



Biodiversity Digital Twin for Advanced Modelling, Simulation and Prediction Capabilities

- *BioDT.eu* -

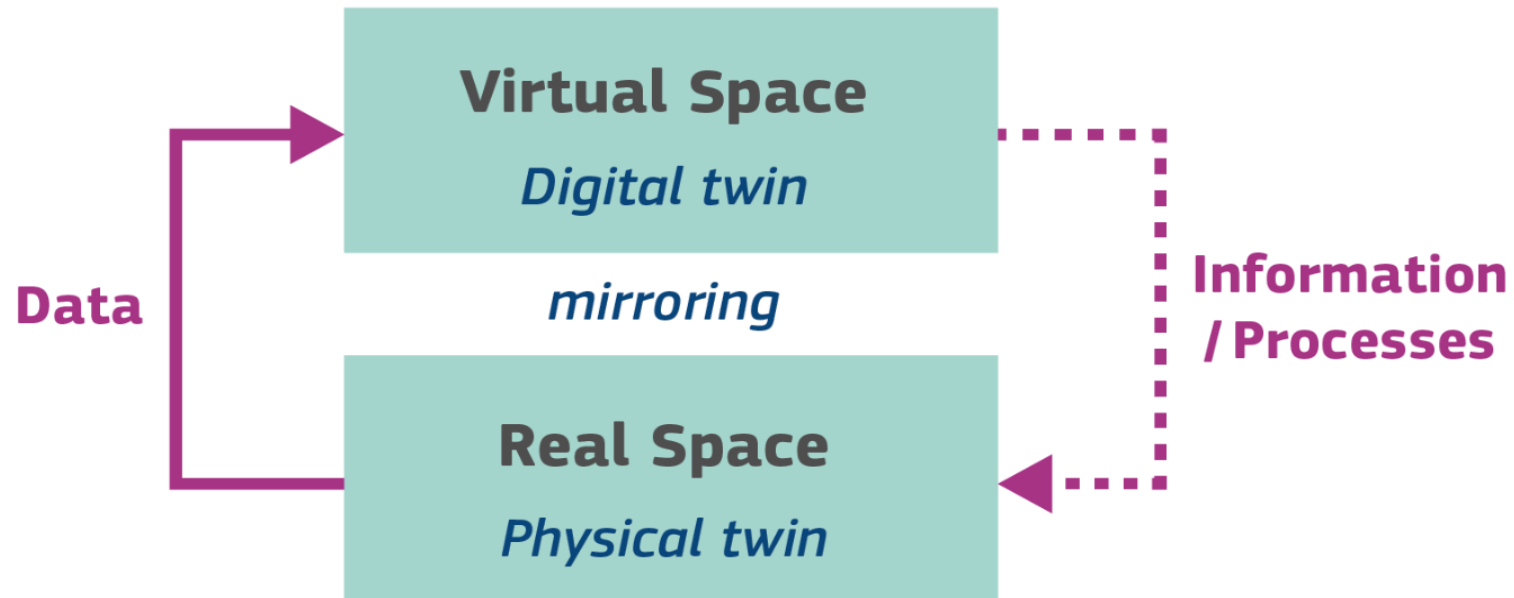
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Funded by
the European Union

A digital twin is a virtual representation of real-world entities and processes

- synchronized at a specified **frequency**
 - **fidelity**



[Image: digital-strategy.ec.europa.eu](https://digital-strategy.ec.europa.eu)

A **digital twin** (DT) is typically composed of:



- 🔥 Data
- 🔥 A model
- 🔥 An application = representation
 - data <-> model



Industrial DTs facilitate:

- 🔥 Product design
- 🔥 Operation of machinery
- 🔥 Maintenance

In **BioDT**:

- 🔥 Mimic behaviour observed in nature, predict responses of human impacts
- 🔥 Contribute toward EC goal of devising a [full DT of the Earth](#)

🔥 OBJECTIVE 1:

- 🔥 Build and deploy prototypes of BioDTs for addressing biodiversity dynamics

🔥 OBJECTIVE 2:

- 🔥 Support the interoperability of data and services
 - 🔥 integration of the BioDT and research infrastructure platforms and workflows

🔥 OBJECTIVE 3:

- 🔥 Ensure interoperability of BioDT with [Destination Earth](#) and [the European Data Infrastructure](#)

The BioDT prototypes are divided into four main groups

1)

Dynamics and threats from and for species of policy concern

 **Invasive Species**

Invasive species

🔥 Levels of invasion under baseline conditions and various climate and land-use change scenarios

The BioDT pDTs are divided into four main groups

2)

Genetically detected biodiversity



 **Crop wild relatives and genetic resources for food security**

 **DNA detected biodiversity in cryptic habitats**

- search for CWR and traditional cultivars
- improving domesticated crops to enhance their nutritional values, resilience to diseases and changing environments

- prioritisation of sampling effort targeting eDNA metabarcoding methods
- improve computation time of PhyloNext to make it a real-time exploration tool

The BioDT pDTs are divided into four main groups

3)

Species response to environmental change



Biodiversity Dynamics



Ecosystem Services

Grassland dynamics

🔥 Climate scenarios, soil and management affect grassland biodiversity and productivity

Forest/bird biodiversity dynamics

🔥 how different forest management and climate change scenarios affect the forest and biodiversity

The BioDT pDTs are divided into four main groups

...3)


Species response to environmental change




 **Biodiversity Dynamics**

 **Ecosystem Services**

Real-time bird monitoring

 Using citizen science to real-time bird monitoring (mobile app)

Ecosystem services

 prioritizing user-defined recreation preferences linked to biodiversity occurrence

The BioDT pDTs are divided into four main groups

4)

Species interactions with each other and with humans



Pollinators



Disease Outbreaks

Disease outbreaks

Wild boar–African Swine Fever (ASF) modelling

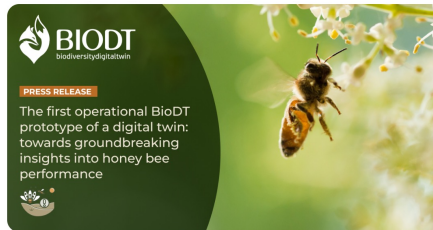
🔥 data-driven responses to manage spread of wildlife diseases

Pollinators

Honey bee Modelling

🔥 different land use patterns, climate, beekeeping practices and climate change scenarios affect the vitality and productivity of honey bees (*Apis mellifera*)

Beehave



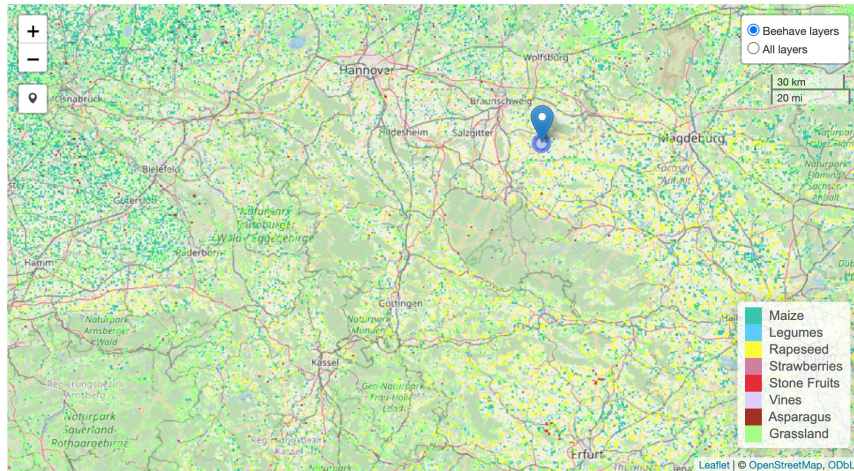
Input Map

First, click the placement icon and then select desired placement on the map.

Selected coordinates are:

Latitude: 52.111566

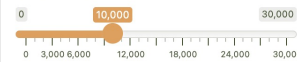
Longitude: 10.759913



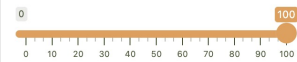
Land Use Classification 2016 (Preidl et al. RSE 2020)

Simulation Parameters

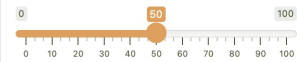
Number of adult bees at the beginning of the simulation



Number of Mites at the beginning of the simulation



Number of infected Mites at the beginning of the simulation



☒ Honey Harvest

☐ Varroa treatment with acaricide

☒ Drone Brood Removal

Simulation length (days):

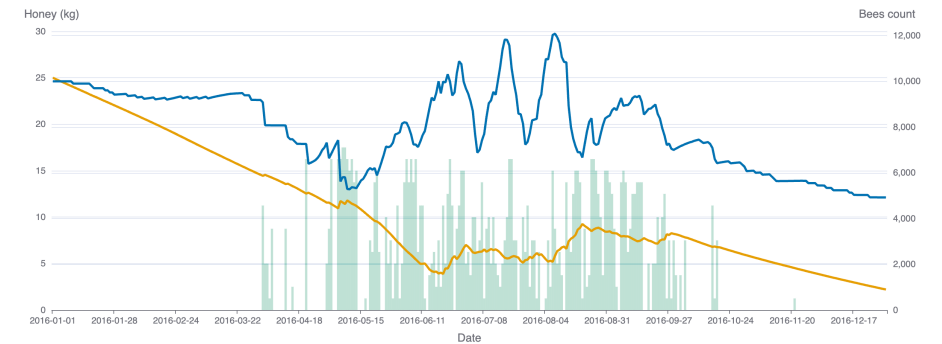
365

Run simulation

Choose experiment:

Run 1

Download plot data



Data from four RIs

GBIF, eLTER, LifeWatch ERIC and DiSSCo

GBIF



The Global Biodiversity Information Facility (GBIF) is an international network and data infrastructure providing open access to biodiversity data.

LifeWatch ERIC



LifeWatch ERIC is the e-Science European infrastructure for biodiversity & ecosystem research.

eLTER



The Integrated European Long-Term Ecosystem (eLTER) focuses on critical zone and socio-ecological research.

Helmholtz Center for Environmental Research (UFZ), UK Centre of Ecology & Hydrology (UKCEH), Environment Agency Austria (EAA) and University of Helsinki (UH)

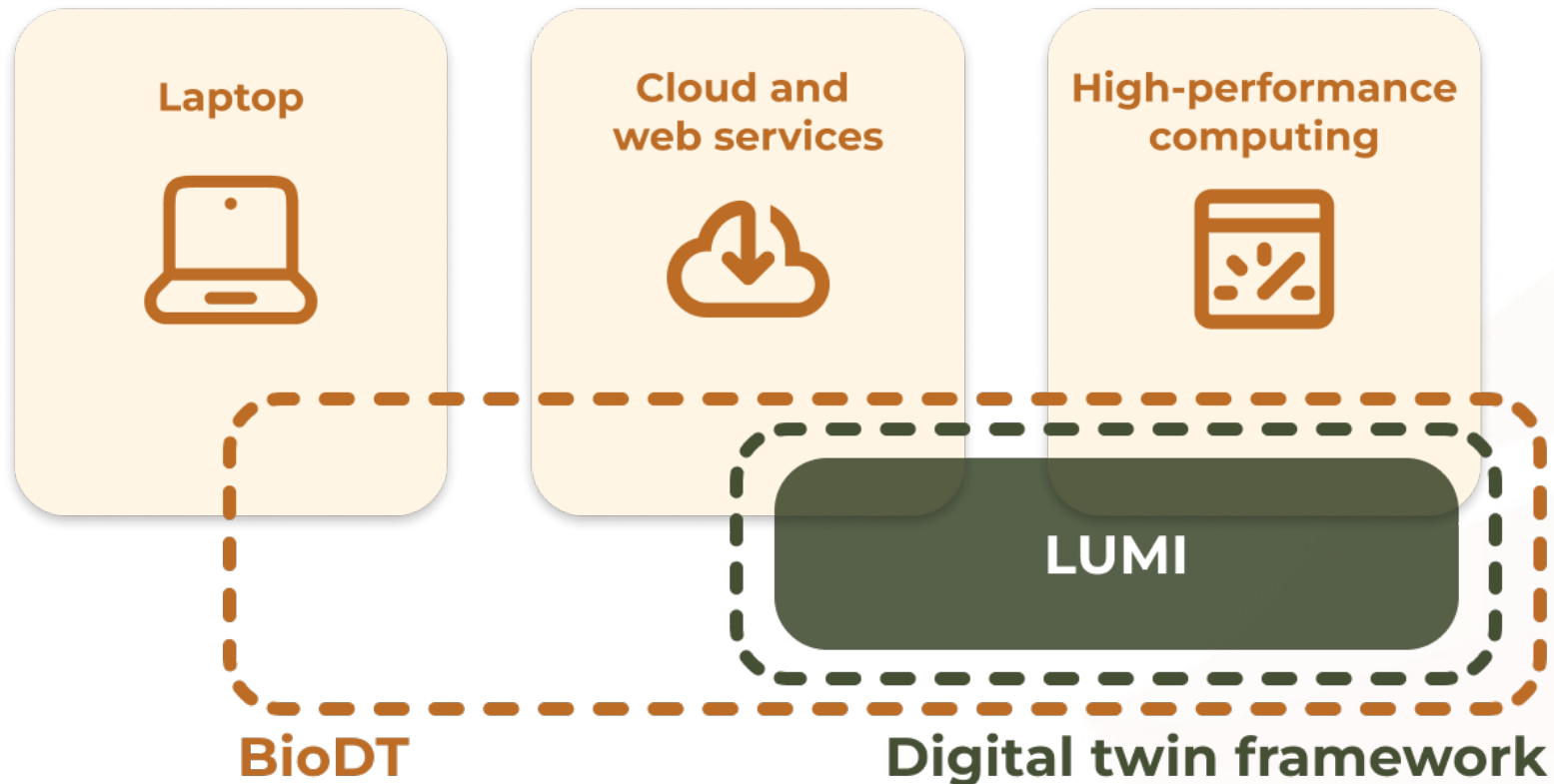
DiSSCo



The Distributed System of Scientific Collections (DiSSCo) is a Research Infrastructure (RI) for Natural Science Collections.

Naturalis Biodiversity Center (Naturalis) and Senckenberg Society for Nature Research (SGN)

💧 Digital twins require platforms for **computational simulation**



Digital Twin Advanced Technical Platform

- 💧 HPC resources
- 💧 portability of DTs across HPC sites and cloud environments
- 💧 Maintaining service catalogue of shared services for integration with EOSC Core services

- ❖ Leveraging high-performance computing, AI and data analytics capabilities of the LUMI supercomputer
- ❖ LUMI is the 3rd fastest supercomputer in the world
 - ❖ Sustained performance: 375 petaflop/s = performs 375×10^{15} calculations per second
 - ❖ Computing power equals to the capacity of 1.5 million modern laptops



Researchers :

- 🔥 In-depth understanding of biodiversity responses to climate change and other human activities
- 🔥 Improve mechanistic models

Citizen scientists and civil society:

- 🔥 Engage
- 🔥 Foster biodiversity and modelling literacy



Biodiversity RIs :
Improve their services
Stream data

Policy makers:

- 🔥 Science-based decisions based on quality data and modelling
- 🔥 Better respond to societal needs and key initiatives

Industrial actors :

- 🔥 Exploit BioDT for business solutions (applications/products) in sectors related to biodiversity, such as agri-food, tourism and healthcare





BIODT
biodiversitydigitaltwin

 @BiodiversityDT

 BioDT



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