BRIEFING / 3.2

June 2013

GLOWA Jordan River

How can land-use be adapted to climate change? An economic analysis for Israel

Key findings

- We created an economic model which enables us to calculate the land and water allocations needed to maximize farming profit under various development scenarios.
- Profits, land-use and water use were calculated for the vegetative agricultural sector in Israel, under the four SAS scenarios and under climate change scenarios developed by GLOWA (Briefing 1.1. and 1.3).
- For Israel, we found that long-term economic losses stem from yield potential reductions driven by forecasted increases in temperature
- Our overall findings indicate that adaptation to climate change should be done by using more heat-tolerant crop varieties and adaptive technologies.

Overview and Objectives

We developed a regional scale economic model named VALUE (Vegetative Agricultural Land Use Economic) to effectively estimate the impacts of future changes on vegetative agriculture in Israel. The objective of VALUE is to simulate the behavior of farmers under climate change (precipitation), the availability of irrigation water, and different prices and limitation of water. The latter changes can be caused by climate change, but also by global processes such as trade conditions or technological advancements. The VALUE model was developed and calibrated for 21 "ecological regions" in Israel (Howitt, 1995; 2005). In each region, the model incorporates 45 crops and calculates the optimal land allocation among them, as well as the allocation of freshwater, treated waste-water and brackish water. The allocations of the different water sources are determined to maximize farming profits given the simulated constraints on land properties and irrigation water.

Research Methods

In the first stage, the model was calibrated in order to represent the 2002 land and water allocations under the assumption that these maximized the farming profit. In a second stage, the VALUE model was updated for assessing climate change impacts on vegetative agriculture based on farmers' adaptations through water and land-use management strategies.
We used climate conditions under the IPCC's (Intergovernmental Panel on Climate Change) A1B scenario, as modeled by Krichak et al. (2010), for simulating agricultural activities during three periods: 2001-2020, 2021-2040, and 2041-2060. The nation-wide average rainfall under these scenarios is expected to change by +5%, -3.5% and -20%, in these 3 periods, respectively. Changes in precipitation led to direct changes in rainfall availability to winter crops, and indirect effects on water quotas allotted to farmers. Moreover, these changes, in combination with population growth, would lead to increased reliance on desalinated water, and thereby increase freshwater prices considerably (Figure 1).

Our simulations indicate a reduction in the cultivated land of about 15% and of 5-7% in the profits of the vegetative agricultural sector. Surprisingly, although the freshwater use should be sensitive to changes in freshwater quotas and prices, land-use and profits are quite robust to these changes. The reduction in profits must be addressed by adaptive land management, i.e. by allocating land to less water-intensive types of usage.

Teams of researchers from Germany, Israel, Jordan and the Palestinian Authority work on how best the hazards posed by global change to the future of the Jordan River basin can be faced and overcome.

www.glowa-jordan-river.de

The GLOWA Jordan River project is part of a larger research initiative launched by the German Federal Ministry of Education and Research under the title "Global Change and the Hydrological Cycle".

http://nbn-resolving.de/urn:nbn:de:bsz:21-opus-69707

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Conclusions

A more proactive approach for analyzing agricultural adaptation to climate change that was done under the umbrella of GLOWA was based on a structural land-use model wherein farmers maximize profit by allocating their land between crop-technology bundles. The profitability of the bundles depends on four technological attributes that are affected by climate variables: potential yield, input requirements, yields' sensitivity to input, and farm-level management costs. Proactive adaptation measures are derived by identifying the technological attributes via which climate variables reduce overall agricultural profitability, despite adaptation by land reallocation among bundles. By applying the model to Israel, we find that long-term losses stem from yield potential reductions driven by forecasted increases in temperature, implying that adaptation efforts should target more heat-tolerant crop varieties and technologies.

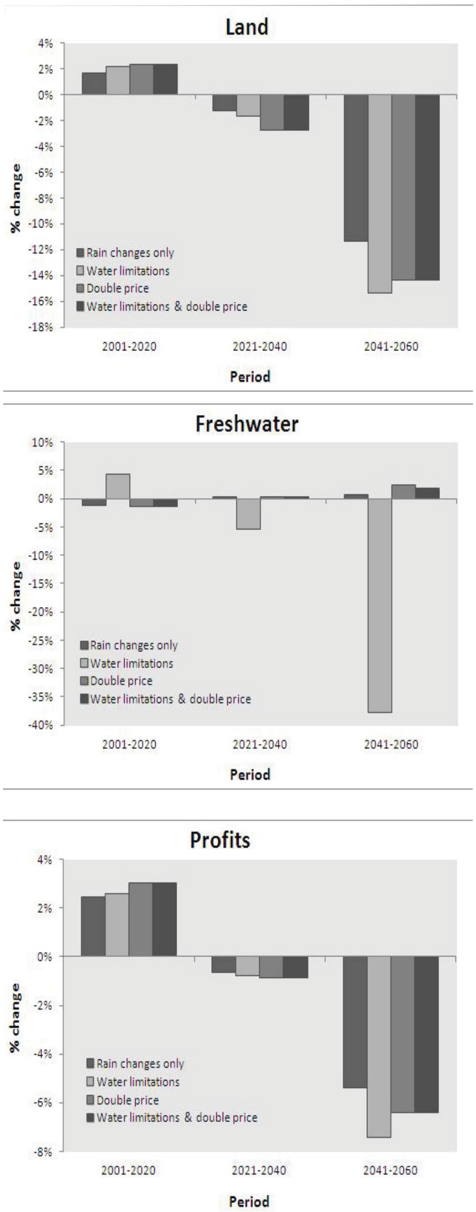

Figure 1: Forecasted changes (relative to the 1981-2000 period) in land and water usage by the agricultural sector, as well as the profits, under various scenarios with respect to freshwater quotas and freshwater prices.

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GLOWA JR Briefings present relevant scientific results of the GLOWA Jordan River project concerning the effects of climate and global change in the Jordan River basin.

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