Naturalist historical databases help us to better understand plant-bee interactions and their dynamics across space and time

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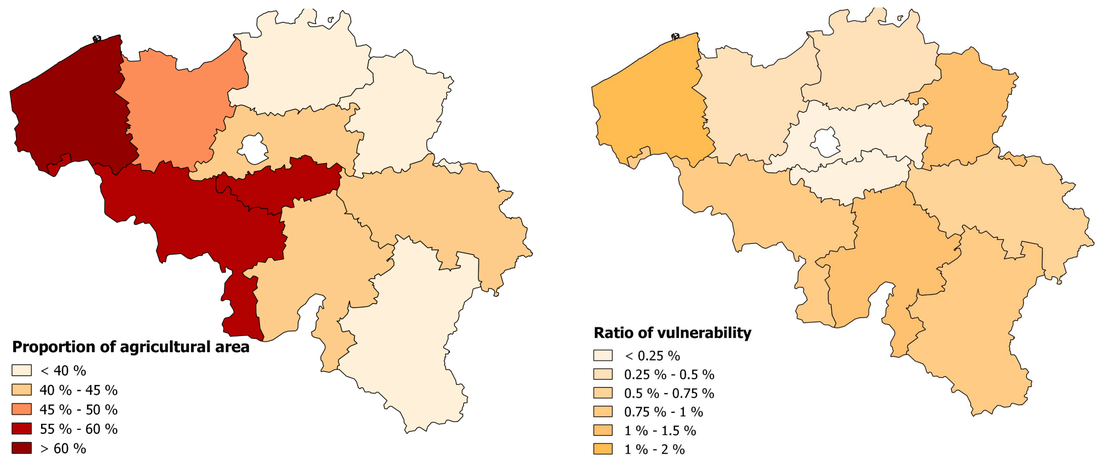
- Introduction -

In recent decades, the intensification of agriculture and urbanization has been accompanied by an **overall loss of biodiversity in the Belgian countryside** [1]. Such landscape disturbances led to an overall reduction of floral resources availability at a country-wide scale.

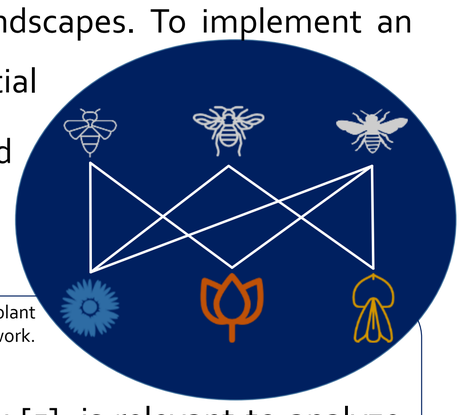
The **wild bee decline** was highlighted in the 1980s in the country [2]. Because flowers are key resources for bees, the wild bee decline is likely to be caused by plant diversity loss.

From left to right: agricultural intensification, roadside management, removal of semi-natural elements in countryside, urbanization,... are probably part of responsible factors of bee decline.



Maps of proportion of agricultural land per province (left) and the vulnerability of Belgian major crops to the decline of pollinators (right) [3,4]. Most of the plant production for human consumption depends little on pollinators (egs. cereals, roots, tubers, sugar crops).

The economic argument of the crop pollination service seems insufficient to ensure their protection in highly agricultural landscapes. To implement an effective action plan for wild bees, it is thus essential to understand their relationships with foraged wild plant species.



Schematic bipartite bee-plant interaction network.

A unique comprehensive country-wide dataset

Thanks to collaboration programs like BELBEES (BELSPO) and SAPOLL (Interreg V fwvl) projects, we have at our disposal historical databases at country-wide scale.

This dataset currently contains:

- observations of ca. 300,000 captured specimens in Belgium since 1900;
- information about the plant species visited at sampling time for almost 50,000 identified specimens (ie. plant-bee interaction database).

Network analysis

This approach, stemmed from the graph theory [5], is relevant to analyze the structural properties and dynamics of plant-pollinator interaction networks (e.g. [6]). It allows to

- investigate species composition, their interactions and dynamics over time;
- relate network patterns to ecological processes: species behaviour, species roles, groups of interacting species and their dynamics.

- Data analysis -

We split *a priori* the historical plant-bee interaction database into three time periods [7,8] and applied network-based approach to each period.

- **< 1950**: before agricultural mechanization - *257 links (111 bees*123 plants)*
- **1950-1990**: agricultural intensification - *1181 links (176 bees*384 plants)*
- **> 1990**: first environmental policy decisions - *967 links (149 bees*248 plants)*

We calculated different indices to characterize the topology of the three networks and the ecological roles of bees within these networks.

It appeared notably that networks have suffered **a loss of bee species specialization** due to a loss of very specialist bee species across time but also an increase in the number of interactions involving the remaining bee species.

From left to right: *Bombus lapidarius* on *Trifolium repens*, *Colletes daviesanus* on *Tanacetum vulgaris*, *Bombus pascuorum* on *Symphytum officinale* and *Eucera sp.* on *Vicia sepium*. © M. Folschweiller & S. Vray.

- Conclusion and perspectives -

This shift towards more generalist species could have led to more stability and resilience in response to land-use intensification.

By crossing network analysis and occurrence data of bee and plant species, it will be possible to point out the community-level changes in pollination services outside crops at a biogeographical scale.

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This work highlights **the interest of:**

- **compiling opportunistic naturalist databases**
- and to **systematically inform the host plants** on which species are observed during sampling time

to assess the impact of land-use changes on plant-bee interactions, thanks to unique historical time series.

Such initiative is a step forward in the perspective of **pollination service mapping** and tracking of changes at a biogeographical scale.

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This study was supported by the BELBEES Project "Multidiciplinary assessment of BELgian wild BEES decline to adapt mitigation management" (BELSPO ; BR/132/A1/BELBEES); the SAPOLL Project "Sauvons nos pollinisateurs/Samenwerken vor pollinators" (Interreg V fwvl), this programme is co-financed by the European Regional Development Fund; and the European Research Council (ERC) Starting Grant Project "Ecophysiological and biophysical constraints on domestication in crop plants" (Grant ERC-StG-2014-639706-CONSTRAINTS).