Estimating woody FPC Using MODIS Time Series Imagery

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AUSTRALIA

Queensland Government
Natural Resources and Mines

Presentation Outline

Decomposition algorithm

    Assumptions and Hypothesis

    Seasonal Trend Decomposition

    CSIRO woody – herbaceous separation model

MODIS woody – herbaceous separation

    MODIS overview

    Processing pipeline

    Early results

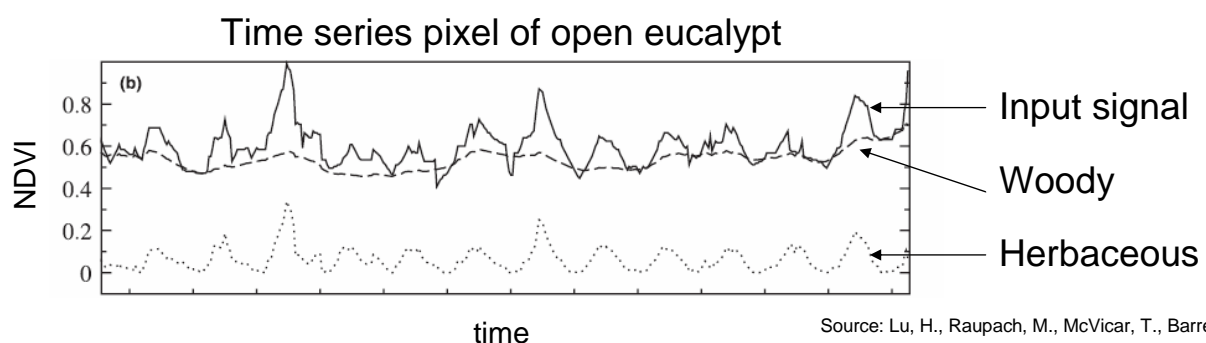   Calibration and Validation

    Future Research

Summary

i am a tree.

Presentation Outline

Estimating woody FPC using MODIS time series imagery

Assumption: vegetation in the QLD Landscape consists of woody plants which are perpetually green (mainly trees) and herbaceous grasses that senesce annually

Fact: The NDVI and EVI are green vegetation indices (VIs) that respond to the quantity of photosynthetic material within plants

Hypothesis: Time series decomposition techniques can be used to split the VI signal into contributions from trees and grass using the above assumption, that is:

    - trees = slow varying woody component

    - grass = seasonally varying herbaceous component

Time series pixel of open eucalypt

Source: Lu, H., Raupach, M., McVicar, T., Barrett, D.

Estimating woody FPC using MODIS time series imagery

Seasonal-Trend Decomposition of Time Series

Breaks the input time series signal into 3 components:
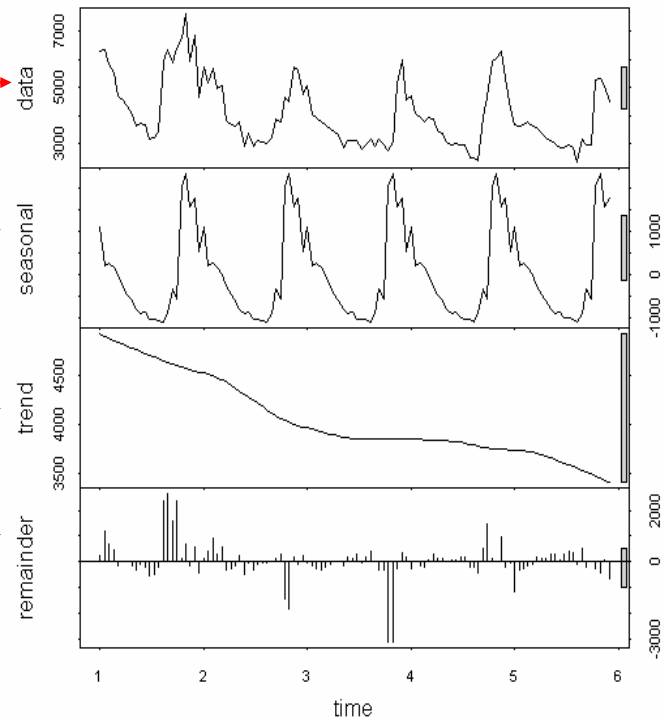
1) Seasonal

2) Trend

3) Remainder

Seasonal Trend Decomposition using LOESS (STL):

LOESS: local polynomial regression fitting

Can handle missing data
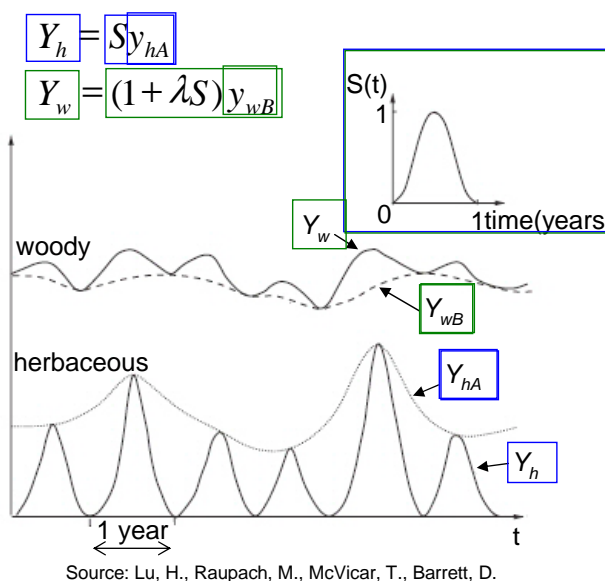
Estimate anywhere along time series

Widely Available

Output of STL algorithm using the R statistics package

Estimating woody FPC using MODIS time series imagery

Decomposition of vegetation cover into woody and herbaceous components using AVHRR NDVI time series

Hua Lu[a,*], Michael R. Raupach[a], Tim R. McVicar[a], Damian J. Barrett[b]

The Model: $Y = aX + b = Y_w + Y_h$

$$Y_h = S y_{hA}$$
$$Y_w = (1 + \lambda S) y_{wB}$$

Source: Lu, H., Raupach, M., McVicar, T., Barrett, D.

$$Y_h = S[a(1 + \lambda s)x_A - \lambda(a x_T + b)]$$
$$Y_w = (1 + \lambda S)[a(x_T - s x_A) + b]$$

where:

$a, b =$ Calibration coefficients from inverse model: $Y = aX + b$

Y is woody FPC, X is woody contribution to VI

$x_T =$ VI trend taken directly from STL output

$x_A =$ Slow varying amplitude of VI derived from STL seasonal and remainder

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MODIS

Moderate Resolution Imaging Spectroradiometer
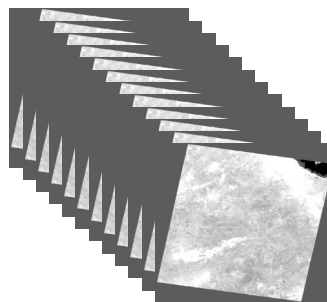
Spectral: 36 spectral bands

Spatial: 250m (bands 1-2, Red-NIR)

    500m (bands 3-7)

    1000m (bands 8 -36)

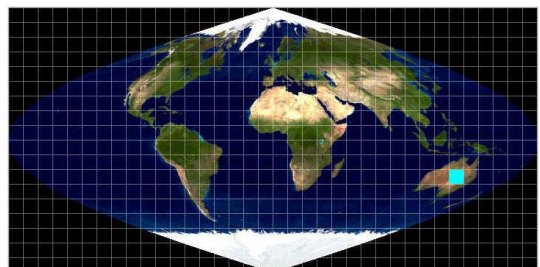Temporal: twice daily – terra and aqua

e.g.: MOD13Q1: 250m, 16 day composites:

NDVI,EVI

Quality

R,B,NIR,MIR

View/solar geometry

MODIS Data Product Level Hierarchy

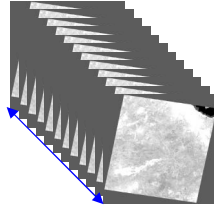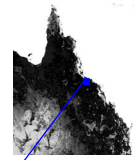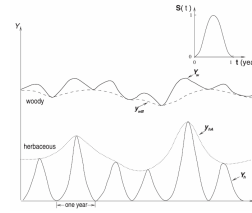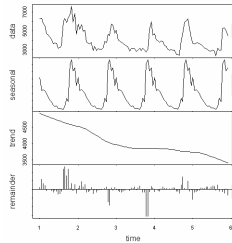| Level 0	Raw
Level 1	Radiometrically calibrated
Level 2	Geophysical parameter data
Level 3	Gridded and temporal composits

Estimating woody FPC using MODIS time series imagery

MODIS woody/herbaceous decomposition: early test

Processing pipeline:

2) Woody/herb separation

1) Input: 115 MODIS NDVI, 16 day composite images from 2000 to 2005
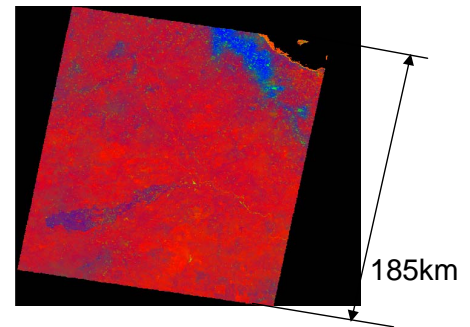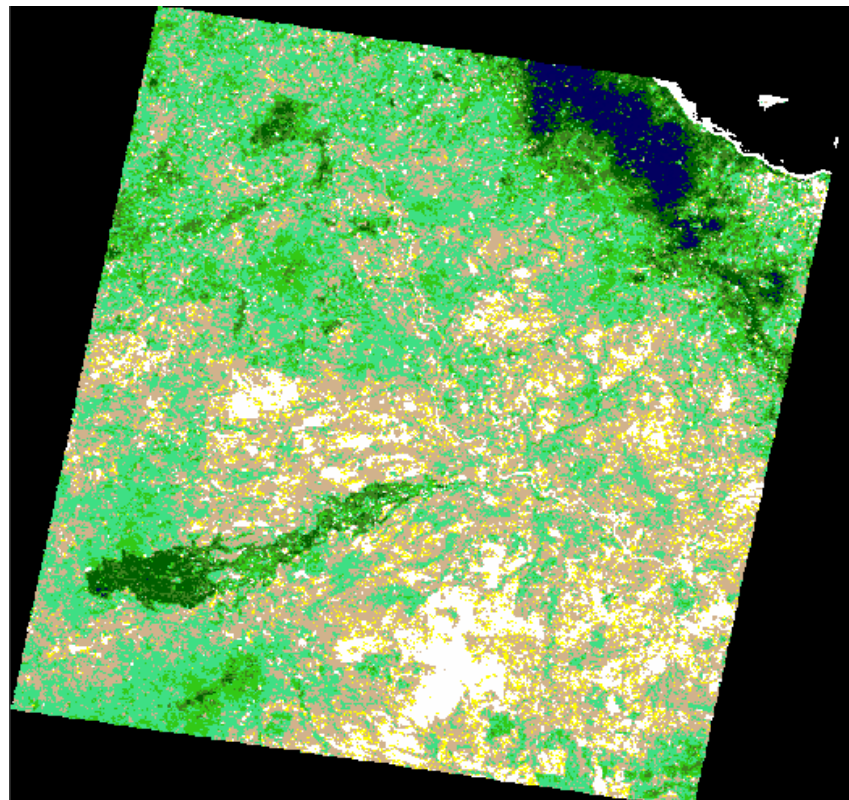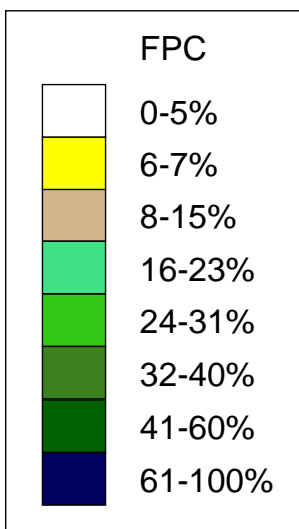

3) Output: images containing 3 layers:

a) % woody cover

b) % green herbaceous cover

c) % bare ground/non-photosynthetic veg

MODIS decomposition for August 2004

woody

Herbaceous green

bare ground/non-photo veg

0   100% FPC

185km

Estimating woody FPC using MODIS time series imagery

MODIS time series woody FPC estimates

FPC

- 0-5%
- 6-7%
- 8-15%
- 16-23%
- 24-31%
- 32-40%
- 41-60%
- 61-100%

Estimating woody FPC using MODIS time series imagery

SLATS Landsat woody FPC estimates

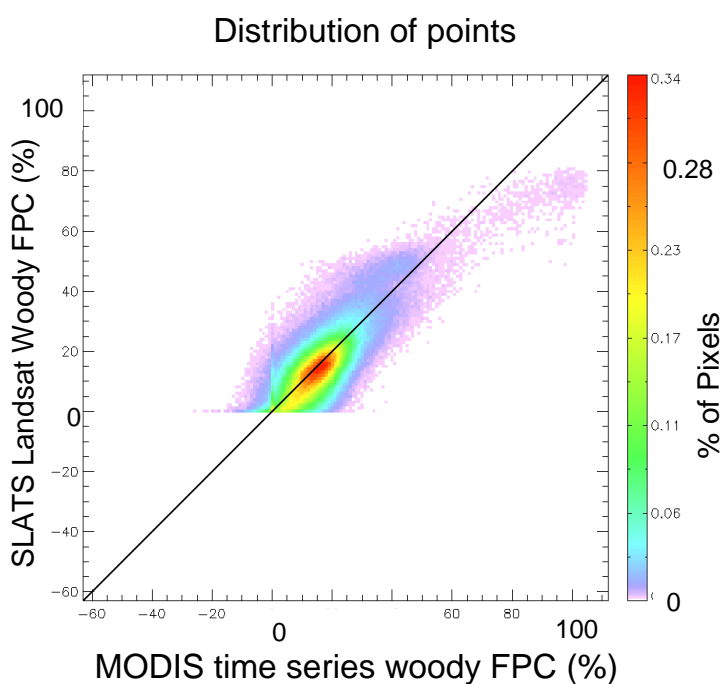| FPC	
	0-5%
	6-7%
	8-15%
	16-23%
	24-31%
	32-40%
	41-60%
	61-100%

Source: Statewide Landcover and trees study

Estimating woody FPC using MODIS time series imagery

MODIS Time series FPC vs SLATS Landsat FPC

Distribution of points

Current Limitations:

Incorrect Calibration

No validation

Future time series work:

MODIS calibration (NDVI, EVI) with LiDAR

MODIS Validation

Estimating woody FPC using MODIS time series imagery

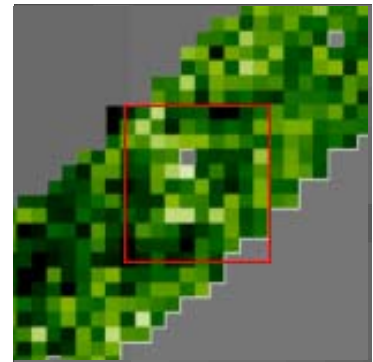# MODIS time series Calibration and validation

Generating calibration, validation data for woody FPC:

Ideally, find where LiDAR transect overlaps MODIS

But, predefined bins in level 3 products

Only 30% overlap, on average between storage bin and ground measuremets (Tan et.al.)

Take field field measurements at 8x the native resolution – i.e. 2km for 250m products (Tan et.al)

OR

Is 2km region homogeneous and is centre pixel statistically similar to region? **YES**

> Estimating woody FPC using MODIS time series imagery

MODIS time series Calibration and validation

Generating calibration, validation data for herbaceous FPC

Currently no plan to validate herbaceous prodcut. I need data!

Product only gives green herbaceous estimates

However ground cover for ground cover green and non-green is very useful

Future Research

Investigate ASTER for determining bare ground and hence vegetation cover

Combine overstorey and ground cover estimates to "see the grass through the trees"

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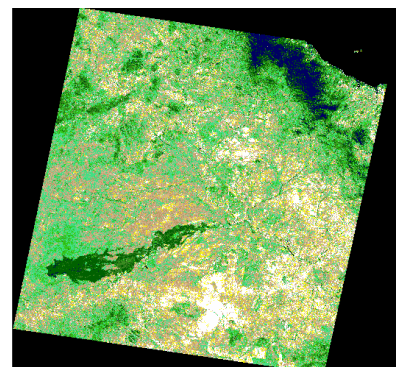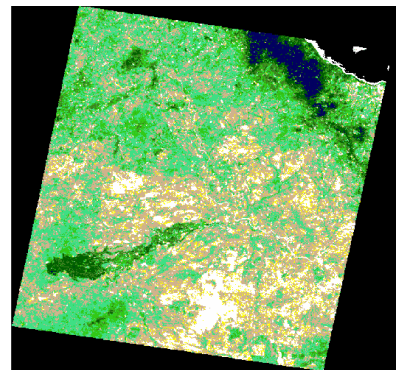

Summary

Time series method requires validation

Early indication is that it provides a reasonable woody-herbaceous separation

May be useful to SLATS for identifying periods when greening up occurs

But ground cover is important

Estimating ground cover accurately may be possible by combining bare ground and overstorey estimates

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Acknowledgements

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Data and expertise

QPSF

Computational support

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