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

Gerd Rücker¹, Christopher Conrad², Mirjam Hahn¹, Qunduz Jumaniyozova³, Ahmad M. Manschadi², John Lamers³, Christopher Martius³, Michael Schmidt¹

¹German Aerospace Centre (DLR), German Remote Sensing Data Center (DFD), 82234 Weßling, gerd.ruecker@dlr.de
²University of Wuerzburg, Remote Sensing Unit, Am Hubland, 97074 Wuerzburg
³University of Bonn, Center for Development Research (ZEF), Walter-Flex-Str. 3, 53113 Bonn

Introduction

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. 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.

Approach

As part of a region-wide monitoring system, daily air temperature data from 47 meteorological stations in the ASB were analysed over the period 2000-2006 (Fig. 1). The data from the stations were radio-transmitted and imported into a 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. Statistical values and time-series plots were established to show temperature indicators that are critical to crop growth and relevant for climate change analysis. Correlations between temperature, NDVI, EVI show how the relationship changes at different periods and for different areas in the ASB (Fig. 2).

Results

Air temperature indicators showed significant gradients in the ASB. For example mean annual air temperature decreased from upstream (ca. 19°C) to downstream (12°C) and were generally higher in the Amu Darya compared to the Syr Darya irrigation systems (Fig. 3).

Conclusions

The temperature and vegetation growth monitoring shows critical values for crop growth and climate change. Integrating this monitoring system to crop biomass accumulation and further parameters such as evapotranspiration, and site-specific soil and irrigation system capabilities will enable the regional decision makers to better match irrigation water supply to actual crop water demands in the irrigation systems of the ASB.