Journal of Physics: Conference Series

PAPER • OPEN ACCESS

The 2018 International Conference on Research and Learning of Physics

To cite this article: 2019 *J. Phys.: Conf. Ser.* **1185** 011001

IOP Conf. Series: Journal of Physics: Conf. Series **1185** (2019) 011001 doi:10.1088/1742-6596/1185/1/011001

IOP Conf. Series: Journal of Physics: Conf. Series **1185** (2019) 011002 doi:10.1088/1742-6596/1185/1/011002

PREFACE

On behalf of the Committee, I would like to thank you for your participation in the 2018 International Conference on Research and Learning of Physics (ICRLP2018) which has been held at the Auditorium Universitas Negeri Padang, West Sumatra, Indonesia, August 9 - 10, 2018.

This ICRLP2018 is organized by the Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. The main purpose of these conferences and seminar is the dissemination of the best research results from academics, researchers, professors, practitioners, observers, teachers, and students in both Physics Research and Physics Learning Research. This conference is expected to become a forum to discuss strategic issues in related fields. The two-day conference is expected to build cooperation between academics, researchers and institutions at both national and international levels. The scope of ICRLP 2018 covers various fields in Physics Research and Physics Learning Research.

I would like to express my sincere appreciation to all the participants, financial sponsors, exhibitors, supporting organizations and all the committee members who has made ICRLP2018 successful. With these strong support, we are sure ICRLP will be beneficial to all the participants, and you enjoy in Padang.

We are looking forward to meeting you in the next ICRLP.

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Assessing performance of L-band SAR backscatter for above ground forest biomass estimation over complex topography

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Abstract. Forest above ground biomass (AGB) estimation is always challenging using SAR backscatter over challenging topography because topographic introduce topographic and radiometric distortion in SAR images. These distortions can be corrected using topographic and radiometric correction methods but these methods are effective over moderate topography. Most of the forest in Pakistan exist over challenging topography. This research is an initial effort to estimate forest AGB of Gilgit-Baltistan, Pakistan. As Gilgit-Baltistan exist in the north of Pakistan, it lies at approximately 5000 m above the sea level. The prime goal of this research is to estimate above ground forest biomass using L-band SAR backscatter. For this, full polarimetric data of ALOS-2 was acquired. Terrain geometric and radiometric correction was performed and backscatter (σ_o) was estimated. Resultant o was correlated with ground based forest AGB and regression analysis was performed. It was identified that σ_{HH} σ_{VH} is most sensitive for biomass estimation.

1. Introduction

Among other terrestrial carbon pools, forests stores CO2 in its roots, stem, branches and leaves which is collectively known as forest biomass[1]. Forest biomass is divided into two categories: 1) above ground biomass (AGB) and 2) below ground biomass (BGB). Using remote sensing techniques, only AGB can be estimated because optical data only give information of canopy structure, lidar data give information of forest vertical profile however synthetic aperture radar (SAR) provides information of leaves, branches, stem and soil depending upon wavelength used for SAR imaging. Interaction of different microwave bands is shown in figure 1.

Many researchers attempted to estimated forest AGB using optical, lidar and SAR datasets. Each of them have potential to estimate different properties of forest structure. Mutanga et al. used utilized high resolution worldview-2 dataset for forest biomass estimation using regression analysis between ground data and parameters extracted using high resolution data[8]. Drake et al. used lidar data to map vertical structure and relate it with forest biomass. SAR backscattering is also effectively used for forest biomass estimation[2, 3, 4, 6]. It's also identified that slop is the dominant factor that affect above ground biomass estimation[5].

The prime goal of this research is to estimate accurate forest AGB by employing L-band SAR full polarimetric data. For this study, L-band ALOS-2 full polarimetric data was acquired during

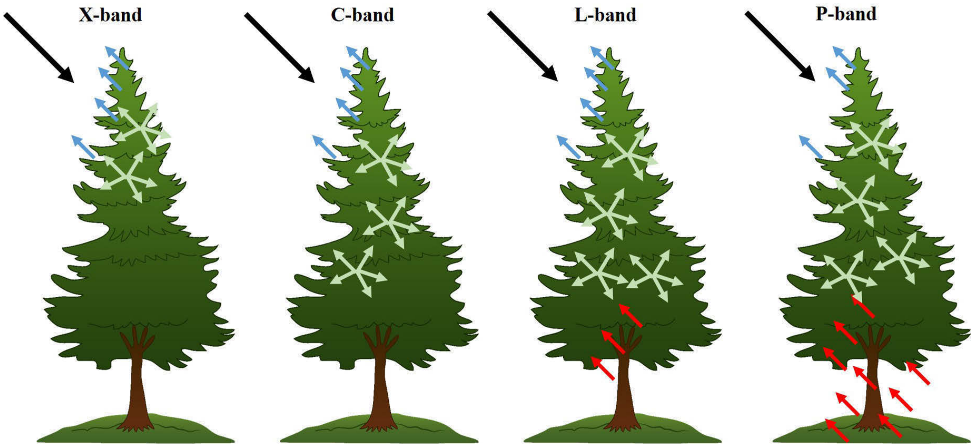

Figure 1. Interaction of different Microwave bands with tree components

summer season (September 01, 2017) with incident angle 36.50o at scene center. TanDEM-X 12 m digital elevation model (DEM), was acquired from DLR. Landcover map of study area was acquired from ICIMOD. A field visit was carried out in this study area to collect biophysical parameters of forest. Parameters collected during field visit includes: DBH, height of tree, tree species, strata of tree. Details of datasets used for this research is shown in table 1.

Table 1. Locally developed allometric equations

Sr. #	Dataset	Specifications	Source
1	ALOS-2 Images	Quad-Pol	JAXA
2	TanDEM-X DEM	12 m	DLR
3	Land Cover Map	30 m	ICIMOD
4	Field Data	17.84 m plot	RED+ PK
5	Allometric Eq.	AGB = f(x)	PFI, PK

2. Study Area

ALOS-2 data acquired cover partially four districts (i.e. Diamer, Gilgit, Nagar and Ghizer) of Gilgit-Baltistan province of Pakistan. Around 70 percent of whole forest in Gilit-Baltistan exist in Diamer district. Gilgit-Baltistan regions topography is very challenging with varying height from 4000m to 8611m. Location of acquired ALOS-2 data is shown in figure 2 with yellow boundary. It can be seen from figure 2, even during summer season few areas in Gilgit-Baltistan are covered with snow. During winter season, this area has heavy snow fall and almost fully covered with snow from December until February.

3. Methodological Framework

ALOS-2 level 1.1 data was acquired in SLC format. This data was multi-looked in range and azimuth direction; resultant pixel spacing was 10m x 10m. As chosen study area contain significant topography, because of this acquired imagery contains geometric and radiometric distortions i.e. layover, foreshortening and radar shadow. To correct these distortions, algorithm

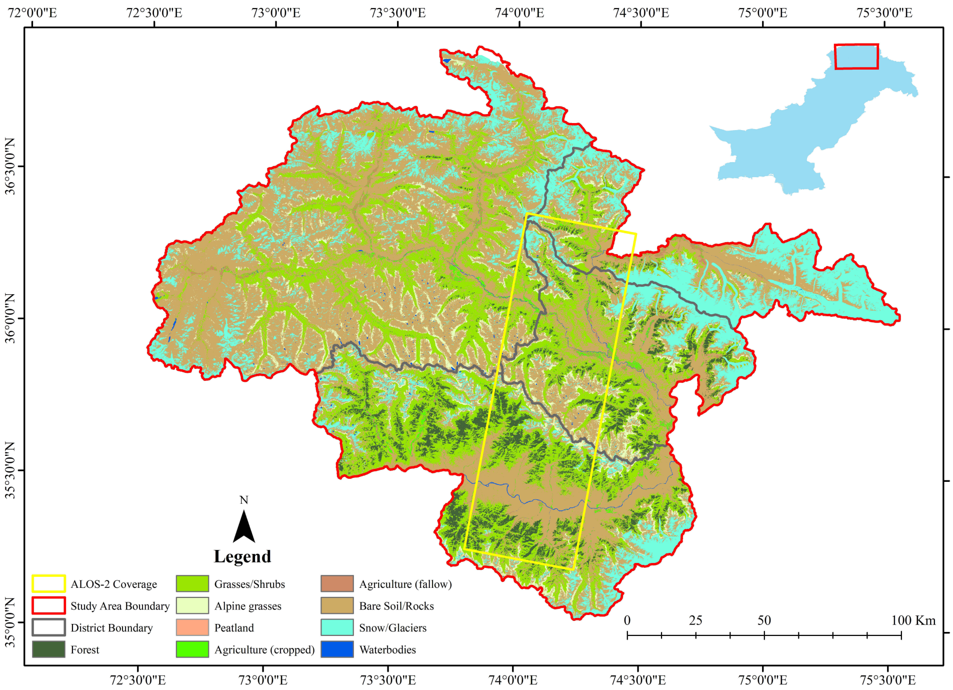

Figure 2. Location of Study Area

proposed by Atwood et al. was employed[7]. Results respective intensities of HH, HV, VH and VV were converted to σ_o. In order to compare these parameters with ground data, all parameters were re-projected to UTM coordinate system and up-sampled to 1 hectare i.e. 10000 m^2. Terrain corrected σ_{HH} is shown in figure 3. In order to collect ground data, a field work was carried out

Table 2. Locally developed allometric equations

Species	Allometric Equations
General	$AGB = 0.1645(pD^2H)^{0.8586}$
Cedrus Deodara	$AGB = 0.1779(D^2H)^{0.8103}$
Pinus Wallichiana	$AGB = 0.0631(D^2H)^{0.8798}$
Pinus Gerardiana	$AGB = 0.0253(D^{2.6077})$
Abies Pindrow	$AGB = 0.0954(D^2H)^{0.8114}$
Picea Smithiana	$AGB = 0.0843(D^2H)^{0.8472}$
Quercus ilex	$AGB = 0.8277(D^2H)^{0.6655}$

during May 2017. A total 59, circular plots of 17.84 m (1000 m^2 area) were collected. In these field plots, biophysical parameters of forest collected includes: Diameter at breast height (DBH), tree height (H), tree species and forest strata. Figure 4, shows the bar graph of two field plots. Outlier exists in both plots. These outliers were removed to make these sample representatives of population and generalizable. Allometric equations developed by Pakistan Forest Institute (PFI), Pakistan were used to convert collected field data to forest AGB [9]. As each plots cover 1000 m^2 area, in order to upscale this field data it was multiplied by the factor of 10 to make it

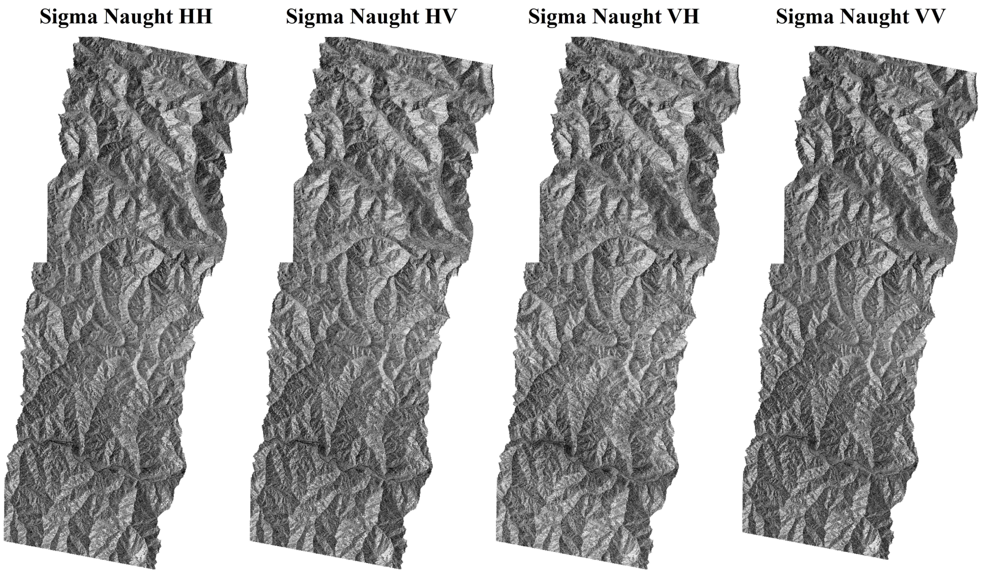

Figure 3. Terrain Corrected Backscatter σ_o

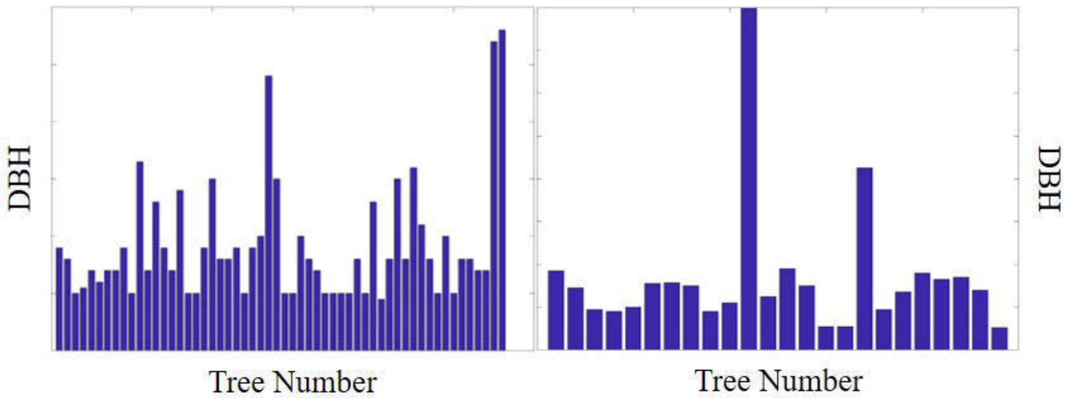

Figure 4. Bar graph of DBH distribution in field plot σ_o

1 hectare (10000 m^2). Allometric equations used in this study are shown in table 2.

Later this upscaled field data and SAR based parameters were correlated using regression analysis and the best parameters was used to estimate biomass in study area. The detailed methodological framework flow chart is shown in figure 5.

Collected field data is uniformly distributed over forested area. Distribution of field plots is shown in figure 7.

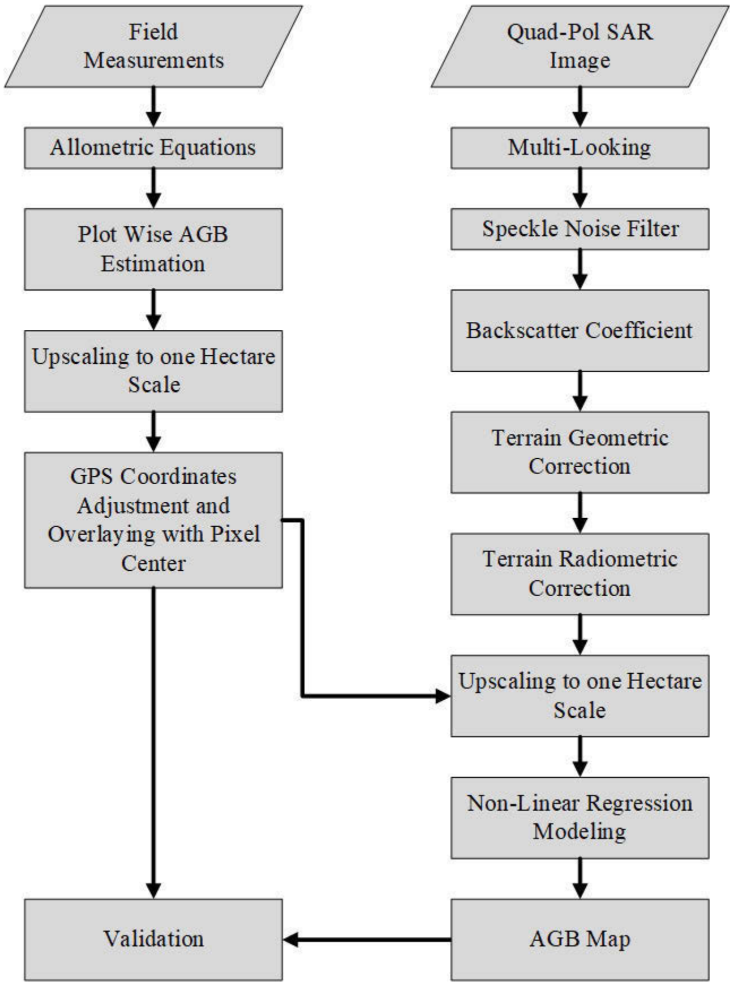

Figure 5. Methodological Framework

4. Results and Discussion

Successive regression analysis was performed between ground collected (upscaled to 1 hector) and signa naught for HH, HV, VH, VV, HH-HV and HH-VV. As mentioned before, chosen study area contain complex topography. Terrain geometric and radiometric correction model was employed to correct these distortions; however it was identified that; adopted model performed geometric correction very well however radiometric correction was not satisfactory. Radiometric values over near and far slope was not normalized even after applying correction model. Regression analysis results for HH, HV, VH, VV and HH-VV gives very poor results. However, HH-HV gives better correlation with R^2=0.42. Regression curve between HH-HV backscatter and forest biomass is shown in figure 7. In the figure, red points corresponds to field plots over those regions which are affected by layover, foreshortening and radar shadow.

5. Conclusion

ALOS-2 full polarimetric is successfully utilized to estimate forest above ground biomass in a very challenging topography. Acquired data was badly affected by layover, foreshortening and radar shadow because of complex topography. Terrain geometric and radiometric terrain correction was successfully implemented using high resolution TanDEM-X DEM. Backscattering

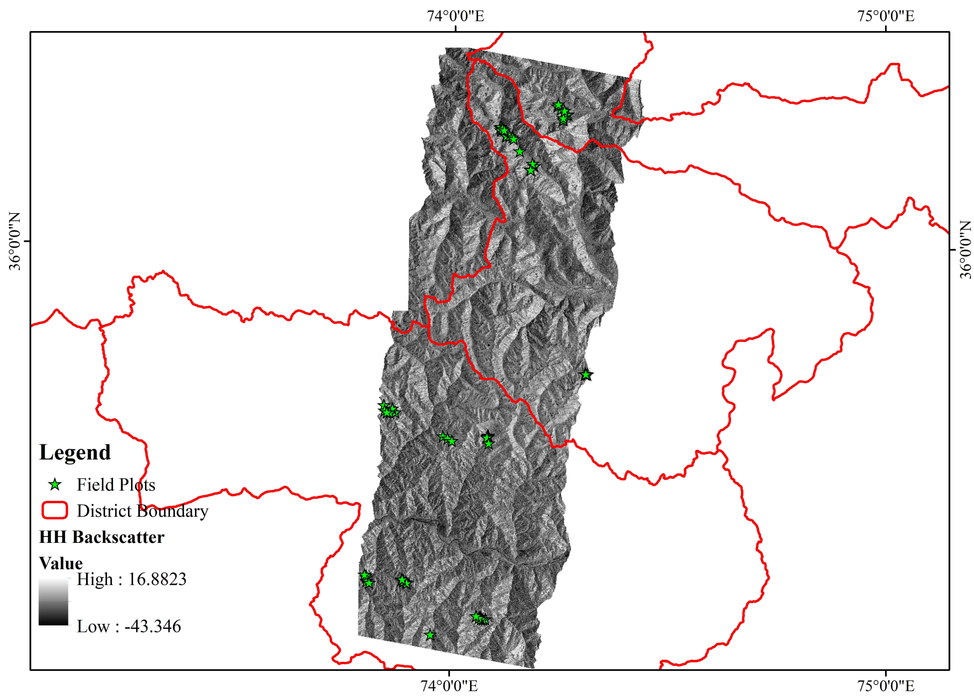

Figure 6. Distribution of field plots

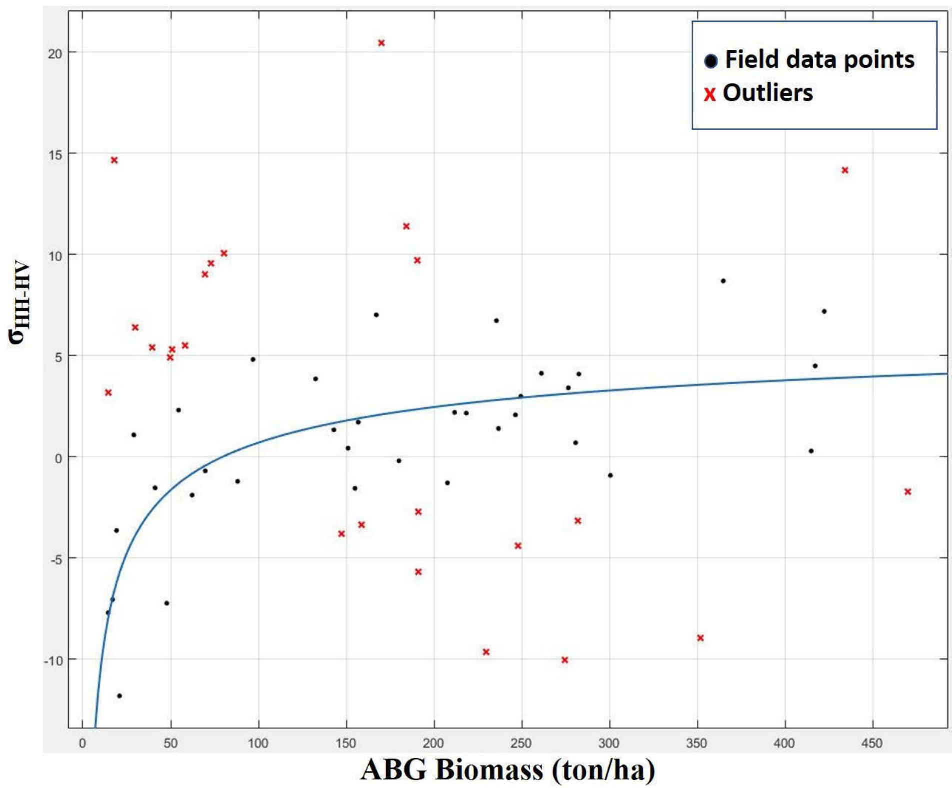

Figure 7. Regression results between HH-HV backscatter and Forest AGB

was estimated for HH, HV, VH, VV, HH-HV and HH-VV and regression analysis was performed. HH-HV backscatter give best correlation with forest AGB. It was identified that HH, HV, VH, VV, HH-VV were not sensitive to biomass because backscatter over layover, foreshortening and radar shadow were not corrected accurately.

6. Acknowledgement

Authors would like to knowledge JAXA for providing ALOS-2 imagery. TanDEM-X 12m DEM was provided by DLR under project id: DEM-FOREST1161. We also would like to thank Secretary Forest, Wild Life and Environment Department, Gilgit Baltistan, Pakistan and GIS team of RED+ team for helping and facilitating us during field visit.

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