Unravelling the architecture of Chinese mitten crab burrows using non-intrusive techniques

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The Chinese mitten crab (*Eriocheir sinensis*) is listed as one of the 100 worst invasive species globally. This species is known to have severe ecological and economic impacts. One of the impacts that is often brought up is its burrowing behaviour, although the impact of their burrows on the environment has never been studied in detail. We hypothesize that in marshes, high burrow densities increase the erosion of creekbanks (due to increased lateral erosion and mass failure) and alter the functioning of the marsh in terms of water purification, porewater fluxes and nutrient cycling.

In order to assess their effects, we first need to characterise what is there: the morphology of the burrows, their interconnectivity and the extent of crab burrow networks. Typically, the morphology of burrows is studied by making epoxy casts. However, this method is not suitable to quantify the attributes of the burrow network on a larger scale. Moreover, it is very destructive to excavate the casts and therefore this method is not appropriate in the natural areas that are studied in this project.

The objective of this study is to map and measure the architecture of the burrow network in a non-intrusive manner using structure-from-motion photogrammetry and ground-penetrating radar (GPR). The methods are tested in both a natural and a restored tidal marsh in the Scheldt estuary. The soil of the restored tidal marsh was historically compacted by agricultural equipment, while the soil of the natural tidal marsh consists entirely out of tidally deposited sediments. We hypothesized that the crab burrow network would be more extensive in the compact subsoil of the restored tidal marsh, compared to the more loosely packed soil in the natural marsh.

In each field site, six creekbank sections of 3 m length were studied. At each section, soil samples were taken to characterise the physical properties of the soil (including; dry bulk density, moisture content, grain size distribution and organic matter content). Based on photogrammetry, 3D models of every creekbank section were created in Agisoft Metashape every two months over a one year period. From the time series of 3D models of every section, the changes in the number of burrow openings, their morphology and the topography of the bank can be assessed over time. GPR is a method to image the soil subsurface based on the reflection and scattering of electromagnetic waves by the soil. The propagation velocity of the waves is determined by the relative permittivity contrast of the soil. This means that a change in soil properties (e.g. the presence of crab burrows) alters the time that the wave travels through the soil profile, which can be used to calculate the depth of a change in soil properties. The GPR data is processed and converted into 3D volumetric representations of the crab burrow network.

As expected, the compact soil of the restored tidal marsh can harbour larger crab burrow densities compared to the natural tidal marsh. Preliminary results indicate that photogrammetry is a suitable method to map the surface of creekbanks and allows the evaluation of temporal variation in burrow openings and topography of the bank. A downside of the technique is that it is time-consuming to construct a high-quality model. The wet and clay-rich environment of the tidal marshes proved to be a difficult set-up for the GPR, however, the first trial was successful. Further analysis of the data will provide more knowledge about the case-study of the bioturbation by the Chinese mitten crab. Ultimately, the insights gained in this project by testing the techniques in new environments can be applied to other bioturbating species as well.

Keywords
Invasive Species; Photogrammetry; Ground-Penetrating-Radar; Tidal Marshes