Ground-truthing of satellite-based forest condition products using precise tree positions

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Forest ecosystems face numerous challenges due to changing climatic conditions which lead to more frequent occurrences of extreme meteorological events, including prolonged dry spells. This increases tree vulnerability to both biotic and abiotic pressures. The Europe Forest Condition Survey is a response to these changes and aims to adapt and improve methods for assessing tree vitality. A key development is the integration of modern GNSS technologies to validate remote sensing products of tree vitality at the individual tree level.

During several-months field campaign, precise RTK GNSS geo-coordinates, diameter at breast height and tree height, were collected, additionally to the annual visual assessment of crown defoliation in the plots of the Forest Condition Survey. Different satellite-based forest vitality products were intersected with the tree positions. Analyses at the individual tree scale also consider crown extents and their overlap with remote sensing pixels. All remote sensing products were derived from the Sentinel-2 satellite mission with spatial resolutions ranging from 10 m to 20 m, and a temporal coverage starting from 2016/2017.

During the field survey in 2023–2024, 1,600 tree positions were collected across Thuringia, Mecklenburg-Western Pomerania, and Baden-Württemberg. A first simple point-based intersection showed only a very weak relationship between the survey-based single-tree defoliation and satellite-based forest condition indices (R^2 = 0.03). We explain this with poor spatial representation of the assessed individual trees in the relatively large Sentinel-2 pixel. We currently examined the relation between the defoliation observations and the remote sensing products can be improved by explicitly considering the spectral mixture caused by the multiple trees located in each pixel.