Estimation Of Forest Change

Using Shortwave SAR

SUMMARY

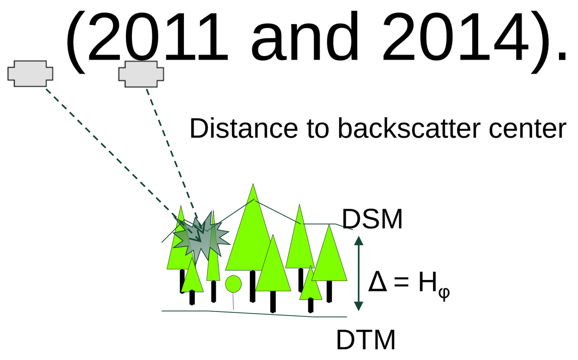
Synthetic aperture radar (SAR) images from TanDEM-X (X-band) and Radarsat-2 (C-band) have been acquired for the test site Remningstorp in southern Sweden. The relationship to biomass and biomass change was analyzed. We conclude that the bistatic configuration at X-band provided strong relationships to biomass and change. RS2 quad-pol data at C-band enabled polarimetry and it provided acceptable biomass estimates, while the use of only dual-pol RS2 backscatter provided poor estimates of biomass change.

Methods

The interferometric coherence $\tilde{\gamma}$ can be derived as:

$$\tilde{\gamma} = \frac{\langle \mathbf{s}_1 \mathbf{s}_2^* \rangle}{\sqrt{\langle |\mathbf{s}_1|^2 \rangle \langle |\mathbf{s}_2|^2 \rangle}} \quad (1)$$

From the images s_1 and s_2^*, *=conjugate. The phase of $\tilde{\gamma}$ relates geometrically to the scattering height. A national laser scanning was used to derive the terrain elevation, which was subtracted from $\tilde{\gamma}$. This procedure was applied to two TDM images (2011 and 2014).



$$H_\varphi = \angle(\tilde{\gamma}) \frac{\lambda R \sin(\theta)}{B_\perp}$$

$$AGB = \alpha_0 \cdot H_\varphi^{\alpha_1} \cdot |\tilde{\gamma}|^{\alpha_2}$$

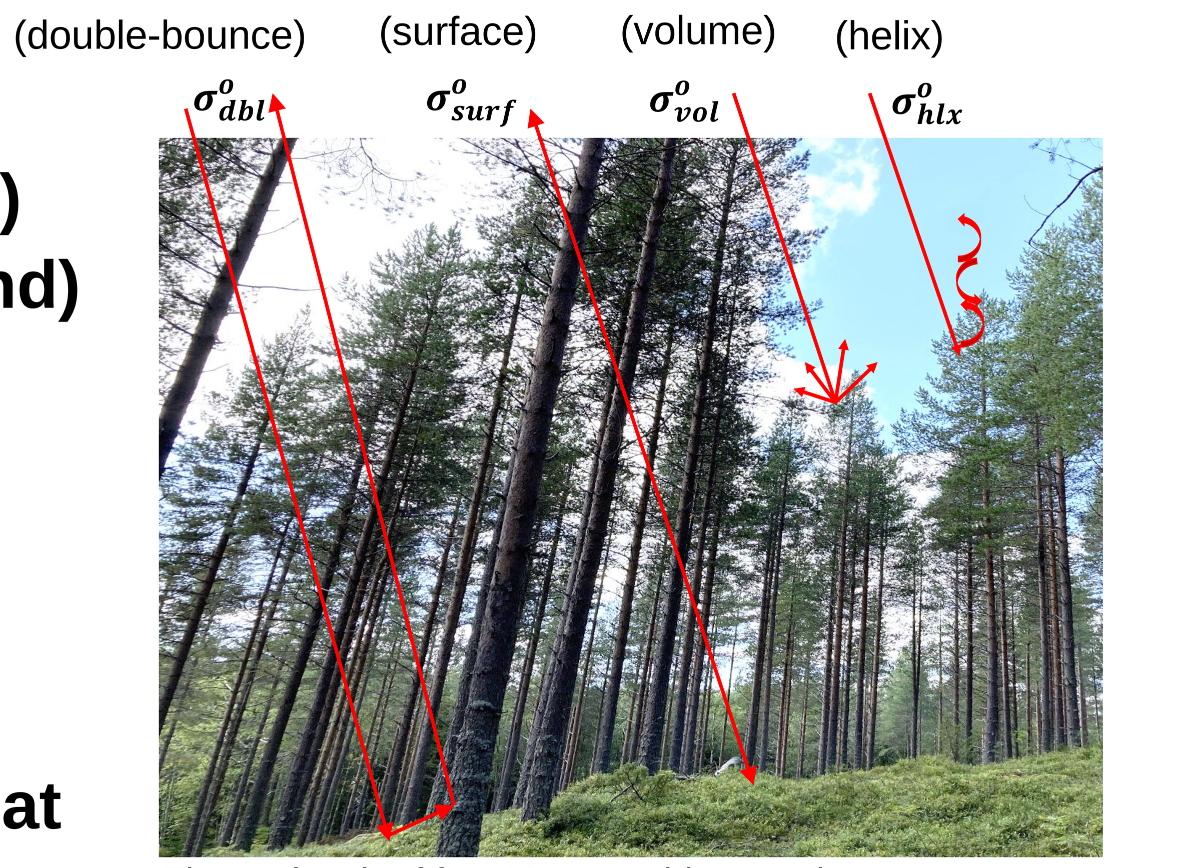
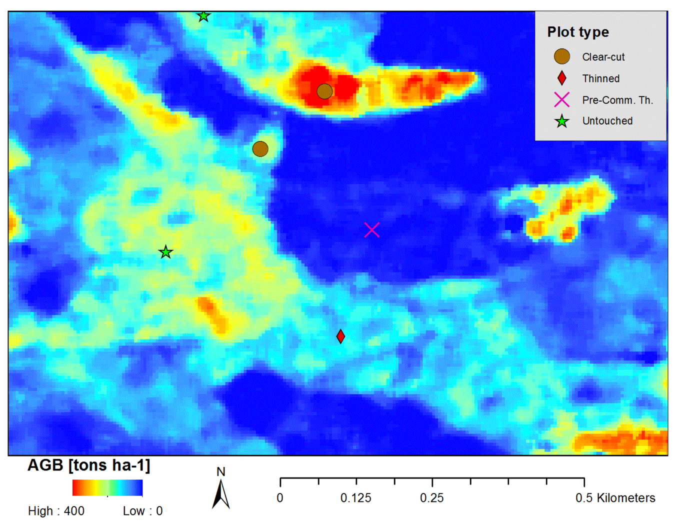


Fig 2: Sketch of four Yamaguchi scattering components.

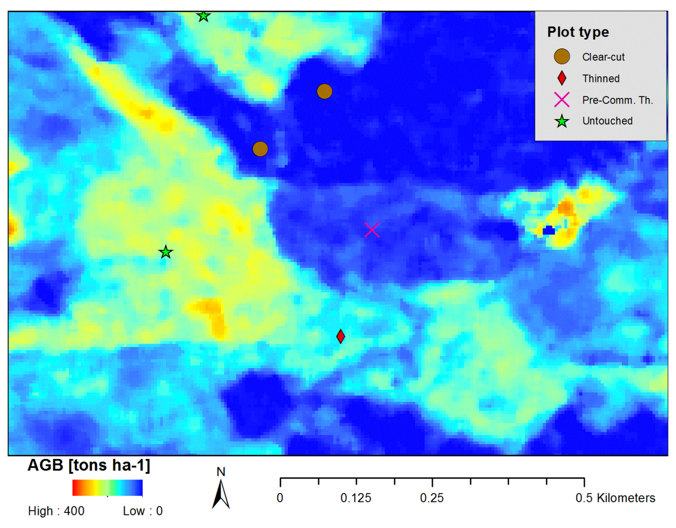
One RS2 quad-pol image was also acquired in 2015 and a dual-pol image in 2020.

The Yamaguchi four-component decomposition model was used to obtain the decomposed scattering components for double bounce, volume, surface and helix scattering from the coherence matrices for the quad-pol image. Only backscatter was derived from the dual-pol image.

Finally, linear regression analysis was used with the InSAR coherence, PolSAR covariates, and dualwave backscatter to derive biomass and biomass change estimates, respectively.



2011



2014

RESULTS

The biomass change was validated on 48 plots (40 m radius, spread in 4 classes). They were captured well with TanDEM-X, with significantly different changes in each class (Table 1 and Fig. 1). The PolSAR variables were used to estimate the AGB with 54.2 tons/ha (34.6%). The use of only backscatter provided poor AGB estimates and hence the biomass change was not successful.

No change	Pre-comm thinned	Thinned	Clear-cut
15.5	17.8	-5.58	-155

Table 1: AGB change in tons/ha estimated from TanDEM-X 4 years difference.

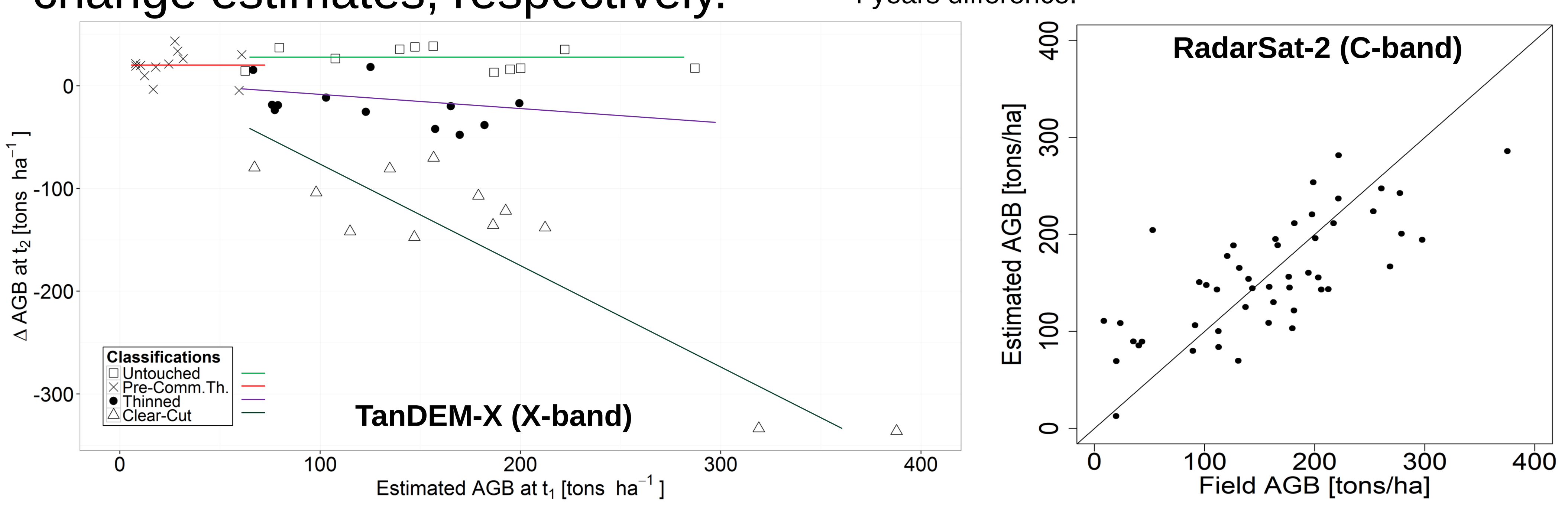


Fig 4: Scatter plots of left) biomass change estimated from TanDEM-X vs. field-references in four classes (no change, pre-commercially thinned, thinned, clear-cut), and right) biomass estimated from Radarsat-2 vs. field-plots.

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