

## **Non-Linear Programming and Particle Swarm Optimization Model for Management of Conjunctive Use of Wastewater and Groundwater in Varamin Plain**

**M. Yousefi, M. E. Banihabib<sup>1\*</sup>, J. Soltani and A. Roozbahany**

PhD student, Irrigation and Drainage Department, College of Aburaihan, University of Tehran.

yusefi@ut.ac.ir

Associate Professor, Irrigation and Drainage Department, College of Aburaihan, University of Tehran.

banihabib@ut.ac.ir

Assistant Professor, Irrigation and Drainage Department, College of Aburaihan, University of Tehran.

Jsoltani@ut.ac.ir

Assistant Professor, Irrigation and Drainage Department, College of Aburaihan, University of Tehran.

roozbahany@ut.ac.ir

### **Abstract**

To address farmers' as well as water resources and environment managers' opinions, it is necessary to develop the optimal cropping pattern models for maximizing farmers' benefits, reducing nitrogen leaching, and improving the rate of aquifer recharge by applying quantitative-qualitative conjunctive use of unconventional surface water (reclaimed wastewater) and groundwater. In this research, the developed models (nonlinear programming (NLP) and particle swarm optimization (PSO)) were run in Varamin Irrigation Network for water year 2012-2013. The results of solving 3-objective nonlinear programming (NLP) model showed that by improving the net benefit of cropping pattern optimization, water productivity and aquifer recharge by about 6%, 22% and 29% led to reduction of conjunctive withdrawals of wastewater and groundwater and fertilizer consumption by about 13% and 85%. Also, the results of solving 3-objective model by Particle Swarm Optimization (PSO) algorithm showed that by improving the net benefit of cropping pattern optimization, water productivity and aquifer recharge by about 7%, 49% and 30%, conjunctive withdrawals of wastewater and groundwater summation and fertilizer consumption decreased by about 35%, 88%, respectively. Comparison of the results of the values of objective functions in different scenarios by NLP and PSO methods showed a difference of about 0.002% to 0.01%. So, heuristic algorithm (PSO) has very little difference with NLP and has great ability in providing optimal results. The results of this research could be applied to the optimum use of water resources, increasing farmers' benefits and decreasing nitrogen leaching in other irrigation network projects. However, it is to be emphasized that use of wastewater for irrigation of food crops for human and domestic animals is not recommended and full compliance with standards and regulations in applying reclaimed waste water in agriculture, is necessary and binding.

**Keywords:** Aquifer recharge, Nitrogen leaching, Unconventional water, Heuristic algorithm.

---

1 - Corresponding author: Associate professor, Irrigation and Drainage Department, College of Aburaihan, University of Tehran.

\*- Received: January 2017, and accepted: May 2017.