HOW MEANINGFUL ARE 'GREENHOUSE GAS STANDARDS' FOR BIOFUELS IN A GLOBAL MARKET?

This background paper discusses the usefulness of 'greenhouse gas standards', based on life-cycle greenhouse gas assessment in ensuring that biofuels mitigate rather than accelerate global warming. It looks at the importance of non-linear feedbacks which could result from deforestation, which could significantly accelerate ecosystem collapse and climate change; at the importance of indirect or 'displacement' impacts from agrofuel production; and at the remit and limitations of life-cycle greenhouse gas assessments. Finally, we briefly look at the wider debate about the amount of agrofuels which could theoretically be used without accelerating climate change and/or further destroying biodiversity, depleting freshwater supplies and soil.

The term 'biofuels' includes both fuels from true waste and fuels from 'energy crops' which in most cases are grown on monocultures, such as sugar cane, corn, oilseed rape, palm oil and soya. Biofuels from true waste, such as biogas from landfill or manure or waste vegetable oil, are clearly 'climate-friendly', although their role in climate mitigation will be limited. We refer to fuels from 'energy crops' as agrofuels – a term which would also include fuels from organic soil and forest residue, which are essential for maintaining soil fertility and biodiversity. This paper looks at the role of agrofuels only.

Rainforest and peatland destruction and accelerated climate feedbacks:

According to the Stern Review, deforestation is responsible for 18% of global anthropogenic greenhouse gas emissions, however that report does not give estimates for peat and other soil emissions. Figures contained in the in the IPCC's Assessment Report Four suggest that carbon dioxide emissions from global peatland degradation exceed those from deforestation[1] . The destruction of South-east Asia's peatlands for oil palm and timber plantations is the biggest single cause of peatland emissions worldwide.

Rainforest and peatland destruction is thus a major contributor to greenhouse gas emissions, and it also threatens the stability of the global climate in ways not reflected in emissions statistics. One direct impact is the loss carbon sinks: At present, around 25% of anthropogenic carbon emissions are absorbed by the terrestrial biosphere, i.e. by soils and vegetation, and a similar amount is absorbed by the oceans. There is strong evidence that old-growth forests and peatlands continue to sequester large amounts of carbon dioxide from the atmosphere. If those carbon sinks are destroyed, more of our emissions will remain in the atmosphere.

Climate scientists are increasingly concerned that, beyond a certain level of warming, carbon locked up in soils, vegetation and methane hydrates will become increasingly unstable and enter the atmosphere, thus making climate stabilization impossible beyond 1.8 to $2^{o}C$ global warming from pre-industrial levels. Staying within this level of warming will require very fast and steep emission cuts – even whilst carbon sinks absorb half of our emissions. If we destroy our carbon sinks in the meantime, then we will be faced with the need to cut global carbon emissions by more than half, possibly in less than a decade – something which will be virtually impossible. Climate stabilization and ecosystem protection must go hand in hand.

When fossil fuels are burnt, the emissions are directly proportional to the amount of fossil fuel we burn. This is not the case for deforestation. Natural forests and peatlands are complex ecosystems. The Millennium Ecosystem Assessment, published by the UN in 2005, warned that ecosystem degradation is leading to an increased risk of non-linear, i.e. accelerating, abrupt changes[2]. There are increasing fears that the Amazon forest could be vulnerable to such abrupt changes, namely to large-scale die-back:

Deforestation and the threat of catastrophic Amazon die-back

The Amazon rainforest 'recycles' 50-80% of the rainfall on which it depends, through a process of evapo-transpiration. Deforestation reduces the amount of evapo-transpiration and therefore has a strong drying effect. Recent scientific evidence shows that conversion to cropland, such as soya, has an even stronger drying effect that conversion for other land-use[3]. There is strong evidence that, beyond a certain threshold of deforestation, the rainfall cycle over the Amazon may well break down. The Woods Hole Research Institute which has been at the forefront of studying the Amazon carbon cycle, hydrological cycle, and vulnerability to logging and climate change, warns:

"The risk of fire and drought is enhanced by logging, which opens the forests, and by farmers and ranchers who use fire to replace rainforests with crops and pastures. A brutal downward spiral of drought, forest fire, and further drought could expand across much of the Amazon, replacing the species-rich rainforest with savanna like vegetation."[4]

Concerns about a possibly rapid large-scale die-back are supported by evidence that the current Hadley cell airflow, which brings rain to much of South America and as far north as the US Midwest, itself depends on evapo-transpiration in the Amazon[5]: As much as 75% of the water picked up by the trade-winds from the Atlantic Ocean is pumped back into the atmosphere by the forest and finally leaves the Basin and brings rain to the Andes, Central America and the southern US. Rainfall changes over the Amazon have already been observed, which are in line with those models that suggest that deforestation could indeed alter the Hadley cell circulation. This includes strong signs of savannization in a large region from Para to Guyana. There is no definite evidence that the Amazon has already crossed a threshold and entered into irreversible die-back, but the droughts of 2005 and 2006, unprecedented in living memory, suggest that it may be close to such a threshold. Extreme drought and tens of thousands of intense fires in the southern Amazon and neighbouring regions, including Paraguay, northern Argentina and Bolivia in 2007 underline the urgency of the crisis. Forest die-back and conversion into savannah has already been observed in some areas around the drier margins of the rainforest. Some climate models suggest that Amazon die-back could be rapid[6], comparable perhaps to the sudden die-back of vegetation in today's Sahara. Between around 8,000 AD and 3,000 AD, most of the Sahara was covered in forests, grasslands and lakes. Temporary cooling of the North Atlantic reduced vegetation cover at different times, however, the complete vegetation die-back and desertification are understood to have happened abruptly and can only be explained by models which show that vegetation losses eventually disrupted the rainfall on which the region depended. This illustrates the strong links between vegetation and rainfall and the danger of dramatic, non-linear changes once vegetation cover can no longer maintain essential rainfall cycles.

There is a high risk of non-linear events, such as Amazon die-back which could be rapid, irreversible and lead to catastrophic acceleration of global warming as well as major changes in rainfall patterns, which could very rapidly cause global food shortages and large numbers of refugees. Those risks cannot be represented in 'life-cycle' studies done for agrofuels. Given the strong evidence that biofuel targets in the EU, US and elsewhere will threaten to accelerate Amazon destruction, a precautionary climate strategy implies opposing such a high-risk policy.

Indirect impacts of agrofuel production are a major threat to rainforests and other ‘carbon sinks’ and there are no proposals to address those in ‘certification’ or ‘standards’

Different kinds of ‘sustainability standards’ are being developed at present: The UK government are proposing a ‘reporting requirement’ as part of the Renewable Transport Fuel Obligation where companies have to complete forms about the sourcing and life-cycle greenhouse gas emissions of the biofuels they sell. There will be no verificationon the ground, standard ‘default values’ can be used for greenhouse gas emissions, regardless of any actual land-use change, and each company only has to provide information about 50% of their biofuel feedstocks. There will be no mandatory certification and agrofuels from any source can be sold in the UK.

The Dutch Cramer Commission submitted a detailed report on ‘certification’ using a variety of criteria, this is has since been translated into policy proposals for ‘reporting requirements’ only, not into any mandatory standards. The Cramer Commission’s ‘assessment framework’, sets out different criteria, indicators and reports, but it does not look at which policy mechanisms might provide safeguards to ensure that the proposed criteria are met. It acknowledges that “Some of the impacts of biomass production are difficult to assess on the individual company level, and only become apparent on the regional, national and sometimes even on the supranational level. This is true in particular for the impacts caused by indirect changes in land use and is especially important in the themes Greenhouse gas emissions, Biodiversity and Competition between food and other biomass uses. In determining the sustainability of biomass it is crucial to take these macro-impacts into consideration”. The recommendations made in the report are currently being translated into policy proposals for ‘reporting requirements’ only, not into any mandatory certification or standards.

Finally, the European Commission has recently consulted on proposals to certify biofuels according to life-cycle greenhouse and their direct impact on high-conservation value ecosystems only. Biofuels which do not meet those criteria would not qualify under a new Biofuel Directive; however, the consultation document acknowledges that indirect impacts on land-use cannot be accounted for. There are no social criteria, meaning that feedstock from plantations where people have been evicted, poisoned by pesticides or even murdered could be certified as ‘sustainable’. An alternative proposal submitted by Dorette Corbey MEP as part of the Fuel Quality Directive appears to mirror the UK government’s approach. It would allow for ‘sustainability’ to be assumed according to bilateral agreements and certification by voluntary stakeholder schemes, such as the FSC or RSPO. For a details discussion of ‘sustainability standards’ and certification proposals, see this report by Corporate Europe Observatory, Grupo de Reflexion Rural and the Transnational Institute: http://www.corporateeurope.org/docs/agrofuelpush.pdf .

This paper, however, focusses specifically on the indirect ‘macro’ impacts from use and production of agrofuels.

Indirect impacts: How higher commodity prices are speeding up deforestation and climate change

+ A 2006 peer-reviewed study by Morton et al.[3],which was press-released by NASA found: “Area deforested for cropland and mean annual soybean price in the year of forest clearing were directly correlated (R^2 = 0.72), suggesting that deforestation rates could return to higher levels seen in 2003-2004 with a rebound of crop prices in international markets.” According to this study, Amazon deforestation rates are coupled to the world market price for soya, rather than to changes in government or private sector policies or practices. If agrofuel expansion pushes up the price of soya, then an increase in deforestation rates in the Amazon can be expected.

+ According to a peer-reviewed study by Ricardo Grau et al.[7], published in 2005, soya expansion is the main cause of the high deforestation rates in tropical and subtropical seasonally-dry forests in South America, and that global factors (technological development and international prices) are the main drivers of soybean expansion and thus deforestation in those areas, including the semi-arid Chaco in Argentina. The study suggests that in Argentina government incentives for soybean production have cushioned industry from fluctuations in prices, suggesting that government optimism in the economic benefits of soybean production may be more important in that country.

+ According to the US Foreign Agricultural Service, world soybean prices rose by 13% between December 2006 and April 2007, despite 8% growth in production in Argentina, Brazil and Paraguay combined[8]. According to a report by the Woods Hole Research Institute published during the same month, soy prices are currently rising as a result of increased demand for corn ethanol in the US, sugar cane expansion for ethanol in Brazil, and the growing use of soy oil for biodiesel[9] . Recent figures from the US Department of Agriculture confirm that US farmers are indeed switching from soya to corn as a result of the demand for ethanol[10] – one of the reasons identified elsewhere why soya prices are now rising.

The impact of both soy biodiesel and corn ethanol on soybean prices has been confirmed by various sources, including the US Department of Agriculture[11], and various media sources[12] . The article by Gargi Shah quotes Mr Pradip Desai, Managing Director, Palmtrade Services Pvt Ltd. Saying “edible oil prices were expected to be driven mainly by the movement in prices of crude oil, demand from the consumption markets (India, China and EU) and the bio-diesel economics (sic)”. A recent study by the International Food Policy Research Institute predicts that the rapid increase in global agrofuel production increase the prices of oilseeds, including soybeans, rapeseeds, and sunflower seeds by 26 percent by 2010 and 76 percent by 2020[13]

A recent study by the International Food Policy Research Institute predicts that the rapid increase in global agrofuel production pushes up the prices of oilseeds, including soybeans, rapeseeds, and sunflower seeds by 26 percent by 2010 and 76 percent by 2020[13].

+ It is widely accepted that palm oil expansion, and in particular the increase in concessions granted for palm oil, is the leading cause of deforestation in Indonesia and Malaysia. The Indonesian government has acknowledged that new palm oil investment correlates with the price of palm oil. A report by the Food and Agriculture Organisation in late 2006[14] concluded: “The new demand for vegetable oil for biodiesel production has had a major influence on the recent strengthening of prices; and the agrofuel driven surge in the price of rapeseed and its oil has lifted vegetable oil prices in general”. The increasing use of European rapeseed oil for biodiesel was identified as a more important cause for rising palm oil prices than imports of palm oil for biodiesel up to 2996. Since late 2005, coinciding with the rapid increase in agrofuel demand, the EU has been a net importer of both rapeseed oil and soy oil, having been an exporter of both until then[15]. This suggests that, so far, the indirect, or displacement, effects of agrofuel use in the EU have had a considerably greater impact on palm oil prices and thus deforestation in South-east Asia than the use of palm oil biodiesel in Europe, let alone the use of palm oil biodiesel from recently deforested land.

+ According to recent findings by Daniel Nepstad of the Woods Hole Research Institute[9], only a relatively small proportion of soya expansion currently happens inside the Amazon rainforest. Far more important is the displacement of other agricultural activities due to soya expansion in neighbouring areas, such as the Cerrado. Dr Philip Fearnside of the Brazilian National Institute for

Research in the Amazon confirms in the same article: "Soybean farms cause some forest clearing directly…but they have a much greater impact on deforestation by consuming cleared land, savanna, and transitional forests, thereby pushing ranchers and slash-and-burn farmers ever deeper into the forest frontier. Soybean farming also provides a key economic and political impetus for new highways and infrastructure projects, which accelerate deforestation by other actors." Brazil's National Agro-energy Plan has qualified 200 million hectares of Brazilian territory as 'degraded' and thus suitable for the expansion of agrofuel monocultures. Most of this is biodiverse dry forest or savannah, on which indigenous people and other local communities depend for their livelihoods, or lands used for cattle ranching or small-scale subsistence farming. This will seriously worsen the situation described by Nepstad and Fearnside above.

+ So far, most of Brazil's sugar cane ethanol has been produced in Sao Paulo state and also in the north-east, but the industry is expanding rapidly into land traditionally covered by Cerrado vegetation, which is the world's most biodiverse savannah. There are reports of sugar cane plantations inside the Amazon forest (tinyurl.com/yu6xee), however there is strong evidence that sugar cane monocultures threaten the Amazon forest mainly by displacing cattle ranching, soya and other types of agricultural activities from other parts of Brazil and pushing them into the Amazon forest (tinyurl.com/2dx6nl).

<u>More indirect impacts: How high commodity prices and market optimism trigger destructive infrastructure investment:</u>

Government support for agrofuels, including agrofuel targets in the EU, affects deforestation not just by pushing up prices. Many companies and Southern governments are drawing up economic development plans and investment strategies based on optimism about future world demand and prices for agrofuels, which is boosted by Northern governments' long-term commitments to create and support a growing agrofuel market. In June 2006, for example, the CEO of Cargill described agrofuels as a 'a bit of a gold rush' in a New York Times article[16] and the President of the Inter-American Development Bank (IDB), Luis Alberto Moreno, has called agrofuels a "transformative opportunity" for Latin America and the Caribbean[17].

This 'market optimism' is being translated into concessions and investment decisions that economic strategies which create 'favourable conditions' for the expansion of monocultures which produce feedstocks for agrofuels. Those decisions, once made, will be difficult to reverse. In Indonesia, for example, palm oil expansion for the global biodiesel market is one of the priorities in the 5-year economic plan, with government plans for the conversion of around 20 million more hectares over the next 20 years[18] . The Asian Development Bank (ADB) has recently committed itself to large-scale investment in agrofuel expansion, including from palm oil, and, in April this year, the Inter-American Development Bank (IDB) announced plans to invest $3 billion in private sector agrofuel projects. The Argentinean government are committed to meeting 10% of Europe's agrofuel demand by 2010, as well as increasing domestic biodiesel use[19], and they have put economic incentives, such as tax breaks and mandatory targets in place to achieve this.

According to an article in the Latin Business Chronicle, the meeting between President Lula and George Bush in March this year encouraged US, European and Japanese investors to draw up new investment plans for sugar cane plantations, mills, road, railway and port projects[20] .

The investment decisions and strategies described above are likely to accelerate deforestation and peat drainage not just because they encourage land conversion to agrofuel plantations. Large numbers of refineries are being built and planned, particularly in South-east Asia and Latin America, which require large plantations to remain economically viable. The Indonesian NGO Sawit Watch estimate that a palm oil mill requires 20,000 hectares of land to be viable, yet a biodiesel refinery needs 50,000 hectares[21]. Ecotropica and the Global Nature Fund have warned that ethanol refineries for which the Mato Grosso state government has recently granted planning permission will make large-scale deforestation and drainage in the Pantanal inevitable [22].

Much of the ‘strategic’ investment by governments and international finance organization, however, will include infrastructure projects, which will fragment and open up many of the world’s remaining rainforests, semi-arid forests and natural grasslands to development. The link between road building and forest degradation and destruction is well-established[23]. The Initiative for the Integration of Regional Infrastructure in South America (IIRSA), for example, is a plan by South American governments to greatly increase roads, waterways and ports, partly in order to facilitate imports of soybeans and grains. A total of 335 projects have been identified, and 31 are currently being implemented at a cost of $4.3 billion, co-financed by the Inter-American Development Bank, Fonplata and the United Nations Development Programme. The largest IIRSA project is the Madeira- Mamoré -Beni-Madre de Dios hydroelectric and channelization complex, which would allow for soybean expansion in the Bolivian Amazon and savannah and the Brazilian rainforest, according to the International Rivers Network[24]. The IIRSA is a far-reaching investment programme which will serve a variety of economic interests, not just agrofuel expansion. Paraguayan farmers organizations have, however, pointed out that national agrofuel strategies in countries like Paraguay, the Ethanol Alliance between the US and Brazil, which other Latin American governments are expected to join, proposals made at the First American Congress on Biofuels in May 2007, as well as bilateral agrofuel co-operation between Latin American states and the US and EU depend on many of the large-scale infrastructure projects planned under the IIRSA[25]. Agrofuel expansion thus provides a very strong incentive for road, port, canal developments which are a major threat to Latin America’s largest natural ecosystems.

This is reflected in the Brazilian government’s Plan for Growth Acceleration (PAC), which was published in January 2007. This includes ambitious infrastructure projects in the Amazon forest. Many of the projects will be financed by Brazilian National Bank for Economic and Social Development (BNDES), and there is a commitment to build 1,150 kilometres of ethanol and biodiesel pipelines for export. Expansion of monoculture plantations for agrofuels, particularly in the Cerrado, forms an important part of the PAC. There are further proposals to devolve environmental protection to states and municipalities which many environmental organsiations fear could water down existing standards[26].

Guyana is another country where rainforests are threatened both directly and indirectly by agrofuel expansion: In April 2007, plans for the first ethanol plants were announced, and there are plans to improve transport links across the border with Brazil and along the Atlantic seabord linked, at least partly, to plans to grow and transport sugar cane for ethanol. It is feared that this could increase settlements, agricultural expansion and port development[27].

And more indirect impacts: Strengthening the political power of corporate interest groups

Another likely ‘indirect impact’ of agrofuel expansion is the strengthening of political power of corporate interests representing large agri-businesses and biotech companies. This may well be reflected in Brazil’s Plan for Growth Acceleration or the Paraguayan and other investment policies and strategies, including those discussed above. In Indonesia, high palm oil prices and government support for biodiesel expansion has greatly strengthened the economic power of companies such as Raja

Garuda Mas, Sinar Mas or the Bakrie Group[28]. Many of those business groups have got strong links to government and have increased their political dominance, particularly in Kalimantan and Sumatra, by taking advantage of decentralization. Raja Garuda Mas and Sinar Mas own the logging/timber companies APRIL and APP, notorious for their destruction of most of Sumatra's rainforests. The biodiesel boom is thus strengthening business groups also responsible for rainforest destruction for timber, pulp and paper. It is therefore impossible to distinguish between rainforest destruction for palm oil or for timber in Indonesia: The government's strategy of granting more concessions to companies for palm oil plantations, together with a virtual lack of law enforcement against those companies is encouraging both rainforest conversion to plantations and illegal logging.

The indirect impacts from agrofuel expansion are in many cases a greater threat to rainforests and other vital carbon sinks than the conversion of those ecosystems to agrofuel plantations. Indirect impacts include the displacement of other forms of agriculture into natural ecosystems as agrofuel plantations are expanded elsewhere, the wider effects of infrastructure projects linked to agrofuel expansion, the strengthening of corporate elites already responsible for deforestation and forest degradation in many Southern countries, and the encouragement of national development strategies and public-private investment decisions which favour monoculture expansion and large-scale infrastructure projects at the expense of rainforests and small-scale sustainable farming. Deforestation rates in many areas are linked to commodity prices, for example for soya and palm oil, which are now being boosted by agrofuel expansion. Furthermore, the 'market optimism' created by biofuel targets in the EU, US and elsewhere is serving as a strong incentive for private investors and governments to provide both the infrastructure and long-term institutional framework for monoculture expansion.

How useful are life-cycle greenhouse gas assessments?

All of the certification/standards/reporting proposals for agrofuels which being discussed at present look at encouraging the use of agrofuels with a 'positive greenhouse gas balance'. Many European NGOs are now calling to restrict public support, granting it only to those agrofuels that achieve at least 50% greenhouse gas reductions. The 'greenhouse gas balance' of agrofuels is established through life-cycle greenhouse gas assessments that should ideally be peer-reviewed though, in reality, very few of them are.

There are no peer-reviewed life-cycle greenhouse gas studies for biodiesel from palm oil, jatropha or soya, and peer-reviewed studies on sugar cane ethanol are limited to those looking at energy gains and fossil fuel displacement, rather than total greenhouse gas balances. One study by Macedo et al, which appears not to be peer-reviewed, looks at the greenhouse gas balance of Brazilian sugar cane, but excludes deforestation and land-use change, despite the fact that sugar cane expansion is linked to land conversion in the Cerrado, the Atlantic Forest and the Pantanal watershed, and contributes to the destruction of the Amazon Forest, probably directly but primarily indirectly[30].

Agrofuels produced in Europe from crops like maize and oilseed rape have been widely assumed to have a positive greenhouse gas balance although, as we have seen above, indirect impacts on deforestation elsewhere which happen via the global commodity prices are being ignored.

A recent paper by Paul Crutzen et al, however, argues that nitrous oxide emissions linked to the use of nitrate fertilisers have been significantly underestimated and that the climate impact of rapeseed biodiesel, for example, is up to 70% worse than that of equivalent amounts of fossil fuel diesel[31]. The authors of the paper suggest that N2O emissions have been underestimated for two reasons: Firstly, most life-cycle assessments have only looked at the direct N2O releases from the fields on which nitrate fertilisers have been applied, whereas nitrogen compounds will be distributed over a much larger area, leading to indirect emissions which, according to IPCC guidelines should be taken into account. Secondly, they suggest that the 'indirect N2O emissions' are considerably larger than the IPCC have assumed.

Some of the problems with life-cycle assessments

- Many assessments point to significant uncertainties, particularly with regard to the attribution of by-products, and soil nitrous oxide emissions, with the new paper by Crutzen et al suggesting that emissions may be routinely underestimated..
- The largest number of peer-reviewed life-cycle greenhouse gas assessments has been done for US corn ethanol. An evaluation of six different analyses by Alexander Farrell et al, published in Science in January 2006[32] reveals a wide range of methods used and different results reached. The authors conclude that corn ethanol brings small greenhouse gas savings of 13% compared to petrol, but only if soil erosion and land conversion are ignored. This study, in turn has been criticized some scientists[33]. Alexander Farrell and his colleagues said in response to this criticism: "Including incommensurable quantities such as soil erosion and climate change into a single metric requires an arbitrary determination of their relative value." Yet soil erosion implies the loss of soil organic carbon and a need to use further energy and fertilizer input (with more nitrous oxide emissions) to be able to farm the land. Soil organic carbon losses and climate change are ignored in virtually all life-cycle assessments, further undermining their usefulness as a benchmark for 'sustainability'.
- As mentioned above, soil organic carbon losses are ignored in virtually all life-cycle assessments, even though they can be substantial. One of the regions where soil organic carbon changes linked to agriculture (though not to agrofuel production in particular) has been studied extensively is Argentina's Pampas region. Here, different studies reach very different results for the same climate zone and farming methods, some indicating minor accumulation of soil organic carbon with non-till farming, whilst others show substantial carbon losses. This is likely due to variations in soil composition and different methodologies.

Although there is no universally agreed methodology for life-cycle assessments, few independent researchers working in this field, and very few peer-reviewed studies, agrofuel companies are increasingly commissioning their own assessments. They use a range of methodologies, often ignoring important sources of emissions, or even all greenhouse gas emissions other than those of carbon dioxide. If governments introduce a reporting requirement or standards based on life-cycle greenhouse gas assessment, then they will have to rely on industry-commissioned, non-peer-reviewed studies that by their nature will not provide independent scientific evidence. The only alternative, not proposed or considered by anybody, would be to delay such a requirement, possibly by several years, and to provide government finance to build the capacity for independent scientific research in this field.

How life-cycle assessments can have an industry bias

- Greenergy Biofuels Ltd claim to have been the first UK company to publish figures on carbon savings from the biodiesel they sell. Like other companies, they ignore greenhouse-gas emissions other than carbon dioxide, even though nitrous oxide emissions account for a large proportion of life-cycle emissions from biodiesel. Greenergy commissions the Edinburgh

Centre for Carbon Management (ECCM) for studies. Greenergy Biofuels Ltd's office is at the same address as ECCM and Greenergy previously owned a lot of the ECCM shares.

- In June 2006, Neste Oil published a report on life-cycle greenhouse gas savings from their NExBTL biodiesel from rapeseed oil and palm oil, which was undertaken by the German Institute for Energy and Environmental Research (IFEU)[34]. The surprising conclusion of this study was that the best greenhouse gas balance comes from converting natural rainforest to palm oil for biodiesel. Biofuelwatch spoke to the IFEU team responsible for the study and were advised verbally that the result was derived by excluding soil carbon emissions, all emissions linked to peat destruction, all emissions linked to forest fires, and dividing deforestation emissions by 100 (i.e. spreading them over a century), even though the maximum life-time of an oil palm plantation is around 25 years. Calculations for nitrous oxide emissions ignored the IPCC observation, contained in the Third Assessment report, that the application of nitrate fertilisers to one hectare of tropical and phosphorous-limited soil resulted in N2O emissions 10-100 times higher than those from applying the same amount to a hectare of temperate soils.

<u>The difficulties with inclusive life-cycle assessments</u>

As discussed above, no methodologies exist which could account for indirect impacts, let alone non-linear feedbacks, when establishing 'greenhouse gas balances'. Accounting for those would indeed be extremely difficult:

a) If Amazon rainforest is converted to soya plantations, a good life-cycle study should calculate how much carbon is lost from each hectare of the new plantation as a result of deforestation. Those figures would be based on the presumption that carbon emissions correlate directly to the area deforested, i.e. that there will be no non-linear feedbacks. As we have seen above, there is a high risk of non-linear feedbacks, yet it is impossible, to predict exactly where the 'tipping point' for a large-scale die-back of the Amazon might lie. No life-cycle study can account for or attribute the release of perhaps 120 billion tonnes of carbon which could result from land-clearance beyond that unknown 'tipping point.'.

b) In South-east Asia, satellite images have confirmed that most of the annual peat and forest fire hotspots are on plantations, many of them oil palm plantations. The spread and intensity of the fires, however, depends on weather conditions. In theory, a life-cycle assessment could account for carbon emissions from forest fires set to clear land for a agrofuel plantation, though no such assessments have been done as yet. In practice, this will be almost impossible to police or prove, and it would also yield vastly different emission figures linked to chance weather conditions rather than company practice. In reality, vegetation burning and, in most cases, land-conversion and deforestation, are ignored completely in life-cycle assessments.

c) Life-cycle assessments are done on a field basis, and thus cannot account for any of the indirect 'displacement' effects described above. Those effects are difficult to quantify and prove and no methodology for including them exists.

Life-cycle assessments are micro-studies, which look at greenhouse gas balances on a field-basis. They cannot account for the wider impacts of agrofuel production, such as displacement of other agricultural activities or accelerated deforestation linked to infrastructure for the transport of agrofuels. Neither can they account for non-linear feedbacks. There are very few peer-reviewed studies, and methodologies vary widely. Most studies ignore some types of greenhouse gases or

sources of emissions, such as soil organic carbon losses and deforestation/land-use change emissions. Scientific uncertainty means that some of the better studies reveal a very wide margin of error, which makes it difficult to use them for any 'certification' or 'reporting' requirements. There is no capacity for independent research to carry out the large number of assessments required by any reporting or certification scheme. This is likely to result in a large number of company-sponsored 'research' projects that will not be independently verified. Most importantly, however, even the best life-cycle greenhouse gas assessment cannot help to prevent agrofuels from accelerating global warming, because it cannot account for indirect impacts/displacement, nor for non-linear climate feedbacks from deforestation, which are amongst the most serious risks to our carbon sinks and thus to the stability of the global climate.

Could sustainable agrofuels play a significant role in future energy supply?

Any major shift from fossil fuel energy to bioenergy will significantly increase human demands on the planet's photosynthetic capacity, and on the biosphere in general. Perhaps the most fundamental question in the agrofuel debate is whether, or in how far, increased use of bioenergy could be possible without further destabilizing ecosystems, depleting the soil and water on which agriculture as well as ecosystems rely, or further disrupting the carbon cycle and thus accelerating climate change. A number of studies suggest that sustainable bioenergy, and agrofuels in particular, could meet a significant proportion of our primary energy demand. All of those studies are based on the assumption that there will be no climate change impacts on agriculture in coming decades – the report by E Smeets et al even states that it is assumed that the climate will not change between now and 2050. All of the studies assume that substantial increases in per hectare yields are feasible, and that further intensification of agriculture is possible without being limited by depletion of water and soil, despite the fact that global grain production has, so far, peaked in 2004 and that per hectare yields of key agrofuel crops are declining in different parts of the world. European oilseed rape per hectare yields, for example, have been falling for four years, with a significant fall in overall output in 2007.

Various studies, including the UN Millennium Ecosystem Assessment Report, show that human pressures on the biosphere and resource use are already highly unsustainable, even without large-scale modern agroenergy. According to that report, 60% of ecosystem services are degraded and there is an increasing likelihood of non-linear changes in ecosystems which could have severe impacts on human society.

Contrary to the widespread presumption that agrofuels are a source of 'renewable energy', the International Panel on Climate Change states that stable ecosystems must approach zero 'net primary productivity'[36]. This means that, in a stable environment and climate, the amount of carbon fixed by plants is equal to the amount of carbon put back into the atmosphere, partly by the plants themselves and partly by symbiotic soil organism. It means that, over the human time-scale, healthy ecosystems do create energy. This is why scientists such as Tad Patzek, geoengineer at UC Berkley warn that agrofuels will require intensive 'mining' of the biosphere, in which ecosystems, including soils, continue to be stripped off their organic materials, which will have to be continuously replaced by fossil fuels (in the form of fertilizers) to prevent or even delay agricultural collapse[37].

The difference between carbon emissions on the one hand and increases in atmospheric carbon dioxide on the other suggests that, at the global level, net primary productivity has been increasing in recent decades, allowing ecosystems to absorb about 25% of anthropogenic carbon dioxide emissions. Many scientists assume that this is a temporary response to higher carbon dioxide levels ('carbon fertilisation'), which may soon be overwhelmed by increasing stress from heat, drought and extreme weather events. It is not a trend on which we can rely in future.

A recent paper by Helmut Haberl et al[38] finds that humans already use 23.8% of the net primary productivity of the terrestrial biosphere resulting in severe ecosystem degradation and bio-geochemical changes, and that large-scale biomass expansion would greatly increase those pressures. NASA satellite images reveal that most net primary productivity in the more densely populated parts of the world is appropriated by humans[39]. Another paper, by Renton Righelato and Dominick Spracklen[40], finds that meeting the EU and US agrofuel targets will require clearance of natural forests and grasslands, and that "clearance results in the rapid oxidation of carbon stores in the vegetation and soil, creating a large up-front emissions cost that would, in all cases examined here, outweigh the avoided emissions". Ecological restoration, rather than land conversion for agrofuels, would offer a significant potential for reducing global carbon emissions, according to the authors.

A presentation by G Huppes and E van der Voet of the University of Leiden[41], links increases in bioenergy use to reduction in land available for ecosystems and finds that large-scale bioenergy expansion will first reduce and eventually eliminate the space available for ecosystems, and thus for most species on earth.

Scientists at a recent conference of the Stockholm International Water Institute warned that agrofuel production would double the amount of water used by agriculture and lead to land clearance and significant carbon dioxide emissions[42]. Water scarcity is a major threat to human society, to agriculture, and to ecosystems.

Second-generation agrofuels, if they were to become commercially available, would allow humans to turn different types of biomass into liquid transport fuels. This could greatly increase human pressure on the biosphere.

It is important to consider natural limits to the use of bioenergy, which are the negligible amount of 'new energy' created by plants, the scale of human appropriation of the planet's photosynthetic capacity and 'ecosystem services', and the fact that demand for agrofuels is increasing at a time when all of the world's ecosystems are already under strain from resource over-exploitation and climate change. There are intrinsic natural limits to 'sustainable agrofuels', which cannot be overcome by more effective regulation, sustainability safeguards or by new technology. Going beyond those limits will greatly increase the chances of ecosystem collapse and non-linear events, as highlighted in the UN Millennium Assessment.

Micro-studies or a systemic life-cycle assessment of the whole industry?

A recent report by the International Forum on Globalization and the Institute for Policy Studies calls for systemic life-cycle assessments which should be the basis for energy policy choices[43]. The report takes account of eight key criteria, including net energy gain, impact on forests, on soils and on water, and it attempts a global, macro assessment of the industry, rather than assessing individual batches of biofuels from different sources. The key question, according to the authors, is whether agrofuels can be produced sustainably on a large enough scale to become accessible to everybody and to provide a significant amount of net energy. There is a strong argument for basing energy policy on such a comprehensive systemic macro-assessment, rather than on different micro-level live-cycle assessments, as several European governments intend to do.

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