Potential of SAR and Optical Image Fusion for the Improvement of Forest Biomass Estimations

Chai Hock Choi[1], Md. Latifur Rahman Sarker[1,2,*], Janet E. Nichol[3]
[1] Department of Geoinformation, Universiti Teknologi Malaysia, Johor Bahru, Malaysia
[2] Department of Geography and Environmental Studies, University of Rajshahi, Bangladesh
[2] Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Kowloon, Hong Kong

The increasing rate of the carbon dioxide (CO_2) concentration in atmosphere has been identified as main factor of global warming and climate change. Forest is one of an effective and inexpensive ways for decreasing the concentration of CO_2 in the atmosphere due to its natural ability to store/sequester CO_2 as biomass. Therefore, an accurate estimation of forest biomass is necessary for monitoring the global carbon cycle and climate change. Hence, this study is investigated the potential of combined use of the SAR and optical image for the forest biomass estimations in Hong Kong forest area. Data from the SPOT-5 and ALOS PALSAR were used and different image fusion techniques such as Intensity Hue Saturation (IHS), Principal Component Analysis (PCA) and Wavelet Transformation (WT) were investigated in order to improve the accuracy of the forest biomass estimation. The relationships between field forest biomass (30 sampling plots, biomass ranging from ca. 50t/ha to 350t/ha) and remote sensing parameters from the different kinds of image fusion techniques and image combinations were established using simple least square regression model as well as stepwise multiple regression models. All models were validated using 16 independent sample plots.

The results showed that fusion of SAR and optical data has a potential to improve the accuracy of the forest biomass estimation, however, not all images fusion techniques significantly improved the accuracy of biomass estimation. Using the simple regression model, a better estimation accuracy (r^2 = 0.75) was obtained from the PCA image fusion method compared to the accuracy (r^2 = 0.50) obtained using the original data. Although little increase of the estimation accuracy was also observed using IHS image fusion method (r^2 = 0.55), WT fusion method was unable to improve the estimation accuracy probably because of the simple WT algorithm was used for this study. However, further improvement of the accuracy of forest biomass estimation was observed using multiple regression model, where the highest accuracies (r^2) of 0.77, 0.59, and 0.69 were obtained from the fusion methods of PCA, IHS and WT respectively. This result clearly states that image fusion of optical and SAR data has the capability to improve the forest biomass estimation and approximately 77% accuracy can be obtained for the biomass range up to 350t/ha.

Keywords : forest biomass estimation; SPOT-5; ALOS PALSAR; PCA; IHS

*Corresponding author. Tel.: +60 075530959/01115158825.
Email address : sarker@utm.my.