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Introduction:

The peat swamp forests of Southeast Asia contain large amounts of carbon within both the living biomass of the forest and thick layers of organic peat, accumulated over thousands of years (1). Degradation of the forests, defined by a gradual loss of canopy cover and forest biomass, is caused by a combination of logging, fire and peat drainage and can lead to large emissions of carbon (2). Intact forest is relatively resistant to disturbance but degradation results in vegetation types prone to further disturbance and a positive feedback that rapidly transforms forests to open, non-woody vegetation types, resulting in a flux of carbon to the atmosphere through decomposition and combustion of peat and woody biomass.

Tropical forests currently act as sinks of atmospheric carbon (through photosynthesis) and as sources through land use change. There is, however, large uncertainty in the carbon budgets of tropical forests (3). Such uncertainties will have to be resolved in order to implement schemes such as REDD and this is most likely to occur through a combination of ground based biomass measurements and remote sensing. The functioning of optical remote sensing systems in the tropics is, however, severely impaired by cloud and smoke haze which can obscure images. Data from the PALSAR instrument onboard the Japanese ALOS satellite remains unaffected by these problems. We are currently investigating the utility of the instrument for detecting and measuring degradation of tropical peat swamp forest in Indonesia and present a preliminary analysis of our results.



Figure 1. Vegetation types across a degradation gradient in Central Kalimantan, Indonesia. From left to right intact forest, advanced regrowth, degraded area with some regrowth and a completely degraded area.

Methods:

Above ground woody biomass was measured for 2355 trees in 51 subsampled plots at 17 locations in Central Kalimantan, Indonesia in July and August 2009 across a range of degradation scenarios from intact forest to open fern-dominated vegetation (Figure 1). From this we calculated the above ground biomass in tonnes per hectare of dry wood using allometric equations (4, Figure 2). Biomass data were compared to the radar reflectance and 46 day coherence extracted from the sampled locations in georeferenced ALOS PALSAR dual polarisation mode (FBD) images acquired at the end of 2008 (Figure 3). The resulting curves were modelled using an exponential line of best fit and these models were then applied to the whole FBD image to give a (very preliminary) map of the biomass in degraded areas (Figure 4).

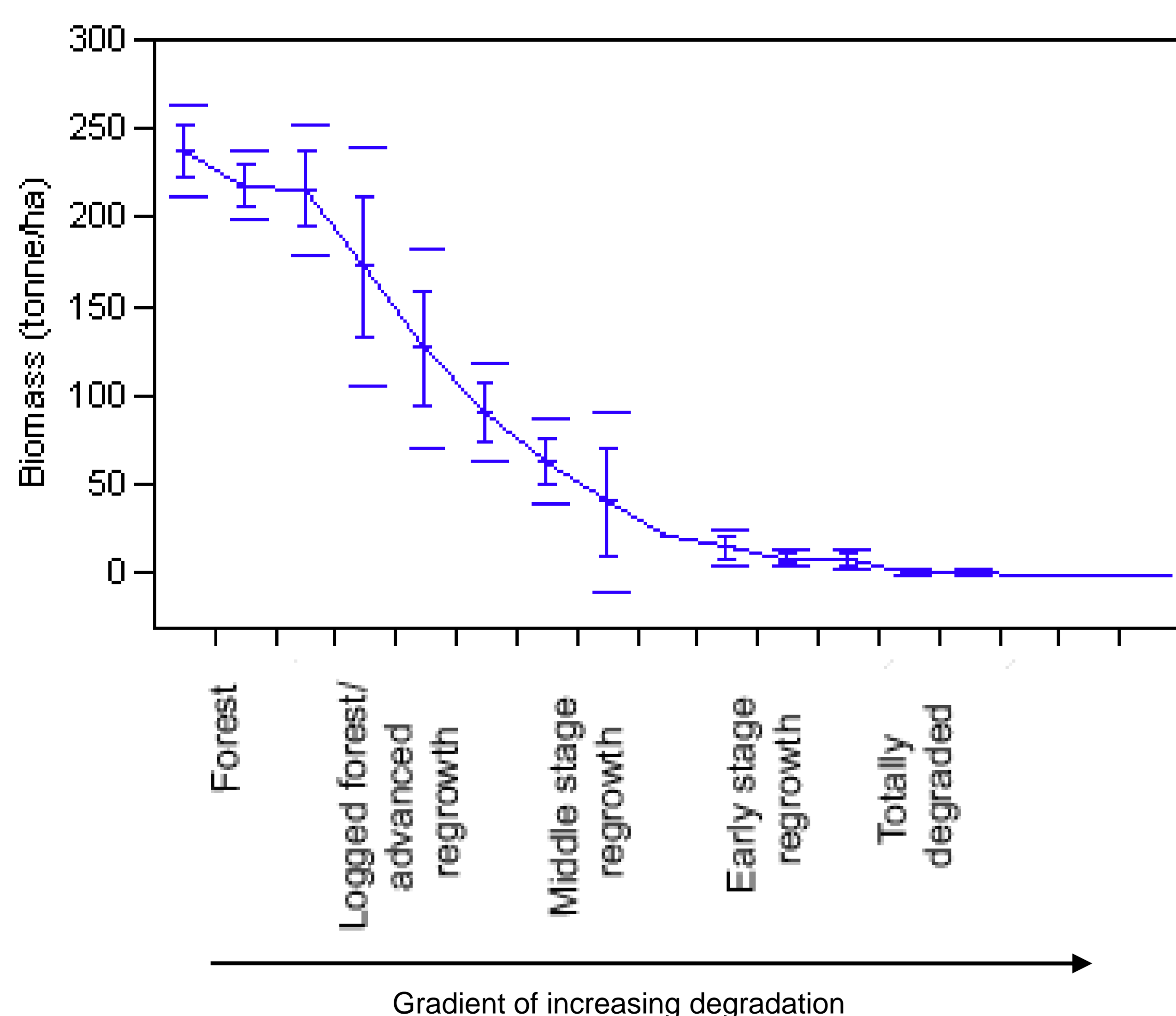


Figure 2. Above ground woody biomass across a gradient of forest degradation in Central Kalimantan, Indonesia. Mean and one standard error given by connected bars, one standard deviation given by outer whiskers

Results & Discussion:

Above ground biomass predictably decreased across our gradient of degradation. Forests and completely degraded areas showed relatively low variation in biomass, whereas areas in the middle of the gradient (i.e. in the process of degradation and regrowth) showed greater variation. This corresponds with the highly heterogeneous landscape experienced on the ground.

ALOS PALSAR dual polarisation data values plotted against above ground biomass for block C of former Mega Rice Project, Central Kalimantan.

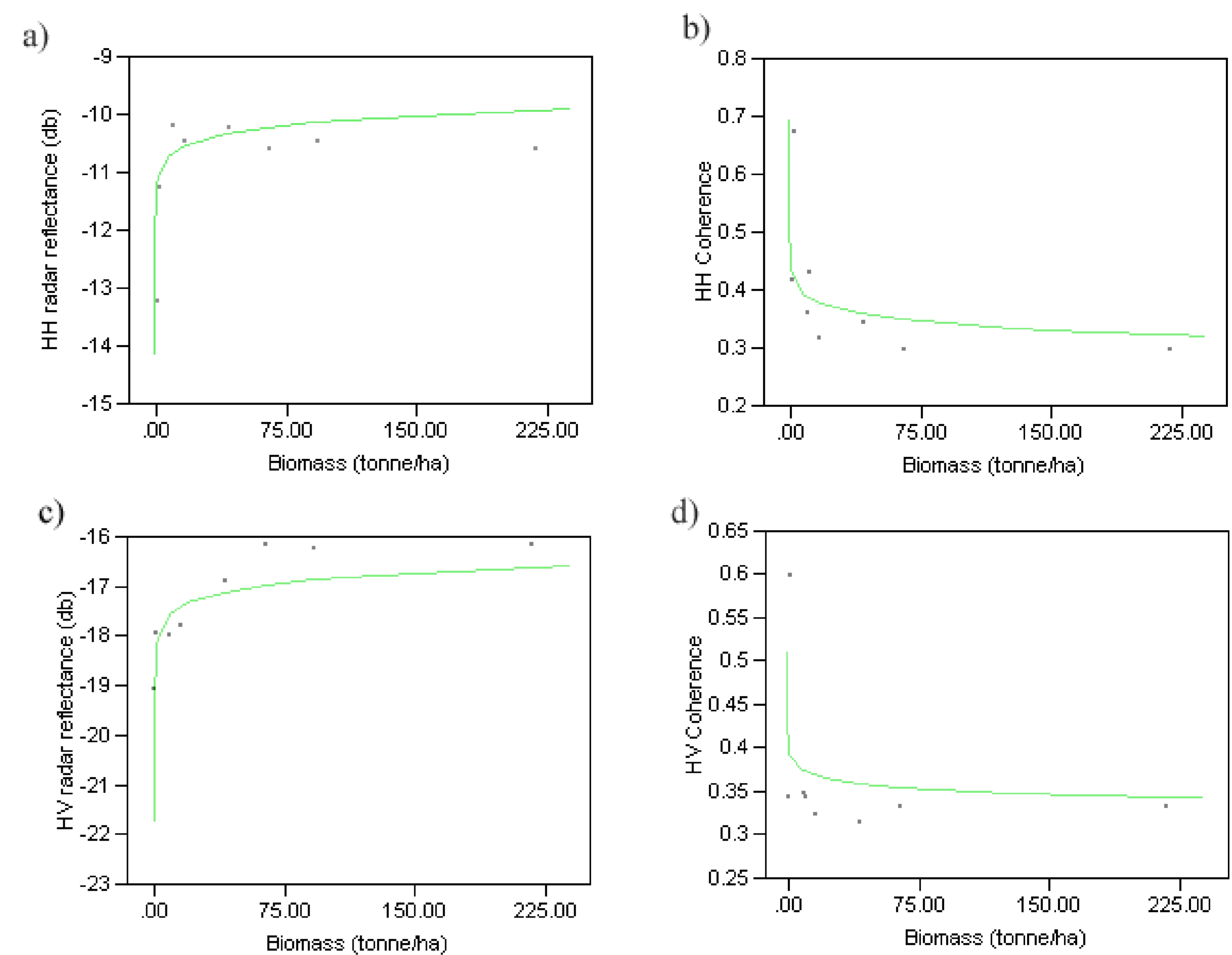


Figure 3. Response of ALOS PALSAR FBD data to woody biomass in intact and degraded Peat Swamp forest in Indonesian. Points are real data and green lines are fitted models. A) HH intensity, b) HH coherence, c) HV intensity and d) HV coherence.

Results & Discussion (continued):

Figure 3 shows relationships between measured biomass and the radar variables, with coherence decreasing with increasing woody biomass whilst backscattered intensity increases. All sets of graphs show a maximum response between 10 and 100 tonnes per hectare. At values greater than this the signal becomes saturated, indicating that HH & HV intensity and coherence data will not be able to directly detect the first stages of degradation which occur in intact forests. HV intensity appears to have the greatest utility in directly measuring biomass in this range (Figure 3) and was used to produce Figure 4.

There was a significant delay between the acquisition of imagery and the collection of field data and this may have reduced the correlation. Future acquisitions will eliminate this problem and enable us to include more ground data when constructing relationships between biomass and radar variables. As we collect more data sets we hope to be able to track changes in biomass loss and regrowth through time. We will also be investigating (i) data processing methods (e.g. detection of ground reflectance) that will allow us to extend the upper limit to measuring biomass, and (ii) integration

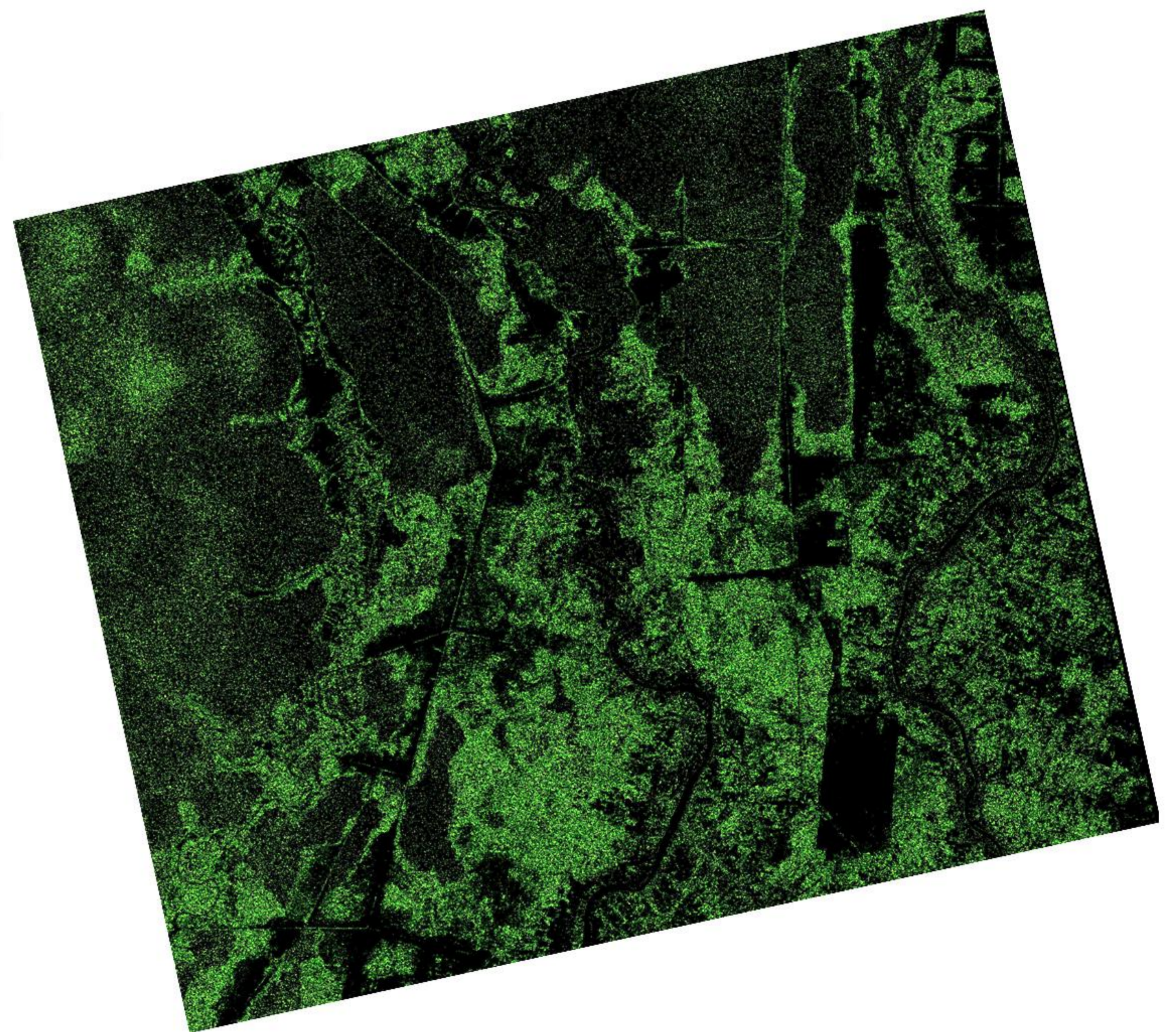


Figure 4. Map of estimated biomass values produced by applying the equation for modelled biomass to the entire ALOS PALSAR HV scene. Values <5 and >100 tonnes per hectare have been masked out and appear in black. Lighter shades of green indicate higher biomass up to the 100 tonne limit of detection.

References:

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