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Patterns of plant Si stocks in a heterogenous catchment – improvements by high resolution, drone-based remote sensing

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Plants play an important role in global Si cycling. Up to now most studies on Si pools and dynamics in plants are related to the scale of pedons/sites (few m2) due to the high effort and technical limitations. In consequence, aspects of spatial heterogeneity in the soil-plant-system, e.g. at catchment scale, had to be negelected in most studies. In recent years emerging remote sensing techniques, mainly drones (“Unmanned Aerial Vehicles", UAS), offers new opportunities for a large-scale, high resolution and spatially explicit imaging of plant canopies, including species distribution and their biomasses.
Here we present results from the 3 ha artificial catchment “Hühnerwasser” (E-Germany) with a dominance of two Si accumulators, namely Calamagrostis epigejos and Phragmites Australis. By multispectral imaging of our fixed-wing UAS Carolo360 we derived vegetation patterns spatially explicit and with very high resolution (few cm). Vegetation indices (NDVI) were calculated from the multispectral images and plant biomasses derived from correlation with ground truthing plant biomasses (n=24 sites). Si contents of different plant species (mean Si content: 2.1% Si in C. epigejos, 2.4% Si in P.australis) differed only slightly between sampling locations. Hence, Si stocks could be determined by multiplying plant biomass (g m-2) with Si contents. As a result we derived a spatially explicit distribution of plants’ Si stocks. A surprisingly high storage of 158 kg Si ha-1 was observed at catchment scale. Furthermore, three clearly distinguishable spatial zones of plant Si stocks could be identified, mainly as a result of a different nutrient and water supply. The presented high resolution drone-based approach was cost efficient and is easily applicable to other ecosystems (grasslands, arable land). It opens a new window to derive the aboveground Si pool of plants multi-annually, e.g. to calculate annual rates of Si accumulation.