Assessing impacts of farming systems on biodiversity using predictive indicators: a gradient of complexity

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Agriculture plays a major role in the erosion of biodiversity, which represents one of the exceeded planetary boundaries. In the quest for solution to mitigate impacts of farming systems on biodiversity, it is essential to have tools to assess these impacts. Besides a plethora of indicators using field measurement of abundance or/and species richness of one or several taxa, predictive indicators offer a compromise between feasibility and integration of processes. Such indicators do not require *in situ* measurements and enable linking the response of biodiversity to drivers like agricultural practices.

Here we review three examples of predictive indicators representing a gradient of complexity regarding the number of input variables on field practices and landscape structure, the number of output variables on biodiversity components, and the model structure. The three indicators are NIVA-Biodiversity, BioSyScan and I-BIO.

NIVA-Biodiversity assesses biodiversity at the landscape and regional level, assessing biodiversity through a global score, without any precision on taxonomic or functional components, based on the percentage of semi-natural habitats (SNH), field size and crop diversity. BioSyScan is calculated at field level and assesses the impacts of field management (e.g. tillage, fertilization, pesticides spraying) and landscape variables (e.g field size and SNH) on soil-dependent species and mobile species. Last, I-BIO considers direct impacts of cropping systems on five taxonomic groups (microorganisms, plants, soil invertebrates, flying invertebrates and vertebrates) and indirect impacts through trophic chains. It includes more precise variables on field and landscape management than the two other indicators. The three indicators are based on mixed models using linguistic rules “if-then”. While I-BIO is based on the DEXi tool and remains totally qualitative, NIVA-Biodiversity and BioSyScan were designed using the CONTRA aggregation method integrating fuzzy subsets in the decision rules, to mitigate threshold effects and increase transparency. We will highlight the potential use of each indicator using case studies, discuss the pros and cons of each indicator, and present the research needs to ensure their scientific validity.