The Classification of Grassland Types Based on Object-Based Image Analysis with Multisource Data

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The spatial distribution of different grassland types is important for effectively analyzing spatial patterns, obtaining key vegetation parameters using remote sensing (e.g., biomass, leaf area index, net primary production), and using and protecting grasslands. Existing classifications of grasslands by remote sensing are mostly divided according to the fractional vegetation cover or biomass, but classifications according to grassland types are scarce. In this study, we focused on the classification of different grassland types using remote sensing based on object-based image analysis (OBIA) with multitemporal images in combination with a 30-m digital elevation model (DEM) and the normalized difference vegetation index (NDVI). The grasslands were located in Hulunber, Inner Mongolia, and an autonomous region of China. The support vector machine (SVM) and random forest (RF) machine learning classifiers were selected for the classification. The results revealed the following: 1) It is feasible to generally extract different grassland types on the basis of OBIA with multisource data; the overall classification accuracy and Kappa value exceeded 90% and 0.9, respectively, using the SVM and RF machine learning classifiers, and the classification accuracy of the different grassland types ranged from 61.64% to 98.71%; 2) Multitemporal images and auxiliary data (DEM and NDVI) improved the separability of different grassland types. The information in the growing season was conducive for distinguishing temperate meadow steppe from temperate steppe and was favorable for extracting lowland meadow and swamp in the nongrowing season. The DEM and NDVI also effectively reduced the number of image segmentation objects and improved the segmentation effects; 3) Spectral and textural features were more important than geometric features in this study. A few main variables played a major role in the classification, while a large number of variables had either no significant effect or a negative effect on the classification results when the optimal feature subset was determined. This study provides a scientific basis and reference for the classification of various grassland types by remote sensing, including the data selection, image segmentation, feature selection, classifier selection, and parameter settings.

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Introduction

As an important component of the terrestrial ecosystem, grasslands serve important ecological and productive functions (Sun et al., 2016; Li et al., 2017; Dass et al., 2018) and include 400 million ha of various types in China that account for approximately 41.7% of the country’s total land area (Ren et al., 2008). The classification of grassland is a basic task in grassland science. Grassland type refers to grassland units with the same natural and economic characteristics in a certain time and space range. It is a highly abstract generalization of grassland plant populations in different habitats and the different combinations of these populations (DAHV and NAHVS, 1996). The classification of grassland types constitutes an important method for people to understand and research grassland and also forms the theoretical basis for the scientific development, rational utilization, and effective protection and cultivation of grassland.

Currently, two grassland classification systems are used widely in China (Lin et al., 2013; Lin and Zhang, 2013; Jin et al., 2014). The first scheme comprises 18 grassland types subdivided according to the plant habitats throughout China in the 1980s by the Ministry of Agriculture of the People’s Republic of China (DAHV and NAHVS, 1996). The second system, proposed by Ren et al. (2008), is the Integrated Orderly Classification System of Grassland, which is subdivided according to the bioclimatic, soil, and vegetation characteristics in 1980. However, both of these grassland classification systems describe the potential...