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Understanding Multifunctional Agricultural Land by Using Low Cost and Open Source Solutions to Quantify Ecosystem Function and Services

Joel Forsmoo (1,2), Karen Anderson (1), Richard Brazier (1), Kit Macleod (2), and Mark Wilkinson (2)
(1) University of Exeter, Penryn, United Kingdom, (2) James Hutton Institute, Aberdeen, United Kingdom

There is a need to advance our understanding of how the spatial structure of farmed landscapes contributes to the provision of functions and services. Agricultural land is of critical importance in NW Europe, covering large parts of NW Europe's temperate land. Moreover, these agricultural areas are primarily intensively managed, with a focus on maximizing food and fibre production. Such landscapes therefore can provide a wealth of ecosystem goods and services (ESs) including regulation of climate, erosion regulation, hydrology, water quality, nutrient cycling and biodiversity conservation. However, it has been shown they are key sources of sediment, phosphorous, nitrogen and storm runoff contributing to flooding, and therefore it is likely that most agricultural landscapes do not maximize the services or benefits that they might provide. The focus of this study is the spatio-temporal assessment of carbon sequestration (particularly through proxies such as above-ground biomass) and hydrological processes on agricultural land. Understanding and quantifying both of these is important to (a) inform payments for ecosystem services frameworks, (b) evaluate and improve carbon sequestration models, (c) manage the flood risk, (d) downstream water security and (e) water quality. Quantifying both of these ESs is dependent on data describing the fine spatial and temporal structure and function of the landscape. Common practice has been to use remote sensing techniques, e.g. satellites, providing coarse spatial resolution (around 30cm at 20° off nadir) and/or temporal resolution (around 5 days revisit time at <20° off nadir). In this paper we will explain how imaging data from lightweight and easily deployed unmanned aerial vehicles (UAVs) can be used to generate structure from motion (SFM) products describing the very fine detailed (<3 cm pixel resolution) structure of the agricultural environment. We will demonstrate how these products can be delivered using advanced free and open source post-processing alternatives and low cost sensors (digital cameras) and platforms (UAVs). We furthermore draw attention to the influence post-processing solutions have on the accuracy of the final product, the digital surface model (DSM), by using recently acquired data. Specifically, when applied in a structurally complex field site with irregular surface roughness patterns, over a land use gradient, from livestock grazing to agricultural crops. We will demonstrate the added value of using very fine detail data, highlighting important structural properties and patterns overlooked with coarser spatial resolution data.