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Objectives

- ▶ **BUILD CAPACITY** to process SAR datasets to monitor forests and estimate biomass
- ▶ **PRODUCE TRAINING MATERIALS** on standard SAR processing techniques to monitor forests and estimate biomass
- ▶ **DETERMINE IMPROVEMENT AREAS** for future SAR capacity building initiatives

Abstract

Earth observations from Synthetic Aperture Radar (SAR) can provide unique observations related to forest structure and condition. Furthermore, SAR has many potential applications in forest monitoring systems, particularly where clouds have impeded optical observations. Currently, there is a reliable, freely available, provision of SAR datasets, such as Sentinel-1, and there are plans to have more observations in the near future (NISAR, BIOMASS). Given SAR's enhanced earth observation characteristics, there is broad interest in using SAR datasets for decision support systems, such as deforestation early warning systems. However, applications of SAR are still underutilized. What is preventing users from using SAR data in their decision support systems?

This study documents the experiences and lessons learned from the SERVIR network on the main limitations of incorporating SAR datasets into existing forest monitoring systems. This research also focuses on the major technical and scientific barriers we experience and best practices to address them. The results of this study are part of the SERVIR-SilvaCarbon collaboration. The primary goal of this collaboration is to build capacity in the applied use of SAR for forest monitoring and biomass estimation. The products of this effort aim to start closing the gap between SAR science and forest applications. We will also present results to generate applied ready knowledge for SAR.

Datasets & Software Used

SOFTWARE	PROGRAMS & PLATFORMS: SNAP, QGIS, Google Earth Engine, PostGISpro, R Studio, Anaconda, Jupyter notebooks SCRIPTING & LIBRARIES: R/RGISLIB, Python, Java, GDAL
SATELLITE DATASETS	Sentinel-1 C-SAR, ALOS PALSAR

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Capacity Building Workshops

TRAINING	DATE	HUB	PARTICIPANTS	SKILLS GAINED
SAR Basics and Forest Degradation and Deforestation	29 Jan - 2 Feb 2018 12 - 16 Feb 2018	SERVIR West Africa SERVIR Hindu Kush Himalaya	26 33	SAR processing using SNAP, Python R/RGIS
SAR Forest Height	12 - 14 Mar 2018	SERVIR Mekong	23	SAR in forest/non-forest classification, biomass and forest stand height (FSH) estimation
SAR Training: Mangrove and Sampling Design	16 - 20 Apr 2018	SERVIR Eastern & Southern Africa	27	Mangrove mapping, above ground biomass estimation, forest sampling design
SAR Forest Structure and Biomass	30 Apr - 4 May 2018	SERVIR Hindu Kush Himalaya	24	Monitoring forest carbon stocks, SAR workflows



SERVIR international hub locations. From left to right: SERVIR West Africa (Nairobi, Niger), SERVIR Eastern & Southern Africa (Nairobi, Kenya), SERVIR Hindu Kush Himalaya (Kathmandu, Nepal), SERVIR Mekong (Bangkok, Thailand)



Clockwise from top left: Participants at the SAR Forest Height training held in Bangkok; a screen displays the results of a guided exercise on crop classification; attendees listen in on a lecture from the HSH Forest Structure workshop; a trainer assists a workshop participant at the SAR Basics training held at SERVIR West Africa.

A global series of SAR capacity building workshops were held for international partners in Africa and Asia throughout 2018 led by SAR Subject Matter Experts (SMEs).

Using the "Train the Trainer" approach, the workshops were set up to prepare academics, governmental researchers, and other professionals to implement similar follow-on trainings.

WORKSHOP FEEDBACK:

After the workshop conclusions, surveys were sent out to participants. Of the respondents, all reported an increase in capacity to use SAR for forest monitoring. Many represented governmental organizations, and expressed an interest in using knowledge gained from the workshops to assist in future forest carbon monitoring and inventory in national reporting.

"We are always faced with issues of cloud cover, and we have never used SAR imagery to resolve that. The knowledge we have obtained will help guide us in monitoring the coastal forests and the other types of forest cover change to counter the challenge we have been facing."

— Eunice (Kenya Forest Service, Mangrove and Sampling Design workshop attendee)

"Bhutan recently completed the National Forest Inventory, but due to a lack of technical capabilities we were not able to move forward. ICIMOD have timely organized this workshop, integrating the SAR, LiDAR, and plots, which Bhutan has been looking forward for such technical backstopping."

— Arun (Bhutan Dept. of Forests & Park Services, Forest Structure and Biomass workshop attendee)

End-Products

Materials from the SAR workshop series and SilvaCarbon collaboration are being compiled into a set of interactive training materials, including a textbook, one-pagers, explainer videos, and web-hosted exercises. These contain practical guidelines to use SAR for forest monitoring applications and can be iterated on with examples from different regions and new data sources (e.g. NISAR, BIOMASS).



The SAR Handbook: Comprehensive Methodologies for Forest Monitoring and Biomass Estimation (textbook)



Selected SAR one-pagers on topics from data acquisition to pre-processing steps

Lessons Learned

- ▶ Basic skills in processing/using SAR increased at all hubs
- ▶ Focus on using open-source software brings additional challenges in terms of capacity building (simultaneous teaching methods and programming skills)
- ▶ Need for follow-on refresher courses, improved skills transfer process to stakeholders
- ▶ Identified need to develop allometric equations to improve localized biomass estimation
- ▶ Future workshops and follow-on trainings would benefit from additional regional examples; translating materials (French, Portuguese, Spanish)