CHINESE NATIONAL FOREST TYPES IDENTIFICATION METHOD USING FY-3A MERSI DATA

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Abstract: Forest distribution mapping is one of the direct comprehensive reports of the achievement in forestry survey. To developing the application method in Chinese forestry management and generating Chinese forest cover distribution map at national scale with 250 meter spatial resolution, based on the analyzing results of related bands of FY3A-MERSI by using typical sample, three forest cover mapping methods, including unsupervised classification method (UC), decision tree classification method (DC), and stratified classification method of combining the unsupervised classification result method (SC), have been applied using time series ten days NDVI data of year 2009 of China, which have been generated by using Maximum VI Value Composite (MVC) method. The validation results show that the overall accuracy of UC, DC and SC is 58.30%, 77.46%, and 86.14% respectively. Their Kappa coefficient is 0.5289, 0.7419, and 0.8427 in turn. It shows that the precision and Kappa coefficient of SC is best than other selected two methods.

INTRODUCTION

Forest vegetation, as a part of the landscape, represents an important natural resource for mankind and other living organisms. Currently, the forestry sector is being considered an appropriate option for limiting green house gases (GHG) concentration in the atmosphere. Deforestation has a great impact on global or regional carbon emissions or uptakes, and is thus of concern to scientists and policy-makers around the world. Previous research on global carbon stocks showed that 55% of global net carbon flux during the period 1850-2000 is from tropical region due to forest cover changes (Achard et al. 2004). Meanwhile, it is also possible to mitigate climate change through conserving existing forests, expanding carbon sinks, substituting wood products for fossil fuels and reducing emissions from deforestation and degradation (known as the REDD mechanism). REDD is an instrument that could reward countries with carbon credits for preserving their forest cover. Under the recent initiative, known as Forest Carbon Partnership Facility (FCPF), 14 developing countries will receive grant support as they build their capacity for REDD through measure including establishing emissions reference levels, adopting strategies to reduce deforestation and designing monitoring systems (DeFries et al., 2007; Vogelmann et al. 2009). Therefore, determining the types and quantifying the extent of forest vegetation, and understanding forest cover and its changes are important for resource management and issues regarding climate change.

At present, there are many classification methods, which can be summarized as supervised classification and unsupervised classification (such as, Zhan, et al., 2000; Liu et al., 2005; Liu et al., 2010; You, et al., 2010). With the development and application of remote sensing technology in the land use/land cover monitoring, the development of classification methods shows three trends. One is using multi-source data to improve classification accuracy and timeliness. One is using comprehensive application expertise and geological knowledge classification, and the other is using object-oriented classification method.

To get the method of Chinese national forest map identification, the 250m FY-3A Medium Resolution Spectral Imager (FY-3A MERSI) data have been selected and compared the results by using the three kinds of classification methods.

1. STUDY AREA AND DATASETS

1.1 Study Area

The country of China was selected as the study area. It locates between 73º40’E to 135º2’30” E and 3º52’N to 53º33’N. The climate includes cold-temperate, temperate, sub-tropical and tropical zone from the Northeast to the South of China. The forest of China is mainly distributed in the northeastern, southwest and south region.

1.2 Datasets

Fengyun-3 (FY-3) satellite is the 2nd generation Polar Orbiting Meteorological Satellite Series of Chinese meteorological satellite. FY 3A and FY 3B have been launched in year 2008 and year 2010 respectively. The sensor of Medium Resolution Spectral Imager carried by FY3A/B (FY3A/B-MERSI), both of them have twenty channels, their spectral range vary from 0.41-12.5 μm. There are five channels with 250 meter spatial resolution. Their center wavelength is 0.470, 0.550, 0.650, 0.865, and 11.50μm respectively (Zhang, et al., 2009). The five bands with 250m spatial resolution have been selected to monitor the vegetation greenness in the experimental area. The characters and useful of selected FY3A-MERSI bands have been listed in Tab. 1.

Table 1: Characters and useful of the selected FY-3A MERSI channels

Channel	Center wavelength (μm)	Spatial resolution (m)	NEΔT	Dynamic range	Purpose
1	0.470	250	0.45	100%	Calculating EVI
3	0.650	250	0.4	100%	Calculating NDVI and EVI
4	0.865	250	0.45	100%	Calculating NDVI and EVI
5	11.25	250	0.54 K	330 K	Cloud flag

2. METHODS

2.1 Flowchart of process

The general classification processing has been shown in Fig. 1.

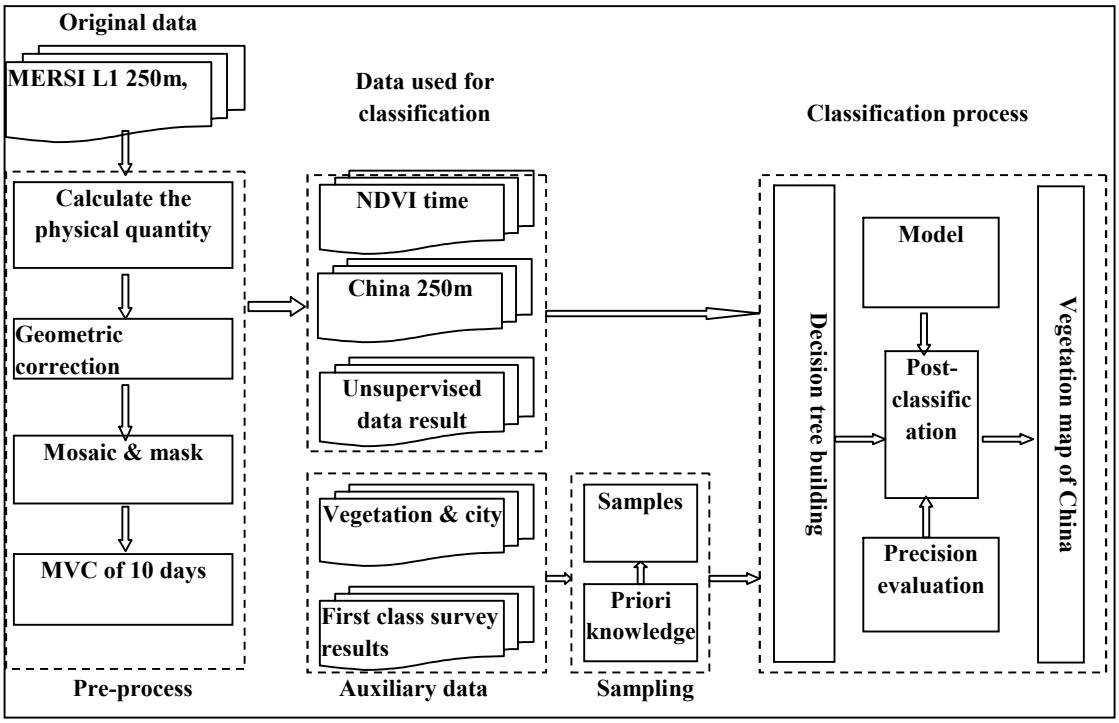

Figure 1: Flowchart of Vegetation Identification using MERSI L1 data

2.2 Classification system design

This Chinese national forest type classification system has been designed based on the land cover classification system (LCCS) and the characters of FY3A-MERSI NDVI images. It has been shown in Tab. 2.

Table 2: Chinese national vegetation types system using FY3A-MERSI

No.		Class name	Abbreviation
1		Evergreen needle leaf forest	ENF
2		Evergreen broadleaf forest	EBF
3		Deciduous needle leaf forest	DNF
4	Forest	Deciduous broadleaf forest	DBF
5		Mixed forest	MF
6		Bamboo	Bamboo
7		Shrub	Shrub
8	Non-Forest	Grass	Grass
9		Crop	Crop
10		Urban and built-up	UB
11		Water	Water
12		Other	Other

2.3 Unsupervised classification Method

The ISODATA algorithm has been selected to classify the with the 23 ten-days' MERSI NDVI images of year 2009.The iterative calculation was set 30 times, and generation 50 level. At the end, 12 types have been assigned according to the reference (such as 1:1000000 national vegetation types map, the eighth survey data, and the city distribution map, etc.) and classification system.

2.4 Decision tree classification method

The decision tree had been designed using different parameters of images. The selected parameters for decision tree classification have been showed in the Tab. 3. The Main process based on the knowledge of the expert decision tree classification has been shown in Fig. 2.

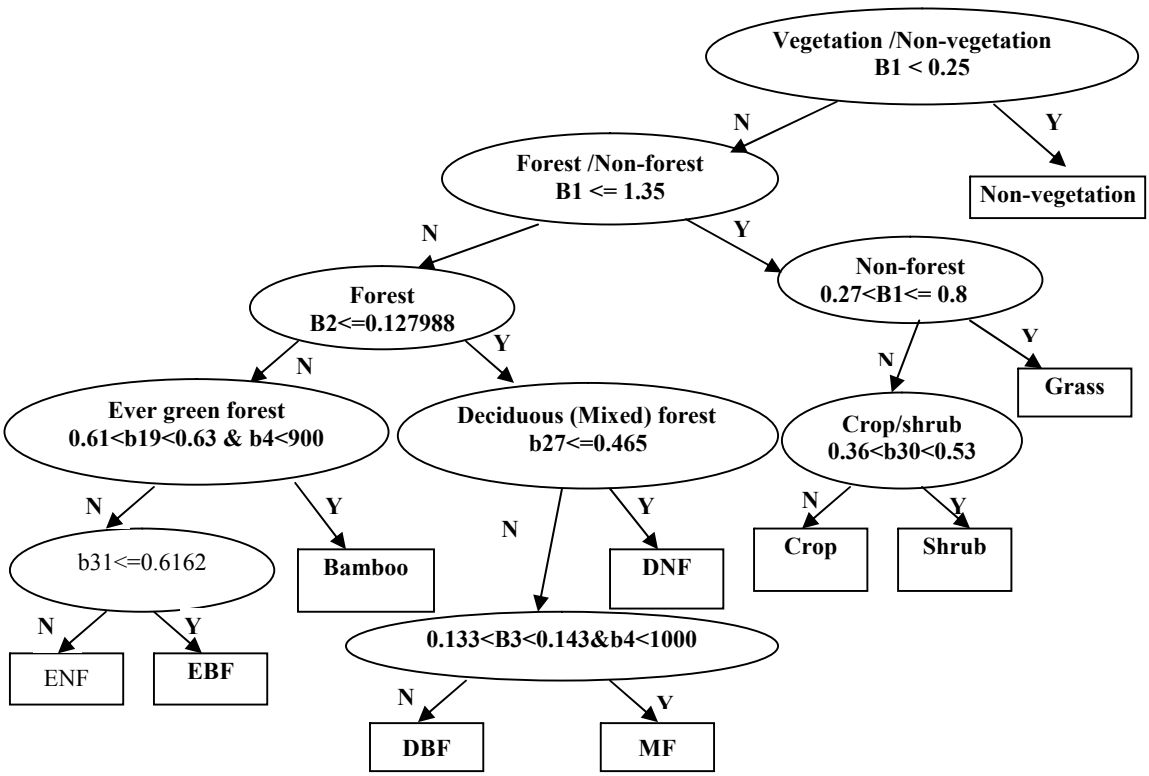

Figure 2: Main process based on the knowledge of the expert decision tree classification

Table 3: The selected parameters for decision tree classification

No.	Bands	Corresponding images
1	B1	1st PCA
2	B2	2nd PCA
3	B3	3rd PCA
4	b4	China digital elevation model image
5	b19	Early July NDVI image
6	b27	Late September NDVI image
7	b30	Late October NDVI image
8	b31	Early November NDVI image
9	b8	Mid-March NDVI image
10	b11	Mid-April NDVI image
11	b15	Late May NDVI image
12	b17	Mid-June NDVI image
13	b18	Late June NDVI image
14	b36	Late December NDVI image

2.5 Stratified classification method

The stratified classification method just supposes there are different characters among the different land cover /land use, which can be used to distinguish the objects from the background images. Based on the result of unsupervised method and the analysis of sample, the flowchart of stratified classification method has been designed in Fig. 3. The selected parameters for the stratified classification method have been listed in Tab. 4.

Table 4: The selected parameters for the stratified classification method

No.	Bands	Corresponding image
1	B1	1st PCA
2	B2	2nd PCA
3	B3	3rd PCA
4	b4	China digital elevation model image
5	b15	Late May NDVI image
6	b19	Early July NDVI image
7	b27	Late September NDVI image
8	b30	Late October NDVI image
9	b31	Early November NDVI image
10	b37	Unsupervised classification result

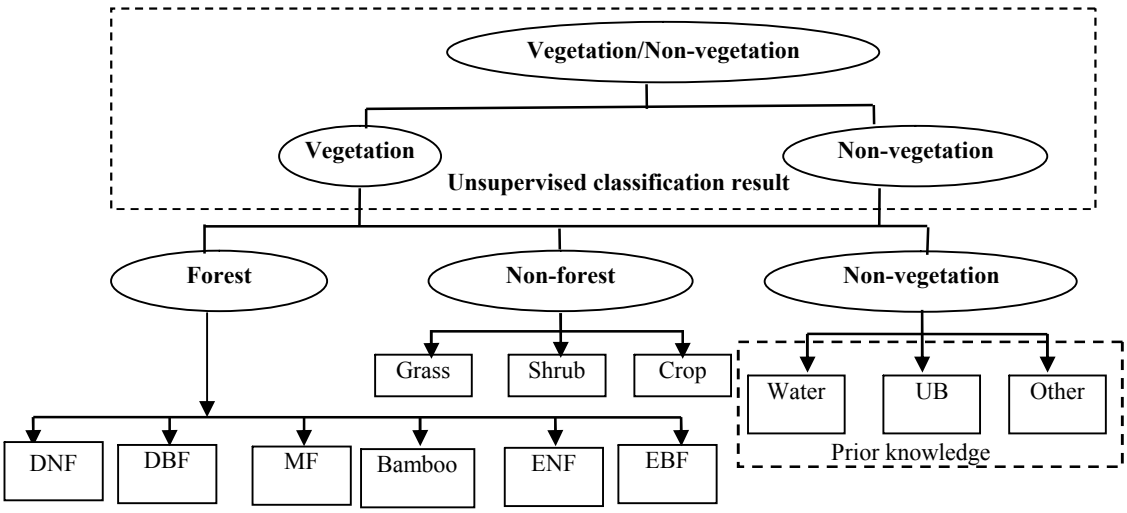

Figure 3: The flowchart of stratified classification method

3. RESULTS AND DISCUSSION

3.1 Results

Based on the method described as section '2.3, 2.4 and 2.5', the Chinese national forest types had been identified using the three classification methods. The forest mapping result has been listed as Fig. 4.

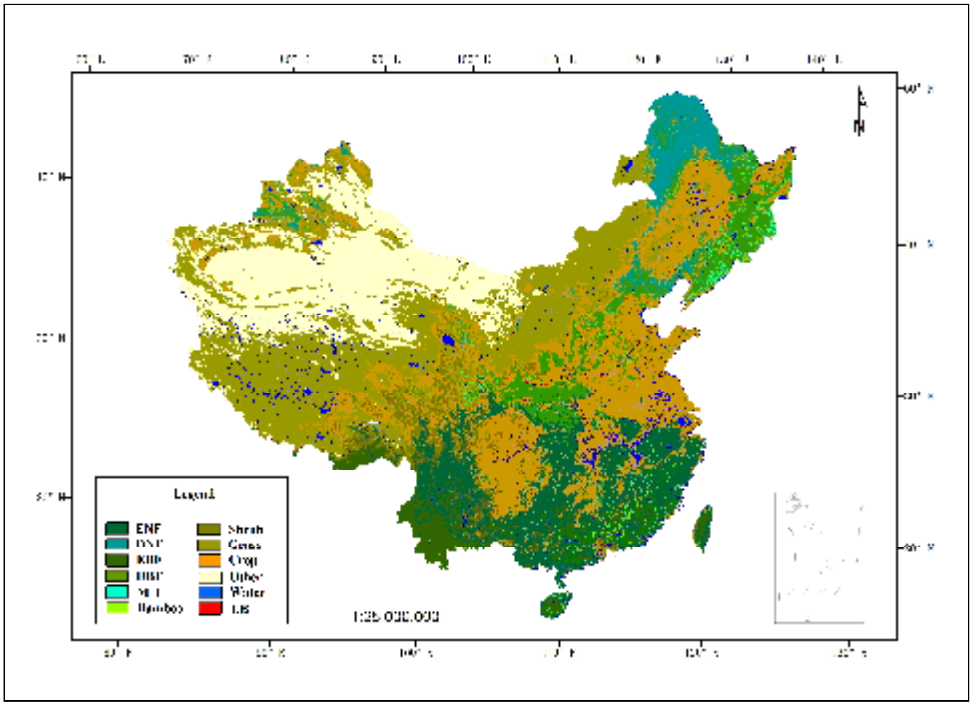

Figure 4: The results of stratified classification method

3.2 DISCUSSION

The overall classification accuracy, Kappa coefficient, production accuracy and user accuracy of all types by using the three kinds of classification method have been analyzed. The results have been shown in Tab. 5.

Table 5: Precision assessment by using the three types of classification methods

Index	**Unsupervised classification method**		**Decision tree classification method**		**Stratified classification method**	
Overall accuracy%	58.29		77.46		86.14	
Kappa coefficient	0.5289		0.7419		0.8427	
	Production accuracy %	User accuracy %	Production accuracy %	User accuracy %	Production accuracy %	User accuracy %
ENF	63.51	58.6	84.32	75.36	93.78	73.36
DNF	75.84	88.75	60.52	75.16	75.84	80.89
EBF	99.77	63.36	84.83	92.02	90.34	91.4
DBF	68.1	99.52	77.19	83.69	89.09	80.33
MF	83.75	38.95	1.25	100	5	20
Bamboo	20.65	63.33	5.43	55.56	4.35	40
Shrub	35.36	31.33	7.5	51.22	91.07	83.06
Grass	46.54	44.56	98.04	81.26	91.12	89.14
Crop	83.61	66.35	87.11	56.26	88.31	85.33
Other	16.35	47.83	77.92	98.92	82.59	97.98
Water	14.33	15.64	99	99.66	99	99.66
UB	28.46	32.17	99.23	97.73	99.23	97.73

Comparing the results of the three kinds of vegetation type classification method (Tab. 5), it showed that the overall accuracy is 58.29%, and Kappa coefficient is 0.5289 by using the unsupervised classification method; the overall accuracy is 77.45%, and Kappa coefficient is 0.7419 by using the decision tree classification method; and the overall accuracy is 86.14% and Kappa coefficient is 0.8427 the stratified classification method. It showed that the overall accuracy and kappa coefficient by using the Stratified classification method are highest precision than the other two methods'.

At the same times, the relative production accuracy and user accuracy are highest by using Stratified classification method than that of the other selected methods except for MF and bamboo. One reason is that the reference data and images for sampling have eight years of time gap exists in the distribution of vegetation changes that lead to the selected sample point misunderstood. One reason is that Bamboo is evergreen vegetation, peripheral often distribution evergreen needle leaves forest and evergreen broadleaves forest, so more difficult to distinguish between bamboo and the surrounding evergreen forest vegetation types. The other reason is many pixels in 250 m spatial resolution images include mixed land cover information, especially for the mixed forest.

4. CONCLUSION

To get the method of Chinese national forest types identification by using the 250m FY-3A Medium Resolution Spectral Imager (FY-3A MERSI) data, three kinds of classification methods have been used. The results showed that the overall accuracy and kappa coefficient by using the Stratified classification method are highest precision than the other two methods'.

However, due to the influence of topography, climate condition, 'things with different spectrum' phenomenon and the 250 m spatial resolution images, the classification precision have been restricted. At the same time, the production accuracy and user accuracy of MF and bamboo are lowest production by using Stratified classification method than that of the other methods. So, more works should be done to improve the precision in further. At the same times, it should be test whether the Stratified classification method is suitable for the forest mapping of Asia-Pacific region in future.

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