Integrating Vegetation and Physical Indices with Satellite Imageries for Carbon Storage Estimation in Forest Plantation of Thailand

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Abstract

Three main plantations, including Eucalyptus, Para rubber and Teak, were selected to represent forest plantation in Thailand. LANDSAT imageries integrated with normalized difference vegetation index (NDVI), bare soil index (BI), and water index (WI) were employed to determine carbon storage in various growing stage for each plantation. Eucalyptus plantation, located in Srakaew province, was classified as one to five years age class. Para rubber plantation, located in Krabi province, was classified as young, harvested, mature, and logging stage. Meanwhile, Teak plantation, located in Prae province, was classified as primary and rotation stage. Then, biomass for each plantation was identified using allometric equation, which had been validated by ground truth operations. Carbon storage was quantified based upon the biomass manipulation. Carbon storage in Eucalyptus plantation was identified as 1.68, 9.09, 15.6, 25.62, and 25.9 ton/ha, for one to
five years age class, respectively. Meanwhile, carbon storage in Para rubber plantation was identified as 2.31, 60.39, 98.11, and 135.03 ton/ha, for young, harvested, mature, and cutting stage, respectively. And carbon storage in Teak plantation was identified as 6.60 and 38.50 ton/ha for primary and rotation stage, respectively. Thus, integrating vegetation and physical indices with satellite imageries could be performed for carbon storage determination especially within the local communities, which might be applied for the expected region.

**Keywords:** LANDSAT data; carbon storage; forest plantation

1. Introduction

The forest area of Thailand has been gradually decreased within the past 50 years. Therefore, the national forest policy of Thailand has been announced to reserve the forest area at about 40% of the whole country. The area of 25% should be remaining for conservation or protection approaches. Meanwhile, the area of 15% should be providing for utilization purposes. To meet the proposed target, the measures and strategies have been conducted to increase the conservation area by announcing more area of national parks and wildlife sanctuaries, for instances. In the meantime, the reforestation activities were also provided within the disturbed forest area. The reforestation can be divided into various patterns. Most of them are authorized by government organizations. The reforestation within the protected area is under the responsibility of the Department of National Park, Wildlife and Plant Conservation. Meanwhile, outside the protected area is under the responsibility of the Royal Forest Department (RFD).

The reforestation activities outside those protected area can be divided into 5 main categories as following. Firstly, the forest plantation within the national reserved forest area is mainly under the operation of the Royal Forest Department; Secondly, the RFD allows the Forest Industry Organization, the state enterprise, to operate the forest plantation especially within the former logging concessionaires’ area. Thirdly, the private sector is asking for the concession from RFD to operate the forest plantation. Fourthly, the local people is providing forest plantation within community forest area which already approved by the RFD. Lastly, the private sector and local people perform forest plantation in their own land right.

The forest plantation especially within private sectors and local communities are now expanding and spread over for the whole country. Therefore, it is very interesting to determine the carbon storage and sequestration in those forest plantations. Besides, the remotely sensed data is now capable to identify the forest plantation area. Thus, the integrating of remotely sensed data and vegetation and physical indices to determine the carbon storage and sequestration in the local forest plantation are needed to be provided.

2. Methodology

Forest plantations selected for this study are including Eucalyptus, Para rubber and Teak plantations. The LANDSAT-5 TM satellite image, complementary provided by the Geo-Informatics and Space Technology Development Agency (GISTDA), were manipulated for the analysis procedure. The geometric correction was manipulated based upon topographical map scale 1:50,000 of the Royal Thai Survey Department (RTSD), series L7018, with UTM grid coordinates reference and spheroid datum of...