Estuary scale experiments with saltmarsh vegetation

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Introduction:

Large-scale planform shape and development of estuaries are partly determined by saltmarsh and riparian vegetation. Thus far the biogeomorphological interactions have been studied mainly on marsh scale and rarely on the scale of entire estuaries for lack of suitable models and scale experiments. Here we develop the first-ever analogue models of entire estuaries with mud and eco-engineering species to form mudflats and saltmarshes to investigate large-scale morphological effects.

Aim:

1. Find different species to represent different habitats
2. Realistically spread seeds to simulate colonization patterns
3. Investigate effects on estuary shape and planform

Methods:

Test vegetation species:
- inundation resistance
- bank strengthening effects
- flow resistance

Simulate estuaries in 20x3m tilting flume

Figure 1: testing the effect of water level and seed burial on vegetation germination and development

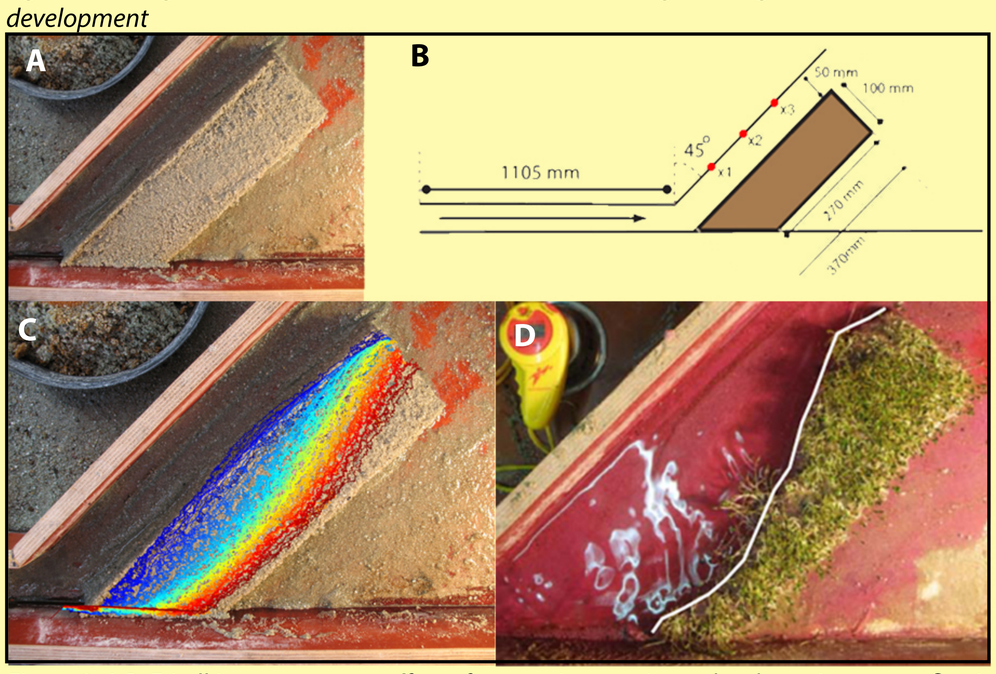

Figure 2: A,B: Friedkin set-up to test effect of vegetation species on bank erosion, water flowing from the bottom left channel and eroding the sediment block. Q=500l/h S=0.02m/m using timelapse photography to measure bank erosion rates. C: the different positions of the bankline over time (blue initial, red after 20 minutes). D: vegetation (Medicago sativa) changes the erosional profile.

Figure 3: 20x3 meter tilting flume tidal facility

Aim 1: vegetation development

- Rumex hydrolapathum, Veronica beccabunga, Medicago sativa, Sorghum bicolor and Lotus pedunculatus give promising results
- Large variability in shoot and root development
- Precise effects on bank erosion and flow resistance yet to be tested

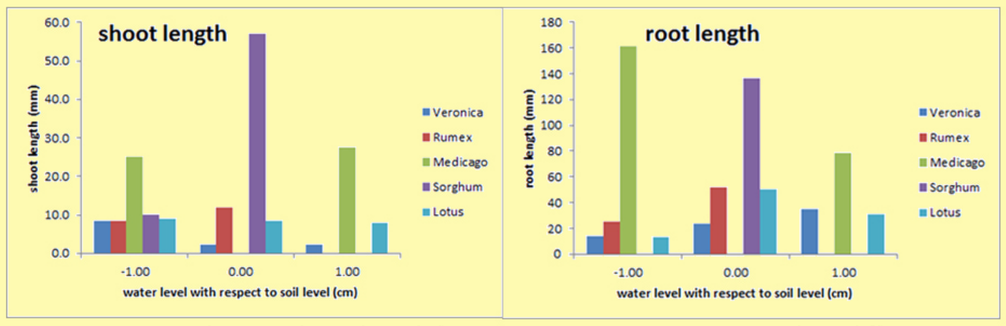

Figure 4: average shoot and root length for 5 promising species grown under 3 different water conditions without any nutrients.

Aim 2: vegetation spreading

-Hydrochorously distributed vegetation
-Realistic colonization locations when released from river, no floodplain development
-Sorting based on seed size and inundation tolerance
-Outer region too active for colonization

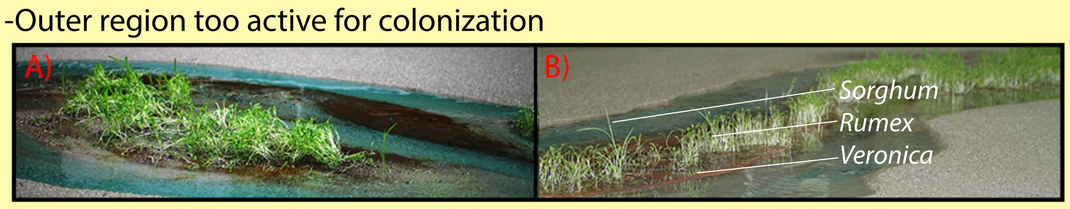

Figure 5: two tidal bars with vegetation A) shows how it is positioned mid-channel with surrounding mud. B) shows different vegetation species growin on the middle and edge of the bars

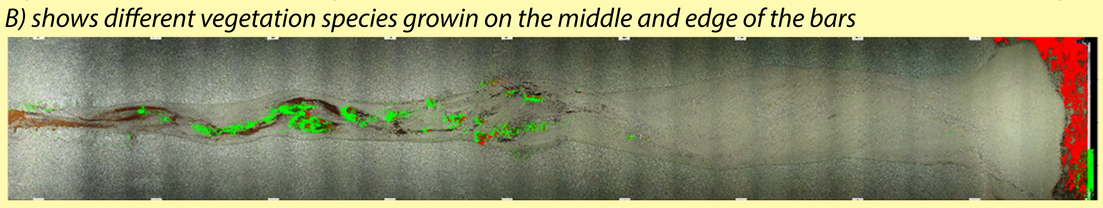

Figure 6: vegetation appears mainly in the inner part of the estuary with limited vegetation disappearing over time (green is new vegetation, red is disappearing vegetation).

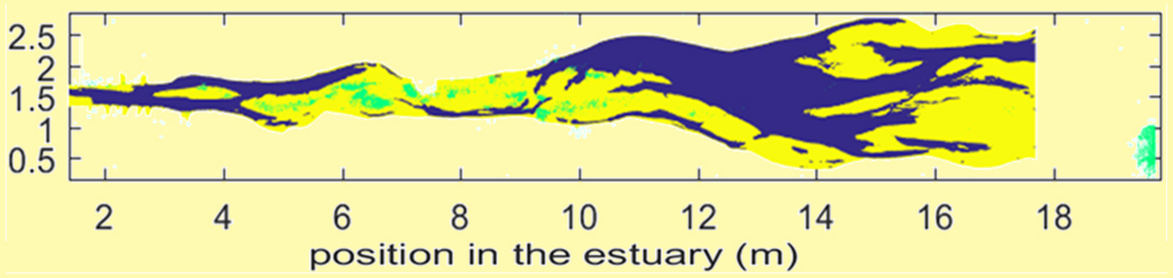

Figure 7: estuarine bars/shoals and their relation to vegetation presence. Yellow are bars, blue are channels and green is vegetation

Aim 3: estuary morphodynamics

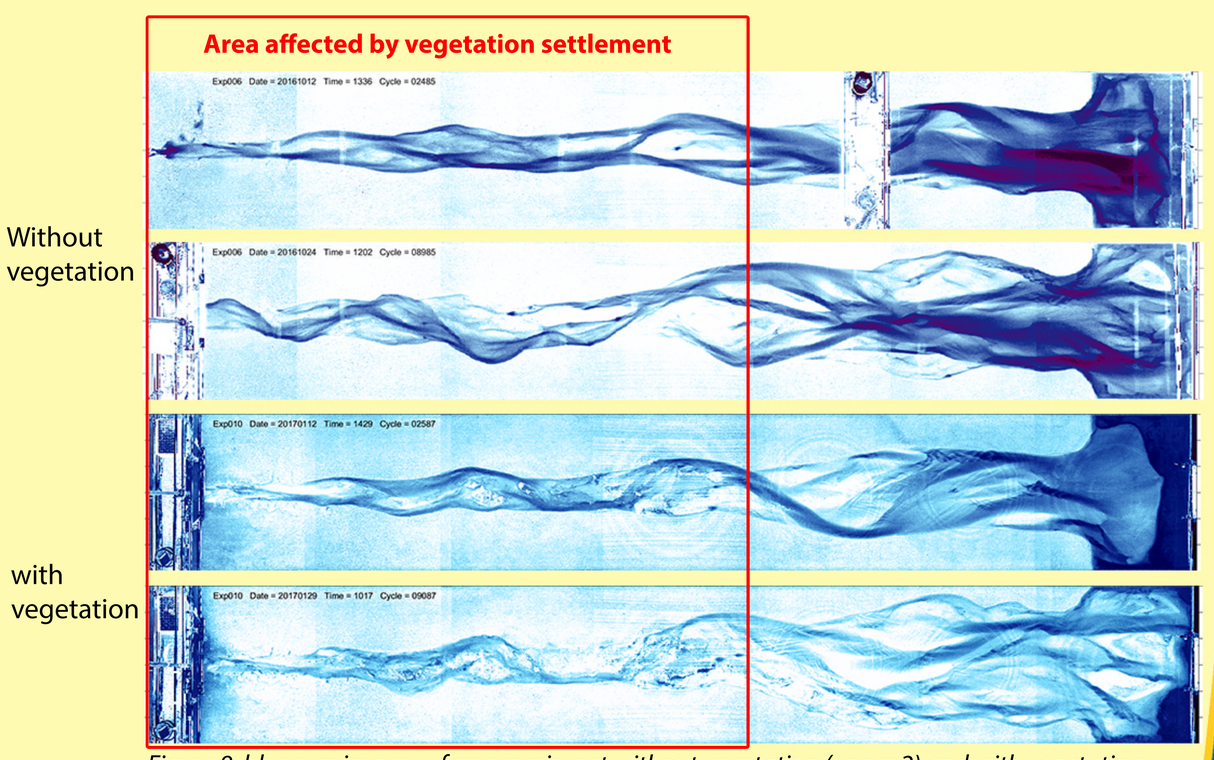

Figure 8: blueness images of an experiment without vegetation (upper 2) and with vegetation (lower 2) after ~2500 and ~9000 tidal cycles. The vegetated part of the estuary has been morphologically very stable compared to the simulation without vegetation.

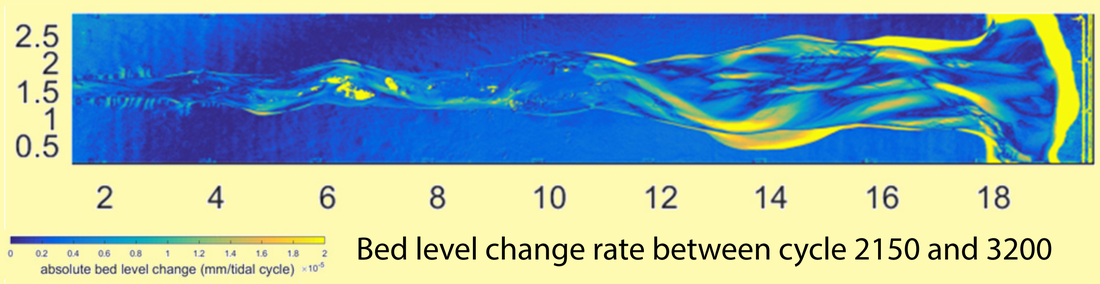

Figure 9: Activity of the estuary between cycle 2150 and 3200. As can be seen the vegetated part is relatively unactive except for the vegetation growth itself and simultaneously the (to large) activity in the outer part of the estuary might be responsible for the lack of vegetation settlement.

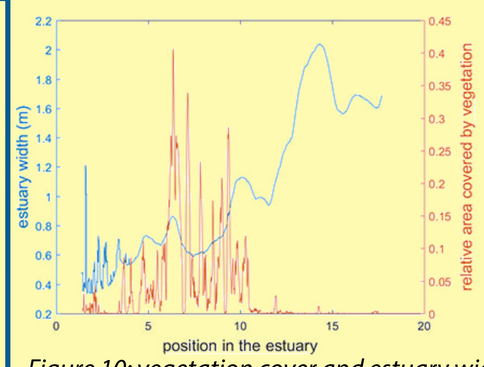

Figure 10: vegetation cover and estuary width along the estuary, there appears to be no clear correlation.

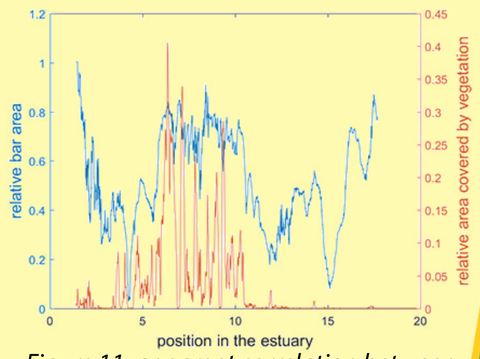

Figure 11: apparent correlation between vegetation cover and relative bar area along the estuary, but why?

Preliminary conclusions

- Different vegetation species settle in different depth zones
- More bare surface in widere reaches leads to more vegetated area
- Vegetation reduces morphodynamics (and narrows the estuary?)