Vulnerability assessment and adaptation of dryland agriculture on the Chinese Loess Plateau and Australian Wheatbelt

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A thesis submitted in fulfilment of the requirements
for the degree of Doctor of Philosophy

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April 2017
Certificate of original authorship

I 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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18/04/2017
Acknowledgements

This project was funded by the joint China Scholarship Council (CSC) and the University of Technology, Sydney (UTS) Doctor of Philosophy (PhD) Scholarship. I extend my heartfelt gratitude to many people who helped me during the process of completing my project both in life and work.

I would like to firstly thank my supervisor Prof. Qiang Yu for his open minded supervising style, enthusiasm, encouragement and considered advice. Thanks for your conceptual input and support during all those PhD crises. Also thanks to my co-supervisors Dr. Anna Roberts, Director of Natural Decisions Pty Ltd and former Senior Research Scientist at Department of Primary Industries Victoria (DPI), who is particular assisted early on in the project, and Dr. Longhui Li from UTS, whose critical advice encourage me to become a better researcher.

I would also give my appreciation to my predecessors, collaborators, colleagues and friends. Dr. Chao Chen from CSIRO Agriculture Flagship, Dr. Hongtao Xing from CSIRO Land and Water and Dr. Liang He from National Meteorological Center of China Meteorological Administration shared their knowledge and gave me advices on my crop model studies; Dr. Wenzhao Liu and Wen Lin from Institute of Soil and Water Conservation Chinese Academy of Sciences and Ministry of Water Resources, assisted field experiments and data collection at Changwu station. Dr. Roger Cremades from Climate Service Center Germany (GERICS) gave helpful comments and feedback on my journal article publication. Prof. Alfredo Huete and his team members at UTS helped me practise for my stage assessment presentation and were willingness to help when I had
funding issues. Zunyi Xie, Hao Shi, Jianxiu Shen, Qinggaozi Zhu, accompanied me for most of my time and we had enjoyable experience together at UTS. All these bit by bit in life and work and relationships are appreciated and cherished. Last, I want to thank my family for their endless support.
Abstract

Sustainable agricultural production on drylands faces challenges from increasing food demand and climate change. The interrelated issues of production instability, vulnerability to climate change and the need for effective adaptations require a comprehensive and integrated ecological-economic assessment. Accordingly, this thesis examines two key dryland agricultural regions, the Australian Wheatbelt and the Chinese Loess Plateau, to provide new insights and improved approaches for dryland agricultural management.

Decomposition analysis was undertaken to identify the driving forces in growth and instability of Australian wheat production from 1900-2010. Results show that instability of Australian wheat production has not been reduced significantly in the past century. The increasing trend of wheat production was mainly due to sowing area increases whilst the yearly fluctuation of production is mainly caused by variable yields. A focus on yield alone may therefore bias assessments of the vulnerability of agriculture to climate change.

A conceptual framework was developed to assess the agricultural vulnerability of 243 rural counties on the Chinese Loess Plateau. A vulnerability index for each county was calculated from statistical indicators. Within the 49 most vulnerable counties, 42 were characterised by high exposure and sensitivity but low adaptive capacity. The most vulnerable area was found to be located in the central northeast-southwest belt of Loess Plateau.
Upon identifying vulnerable areas, the effectiveness of the regionally significant adaptation, plastic film mulching, on maize growth was assessed in the Loess Plateau. The APSIM model was calibrated and validated using field experiment data, then applied to simulate maize growth during 1961-2010 at Changwu station. Plastic film mulching could significantly increase maize yields by an average of 15.3%, and increase the cumulative probability at mid-range yield levels at Changwu. The advantage was found to be more pronounced in dry years than wet years. Geostatistical analysis was used to extend the modelling across the Loess Plateau to identify areas with climate favourable for adopting plastic film mulching. The central south presented high and stable production while the northwest showed the greatest potential in yield increase and variability reduction.

The multiscale studies concern both developing and developed counties, can be referenced to location-specific information for policy makers and researchers. The principles, frameworks, technologies and tools can be modified and adopted in other dryland regions.

**Key words:** Dryland, Australian Wheatbelt, Loess Plateau, Climate change, Agricultural production, Vulnerability, Adaptation
# Symbols and abbreviations

<table>
<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>ABARES</td>
<td>Australian Bureau of Agricultural and Resource Economics and Sciences</td>
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<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>APSIM</td>
<td>Agricultural Production Systems sIMulator</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
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<tr>
<td>ESW</td>
<td>Extractable soil water</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<tr>
<td>LAI</td>
<td>Leaf area index</td>
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<tr>
<td>WUE</td>
<td>Water use efficiency</td>
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<tr>
<td>RCP</td>
<td>Representative concentration pathways</td>
</tr>
<tr>
<td>UNDP</td>
<td>Office to Combat Desertification and Drought</td>
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<td>UNSO</td>
<td>United Nations Sudano-Sahelian Office</td>
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