

Do in situ or satellite-based vegetation indices capture the effect of drought on photosynthesis in a temperate heathland?

Maral Maleki

Supervisors

Prof. Ivan Janssens & Dr. Manuela Balzarolo





National Network Belgium



Models for estimating GPP

→are based mainly on observations on surface greenness (e.g. NDVI)

Deciduous forest

Wong et al., New Phytol. 2020

NDVI ≠ GPP Evergreen forest

Wong et al., New Phytol. 2020







NDVI ≠ GPP during drought → Resolve this issue by no longer depending on NDVI

→ Use vegetation indices that correlate with plant functioning, not with canopy greenness

```
Terrestrial Chlorophyll Index (TCI)
= (\rho_{750} - \rho_{710}) / (\rho_{710} - \rho_{665})
```

Inverted Red-Edge Chlorophyll Index (IRECI) = $(\rho_{783} - \rho_{665}) / (\rho_{705} / \rho_{740})$









Is not only prominent and valuable ecosystem in Western Europe but also is the first heathland that greenhouse gasses are being monitored since 2016. Mid-day average GPP by eddy covariance



Universiteit Antwerpen



Non-drought days — GPP=f(VI)

	IRECI	тсі	NDVI
R ²	0.87	0.87	0.40
RMSE	1.39	1.41	2.98
MAE	1.23	1.12	2.40
pBias	1.8×10 ⁻⁷	4×10 ⁻⁸	1.3E-07
AIC	29	30	81
p-value	<< 0.01	<< 0.01	<< 0.01





Results: Non-drought days, GPP = f(VI)

GPP anomaly = f(drought)

Drought: SWC, AI, AET/PET ratio





Results: Non-drought days, GPP = f(VI)

GPP anomaly = f(drought) Drought: SWC, AI, AET/PET ratio GPP = f(VI, SWC)

Linear	IRECI	тсі	NDVI
R ²	0.73	0.77	0.53
RMSE	1.85	1.69	2.39
MAE	1.46	1.28	1.83
Pbias	2.43	3.01	-3.87
P-value	<<0.01	<<0.01	<<0.01





Comparing proposed model with other approaches

- Multiple linear function between PRI and VI GPP=f(PRI and VI)
- ϵ -like approach, modeling ϵ as linear function of PRI and PAR and linear function of VI GPP =f(PRI, VI, PAR)

PAR= photosynthetically active radiation, in μ mol m⁻² s⁻¹ PRI= Photochemical Reflectance Index ($\rho_{531.6} - \rho_{568.9}$) / ($\rho_{531.6} + \rho_{568.9}$)







- Chlorophyll indices are more suitable candidates for GPP estimation than greenness indices.
- Non of the in situ indices capture well the drought impact on GPP.
- Drought indicators (e.g. soil moisture) are needed for accurate estimation of GPP during drought.





Satellite based indices

- Sentinel-2
- MODIS
- GOMI







Site Names:

- 1. Norunda, Sweden.
- 2. Soroe, Denmark.
- 3. Loobos, The Netherlands.
- 4. Brasschaat, Belgium.
- 5. Maasmechelen, Belgium.
- 6. Vielsalm, Belgium.
- 7. Fontainebleau, France.
- 8. Hainich, Germany.





THANK YOU

National Network Belgium