Integrity and the ERF's Human-Induced Regeneration Method: The Measurement Problem Explained

Andrew Macintosh,[a] Don Butler,[a] Megan C. Evans,[b] Pablo R Larraondo[c], Dean Ansell[a] and Marie Waschka[a]

[a] The Australian National University; [b] University of New South Wales, Canberra; [c] Haizea Analytics Pty Ltd.

The Emissions Reduction Fund (ERF) is a $4.5 billion program that forms the basis of Australia's carbon market. Under the ERF, projects that reduce emissions receive carbon credits that can be sold to the Australian Government and private entities that are required or voluntarily choose to offset their emissions.

The ERF's most popular method is the *Human-Induced Regeneration of a Permanent Even-Aged Native Forest* (or HIR). HIR accounts for almost 30% of issued carbon credits, more than 30% of registered projects and more than 50% of carbon credits contracted for sale to the Australian Government.

HIR projects are supposed to involve the regeneration of native forests through changes in land management practices, particularly reduced grazing by livestock and feral animals. The projects do not involve planting seedlings or seeds. The forests are supposed to grow through natural regeneration.

The idea of providing landholders with carbon credits for allowing native forests that have previously been cleared to naturally regenerate is a sensible and cheap way to reduce emissions. But the HIR method contains numerous flaws, arguably the most alarming of which is that proponents are being issued carbon credits for growing trees that were already there when the projects started. This has arisen because the Clean Energy Regulator (CER), who administers the ERF, is allowing proponents to misapply the measurement requirements in the method.

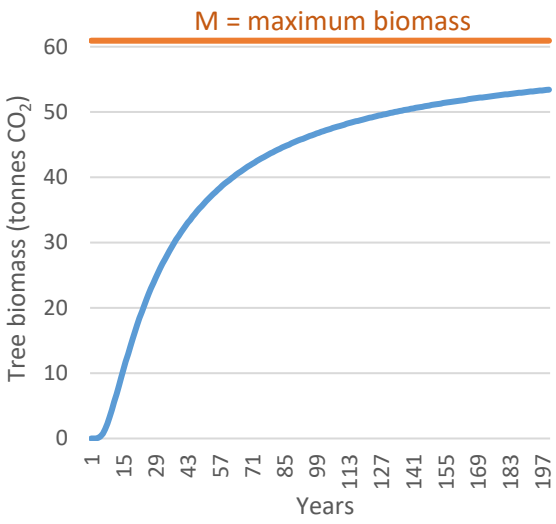
Under the method, proponents do not have to measure sequestration. They estimate it using a model. The model is elegant in its simplicity and is based on two key concepts that are well-founded in forest science: (1) there is only so much vegetation that a parcel of land can support based on rainfall, temperature and soil (maximum mass of the vegetation, called 'biomass'); and (2) as vegetation ages, the growth rates slow as the vegetation competes for site resources (e.g. water, nutrients and light).[1] These concepts are expressed in the model by a tree yield formula (TYF) with two main variables: *M* (an estimate of the maximum amount of biomass the site can hold when it contains native vegetation); and *G* (an estimate of the age of maximum tree growth in the regeneration).[2] These two variables are combined to define an S-shaped curve that reasonably approximates the way even-aged forests grow when planted or regenerating after clearing. They

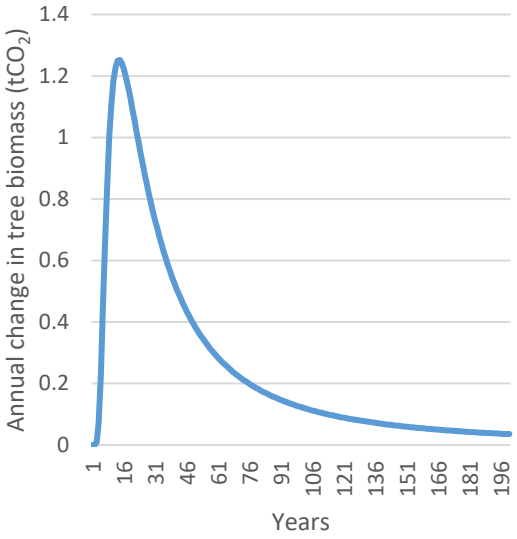
[1] Waterworth, R., Richards, G., Brack, C., Evans, D. (2007) A generalised hybrid process-empirical model for predicting plantation forest growth. Forest Ecology and Management 238, 231–243.

[2] In the model, *M* is actually maximum above-ground biomass in undisturbed native vegetation. We use tree biomass here as shorthand and to aid comprehension. Consist with the model, we have assumed above-ground biomass accounts for 65% of total tree biomass. Roxburgh, S., Karunaratne, S., Paul, K., Lucas, R., Armston, J., Sun, J. (2019) A revised above-ground maximum biomass layer for the Australian continent. Forest Ecology and Management 432, 264–275; Paul, K., Roxburgh, S. (2020) Predicting carbon sequestration of woody biomass following land restoration. Forest Ecology & Management 460 (2020) 117838.

start slowly, then growth accelerates to peak when the forest is young and vigorous, and slows as the expanding trees begin to compete with one another.

This is illustrated in the graphs below: the left graph shows the cumulative tree biomass on a hypothetical 1 hectare parcel of land (in carbon dioxide (CO_2)); and the right graph shows the growth rate, which is the annual increase in tree biomass. In the example, the potential total maximum tree biomass (*M*) is equivalent to 61 tCO_2 per hectare (the area-weighted average for HIR project areas) and the assumed year of maximum growth (*G*) is 12.53 years (the *G* used in the latest version of the model).





The type of even-aged regeneration envisaged in the HIR method and represented by the models of growth shown above, is commonly observed following broadscale tree clearing. However, contrary to the method requirements, the CER has been allowing registrations of HIR projects in arid and semi-arid rangeland country that already supports native vegetation and where evidence of past broadscale clearing is rare.[3]

This means HIR projects are applying the model, which assumes sites have no or negligible mature trees and shrubs on them at commencement (immaterial starting biomass), to sites that have a substantial number of pre-existing mature trees and shrubs when they start (material starting biomass). The CER has only been requiring pre-existing trees and shrubs to be excluded from credited areas where they have already achieved 'forest cover' (i.e. crown cover greater than 20% over an area of 0.2 hectares).[4] Large areas of naturally open shrublands and woodlands typical of arid and semi-arid Australia have been signed-up as supposedly regenerating native forests.

There are two issues with what is occurring: (a) it is leading to over-crediting (carbon credits are being issued for sequestration that has not occurred and, in most cases, will never occur); and (b) it is unlawful because the method requires mature trees and shrubs to be excluded from credited sites.

[3] Clean Energy Regulator (2022) 'Area-based Emissions Reduction Fund (ERF) projects', available at: https://data.gov.au/data/dataset/erf_project_mapping (23 June 2022).
[4] Emissions Reduction Assurance Committee (2022) Emissions Reduction Assurance Committee findings on the Emissions Reduction Fund's Human Induced Regeneration method. Clean Energy Regulator, Canberra, pp 34-35.

The CER and Emissions Reduction Assurance Committee (ERAC) (the body that oversees the methods) claim there is nothing wrong. They argue the model was recalibrated in 2020 using data from sites that contained mature trees and shrubs so there is no problem provided the mass of pre-existing trees and shrubs on the credited sites is less than what was used in the recalibration.[5] There are four problems with this position.

Problem 1: The CER/ERAC's position conflicts with the fundamentals of the model and how it is calibrated. The CSIRO scientists responsible for the 2020 calibration agree.[6] They have advised that the model should not be used to estimate biomass on sites where the biomass of pre-existing trees and shrubs (what they refer to as 'baseline biomass') exceeds 5% of the potential maximum (*M*).[7] The advice provided by the CSIRO to the CER/ERAC on this issue states:

> Although a baseline AGB [above ground biomass] could be accommodated … in the optimisation of G as the calibration stands were generally young with small baselines, a baseline AGB cannot be similarly accommodated when applying the resulting calibrated TYF [tree yield formula] to predict AGB at any given age. This is the case even in a project area where there is only a moderate baseline because as the regenerating plants grow, some of them may not survive, or may suffer reduced growth, as they compete for space and resources with the baseline trees and shrubs. … The premise of the TYF is to predict yields of AGB at sites with near-zero baselines. This is because the TYF is 'blind' to the baseline AGB. Hence, application of the TYF is only valid for sites with near-zero baselines, as it predicts the stand will grow towards M from a near-zero starting point. If the TYF is applied to a stand with moderate-high AGB baselines, this will erroneously predict a final maximum AGB that exceeds M. The final maximum AGB effectively being assumed to be M plus the baseline AGB.[8] [Emphasis added]

To reiterate, the rate of forest growth (carbon accumulation), and hence the credits issued to a project, is driven by both *M* and *G*, where the calibration of G by CSIRO is from a near zero baseline. Given this, the model used to estimate carbon sequestration for HIR projects cannot be validly applied to sites that contain a significant number of mature trees and shrubs at project commencement. CSIRO's advice could not be clearer.

Problem 2: Even if problem 1 is ignored, the majority of projects that have been credited to date do not use the recalibrated 2020 version of the model. They have been allowed to continue to use older versions of the model (from 2013 and 2016) that were not calibrated using data from sites that contained pre-existing trees and shrubs. Hence, it should be beyond doubt that most projects that have received credits to date are being over-credited and, if nothing changes, will continue to be over-credited for roughly 20 years.

Problem 3: The CER/ERAC argue HIR projects are not being over-credited because the median level of pre-existing baseline biomass in the sites used to undertake the 2020 calibration was equivalent

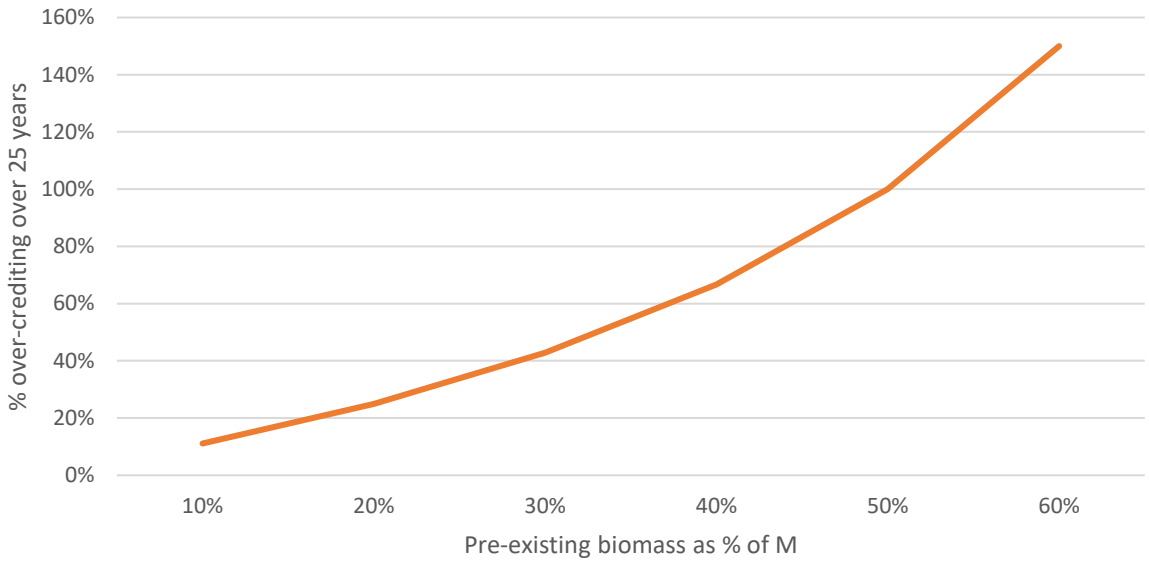
[5] Emissions Reduction Assurance Committee (2022) Emissions Reduction Assurance Committee findings on the Emissions Reduction Fund's Human Induced Regeneration method. Clean Energy Regulator, Canberra, pp 35-39; Clean Energy Regulator (2021) Issues Summary – Concerns about the ERF Human-Induced Regeneration method. Clean Energy Regulator, Canberra, p 4.
[6] CSIRO (2021) Baseline AGB: TYF calibration for natural regeneration in land managed for grazing. CSIRO, Canberra.
[7] Paul, K. (2021) Email to Andrew Macintosh. RE: Letter from David Byers - HIR issues. 12 October 2021; CSIRO (2021) Baseline AGB: TYF calibration for natural regeneration in land managed for grazing. CSIRO, Canberra.
[8] CSIRO (2021) Baseline AGB: TYF calibration for natural regeneration in land managed for grazing. CSIRO, Canberra, p 5.

to 6.23 tonnes of carbon (tC) per hectare, while the 'median level of baseline carbon in [credited sites] is 0-3.6 tonnes of baseline carbon'.[9] There are three problems with this argument.

- The CER/ERAC derived their estimate of the median level of baseline biomass in credited sites (0-3.6 tC per hectare) using a two-step method: they estimated the median crown cover in credited areas; and then they used a statistical relationship between crown cover and biomass to derive a biomass estimate.[10] If the statistical relationship between crown cover and biomass was based on sites with mature trees and shrubs it might have some merit. But it was not. The statistical relationship was drawn from research undertaken by the CSIRO in 2018 that was based on regenerating vegetation and it should not be used to estimate the amount of biomass in mature remnant vegetation.[11] This is because naturally, regenerating vegetation will have less biomass than mature remnant vegetation, for the same amount of canopy cover.

- The CER/ERAC's 'benchmark of acceptability' for pre-existing biomass is an absolute measure: 6.23 tC per hectare. However, it is not the absolute amount of pre-existing biomass that matters, but the amount of pre-existing biomass relative to *M* for the location (the maximum amount the site can hold). Because the models 'grow' to *M*, the closer the site is to *M* to begin with, the greater the likely magnitude of the over-crediting.[12] This is illustrated in the figure below, which shows the relationship between the amount of baseline biomass on site at project commencement and the extent of over-crediting after 25 years. The relationship is exponential rather than linear. For example, if baseline biomass is 10% of *M* at commencement, tree biomass will be over-estimated by 11% after 25 years. In contrast, if pre-existing biomass is 60% of *M* at commencement, tree biomass will be over-estimated by 150% after 25 years. The CER/ERAC benchmark for acceptable pre-existing total tree biomass (6.23 tC per hectare) is approximately 37% of the area-weighted average *M* across HIR project areas (total tree biomass equivalent of 16.6 tC per hectare).[13] At this level, tree biomass will be over-estimated by 60% after 25 years. By any measure, a method that routinely allows abatement to be over-credited by 60% cannot be called conservative, as is required by the ERF legislation. This is why the CSIRO has advised that the model should not be used on sites whose baseline biomass is greater than 5% of *M*.[14]

[9] Emissions Reduction Assurance Committee (2022) Emissions Reduction Assurance Committee findings on the Emissions Reduction Fund's Human Induced Regeneration method. Clean Energy Regulator, Canberra, p 38.
[10] Emissions Reduction Assurance Committee (2022) Emissions Reduction Assurance Committee findings on the Emissions Reduction Fund's Human Induced Regeneration method. Clean Energy Regulator, Canberra, p 38.
[11] Larmour, J., Davies, M., Paul, K., England, J., Roxburgh, S. (2018) Relating canopy cover and average height to the biomass of the stand. Report prepared for the Department of the Environment and Energy. CSIRO Land and Water, Canberra.
[12] CSIRO (2021) Baseline AGB: TYF calibration for natural regeneration in land managed for grazing. CSIRO, Canberra.
[13] Emissions Reduction Assurance Committee (2022) Emissions Reduction Assurance Committee findings on the Emissions Reduction Fund's Human Induced Regeneration method. Clean Energy Regulator, Canberra, pp 37-38.
[14] Paul, K. (2021) Email to Andrew Macintosh. RE: Letter from David Byers - HIR issues. 12 October 2021.



- Not only have the CER/ERAC used a statistical relationship for regenerating vegetation to estimate the biomass of mature remnant vegetation, and used an absolute measure to determine the acceptability of pre-existing biomass instead of a relative measure, but their estimate of the median level of baseline biomass in credited sites (0-3.6 tonnes) was also taken from projects that mostly use the older versions of the model. That is, the CER/ERAC are arguing there is nothing wrong with the projects that use the 2020 calibration on the basis of evidence from projects that largely do not use it. This is nonsensical.

Problem 4: The sharper end of our argument is that the HIR methods all require proponents to exclude mature trees and shrubs from their credited areas. This interpretation is supported by a number of lines of evidence, the most obvious being the method's name. If it was intended that proponents could include mature trees and shrubs in their credited areas, the method would be called *Human-Induced Regeneration of a Permanent **Multi-Aged** Native Forest*, not *Human-Induced Regeneration of a Permanent **Even-Aged** Native Forest*. Further support for this interpretation comes from the fact that the first versions of the model—that were in place when the method was introduced and subsequently amended—were not calibrated for use on sites that contain mature trees and shrubs; a point the CER/ERAC have now finally conceded. The CER/ERAC deny the methods require the exclusion of mature trees and shrubs from credited areas.[15] But, in taking this position, they are trying to contend that, when the method was initially drafted, it was intended that projects would be over-credited. It is difficult to believe a court would agree with this view. A court will seek to interpret the method in a way that supports the purpose of the legislation.[16] It is difficult to argue the legislation was intended to lead to the issuance of credits for growing trees that were already there when the projects started.

The CER/ERAC defence of the HIR method is deeply flawed and well below the standard that should be expected of government agencies that are responsible for the oversight of a financial market. It is time for both the CER and ERAC to concede that the HIR method has been misapplied and that this has resulted in significant over-crediting, and to start working constructively on solutions.

[15] Emissions Reduction Assurance Committee (2022) Emissions Reduction Assurance Committee findings on the Emissions Reduction Fund's Human Induced Regeneration method. Clean Energy Regulator, Canberra, pp 34-35.
[16] *Acts Interpretation Act 1901*, s 15AA; *Legislation Act 2003*, s 13.