3D characterization of Holocene peat to quantify and predict coastal-deltaic land subsidence

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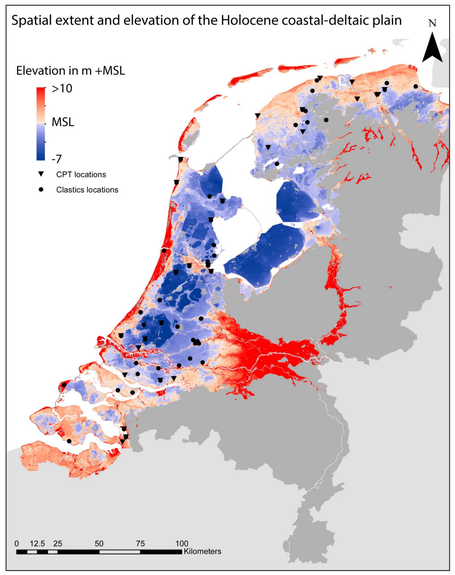
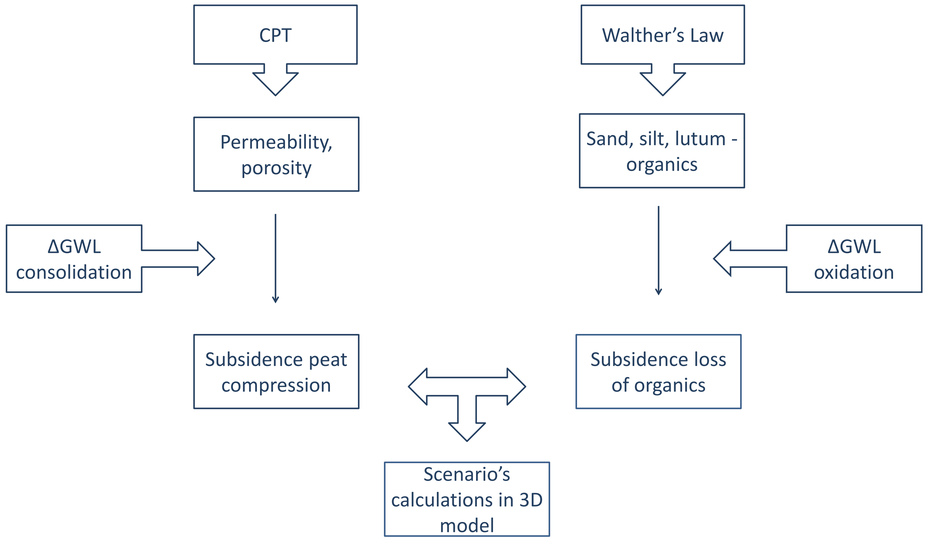
Introduction and Motivation

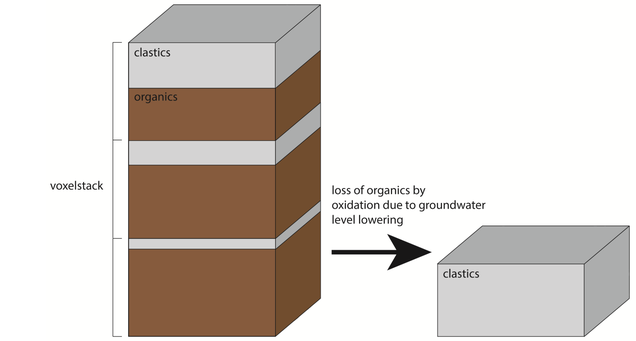


- Vast areas of the Dutch coastal plain subsided below MSL by peat compression and oxidation.
- Approximately 17 km^3 of peat is still situated within the subsurface, making the area vulnerable to future subsidence.
- Subsidence occurs when vertical stresses are changed by groundwater level lowering and loading.
- Predicting the susceptibility of the area to subsidence, and spatial variability herein, is important for stakeholders regarding water management and land use.
- We present preliminary results of a 3D modelling procedure predicting subsidence in the Dutch coastal plain by peat compression and oxidation.



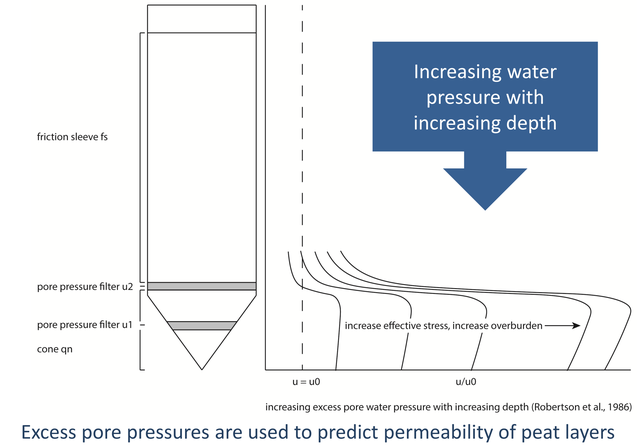
Oxidation approach

- Aeration of peat causes decomposition of organic material, leaving a residue of clastic admixture.
- We map per peat-voxel the percentage of lutum, silt and sand, to determine the volume loss of organic material after oxidation, based on a large grainsize and organic matter dataset
- We use a 'Walther's law of facies' approach to predict clastic admixture based on stratigraphic position and thickness of the peat.



Consolidation approach

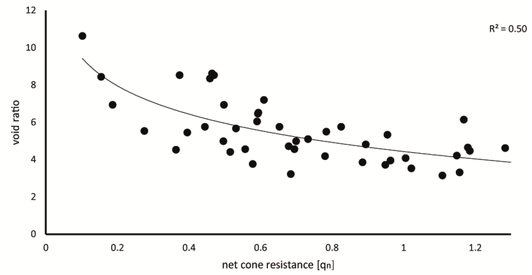
- We use Cone Penetration Testing (CPT) to predict porosity and permeability of Holocene peat layers.
- Thousands of CPTs are stored in a national database, and will be used to interpolate permeability and porosity of peat voxels lacking direct measurements.
- We use excess pore water pressure generated around the cone to predict permeability. Increased stiffness by compression to predict void ratios.



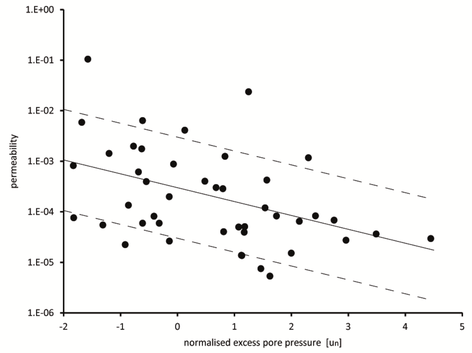
increasing excess pore water pressure with increasing depth (Robertson et al., 1986)

Excess pore pressures are used to predict permeability of peat layers

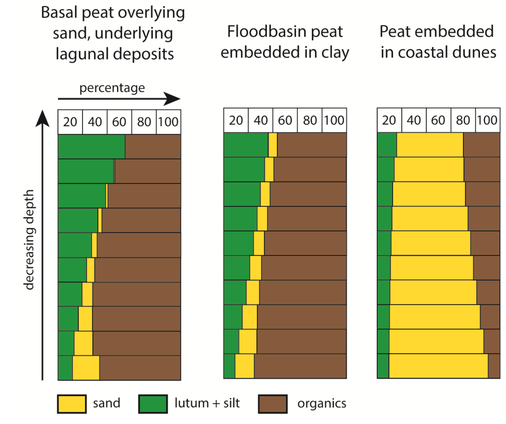
Results and conclusions



- Net cone resistance increases with decreasing porosity.
- Decreasing porosity with depth, increases stiffness of peat.



- Normalized excess pore pressure increases with decreasing permeability.
- Excess pore water pressures experiences more resistance during dissipation with deeper buried peat layers.



- Clastics increase upwards in peat sequences, i.e. when distance to clastic source (river, lagoon etc.) decreases.
- Thick peat was more distal to a clastic source than thinner peat, and hence is more organic.
- Bioturbation in underlying sand is the source of sand in bottom of peat.

Work in progress

- 3D interpolating of CPT values to assign each Holocene peat voxel with permeability and porosity.
- Assigning Holocene peat voxels with percentage of clastic admixture based on their thickness and stratigraphical position.
- Run future scenario's of groundwater level lowering and calculate land subsidence by oxidation and consolidation.
- Analyze spatial variability in amount of subsidence, and subsidence rates.