Call for proposals for a Master's thesis on the topic:

Carbon quantification of aboveground woody biomass of urban forest gardens by TLS point cloud analysis

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The project "Urban Forest Gardens" is a pilot project testing the concept of forest gardens in Berlin and Kassel. The joint project with 3 practice partners is coordinated and scientifically accompanied by the University of Potsdam. The research and implementation of the project is funded by the German Federal Program on Biological Diversity from April 2021 to March 2027.

Climate change and the loss of biodiversity are widely regarded as the greatest ecological challenges of our time. In contrast, the Urban Forest Gardens (UFG) project, develops forest gardens based on agroecological principles as a novel, multifunctional green space and explores the combination of social and environmental benefits. UFG bring benefits not only by providing environmentally sustainable food production, but also by supporting local nutrient cycling, soil and water conservation, microclimate modification, and sequestration of carbon in the form of wood, which is considered an effective tool for mitigating climate change. They can have a positive impact in urban areas in terms of the prevalent water cycle disturbance, climate change, and habitat and biodiversity loss. Forest gardens are structurally designed to resemble multi-layered forest edges. A forest garden is an edible polyculture landscape with different layers of mostly perennial vegetation. UFGs have the ability to contain diverse, biologically important, and culturally relevant tree species that are not used for forestry. Forests sequester large amounts of atmospheric carbon dioxide (CO_2) annually and store carbon above and below ground for long periods of time. The large proportion of woody plants in UFGs means that carbon storage is potentially high compared to other green spaces.

There have been research approaches to quantify the potential of agroforestry systems as carbon sinks, that have focused for the most part on the contribution of larger trees, relying only on allometry methodology rather than direct measurement of woody vegetation matter. In addition, there is still only a few forest gardens and food forests in temperate cities, so much research is needed.

With new developments, there are now different approaches to carbon quantification. The latest technologies in remote sensing and data analysis can reduce the cost of data collection while improving accuracy. LiDAR is an active remote sensing method that uses laser beams to measure the distance between an object and the carrier platform. The data sets (3D point cloud) obtained with LiDAR can help determine the three-dimensional (3D) structure of tree features, including tree heights and canopy metrics.

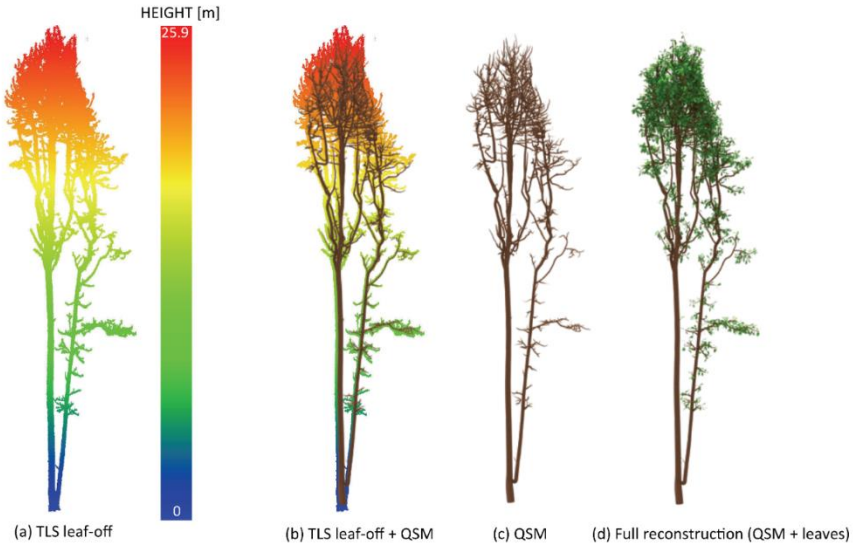

Abbildung 1: Reconstruction of a Sycamore (Acer pseudoplatanus) tree. (**a**) TLS leaf-off point cloud coloured by height (note that this multi-stem tree splits below 1.3 m and is therefore considered to be two trees in the analysis); (**b**) TLS leaf-off point cloud overlaid with QSM; (**c**) QSM; (**d**) Fully reconstructed tree: QSM + added leaves. (Calders et al., 2018)

Within this master thesis, the aim is to investigate how to infer carbon storage from a 3D point cloud (TLS generated). A semi-automated procedure, based on a combination of existing methods, will be developed with the goal of applying the process to other datasets of UFGs. The procedure should include: an algorithm for automatic single tree detection with highest segmentation accuracy, determination of wood volumes using quantitative structural models (QSMs), AGB (above-ground biomass) determination by adding species-specific wood densities from databases, and thus ultimately deriving carbon content.

Comparison to other methods to assess and evaluate accuracy, suitability, and workload is useful. Development / exploration of less complex survey methods (suitable for Citizen Science) is also an option as an extension of the work (working with Ipad scans).

The candidate should have interest and basic knowledge in geography/geoecology and enjoy working with datasets.

For the Master's thesis, we are looking for a candidate with a background in remote sensing, geoecology, or geography with knowledge of remote sensing methodologies. Especially experiences with point cloud processing, as well as working with models and programming languages (R, Python) is an advantage.

Start date: mid-August 2023 with insight into field work.