



Health mapping of forest with TreeMaps

AFRY Smart Forestry

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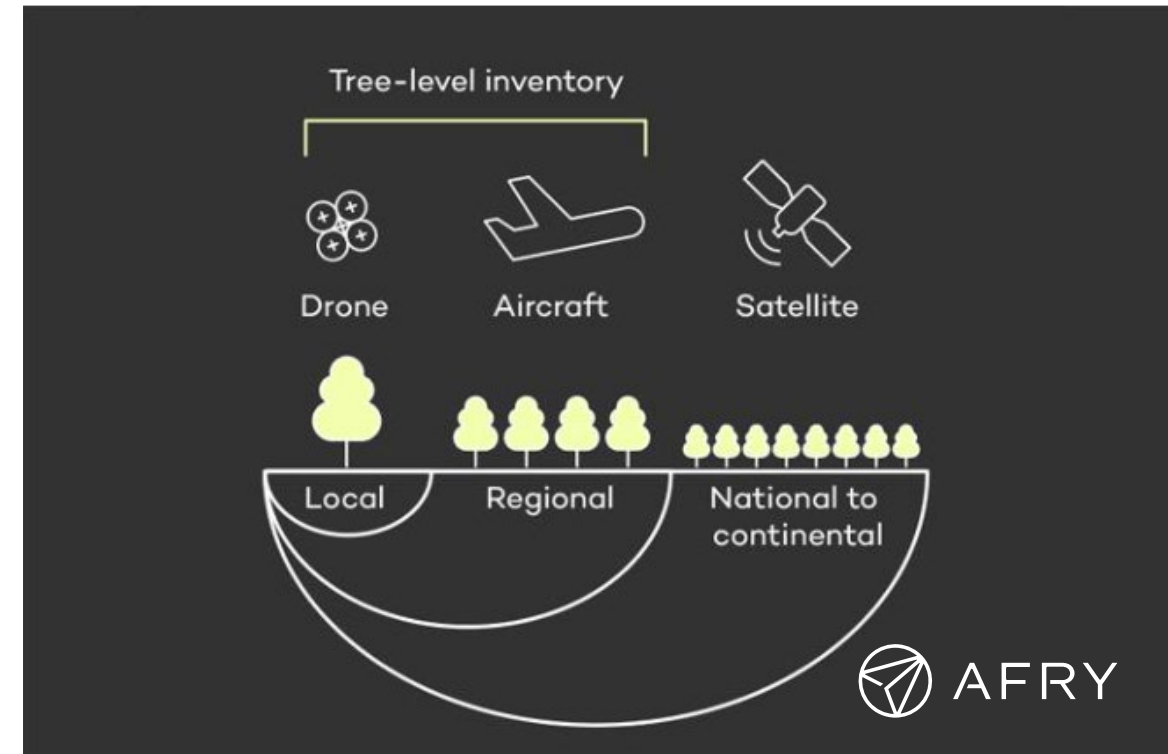
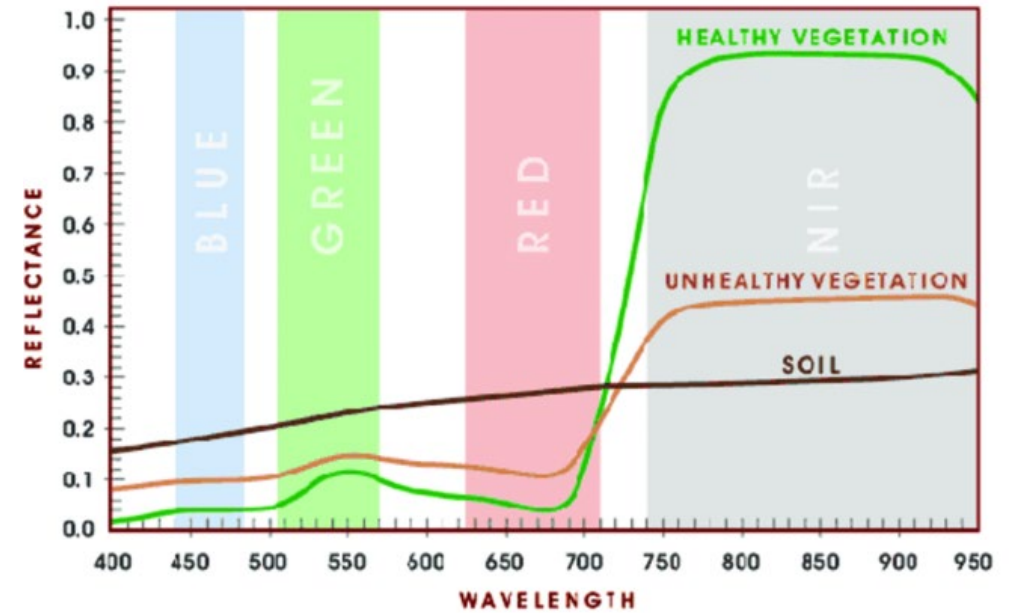
Challenge

- Pests and diseases are a natural part of forest dynamics but cause big economic losses if they are uncontrolled.
- The changing climate with extreme temperatures and changes in rainfall patterns are the main reasons for increasing forest health problems.
- Monitoring damage is the key to managing the problem.
- Traditionally, monitoring has been implemented by manual field observations, but this is too slow, costly, and inaccurate a procedure.
- Remote sensing tools and methods offer solutions for effective monitoring.
- This document outlines the approach to how this can be achieved.



Solution outline

- Forests cover vast land areas, but disturbance monitoring requires wall-to-wall surveys. However, detailed analysis should be done with high-resolution data.
- The most effective solution is to carry out a two-phase inventory:
 - Wall-to-wall satellite image-based time series can help in the identification of disturbance areas in the plantation
 - After identification of the problematic area, a detailed health analysis should be carried out with a Hyperspectral or Multispectral drone survey
- A hyperspectral (HS) sensor should be applied at least in the R&D phase to find the best band combination for detailed analysis. After the R&D component is implemented, it might be possible to simplify the sensor setup to scale up the surveys.



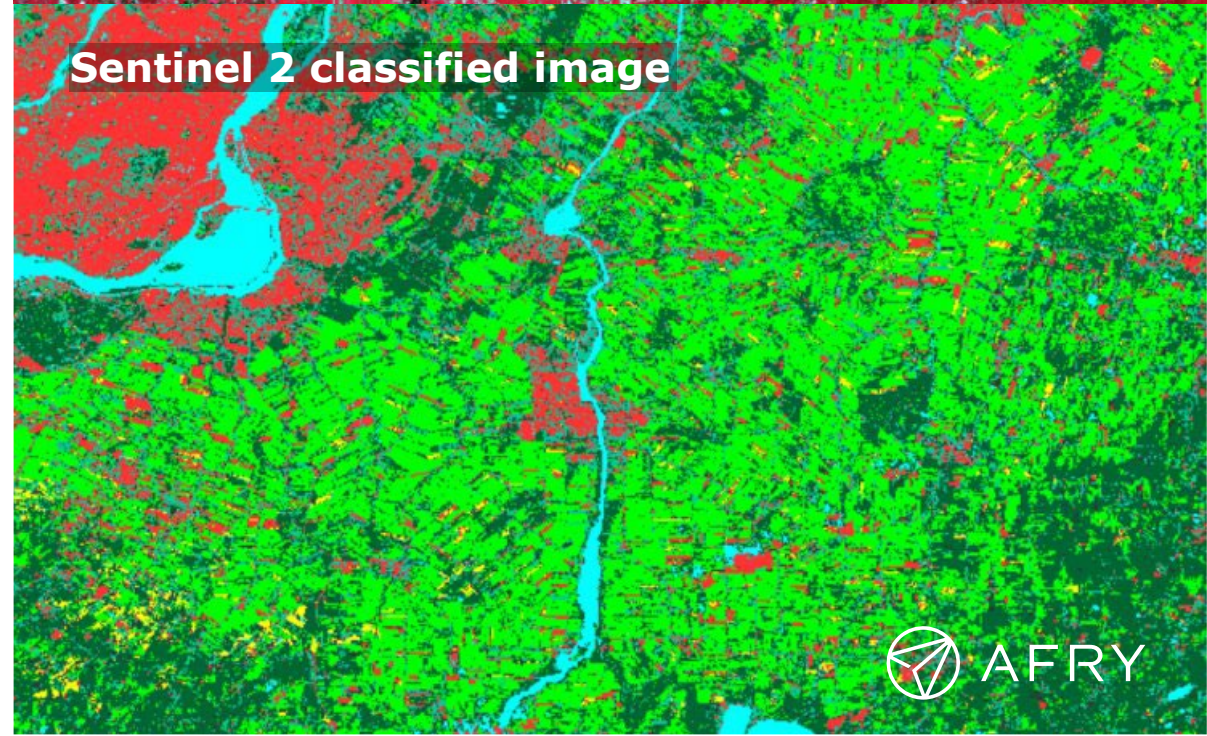
Satellite inventory: Identifying disturbed areas

- Satellite images are used to detect potential disturbances in vast areas. One method is to change monitoring through a time series of low-cost Sentinel data.
- Sentinel 2 has a spatial resolution of 10 meters and an excellent spectral resolution with 14 bands – thus, it is excellent for this purpose.
- Severely damaged areas can be initially delineated by satellite data.
- Availability of cloudless images might be limited.
- The approach will be improved in the future with novel hyperspectral satellites.

Sentinel 2 CIR image

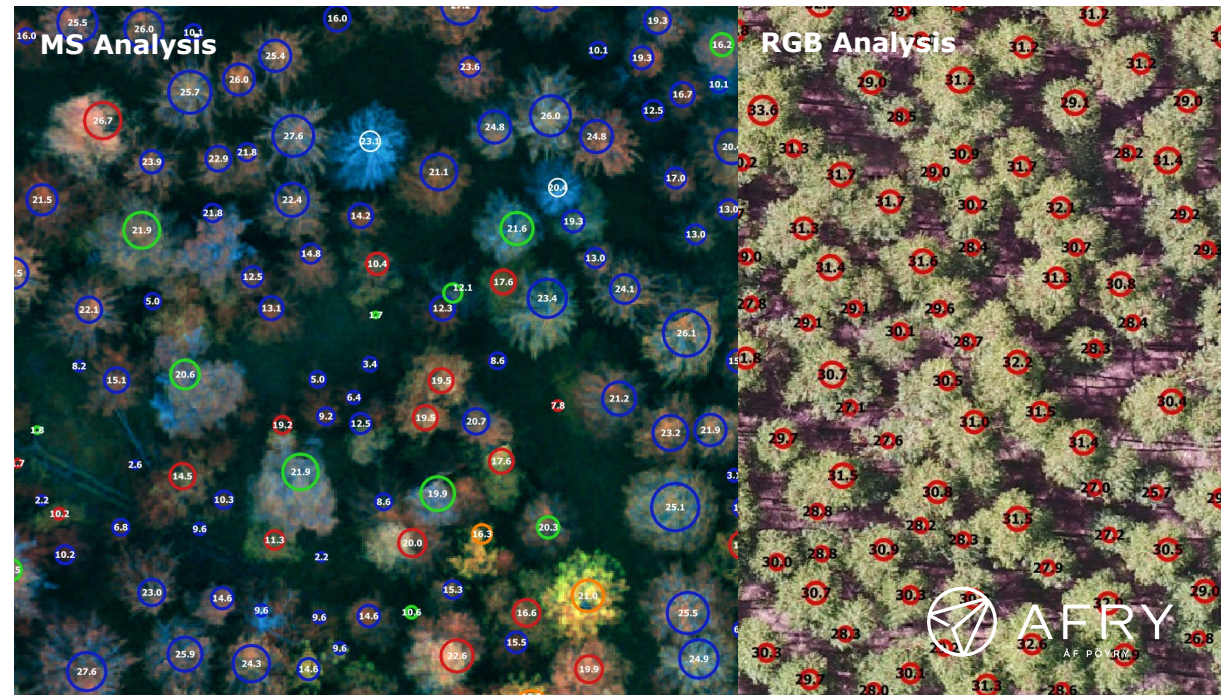
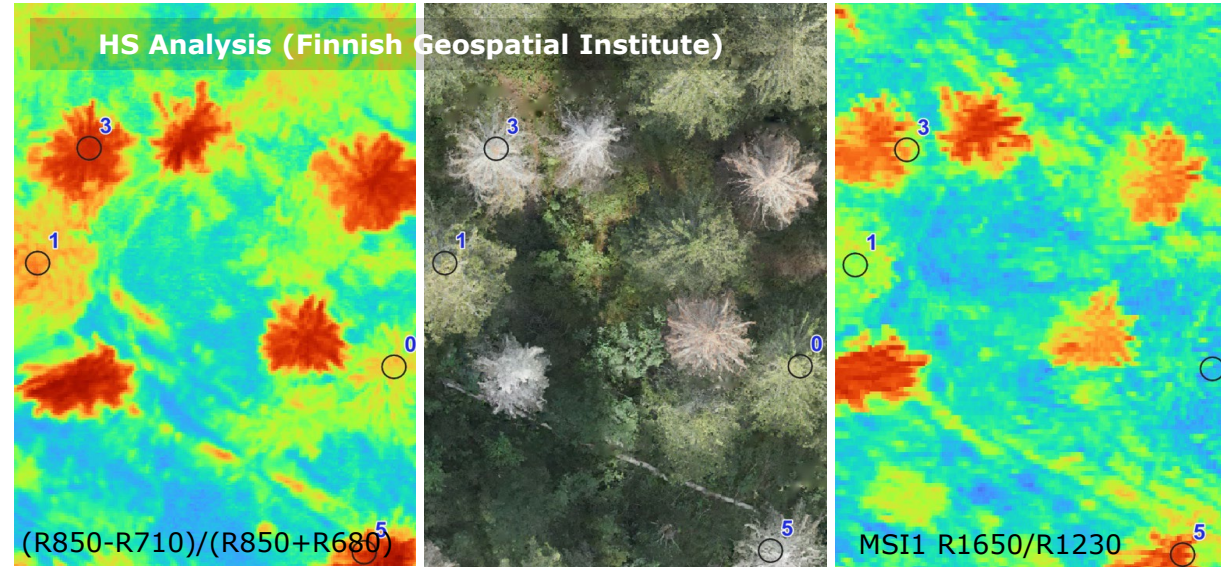


Sentinel 2 classified image



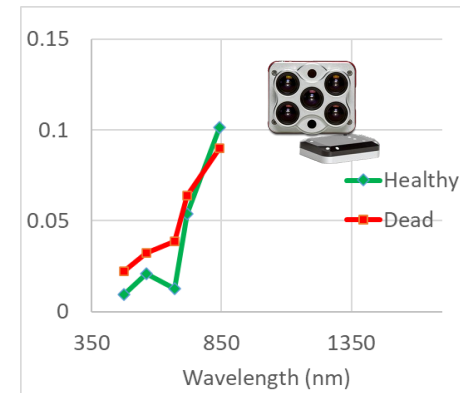
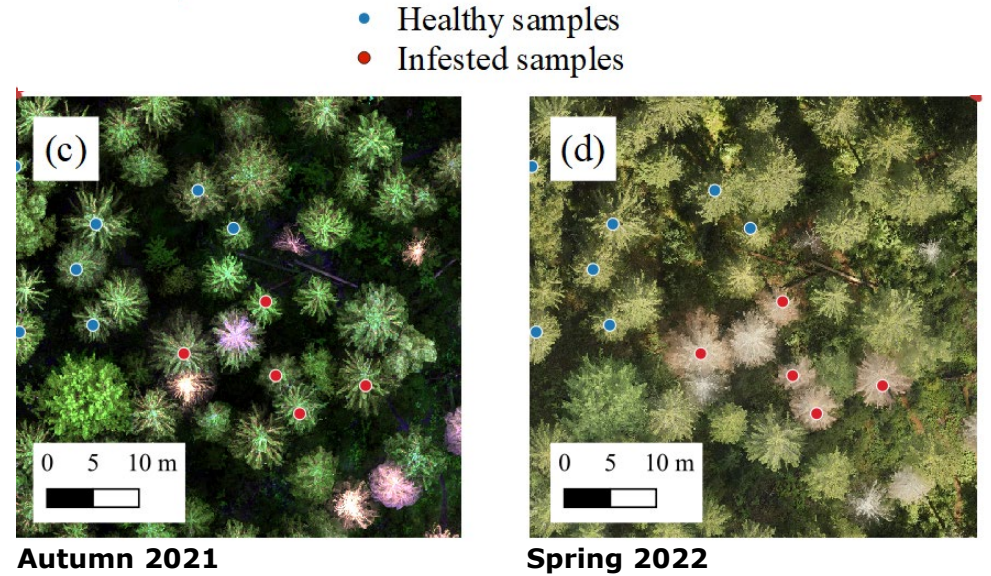
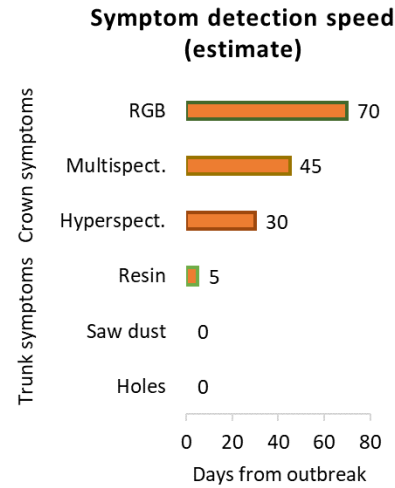
Drone surveys: Analysis of disturbed area

- Drone surveys or manned LiDAR surveys enable highly detailed tree-level analyses of health problems.
- AFRY Smart Forestry TreeMaps provides the following output:
 - tree locations,
 - heights,
 - canopy diameters and
 - through models DBH and stem volume.
- Results can be aggregated, for example, to value the damaged forest.
- Applications of different sensors:
 - RGB: interpretation of dead and alive trees
 - Multispectral (MS): interpretation of sick trees
 - Hyperspectral (HS): detailed analysis of abnormalities

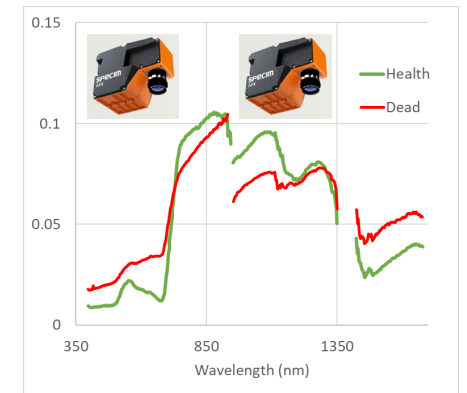


Drone surveys: MS and HS analysis

- All sensors can distinguish between dead and living trees.
- The benefit of better spectral resolution is in the health analysis of early symptoms before an outbreak has occurred.
- Development of disturbances can occur rapidly (as shown in the upper right pictures).
- AFRY co-operates in health analysis R&D with leading organisations, and all pictures and graphs on this page have been provided by the Finnish Geospatial Institute.



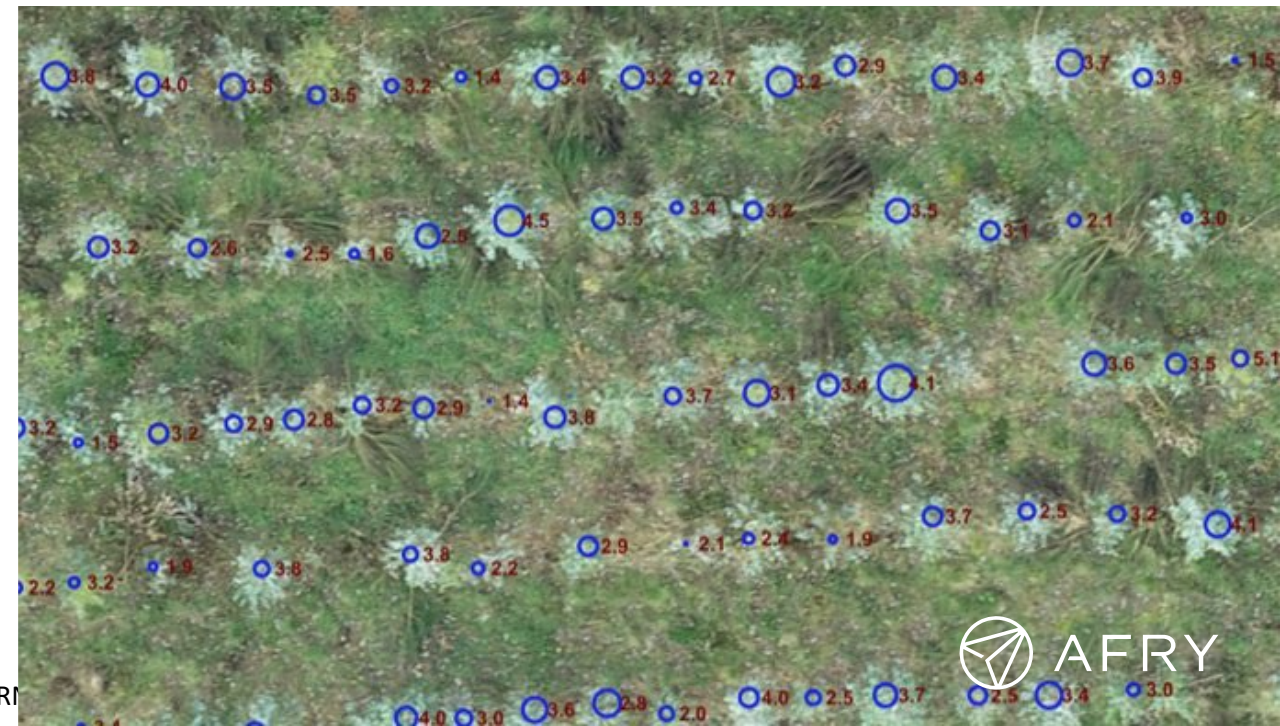
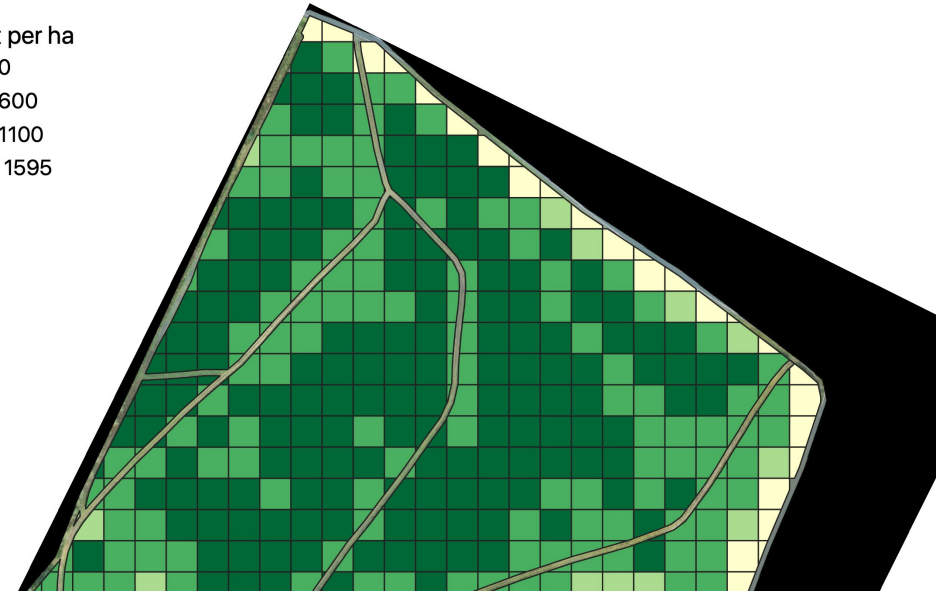
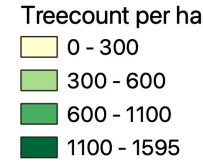
Multispectral



Hyperspectral

Drones in survival mapping

- Survival mapping is carried out exclusively with drones as it requires high resolution.
- In survival monitoring, the challenge is to complete the inventory in a very narrow timeframe, ideally before the 3-week mark (in tropical plantations).
- Seedlings are typically about 15–25 cm in height, and monitoring requires very high resolution. Thus, the flying altitude should be very low, down to 15–20 meters.
- In case there are also weeds that must be separated from seedlings, an MS sensor should be applied
- MS/HS sensors would require R&D work to determine the optimal band combination and approach, whereas the RGB sensor solution is ready for deployment.



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