



# Involved countries and partners

## France (UMR EGCE; IRD, CNRS, Univ. Paris-Saclay)



Fabrice Requier  
(project coordinator)

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François Rebaudo  
Etienne Minaud (PhD student)  
Elise Verrier (postdoc)



## Germany (University of Würzburg, Department of Animal Ecology and Tropical Biology)



Ingolf Steffan-Dewenter

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Andreas Hotho  
Giulia Mainardi (PhD student)  
Anna Krause, Pdraig Davidson



## Greece (Hellenic Agricultural Organization "DEMETER"- Dept. of Apiculture)



Fani Hatjina

+

Leonidas Charistos  
Philippos Vardakas



**Duration:** from 01/02/2021 to 31/01/2024 (with cost-neutral extension until 30/09/2024)

**Overall budget:** 1,112k€

# Objective

Over the past 20 years → **mortality of honey bee colonies** (*Apis mellifera*)  
Alarming due to the critical role of bees for human well-being by producing honey,  
sustaining populations of wild plants and supporting production of numerous crops

Abnormal high mortality rates of honey bee colonies have been revealed in several  
regions of the world, including Europe where it can reach up to **25–50% every winter**



The goal of the project is to investigate, develop and test **new digital solutions** based on data collection to deliver **early-warning signals of honey bee colony mortality** and decision-support tools to help beekeepers limiting **colony losses** and associated economic losses





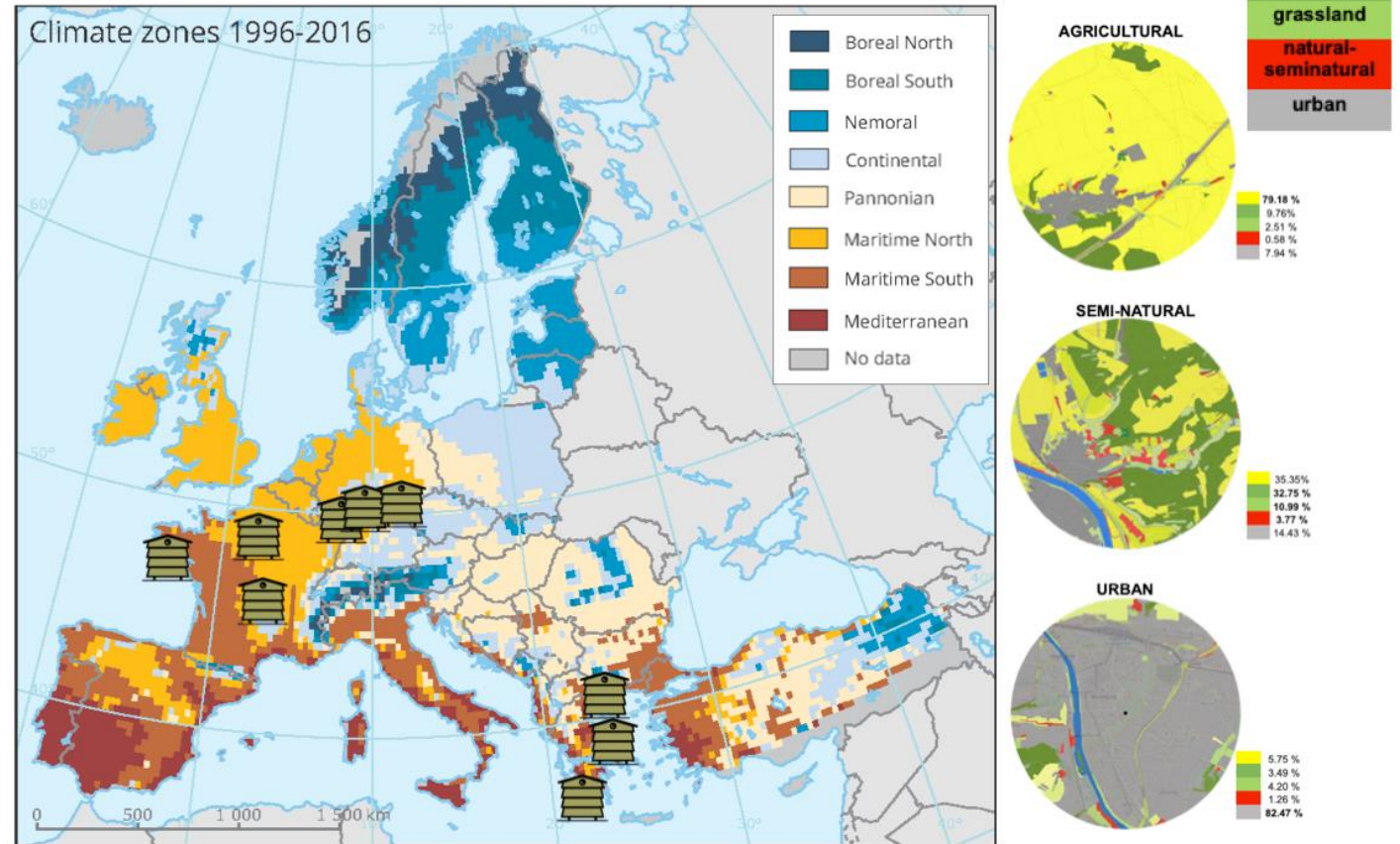
# Selected research approach, methodology

**Large-scale monitoring of honeybee colonies** along combined gradients in climate (continental, temperate and Mediterranean) and landscape structure complexity

N = 27 study sites in **France, Germany and Greece**

In close **collaboration with beekeepers**

## Climate × landscape experimental design

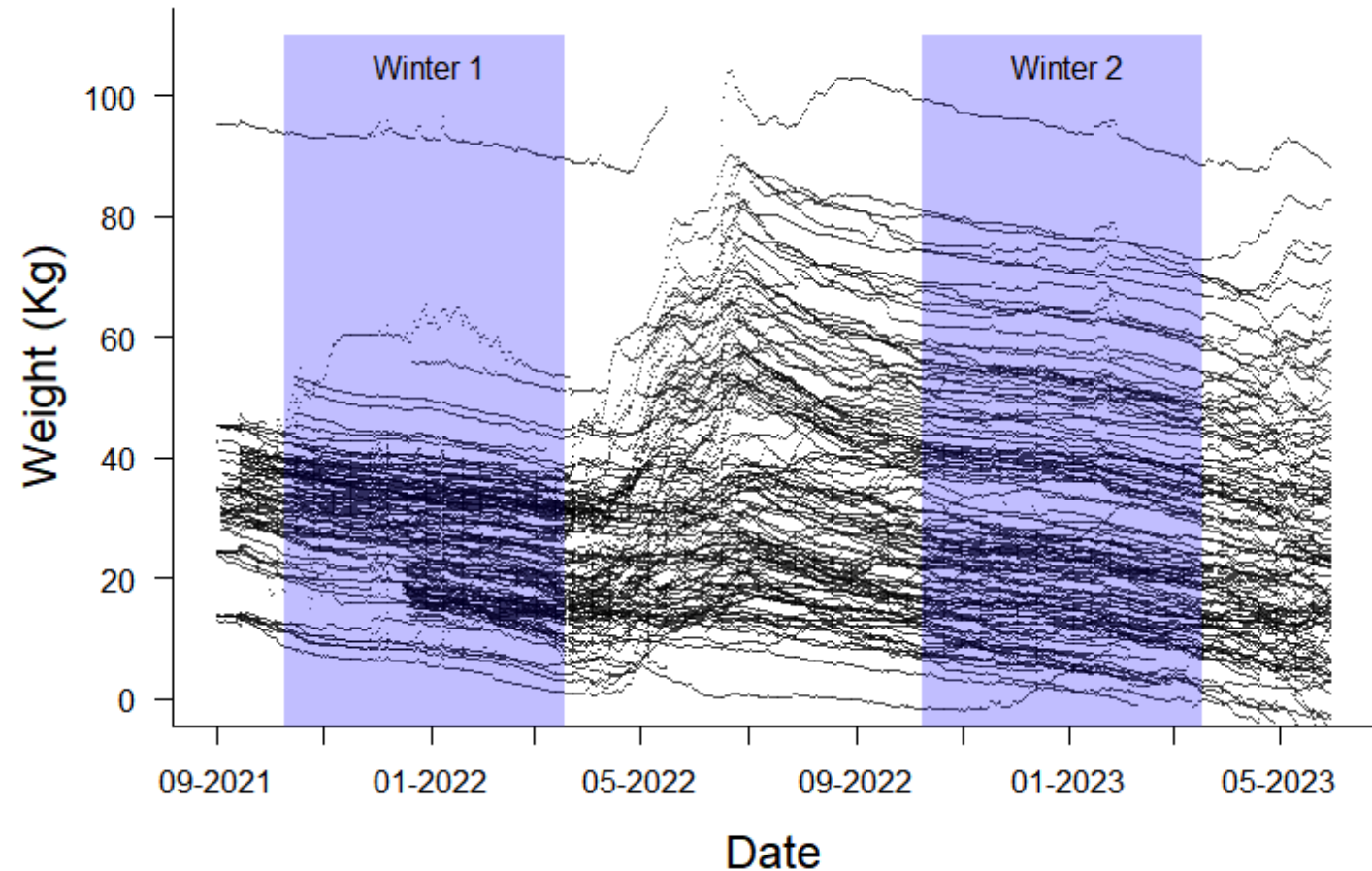


# Selected research approach, methodology



## Weight, temperature and sound monitoring

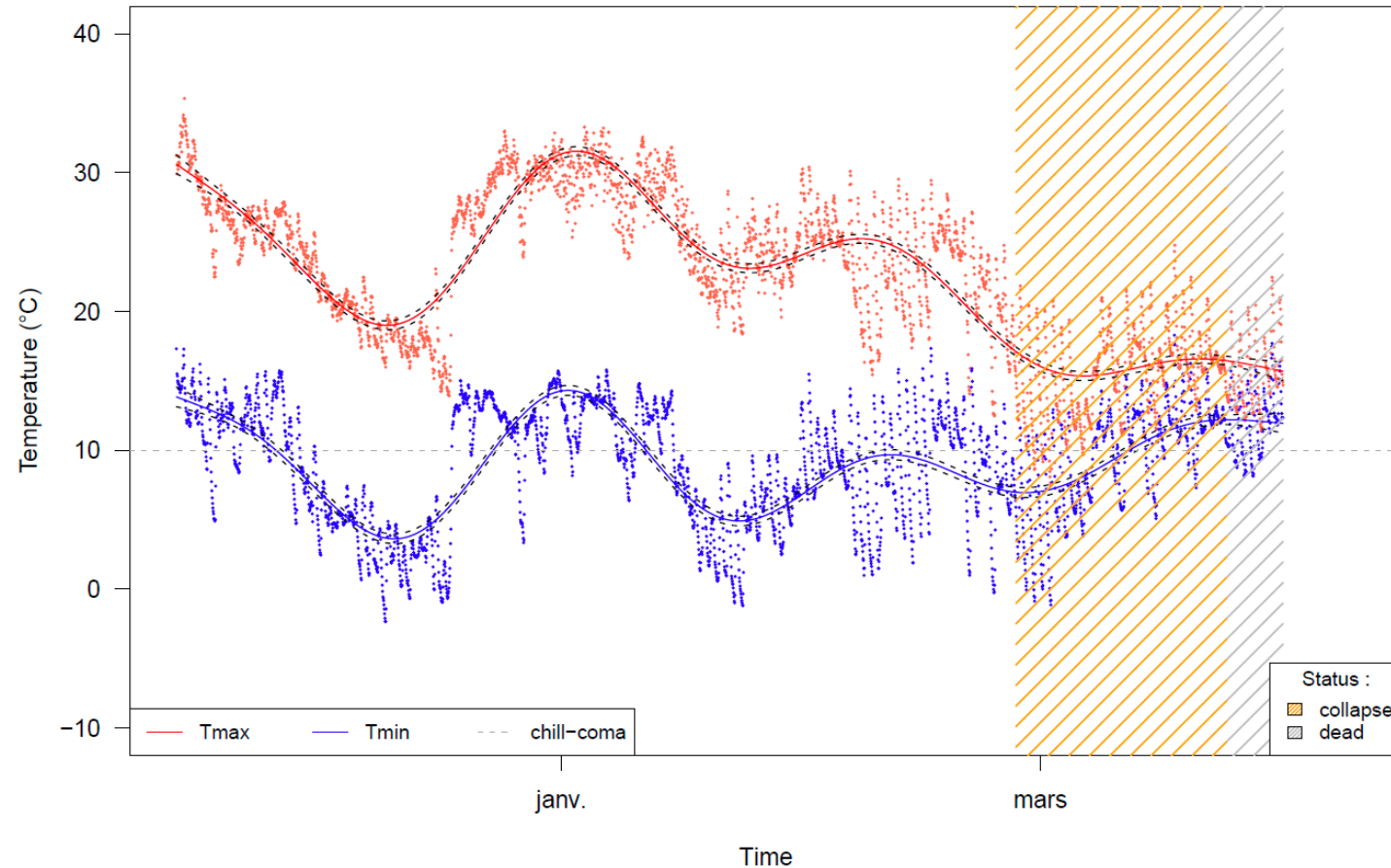
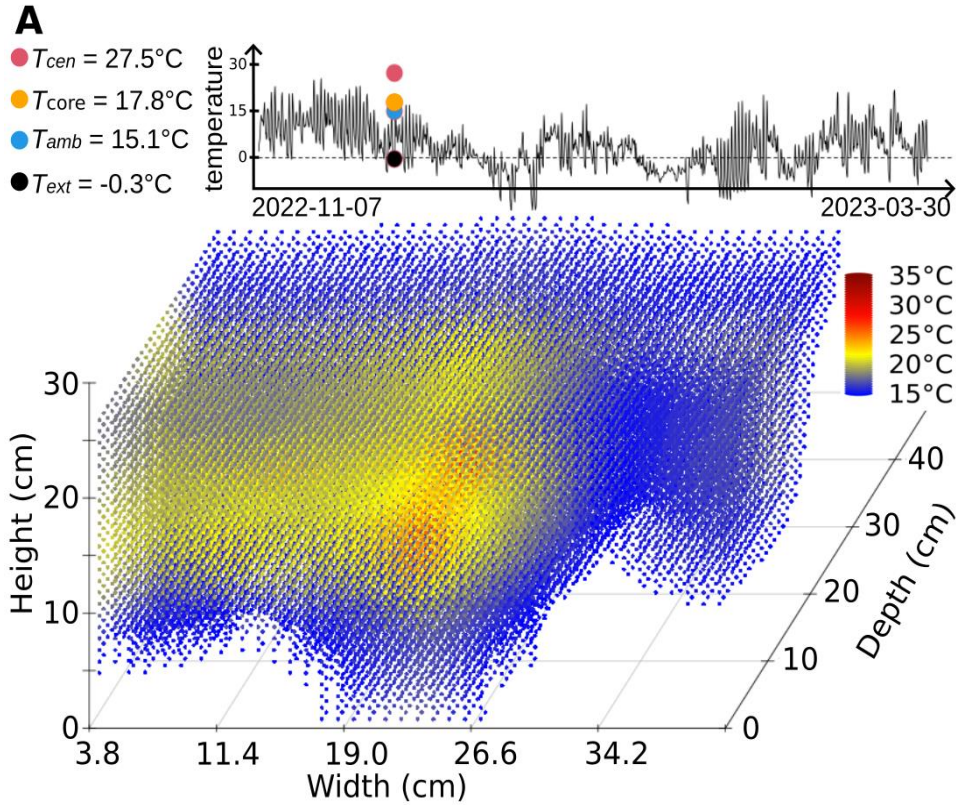
- 135 hives with connected scales (*data every 15mins over 2 years, 137.83 Mo*)
- 1620 temperatures sensors (*data every 15mins over 2 year, 1.4 Go*)
- 15 hives with sound record devices (*data recording over one winter, 30Tb*)





# Major results

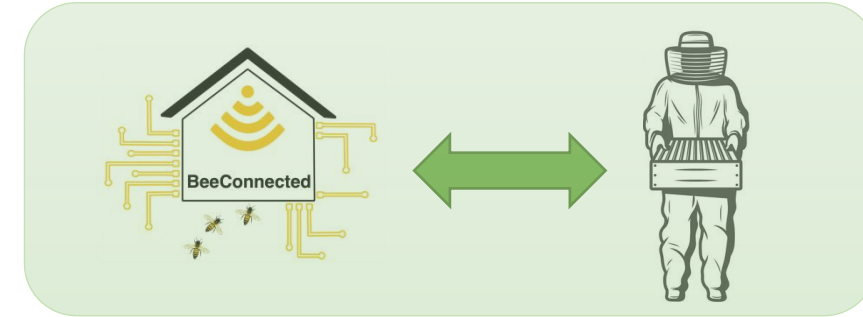
- Tracking of the social thermoregulation in three dimensions (3D)
- Detection of early warning signals of colony health and winter mortality
- A decision-support tool to help beekeepers minimizing colony losses in winter



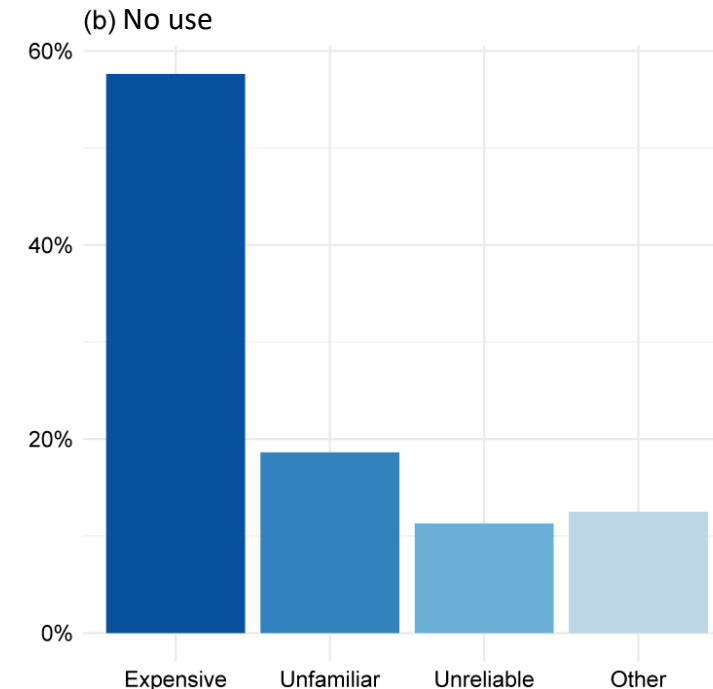
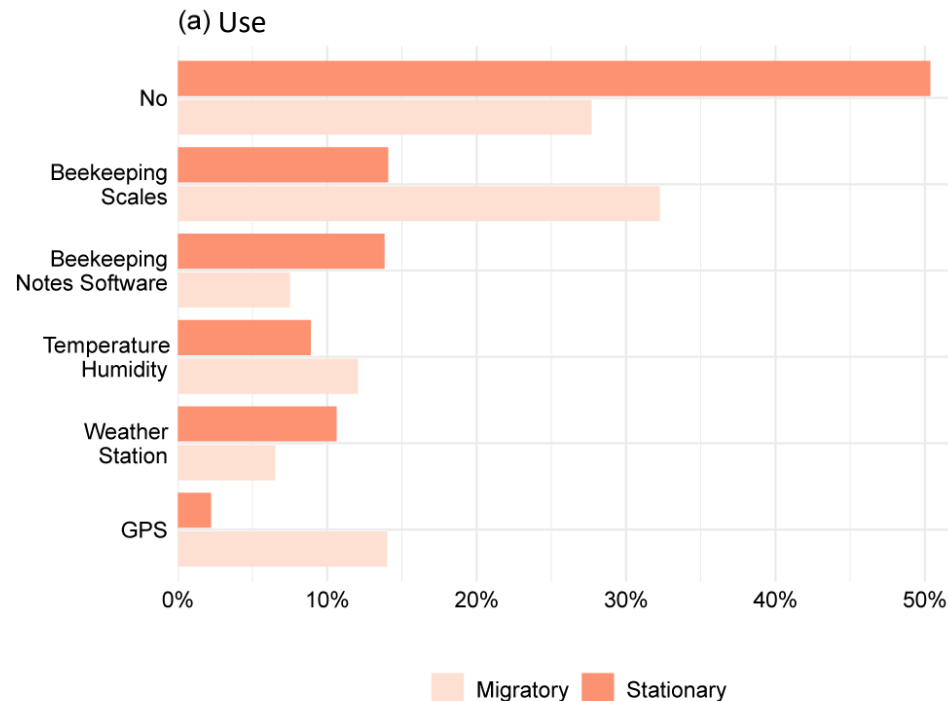
# Cooperation with stakeholders

## Close collaboration with beekeepers:

- Monitoring of the colonies (empirical field observations)
- Acceptability analysis of the ICT use in their practices (citizen science study)
- Use of the developed multiple low-cost sensors



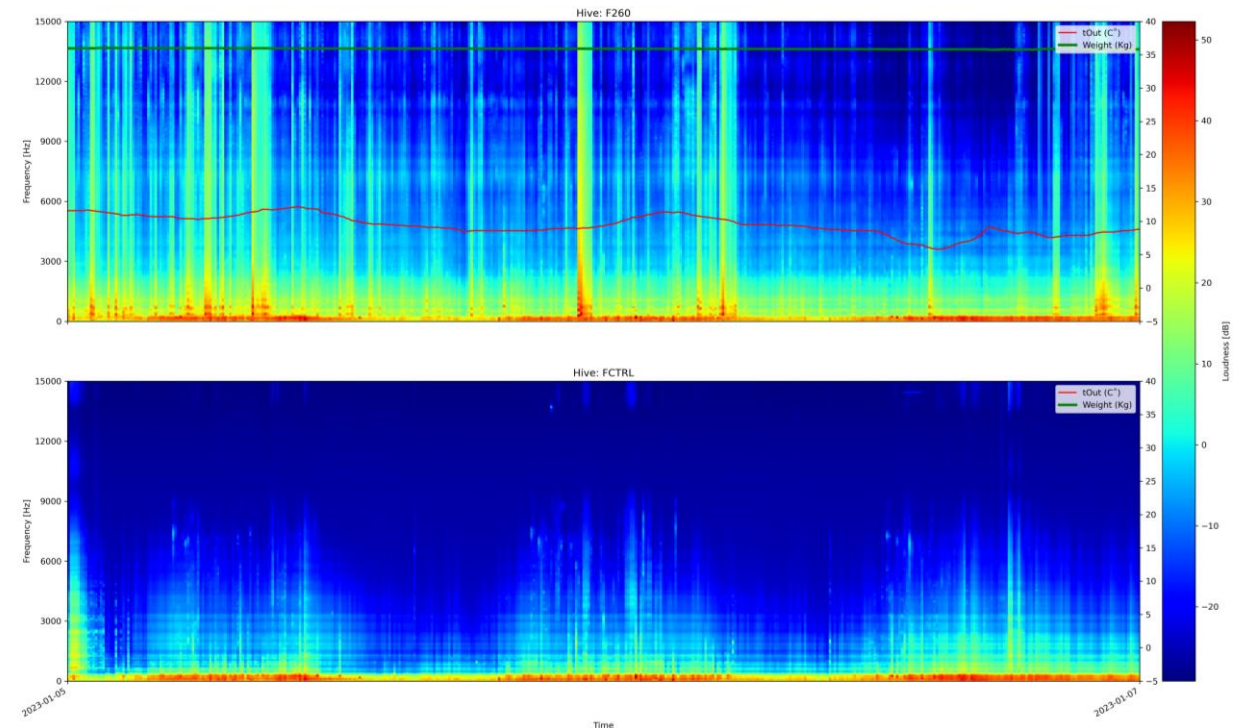
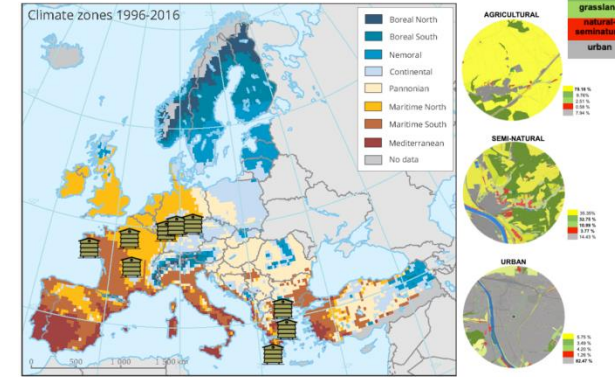
N = 538 beekeepers, 45% use ICT, with scales being the most commonly used



# Opportunities and next steps for innovation

- Assessing the **effects of climate and landscape structure complexity** on colony dynamics and winter behaviour
- **Adapting machine-learning algorithms** to automatically detect behavioural anomalies and early-warning indicators of colony mortality
- Use of **remote sound recording devices** to detect early warning signals of colony health and winter mortality

Climate x landscape experimental design



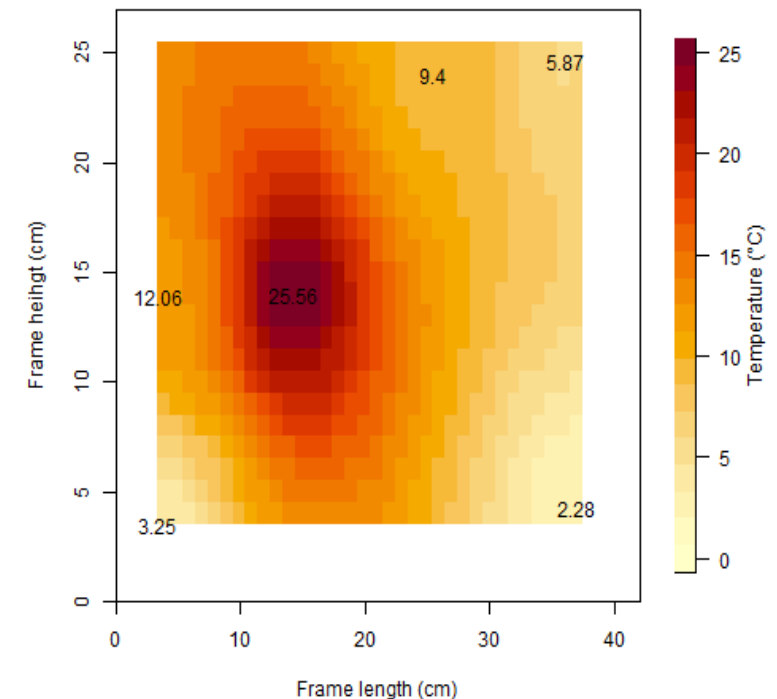


# Summary and Conclusion

## takeaways and lessons learned

BeeConnected has developed **low-cost tools** for ICT-connected hives that:

- 1) **track** the internal size and behaviour of honey bee colonies
- 2) **detect** early warning signals of colony health
- 3) can **help** a wide range of beekeepers to sustain their professional activities by preventing colony losses



# LET'S KEEP IN TOUCH!

Please feel always free to reach out to us.

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# Thank you for your attention!