



BioDT User Case 4: Pollinators

A digital twin for honey bee dynamics in an agricultural landscape

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- Pollinators are omnipresent in ecosystems
- Critical for food security and plant biodiversity
- Climate and environmental changes are accelerating the decline of pollinators
- The full risks associated to their decline are not fully understood



- In the first user case with pollinators, we will study honey bees
- Vital in the pollination of crops: estimated to be responsible for 30 billion euro/year in crops
- If honeybees die, the crops that they pollinate would also either die or be vastly reduced.



- Varroa (mite)
- Diseases
- Pesticides
- Modern agricultural practices that lead to forage gaps
- Beekeeping practices



It is not practically possible to test multiple stressors with experiments

Varroa: <http://www.bienenaktuell.com/>
Pestizide: <http://georgiaag.com/>
Monokultur: <http://www.taz.de/>
Truck: <http://georgiabees.blogspot.de/>



COLONY AND POPULATION DYNAMICS



**COLONY AND
POPULATION
DYNAMICS**



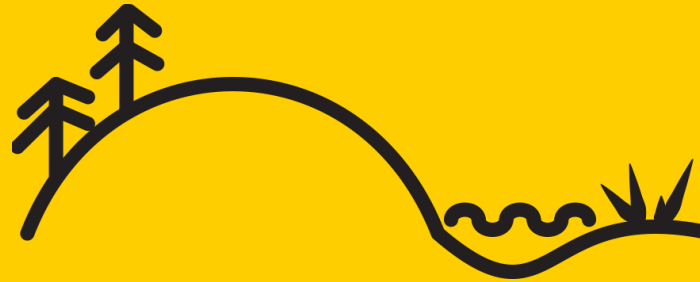
FORAGING



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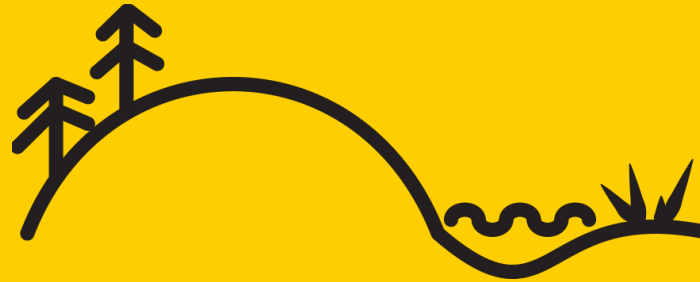
**LANDSCAPE AND FORAGE
AVAILABILITY**



**COLONY AND
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FORAGING



**LANDSCAPE AND FORAGE
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**VARROA AND
BEEKEEPING**

- Implement multiple stressors: Represent stressors within hives (varroa, diseases) **AND** in the landscape (nutrition, pesticides, forage gaps, weather)
- This requires combining models of
 - In-hive development
 - Mite infestation and dynamics
 - Disease transmission

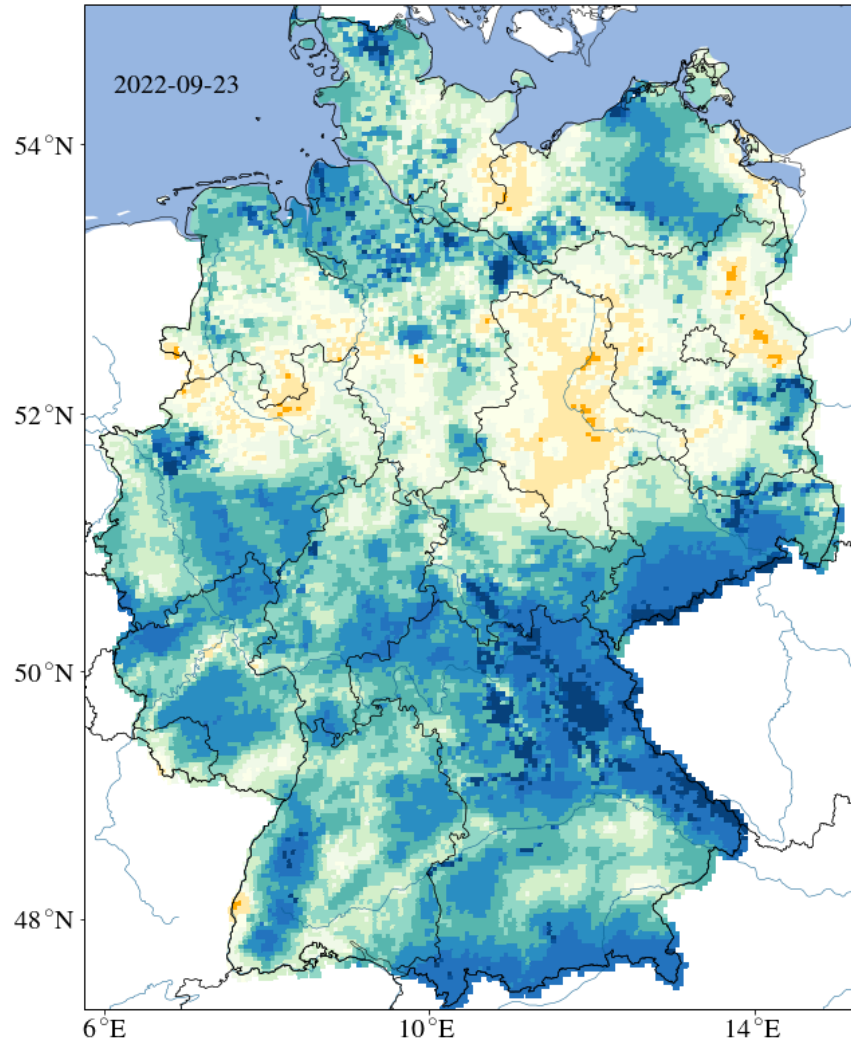


Why BioDT?

- BioDT is essential for access to fast computing and comprehensive data expertise:
- Increasing the model's spatial extent, while keeping the resolution (eg. running the model for the entirety of Germany)
- Comprehensive uncertainty and sensitivity analysis

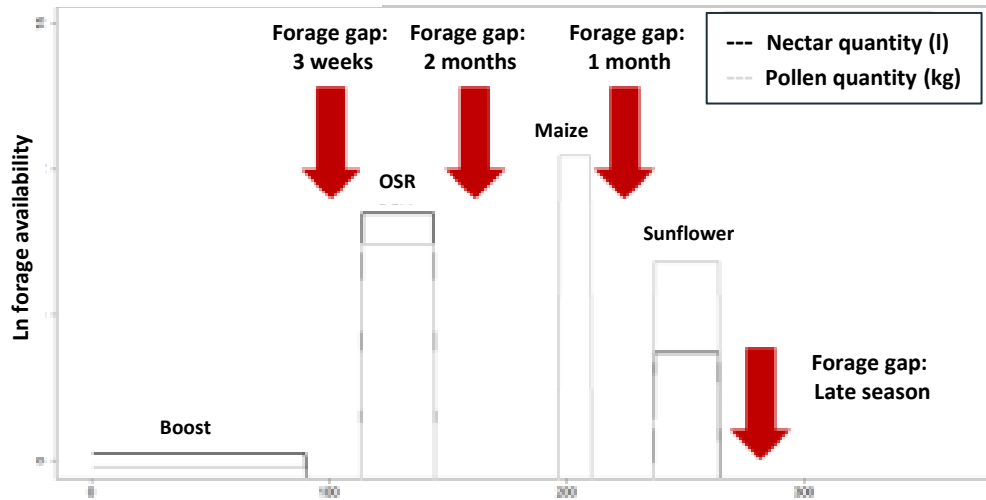
What turns BEEHAVE into a DT:

- Automation of data flow
- Dynamic model updating (e.g. feeding in updated environmental data, followed by new model iteration)
- Automated model uncertainty analysis (comparisons with real-life data)

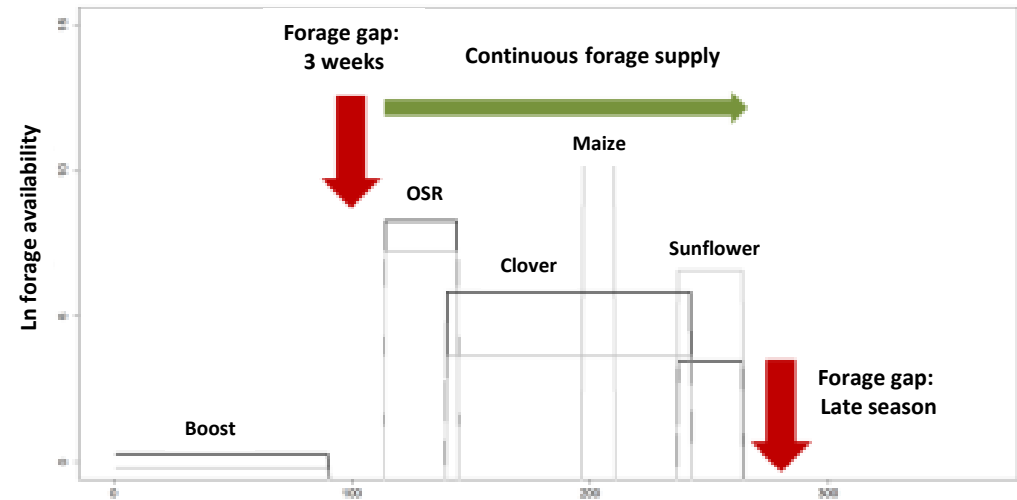


- Interactive and/or static maps where the color would code the risk of forage gaps and hence bee colony failure.
- This will indicate where certain changes in land use could and should improve the forage supply situation for pollinators.

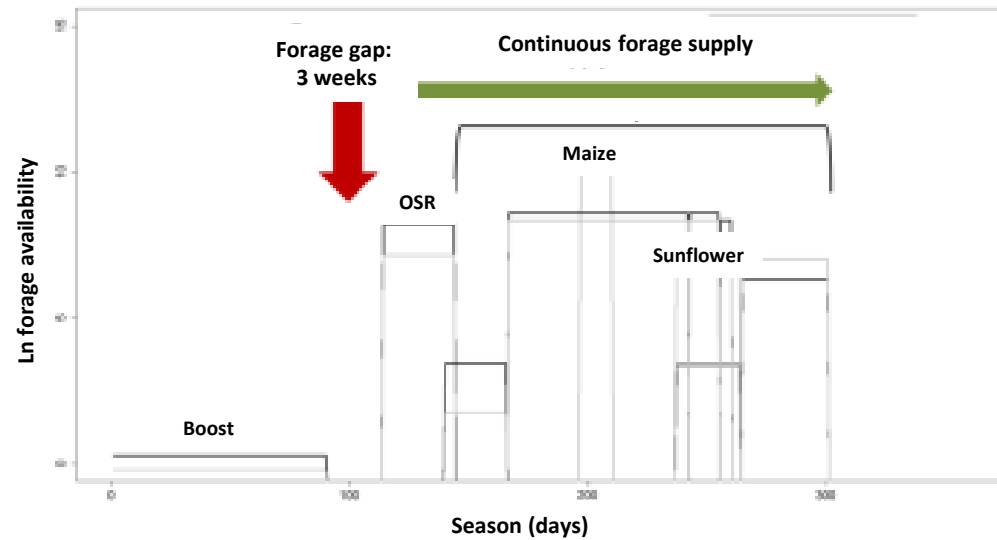
Baseline: 4 crops without EFA



EFA: 4 crops with 10% N2-fixing clover culture



EFA: 4 crops with 10% flower strip margin



- Academia
- Beekeepers (institutes, associations)
- Farmers (land management)
- Policy developers (land use)

User case leaders:

Prof Volker Grimm and Jürgen Groeneveld (from June 2023 on)

Helmholtz Center for Environmental Research

Departments of Ecological Modelling and Remote Sensing

Bee Institute Mayen (TrachNet)


BEEHAVE developed by Matthias Becher, Peter Kennedy, Juliet Osborne) at Rothamsted Research and the University of Exeter in the UK, in collaboration with Prof Volker Grimm at the Helmholtz Center for Environmental Research (UFZ, Leipzig, Germany) and Dr Pernille Thorbek (Syngenta).





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