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How science-based models can serve rural development: FLEOM applied

Summary

This science brief provides a review of the discussion support model FLEOM as developed and implemented in the ZEF/UNESCO Project

Introduction

The **Farm-Level Economic-Ecological Optimization Model (FLEOM)** is a model that was developed by an interdisciplinary team of researchers of the ZEF/UNESCO project in Khorezm, Uzbekistan. FLEOM is a site-specific integrated model for scenario analyses and its primary objective is to support the discussions and decisions of policy makers and relevant institutions on developing agriculture and rural areas in the region. Hence, potential users of FLEOM are high-level stakeholders such as policy makers and local authorities. Besides, FLEOM is a tool for scientists in the respective fields and a policy simulation instrument for educational purposes, e.g. at high education institutions, workshops or the like.

Background: Challenges and constraints of farming in Khorezm

Agricultural productivity, comprising economic efficiency of the farmers, is a decisive element for promoting rural development. However, farmers in Khorezm have to take into account a whole range of factors such as the heterogeneity of their scattered fields in terms of soil typology, soil salinity, ground water level and groundwater salinity, in addition to the complexity of irrigation networks, availability of inputs, and input and output prices. Obviously, it is not easy to decide where and what crop to grow and consequently there is a risk that farm resources are managed sub-optimally. Furthermore, Khorezm faces major problems such as soil degradation and low productivity of scarcity prone water, which climate change will most likely exacerbate in the future. This all will keep farmers' yields and profits low and environmental degradation high.



Figure 1: Farm parcels prior to sowing

Modeling Science-based planning of agricultural reforms concerning economic and ecological restructuring of land and water use in the region can mitigate the negative



Zentrum für Entwicklungsforschung
Center for Development Research
University of Bonn



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consequences of climate change and therefore facilitate sustainable rural development. One of the research objectives of the ZEF/UNESCO project is to understand decision-making processes on land and water use as well as on the choice of farm-field technology in a better way and to suggest improvements. In addition, the project has tested and brought a number of technological alternatives and innovations to farm-gate which can facilitate sustainable land and water use in Khorezm. Socio-economic and ecological consequences of adopting these are still to be tested as well as the policy options for promoting the alternatives and innovations among agricultural producers. Therefore, FLEOM was developed as a discussion support model and an interdisciplinary "toolbox", tackling various questions at different levels.

FLEOM: What it is and how it works

FLEOM has been developed by researchers of the ZEF/UNESCO project as a site-specific integrated model for scenario analyses at the levels of farms and Water Users Associations (WUA). FLEOM captures the basic features of the regional agriculture, as well as the interrelations of production activities most prevalent to the local farmers. Moreover, it comprises regionally specified input-output parameters and conditions of land and water use. FLEOM was developed as a user-friendly and easy-to-use stand-alone software.

FLEOM is based on a comprehensive system-understanding composed by a range of biophysical and socio-economic studies carried out in the ZEF/UNESCO project. As a good discussion support system FLEOM is structured in a way that has the necessary flexibility to add new

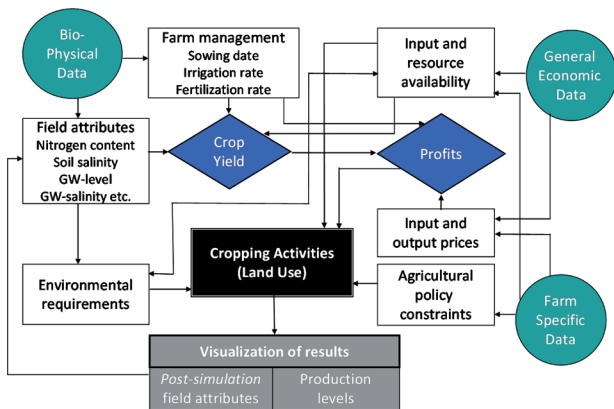


Figure 2. Modular structure of FLEOM

crops, simulate changes in a socio-economic environment and in production technologies and, thus, secures a wide range of its possible uses in the future. The model works in three steps: First, it utilizes an agronomic data base carefully compiled through the cropping system simulation model (CropSyst) using field experience and knowledge of a range of agronomic and hydrological studies of the ZEF/UNESCO project. Next, the agronomic database together with socio-economic information goes through an optimization process in the General Algebraic Modeling Software (GAMS). Finally, the model transfers the results into easily understandable tables, figures and maps.

What FLEOM can do

The presented discussion support system can be used for planning and evaluating changing economic and/or environmental conditions in agriculture and rural areas in Khorezm. Therefore, FLEOM has been developed and applied with the following objectives:

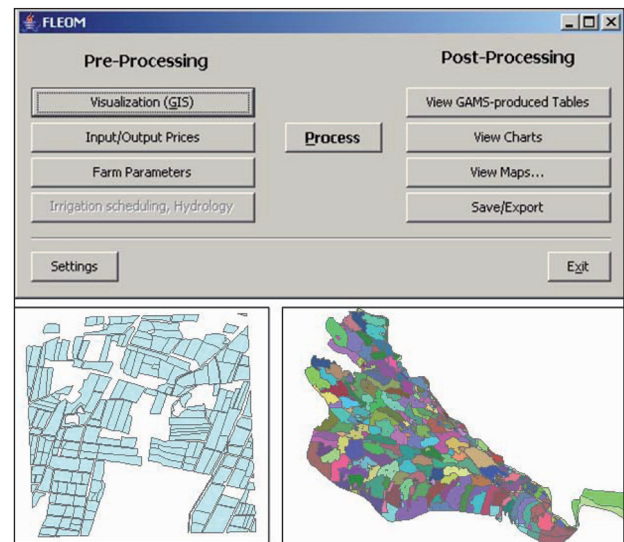


Figure 3: FLEOM results of one area can be transferred for whole region.

- to show the potentials and constraints of alternative land- and water-management options – that can increase rural incomes while maintaining agricultural production with at least a medium-term ecological sustainability,
- to design new plans for sustainable development and to check if selected adaptation measures are feasible,
- to develop and suggest to stakeholders optimal land use options under various external shocks, e.g. water scarcity,
- to assess the respective impacts of various external shocks on farm income, crop and animal production, cropping pattern, water and resource use and soil attributes.

To simulate an environmentally friendly development, FLEOM allows setting limits to environmental hazards, such as irrational irrigation, the pollution of groundwater by excessive nitrate leaching and the deterioration of land by secondary soil salinization.

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Authors:

Nodir Djanibekov (ZEF/UNESCO) and Rolf Sommer (ICARDA)
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>