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Optimal Cropping Pattern under Conditions of Uncertain Water Supply. A Spatially Explicit Approach for Khorezm Region, Uzbekistan

IHTIYOR BOBOJONOV, MARC MÜLLER, JOHN LAMERS, CHRISTOPHER MARTIUS

University of Bonn, Center for Development Research (ZEF), Germany

Abstract

Khorezm is an Oblast of Uzbekistan in the lower Amu Darya Basin close to the remainders of the Aral Sea, and therefore strongly affected by the well-known ecological problems, that have their roots predominantly in the national and international water use policies. The latter contribute to elevated water usage and an estimated 16–18,000 m³ of irrigation water per hectare are used. The high level of irrigation water application causes shallow groundwater tables and secondary soil salinity. Moreover, fluctuations in the regional irrigation water supply from the Amudarya River create severe uncertainty in agricultural production. Therefore, there is an urgent challenge for improving both, the ecological situation and the security of agricultural income, which presently is very low compared to the Uzbek average. Despite various reforms, farmers are still restricted in their decisions what to crop and when. Therefore, the work described in this paper aims at supporting the regional crop allocation and water distribution process with the purpose to improve the ecological and economic situation in the Khorezmian agricultural sector. The model established in this study aims at decision makers on the governmental level as well as at single farmers. Economic/mathematic optimisation techniques and GIS tools were combined for a better implementation and integration of spatial data and microeconomic data. An expected value-variance (EV) approach is used to analyse the risk associated with variability and the stochastic nature of water availability. Capillary rise from groundwater, soil salinity, soil texture and soil humus, distance from irrigation canals are the main criteria for defining optimal crop-mixes for certain locations while taking into account the risk associated with the activity type and level of water use. Results show that substantial increase in water efficiency can be achieved by adjusting the production patterns with respect to risk issues, which is essential in improving the ecological and economic situation in the region.

Keywords: Amu Darya Basin, Expected value-variance (EV) analysis, Spatial approach, Uncertainty, Water use efficiency