



## **Assessment of groundwater utilization for irrigating park trees under the spatiotemporal uncertainty condition of water quality**

Cheng-Shin Jang (1) and Yi-Ming Kuo (2)

(1) Department of Leisure and Recreation Management, Kainan University, Taoyuan, Taiwan (csjang@mail.knu.edu.tw), (2) Department of Design for Sustainable Environment, MingDao University, Pettow, ChangHua 52345, Taiwan

Parks have a variety of functions for residents and are important for urban landscape planning. The healthy growth of urban park trees requires regular irrigation. To reduce the pressure of high groundwater levels and to avoid wasting groundwater resources, proper groundwater extraction for irrigating park trees in the Taipei Basin is regarded as a reciprocal solution of sustainable groundwater management and preserving excellent urban landscapes. Therefore, this study determines pristine groundwater use for irrigating park trees in the metropolitan Taipei Basin under the spatiotemporal uncertainty condition of water quality. First, six hydrochemical parameters in groundwater associated with an irrigation water quality standard were collected from a 12-year survey. Upper, median and lower quartiles of the six hydrochemical parameters were obtained to establish three thresholds. According to the irrigation water quality standard, multivariate indicator kriging (MVIK) was adopted to probabilistically evaluate the integration of the six hydrochemical parameters. Entropy was then applied to quantify the spatiotemporal uncertainty of the hydrochemical parameters. Finally, locations, which have high estimated probabilities for the median-quartile threshold and low local uncertainty, are suitable for pumping groundwater for irrigating park trees. The study results demonstrate that MVIK and entropy are capable of characterizing the spatiotemporal uncertainty of groundwater quality parameters and determining suitable parks of groundwater utilization for irrigation. Moreover, the upper, median and lower quartiles of hydrochemical parameters are served as three estimated thresholds in MVIK, which is robust to assessment predictions. Therefore, this study significantly improves the methodological application and limitation of MVIK for spatiotemporally analyzing environmental quality compared with the previous related works. Furthermore, the analyzed results indicate that 64 parks in this basin are recommended to use groundwater for irrigating trees. Most of the recommended parks are located in the central and northern foothill regions. The result findings can help government administrators establish a reciprocal plan of sustainable groundwater utilization and preserving excellent park landscapes in the Taipei Basin.

Keywords: Park; Irrigation; Groundwater; Uncertainty; Multivariate indicator kriging (MVIK); Entropy