Tropentag, September 9-11, 2020, virtual conference

"Food and nutrition security and its resilience to global crises"

Institutional Innovation in Groundwater Governance: A Numerical Simulation of the Principal-Agent Model

Surajit Haldar[1], Ernst-August Nuppenau[1], Debdutt Behura[2]

[1] *Justus-Liebig University Giessen, Inst. of Agric. Policy and Market Res., Germany*
[2] *Odisha University of Agriculture and Technology, Bhubaneswar, of Agribusiness Management, India*

Abstract

The groundwater procurement with recurrent drought and erratic rainfall has increased in the recent decade in India, in order to meet the diversified land-based production activities. This increased irrigation acreage translated into higher-margins but at the expense of increased costs. However, marginal and small farmers of a government-subsidized community groundwater irrigation sharing arrangement (CISA) in Odisha state do harness higher margins by avoiding such increases in investment cost. A CISA aims to maximize the irrigated area that decreases the marginal cost of water by increasing the membership or by expanding the irrigation to the unirrigated plots, but at the cost of accelerated decline in the water table. Thus, any myopic extraction ultimately endangers the ecologies of the retention system in terms of decline in the water table and a premature well failure as an extreme event. To address this trade-off, the present study aims to develop a teamwork approach to optimize the cost of groundwater extraction and its distribution for various land-based activities. The teamwork necessitates participation and provides incentives to the members for sustaining the groundwater ecology and thereby for the survival of rural communities.

We first developed a framework for teamwork that involved water sharing using linear programming. It determined the plot/farm scale land-based production decision making. . Under the steady-state water procurement, the well scale optimal land-based activities are derived and that simultaneously optimizes the gross margin of the CISA. Back interaction is performed to calibrate the water allocation at farm and plot scale in order to achieve the CISA scale optimal gross margin. This is achieved by maximizing the area under water-saving land-based production activities subject to the minimal water procurement. The following step involves a cost-sharing regulation to minimize the procurement cost for its optimal allocation. This is developed using a principal-agent model. Further, we link the teamwork with a mathematical modelling approach built on dynamic inter-temporal optimization. Hence, this teamwork explicitly coordinates optimal water procurement on participation with dynamic control of the groundwater resource use.

Keywords: Groundwater, linear programming, India, Odisha, principal-agent model

Contact Address: Surajit Haldar, Justus Liebig University Giessen, Institute for Agricultural Policy and Market Research, Senckenbergstrase 3, 35390 Giessen, Germany, e-mail: surajit.haldar@agrar.uni-giessen.de