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Remote sensing of canopy nitrogen in Catalonian forests

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Background

Nitrogen (N) is an essential nutrient for plant growth. Leaf nitrogen content is linked to photosynthesis capacity, leaf chlorophyll content and Rubisco. **Canopy nitrogen**, which is the leaf nitrogen content averaged over a forest stand, is linked to forest productivity (1) and canopy-level photosynthetic capacity (2). For these reasons, it is crucial to find efficient ways to detect canopy N.

Relevance
Remote sensing (RS) has already been used to estimate canopy nitrogen at local and regional scales (2). However, few studies to date have looked at canopy nitrogen in **Mediterranean forests**.

Research challenge

We investigated the opportunity to detect **canopy nitrogen** in Mediterranean forests at regional scale using the **Meris Terrestrial Chlorophyll Index** (**MTCI**), a readily available remote sensing product.

Study area

- Catalonia region, NE Spain
- 1892 forest plots
- Broadleaf deciduous, broadleaf evergreen and needleleaf tree species

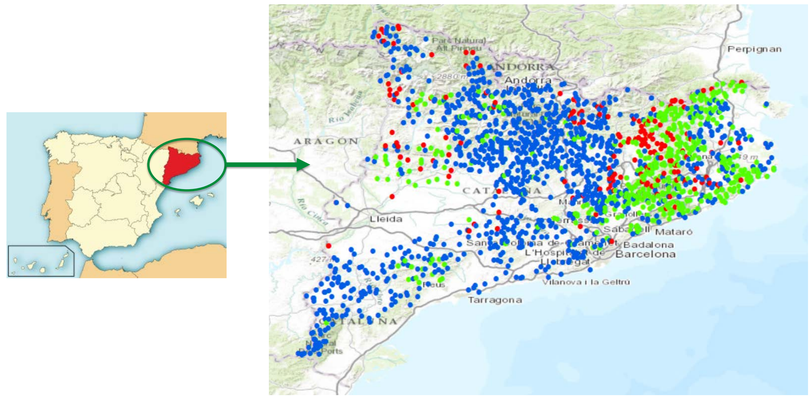

Fig 1. Forest plots map in the region of Catalonia, NE Spain. Red = broadleaf deciduous; green= broadleaf evergreen; blue = needleleaf

Remote sensing analysis

MTCI is a remote sensing product globally available from MERIS, aboard Envisat satellite. It is a ratio of three spectral bands (681, 708 and 754 nm) located around the **red-edge region** of the spectrum.

The spatial resolution is 1km.

Fig 2. Envisat satellite
(source: ioccg.org)

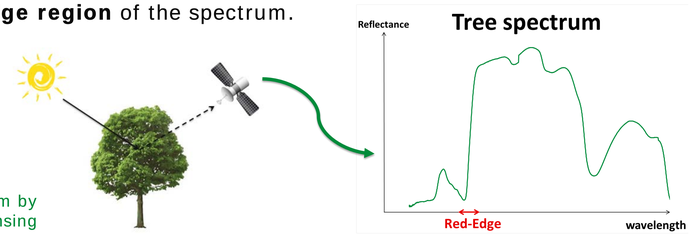

Fig 3. Obtaining a tree's spectrum by remote sensing

Results

- The relationship between canopy N and the entire dataset is significant (Fig 4.)
- A relationship is found for broadleaf deciduous tree species but not for either broadleaf evergreen or needleleaf tree species (Fig5.)
- There is a relationship for *Fagus sylvatica* and *Castanea sativa* but not for *Quercus humilis* plots (Fig 6.)

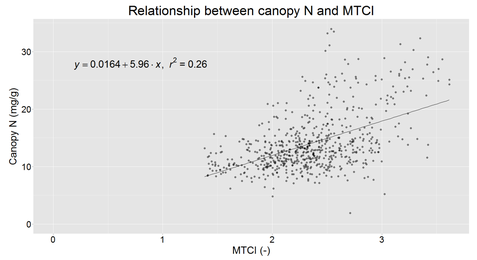

Fig 4. Relationship between canopy N (mg/g) and MTCI (-), only the plots sampled during summer are included, n=653.

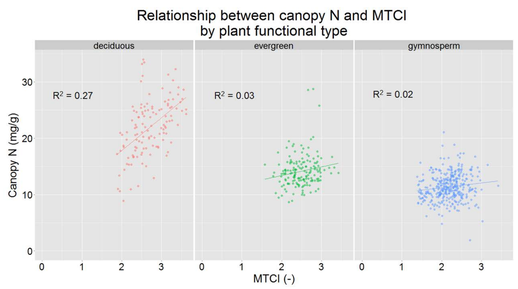

Fig 5. Relationship between canopy N (mg/g) and MTCI (-) by plant functional type. Red =broadleaf deciduous; green =broadleaf evergreen; blue = needleleaf

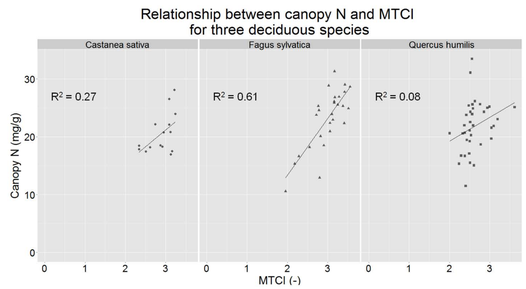

Fig 6. Relationship between canopy N (mg/g) and MTCI (-) for three deciduous species: *Castanea sativa* (n=15), *Fagus sylvatica* (n=27) and *Quercus humilis* (n=36).

Conclusions and perspective

- **The relationship between canopy N and MTCI is significant**
- It is influenced by the **plant functional type**: higher correlation for **broadleaf deciduous plots**
- A relationship between the variables is also found **at the species scale**
- Given the availability of MTCI data, this method could be applied at a broader, even **continental scale**

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NWO
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