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Preliminary Research on Grassland Fine-classification Based on MODIS

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Abstract. Grassland ecosystem is important for climatic regulation, maintaining the soil and water. Research on the grassland monitoring method could provide effective reference for grassland resource investigation. In this study, we used the vegetation index method for grassland classification. There are several types of climate in China. Therefore, we need to use China's Main Climate Zone Maps and divide the study region into four climate zones. Based on grassland classification system of the first nation-wide grass resource survey in China, we established a new grassland classification system which is only suitable for this research. We used MODIS images as the basic data resources, and use the expert classifier method to perform grassland classification. Based on the 1:1,000,000 Grassland Resource Map of China, we obtained the basic distribution of all the grassland types and selected 20 samples evenly distributed in each type, then used NDVI/EVI product to summarize different spectral features of different grassland types. Finally, we introduced other classification auxiliary data, such as elevation, accumulate temperature (AT), humidity index (HI) and rainfall. China's nation-wide grassland classification map is resulted by merging the grassland in different climate zone. The overall classification accuracy is 60.4%. The result indicated that expert classifier is proper for national wide grassland classification, but the classification accuracy need to be improved.

1. Introduction

Grassland is essential to mediate the climate, maintain the soil and water beneath it and keep the ecosystem balanced. It is also one of the most important natural resources and a mainstay of the animal husbandry. Therefore, grassland has gained attentions for scientific use because of its important role in environment and economy.

Geographical Information System (GIS) and remote sensing provide an effective method to investigate and monitor grassland in a large area. For example, Jiang et al. (2007) developed a grassland degradation monitoring method based on single phase remote sensing data in northern China based on MODIS in 2003 [1]. Zhao et al. (2004) established the relationship between grass biomass and MODIS NDVI product. The result indicated that the established biomass estimation method has a better accuracy for the grassland where fractional vegetation cover is high, distribution is even and NPP value is high[2].



2. Research method

2.1. Technical process of grassland classification

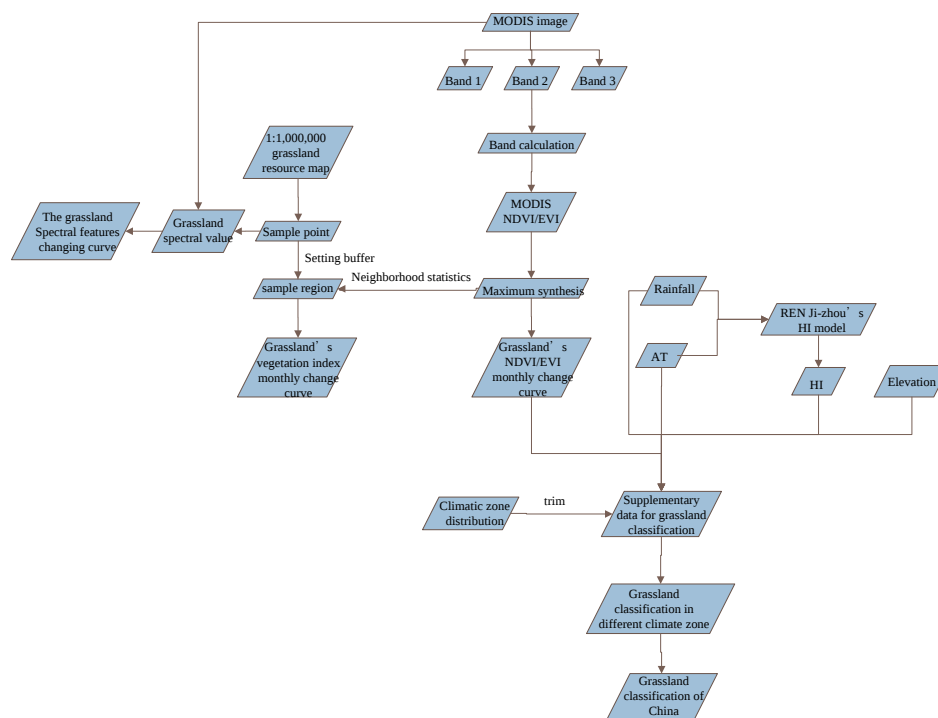


Figure 1. The technical process of grassland classification in China.

2.2. Climate zoning in China

Because grassland is affected by heat and water conditions, different types of grassland distributes in different climate zone. In this study, we used B W Huang [3] of climate zoning map of China, and merged the climate zone, and finally got the main climate zone distribution, as shown in figure 2.

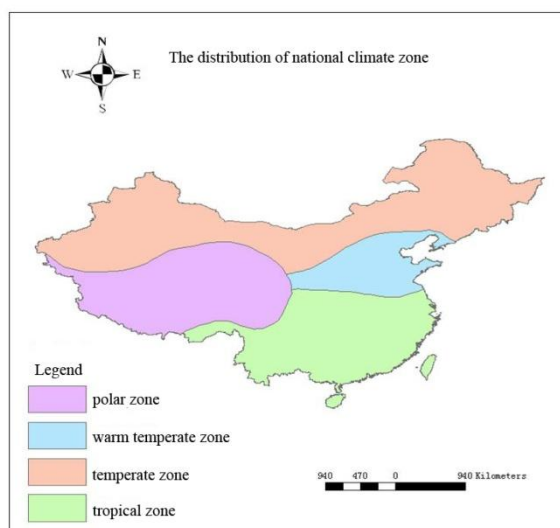


Figure 2. The distribution of national climate zone.

3. Data and grassland classification system

3.1. Grassland classification system

Take the first national survey of grassland resources classification system [4] as basis, make proper adjustment, the grassland classification system was generated as shown in table 1.

Table 1. Comparison between grassland classification system and first national survey of grassland resources classification system.

ID	grassland type	grassland type(First National Survey of Grassland Resource)
1	temperate meadow-steppe	temperate meadow-steppe
2	temperate steppe	temperate steppe
3	temperate desert-steppe	temperate desert-steppe
4	alpine meadow-steppe	alpine meadow
5	alpine steppe	alpine steppe & alpine meadow-steppe & alpine desert-steppe
6	alpine desert-steppe	alpine desert-steppe
7	mountain meadow	mountain meadow
8	warm-temperate tussock/shrub-tussock	warm-temperate tussock & warm-temperate shrub-tussock
9	warm-tropical tussock/shrub-tussock	tropical tussock & tropical shrub-tussock & scattered grassland

3.2. Research data

In our study, we are going to investigate national grassland classification method mainly based on MODIS NDVI/EVI. MODIS has a resolution of 250m, a scale suitable for nation-wide classification.

Table 2. data resources.

Name	Type	Time	Resolution	Method
MODIS NDVI	raster	2005	250m	$NDVI = (\rho_{nir} - \rho_{red}) / (\rho_{nir} + \rho_{red})$
MODIS EVI	raster	2005	250m	$EVI = 2.5(\rho_{nir} - \rho_{red}) / (\rho_{nir} + C_1\rho_{red} - C_2\rho_{blue} + L)$

Based on the 1:1,000,000 Grassland Resource Map of China, we generated 20 samples evenly distributed in each grassland area. In order to avoid the influence of the outlier, we built a 10-km circle buffer around the sample point and calculated the mean MODIS NDVI and EVI value within each buffer area, then used NDVI/EVI product to summarize different spectral features of different grassland types. All data in this study used same spatial reference and with same spatial resolution.

As the vegetation index can't distinguish every type of grassland, we took advantage of elevation, accumulative temperature(AT), humidity index(HI) and other auxiliary data, including elevation, rainfall and moisture degree index [6].

3.3. Grassland classification method according to different climate zone

3.3.1. Grassland classification in temperate zone

Temperate climate zone is mainly located at north China[3]. In this climate zone, the predominant types are: mountain meadow, temperate meadow steppe, temperate steppe, temperate desert steppe, alpine steppe and alpine meadow steppe.

The following 4 figures demonstrated that the NDVI of mountain meadow is high (0.45~0.87) while others are low in May, for example, NDVI of temperate meadow steppe is 0.26 to 0.56. In the overlap region (0.45-0.56), we used AT and HI to distinguish them. Alpine meadow steppe's EVI is greater

than 1 in July, while alpine steppe's EVI is lower than 1. We can also distinguish temperate steppe and temperate desert steppe in the similar way.

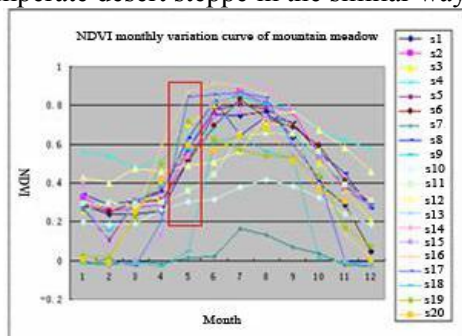


Figure 3. NDVI monthly variation curve of mountain meadow.

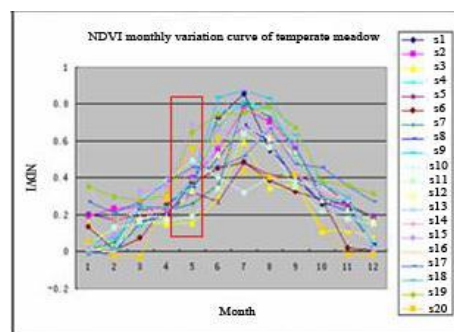


Figure 4. NDVI monthly variation curve of temperate meadow.

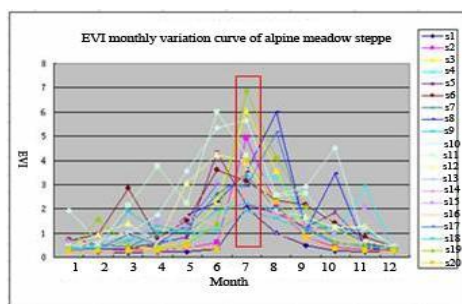


Figure 5. EVI monthly variation curve of alpine meadow steppe.

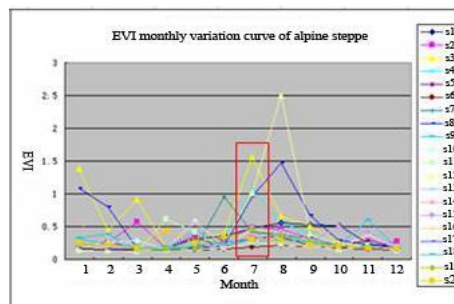


Figure 6. EVI monthly variation curve of alpine steppe.

In summary, we can get the grassland classification of temperate zone, as figure 11 shows.

3.3.2. Grassland classification in polar zone

Polar climate zone are mainly located in Tibet [3], Qinghai and Qilian Mountain area of Gansu province. In this area, the predominant types are mountain meadow, alpine steppe, alpine meadow steppe, alpine desert steppe, temperate steppe and temperate desert steppe.

As temperate climate zone, mountain meadow has greater NDVI than other grassland types in May. The EVI of alpine steppe is greater than 0.23 while alpine desert steppe is lower than 0.23 in August. The EVI of temperate desert steppe is greater than 0.3 while temperate steppe is lower than 0.3.

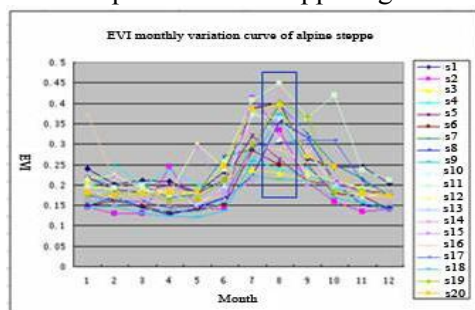


Figure 7. EVI monthly change curve of alpine steppe.

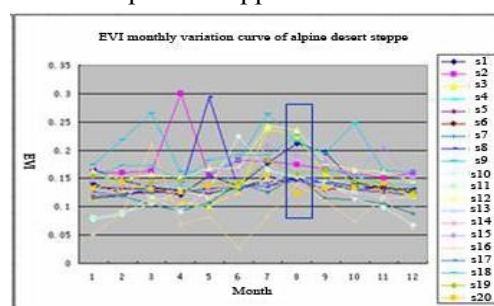


Figure 8. EVI monthly change curve of alpine desert steppe.

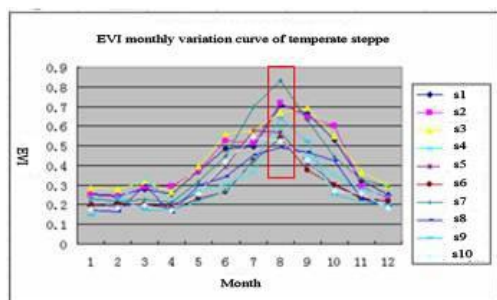


Figure 9. EVI monthly variation curve of temperate steppe.

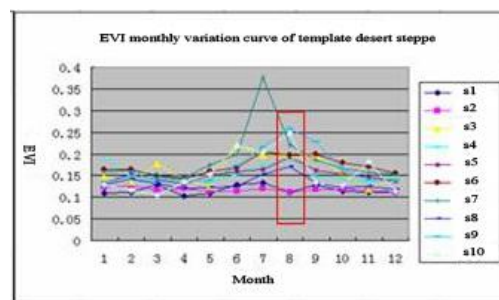


Figure 10. EVI monthly variation curve of template desert steppe

In summary, we can get the grassland classification of polar zone, as figure 12 shows.

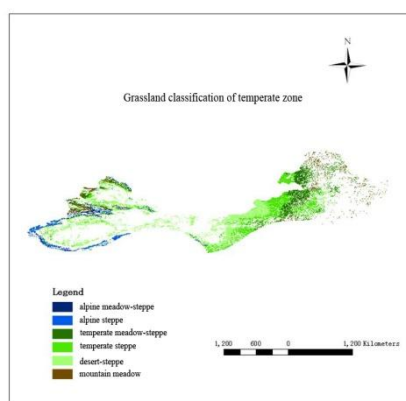


Figure 11. Grassland classification of temperate zone.

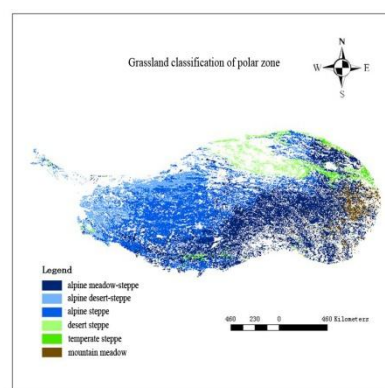


Figure 12. Grassland classification of polar zone.

3.3.3. Grassland classification in warm template zone

Warm template zone is located mainly in North China[3]. The predominant types are warm-temperate tussock/shrub-tussock, mountain meadow, template meadow steppe and template steppe.

We can see from these following figures, the NDVI of warm-temperate tussock/shrub-tussock ranges from 0.63 to 0.92 in July, while NDVI of temperate meadow-steppe ranges from 0.42 to 0.89. Because the moisture of temperate steppe is less than other grass types, it's easy to separate it from others. Mountain meadow is mainly distributed in the 200-2300 meters height, and the others are distributed in slightly lower elevation.

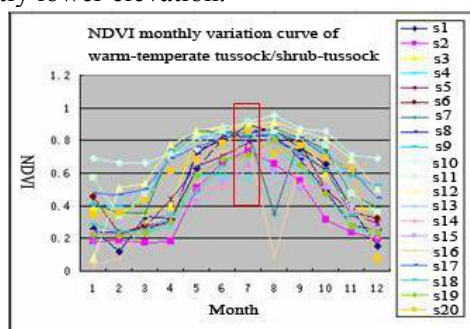


Figure 13. NDVI monthly variation curve of warm-temperate tussock/shrub-tussock.

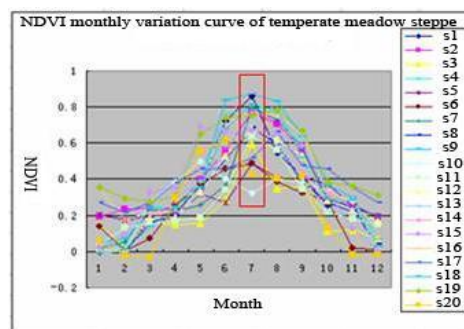


Figure 14. NDVI monthly variation curve of temperate meadow steppe.

In summary, the grassland classification of warm temperate zone was generated as shown in figure 15.

3.3.4. Grassland classification in tropical zone

Tropical climate zone covers most of southern China [3]. The temperature is high all the year, the annual rainfall is rich, so there's a high HI in this climate area. The predominant types are warm shrub tussock, mountain meadow, tropical shrub tussock and alpine meadow steppe.

The classification rules for tropical grassland were demonstrated in table 3.

Table 3. Knowledge of grassland classification in tropical zone.

Type	NDVI	elevation	humidity index	Accurate temperature
alpine meadow-steppe	NDVI<0.35 in June	3800-5400		
warm-tropical tussock/shrub-tussock		<3000	>700	>4000
warm-temperate tussock/shrub-tussock		<3500	540-800	
mountain meadow		2000-5500		

In summary, we can get the grassland classification of tropical zone, as figure 11 shows.

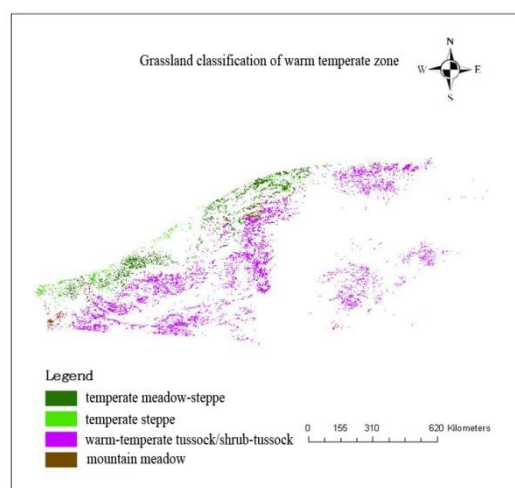


Figure 15. Grassland classification of warm temperate zone.

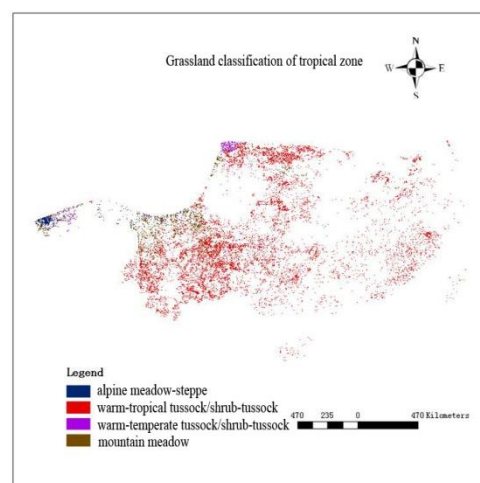


Figure 16. Grassland classification of tropical zone.

4. Classification result and accuracy evaluation

4.1. China's grassland classification result

By integrating the classification results in all climate zones, we generated China's grassland classification result in figure 17.

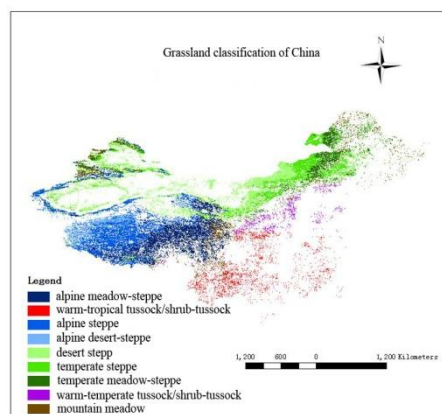


Figure 17. Grassland classification of the whole country.

4.2. Evaluation of Classification accuracy

In this paper, we use simple random sampling method to select samples in 1:1,000,000 grassland resource map as the main reference to evaluate the accuracy of the classification result. Some field samples were also used to evaluate the classification result.

The evaluation result indicates that the overall classification accuracy is 60.4%, Kappa coefficient is 0.61. The classification accuracy of each grassland type varies from 52% to 73%. Classification accuracy for temperate steppe was the best, temperate meadow steppe and lowland meadow were the worst. There is no obvious difference among 10 types of grassland.

5. Conclusion

The result suggests that our method is appropriate for China's nation-wide grassland classification, but the classification accuracy is not very high. The first possible reason was related to the 1:1,000,000 grassland resource map. This map was based on China's first nation-wide grass resource survey which carried out from 1980 to 1991. There is time gap of more than 10 years between MODIS NDVI/EVI product in 2005 and the grassland resource map. Secondly, our classification method needs to be improved to increase the classification accuracy, for example, higher spatial resolution remote sensing data can be used for classification.

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