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Ecosystem services - from assessements of estimations to quantitative, validated, high-resolution, continental-scale mapping via airborne LIDAR

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"Ecosystem services" defined vaguely as "nature's benefits to people" are a trending concept in ecology and conservation. Quantifying and mapping these services is a longtime demand of both ecosystems science and environmental policy. The current state of the art is to use existing maps of land cover, and assign certain average ecosystem service values to their unit areas. This approach has some major weaknesses: the concept of "ecosystem services", the input land cover maps and the value indicators. Such assessments often aim at valueing services in terms of human currency as a basis for decision-making, although this approach remains contested. Land cover maps used for ecosystem service assessments (typically the CORINE land cover product) are generated from continental-scale satellite imagery, with resolution in the range of hundreds of meters. In some rare cases, airborne sensors are used, with higher resolution but less covered area. Typically, general land cover classes are used instead of categories defined specifically for the purpose of ecosystem service assessment. The value indicators are developed for and tested on small study sites, but widely applied and adapted to other sites far away (a process called benefit transfer) where local information may not be available. Upscaling is always problematic since such measurements investigate areas much smaller than the output map unit. Nevertheless, remote sensing is still expected to play a major role in conceptualization and assessment of ecosystem services.
We propose that an improvement of several orders of magnitude in resolution and accuracy is possible through the application of airborne LIDAR, a measurement technique now routinely used for collection of countrywide three-dimensional datasets with typically sub-meter resolution. However, this requires a clear definition of the concept of ecosystem services and the variables in focus: remote sensing can measure variables closely related to "ecosystem service potential" which is the ability of the local ecosystem to deliver various functions (water retention, carbon storage etc.), but can't quantify how much of these are actually used by humans or what the estimated monetary value is. Due to its ability to measure both terrain relief and vegetation structure in high resolution, airborne LIDAR supports direct quantification of the properties of an ecosystem that lead to it delivering a given service (such as biomass, water retention, micro-climate regulation or habitat diversity). In addition, its high resolution allows direct calibration with field measurements: routine harvesting-based ecological measurements, local biodiversity indicator surveys or microclimate recordings all take place at the human scale and can be directly linked to the local value of LIDAR-based indicators at meter resolution. Therefore, if some field measurements with standard ecological methods are performed on site, the accuracy of LIDAR-based ecosystem service indicators can be rigorously validated. With this conceptual and technical approach high resolution ecosystem service assessments can be made with well established credibility. These would consolidate the concept of ecosystem services and support both scientific research and evidence-based environmental policy at local and - as data coverage is continually increasing - continental scale.