Evaluating the climatic impacts on dryland crop growth using multi-source datasets across Australia

A Dissertation Presented

by

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Certificate of Original Authorship

I, Jianxiu Shen, certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Publications arising from this thesis

Journal papers directly included in this thesis

Shen, J., Huete, A., Tran, N.N., Devadas, R., Ma, X., Eamus, D. & Yu, Q. 2018, 'Diverse sensitivity of winter crops over the growing season to climate and land surface temperature across the rainfed cropland-belt of eastern Australia', *Agriculture, Ecosystems & Environment*, vol. 254, pp. 99-110. (Chapter 4)

Shen, J., Huete, A., Tran, N.N., Ma, X., Joiner, J., Beringer, J., Eamus, D. & Yu, Q. 2019, 'Dynamics of light-use efficiency using satellite solar-induced chlorophyll fluorescence and the enhanced vegetation index across Australian rainfed croplands'. (Under review) (Chapter 5)

Shen, J., Huete, A. & Yu, Q. 2019, 'Dryland climate-crop growth relationship: a Review' (Under review) (Chapter 2)

Parts of the journal paper arising from this thesis

Azmi, M., Shen, J., Mohan, C., Dijk, A. 2019, 'Spatiotemporal prediction of rainfed grain annual yield across Australia based on soil moisture and gross primary production estimates'. (Under Review) (Chapter 3)

Peer-reviewed conference proceedings

1. Shen, J., Huete, A., Tran, N.N., Ma, X. & Yu, Q. 2017, 'Detecting the response of seasonal light-use efficiency to canopy temperature by using satellite solar-induced chlorophyll fluorescence and enhanced vegetation index across Australian rainfed croplands', *American Geophysical Union Fall Meeting (AGU)*, New Orleans, Louisiana, U.S.A, 11-15 December.

2. Shen, J., Huete, A., Ngoc, T.N., Devadas, R. & Yu, Q. 2016, 'Incorporating remote sensing methods into crop-climate relationships across the rain-fed cropland belt in NSW, Australia', *The Australian energy and water exchange research initiative National workshop*, Canberra, Australia, 14-15 December.

3. Shen, J., Tran, N.N., Devadas, R., Huete, A., Zhang, H. & Yu, Q. 2016, 'Climate impacts on wheat phenology and production using muti-source data in NSW, Australia', *Geoscience and Remote Sensing (IGARSS), IEEE International Symposium*, Beijing, China, pp. 6296-99. 10-15 July.

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Abstract

The rainfed cropland belt in Australia is of great importance to the world grain market but has the highest climate variability of all such regions globally. This thesis aims to quantify the spatial temporal climatic impacts on crop productivity, crop phenology and cropland photosynthesis activities across the Australian rainfed cropland belts using multiple source of observed datasets.

The literature review on climate-crop growth relationship called for a future agenda on integrated climate driving factor employment, crop phenology and photosynthesis response focus, multiple source of datasets engagement, and bottom-up approaches for agricultural adaptation. Consistent findings from the three empirical studies in this thesis, which focused on different broad angles of the crop response, indicate that: (1) August and September are the optimum trigger months to spatially predict agricultural annual yield across the rainfed cropland belts in Australia; (2) two critical 8-day periods, beginning on day of the year (DoY) 257 (in September) and 289 (in October), were identified as the key 'windows' of crop growth variation that arose from the variability in climate and land surface temperature. (3) there was a seasonal hysteresis of crop photosynthesis activities in response to surface temperature change throughout the winter crop growing season in Australia. The optimum surface temperature range for satellite observed photosynthesis activity were identified as16.6-17.6 °C during August.

This thesis systematically assessed the climatic impacts on crop growth across the Australian rainfed cropland belts. Practically, it provides new opportunities for large-scale cropland heat and water stress detection and can serve as an early warning system for agricultural adaptation in broad-acre rainfed cropping practices. Theoretically, it offers a fresh understanding for analyses of the climate-crop growth relationship across diverse spatial-temporal scales.

Key words

Climate change and variability, crop growth, rainfed croplands, multi-source datasets, remote sensing, Australia