University of Leicester

Centre of Landscape and Climate Research

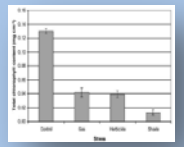
Amazon forest, Chlorophyll and Petroleum: from leaf to canopy

Paul Arellano[1], Kevin Tansey[2] and Heiko Balzter[3]

1) Why Chlorophyll?

- Photosynthesis is the most important biochemical process on the Earth. Chlorophyll enables light harvesting converting the sun energy to stored chemical energy that powers the biosphere.
- The amount of solar radiation absorbed by vegetation is a function of chlorophyll concentration and it can be related to Net Primary Production (NPP).
- Chlorophyll content can be directly related to vegetation stress.

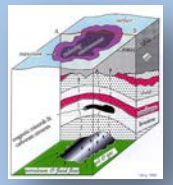
Smith et al., 2005



Smith et al., 2005

2) Why Petroleum?

- During the last decades petroleum production in the Amazon forest has been a source of pollution.
- Hydrocarbons migrates to the Earth surface in a natural process known as Micro/Macro seepages. They are a source of methane in the atmosphere.



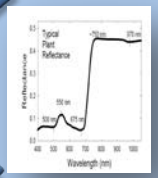
3) Methods

In order to simulate the interaction of the light with the plant leaves, 3D models have been developed using “radiative transfer theory”. These models have shown good results estimating reflectance based on the relationship between biochemical/ biophysical properties of the leaves and forest stands.

3.1) Leaf model (PROSPECT)

http://www.bbc.co.uk/bitesize/standard/biology/world_of_plants/making_food/revision/5/

Chlorophyll a+b
Water content
Organic matter
Structure



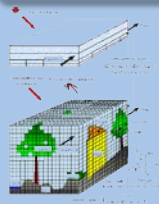
3,2) 3-D Canopy model (FLIGHT and DART)

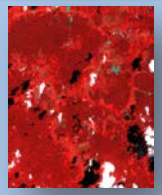
LAI, leaf angle distribution and size, DHB, tree high, crown (shape, coverage, size)

3.3) Inverse process of the models

Biochemical and biophysical parameters → Inverse process of the model → Hyperspectral image (Hyperion)

Chlorophyll a+b



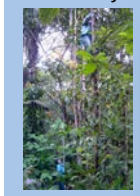


http://rami-benchmark.jrc.ec.europa.eu/HTML/RAMI2/MODELS/DART/DART.php

4) Fieldwork Campaign

Fieldwork took place in the Amazon rain forest of Ecuador.

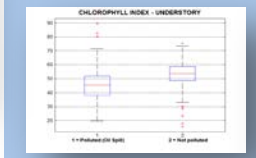
- Leaves were collected from the upper/middle canopy and understory by climbing trees and using canopy towers
- Parameters were determined from fresh and dry leaves in the laboratory

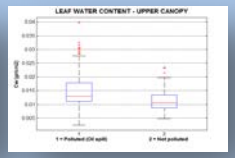


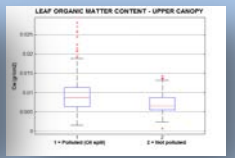
5) Preliminary results

6.1 Leaf biochemical parameters in the vertical profile of the forest

- From the results, in polluted areas chlorophyll values are lower, especially in the understory and leaf water/organic matter contents are higher, especially in the upper canopy.

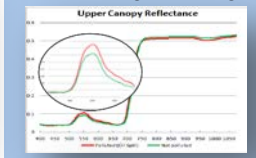


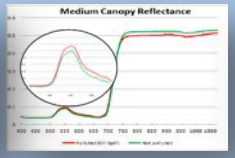


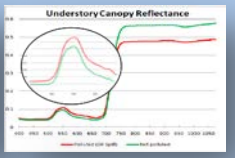


6.2 VIS and NIR Reflectance in the vertical profile of the forest

- VIS reflectance is higher in polluted areas and this means less photosynthetic activity produce less pigments.
- NIR reflectance is lower in polluted areas and this suggests that there are some changes/damages in the internal structure of the leaves.







6) Next steps

- Apply leaf and canopy models (forward mode)
- Perform the inverse process of the models using the reflectance values coming from hyperspectral images
- Map chlorophyll content of the tropical forest as an indicator of vegetation stress caused by hydrocarbon pollution.

7) References

- Yang, H. (1999) *Imagining Spectrometry for Hydrocarbon Microseepage*. PhD thesis. Delf University of Technology, Delft-The Netherlands.
- Smith, K.L., Steven, M.D. & Colls, J.J. (2005) *Plant spectral responses to gas leak and other stresses*. International Journal of Remote Sensing, 26: 18, 4067-4081

[1]pa134@le.ac.uk; [2]kjt7@le.ac.uk; [3]hb91@le.ac.uk;