BIOFUELS: RENEWABLE ENERGY OR ENVIRONMENTAL DISASTER IN THE MAKING?

http://www.greenfuels.org/biodiesel/i/banner.jpg

'In the absence of governmental constraints, the rising price of oil could quickly become the leading threat to biodiversity, ensuring that the wave of extinctions now under way does indeed become the sixth great extinction.'

Lester Brown (Director of the Worldwatch Institute) about the growth of biofuels


Peat and forest fires on Borneo-mostly set by oil palm plantation owners
http://www.esa.int/images/Fire72_M.jpg

Amazon destruction to grow soya
http://earthhopenetwork.net/brazil_deforestation.jpg

INTRODUCTION

Biodiesel plant
www/oekotec.ibg-monoforts.de/bio-e/040.html

Bio-ethanol car in Europe
www.somerset.gov.uk/

Biofuels have become one of the fastest growing markets in the world – at 15% growth a year. They are being promoted by European governments hoping to meeting Kyoto targets – and by George Bush wanting to replace some Middle Eastern oil imports. With oil prices steady above $60 a gallon, biofuel has become competitive. Whilst it attracts subsidies in Europe and the US, Brazil have shown that a mature biofuel industry can now compete with petrol on the free market.

Many environmental NGOs strongly support biofuels as one of many renewable technologies needed to reduce our dependence on hydrocarbons and to avert the worst of climate change. They want targets to greatly increase the use of biofuels whilst ensuring that all supplies have to be certified as coming from sustainable sources. Meantime, governments around the world are introducing the targets without the environmental safeguards. A European Union Directive, for example, mandates the use of biofuels in 5.75 – and possibly even 8% of all road transport fuel. A 20% target is stated for 2020.

So – what do we really know about biofuels? Can they reduce climate change emissions without causing serious other damage? Can we get the 'biofuel revolution' right and, if so, how do we do it?

WHAT DO WE REALLY KNOW ABOUT BIOFUELS?

Corn grown for bioethanol in the US
www.state.nj.us/agriculture/ photos/cornfield.jpg

Oilseed rape field for biodiesel
www.houstonbiodiesel.com/

DEFINITIONS:

This paper looks at fuels gained from energy crops which have been grown either for biomass burning - to produce heat and energy - or for transport fuel. It does not discuss the production of biogas from organic waste, the burning of waste products from existing agriculture for heating or electricity, or the use of waste vegetable oil as biodiesel. Gaining energy from waste can make a positive contribution to reducing greenhouse gas emissions, and should definitely be supported. At present, organic waste, including massive amounts of straw and other residues from agriculture, are openly burnt (still legally so in the US and UK, as far as plant matter is concerned) or dumped, contributing to large amounts of methane and CO2 emissions. This practice is irresponsible when valuable clean energy could be gained instead.

There are two main types of biofuels for transport: Bioethanol, which is alcohol derived from sugar or starch, for example from sugar beet, cane or from corn, and biodiesel, derived from vegetable oils, for example from rapeseed oil, jatropha, soy or palm oil.

The US are the world's largest bioethanol producer, and this accounts for 99% of their biofuel for road transport. The European Union is so far the world's largest biodiesel producer, and use considerably more biodiesel than bioethanol.

In this paper the comparison between biofuels and diesel or petrol is made on a 'per kilometre' basis, not on a volume basis, because cars will drive less far with the same volume of biofuel than petrol or diesel.

CAN BIOFUELS GROWN IN EUROPE AND THE US REDUCE CLIMATE CHANGE EMISSIONS?

It is often claimed that biofuels are carbon-neutral because when they are burnt they only release the CO2 that was already in the atmosphere. There are, however, considerable CO2 emissions from the refinery and distillery process needed to produce biodiesel or bioethanol, as well as from transport, the use of farm machinery, and fertilizer

production. Biodiesel in particular is linked to high emissions of the potent and long-lasting greenhouse gas nitrous oxide, which is released by microbes when nitrogen fertilizers are applied to soils, and also during the production of nitrogen fertilizers. Some, though not all studies, also link biodiesel to higher tailpipe emissions of nitrous oxide and nitrogen oxide. Nitrogen oxide is a precursor to tropospheric ozone, a strong but short-lived greenhouse gas. And, finally, there are emissions of CO2 from soils as more land is put under the plough.

In a world dominated by fossil fuels, no energy source can be completely carbon neutral: Wind mills, for example will take 6-8 months to produce the amount of energy which went into constructing them (and which generally comes from fossil fuels). They last, on average, for twenty years, so they produce far more clean energy than the polluting energy which went into making them. This means that wind energy has a very positive energy and carbon balance.

What matters, therefore, is the energy and carbon balance – and in the case of biofuels the whole greenhouse gas balance, including the very powerful greenhouse gas nitrous oxide.

Many studies have looked at 'life-cycle assessments' for different kinds of biofuels to find out whether they have a positive energy and greenhouse gas balance – i.e. whether they actually are better for the climate than burning fossil fuels.

The results are certainly far less encouraging than for solar energy or wind energy – or even for nuclear energy (looking at greenhouse gas emissions only, not the dangers of radiation). They are also controversial, because most studies ignore the CO2 and nitrous oxide emissions from soils, which happen as land is converted to agriculture, or more fertilizers are applied.

Many researchers are optimistic that new technologies could, in 5-10 years time, greatly improve the picture for biofuels. Those are lingo-cellulosic technology for bioethanol and Fischer-Tropsch gasification technology for biodiesel. In future, not just agricultural waste products but also switchgrass, forestry residues and fast-growing trees could be used to make biofuels for transport. Governments all over the world, however, are implementing biofuel targets now – and for the short- and medium-term targets at least, it is the present technology which matters.

Finally, no matter how efficient future technologies might be – producing biofuels for cars will always be far less energy and carbon efficient than burning biomass for primary energy and heat generation, which leaves out the energy-intensive refinery process.

ENERGY AND GREENHOUSE GAS BALANCE OF BIO-ETHANOL

In the US, a 2006 study[1] reviewed six peer-reviewed papers and came to the following conclusion for bio-ethanol made from corn (the main biofuel in that country):
It found that, over the whole life-cycle, ethanol has 13% less greenhouse gas emissions than burning petrol, but only if one assumes that co-products from producing ethanol displace other animal feeds, such as soy meal – and it is not proven that this actually happening. If animal feeds are not being replaced, then there will be little or no

greenhouse gas savings. Nitrous oxide emissions were not discussed, but will be smaller than for oilseed rape biodiesel, since less nitrogen fertilizers tend to be used to grow corn. The authors warn that 'global sustainability of ethanol has not yet been fully researched' and that the negative effects of fertilisers, pesticide and herbicide use, and of soil erosion and possible deforestation to make way for energy crops have not been considered. This appears to be the most comprehensive study yet – but all figures are taken from the US, where energy production, and thus the refining process, is more carbon intensive than in the EU. CO2 savings might, therefore be slightly higher for corn bioethanol made in Europe, and still higher if other crops are used. The figures for sugar-cane ethanol made in Brazil are very different, and will be discussed below.

ENERGY AND GREENHOUSE GAS BALANCE OF BIO-DIESEL:

Amongst biofuel crops grown in Europe and the US, biodiesel is generally considered to be more energy efficient than bioethanol. Some biodiesel crops, such as oilseed rape, however, are grown with large quantities of fertilizers, which offset a lot of the greenhouse gas savings.

There are many studies which look at the life-cycle greenhouse gas balance.
Most of those studies which that take N2O from fertilizer production and tailpipe emissions into account calculate greenhouse gas savings of 53-56% when comparing biodiesel made from rapeseed oil to diesel or petrol. Biodiesel from sugar beet and wheat yields far lower savings. Moreover, most studies agree that savings could be greatly improved with new technologies in 5-10 years time.[2 and 3] . One recent study by Ifen, the French Environment Institute, suggested greenhouse gas savings of 75% for biodiesel and of 60% for bioethanol – a higher figure than that found by most studies. Greenpeace warned, however, that inputs during crop production were not fully considered by Ifen.[4]

It may sound encouraging that biodiesel appears to have less than half the emissions of diesel or petrol. It is less encouraging to look at the amount of land needed for biodiesel crops in order to reduce transport emissions. One European study by CONCAWE (not peer-reviewed)[3] offered the following calculation: If all 5.6 million hectares of set-asides in the 15 'long-standing' EU nations were intensively farmed for biofuel crops, we could save 1.3-1.5% of road transport emissions, or around 0.3% of total emissions from those 15 countries.

PROBLEMS WITH THE CALCULATIONS:

Even the more optimistic studies suggest only marginal greenhouse gas savings from biofuels. Yet there is fear that even those results could be over-optimistic – as the CONCAWE and the University of Berkeley studies mentioned above concede.

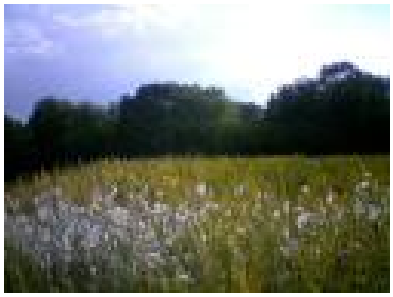
1. Energy and greenhouse gas savings would be far lower if it was not assumed that all by-products would be used for animal feed and would displace an equivalent amount of existing animal fodder production, e.g. of soy meal. According to the CONCAWE study, biofuel residues are, however, not replacing animal feed on as large a scale as expected.

2. The amount of CO2 released from the soil as natural vegetation makes way for agriculture has been ignored. Those emissions have been estimated as 3 tons per hectare in temperate zones[5] – according to the CONCAWE report they would cancel out all or most of the apparent savings! Soil emissions will be even higher in some places, e.g. in Scotland which has a lot of peat soils. Looking at it differently, spare agricultural land could either be used for biofuels or for natural regeneration – and restoring original ecosystems might, even in Europe and the US, do more for climate change emissions than growing energy crops.

3. The International Panel on Climate Change stated in their Third Assessment Report that increasing nitrogen in the soil through fertilizer increases the emission of N2O from the soils. They pointed to evidence of a faster-than-linear feedback in such soil emissions as more fertilizer is applied.[6] N2O is 310 times as potent a greenhouse gas as CO2 and remains in the atmosphere for 110-120 years. If those figures are taken into account, greenhouse gas savings for biofuels drop from 53% to just 7%[3].

This means that the greenhouse gas savings from biofuels grown in Europe and the US might be even smaller than widely assumed – we cannot even be confident that there are any such savings. There is no comprehensive study which fully discusses all the data on CO2 and N2O emissions from soil erosion, and also looks at whether by-products are actually being used to displace other production. This means that nobody can say with any confidence whether biofuels from the US or Europe are any better for the climate than burning fossil fuels!

THE ENVIRONMENTAL DOWNSIDE OF BIOFUELS GROWN IN EUROPE:



Set-aside land in Europe
www.revlop.com

Yellowhammer on set-aside land
www.rspb.org.uk/countryside/farming/

Putting millions of hectares of land under intensive agriculture to produce biofuels will have major impacts on habitats, biodiversity, water supplies, and soils.

The European Union have a target of halting the loss of biodiversity by 2010. Expert reports at a 2006 meeting warned that we are on track to miss 8 out of 9 of the specific targets to achieve this.[7] There have been major declines in birds, particularly farmland birds, amphibians, moths and butterflies in recent years, as well as serious population declines of mammals in some areas (such as hedgehogs in the UK). Habitat loss and intensive agriculture have been identified as major reasons for this loss of biodiversity, together with alien species invasions and climate change. Set-asides sustain many of our wintering birds, as well as other species. Autumn-sown oil seed rape and winter-sown

wheat in particular are linked to massive declines in farmland birds. Meeting the EU Biofuel Directive from European soils would, therefore, speed up the loss of much of our wildlife.

Water stress from increasing intensive agriculture will become a serious problem, particularly in countries like Spain which are becoming drier due to climate change. Spain already has a large biofuel production, drawing on diminishing groundwater. Large parts of England are also water-stressed and any agricultural expansion for biofuels would make the situation worse. Water stress threatens wildlife which depend on rivers and wetlands.

Using fertilisers leads not just to N2O emissions but increases the nutrient-overload which is already a major threat to the biosphere. The amount nitrate available to the biosphere worldwide has been doubled by human activity already. It is threatening plants on land, rivers and lakes (through eutrophication) and has been described as a greater threat to marine life than over-fishing by the United Nations.

It would be possible to grow biofuel crops on land currently used for food production, which could even reduce the amount of produce dumped on poorer countries. This might appear to be more sustainable for the environment, as none of the problems from land-use change would arise. If land for food production can be spared, then we should compare the biofuel scenario to one where land was taken out of agricultural production altogether. Allowing natural vegetation to regrow would reduce greenhouse gas emissions from soil, stress on water resources and create much needed wildlife habitats and 'corridors' – including for the many species who have to migrate northwards and upwards as temperatures rise. Unfortunately, this possibility is generally ignored in studies about biofuel production.

Global concerns about biofuels and food security will be discussed in the Southern Africa case study below. Even in Europe, we cannot assume that we will maintain our current food surplus for much longer, as global warming intensifies and brings with it ever more extreme weather.

BIOFUELS FROM ALGAE?

One of line of research, undertaken in the US but not supported in Europe, looks at using green algae, grown in large fresh-water tanks for biofuel. There has been no peer-reviewed life-cycle assessment of this technology, which is not yet commercially used. Initial studies, however, suggest that the energy produced this way is very much greater than that from any land-based biofuel crop (including all tropical ones), and that there could be considerable fossil-fuel savings whilst using a very limited area of land. If the claims are supported by further research, then this technology might allow for substantial amounts of transport fuels to come from algae without too large an impact on land use[8].

AND WHAT ABOUT BIOFUELS FROM THE TROPICS?

Jatropha for biodiesel
flow.blogspirit.com/ economie/

Sugar cane
www.gregdooly.com

All the studies commissioned in Europe and the US look at biofuels produced in those countries. As shown above, they suggest that there are marginal greenhouse gas savings, albeit at a considerable costs with regard to biodiversity, soil and water supplies. Based on those studies, the EU and the US passed policies to promote the rapid expansion of biofuels. One result, however, is the creation of a huge new market in tropical countries, with millions of hectares being converted to bio-crop monocultures to fuel European and US American cars. And yet…there are very few life-cycle assessments for tropical biofuel crops, and even less that look at the effects of land-clearance to grow them. Neither the US nor the EU have studied or discussed what importing tropical biofuels will do to the planet.

An analogy would be an Environmental Impact Assessment which looks at building a bypass around a town. At the planning stage, people would have argued about the facts used and the need for a bypass. But then, based on the assessment of a bypass, something totally different is built…perhaps a motorway right through a city centre. Something nobody had ever assessed or debated. This is the situation which the European Union is finding itself in, having studied domestic biofuels and now creating a massive market for tropical crops.

What we know is that, on average, biofuel crops grown in the tropics yield about five times as much energy as those grown in temperate zones.

Corn produces 145 kg of oil per hectare per year, sunflowers 800 and rapeseed 1000.

The tropical jatropha produces 1590 kg of oil per hectare per year, oil palms a full 5000.

This explains why, in a free market, we will have to rely more and more on imports from the tropics – even if were able to meet the official targets from European and US soils (which is, of course, questionable): Our crops simply cannot compete with tropical ones.

There is very little scientific information about growing biofuels in the tropics, except for basic data on energy balance (i.e. energy input compared to energy yields). The life-cycle assessments which have been done for biodiesel and bioethanol in the US and Europe will not apply to the tropics:

1. A much higher energy and oil content from tropical crops means that the energy balance will be more positive for, say, jatropha or palm oil than it is for, say, rapeseed oil. This should result in lower CO2 emissions from the refinery process, although emissions from transporting either the biofuels or the raw materials abroad will be higher than for domestic production. CO2 emissions will depend on how carbon-intensive refinery

processes are in different countries where biofuels are made: In the US, coal is widely used for biofuel refinery, so those emissions are high. In Brazil, sugar cane residue is used to create the power for ethanol refining, so there are no CO2 emissions in this sector.

2. Carbon emissions from soil depend on soil type and climate. Replacing tropical peat swamps with biodiesel crops, for example, would trigger particularly large CO2 emissions from soils, as discussed below.

3. According to the International Panel on Climate Change, N2O emissions from soil are 10-100 times higher if fertilizer is applied to tropical soil, compared to temperate climate zones. And, as mentioned above, N2O is a far more potent greenhouse gas than CO2.

4. There could be catastrophic effects from replacing tropical rainforests with biofuel-crops. Rain forests are major carbon sinks – and some of them are believed to have a self-sustaining hydrological cycle which might collapse if deforestation reaches a 'tipping point' (see below for Brazil).

No life-cycle assessments of tropical bio-fuel crops can be found on the internet, hence we shall look at three country profiles.

CREATIVE ACCOUNTING UNDER THE KYOTO AGREEMENT?

When the UK government announced their plans for biofuel targets, they claimed that 5% of biofuel used in road transport fuel mean 5% less greenhouse gas emissions. There is no scientific basis for such a claim. The government stressed, however, that under international rules, none of the greenhouse gases linked to the production of biofuels will be attributed to the transport sector (although no rules will have allowed the UK to omit NOx tailpipe emissions and treat diesel and biodiesel volumes as equivalents). The emissions that arise during biofuel production will be counted towards agricultural and industry and or energy sector emissions. This is fair as far as home-grown biofuels are concerned. It means, however, that all the emissions that come from growing and refining, say, palm oil in Indonesia, will count towards Indonesia's emissions, whilst countries like the UK can use them to improve their greenhouse gas inventory. This allows rich importing nations to 'out-source' some of their emissions and claim credit for doing so under the Kyoto Agreement.

COUNTRY STUDY 1

GREEN GOLD FOR SOUTHERN AFRICA? JATROPHA PLANTATIONS IN MALAWI AND ZAMBIA

Jatropha plant in Malawi
www.newfarm.org

Women gathering wood fuel in Malawi
http://images.wri.org/photo_fuel_print.jpg

Biodiesel is hailed as a sustainable and profitable new export sector for some of the poorest nations in the world, including Malawi and Zambia. Energy crops grown in southern Africa have the support of the Southern African Development Community (SADC), the United Nations (Food and Agriculture Organisation) and the European Union, and may attract money under the Clean Development Mechanism of the Kyoto Protocol. It is hoped that growing biofuel crops for export will improve farmers' income levels and thus protect them from food shortages, and that economic diversity and the balance of trade will be improved.

The main biofuel crop now grown in southern Africa is jatropha. It has the second-highest oil/energy content of all crops, after palm oil – and thus has an advantage over most crops grown in Europe or the US. It is a drought-resistant plant which requires little or no irrigation, and needs little or no input from pesticides or fertilizers. Jatropha beans can be harvested three times a year and by-products can be used to make soap and even medicines. Refining is done in South Africa.

Many of the farmers who are switching to jatropha previously grew tobacco: a far more destructive crop, not just for end-users but also for soils and water supplies. World market prices for biodiesel are likely to be better and more reliable for than for tobacco and other cash crops grown in southern Africa. So far some 200,000 ha are under jatropha in Malawi and 15,000 ha in Zambia, almost all of them under a formal lease or through agreements with the UK-based company D1-Oils.

At first sight, this seems to be a truly positive and sustainable development – particularly where jatropha replaces more destructive cash crops. No web-based information is available other than from stakeholders, i.e. industry and funding bodies. There appears to have been no life-cycle assessment to show what the greenhouse gas and energy balance of biodiesel from southern African jatropha is. We know, however, that jatropha has a high energy content and there is no evidence that, so far, those plantations have been linked to deforestation or ecosystem destruction in southern Africa. On the other hand,

South African industry uses mainly coal for energy production, so the refinery process will probably be as carbon-intensive as that for US bioethanol. There will also be emissions from shipping the biodiesel to Europe and elsewhere. We can assume that the greenhouse gas balance for southern African jatropha will be better than for US corn-based ethanol. There are no figures to say how it compares with biodiesel made in Europe. Furthermore, the yields predicted by biofuel companies may rarely be reached in countries suffering from increasingly common and severe droughts, interspersed by more severe flooding events. So far, nobody can predict whether jatropha plantations in southern Africa will remain small-scale, or whether they can expand despite competition from south-east Asian palm oil and Brazilian biodiesel and bioethanol – nor whether the planned jatropha expansion in the Philippines, India, Indonesia, Malaysia and elsewhere will marginalise semi-arid southern Africa.

It is worth looking at jatropha plantations in the context of Malawi's and Zambia's general food security, energy security and ecological situation. After all, if there was a scheme to ensure only sustainable biofuels were used then those from southern Africa would have a very high chance of being certified, so it is important to look closely at what 'sustainable biofuels' might look like.

Food and biofuels:

Southern Africa is one of the most vulnerable regions in the world to climate change. All climate models predict that region (not including most of South Africa, Lesotho and Swaziland) to become a lot warmer and drier, with more frequent and severe droughts, interspersed by more severe flooding. Two reports considered by the Avoiding Dangerous Climate Change Conference in 2005 predicted a major decline in food production above 2 degrees C of global warming (likely by 2050), and crop failure of up to 75% above 2.5 degrees C warming.[9]

Unpredictable rainfall has led to massive food shortages in Zambia, Malawi and neighbouring countries in recent years. By the end of 2005, half of Malawi's 10 million population relied on food aid, as did 1.1 million Zambians, following one of the worst droughts on record. Although cyclical droughts have always happened in the region, severe multi-year droughts and unexpected rainfall patterns have stretched the resilience of farmers beyond their limit. Whilst 2006 is promising relief from drought in both countries, part of Zambia's crops were wiped out by flooding in March (though a food surplus is still within reach for most of 2006 in Zambia).

The Millennium Ecosystem Report found that agriculture is likely to expand and degrade existing ecosystems in both Malawi and Zambia over coming decades, although improving yields might limit the harm done.[10] Nobody has fully examined the impact of introducing what could be a new large-scale cash-crop on food production and habitat loss.

Nor has the impact of a growing global biofuel sector on global food prices been considered, except by Lester Brown, founder of the Worldwatch and the Earth Policy Institutes. He warns that, with oil prices above $60 dollars a gallon, competition between biofuel and food crops will quickly arise, and food crops only competing when

food prices are higher than those for biofuel.[11] This is particularly worrying in southern Africa, where high food prices are the most immediate reason why people go hungry. The global switch to biofuel crops, at the expense of part of the food production, is happening at a time when global grain production may well have peaked: It fell for three years from 2001 to 2003, and the record harvest of 2004 coincided with cool conditions and reliable rainfall in major growing regions, unlikely to continue with global warming. The US, for example, are seeing regular crop losses from drought and are also turning an increasing part of their food production over to bioethanol (12% of corn by 2005). Those dual pressures might well reduce the grain reserves on which the World Food Programme can draw, and thus on the food aid which is helping millions of Zambians and Malawians survive during droughts and floods. Indeed, in early 2006 the World Food Programme cut rations to starving refugees in Zambia in half, stating that their needs could no longer be met!

Local energy needs and biomass:

About 80% of Zambia's population rely on biomass for all or most of their energy needs, with only 12% having access to electricity. In Malawi, 90% of primary energy production comes from biomass, i.e. firewood and charcoal. Most rural people rely on burning firewood, often on inefficient cooking stoves which cause serious indoor pollution and are a major cause of ill health and death. Urban people tend to use charcoal, which is usually produced extremely inefficiently. Demand for wood fuel has contributed to deforestation, particularly in south Malawi and the Zambian copper belt. As a result, women and girls have to spend more time every day collecting firewood or families go without heating or cooking facilities. Household incomes, health and girls' education suffer.

The Millennium Ecosystem Report discusses how more efficient use of biomass could improve the well-being of the population and help southern Africa to develop without increasing climate-change emissions, and without their balance of trade suffering from fossil fuel imports. Both access to sustainable, locally-sourced transport fuels, and efficient use of biomass for energy and heating could improve the lives of millions of people in southern Africa, as well as helping the economies of some of the poorest countries on the planet.

Jatropha is an ideal plant to intercrop with food plants, in order to reduce soil erosion and improve overall yields, and it could well contribute to both countries' energy needs. The oily beans could also be used for primary heat and energy production, reducing the need for charcoal in urban areas and thus relieving the pressure on forests.

This, however, is not the development planned and funded at present. Instead, jatropha is grown on large plantations, for a British-based company, taken to South Africa for refining and destined for cars in Europe and possibly other rich countries.

CASE STUDY 2
BRAZIL: RENEWABLE ENERGY EXAMPLE TO THE WORLD OR TIME-BOMB FOR THE AMAZON?

soya for biofuel
http://www.biofuel.sg/picts/soya.jpg

Brazil's Cerradp
www.brazadv.com/ images/cerrado.jpg

Brazil's bioethanol programme goes back to the 1970s, and it is the only large-scale programme which is now able to expand without government subsidies. 40% of Brazil's transport fuel comes from ethanol made from sugar-cane. Brazil produces one third of global bioethanol, and comes second only to the US (where corn ethanol is, however, heavily subsidised). No country produces ethanol as cheaply and efficiently as Brazil. If global ethanol use is to soar then much of this will come from Brazil.

Thanks to growing markets in the EU, US, China, Japan and elsewhere, Brazil is looking to double its bioethanol production in the next decade, and to vastly expand its biodiesel production for export, using soya, palm oil and castor oil.

At the Montreal climate conference in 2005, the World Resources Institute's 'Growing in the Greenhouse' report cited Brazil's biofuel programme as an example to other developing countries.

Energy and greenhouse gas balance:

Brazilian ethanol has a closed cycle, where energy for the refinery and distillery process comes from sugar cane residue, hence no fossil fuels are needed. For every energy unit invested, Brazilian ethanol yields 8.3 units – followed by sugar beet in France, which yields 1.9 energy units for every unit put in (and which itself is still far superior to US corn ethanol. Brazilian biodiesel, on the other hand, is far less energy efficient: Energy yields per unit of energy input have been estimated as 5.63 for castor oil, 4.2 for palm oil and 1.43 for soy.[12] Despite the low energy yields, the Brazilian government promote soya biodiesel in particular.

A WWF report to the International Energy Agency in 2005 suggested that the bioethanol programme reduces transport emissions in Brazil by 9 million tons a year. BUT - 80% of Brazil's greenhouse gas emissions officially come from deforestation. What matters is not just how many transport emissions are 'saved', but whether far more emissions are created through destroying forests in order to grow biofuel crops.

One study found that one hectare of land in Brazil grows enough sugar cane to make ethanol which saves 13 tonnes of CO2 every year, by replacing petrol or diesel. If, however, natural forests were allowed to regenerate on the same hectare of land, the trees would absorb 20 tonnes of CO2 every year[13]. There is no conclusive study life-cycle assessment that takes all emissions from different types of land-use change and from soil erosion and fertilizer use into account. This means, even if Brazil's biofuels did not threaten the Amazon, there would still be no evidence whether they lead to more or less climate change emissions.

Unfortunately, though, the Amazon is very much threatened by biofuels, and any threat to the world's largest rainforest threatens the global climate and carbon cycle. The world's climate might pay the ultimate price for Brazil's biofuel programme.

Biodiesel and the Amazon:

Soya is almost certainly the most damaging choice - not just because it has very few greenhouse gas and energy savings compared to petrol or diesel. Soya cultivation is understood to be responsible for more Amazon destruction than any single other business in present times - including cattle ranching or logging. It is also linked to destruction of Brazil's Atlantic forests.

Palm oil is, so far, a small business in Brazil, but also targets the Amazon.

Deforestation rates in the Amazon had been coming down for eight years until 2003 and then suddenly increased, almost solely due to soya monocultures. The business is largely controlled by a company belonging to the governor of the Amazon state Mato Grosso – Gruppo Maggi – and the US corporation Cargill as the main exporter. So far, it has been grown largely for animal feed in Europe, the US and China, and to satisfy Europe's demand for GM-free soya. A soya-based biodiesel programme, supported by President Lula's government, is almost certain to accelerate the destruction of the Amazon forest. Vast tracts of Amazon forest are being set ablaze to clear the land for soya - and fires spiral out of control during droughts.

Whilst soya businesses are reaping high profits and helping the government to pay foreign debt, infant mortality and starvation have reached record levels around Mato Grosso's soya plantations. Ongoing violence against indigenous people has been recorded by amnesty international and by the United Nations. As Survival International quote from one tribe: ***"Soya is killing us"***[14].

Bioethanol and ecosystem destruction:

Sugar cane, too, encroaches on the Amazon, but far more so on the Atlantic forest and the Cerrado, a very bio-diverse and unique savannah-type ecosystem. Two-thirds of the Cerrado have already been destroyed or degraded, and the loss of hundreds of species looms. The Brazilian government have declared this ecosystem as being available for agriculture, and sugar cane is threatening the rest of the region. According to Birdlife International, sugar cane provides no habitat at all for birds – and presumably little or none for other wildlife. It is therefore more destructive than many other tropical crops[15].

What is the role of the Cerrado in the carbon cycle and how would carbon emissions be affected if it was completely destroyed? Nobody knows. Even if the planned sugar cane expansion for ethanol was to happen away from the Amazon – there is great concern that it will displace other agricultural activities into the rainforest.

Amazon deforestation and the world's climate:

The International Panel on Climate Change suggested in its 2001 report that about 20% of increased CO2 emissions come from rainforest destruction. Brazil reported in 2003 that even if deforestation is accounted for, Brazil is only responsible for 3% of global CO2 emissions – only slightly more than the UK. Those figures are very rough estimates: Scientists are still trying to find out how much biomass and thus how much carbon one hectare of Amazon rainforest holds. Indeed, emissions from rainforest destruction could be far higher than thought already: One recent study suggests that mangroves supply more than one-tenth of the dissolved organic carbon that is absorbed from the land into the oceans. Destroying the mangrove swamps, as is happening in the Amazon and in south-east Asia, will therefore destroy a barely known carbon sink[16].

The Amazon itself is one of the largest terrestrial carbon sinks, and losing it would greatly increase CO2 levels in the atmosphere and warm the planet by perhaps a further 1.5 degree C, over and above the warming already predicted for this century[17]. Even a reduced carbon sink in the Amazon means that CO2 emission cuts will have to be greater and faster if the climate is to be stabilized eventually. This means that climate stabilization becomes far costlier and more difficult as the rainforest disappears.

Scientists are increasingly concerned about a likely threshold of deforestation, beyond which the entire ecosystem could collapse and begin to die back. The reason for this is that much of the rainfall that sustains the forest is recycled, i.e. it is water absorbed by the trees and returned to the atmosphere via 'evapo-transpiration'. An estimated 7 trillion tons of water are recycled that way, and help to cool the atmosphere immediately above the forests. The water-cycle, which allows not just the Amazon but all agriculture in the region to thrive, appears to be a self-sustaining cycle, and it could break down. Periodic droughts in the Amazon tend to be followed by drought in large parts of the US grain-belt, so permanent drought over the Amazon basin might seriously reduce global food supplies.

Nobody has identified the threshold beyond which the Amazon might begin to die back. The record-breaking 2005 drought in the region has caused great concern, although it is impossible to draw conclusions from one single extreme event. Climate change itself may cause the same results expected from deforestation, because it may be changing rainfall patterns throughout the tropics.

There may be a warning from the past: Some 5600 years ago, the Sahara turned from a lush and green bush- and grassland region into today's desert, whilst global temperatures were relatively stable. Changes in the ocean heat-transfer have been identified as the cause but cannot explain the extent of the sudden drying. A new model, however, shows that lower rainfall caused vegetation to die back which in turn reduced rainfall much further - until the whole region turned into desert [18].

Amazon rainforest
http://www.des.ucdavis.edu/esp133/rainforest.jpg

CASE STUDY 3

SOUTH EAST ASIAN PALM OIL: A CLIMATE, SOCIAL AND ECOLOGICAL CATASTROPHE

Logging Indonesia's rainforest
for palm oil
http://www.peopleandplanet.net/doc.php?id=2492

Oil palm plantation in Indonesia with fires
in the background
http://www.rainforestweb.org/images/cat/palmoil-big.jpg

Palm oil has by far the highest energy yield of all the biodiesel crops grown at present. This, together with low wages and the lack of any rights for plantation workers, gives south-east Asian palm oil a great competitive advantage in the new free biofuel market. Biodiesel companies in the UK, such as Biofuel Corporation, favour palm oil as their main source. Once the UK's Renewable Transport Obligation comes into force, in 2008, the amount of biodiesel sold in the UK will dramatically increase and it is likely that most of it will come from Indonesian and Malaysian palm oil.

Palm oil, together with illegal logging, is destroying some 2 million hectares of Indonesia's rainforest every year – more than the forest destroyed by other country apart from Brazil. Across Sumatra and Borneo, there are now 6.5 million hectares of oil palm plantations, and up to 10 million hectares of rainforest have been destroyed by plantation owners. On current trends, plantations will triple in size to 16.5 million hectares by 2020

– and much of this growth will be fuelled by global demands for biodiesel. Both governments are strongly pushing for the conversion of what they deem to be 'unprofitable forests' into oil palm plantations. They are also considering land conversion to jatropha.

Palm oil plantations have close links to the illegal timber business. Governments are more likely to grant concessions for plantations than for logging, but some of those concessions are used to simply log vast tracts of forest. Many plantations have been abandoned whilst more rainforest is cut down for new ones. It is likely that production could be greatly increased without clearing any more land. In reality, though, high levels of corruption are driving the cycle of rainforest destruction.

Palm oil plantations are largely grown on what was the customary land of millions of indigenous people and local communities on Borneo and Sumatra. This is one of the most violent sectors in south-east Asia: Between 1998 and 2002, 479 people were tortured in Indonesia in conflicts defending community rights and dozens have been killed[19]. Whilst palm oil is a great source of revenue for businesses and the Indonesian government, the local populations are suffering. Even national parks and protected areas are being destroyed for oil palm plantations. Orangutans are the best known of the many species now highly endangered.

Palm oil and the climate:

There may be a debate as to whether different types of biofuel increase or reduce climate change emissions. When it comes to south-east Asian palm oil, however, there are no doubts at all: This sector is linked to massive forest and peat fires, which, in 1997, released the equivalent of 13-40% of all global emissions from burning fossil fuels[20]. In that year alone, 5 million hectares of forest were burnt. Similar, though slightly smaller fires, have burnt most years since then and satellite images have shown that around 75% of them have been lit by plantation owners.

The years 1998, 2002, 2003 and 2005 saw annual rises in atmospheric CO2 concentration well above those of most other years, and well above the rise expected simply from the gradual increase in fossil fuel burning, all other factors being equal. As CO2 levels are rising faster, the future rate of global warming will accelerate. Nobody knows for certain what causes CO2 levels to grow faster, and there is fear that parts of the natural carbon cycle are responding to warming, creating 'positive feedback' which will heat the planet even more. Some scientists, however, warn that the peat fires in Borneo may explain at least part of the record rises in CO2 levels[21]. The record years for those fires were… 1998, 2002, 2003 and 2005.

The peat fires on Borneo are the direct result of land clearance and drainage to make way for the Mega Rice Project in the mid-1990s. This project lowered the water table of the peat, dried it up during the annual dry season and made it vulnerable to fires. The soil was so acidic that no rice was ever grown. Although the first post-Suharto government abandoned the scheme and allowed for small-scale international efforts to re-flood the peat, the current government are granting concessions for some of the area to oil palm plantations. Laws forbidding fire-raising have been passed but are not being enforced.

Unless the peat is re-flooded, the billions of tonnes of carbon it holds will be released into the atmosphere – fires only speed up this process. This is enough carbon to make the European Union's aim of keeping global warming to within 2 degrees C unattainable, no matter what other efforts are made.

As for the direct health-effects, the pollution from peat and forest fires causes severe respiratory problems to people across south-east Asia. Biodiesel from palm oil could at least reduce some of the extreme air pollution levels caused by traffic in Indonesia's cities – but the Indonesian government are only interested in exporting it, not in using it at home.

NGOs including WWF and Friends of the Earth are promoting the Round Table on Sustainable Palm Oil, which would certify sustainably produced palm oil. This, however, is a voluntary approach expected to involve less than half the sector. Environmental NGOs hope that the European Union will only subsidise biofuel, including palm oil, certified as sustainable. Such a policy has not yet been adopted in Europe, however. There is some concern that EU imports of certified palm oil could simply allow the whole sector to expand, whilst uncertified palm oil was sold elsewhere. On the other hand, certification could provide an incentive to make existing plantations more productive, rather than destroying more rainforest. The question is not whether certification is needed and whether it should be pioneered by some nations now: Without it the global outlook is bleak. The questions is whether Europe and nations elsewhere should be increasing their biofuel imports before the whole sector has become sustainable.

A GLOBAL OUTLOOK FOR BIOFUEL

Dead zone in the sea linked to nitrogen run-offs from fields
www.nasa.gov

There are two clear findings from those observations:

Firstly, there is potential for reducing greenhouse gas emissions if biofuels are used sustainable and in the most efficient way. The potential will be far greater with technologies that are not yet commercially available. Greenhouse gas savings will always be greater if biomass is used for primary heat and energy production, not for transport fuel – although there might be good reasons to use biofuels for transport particularly in poorer countries which cannot meet their essential needs otherwise. There has been no study to suggest how much biomass can be sustainably used as biofuel.

Secondly, if the biofuel market is allowed to grow without constraints, this will almost certainly lead to a net increase in greenhouse gas emissions. An unfettered biofuel market will favour tropical crops, including from Brazil and South-East Asia. This will threaten the survival rainforests throughout Latin America and in south-east Asia, as well as contributing to billions of tons of carbon from Borneo's drained peat swamps being released into the atmosphere.

The United Nations warn that we are in the middle of the greatest extinction of life since the dinosaurs died 65 million years ago. The four main causes identified are habitat loss, nutrient overload, climate change and alien species invasion. Large-scale agriculture is the leading cause for habitat loss and nutrient overload, and significantly contributes of climate change. Growing biofuel crops will either reduce the amount of food produced (with per capita production already in decline and indications that overall food production may peak soon or have peaked already) – or expand the global area of land used for agriculture. The United Nations' Millennium Assessment Report warn of the catastrophic impacts on all ecosystem services of further agricultural expansion, most of which is now happening in the tropics. Of particular concern is the fact that the amount of nitrogen now available to the biosphere has been doubled by humans, largely through fertilisers. This is aggravating global warming, threatening marine and freshwater life, as well as causing declines in biodiversity on land. Growing biofuel crops on a large scale will further increase this nutrient-loading.

CONCLUSIONS AND RECOMMENDATIONS:

I.
Nearly all environmental NGOs believe that biofuels should not automatically be classed as 'renewable energy'. Only sustainably sourced biofuels should be certified as such. There is a campaign (as yet unsuccessful) to get the European Union to adopt a mandatory certification scheme for all biofuels as part of the European Biofuel Directive.

It is essential that mandatory certification is put in place before any further expansion of the biofuel market, or any further large-scale land conversion are pursued. Ideally, this would be part of an international agreement, but meantime it must be adopted by individual countries and purchasers to reduce the market for destructive biofuels and create a sustainable renewable energy sector.

II.
A certification scheme must be based on scientific evaluation, which looks at

- the energy and greenhouse gas balance of biofuels, including the best evidence on CO2 and N2O emissions;
- a comparison with the CO2 and N2O emissions saved if the same land was left under natural cover or restored to natural vegetation;
- whether there is any negative impact on ancient forests or other ecosystems important for biodiversity and for the carbon cycle (including an indirect effect by pushing other agricultural sectors into those areas);
- all impacts on soils, atmospheric pollution and water supplies;
- the impact on local and global food supplies;
- social and economic impacts on local populations.

In the case of Indonesia, for example, it would be very concerning if only new deforestation was classed as unsustainable. The drained peat swamps will continue to emit vast quantities of carbon unless they are fully restored, hence no oil palm plantation in that area could ever be sustainable. Studies will have to be undertaken in respect of different biofuel crops and different regions where they are grown. They should be commissioned as a matter of urgency, by the European Union and other countries looking to import biofuels, and also by the United Nations.

III.
Without a scientific assessment and certification, funding under the Kyoto Protocol's Clean Development Mechanism and other multilateral funding to expand the biofuel sector cannot be justified.

IV
It is essential that all emissions that arise from the production of biofuels be counted as emissions of the user-country – otherwise rich countries will be 'out-sourcing' their emissions to poorer nations.

V.

One urgent question is whether the European Biofuel Directive, and similar biofuel quotas and subsidies in other countries, should be implemented. Many NGOs argue that those mandatory quotas should be implemented (albeit with a certification scheme), because of the positive role that biofuels can play in reducing greenhouse gas emissions. All the observations made in this paper would support a moratorium on the European Biofuel Directive and similar policies in other countries, pending full scientific assessment and the establishment of a certification scheme. This is particularly justified because

- possible greenhouse gas savings from the most sustainable biofuel sources are tiny using current technologies;
- the development of better biofuel technologies does not benefit from quotas being adopted now;
- quotas were adopted following studies which did not look at what is becoming the 'market reality', i.e. the import of tropical energy crops;
- the potential for a major disaster to the climate, biodiversity, food supplies and local communities in poor countries is very great if biofuel promotion is done 'wrongly';
- there are far more cost-effective and uncontroversial ways of reducing greenhouse gas emissions which can be implemented now – such as high fuel-efficiency standards for cars, energy efficiency or the development of obviously renewable energies like wind or solar power. Subsidies for the biofuel industry could take money away from those obvious measures. They could also reduce the political will to reduce the amount of fuel used for road traffic.

VI.

A moratorium on the European Biofuel Directive and similar policies does not mean that all support for biofuels should be suspended. There is a strong case for government and business investment into lingo-cellulosic technology, biodiesel gasification and algae research, all of which could vastly increase the amount of truly sustainable biofuels available to us. This should include funding of life-cycle studies which look at greenhouse gas emissions, land-use changes, impacts on biodiversity and on food supplies linked to those new technologies. Those studies should then be used as a basis to determine research priorities.

Targets could – and should – be immediately introduced to ensure that agricultural and organic waste are used for energy and heat production in the most efficient way. There should be ongoing support for local, domestic schemes that have been fully assessed as being sustainable.

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