Species-dependent variation in geotechnical properties and erodibility of salt marsh sediments


https://youtu.be/4ZoPBfm2aBY
Hypothesis: Halophytes modify sub-surface structure $\rightarrow$ alter response to hydrodynamic forcing $\rightarrow$ modulate erosion

Use insights to better map salt marsh vulnerability to erosion

Approach

Multispectral UAV mapping, ground survey, satellite image analysis

Micro-CT scanning, Segmentation, Topological characterisation

Integration with Coastal Vulnerability Index (CVI)

Geotechnical field and lab tests, Geochemistry, Sedimentology, Flume experiments

https://www.bgs.ac.uk/products/geohazards/coastalVulnerability.html

(D1196 | EGU2020-10298)

(D1200 | EGU2020-17681)
**Findings 1: Field**
Root morphology varies with species,
Shear strength of underlying sediments in the root zone (measured by shear vane) varies with species

Sites:
WS = Warton Sands (sandy)
TF = Tillingham Farm (muddy)

Surface Cover Types:
BARE = Bare Ground
PUC = *Puccinellia*,
SAL = *Salicornia*
SPA = *Spartina*

- Effect of species appears greater at WS than TF
- PUC associated with the highest shear strengths
- BARE has lowest shear strengths

All treatments separable \((p<0.05)\) except
TF_BARE:TF_SAL, TF_BARE:TF_SPA,
TF_SAL:TF_SPA and TF_PUC:WS_BARE
Findings 2: Lab

Undisturbed samples analysed in the geotechnical laboratories (British Geological Survey)

Presence of roots emulates an increase in cohesion, with PUC having the strongest influence

Coarser sediments (WS) have higher friction angles and lower cohesion than fine sediments

Presence of SPA in fine sediments emulates a higher friction angle

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Shear Box test

Triaxial sample

Triaxial test

\[ \sigma_1 = \text{Major principal stress} = \text{Axial stress } \sigma_a \]

\[ \sigma_3 = \text{Minor principal stress} = \text{Radial stress } \sigma_r \]

\[ q = \text{Deviator stress} = \frac{F}{A} = \frac{A}{A} \text{ Axial load/Area} \]

\[ \sigma_t = \text{Major principal effective stress} = \sigma_a - u \]

\[ \sigma_s = \text{Minor principal effective stress} = \sigma_3 - u \]

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celtest.com
Upscaling: Mapping of vegetation cover type using multispectral UAV data

Inference of patterns of vegetation-induced modification of geotechnical characteristics

Conclusions and Further Work:

- Different halophyte species have different root network morphologies
- Vegetation presence and type modify the geotechnical characteristics of marsh sediments in the lab and field
- The “vegetation effect” appears to be stronger in coarser sediments
- Multispectral UAV data useful for mapping salt marsh vegetation
- Further work needed to understand how the differences in geotechnical parameters translate into different vulnerabilities to erosion (D1202 | EGU2020-510)
- Further work needed to gain mechanistic understanding of vegetation effect on subsurface structure and properties – inc. geochemistry