L-Band SAR quantifies a decade of woody vegetation changes in savannas.

Wessels K.J., et al. Quantifying the sensitivity of L-Band SAR to a decade of vegetation structure changes in savanna. (2023) RSE 113369. https://doi.org/10.1016/j.rse.2022.113369

NASA CMS CARBON MONITORING SYSTEM

Science Question

Woody vegetation structure of African savannas are changing rapidly due to climate change, fire regimes, animal management (especially elephants), and intense fuelwood harvesting. The carbon outcomes of these changes and management actions need to be monitored and quantified. The ability of L-band SAR to quantify subtle, long-term changes in structure, (e.g. shrub encroachment) have not yet been clearly demonstrated, largely due to lack of repeat airborne Lidar reference data.

Analysis

The ability of ALOS PALSAR 1&2, backscatter (HH, HV, γ^0) data to quantify woody cover and volume change in savannas over 2-, 8- and 10-year periods was tested through comparison to rare, repeat airborne LiDAR data (ALS), in South Africa (Asner et al. 2016; Wessels et al. 2019).
Cover change was predicted using (i) direct backscatter change or (ii) the difference between annual cover maps derived using Bayesian Water Cloud Model (BWCM) and logarithmic models.

Results

- The linear relationship between $\Delta\gamma^0$ and $\Delta Cover_{ALS}$ between year pairs had R^2 of 0.4-0.7, RMSE = 0.15, (13%). 1dB $\Delta\gamma^0$ corresponded to ~ 0.1 cover change.
- Cover change models could reliable distinguish cover change at 0.25 increments.
- SAR-based cover change maps detected the loss of stands of big trees and widespread increases in cover of 0.35-0.65 due to shrub encroachment. Distinct fence-line effects showed reduction of woody cover in conservation areas potentially caused by rapid increases in elephant numbers and frequent, intense wildfires in reserves (Davies et al. 2018).

Significance

L-band backscatter sensitivity to sparse and short stature vegetation change exceeded expectations, and the NISAR mission requirements of detecting >50% cover change. NISAR will therefore be very useful for monitoring various types of change in global savannas.

Acknowledgements

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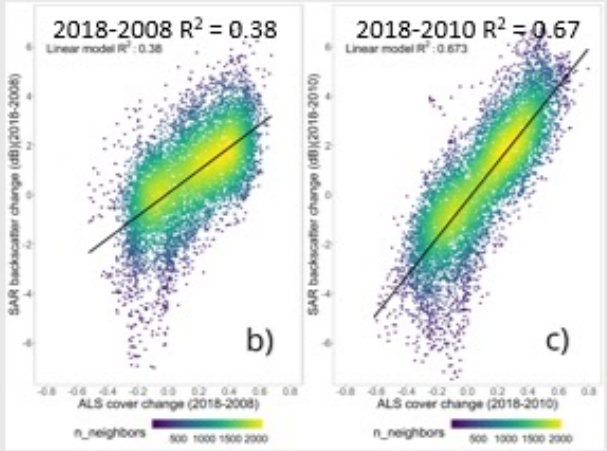

Figure 1. HV SAR backscatter change ($\Delta\gamma^0$) vs. ALS CHM cover change (ΔC_{ALS}).

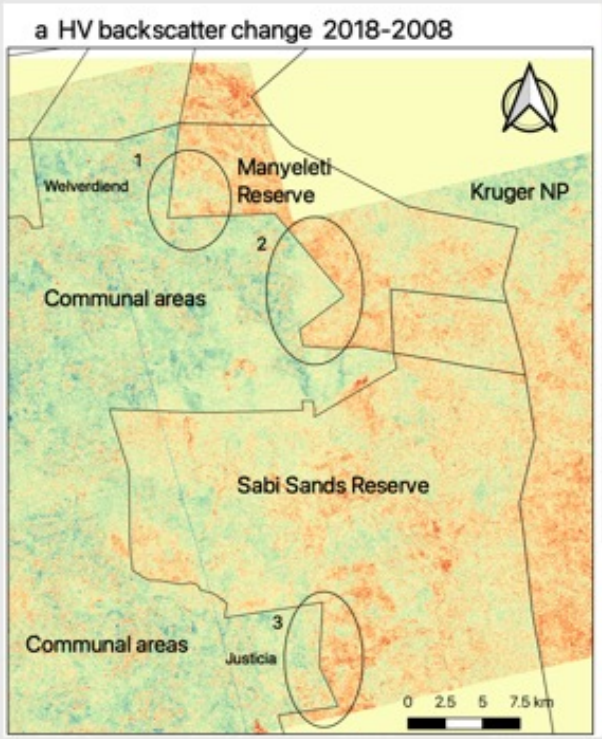

Figure 2. Backscatter change (HV, 15m x 15m), 2018-2008. Fence-line effects: Reductions in γ^0 and woody cover likely caused by high elephant numbers and prescribed burns within conservation areas (sites 1, 2,3).