COMPARISON WITH EXISTING CARBON ACCOUNTS

Soil matrix with fine roots: Red Dermosol, Brindabella Ranges. Photo: Heather Keith.

One way to understand the significance of our estimates of the carbon carrying capacity of the natural forests of south-eastern Australia is to compare them with values estimated from other sources. Two widely used sources of forest carbon data are the default values published by the Intergovernmental Panel on Climate Change (IPCC) and estimates derived from the Australian Government's National Carbon Accounting System (NCAS).

The IPCC recommends default values for estimating green carbon stocks in the absence of local data (Watson et al. 2001). Mean carbon stock and flux values are provided for the world's major biomes[12], as detailed in Table 2. Our analyses (Table 1) showed that the stock of carbon for intact natural forests in our study area is about 640 t C ha^{-1} and the average NPP of natural forests is 12 t C ha^{-1} yr^{-1} (with a standard deviation of 1.8). In terms of global biomes, Australian forests are classified as temperate forests. The IPCC default values for temperate forests are a carbon stock of 217 t C ha^{-1} and an NPP of 7 t C ha^{-1} yr^{-1}.

TABLE 2: ESTIMATED AVERAGE UPTAKE AND CARBON STOCKS IN THE WORLD'S MAIN FOREST BIOMES

Forest biome	NPP (t C ha^{-1} yr^{-1})	Carbon stock (t C ha^{-1})		
		Soil	Biomass	Total
Boreal forests	2.1	296	53	349
Temperate forests	7.0	122	96	217
Tropical forests	10.0	122	157	279

Source: Watson, R. T., Noble, I. R., Bolin, B., Ravindranath, N. H., Verardo, D. J. and Dokken, D. J. (eds) 2001, *Land Use, Land-Use Change, and Forestry*, Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Third Assessment Report, Table 3.2.

Comparing the values in Tables 1 and 2, it can be seen that the IPCC default values represent only one-third of the natural carbon carrying capacity of the eucalypt forests of south-eastern Australia, and only 27 per cent of the biomass carbon stock. Using our figures, the total stock of carbon that can be stored in the 14.5 million ha of eucalypt forest in our study region is 9.3 Gt, if it is undisturbed by intensive human land-use activity and allowed to reach its natural carbon carrying capacity; applying the IPCC default values would give only 3.1 Gt. Note that while our model estimates the average total carbon stock of natural eucalypt forests at 640 t C ha^{-1}, real site values range up to 2500 t C ha^{-1}. This range reflects the natural variability found across landscapes in the environmental conditions and disturbance regimes that affect forest growth.

12 Biomes are large areas that have a similar climate and vegetation structure—that is, the vegetation has a similar height and density, even though the floristic composition might differ.

How can we explain the difference in total carbon between our estimates and the IPCC default values? The answer lies in the fact that current approaches to carbon accounting have been designed to estimate carbon stocks and flows in industrialized forests, including plantations. That is, they are designed to measure what we call *brown carbon*, not *green carbon*. As we discussed earlier, current approaches generally use field data from forestry mensuration plots. These plots are designed to provide estimates of growth rates in regenerating trees of commercial importance, which store much less carbon than unlogged natural forests. This is the main reason why carbon accounting methods that are calibrated using field data from industrialized forests significantly underestimate a landscape's carbon carrying capacity. There is also the problem of definition of forest and how different average values are compared. The definition of forest used in the Australian classification is trees taller than 10 m and canopy cover greater than 30 per cent, whereas the definition of forest used for the IPCC default values is trees taller than 2 m and canopy cover greater than 10 per cent (UNFCCC 2002). Additionally, the forests of south-eastern Australia have high GPP relative to typical default values.

Green carbon accounting tools for natural forests need to be calibrated using ecological field data obtained from sites that have not been disturbed by intensive human land-use activity, especially commercial logging. We made a special effort to find such ecological field data for our study region so that our estimates of carbon stocks were calibrated appropriately to represent the landscape's carbon carrying capacity.

Further insight into the requirements of green carbon accounting can be gained by comparing our estimates with those generated from the NCAS (Australian Greenhouse Office 2007a). The NCAS was designed to model biomass growth in plantations and afforestation/reforestation projects using native plantings. The empirically based calculations within the NCAS were calibrated using data appropriate for that purpose. Consequently, the NCAS was not designed to estimate the carbon carrying capacity of undisturbed natural forests.

To illustrate the need to calibrate carbon models using data that are appropriate for the purpose of a study, we used the NCAS to calculate carbon stocks at the locations for which we had obtained field data. Figure 8 shows the results of this analysis and compares the biomass estimates from the NCAS with our modelled predictions and with the real biomass calculated at each of the field sites used in our study (see Figure 4).

The NCAS generally underestimates biomass in natural forests that are largely undisturbed by human land-use activity—that is, the NCAS underestimates the carbon carrying capacity of natural forests. This is not surprising because it was not developed with this purpose in mind. The NCAS is a well-designed carbon accounting tool that represents the main ecological processes shown in

Figure 3. It is theoretically and technically possible to modify this program by calibrating it with data and empirical relationships—such as those we have used to develop our model—appropriate for the purpose of estimating the natural carbon carrying capacity of forests.

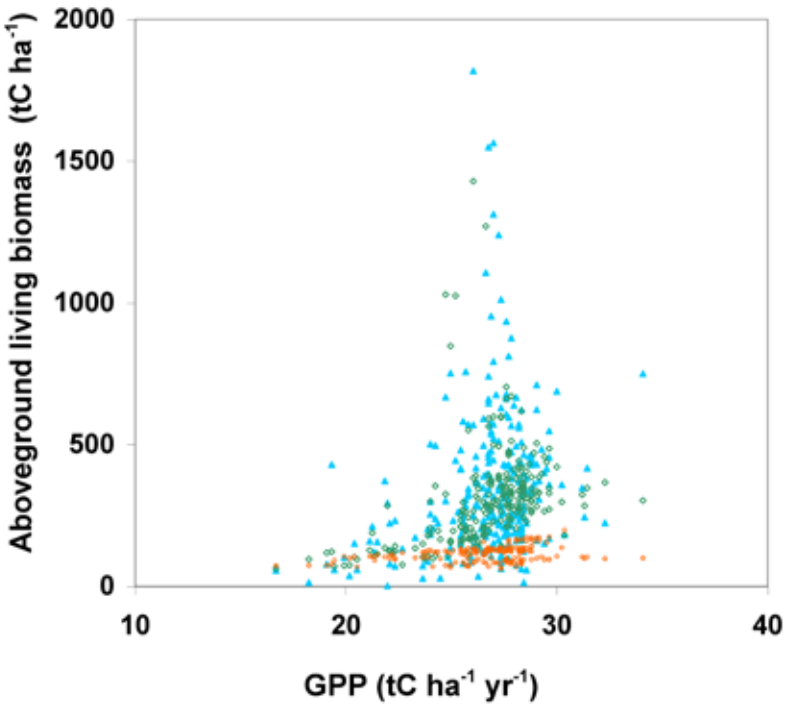

FIGURE 8: COMPARISON OF GPP AND BIOMASS

GPP was calculated by the methods used in this report and biomass estimates were derived from: i) the NCAS (orange open circles); ii) field sites (blue triangles); and iii) our modelled relationships between NPP and environmental variables (green open diamonds).