



UAV-based precision mapping techniques for disease and pest identification

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Building digital competencies for detecting and monitoring diseases in mo**U**ntain a**G**riculture fields (**BUGs**)

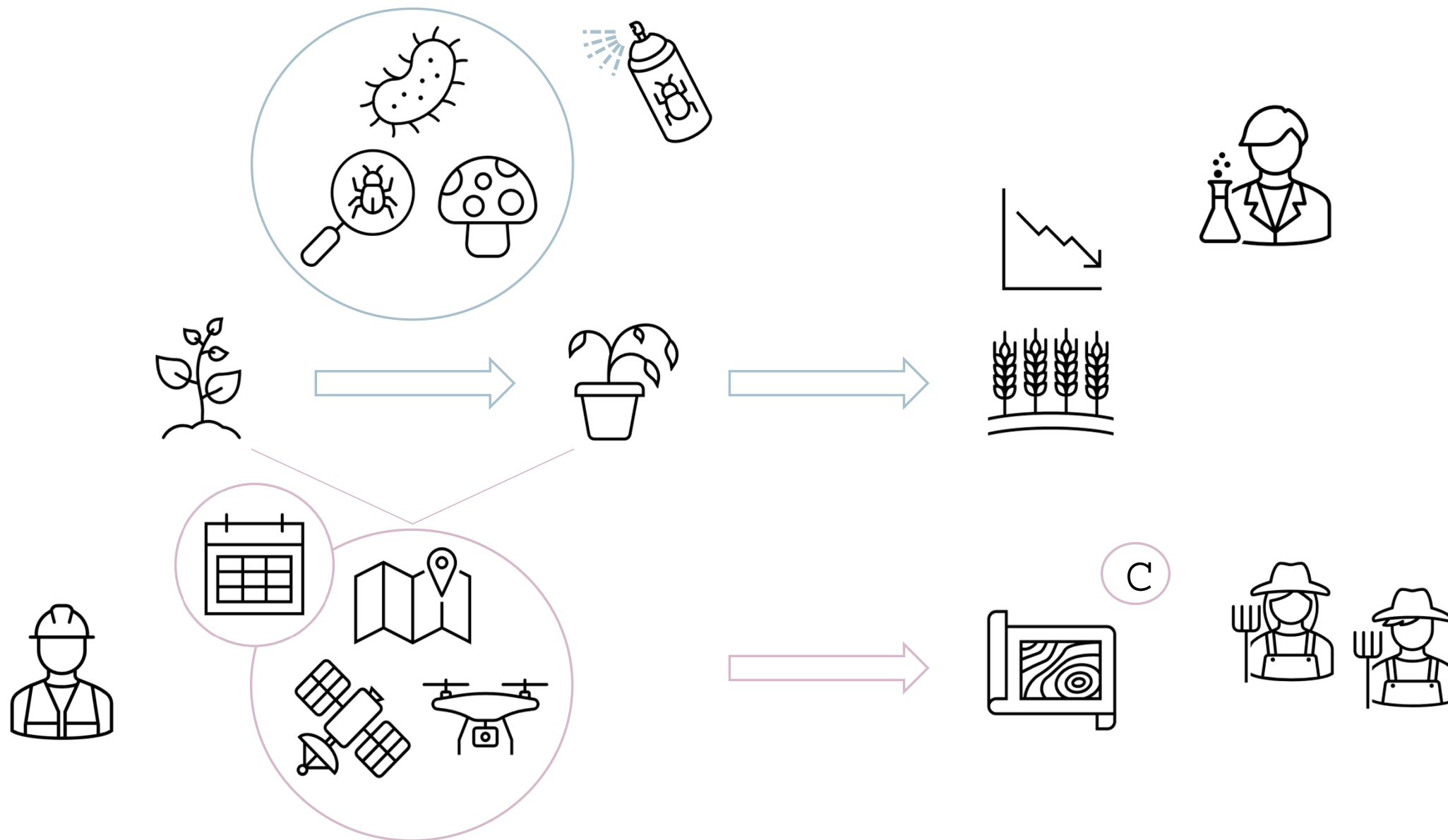
BUGs is a technical experiment that aims at a non-invasive method (NIR spectroscopy) to monitor plant diseases and pests and deliver the information to users using web-based precision maps derived from machine learning algorithms based on ground and aerial infrared spectroscopy (hyperspectral/thermal).

BUGs wants to foster the collaboration between agriculture specialists, technical staff and final users

BUGs explores the applicability of NIR in apple orchards, vineyards and forest.

Smart Agri Hubs is an EU H2020 project (818 182) to **support** to the individual **HUBS** (competence centers) comes through different cascade calls (PREPARE, EXPAND and RESTART)

In South Tyrol, Nord Italy, **Eurac Research** is part of the Digital Competence Center at **NOI tech park** supporting **technology actions**, with the hub status.



BUGs in a nutshell

- * non-invasive method (NIR spectroscopy) to monitor plant diseases
- * Using UAVs to overcome limitations of spatial-temporal-spectral resolution, data collection
- * Web-based precision maps
- * multidisciplinary approach



Area	Climate
Adige valley	Humid subtropical
Midlands	Subpolar oceanic
Low alpine valleys	Humid continental
Mid alpine valleys	Subarctic climate
Highlands	Alpine tundra



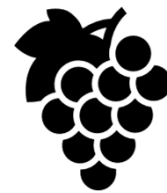
The autonomous province of South Tyrol has the biggest single area producing apple trees in Europe. The **19 000 ha** of apple production area in South Tyrol supplies up to 50% of the national Italian apple market, 15% of the European and 2% of the global apple market.



Alternaria presents severe defoliation leads to premature fruit drop. Fruit infections result in small, dark, raised lesions associated with the lenticel.

Apple proliferation AP- infected trees show typical symptoms such as witches' broom, enlarged stipules, tasteless, and dwarf fruits





Because of its unique history and location within the southern Alps and Dolomites, in this region grows a wide range of **grape varieties that are not usually seen in other parts of Italy**. Winemaking in South Tyrol is particularly intensive: often involving handwork, on steep terraced slopes, with environment-friendly techniques.



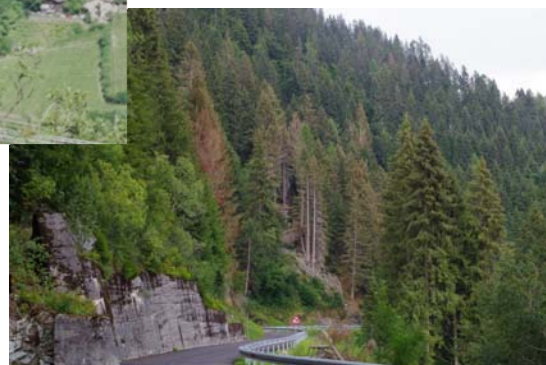
Flavescence dorée is a phytoplasma disease of the vine with the potential to threaten vineyards. Leaves become red or yellow depending on variety. Symptoms usually appear the year after infection and worsen until the vine dies



South Tyrol is a woodland: About half of the area is covered with forest. The change from a largely farming community to a production and service community has led in particular to grazing land giving way to bushes and trees. In recent decades the recorded area covered by forest has grown by 30,000 ha.

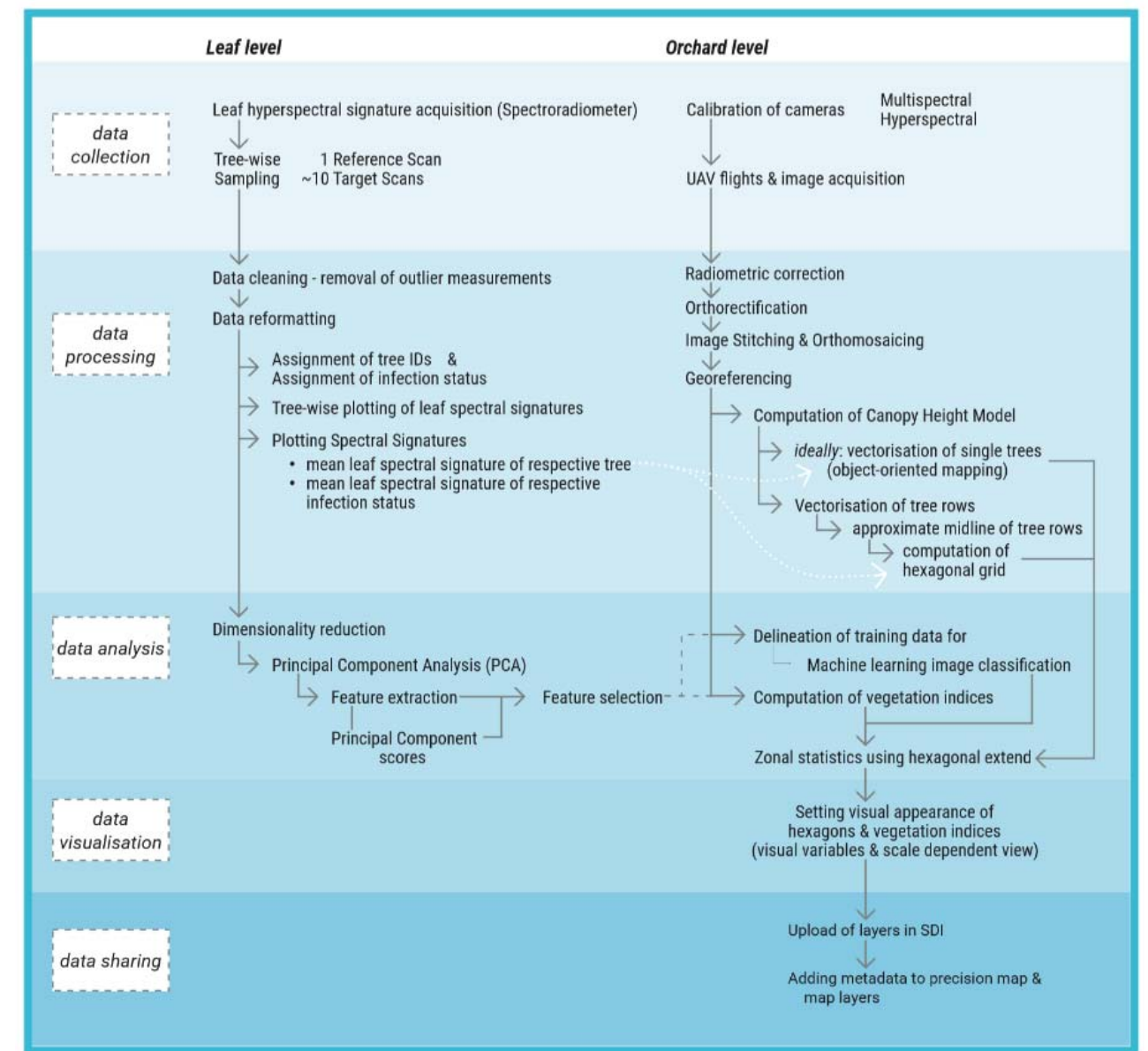
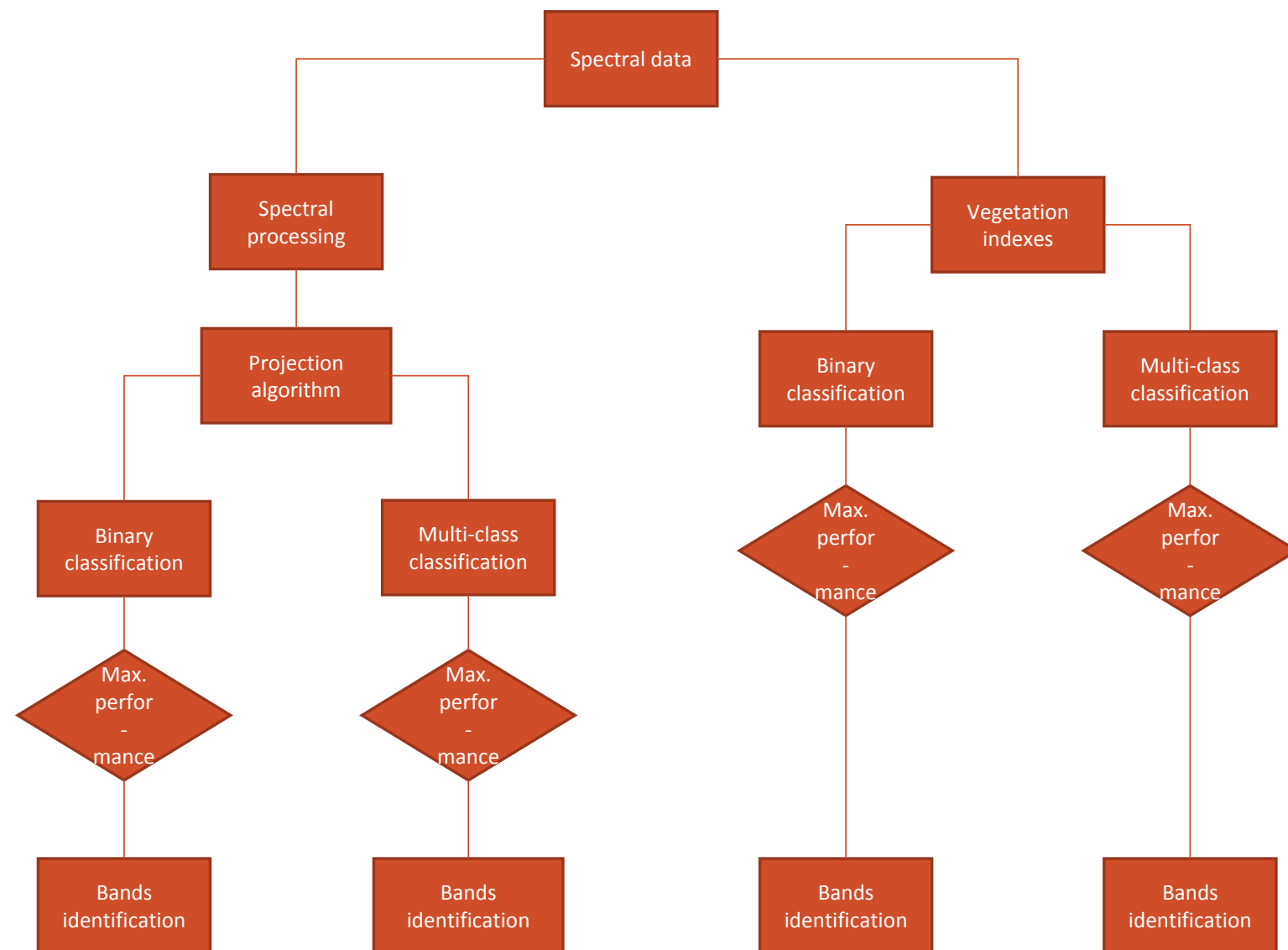


The pine processionary is a major economic pest in coniferous forests in southern Europe. The caterpillar is responsible for most of the defoliation seen in coniferous trees. The caterpillars can completely defoliate trees if large quantities are present





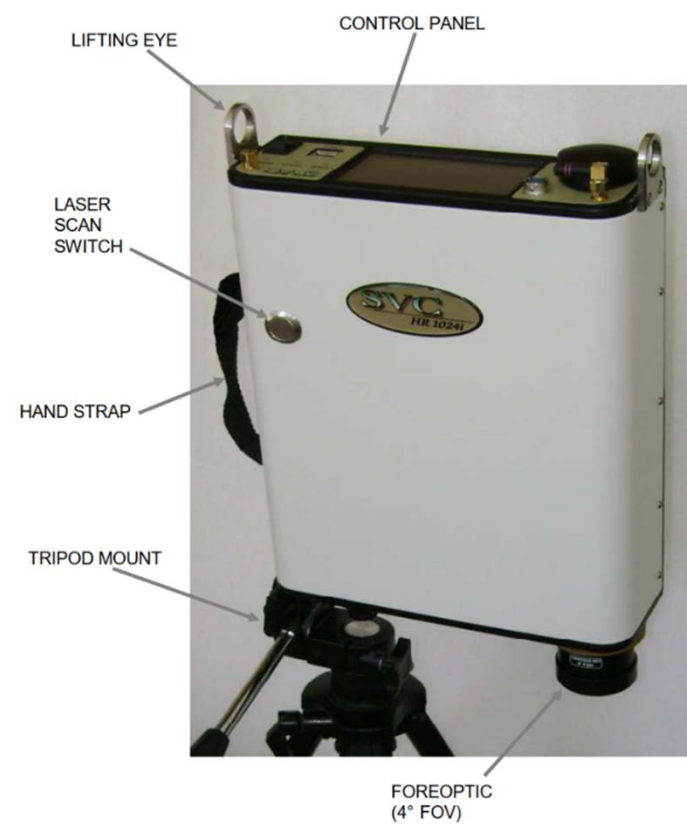
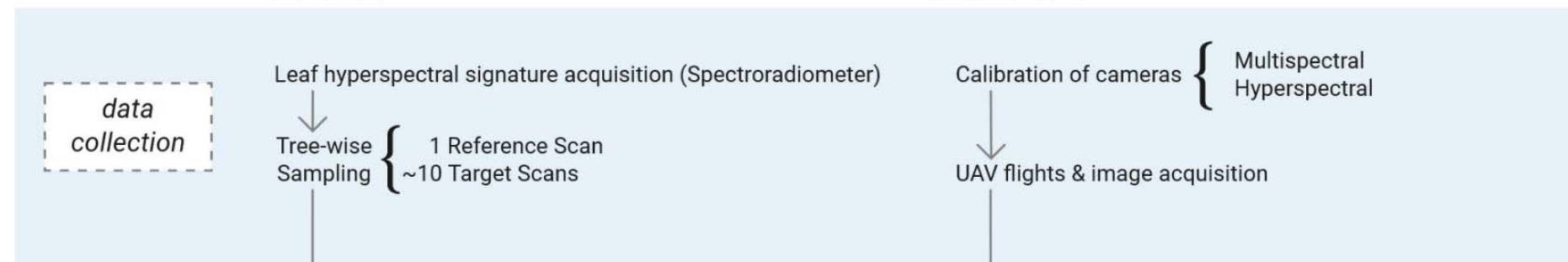
Data collection workflow





Leaf level

Orchard level

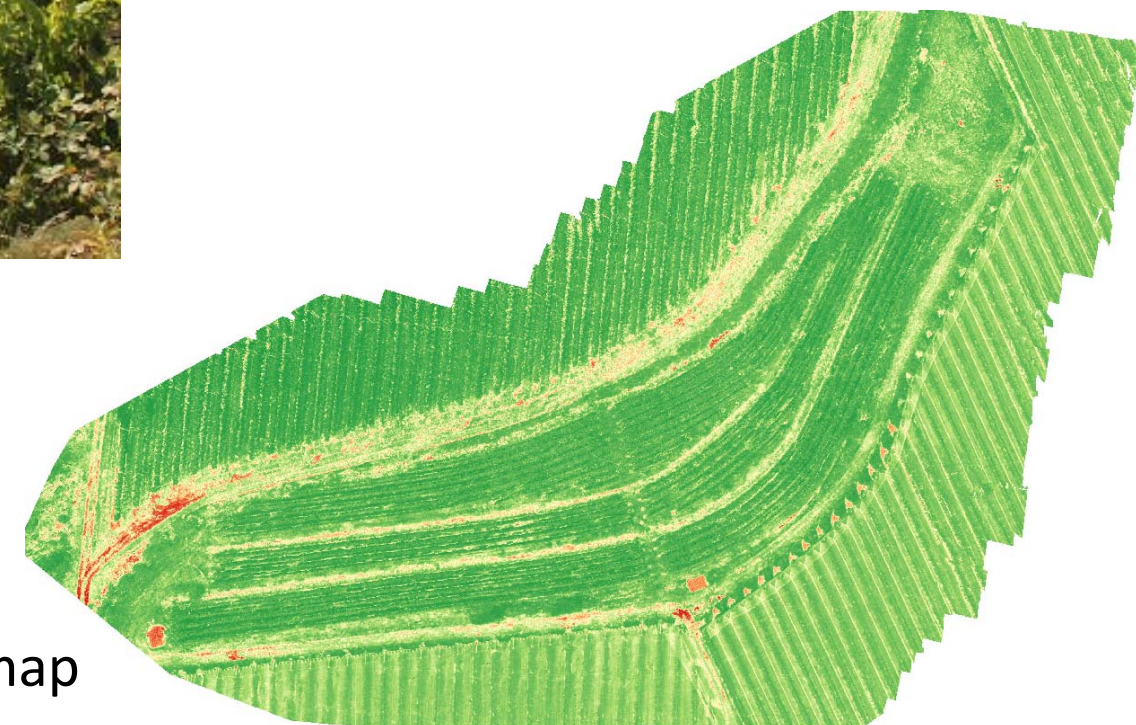
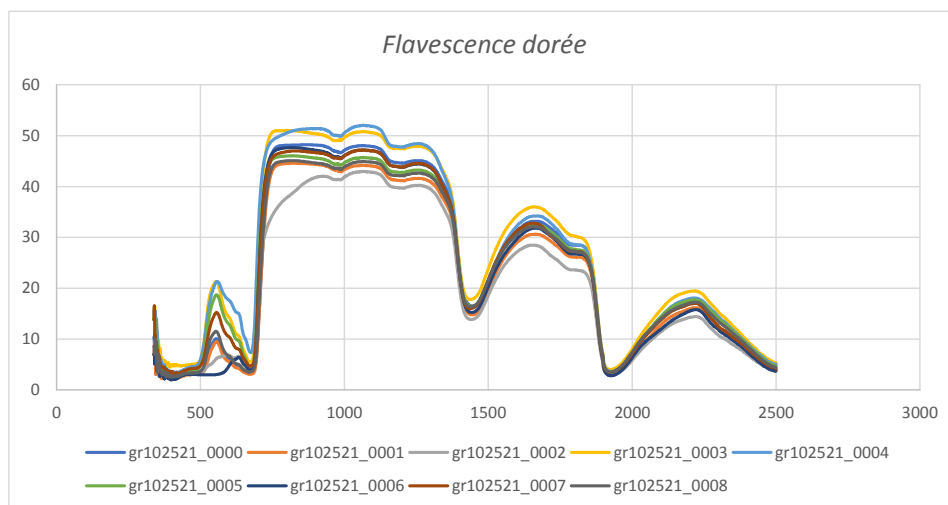
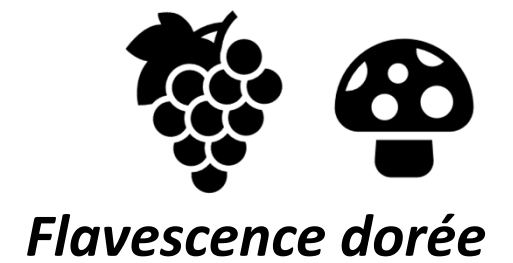




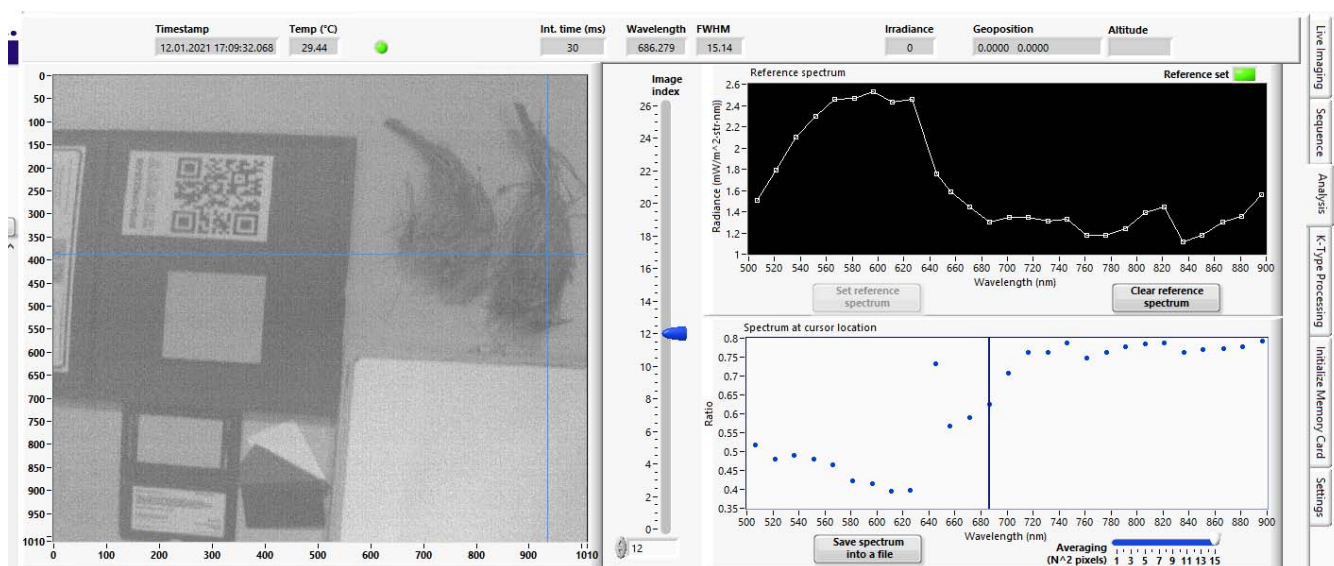
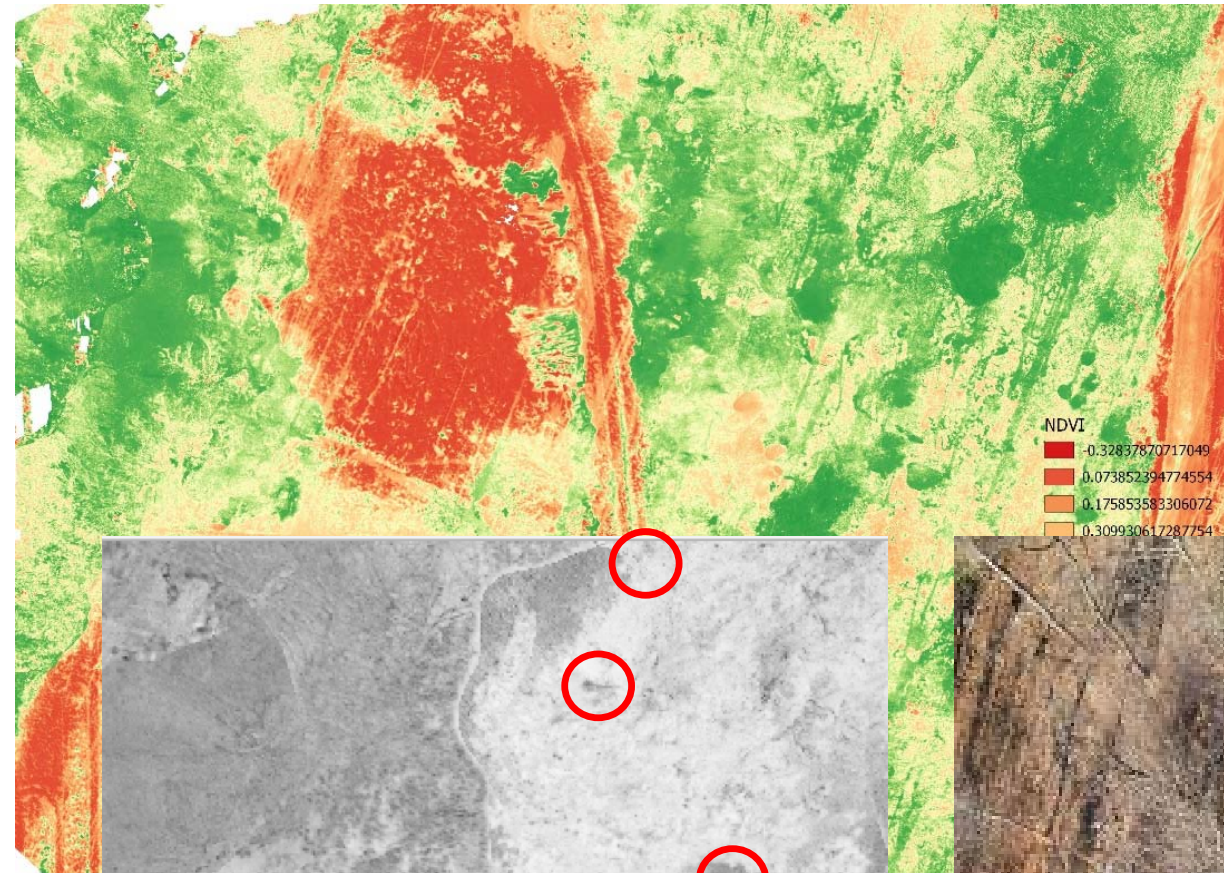
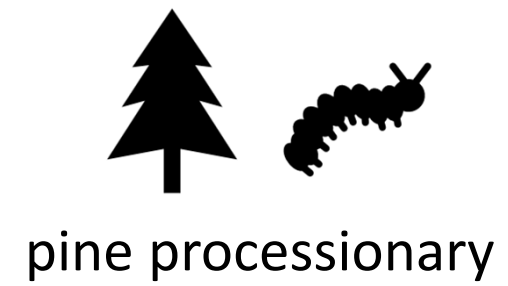
Hyperspectral signatures



Areas of interest

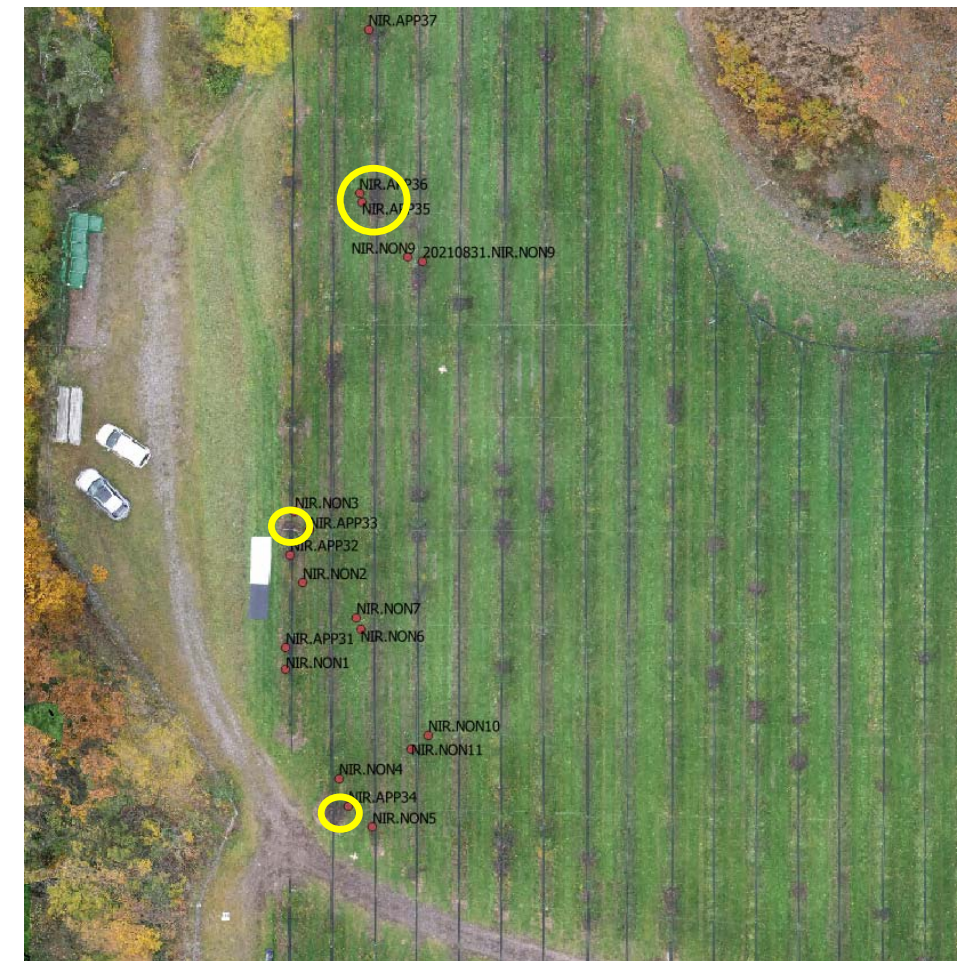
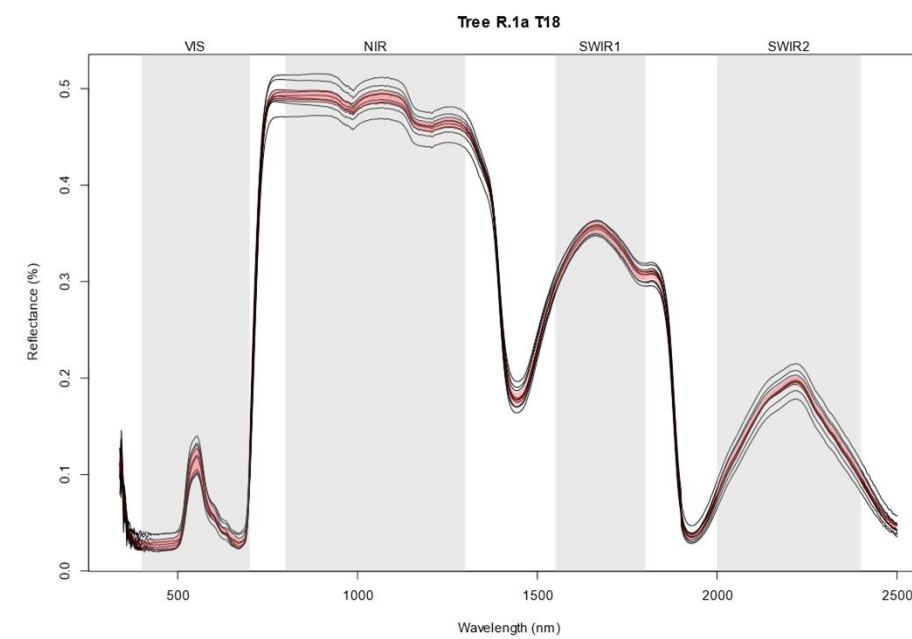


NVDI map





Apple proliferation

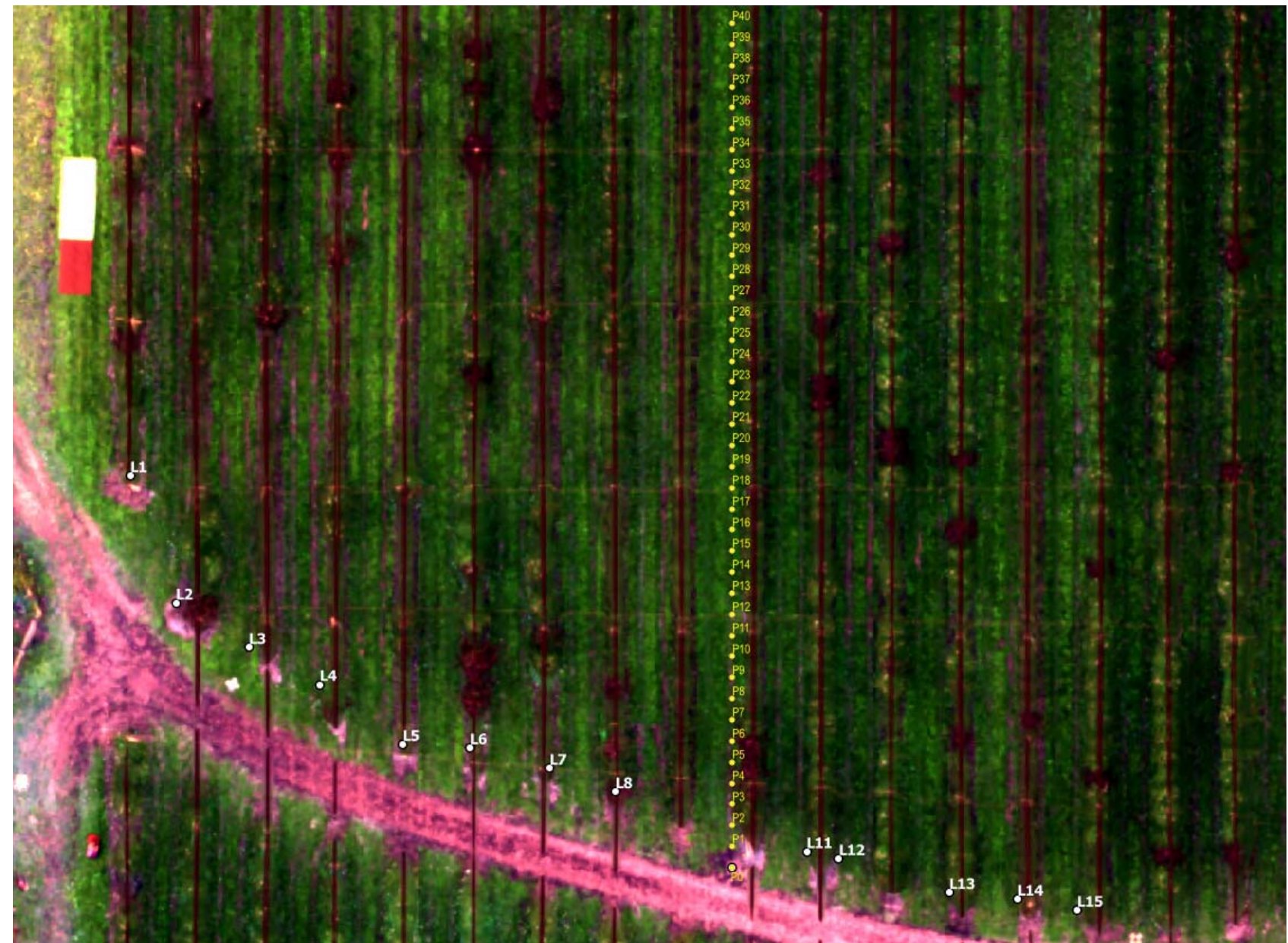




Classification

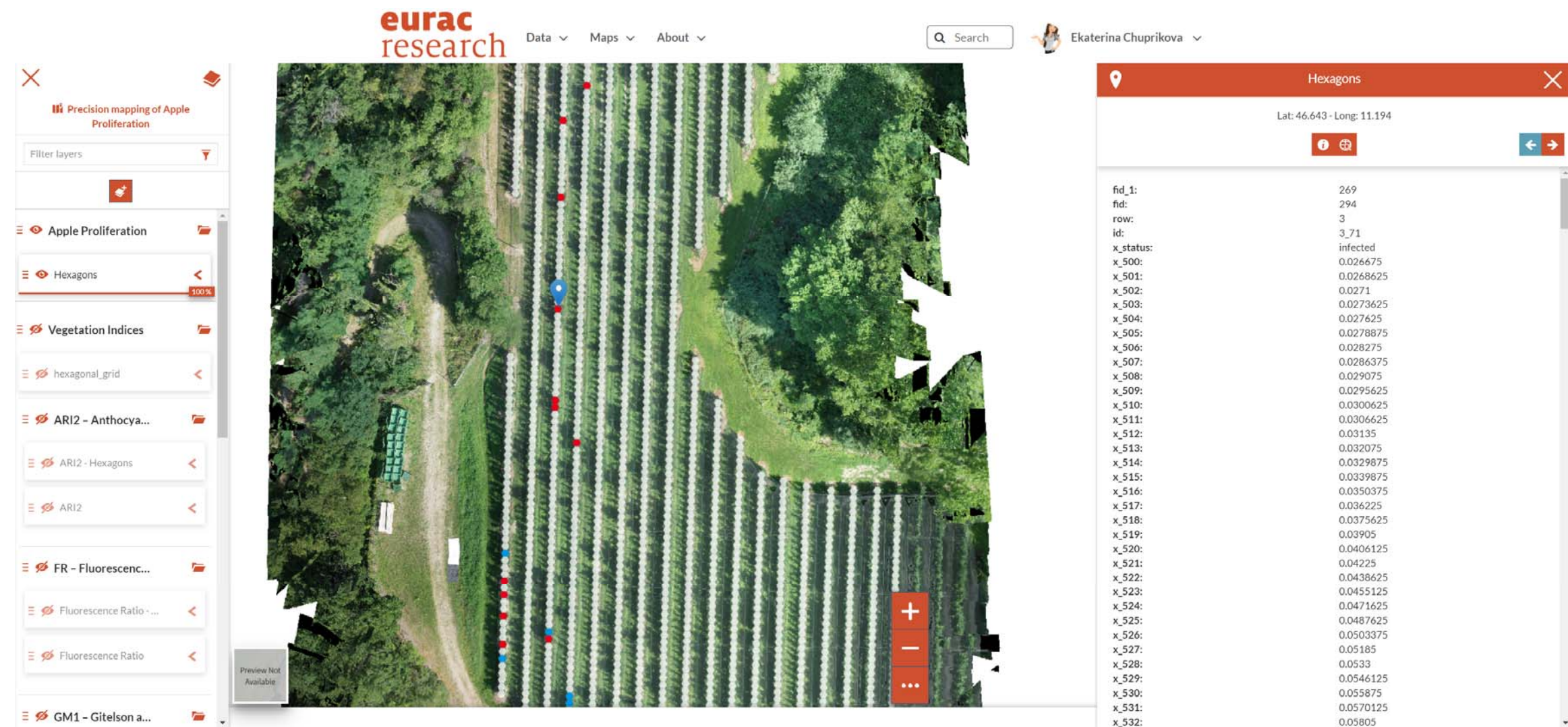
Training

Automatic identification





- Grid structure represents apple trees in rows and abstract an information about an individual tree
- Hexagons shows a tree status: infected/non-infected





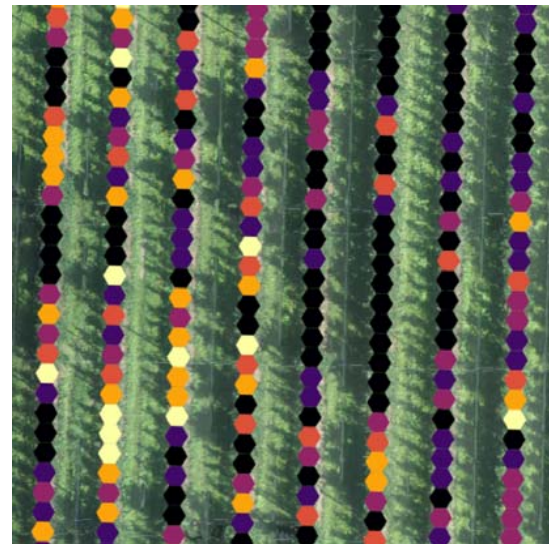
(a) ARI2 - Anthocyanin Reflectance

(b) FR - Fluorescence Ratio

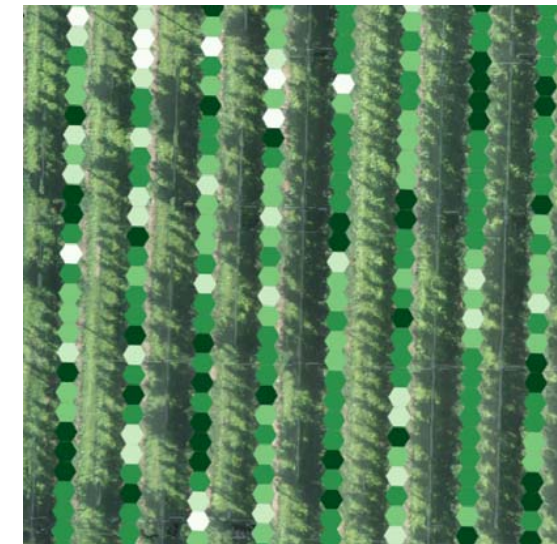
(c) GM1 and (d) GM2 - Gitelson and
Merzylak 1 and 2

(e) PRI - Photochemical Reflectance Index

(f) ZTM - Zarco-Tejada Miller



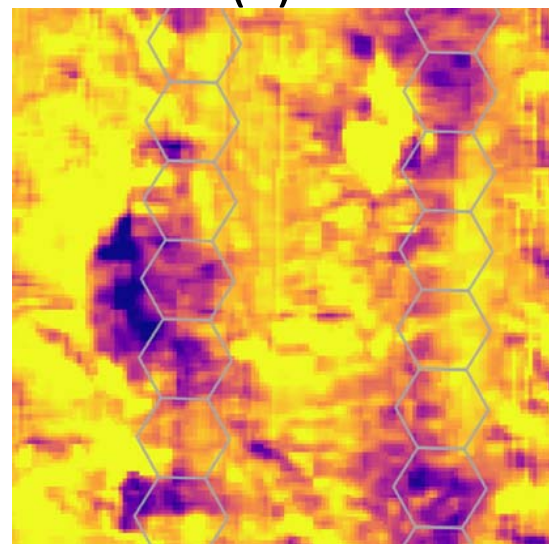
(a)



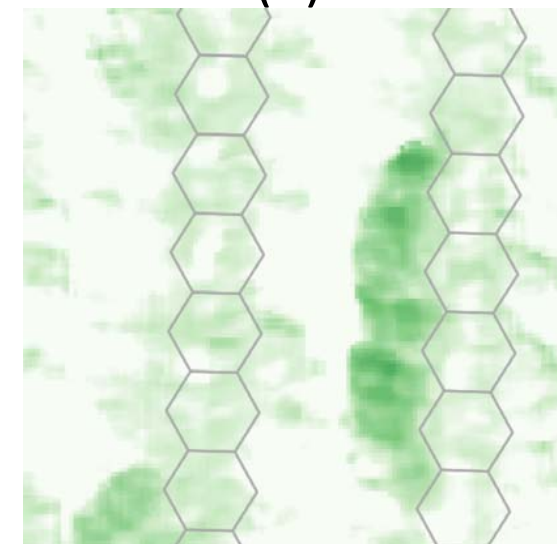
(b)



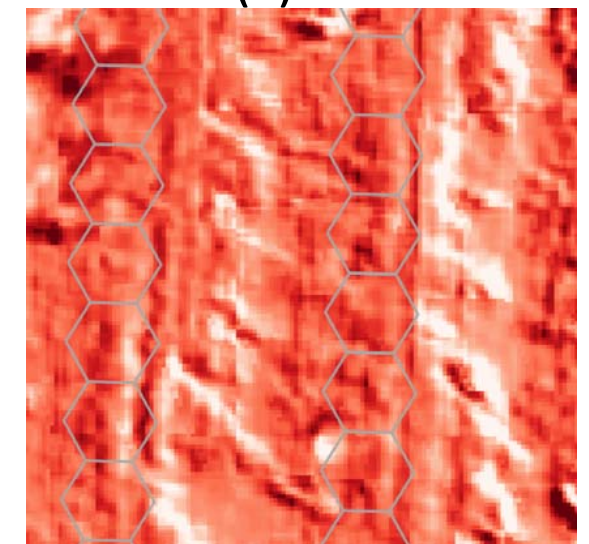
(c)



(d)



(e)



(f)

Thanks for your attention!

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research



The research leading to these results has received funding from the EU H2020 project (818 182) SMART AGRI HUBS , under Sub-Grant Agreement 2282300354-PREPARE-1, “Building digital competencies for detecting and monitoring diseases in moUntain aGriculture fields (BUGs)”