

*Exploring the use of phenocams
and satellite data to better inform
the pasture phenology and
aerobiology of allergenic grass
pollen in eastern Australia*

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the degree of

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under the supervision of

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CERTIFICATE OF AUTHORSHIP

I, Yuxia Liu, declare that this thesis is submitted in fulfilment of the requirements for the award of the degree of Doctor of Philosophy, in the Faculty of Science at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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To my parents.

I love you.

To Professor Alfredo Huete, and Doctor Qiaoyun Xie.

For their endless support and encouragement.

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Abstract

Phenological studies of grassland/ pastures have attracted increased attention for their sensitivity to climate change with associated impacts on allergenic pollen release and public health. Allergenic pollen exposure is expected to increase with global warming following extended grass growing and grass pollen seasons and the prevalence of allergic diseases in Australia is among the highest globally. The primary aims of this thesis were to integrate phenocam and satellite imagery with pollen concentration data, over subtropical to temperate grassland sites in Australia, in order to address critical knowledge gaps in our understanding of the ecological drivers of grass pollen aerobiology.

Phenocams were used to investigate the diurnal and daily greenness variations across solar zenith angles, solar intensity, and direct/ diffuse sky conditions. This information was used to develop an optimised daily compositing methodology. Next, I successfully registered a 3×3 window of Sentinel-2 pixels at 10 m resolution with the phenocam measurement footprint to conduct upscaling analyses. The relationships between Sentinel-2 Enhanced Vegetation Index (EVI) and phenocam green chromatic coordinate (GCC) index were strong and independent of the time of year and grass phenophases. This enabled the more sparse temporal sampling of Sentinel-2 greenness to be converted to daily values.

Relationships between seasonal grass pollen concentrations and phenocam GCC and satellite EVI phenology were also strong with pollen concentration peaks in phase with grass greenness peaks, including multiple sub-seasonal pollen and greenness peaks. The grass greenness amplitudes, a surrogate of biomass, were found to be correlated with total pollen concentrations. Finally, I investigated grass pollen sources at more detailed, 10 m resolution, by generating a neural net grass map, from the Sentinel-2 sensor. This enabled urban, peri-urban and regional grass sources to be quantified based on distance and orientation to the pollen sampler, providing new insights for pollen forecasting. This thesis highlights the ability of near-surface and satellite remote sensing to achieve more accurate grassland/ pasture phenology to improve upon the understanding of ecologically relevant factors for grass pollen aerobiology in Australia.