



“Gheorghe Asachi” Technical University of Iasi, Romania



---

## A SUPPORT VECTOR REGRESSION AND MONTE CARLO SIMULATION - BASED INTERVAL TWO-STAGE PROGRAMMING FOR ENVIRONMENTAL SYSTEMS PLANNING IN BEIJING

Chao Dai<sup>1</sup>, Yongping Li<sup>2</sup>, Yanpeng Cai<sup>3\*</sup>, Wei Sun<sup>2</sup>, Guohe Huang<sup>2</sup>

<sup>1</sup>Department of Environmental Sciences, Peking University, Beijing 100871, China

<sup>2</sup>Institute for Energy, Environment and Sustainable Communities, University of Regina, 120,  
2 Research Drive, Regina, Saskatchewan S4S 7H9, Canada

<sup>3</sup>State Key Laboratory of Water Environment Simulation, School of Environment,  
Beijing Normal University, Beijing 100875, China

---

### Abstract

In this research, a support vector regression and Monte Carlo simulation-based interval two-stage programming (SVRMC-ITSP) method was developed through integrating support vector regression (SVR) and Monte Carlo simulation into a two-stage interval-stochastic programming (TISP) framework. The developed SVRMC-ITSP method can effectively tackle dynamic, interactive and uncertain characteristics of municipal solid waste (MSW) management systems. It can also be used to simulate waste generation rates to provide relevant their PDFs for the consequent optimization. The method can improve previous studies in terms of uncertainty reflection and simulation. The developed method was applied for planning of Beijing's MSW management system. The results indicated that the SVRMC-ITSP method performed better than the original TISP model in its capability of improving the credibility of computed results. Uncertainties that can be expressed as both intervals and PDFs can be tackled through the introduction of SVR, Monte Carlo simulation, and TISP. The approach was valuable for supporting the adjustment of the existing waste allocation patterns, and the capacity planning of the city's waste management system.

**Keywords:** Monte Carlo, municipal solid waste, support vector regression, two-stage stochastic programming

*Received: April, 2014; Revised final: June, 2015; Accepted: June, 2015; Published in final edited form: February, 2019*

---

\* Author to whom all correspondence should be addressed: e-mail: [yanpeng.cai@iseis.org](mailto:yanpeng.cai@iseis.org); [yanpeng.cai@bnu.edu.cn](mailto:yanpeng.cai@bnu.edu.cn)