The application of Species Distribution Modeling for wetland restoration: A case study in the Songnen Plain, Northeast China

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Species distribution models (SDMs) are an effective tool for measuring and predicting plant response to climate change, but their application to wetland species has been relatively limited. Here, we investigate the application of SDMs to study the current and future delimitation of wetlands in the Songnen Plain, one of the densest areas of natural wetlands in China. Specifically, we focus on the iconic wetland species *Phragmites australis*, one of the dominant species in the Songnen plain, which has been widely used for wetland restoration efforts.

Our study has four main goals: (i) to test and improve the applicability of SDM in our study; (ii) to delimit wetland areas for prioritization; (iii) to investigate the projected change in wetland distributions under future climate change scenarios; and (iv) to identify regions that appear more (or less) stable in the face of change, and to propose areas for suitable restoration efforts with land-use.

To achieve our goals, we apply a broad variety of environmental variables using MaxEnt, to project present and future (2050s) suitable areas under two representative concentration pathways (RCP4.5 and RCP8.5). AUC (area under the curve) is used as the test measure for model evaluation. To obtain a rich representative sampling of this species' distribution, we use field-observational records from the National Science and Technology Fundamental Research Project “Investigation on Wetland Resource of China and Its Ecological and Environmental Benefits” (2013FY111800). In addition to exploring key abiotic parameters that influence *P. australis* distribution, we also explore the impact of different spatial resolutions (1 km², 250 m², 90 m², 30 m²) of topographic information to assess model performance.

Our results demonstrated that the performance of the MaxEnt projection of *P. australis* was excellent (AUC=0.922), and improved with the addition of soil, topographic and hydrological variables, but did not improve significantly with increased resolutions of topographic variables. Using the optimized model, we delimited 28,644 km² of suitable areas and 7,959 km² of highly suitable areas under current scenarios. The future model under RCP4.5 scenario predicted a 9.5% and 3.1% increase in the suitable and highly suitable areas, respectively. The model under RCP8.5 predicted a much smaller increase in suitable areas, and a slight reduction in highly suitable
habitat compared with the current scenario. Under both future scenarios, the geographic centers of potential habitat moved toward the southeast, with the mean latitude slightly rising. Finally, we delimited 2,364 km$^2$ of priority restoration areas under RCP4.5, including 152 km$^2$ of paddy field, 950 km$^2$ of dry field and 1,262 km$^2$ of saline-alkali land. The priority areas under RCP8.5 were smaller in all three land-use types.

Our study illuminates potential priority areas of the Songnen Plain for consideration in future wetland restoration efforts. For future research, we recommend more applications of SDMs with multiple species in wetland restoration, especially over larger scales and higher resolutions.