A new soil mechanics approach to quantify and predict subsidence by peat compression

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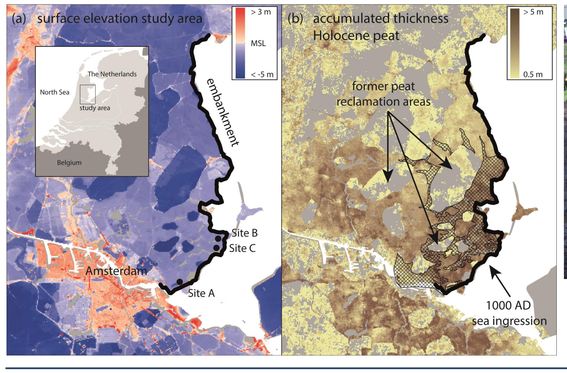
Introduction and motivation

Example of subsidence in a former coastal-deltaic wetland, near Utrecht, western Netherlands

- c. 50% of the Dutch deltaic-coastal plain subsided below MSL, primarily by changes in vertical stress in peat.
- Data and methods to quantify past- and predict future subsidence are sparse.
- New approaches are necessary.

Study area

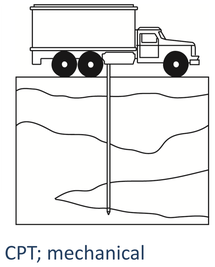
We focus on a differentially loaded peat layer in the coastal plain of Holland. The peat is overlain by marine sediments and an embankment. The differential loading resulted in differential compression. Compression leads to tightening of the fibers, increasing the stiffness of the peat. We use current stiffness of the peat as a proxy for past- and future compression.



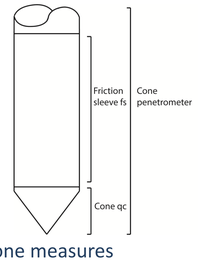
Enclosure of the examined peat layer at Site A.

Methods

We use Cone Penetration Testing (CPT): the more compressed and stiff a peat layer, the higher the mechanical resistance it will provide during sounding.



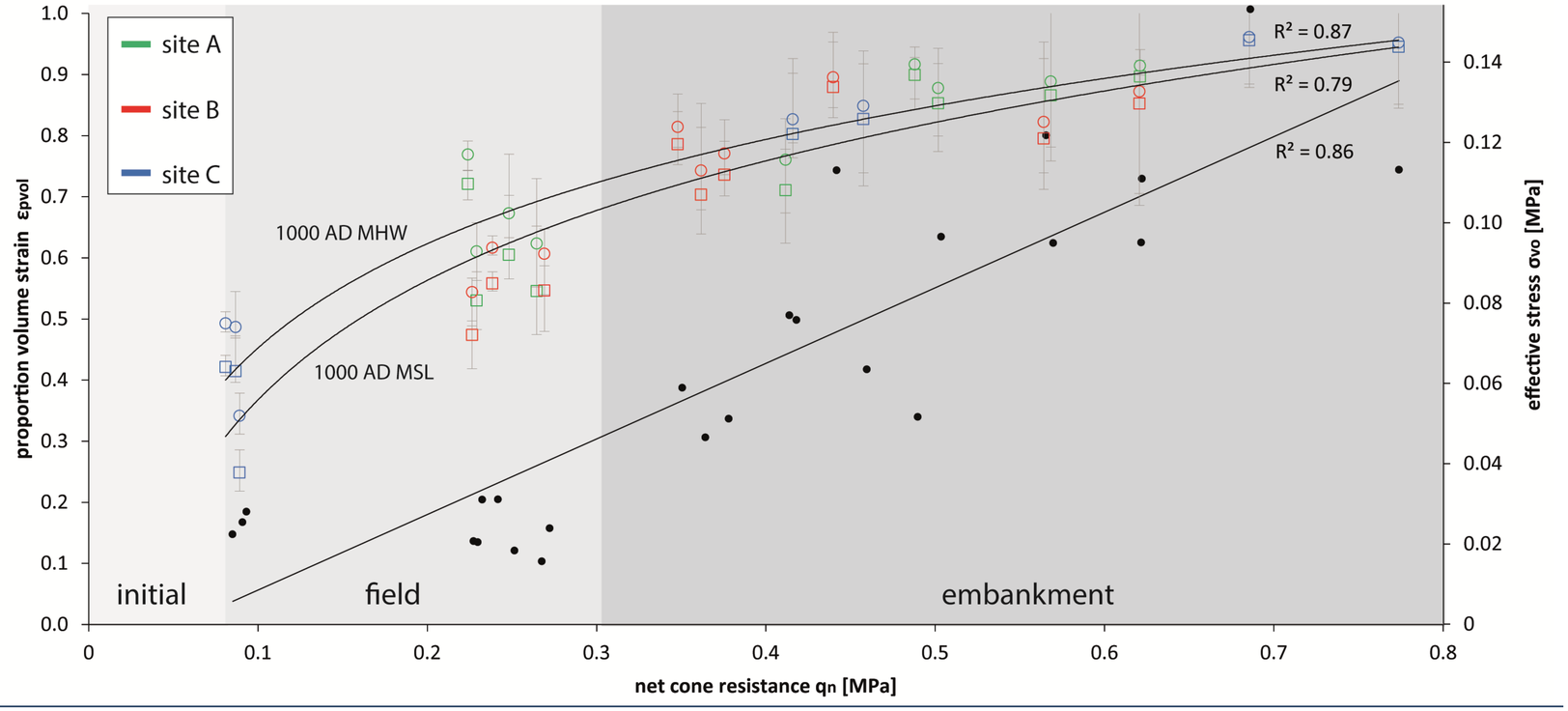
CPT; mechanical properties are sounded every 2 cm



Cone measures mechanical resistance at its tip and sleeve [MPa]

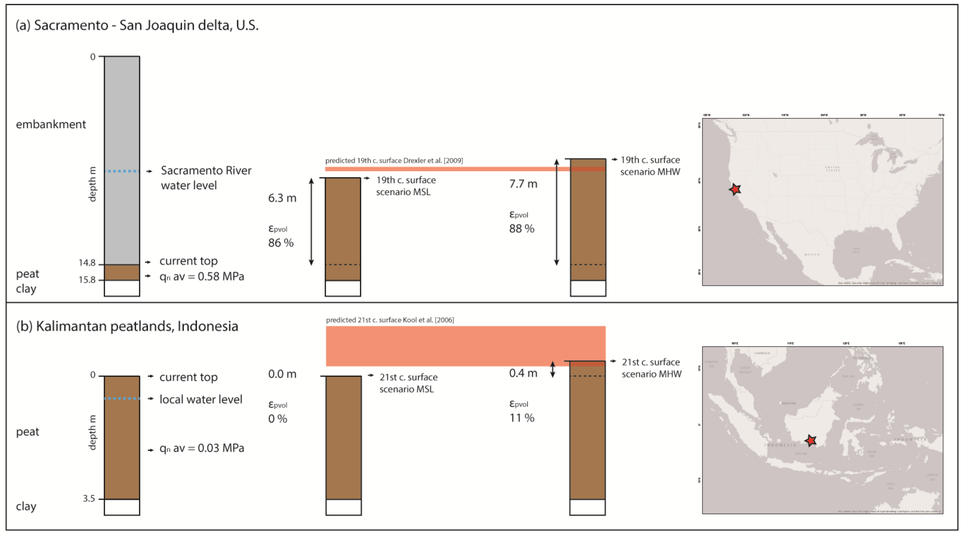
Results

The peat lost between 20 – 95 % of the initial volume it possessed during Holocene coastal-deltaic built-up. This is related to an increase in net cone resistance of 0.10 – 0.78 MPa. The net cone resistance increases linearly with effective stress (black dots).



Application in other peat-rich subsiding hot-spots

We applied the relation between net cone resistance and peat compression to reconstruct past volume loss in two penetration tested peat-rich subsidence hot-spots, and found convincing similarities with other reconstruction.
studies.



Conclusions

- CPT predicts past peat volume loss by changing vertical stress, by using stiffness as a proxy.
- It can be used to determine maximum future volume loss of peat layers.
- The obtained relations are generic and applicable in other areas.
- It can be used as ground truthing for geodetic and satellite measurements.