Universiteit Utrecht

NWO
Netherlands Organisation for Scientific Research

Faculty of Geosciences
[1]Copernicus institute of sustainable developement &
[2]Department of Physical geography

Remote sensing of canopy nitrogen in Mediterranean forests

Y. Loozen[1,2], K. T. Rebel[1], D. Karssenberg[2], S.M. de Jong[2], M.J. Wassen[1]

Background

Nitrogen 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 measure canopy N.

Relevance
Remote sensing has already been used to estimate canopy nitrogen at 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 forested ecosystems at regional scale using the Meris Terrestrial Chlorophyll Index (MTCI), a readily available remote sensing product.

Study area

- Cataluña, NE Spain
- 1892 Mediterranean forest plots
- Frequent tree sp. : *Pinus sylvestris*, *P. halepensis* and *Quercus ilex*

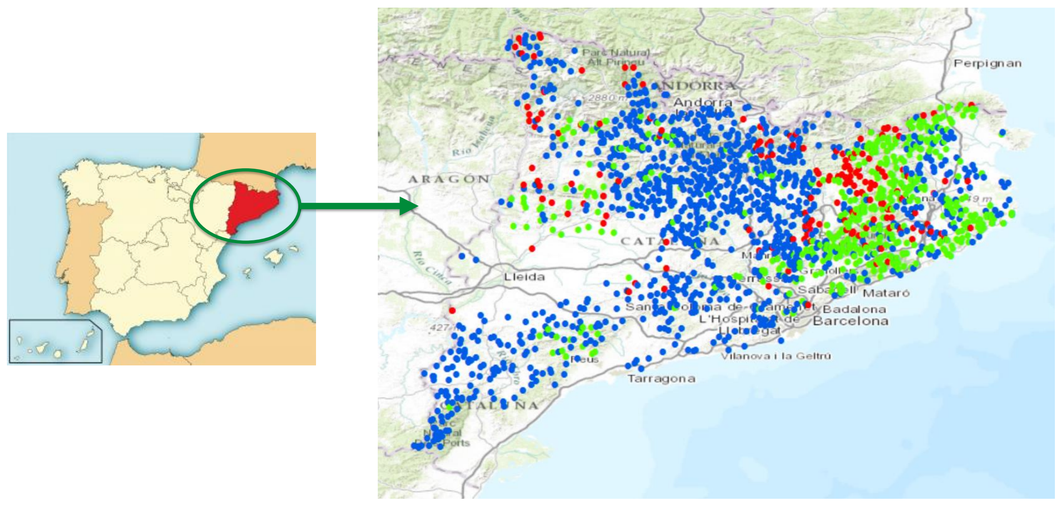

Fig 1. Forest plots map in Cataluña, NE Spain. Blue = needleleaves; red = broadleaves deciduous; green= broadleaves evergreen

Remote sensing analysis

MTCI is a remote sensing product from MERIS, aboard Envisat satellite. It is a based on the spectrum **red-edge region**.

Canopy N data were analyzed with MTCI using a **linear regression method**.

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

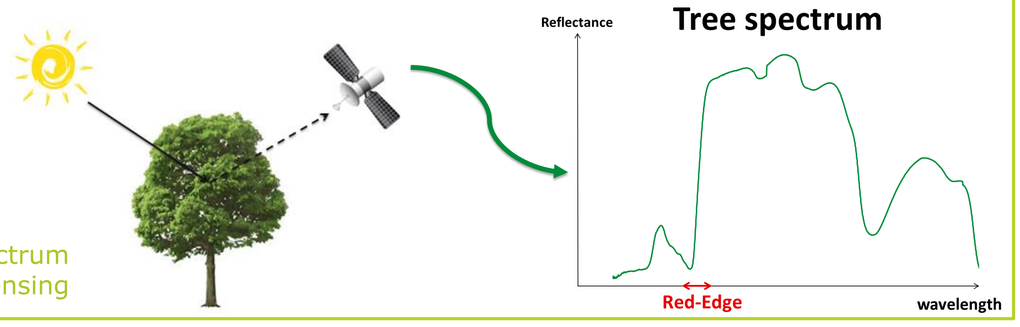

Fig 3. Obtaining a tree's spectrum by remote sensing

Results

The **relationship** between canopy N and MTCI was **significant** ($p < 0.001$, $R^2 = 0.13$). The method performed better for broadleaves deciduous plots ($R^2 = 0.10$) than for needleleaves or broadleaves evergreen plots. The relationship between leaf N and MTCI was also higher for the plots sampled during summer ($R^2 = 0.28$ in July).

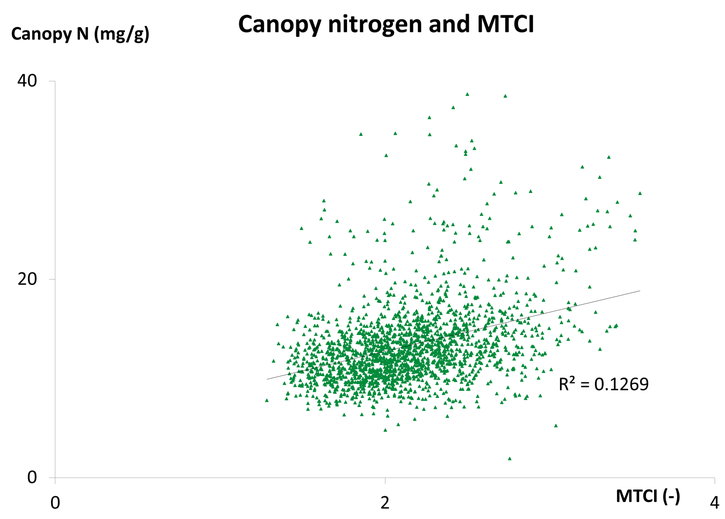

Fig 4. Relationship between canopy nitrogen (mg/g) and the Meris Terrestrial Chlorophyll Index, MTCI (-) (n = 1890).

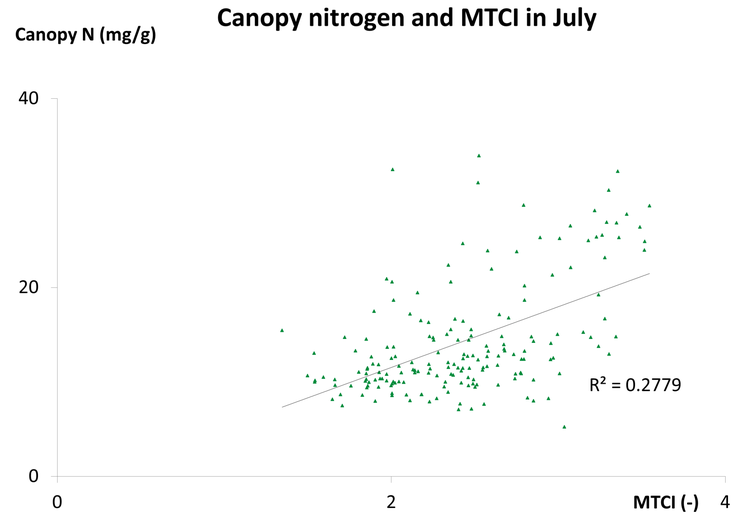

Fig 5. Relationship between canopy nitrogen (mg/g) and the Meris Terrestrial Chlorophyll Index, MTCI (-) for forest plots sampled during July (n = 187).

Conclusions and perspective

- **The relationship between canopy N and MTCI was significant**
- **Higher correlation for both deciduous forest stands and plots sampled during summer**

Copernicus Institute of Sustainable Development
Section of Environmental Sciences | Heidelberglaan 2, 3584 CS Utrecht
Contact: y.m.a.loozen@uu.nl T +31 (0)302 53 73 50
www.uu.nl/staff/YMALoozen/0

References: (1) Reich, P. B. (2012). "Key canopy traits drive forest productivity." Proceedings of the Royal Society B: Biological Sciences **279**(1736): 2128-2134.

(2) Ollinger, S. V., et al. (2008). "Canopy nitrogen, carbon assimilation, and albedo in temperate and boreal forests: Functional relations and potential climate feedbacks." Proceedings of the National Academy of Sciences of the United States of America **105**(49): 19336-19341.