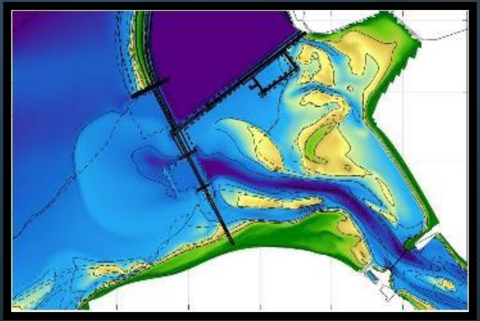
Stability of intertidal and subtidal areas after Delta21 plan

Evaluating the morphological development produced by the intervention

M. I. Zaldivar Piña

Green-Light meeting



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Outline

1. Project Overview
2. Research Questions and approach
3. Main findings
4. Results (S0-S1)
5. Conclusions and Recommendations

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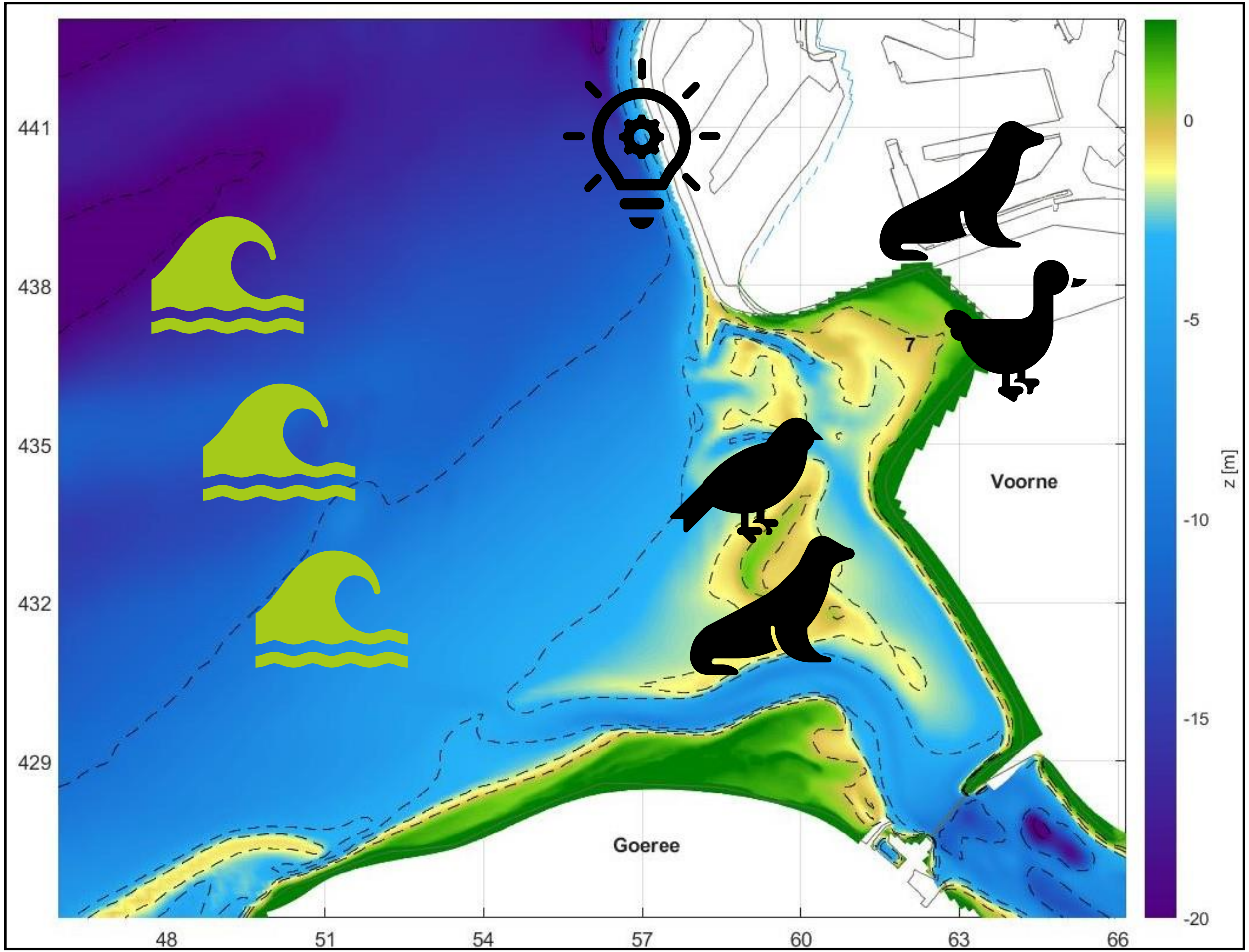
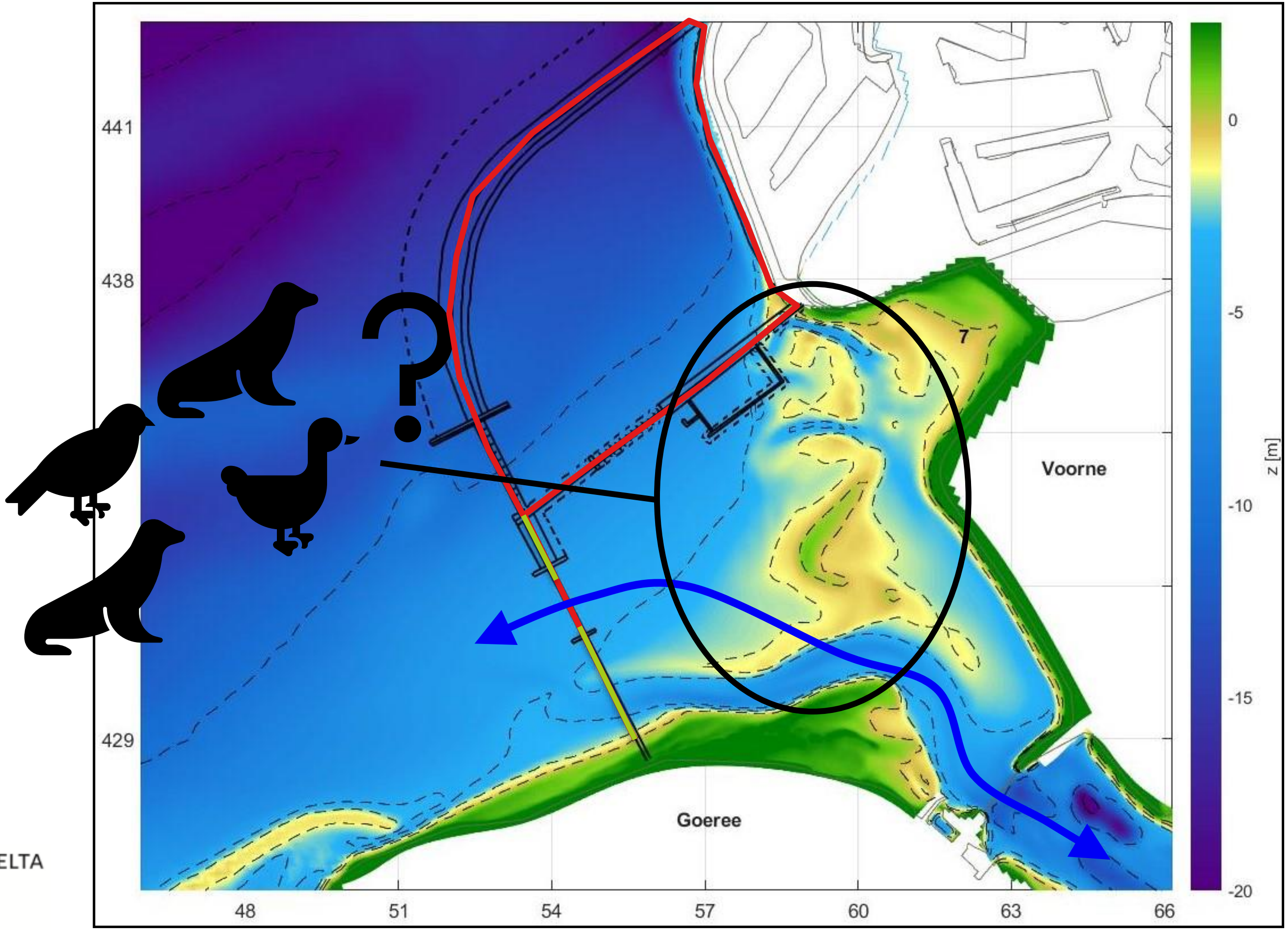
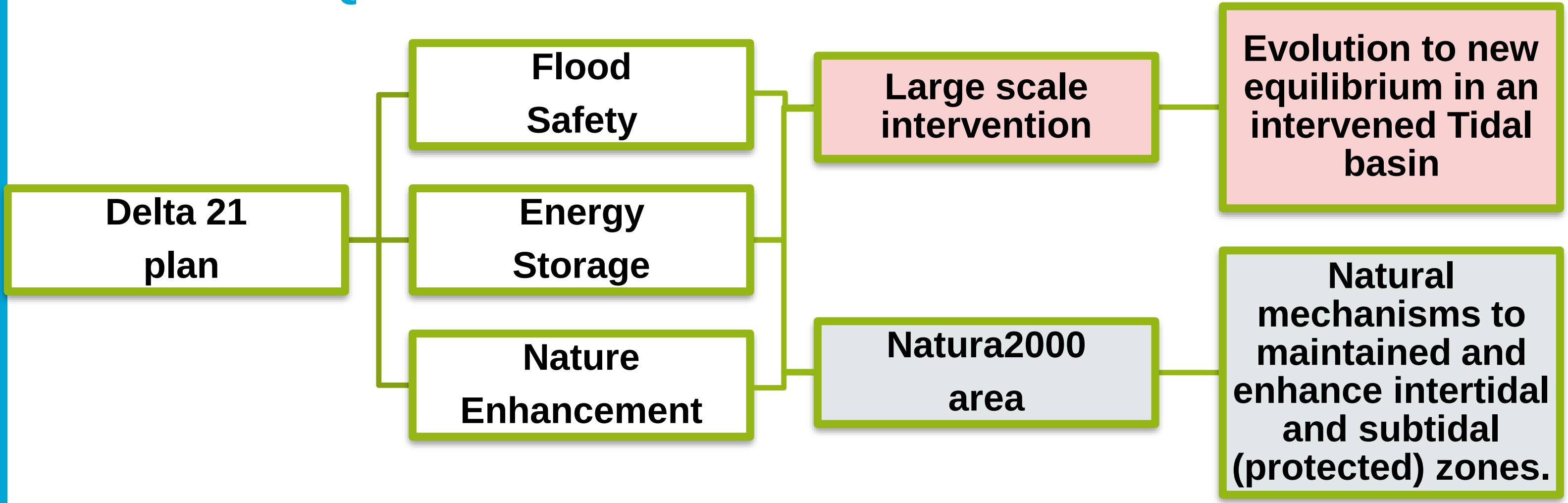
Overview of the project



Overview of the project



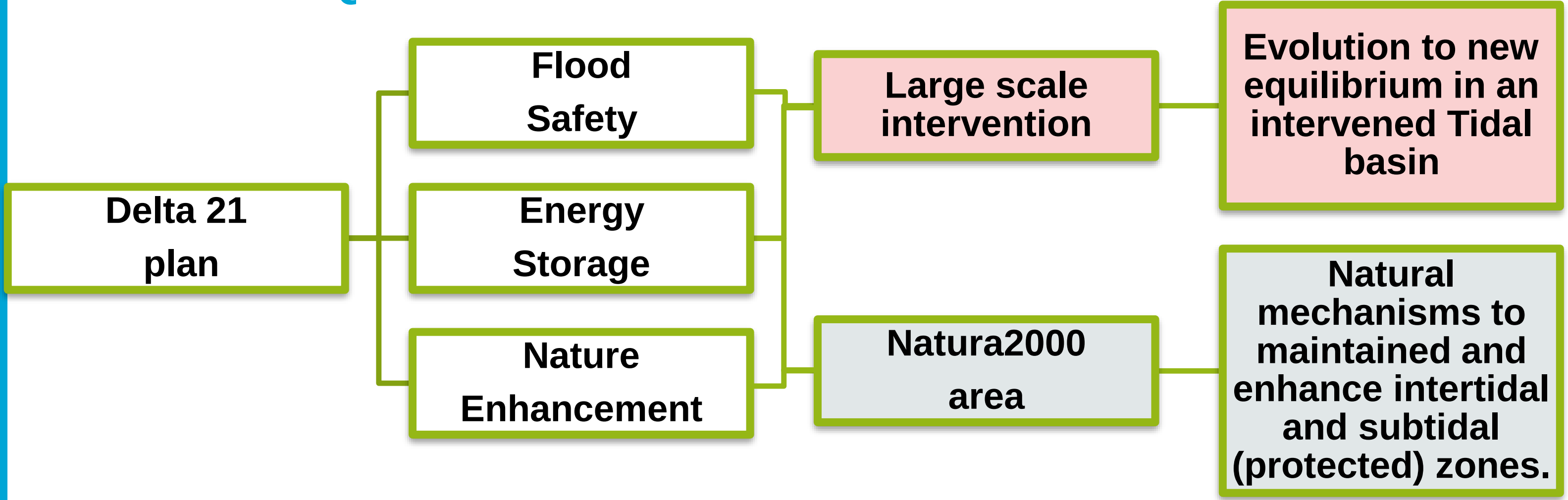
Research Questions



General behavior

1. Hydrodynamics of the Haringvliet mouth since the Maasvlakte 2.
2. Morphological features of the Haringvliet mouth since the Maasvlakte 2.
3. Overall expected behavior of the Haringvliet mouth with Delta21 and effects on the water motion.
4. Effect on the net sediment transport patterns and morphology.

Research Questions



Stability of intertidal areas

5. Behavior of intertidal and subtidal zone at the Haringvliet mouth with D21.
6. Behavior of an artificially nourished sandbank at the seaward side of the TL.
7. Configuration of the nourished sandbank to trigger its own growth by taking advantage of bypassing mechanisms.

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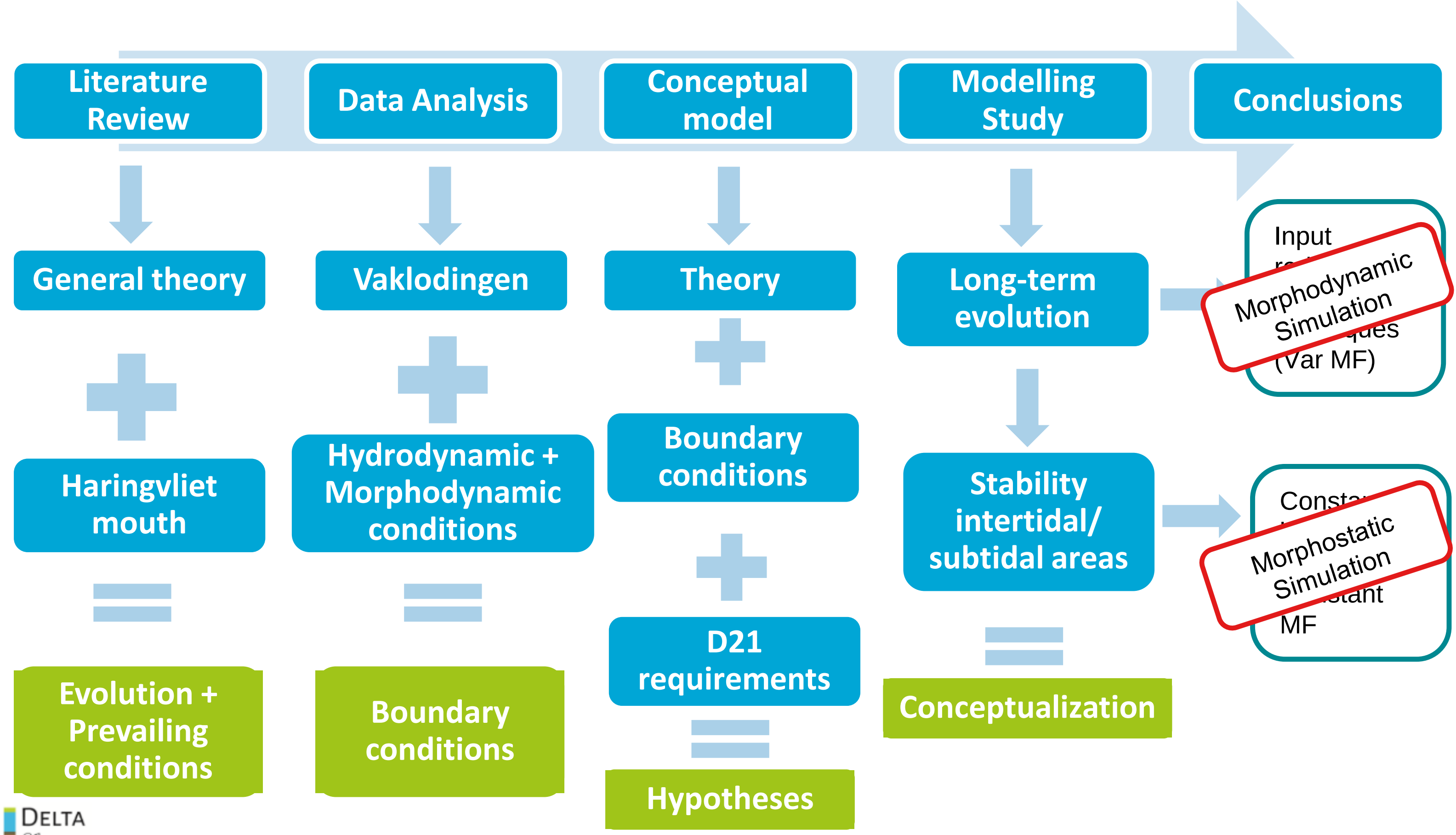
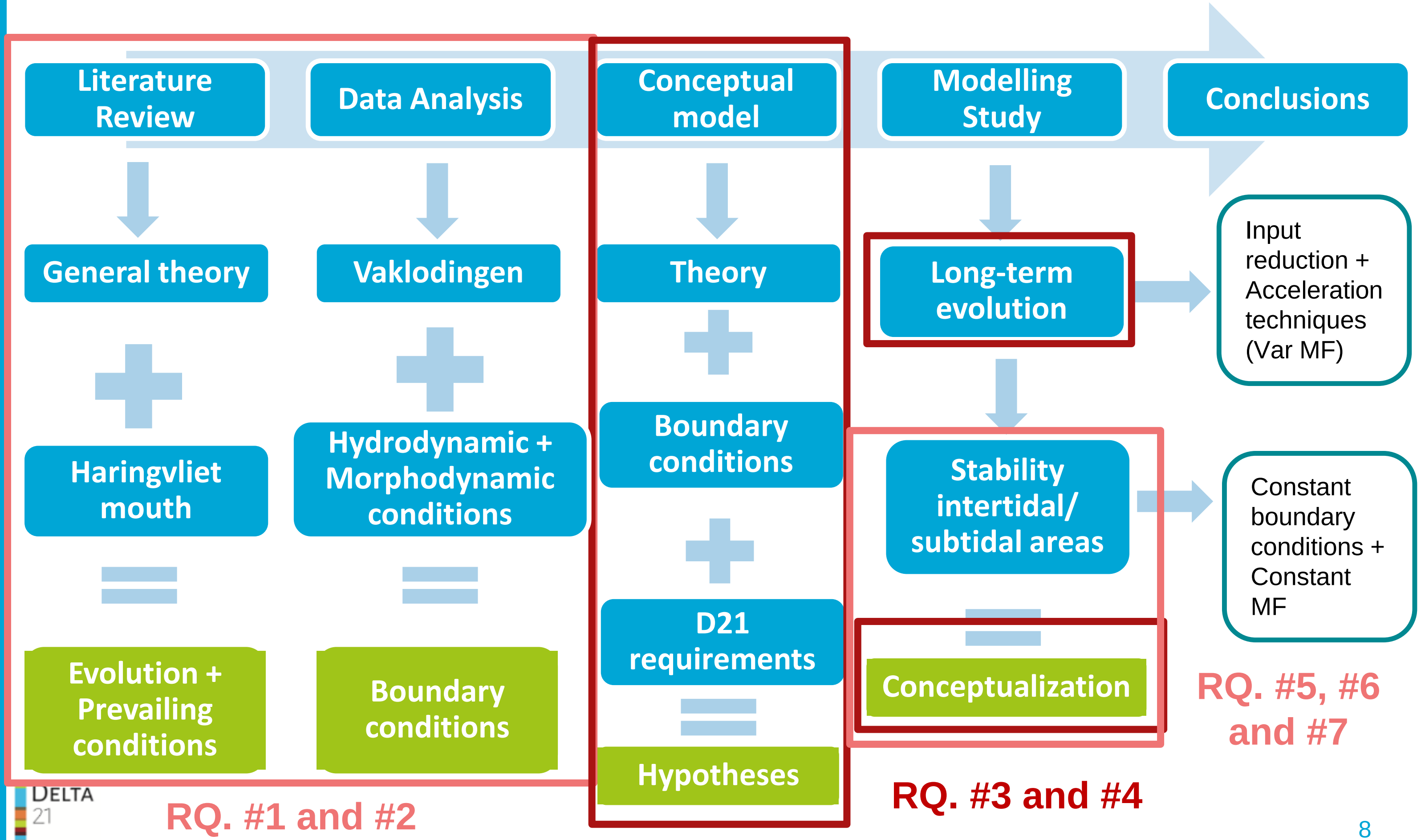
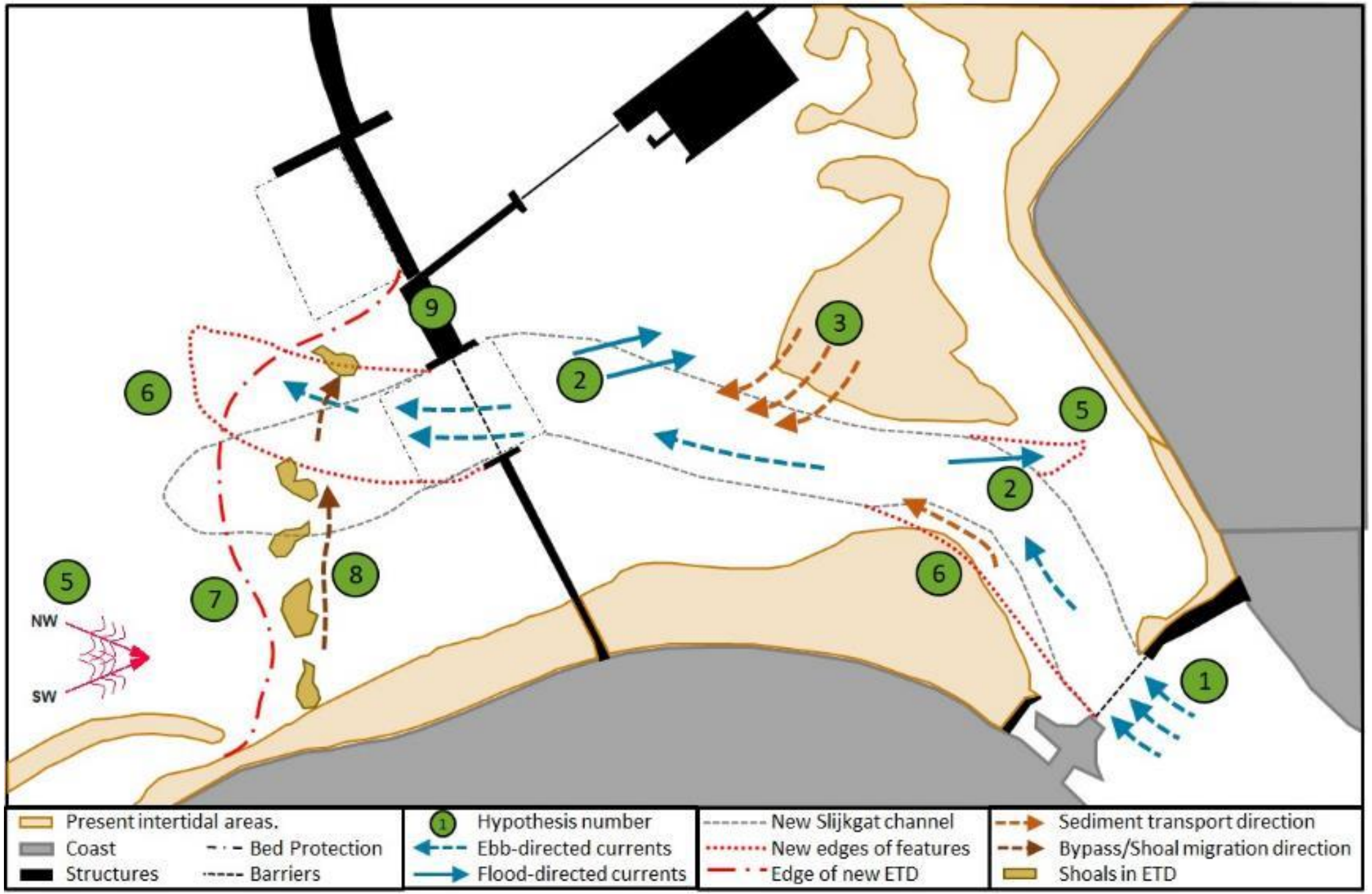
Research approach



Research approach



Hypotheses



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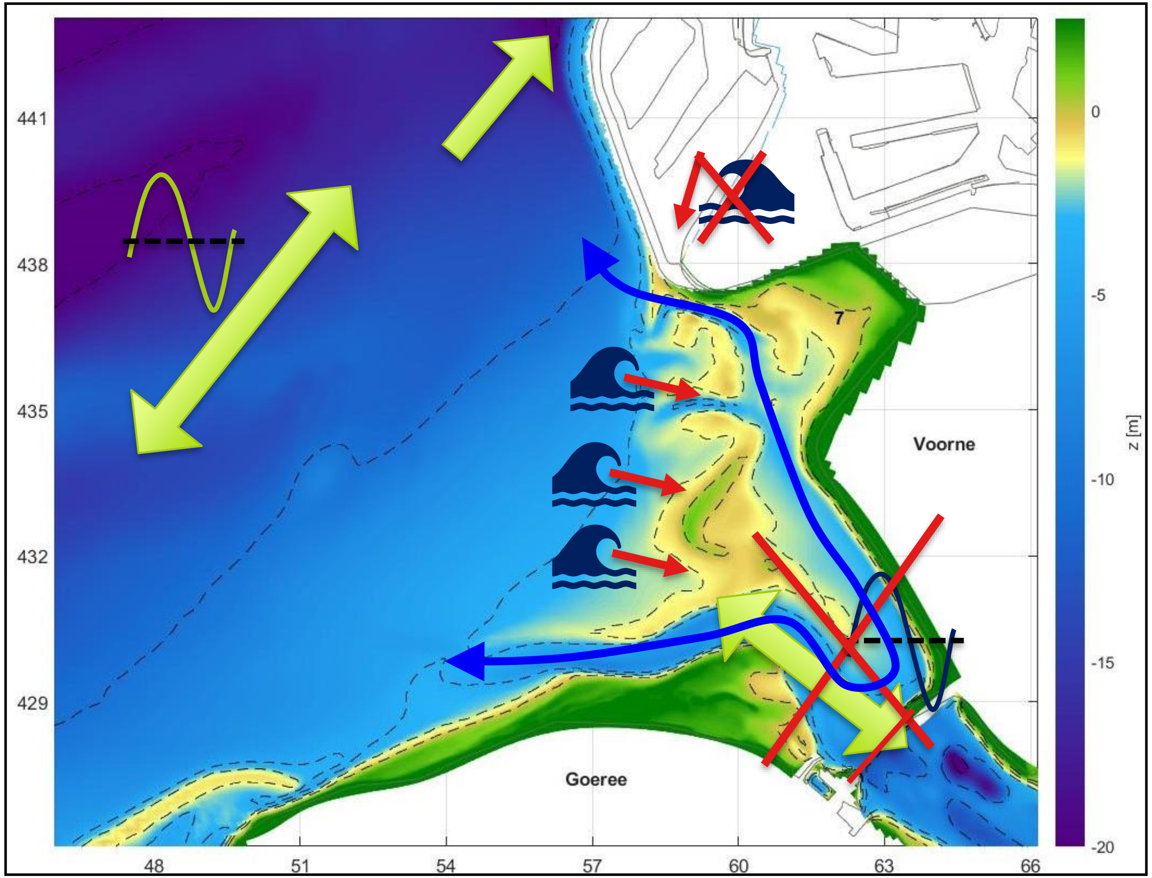
Main findings

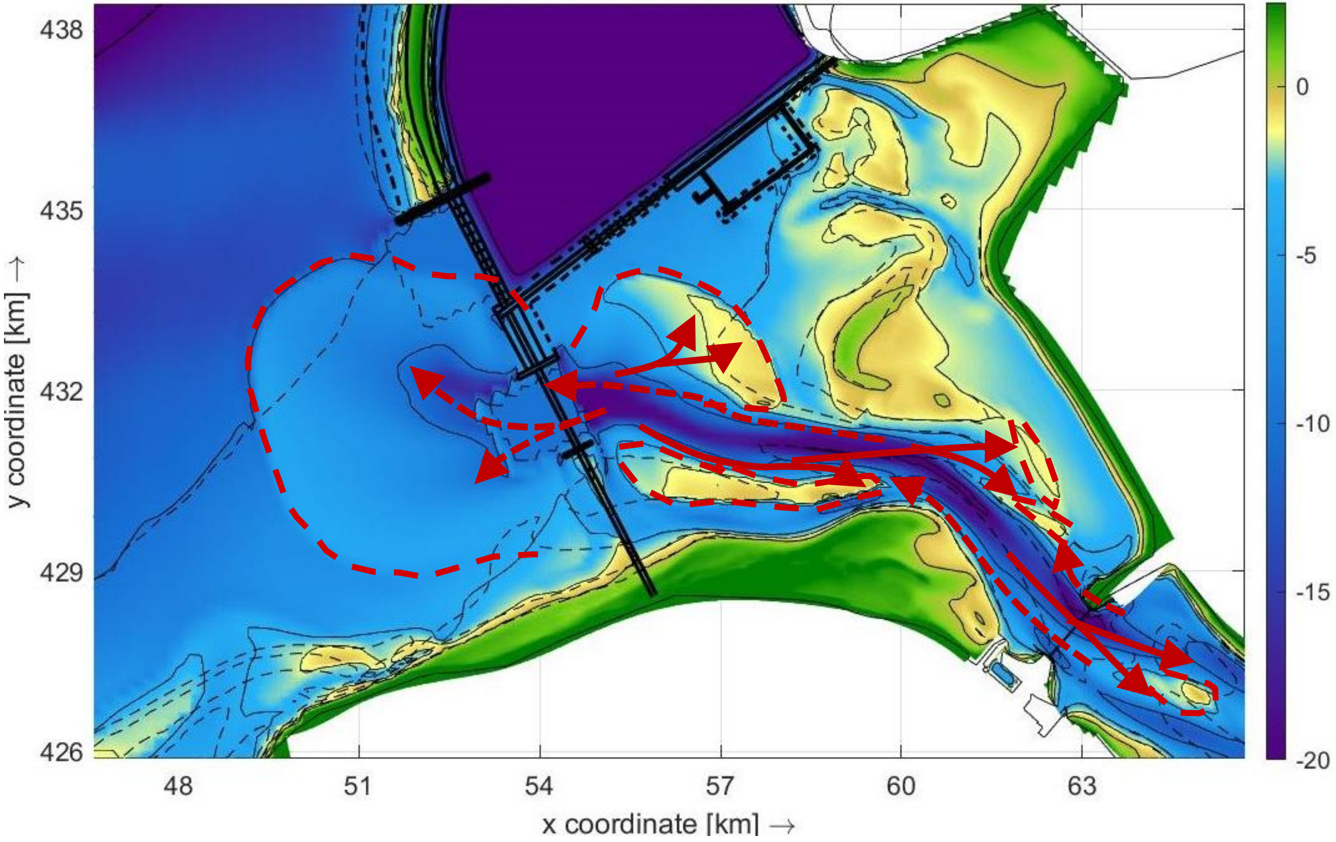
- **MV2 has not change the existing trends in the Haringvliet.**



Tonis et al. (2002)
Elias et al. (2016)
Groen (2014)

Main findings

- **Emergence an ETD, FTD and shoals inside the TL as product of a redistribution of material inside the TL.**



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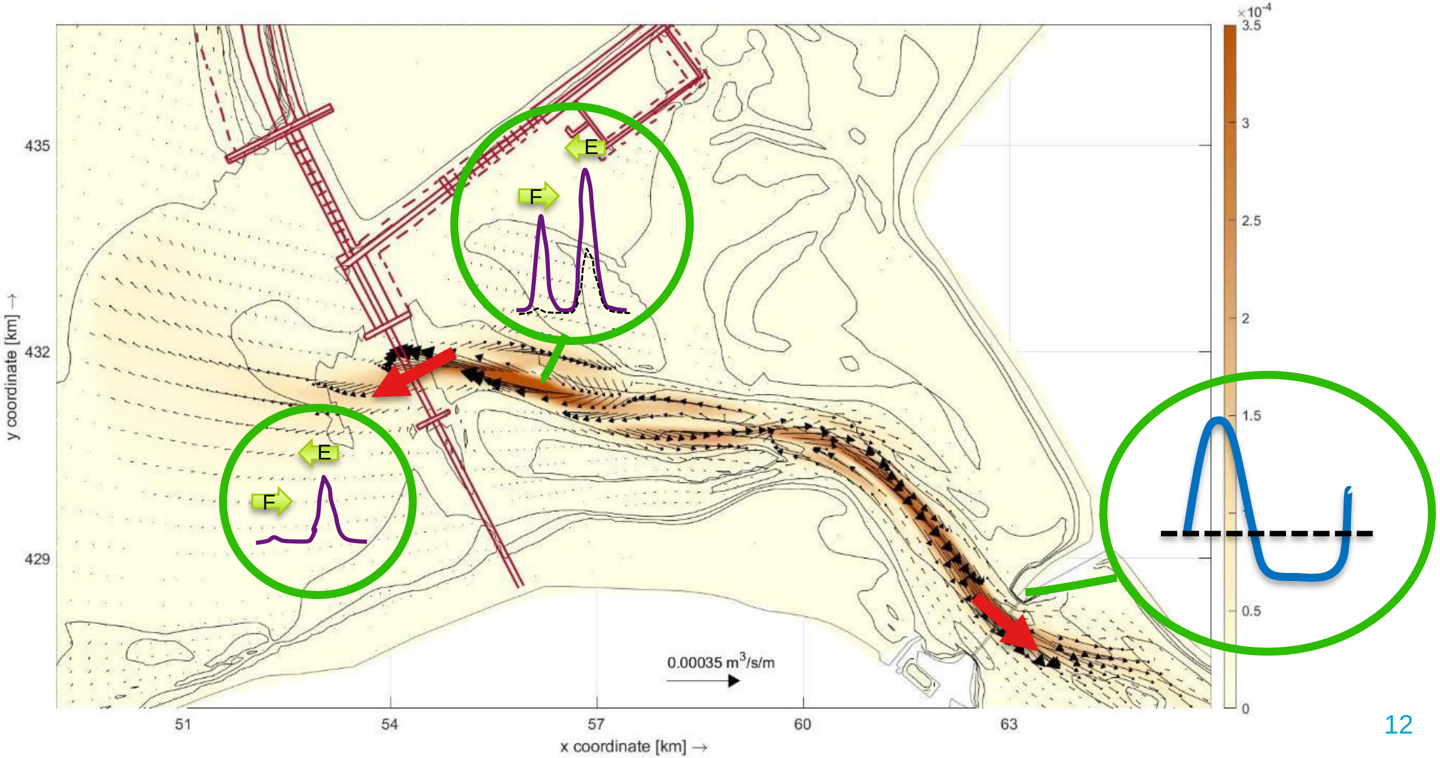
Main findings

- **TL shows a net export of sediment:**
  - **At Haringvliet Dam product of Tidal Asymmetry**
  - **At TL inlet due to the difference in concentrations in the water column in the different stages of the cycle.**



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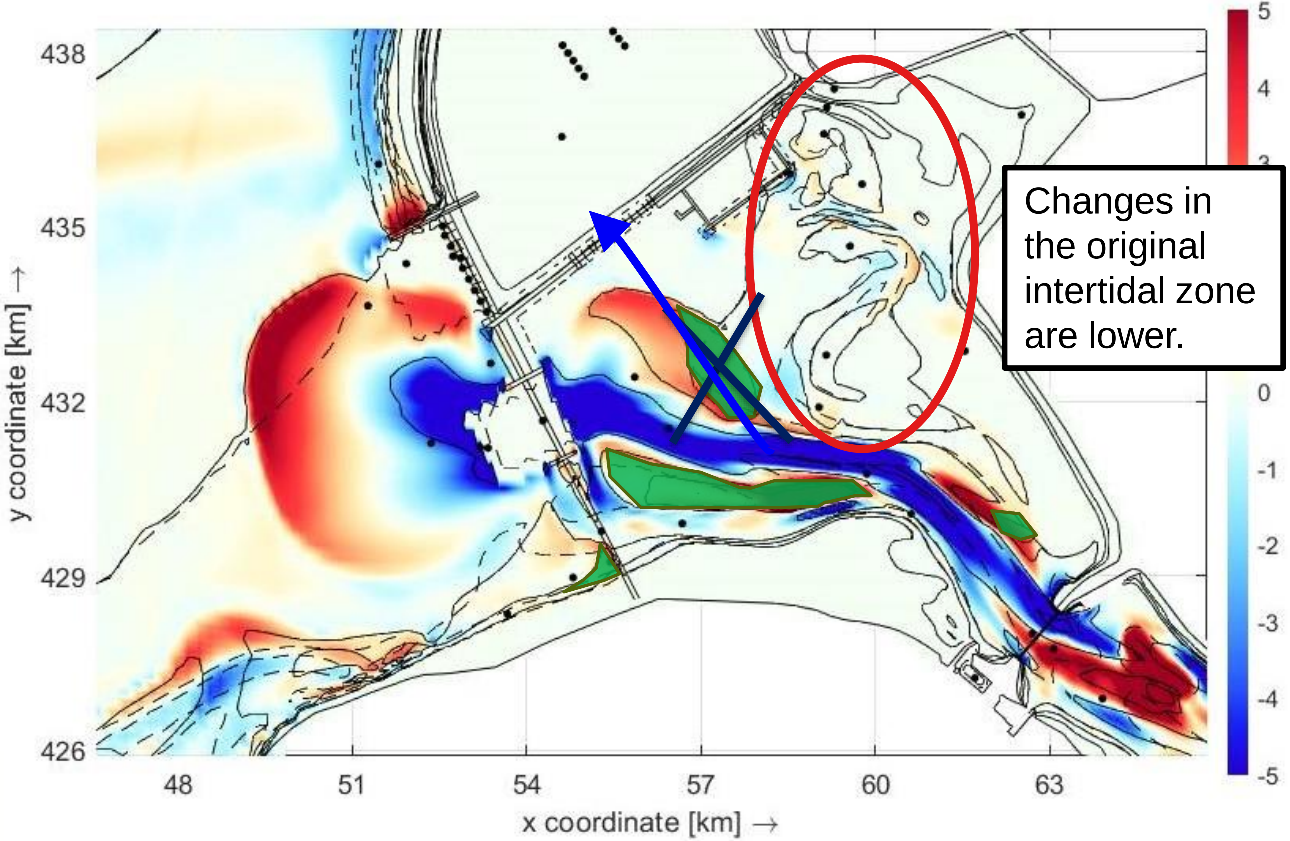
Main findings

- **The growth of intertidal and subtidal areas inside the TL, compensate for the dredging due to D21 implementation**



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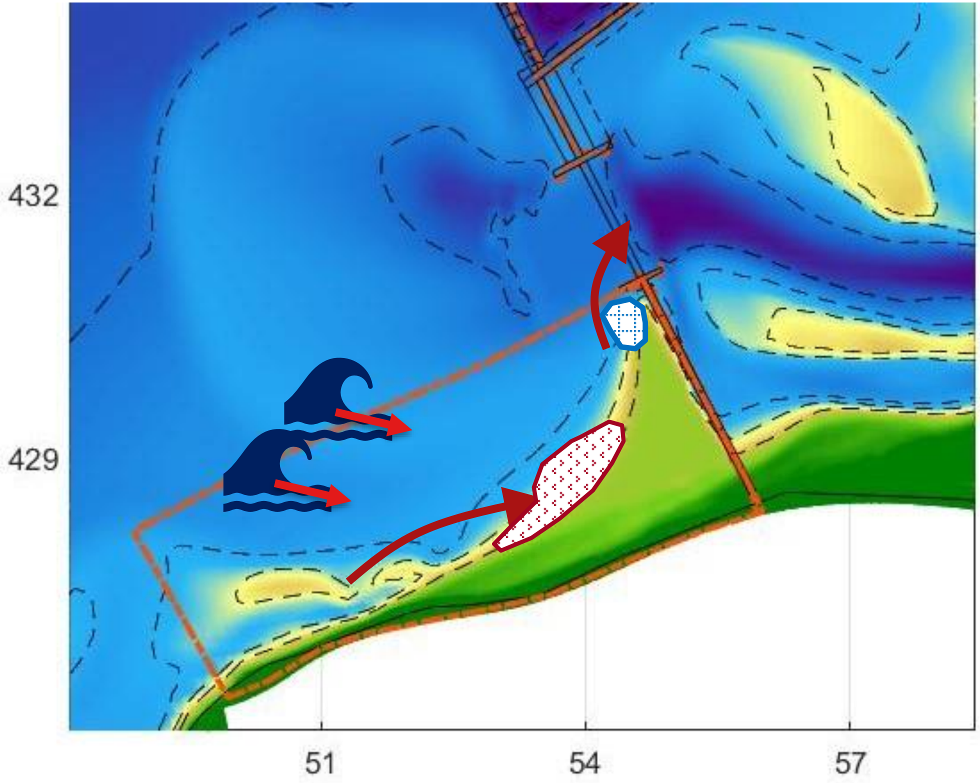
Main findings

- **A new sandbank in the seaward side is more stable when is geometry is smoother with the original coastline. Growth is promoted at a very slow rate.**



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Results

S0

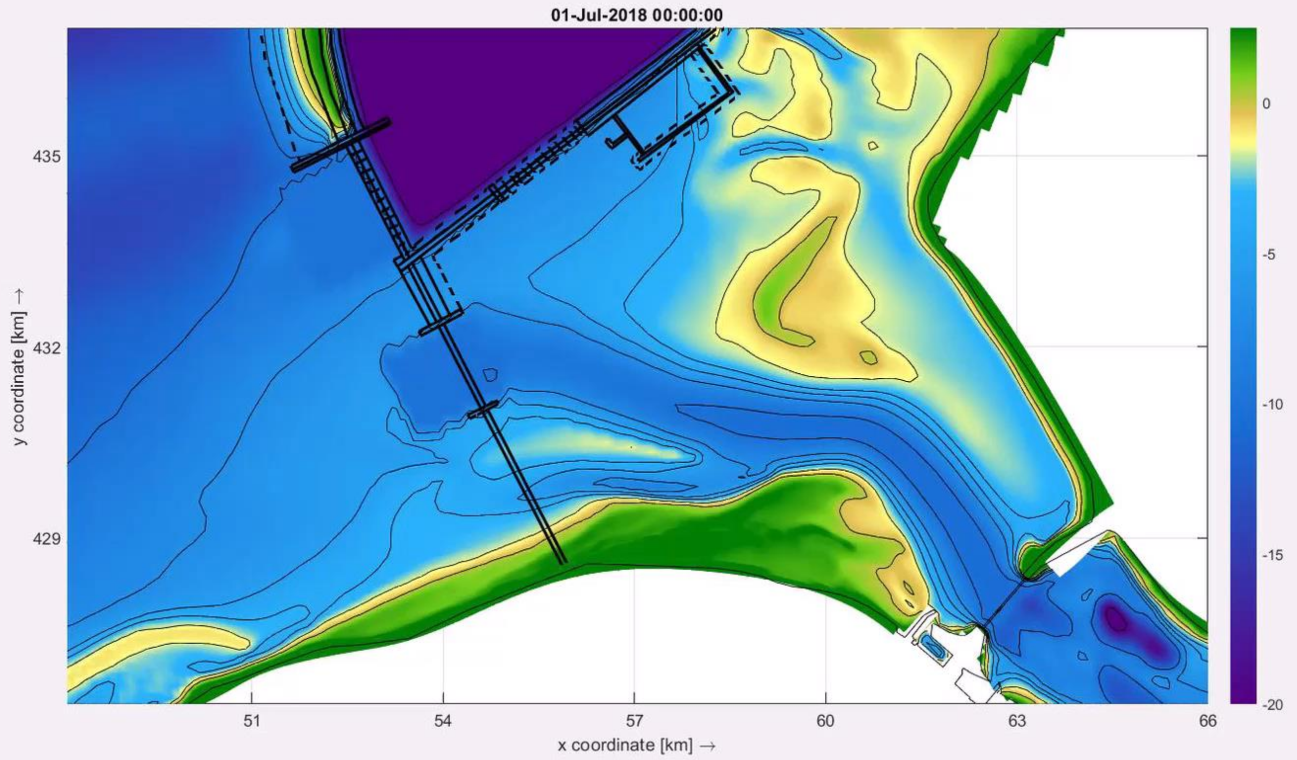
S1

Residual Currents → Net sediment transport patterns → Bed level changes

=

Morphological Evolution

Results – S0



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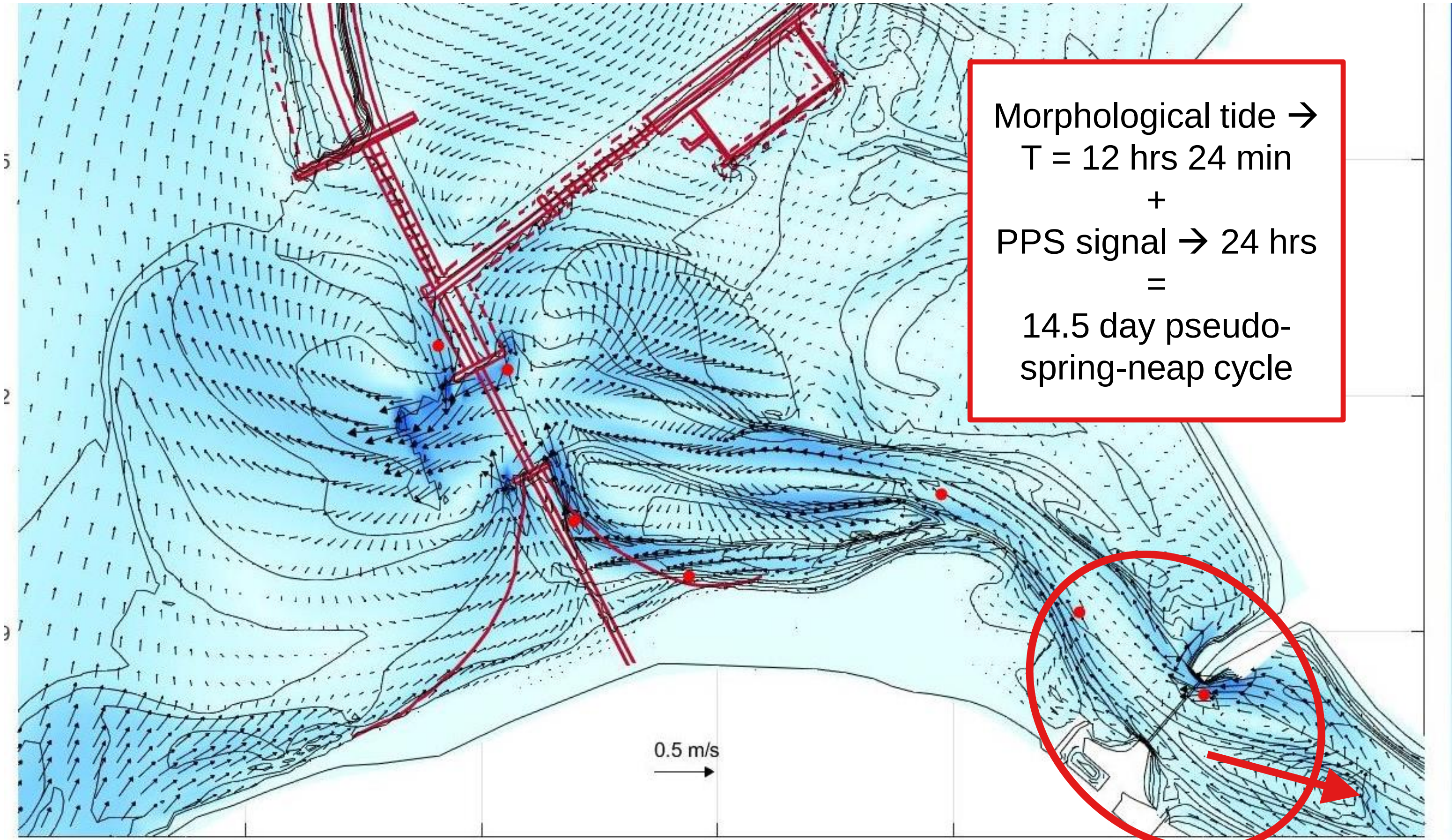
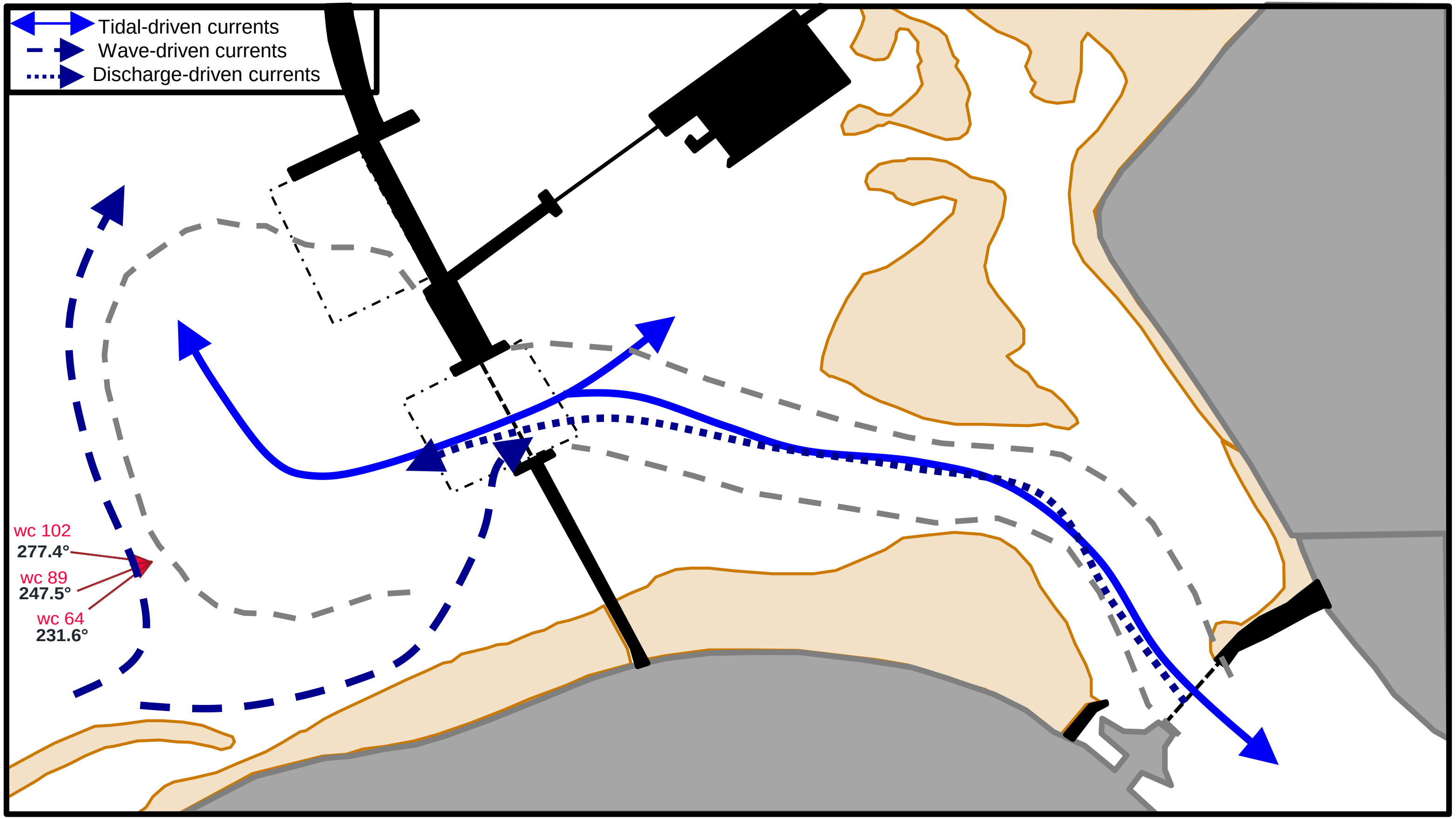
S0 Results – Residual Currents

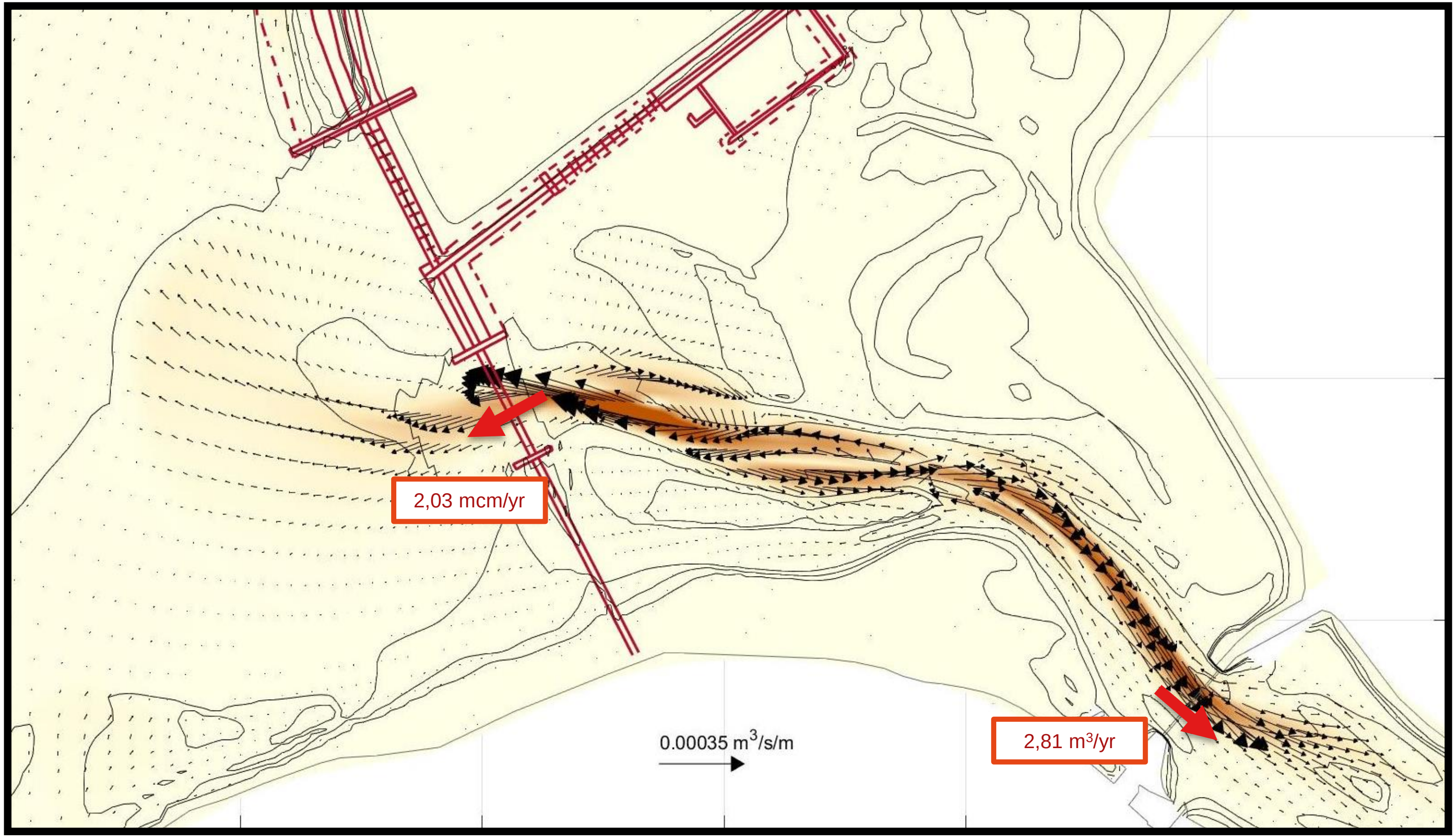


Morphological tide → T = 12 hrs 24 min
+
PPS signal → 24 hrs
=
14.5 day pseudo-spring-neap cycle

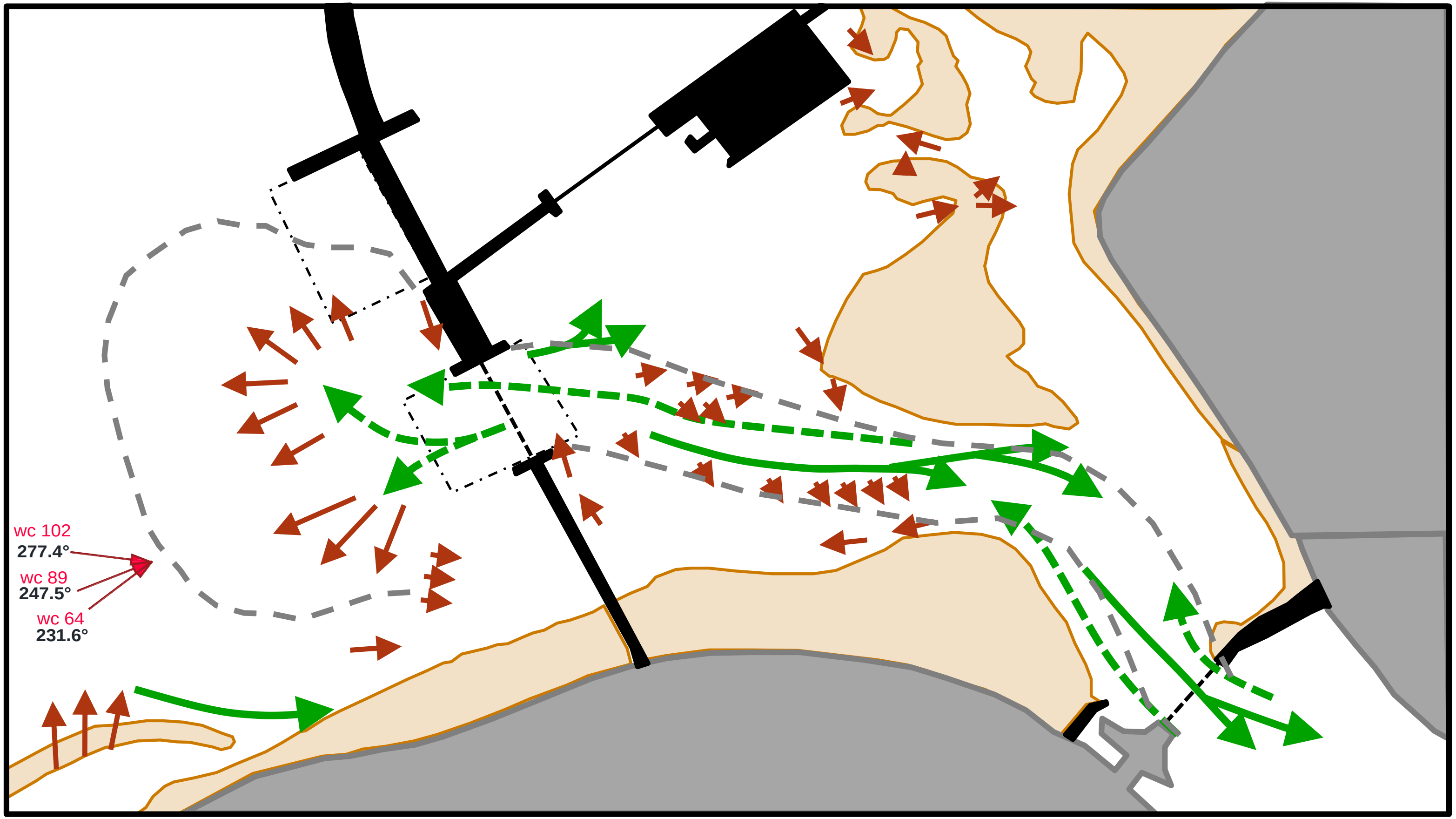
S0 Results – Currents



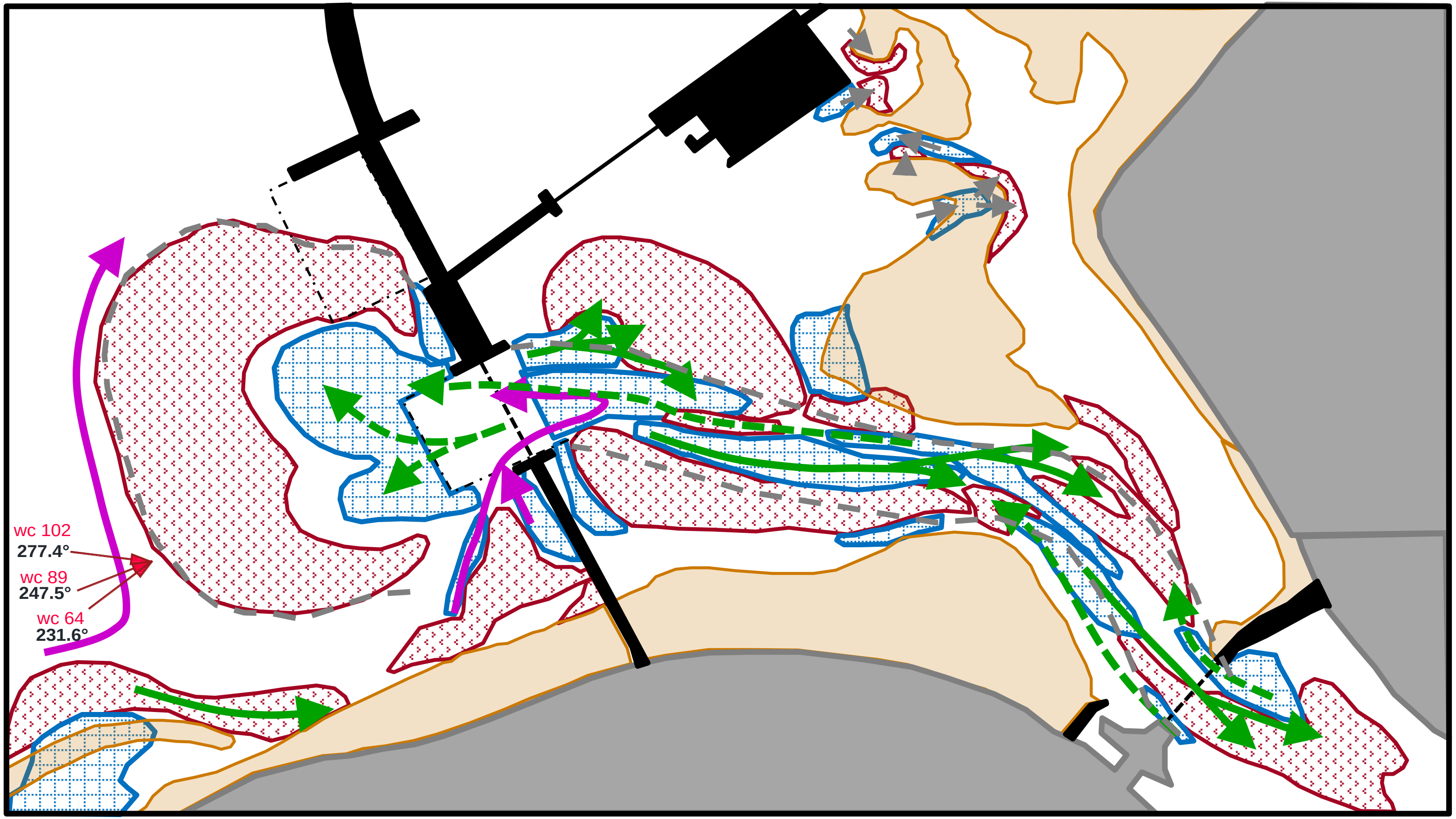
S0 Results – Sediment Transport Pathways



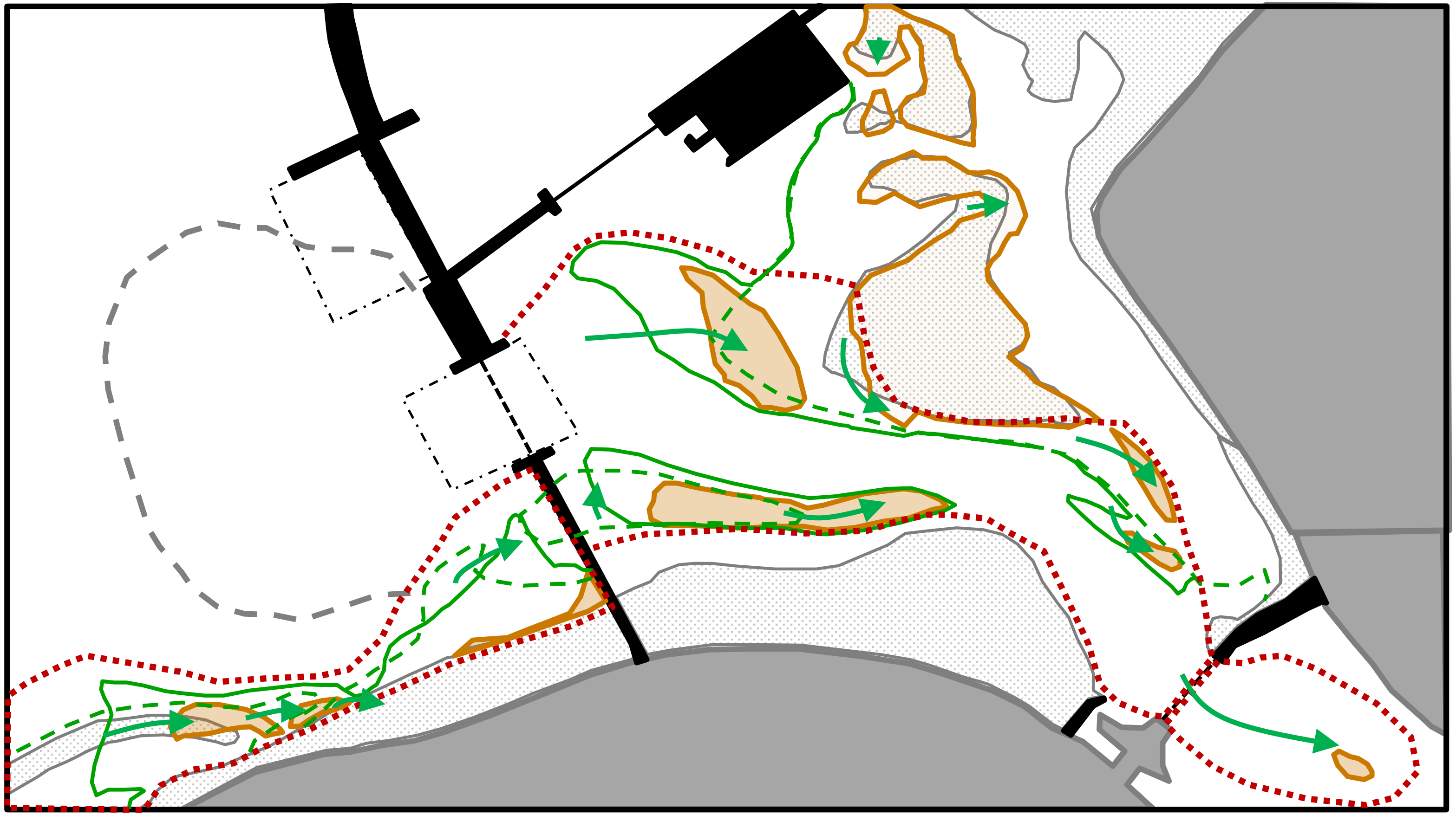
S0 Results – Sediment Transport Pathways



S0 Results – SedEro patterns and bypass



S0 Results – Shallow areas



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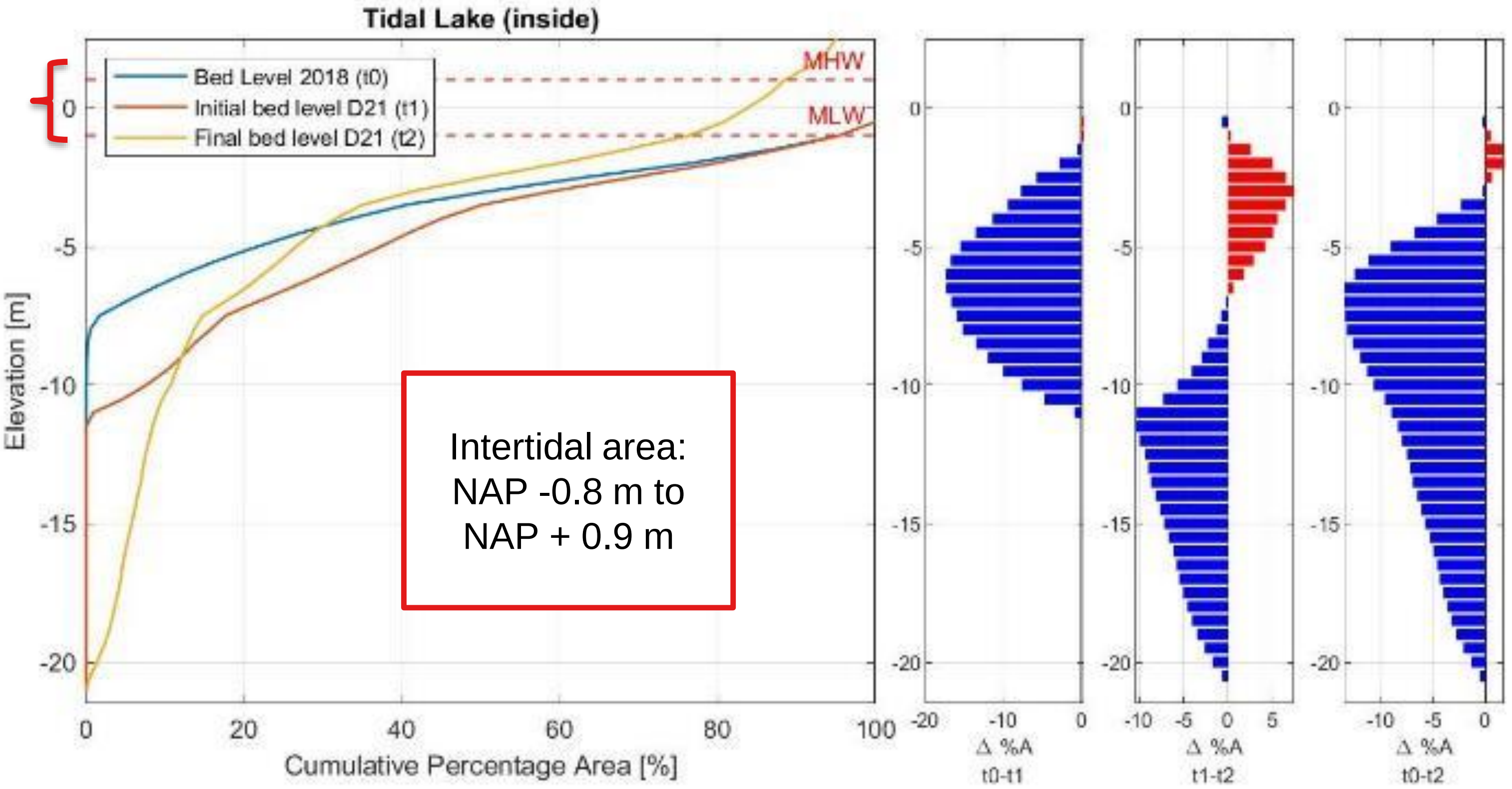
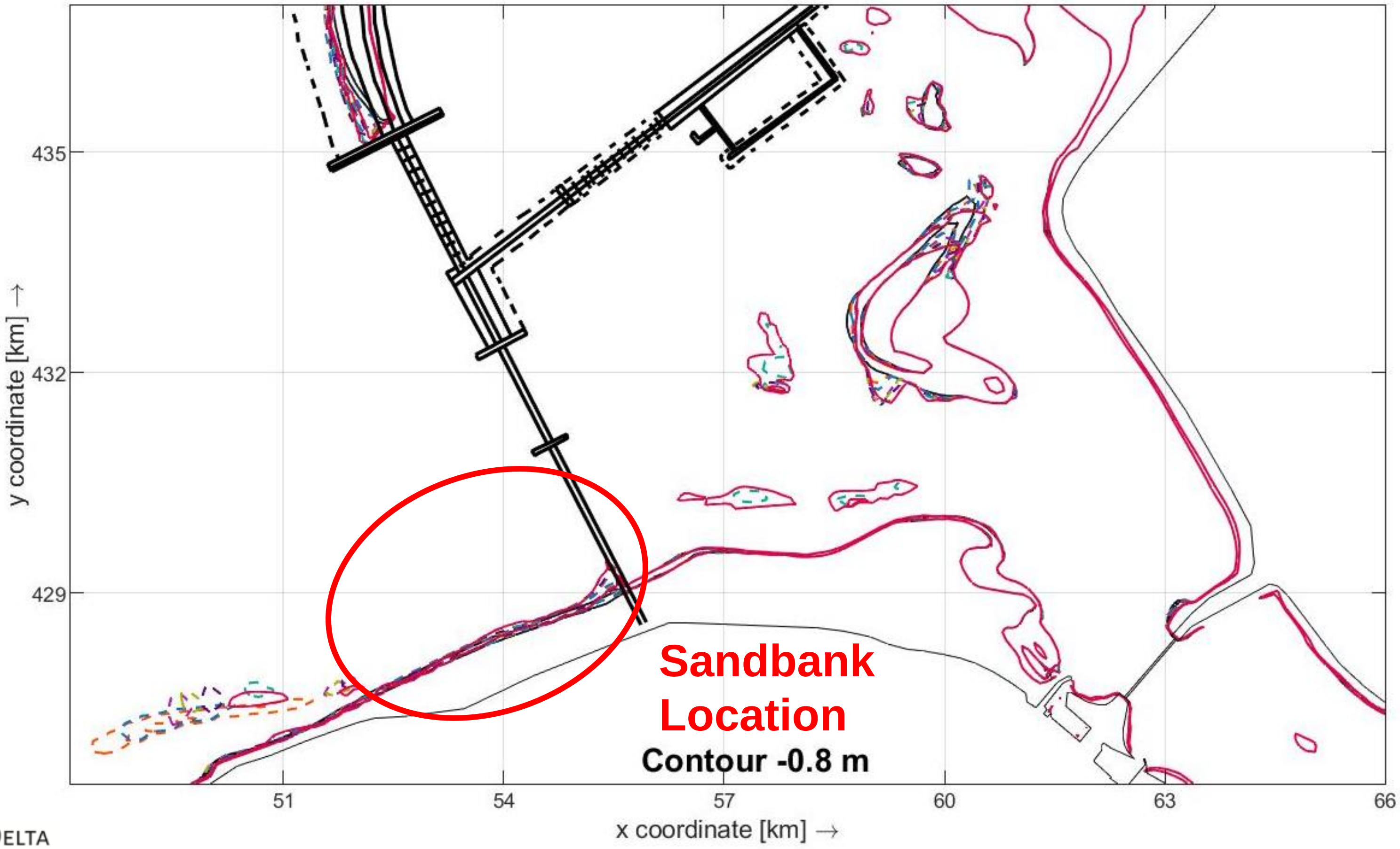
S1 – Hypsometry



Intertidal area:
NAP -0.8 m to
NAP + 0.9 m

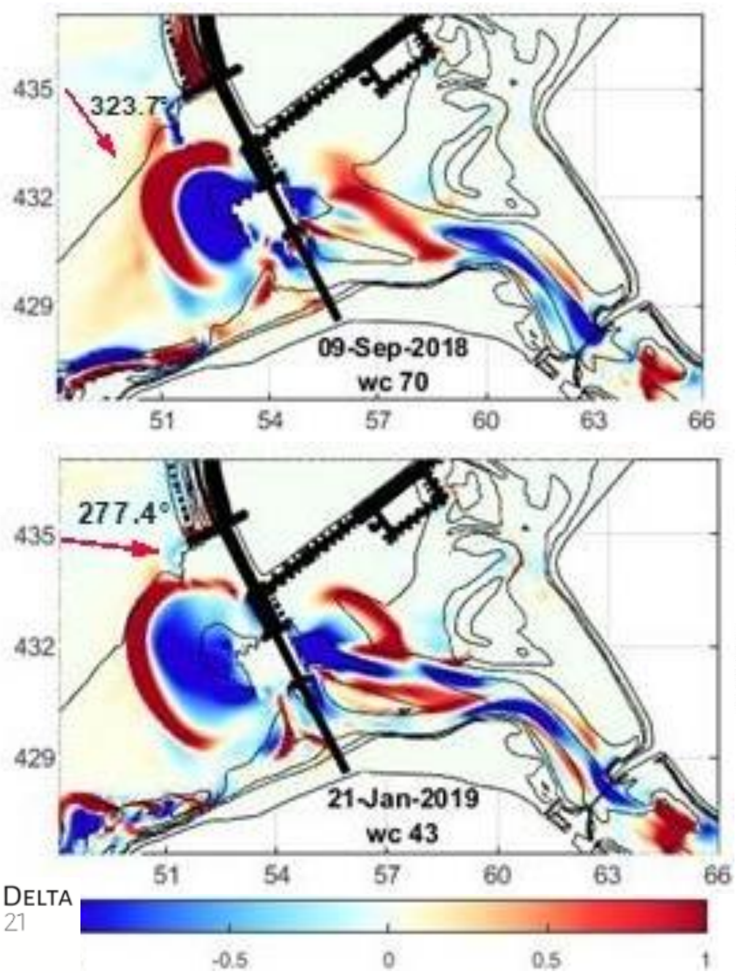
The growth of intertidal and subtidal areas inside the TL, compensate for the dredging due to D21 implementation

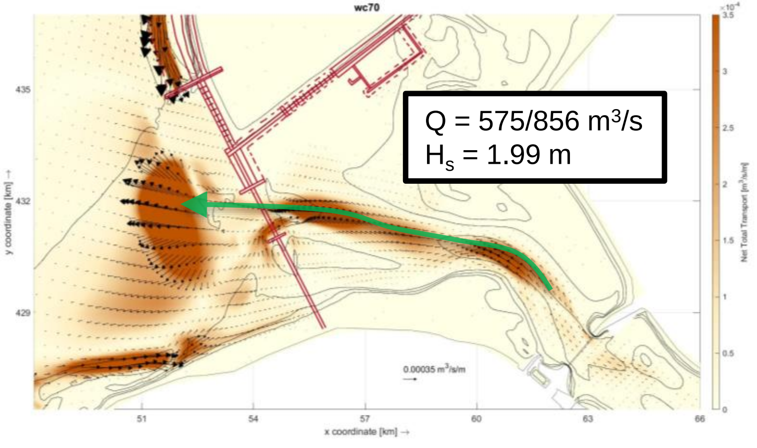
S1 – Contours

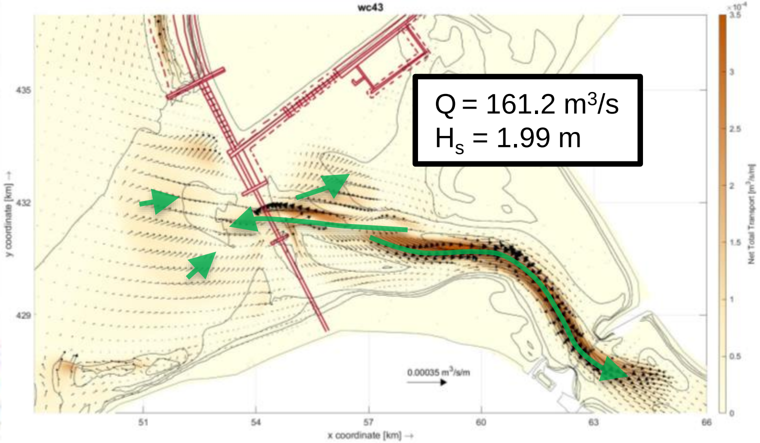


435
432
429
y coordinate [km] →
51
54
57
60
63
66
x coordinate [km] →
Sandbank Location
Contour -0.8 m

S1 – Wave conditions







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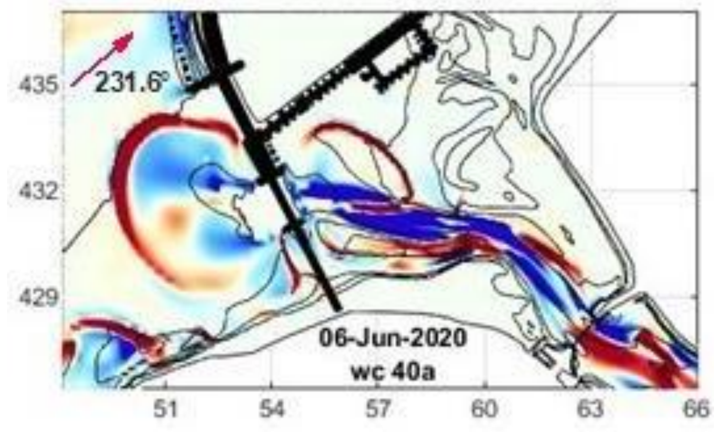
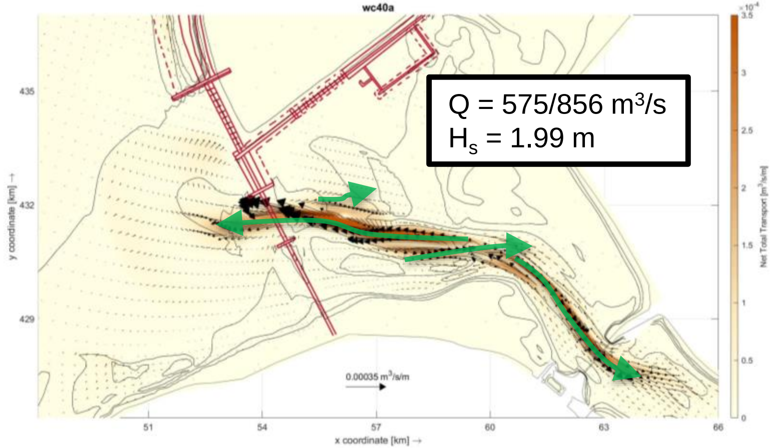
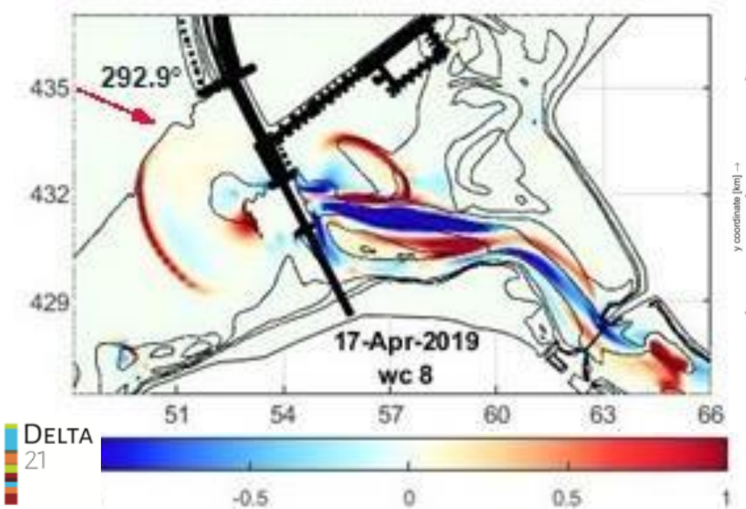
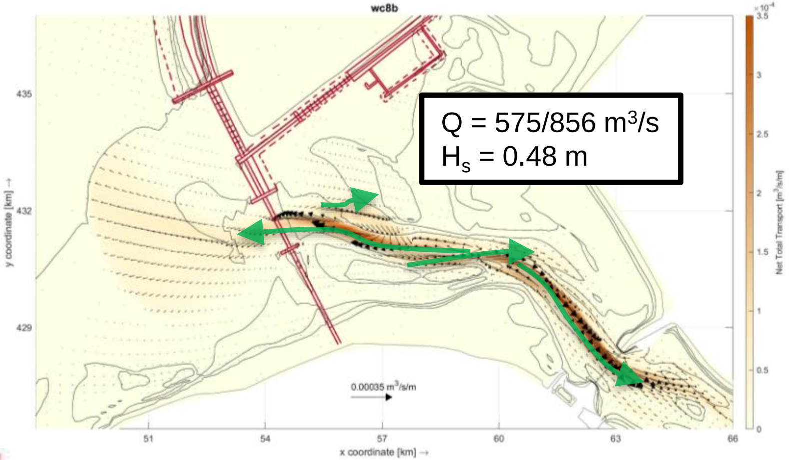
S1 – Wave conditions









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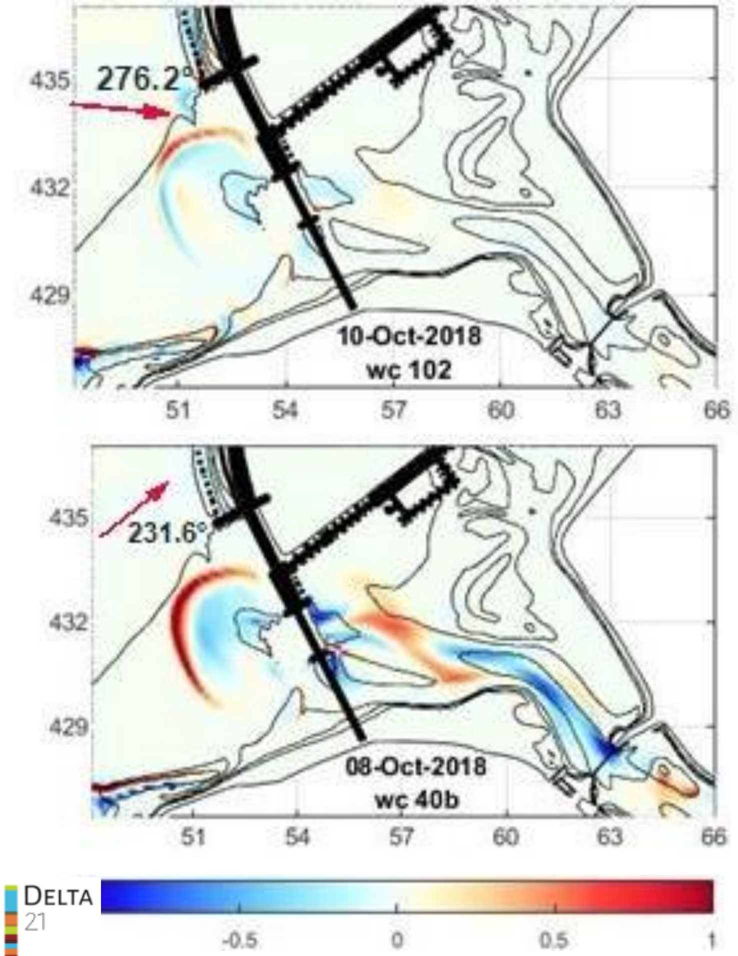
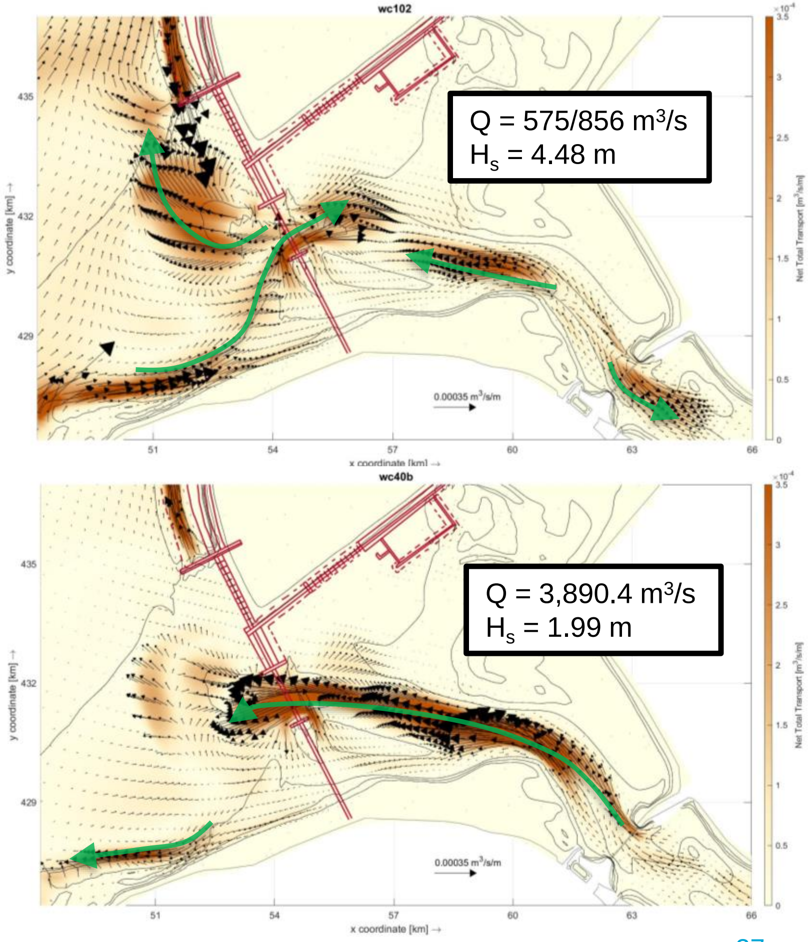
S1 – Wave conditions





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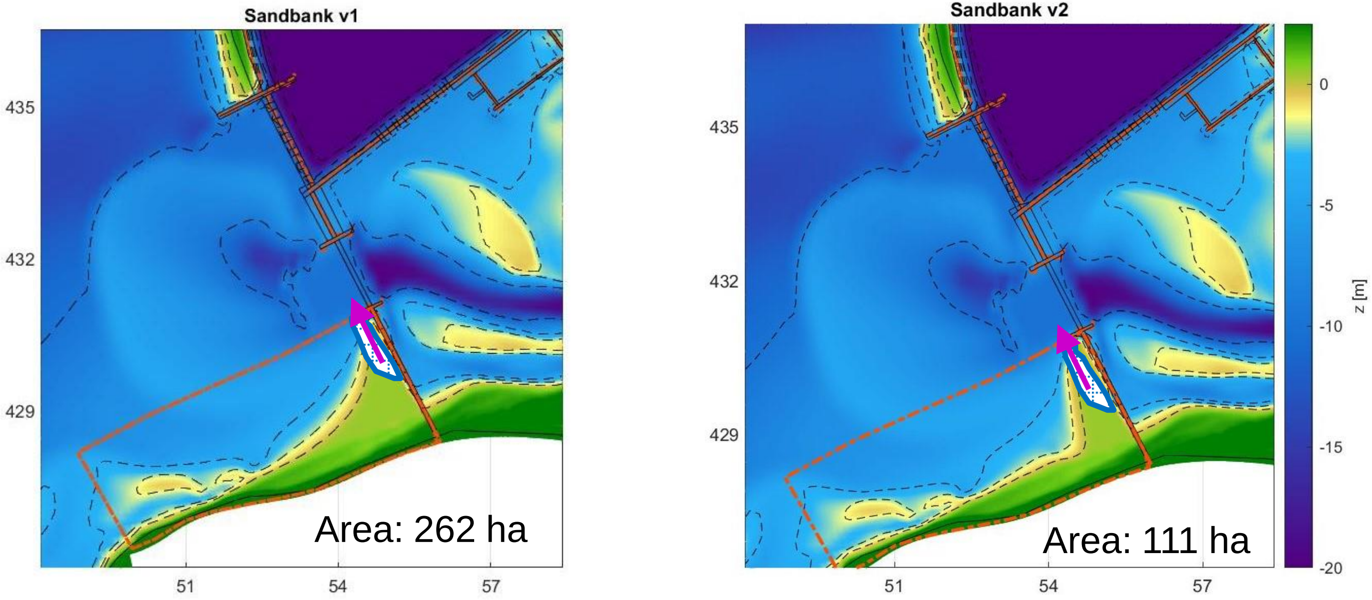
S1 – Sandbanks addition



- Constant MorFac = 5.
- Q = 873.7 m^3/s
- Constant wave/wind condition.
- 24 hour PPS signal.
- Morphostatic simulation → 8 morphological tides.

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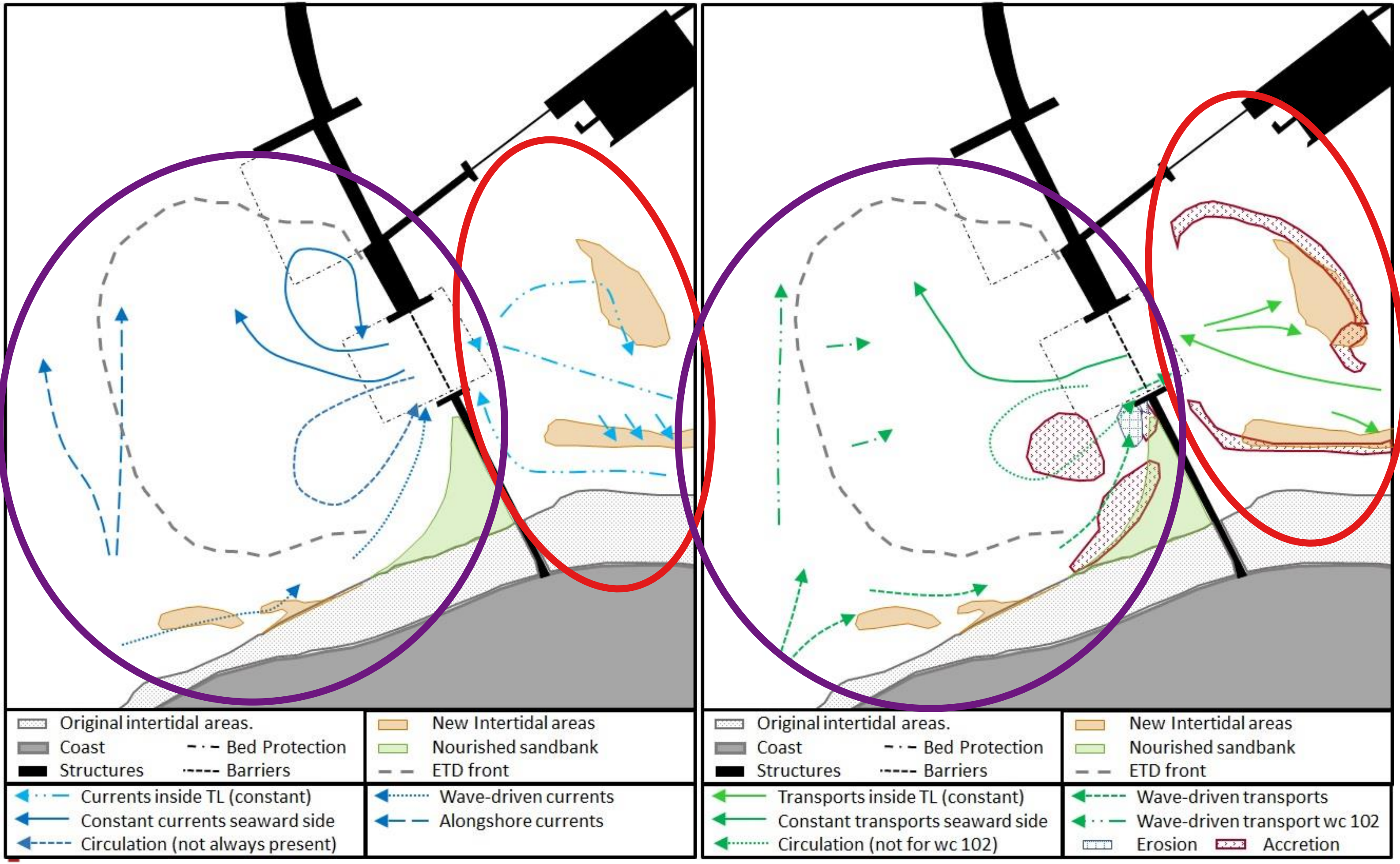
S1 Results – General behavior



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Conclusions

- MV2 has not change the existing trends in the Haringvliet.
  - Tidal cycle is still distorted as after the damming.
  - Erosion in the delta front, siltation in the back sheltered area.

RQ. #1 and #2

- Emergence an ETD, FTD and shoals inside the TL as product material redistribution in the TL.
  - Bypassing mechanisms under most energetic wave conditions. Can benefit ESL dunes
- TL shows a net export of sediment:
  - At Haringvliet Dam product of Tidal Asymmetry
  - At TL inlet due to the difference in concentrations in the water column in the different stages of the cycle.

RQ. #3 and #4

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Conclusions

- The growth of intertidal and subtidal areas inside the TL, compensate for the dredging due to D21 implementation.
  - FTD compromises D21 operation → Compensation.

RQ. #5

- A new sandbank in the seaward side is more stable when is geometry is smoother with the original coastline.
  - Growth is promoted at a very slow rate.
  - Inside the TL trends are independent of the studied wave condition.

RQ. #6 and #7

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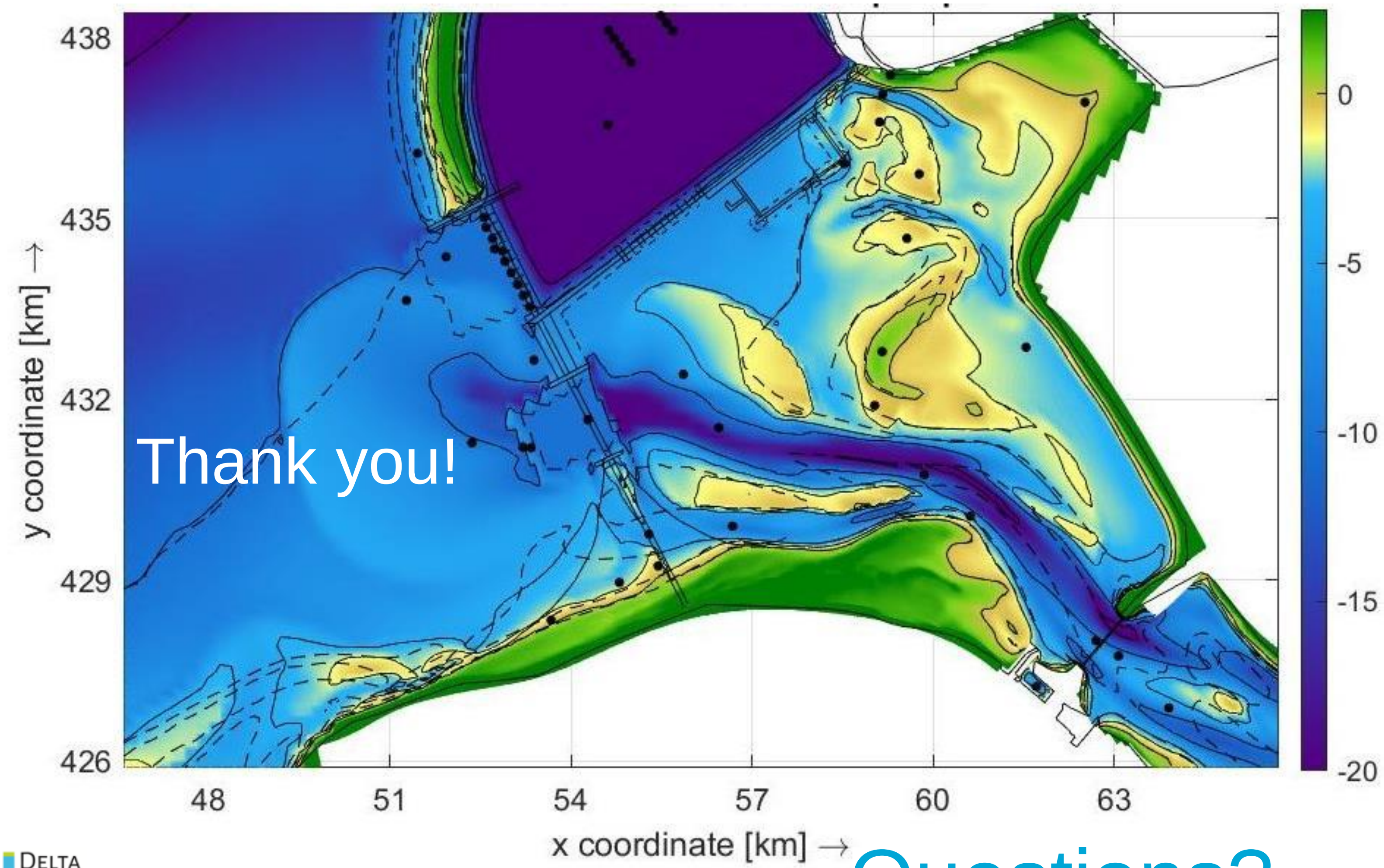
Recommendations

- D21 morphology studies
  - Longer time span of morphological evolution e.g. an idealized model + SLR.
  - Bypassing mechanisms for benefit of downdrift ESL dunes.
  - Sandbank area optimization.
  - Sandbank stability under a broader set of boundary conditions.
  - Bollen van de Ooster stability.

Recommendations

- Haringvliet studies
  - Evolution of system considering just the reopening of the sluices.
  - Morphological studies should include finer sediment fractions and transport of cohesive material at this site.
  - Dominance of waves vs tides in the presence of MV2.
  - Bollen van de Ooster stability

- Tidal environments + Interventions
  - In tidal environments the transport of different sediment fractions becomes important (Dam et al. 2006, Herrling et al. 2018).
  - The interaction of nature-driven forces and anthropogenic influence in sensitive systems as Tidal basins become a key basis for the study of long-term morphological impacts due to interventions and should be taken into account.



Recommendations?

Questions?

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