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 Rücker[1], Christopher Conrad[2], Mirjam Hahn[1], Qunduz Jumaniyozova[3], Ahmad M. Manschadi[3], John Lamers[3], Christopher Martius[3], Michael Schmidt[1]

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

Deutsches Fernerkundungsdatenzentrum

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.

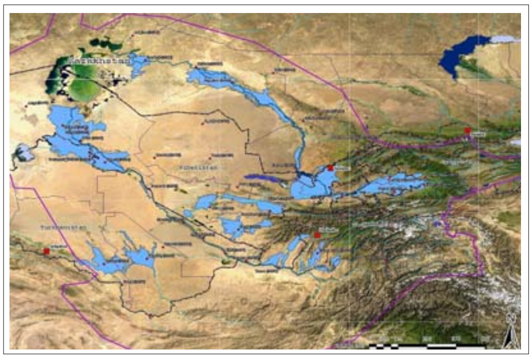

Figure 1: Aral Sea Basin with irrigation systems (blue areas) and climatic stations (red dots).

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°) and were generally higher in the Amu Darya compared to the Syr Darya irrigation systems (Fig. 3).

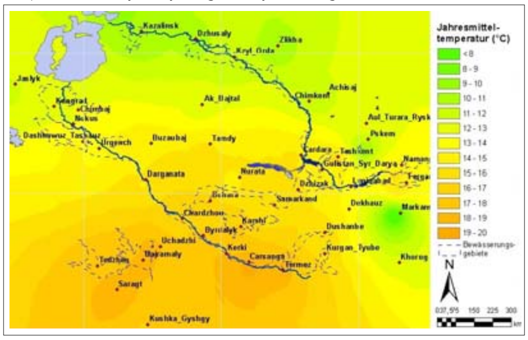

Figure 3: Mean annual air temperature in the ASB (2000-2006).

Time-series plots of 8-days average daily **air temperature and vegetation indices** show a strong correlation between the two parameters and the retarding evolution of the vegetation signal (Fig. 4).

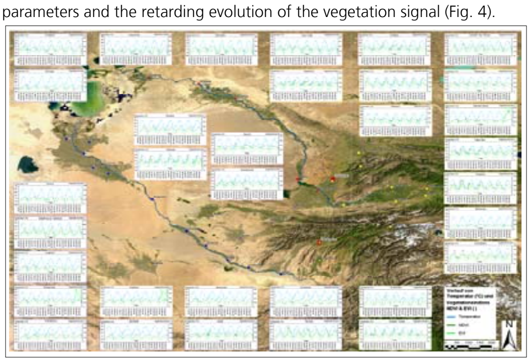

Figure 4: Time-series plots of 8-day air temperature and vegetation indices in the ASB.

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 indictors 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).

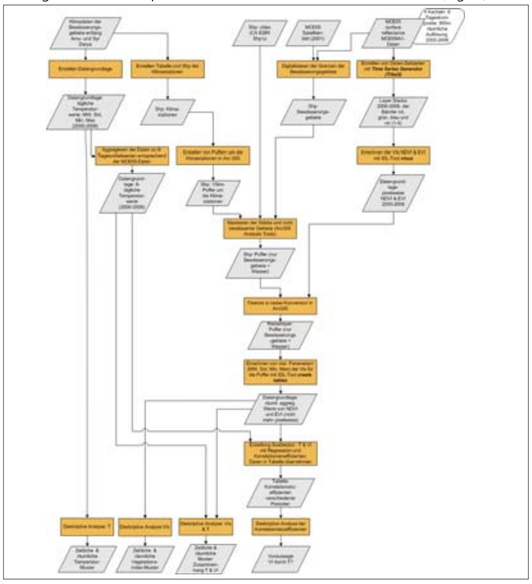

Figure 2: Work flow of the temperature and vegetation growth monitoring system.

Correlations between 8-days average daily air temperature and vegetation indices show higher values for EVI compared to NDVI. The correlations were also generally higher if the whole year was considered compared to the period when temperature was higher than 10° (reference threshold for cotton growth), indicating that other factors such as irrigation water are influencing crop growth during this period (Fig. 5).

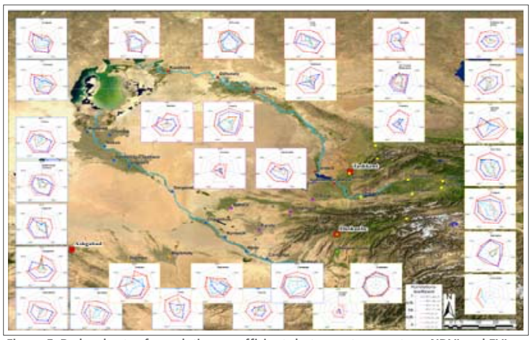

Figure 5: Radar charts of correlations coefficients between temperature, NDVI and EVI.

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.

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

Acknowledgements
This study is part of the ZEF/UNESCO Khorezm project (http://www.khorezm.uni-bonn.de) and was funded by the German Federal Ministry of Education and Research (BMBF).

Deutsches Fernerkundungsdatenzentrum
DLR Oberpfaffenhofen
D-82234 Wessling
Internet: www.dlr.de/caf