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Is the impact of climate change on desertification predictable?

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Desertification, as one of the gravest ecological and environmental problems in the world, is affected both by climate change and human activities. As the consequences of global warming, the temperature in global arid and semi-arid areas is expected to increase by 1-3□ by the end of this century. This change will significantly influence the spatial and temporal pattern of temperature, precipitation and wind speed in global arid and semi-arid areas, and in turn, ultimately impact the processing of desertification. Although current studies point out that future climate change tends to increase the risk of desertification. However, the future global or regional desertification risk under different climate change scenarios hasn't been quantitively assessed. In this paper, we focused on this question by building a new model to evaluate this risk of desertification under an extreme climate change scenario, i.e. RCP8.5 (Representative Concentration Pathways, RCPs). We selected the northern agro-pastoral ecotone in China as the study area, where is highly sensitive to desertification. Firstly, the risk indicators of desertification were chosen in both natural and anthropic aspects, such as temperature, precipitation, wind speed, evaporation, and population. Secondly, the decision tree C5.0 algorithm of the machine learning technique was used to construct the quantitative evaluation model of land desertification risk based on the database of the 1:100,000 desertification map in China. Thirdly, with the support of the simulated meteorological data by General Circulation Models of HadGEM2-ES, the risk of desertification in the agro-pastoral ecotone in the north China under the RCP 8.5 scenario and SSP3 scenario (Shared Socioeconomic Pathways, SSPs) were predicted. The results show that the overall accuracy of the C5.0-based quantitative evaluation model for desertification risk is up to 83.32%, indicating that the C5.0 can better distinguish the risk of desertification according to the status of desertification impacting factors. Under the influence of future climate change, the agro-pastoral ecotone in northern China was estimated to be dominated by mild desertification risk, covering an area of more than 70%. Severe and moderate desertification risk is mainly distributed in the vicinity of Hulunbuir sandy land in the northeast of Inner Mongolia and the Horqin sandy land in the junction between Inner Mongolia, Jilin and Liaoning provinces. Compared with the datum period, the risk of desertification will decrease under the RCP8.5-SSP3 scenario. However, the desertification risk in Hulunbuir sandy land and that in the northwest of Jilin province will increase. The results of this study provide a scientific basis for developing more effective desertification control strategies to adapt to climate change in the agro-pastoral ecotone in north China. More importantly, it shows that the desertification risk can be predicted under the different climate change scenarios, which will help us to make a better understanding of the potential trend of desertification in the future, especially when the earth is getting warmer.