

# Simulation and Optimization Control of the Water-Energy-Environment Coupled Metabolic System

**Yang Zhang<sup>\*</sup>**

Chinese Academy of Environmental Planning, Beijing, China

## Email address:

zhangyang2019@pku.edu.cn (Yang Zhang)

<sup>\*</sup>Corresponding author

## Abstract

As key elements of urban development, water resources, energy, and the environment are closely and intricately coupled. The correlation and constraints among these three factors are becoming increasingly significant, rendering the traditional “single-factor” management model incapable of resolving the contradictions between resource supply and demand and industrial development. Therefore, focusing on the dynamic evolution process of urban water-energy-environment coupling, clarifying the impact mechanism of individual water and energy use behaviors on the macroscopic water-energy-environment coupled system, and elucidating the inter-industrial metabolic linkages of water-energy-environment elements are of great significance for exploring the coordinated management pathways of water resources, energy, and the ecological environment. This study, based on the practical issues of urban resource scarcity, environmental crises, and high-quality development, follows the research thread of system identification-coupling simulation-optimization control. By quantifying the complex coupling relationships among water resources, energy, and the environment, it reveals the inter-industrial water-energy-environment coupling metabolic mechanisms and proposes an industrial optimization control method based on multiple risk avoidance. A comprehensive simulation and optimization control method system for urban water-energy-environment coupled metabolic systems has been established, providing new insights for promoting the harmonious and sustainable development of urban water-energy-environment systems.

## Keywords

Water-Energy-Environment Coupling, Coordinated Management, Element Mechanism, Risk Avoidance, Optimization Control