Ecosystem total LAI partitioning in a seasonally dry tropical forest

Rodolfo Nóbrega¹,² | Magna Moura²,³ | Desirée Ramos⁴ | Cloves Santos⁵ | Rodrigo Miranda⁵ | Rodolfo Souza⁵ | Patricia Morellato⁴ | Jon Lloyd¹ | Iain Colin Prentice¹ | Anne Verhoef²

Introduction
The leaf area index (LAI) has been quantified for different vegetation types around the world. However, there is a lack of studies that partition the ecosystem total LAI into LAI for individual plant species. This is particularly important for natural ecosystems that have dominant species driving the total LAI. Here, we present an effort to estimate LAI for dominant species in an area of the Brazilian Caatinga.

Methodology
Overview
Our approach is based on the fact that the Caatinga LAI has timely responses to the soil moisture variations. We use a soil moisture bucket model to estimate the soil-adjusted vegetation index (SAVI), which in turn will be used to estimate the total plant area index (PAI). With individual (per species) PAI measurements, we estimate the LAI for each dominant species.

Field data
Our area of study is an experimental site with pristine Caatinga vegetation at the Embraapa Tropical Semiarid in Petrolina, Brazil. We used measurements of rainfall, soil moisture content and PAI. The tree inventory was conducted by members of the Nordeste project.

Remote sensing
We obtained SAVI series from 106 cloud-free Landsat images (from 2011 to 2018). We used these data for calibration and verification of the model.

Modelling soil moisture and vegetation index
To estimate the soil moisture (s) and SAVI (N) we used the methodology that Souza et al. (2016) applied to and validated for a Caatinga experimental area.

\[ \frac{dn(t)}{dt} = R(t) - I(R(t)) - Q(R(t); s(t)) - ET(s(t)) + L(s(t)) \]

\[ ET(s) = \frac{r_s - r_w}{2} \frac{L(t)}{K_s^{2r_s}} \]

SAVI (N) estimation
\[ s = b_1 \frac{N_{\text{max}} - N(t)}{N_{\text{max}} - N_{\text{min}}} \]

LAI estimation
We obtained LAI by extracting the woody area index (WAI) from the PAI following the equations calibrated and verified for the same area (Miranda et al., 2019, Poster number EGU2019-1816 in this session):

\[ \text{PAI} = 3 \times (e^{SAVI}) - 2 \]

\[ \text{WAI} = (1 - [\text{ln(PAI)} 	imes 0.5]) \times \text{PAI} \]

\[ \text{LAI} = \text{PAI} - \text{WAI} \]

Results
Soil moisture and SAVI

Plant area index was continuously measured throughout the years

Conclusions and further work
- This methodology can be used to discretize the LAI of different plant species in relatively sparse vegetation like the Caatinga, where most species had their LAI varying between 1 and 3 m²/m².
- We will improve the LAI partitioning considering the different senescence and growth conditions of different plant species.

References

Acknowledgements
We thank the funders (NERC and FAPESP) and the Nordeste Project team.

Contact information
Ecosystem modelling team: rodolfonobrega@imperial.ac.uk, scovento@reading.ac.uk, magnamoura@embrapa.br, rodolfosouza@embrapa.br
Project coordinators: Prof. Celso Prentice (c.prentice@imperial.ac.uk) and Prof. Jon Lloyd (jJonLloyd@embarpa.br)