

# ZUR no. 25

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Zentrum für Entwicklungsforschung  
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## Integrated modeling for sustainable and economically efficient use of resources in Khorezm

### Summary

Enhancing irrigation performance and improving crop allocation are crucial steps to strengthen the performance of the agricultural sector and to lower pressure on the environment in the Khorezm region. In this ZUR we present a model calculating water, crop allocation and economic outcome and integrating bio-physical, economic and institutional aspects. With this approach we can analyze the current hydrologic and agricultural system and evaluate effects of political incentives, as well as develop interdisciplinary concepts that make a more effective use of natural resources and an optimized economic output possible.

### Background

Since national independence, Uzbekistan, and in particular Khorezm, has experienced an increase in ecological, economic and social problems, which are caused to a larger extent by water related deficits:

- Variable and decreasing water availability.
- Inequitable water distribution within the districts.
- Unfavorable crop allocation based on soil type and water supply, mainly caused by the state order system for cotton and wheat.
- Low irrigation efficiencies, insufficient water supply at farm level and drainage deficits due to inflexible irrigation strategies.
- Unfavorable and marginal soils are used for agricultural purposes, creating problems such as salinity increase and a reduction in crop yields.

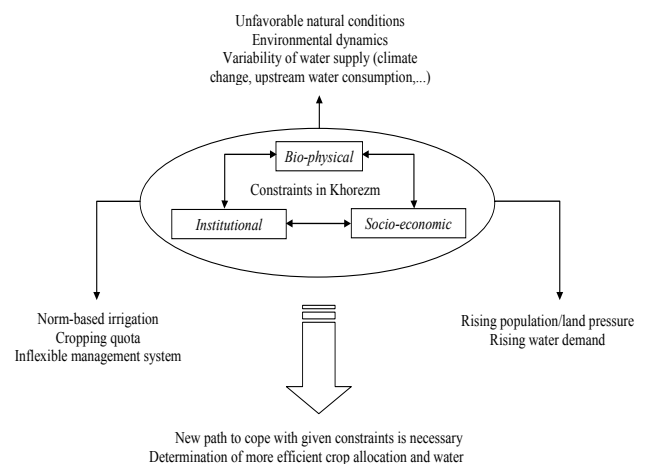


Figure 1: Constraints in Khorezm.

In order to achieve an effective and sustainable use of natural resources in Khorezm and to optimize economic outcomes, water and crop management needs to be modeled within the economic and institutional context.

## Methodology and innovative features of the approach

The novelty of this study is the combination of interdisciplinary aspects in a consistent modeling framework. Essential hydrologic, meteorological, agronomic, institutional and economic relations are integrated into one coherent model for the Khorezm region.

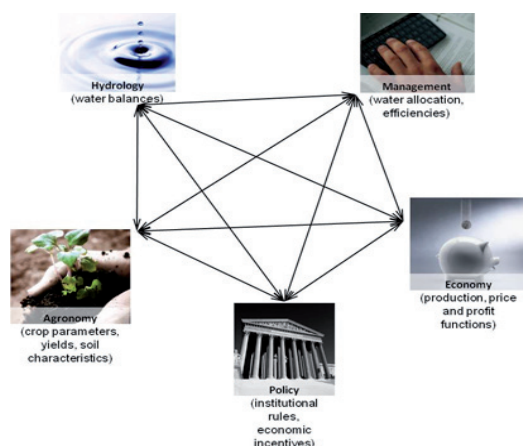


Figure 2: Model components

Several aspects and elements of other studies conducted within the project can be incorporated, utilized (see ZUR No. 1, 13, 18) and analyzed with regard to the impacts on the regional scale and overall effects (water quantity, groundwater, efficiencies, drainage, laser leveling, soil water, evapotranspiration, salinity, crop water demand, prices etc.).

The capacity of the model to link the surface water, groundwater and drainage components enables an integrated use of these resources. Furthermore, the water balance approach (accounting for water input and output) has the potential to derive flexible irrigation schedules. Different from the current water distribution based on static norms, the model enables a closer matching of the site-specific and time-dependending demands and allows to simulate optimal deficit irrigation strategies minimizing the impact of water stress on yield in case of non-avoidable under-supply.

## Results and recommendations

In this study the effects of political and institutional incentives and technological and environmental conditions such as the reform of the cotton sector, the introduction of water prices and the improvement of the irrigation system were evaluated in terms of their impact on regional water distribution, crop allocation and economic outcomes. Here follows the main outcome:

Simulations of an improved water distribution and irrigation system indicate that percolation losses could be diminished, especially at the field level, leading to additional available crop water and higher crop yields. The most suitable measure for improving water use efficiencies for local conditions in Khorezm seems to be the

refinement of gravity irrigation and measures to control drainage, consistent land leveling and the introduction of soil moisture-increasing crop techniques, such as mulching, no-tilling, or planting of shelterbelts.

According to our simulations, a complete liberalization of the cotton sector would lead to a fundamental reallocation, and to less water-demanding and higher economically valued crops. It would result in a general reduction of acreage, whereas losses caused by the abolition of cotton subsidies and the quota system would be fully compensated. Simulations also show that more farmers would choose to cultivate crops that can be traded on local markets and crops with a good balance between water consumption and cost/revenues. This would also result in high economic water use efficiency. When agriculture in Khorezm shifts from extensive cotton production to the diversified cultivation of crops -such as vegetables, fodder and fruits (and rice, if enough water is available), the proportion of semi-subsistence farming could be increased. Since crop cultivation of vegetables is labor-intensive, employment rates of the rural population could be maintained.

The introduction of water pricing results in a sharp decline of farmers' income. Even with liberalizing the cotton market, pricing water seems to become very difficult: Whereas income and welfare of farmers could be increased due to alternative crop allocation and higher sales prices, the growth rate of gross margins is relatively low. Thus, high losses caused by additional costs for water pricing would eliminate additional income. As a result of the extremely low gross crop profit margins in Khorezm, only a water price on a very low level of less than 6 USD/1000 m<sup>3</sup> could feasibly be introduced in this region. However, converting to a long-term sustainable water management system is only promising if the water pricing is combined with other factors, such as certain policies (e.g. decrement of farmer's support/subsidies and public financing) and if property rights for farmers are guaranteed.

## Reference

Schieder, T.-M. (2011): Analysis of water use and crop allocation for the Khorezm region in Uzbekistan using an integrated hydrologic-economic model, in: Ecology and Development Series, Vol. 79, Center for Development Research, University of Bonn, 230p, Dissertation.

## IMPRINT

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