Tropentag, September 14-16, 2010, Zurich

"World Food System —
A Contribution from Europe"

The Potential of Medium-resolution Satellite Imagery to Estimate Regional Yields of Cotton, Wheat and Rice in Irrigated Cropping Systems in Uzbekistan

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Abstract

Regional crop growth monitoring and yield estimation continuously gain in importance, especially with regard to climate change and food security issues. Remote sensing data combined with light-use efficiency (LUE) models based on the fraction of photosynthetic active radiation (FPAR), have a great potential to monitor regional plant growth. The objective of this study was to develop and evaluate a satellite-driven LUE model using 250 m MODIS (Moderate Resolution Imaging Spectroradiometer) data to predict regional yields of cotton, wheat and rice in the Khorezm province, Uzbekistan.

For this purpose, freely available 16-day FPAR data from MODIS was processed for the years 2000–2009. Meteorological data and photosynthetic active radiation (PAR) were taken from a weather station and modelling results, respectively. A satellite-derived land use classification was used to distinguish between crops. Actual crop light-use efficiency was calculated via daily weather data and crop-specific maximum LUE. FPAR, PAR and actual LUE were used to calculate daily biomass accumulation. Crop yields were then estimated by multiplying total biomass with species-specific harvest indices. The estimated yields were evaluated against field and secondary data.

Our results suggest the MODIS-driven model can accurately estimate regional crop biomass production and yield. The observed yield trends in official statistics were generally captured by the model. Moreover, calculation of multi-year average yields allows detecting seasonal over- or underperformance of crops in terms of biomass production and yield. Problems exist with the calculation of actual regional yield amounts because of the discrete nature of the land use classification. The possibility of identifying underperforming areas demonstrates the potential for planning purposes and early warning systems.

Keywords: FPAR, irrigated croplands, light-use efficiency, MODIS, remote sensing, Uzbekistan

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