THE AUSTRALIAN NATIONAL UNIVERSITY

# What we have leant about carbon accounting in natural forests and pit falls to avoid


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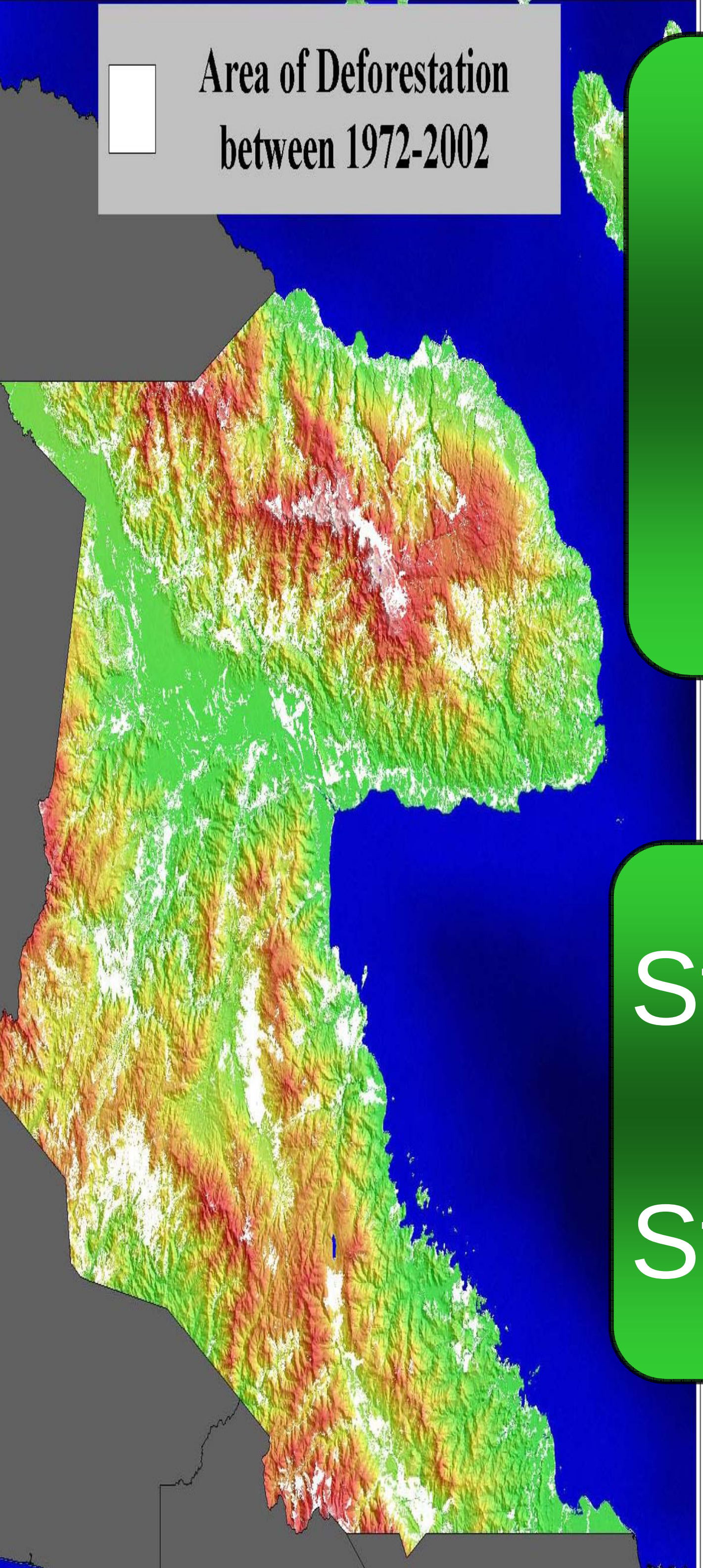
Natural forests are different to industrialized forests, especially plantations.

We have learnt many lessons from our research into carbon accounting in the natural forests of Australia, PNG (Peter Hitchcok) and Indonesia (Phil Shearman)

http://forestpathology.cfans.umn.edu/photos/Gyrinops%20PNG.JPG




The differences between natural and industrialized forests have important implications for carbon accounting

Step 1. Get the concepts right

Step 2. Get the data right


1. For carbon accounting in natural forests, a baseline must be established, that takes into account environmental heterogeneity and land use history.

We need estimates of three variables:

- Natural Carbon Carrying Capacity
- Current Carbon Stocks
- Carbon Sequestration Potential

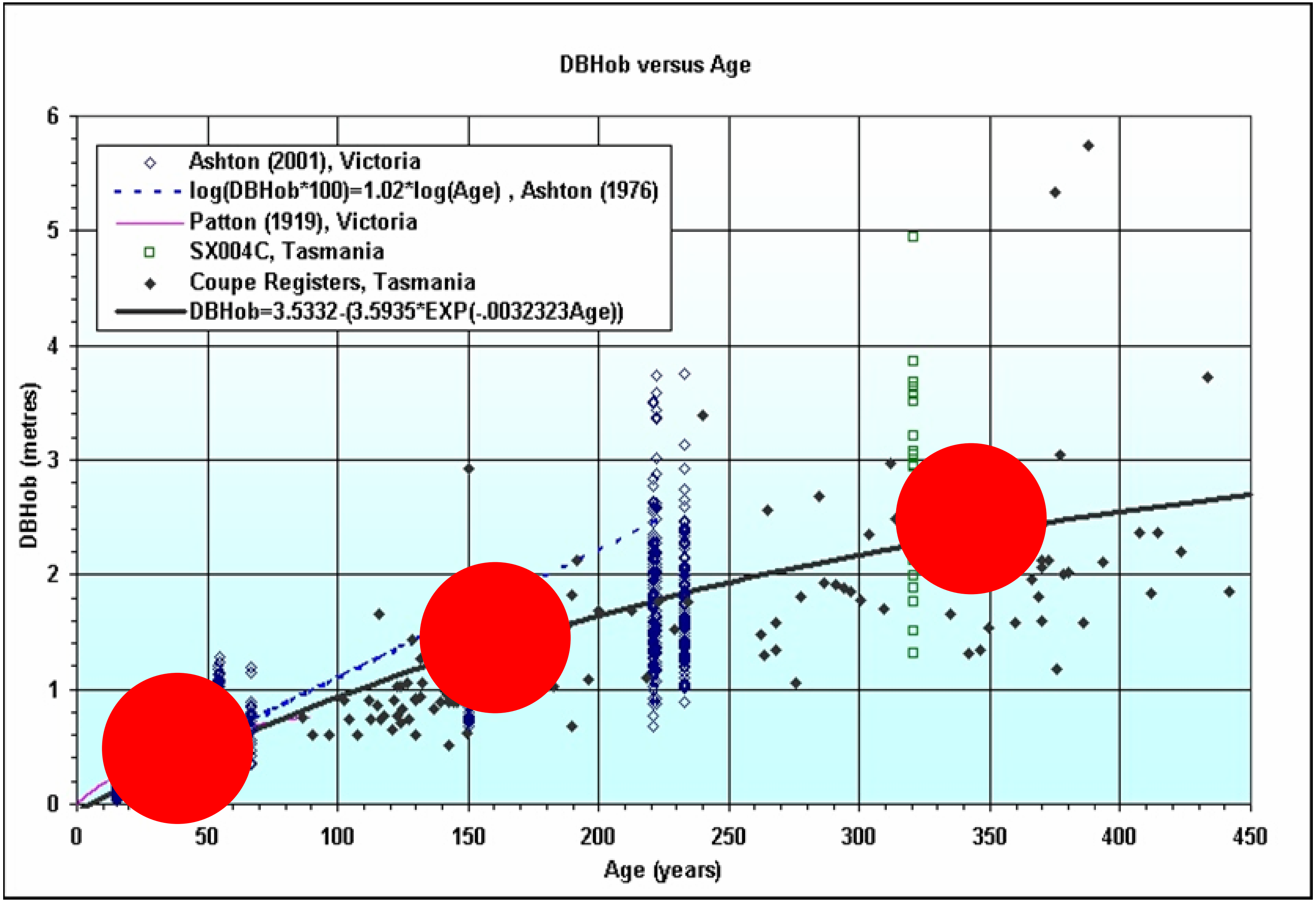
The natural Carbon Carrying Capacity is the mass of carbon able to be stored in a forest ecosystem under prevailing environmental conditions and natural disturbance regimes, but excluding anthropogenic disturbances.

2. Carbon stocks are much larger and have longer residency times

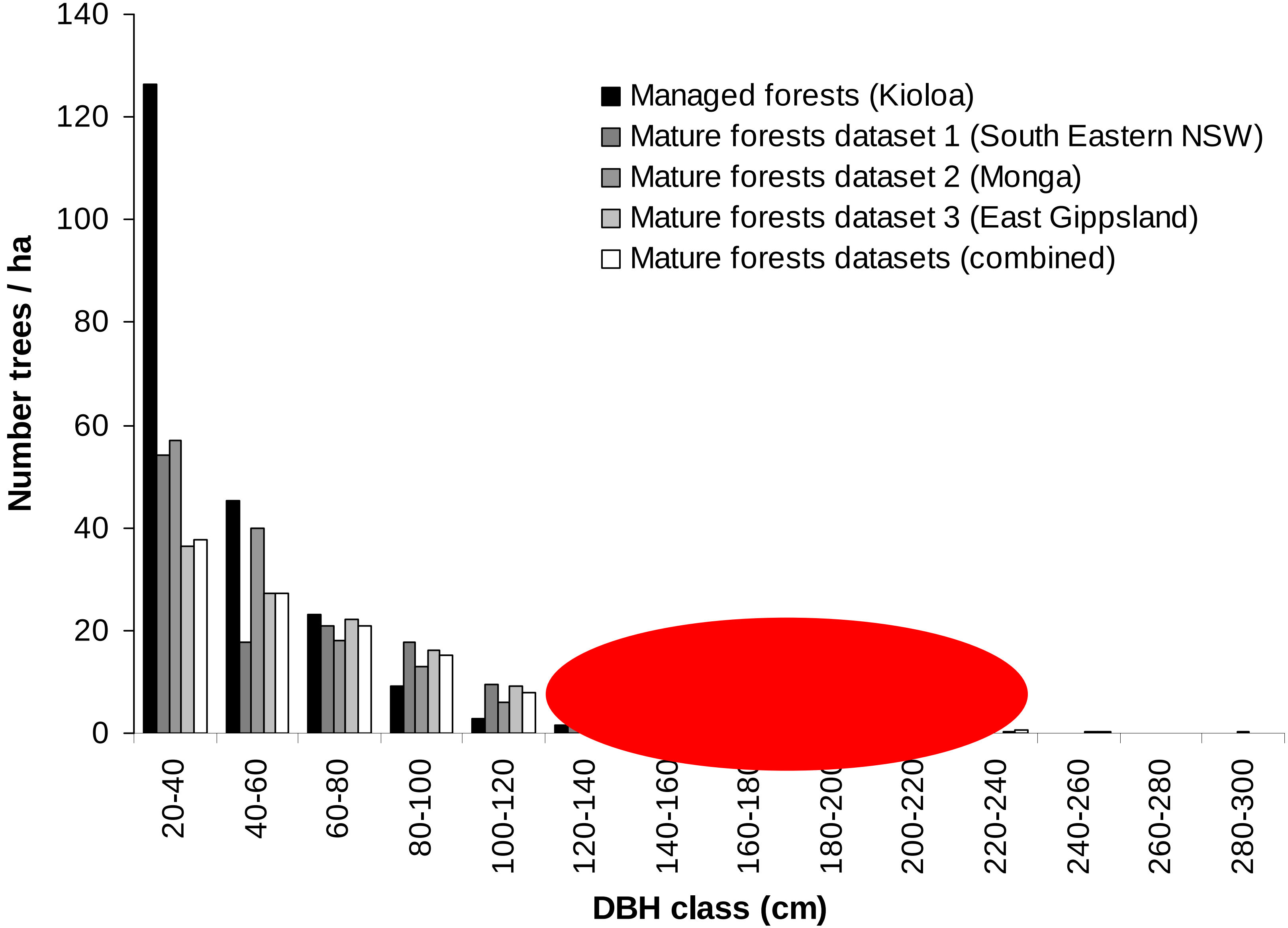
Primary forest ‘turn over’ time is up to 1,000 years and primary canopy tree species are dense and slow growing, living for 100’s of years.

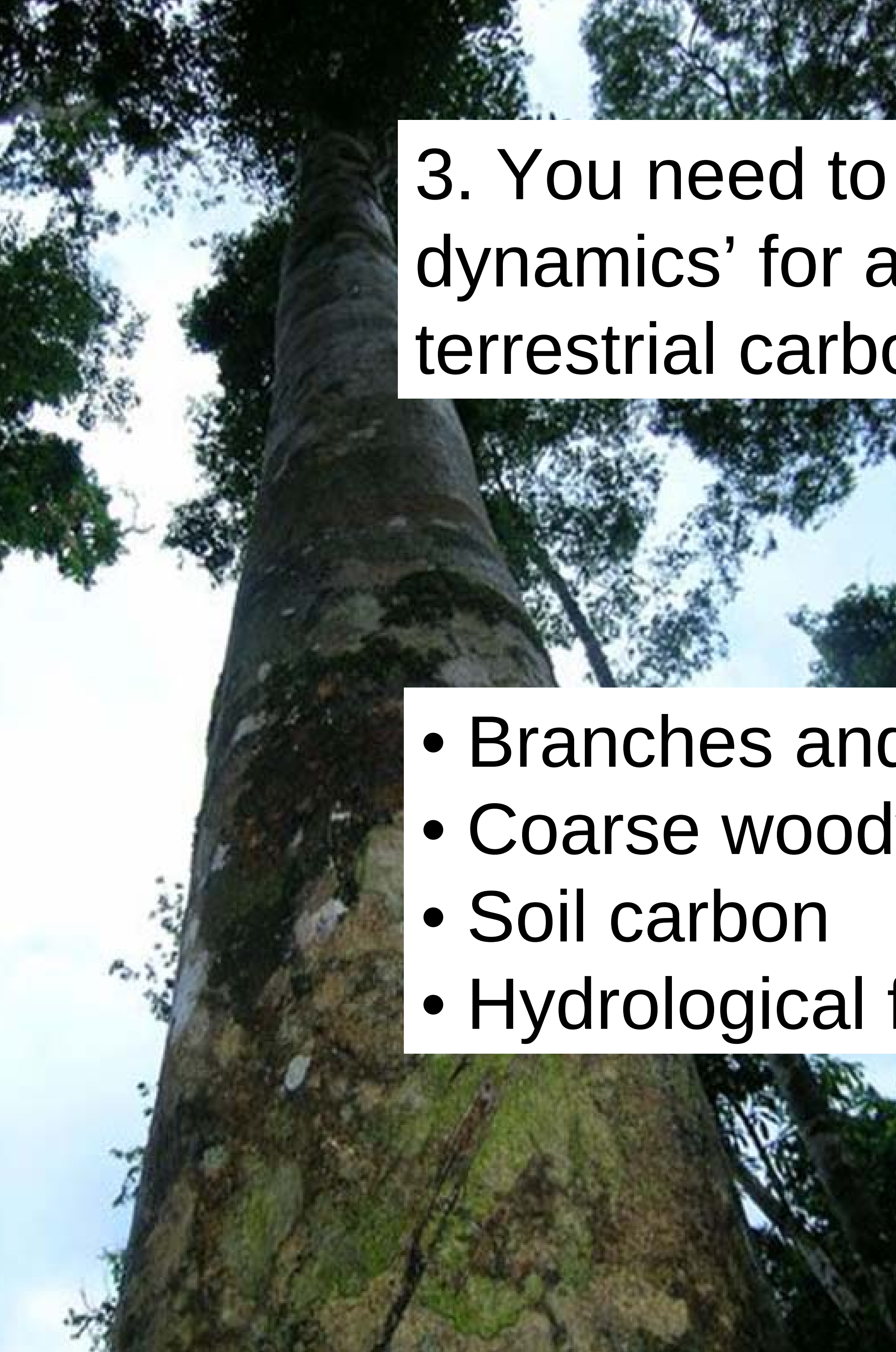
Forestry forecasting models are only calibrated for young, re-growth forests

Allometric equations for estimating tree biomass from DBH must be based on samples of old trees



Most of the carbon in a natural forest is in the big old trees, and these are largely removed over the logging cycle. So, your models must be calibrated from samples in intact forest

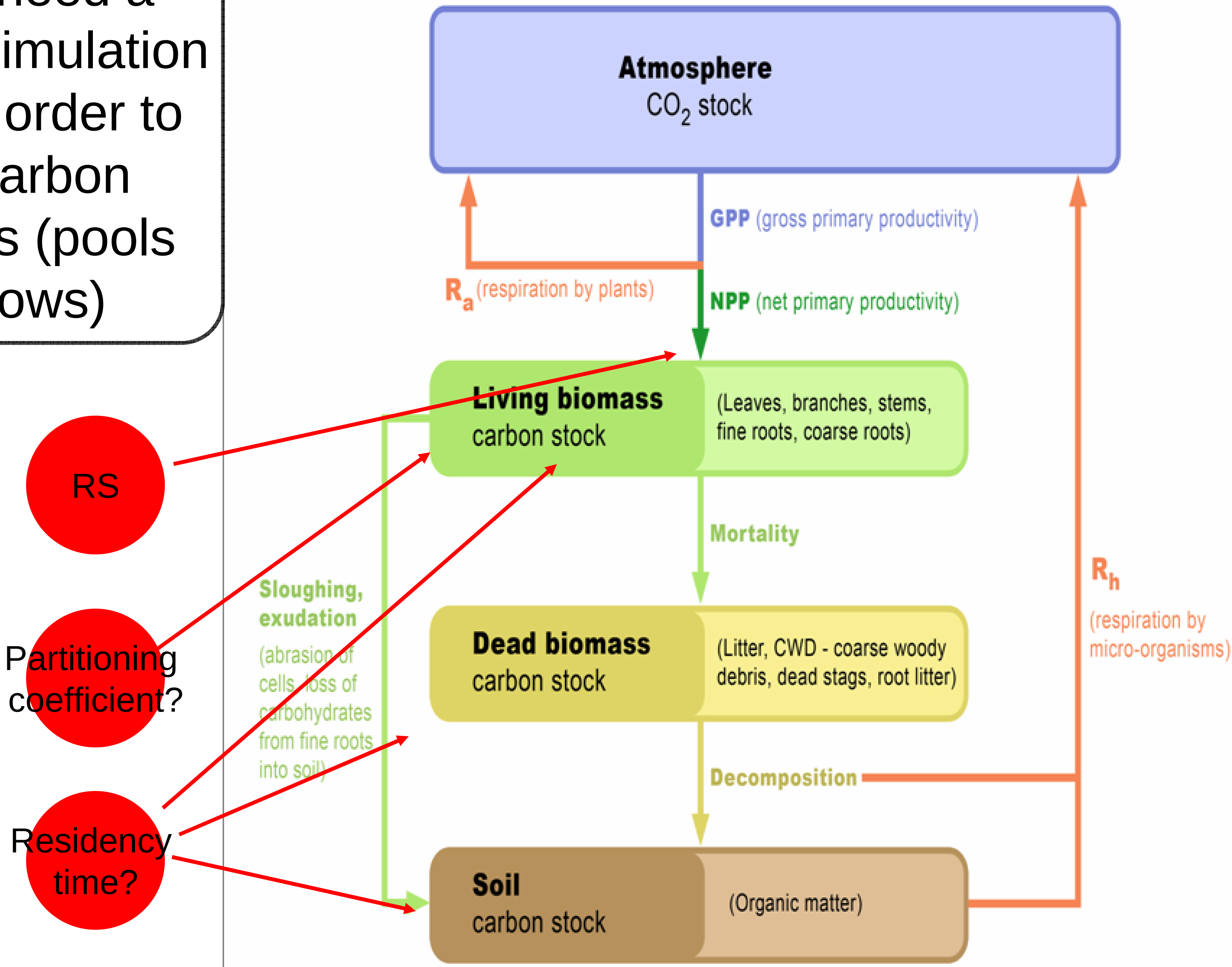




3. You need to account fo the ‘carbon dynamics’ for all forest pools in the terrestrial carbon cycle…

- Branches and roots
- Coarse woody litter
- Soil carbon
- Hydrological flux of carbon

So, we need a dynamic simulation model in order to track carbon dynamics (pools and flows)



Over the logging cycle, the *current carbons stock* is lowered relative to natural *carbon carrying capacity*, creating a *carbon sequestration potential*

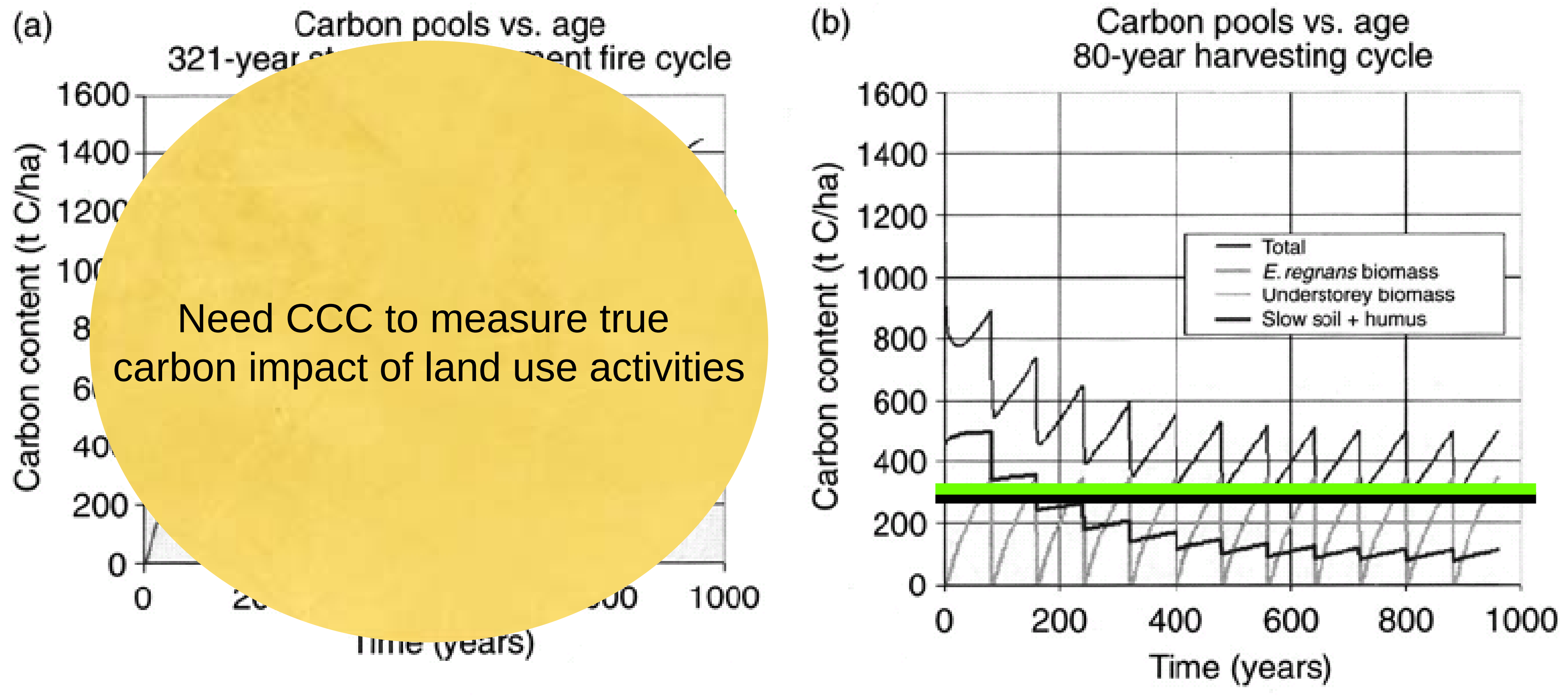
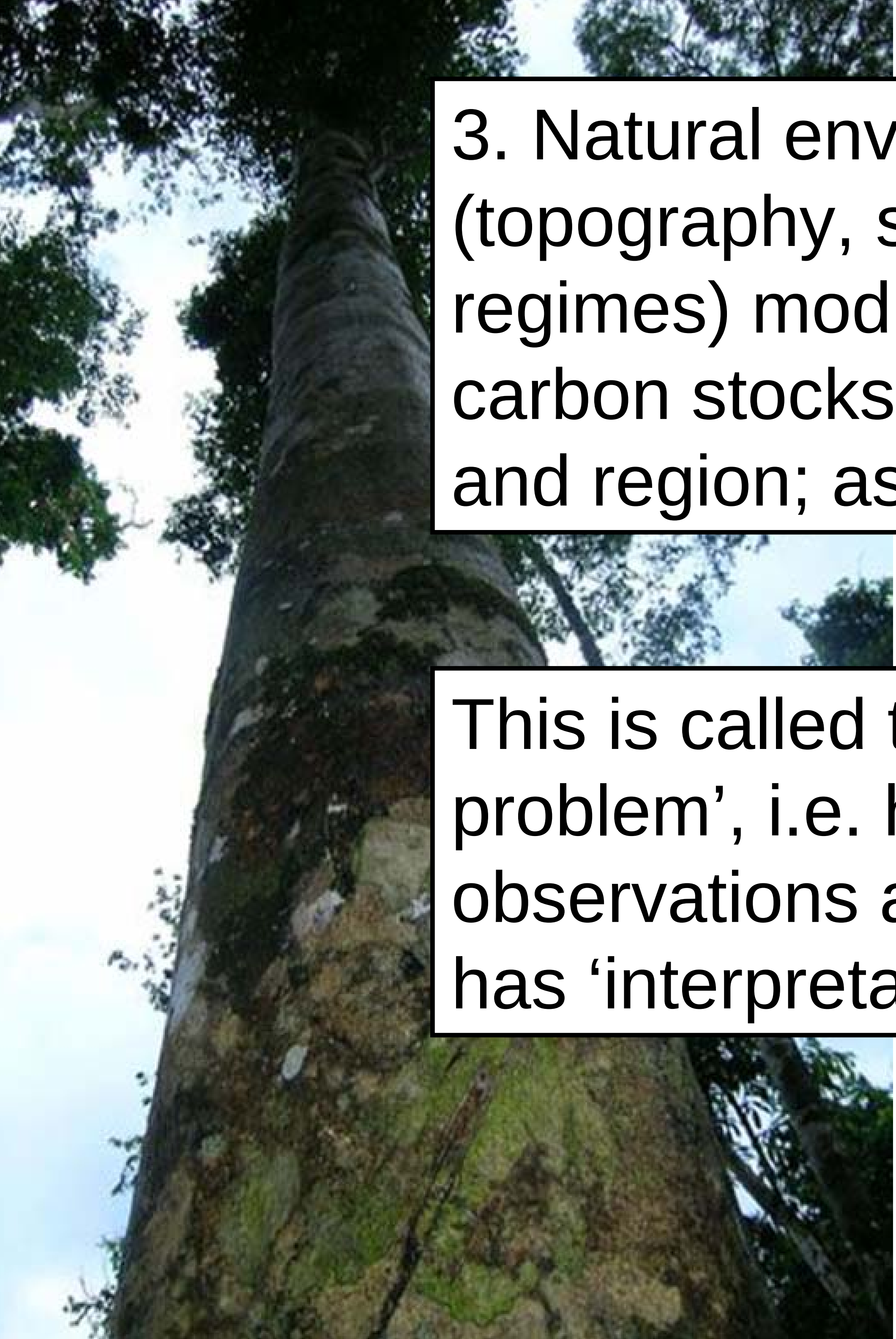


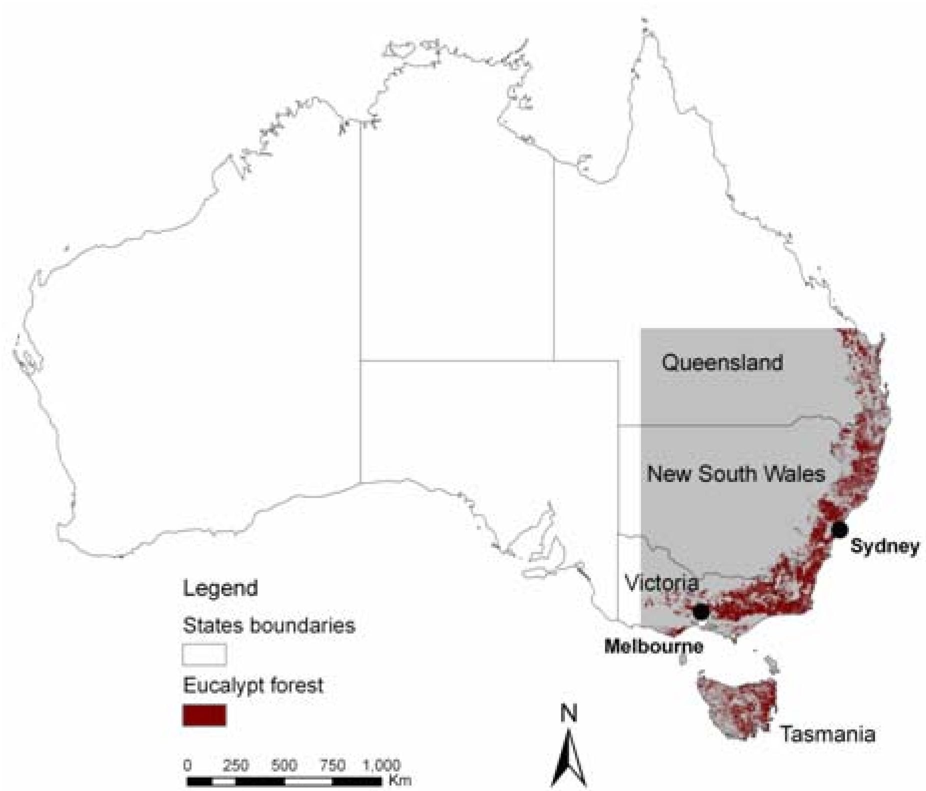

**Fig. 3.5.** Carbon pools. Starting from ten cycles of 450 years then a further 321 years of growth followed by (a) further stand replacement fires every 321 years (without logging); and (b) clearfelling for pulp followed by reforestation and harvesting for sawlog every 80 years. Total includes wood products.

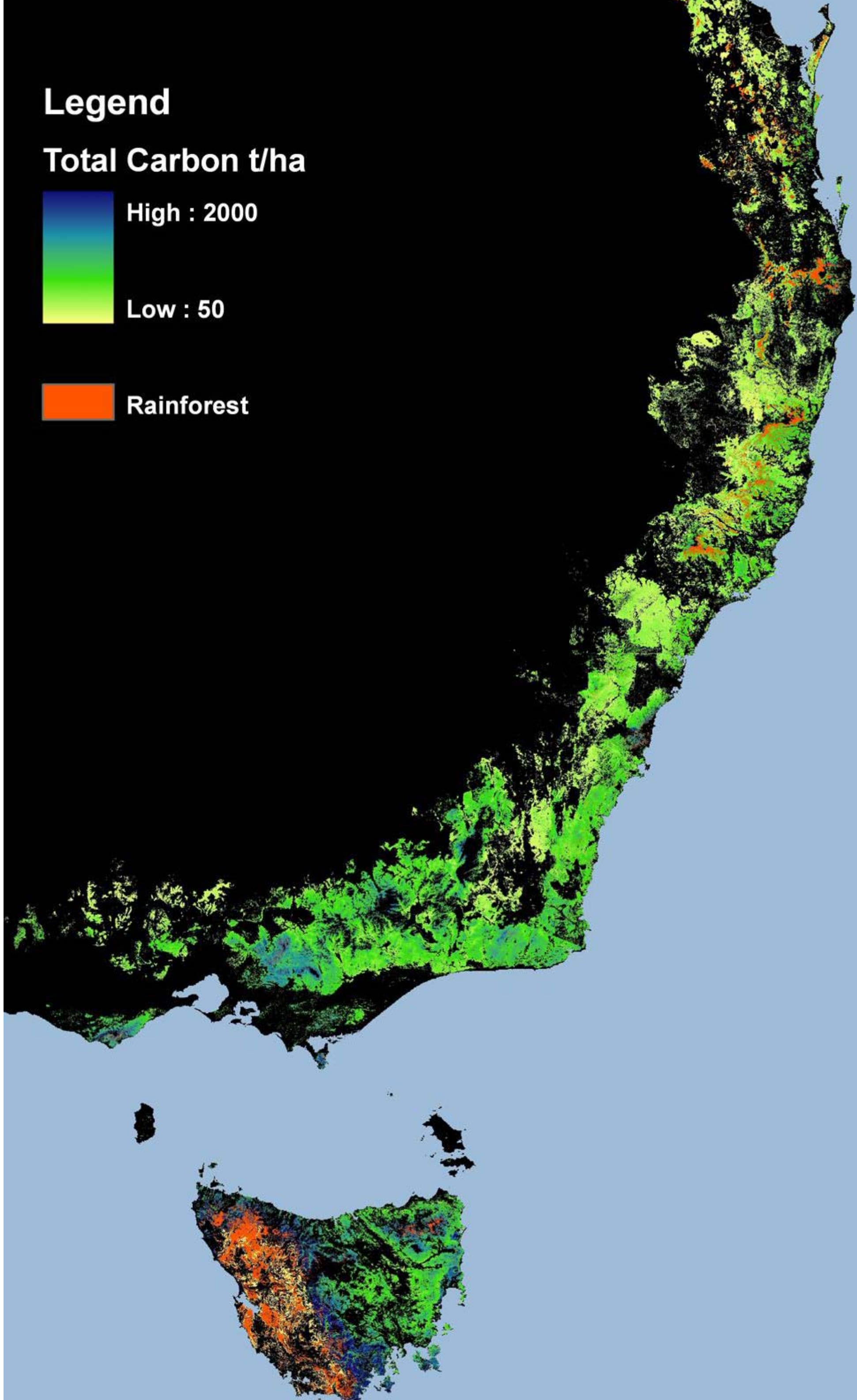


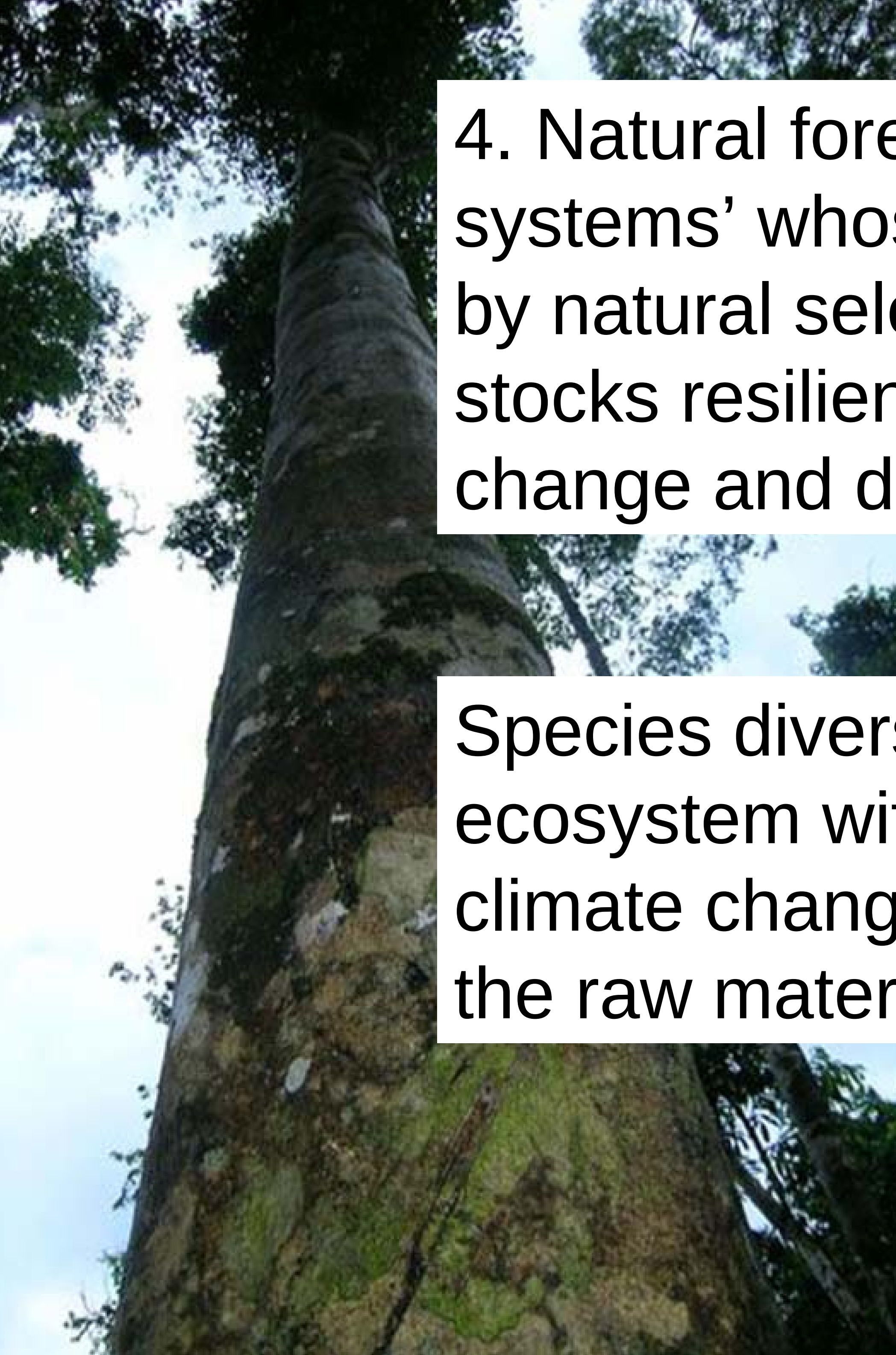
3. Natural environmental heterogeneity (topography, soil, climate, disturbance regimes) modifies GPP & NPP, so that carbon stocks vary across the landscape and region; as can GPP:NPP

This is called the ‘spatial extension problem’, i.e. how to extrapolate field observations across the landscape? (RS has ‘interpretation problem’)

We have modelled the effect of environmental heterogeneity on geographical variability in the natural *Carbon Carrying Capacity*





4. Natural forests are 'complex adaptive systems' whose biodiversity, managed by natural selection, gives the carbon stocks resilience to environmental change and disturbance

Species diversity provides the ecosystem with 'options' in responding to climate change, and genetic diversity is the raw material for local adaptations

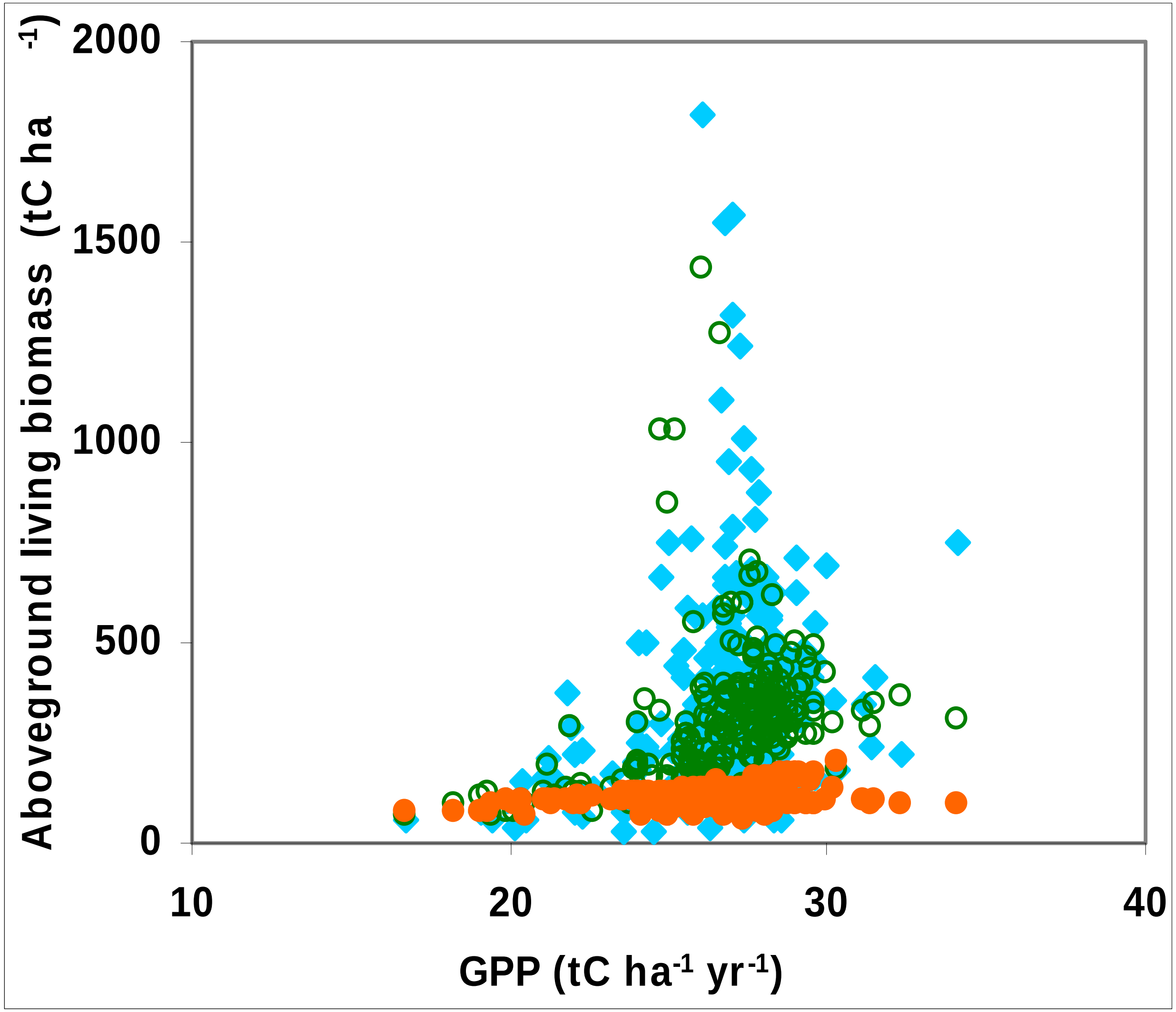
Using default values or unrepresentative data can result in poorly calibrated models and inaccurate output

# Compare our results with default IPCC values for temperate forest

| | Carbon Stock (t C ha$^{-1}$) | | | |
|---|---|---|---|---|
| | **Soil** | **Total biomass** | | **Total** |
| **ANU** | 280 (161) | 360 (277) | | 640 (383) |
| **IPCC** | 122 | 96 | | 217 |

# ANU estimates compared with NCASS which is calibrated for early re-growth forests

Comparison of GPP (calculated by ANU methods) with biomass estimates derived from (i) NCAS (orange), (ii) field sites (blue), and (iii) our modelled relationships between NPP and environmental variables (green).



Forest degradation must be defined in terms of human activities that reduce the *Current Carbon Stock* relative to the natural *Carbon Carrying Capacity*.

We need to distinguish between (1) degraded forests and (2) intact forest when considering policy and mechanisms for REDD

The ‘low hanging fruit’ lies in (a) keeping intact natural forest intact, (b) allowing logged forest to regrow its natural carbon carrying capacity, and (c) directing plantation forestry to already degraded forest land which has lost its natural regenerative capacity

We need REDD mechanisms that will provide $$ for ‘preventing degradation’ of intact natural forests

**Publication:**

Roxburgh, S.H., Wood, S.W., Mackey, B.G., Woldendorp, G. & Gibbons, P. (2006) Assessing the carbon sequestration potential of managed forests: A case study from temperate Australia. *Journal of Applied Ecology* 43:1149-1159.

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Roxburgh, S.H., Mackey, B.G, C. Dean, L. Randall, A. Lee & J. Austin (2006) Organic carbon partitioning in soil and litter in subtropical woodlands and open forests: a case study from the Brigalow Belt, Queensland. *The Rangeland Journal* (28): 115–125

Mackey, B.G. & Su, W. (2005) Dynamic Landscape Models for Tropical Rainforests. In E. Bermingham, C. W. Dick, and C. Moritz (editors) *Tropical Rainforests: Past, Present and Future.* The University of Chicago Press, Chicago, pp. 202-222.

Dean, C., Roxburgh, S. & Mackey, B.G. (2003) Growth modelling of *Eucalyptus Regnans* for carbon accounting at the landscape scale. Amaro, A., Reed, D. and Soares, P. (eds) *Modelling Forest Systems*. CABI Publishing, Wallingford, UK.