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NATURAL RESOURCES
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The role of remote sensing in European level monitoring of forests

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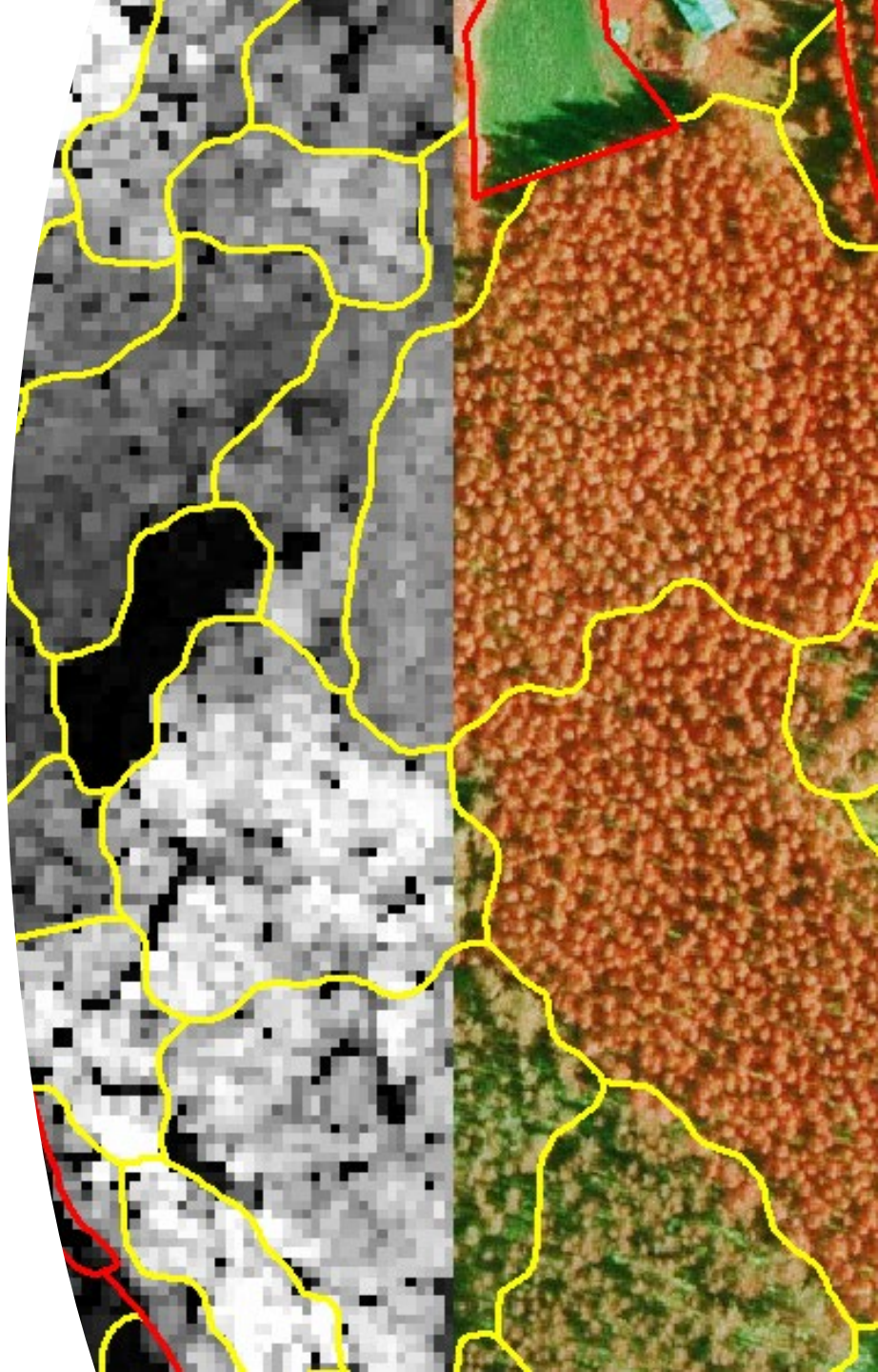
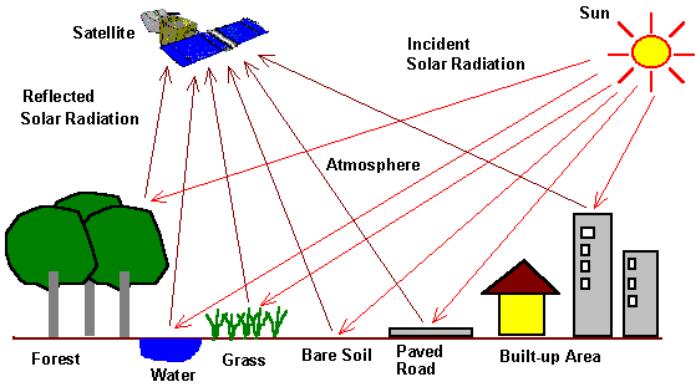
UNITE
FOREST-HUMAN-MACHINE INTERPLAY

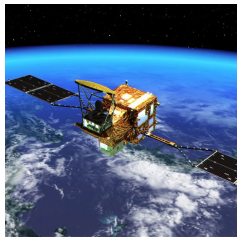


What is remote sensing?

- Remote sensing is the process of detecting and monitoring the physical characteristics of a target by measuring its reflected and emitted radiation at a distance.
- Special instruments collect remotely sensed data, which help to "sense" things about the Earth.
- Remote sensing technology is used in a wide variety of disciplines in different use cases, including most earth sciences, such as geology, hydrology, ecology, geography and *forest sciences*.



Platforms



- Spaceborne
  - Satellites, typically in sun-synchronous orbit
- Airborne
  - Aircrafts, fixed-wing, rotary-wing; manned

  - Drones; unmanned

- Ground
  - Static, mobile
  - “close-range remote sensing”

Scale

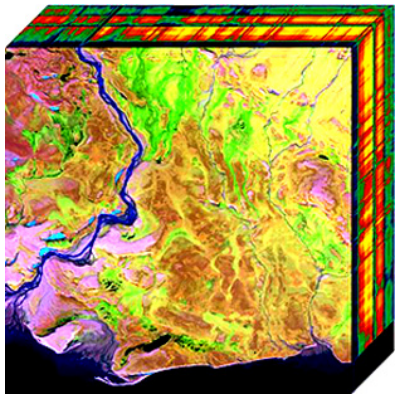
- Spaceborne data is mainly used in large areas (region, country, global)
- Fixed-wing aircraft data is typically used in regional and country level
- Drone data cover substantially smaller areas than aircraft data
- Ground sensing suits at best for non-areal targets
- Extent vs. resolution

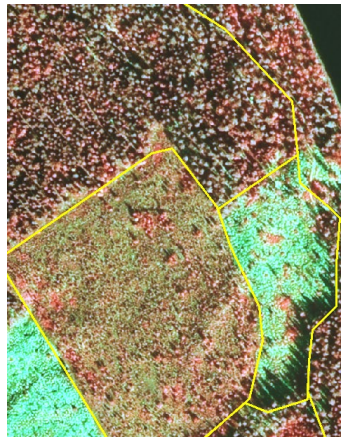
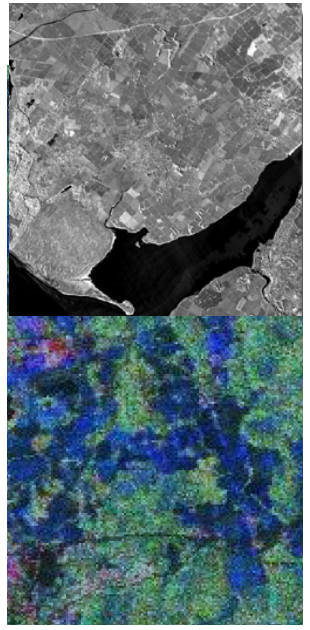
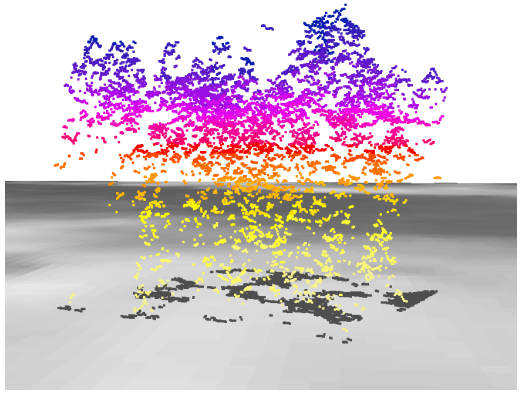
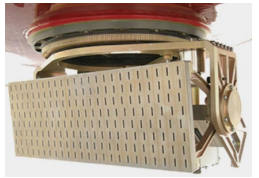
Platform type limits for which use cases data can be used.

Sensors

- Passive cameras
  - Multispectral, hyperspectral
  - Typically VIS+IR
  - Data availability limited due to clouds
- Active sensors
  - Imaging radar e.g. SAR
  - Scanning Lidars
    - Data not available at European level



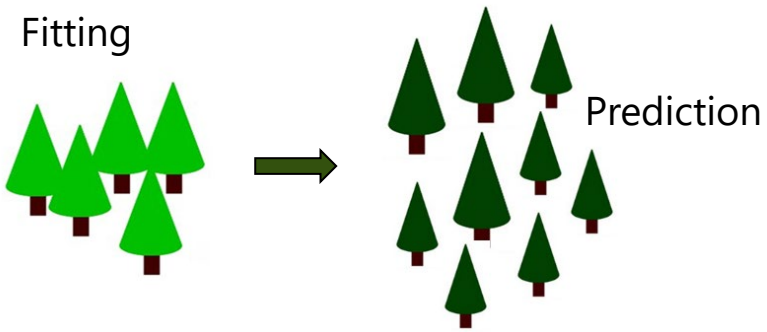


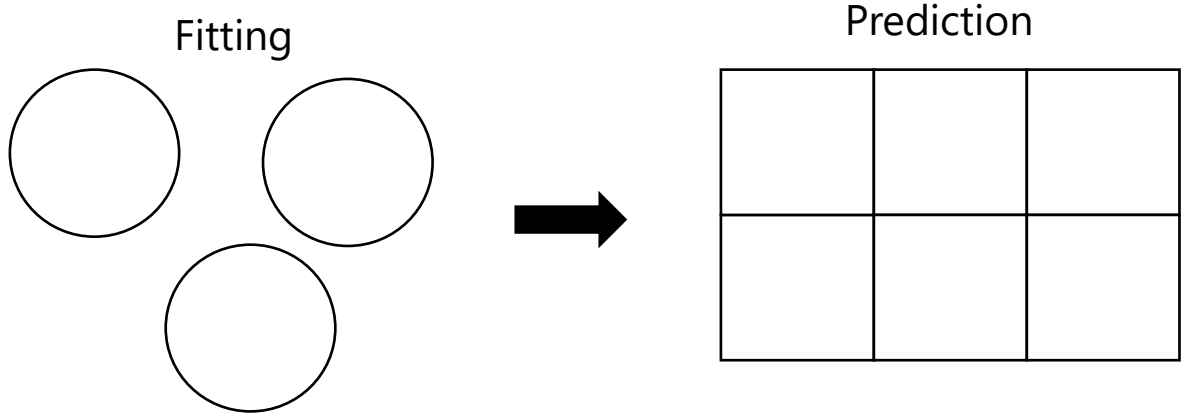






How it works?

- Remote sensing metrics are computed from the response of an instrument
- A model ***Y = f(metrics, parameters)*** is fitted with field data of the target area
- ***Y*** is typically a plot (or tree, stand etc.) in training stage
- Prediction unit is often different, e.g., pixel or square cell
- Inference at the scale of interest (e.g. stand, country, Europe …)
- Predictions and parameter estimates have inherent uncertainty

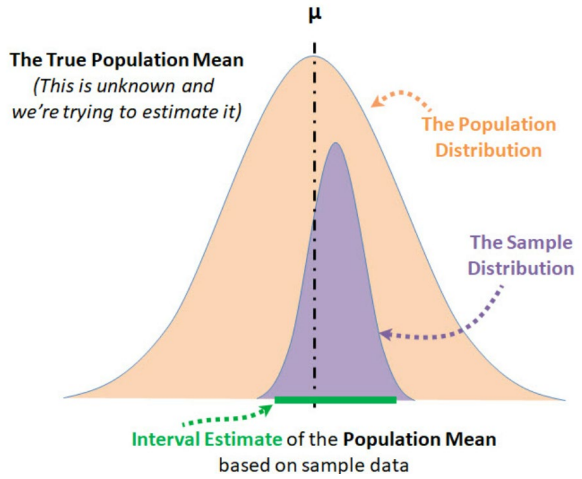
"local model"

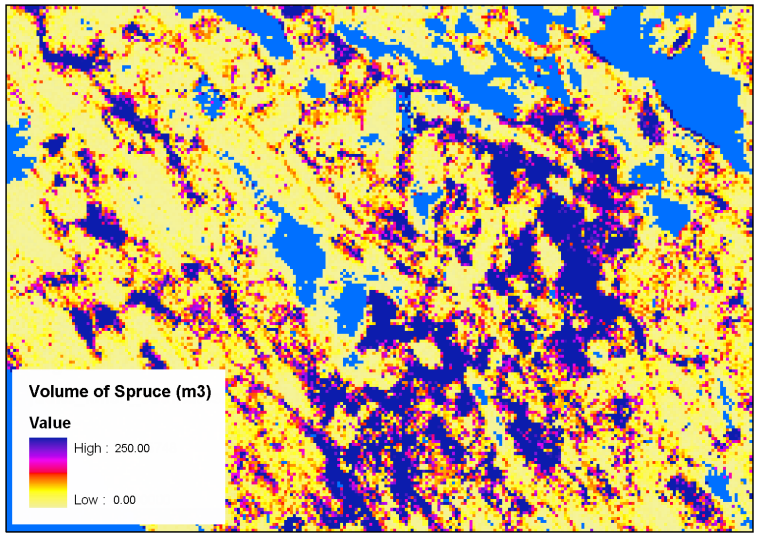




Remote sensing can be used in both mapping and point estimation – what do we want to achieve?

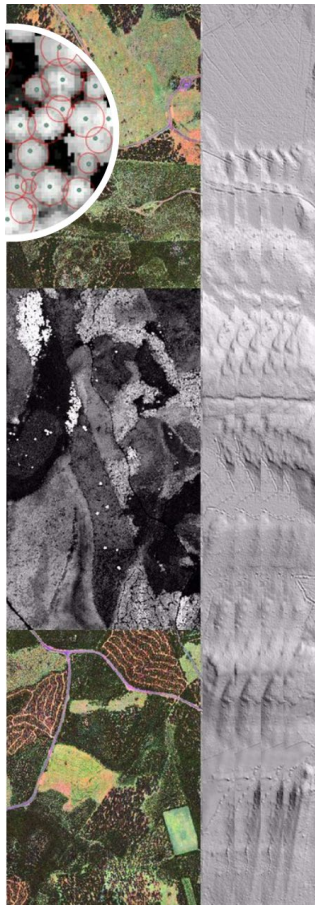
- Mapping refers to the prediction of some attribute in a wall-to-wall manner
- Elements of map may be used at chosen scale
- Accuracy must be sufficient for the decision-making case at relevant scale
- Unbiasedness is not guaranteed (by design)





- Point estimation means the use of sample data to calculate an estimate of an unknown population parameter
- E.g. the estimate of mean AGB and its confidence intervals (CI)
- Remote sensing can be used to improve the efficiency of estimators (i.e. narrower CI)
- Unbiasedness is typically a requirement

What to consider regarding remote sensing of forests?



Field measurements from the area of interest are needed to train the prediction or estimation model. Is unbiasedness a requirement?

Homogenous remote sensing data through space and time and field data from the same time frame is a mandatory requirement. This is easier to achieve in small than large area. Therefore, it is often reasonable to implement an inventory area-by-area.

Clouds restrict the use of passive satellite images. In Nordic countries, for instance, it is not possible to get even one cloud-free image from each area every year. Radar (SAR) data do not fit well for the purposes of forest inventory and assessment.

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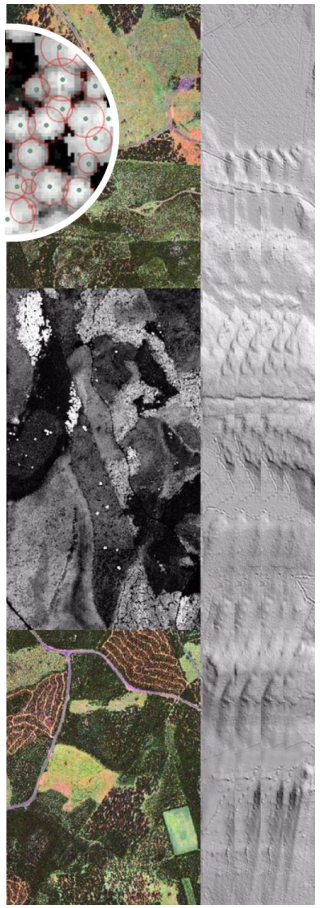

Remote sensing can be used to improve the efficiency of forest surveys but not with respect to all attributes (e.g. tree species specific attributes are difficult).

Many biodiversity or disturbance related characteristics are challenging to predict, such as deadwood, naturalness or old forests.

Soil properties of forest land is difficult to predict by remote sensing. Seeing “below” forest canopy is not usually possible (cf. agricultural fields).

There is nothing in the foreseeable future that would drastically change the role of remote sensing in the monitoring of forests in large areas.

Thank you!

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