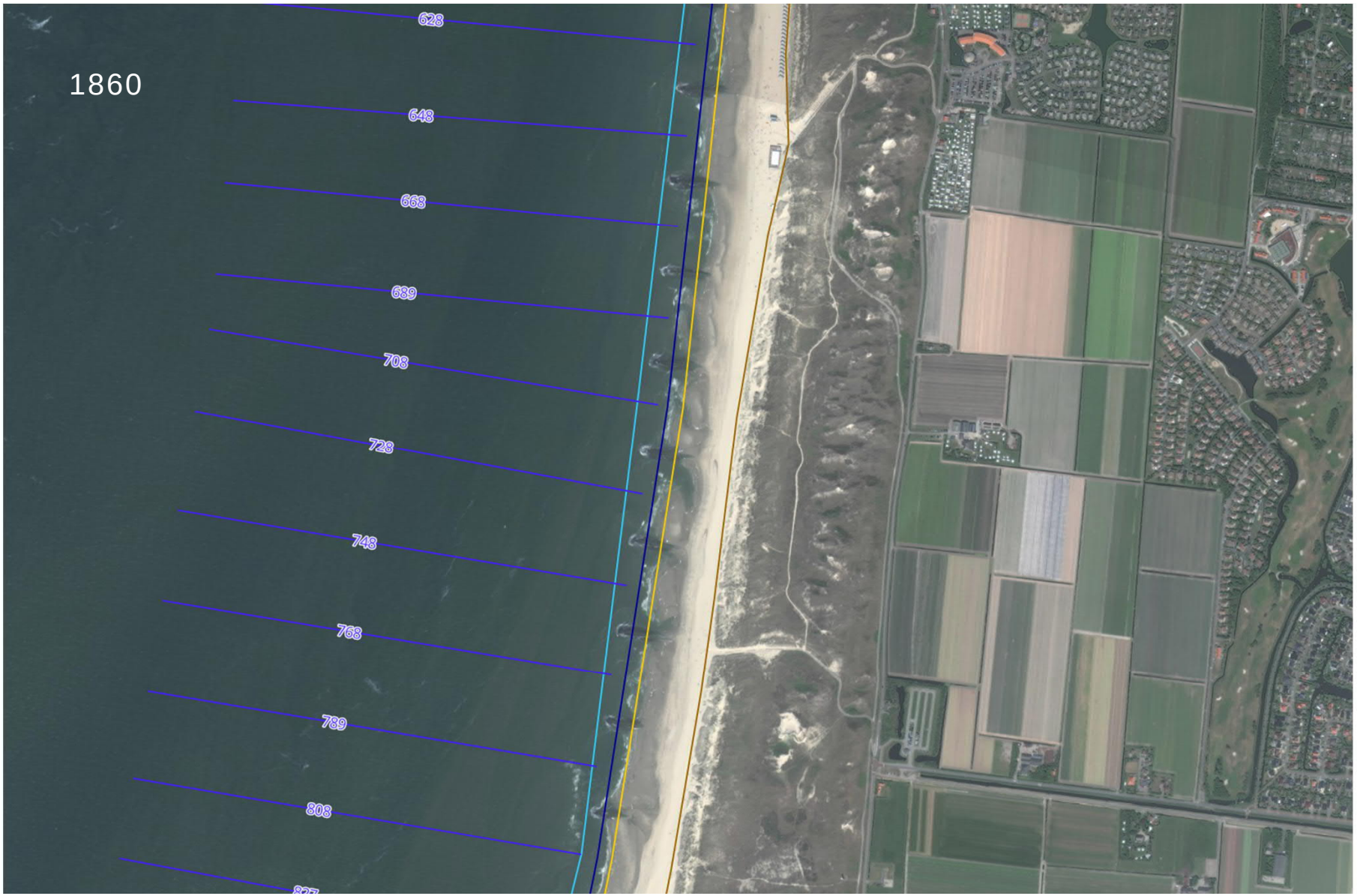

15
10
5
0
-5
-10
$h_{e,zss}$
h_e
Initial profile
New profile
Average Sea Level
New Average Sea Level
Nourishment

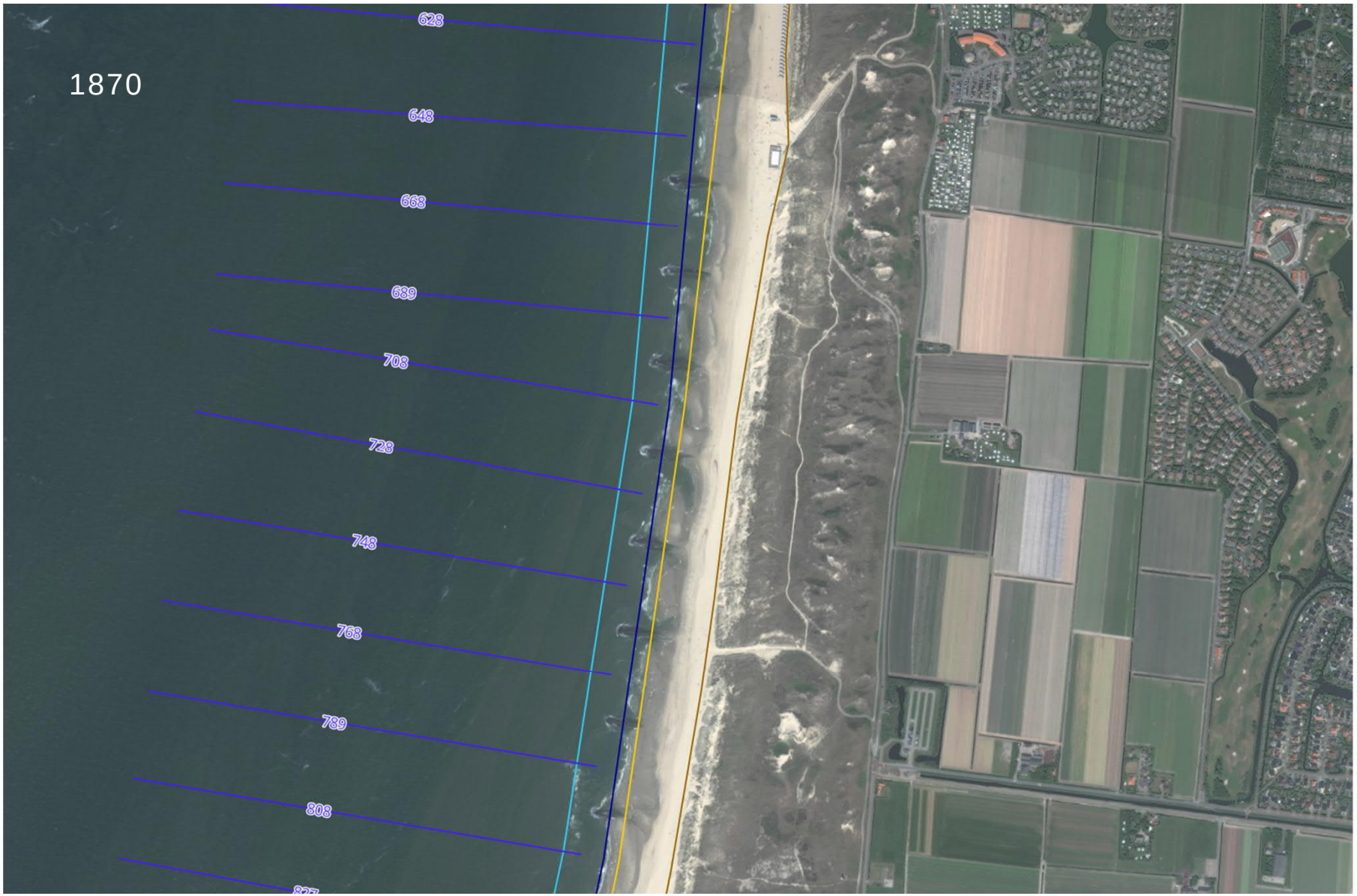

15
10
5
0
-5
-10
$h_{e,zss}$
h_e
Initial profile
New profile
Average Sea Level
New Average Sea Level
Nourishment

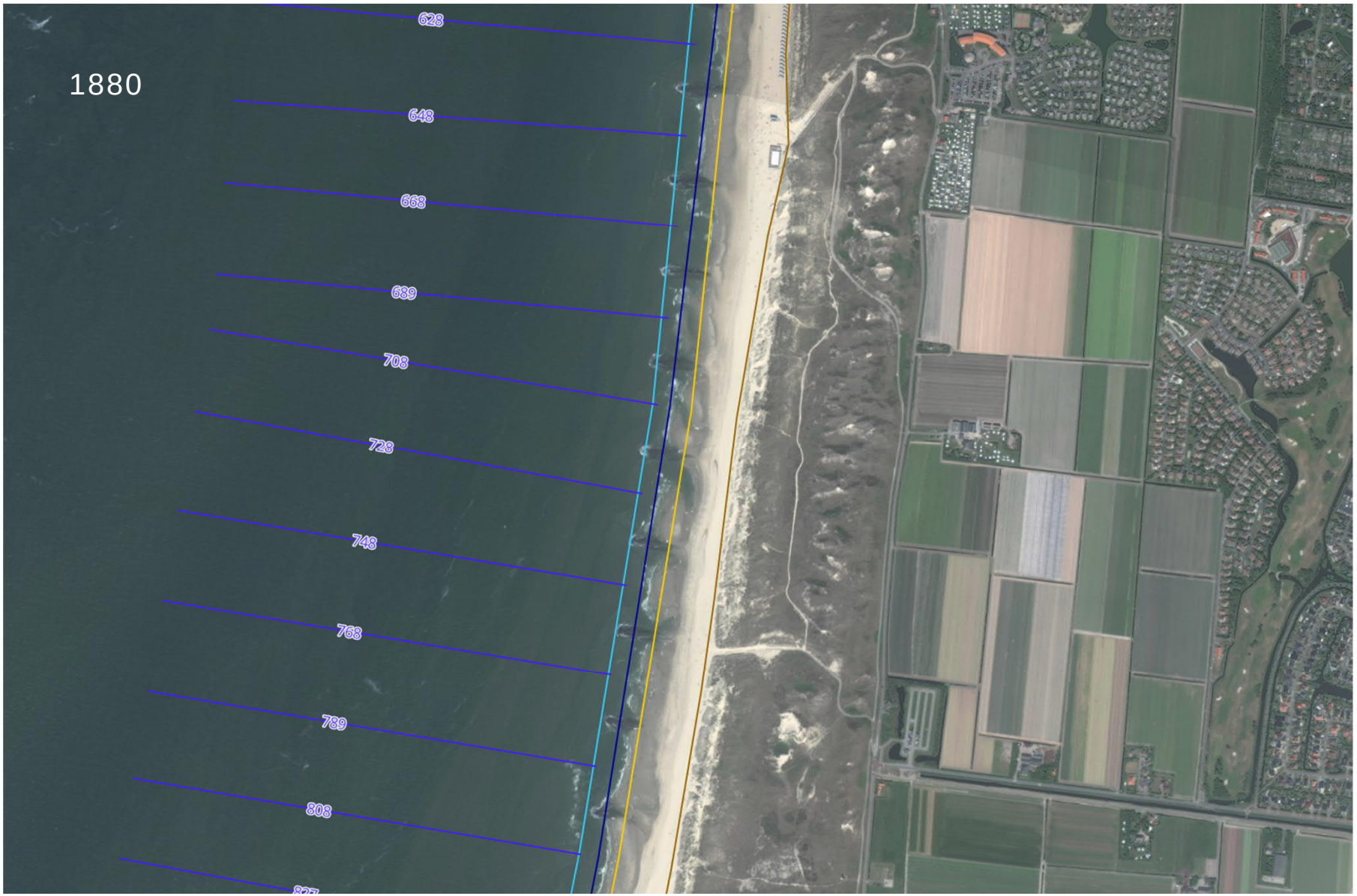
We have an on average eroding coastline

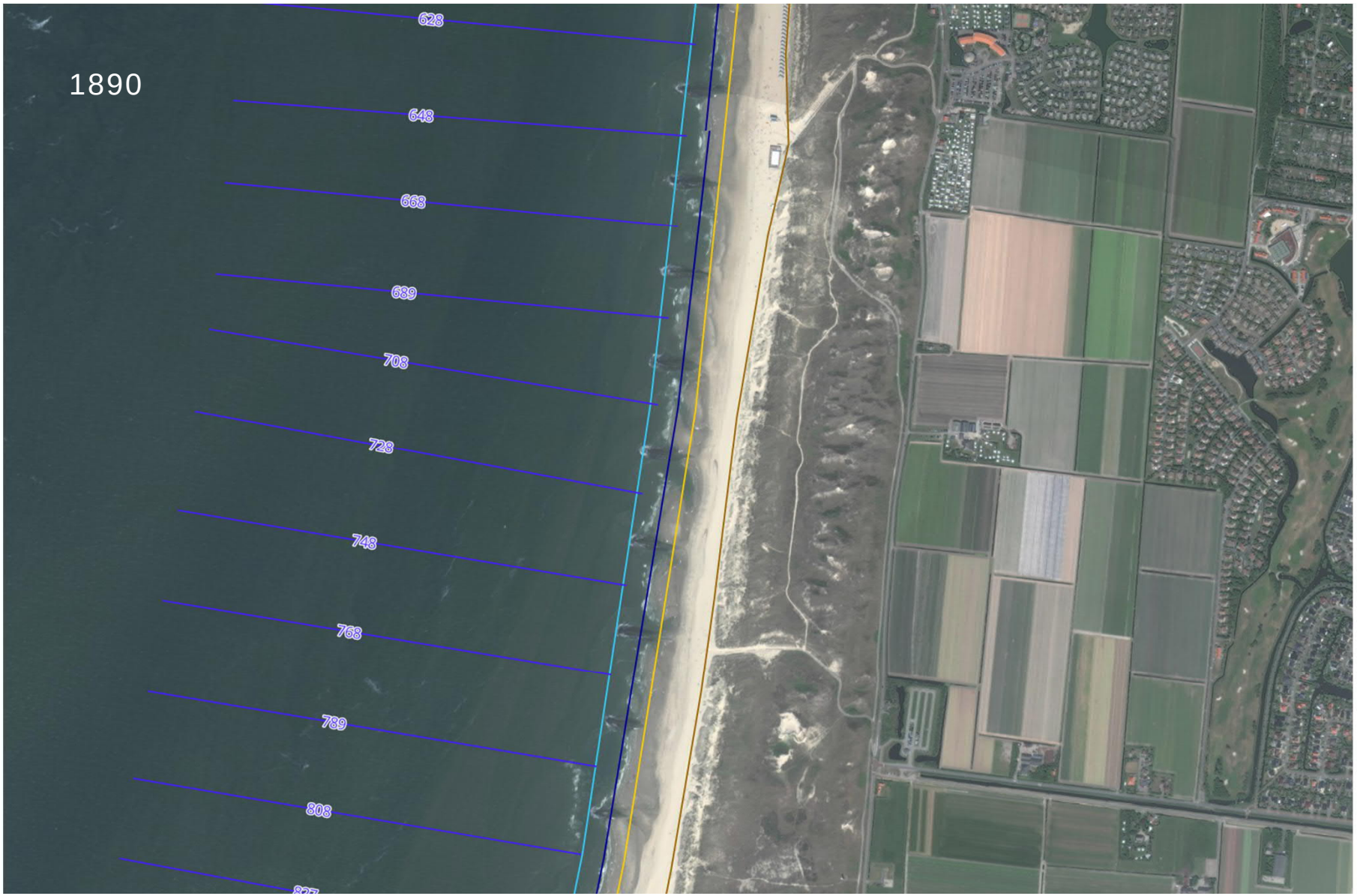


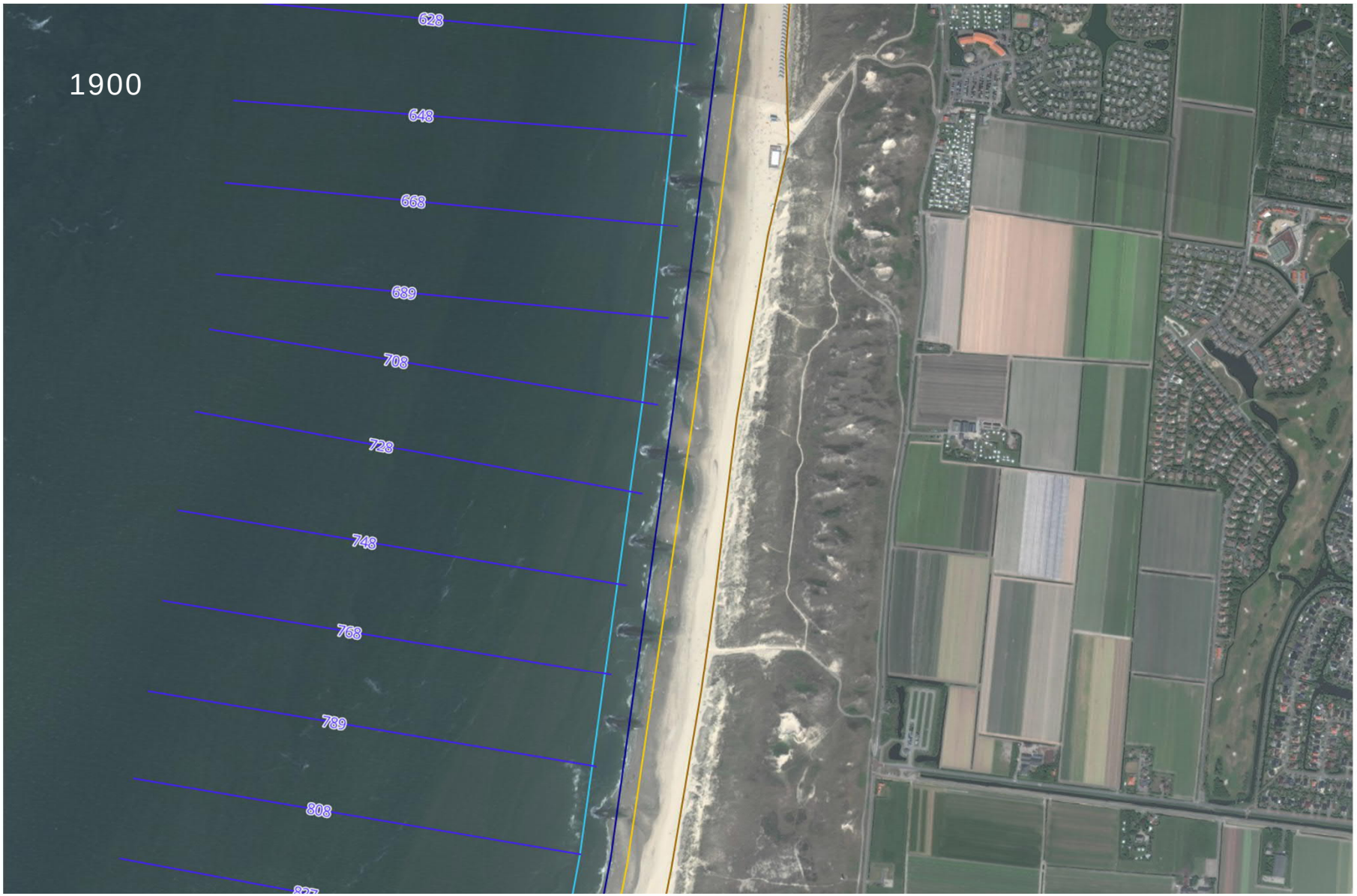

1850
628
648
668
689
708
728
748
768
789
808

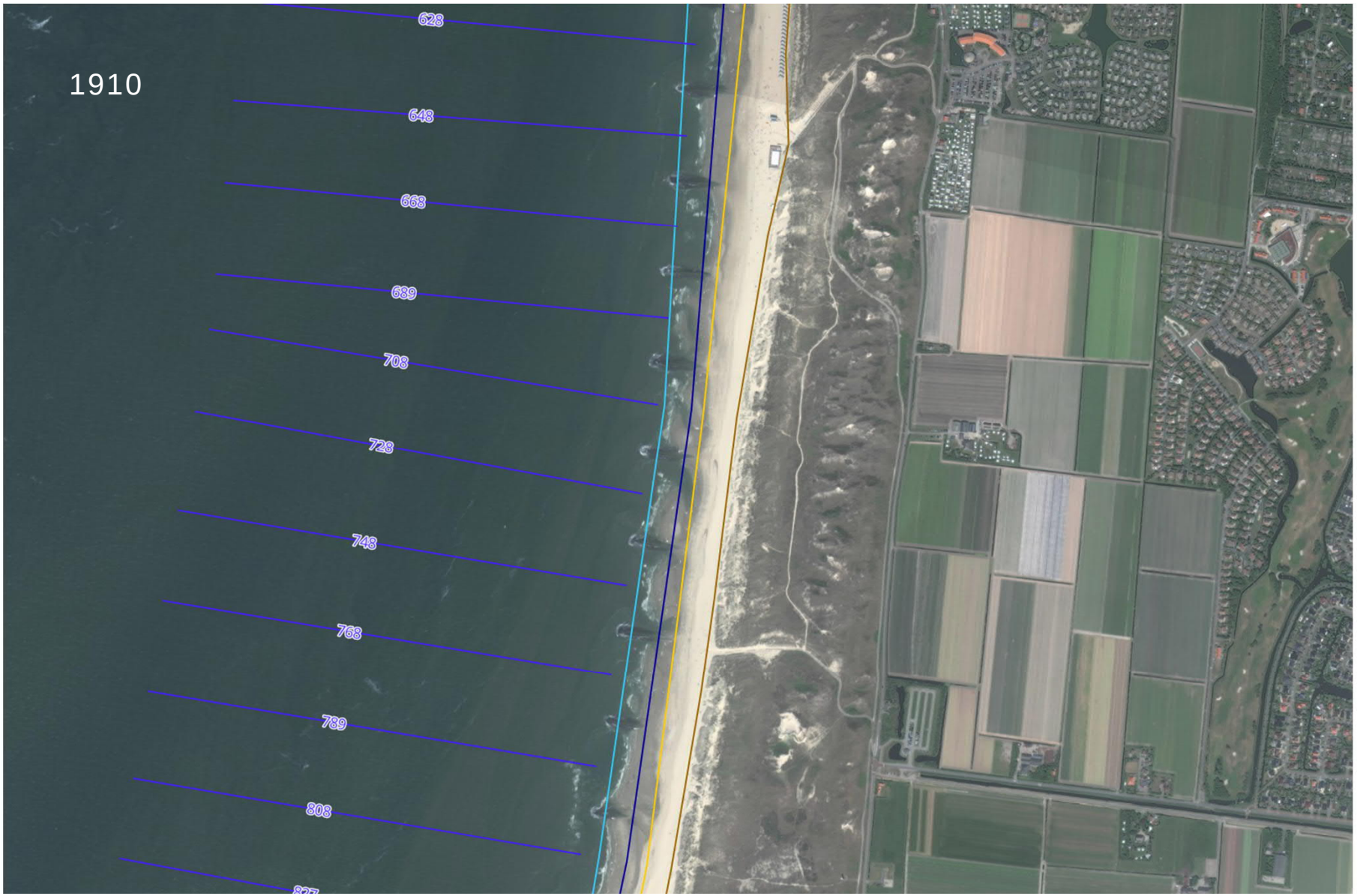

1860
628
648
668
689
708
728
748
768
789
808

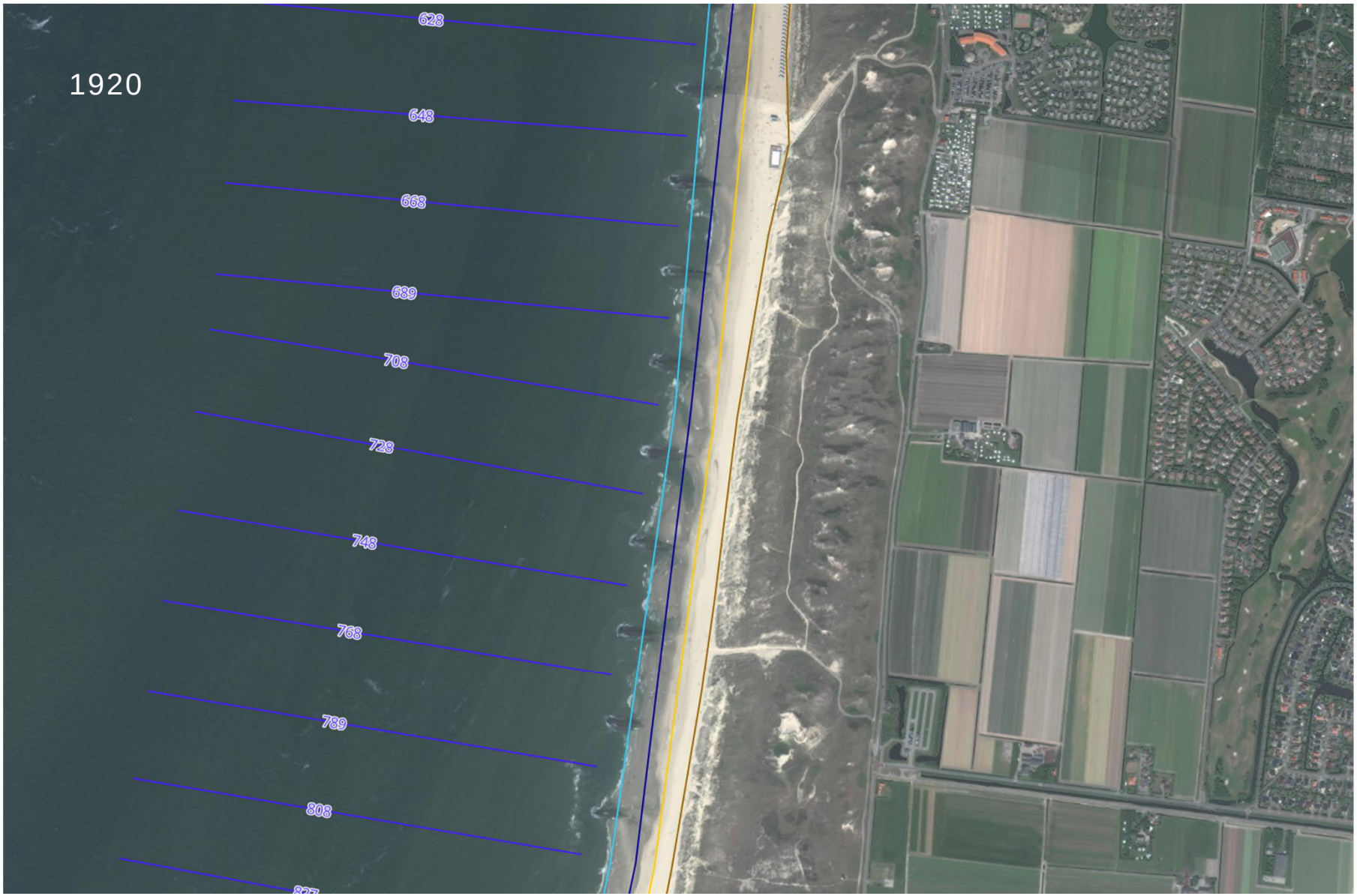

1870
628
648
668
689
708
728
748
768
789
808

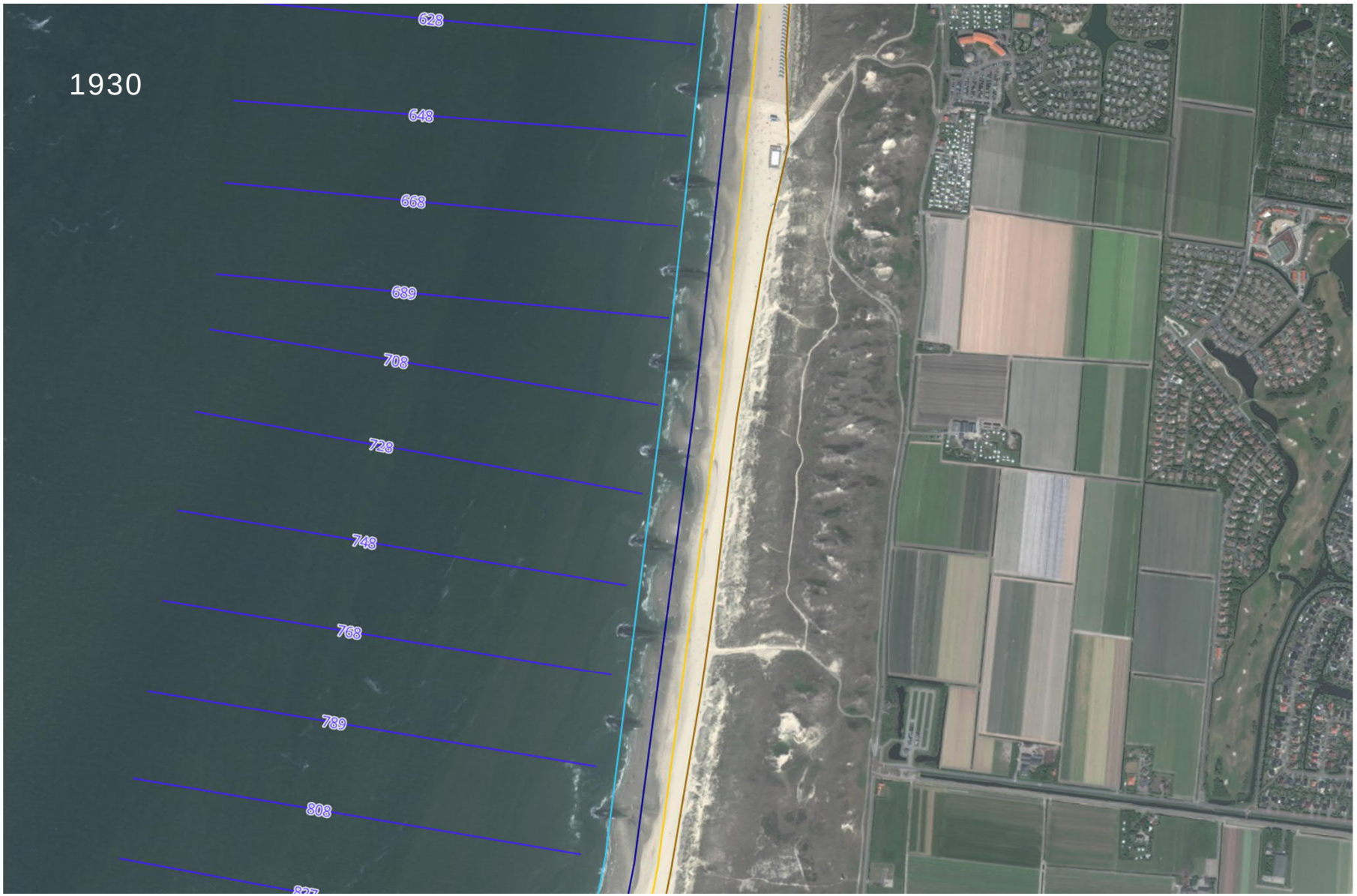

1880
628
648
668
689
708
728
748
768
789
808

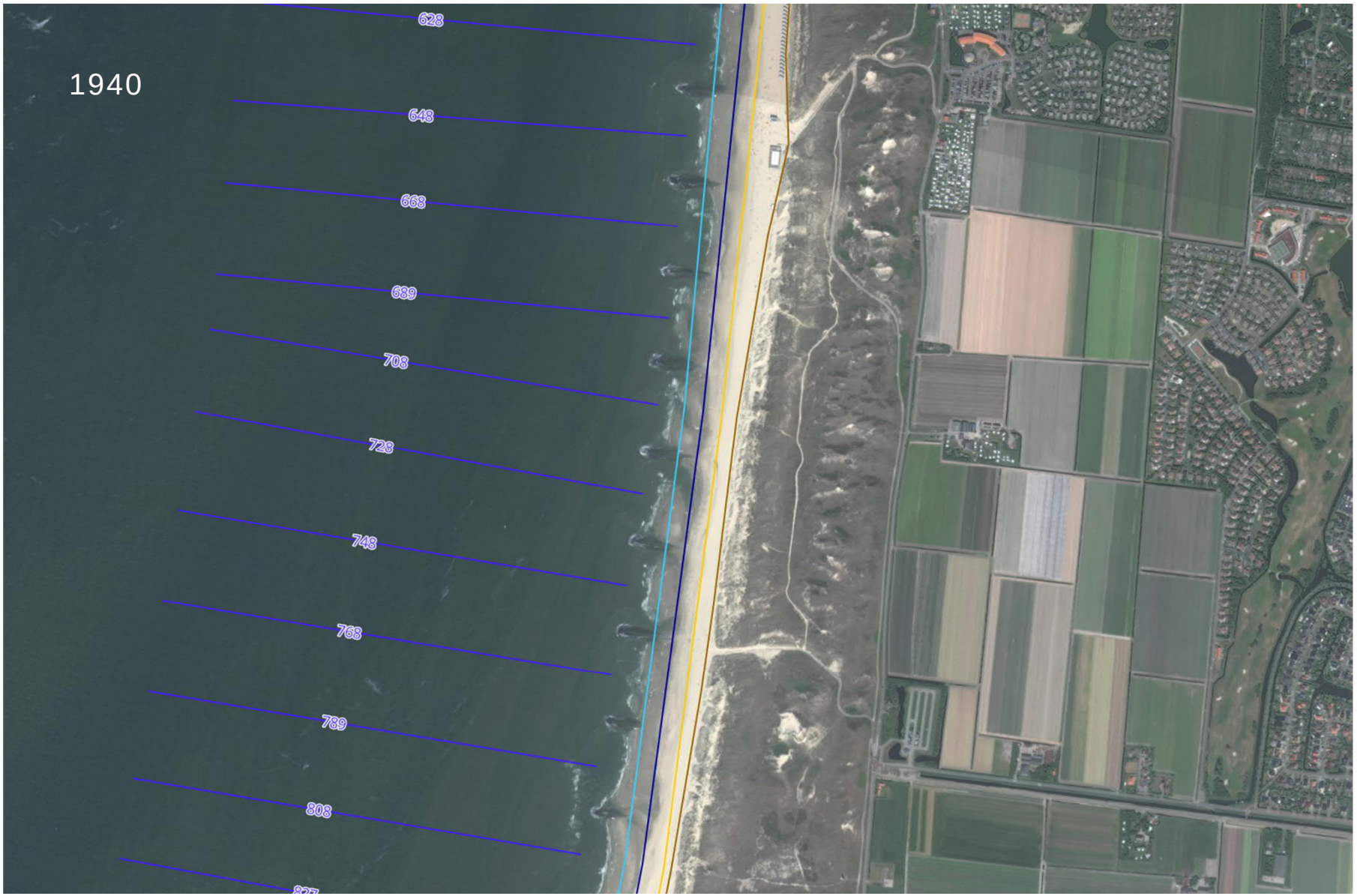

1890
628
648
668
689
708
728
748
768
789
808

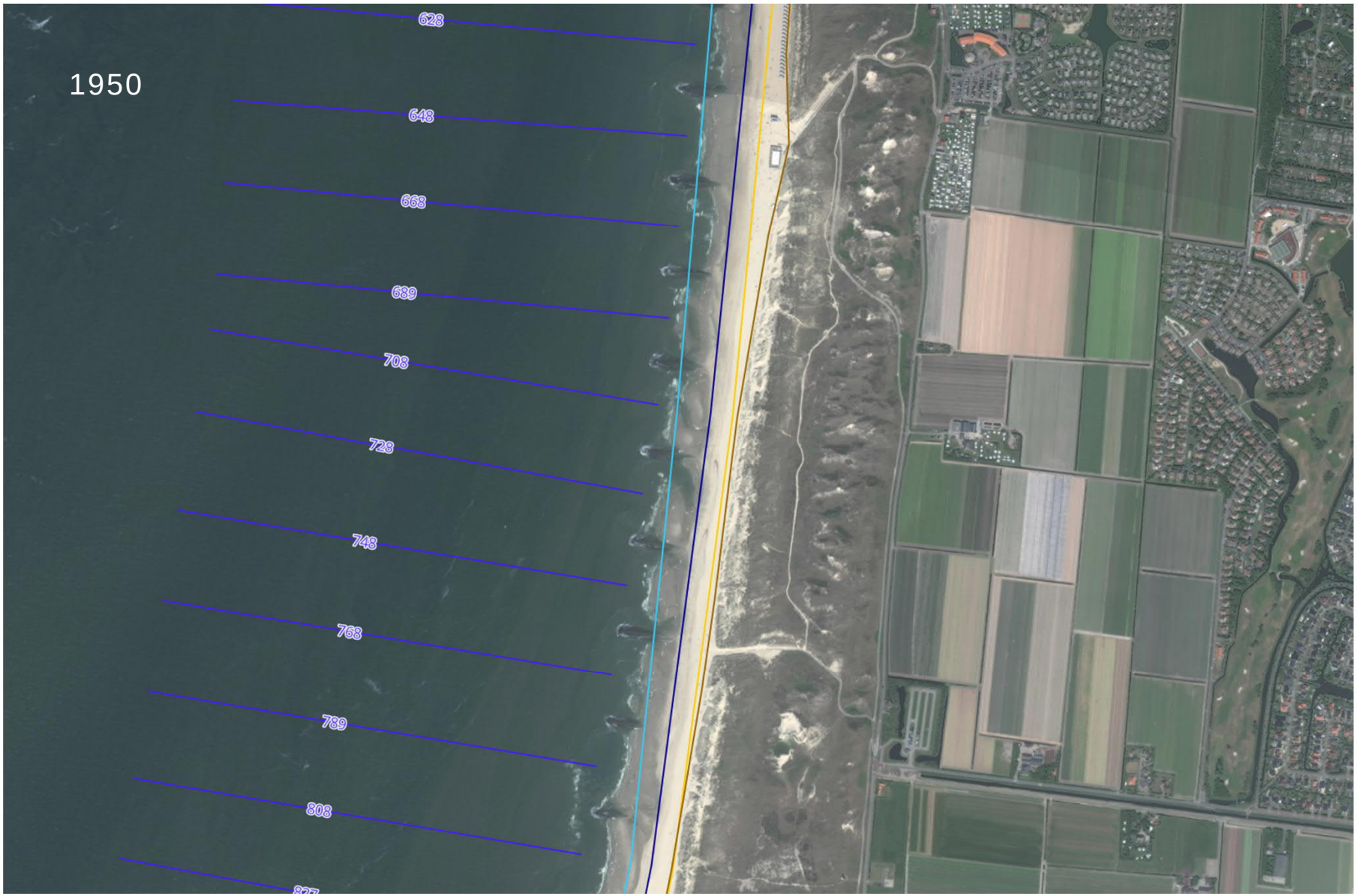

1900
628
648
668
689
708
728
748
768
789
808


1910
628
648
668
689
708
728
748
768
789
808


1920
628
648
668
689
708
728
748
768
789
808


1930
628
648
668
689
708
728
748
768
789
808


1940
628
648
668
689
708
728
748
768
789
808


1950
628
648
668
689
708
728
748
768
789
808


1960
628
648
668
689
708
728
748
768
789
808


1970
628
648
668
689
708
728
748
768
789
808


1980
628
648
668
689
708
728
748
768
789
808


1990
628
648
668
689
708
728
748
768
789
808


2000
628
648
668
689
708
728
748
768
789
808

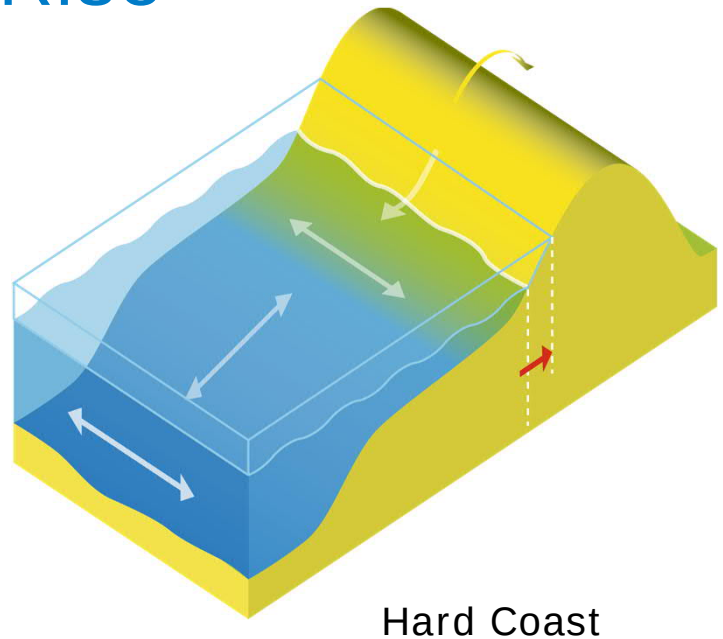

2010
628
648
668
689
708
728
748
768
789
808


2019
628
648
668
689
708
728
748
768
789
808

The erosion treatens coastal functions

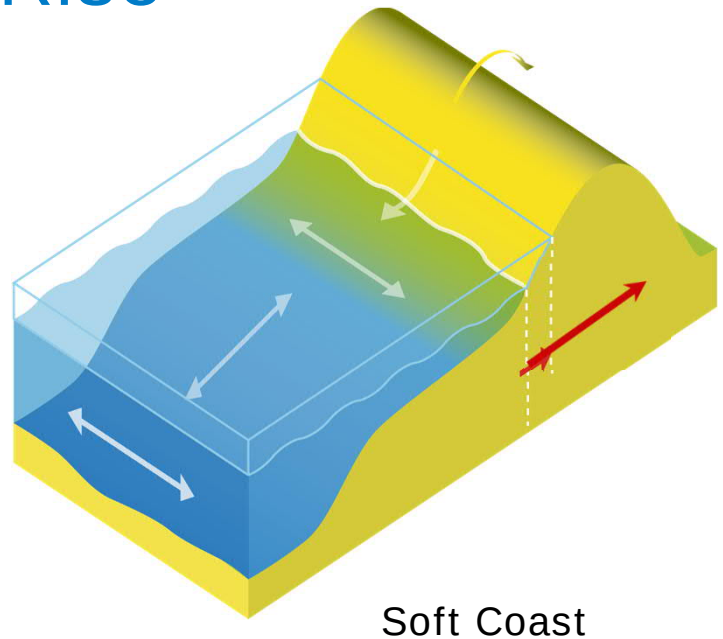
Coastal Protection with Sediments

Effect Sea Level Rise



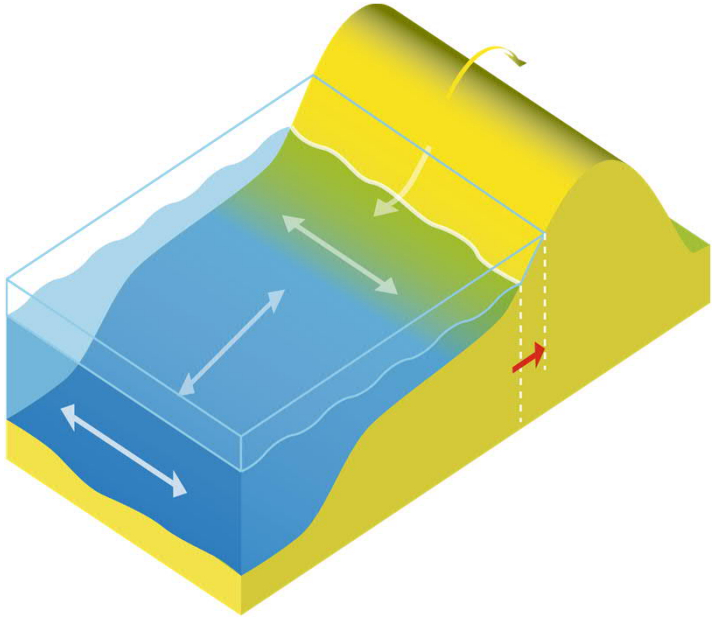
Hard Coast

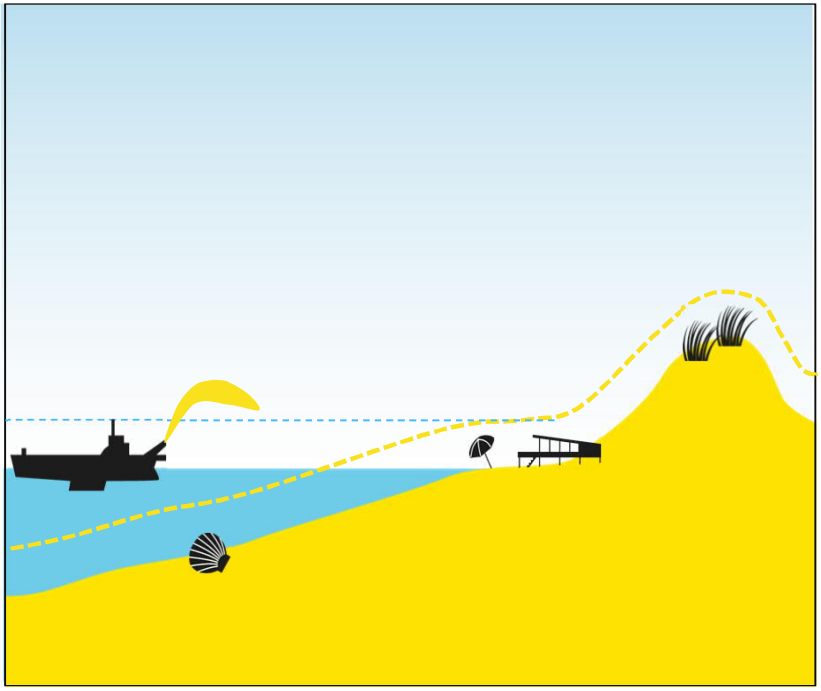
Effect Sea Level Rise



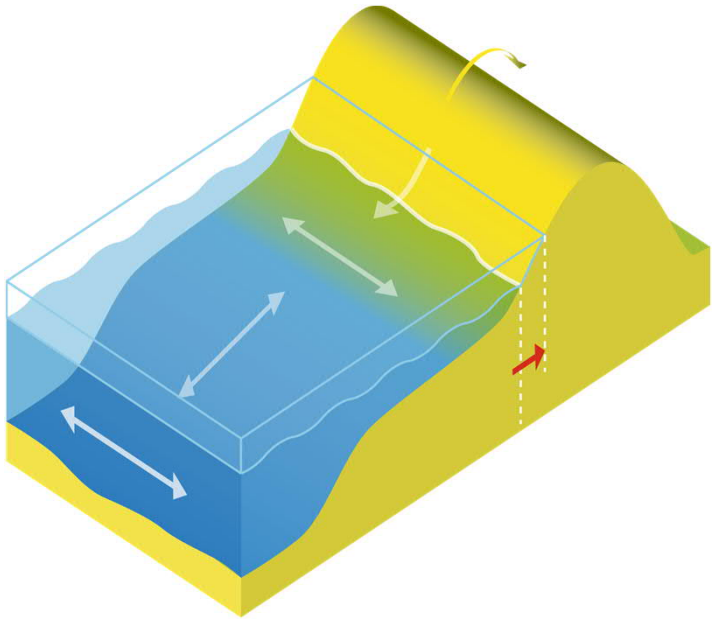
Soft Coast

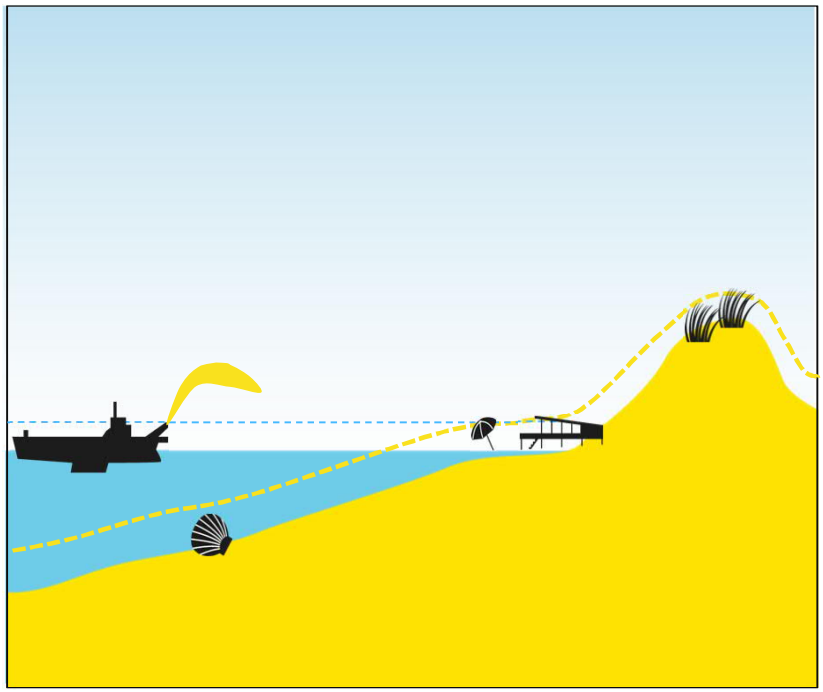
Dutch Strategy: Feed the Coast with Sediments



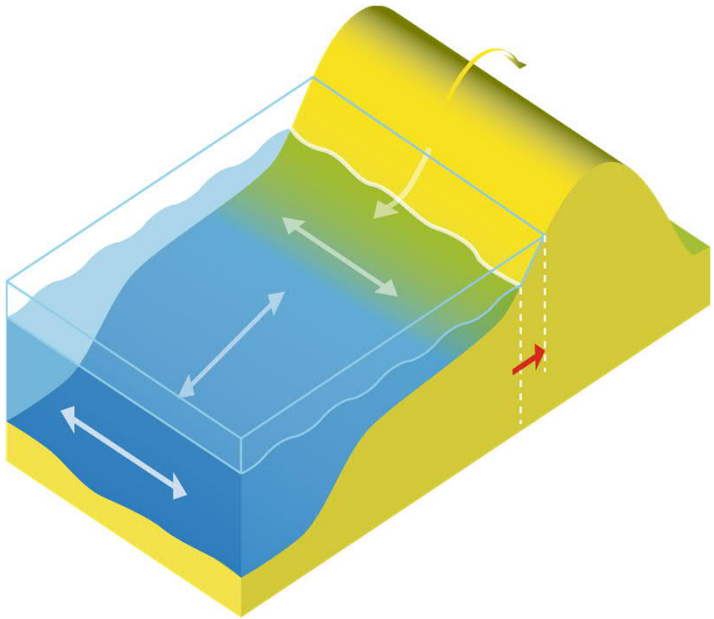


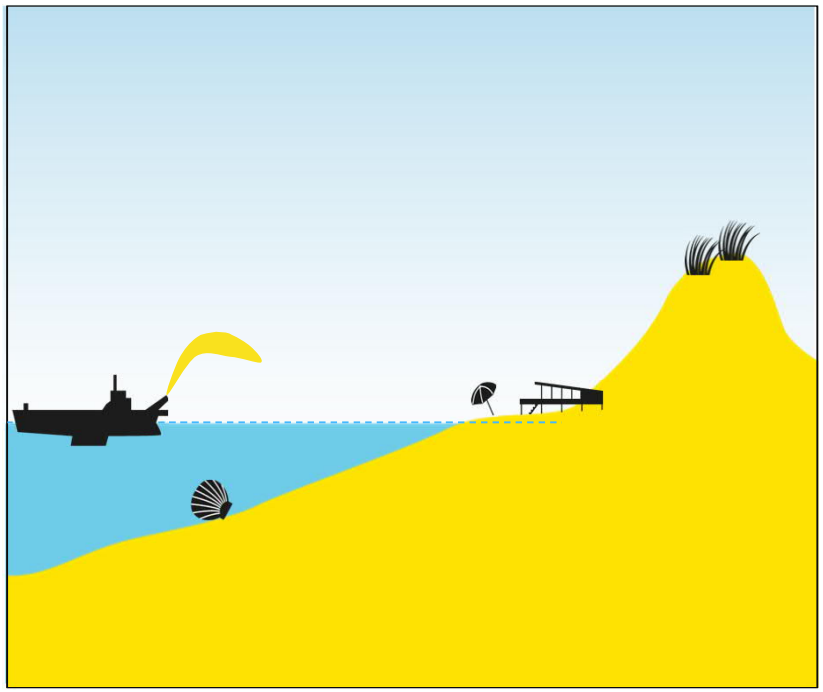
So it can grow with Sea Level

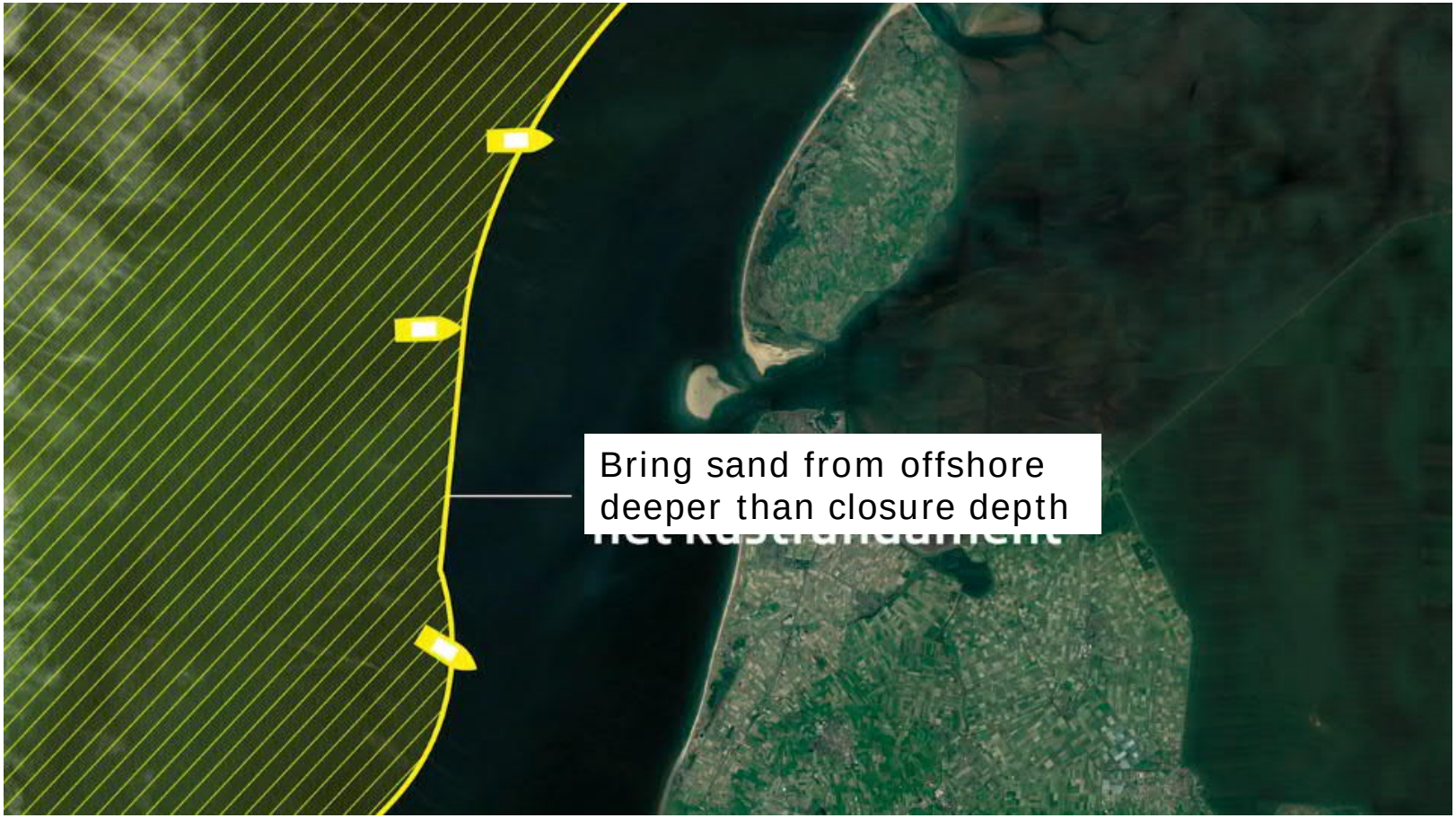


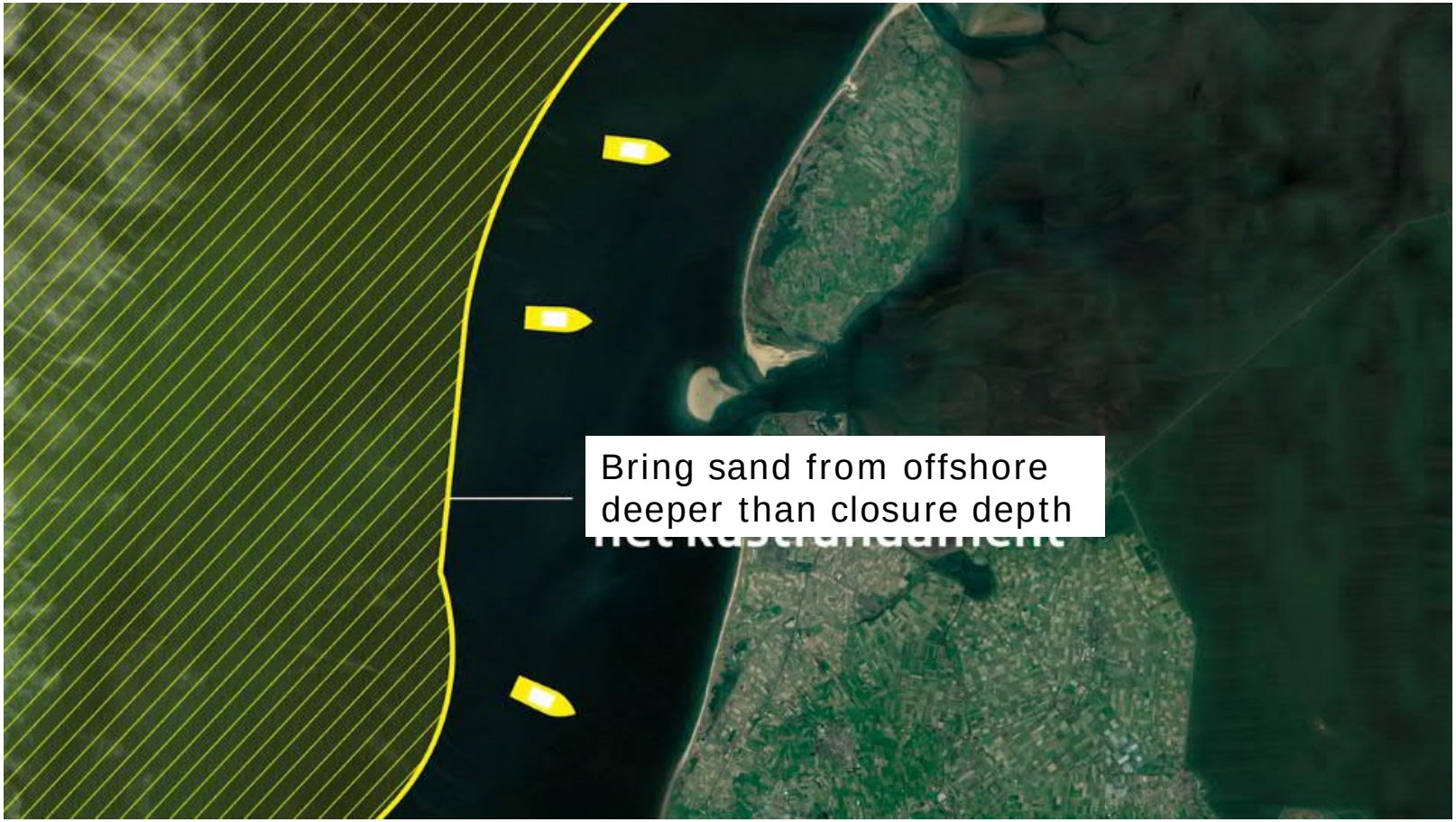


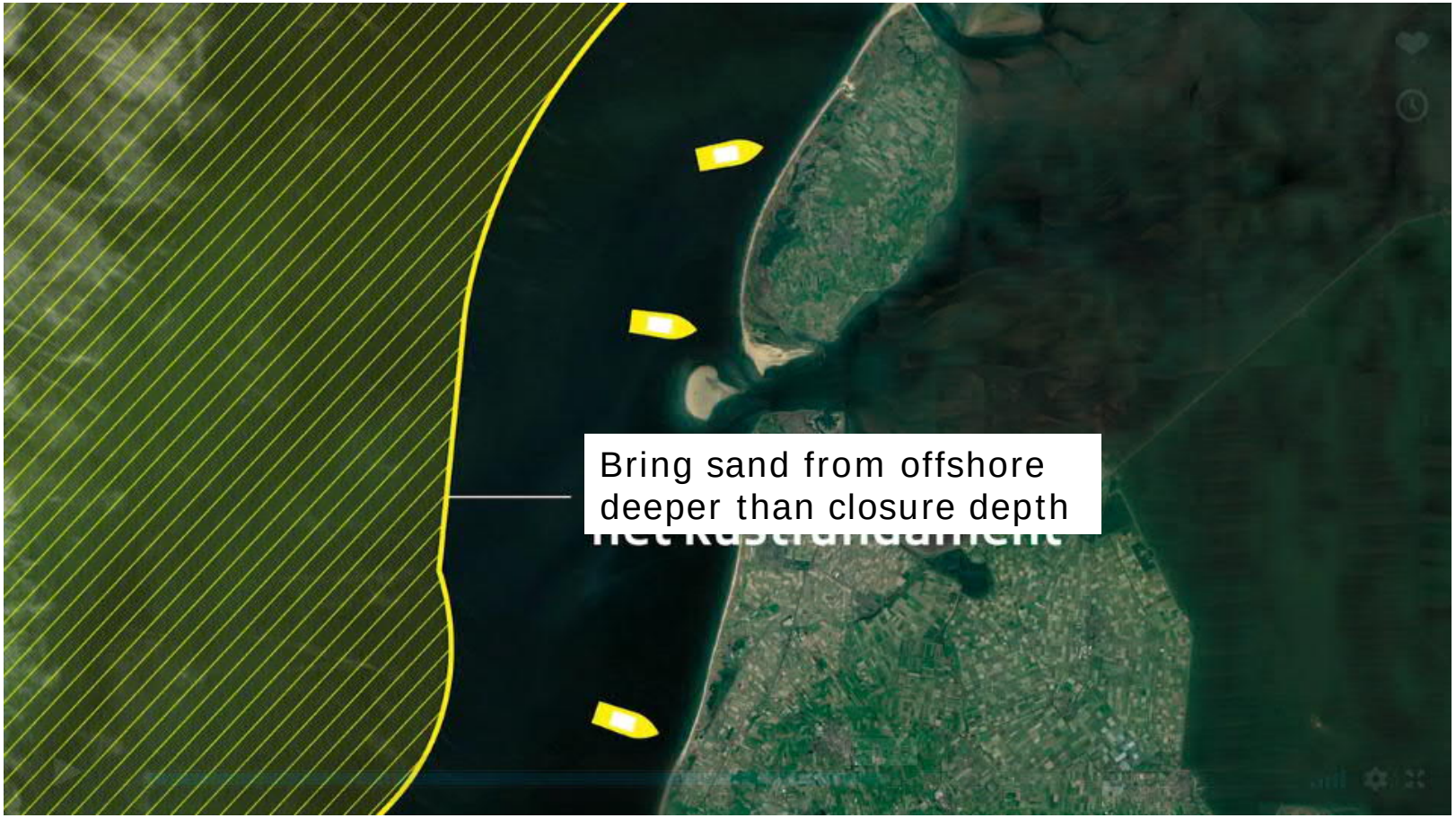
So it can grow with Sea Level






Bring sand from offshore
deeper than closure depth


Bring sand from offshore
deeper than closure depth


Bring sand from offshore
deeper than closure depth

Thats set policy but how did we get there?

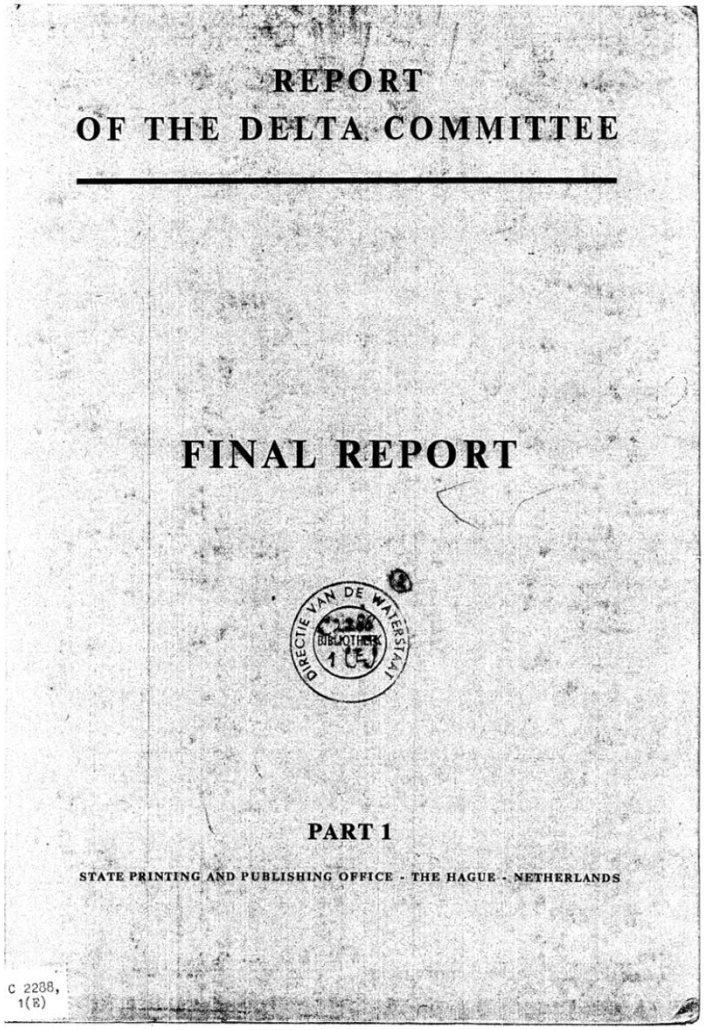
After 1953 storm surge and floods

-> Advice Delta Committee

Advice (Brief):

- Reduce length coastline -> Deltaplan
- Improve flood safety
- Set standards for design heights (1/10.000 surge event for Central Holland Coast)
- Increase research and monitoring

https://puc.overheid.nl/rijkswaterstaat/doc/PUC_25215_31/1/



Thats set policy but how did we get there?

1990, Coastal Defence policy white paper

Advice (Brief):

- To maintain the flood risk reduction achieved by the Deltaplan, coastal erosion/retreat should be stoppen
- Dynamically maintain the coastline using soft techiques -> Nourishments
- Establish a reference coastline

Thats set policy but how did we get there?

2001, 3th Coastal Defence policy white paper

Advice (Brief):

- Continue the Dynamic conservation policy
- Compensate for relative sediment losses due to Sea Level Rise

Thats set policy but how did we get there?

2008, policy advice by the Delta Committee 2008

Main question:

- What should be done adapt the Netherlands to climate change and Sea Level Rise?

Advice (Brief)

- Even with (then) high end scenario's it is possible to adapt the Netherlands to SLR (we can stay in the low parts of the country)
- Develop strategies for adaptation, now and till 2100.

Delta strategies (first set in 2015, re-evaluation every 6 years)

Flood protection standards

In 2050 all levees are up to new standards

Water level Lake IJssel area

Combine free outflow and pumping to regulate water levels in the lakes

Strategy fresh water supply

In 2050 NL is resilient to fresh water shortage

Protection strategy Rotterdam area

Open, but closable

New framework spatial planning urban areas

In 2050 NL is spatially adapted to climate change

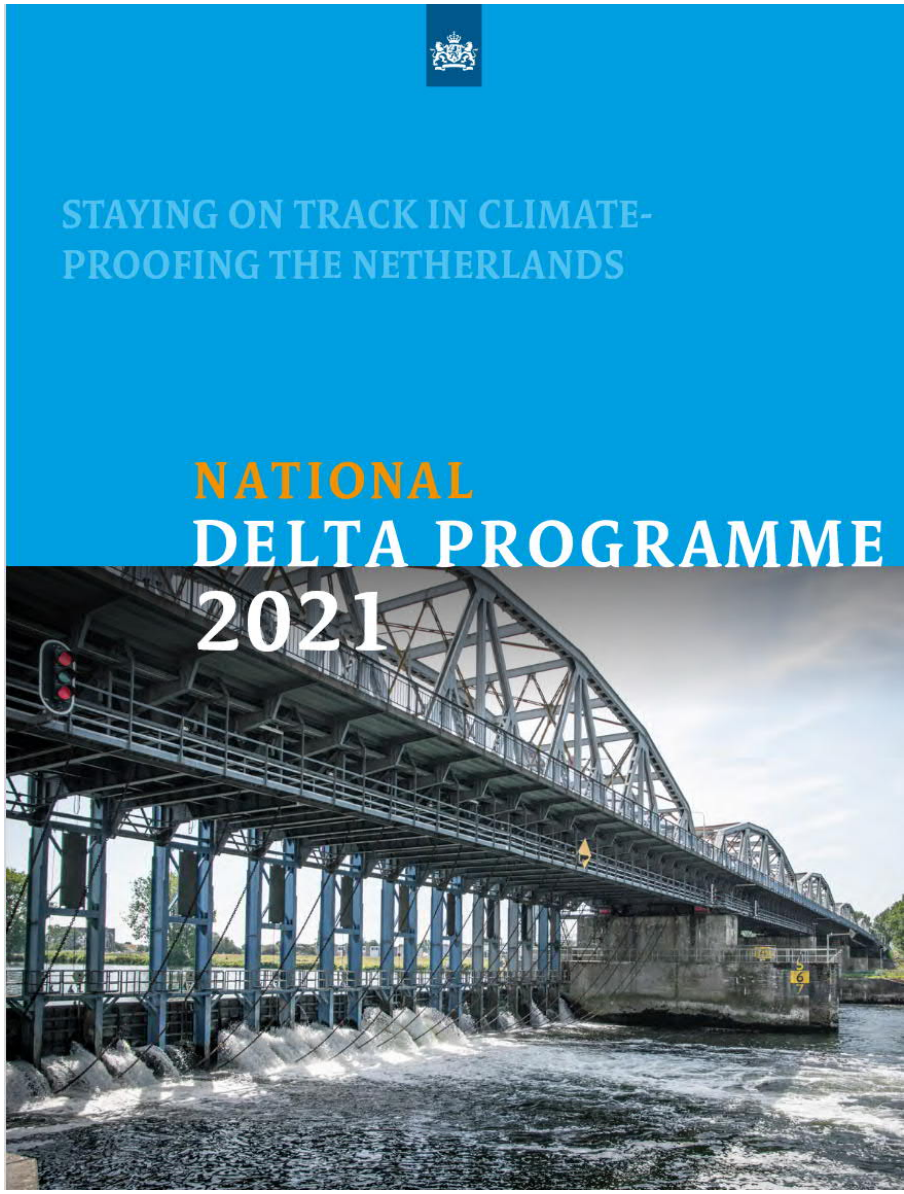
Sandy Coast

Feed the coast with sediments, so it can keep up with Sea Level

Policy developments

- Delta Programme 2021 (there are annual progress reports since 2011)
- Delta strategies can remain at the core of the Delta Programme
- However there are quite large uncertainties due to namely Sea Level Rise

(https://english.deltaprogramma.nl/documents/publications/2020/09/15/dp2021-eng-printversie)



Delta Strategies Dutch Coast 2015

- Area: the whole of the coast that is connected through sediment exchange on centennial time scales
- Problem assessment (Brief):
  - Sustainable Flood Risk protection of the coast requires continues work: Coastal reinforcements and Nourishments.
  - Economic developments at the coast are needed to improve the quality of life and economy at the coast
- Investments in FRM and economy do not match in time.

Delta Programme | Coast

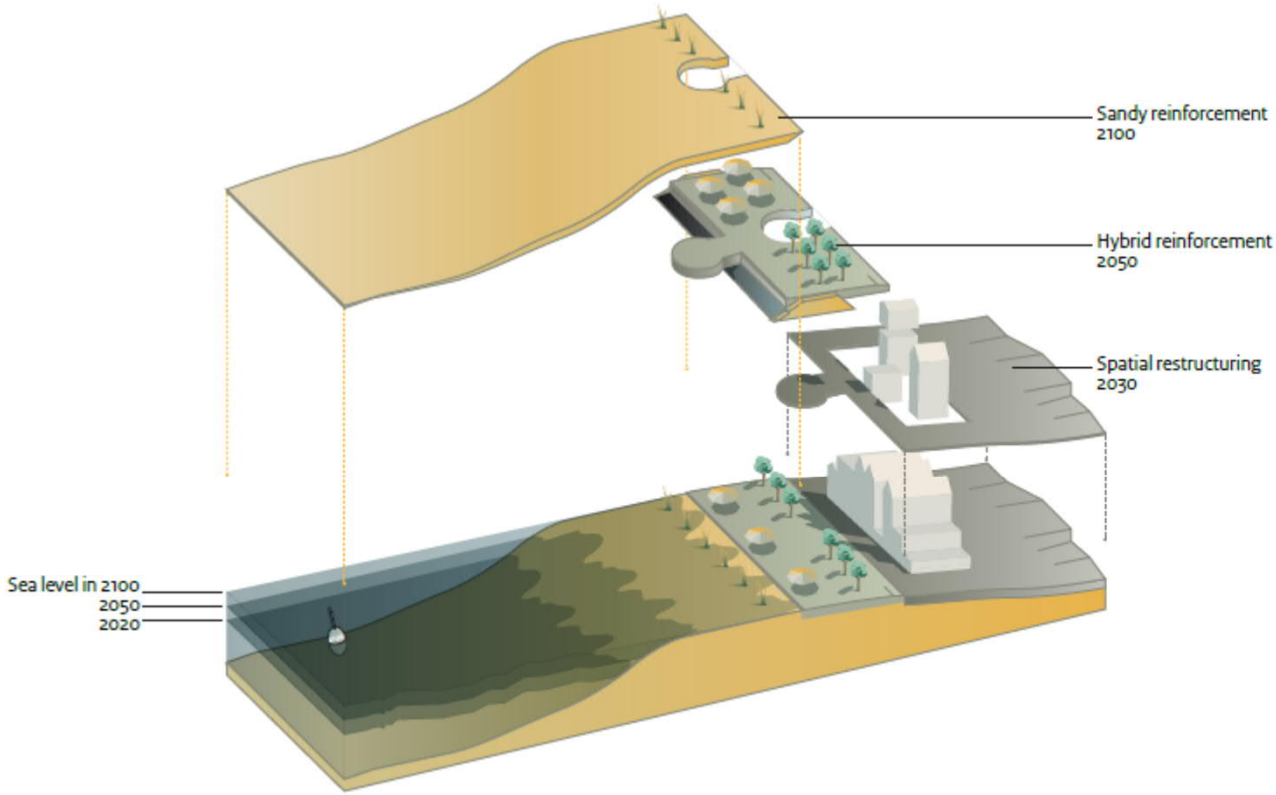
National Coastal Strategy

Compass for the Coast

Regional design workshops

- How can reinforcement for FRM be combined with spatial developments in time.

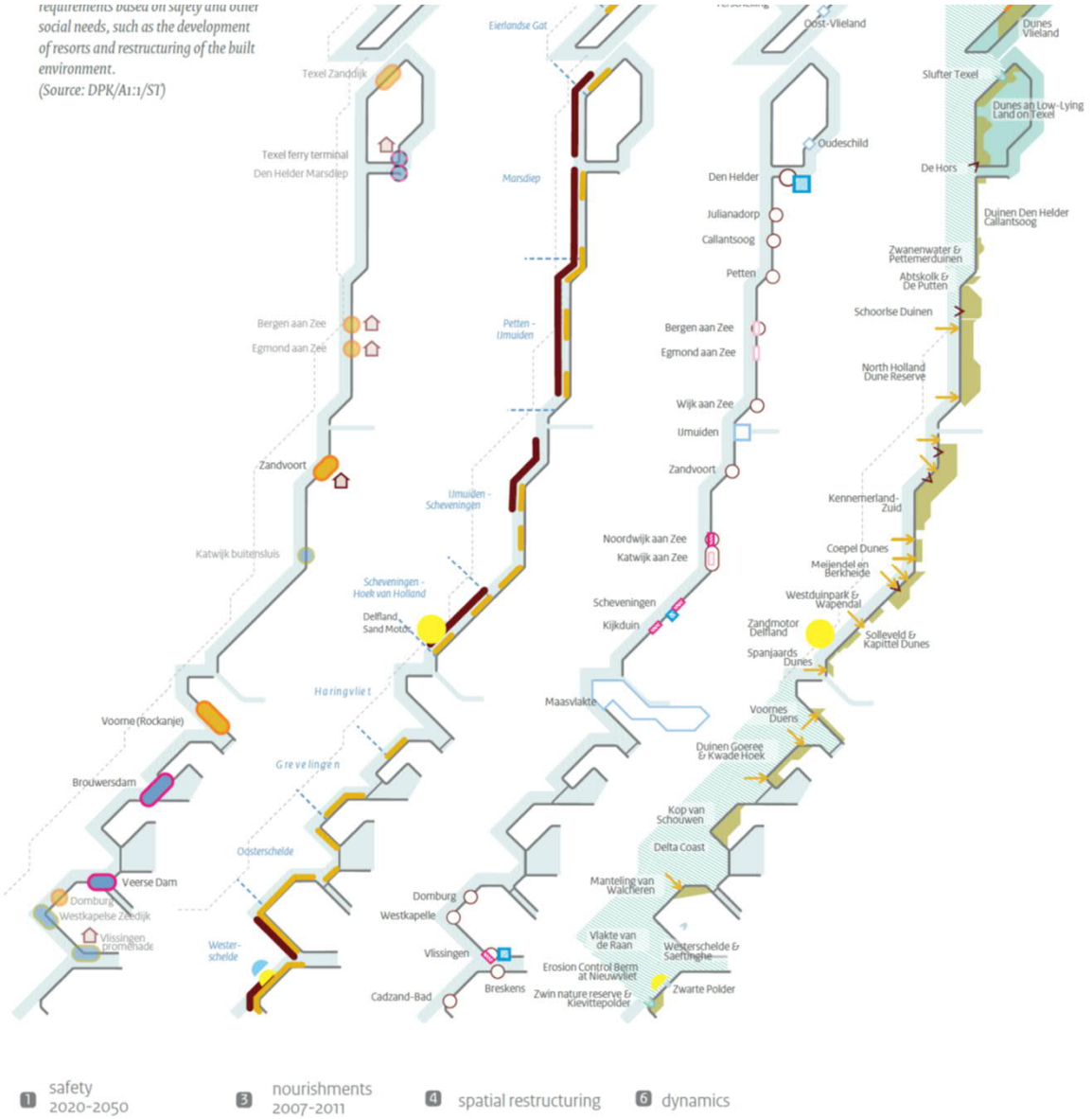
- Conclusion this is quite hard but still worth the discussion. Especcially with SLR



This illustration shows the principle of adaptive concepts, in which consecutive spatial development and safety interventions are addressed coherently (using a resort as an example).
(Source: DPK, illustration: BM).

Trying to find synergy

- Spatial development
- Urban restructureing
- Flood Risk Management
- Dune Dynamics



Set policy

- Feed the coastline with sediments needed to adapt to SLR
- Increase research to reduce uncertainty in effect of SLR on the coast
- Adapt nourishment volume when needed. But do not yet increase nourishment volume
- Make sure enough nourishment sand is available for the long term (100 + years)

Nationaal Waterplan
2016-2021

How do we chose Climate Adaptation measures at the Coast?

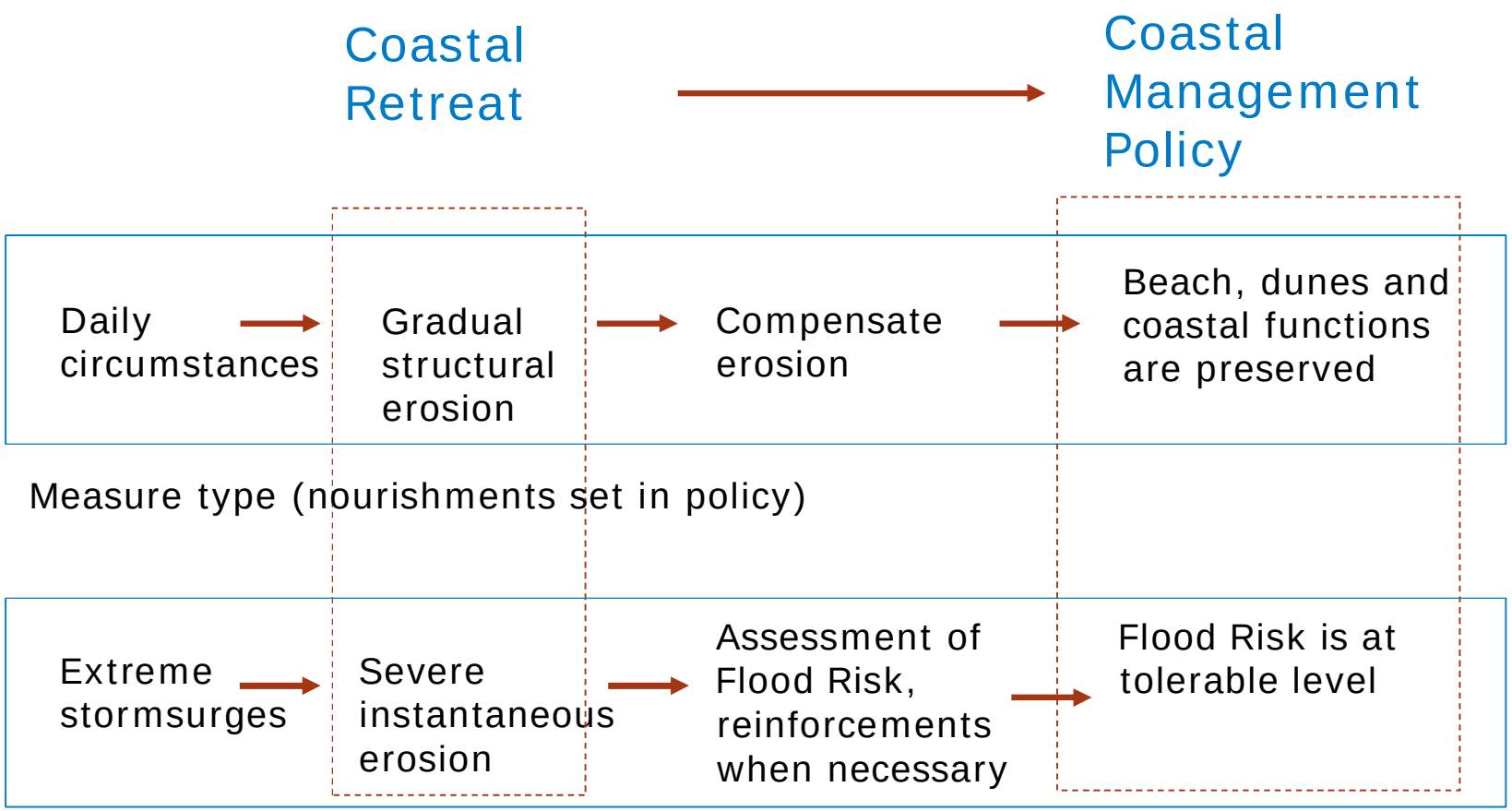
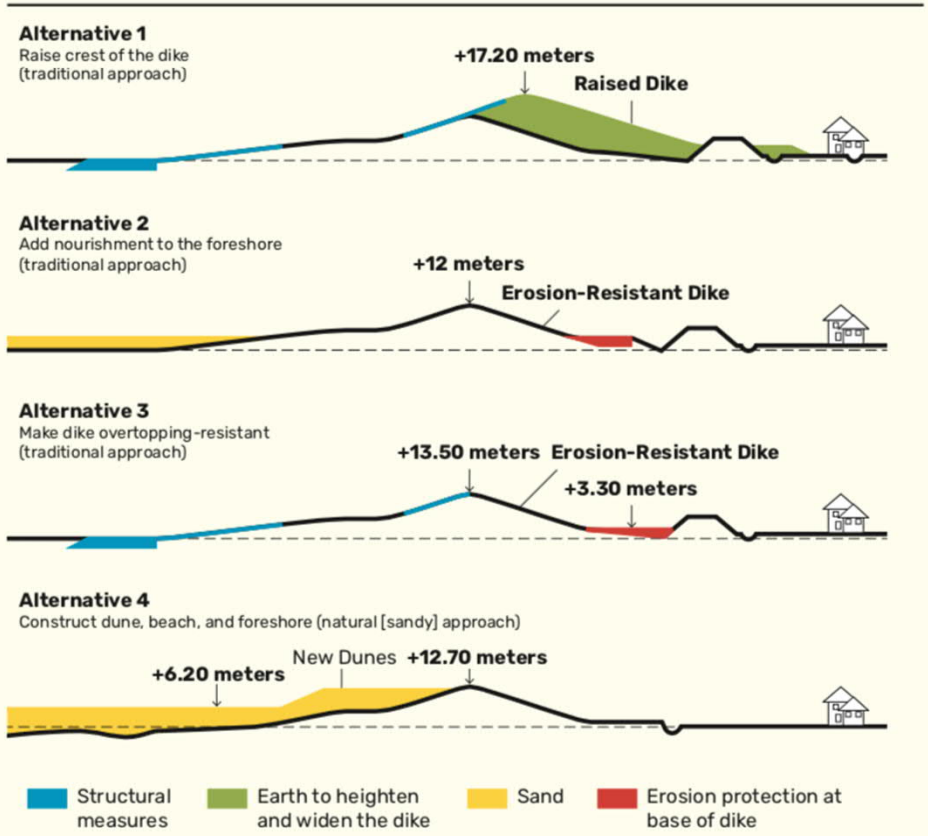

Coastal Retreat
Coastal Management Policy
Daily circumstances
Gradual structural erosion
Compensate erosion
Beach, dunes and coastal functions are preserved
Measure type (nourishments set in policy)
Extreme stormsurges
Severe instantaneous erosion
Assessment of Flood Risk, reinforcements when necessary
Flood Risk is at tolerable level
Measure type chosen through societal process and multicriteria analysis. Politicians chose!

Table 9.3. *Example of Multicriteria Analysis Applied to Katwijk, the Netherlands*

Criterion	Reference situation	Sand in front of boulevard				Construction in dune in front of boulevard	
		7.5 meters NAP	10.5 meters NAP	7.5 meters NAP, no change legal position	10.5 meters NAP, no change legal position	7.5 meters NAP	10.5 meters NAP
Safety and design							
Ensure safety in hinterland	0	++	++	++	++	++	++
Expandability	0	++	++	++	++	+	+
Robustness	0	++	++	++	++	+	+
Sustainability	0	++	++	++	++	+	+
Construction and maintenance							
Construction	0	+	+	+	+	+	+
Management and inspectability	0	++	++	++	++	-	-
Need for maintenance	0	--	-	--	-	-	0/-
Risk management							
Magnitude of erosion	0	0/+	0/+	0/+	0/+	++	++
Area that floods at normative water levels	0	0	0	0	0	++	++
Use of space							
Influence on living and working	0	-	-	-	-	-	-
Influence on infrastructure	0	-	-	-	-	0/-	0/-
Nuisance during construction	0	-	-	-	-	-	-
Spatial quality							
Effect on view from houses at boulevard	0	--	--	--	--	0/-	-
Effect on identity of Katwijk	0	--	--	--	--	-	-
Effect on spatial quality and landscape	0	0/-	0/-	0/-	0/-	0	0
Potential of reinforcement for spatial quality and economic development	0	0/+	0/+	++	++	++	++
Social Impact	0	-	-	-	-	-	-
Costs × €1 million euros ($1.2 million U.S. dollars)		40.5	30.45	42.35	33.2	32.0	37.3

Notes:
+, –, and 0 indicate relative effects on criterion with + being positive, - being negative, and 0 being neutral.
0/+ and 0/- mean neutral or positive and neutral or negative.
The maximum rating is +++ for greatest positive effect and --- for greatest negative effect.

Figure 9.26. *Alternative Designs to Improve Coastal Safety at the Hondsbossche and Pettemer Sea Dike*



Note: Alternative 4 was selected as the preferred design.

Source: Ecoshape.org 2021

Katwijk

Construction of “Dike in dune” with integrated car park.


1


1


1

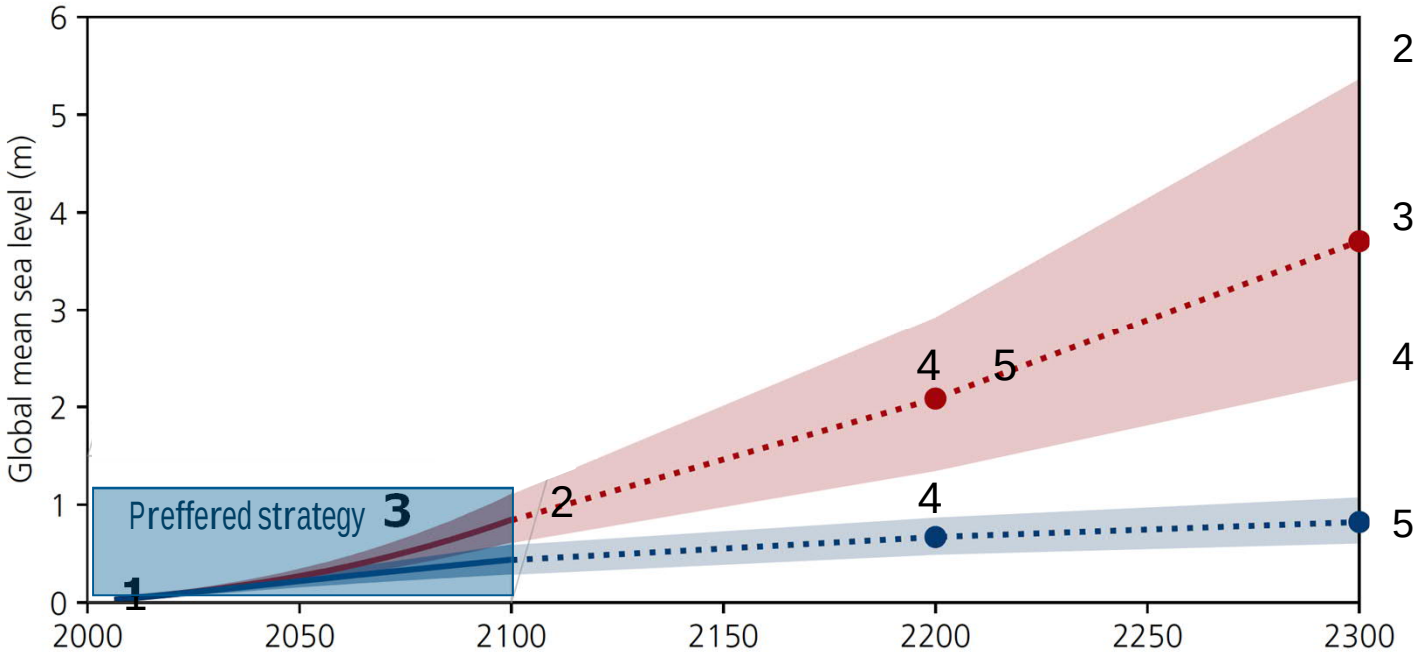

2

Flood defence upgrade paid by National government, Car park by local

Bron:
1. https://beeldbank.rws.nl, Rijkswaterstaat (Maarten van Rijn)
2. https://www.rijnland.net/werk-in-uitvoering/kust/kustversterking-katwijk

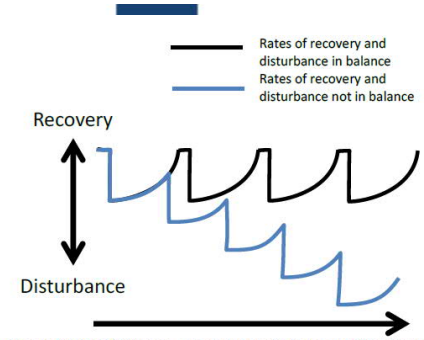
Which climate change adaptation measures use which projections?

Long term projections IPCC SROCC/AR6

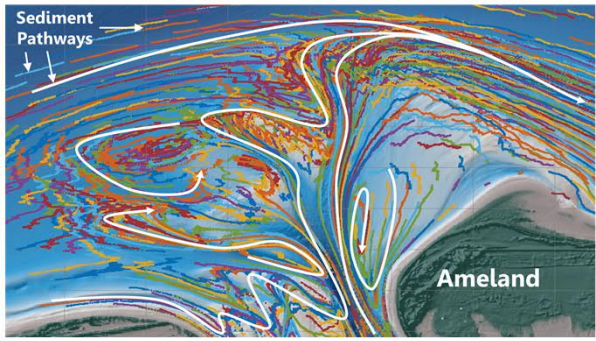


1. Nourishments
2. Investments with long horizo (100+ years)
3. Strategic choices within ‘preferred strategies’ (2050-2100)
4. Extending the strategy (>2100, large range SLR)
5. “*Low probability, high impact* scenario’s (what if)

Issues to solve with implementation (examples)

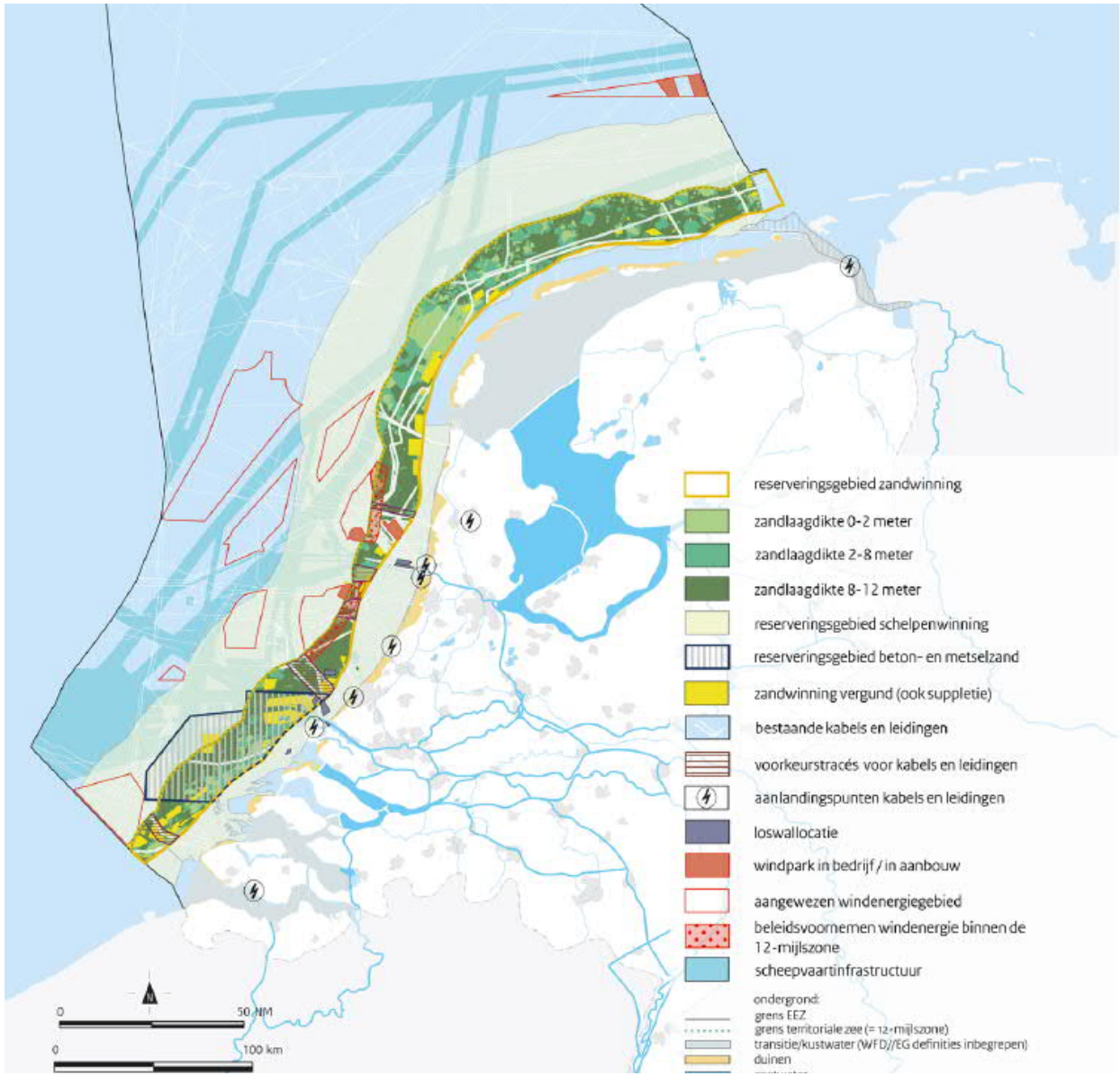


Figuur 4.3 Stabiliteit van een systeem bij herhaaldelijke verstoringen (Palumbi *et al.* 2008)



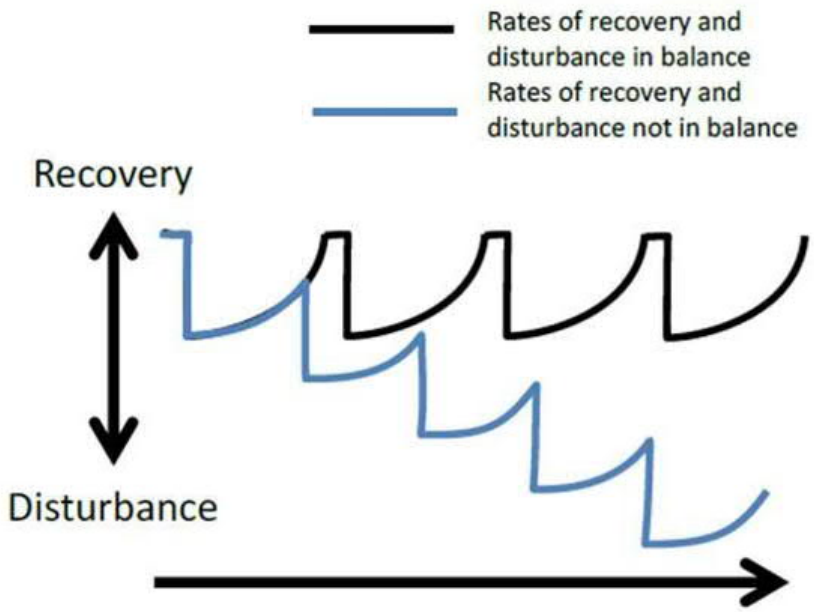
- Nourishments
  - Reservation of strategic sand reserves
  - Ecological impacts (a lot of unknows) -> research as integral part of solution
  - Synchronizing work along the coast (central coordination, with local implementation)
  - Performance and benefits, how to prove it works? -> research
- Reinforcements
  - Set dual goals at political level (not just flood risk management but also spatial development, each with own budget)
  - Find solutions that have local support from the community. Try to be flexible enough to change the plan if that is wanted by stakeholders. And goal is still met (example Katwijk).
  - Designs using sand: include monitoring and adaptation into the design and plan. Adaptive management is needed.

Extra Slides used in discussion


reserveringsgebied zandwinning
zandlaagdikte 0-2 meter
zandlaagdikte 2-8 meter
zandlaagdikte 8-12 meter
reserveringsgebied schelpenwinning
reserveringsgebied beton- en metselzand
zandwinning vergund (ook suppletie)
bestaande kabels en leidingen
voorkeurstracés voor kabels en leidingen
aanlandingspunten kabels en leidingen
loswallocatie
windpark in bedrijf / in aanbouw
aangewezen windenergiegebied
beleidsvoornemen windenergie binnen de 12-mijlszone
scheepvaartinfrastructuur
ondergrond:
grens EEZ
grens territoriale zee (= 12-mijlszone)
transitie/kustwater (WFD)/EG definities inbegrepen)
duinen
0
50 NM
0
100 km

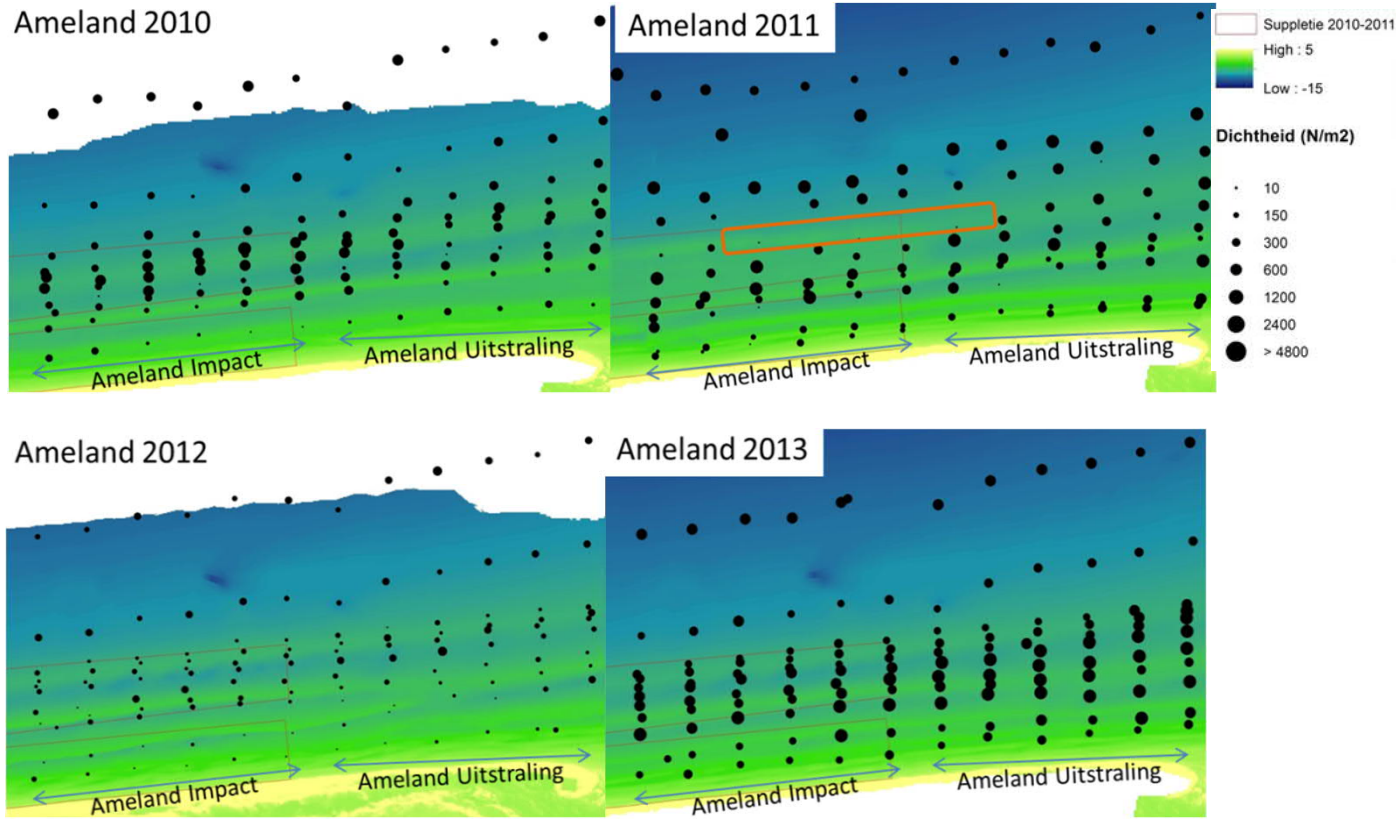
R&D
Effects of subsequent nourishments?

- Recolonization vs nourishment frequency
- Cumulating of effects?
- Monitoring



Palumbi et al, 2008

Ecological monitoring of Ameland Shoreface Nourishment



Lessons From The Past

Development of Eastoke – 'A line was drawn in the sand' as defences began to be constructed

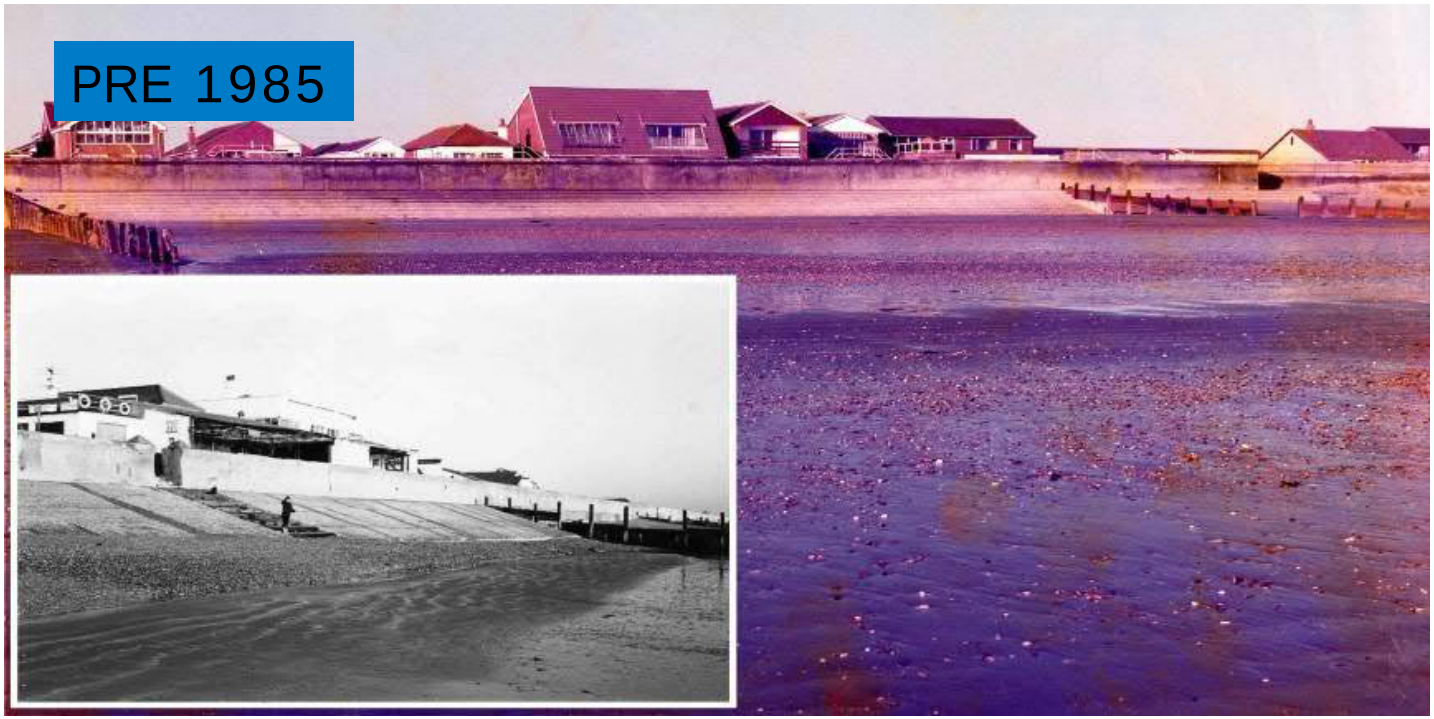
Lessons From The Past

Beach eroded. Early seawalls were undermined and replaced with bigger seawalls.

Lessons From The Past

Major repairs required, as once again seawall is at risk of undermining.

Lessons From The Past



The beach levels dropped further still, leaving sand and soon the clay bed.

Lessons From The Past

Storm event Pre-1985. One of many causing substantial flooding & property damage.

Lessons From The Past

Substantial flooding of Eastoke