REMOTELY SENSED PHENOLOGY FOR MAPPING BIOMES AND VEGETATION FUNCTIONAL TYPES.

K.J. Wessels[1], K Steenkamp[1], G. Von Maltitz[2], S. Archibald [2], R.J. Scholes[2], S. Miteff[1], A. Bachoo[1]*

[*1]Remote Sensing Research Unit, Meraka Institute, CSIR, Pretoria, South Africa, kwessels@csir.co.za
[2]Ecosystems, processes and dynamics, Natural Resources and Environment, CSIR, Pretoria, South Africa

1. INTRODUCTION

Vegetation biomes are traditionally mapped in one of two ways: (i) top-down – based on vegetation structural types and their association with regional climate [1], or (ii) bottom-up – by grouping vegetation types together based on composition and structure measured at the plot level [2]. There is a huge discrepancy between the scales and the measurement of regiona climate data and plot-level floristic data. Satellite-derived vegetation phenology data have tremendous potential for bridging the afore-mentioned gap in measurements, since they capture the spatial patterns of vegetation dynamics through repetitive observations at regional scales [3, 4]. This study used remotely-sensed phenology data in a fully supervised decision-tree classification based on the new biome map of South Africa [2]. This allowed an objective assessment of which phenological attributes are most characteristics of the newly defined biomes.

Vegetation functional types (VFT) are defined as areas of the vegetated land surface which have similar ecological attributes such as composition, structure (e.g. distribution of leaf area with height) phenology (distribution of leaf area over time), and potential biomass and production and response to disturbance [5]. Remotely sensed phenology are the ideal data on which to base such VFT classifications since they represent consistent measurements of vegetation processes and function and can be applied across vast areas with limited floristic data [6, 7]. The present study used remotely-sensed phenology to map and define VFT's in an unsupervised manner for the entire southern Africa.
The objectives of this study were therefore:

1. To produce new biome map of SA using a supervised decision tree classification based on remotely-sensed phenology data.
2. To identify the phenological attributes that distinguish between the different biomes - above.
3. To identify and map VFT in an unsupervised manner based on remotely-sensed phenometrics.
4. To relate the VFT to the biomes.

2. METHODS

AVHRR NDVI data:
Advanced Very High Resolution Radiometer (AVHRR) data consisting of 10-day maximum value composite NDVI values (decads) at 1-km^2 was used for the period 1985 - 2000. The processing and calibration of this Local Area Coverage (LAC) dataset is described in full elsewhere [8].

Seawifs FPAR data:
Sea Wide Field-of-View Sensor (SeaWiFS) were used to model Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) for the period 1997 - 2006 [9]. FPAR has more biological meaning than the unitless vegetation indices (e.g. NDVI) and sets the upper limit for NPP in light efficience models. It is also reported to have a much higher signal to noise ratio than NDVI [9] and is therefore expected to provide more reliable phenometrics.

Extracting phenology from satellite data:

A widely used time-series analysis program, TIMESAT, was employed to calculate phenometrics from the AVHRR data [4]. An adaptive Savitsky-Golay filter, that uses a local polynomial fit together with small moving windows in two fitting steps to reduce noise and fit curves to the data. The threshold method used by TIMESAT provides a robust and computationally simple method for identifying START and END of growing season as 20% of the seasonal amplitude. Alternatively, the points of intersection with the delayed moving average (DMA) [3]. The successive points of intersection of the original time series data with the delayed moving average are used to successively identify the START and END of season. The other seasonal phenometrics were calculated accordingly.

3. CONCLUSION

The biome map derived from the phenometrics using a supervised decision tree approach demonstrates that the phenometrics can capture sufficient functional diversity. Vegetation functional types could be classified based on function in an unsupervised manner and mapped across vast regions, with little floristic data. It therefore provides method for rapidly producing a standardised regional vegetation map and gather information about the function of each vegetation unit. The remotely sensed phenometrics are thus clearly useful for bridging the gap between plot level vegetation data and climate data, especially in sparely surveyed regions [10]. This ultimately suggests a convergence of composition, structure and function at a biome-level [7]. All of the above leads us to conclude that long-term remotely-sensed phenometrics can play an indispensable role in (i) the production of regional vegetation (biome) maps, (ii) understanding ecosystem function in relation to bioclimatic drivers and (iii) tracking the impact of future climate change on vegetation phenology and distribution.

4. REFERENCES

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