



Ridge-runnel patterns as early indicators of tidal ecosystem shifts in estuaries

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Royal Netherlands Institute
for Sea Research



Universiteit
Antwerpen





Yerseke 

Antwerp 

Western
Scheldt

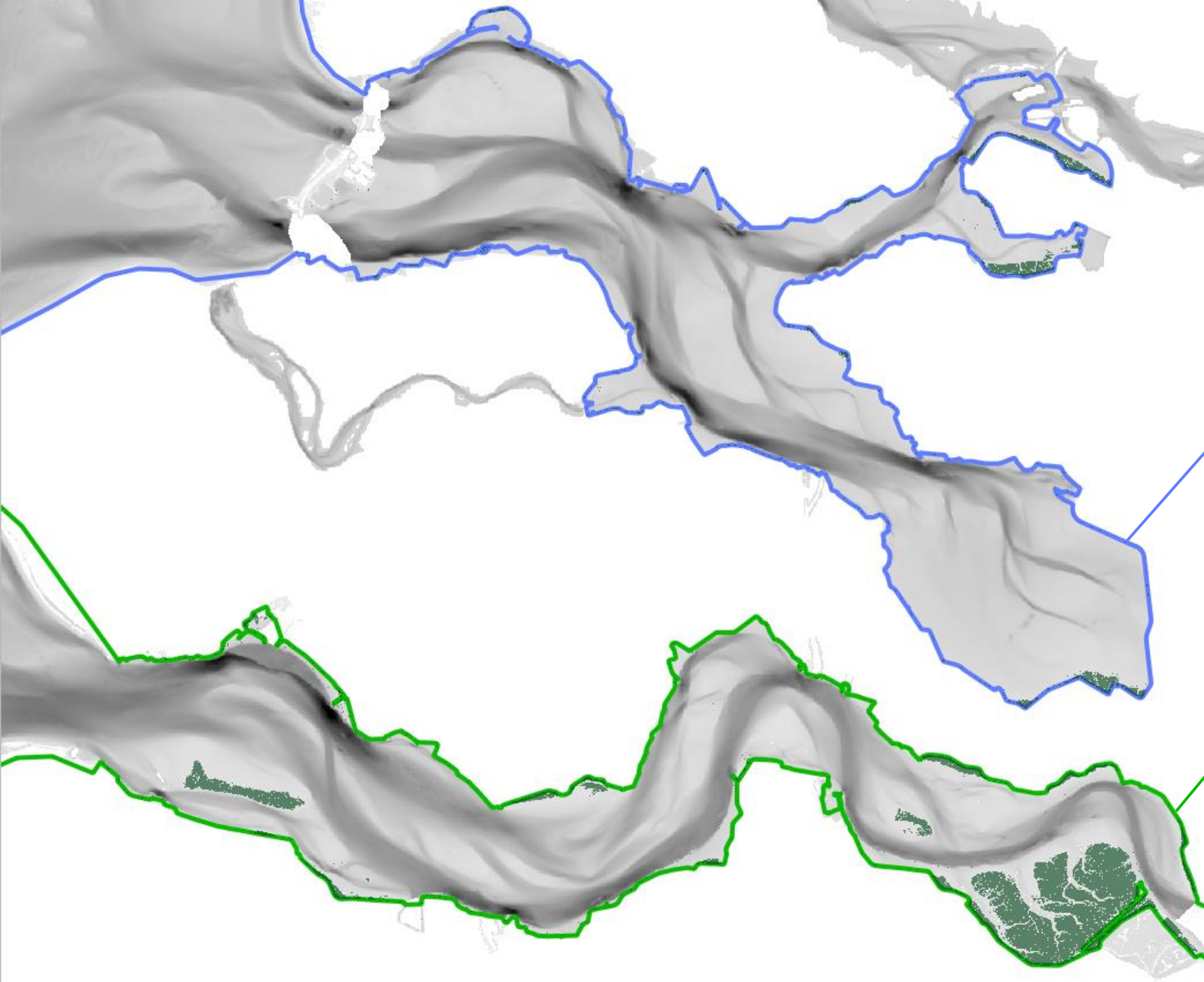
Tidal flats



Marshes



Both provide unique but different habitat & services in the estuary



Tidal **reduction**
in Eastern Scheldt

Tidal **amplification**
in Western Scheldt

How is the changing **tidal amplitude** effecting the **geomorphology** and **ecology** of the Scheldt?

Western Scheldt, 2004



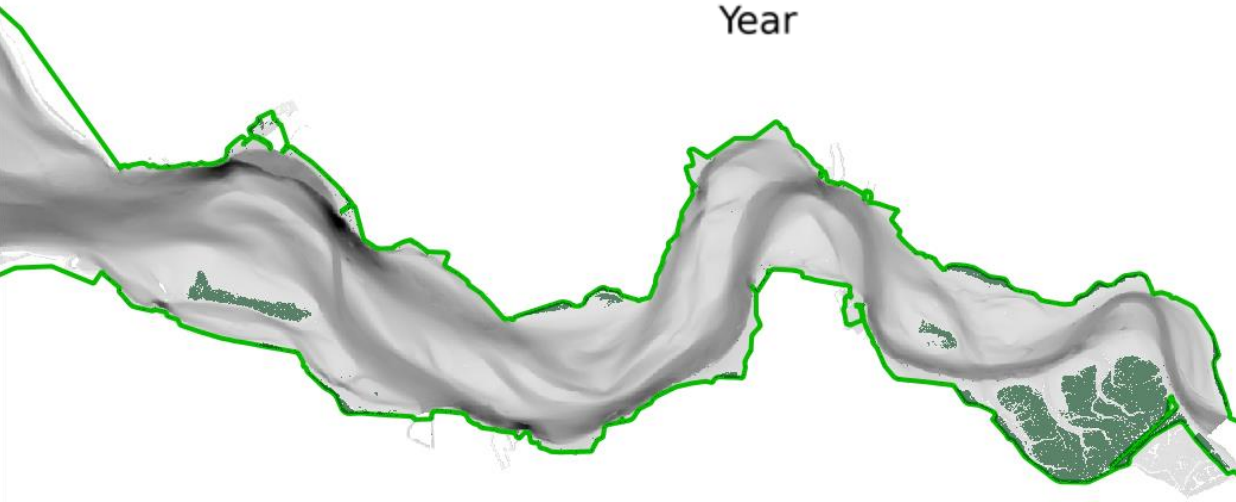
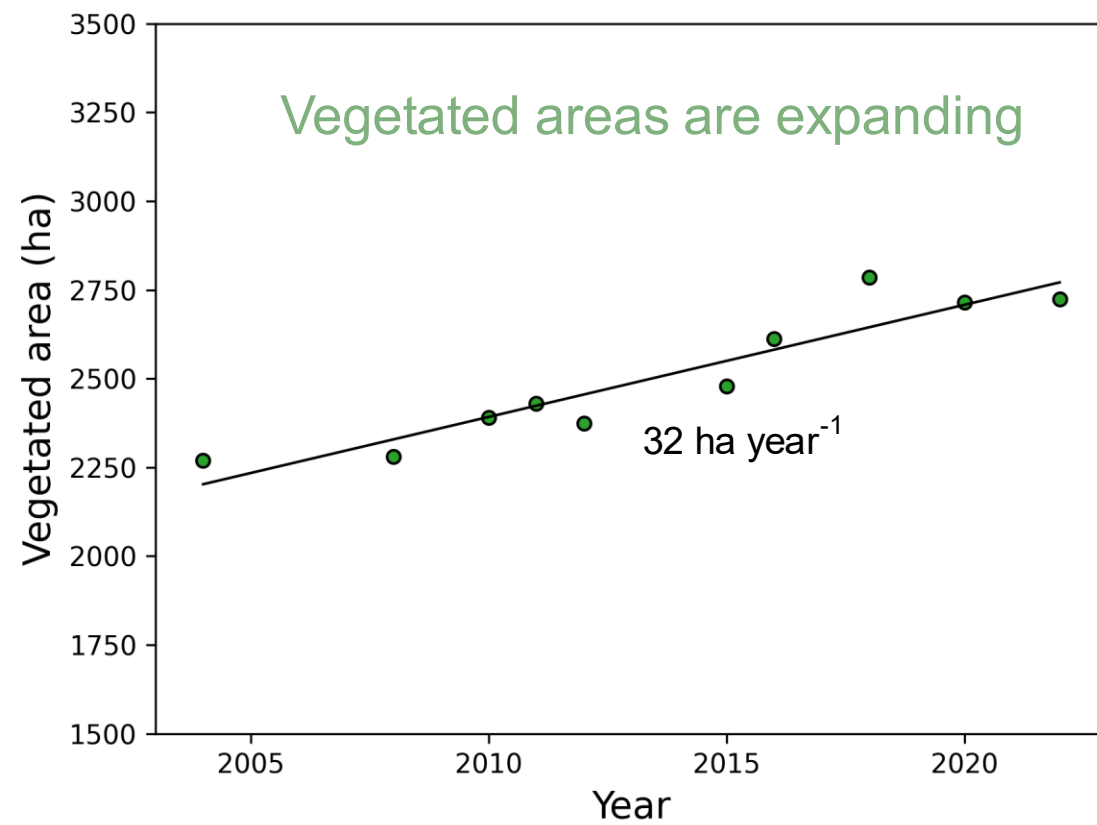
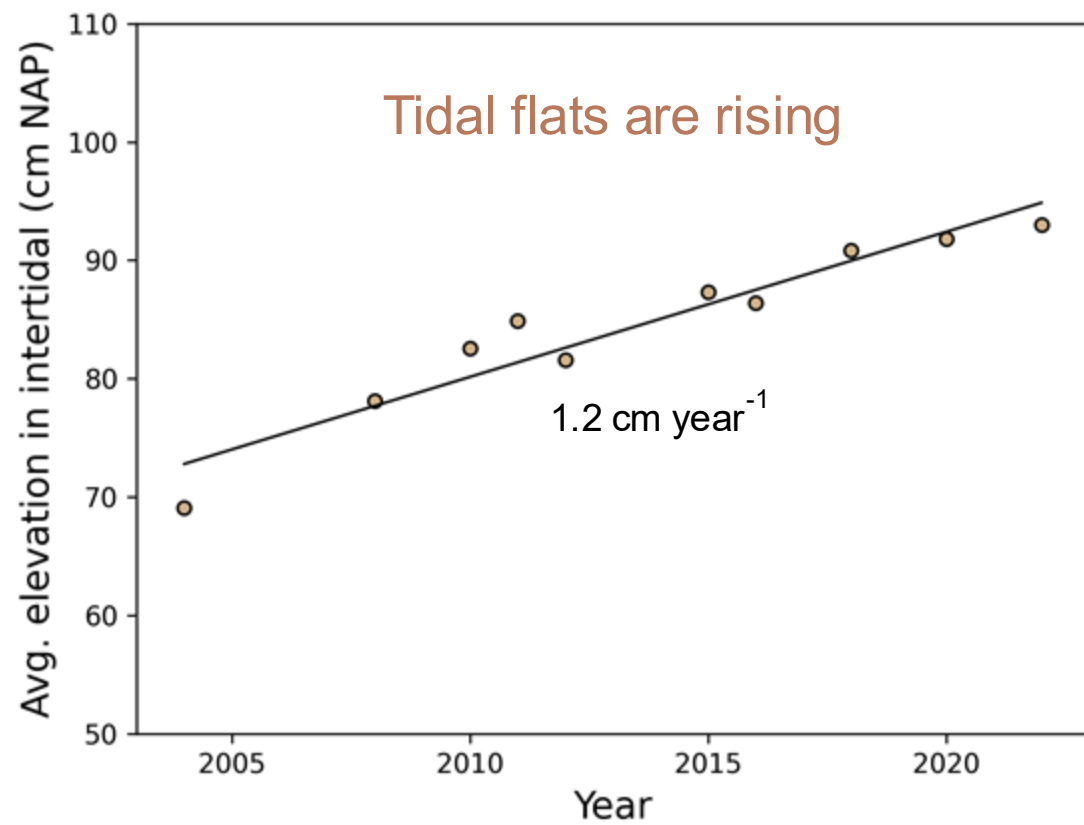
5km

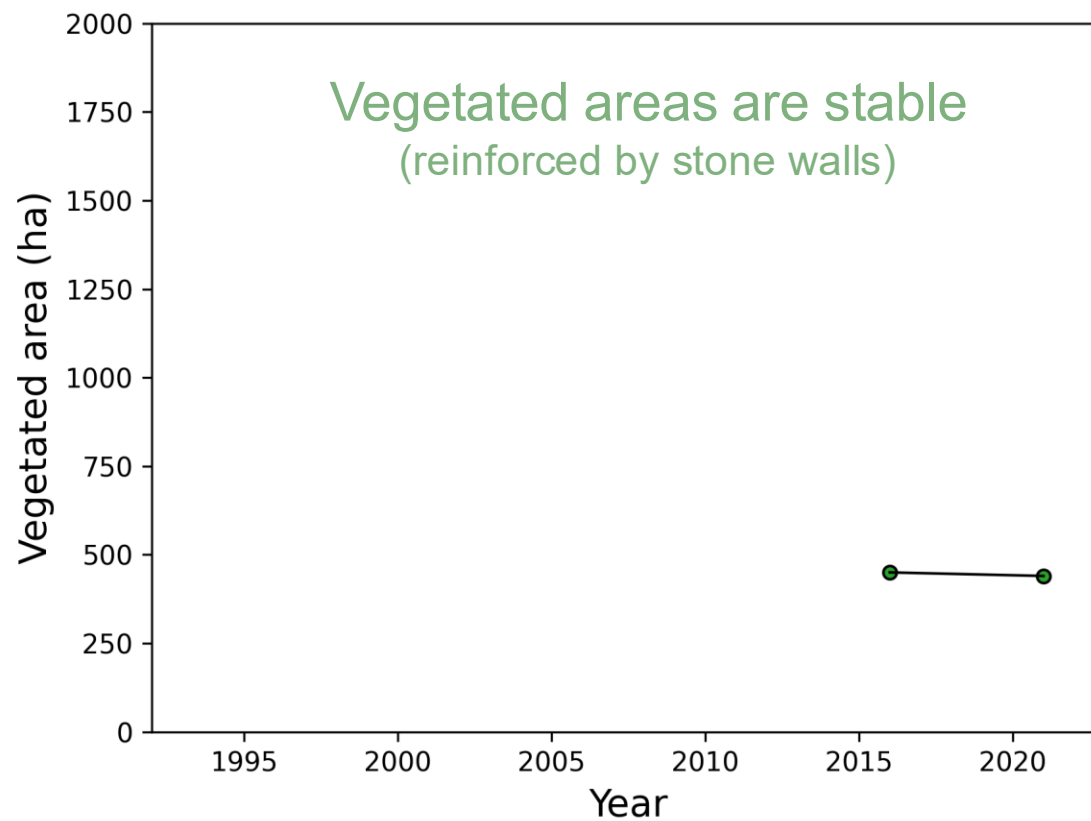
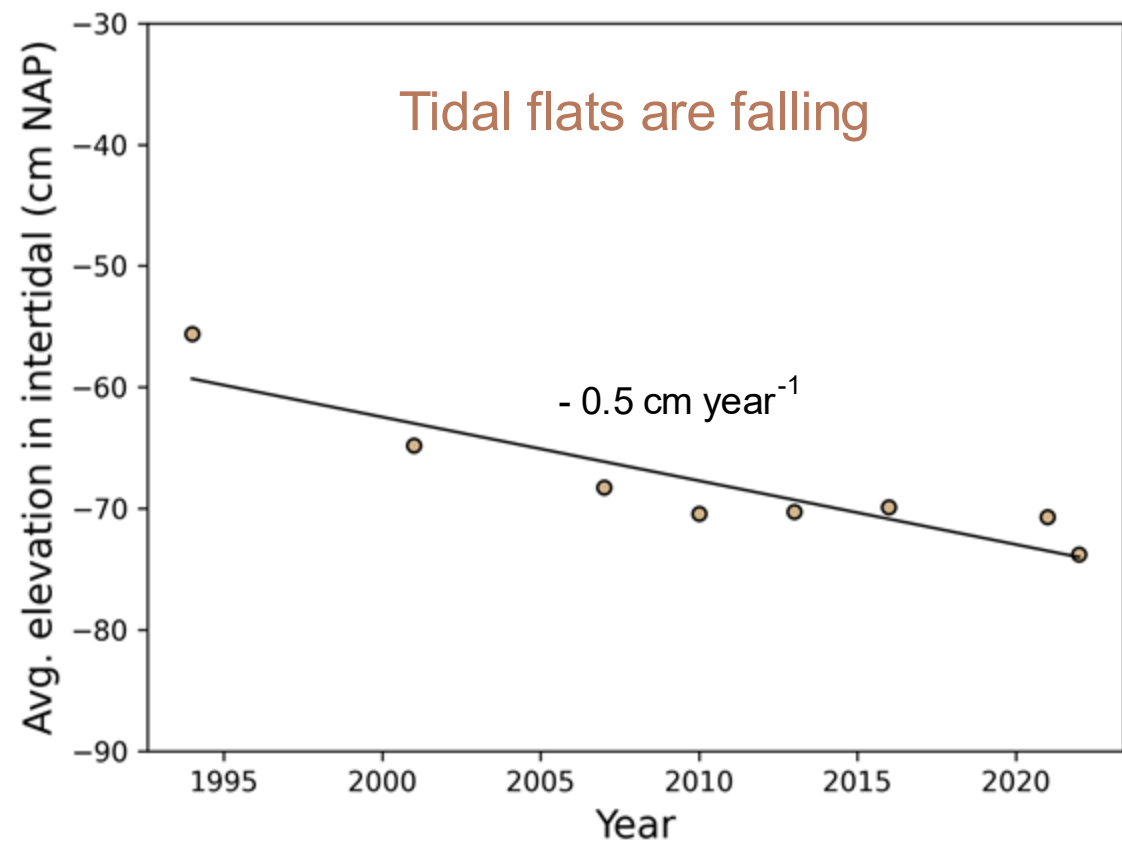
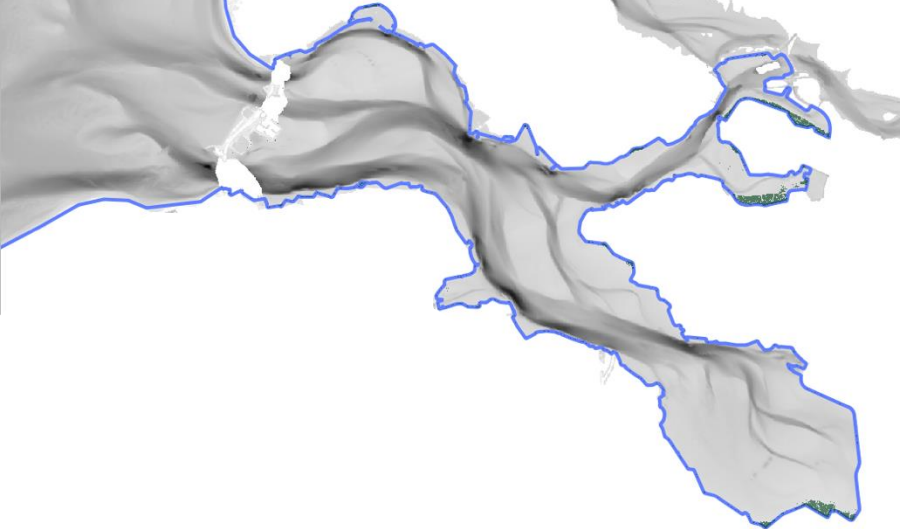
Western Scheldt, 2020



New vegetation development: ~30 ha / yr

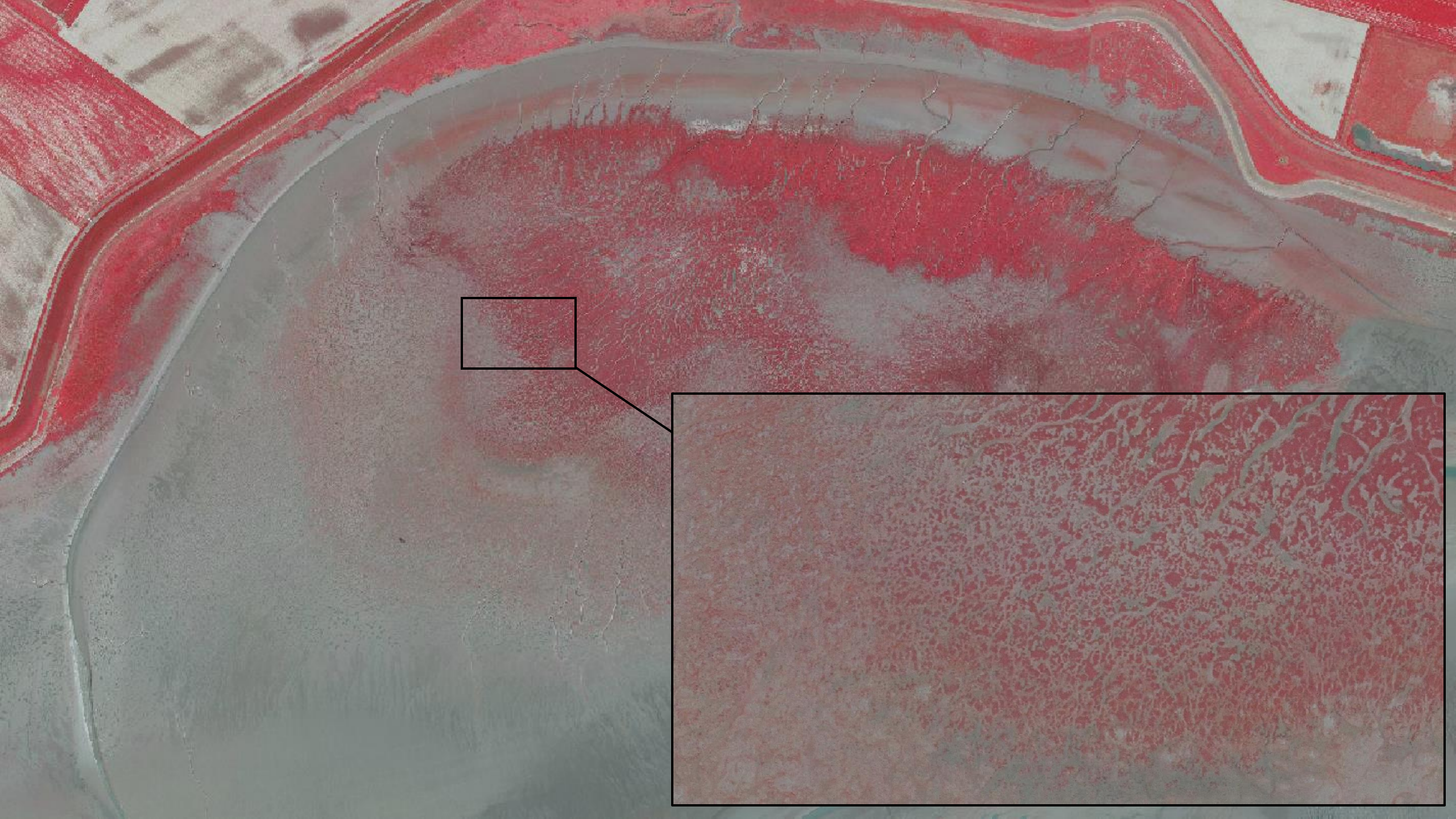
5km

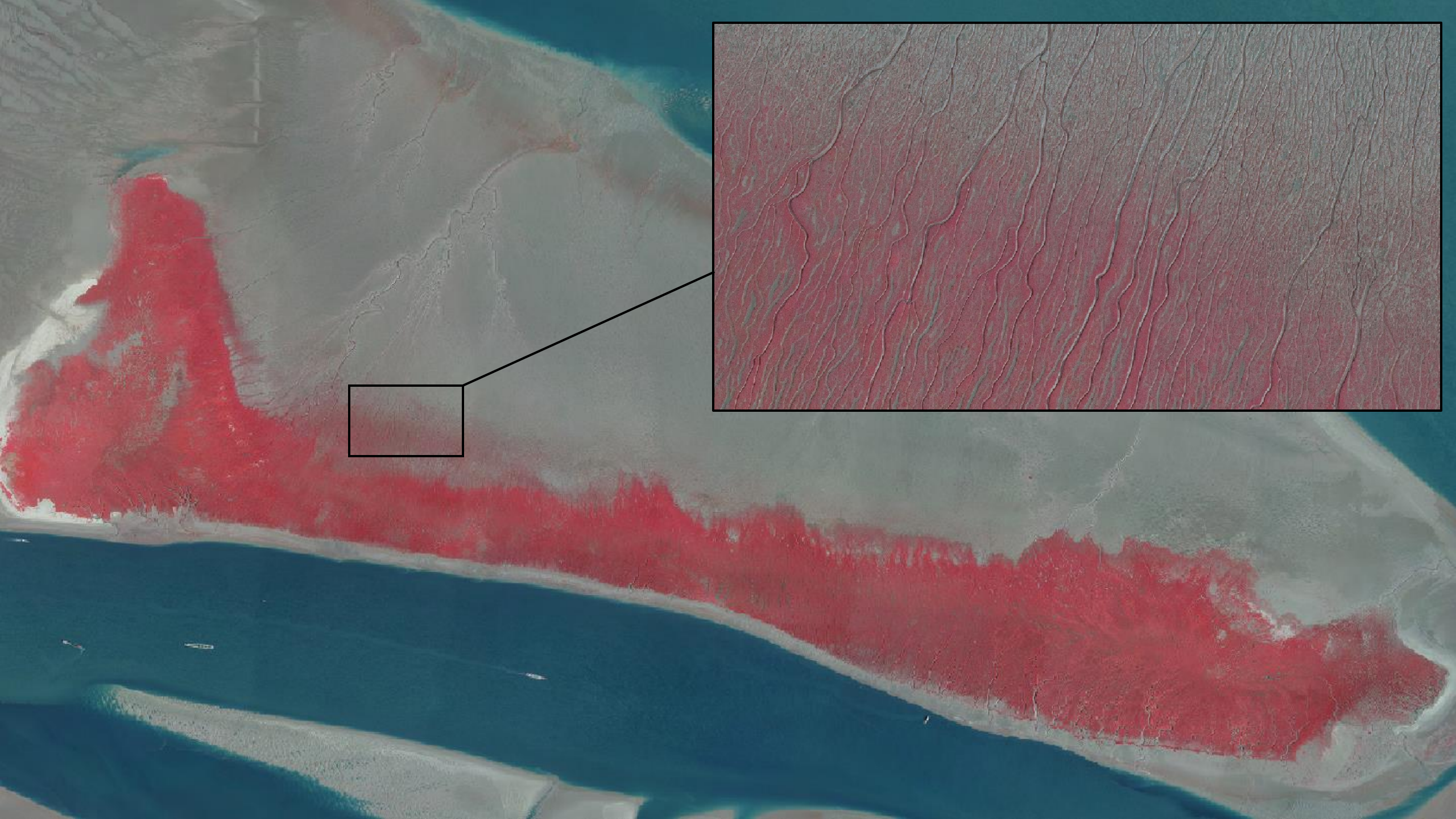


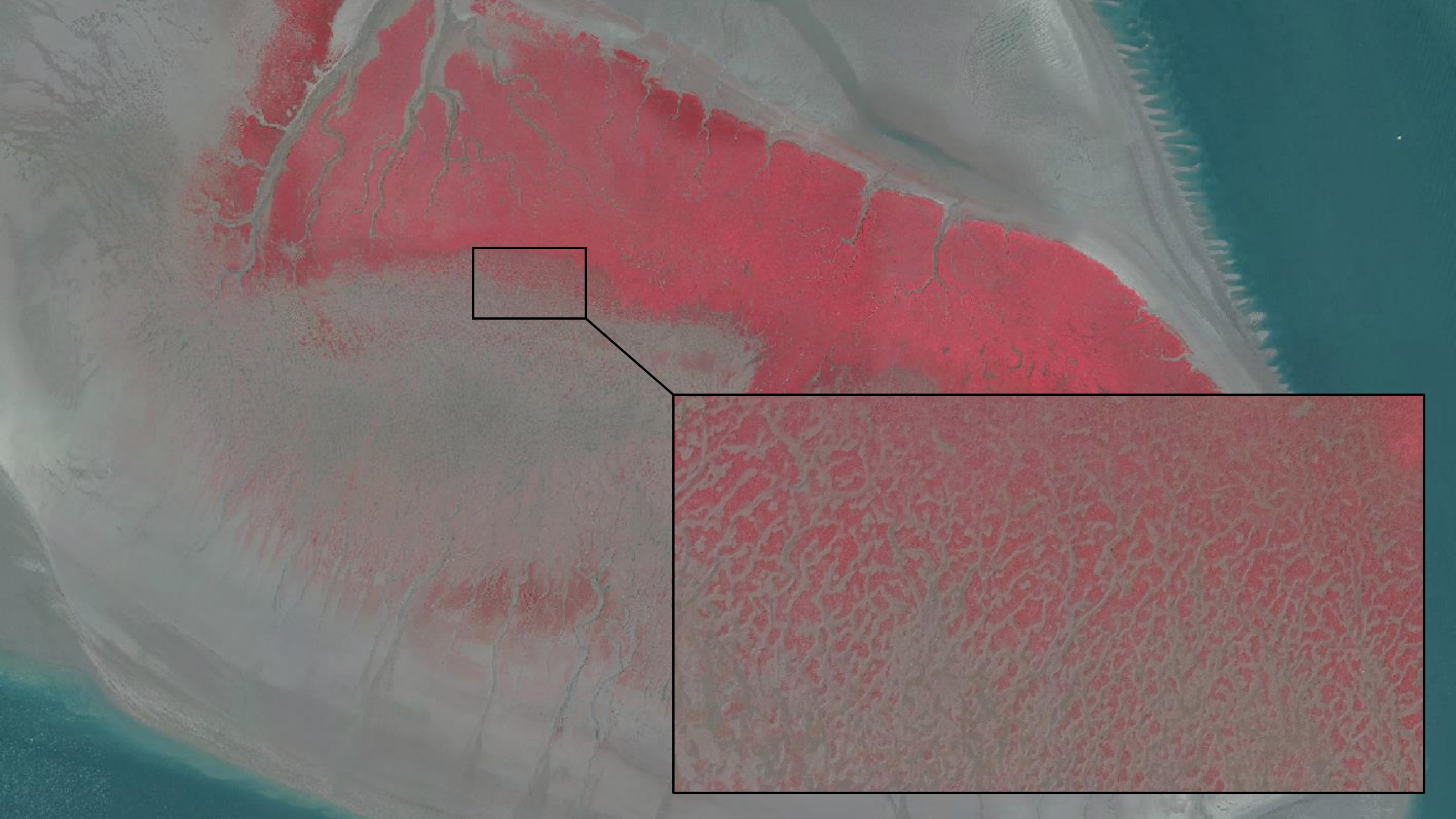


Zuidgors East 2022





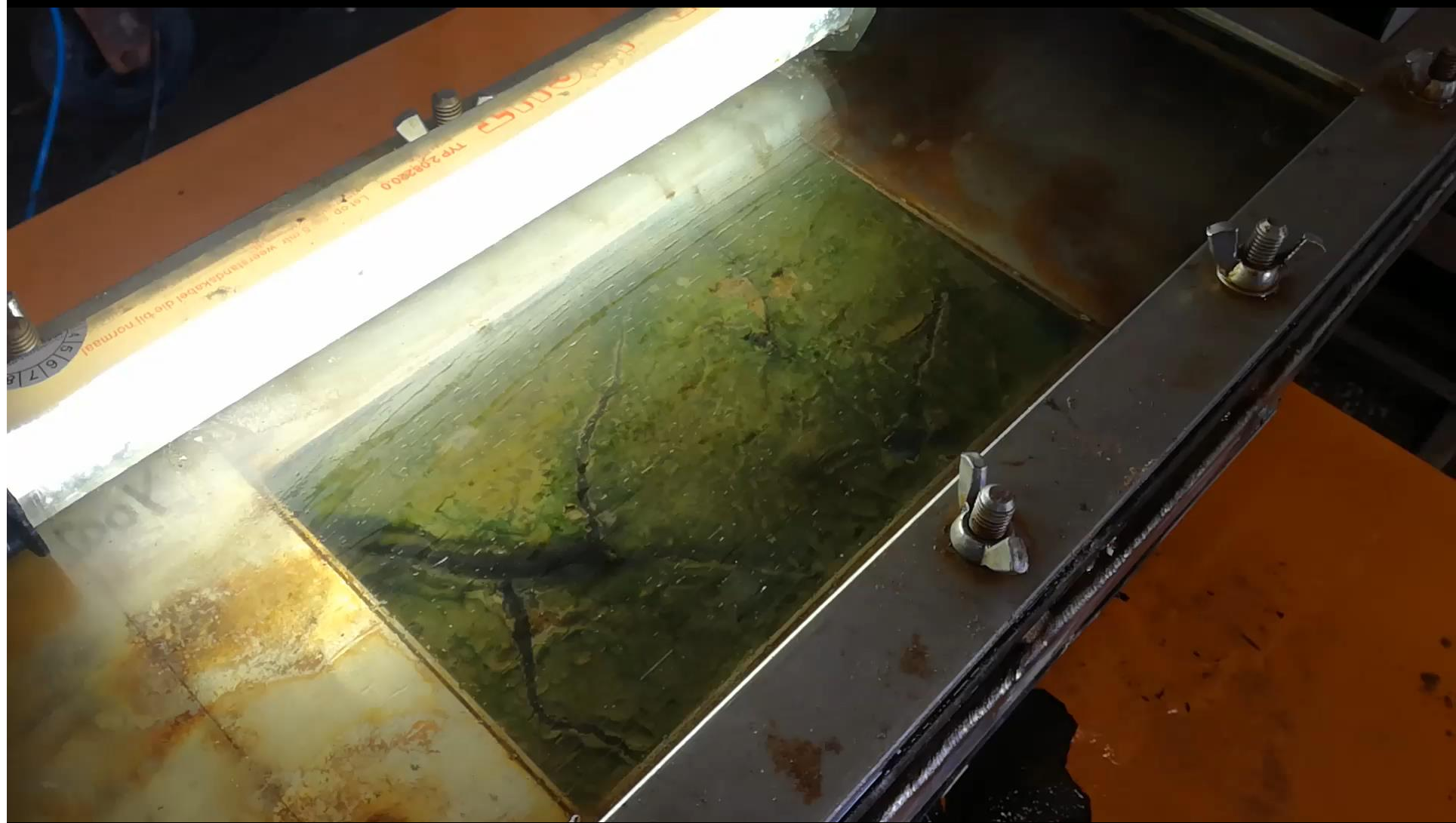


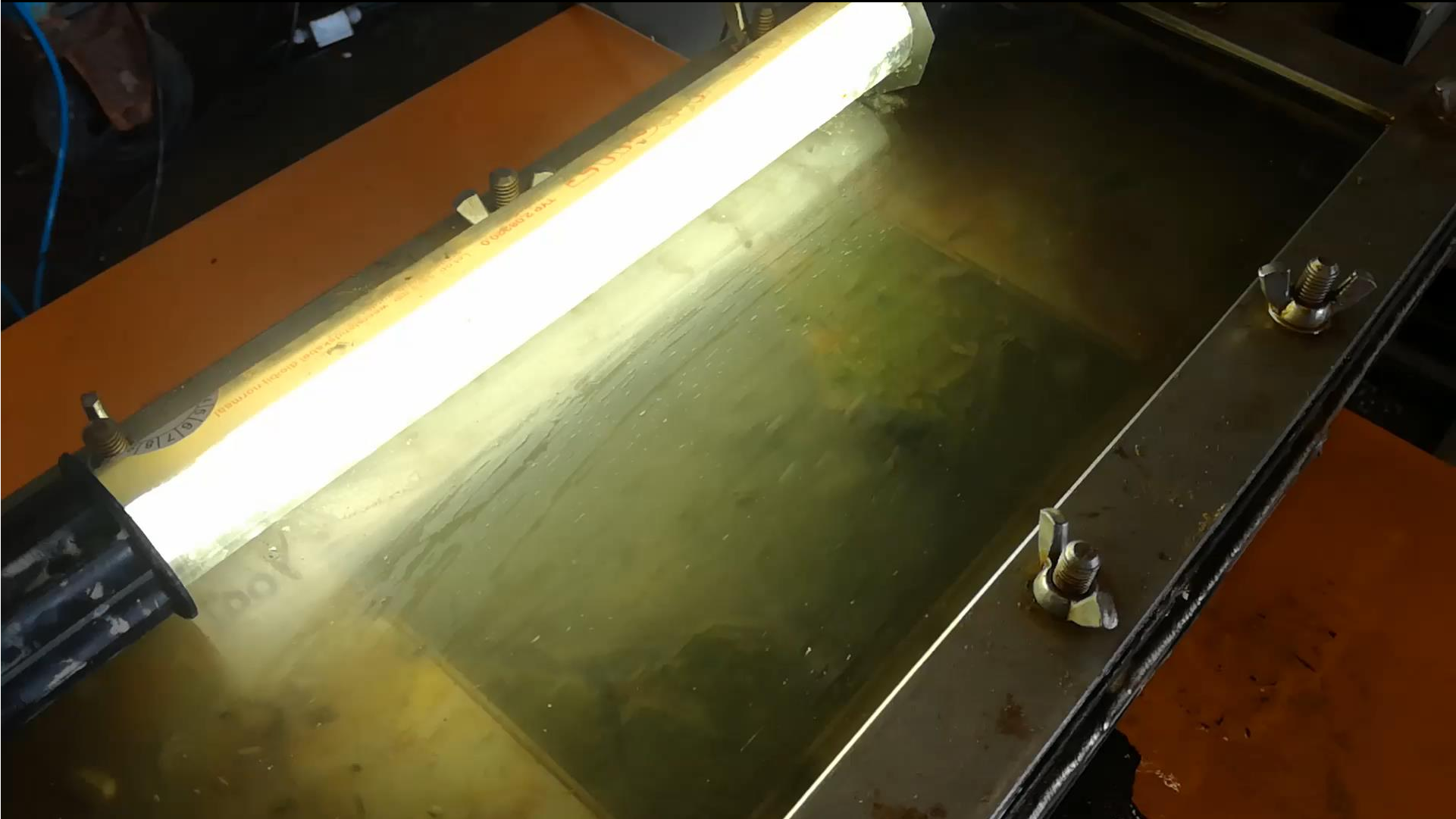


Ridge-runnel patterns:

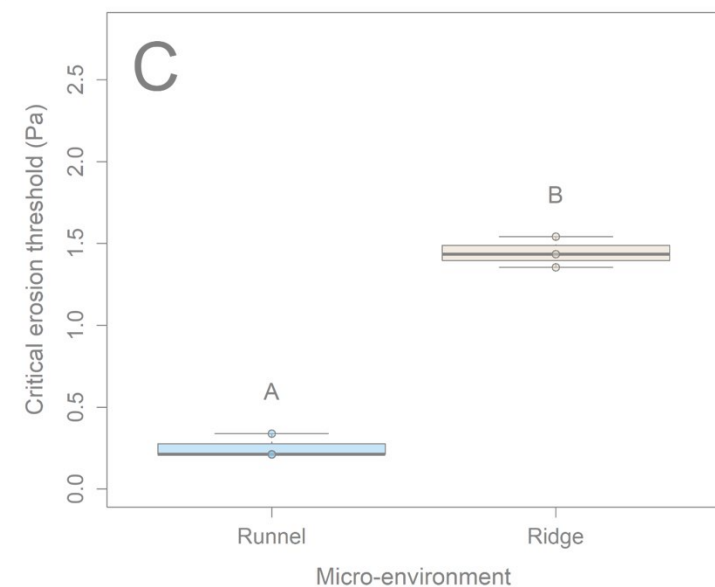
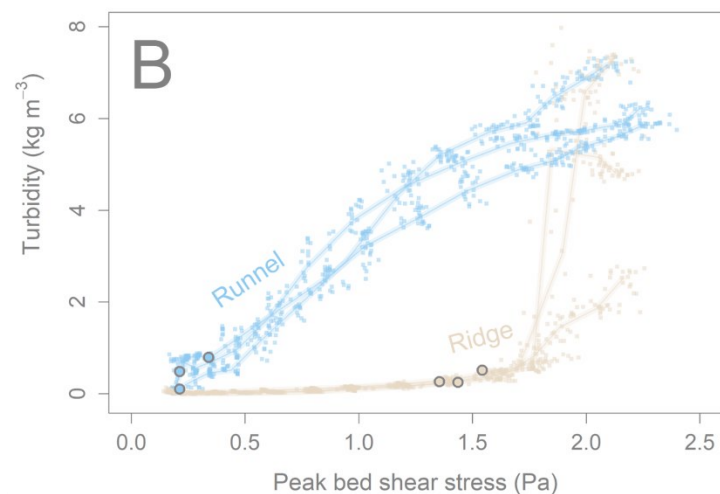
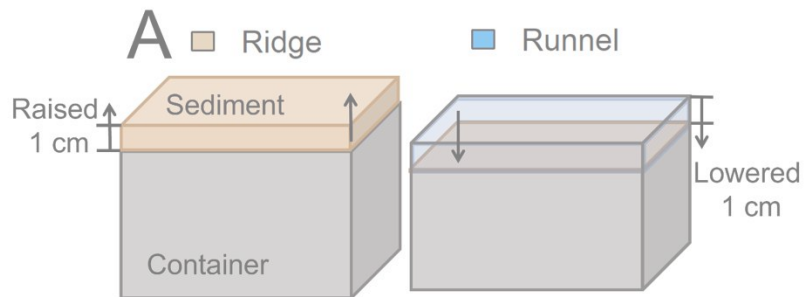
1. How do they form?
2. WHERE do they form?
3. What is their role in vegetation expansion?

1.How do they form?

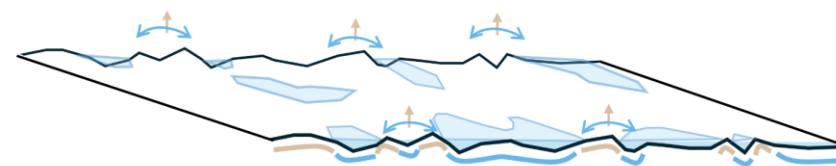




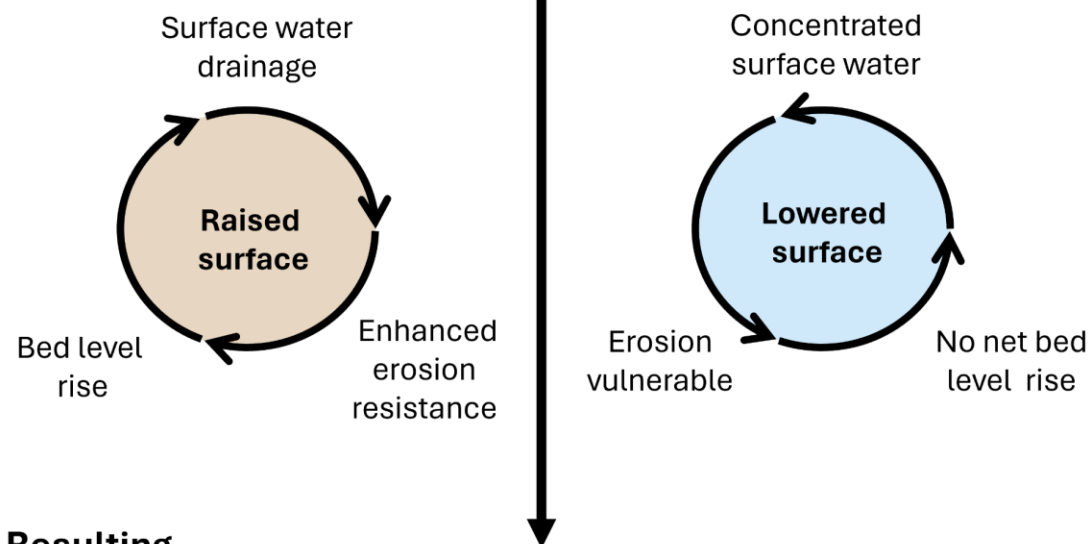




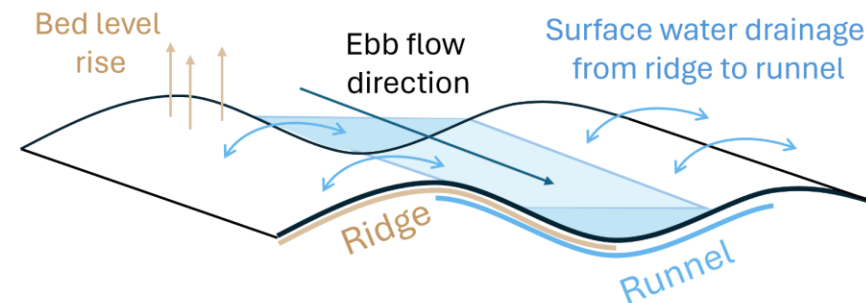
Initial bed



Reinforcing scale-dependent feedbacks



Resulting patterned bed

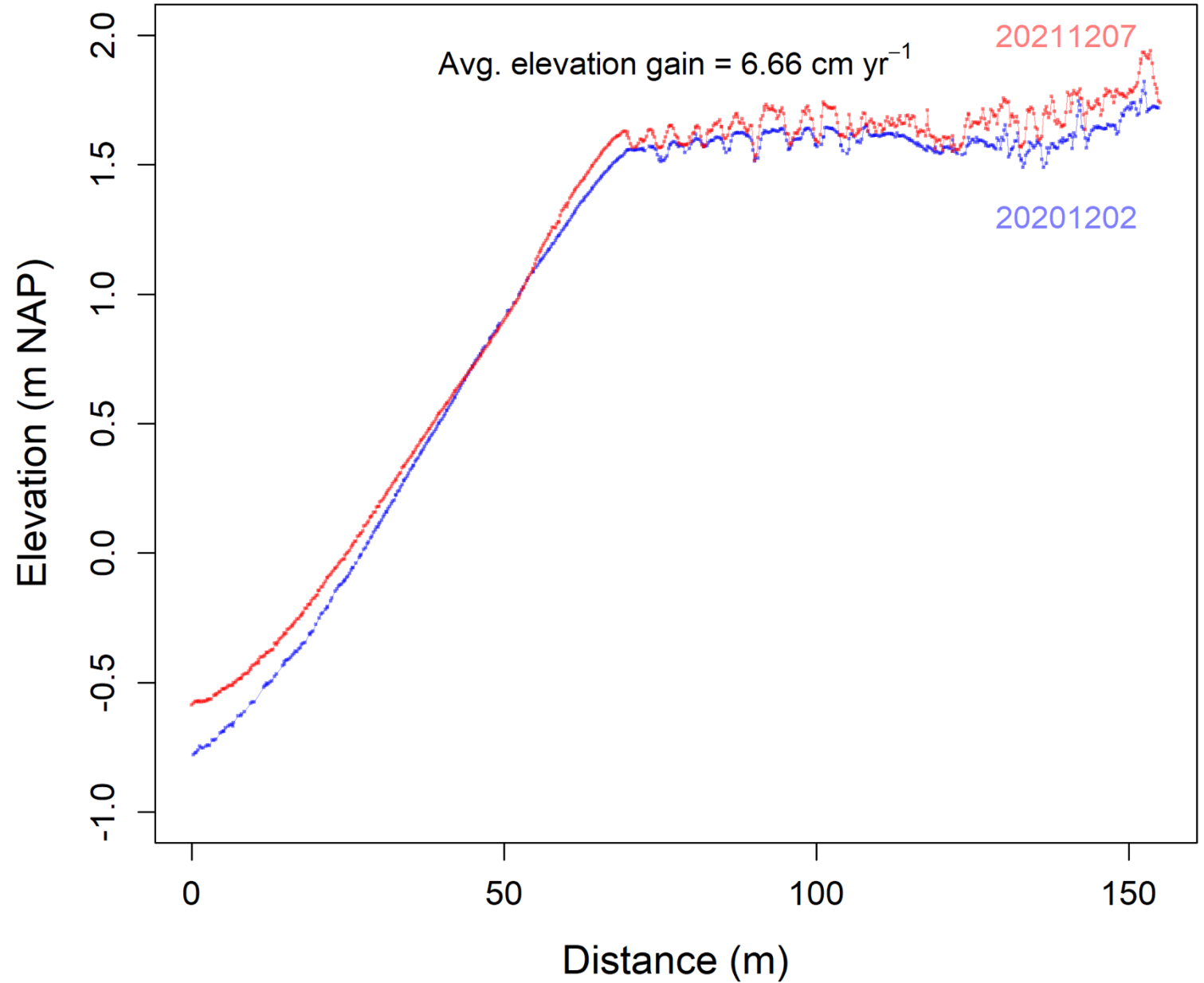
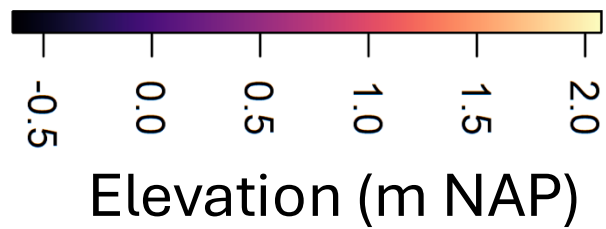
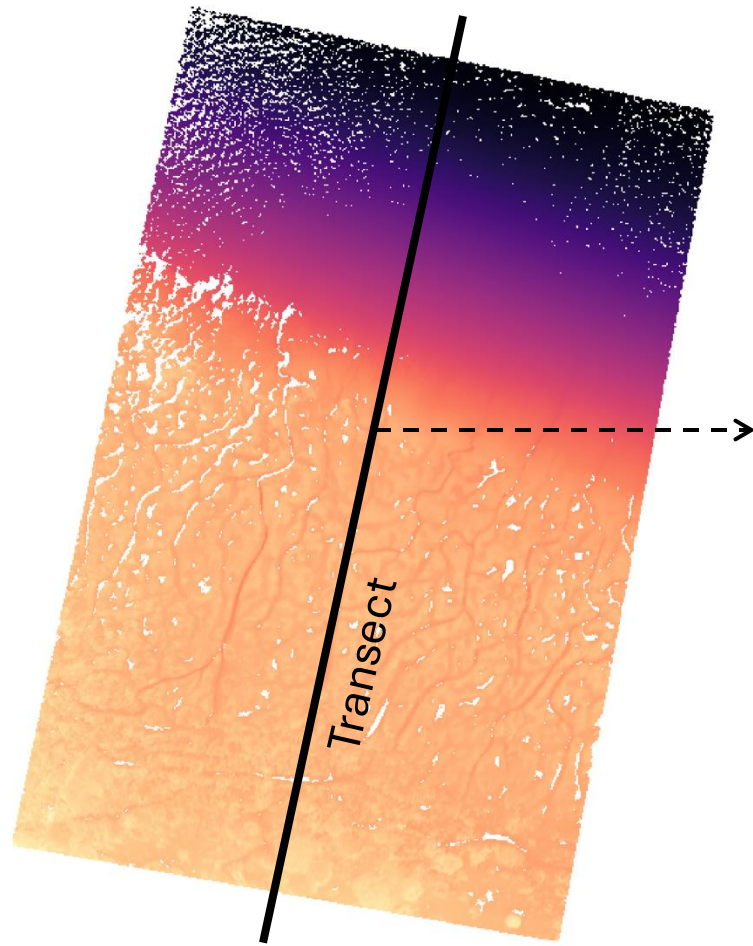


2. WHERE do they form?

Hoofdplaat, Westerschelde

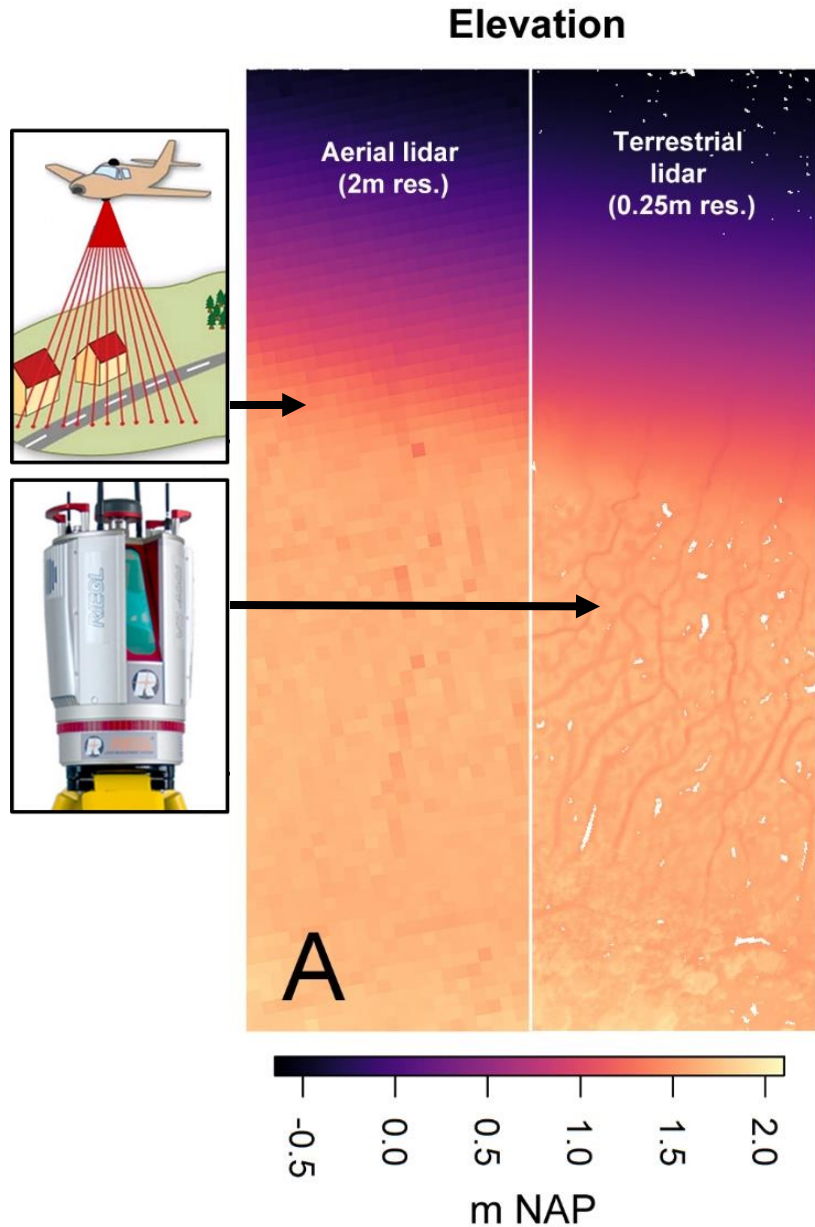


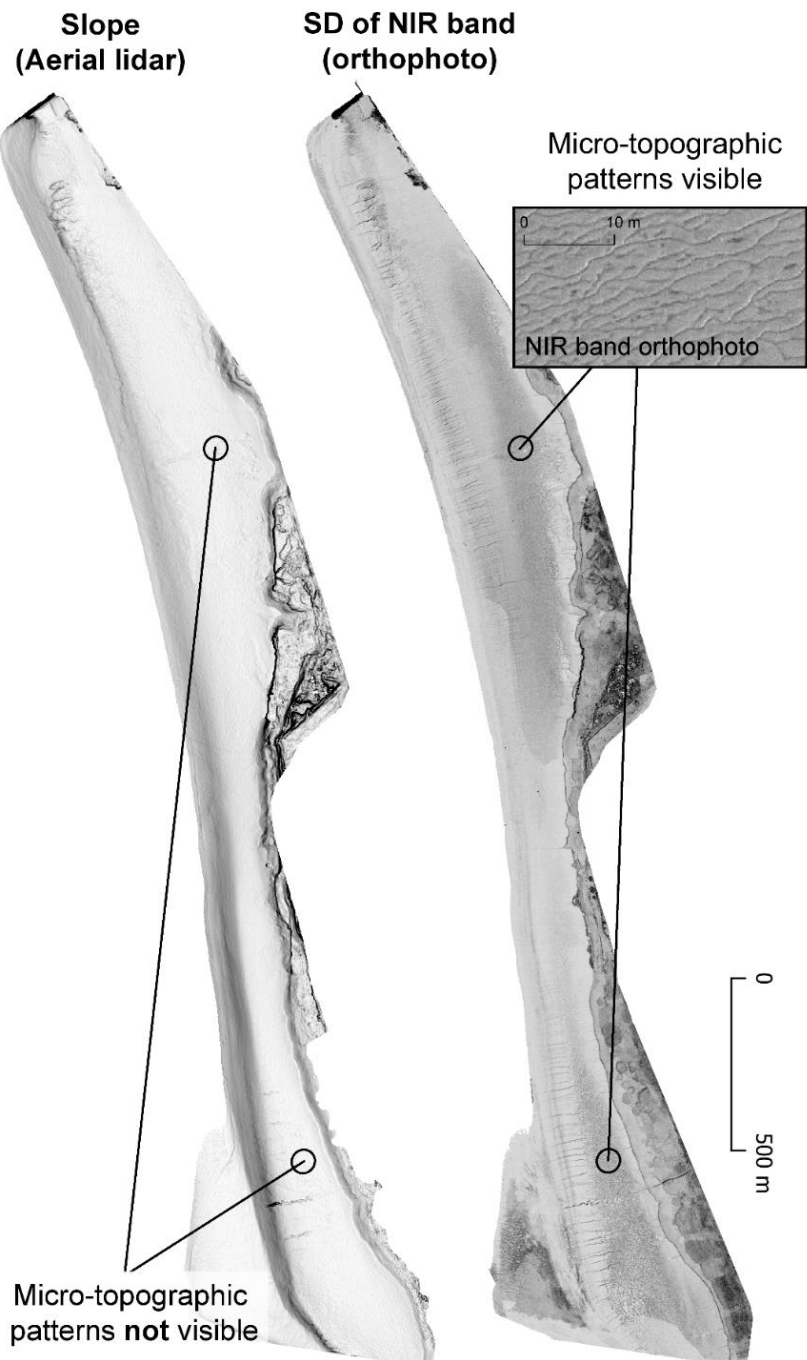
Patterned area found on *high & flat* tidal flats

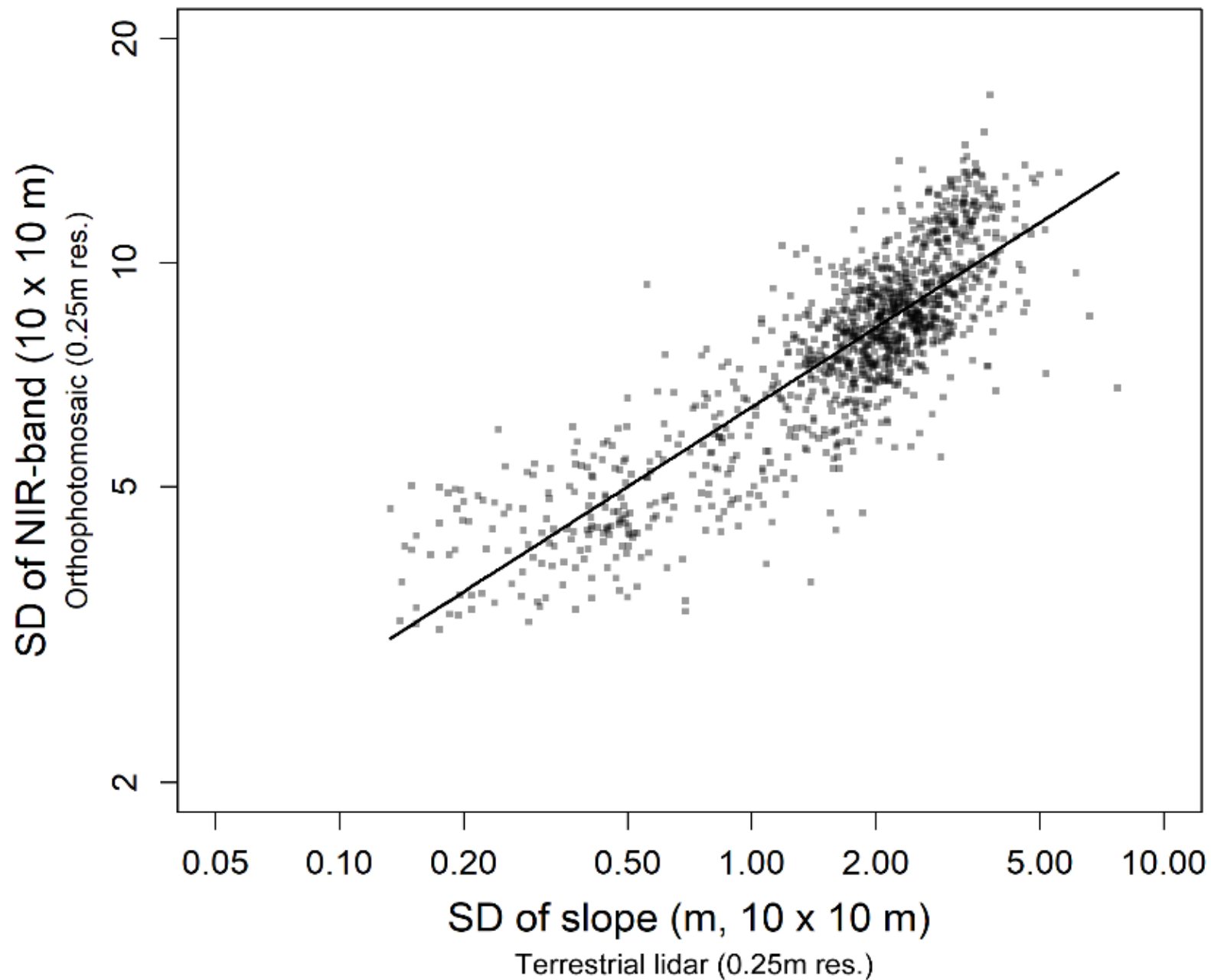
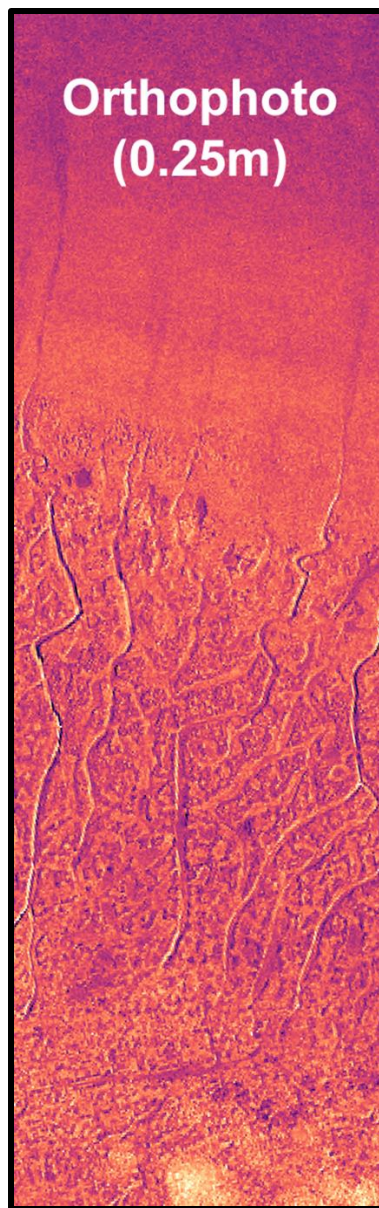
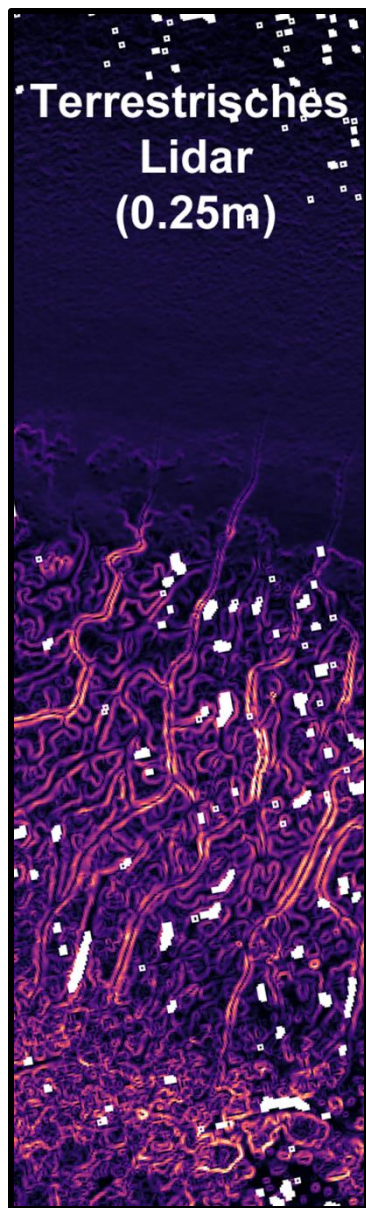


Is this a *GENERAL* pattern?

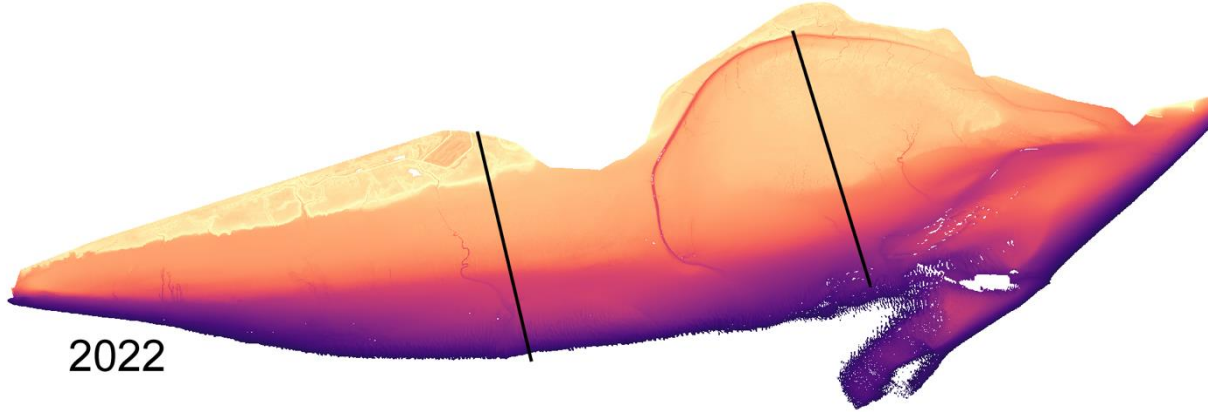
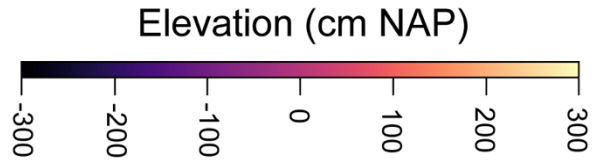
How can we *remotely sense* ridge-runnel patterns?



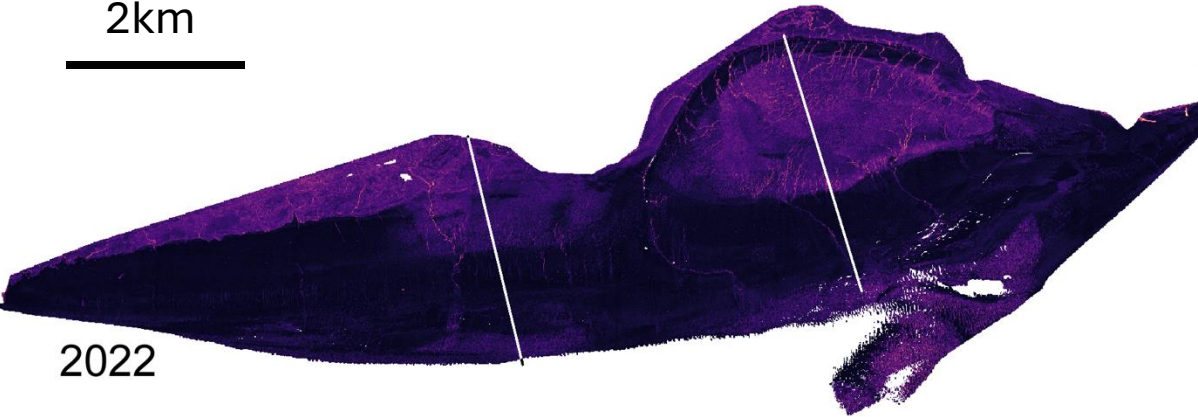




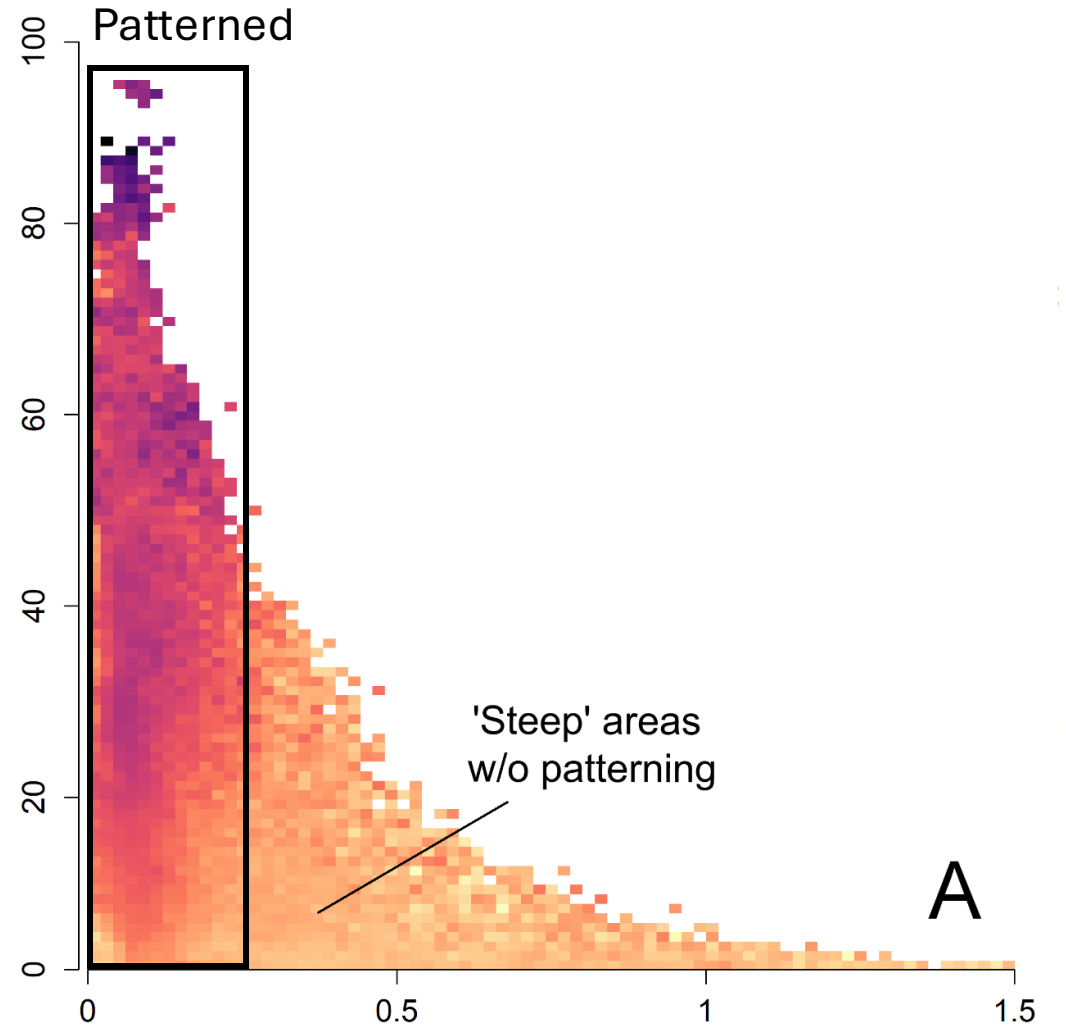
‘Ridge-runnel’ patterns occur on *high & flat* tidal flats



2km



Pattern intensity



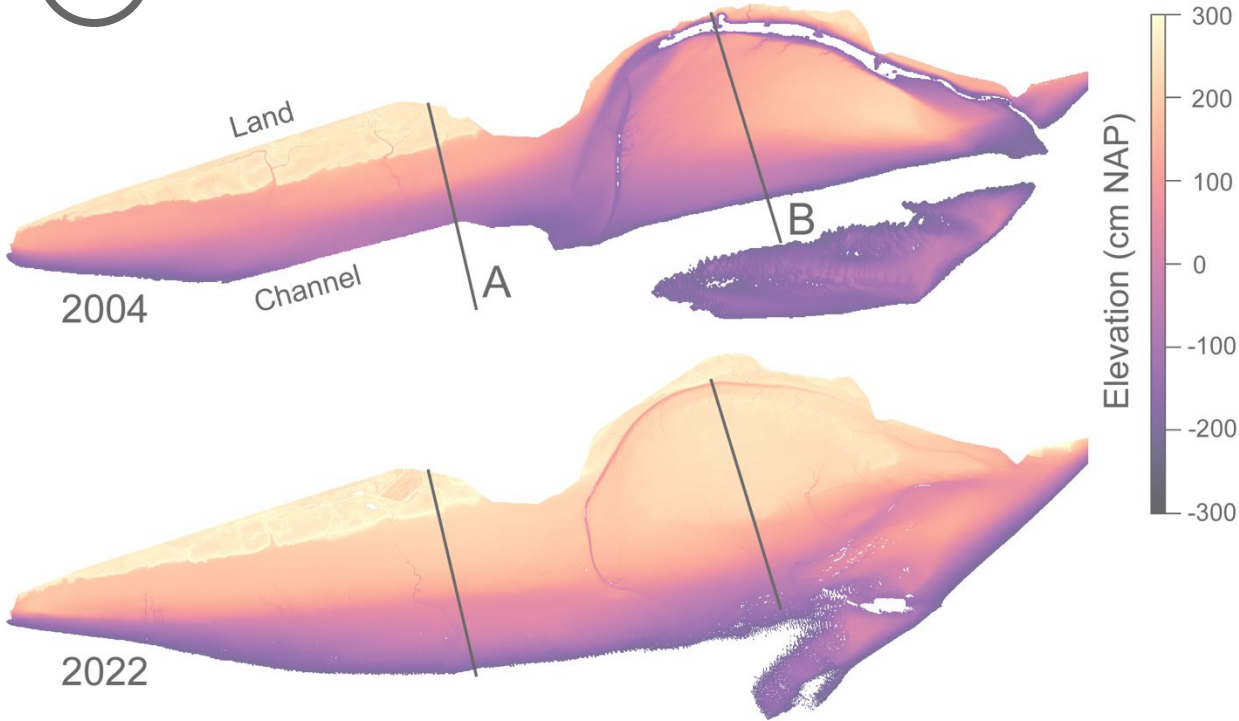
Elevation 1. Requires sufficient drying time

Slope 2. Requires tidal flat slope < 0.3 degrees

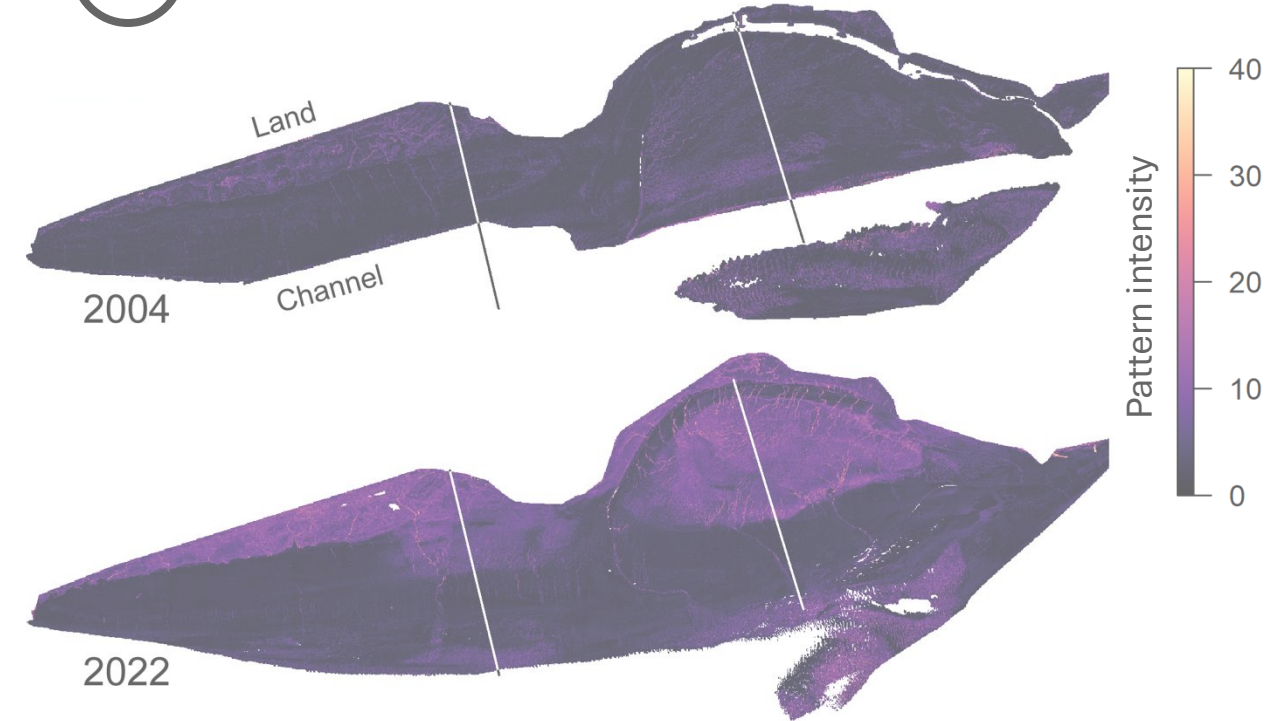
3. What is their role in vegetation expansion?

Hypothesis....

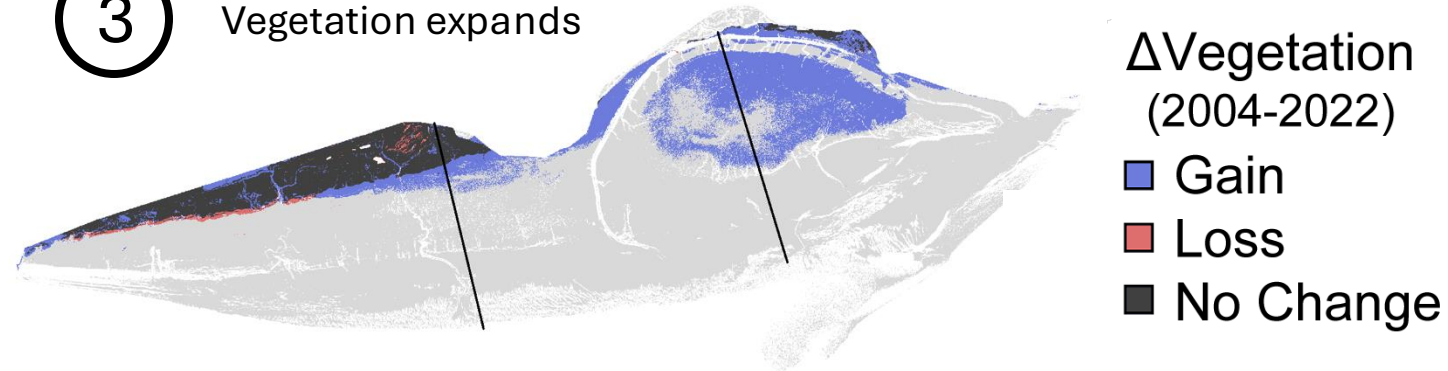
① Mudflat gets **higher** and **flatter**



② 'Ridge-runnel' patterns appear on the tidal flat

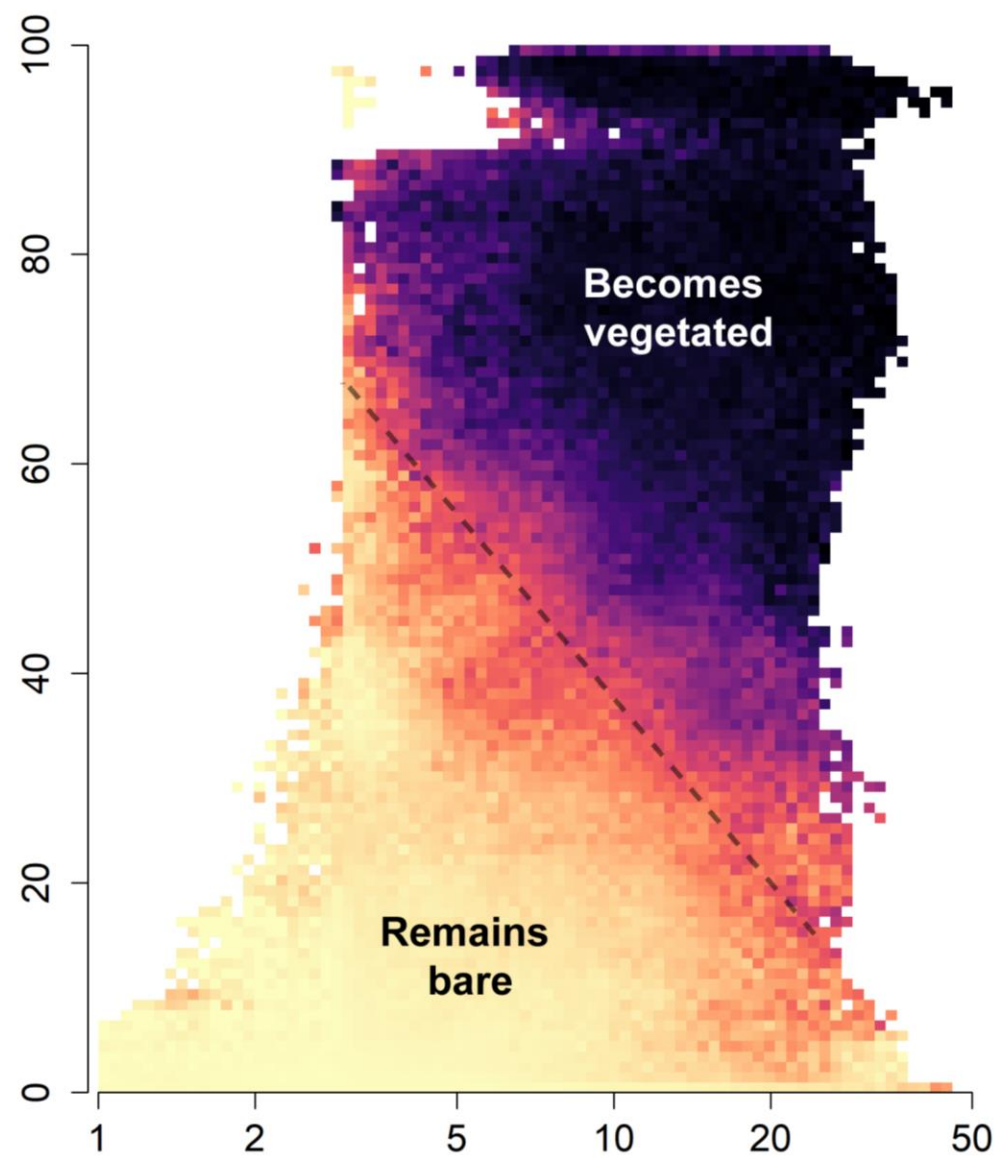


③ Vegetation expands



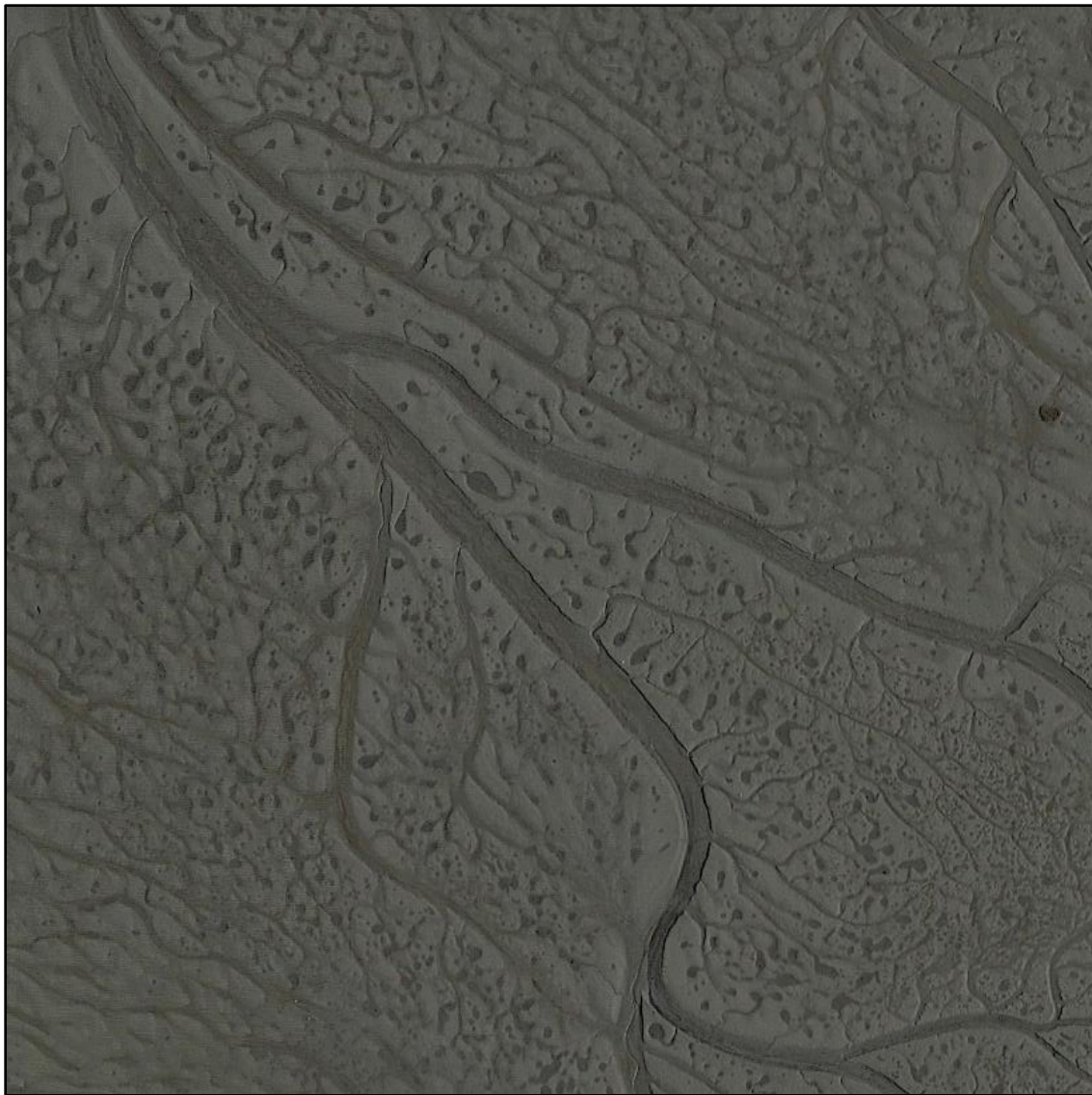


Is this a *GENERAL* pattern?

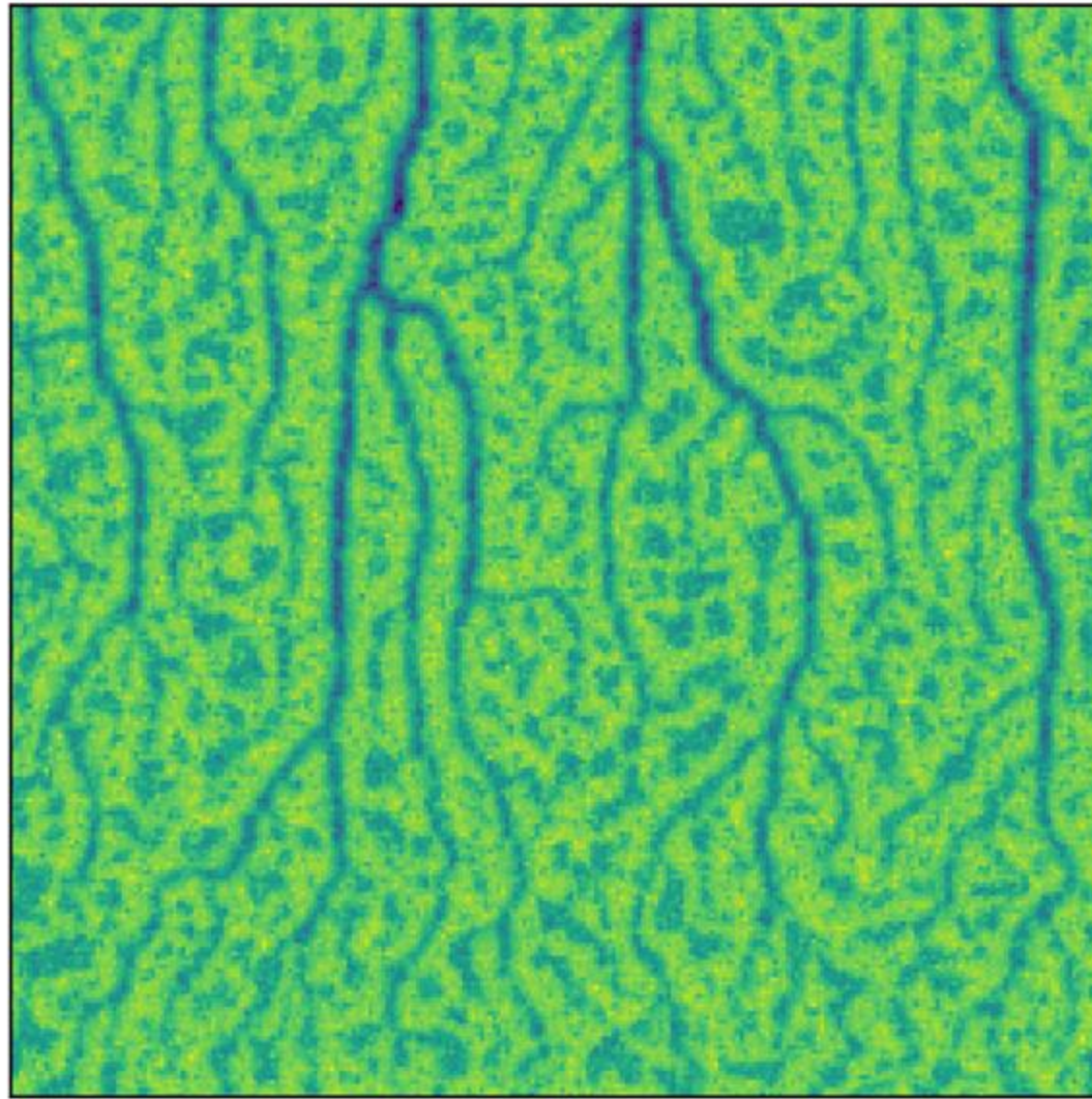


Then we can use **models** to develop **hypotheses** that explain what we see

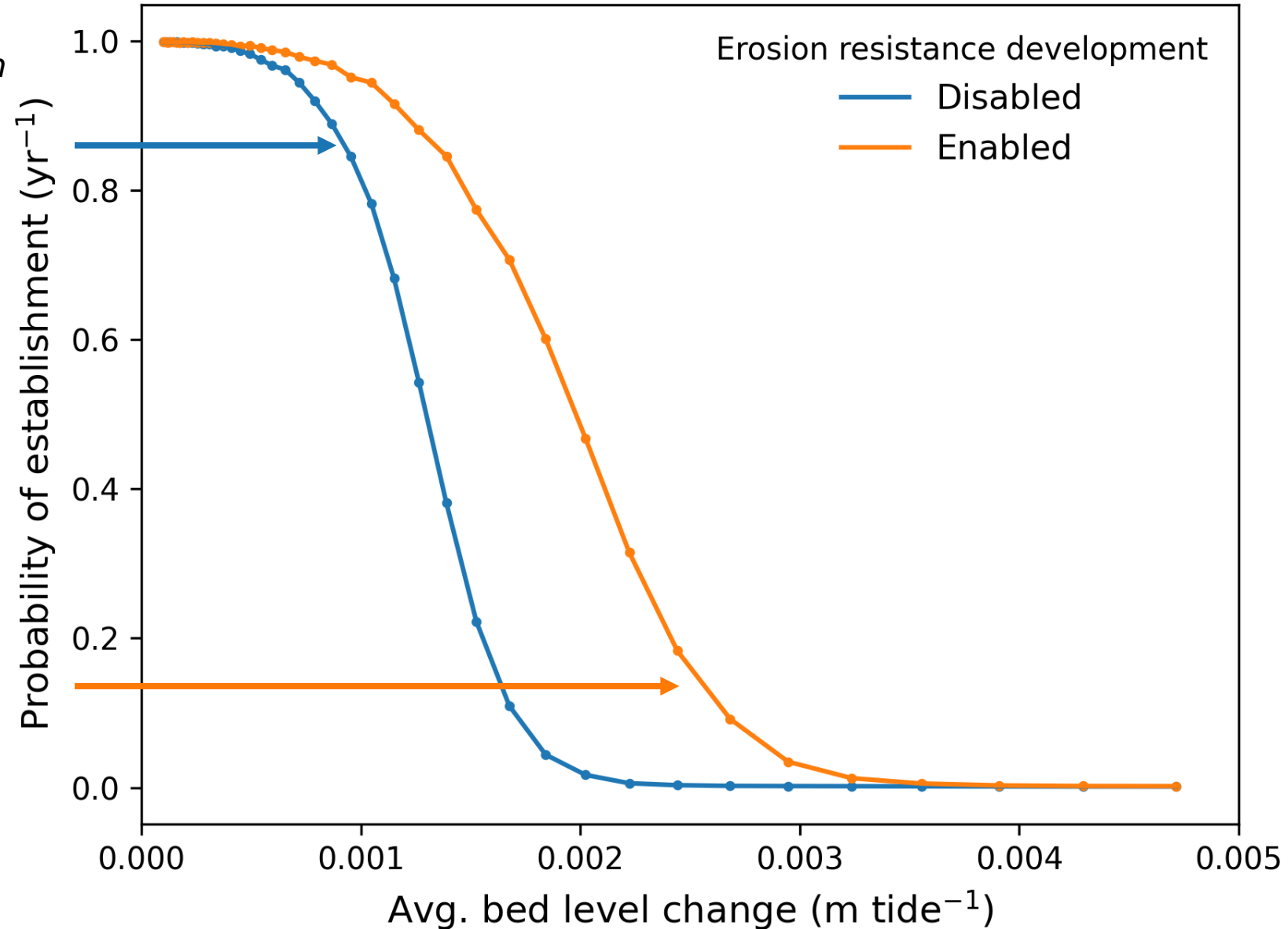
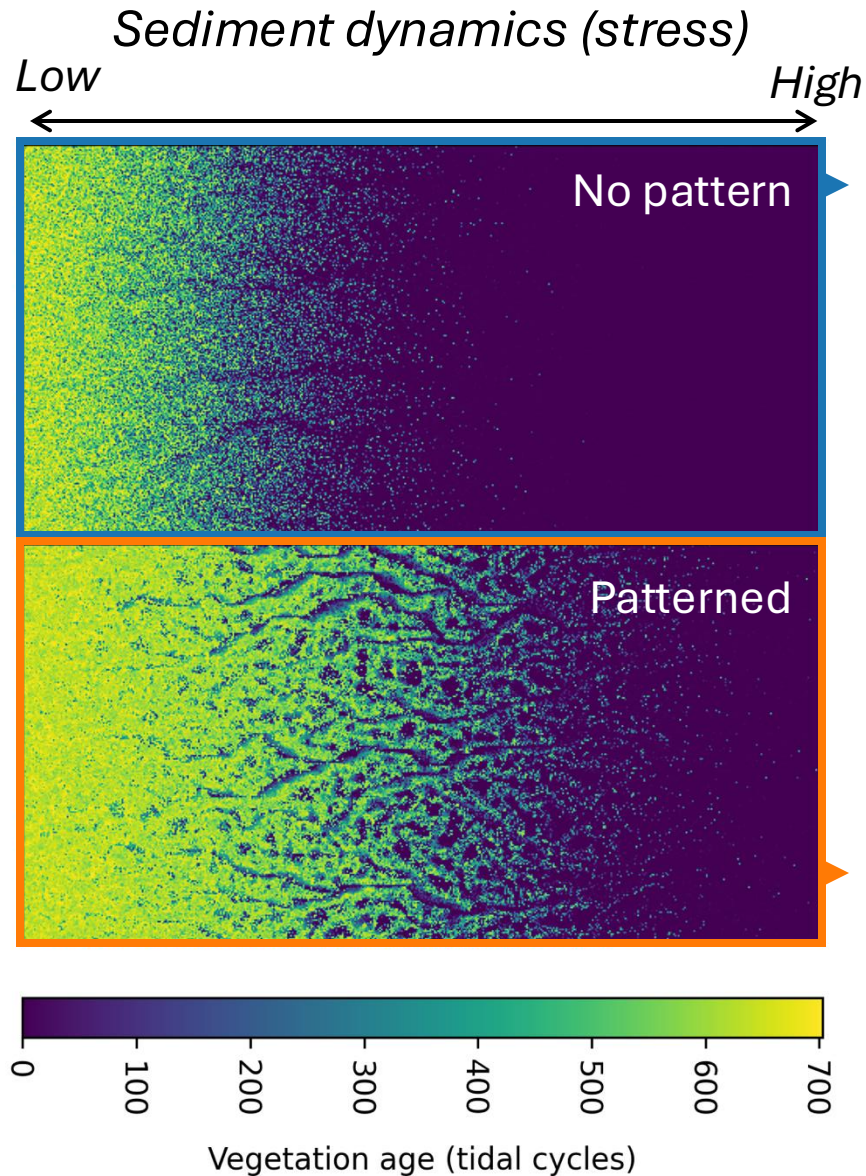
Ridge-runnel pattern



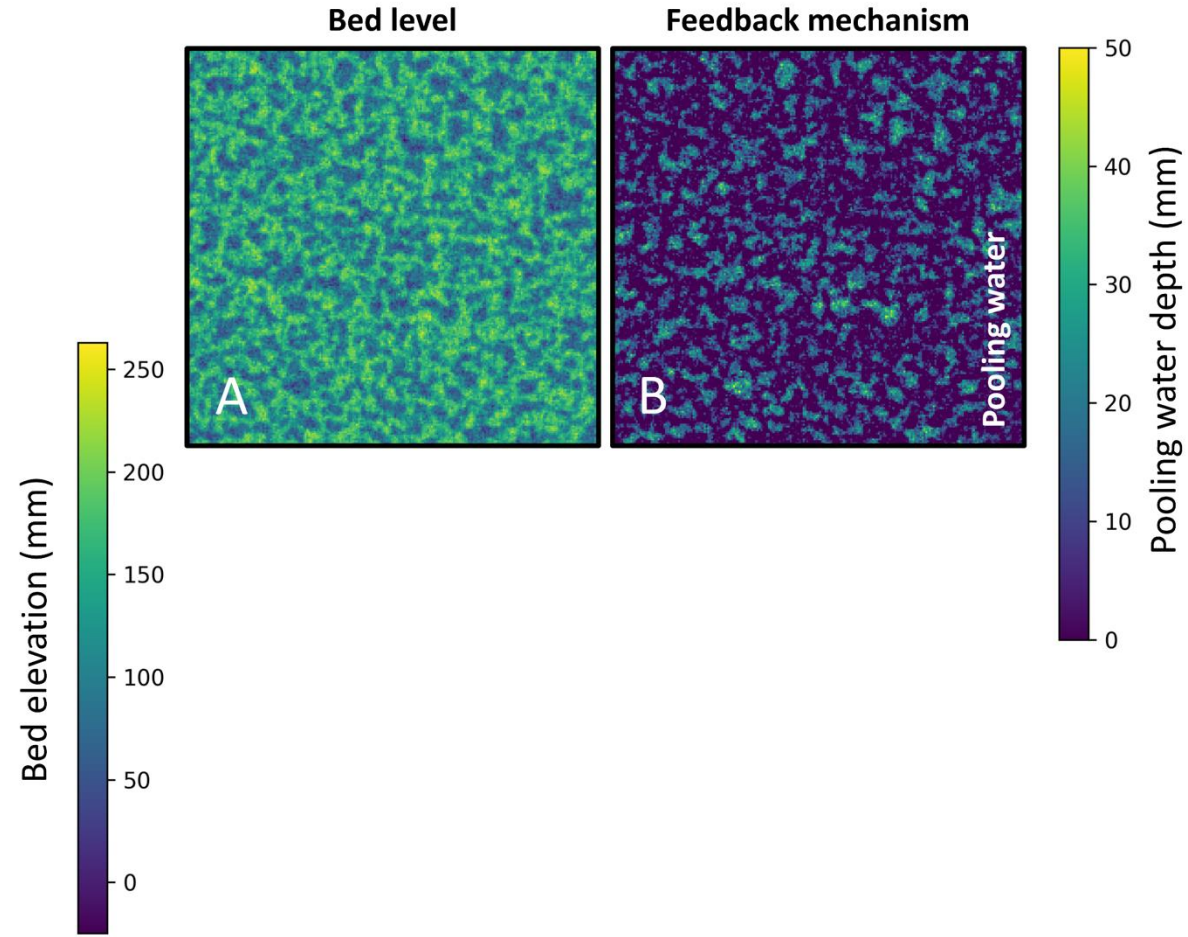
Numerical model

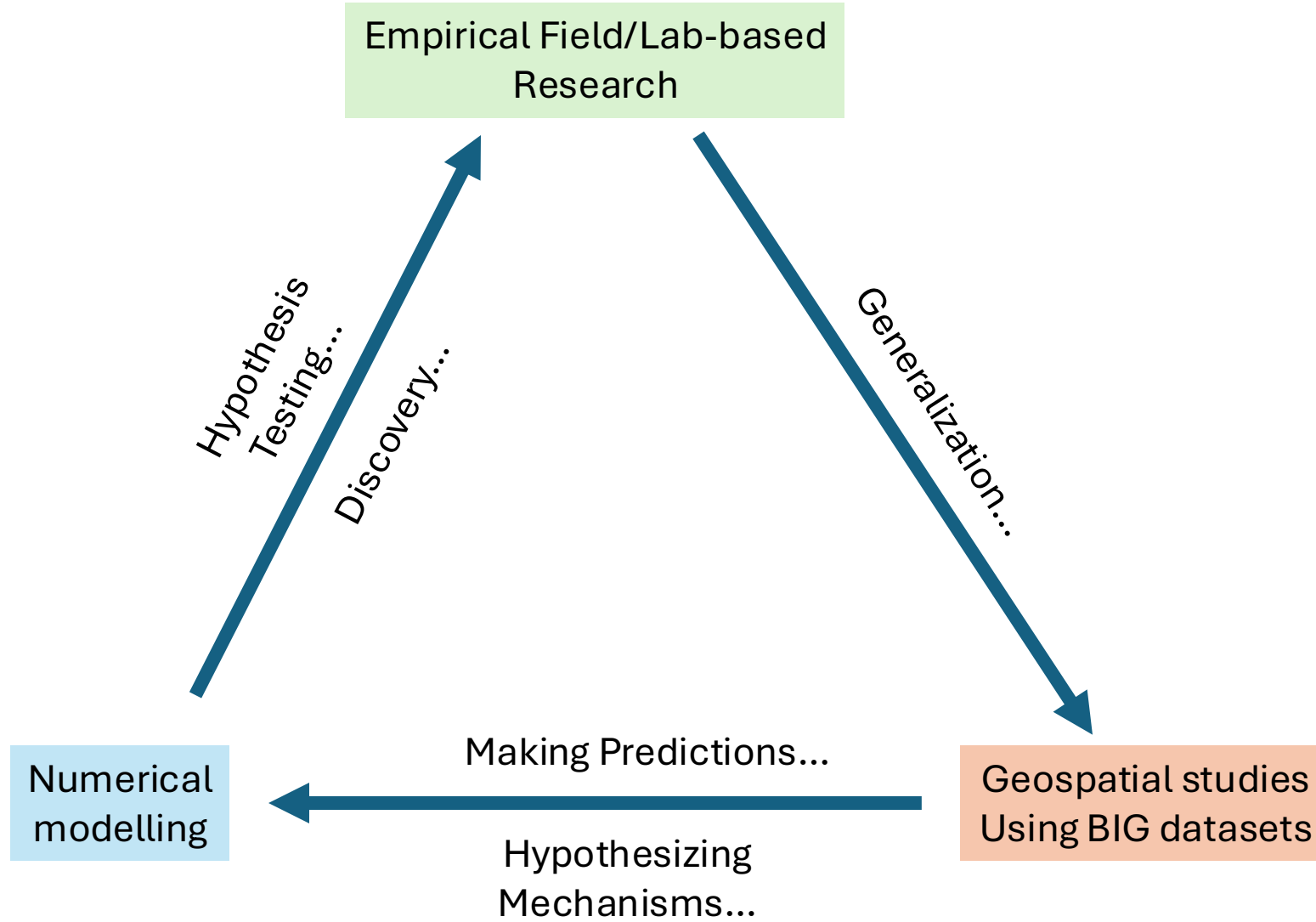


Ridge runnel patterns reduce erosion → increase seedling survival



Hypothesis: How ridge-runnel patterns develop and self-organize...



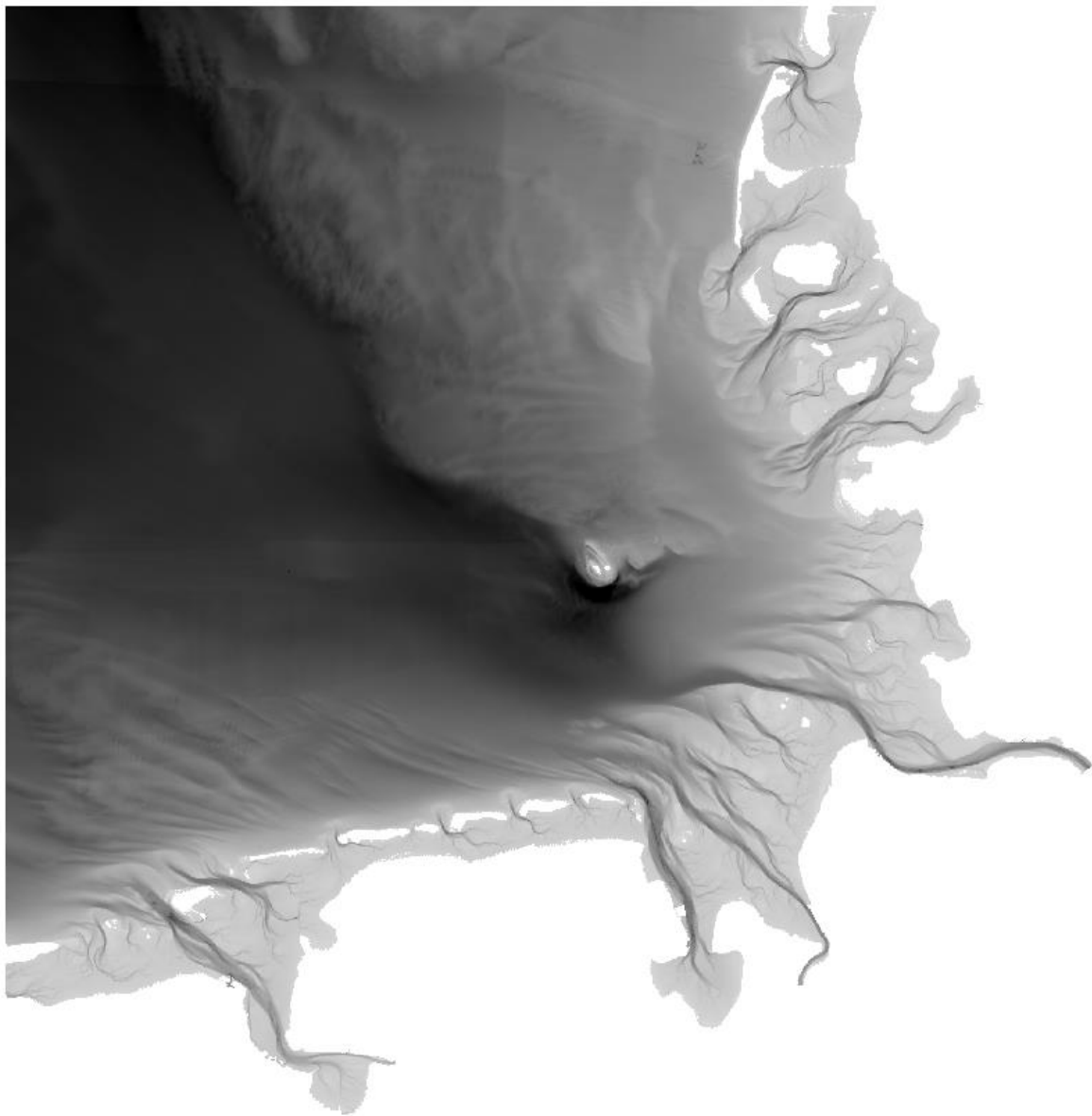


Appendix slides...

Introduction to
Bed level equilibria

Example 1

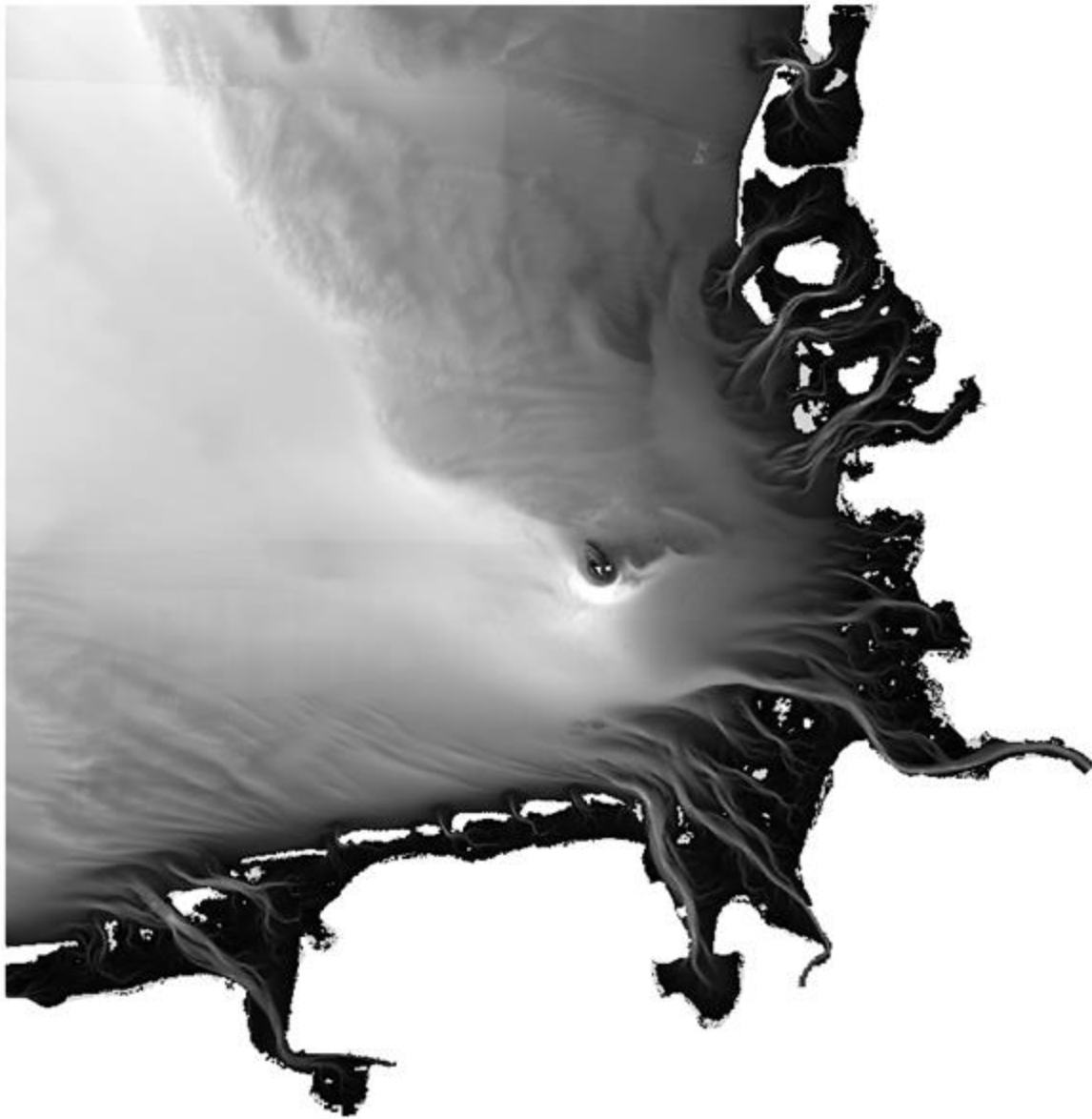
Elevation (m MSL)



Median grain size (μm)

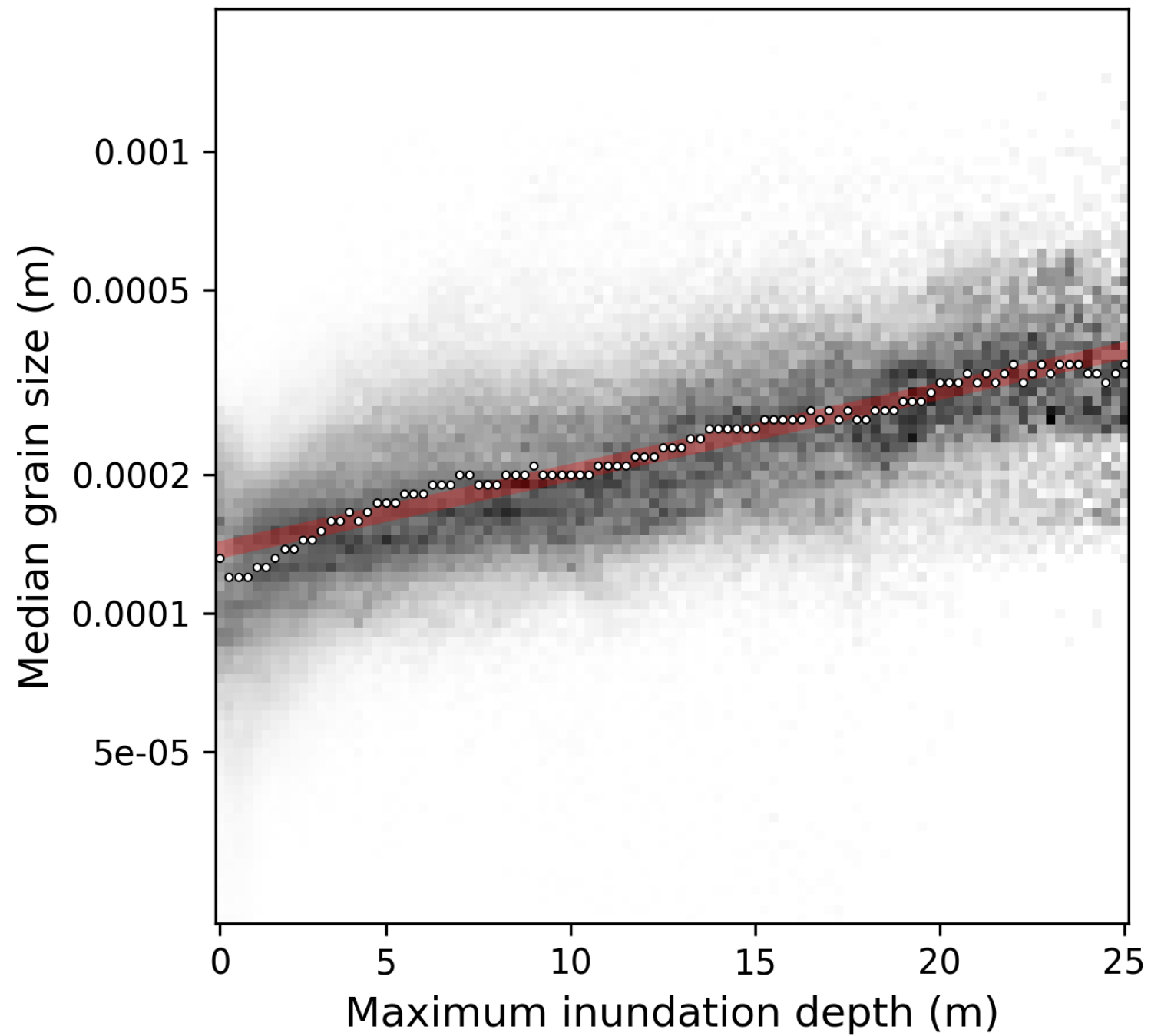


Maximum inundation depth (m)



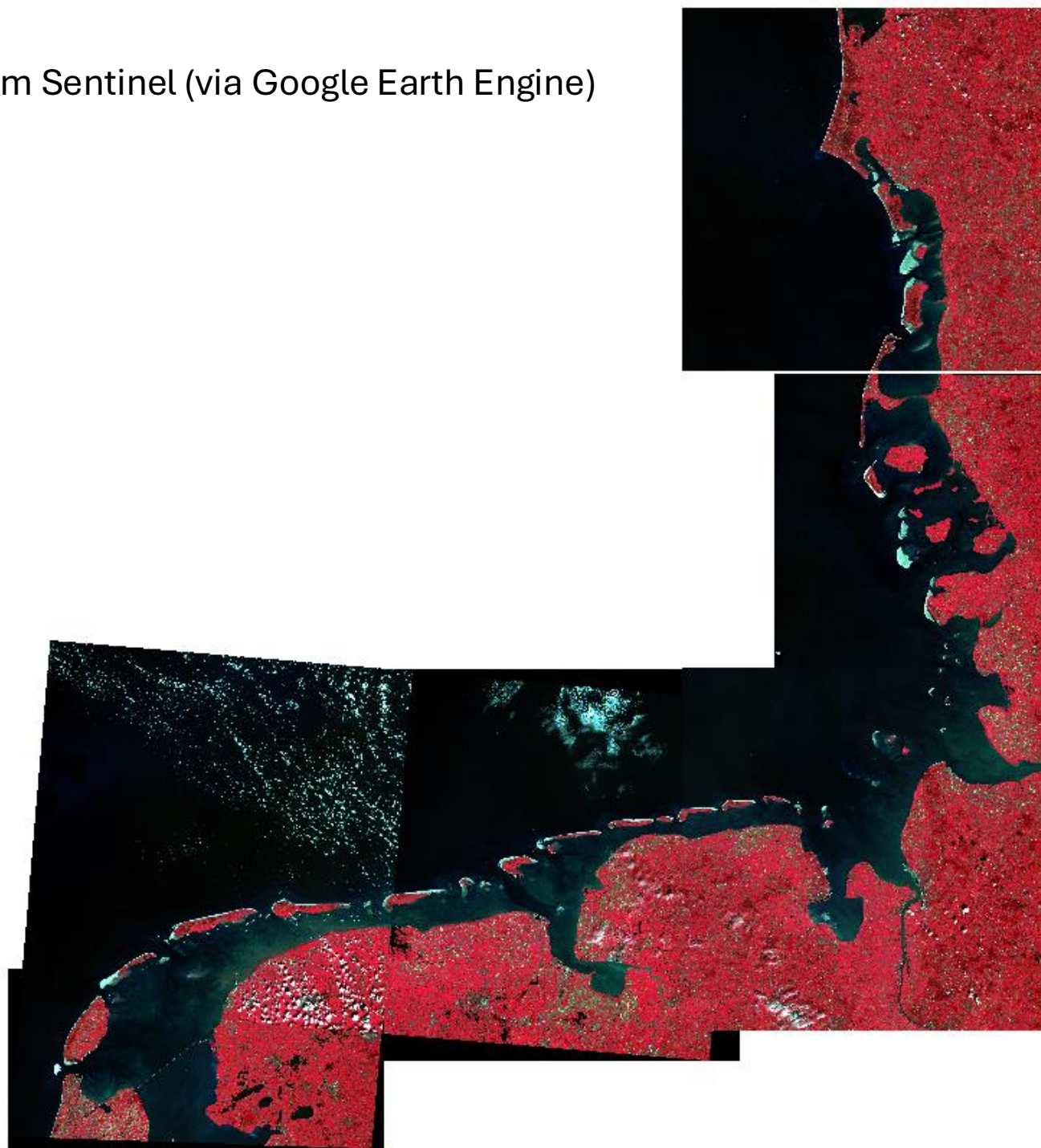
Median grain size (μm)



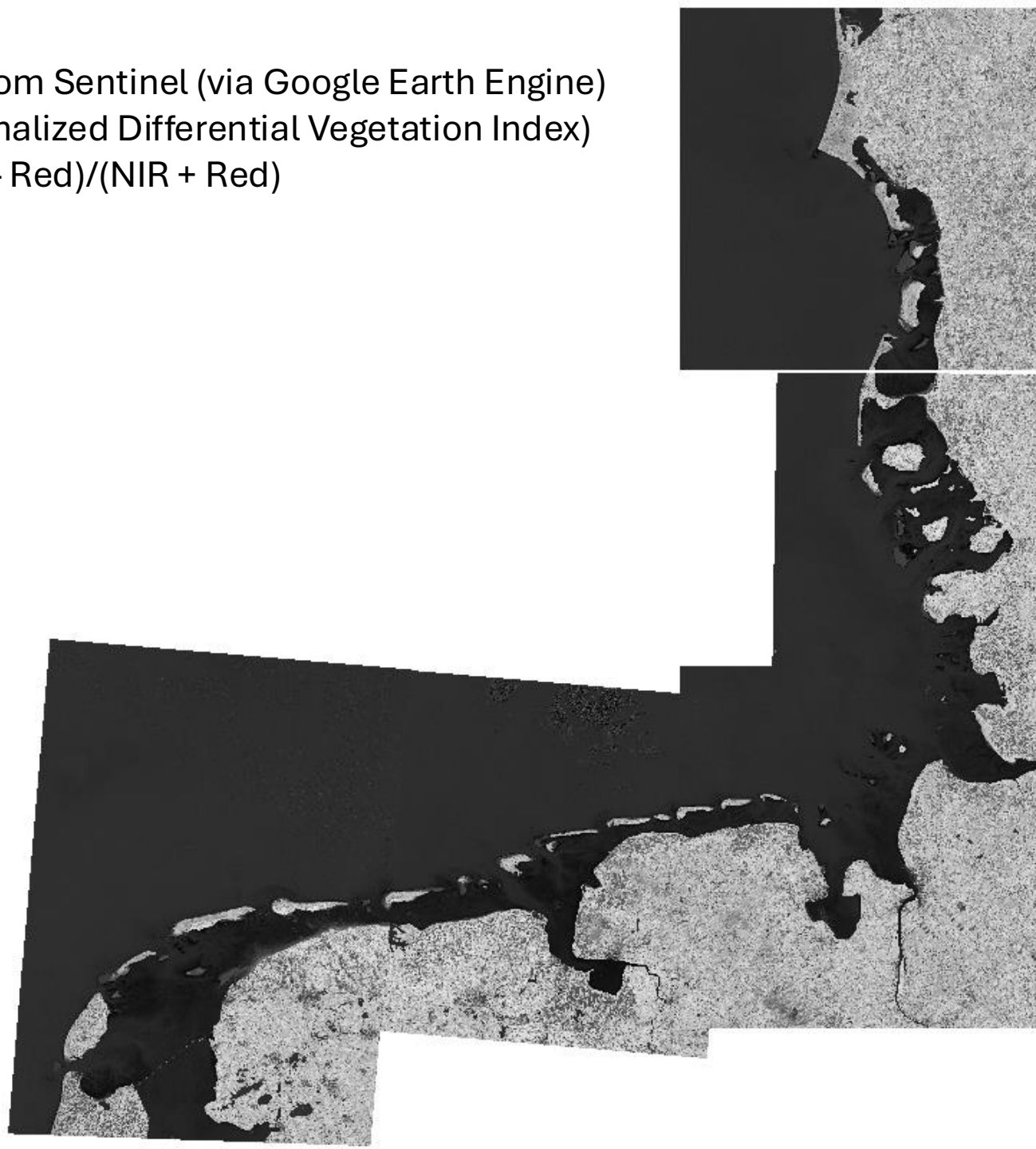


Example 2

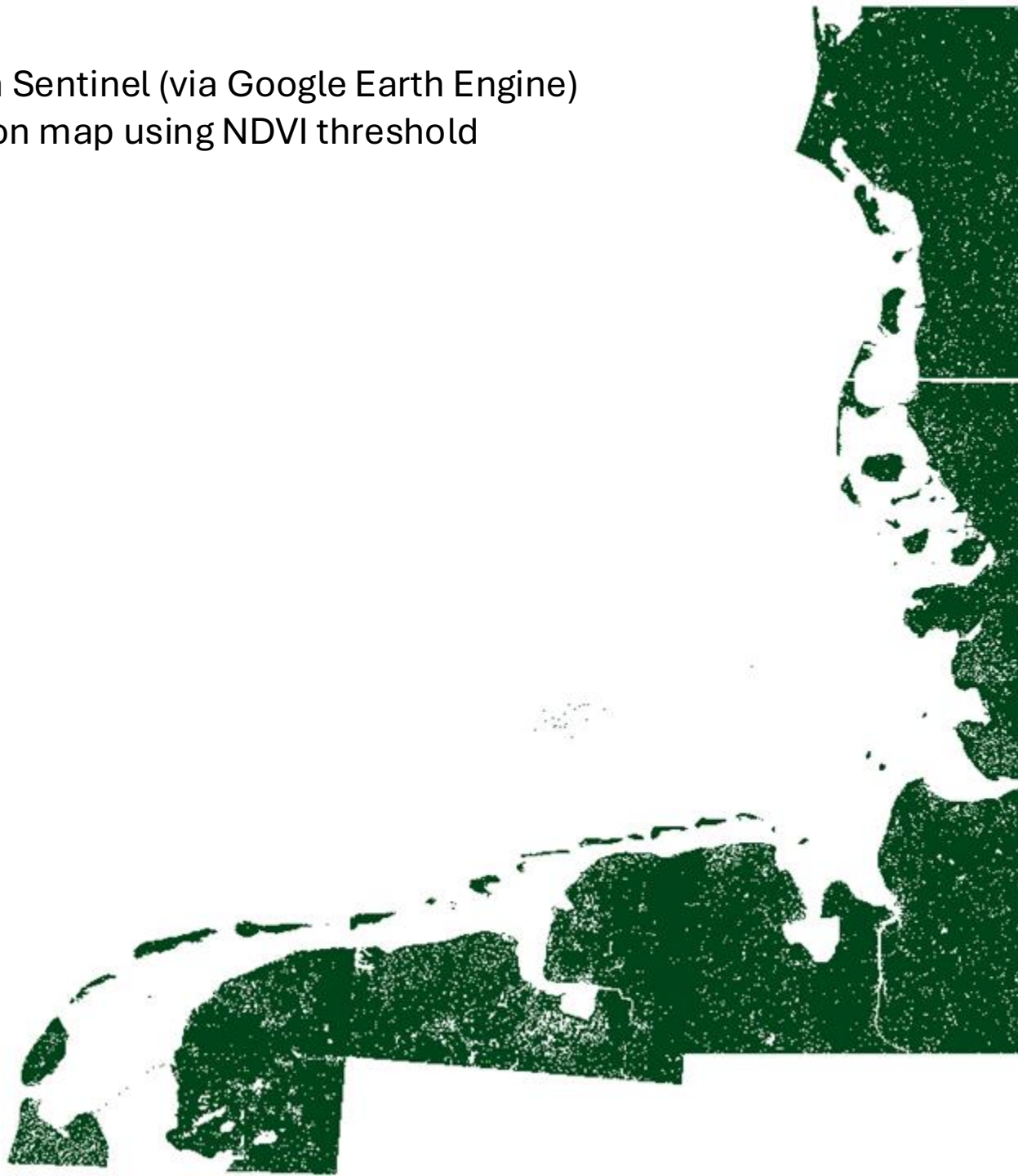
Multiband orthophotos from Sentinel (via Google Earth Engine)



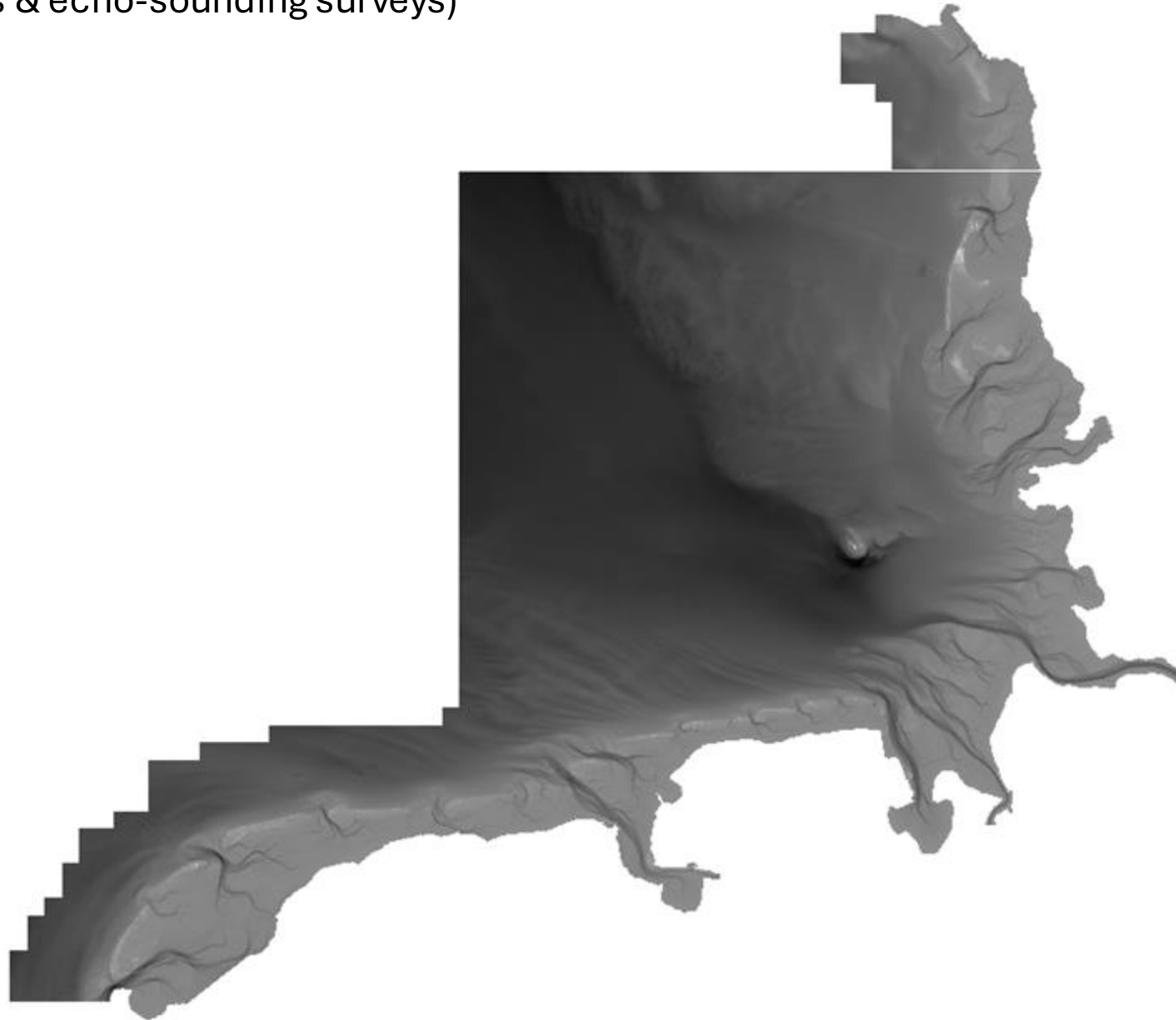
Multiband orthophotos from Sentinel (via Google Earth Engine)
Converted to NDVI (Normalized Differential Vegetation Index)
 $(\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$



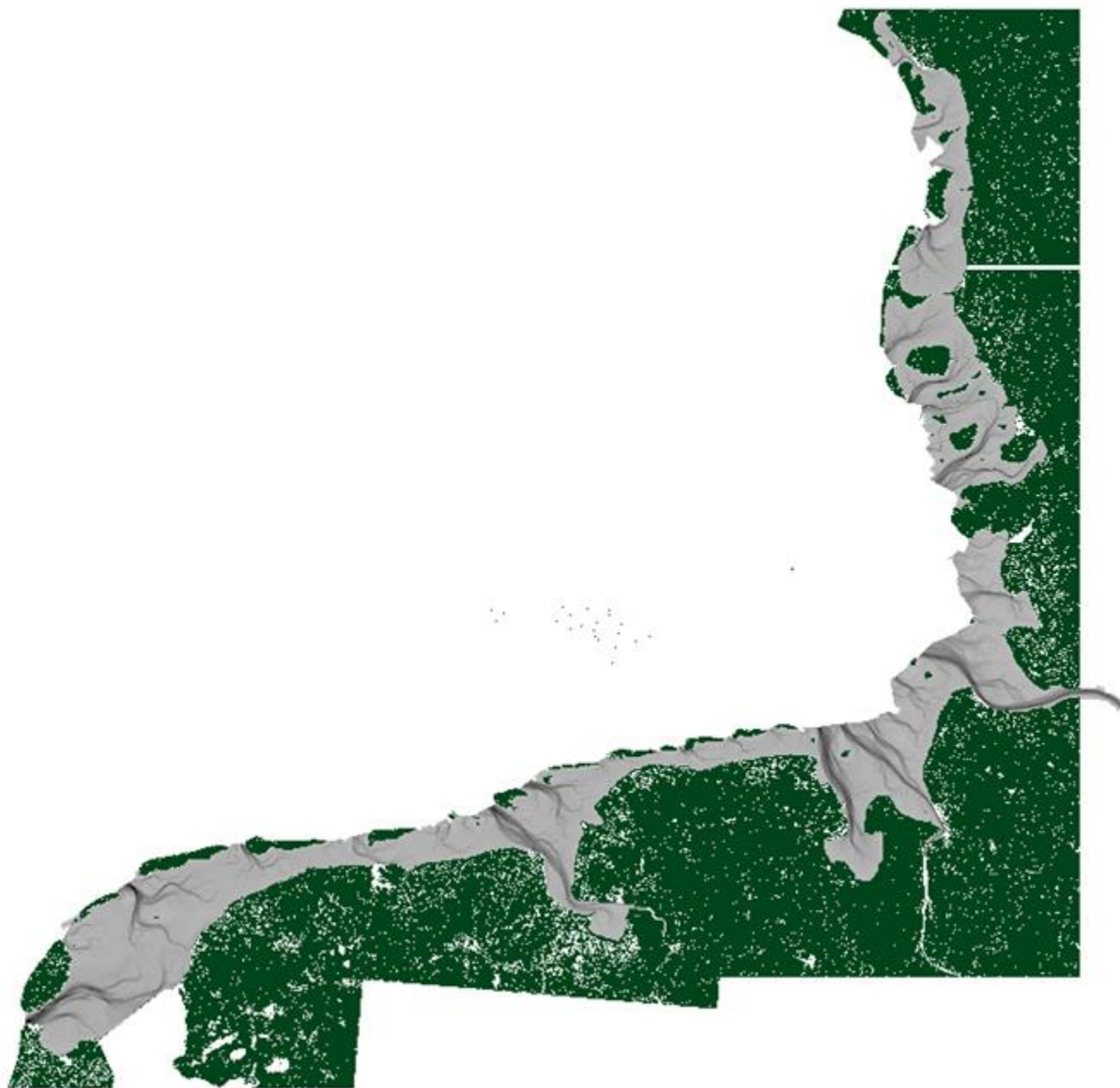
Multiband orthophotos from Sentinel (via Google Earth Engine)
Converted to vegetation map using NDVI threshold



Digital elevation model (DTM) of Wadden Sea
(Derived from lidar flights & echo-sounding surveys)







Wadden Sea

