BANKBUSTERS

BENEFICIAL RE-USE OF SOFT DREDGED MATERIALS TO ENGINEER TIDAL MARSHES

Lisbon, Sednet, September 6 2023 - Tomas Sterckx, Marc Huygens – DEME Dredging – huygens.marc@deme-group.com

Highly valuable but sensitive estuarine tidal marshes

- Delivering ecosystem services

such as
natural flood protection,
wave dampening impact,
control tidal riverbank erosion,
carbon sequestration,
habitat-biodiversity,..

- Under pressure

due to
climate change,
sea level rise, estuary deepening,
ecosystem degradation, invasive species, …

Intensive marine works as part of socio-economic (port) development

- Capital - Maintenance dredging works

to manage port access
To facilitate economic activities
to control-remediate erosion
to mitigate climate change effects
….

- River bank protection/restoration

to restore flood protection
to enhance ecological habitats
to explore recreation along dikes
….

Estuarine river embankment protection

Beneficial re-use of dredged materials in particular soft mud sediments

Climate resilient port access

Tidal marsh habitat restoration

Enhancement of tidal marsh ecosystems

Our Research & Development

Bankbusters

Engineered tidal marsh, by beneficially re-using soft dredged sediments.

AGENTSCHAP INNOVEREN & ONDERNEMEN
BLAUWE CLUSTER
Samen sterk voor groei

Bankbusters

Acquire knowledge on

- Ecosystem processes,
- Technical (embankment) boundary conditions
- Beneficial re-use of soft dredging material,

in order to

- Facilitate tidal marsh habitats restoration
- Enhancing ecosystem services delivery

Research & Development Framework

- Academic & Private partners
- Multidisciplinary knowledge center
- Living riverbank continuum - Experimental facilities – Operational excellence

"To bring back sediments to their original river bank ecosystems"

Subsidising authority: VLAIO - The Blue Cluster

Research & Development Framework

Smart targets and deliverables

- Minimum ecosystems boundary criteria to facilitate-enhance tidal marsh creation and development (physical-chemical-biological next to hydraulic-geotechnical-civil technical)
- “DRECO” BluePrint (design-installation-maintenance) for engineered tidal marsh with soft dredged materials
- Advanced integrated observation and real-time monitoring to assess complex interactions between sediments, water and vegetation.
- Ecosystem services provision

Research Building Blocks

Beneficial re-use of soft dredged sediments

There is a lot of dredged material available…

How to deal with it?

What can we do with it?

Beneficial re-use of soft dredged sediments

ALSO soft (mud) dredged sediments
in applications that are beneficial and in harmony to human and natural development

- for habitat creation – enhancement – restoration

Actual focus = restoring tidal marshes in previously embanked “polder” areas
These restorable areas have already been claimed for different functions (e.g. SIGMA plan in Scheldt-estuary)

Shifting Engineering (*creation-facilitation*)
for more dynamic, eroded tidal marshes (and associated mud flats)
directly under tidal impact

towards restoration of natural gradients of tidal marsh river banks
directly adjacent to the estuarine channel

- more harsh hydrodynamic conditions
- more complex sediment behaviour (settling, consolidation, permeability,…)
- more integrated ecological processing (dewatering, vegetation, oxidation,…)

Beneficial re-use of soft dredged sediments

Ripening of the soft mud material – “From mud slurry to tidal marsh fill”

- Accelerate oxidation and increase dewatering with reed and willow (wetland species)
- Enhance soil drainage by mixing plant based organic waste with the dredged slurry
- Create void spaces as preferential soil drainage channels
- Artificial preformed creeks-channels in marsh core

Outer Containment bund from soft sediments

- To ensure stable tidal marsh fill
- To facilitate interaction with tidal estuary channel
- To ensure drainage from marsh land fill

Ecological engineering of tidal marshes

Tidal inundation water

>>>Soil Characteristics

>>> Hydrological & Biogeochemical functioning of marsh soil

>>> Vegetation development on marsh land

Soil drainage dynamics = crucial – “best possible stratification”

- Permeability - Infiltration into marsh soil
- Variably satured marsh soil – Vegetation development
- Macropores (plant roots, animal burrows, cracks from shrinking/swelling)
- Seepage towards (engineered) tidal creeks
- Evapotranspiration via marsh vegetation

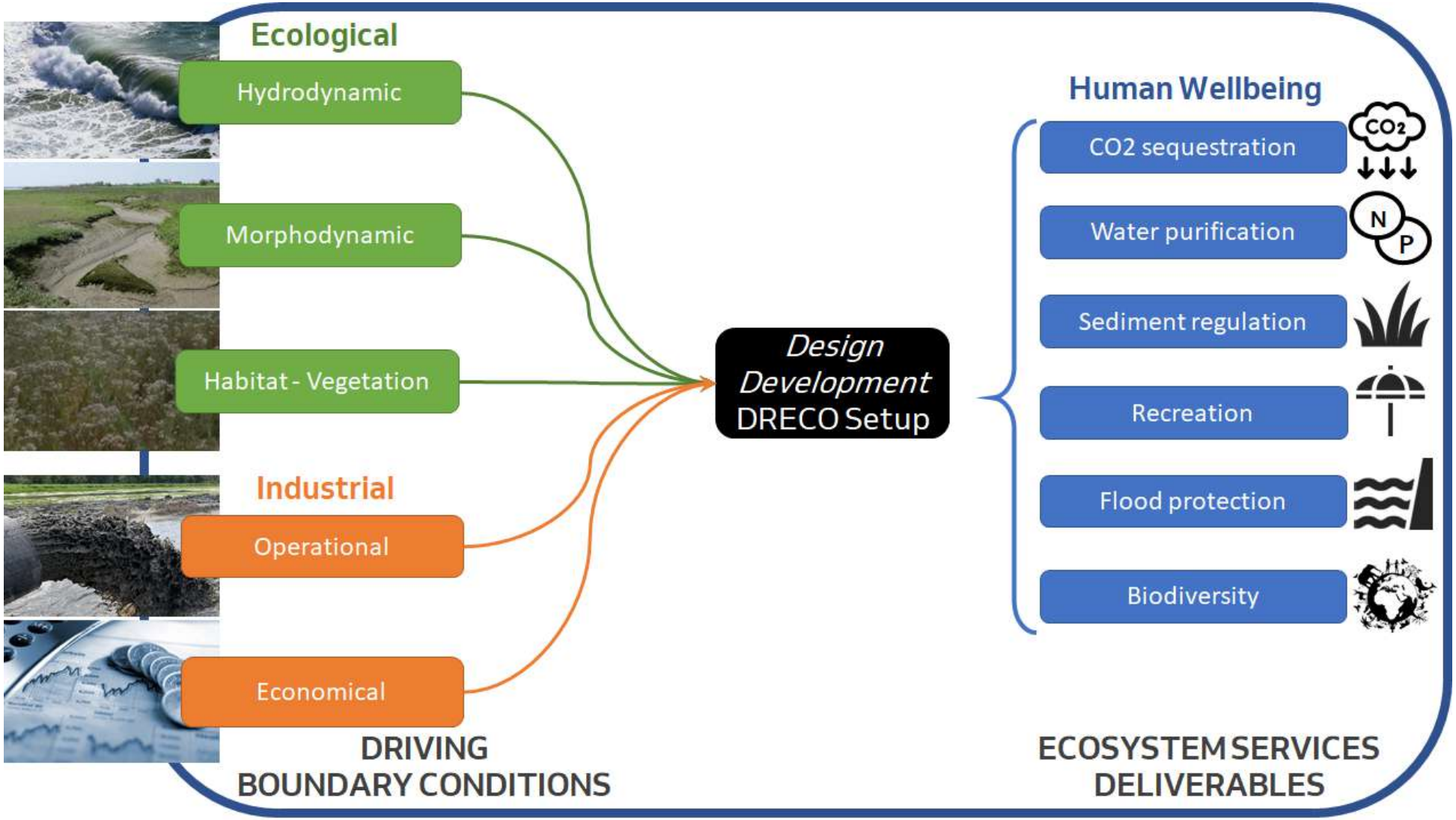
Physical interactions water-soil-vegetation

- Sedimentation/erosion – Soil accumulation
- Resilient marsh land development

Biogeochemical interactions water-soil-vegetation

- Nutrients (nitrogen & phosphorus) removal
- Recycling silicate
- Water quality regulation in tidal rivers
- Carbon storage (organic matter stored in anoxic soil)

Ecosystem Services to guide project development



Experiments, Simulations & Monitoring

Ex-situ Experiments – Laboratory Tests

MESODROME (UA – EcoSphere)

Integrates vegetation/ecology
as an integrated experimental component

Detailed sediment-water-plant interaction
in full subtidal-intertidal continuum
under controlled laboratory test conditions

➢ Validating # DRECO designs

Ex-situ Experiments – Laboratory Tests

MESODROME (UA – EcoSphere)
Numerical Tools (Ugent – Delft 3D/Ansys)

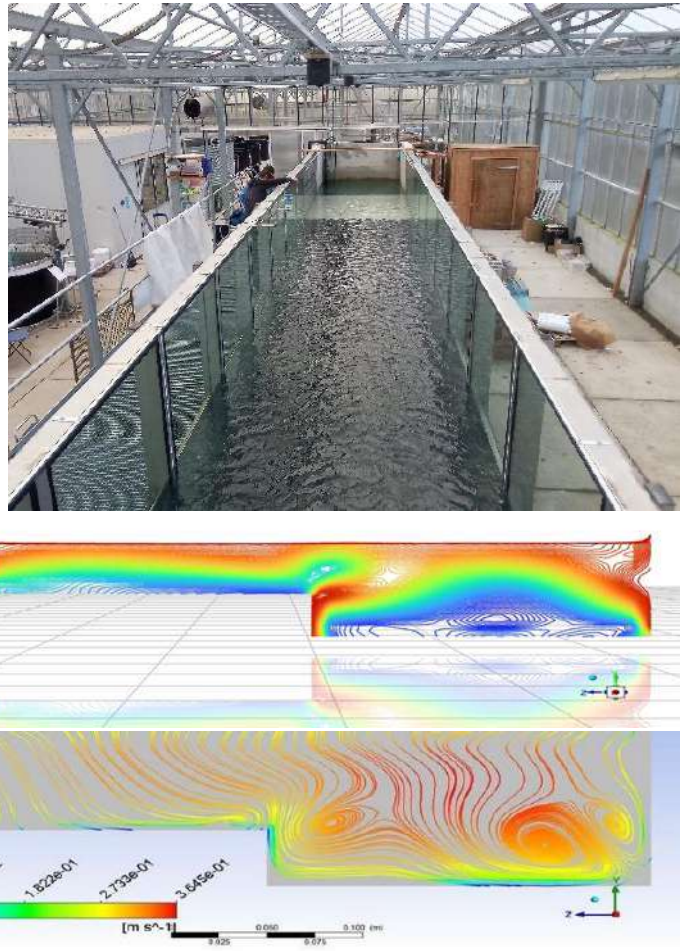
➢ Validating # DRECO designs

Defining optimum transversal profile
Connecting the marsh land with tidal mud flats
in the estuarine river section

Tidal flow impact on marsh land & containment bund

- Stepped riverbank cross-section
- Cross-sectional Flow Turbulence – Secondary flow
- Erosion/Sedimentation
  - ✓ 2D stepped system
  - ✓ 3D stepped system
  - ✓ Scaled DRECO set-up

Vegetation / sediment impact on marsh land



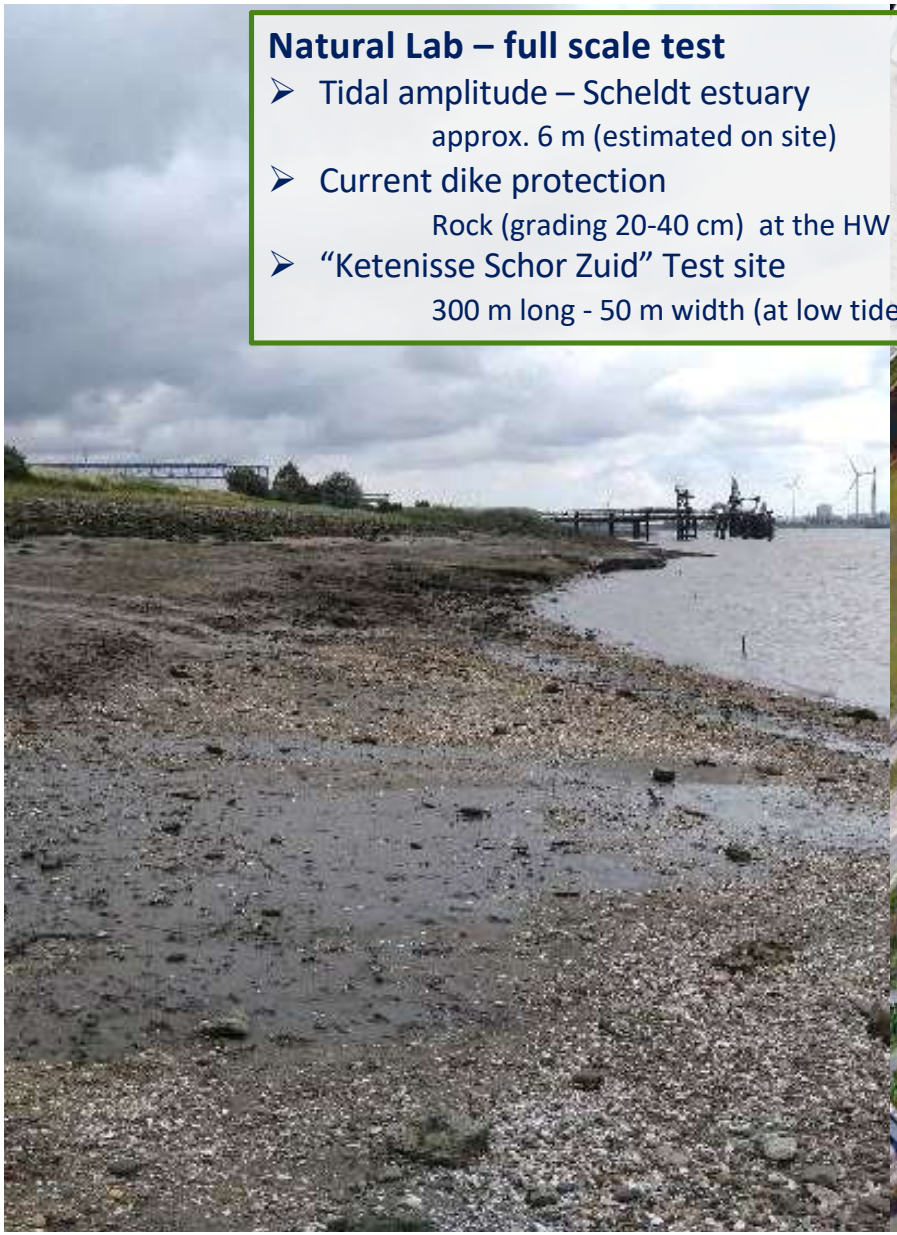
Natural Lab – full scale test

Eroded marsh land along Scheldt river adjacent to existing marsh land

Ketenisse site

Natural Lab – full scale test

- Tidal amplitude – Scheldt estuary
  approx. 6 m (estimated on site)
- Current dike protection
  Rock (grading 20-40 cm) at the HW dike body (2016)
- “Ketenisse Schor Zuid” Test site
  300 m long - 50 m width (at low tide)



In-situ Experiments – Natural Lab Pilot Tests

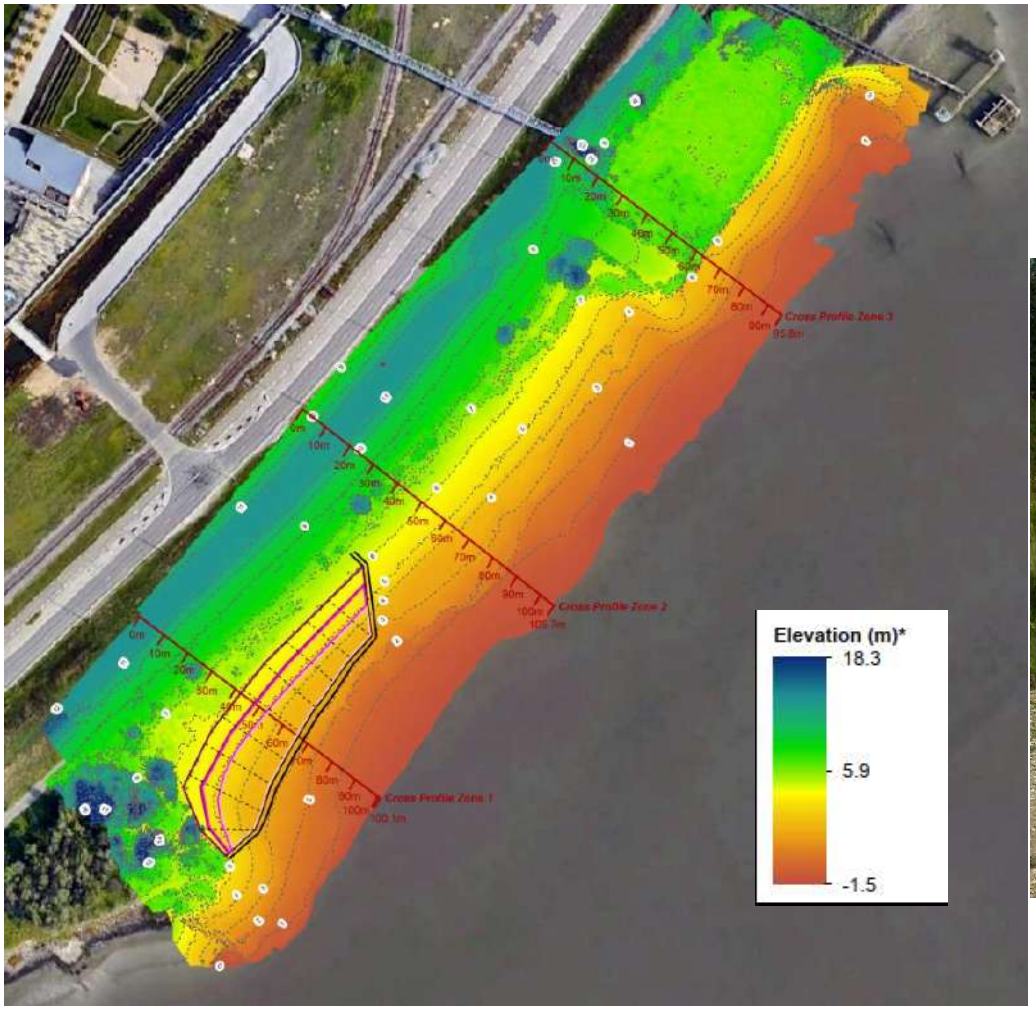
Baseline Survey Ketenisse

Eroded river embankment zone

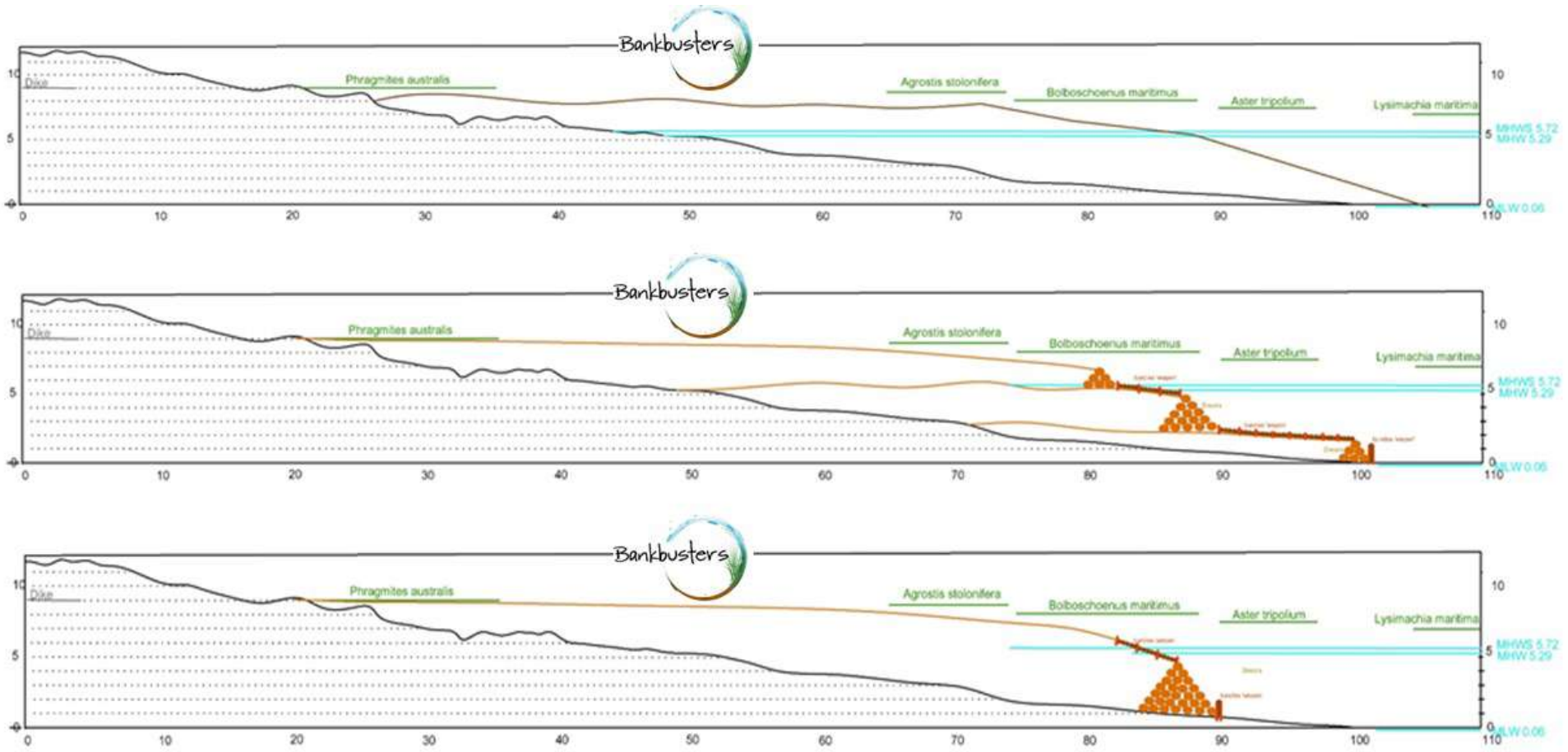
In-situ Experiments – Natural Lab Pilot Tests

Baseline Survey Ketenisse
Eroded river embankment zone

- Site exploration
- Detailed bathymetrical survey

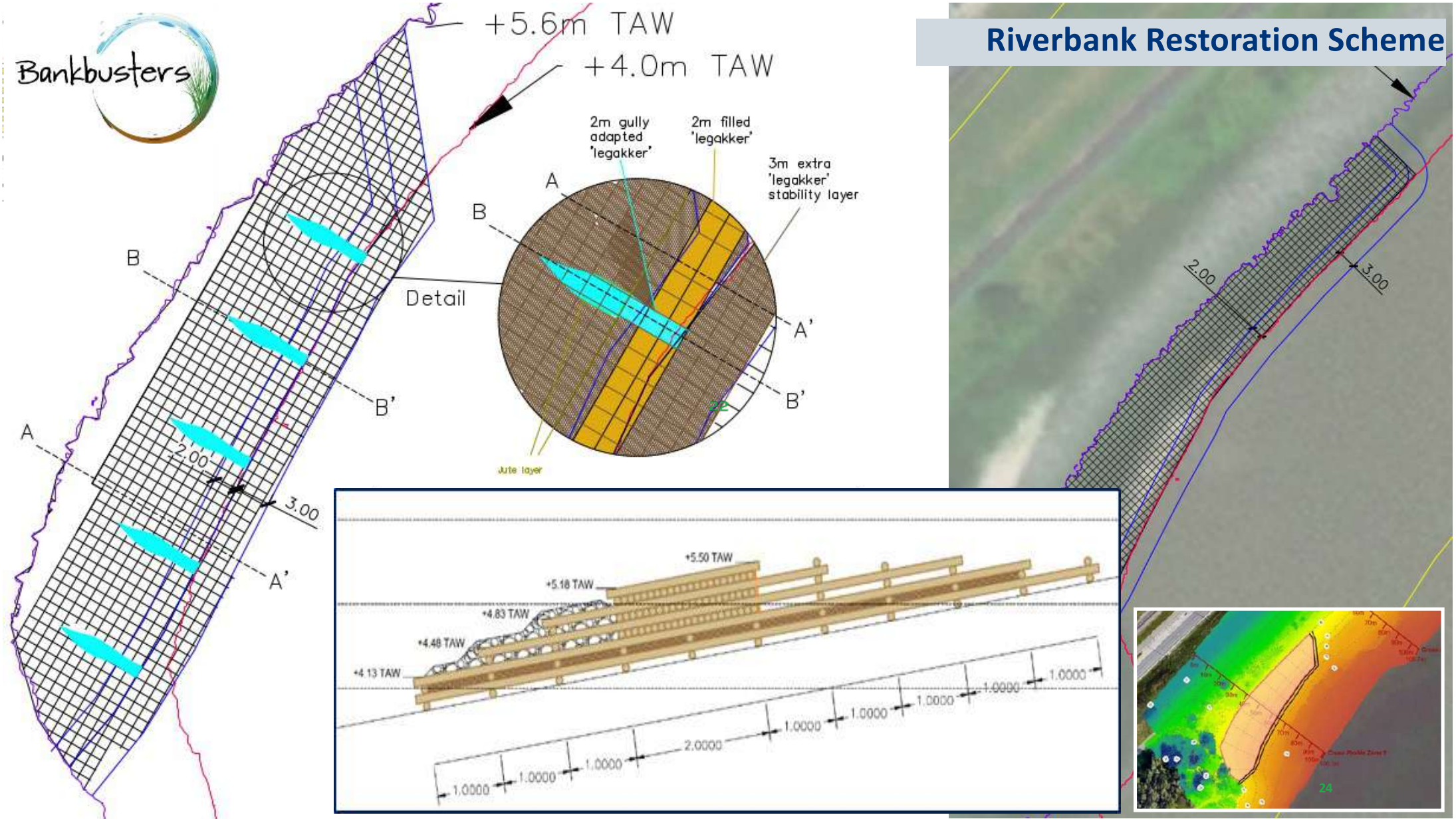


In-situ Experiments – Natural Lab Pilot Tests



- **Restore the steep vertically eroded riverbank cliffs into a stable natural marsh land embankment**

Riverbank Restoration Scheme



VAN AALSBURG BV

In-situ Experiments – Natural Lab Pilot Tests

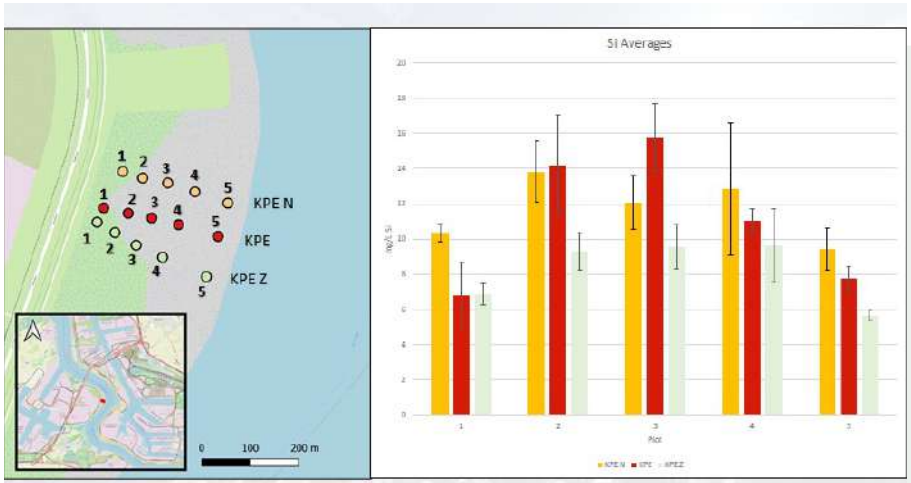
Baseline Survey Reference Marsh land

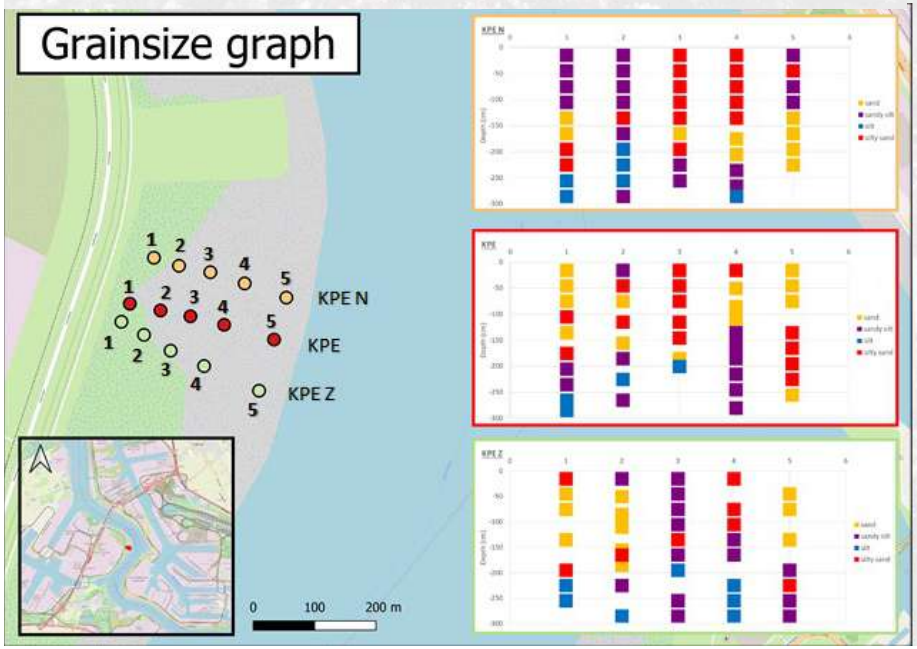
- Ecological inventory
  Vegetation coverage – root mass – soil grain size
- Subsurface hydrology
  Moisture content – Organic Matter
  Groundwater dynamics (flow-direction)
- Solutes concentrations Nutrients & Metals
  (nitrate, nitrite, iron, phosphate, silicate,..)

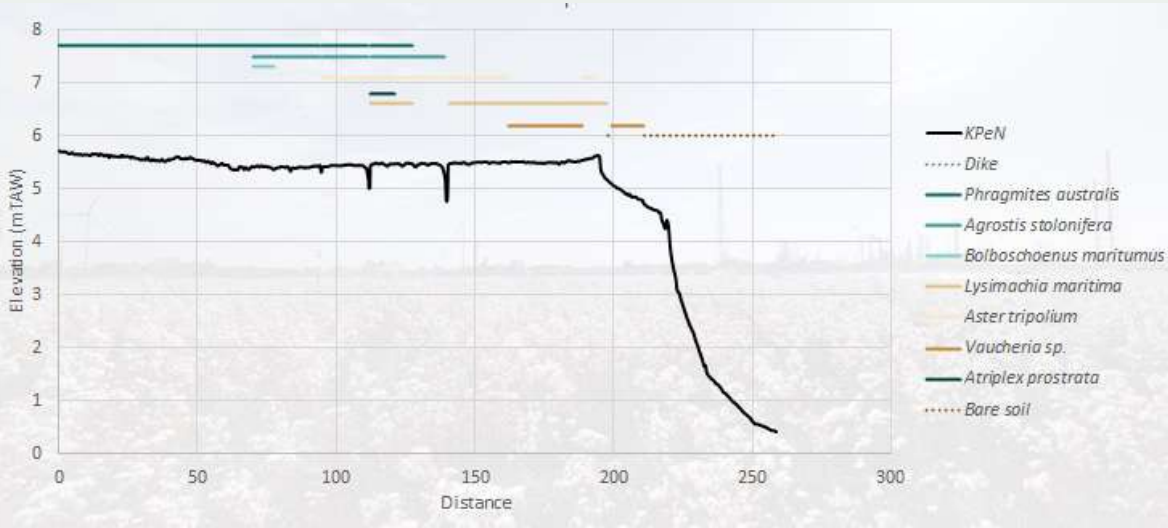
➢ ***Online & real-time recording***

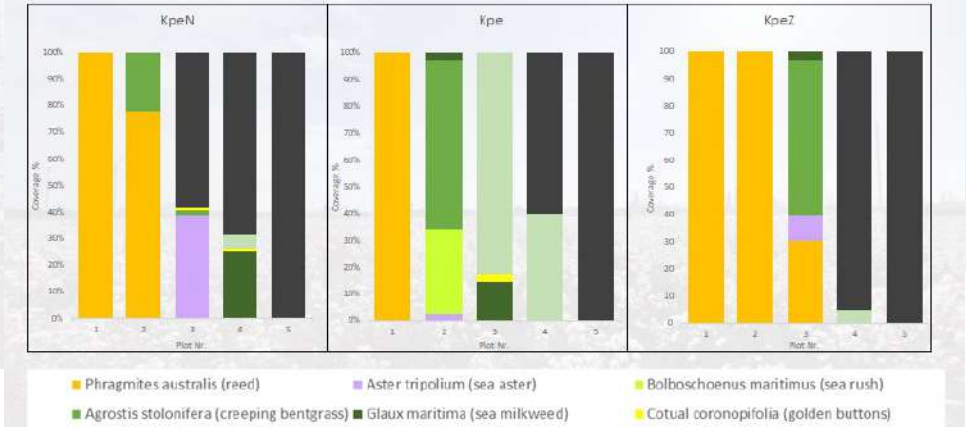
In-situ Experiments – Natural Lab Pilot Tests

Baseline Survey Reference Marsh land









Up to work…