

Process-Based Morphodynamic Modelling of Tidal Flat Nourishment Evolution in the Eastern Scheldt

The importance of wind on the morphological evolution of tidal flats

Ype Attema^{1,*}, Bas van Leeuwen¹, Anna Kroon¹, Pepijn van Denderen²

(1) Svašek Hydraulics, (2) HKV, *correspondence: attema@svasek.com

INTRODUCTION

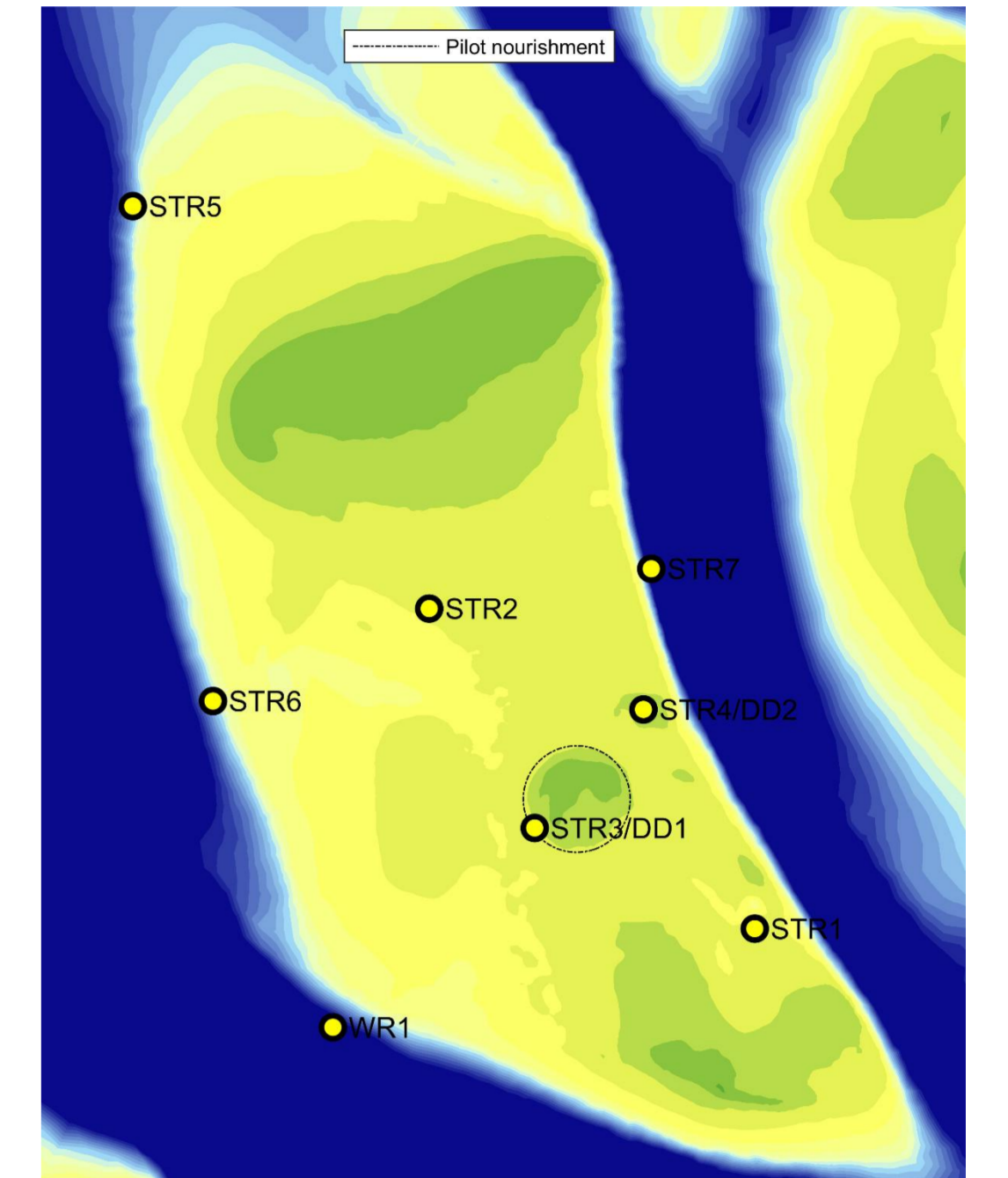
The Eastern Scheldt has experienced a structural sediment deficit since the storm surge barrier was built in 1986.

- Barrier reduced tidal prism, flow velocities, and sediment import
- As a result, intertidal flats are eroding:
 - Wave action-induced erosion remains unchanged
 - Sediment supply and accretion are reduced
- Loss of intertidal area threatens bird foraging habitat
- Sand nourishments are applied to mitigate habitat loss
- Lifespan predictions of sand nourishment remain uncertain

MEASUREMENTS (Source: RWS)

A pilot nourishment and measurement campaign was carried out in 2008 on the Galgeplaat.

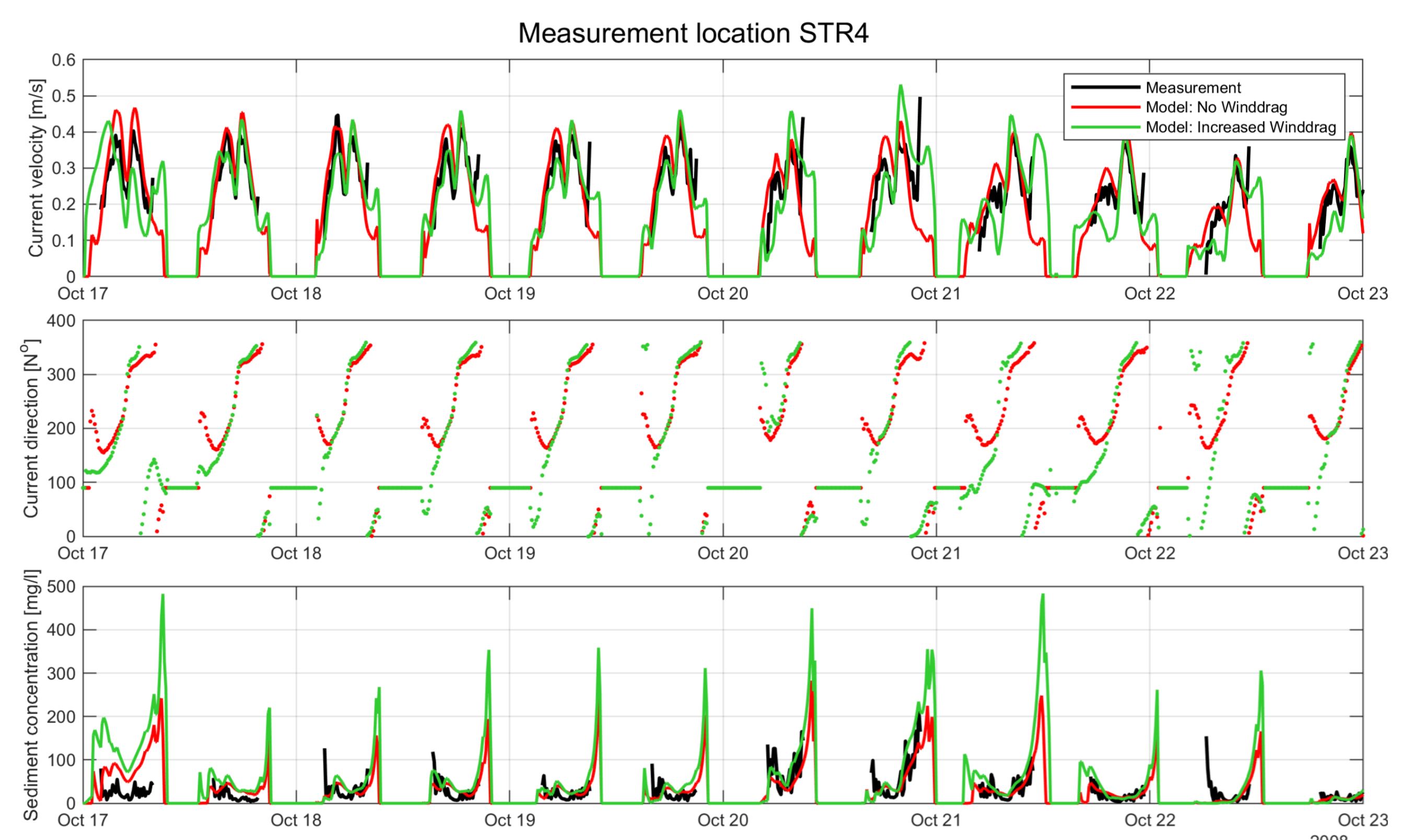
- Hydrodynamic measurements taken at 6 locations in 2008.
- LiDAR-derived bathymetry used to assess bed-level change between 2019 and 2021.



MODELLING APPROACH

A coupled 2D FINEL-SWAN model was applied to simulate hydrodynamics, waves, and sediment transport.

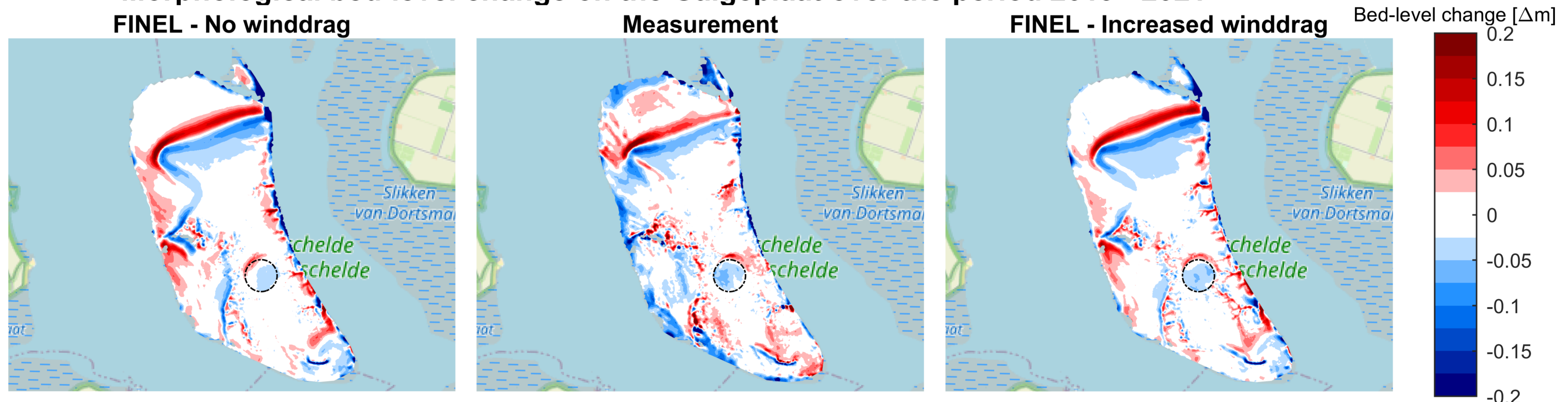
- Unstructured triangular grid: 15-meter grid cell resolution
- Boundary conditions at offshore sea boundary:
 - Astronomical tidal components
 - Storm-surge from Europlatform
- Wind forcing: Measured wind from Stavenisse
- Sediment transport: Van Rijn 2007 & Van Ledden
- Sediment fractions (sand-silt interaction):
 - Sand, D_{50} : 175 μm
 - Silt, Fall velocity: 1 mm/s



STUDY RESULTS

- Wind forcing is essential to reproduce current velocities and sedimentation patterns
- Both silt and sand fractions are required to match observed suspended sediment concentrations
- Default sand transport settings overestimate bed-level changes, a factor 10 scaling reduction was needed to match observations.
- Model accurately reproduces nourishment evolution and large-scale morphological patterns on the Galgeplaat

Morphological bed-level change on the Galgeplaat over the period 2019 - 2021



KEY POINTS TO TAKE AWAY

- Model provides quantitative and reliable estimates of nourishment lifespan
 - Preliminary estimates suggest nourishment erosion may be twice as fast as simpler methods indicate
- Wind forcing is a critical driver of sediment redistribution
- Field measurements are essential for model reliability
 - Current velocity and directions measurements crucial for hydrodynamic calibration
 - Bed-level measurements essential to calibrate sand transport formula settings

Study carried out on behalf of Jan de Nul