Assessing the impact of climate change on fungal pathogens and insect pests in wheat: A joint species distribution model approach.

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Ecosystems are complex systems in which species do not exist in isolation; they co-occur and interact among others via competition, predation, and facilitation. These ecological interactions are critical to the functioning of ecosystems and provide the basis for biodiversity. In the face of ongoing climate change, these ecological interactions are also expected to change, including economically important interactions, such as those between a crop and its multiple fungal pathogens and insect pests. Wheat is the world's most important staple crop, and it is threatened by a range of fungal pathogens and insect pests. Acknowledging and accounting for multi-species interactions remain a challenge for species distribution models. Joint Species Distribution Models (JSDMs) are a relatively new statistical approach for analyzing multiple coexisting species in an assemblage or community. By using JSDMs, we can better understand the global distributions and co-occurrence patterns of fungal pathogens and insect pests in wheat and predict how these threats may affect wheat in the future.

In our study, we used JSDMs to analyze the distributions of wheat, its fungal pathogens, and insect pests globally. We incorporated climate change scenarios into our analyses to make predictions about the future. Our analyses can identify potential shifts in the hotspots of wheat pathogens and pests, revealing co-occurrence patterns in agro-ecosystems that have important ramifications for optimal control strategies. Our results showed that the distributions of fungal pathogens and insect pests in wheat are influenced by a complex set of factors, including climate, crop management practices, and geographic location. We found that certain regions, such as Europe and South Asia, are particularly vulnerable to multiple fungal pathogens and insect pests. Our analyses also revealed that the co-occurrence patterns of fungal pathogens and insect pests in wheat are likely to change in response to climate change, with some regions becoming more favorable for pests and pathogens, while others become less so. Our study highlights the importance of considering multi-species associations in species distribution models to better understand the impacts of climate change on ecosystems and to develop effective control strategies for pests and pathogens. By analyzing together crop, pathogen, and pest distributions, our work provides a valuable tool for predicting the effects of climate change on agro-ecosystems and can help inform strategies for sustainable food production.