COMPARISON OF THREE INDIRECT FIELD MEASURING METHODS FOR FOREST CANOPY LEAF AREA INDEX ESTIMATION

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1. INTRODUCTION

Leaf Area Index (LAI) is a key canopy structural parameter of forest ecosystem. Global or regional vegetation LAI derived from remote sensing data requires the validation datasets from LAI field measurement. Because of the complicated terrain and changeable weather, it is very difficult to do forest LAI measurement in field. Therefore, to have the effective method for rapid, simple and reliable LAI measurement is needed urgently. At present, there are a variety of instruments used for forest canopy LAI measurement[1], however, the results using these instruments are different because of their different measure principles and suitable measuring environmental conditions. Therefore, in forest quantitative remote sensing study, it is significant to assessment of the consistency and uncertainty between these instruments. In this paper, taking 36 typical sample plots of forest canopy in China as our study sites, we compared and analyzed the Effective Plant Area Index (PAIe) of forest canopy measured and estimated by TRAC, LAI-2000 and Digital Fisheye Camera . And the uncertainty of the results is given. Furthermore, the method of minimizing overall standard error is adopted to obtain the PAIe of each sample plot for reference. This approach for having the ground truth PAIe measured in field is also validated by using computer simulated wide-angle viewing pictures.

2. MATERIALS AND METHOD

2.1 Study sites

The study sites with 36 typical sample plots of forest canopy are located in three different areas in China. The first study site is located in Dayekou in Gansu province. Dayekou is located in Heihe river basin and mostly covered by forest and upland meadow. This study site includes 30 sample plots dominated by Qinghai spruce. The second study site is located in Haidian Park in Beijing including 3 sample plots. These sample plots are planted forests of poplar, willow and silver chain, respectively. The third study site is located in Baoding in Hebei province including 3 sample plots. The species of planted forests in these sample plots are poplar, peach and silver chain, respectively.

2.2 Data

In Dayekou study site, the measuring data of each sample plot is obtained by one TRAC, one NIKON D80 Fisheye Camera and two LAI-2000 units with different sampling methods[2]. In Haidian Park study site and Baoding study site, the measuring data of each sample plot is obtained by one TRAC and one LAI-2000.
Data from TRAC are downloaded and processed using the provided software TRACWin. And the estimated results from TRACWin include PAIe, LAI and clumping index of the forest canopy[3]. Data files from the LAI-2000 are downloaded and also processed using provided software FV2000[4]. Only estimated PAIe can be obtained by using the software. The digital fisheye images are processed with software CAN_EYE which can calculate PAIe of vegetation out from fisheye images[5]. In our paper, the PAIe derived from these instruments are called TRAC PAIe, LAI-2000 PAIe and CAN_EYE PAIe, respectively.

2.3 Method

Based on the results of forest canopy PAIe estimated from LAI-2000, the effect of the 5th ring measurement of LAI-2000 on the result is analyzed, because it takes lager viewing angle and may bring more information and uncertainty for the estimation. And PAIe calculated by CAN_EYE in different zenith angles are compared. CAN_EYE PAIe of different sampling methods are also compared. Moreover, the estimated results from LAI-2000 and TRAC are compared. And PAIe from LAI-2000 and CAN_EYE PAIe are contrasted. Furthermore, the uncertainty of the results from these equipments are analyzed, On this basis, the method of minimizing overall standard error is adopted to obtain PAIe of each sample plot. For validated the new approach, we take simulated wide-angle viewing pictures on forest canopy as the standard data, to calculate the PAIe using the models which TRACWin, FV2000 and CAN_EYE take respectively, then to obtain the estimated PAIe by using the minimizing overall standard error method. The estimated PAIe is compared with the true PAIe used in the simulation.

3. RESULTS AND DISCUSSION

The results show that TRAC PAIe and LAI-2000 PAIe have good correlation, and TRAC PAIe is larger than LAI-2000 PAIe of each sample plot. CAN_EYE PAIe and LAI-2000 PAIe have different correlation in different observation zenith angles. Moreover, combining the results of these instruments can decrease overall measurement error. Furthermore, the results from TRAC are more reliable than LAI-2000 and Digital Fisheye Camera in this experiment. The estimated PAIe by the method of minimizing overall standard error can be taken as reference for having the ground truth PAIe measured in field.

4. REFERENCES

[1] I. Jonckheere, S. Fleck, K. Nackaerts, B. Muys, P. Coppin, M. Weiss, F. Baret, “Review of Methods for in Situ Leaf Area Index Determination Part Ⅰ. Theories, Sensors and Hemispherical Photography,” Agricultural and Forest Meteorology, Vol. 121, pp.19-35,2004.

[2] M. Weiss, F. Baret, G.J. Smith, I. Jonckheere, P. Coppin, “Review of Methods for in Situ Leaf Area Index Determination Part Ⅱ.Estimation of LAI, Errors and Sampling,” Agricultural and Forest Meteorology, Vol. 121, pp.37-53,2004.

[3] J.M. Chen, “Optically-based Methods for Measuring Seasonal Variation of Leaf Area Index in Boreal Conifer Stands,” Agricultural and Forest Meteorology, Vol.80, pp.135-163,1995.

[4] Li-Cor I., “LAI-2000 Plant Canopy Analyzer Instruction Manual,” LI-COR Inc, Lincoln,Nebraska,USA,1992.

[5] S. Garrigues, N.V. Shabanov, K. Swanson, J. Morisette, F. Baret, R.B. Myneni, “Intercomparison and Sensitivity Analysis of Leaf Area Index Retrievals from LAI-2000,AccuPAR,and Digital Hemispherical Photography over Croplands,” Agricultural and Forest Meteorology, Vol.148, pp.93-109,2008.