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Zentrum für Entwicklungsforschung
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University of Bonn

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GERMAN-UZBEK KHOREZM PROJECT

A GIS-based tool for making better use of data on groundwater level and salinity

Summary

Information on groundwater (GW) level and salinity is crucial for improving management of irrigated agricultural systems. In the project region of Khorezm there is an extensive network of wells which makes a regular monitoring of GW level and salinity possible. However, the current procedure for GW data analysis, visualization, and dissemination is time-consuming and out-of-date. The ZEF/UNESCO project has developed an easy-to-use GIS-based tool that can improve the speed of GW data processing and visualization. This tool also allows linking of GW information with other important characteristics of the water system, such as the irrigation and drainage canals. Thus, integrated maps can be created supporting the analysis and understanding of the causes of shallow GW tables and soil salinity.

Background

Groundwater (GW) can supply a large share of total crop water use in irrigated agricultural systems. However, the advantage of shallow GW as a source of water supply may be off-set by its negative impacts on soil salinity. For instance, a shallow GW table accelerates the rate of salt accumulation in the root zone and reduces the effectiveness of salt leaching, which may result in soil degradation and total crop failure. Hence, keeping the GW level at an optimum depth is crucial for sustainable irrigation management. The GW table is affected by many factors including the topography, soil texture, effectiveness of the drainage network, crop/soil management practices, the recharge rate as well as the hydro-geological conditions. As these factors vary both spatially and temporally, access to timely information on actual GW levels is crucial to irrigation water managers and farmers. This helps to identify the deficiencies in the drainage network, adjust the irrigation timing and quantity, control soil salinity, and improve crop and soil management practices.

Traditional monitoring of groundwater level in Khorezm

The GW table in the Khorezm region is shallow with an average depth of 1.4 m below the ground surface in April after pre-season leaching and 1.2 m during the peak irrigation season in July (Ibrakhimov et al., 2007). The regional governmental organization Hydrogeological Melioration Expedition (OGEM) is responsible for monitoring GW table and salinity in Khorezm. A large dataset is collected from an extensive network of ca. 2,000 monitoring wells at a 5-10 days period each year for GW table, and three times a year (April, July, October) for GW salinity. The data is analyzed using traditional approaches and visualized in form of paper maps (Figure 1). The traditionally used interpolation method of triangulated irregular networks and manual drawing of maps are not only time-consuming and cumbersome but also difficult to update regularly.

When speed and accuracy of data processing and visualization are improved and reliable information on GW table and salinity is disseminated timely to Water Users Associations (WUAs) as well as to regional land and water management planners, better-informed decisions can be made. This includes decisions on how to invest the limited financial resources most efficiently in the maintenance of drainage infrastructure and how to adopt appropriate soil and crop management strategies for controlling soil salinity.

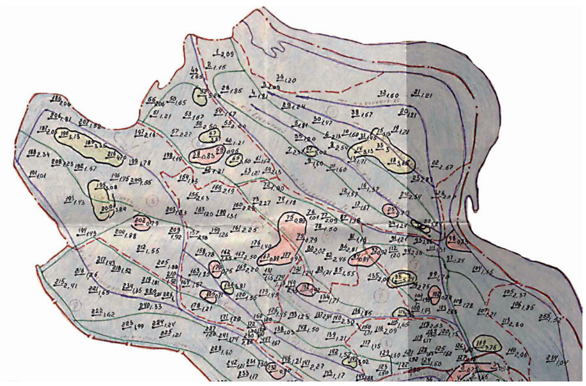

Figure 1: Traditional map of groundwater table for the Gurlan district

A GIS-based tool for improved analysis and visualization of GW level and salinity

To overcome the current deficiencies in the analysis and visualization of GW data, the ZEF/UNESCO project has developed a computer tool based on a free, yet full-featured, GIS-software (SAGA GIS; www.saga-gis.org). The advantages of this GIS-based tool lie in the possibility of an easy entering and timely processing of newly acquired GW data, the ability to compare the produced maps with previous data, and to link up the GW maps with other important spatial information such as field contours, vectors of irrigation canals and drainage network, and soil characteristics. This allows the application of more sophisticated techniques such as kriging for interpolation of point data from GW wells to generate regional maps of GW table and salinity (Figure 2).

Recommendations

The GIS-based tool for GW mapping developed by the ZEF/UNESCO project provides rapid and reliable outputs that can be used by OGME experts, WUAs, and farmers in the Khorezm region. The ZEF/UNESCO project's research staff in Uzbekistan can conduct a basic training course upon request for potential users without a GIS background. There is no need for expensive and powerful computers for using this tool. The input data required for the application of this tool, such as coordinates of GW monitoring wells, vector layout data on canals, drains and soils, is also available at the GIS-Laboratory of the project and can be provided to users free of charge. This computer-based tool for GW analysis and visualization can improve irrigation and soil salinity management - not only in the Khorezm region but also in other parts of Uzbekistan and Central Asia where data from GW wells are available.

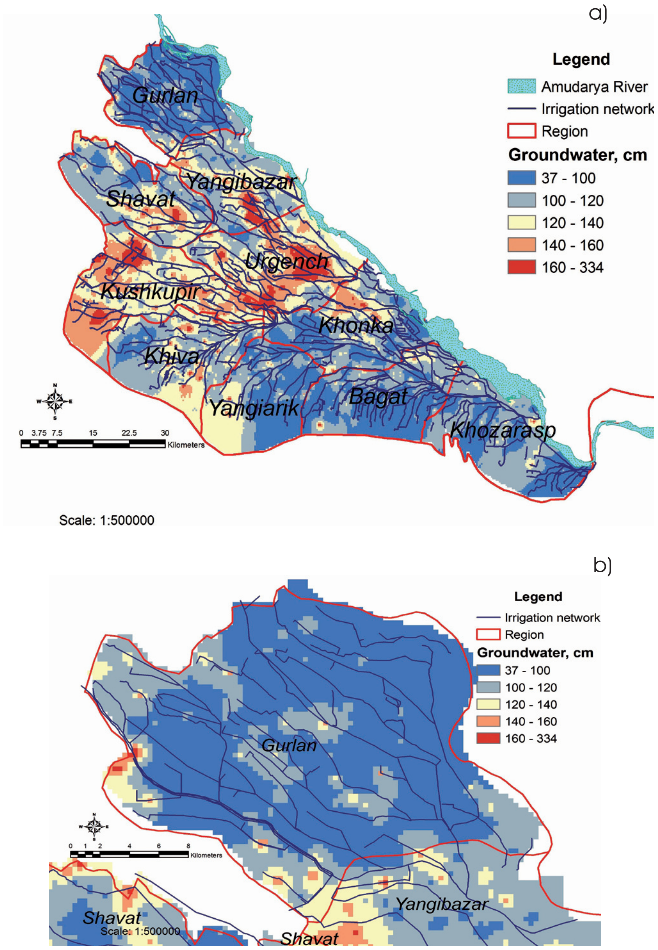

Figure 2: GIS-based maps of groundwater table for the entire Khorezm region (a) and the Gurlan district (b)

Reference

Ibrakhimov, M., Khamzina, A., Forkutsa, I., Paluasheva, G., Lamers, J. P. A., Tischbein, B., Vlek, P. L. G., and Martius, C., 2007. Groundwater table and salinity: Spatial and temporal distribution and influence on soil salinization in Khorezm region (Uzbekistan, Aral Sea Basin). Irrigation Drainage Systems, 21, [3-4], 219-236.

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Authors:
M. Ibrakhimov, B. Tischbein, J. Lamers, A. M. Manschadi. All the authors work or are affiliated with the ZEF/UNESCO project in Uzbekistan.

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University of Bonn, Germany
Uzbekistan Project Office
phone: # 49 228 731917 or 731865
e-mail: khorezm@uni-bonn.de
homepage: http://www.khorezm.uni-bonn.de