From pixels to decisions: Uncrewed aerial vehicle remote sensing across agriculture and ecology

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Remote sensing (RS) with uncrewed (or unmanned/unoccupied) aerial vehicle (UAV) borne systems has transformed the observation of agricultural and ecological systems by providing flexible, high-resolution and time-sensitive measurements of vegetation and soil properties. Bringing UAV-borne RS into both agriculture and ecology shows how aerial images can be turned into useful information for real-world decisions. In agriculture, UAV-borne RS data can help estimate crop growth, identify stressed areas, and guide input management (e.g., fertilisation). In ecology, UAV-borne RS data can map habitats, monitor invasive species, and assess changes caused by disturbance or climate. These applications support more sustainable farming, better conservation planning and improved responses to environmental change. However, the scientific and practical value of UAV-borne RS data extends beyond producing detailed images or maps. The central challenge is to convert observations into reliable, spatially explicit information about biological processes and actionable decisions.

This keynote will discuss how UAV-borne imagery can be used to monitor crop growth, plant stress, canopy structure and above-ground biomass. Different sensors, including RGB, multispectral, thermal and LiDAR systems, will be considered in relation to their applications and limitations. Attention will also be given to the effects of growth stage, environmental conditions, sensor calibration and field sampling on model accuracy and transferability. The talk will then extend these concepts to ecological applications, including habitat mapping, vegetation monitoring, biodiversity assessment, invasive-species detection, restoration and disturbance monitoring. Recent developments in artificial intelligence, sensor integration, and UAV–satellite data fusion will be discussed, along with challenges related to uncertainty, validation, and operational use.

The keynote will argue that the future of UAV-borne RS depends on moving beyond collecting high-resolution images. The main objective is to convert pixels into meaningful, reliable knowledge that supports sustainable crop management, ecosystem conservation and informed environmental decision-making.