A multi-stressor analysis of spatio-temporal shifts in Belgian bee community

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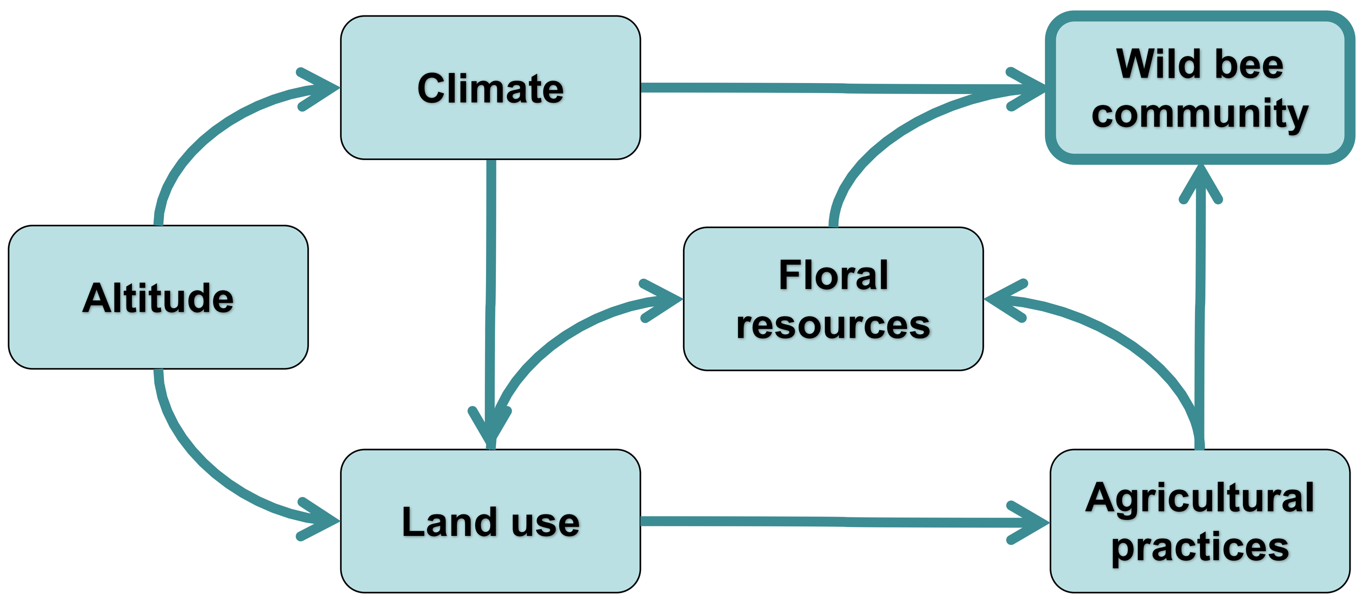
Introduction

❖ The last fifty years has witnessed substantial bee (Ampliforms) population and diversity declines in many European regions. Various studies showed the synergetic effect of multi-stressor causes at different spatio-temporal scales.

❖ As recommended by Potts et al (2010)*[1]*, it is necessary to address the multiple effects of drivers as interactions to evaluate the supposed role of non additive effects. Species distribution models are increasingly used to predict species distribution shifts under scenarios of future change of environmental conditions.

❖ ***Objective*** **: to perform modelling of wild bee species' probability of presence per landscape unit in Belgium**, taking into account possible land use and climate change, to facilitate decision-making with regards to these species' conservation



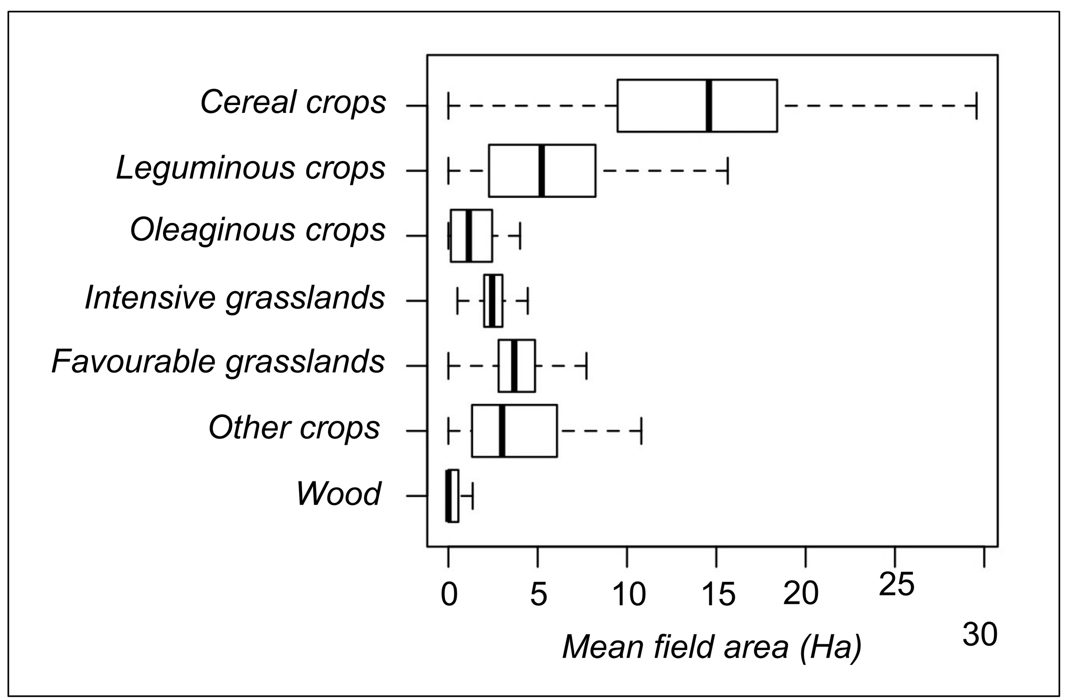


Figure 2. *Mean field area (in hectare) for various types of crops*

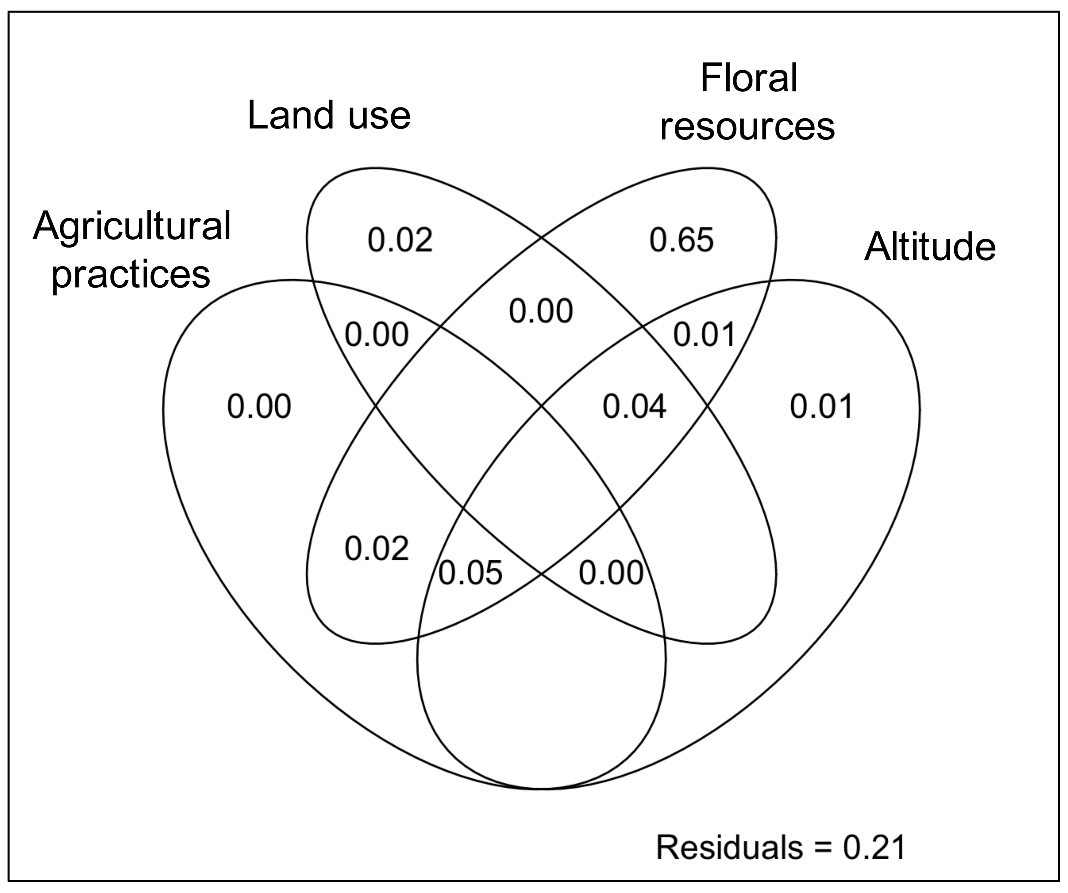


Figure 3. *Venn diagrams of the variance of the wild bee species composition partitioning into Altitude, Proportion of land use, Agricultural practicies (as mean size of field area) and Floral resources composition. Figures are positively adjusted coefficients of determination (expressed in percentage) and represent the variability explained by each subspace being either a single variable (e.g. altitude) or shared effect between two or more variables*

Methods

❖ ***Bee data compilation*** **:** biogeographical records of ~650,000 wild bee specimens recorded in the Belgian database of the universities of Mons and Gembloux (Banque de Données Fauniques de Gembloux et Mons – BDFGM *[2]*). We used the observation number of each species.

❖ ***Environmental data*** **:** Land use and agricultural practices from GIS data provided by SIGeC (*Système Intégré de Gestion et de Contrôle*), HILDA ("*Historic Land Dynamics Assessment*" version 2.0*[3]*) a nd TOP10Vector (IGN data) projects**;** Climate data from the ClimateEU program version 4.63; Floral resources from plants-bees interaction data of the BDFGM *[2]*); Altitude from the Atlas of Belgium.

❖ ***Sampling design*** **:** The investigated area comprises the 380 U.T.M. (*Universal Transverse Mercator projection system)* squared of 10km side covering Belgium (*Fig.1*). The U.T.M. squared represent the geographical unit of the study for which we scored the ecological and environmental variables.

❖ ***Statistical analysis*** **:** comprehensive comparative analyses, using the techniques of redundancy analysis (RDA) see Legendre and Legendre (2012). Analysis presented here focus on the more recent period (1990-2017) across Wallonia region (actual lack of some data for the Flanders region).

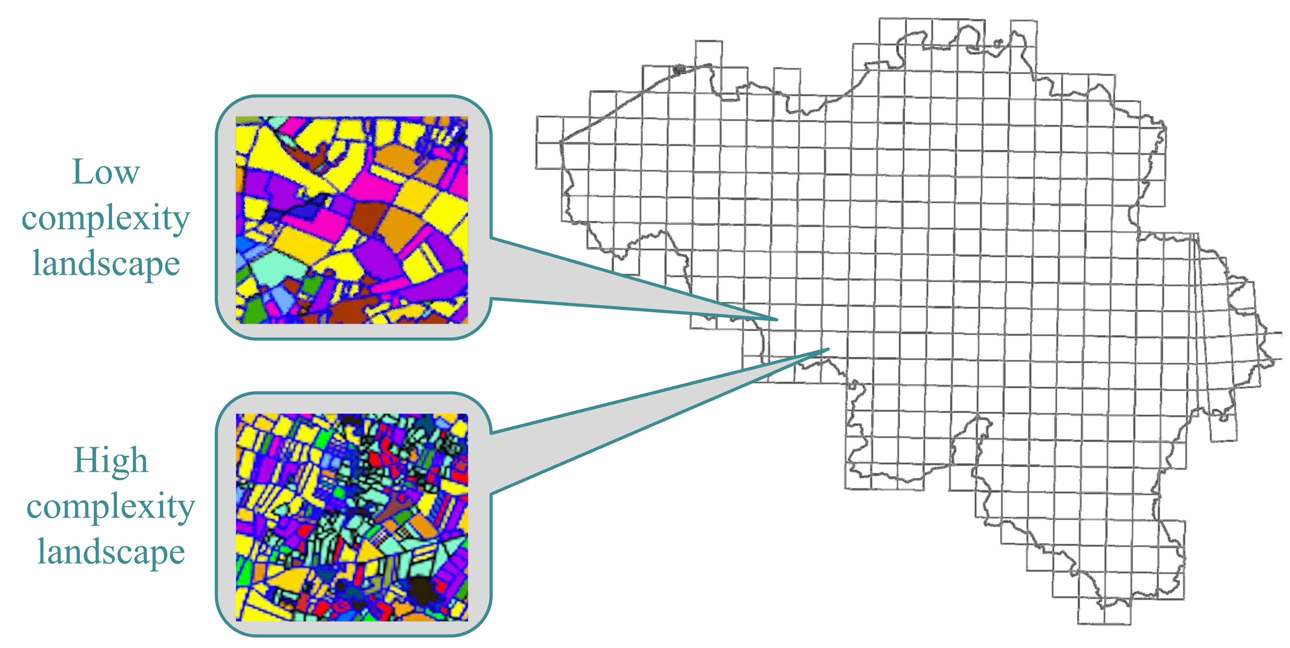


Figure 1. *The Universal Transverse Mercator projection system (UTM) covering Belgium (squared of 10 km side) and schematic potential intensity landscapes*

Preliminary Results

❖ Altitude is a good predictor of the climatic conditions at the Belgium scale and can replace a pool of complex variables (temperature, humidity…), as showed in previous studies *[4]*.

❖ Agricultural practices are better represented by the mean field size (*Fig.2*) (in comparison with the number of field by surface unit or the field structure), especially field size of favourable grasslands, oleaginous crops (e.g. oilseed rape, sunflower) and other crops (including market gardening).

❖ Venn diagrams (*Fig.3*) of the variance of wild bee communities showed that agricultural practices and land use (*Fig.4*) seem to be highly correlated with the altitude.

❖ Floral resources explained a high proportion of the data variability. However, it could be important to analyse effect of floral resources according to their functional diversity (and not only the number of species), which is a key point in pollination service for example

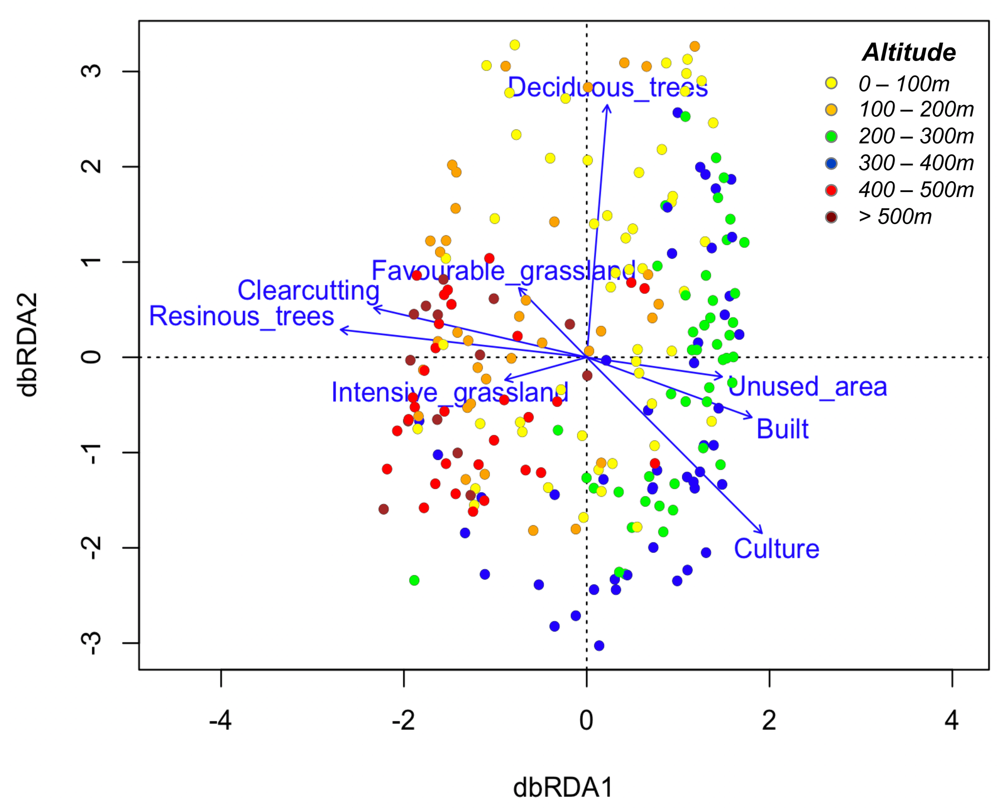


Figure 4. *RDA results showing the link between land use, when controlling for landscape elevation (altitude in meters). X-axis represents the constrained axis and y-axis, the first residual component. Points represent UTM squared (10km side) sorted per altitude. Black crosses represent wild bee species.*

Perspectives

❖ Current analysis are based on data set at the Wallonia region. Further analyses will integrate (i) Flanders for an overview at the country scale and (ii) two more previous temporal periods to assess evolution of wild bee communities across the last century: 1910-1930 (before the agricultural revolution) and 1970-1989 (after the beginning of chemical input using).

❖ Link with functional diversity of both wild bees and floral resources could be help to create and optimize pollinator-friendly practices and increase their positive impact for biodiversity conservation and the sustainability of pollination services.

References

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