Life Cycle Assessments of Greenhouse Gas Emissions for Common Agrofuel Feedstocks

Deepak Rughani, October 2008

Making life cycle assessments (LCAs) based on just part of the agrofuel production life cycle and without taking account of the wider impacts is irrelevant and entirely misleading. The micro-lifecycle is the one most often quoted by industry analysts who measure the fossil fuel investments but ignore the macro-impacts of increased greenhouse gas (GHG) emissions, accelerating deforestation, the loss of ecosystem functions and ultimately the triggering of irreversible climate feedbacks. These macro-impacts are so expansive and impossible to assess that there can be no accurate figure for agrofuel LCAs making agrofuel standards and certification impossible and irrelevant.

Paul Crutzen et al[1] attemped to close part of the gap in life-cycle emissions by assessing the full indirect as well as direct GHG emissions from nitrous oxide (N2O). Factoring in full N2O emissions for the following feedstocks resulted immediately in unfavourable GHG balances, although no other greenhouse gas emissions from the production of biofuels were considered in that study.

Crutzen: Global warming impact of biofuels compared to their fossil fuel equivalent, based on not a full life-cycle assessment but solely on comparing N2O emissions from biofuel use with CO2 savings from replacing fossil fuels (Note: 1.5 means 1.5 times as great an impact)

Rapeseed biodiesel	Wheat ethanol	Corn ethanol	Ethanol from sugar beet leaves
1-1.7 times	1.3-2.1 times	0.9-1.5 times	1.5-2.4 times

Other studies, by Joseph Fargione et al[2], Timothy Searchinger et al[3] and Holly Gibbs et al[4], have looked at carbon dioxide emissions from direct and indirect land use change linked to biofuel production. They have not taken account of other emissions linked to biofuel production, including N2O emissions.

Here are some examples of their findings based solely on carbon dioxide emissions from land-use change. They express their findings in 'years to repay the carbon debt', i.e. the number of years the feedstock would have to be grown on the same land for agrofuels before the 'emissions savings' from burning less fossil fuels will have made up for the carbon dioxide emissions from land use change. In reality, however, monocultures can render soil infertile and in many cases where monocultures replace tropical forests, regional drying could result in permanent droughts long before the 'carbon debt' could ever be repaid.

Fargione et al:

Palm oil/S.E. Asian rainforest	Palm oil / SE Asian peatlands	Soya/Amazon forest	Corn on set-aside land, US
86 years	840 years	320 years	43 years

Gibbs et al:

Holly Gibbs et al also quantified the carbon debt in number of years of continuous feedstock growth for maize, soya bean and palm oil on deforested land and deforested peatland as follows.

Palm oil on deforested land	Palm oil on deforested peatland	Maize and soya beans on deforested land
30 – 120 years	900 years	300-1500 years

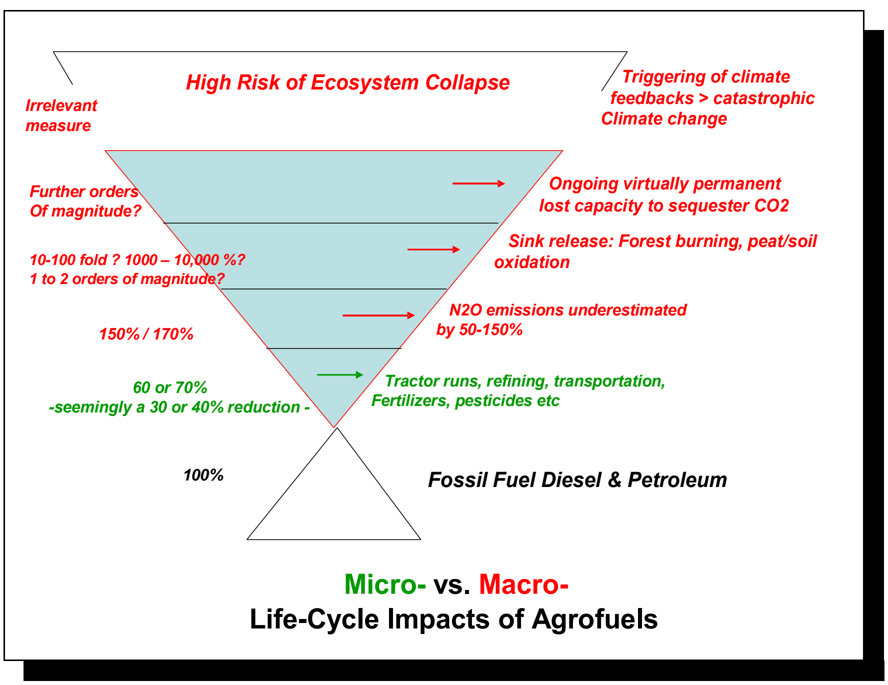
Searchinger et al looking at the different types of displacement actually caused by corn ethanol in the US and concludes that the carbon dioxide emissions from direct and indirect land-use change linked to US ethanol nearly doubles greenhouse gas emissions over 30 years (compared to using the equivalent amount of fossil fuel) and increase greenhouse gases for 167 years.

Here we see an order of magnitude increase in GHG balances associated with LCAs.

No peer-reviewed study so far looks at the combined direct and indirect CO2 and N2O emissions. The only indirect land-use change impacts which have been studied are those of straightforward displacement: if corn currently used for food or animal use is used for ethanol instead then more land will be converted elsewhere to grow food or animal feed. Other, often even greater indirect impacts are ignored, particularly the impact of infrastructure investment (such as roads, ports, waterways) linked to agrofuels, or the impact of agricultural expansion based on agribusiness 'market optimism'.

None of these reports can possibly include the lost capacity of ecosystems to remove atmospheric CO2 in subsequent years and Fargione et al admit as much. If this were quantifiable it could add further orders of magnitude to the already swollen GHG balance.

Finally it is also impossible to quantify the impact of lost ecosystem functions and therefore the contribution of plantations to the acceleration of climate feedbacks including ecosystem collapse. Ecosystems regulate the climate not just by sequestering CO2, but also by regulating rainfall and weather systems, contributing to cloud formation, changing the earth's albedo, producing hydroxyl (OH-) etc. A systemic understanding illuminates the irrelevance of a reductionist analysis which accounts only for GHG emissions.



According to Searchinger et al and Fargione et al, all agrofuels result in a loss of natural ecosystems either directly or indirectly. An indirect example would be rapeseed oil grown in the UK being used for agrofuels, with food and cosmetics companies importing more palm oil as a result.

Given that prices for different types of oilseeds are closely linked, as are those for different types of grains (and displacement can link grain and oilseed markets together), a very high assessment of total GHGs applies to all feedstocks. Market substitution will ensure that all additional demands will continue to be met by ecosystem loss.

Industry statements about 'marginal' and 'degraded' land are almost completely inaccurate. Very often such land is communal land used for grazing, gathering and low intensity crop production. As Fargione et al have shown, even conversion of land previously 'set-aside' for 15 years, to fuel crops results in a carbon debt of over 40 years. On truly degraded land, if drought-tolerant agrofuel crops can produce a yield, then it's highly likely that drought-tolerant food crops or hardy grasses suitable for grazing can equally be grown.

References

1) 'N2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels', Paul Crutzen et al, Atmos. Chem. Phys. Discuss., 7, 11191–11205, 2007

2) 'Land clearing and the biofuel carbon debt', Joseph Fargione et al, 7 February 2008 / 10.1126/science.1152747

3) 'Use of US cropland for biofuels increases greenhouse gases through emissions from land use change', Timothy Searchinger et al, 7 February 2008 / 10.1126/science.1151861

4) 'Carbon payback times for crop-based biofuel expansion in the tropics: the effects of changing yield and technology'. Holly Gibbs et al, Environ. Res. Lett. 3 (2008) 034001 (10pp)