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Monitoring Spatial Patterns and Temporal Changes in Air Temperature and Vegetation Growth in the Aral Sea Basin: Decision Support for Improved Land Use and Water Management

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Abstract

Matching actual water demand to supply from the irrigation system is crucial for reducing water losses and improving productivity and resource use efficiency of agricultural systems in the Aral Sea Basin (ASB). Air temperature and vegetation growth belong to the major determinants of crop water demand in irrigated agriculture. Considering the impact of global and regional climate change, land and water decision makers in the ASB will greatly benefit from improved information on the spatial patterns and temporal changes of air temperature and vegetation growth to better target land and water management recommendations. This paper describes first the framework for generating temperature indicators as part of a region-wide monitoring system for the irrigation systems in the ASB. Secondly, examples of temperature and space-borne vegetation indicators are presented to illustrate their spatial differences and changes during recent years in the ASB. Thirdly, relationships between temperature and vegetation indicators are shown for different seasonal time sections and areas within the ASB.

For the temperature monitoring system, daily temperature data from 47 meteorological stations in the ASB were analysed over the period 2000–2006. The data from the distributed stations were radio-transmitted and imported into a Geographic Information System (GIS) via web-based tools. Considering vegetation growth, Normalized Differenced Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) were calculated for the area surrounding the stations using 8-day time-series data of the Moderate Resolution Imaging Spectroradiometer (MODIS) over the same period. Time-series plots concisely show temperature indictors that are critical to crop growth and relevant for long-term climate change analysis at the regional scale, e.g. end of frost days, length of growing period, and temperature variability. Similarily, plots show seasonal and annual changes of vegetation growth at different areas within the ASB. The correlations between temperature and vegetation indices show how the relationship changes at different time sections and for different areas in the ASB during the year.

Integrating the temperature monitoring system to crop biomass accumulation and further parameters such as evapotranspiration, and site-specific soil and irrigation system capabilities will enable the decision makers to better match irrigation water supply to actual crop water demands.

Keywords: Climate change, indicators, NDVI, regional monitoring, remote sensing, time-series

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