Aboveground biomass retrieval in tropical forests – the potential of synergistic X- and L-band SAR data use

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Introduction

• Accurate biomass and carbon estimation is the most important requirement for Reducing Emissions from Deforestation and forest Degradation (REDD)

• Tropical forests cover ~15% of the Earth's surface and contain up to 40% of terrestrial carbon (FAO 2009, Page et al. 2009)

• SAR systems are weather and daylight independent which is very advantageous in the tropics with frequent cloud coverage

Study objectives

• Potential of combined X- and L-band SAR data use for above-ground biomass retrieval

• Up-scaling of biomass reference data:

in-situ data* ➡ *LiDAR estimations* ➡ *SAR estimations

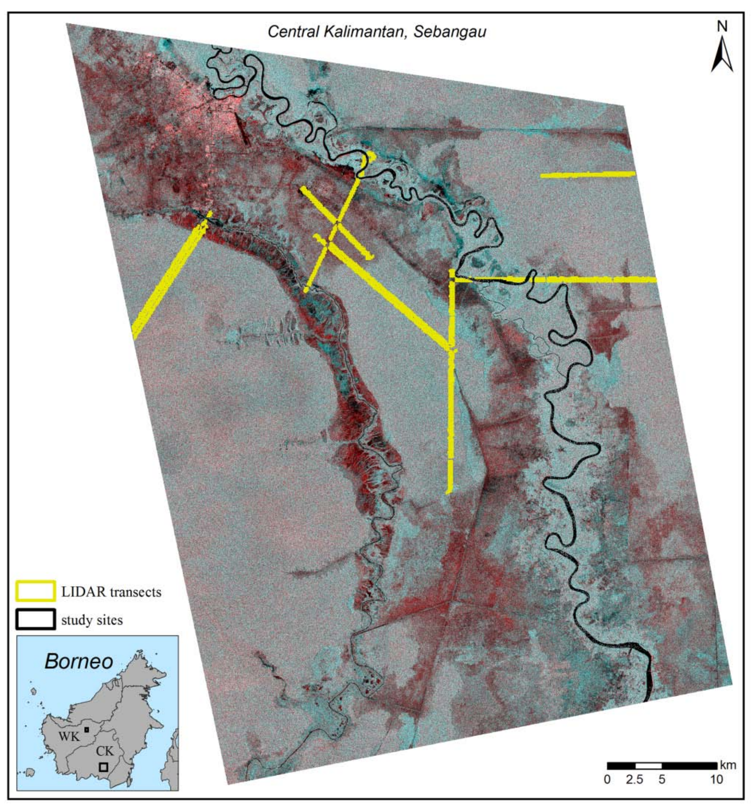


Figure 1: Multi-sensory image combining TerraSAR-X (R) and ALOS PALSAR (GB) scenes

Table 1: Properties of remote sensing data used for the study in Central Kalimantan, Indonesia

Sensor	date (dd/mm/yyyy)	polarization	pixel spacing (m)	incidence angle
Central Kalimantan, Sebangau				
ALOS PALSAR *fine resolution*	07/09/2007	HV	12.5	38.8°
	24/08/2007	HV	12.5	38.8°
	10/09/2007	HV	12.5	38.8°
	26/05/2008	HV	12.5	38.8°
	26/08/2008	HV	12.5	38.8°
	11/10/2008	HV	12.5	38.8°
TerraSAR-X *ScanSAR*	14/06/2008	VV	8.25	32.1°
	08/08/2008	VV	8.25	29.9°
	30/08/2008	VV	8.25	32.1°

Study area

• Study site in Central Kalimantan (298,745 ha), Borneo/Indonesia

• Located in flat, alluvial plains comprising peat swamp forests (intact, heavily degraded or regrowing)

• Peatlands have an enormous carbon storage: aboveground forest biomass and belowground peat deposits

Methods

• SAR data: calibration, co-registration, speckle filtering

• Up-scaling of biomass reference data: airborne LiDAR measurements were in turn calibrated to field inventory data (Kronseder et al. 2010)

→numerous biomass reference data (n= 3,970) representing the spatial distribution over the whole biomass range (*Fig.2*)

Biomass modeling of TerraSAR-X and PALSAR backscatter

→mono- and multi-temporal

→alone and in combination

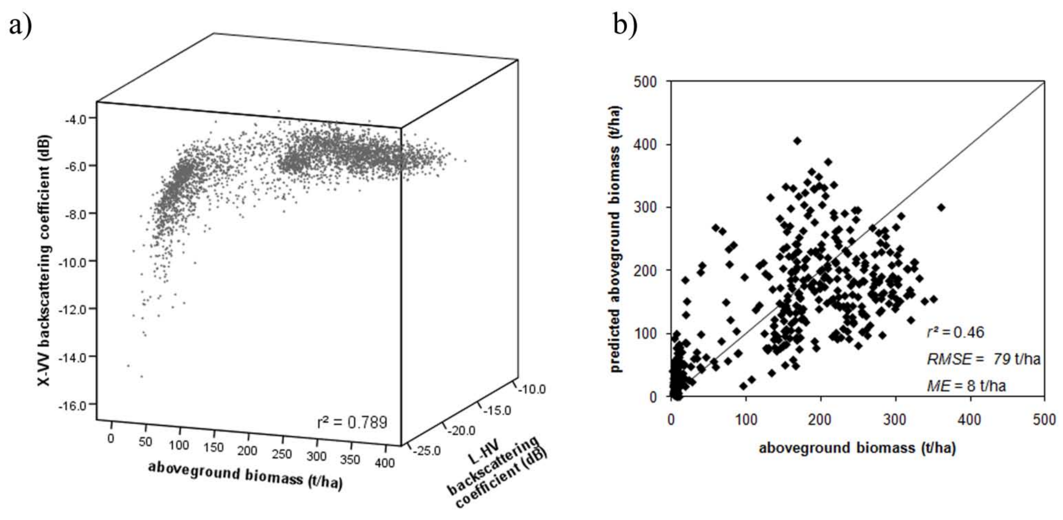


Figure 2:
a) Multi-temporal correlation between biomass, TerraSAR-X and ALOSPALSAR backscatter signal
b) Corresponding estimated vs. actual biomass of the independent validation

Results and Discussion

❖ <u>X- and L-band combined multi-temporal biomass estimation model achieved the best results</u>

→multi-temporal models compensate extreme climatic conditions

→different penetration depths of X- and L-band signal into the vegetation (X-band signal more sensitive to low biomass, L-band signal more sensitive to high biomass) (*Fig.4*)

❖Spatially and temporally transferable (*Fig.3*)

❖ Biomass estimation model valid up to 600 t/ha

→accuracy decreases at high biomass values

→up-scaling approach makes regression models powerful, even in high biomass ranges

→average biomass estimation of different forest types very accurate featuring the spatial distribution (*Fig.3*)

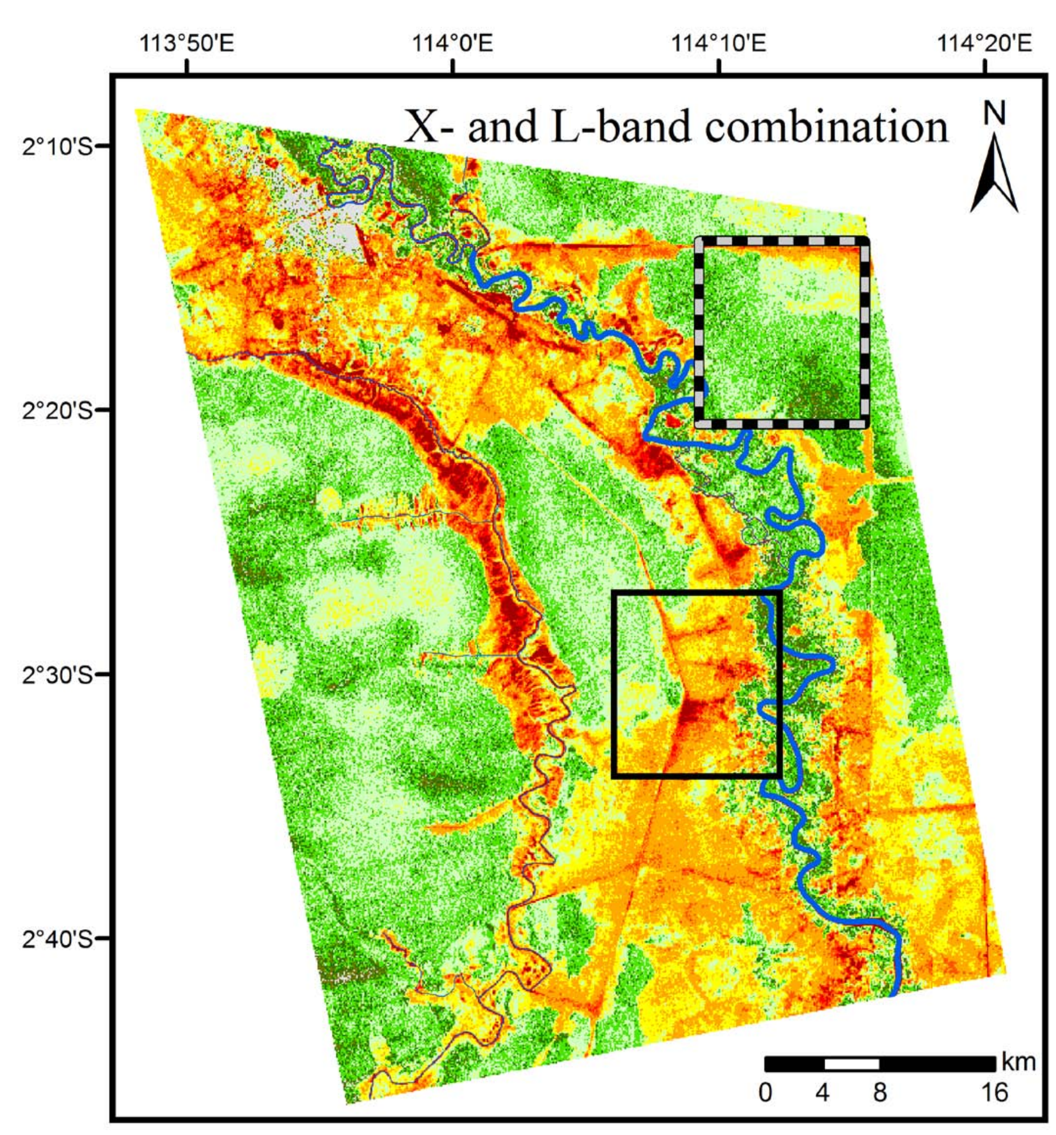
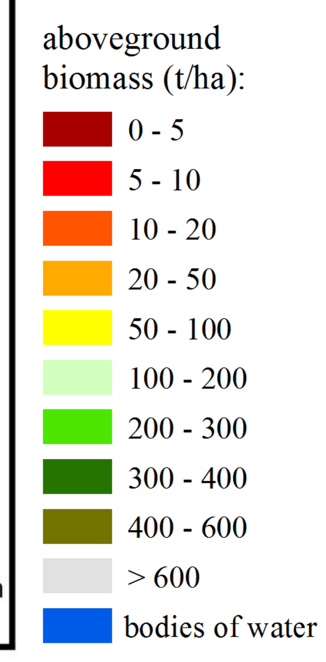


Figure 3: Application of the multi-temporal combined regression model to the whole study site indicating the extent of the subsets shown in Fig.4



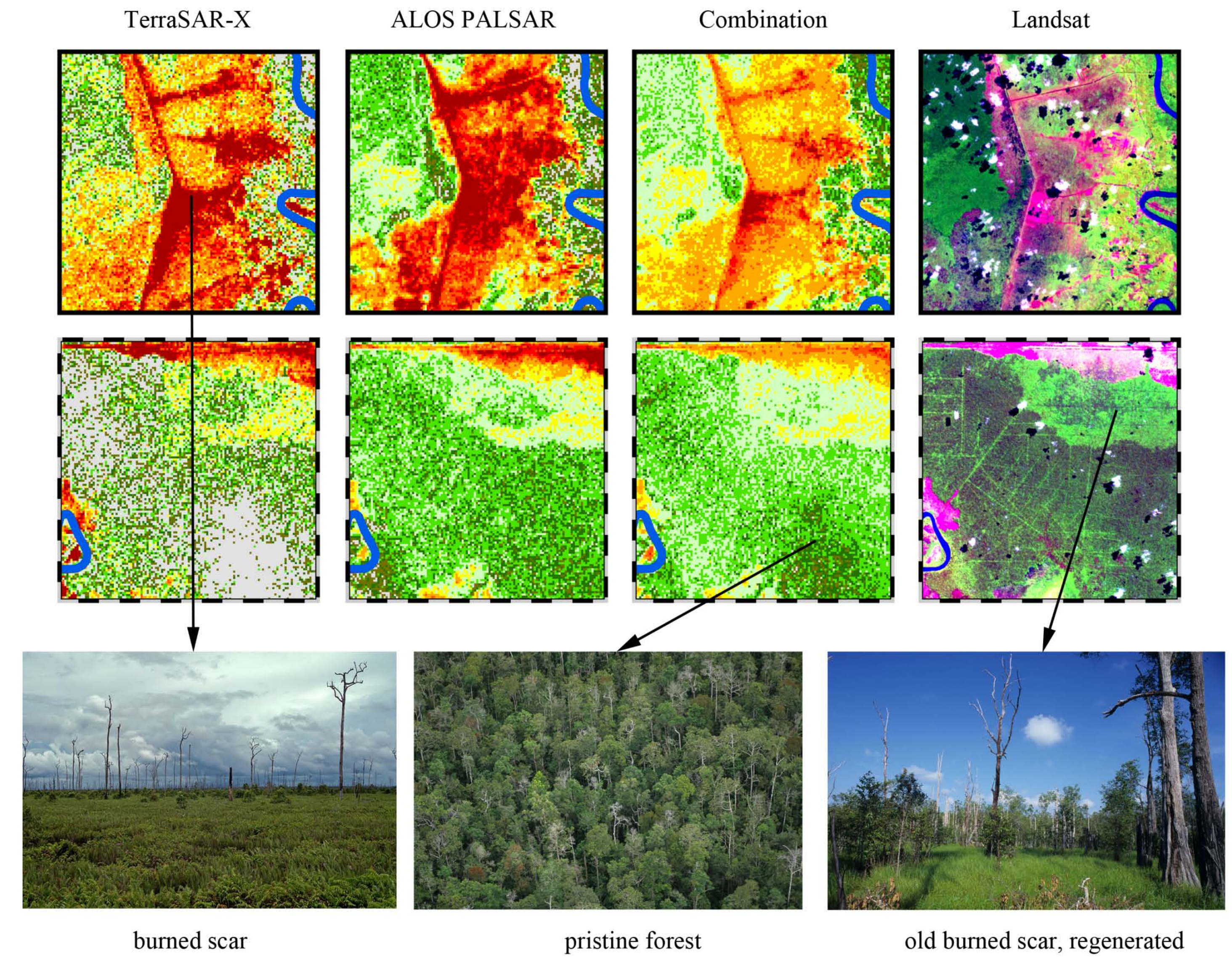


Figure 4: Application of multi-temporal TerraSAR-X, ALOS PALSAR and combined regression models to the study area with details of deforested areas with low biomass (fat-line) and peat swamp forests with high biomass (dashed-line). Arrows and photographs show examples of different land covers (© F. Siegert)

References

FAO (2009). State of the World´s Forests 2009. *Food and Agriculture Organization of the United Nations, Rome, Italy,* http://www.fao.org/docrep/011/i0350e/i0350e00.htm

Kronseder, K., Ballhorn, U., Böhm, V., and Siegert, F. (2010). Estimation of above ground biomass across forest types at different degradation levels in Central Kalimantan (Borneo) using LiDAR and field inventory data. *Forest Ecology and Management*, submitted

Page, S.E., Hoscilo, A., Langner, A., Tansey, K., Siegert, F., Limin, S. et al. (2009). Chapter 9: Tropical peatland fires in Southeast Asia. In: Cochrane, M. A. (Ed.), *Tropical Fire Ecology: Climate Change, Land Use, and Ecosystems Dynamics*. (pp. 263 - 287). Berlin: Springer-Praxis

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