Crop frequency mapping for land use intensity estimation during three decades

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Introduction

Crop extent and frequency maps are an important input to inform policy and initiatives related to land value, competitive land uses, food security and long-term impacts and sustainability of agricultural practices. Such spatial datasets can support decisions on natural resource management, planning and policy. The complete Landsat TM, ETM+ and OLI archive from 1987 to 2015 for 23 Landsat footprints was used in a multi-temporal mapping approach in central and southern Queensland, Australia. Spatial, spectral and temporal information were combined in multiple crop-modelling steps, supported by on-ground training data sampled across space and time for the classes Crop and No-Crop [1]. Validation showed that the predictive accuracy varied by growing season and region, with kappa values between 0.88 and 0.97 and was considered suitable for mapping current and historic cropping activity [1]. Crop frequency maps were produced for all regions and different time intervals. The crop frequency maps were validated separately with a historic crop information time series. Different land use intensities and conversions (e.g. from agricultural to pastures) are apparent.

Data

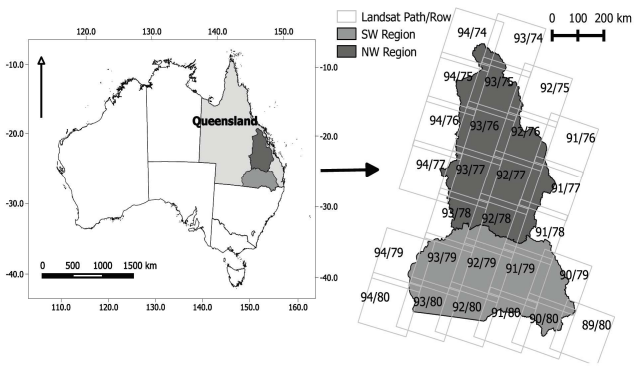

Figure 1: Landsat footprints used for the seasonal *Crop/No-Crop* mapping [1].

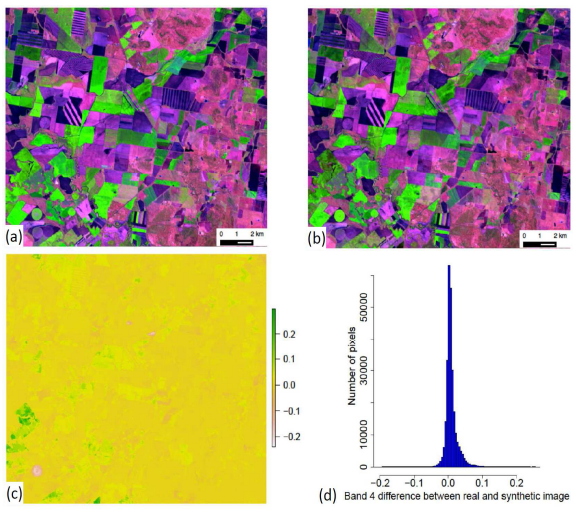

Figure 2: Real Landsat image from 2015/02/14 (a) in comparison with the synthetic seasonal image (b) omitting (a). Created at peak cropping activity for each summer and winter, as the basis for a per-season image segmentation [1]; band 4 difference image (a) - (b) = (c) and histogram (d).

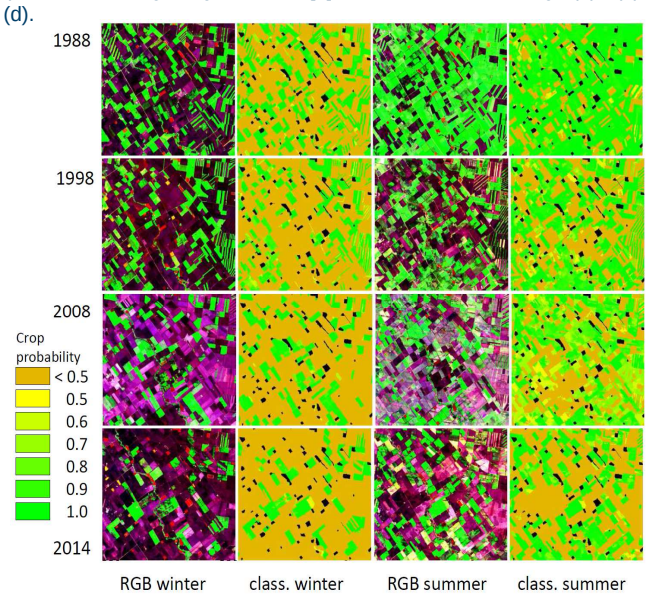

Figure 3: Random forest based *Crop/No-Crop* classification for summer and winter crop, based on temporal and spectral attributes of image segments [1].

Crop frequency mapping

Seasonal crop probability layers [2] are combined to produce crop frequency [3] maps for the entire Landsat archive (1988-2015). These data are used in support of the *Regional Planning Interest Act*, 2010 to inform land use planning decisions [4].

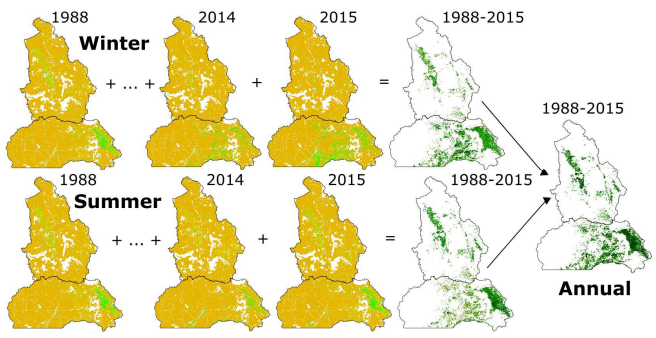

Figure 4: Seasonal crop frequency maps with single season crop probabilities > 0.5 summed. The seasons are also combined with maximum of one crop per annum.

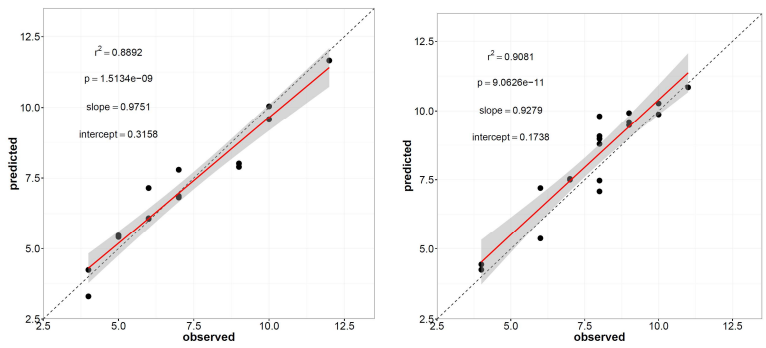

Figure 5: Winter (left) and summer (right) crop frequency independent validation at 20 locations between 2000 and 2013 (SW Region); and check for a potential data bias.

Applications

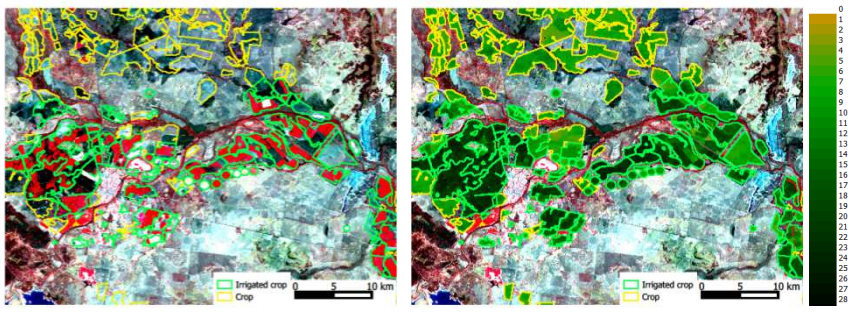

Figure 6: Irrigated and non-irrigated cropping near Emerald, Queensland (Landsat 8 r/g/b 4/2/3; 2015/11/21), and the summer crop frequency (overlaid on the right) highlights the land use intensity (horticulture excluded).

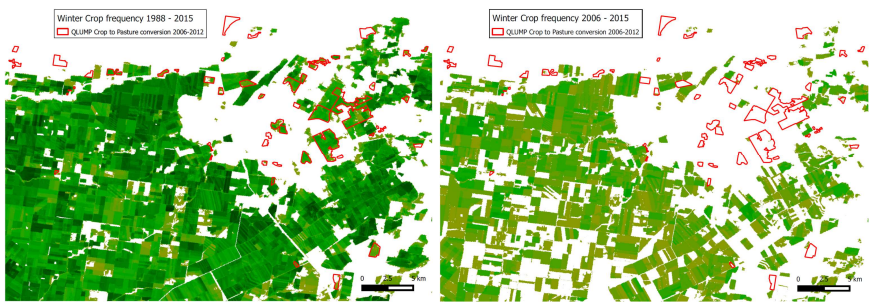

Figure 7: Known land use change from cropping to pasture as mapped by the Queensland Land Use Mapping Program (red outlines) [5]. The crop frequency maps support this mapping is shown in the image on the right which has no cropping mapped in the marked areas.

Figures 1 to 4 illustrate the crop mapping process described in [1]. The crop probabilities of the single season crop maps were combined to a seasonal crop frequency dataset as well as an annual crop layer, where the occurrence of a crop is only counted as a maximum of one per year. An independent validation on crop history information (Figure 5) of 20 sites (SW Region) revealed no bias in the crop frequency maps for winter and a marginal bias for summer. Examples of potential applications of the crop frequency maps are shown in Figure 6, where the intensive cropped fields in an irrigation area close to the township of Emerald are clearly visible compared to the surrounding rain-fed cropping and pastoral areas. Figure 7 displays areas of known land use conversion between 2006 and 2012 [5], supported by the frequency maps. The crop maps are available for download via [2] and the crop frequency maps via [3].

References

[1] Schmidt, M., Pringle, M., Devadas, R, Denham, J, and Tindall, D. *(2016).* A Framework for Large-Area Mapping of Past and Present Cropping Activity Using Seasonal Landsat Images and Time Series Metrics. Remote Sensing **2016**, 8, 312; http://dx.doi.org/doi:10.3390/rs8040312

[2] Schmidt, M.; Pringle, M.; Devadas, R.; Denham, R.; Tindall, D. Active Crop Mapping in the Western Queensland Cropping Region [data-set]. http://dx.doi.org/10.4227/05/555A826AC41DC

[3] Schmidt, M.; Pringle, M.; Devadas, R.; Denham, R.; Tindall, D. Active Crop Frequency Mapping in the Western Queensland Cropping Region [data-set]. http://dx.doi.org/10.4227/05/555A856191970

[4] Crop Frequency Report https://www.longpaddock.qld.gov.au/forage/cropfrequency.php (accessed on 11 April 2016).

[5] QLUMP, DSITI. Available online: https://www.qld.gov.au/environment/land/vegetation/mapping/qlump/ (accessed on 11 April 2016).

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