



## Editorial: Remote and Proximal Sensing of Grasslands

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Even a short glance at the Web of Science clearly shows that research interest in grassland and remote sensing for monitoring purposes has increased significantly since 2010. Furthermore, research activities in using Unmanned Aerial Vehicles (UAVs) for grassland monitoring have risen almost exponentially since 2015, with first studies using remotely controlled fixed wing or helicopter UAVs dating back to the 1990s. The answers to why grasslands have become of more interest are manifold. One reason is their diversity, ranging from natural grassland, over extensively used pastures and meadows to very intensively managed systems. Ecosystems connected with prairies, pampas, steppes, savannahs, rangelands, alpine pastures, silvo-pastoral systems, and many more characterize grasslands diversity and their global presence. Estimates show that 30–40% of the terrestrial land masses are covered by these grassland ecosystems. Another reason is their importance in the context of global and climate change. Soils are the largest carbon stock and the significance of grasslands in the global carbon cycle and their role as a carbon sink are well known. Furthermore, managed grasslands are an important food supplier and play an essential role in the agribusiness when it comes to producing meat, milk, cheese, wool, etc.

Considering this background, the DGPf Working Group “Remote Sensing Applications for Forestry and Agriculture” decided to initiate special sessions on remote and proximal

sensing of grasslands at the annual DGPf conference in Stuttgart in March 2020 (Stilla 2020). At the same time, the Working Group announced in 2019 a call for this special issue on the same topic. The four papers of our special issue, the presentations at the DGPf 2020 conference (2020), and the two papers of the conference proceedings clearly show the broad topics when it comes to remote sensing of grasslands. The applied sensors of the studies range from satellite to UAV sensors and include proximal sensing for grassland research.

In the conference proceedings, Schaumberger and Adelwöhler (2020) present an impressive data management system, the SpectroAnalyst, for handling spectral experiment plot data acquired with field spectroradiometers. Wachendorf et al. (2020) applied the Cubert Firefly, a hyperspectral UAV-mounted imaging sensor, to estimate forage quality and invasive species in species-rich grasslands. The authors found high  $R^2$  in forage quality estimation and established an analysis workflow to map invasive species.

In this special issue, two papers present Sentinel-2 data analysis to estimate LAI for grasslands. The first one is a study by Schwieder et al. (2020, <https://doi.org/10.1007/s41064-020-00120-1>) that show how Sentinel-2 data can be applied to map grassland parameters such as biomass and LAI. Similar results for LAI are presented by Klingler et al. (2020, <https://doi.org/10.1007/s41064-020-00119-8>) who investigated different indirect and direct methods of LAI retrieval. Both studies evaluated their Sentinel-2 data analysis using comprehensive field measurements. Wijesingha et al. (2020, <https://doi.org/10.1007/s41064-020-00121-0>) presented a detailed study on mapping invasive species in semi-natural grasslands using an object-based image analysis approach. In that study, UAV-derived RGB and thermal data in ultra-high resolution were acquired and analyzed. Finally, Lussem et al. (2020, <https://doi.org/10.1007/s41064-020-00117-w>) use a 3-year data set to investigate the potential of low-cost UAVs and RGB data acquisition for forage mass monitoring.

In general, promising remote-sensing approaches to monitoring grasslands are (1) stereo-photogrammetry to

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derive precise sward height and growth, (2) multi- and hyperspectral data analysis for forage quality and quantity, and (3) machine learning as well as combined spectral and structural data analysis. However, the spatial and temporal heterogeneity of grasslands when establishing robust estimators for monitoring purposes remains research challenges. The 2021 virtual conference of the European Grasslands Federation (EGF) picks up on the increasing importance of this topic with its title: “Sensing—New insights into grassland science and practice” (<https://www.uni-kassel.de/go/egf2021>).”

And at the DGPF 2021 annual conference in March 2021, we will again organize conference sessions on remote sensing of forestry, crops, and grasslands. Updates will be announced on the DGPF website (<https://www.dgpf.de/con/>).

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