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|  | RESEARCH PROPOSAL  PhD in Geography & Environmental Studies  **VERY HIGH RESOLUTION REMOTE SENSING OF CARBON STOCKS IN SUBTROPICAL THICKET** |  |
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# Problem statement

*Portulacaria afra* (Spekboom) is an important species in the Subtropical Thicket biome.  It is an evergreen succulent tree growing to 2.5m, with small fleshy leaves and is the dominant species in the arid and valley thicket habitat types.  *P. afra* is an attractive browse plant for indigenous herbivores but is highly susceptible to over browsing by goats.  *P. afra* is unusually effective at storing carbon compared to other arid region vegetation.  It has the uncommon ability to switch between C3 and CAM photosynthetic mechanisms depending on season.  This means it is productive year-round which likely contributes to its substantial sequestration abilities.  Comparison of degraded and intact sites has shown that *P. afra* restoration could sequester up to 85 t C ha-1.  This number competes with the carbon storage capacity of mesic forests.

The production of detailed, carbon stock and canopy cover maps using manual methods is prohibitively time-consuming and expensive, particularly for large areas. This research presents a number of challenges from a technical remote sensing perspective.  The South African government, specifically the Chief Directorate: National Geo-spatial information (NGI), routinely acquires very high resolution (VHR) (i.e. 0.5m resolution) multi-spectral data with national coverage. This imagery represents a rich source of information, but to date it has only been used for topographical mapping and photo-interpretation, and has not been exploited for automated vegetation monitoring.  While receiving increasing attention, use of VHR imagery for estimation of environmental variables is still fairly uncommon, especially over large areas such as the Little Karoo or Eastern Cape.

An automated or semi-automated image analysis technique that is robust to the inherent temporal, topographic and radiometric variations in VHR aerial imagery is needed to monitor total above-ground carbon (TAGC) and *P. afra* canopy cover dynamics in the Subtropical Thicket biome.

# Rationale

Subtropical Thicket has been degraded by overgrazing over much its range.  There is significant interest and a growing body of research in thicket restoration.  Restoration projects will generate employment, restore ecosystem services and produce carbon credits that can be traded to offset restoration costs.  There is a need for spatial information, in the form of TAGC stock maps, to support restoration projects in the quantification of carbon stocks required for trading under schemes such as the Clean Development Mechanism (CDM).  *P. afra* canopy cover is an important predictor of TAGC in Subtropical Thicket.  *P. afra* canopy cover maps are also useful in isolation for the identification of suitable areas to plant and in the monitoring of restoration progress over time.  Restoration is planned for large areas of the Little Karoo and Eastern Cape.  Map scales of at least 1:10000 are required to provide sufficient accuracy for farm-level restoration planning.

# Methodology

This research investigates the use of quantitative remote sensing methods for estimating *P. afra* canopy cover and TAGC in Subtropical Thicket.  Remote sensing methods are common for carbon stock estimation and will help facilitate cost-effective canopy cover and carbon stock estimation of large areas at repeated intervals.  This research can be regarded as a methodological study that is experimental in nature.  The work is intended to be applied research.  Emphasis will be placed on producing maps that are both useful and usable.

# Scientific contribution

This research forms part of a larger research programme in the Department of Geography and Environmental Studies in the use of geographical information technologies (GIT) for sustainable land management decision support. It is also strongly linked to the “Carbon Stabilization Mechanisms in Spekboom Thicket Soils, Eastern Cape, South Africa” and “Thicket-wide Plot Experiment” projects being conducted by the Department of Soil Science. The scientific contribution will be both on a technical and application level. The research aims to develop a novel automated or semi-automated image analysis technique to accurately estimate *P. afra* canopy cover and TAGC in pristine and transformed Subtropical Thicket, over large areas. The main technical contribution will be to develop mapping techniques that can make use of freely available, uncalibrated, very high resolution (VHR) aerial imagery that is currently being produced by NGI, but that has to date not been used for any quantitative vegetation monitoring and carbon stock estimation purposes. The techniques that will be developed as part of this research will also be applicable (with slight modifications) to other types of vegetation and can also be extended to be applied to VHR satellite imagery, which will have tremendous international value. Apart from the technical contributions (the main focus of the research), the results will also contribute to knowledge relating to the management of Subtropical Thicket which has been significantly degraded by overgrazing and for guiding ongoing restoration efforts.