



Grootschalig morfologische ontwikkelingen in het Waddengebied --- in relatie tot natuurlijkheid

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Inhoud

Het sediment-delende systeem in
het Waddenzeegebied

Ontwikkelingen in het verleden –
invloed ingrepen

Ontwikkelingen in de toekomst --
invloed ZSS

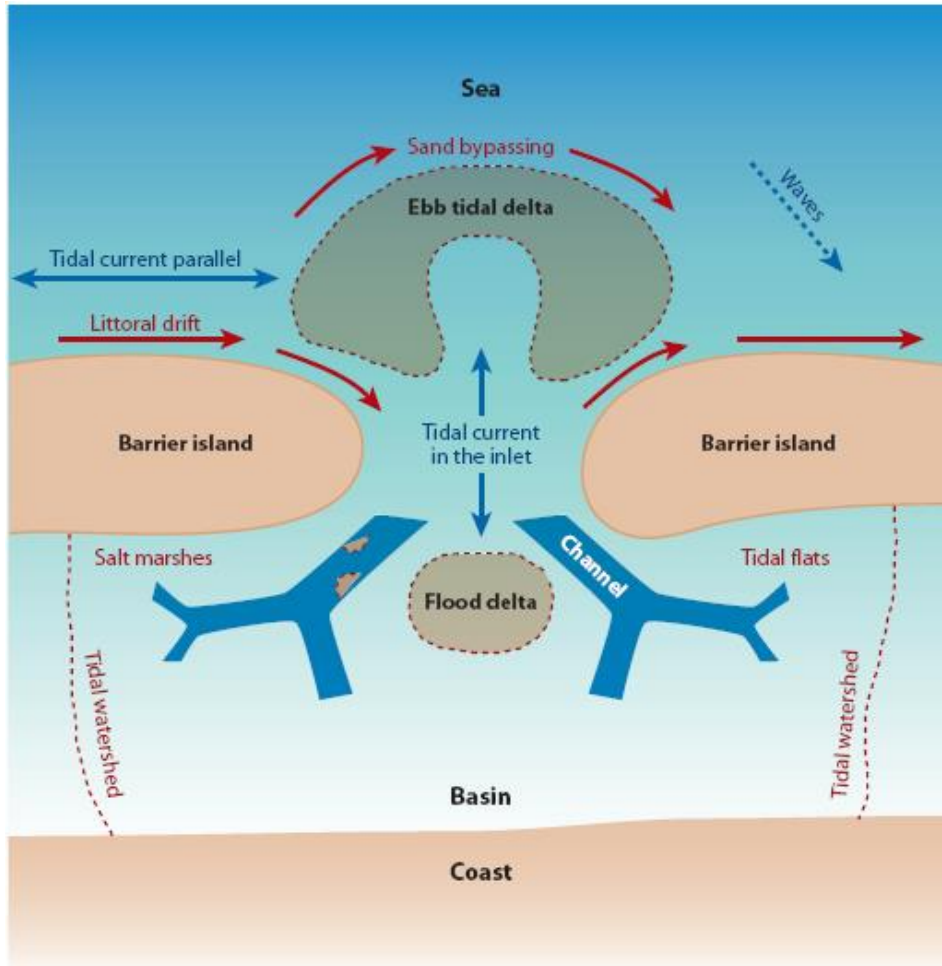
Relatie tot beheer



An aerial photograph of a coastal area in the Wadden Sea region. The image shows a large body of water on the left, a dike system in the center, and agricultural fields on the right. The dike system consists of a long, straight dike with several smaller, curved dikes branching off. The fields are a mix of green and brown, indicating different crops or stages of growth. The sky is clear and blue.

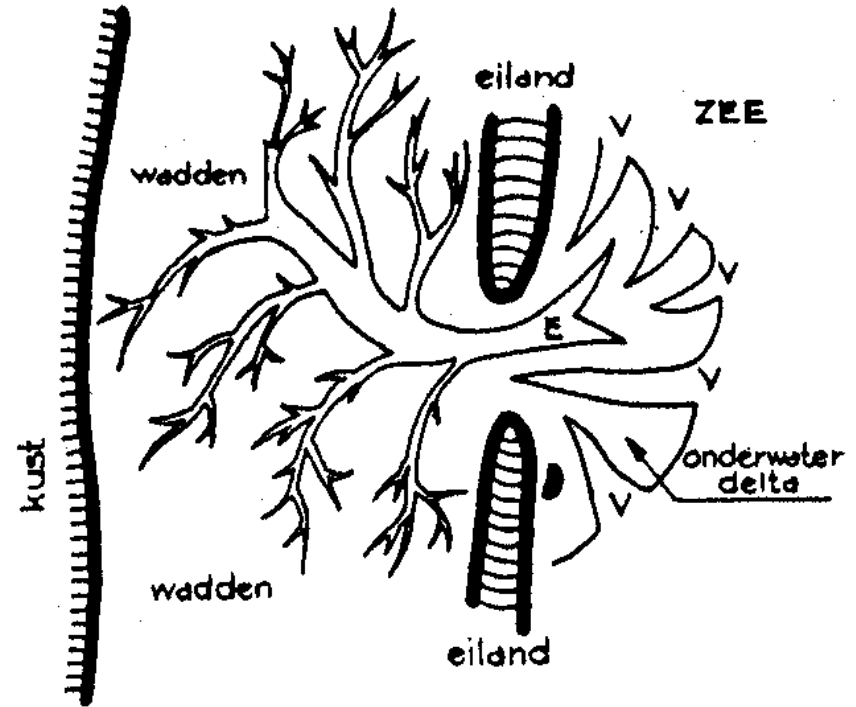
Het sedimentdelende systeem in het Waddenzeegebied

Schematic sketch of a tidal inlet system



de Swart and Zimmerman, (2009)

Van Veen (1950)



Well-developed flood-tidal delta, as sketched in Van Veen's characterisation of a Wadden Sea lagoon

Waddenzee op geologische tijdschaal



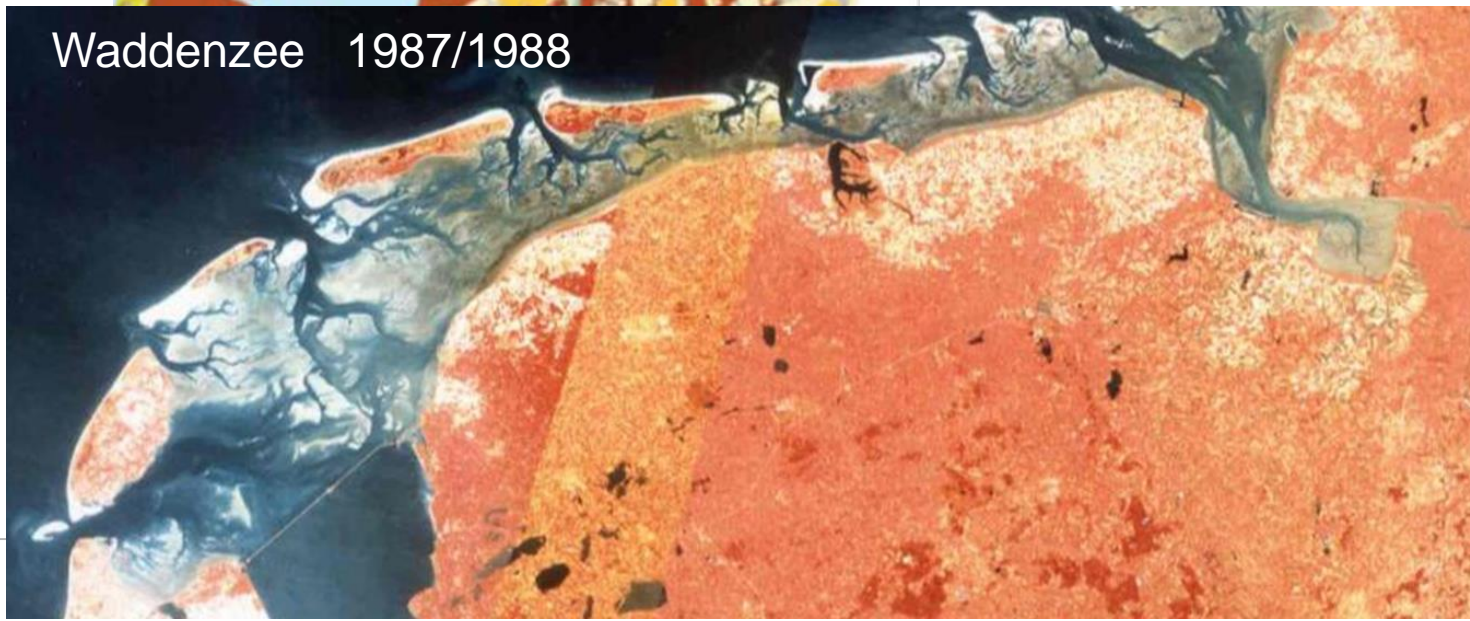
•Verleden:

- 6000-5000 jaar geleden ontstaan
- Dankzij relatieve zeespiegelstijging
- Menselijke invloeden

•Toekomst:

- Verlanding bij te langzame zss
- Verdrinking bij te snelle zss

Waddenzee 1987/1988



Kustontwikkeling - 'vraag' en aanbod sediment

aanbod > vraag :

overschot! → uitbouw



aanbod = vraag :

stabiel



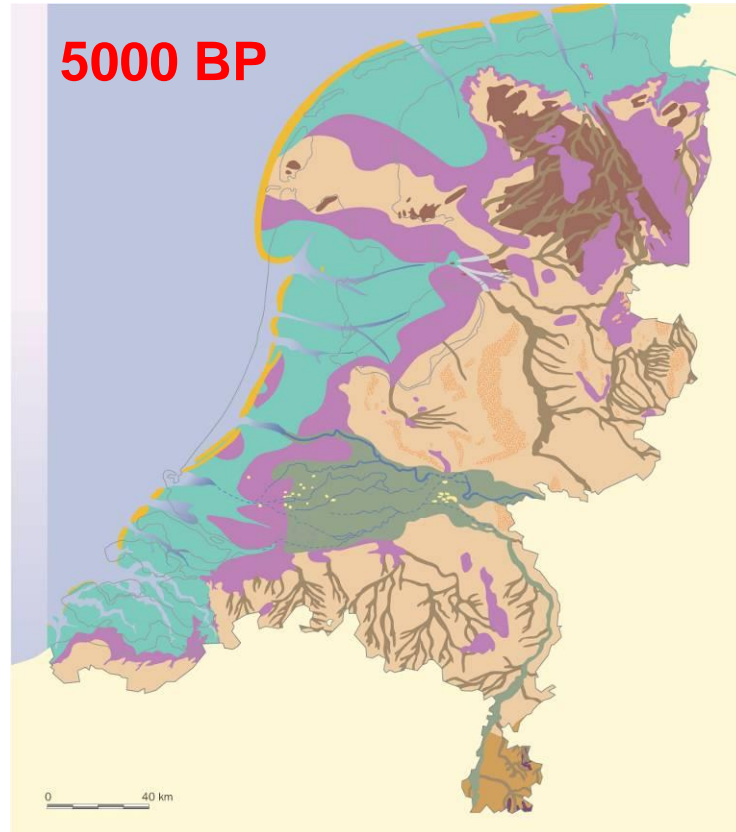
aanbod < vraag :

tekort ! → terugtrekking

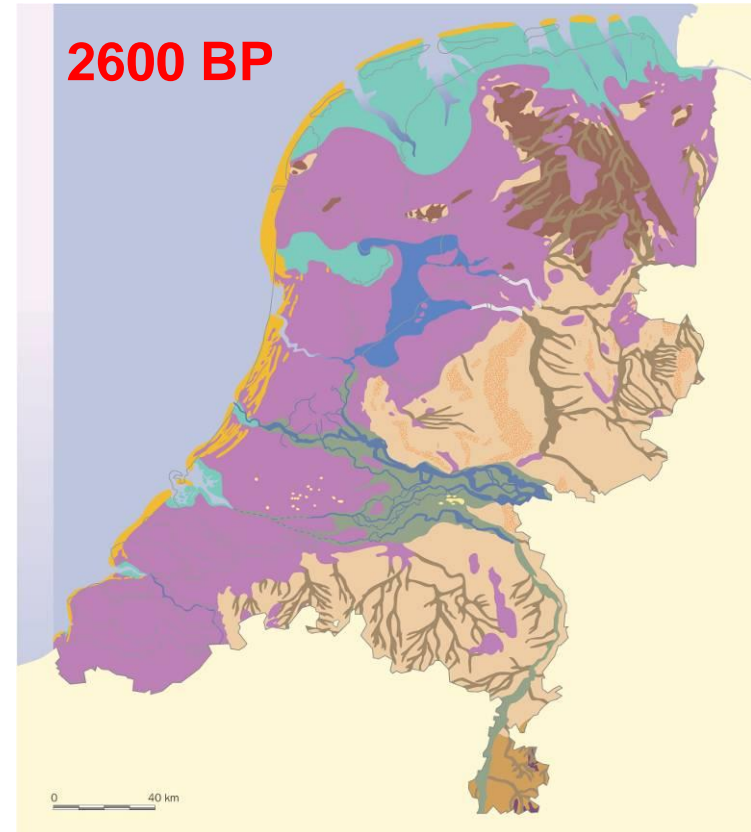


naar Nichols, 1989.

Kustontwikkeling: vraag en aanbod



vraag > aanbod



vraag < aanbod

Sedimenthuishouding Nederlandse kust

Netto accretie

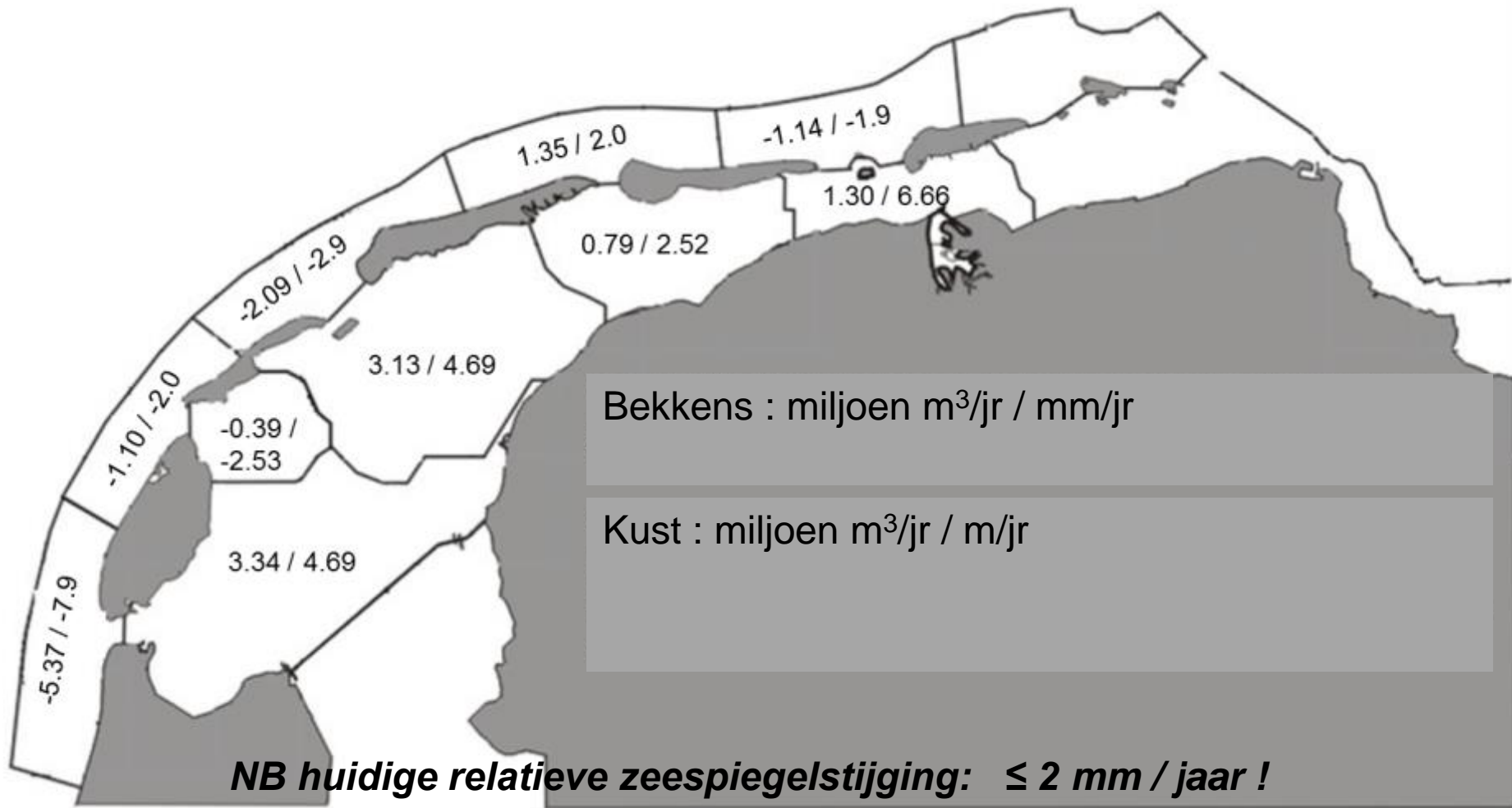
Netto erosie





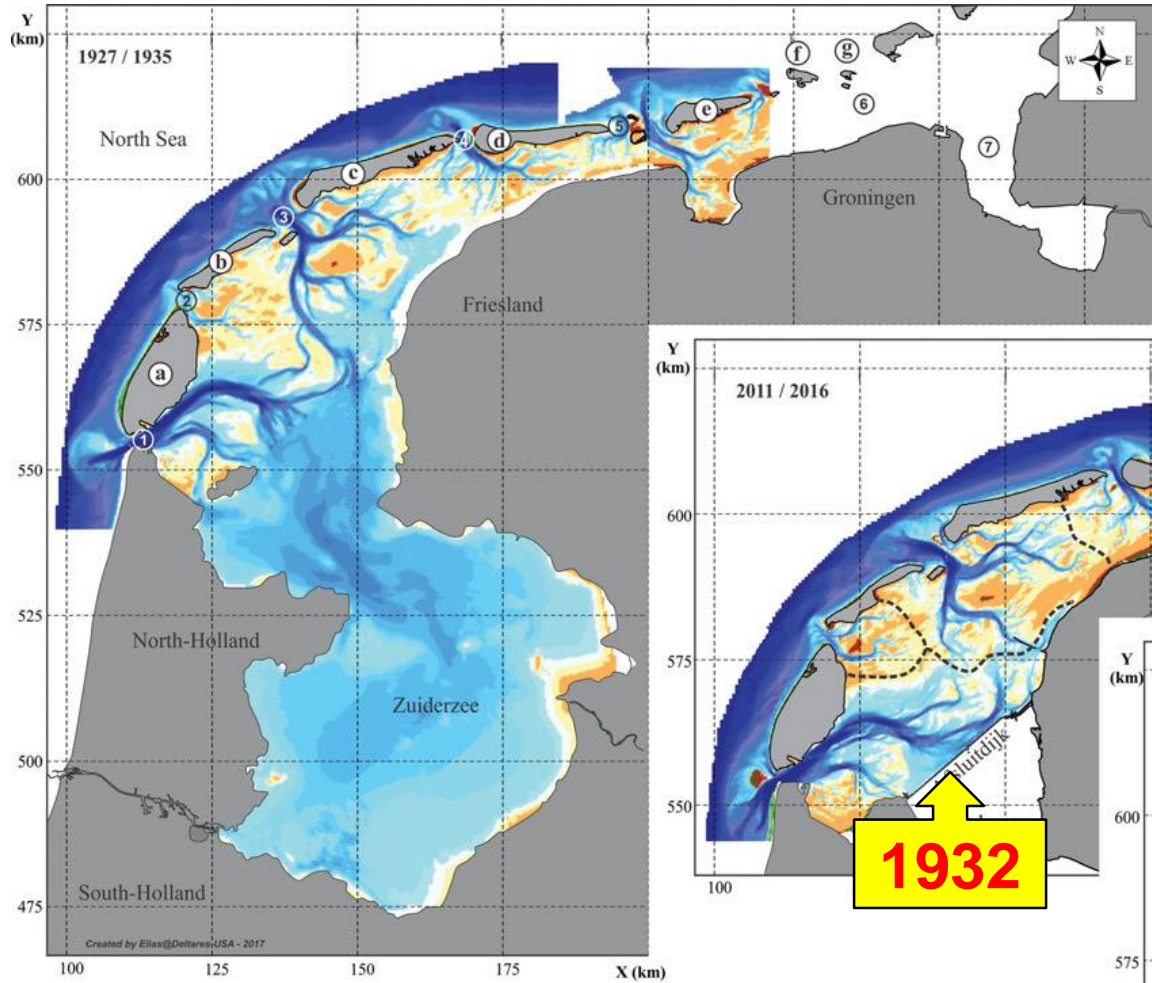
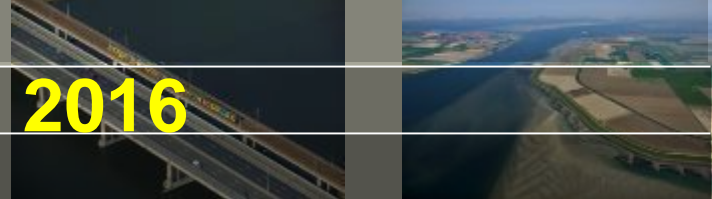
Grootschalige ontwikkelingen onder invloed van ingrepen

Volumebalans – verandering per jaar

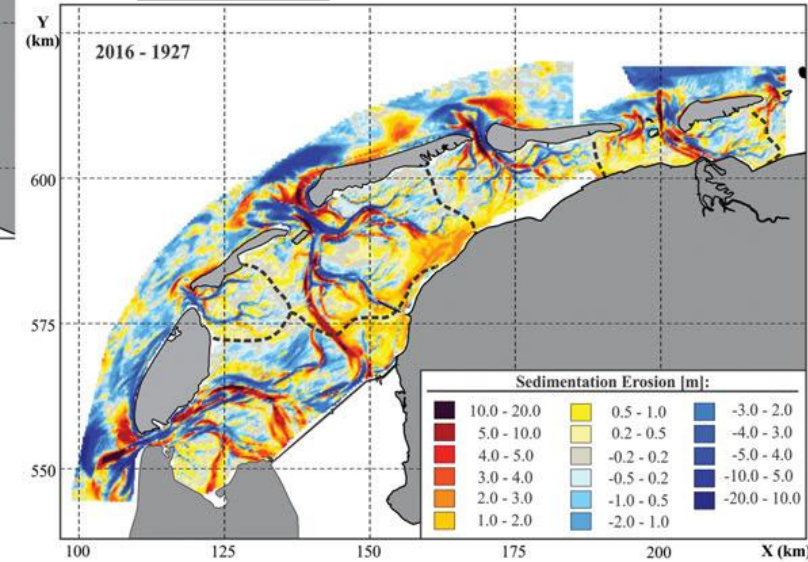
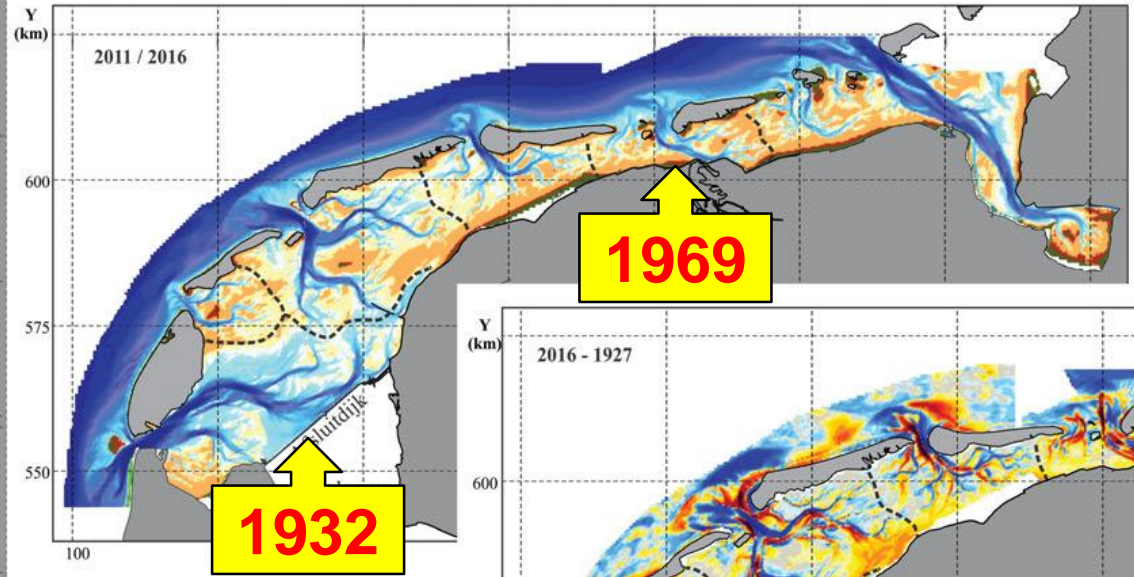


Sedimentatie in bekkens overtreft huidige relatieve zeespiegelstijging !!

Recente veranderingen 1927 - 2016



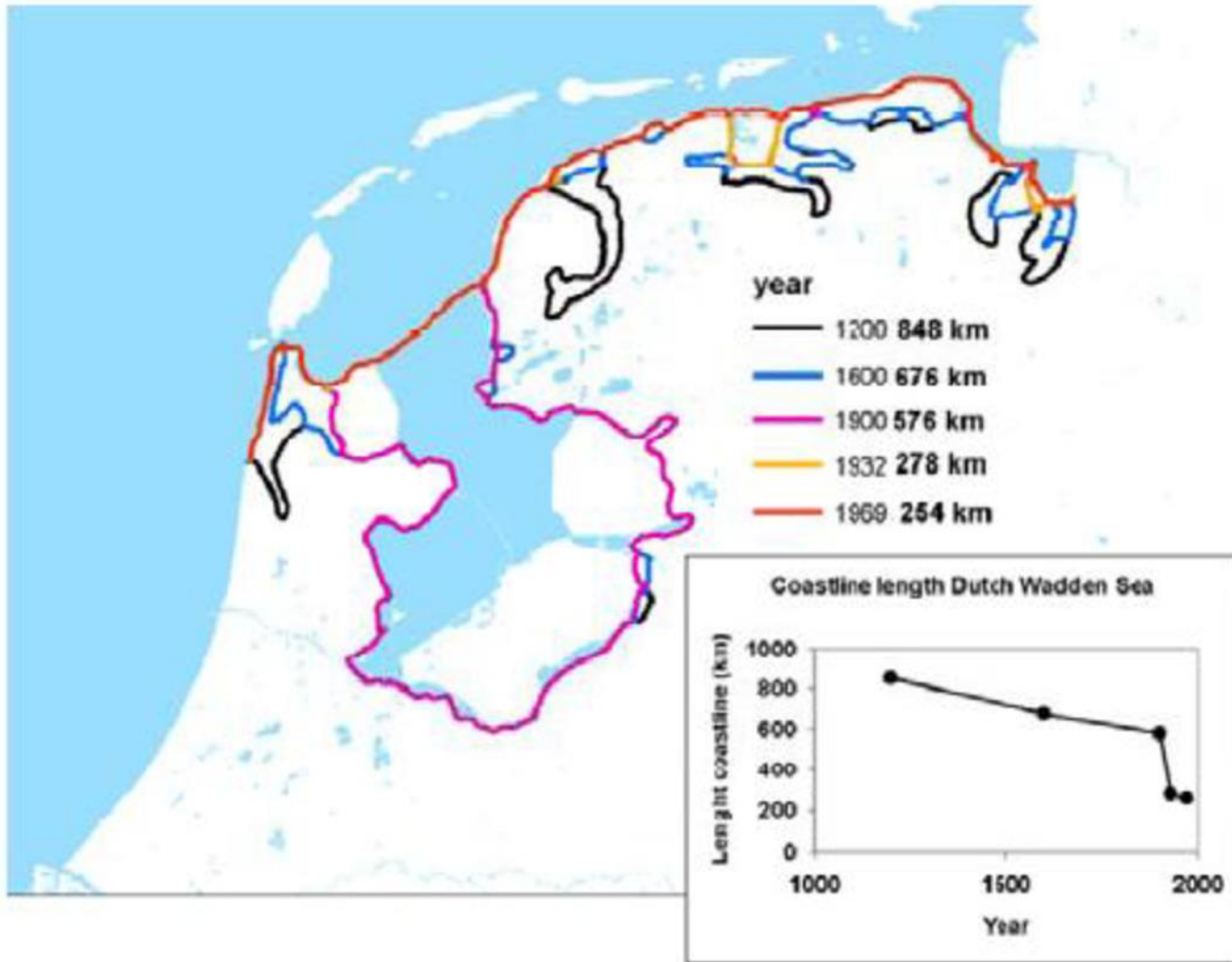
- (a). Texel
 - (b). Vlieland
 - (c). Terschelling
 - (d). Ameland
 - (e). Schiermonnikoog
 - (f). Rottumerplaat
 - (g). Rottumeroog
- (1). Texel Inlet
 - (2). Eijerlandse Gat Inlet
 - (3). Vlie Inlet
 - (4). Ameland Inlet
 - (5). Frisian Inlet (Pinkegat & Zoutkamperlaag)
 - (6). Groninger Wad
 - (7). Eems-Dollard (Ems) Estuary



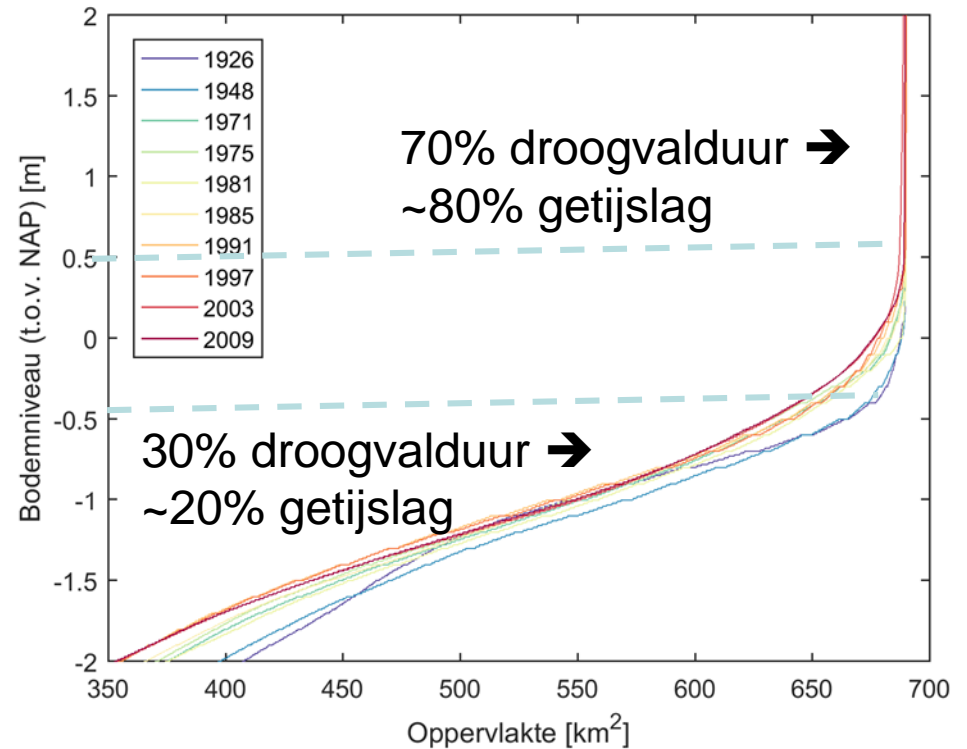
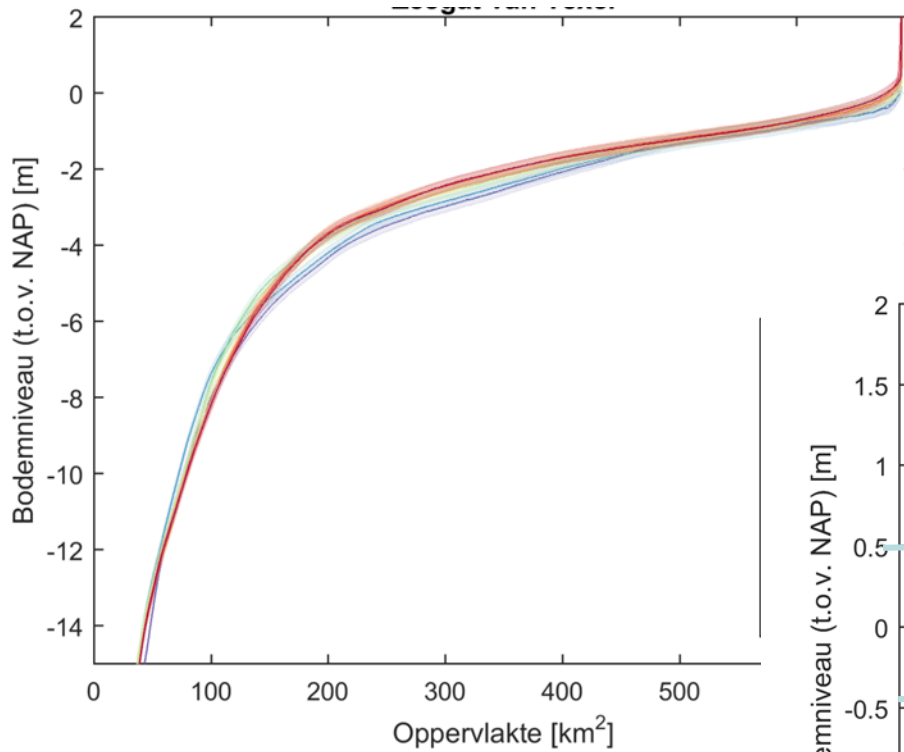
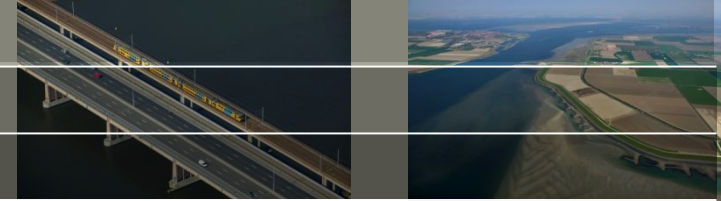
Depth m to NAP:

5.0 - 10.0	-2.0 - 1.5	-6.0 - 5.0	-11.0 - 10.0	-17.0 - 16.0
1.0 - 5.0	-2.5 - 2.0	-7.0 - 6.0	-12.0 - 11.0	-20.0 - 17.0
0.5 - 1.0	-3.0 - 2.5	-8.0 - 7.0	-13.0 - 12.0	-30.0 - 20.0
-0.5 - 0.5	-3.5 - 3.0	-9.0 - 8.0	-14.0 - 13.0	-40.0 - 30.0
-1.0 - -0.5	-4.0 - 3.5	-10.0 - 9.0	-15.0 - 14.0	
-1.5 - -1.0	-5.0 - 4.0	-11.0 - 10.0	-16.0 - 15.0	

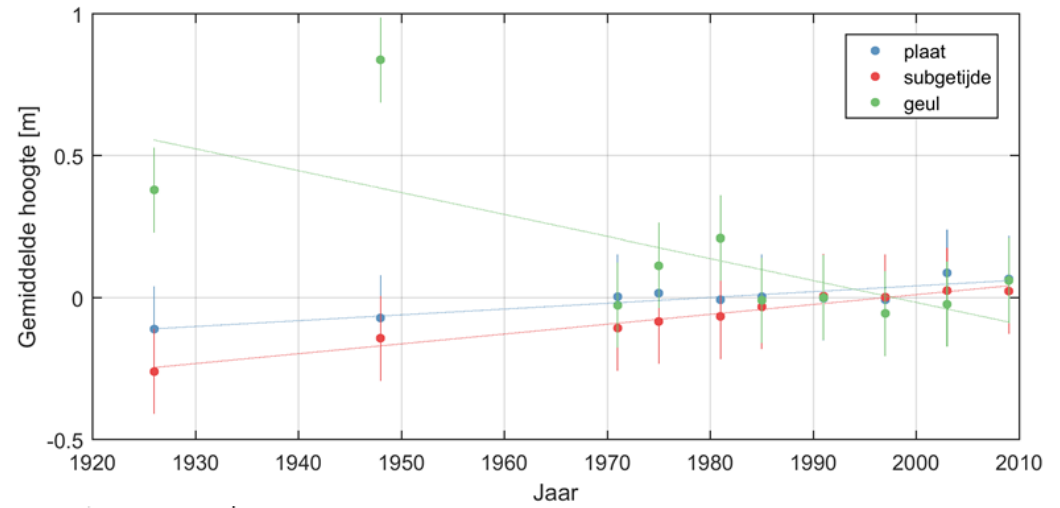
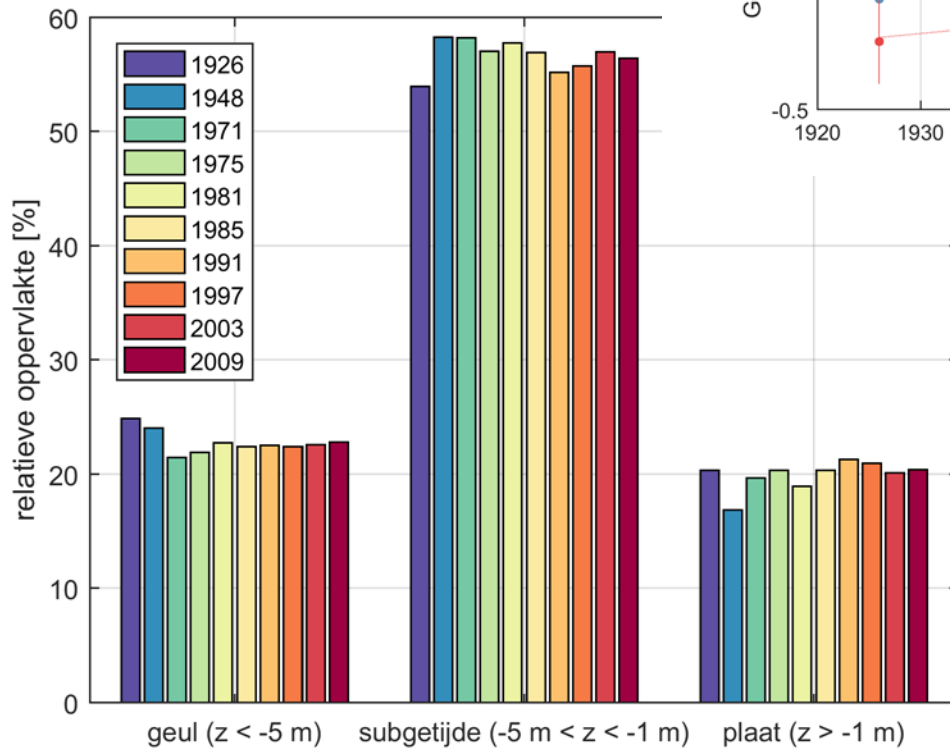
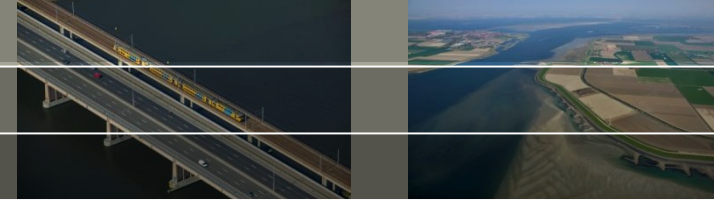
Afsluitingen Zuiderzee en Lauwerszee betreffen voortzetting van ingrepen sinds de middeleeuwen



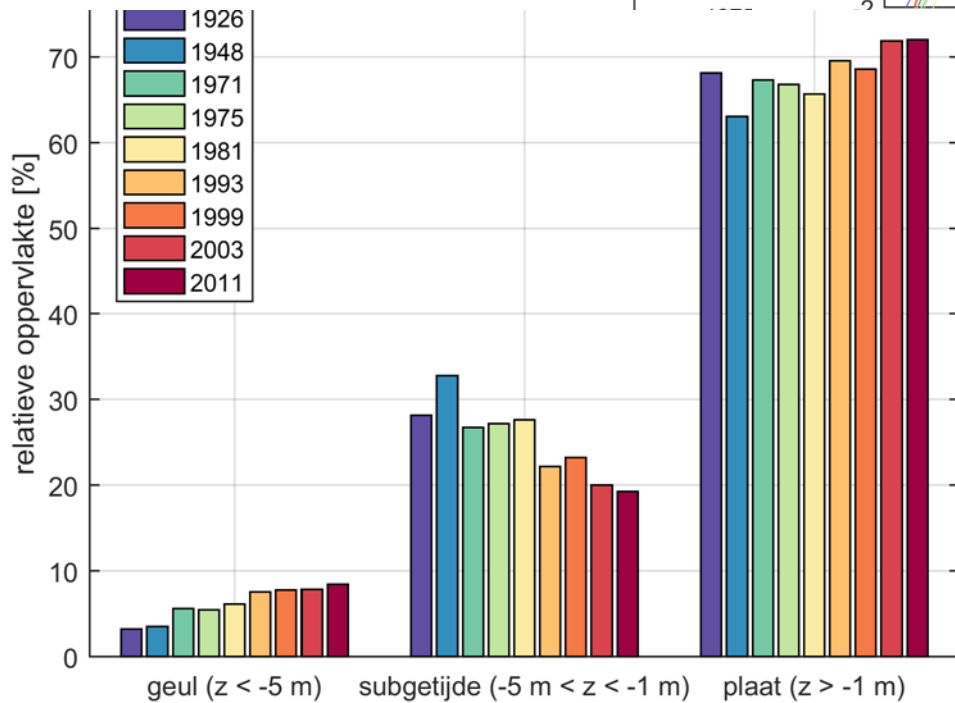
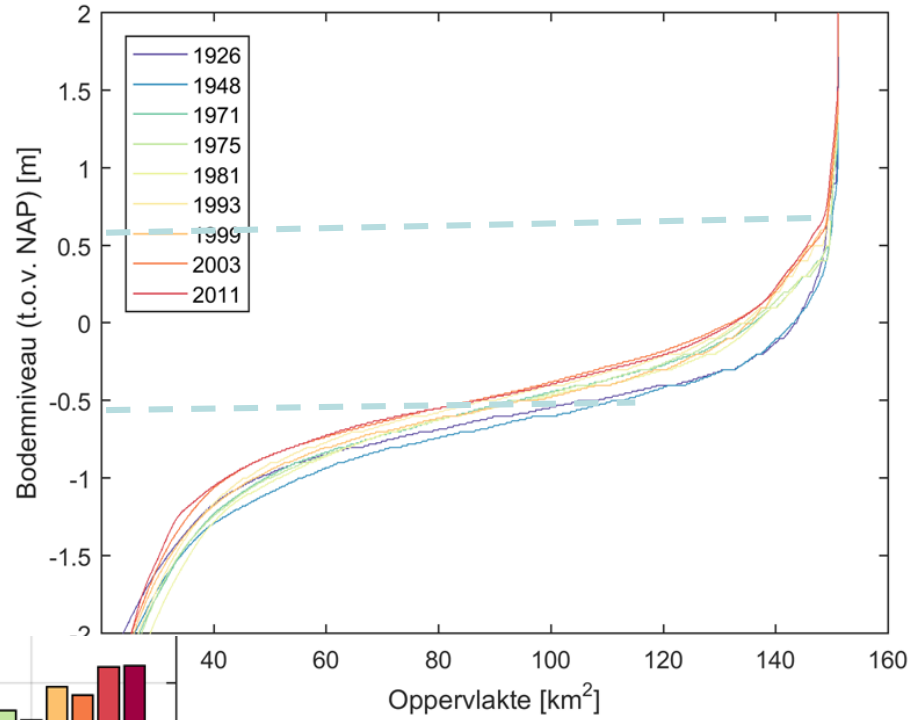
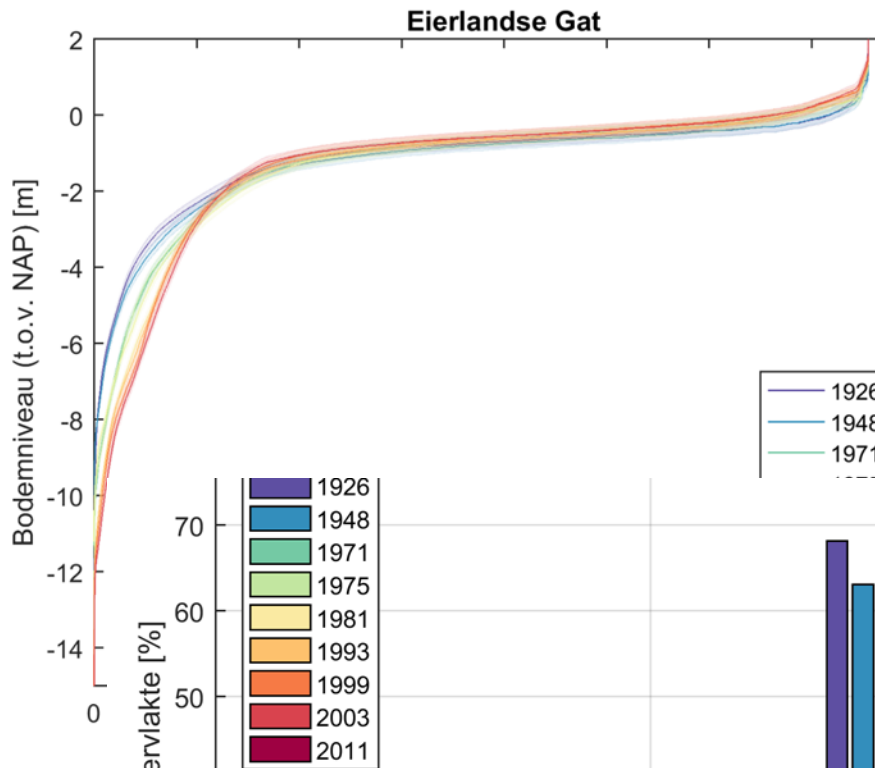
Marsdiep



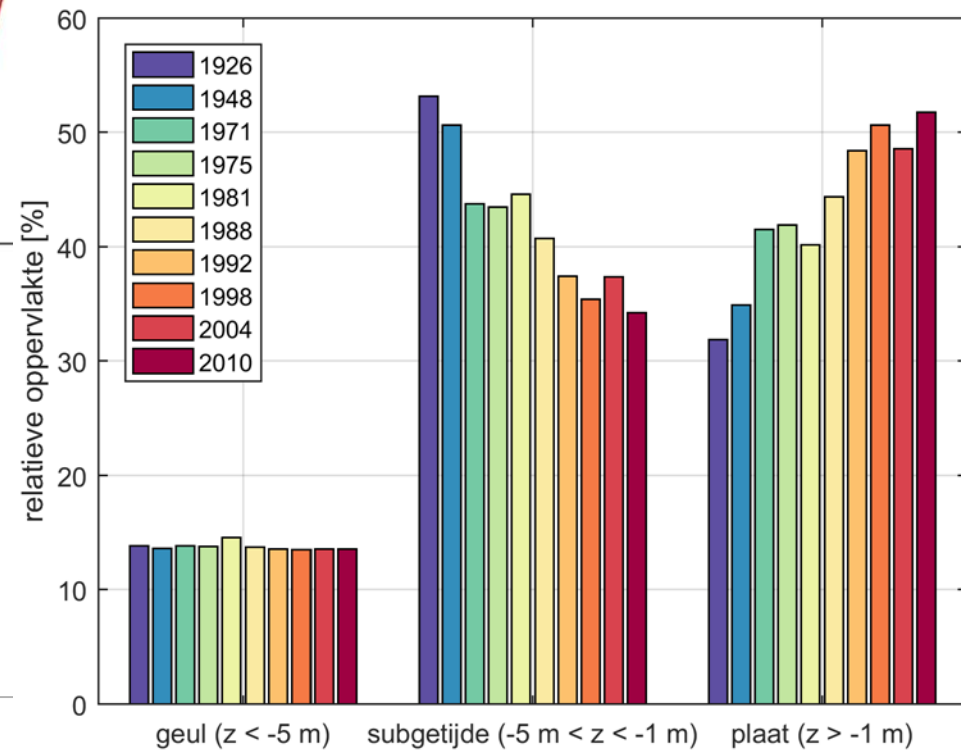
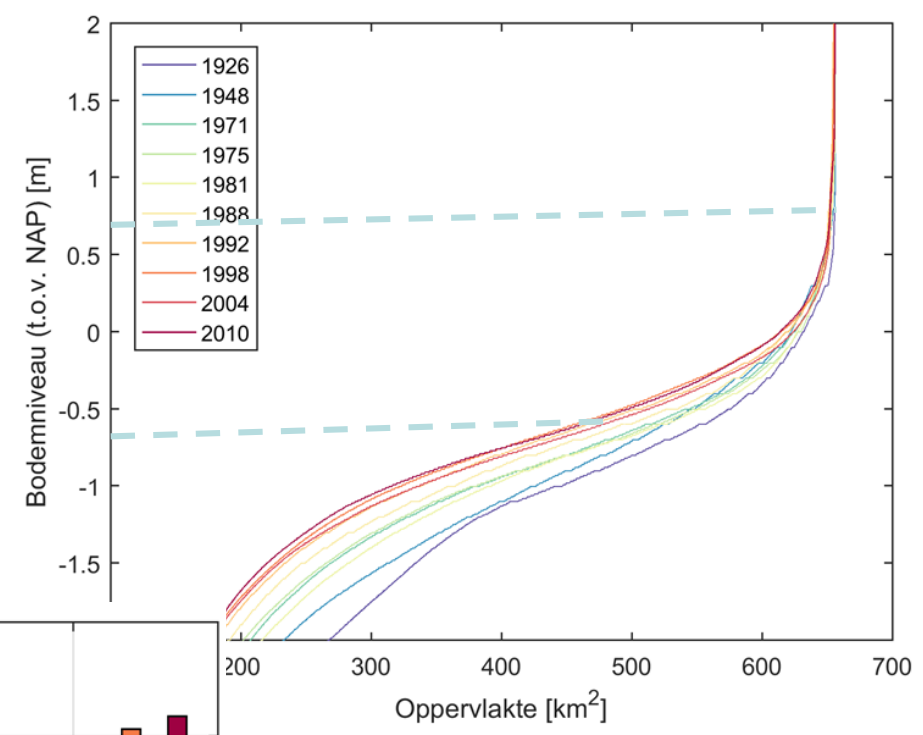
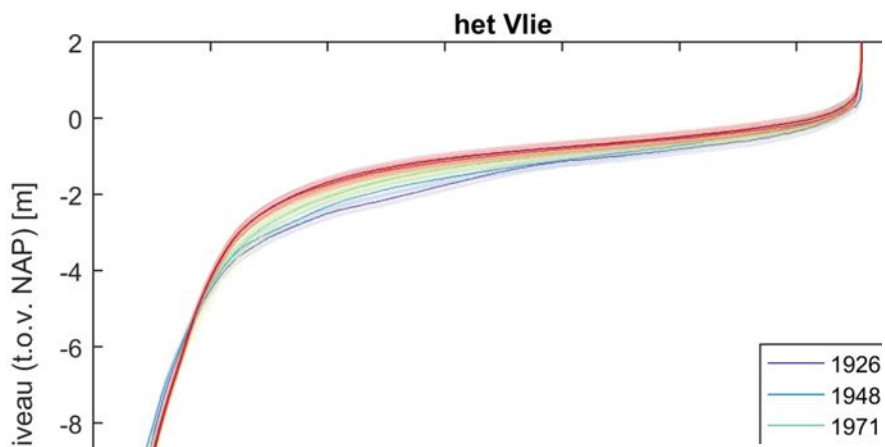
Marsdiep



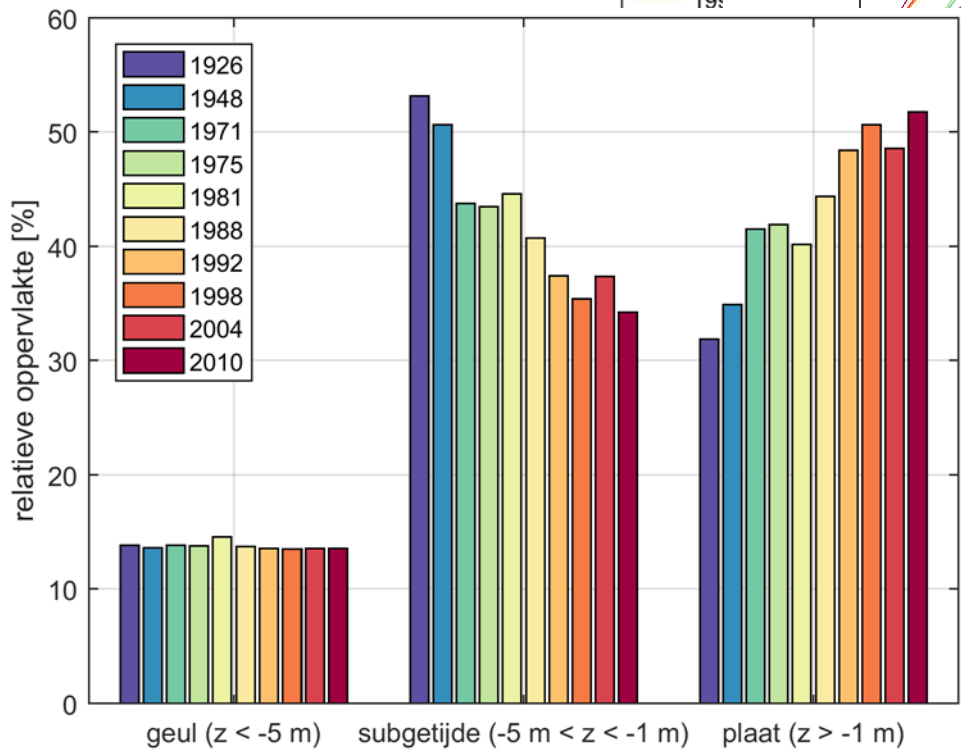
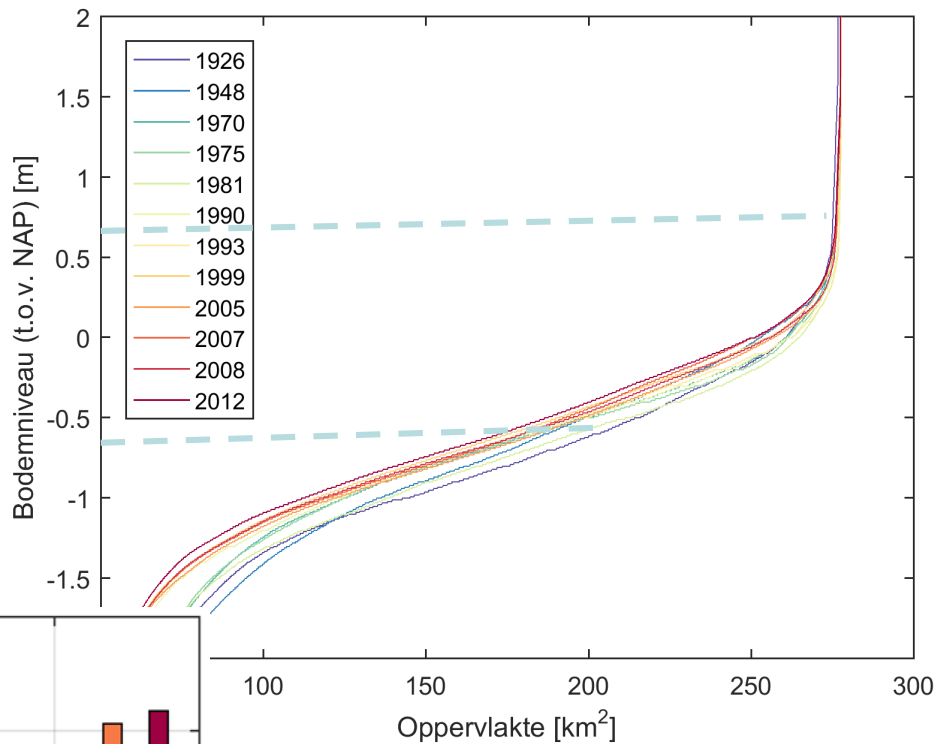
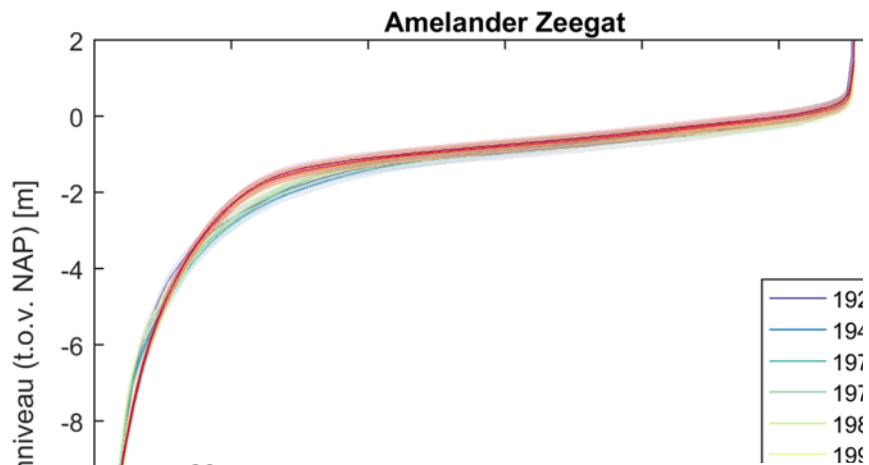
Eierlandse gat



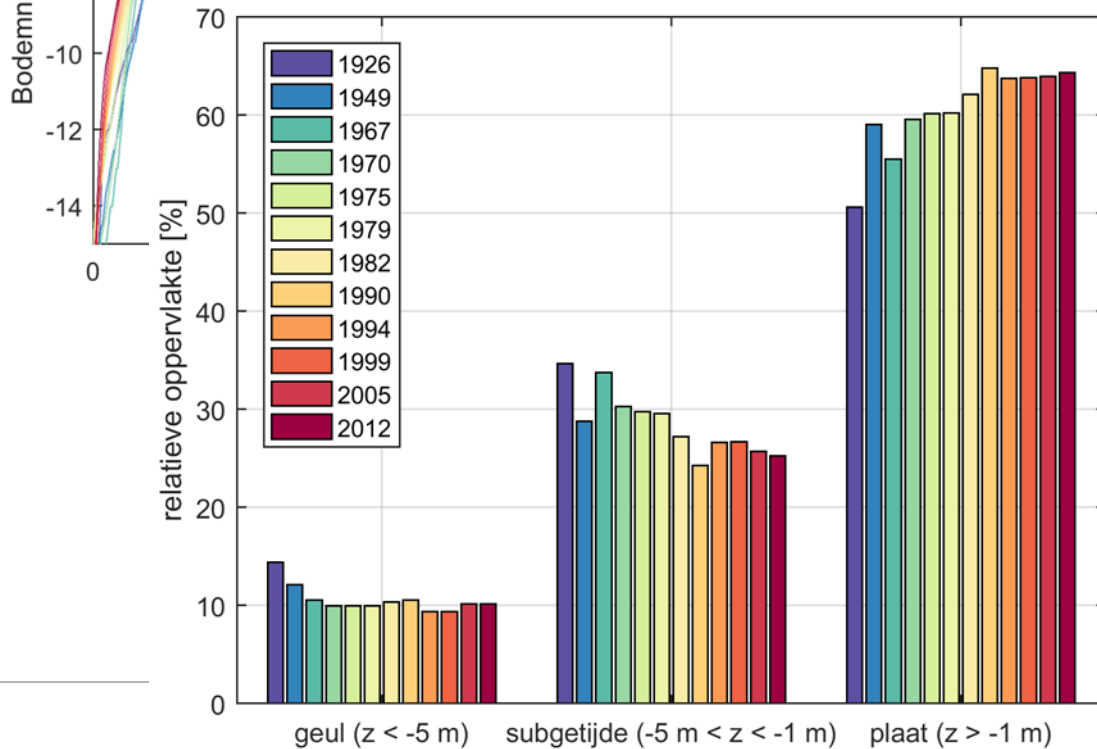
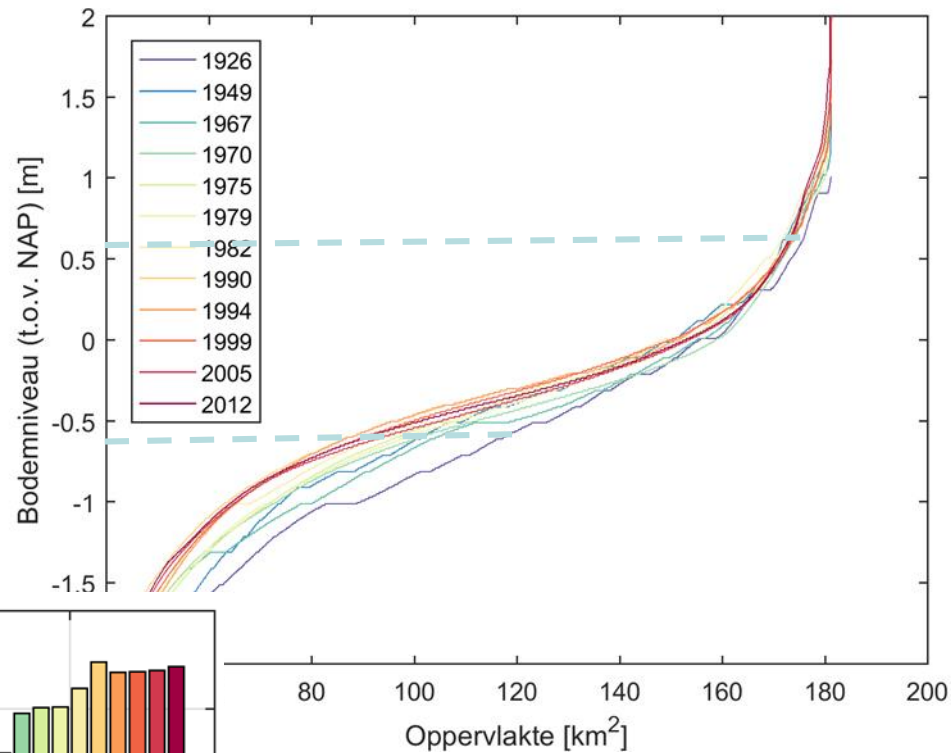
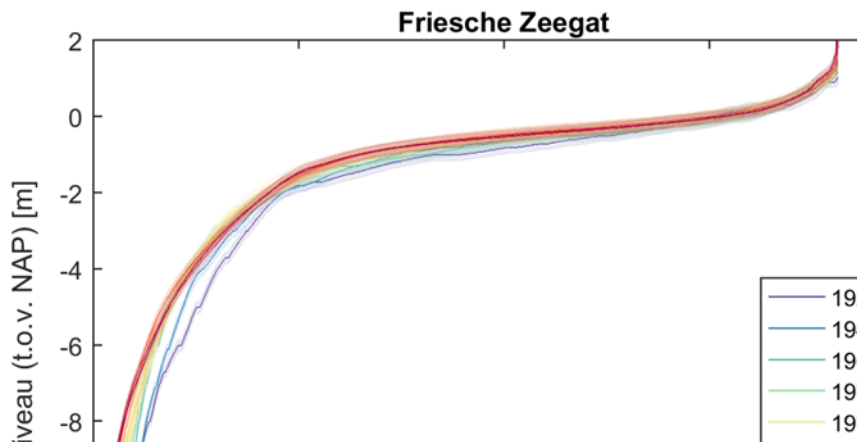
Vlie

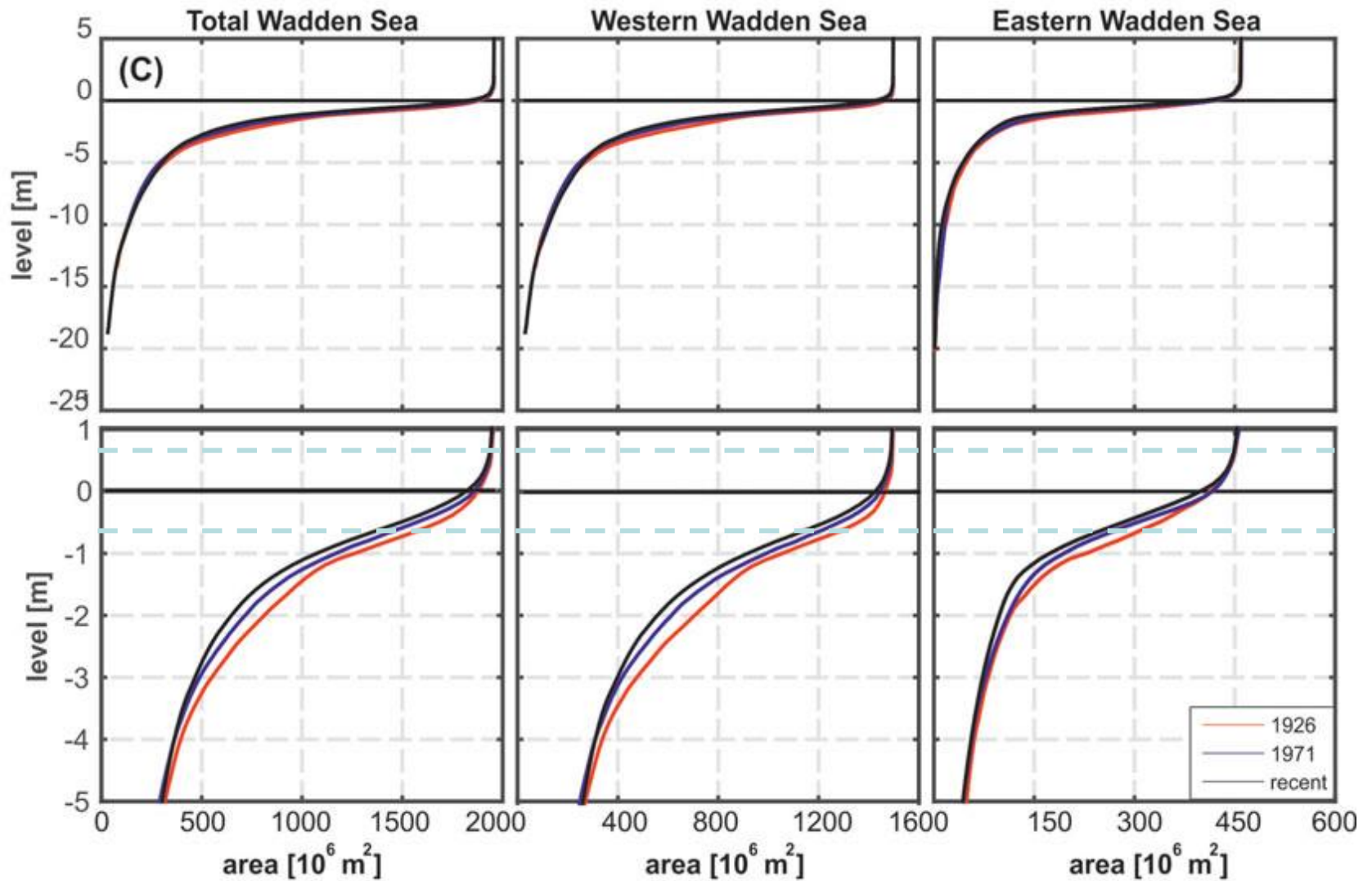
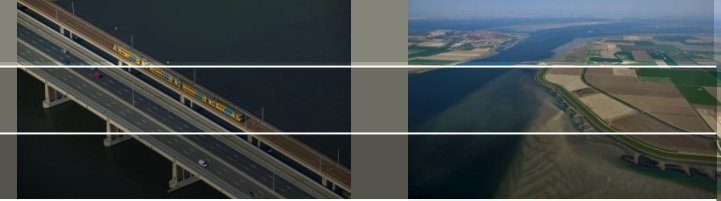


Amelanderveegat

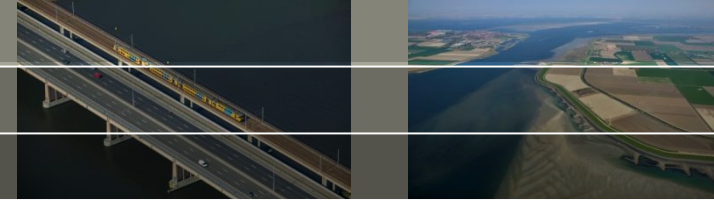


Friesche Zeegat





Samenvattingen



Sedimentatie in NL Waddenzee, met een gemiddelde snelheid hoger dan de relatieve ZSS

Alleen Eierlandsegat erodeert en alle andere bekkens sedimenteren.

Grootste veranderingen gevolg van ingrepen: afsluitingen Zuiderzee en Lauwerszee

Sedimentatie intergetijdendeel in alle NL Waddenzeebekkens, inclusief Eierlandsegat

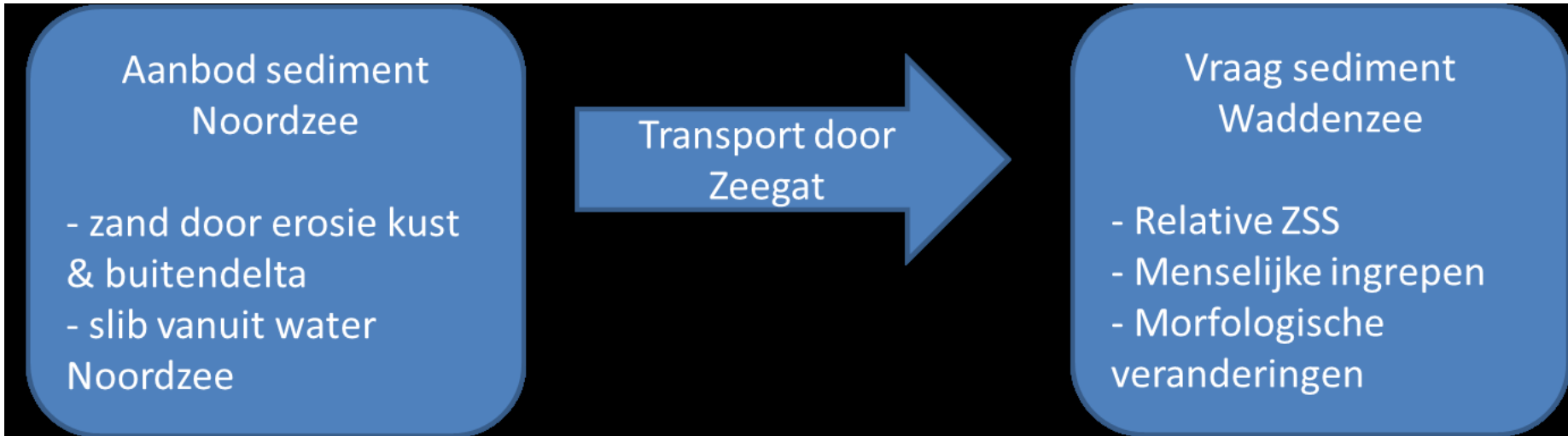
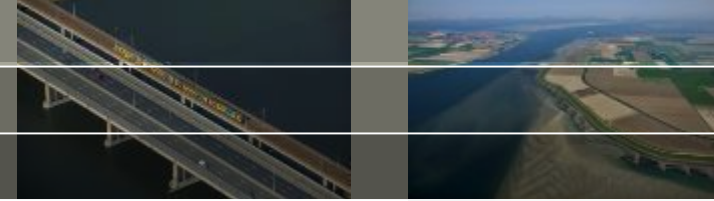
Verandering van LW (i.p.v. MSL) essentieel voor areaal intergetijdengebied

Areaal ecologisch waardevolst deel (30-70% droogvalduur) toegenomen



Huidige toestand NL Waddenzee & doorkijk toekomst

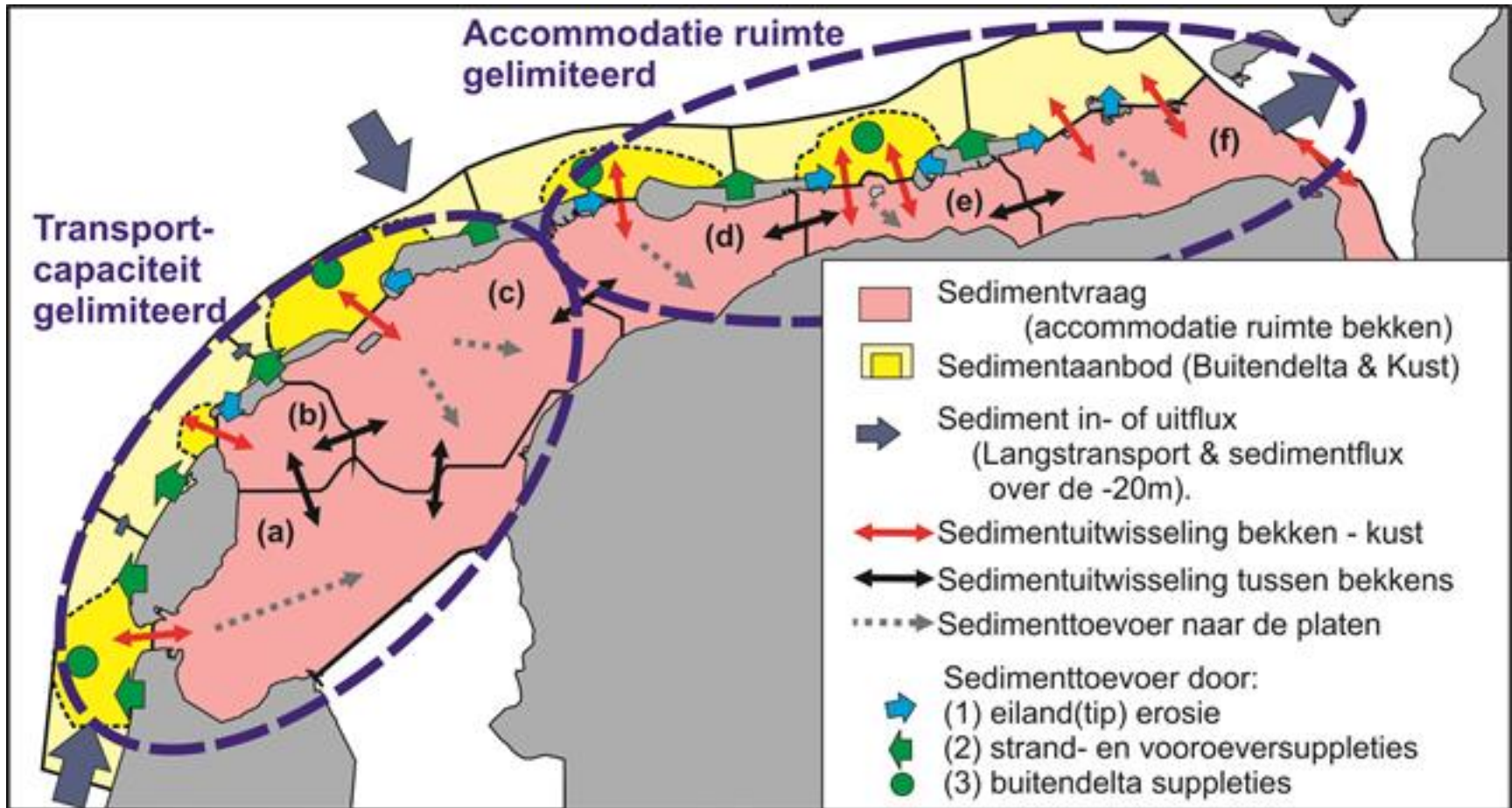
Een denkmodel



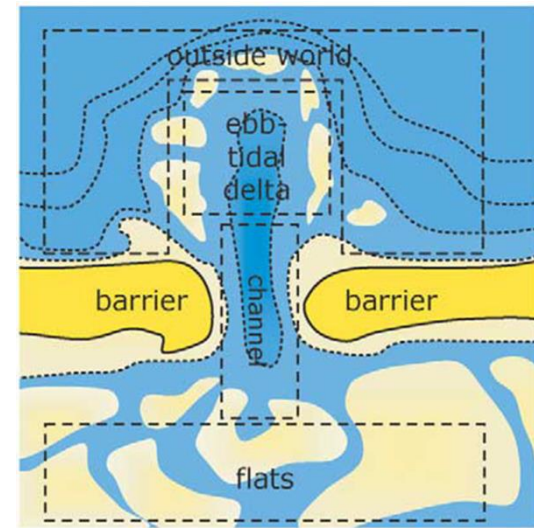
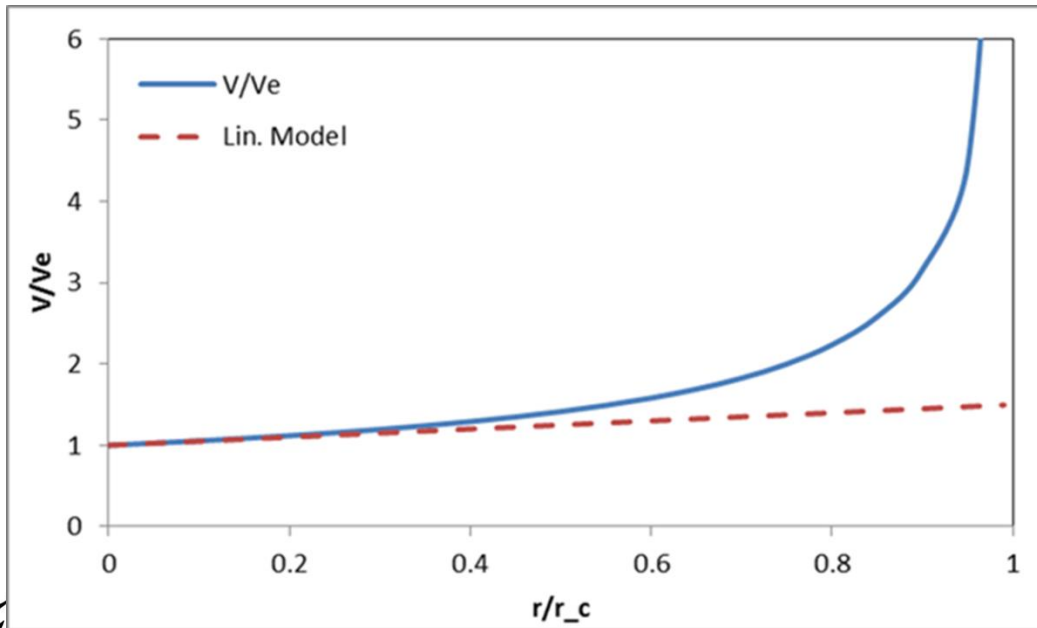
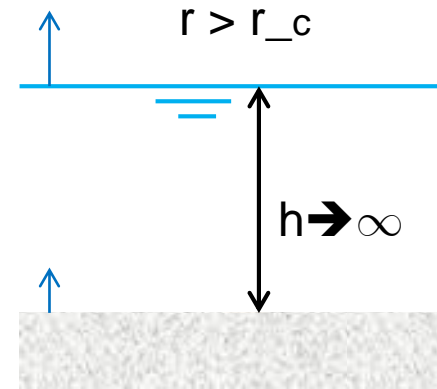
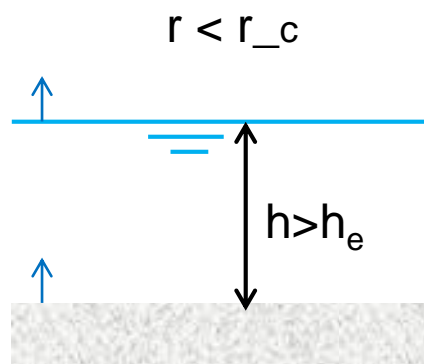
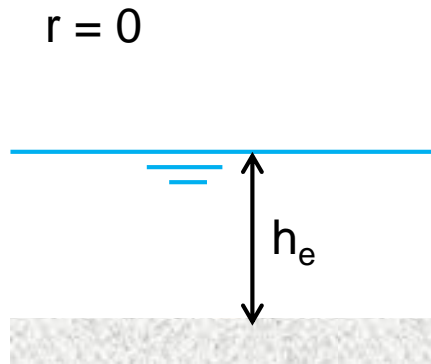
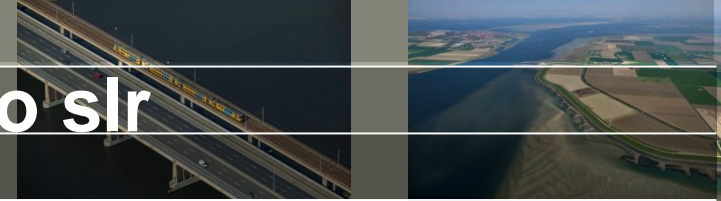
Sedimenttransport naar de Waddenzee:

- Vraag gestuurd, maar beperkt door transportcapaciteit
- West: transportcapaciteit gelimiteerd
- Oost: vraag gelimiteerd

Sediment-delend systeem Waddenzee



Conceptual model response to slr



ASMITA

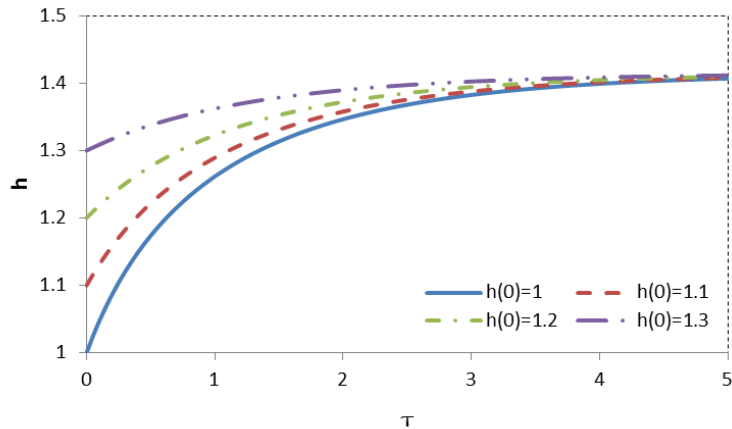
Kritische snelheid ZSS voor verdrinking

Inlet	A_b (m ²)	2a (m)	V_e (Mm ³)	H_e (m)	R_c (mm/y)	T (year)
Texel	655	1.65	1849	2.82	7.00	403
ELGT	157.7	1.65	263.8	1.672	18.0	93
Vlie	715	1.9	2512	3.51	6.30	558
Amel	276.3	2.15	756	2.73	10.4	263
PinkeG	49.6	2.15	86.7	1.75	32.7	53
ZoutK	105	2.25	225.1	2.14	17.1	125

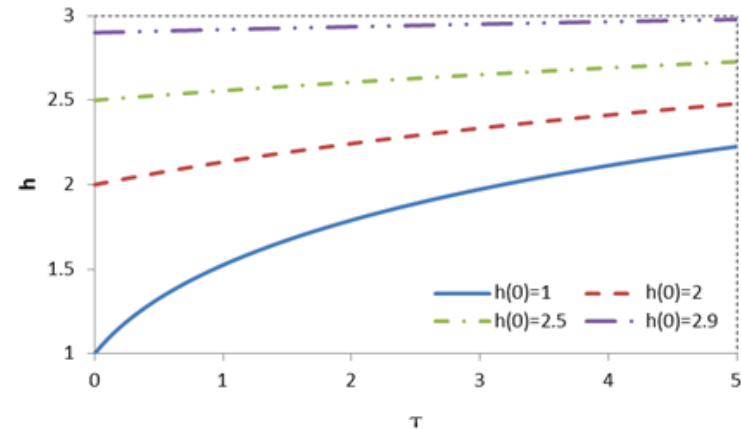
Grotere bekken gevoeliger voor versnelling ZSS

Transient development when SLR accelerates

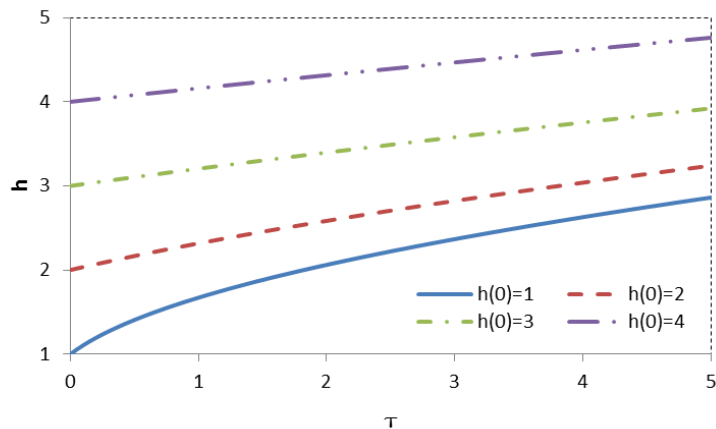
(a) $r=0.5: h_e=1.4, \tau_a=1.4$



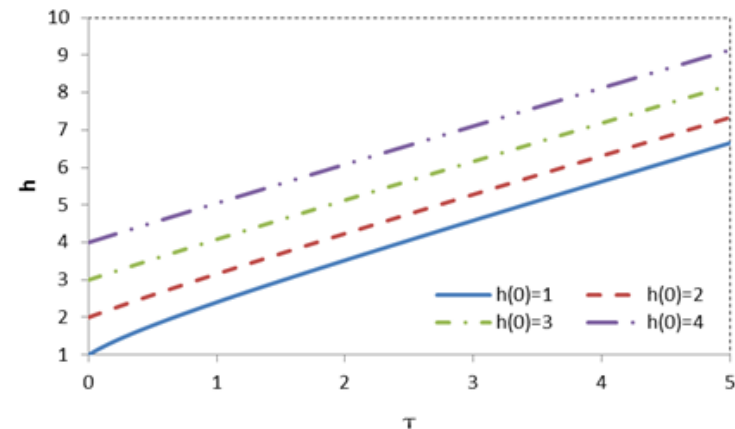
(b) $r=0.9: h_e=3.2, \tau_a=15.8$



(c) $r=1.1: h_e=\infty$



(d) $r=2: h_e=\infty$

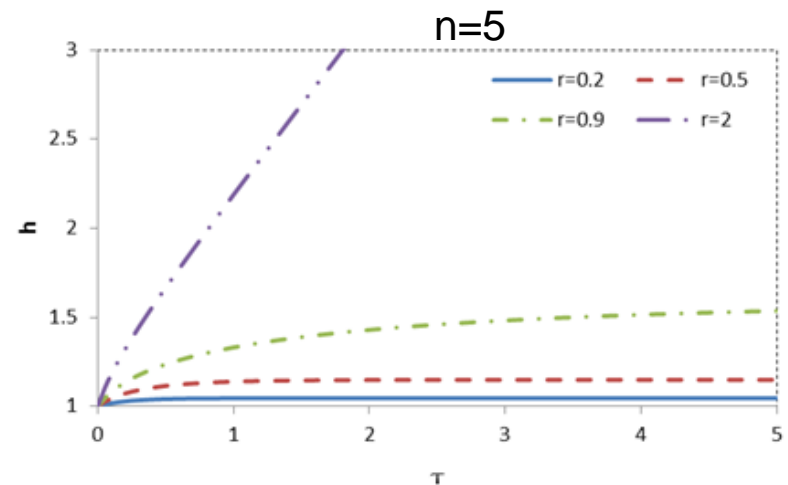
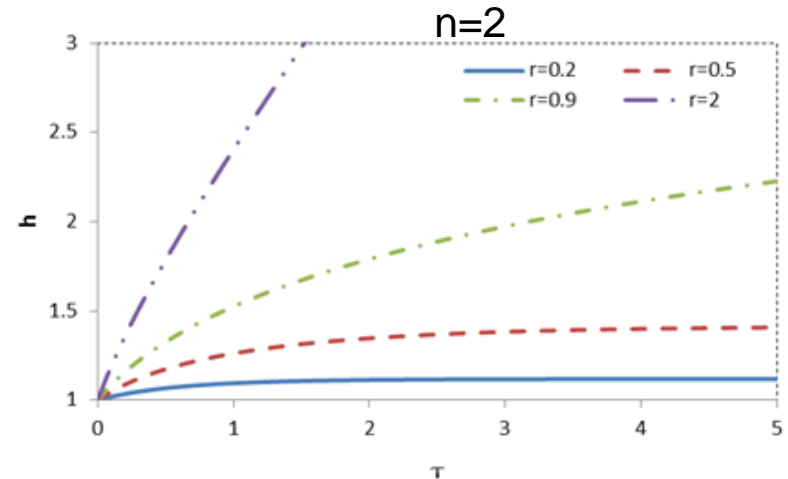


Transient development when SLR accelerates

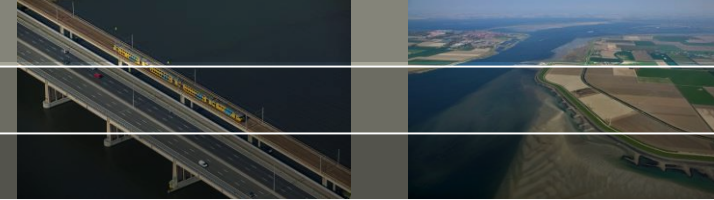
SLR rate influences not only the dynamic equilibrium, but also the transient development towards the new dynamic equilibrium

It is the **dimensionless** SLR rate that matters: the same SLR acceleration has different effect on different basins

Development of the tidal divides will be very important



Effecten van ZSS

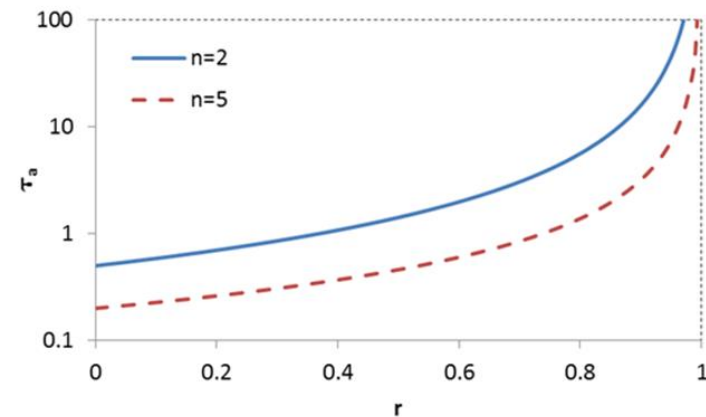
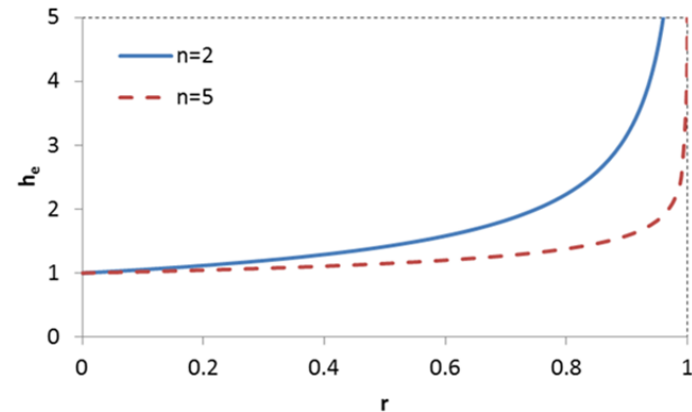


Kritische snelheid van zss, Van Goor e.a. (2003), ...

Kanttekeningen:

- Ook als de snelheid van zss onder de kritische grens ligt is er effect van (versnelde) zss.
- Bij overschrijding van de grens kan het nog eeuwen duren voordat de verdrinking plaatsvindt.
- Niet alleen morfologie, maar ook de bodemsamenstelling kan veranderen.

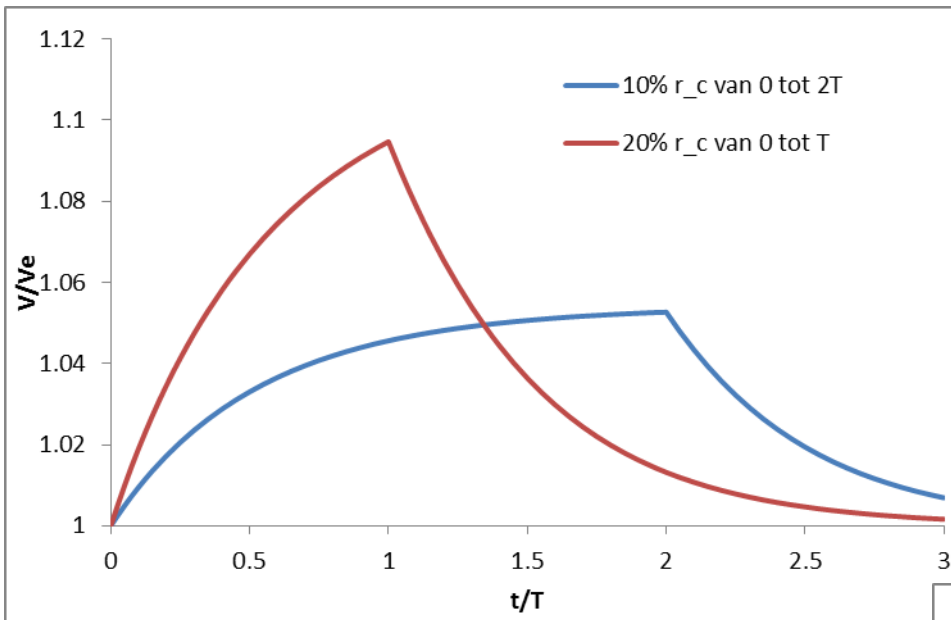
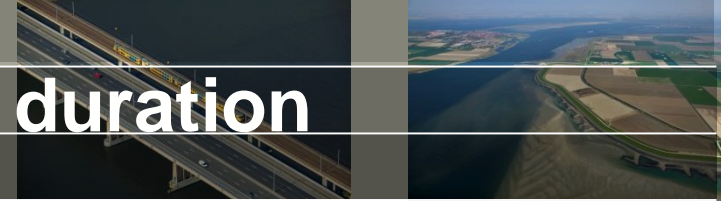
Ontwikkeling ZSS grootste onzekerheid voor de toekomst van Waddenzee.



An aerial photograph showing a coastal landscape. A large body of water is on the left, with a prominent green dike or levee running along the shore. Behind the dike, there are various agricultural fields in shades of brown, tan, and green. In the distance, a small town or village is visible on the left side. The sky is clear and blue.

Relatie tot beheer

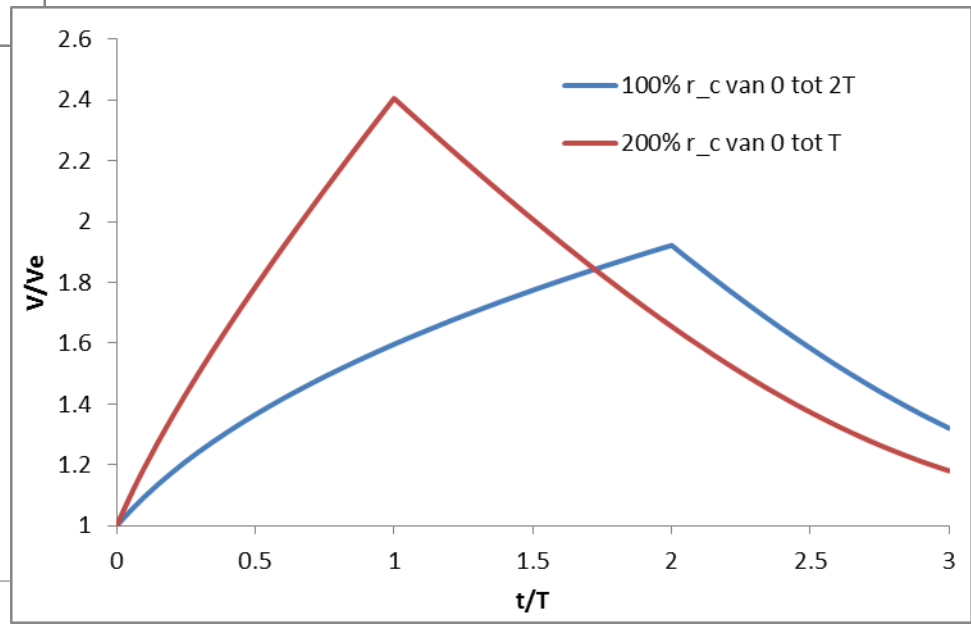
Effect of relative slr of limited duration



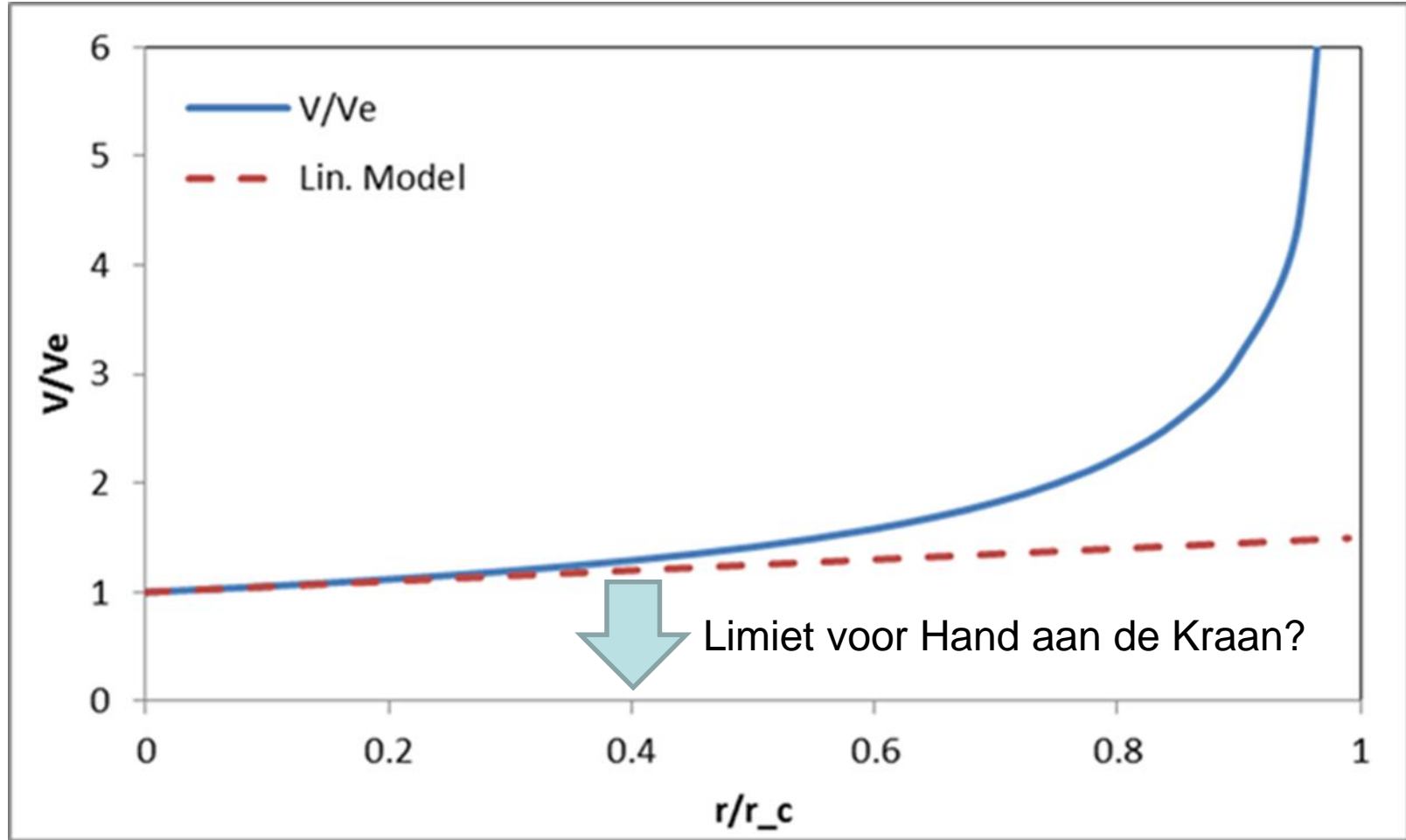
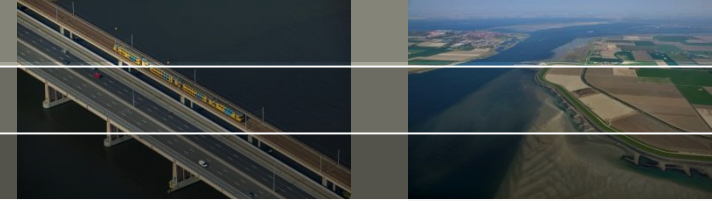
Linear model applicable:
shorter and faster slr →
larger max. effect, cum. effect the same

Linear model not applicable:
Shorter & faster →
Larger max. AND cum. effect

$$\int_0^{\infty} (V - V_e) dt = \int_0^{t_0} (V - V_e) dt + \int_{t_0}^{\infty} (V - V_e) dt = Srt_0T$$

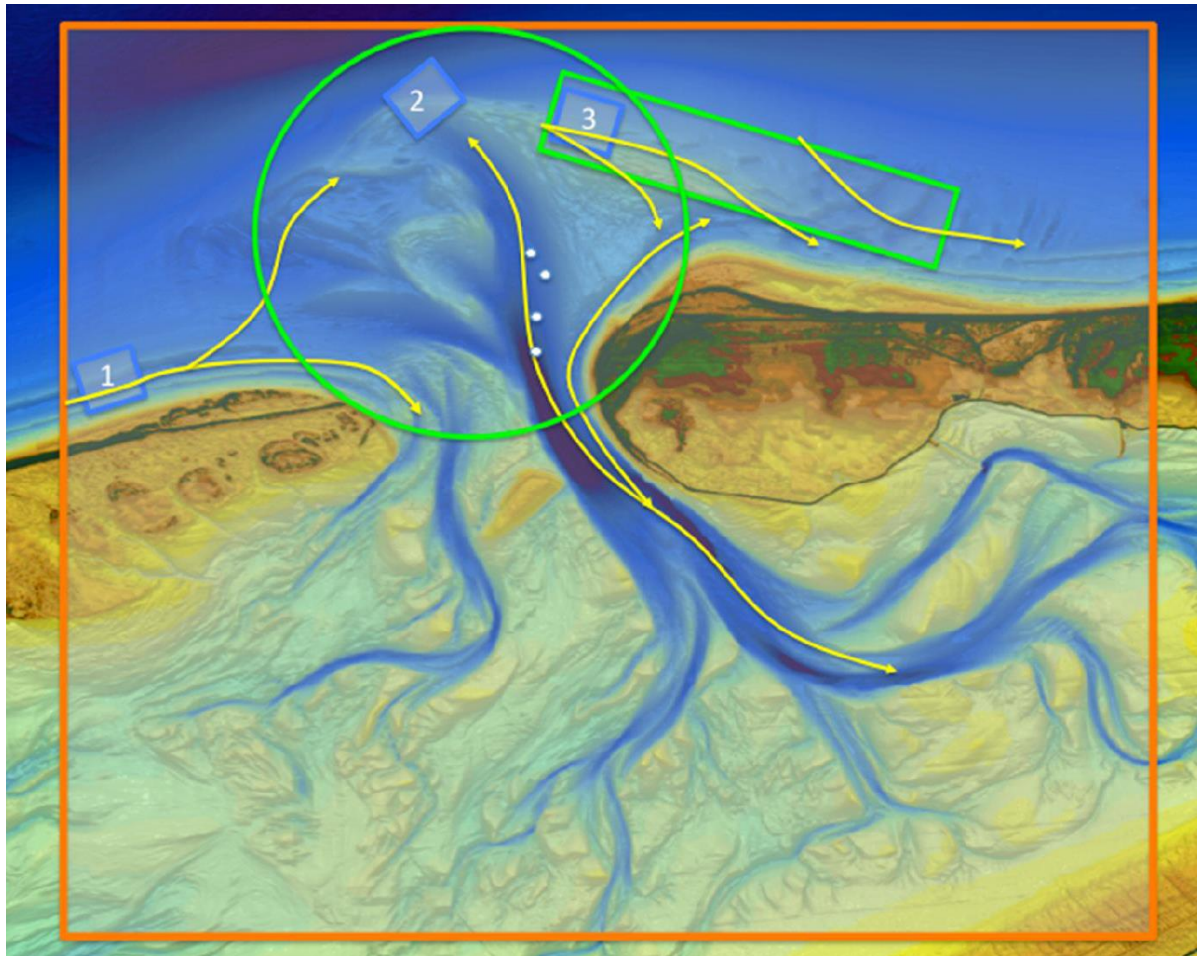


Response to sea-level rise



LT kustsuppletie strategie (KG2 & SEAWAD)

Waar en hoe kunnen wij het best suppleren, ook rekening houdend met Behoud van ecologische waarden in de Waddenzee?



Processes & mechanisms

Transport pathways

Ecological processes

Dank voor uw aandacht !

