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Science brief from the ZEF-UNESCO project on Sustainable Management of Land and Water Resources in Khorezm, Uzbekistan

How satellite images can improve agricultural land and water management

Summary

Continuous land use mapping is essential for improving irrigation water distribution, identifying deficiencies in irrigation water supply, and estimating yields. Findings from the ZEF-UNESCO research project in Khorezm, Uzbekistan, demonstrate how remote sensing and Geographical Information Systems (GIS) can contribute to monitoring and improving land use in irrigation systems.

Methodology

Remote sensing is a beneficial tool for land and water managers to develop strategies and policies for profitable and sustainable land and water management. This is especially relevant for Khorezm, a region dominated by irrigated cotton cultivation and production. But implementing remote sensing technology requires expert knowledge on digital data acquisition and analysis software such as GIS. The processing of data requires technical training and a good internet connection. Moreover, although satellite data are still partly available free of charge, this will change in the very near future.

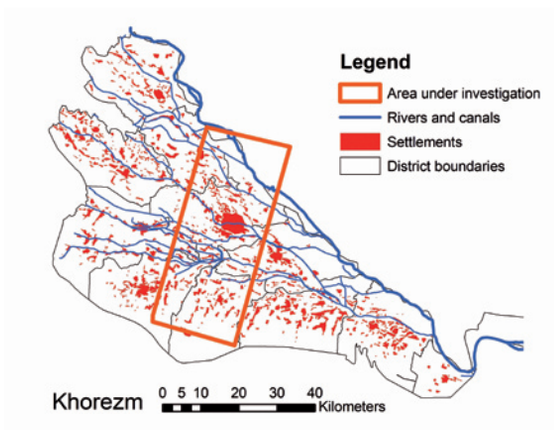

Figure 1: The land use analysis was carried out in the area delineated by the orange box.

Remote sensing experts in the ZEF-UNESCO project investigated the possibilities of using remote sensing technology to provide region-wide information on land use, thus gaining knowledge on actual land use and its temporal dynamics. They analyzed satellite data for Khorezm recorded between 2004 and 2007 in a twin exercise. First, field boundaries were extracted to simulate cadastre information and separated from non-agricultural areas, such as cities, lakes, canals, and the desert. The results were stored in a GIS data base. Field samples of the major land use classes were collected comprising cotton, rice, crop rotations with winter wheat, and a further class summarizing land use aside the aforementioned. The information was then

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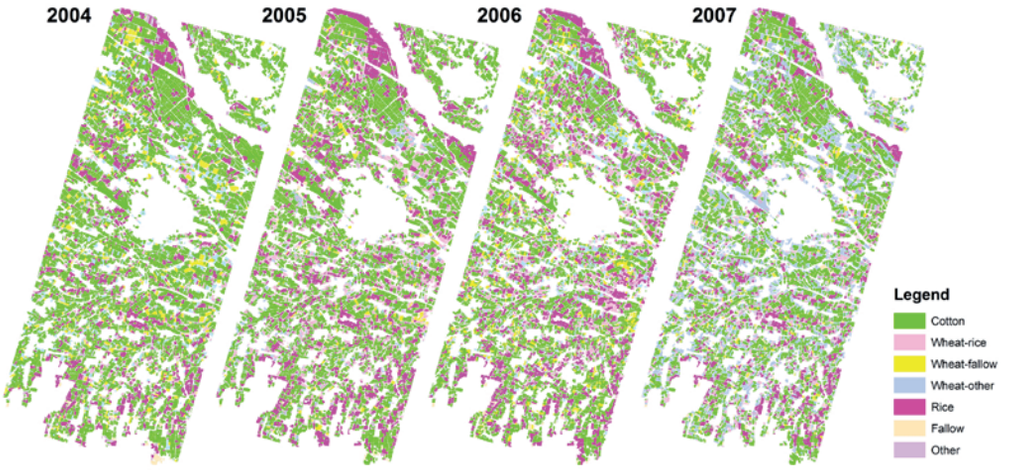

Figure 2: Distribution of major crops in the area under investigation (years 2004-2007)

extrapolated using knowledge-based classification methods provided by the powerful GIS-tools. Criteria for land use classification were derived from the cropping calendar, which was established with the aid of local farmers.

Outcome of remote sensing technology

On the basis of the data collected we can say that remote sensing can help with the following issues:
a) optimizing crop rotations on fields of (neighboring) farmers in terms of water distribution and soil conservation,
b) supporting the Uzbek government's ongoing land reforms, since changes in cropping patterns can be detected and reported rapidly and easily,
c) carrying out water saving interventions, especially in reaction to water scarcities, because timely information on cropping patterns enables the updating of water demand calculations and proposals for in-season corrections, and
d) modeling area-wide and field-specific crop yields and water use (water productivity).

Taking into account an accuracy of the land use maps of between 81% and 86%, the maps showed the following regional characteristics and developments: An intensive use of land; an increase in crop rotations with winter wheat during 2004-2007; a decrease in cotton cultivation; and a low percentage of fallow land (below 3%) in all observed years. Furthermore, rice cultivation is concentrated in areas close to the Amu Darya River, but also occurs scattered throughout the region. Although cotton or rice monocultures still prevail in nearly 20% of the study area, an increasing trend towards crop rotation is noticeable.

The ZEF-UNESCO project will investigate, if the latest satellite systems can provide more accurate information on crops which cover small area portions, e.g. on the numerous small household plots.

Recommendations

Remote sensing technology can complement conventional data collection and analysis for strategic land and water management. The latter is obtained, for instance, by exchanging findings during discussions among farmers on the optimization of land use. For example, if farmers make a decision about the common use of water on neighboring fields, land use maps of previous seasons can disclose problems in cropping patterns or bottlenecks for water distribution. Farmer groups can elaborate options, where to plant which crops with comparable water demands. Canal sections and pumps may be operated jointly, preventing a repeated overflow of freshwater to the drainage systems and saving water, especially in cases of water scarcity.

Managers of Water User Associations (WUA) might use crop rotation maps as additional information for improving the productivity of their land. Comparing the land use maps of different WUAs can help to understand whether changes in crop rotations are beneficial to increase and sustain farmers' incomes. Present cropping patterns can be improved by reducing monocultures, which contribute to soil degradation. Due to the complexity of remote sensing and GIS applications, it would be advantageous to have special training for land and water managers and to integrate remote sensing and GIS technology in the curriculum of the local university of Urgench.

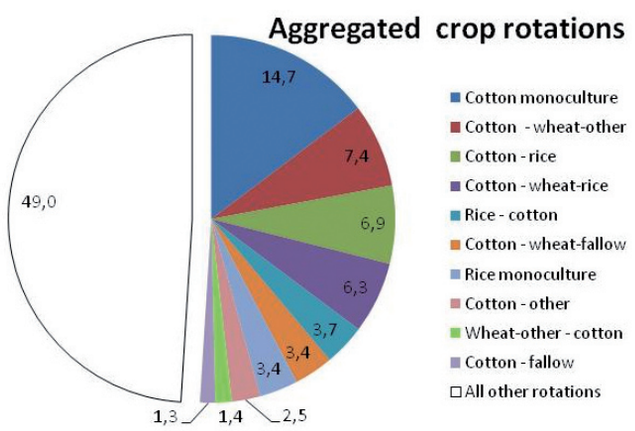

Figure 3: Percentage of major crop rotations between 2004 and 2007

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