International Journal of Science, Environment and Technology, Vol. 8, No 5, 2019, 1080 – 1086

ISSN 2278-3687 (O)
2277-663X (P)

THE APPROACH OF ABOVE GROUND BIOMASS ESTIMATION USING SENTINEL SAR DATA

Bayanmunkh Norovsuren[1,4], Tsolmon Renchin[2], Batchuluun Tseveen[1], Zaya Mart[3] and Enkhjargal Natsagdorj[2]

[1]Department of Environment, Forest Engineering, School of Engineering and Applied Sciences, National University of Mongolia; [2]Laboratory for Space Science and Remote Sensing, School of Arts and Sciences, National University of Mongolia; [3]Department of Environmental Remote Sensing, Graduate School of Science and Engineering, Chiba University, Japan; [4]Laboratory for Geo Mineralization, Mongolian National University

E-mail: n.bayanmunkh@mnun.edu.mn

Abstract: This paper presents about biomass estimation approach using VV and VH of Sentinel satellite. Ground measurements of forest biomass was compared with backscatter coefficients of SAR data. Backscatter coefficients for polarizations VV and VH of Sentinel-1B (2016) were related to the ground truth biomass. The relationship between backscattering coefficients for VV and VH of C-band and forest biomass was obtained for the high elevated areas in Mongolia. The result shows that backscattering coefficients for quality, tree parameters such as diameter at breast of height (DBH) are different for the various trees.

Keywords: Sentinel 1B-SAR; forest biomass; backscatter coefficients.

1. Introduction

The retrieval of forest biomass using remote sensing data has received increasing attention in the last decades for several reasons: primarily, for the ability of remote sensing to spatially extrapolate point field information on forest parameters, enabling forest biomass mapping over large areas; for the increased availability of different Earth Observation data types; and, in a global scenario of climate change and biodiversity loss, for the relevance of forest biomass with respect to global carbon accounting and reporting, conservation and management of natural resources, and environmental modeling (Laurin, et al. 2018) (Korhonen, et al. 2017). The quantification of biomass is required as the primary inventory data to understand pool changes and productivity of boreal forest (Çolak and Sunar 2018); (Sasan, et al. 2018).

The objective of this research is to use Sentinel-1B SAR C-band and Sentinel-2B multispectral data for estimating forest biomass in Bulgan province of Mongolia. Combination of Sentinel-1B data is being important tool for forestry analysis and studies.

*Received Sep 11, 2019 * Published Oct 2, 2019 * www.ijset.net*

2. Study area

The study area is Khandgait valley, Khangal soum, Bulgan province, which located in Northern part of Mongolia (Figure 1).

Bulgan province is situated in the northern part of Mongolia. This area has a subarctic climate where the annual average temperature is -1.3 degrees Celsius (29.7 degrees Fahrenheit) and total annual precipitation averages is 278.4 mm (11 inches). According to our survey, the forest in Khandgait valleys covers an area of 11750 hectares and its elevation is between 1260m and 1570m.

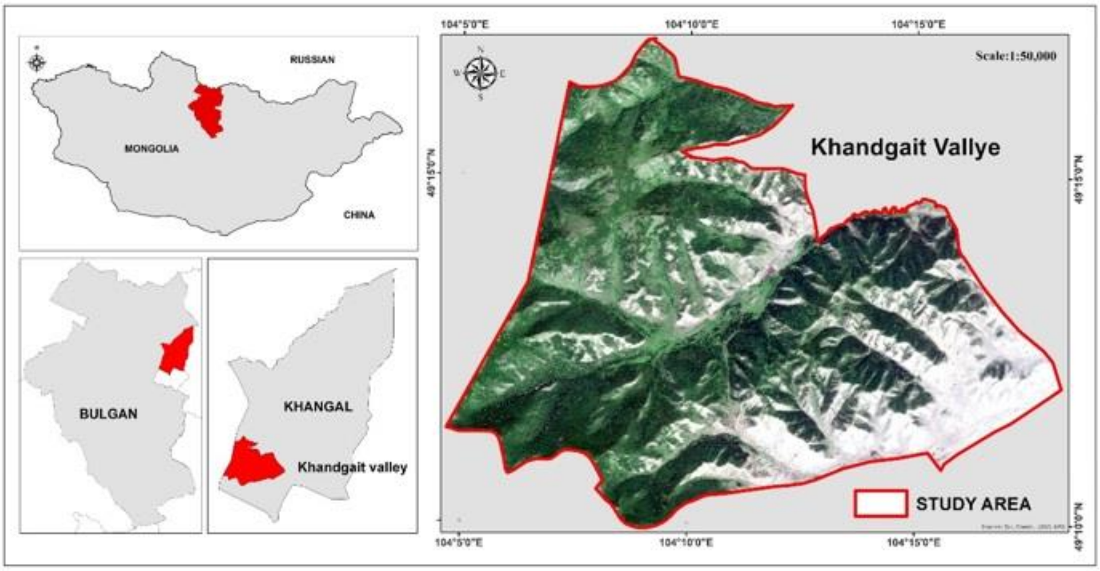


Figure 1. The study area location (49^0 15′ to 49^0 10′ N and 104^0 05′ to 104^0 15′ E)

3. Data set

The sample stands differ for main type, leaf presence and type of field plots (size, shape, and number). Field data were compiled in July, 2016. Biomass growth is high in July. We measured diameter at breast (DBH) and height. The Sentinel-1B SAR C-band data used for estimating forest biomass for this study (Table 1).

Table 1. Sentinel satellite remote sensing data

Satellite	Date	Resolution	Level	Polarizations
Sentinel-1B SAR	August 2016	10m	C-band	VV, VH,

The Sentinel-1B is an imaging radar mission providing continuous all-weather, day-and-night imagery at C-band (Table 1). Sentinel-1B SAR C-band data interferometric wide swath mode was used, with a 250-km swath width at 5×20m spatial resolution, an incidence angle between 29.1 degree and 46.0 degree, and VV and VH dual polarizations (Bayanmunkh N

2019). Scenes were multi-looked (one look in range and four azimuth), geocoded based on Shuttle Radar Topography Mission (SRTM) data, and radiometrically calibrated with a final pixel spacing of 10 × 10 m (Tsyganskaya, et al. 2018).

4. Methodology

Approach for this research developed by the scheme (Figure 2).

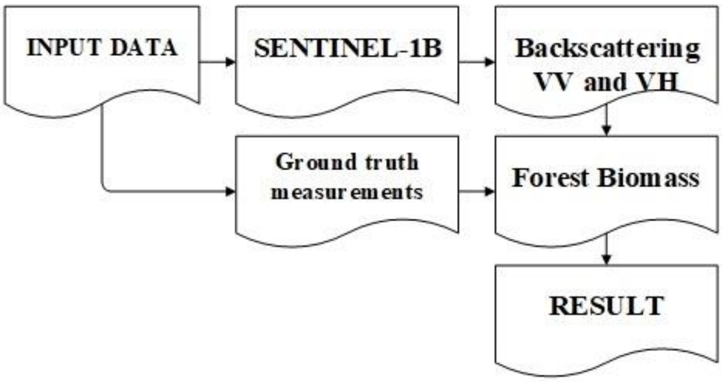


Figure 2. Scheme of methodology

Sentinel-1B used for estimation forest biomass. A backscatter coefficient from VV, VH polarizations was estimated for larch and birch biomass. Relationship between backscattering coefficients and ground truth biomass was obtained.

In order to find backscatter, we used SNAP v. 4.0.0. (Sentinel Application Platform) software developed by ESA (European Space Agency). Radiometric calibration to the sigma 0 values, spekle filter, calibration, range-doppler terrain correction using SRTM digital elevation model and conversion from linear to decibel scale was used from (Alena, et al. 2018).

To determine backscatter coefficients, we used VV and VH polarizations. The intensity values for the polarizations were converted to the normalized radar backscattering coefficients (σ0), measured in decibel (dB) using Equation (1) by (Sasan, et al. 2018).

$$\sigma 0 \text{ dB } = 10 \log 10\sigma 0 \quad (1)$$

in which σ dB is the normalized radar cross section and σ0 is the backscatter for a specific polarization. Formula (2) (MNETM 2016) was selected to estimate tree trunk biomass in this study area. Where α, β and γ are parameter coefficients (Table 2).

$$B_{stem} = \alpha \, D_{bh}{}^{\beta} * H_{tot}{}^{\gamma} \quad (2)$$

Table 2. Coefficients and volume equations for forests in the study area

Forest type	α	β	γ	Equations
Larch	0.229067	1.75631439	1.04530318	V=0.23R1.75H1.05
Birch	0.121815	1.79633106	1.24762399	V=0.12R1.8H1.25

5. Analysis

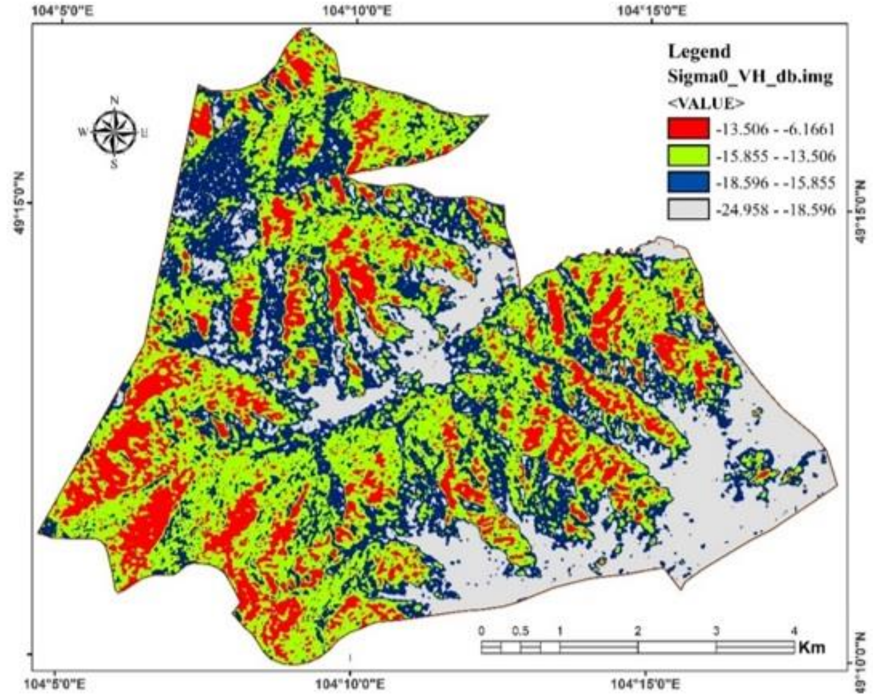


Figure 3. VH backscattering values for forest

Backscatter coefficients from VH and VV polarizations compared with biomass for larch and birch forests. Figure 3 indicates the VH backscattering in the study area. Figure 4 (a) and (b) describe the relationship between VH backscattering for larch and birch biomass respectively.

(a) (b)

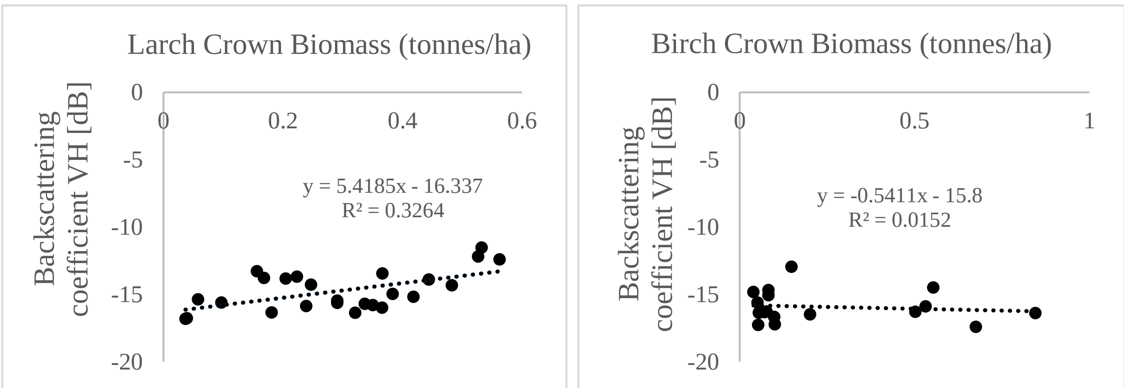


Figure 4. The relationship between VH backscattering for larch and birch biomass

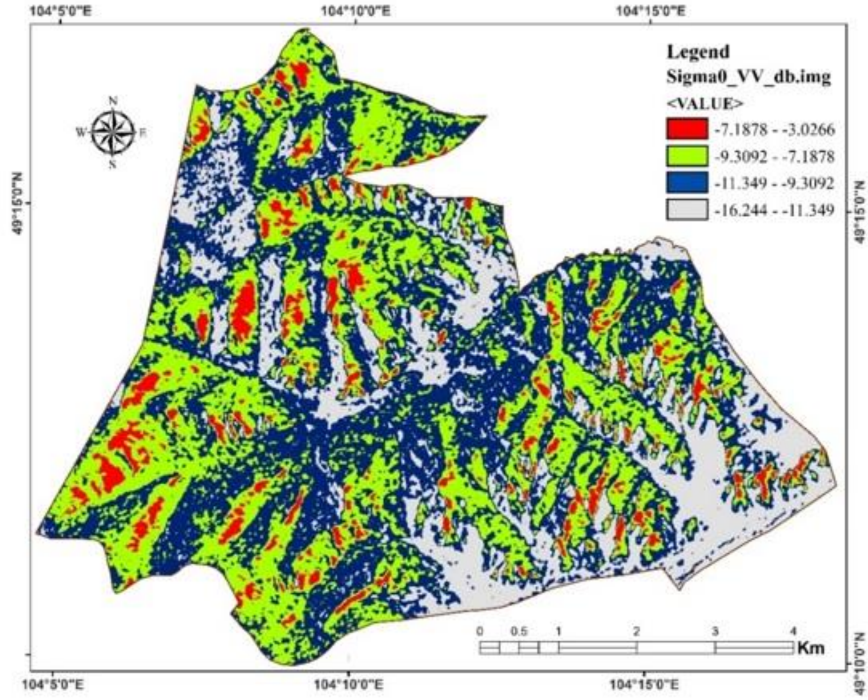
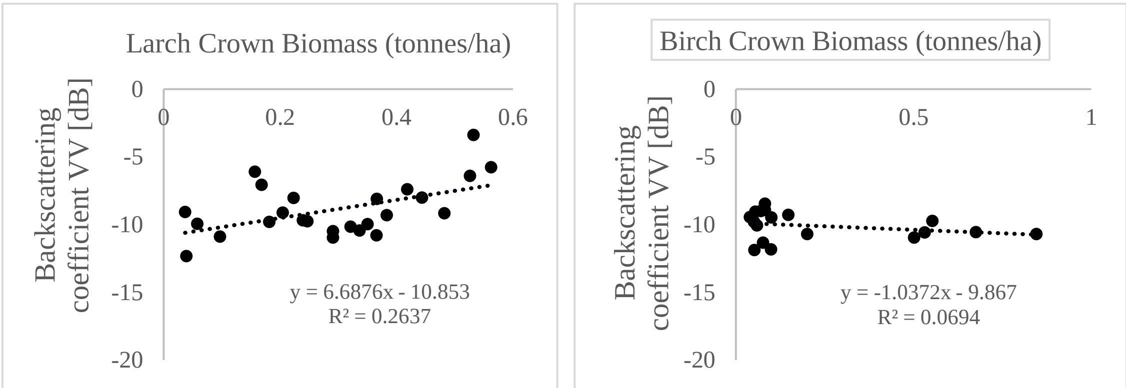


Figure 5. VV backscattering values for forest

VV backscattering values are in the study area (Figure 5). Figure 6 (a) and (b) describe the relationship between VV backscattering for larch and birch biomass respectively.



(a) (b)

Figure 6. The relationship between VV backscattering for larch and birch biomass

6. Conclusion and discussion

The Figure 4 (a) shows relationship between VH backscattering values and biomass. Backscattering values for VH arrange between -11 to -17 for larch and -13 to -18 for birch. Backscattering values for VV are -5 to -13 for larch and -8 to -12 for birch. From the analysis backscattering value is high for larch biomass.

The detailed description of the sampled stands (Table 3) and (Table 5) was used as ground truth validation. VH backscatter coefficient for larch biomass is higher than VV backscatter coefficient for birch biomass. From the analysis there is high biomass for the sampled stands where heights are 20 m or higher for the larch forest. Sentinel-1B is important for forest biomass study. This approach was used for above ground biomass. SAR C-band data confirmed backscattering coefficient to be dependent upon not only the quantity of biomass, but also tree parameters, types and high elevated area.

Acknowledgements

This research was partially supported by Asian Research Center (ARC), Mongolia and Korea Foundation for Advanced studies and “Monitoring forests cover change in Mongolia with participatory approach” (APFNet) project. The authors would like to gratitude the “Forest Research and Development Center” in Mongolia and “Eco-Khanbuyan” forest community for their kind support. Authors are thankful for Sentinel data center for providing data.

References

[1] Alena, Dostálová, Hollaus Markus, Milenković Milutin, and Wagner Wolfgang. 2018. "Forest area Derivation from Sentinel-1 data." *ISPRS Ann. Photogramm Remote Sensing* III-7, 227-233.

[2] Bayanmunkh N, Batchuluun Ts, Valentin Batomunkuev and Tsolmon R. 2019. "Estimation for forest biomass and coverage using Satellite data in small scale area, Mongolia." *IOP Conference Series: Earth and Environmental Science* Volume 320, Number 1.

[3] Çolak, E, and A, F Sunar. 2018. "Remote sensing & GIS integration for monitoring the areas affected by forest fires: a case study in Izmir, Turkey." *TheInternational Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.* Istanbul, Turkey. XLII-3/W4, 165-170.

[4] Korhonen, Lauri, Hadi Hadi, Petteri Packalen, and Miina Rautiainen. 2017. "Comparison of Sentinel-2 and Landsat 8 in the estimation of boreal forest canopy cover and leaf area index." *Remote Sensing of Environment* 195, 259-274.

[5] Laurin, Gaia Vaglio, Johannes Balling, Piermaria Corona, Walter Mattioli, Dario Papale, Nicola Puletti, Maria Rizzo, John Truckenbrodt, and Marcel Urban. 2018. "Above-ground biomass prediction by Sentinel-1 multitemporal data in central Italy with integration of ALOS2 and Sentinel-2 data." *Journal of Applied Remote Sensing* 12(1), 1-17.

[6] MNETM, Ministry of Nature, Environment and Tourism of Mongolia. 2016. *Multi-Purpose National Forest Census.* Ulaanbaatar.

[7] Sasan, Vafaei, Soosani Javad, Adeli Kamran, Fadaei Hadi, Naghavi Hamed, Dat Pham Tien, and Tien Bui Dieu. 2018. "Improving Accuracy Estimation of Forest Aboveground Biomass Based on Incorporation of ALOS-2 PALSAR-2 and Sentinel-2AImagery and Machine Learning: A Case Study of the Hyrcanian Forest Area (Iran)." *Remote Sensing* 10(172), 1-21.

[8] Tsyganskaya, Viktoriya, Martinis Sandro, Marzahn Philip, and Ludwig Ralf. 2018. "SAR-based detection of flooded vegetation – A review of characteristics and approaches." *International Journal of Remote Sensing* 39:8, 2255-2293.