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Optimization of the fuzzy matter element method for predicting species suitability distribution based on environmental data

Quanzhong Zhang, Haiyan Wei, Zefang Zhao, Jing Liu, Qiao Ran, Junhong Yu and Wei Gu
Shaanxi Normal University, China

Over the years, with the efforts of many researchers, the field of species distribution model (SDM) has been well explored. The model of fuzzy matter elements (FME), which, combined with GIS to predict species distribution, has received extensive attention since its emergence. Based on previous studies, this paper improved FME, extended the scope of the membership degree and habitat suitability index, and explored the unsuitable areas of species. We have enhanced the limitation effect of key variables on species habitats, making the operation of FME more consistent with biological laws. By optimizing the FME, it could avoid the accumulation of predicted errors with multi-variables, and make the predicted results more reasonable. In this study, *Gynostemma pentaphyllum* (Thunb.) Makino was

used as an example. The experimental process used several major environmental variables (climate, soil, and terrain variables) to predict the habitat suitability distribution of *G. pentaphyllum* in China for its current and future period, which includes the period of 2050s (average for 2041–2060) and 2070s (average for 2061–2080) under representative concentration pathways 4.5 (RCP4.5). The results of the analysis showed that the model performed well with a high accuracy by reducing the redundancy of the environmental data. The study could relieve the reliance on a large database of environmental information and propose a new approach for protecting the *G. pentaphyllum* in unsuitable areas under climate change.

Zhangqz@snnu.edu.cn