



# Ecosystem services and biodiversity of agricultural systems at the landscape scale

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Agricultural systems all over the world are key for supplying vital goods such as food, fibre and energy from biomass. These agricultural systems form the foundation of human material well-being. However, increasing intensification, monocultures and overexploitation have often led to the serious degradation of the ecosystems upon which agricultural systems are embedded. Therefore, the functioning of these systems and their

constituent biodiversity are at risk (Beckmann et al. 2019). Designing more sustainable agricultural systems requires continued research on land use strategies and management that focuses not only on the provision of agricultural commodities but also on the supply of non-agricultural ecosystem services, the conservation of biodiversity and the stable conditions needed for ecosystem functioning (Tilman et al. 2002, Swinton et al. 2007). Agricultural land uses are driven by anthropogenic and natural factors and show site-specific advantages and disadvantages (Power 2010). Agricultural activities have the potential to enhance the provision of specific kinds of ecosystem services and biodiversity, while mismanagement often leads to degraded services, declines in biodiversity and degraded ecosystem conditions (Huang et al. 2015).

Many of the fundamental processes and interactions affecting the long-term sustainability of such systems happen at the landscape scale. For example, pollination services provided by wild bees to agricultural crops increase with the amount of natural area in the farming landscape (Nicholson et al. 2017). As such, at the landscape scale, agro-ecosystems are not only suppliers of benefit for human well-being but also users of various ecosystem services, such as water and nutrient regulation, soil erosion control and pollination (Jones et al. 2016). Understanding this landscape scale is vital to our understanding of specific kinds of ecosystem interactions and, therefore, any potential land use conflicts caused by the divergent needs and preferences of stakeholders across a landscape.

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The same management can have different consequences according to the site-specific conditions. However, there is a large mismatch among the spatiotemporal scales where land use decisions are made and where and when the impacts appear (Pelosi et al. 2010). While most of the decisions for management choices are conducted at the plot or field scale, the impacts of these decisions often emerge at the scale of the landscape or larger. Decisions on the use of land are sometimes made by land owners that are located far from the field. Their decisions are often based only on the global prices for demanded commodities such as food, fibre and feed and not on the locally provided ecosystem services and biodiversity. Such mismatches of scales and stakeholders are, however, rarely considered in research and practice. New management approaches are needed to consider all the effects at different scales.

In this Special Issue, we address this emergent issue, particularly addressing the following fundamental questions: (a) what kind of land use trade-offs and synergies among agricultural production, ecosystem services and biodiversity can be identified at the landscape scale; and (b) how can the influence of agricultural land use on ecosystem services and biodiversity be monitored and evaluated at the landscape scale? The idea for this Special Issue emerged at the *Landscape 2018 - Frontiers of agricultural landscape research* Conference in Berlin, from where the individual contributions were drawn. The aim of the Conference was to present recent advances in landscape research to promote the development of sustainable agricultural land use and landscape strategies in an interdisciplinary and application-oriented manner.

The research in this Special Issue addresses these landscape-related issues: (a) a general approach to enhance the indication of the supply of provisioning ecosystem services in agricultural landscapes is introduced by Bethwell et al. (2020); (b) aspects of biodiversity are discussed based on approaches from behavioural science in Byerly et al. (2020) and based on the effect on biological pest control (Petit et al. 2020); and (c) ecosystem services relating to soils are presented from aspects including roots (Cebrián-Piquera et al. 2020), soil erosion (Steinhoff-Knopp et al. 2020), soil properties (Cheng et al. 2020) and hydrology (Zikalala et al. 2020). The collection of articles in this Special Issue provides a glimpse of cutting-edge research in agricultural landscape science. It is our hope that such research

can aid in the development of more sustainable land use strategies in agricultural landscapes by focusing on the important unit of the landscape.

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