COMPARISON OF NEEDLELEAF EVERGREEN FOREST AND NEEDLELEAF DECIDUOUS FOREST IN THE GLCNMO WITH IGBP DISCOVER AND GLC2000

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1. INTRODUCTION

Global land cover maps are used in the numerical models that estimate ecosystem behavior, water cycle and climate at the global scale. Within the past decades, multiple global land cover maps were produced, such as IGBP DISCover product [1], the MODIS land cover product [2] and Global Land Cover 2000 product [3]. They were all derived from remotely sensed data with moderate resolution. Global Mapping Project has produced a new 1km global land cover map Global Land Cover by National Mapping Organizations (GLCNMO) [4]. In the GLCNMO, 16-day composite MODIS data of the year 2003 were used as source data. Accuracy assessment of GLCNMO was completed by a stratified random sampling method and its categorical accuracies were calculated [5]. A total of 600 random sampling pixels were used for the accuracy assessment. The overall accuracy derived from the confusion matrix is 76.5%. In the categorical accuracies, needleleaf deciduous forest has a lowest user's accuracy of 50.0% and 7 sampling pixels out of 30 are misclassified into needleleaf evergreen forest. Needleleaf evergreen forest also has a lower user's accuracy of 68.5% and 4 sampling pixels out of 30 are misclassified into needleleaf deciduous forest. Both of the needleleaf evergreen forest and needleleaf deciduous forest play the important roles on the uptake of Carbon Dioxide (CO_2). However, because the dormant period of needleaf evergreen trees are shorter than that of deciduous trees, needleleaf evergreen forest makes a greater contribution to the absorption of CO_2 [6]. Correctly classified needleleaf evergreen forest and needleleaf deciduous forest are very useful for estimating the total absorbing amount of CO_2 and for analyzing the ecosystem balance. In this study, needleleaf evergreen forest and needleleaf deciduous forest in the GLCNMO were classified again and the accuracy improvement for GLCNMO was realized. The classification result was also compared with IGBP DISCover and GLC2000.

2. GLOBAL LAND COVER PRODUCT-GLCNMO

The GLCNMO is a global land cover map with 1km spatial resolution. The main source data used for GLCNMO is MODIS/TERRA Nadir BRDF- Adjusted Reflectance 16-DAY L3 Global 1 KM SIN Grid Product (MOD43B4 NBAR). Seven spectral bands and NDVI patterns of MODIS 2003 were used. GLCNMO consists of 20 land cover classes defined by Land Cover Classification System (LCCS). Maximum likelihood method, which is one of the supervised classification techniques, was mainly used for classification. 14 classes out of 20 were classified by Maximum likelihood method and the rest of 6 classes Water, Snow/ ice, Urban, Wetland, Mangrove and Tree open were classified independently because of the complicated characteristics of the data [7]. Land cover legend of the GLCNMO is shown in the Table 1.

Table 1. Land cover legend of the GLCNMO

GLCNMO code	Class name	GLCNMO code	Class name
1	Broadleaf evergreen forest	11	Cropland
2	Broadleaf deciduous forest	12	Paddy field
3	Needleleaf evergreen forest	13	Cropland / other vegetation mosaic
4	Needleleaf deciduous forest	14	Mangrove
5	Mixed forest	15	Wetland
6	Tree open	16	Bare Area, consolidated (gravel, rock)
7	Shrub	17	Bare Area, unconsolidated (sand)
8	Herbaceous	18	Urban
9	Herbaceous with sparse tree / shrub	19	Snow / ice
10	Sparse vegetation	20	Water bodies

3. METOHODLODY

Needleleaf forest is predominantly in two great continental belts, one in North America and one in Eurasia. For this reason, North America and Eurasia were selected for the classification of needleleaf evergreen forest and needleleaf deciduous forest in the GLCNMO. In the new classification process, other eighteen classes were masked. Forest Cover Type developed by the National Atlas of the United States of America and Forest Map of the USSR for the year 1990 developed by Central Administrative Board of Geodesy and Cartography of the Ministerial Council of the USSR were used for training data collection. 4 pure training sites for needleleaf evergreen forest and 4 pure training sites for needleleaf deciduous forest were collected for North America. And 3 pure training sites for needleleaf evergreen forest and 4 pure training sites for needleleaf deciduous forest were collected for Eurasia. The parameters that make the categorical accuracies of needleleaf evergreen forest and needleleaf deciduous forest low are considered to be the seasonal affection and the threshold of NDVI selected for classification. For this reason, MODIS NDVI monthly changed patterns were made for all the 15 pure training sites. From the NDVI patterns MODIS data of October 16 were chosen in both areas.

4. RESULT

MODIS data of October 16 were chosen because the difference of needleleaf evergreen forest and needleleaf deciduous forest is the biggest. According to the difference, the NDVI thresholds were set for classification in North America and Eurasia respectively. After several times validation the best two thresholds were selected for classification. That is when the threshold of NDVI pattern is 0.31 in North America and the threshold of NDVI pattern is 0.36 in Eurasia. Finally the new GLCNMO with improved accuracy of needleleaf evergreen forest and needleleaf deciduous forest was derived.

5. COMPARISON

Needleleaf evergreen forest and needleleaf deciduous forest in the GLCNMO were compared with that in the IGBP DISCover and the GLC2000 qualitatively and quantitatively. All the three maps are global 1km resolution land cover products. They are classified by different classification systems. The IGBP DISCover was classified by IGBP classification scheme [1], while the GLC2000 [3] and the GLCNMO were classified by LCCS. However, in all three products there are corresponding classes of needleleaf evergreen forest and needleleaf deciduous forest [8]. For comparison, other classes except for needleleaf evergreen forest and needleleaf deciduous forest were masked out. Three types of comparisons were made. They are areal, per-pixel and the ground truth data based comparison [9]. In the areal comparison, GLCNMO shows the most areal total for needleleaf evergreen forest, while IGBP DISCover shows the most areal total for needleleaf deciduous forest. In the per-pixel comparison, agreement and disagreement for two classes were estimated in the three maps. Central parts have more agreements in the three maps, while in the edge zone they are much different. In the ground truth data based comparison, because the big volume of data it is difficult to compare at the global range. For the preliminary comparison, western part of North America was selected. Forest Cover Type developed by the National Atlas of the United States of America was used for ground truth data. The result shows that the DISCover map has more needleleaf deciduous forest and compared with the ground truth data it is over extracted. GLC2000 map has more needleleaf evergreen forest and compared with the ground truth data it is over extracted.

6. CONCLUSIONS

Land cover maps derived from the remote sensing data are simple attempts to represent what actually exists in the world, but they are never completely accurate. There are many reasons lead to errors. It is difficult to modify the errors caused by the data themselves. However, it is possible to do some technical improvements in the classification process. This study concentrates the errors caused by the classification methods. The accuracy of GLCNMO was improved mainly by decreasing the error caused between the similar classes. The results proved that this is just one part of the improvement for the map. For further study, it is necessary to improve the overall accuracy of the map. In order to achieve this purpose, the heterogeneous classes should be the focus of consideration.

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