Integrated Economic-Hydrologic Water Management Model
-Analysis of Water Use and Allocation for the Khorezm Region in Uzbekistan-

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GERMAN-UZBEK KHOREZM PROJECT

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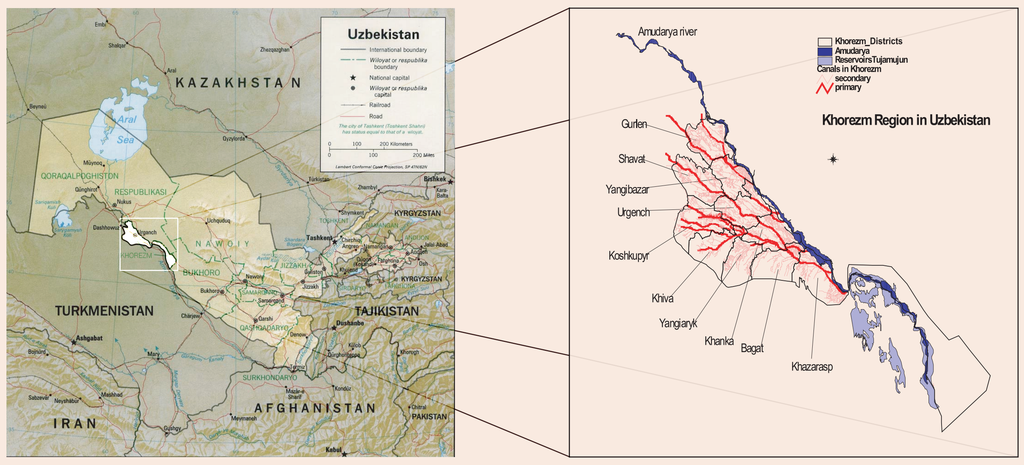
Region:



Regional Characteristics:

Irrigation agriculture	Decreasing water availability
Cotton main crop	Salinization and erosion of soils
Low rainfall	Decreasing biodiversity
High water consumption	High water losses in irrigation system
Air pollution	High population growth rate...
Health problems	

Methodology:

- 1. Positive Model ("what is situation")
- 2. Optimization Model ("what should be"), non-linear
- Coded in Gams (General Algebraic Modeling System)
- Valuation and quantification of alternative water management via scenario analyses

Objectives of the Study:

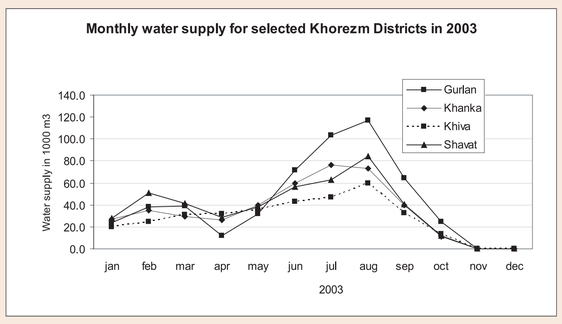
- Identification of strategies and policies for more efficient water allocation among users, agricultural development and water resources demand management in Khorezm
- Detection and determination of water supply and demand and as a consequence thereof the water availability and water use patterns in the region of Khorezm
- Evaluation of economic and environmental consequences (costs, benefits, tradeoffs and complementarities) of water uses in the region, water based or related constraints to agricultural and economic development
- Exploration of impacts of economic incentives such as water prices, irrigation investment; salinity control measures on crop pattern change, hydrology and water uses

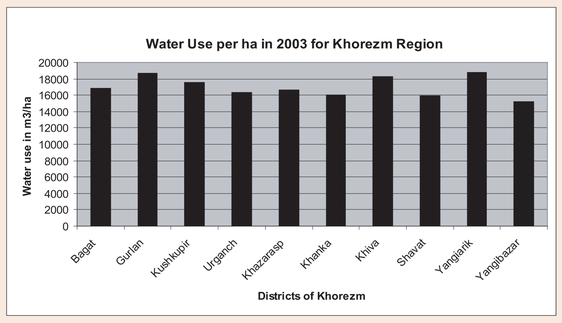
Model Structure and Components:

- Hydrologic components (water flow and salinity transport and balances, groundwater and drainage balances)
- Economic components (production and profit functions for different crops and water uses, costs, welfare, water prices, taxes, water value…)
- Agronomic components (crop parameters, yields, soil characteristics…)
- Irrigation management (efficiencies)
- Institutional rules, policies and economic incentives (as scenario analyses)

Data and Results:

Some Basic Data of the Positive Model:



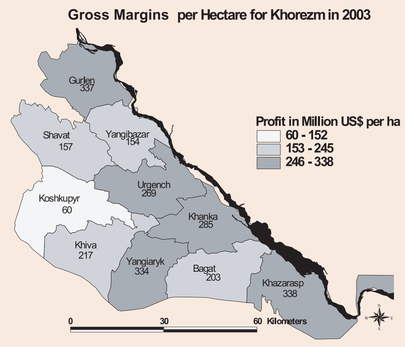


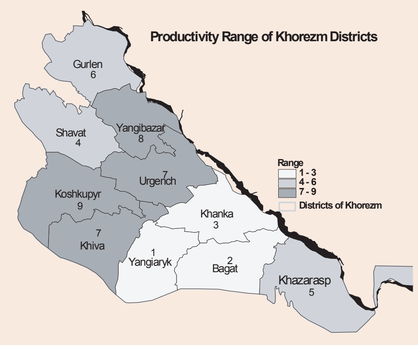
Some Economic Analyses:

		Khasarasp	Khanka	Urgench	Yangibazar	Gurlan	Bagat	Yangiarik	Khiva	Khushkupir	Shavat	Khorezm total
Gross margin, in M US $	with water price	7.435	7.031	5.832	2.663	8.103	3.593	4.857	3.709	0.958	3.588	47.769
	without water price	8.007	7.626	6.479	3.167	8.846	4.089	5.287	4.179	1.634	4.181	53.495
Gross margin, US$/ha		314	263	242	129	309	178	307	193	35	134	207
Cropped area in ha		23715	26720	24070	20610	26220	20160	15821	19221	27290	26710	230537
Revenue in M US $		16.31	15.64	14.29	9.93	18.26	10.42	10.58	9.87	9.46	12.07	126.82
Variable planting costs, M US$		8.30	8.01	7.81	6.76	9.41	6.33	5.30	5.69	7.82	7.89	73.33
water costs, M US$		1.24	1.26	1.38	1.05	1.58	1.10	0.98	1.02	1.54	1.33	12.46
total water applied, M m3		411.8	418.5	458.5	350.9	526.6	366.1	326.6	338.6	513.5	443.6	4154.7
Value of water US $/m3	with water price	0.018	0.017	0.013	0.008	0.015	0.010	0.015	0.011	0.002	0.008	0.011
	without water price	0.019	0.018	0.014	0.009	0.017	0.011	0.016	0.012	0.003	0.009	0.013
Marginal value		0.107	0.061	0.057	0.056	0.107	0.023	0.024	0.037	0.024	0.046	

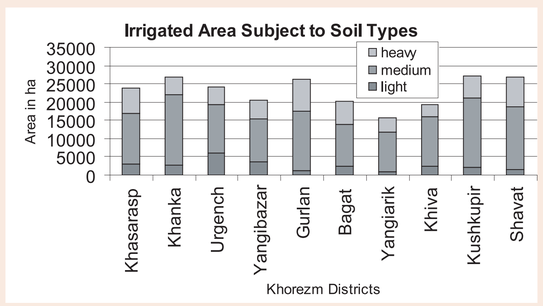
Gross margin per crop in M US$

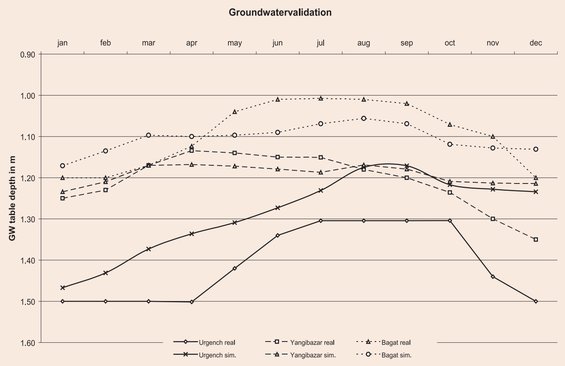
	cotton	wheat	rice	other grain	alfalfa	vegetable	fruit	potato
Khasarasp	-0.52	0.50	6.54	0.02	-0.22	1.10	0.01	0.01
Khanka	-0.27	0.48	4.85	0.02	-0.27	1.93	0.05	0.23
Urgench	-0.78	0.64	4.93	0.05	-0.21	1.00	0.18	0.02
Yangibazar	-0.89	0.36	3.02	0.01	-0.21	0.44	-0.14	0.09
Gurlan	-1.63	0.32	8.34	0.06	-0.36	1.08	0.15	0.15
Bagat	-0.63	0.56	3.05	0.02	-0.29	0.78	0.02	0.09
Yangiarik	-0.44	0.32	3.68	0.03	-0.16	1.23	0.06	0.14
Khiva	-0.13	0.20	1.04	0.01	-0.15	2.44	0.06	0.26
Kushkupir	-1.37	0.51	1.72	0.04	-0.51	0.52	-0.02	0.08
Shavat	-0.67	0.44	2.14	0.02	-0.29	1.20	0.28	0.47
Khorezm total	-0.73	0.43	3.93	0.03	-0.27	1.17	0.07	0.15

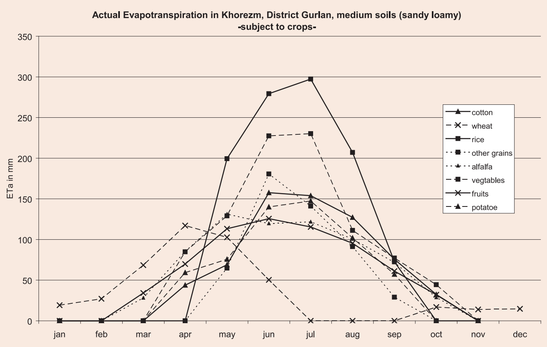


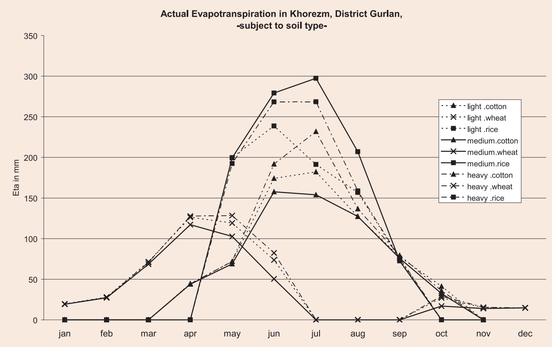


Some Hydrologic and Agronomic Analyses:









Conclusions:

Model Advantages:

flexibility to integrate aspects of social-economical-hydrological-ecological aspects in an endogenous system and due to this account for the interdisciplinary nature of water resource problems

model is build up in a way to afford further considerations on a river basin scale or just for a more detailed spatial scale for e.g. district level

can serve as one part of a decision support system

expandable to dynamic model (node-link-network)

further steps:

expansion of salinity mechanisms and optimisation model

sensitivity analyses, scenarios on economic incentives