Rough bark: *E. delegatensis*, Bago State Forest, southern NSW. Photo: Heather Keith.

THE GREEN CARBON BASELINE PROBLEM

In recognizing the importance of reducing emissions from deforestation and forest degradation (REDD), the international community is now exploring appropriate mechanisms that will provide the financial investments needed to protect natural forests and keep them intact. Irrespective of the mechanism, it will be essential to have reliable estimates of baseline carbon accounts against which changes in carbon stocks can be gauged. Two kinds of baselines are needed: 1) the current stock of carbon stored in forests; and 2) the natural carbon carrying capacity of a forest (the amount of carbon that can be stored in a forest in the absence of human land-use activity). The difference between the two is called the carbon sequestration potential—the maximum amount of carbon that can be stored if a forest is allowed to grow given prevailing climatic conditions and natural disturbance regimes.

The greater the carbon sequestration potential of a forest, the more the carbon stock has been degraded by human land-use activities. It follows that stopping the carbon-degrading land-use activities will allow the forest to regrow carbon stocks to their potential—assuming the natural regenerative capacity of the ecosystem is maintained. Most carbon accounting schemes focus simply on the current carbon stocks in a landscape and do not consider a forest's natural carbon carrying capacity. This is partly because the concept is not widely appreciated but also because its calculation is difficult.

E. fraxinoides, Deua National Park, NSW (400 t C ha^{-1} of biomass carbon). Photo: Ian Smith.

It is not possible to predict the carbon carrying capacity of a natural forest reliably from process-based simulation models. This is because the carbon stock is the result of a complex set of multi-scaled natural processes, some of which can be modelled reliably (for example, gross primary productivity), while others cannot because they are understood only poorly (in particular, allocation of biomass components, turnover times of components and rates of decomposition). Consequently, estimating carbon carrying capacity relies on empirical data gathered from natural forests largely undisturbed by human land-use activity. Natural disturbances, however, have to be taken into account. As noted above, commercial logging significantly reduces the standing stock of carbon below the natural carbon carrying capacity because most of the biomass carbon in a forest is in the woody stems of large trees (more than 70 cm diameter at breast height; Brown et al. 1997), which are removed over time. In contrast, tree mortality by natural processes such as wind, fire or pests removes more of the small, weaker trees and a smaller proportion of large trees. The role of fire in natural forests is complex and must be considered on a landscape-wide basis in terms of the pattern of fire events over time (so-called 'fire regimes') (Mackey et al. 2002). It follows that estimating natural carbon carrying capacity requires data that sample the range of ecosystem conditions found in a natural forest.

Conventional approaches to estimating biomass carbon stocks are based on stand-level commercial forestry inventory techniques. These data are not, however, suitable for calculating the carbon carrying capacity of natural forests. In industrialized forests, mensuration is focused mainly on estimating regrowth rates in logged stands. Consequently, the most commonly available field-survey data about the standing crop of carbon in forests are from regrowth stands. These data cannot be used to estimate the carbon stocks of ecologically mature natural forests. To estimate the carbon carrying capacity of a natural forest, field data are needed from sites that have not been subjected to commercial logging and that sample all carbon pools in the ecosystem (living biomass, dead biomass and soil) at appropriate space/time scales. As natural forests can take 200 to 400 or more years to reach their mature biomass levels (Saldarriaga et al. 1988; Dean et al. 2003), carbon accounts must reflect such long-term dynamics.

In the next section, we present some results from our continuing investigations into baseline green carbon accounts using the eucalypt forests of south-eastern Australia as our case study. We present estimates of the natural carbon carrying capacity of these forest ecosystems. We then use these results to consider some of the policy implications for reducing emissions from deforestation and forest degradation.