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The Carbon Absorption Paradigm

An article from OPT Journal October 2002

Most articles in the OPT Journal, with full references, are concerned with the development of Ecological Footprinting. Online contributions, critical comment and analysis are welcome - please e-mail us at info@optimumpopulation.org, giving your full contact details.

"A Second Footprint Forum, Part I"

introduced and moderated by Andrew Ferguson

Introduction

A Forum on Ecological Footprints appeared in the March 2000 edition of *Ecological Economics*. From now on this Forum will be referred to as simply 'the EE Forum'. Page numbers given for contributors to the EE Forum refer to this March 2000 issue. Some fundamental issues were raised in the EE Forum but they were not resolved. That is the context in which a 'Second footprint forum' appears in these pages. In this forum, I intend to raise the two most important issues in eco-footprinting. In *Part I* we will deal with one of them. *Part II* will follow later.

It was in September 2001 that those with an interest in eco-footprinting were invited to respond. They were Mathis Wackernagel, Nicky Chambers and Craig Simmons.The last two are at *Best Foot Forward* and all three co-authored *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability (Chambers et al, 2000)*; William Rees; and Rod Simpson, who wrote *An Ecological Footprint Analyis for Australia (Simpson et al, 2000).* We have also asked three people who are knowledgeable about eco-footprinting but who do not have a position to defend, because none of their work has hinged on the subject, namely Jill Curnow, Robert Herendeen and David Pimentel.

Ecological footprints: the energy component

> *Note: it is recognised that changes in technology and lifestyle can reduce fossil fuel emissions, but OPT stresses that these have consistently been negated by both economic growth and population growth. The debate below concentrates on the relationship between population and fossil fuel emissions.*

In the EE Forum, Robert Herendeen elucidated the main problem of what I call the 'carbon absorption paradigm'; that is, basing the energy component of the Ecological Footprint on carbon absorption [the capacity of forests to sequester carbon released as fossil fuel emissions]. He said (page 357): *"Net CO_2 uptake is overestimated; it saturates to zero as succession is completed, unless there is a scheme to harvest the wood and prevent it from decaying. Thus EF estimates energy land [the amount of land needed for the energy component of the eco-footprint]."* One response to Herendeen's point would be that *the carbon absorption paradigm is not meant to be realistic*: the proponents readily

accept that such carbon absorption would not actually happen; the concept is useful purely as a measure of the amount of forest that *would* be needed to absorb excess carbon dioxide were it possible to find some way of locking up the carbon in perpetuity.

If that is the case, how successful have the proponents of eco-footprinting been in making their position clear? Not very, judging from another contributor to the EE Forum, Robert Ayres, who said (page 347) *"The hidden implication, which is not sufficiently clearly spelled out by the EF proponents, is that in a sustainable world, energy would be obtained from fossil fuels but the latter would be burned - in any given country - in just such quantities as to permit the resulting carbon dioxide emissions to be absorbed by vegetation within the country."* No mention there of the whole thing being based on an unrealistic proposition, requiring that after the forest has finished doing its job of absorbing carbon, the wood is to be whisked away, never to be seen again [therefore avoiding natural decay which would produce more carbon].

Simpson et al. (2000) also appear to imagine that eco-footprinting is dealing with the real world when they say (page 15) *"The use of carbon dioxide emissions also links the indicator directly to the very topical issue of global warming."* Would they have said that if they understood that the carbon absorption paradigm was unrealistic?

However, it has to be said that a careful reading of Wackernagel and Silverstein's (2000) contribution to the EE Forum does make it clear that the paradigm is unrealistic, for they say (page 392) *"Therefore, the footprint includes fossil fuel in terms of ecological capacity necessary to reverse its wast impact, namely CO_2. The only eco-systems that can remove significant amounts of CO_2 from the atmosphere, at least for their first 30-50 years, are growing forests - and using them to sequester CO_2 is still the prevailing [carbon dioxide absorption] technology. As our calculations show, such absorption forests would require absurdly large portions of the bioproductive surface of this planet."* Careful consideration of the words "at least for their first 30-50 years" provides a *reasonably clear* indication that the whole concept is unrealistic.

However, the proponents of eco-footprinting have rarely been as lucid as that. Wackernagel and Rees (1996) state (page 72) *"Data on typical forest productivities of temperate, boreal and tropical forest show that average forest can accumulate approximately 1.8 tonnes of carbon per hectare per year. This means that one hectare of average forest can sequester annually the CO_2 emissions generated by the consumption of 100 gigajoules of fossil fuel."* No reference there to the fact that the "sequestering" will only happen during the period up to 30-50 years after the forest has been planted. (To avoid confusion later it should be mentioned that subsequent reappraisals change the carbon absorption rate to 0.95tC/ha/yr). Chambers et al. (2000), when explaining their methodology, are also cryptic about the energy footprint and the related "sequestering", saying only (page 67) *"This portion of the calculation is used to derive the energy footprint - usually the amount of forested land necessary to sequester the CO_2 emissions."*

An unequivocal decision to use an unrealistic metric, *if stated openly*, would not matter if the results which emerged did not tend to mislead. Our contention is that they do tend to mislead, insofar as the carbon absorption paradigm carries an implication, rarely if ever denied by the proponents, that it really does (or would if only it were possible to plant enough forest), somehow take account of excess carbon. But when eco-footprinting is used to estimate the extent that humans have overshot the planet's carrying capacity, the result is around a 30% overshoot, as per page 1 of *The Living Planet*

Report (LPR) 2000 (WWF 2000, now superseded by LPR 2002). No one can read *LPR 2000* without presuming that it 'takes carbon dioxide into account'. **Yet the correct overshoot figure (in 1990, see below) based on a realistic appraisal of carbon dioxide alone is 150%.**

Ecological overshoot based on carbon dioxide alone

To express the matter succinctly, I will adopt a notional position. As mentioned, the *Living Planet Report 2000* was in line with previous eco-footprinting studies in stating that world population is overshooting [Earth's] biocapacity by around 30%. Like other eco-footprinting work of Wackernagel and his colleagues, the report aimed to be a snapshot of the situation at a point in time. If the overshoot is 30%, it follows that a representative reduction of world population, reducing it to 1/1.30 = 77%, would, at that point in time, cure the overshoot. Insofar as eco-footprinting - based on the carbon absorption paradigm - is realistic, this should guarantee that carbon emissions are brought into balance with the Earth's capacity to absorb the excess carbon is currently *increasing* at a rate of 3.5 billion tonnes a year (Houghton, 1997:23).

The Intergovernmental Panel on Climate Change (IPCC) stated in 1992 (Engelman, 1998:15), that we need to reduce fossil fuel emissions to 40% of the 1990 level in order to bring emissions into balance with the absorptive capacity of the Earth. The 40% figure is not a matter of doubt, as the arithmetic relating to the necessary reduction - to stop atmospheric carbon levels increasing - is simple. So, with the 40% figure secure, the requirement is for a representative reduction of the population sufficient to reduce it, living in its present lifestyle, to 40% of its 1990 size. Or, to put it another way, according to the IPCC, based on carbon dioxide alone, **the [emissions] overshoot in 1990 was (100/40) - 1 = 150% (a figure that has since increased to 165%)**.[1] While there are other reasons for challenging the logical basis of the carbon absorption paradigm, the gap between 30% and 150% surely indicates that the carbon absorption paradigm needs to be consigned to history without delay.

We in OPT are not challenging the concept of eco-footprinting. We believe it to be a valuable methodology - indeed the best method available for making a quantitative assessment of both national and global carrying capacities (Ferguson, 1998, 1999). We argue only for a change in the *logical basis* of dealing with the energy component of ecological footprints. In our estimation, the energy/land ratio [the amount of land required to provide energy and accommodate the direct impacts of providing that energy] has the right value. That ratio is in the region of 95 GJ/ha/yr, 3kW/ha, not greatly different from the 100 GJ/ha/yr used initially in eco-footprinting or the mean figure of 80 GJ/ha/yr used in LPR 2002 (WWF 2002). Thus it is not the value that is in dispute, but the basis on which the value is to be established. We believe that basis needs to be *net* energy capture (the amount of 'useful' energy that can be captured per hectare) from renewable resources. Work remains to be done to make the 3kW/ha value secure, but progress in the field is good, and the figure looks highly plausible on present evidence.

[1] These are the actual numbers for those percentages. Carbon emissions in 1990, from burning fossil fuels, were 5.95 billion *t*/yr (Vital Signs, 2000). Thus the 40% reduction figure, which was required to prevent carbon concentrations continuing to increase, was 2.38 GtC/yr. Thus overshoot in 1990 was (5.95/2.38) - 1 = 150%. 1999 fossil fuel emissions were 6.31 GtC/yr, making the overshoot (6.31/2.38 - 1 = 165%).

Additional Notes

Note 1: A further pointer that 9Gt/yr of carbon dioxide (9/3.664 = 2.5 GtC) emissions is probably too high to stabilise atmospheric concentration is that in 1960 (about when CO_2 emissions started to be measured) emissions were about 2.5 GtC/yr, yet between 1960 and 1965 CO_2 concentration was increasing at a rate of

(319.9 - 316.7)/5 = 0.64 ppm/yr.

From 1990 to 2000 it was increasing at

(369.4 - 354)/10 = 1.54 ppm/yr.

By 1960 atmospheric CO_2 concentration had increased from pre-industrial levels of 280 ppm to about 320 ppm, even though emissions were below 2.5GtC per year. An alternative explanation, of course, might be that the increase was occurring naturally and was not anthropogenic (caused by humans). The conclusion to draw from this is that when the IPCC (although its estimates are almost certainly in the right range) mentions that 2.5GtC per year would stabilise atmospheric concentration, it is no more than an estimate.

Note 2: Carbon capture and sequestration - UK: It is possible that future UK government policy on energy (The Energy Review, Government's Performance and Innovation Unit, February 2002) will *"adopt a strategy which puts the UK on a path to reducing carbon dioxide emissions by some 60 percent from current levels by about 2050"*. (OPT welcomes such a strategy but believes the target is based on unrealistic assumptions which neglect the undermining influence of future population and economic growth.) A carbon capture and sequestration programme should be considered as part of this strategy, according to the PIU review (Chapter 7), though "the uncertainties surrounding costs, environmental impacts and public and investor acceptability are large."