Sustainable Groundwater Management in Konya Closed Basin in Turkey: Participatory System Dynamics Approach

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Introduction

Lack of available surface water, especially in arid or semi-arid regions, render groundwater a vital resource for the continuity of agricultural production. Konya Closed Basin (KCB) is a semi-arid watershed located in Central Anatolia, Turkey. It has significant agricultural potential, however, the expansion in irrigated land and the transition in the crop pattern from water-conserving winter grains to high-water-demanding summer plants threaten the sustainability of groundwater resources in the basin.

Research Objectives

To explore the drivers of unsustainable use and to build a shared understanding on future sustainable pathways in KCB.

Methodology

The model is built with a dynamic systems approach, and together with relevant stakeholders through facilitated Group Model Building (GMB) workshops.

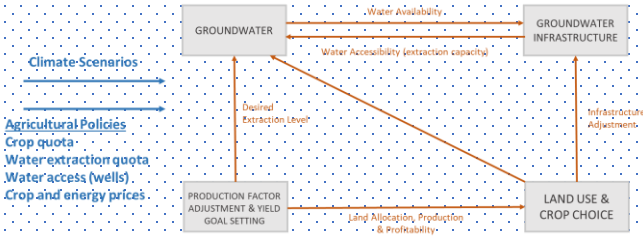

Figure 1: Conceptual Model

Model Description

The model consists of 5 sub-sectors related to crop choice, groundwater and pumping infrastructure, production factor adjustment, yield goal setting, and irrigation technology. The model is built on theoretical and empirical knowledge, as well as assumptions regarding farmer decision-making processes regarding crop selection and irrigation level for each crop type. The conceptual model is presented in Figure 1, and the main feedback relationships are shown in Figure 2. The model works on a yearly basis and the simulation period is between 2004-2044 (40 years). The model is initiated with the existing data from 2004 on groundwater table depth, and land size for each crop type.

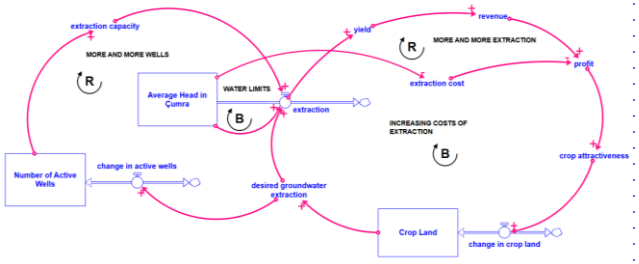

Figure 2: Main Feedback Loops

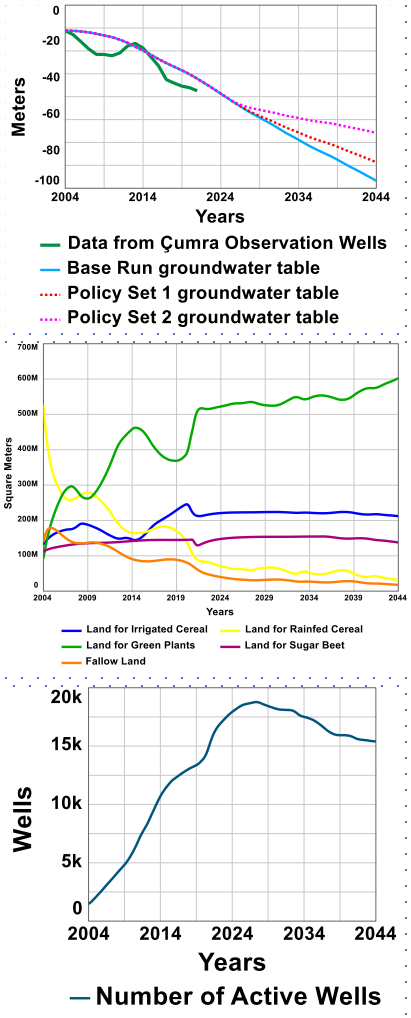

Figure 3: Simulation Outputs

Table 1: Summary of Simulation Results

Scenario	Change in Head	% Contribution
Business-as-usual	81,9 m	-
Policy Set 1	71,8 m	~12%
Policy Set 2	55,7 m	~32%

Results

The business-as-usual scenario shows that the increase in the high-water demanding croplands and the declining trend in the groundwater table will be continued in the upcoming two decades.

Two sets of policies are tested on the model; the first includes an additional surface water supply to the region, and a crop rotation policy, in which the green plants can only be grown once in every four years, effective after 2025. The second set includes a cereal price incentive and an irrigation cap on green plants and sugar beet. Table 1 summarizes the results.

Conclusion

In this research, complex dynamics of agricultural groundwater use in the Konya Closed Basin are studied. The model serves as a testing and learning platform to observe the behavior of key system variables such as groundwater table and various croplands, under different policy scenarios.

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References: Barlas, 1996; Hovmand, 2014; Sterman, 2000; Saito, 2021; WWF, 2014; Dietz et al., 2002; Hardin, 1968; Sterling, 2019