High resolution remote sensing for native vegetation assessment and monitoring: an impact assessment approach

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Candidate's Certification

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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Signature

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Abstract

The last decade has seen major advances in remote sensing technology, particularly in high-resolution satellite imagery and airborne laser scanning (ALS). Fundamental differences in data capture mean that new assessment techniques are required, particularly for vegetation structure and multi-temporal analysis. Here, high-resolution remote sensing tools are developed using a longwall mine subsidence impact assessment framework, based primarily on a scrubby forest-woodland setting on the Woronora Plateau, NSW Australia.

Linear regression and *t*-tests were used to compare vegetation structural metrics from field and ALS data, with ANOVA and post-hoc tests used to determine solar energy and moisture controls on vegetation variation at hillslope scale. Landscape stratification was based on insolation and topographic wetness surfaces derived from ALS-based digital elevation models (DEM). Image matching and linear regression was used to test 3D-method orthorectification accuracy for off-nadir QuickBird imagery using different-resolution DEM.

High resolution ALS-derived digital elevation models (DEM) allow pixel-accurate orthorectification of off-nadir imagery, a necessary precursor to multi-temporal image analysis. ALS-derived vegetation metrics correlate well with field data (canopy height: $R^2 = 0.915$; SE = 2.08 m; $p < 0.01$; and foliage projective cover: $R^2 = 0.916$; SE = 4.5%; $p < 0.01$; and a significant though weaker correlation for canopy cover: R^2 c. 0.5; SE c. 16%; $p < 0.01$). Repeat survey indicates that individual tree mortality is detectable, and that height percentiles from the upper part of the canopy are robust, as are foliage cover and canopy cover. Foliage cover and crown cover are moderately well correlated ($R^2 = 0.65$; SE = 16%; $p < 0.001$). Statistically significant structural and spectral vegetation variations were quantified at hillslope scale. Foliage cover varies according to insolation and NDVI (normalised difference vegetation index) varies according to topographic wetness, demonstrating that different remote sensing metrics capture local vegetation variation according to the fundamental plant growth requirements of energy and water.

A particular application was developed for upland swamp assessment and monitoring; identified as a key mine-subsidence monitoring requirement for the Sydney Basin Southern Coalfield. Swamp boundaries can be derived from stratification of ALS canopy height models to tree-level accuracy (overall accuracy 98%), and multispectral image classification is suitable for swamp vegetation community monitoring.

The various techniques described, developed and evaluated also have more general ecological and environmental application for fine-grained environmental impact studies, and this study provides a warm-

temperate Australian context to studies predominately focussed on cool-temperate or boreal resource management applications.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES