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Modelling the distribution of 44 urban bird species using Earth observation based plant trait indicators and machine learning

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Birds strongly respond to vegetation structure and composition, yet typical species distribution models incorporating Earth observation (EO) data use pre-classified data such as land-use/cover classes for the habitat suitability modelling. Since this neglects factors of internal spatial composition and heterogeneity of the land-use/cover classes, we propose a new scheme of deriving multiple continuous indicators of urban vegetation heterogeneity using a high resolution EO dataset. The deployed concepts encompass spectral trait variations for the quantification of vegetation heterogeneity as well as subpixel vegetation fractions for the determination of the density of vegetation and the management leading to that density. Both indicators are derived from RapidEye satellite data, thus featuring a continuous spatial ground resolution of 6.5 metres. Using these indicators of plant heterogeneity and quantity as predictors, we can model breeding bird habitats with a random forest machine learning classifier for our case study Leipzig, Germany, while exclusively using a single EO dataset. Separate models are trained for the breeding sites of 44 urban bird species (including six on the German Red List), featuring medium to very high accuracies (60–91%). Analysing similarities between the models regarding variable importance of the single predictors allows species groups to be discriminated based on their preferences and dependencies regarding the amount of vegetation, and its structural heterogeneity. When combining the results for the individual species, a statically significant ($p>0.005$) model for an overall urban bird species richness can be plotted. The combination of continuous high resolution EO data paired with the random forest machine learning technique creates novel and very detailed insights into the ecology of the urban avifauna, opening up possibilities of analysing and optimising different greenspace management schemes or future urban developments concerning overall bird species richness or single species under threat of local extinction.