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Annual cropland mapping using reference Landsat time series: a case study in Central Asia

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Mapping the spatial and temporal dynamics of cropland is an important prerequisite for regular crop condition monitoring, management of land and water resources, and assessing the effects of agricultural activities on the environment. The problem is that agricultural statistics in the region are often outdated, of doubtful quality or missing adequate sub-national historical inventory data in the FSU. Satellite earth observation is a proven means to accurately identify croplands. However, existing maps of the annual cropland extent either have a low spatial resolution (e.g. 250 m – 1000 m), or existing high resolution maps (such as 30m) are not provided at annual frequency to support regular monitoring. Obstacles to regularly producing cropland maps can be a lack of in situ reference data and irregular timing of the image time series, like for instance Landsat or Sentinel-2.
Against this backdrop, this paper proposed a method to identify croplands using Reference time series (temporal features that remain stable over time), and to create binary cropland vs. non-cropland maps annually between 2001 and 2016 at 30m resolution. Landsat time series data were acquired by monthly compositing Landsat-5/7/8 data. Training samples for Cropland, Bareland, Water, Natural Vegetation and Residential Area in 2016, 2010 and 2005 were selected visually interpretation of very high resolution images. Then, optimal land cover mapping features were selected using Random Forest, and the reference time series of the five land cover classes for the were generated using an Artificial Immune Network algorithm for the optimal features. Finally, the reference time series were used to generate annually cropland maps.
This study presents a rigorous assessment of annually created cropland masks at 30m resolution in seven distinct agricultural landscapes in Xinjiang, China and the Aral Sea Basin, which are part of Central Asia. Results showed that reference-time-series based mapping (RBM) method had good potential to identify cropland annually, with producer's accuracies (PA) and user's accuracies (UA) higher than 85% between 2006 and 2016. NDVI, NBR, NIR band and SWIR2 band were selected as optimal feature for cropland mapping, and NDVI was selected as the most important feature as NDVI has the highest Gini importance score. In addition, growing season of the major crops (mainly between May and August) of the study sites. In addition, the comparison in 2010 showed that cropland maps generated from RBM were more accurate than the two exist land cover products, GlobaLand30 and FROM-GLC in 2010, and the annual cropland maps could be used to monitor temporal and spatial cropland dynamics at 30m resolution.