UNIVERSITY OF CAMBRIDGE

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Geotechnical properties of salt marsh and tidal flat substrates at Tillingham, Essex

Presenting Author: *Helen Brooks.* ***Supervisors:*** *Iris Möller (Cambridge), Tom Spencer (Cambridge), Kate Royse (BGS)*

Resist UK

BLUE coast

CBESS

NERC SCIENCE OF THE ENVIRONMENT

UK vs US salt marshes

- Muddy coastal wetlands
- Flooded and drained by salt water (brought in by tides)
- Less organic in UK (compared to USA)

Tillingham Salt Marsh, Essex, UK

Tillingham Marsh

Why am I interested?

- Salt marshes are important

  -ecologically

  -biogeochemically

  -for flood defence

Tillingham Marsh.

- So, we want to understand how these landforms function now

- Then model how they might evolve in future (under climate change)

  -This is vital for future coastal defence planning

Why am I interested?

- Salt marsh stability is key

  -resistance to erosion

  -increase in surface elevation a rate commensurate with sea-level rise

- Resistance to erosion

  -surface resistance

  -resistance of material at marsh edge

Tillingham Marsh.

- Marsh evolution models require improved parameterisation

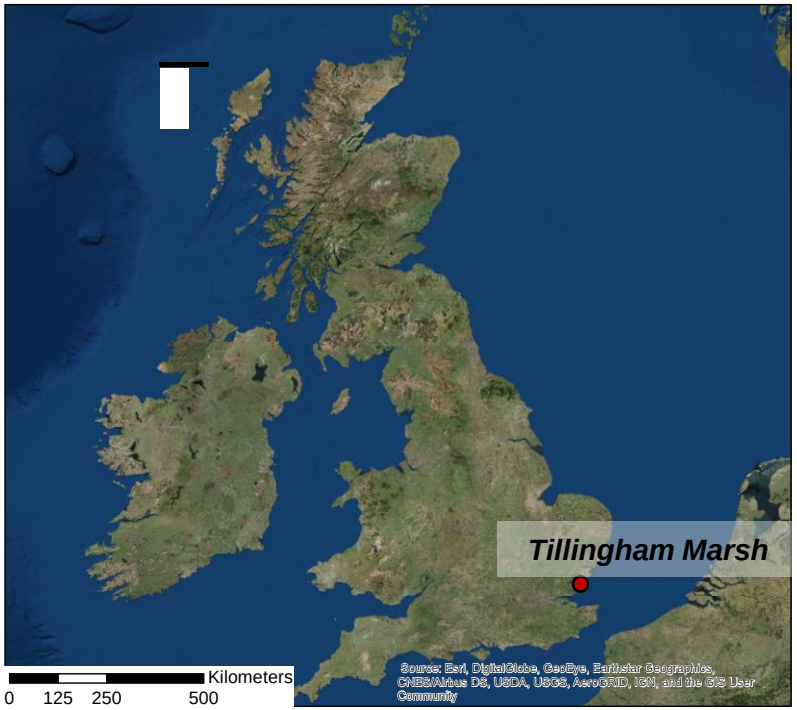
Sediment properties

- Characterise sediment properties (composition and behaviour)
  - Particle size
  - Organic content
  - Shear strength
  - Consolidation
  - Clay vs. silt behaviour (cohesive vs non-cohesive)

Cores taken at Tillingham Marsh (Sep 2017).

- Compare sediment properties to vertical and lateral erosion rates

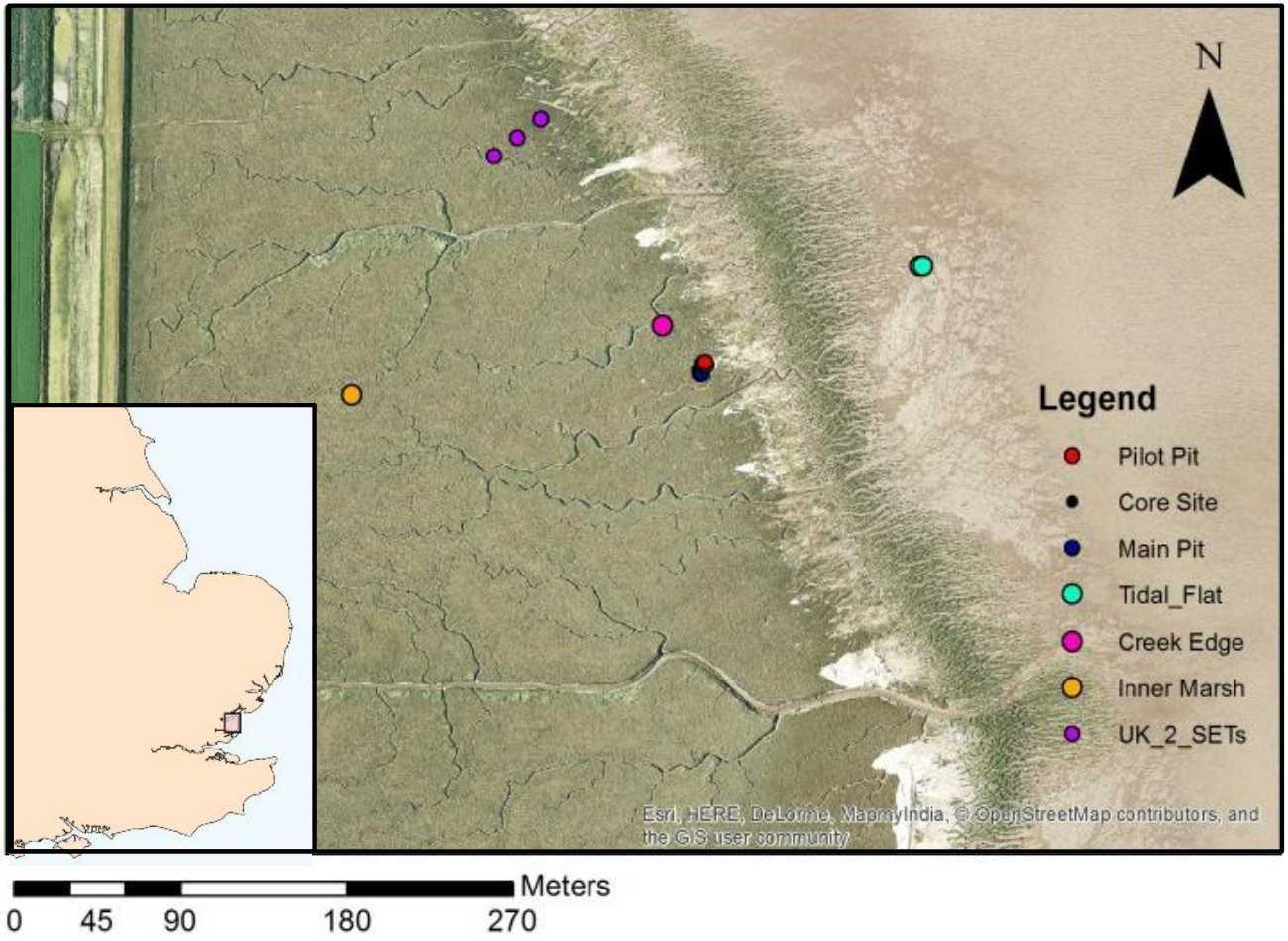
Field site



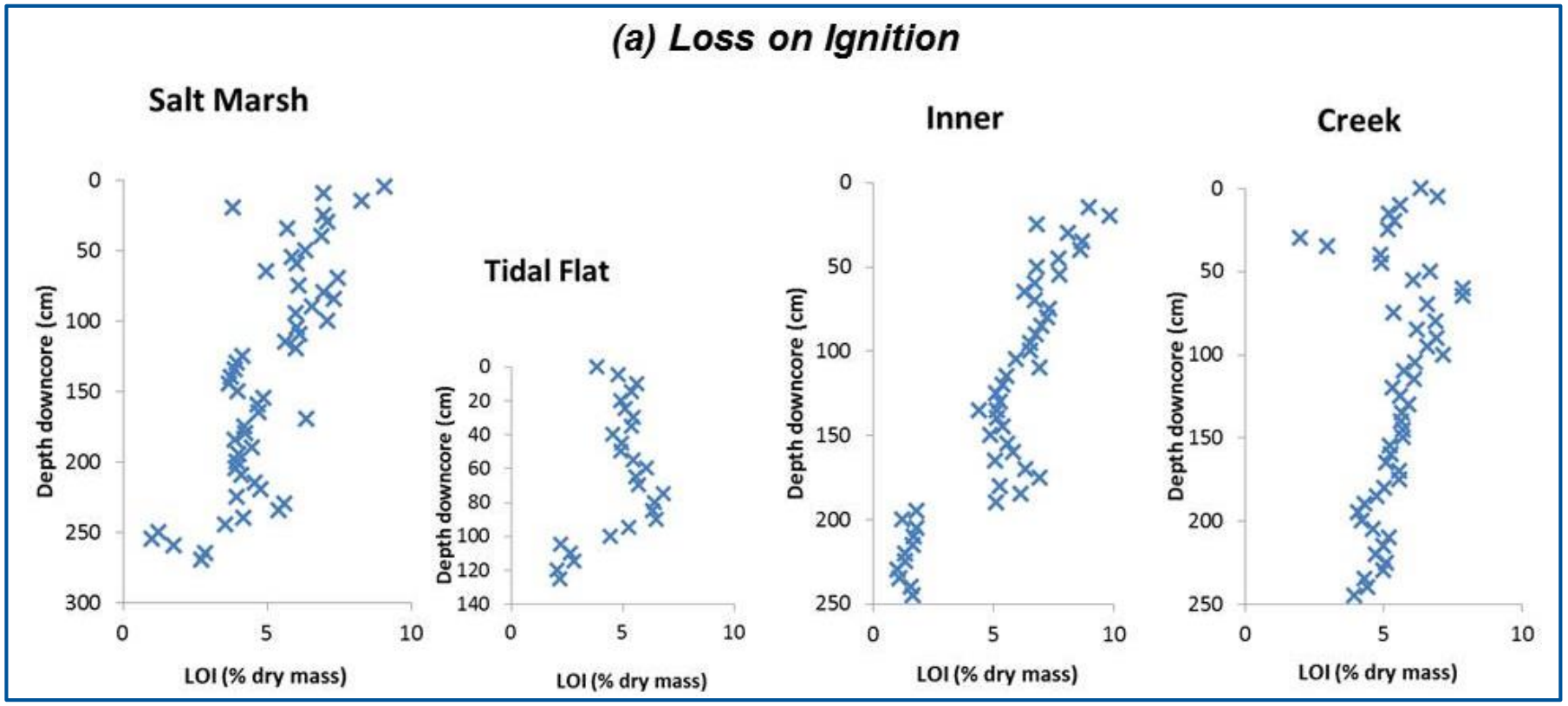
Tillingham Marsh (September 2017).

- Cohesive properties
- Fine sediment (silt-clay)
- Open coast

Field Site


N
Legend
Pilot Pit
Core Site
Main Pit
Tidal_Flat
Creek Edge
Inner Marsh
UK_2_SETs
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Meters
0
45
90
180
270

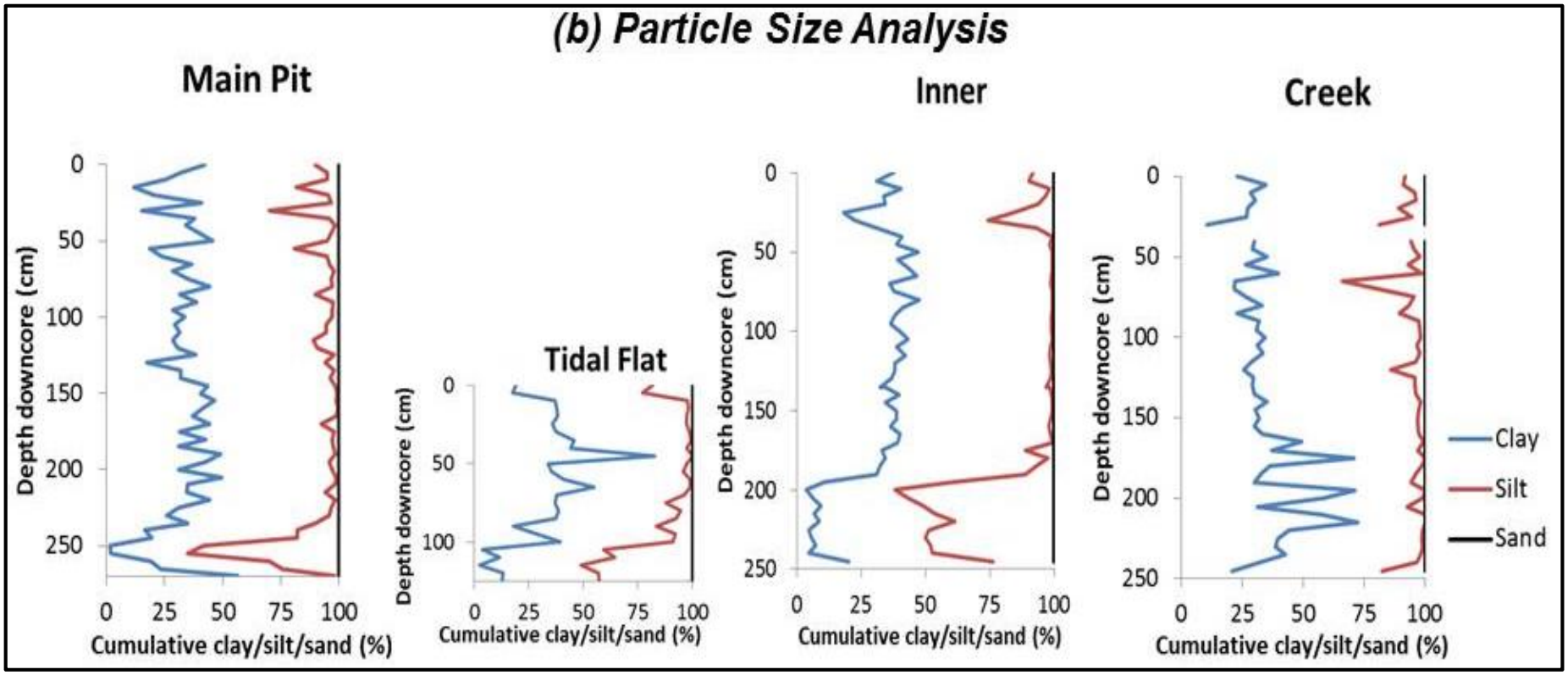
Composition



Loss on Ignition from Tillingham Marsh cores taken in September 2017

- Variable LOI in upper core, lower LOI at base

Composition



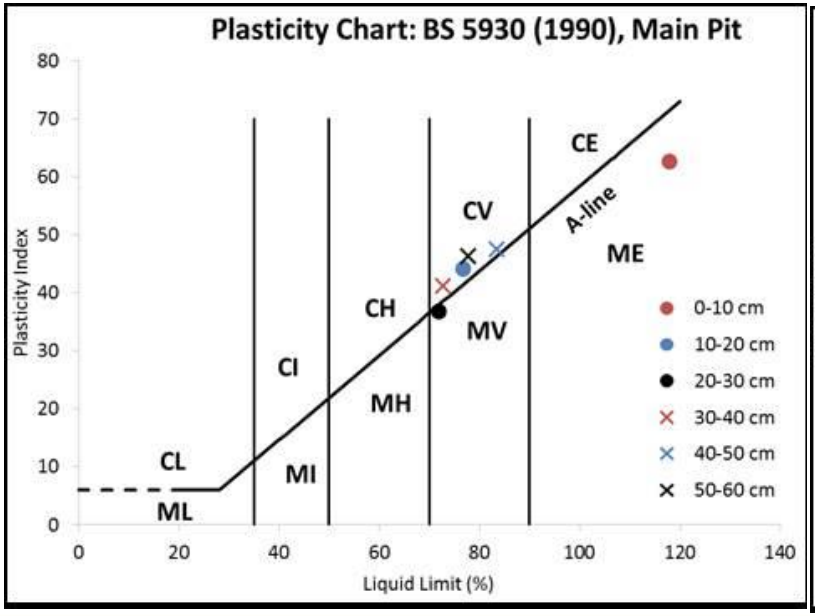
Particle Size Analysis from Tillingham Marsh cores taken in September 2017

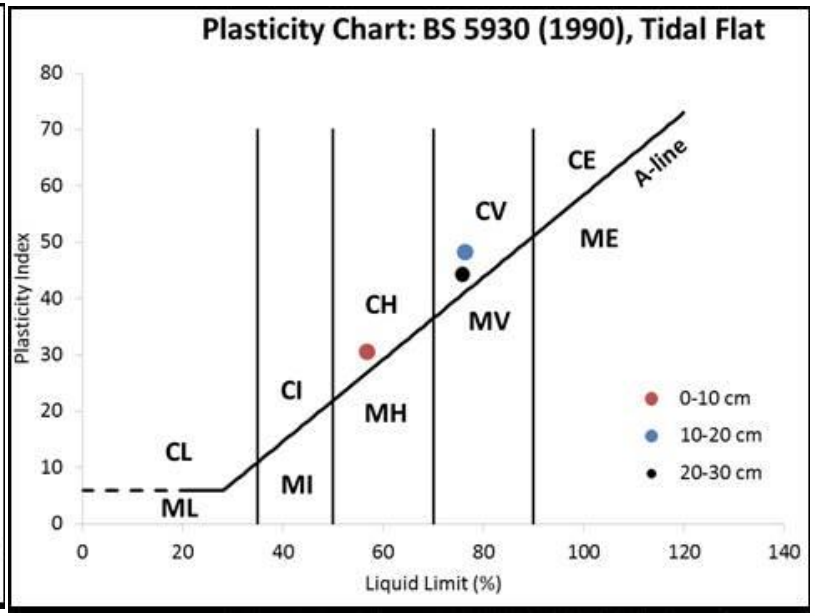
- Fluctuating clay/silt/sand in upper core, sandy base layer.
- Generally low sand content (at least until base layer).

Behaviour

Cone penetrometer, used to calculate liquid limit (a). Example sample for liquid limit testing (b).

- High/very high plasticity clays on marsh, slightly lower plasticity on the mudflat
- All values plot close to the A-line-mixture of clay- and silt-type behaviour.
- No consistent variation with depth





Plasticity Charts for main marsh site and tidal flat site.

Fieldwork-undisturbed sampling

- ‘Undisturbed’ conditions

- Subsample further in lab

Fieldwork-undisturbed sampling

Salt marsh sample extraction (Sep 2017).

Lab work

Taken: Oct 2017.

Taken: Aug 2017.

Lab work-shear box test

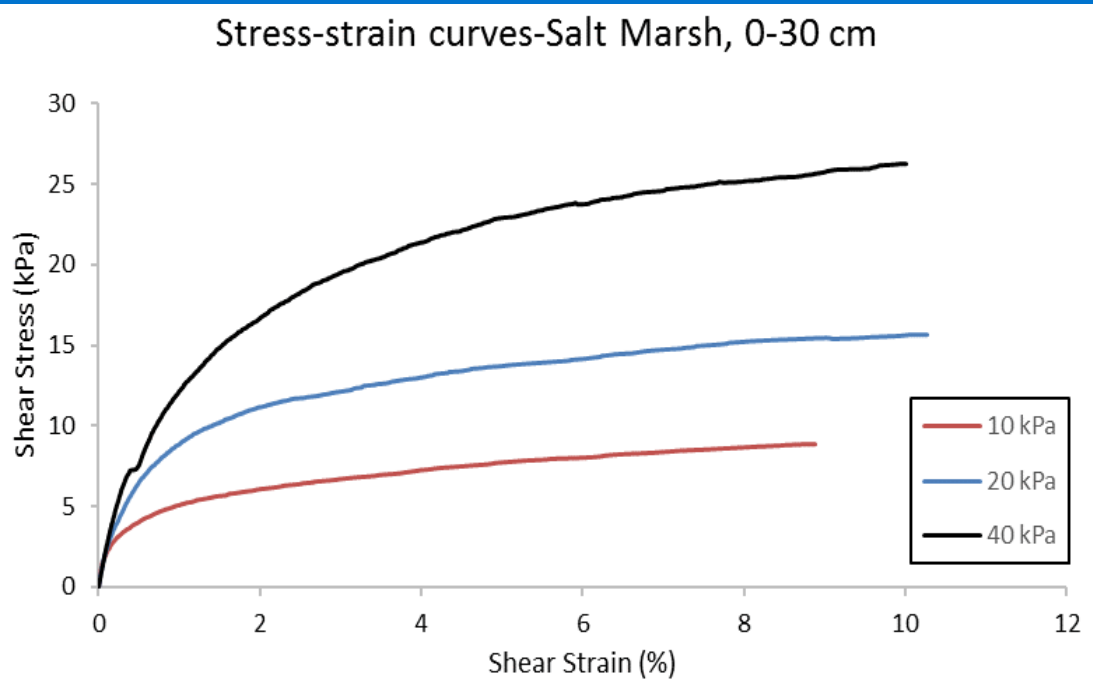
- Quantify shear strength
- Understand material behaviour
- Understand compressive properties
- Aim: to understand the resistance of the marsh surface and vertical profile, to erosive forces.

Sample preparation for shear box test. Taken: Feb 2018.

Shear plane created by shear box test. Taken: Dec 2017.

Shear Box Test

- Ductile behaviour
- Frictional strength has greater importance on the mudflat
- Cohesive strength is relatively more important on the marsh



Sample ID	Cohesion (kPa)	Friction Angle (°)
Marsh, 0-30 cm	3.56	29.8
Marsh, 30-60 cm	5.68	29.9
Tidal flat, 0-30 cm	0	36.1

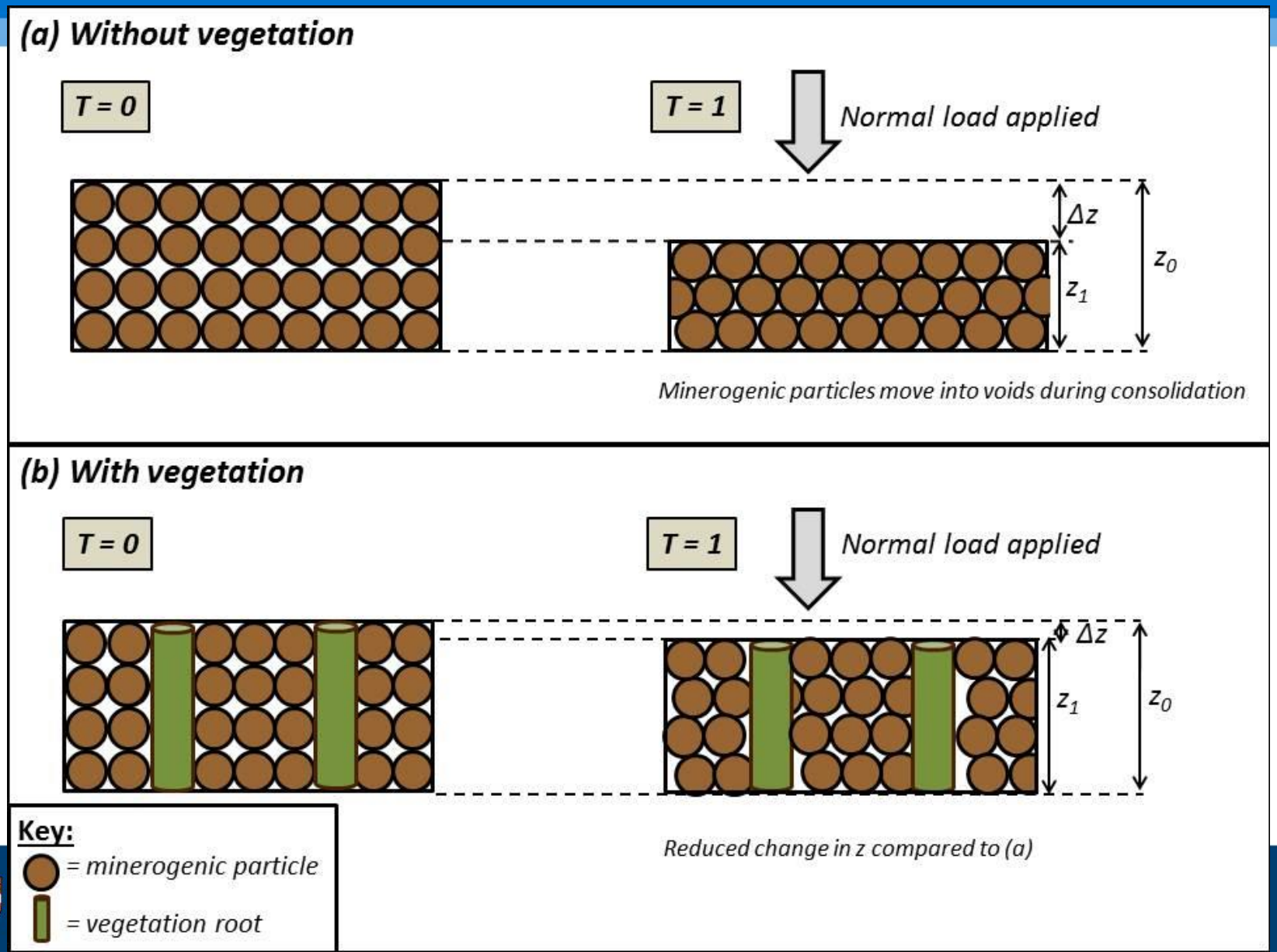
Shear box test results for the main marsh site.

Cohesive vs frictional strength?

- The strength of a soil can be divided into two types:
  - Cohesive strength
    - Electrostatic forces
  - Frictional strength
    - Interlocking of particles

Tillingham Marsh (Taken Sep 2017)

Why do we see these results?



Relation to marsh evolution

- Mapping on aerial photographs
- Measurements of vertical marsh change
- Flume experiments (RESIST-UK and Hydralab+)
- Comparison with non-cohesive site in Morecambe Bay (North West England)

GWK flume, Hannover.
Source: https://www.fzk.uni-hannover.de/

Summary

- Understanding of how salt marsh and tidal flat substrates affect resistance to erosion is poorly understood
- Sediment cores show evidence of a base layer
- Undisturbed samples allow testing of in situ shear strength
- Tidal flat substrates seem to have greater frictional strength at Tillingham, UK

Any questions?

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Twitter: @hbrooks94