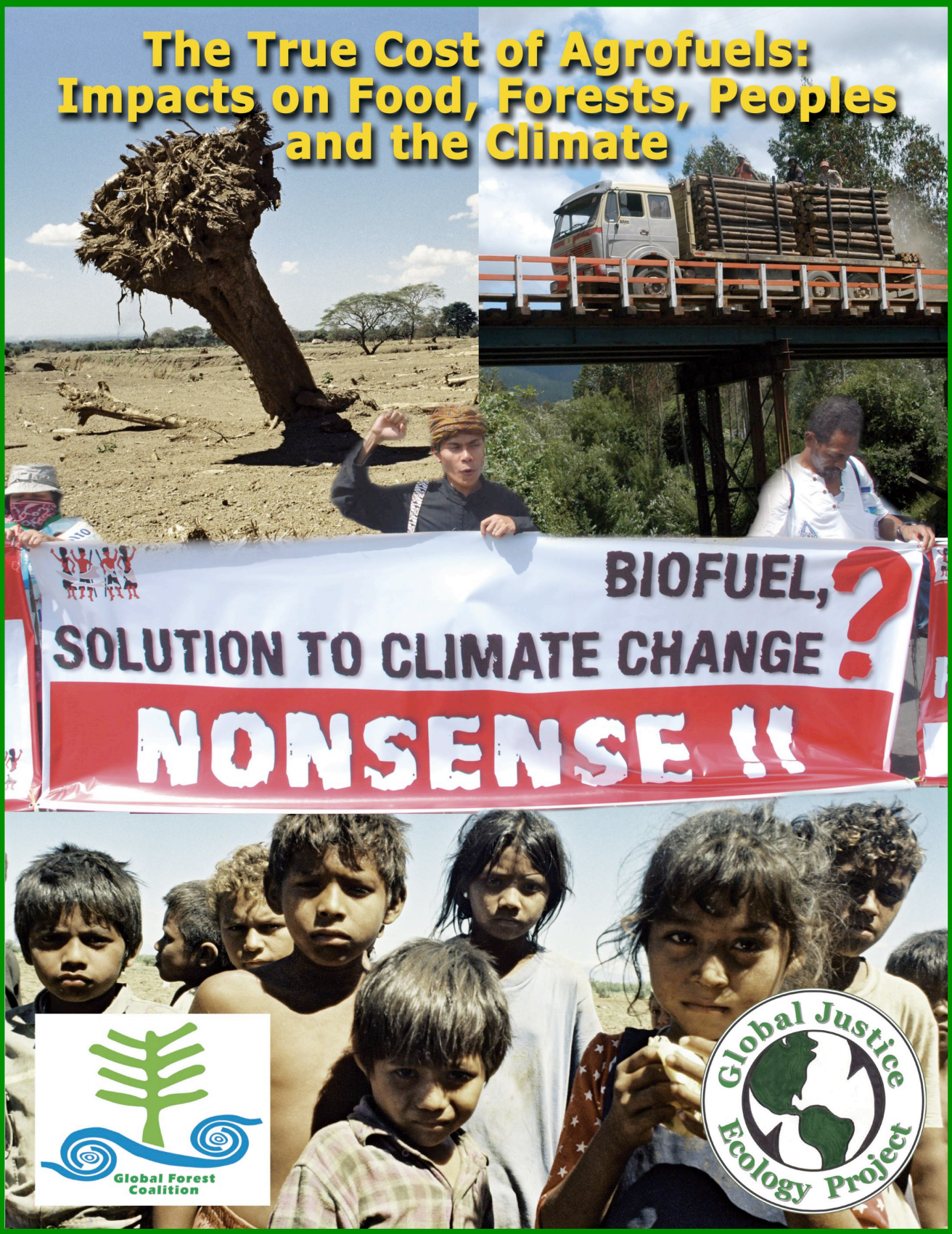
The True Cost of Agrofuels: Impacts on Food, Forests, Peoples and the Climate



The Real Cost of Agrofuels: Impacts on food, forests, peoples and the climate

Contents

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Foreword

In 1992, George H. W. Bush, then President of the United States, initially announced that his administration would not sign the United Nations Framework Convention on Climate Change, because there was insufficient knowledge about the causes of climate change. He ridiculed global warming, assuring the public he would counter the greenhouse effect with the "White House effect," even though the U.S.'s National Center for Atmospheric Research had pointed out that global warming "could well cause climate change over the next two generations as large as or larger than civilization has experienced." Five years later, his son George W. Bush, explicitly rejected the legally binding Kyoto Protocol on climate change.

Given the unbridled energy use of the U.S., it could be argued that father and son are little more than prestidigitators attempting to distract their audience while they drink all the wine. Unfortunately, the impacts of the 's approach have been manifold and this type of attitude – distract, ridicule, deny and if necessary, falsify – has since characterized the climate change debate, discouraging governments from taking the swift and decisive action so urgently needed.

Climate change deniers have been around for decades: for many years they insisted that climatic changes were normal, the tale-tale signs of a healthy, dynamic and evolving biosphere. Curiously, however, many of these critics are much quieter at the moment. Could it be that they have suddenly realized that there's money to be made – and a great deal of it - from policies that pretend to mitigate climate change? That it might even be possible to profit from destroying the climate and implementing solutions (workable or not) at the same time?

There has been a massive, collective jump onto the climate change bandwagon, by fossil fuel and nuclear companies, agribusiness and commercial carbon traders. Biofuels (more correctly called agrofuels, since there is nothing green about them) are at the top of their agenda. They are clearly considered to be hugely profitable. But, thanks to the fervent efforts of Dr Rachel Smolker and many other colleagues in the Global Forest Coalition, we can now assess the real 'value' of these agrofuels.

Fuel wood cut from the rainforest of Java.
Photo: Rhett A. Butler

By reading the report "The Real Cost of Agrofuels: Impacts on food, forests, people and the climate", we can discover how illogical, inappropriate and downright counterproductive these fuels can be; how they are already disrupting thousands of families around the world, who face eviction to make way for 'biomass' plantations; how large areas of forests are being destroyed to plant oil palm, corn, and oilseeds; and how the widespread use of transgenic crops and trees, which threaten the health of remaining natural forests, lingers just over the horizon.

The fact that agrofuels are a key direct and indirect cause of global deforestation, and thus contribute to climate change, is of little interest to the new ethanol millionaires. They shrug their shoulders when they hear about deforestation rates in the Amazon, which increased by 84% between 2006 and 2007 in some agrofuel-producing states, due to the increase in soy prices, in turn triggered by the agrofuels boom. They look the other way when scientific experts meet; and when special UN rapporteurs on water, forests, biodiversity, indigenous peoples, invasive alien species and food security, publish one report after the other warning that agrofuels are a looming calamity for the planet, and a false solution to global warming. After all, if there ever was a good excuse to trade in hot air, it is climate change.

Miguel Lovera
Chairperson, Global Forest Coalition

I: Introduction

Agrofuels, which rely on large-scale industrial monocultures, are a cause of global warming, not part of a solution. Promoted as a means to reduce greenhouse gas emissions, they are in fact resulting in greater emissions because they promote deforestation and the destruction of ecosystems, including carbon-rich peat lands which play a vital role in regulating the climate. They displace other possible uses of land, and lead to an increase in the use of nitrogen and other fertilizers and agrichemicals.

The hasty promotion of agrofuels has already caused an expansion of large scale monoculture plantations of soy, oil palm, jatropha, sugar cane, maize, cassava and other "fuel crops", which are being planted over very large areas. Huge financial investments are being made, and policy mechanisms introduced. The pace of these developments has accelerated dramatically, especially over the past two years, causing food prices to skyrocket, driving deforestation, impinging on biodiversity protection, threatening the rights and livelihoods of Indigenous Peoples, stressing freshwater and soil resources, and increasing the use of toxic pesticides, herbicides and fertilizers. As demand for more arable land increases, entire ecosystems, such as the Brazilian Amazon, Cerrado, Pantanal, and Mata Atlantica, and the rainforests of Southeast Asia are seriously threatened. Throughout the global south, indigenous peoples and rural communities are being evicted from their land, often violently, to make way for large scale monocultures of agrofuel crops, undermining efforts to ensure land reform and food sovereignty.

Recognition of the problems created by this rapid expansion of agrofuels has come from virtually all sectors of society, from people living in direct contact with agrofuel production, to high-ranking officials and advisors to United Nations and other international bodies. Indigenous groups and peasant movements facing increased demand for their lands, and erosion of their food sovereignty, have made numerous statements of opposition: "We Want Food Sovereignty, Not Agrofuels;" and "No Full Tanks on Empty Stomachs." These statements come from major organizations like the MST and Via Campesina and from NGO's and members of civil society across Latin America, Asia, Africa and elsewhere.[1]

Green blanket of large scale monoculture plantations. Photo: Wally Menne

The United Nations Permanent Forum on Indigenous Issues released a report in which agrofuels were identified as an emerging concern and stated that "Expanding plantations for biofuels or energy crops and for carbon sinks are recreating and worsening the same problems faced by indigenous peoples with large-scale monocropping, agricultural and tree plantations." [2]

[1] See statements at <www.Biofuelwatch.org>
[2] V. Tauli-Corpuz, and P. Tamang, 2007. "United Nations Permanent Forum on Indigenous Issues: Oil Palm and Other Commercial Tree Plantations, Monocropping: Impacts on Indigenous Peoples' Land Tenure and Resource management Systems and Livelihoods." http://www.un.org/esa/socdev/unpfii/en/special_rapporteurs.html

Jean Ziegler, The UN's Special Rapporteur on the Right to Food, called the diversion of food crops into agrofuel production a "crime against humanity" in light of the fact that over 854 million people are chronically undernourished. He called for a five year international moratorium on agrofuels.[3]

The Organization for Economic Cooperation and Development (OECD), in a report entitled "Biofuels, Is The Cure Worse Than The Disease?" states that "The rush to energy crops threatens to cause food shortages and damage to biodiversity with limited benefits."[4] The Convention on Biological Diversity Ad Hoc Technical Expert Group on Forest Biodiversity advised that: "The rapidly emerging threat posed to forest biodiversity by bioenergy production, in particular biofuels, should be addressed."[5]

A recent study published in *Science* demonstrated that greenhouse gas emissions from indirect land use change resulting from agrofuel crop expansions can be much greater than the savings achieved from substitution of fossil fuels, completely defeating the intent of biofuel policy.[6]

In spite of these and many other expressions of concern, the headlong plunge to develop policies, garner financial investments, and negotiate trade deals continues unabated, orchestrated by some of the most powerful corporate sectors on the planet: oil, agribusiness, automobile manufacturers and biotechnology industries.

Claims that agrofuels will "reduce greenhouse gas emissions" and "benefit the poor," have already proven to be far from the truth. When this is pointed out, promises of "new and improved technologies" in the future are offered as a reason to continue along the current path even though it is clearly flawed. The impacts of those future technologies have not been carefully considered, the technologies are not available now and may not be for another ten years or more! Meanwhile it is clear from the near daily reports that ecosystems are collapsing or being degraded and that climate change is occurring much more rapidly than expected, in ways that were not predicted. [7] We cannot afford to move in the wrong direction or to wait an indeterminate number of years for possible new technologies.

The purpose of this report is to examine the impact of agrofuels development, with particular emphasis on forests and forest-dependent peoples. This emphasis on forests is critical for several reasons:

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[3] Jean Ziegler, "Special Report on the Right to Food to the UN General Assembly," 62nd session, 2007, http://www.swissinfo.org/eng/front/detail/UN_rapporteur_calls_for_biofuel_moratorium.html?siteSect=105&sid=8305080&cKey=1192127505000&ty=st

[4] R. Doornsbosch, and R. Steenblick, Biofuels: Is the Cure Worse Than The Disease? OECD Roundtable on Sustainable Development, 2007, http://media.ft.com/cms/fb8b5078-5fdb-11dc-b0fe-0000779fd2ac.pdf

[5] "Report of the fourth meeting of the ad hoc technical expert group on review of the implementation of the programme of work on forest biological diversity." Fourth meeting, Rome, 28 May-1 June 2007 http://www.cbd.int/doc/reviews/for/tegfor-04/tegfor-04-02-en.doc

[6] Timothy Searchinger, Ralph Heimlich, R. A. Houghton, Fengxia Dong, Amani Elobeid, Jacinto Fabiosa, Simla Tokgoz, Dermot Hayes, and Tun-Hsiang Yu**.** "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change." Science Vol. 319: pp. 1238-1240

[7] Joseph G. Canadell, Corinne Le Quere, Michael R. Raupach, Christopher B. Field, Erik T. Buitenhuis, Philippe Ciais, Thomas J. Conway, Nathan P. Gillett, R. A. Houghton, and Gregg Marland "Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks. Proceedings of the National Academy of Sciences." October 2007. This study reported that atmospheric CO2 has grown a very alarming 35% faster than predicted, apparently due to 1) a decrease in ocean uptake as a result of the fact that stronger winds over the Southern Oceans are driving water circulation so that carbon rich waters from the depths are brought up to the surface. These waters are less able to absorb further carbon from the air. 2) severe droughts in some areas (Australia, for example) have reduced plant growth and hence uptake of carbon. 3) improvements towards reducing the carbon intensity of the global economy have slowed:

1. Agrofuels are contributing to the destruction of forests and ecosystems that are essential to regulating climate

Global warming is caused by a severe disruption of the global carbon cycle that results from adding too much carbon, and other greenhouse gases, into the atmosphere, while simultaneously depleting the capacity of earth's ecosystems to sequester them. Any real solution therefore requires not only a switch from fossil fuel use, but also protection of ecosystems like forests, which are critical to regulating carbon. Without adequate protection of forests, in fact, we have no chance of staving off the disastrous consequences of global warming. For some countries, the majority of carbon emissions result from deforestation. Indonesia and Brazil rank third and fourth behind only the U.S. and China as a result of deforestation and (in the case of Indonesia) the destruction of peat lands. Agrofuels are contributing to deforestation in these and other countries.

The UN Framework Convention on Climate Change specifically states (article 4) that it is committed to "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems."[8] A complete understanding of the impact of agrofuel production on forests is therefore highly relevant to policy decisions.

When indirect land use changes are incorporated into calculations of agrofuel greenhouse gas balances, the purported benefits of these fuels are negated: Agrofuels contribute to- rather than reduce- greenhouse gas emissions.

2. Cellulosic ethanol will not resolve the problems

Competition between food and fuel is becoming increasingly problematic (see chapter 4). A proposed 'solution' to this dilemma is the development of cellulosic ethanol production. It is claimed that future advances in technology will enable the production of cellulosic ethanol from wood and other biomass sources. This, it is argued, will allow us to sidestep the food-versus-fuel conflict because, in addition to providing better energy yields than starch and sugar sources, these feedstocks do not depend on the use of prime agricultural lands and will not result in the diversion of food crops. Trees and other cellulose feed stocks are considered to be 'widely available' and can be grown on "marginal" lands. However, given the scale of demand, introduction of these technologies would almost inevitably require or lead to the use of genetically engineered feed stocks and microbes, and the expansion of monoculture plantations devoted to agrofuel production, including industrial tree plantations, falsely defined as "planted forest" by the UN Food and Agriculture Organization (FAO).

3. The use of genetically engineered trees for fuel production will result in contamination of native forests.

The biotechnology industry views agrofuels as a tremendous opportunity to promote the use of genetically engineered (GE) organisms, ranging from GE maize and soy, to GE trees and microbes for cellulosic ethanol production. There are already a number of tree varieties being engineered to contain particular traits, such as reduced and altered lignin

[8] UN Framework Convention on Climate Change, Article 4.1d http://unfccc.int/resource/docs/convkp/conveng.pdf

content, more rapid carbon sequestration and cold tolerance, specifically so that they can be used to produce fuel (see chapter 6).

The introduction of GE trees into and adjacent to native forests is extremely risky. Introduction of GE food crops has already resulted in widespread contamination despite industry claims that it was unlikely to occur. The same is likely to occur with GE trees. If native forests become contaminated with traits such as reduced lignin production, the impacts – at this point completely unknown - could be catastrophic and, once they occur, irreversible.

4. Continued expansion of agrofuels is contributing to human rights abuses

Already, competition between food and fuel use for grains is contributing to rapidly rising food prices and placing further demands on dwindling freshwater resources. The demand for agricultural lands is resulting in the displacement, often violent, of massive numbers of people from their traditional lands. Indigenous and rural peoples are increasingly marginalized and exposed to toxic agrichemicals as industrial monocultures spread.

To avoid the devastating consequences of climate change, we must carefully assess and prioritize the measures we need to take. The International Energy Authority estimates that agrofuels are currently providing about 1% of transport fuel demand, and may be able to provide, at most, 8% by 2030. Meanwhile, in absolute terms, fossil fuel use will still increase because of growing demand for transport overall,[9] negating any possible benefits. Furthermore, agrofuels may themselves contribute dramatically to global warming, by increasing emissions from deforestation, peat degradation and agriculture expansion.

[9] Claude Mandil, ED. "A Global Oil Outlook: Demand and Supply,: International Energy Authority," 12th February 2007 http://www.iea.org/textbase/speech/2007/mandil/london_ip.pdf

II: Forests and climate

It has been repeatedly emphasized that forests are essential to climate stabilization.[10] Halting deforestation is critical to any effective climate change regime, and any climate-related measures that are likely to increase deforestation must be rejected.

Tropical forests, especially old growth tropical forests, accumulate and store carbon and continue to do so even after growth has slowed. [11] Healthy and undisturbed forests are long-lasting and therefore retain their carbon stores over long time periods. A very gradual release of carbon, when individual trees decompose, is offset by new growth.

Forests also help to regulate greenhouse gases other than carbon, especially methane and nitrous oxides. These two gases contribute about 21% and 6% respectively to global greenhouse gas emissions, but there are no good measures of their flux with respect to forests and land use change. Estimates are, however, that they could add as much as 15% to the impact of deforestation on climate change.[12]

As much as two-thirds of the carbon in some forest ecosystems is contained in soils and associated peat deposits[13]. The ratio of vegetation to soil carbon varies, especially with latitude. In colder temperate forests, organic matter decomposes more slowly and hence a deep layer of carbon rich organic matter collects. In some areas of the tropics decomposition is inhibited by anaerobic conditions resulting in the formation of a deep layer of peat, such as occurs in parts of Southeast Asia, especially Indonesia. In these conditions, soil carbon stores far exceed carbon stored in vegetation. When trees are harvested and especially when they are clear cut, soils are exposed to compaction, erosion, more light exposure, drying and other changes that cause the demise of microbes and release of carbon into the atmosphere. These emissions, although they are a direct result of removing forest vegetation, are typically not incorporated into tallies of "deforestation emissions".

Rainforest on the island of Borneo.
Photo: Monongabay.com

Peat soils are particularly rich carbon stores because they are made up of compressed and concentrated organic material. The world's peat lands cover an area of about four million km2, or about 3% of the earth's surface in tropical, subtropical, arctic, boreal and temperate zones.[14] They contain an estimated 528,000 Megatons (1 Megaton= 1 million metric tons), which is about 75% of the carbon currently in the atmosphere.[15] Maintaining peat lands throughout the world so that their carbon reserves are not released into the atmosphere is critical. The IPCC only recently acknowledged that emissions from peat land degradation resulting from

[10] For example: N. Stern, "The Stern Review on the Economics of Climate Change. Cambridge University Press; IPCC fourth assessment report" 2007 http://www.ipcc.ch/; Santilli et. al., Tropical Deforestation and the Kyoto Protocol. Climatic Change (2005) 71: 267–276

[11] Britton, S.B. et al. "Weak Northern and Strong Tropical Land Carbon Uptake from Vertical Profiles of Atmospheric CO2." Science 22 vol. 316 no. 5832 pp. 1732-1735 http://www.nsf.gov/news/news_summ.jsp?cntn_id=109647

[12] P.M. Fearnside, and W.F. Laurance, "Tropical deforestation and greenhouse gas emissions." Ecological Applications. 2004, 14(4): pp. 982-986

[13] R.X. Dixon, A.M. Solomon, S. Brown, R.A. Houghton, M.C. Trexier, and J. Wisniewski, 'Carbon Pools and Flux of Global Forest Ecosystems." Science, 1994, vol 263 no 5144 pp 185-190

[14] Global Peatlands Initiative, 2002. World Peatland Map.

[15] E. Gorham "Northern peatlands: role in the carbon cycle and probable responses to climatic warming." Ecological Applications 1991, 1: 182–195. See also: C.P. Immirzi, E. Maltby, "The Global Status of Peatlands and their Role in Carbon Cycling. A report for Friends of the Earth by the Wetland Ecosystems Research Group." 1992, Report 11, Department of Geography, University of Exeter, Exeter, UK. Friends of the Earth: London.

deforestation may even exceed those from the loss of vegetation[16].

Forest soils release carbon when fertilizers are applied, now a global phenomenon. Nitrogen pollution from burning fossil fuels and from agricultural fertilizer use is transported around the globe and deposited by huge transcontinental dust clouds. When deposited in tropical forest soils, they result in a dramatic rise (about 20% annually), in soil carbon emissions by increasing microbe metabolism[17]

Importantly, a recent study of soil carbon in China revealed that the soils in old growth forests are actively storing more carbon and therefore playing a more important role in regulating atmospheric carbon than was previously assumed.[18]

Forest fires releasing massive quantities of carbon into the atmosphere. Photo: Monongabay.com

The impact of deforestation and warming on forests worldwide will be a decisive factor in determining the future climate. Northern Boreal Forests, for example, cover about 14.5% of earth's surface and are the largest terrestrial carbon pool, holding as much as 30% of the world's terrestrial carbon, largely concentrated in the soils. As the climate is warming, more pronounced in northern latitudes, the rate of decomposition has increased and the forest is experiencing an overall drying. [19] This has resulted in more fires. In 2004, for example, an area of 2.5 million hectares (about the size of the state of Vermont) burned, releasing massive quantities of carbon into the atmosphere. The Boreal Forest ecosystem is critical to stabilizing climate, but the capacity of these forests to adapt to dramatic warming remains uncertain.

Accurate assessments of the amount of carbon that is stored in forests are very difficult to obtain, as this requires knowing the area forested and the biomass density for various different types of forest cover. Uncertainty in this measure has been estimated to be as high as 150%.[20] What estimates do exist suggest that globally, forest vegetation and soils contain on the order of over 1100 billion metric tons of carbon, with approximately 37% of this carbon in low-latitude forests, 14% in mid-latitudes, and 49% at high latitudes[21]. This is about double what is already in the atmosphere. In tropical forests, vegetation alone contains as much as 300 tons of carbon per hectare.[22] [23]

Currently about eight billion metric tons of carbon are emitted from fossil fuel burning, and when peat oxidation and deforestation are added, the figure rises to somewhere around 9.9-10.9 billion tons annually. Approximately 25% of this is taken up by forests and other terrestrial sinks,[24] an additional 25% is absorbed by the oceans, and the remaining 50%

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[16] http://www.ipcc.ch/SPM040507.pdf

[17] C. Cleveland and A. Townsend, "Nutrient additions to a tropical rain forest drive substantial soil carbon dioxide losses to the atmosphere." Proceedings of the National Academy of Sciences. July 5, 2006. Vol. 103 no. 27. pp 10316-10321 http://www.pnas.org/cgi/content/abstract/103/27/10316

[18] G. Zhou, S. Liu, Z. Li, X. Tang, C. Zhou, J. Yan, and J. Mo, "Old Growth Forests can Accumulate Carbon in Soils." Science 2006, 314: 1417

[19] Woods Hole Research Center "Boreal Forest" http://www.whrc.org/borealnamerica/index.htm

[20] K.A. Baumert, T. Herzog, and J. Pershing, "Navigating the Numbers: Greenhouse Gas Data and International Climate Policy." 2005. Washington D.C. World Resources Institute.

[21] R.K. Dixon, A.M. Solomon, S. Brown, R.A. Houghton, M.C. Trexier, and J. Wisniewski, "Carbon Pools and Flux of Global Forest Ecosystems." 2005. Science vol 263 no 5144 pp 185-190

[22] C.A. Pal, et al. "Carbon Sequestration and Trace Gas Emissions in Slash and Burn and Alternative Land Uses in the Humid Tropics." ASB Climate Change Working Group, Final report, phase 11, 1999. http://www.asb.cgiar.org/pdfwebdocs/Climate%20Change%20WG%20reports/Climate%20Change%20WG%20report.pdf

[23] "Special Report on Land Use, Land Use Change and Forestry, Summary for Policy Makers" Table 1, IPCC 2000

[24] B. Locatelli, and A. Karsenty, "Tropical forest dynamics and climate change." In: Babin (Ed.) "Beyond Tropical Deforestation: from tropical deforestation to forest cover dynamics and forest development." 2004. UNESCO pp 97-120.

stays in the atmosphere. In the tropics however, while remaining forests are sequestering carbon, forests are being cut and burned so extensively that overall they are a net source of atmospheric carbon. At current rates, tropical deforestation contributes somewhere between 0.6-3 billion tons of carbon to the atmosphere each year.[25] Worldwide, it is predicted that an amount on the order of 40 billion tons will be released during the period from 2008-12.[26]

Deforestation emissions from Brazil and Indonesia alone in 2005 were equivalent to about four-fifths of the emissions reduction commitments during the first commitment period of the Kyoto Protocol.[27] These are gross underestimates because they do not incorporate the huge emissions that result from the degradation of Southeast Asian peat lands, caused by deforestation.

In addition to regulating greenhouse gases, forests also are essential to weather and hydrological cycles that affect the climate globally.[28] Forests regulate weather by exchanging moisture and energy with the atmosphere, playing a vital role in driving atmospheric circulation and rainfall patterns. Water is absorbed from the soil through roots and then released into the air through evapotranspiration. Forest vegetation also emits isoprene's, which serve as condensation nuclei, aiding in the formation of clouds and raindrops.[29]

Major tropical forests in the Amazon, the Congo, and Southeast Asia are responsible for regulating rainfall patterns over very large areas of the earth's surface.[30] In the Amazon basin, for example, trade winds coming over the Atlantic Ocean pick up moisture and deposit it as rainfall on the forests. Rather than running off, the water is pumped back into the atmosphere (as much as 75% of it) by forest evapotranspiration. The resulting clouds then move along and deposit their rainfall over much of South and Central America and the southern United States. Precipitation over large areas of the planet is affected by the formation of cloud systems generated within the tropics. Some scientists now believe that the heat, moisture and kinetic energy, which get carried from the tropics to the middle and higher latitudes, have a profound impact on the ridge-and-trough pattern associated with the polar jet stream.

When forests are cut, the surface temperature rises and moisture levels drop, hence rainfall declines. Deforestation in the tropics may therefore influence rainfall, and hence water availability in many parts of the world.[31]

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[25] Santilli et. al. "Tropical Deforestation and the Kyoto Protocol." Climatic Change (2005) 71: pp 267–276
See also: K.M. Chomitz, "At Loggerheads Agricultural Expansion, Poverty Reduction and Environment in the Tropical Forests." 2006 World Bank Policy Research Report.

[26] N. Stern, "The Stern Review on the Economics of Climate Change." Cambridge University Press; IPCC fourth assessment report 2007 http://www.ipcc.ch/; Santilli et. al. "Tropical Deforestation and the Kyoto Protocol. Climatic Change" (2005) 71: pp 267–276

[27] Santilli et. al. "Tropical Deforestation and the Kyoto Protocol. Climatic Change" (2005) 71: pp 267–276

[28] See for example: Bunyard, P. Gaia, "Climate and the Amazon" http://www.indsp.org/SWPeterBunyard.php. ; Gedney, Nicola, and Paul J. Valdes. 2000. The Effect of Amazonian deforestation on the northern hemisphere "Circulation and Climate." Geophysical Research Letters, 19, pp. 3053-3056; W.O. Shem, and Dickinson "How the Congo Basin deforestation and the equatorial monsoonal circulation influences the regional hydrological cycle." January 2006, presented at 86th meeting of the AMS

[29] M. Claeys, M. Graham, G. Vas, W. Wang, R. Vermeylen, V. Pashynska, J. Cafmeyer, P. Guyon, M.O Andreae, P. Artaxo, and W. Maenhaut, "Formation of Secondary Organic Aerosols Through Photooxidation of Isoprene Science" 2004, 303, 1173, http://www.sciencedaily.com/releases/2004/02/040226071042.htm

[30] see http://news.mongabay.com/2005/0919-nasa.html

[31] R. Avissar, and D. Werth, "Global hydroclimatalogical teleconnections resulting from tropical deforestation." Journal of Hydrometeorology 2005, 6(2): 134-145

Tropical deforestation.
Photos: Monongabay.com

Flowering trees in the rainforest canopy, Southeastern Peru.

Current rates of deforestation and their impacts on climate

Without these various functions provided by healthy forest ecosystems, it will be impossible to protect the earth's climate from the worst impacts of global warning. Yet deforestation still continues largely unabated. Figures on global deforestation vary widely. According to the FAO[32], for example, between 1990 and 2005 we lost 3% of global forest cover, a rate of 0.2% per year. However, this figure is deceptive because the FAO considers that 'forests' includes old growth primary forest, secondary growth, planted semi natural forests and even industrial monoculture plantations of exotic species, which are basically cornfields with trees in place of corn plants that bear little resemblance to any biologically diverse and balanced forest ecosystem. All are counted as forest cover.

Even so, this very conservative figure amounts to a loss of close to eight million hectares per year, or 22,000 hectares per day. If plantations are excluded from the calculations this figure could rise as high as 32,300 hectares permanently lost every day while an equivalent area is also degraded.[33] Tropical deforestation rates increased by at least 8.5% between 2000 and 2005, with over 10 million hectares of tropical forest lost each year since the 1990's. Furthermore, during the same time period, there was a 25% increase in the loss of primary forest compared to the previous five year period.[34] These losses are not evenly distributed across the globe. Deforestation has been much higher in tropical forests of Latin America, the Caribbean, Africa and Southeast Asia, where 80% of the world's remaining primary forest stands. According to FAO, these losses of primary old growth tropical forest are "countered" by gains in forested land in some temperate areas. But these are in fact tree plantations, largely in China, European Union (EU) and North America. In other words, on a global scale old growth forests, the most biodiverse ecosystems on earth and critical to climate stabilization are being replaced by barren industrial monoculture tree plantations, sometimes of introduced exotic species, in countries like China, the EU and North America.

Causes of deforestation

The forces driving deforestation and conversion to monoculture plantations include legal and illegal logging, the expansion of agricultural lands, (especially for livestock production, soy, palm oil, cereals and industrial timber plantations), mining and oil exploitation and subsistence agriculture.[35] Underlying many of these forces is the demand for land and

[32] "State of the World's Forests" FAO 2007, http://www.fao.org/docrep/009/a0773e/a0773e00.htm
[33] http://rainforests.mongabay.com/0801.htm
[34] http://rainforests.mongabay.com/primary_alpha.html
[35] "Underlying Causes of Deforestation," World Rainforest Movement. http://www.wrm.org.uy/deforestation/indirect.html

forest products created by consumption patterns, especially in industrialized countries, and the trade and export policies and international financing arrangements that support that demand. For example, northern countries' demand for fast-food hamburgers created a huge market for beef from Central America. The consequent need to increase land available for cattle grazing has had a huge impact on deforestation rates. Currently, the expansion of livestock farming, soy for livestock feed and agrofuel crops is driving deforestation throughout Latin America and Asia to fulfill demand from northern and newly industrialized countries. Southeast Asia and Latin America alone account for over 80% of the carbon emissions that result from land use change, mostly from deforestation.[36]

According to the FAO, most recent agricultural expansion has been at the expense of forests. As demand for agricultural lands increases, the impetus to clear forests out of the way increases, as can be seen in the Brazilian Amazon and many other areas in Latin America. Agricultural expansion contributes further to greenhouse gas emissions via subsequent fertilizer use which causes emissions of nitrous oxide.[37]

Growing demand for wood products is a major factor in deforestation. The overall export and import of primary and secondary wood products has risen dramatically in the period from 2000-2004[38]. One recent trend is the export of round wood from the Russian Federation (42 million cubic meters in 2004, accounting for 35% of global trade), to East Asia and Europe. This is in part a reflection of an increase in secondary processing industries: wood imported to China, for example, is then made into furniture exported to Europe or North America. China's forest products industry grew from $US4 billion to $US17.2 billion in the past five years alone. Paper consumption has doubled, and feeding this demand are the forests of Indonesia and Russia. Globally, the pulp and paper industry is in the process of a fivefold expansion.[39]

Meanwhile, wood is playing an increasing role in energy supply, and is now traded internationally for bioenergy production. Bioenergy comprises about 80% of renewable energy, which, along with other "renewables" contributes about 13.3% of world energy supply. Wood accounts for 75% of biomass and therefore contributes more than nuclear sources, and about four times the contribution of hydro, wind, geothermal and solar combined[40]. Most of this wood is used for cooking and heating in Asia and Africa, but increasingly wood is being used for heat and power generation in OECD countries. As oil prices rise, wood is likely to become increasingly attractive as an energy source and the use of wood for electricity production is expected to triple by 2030.[41] Byproducts of pulp and paper production including sawdust, mill ends, black liquor etc. are becoming more valuable. If liquid biofuel production from solid biomass becomes technologically and commercially feasible, this will add a huge additional demand for wood.

How can the world's forests meet all of these demands? Can they supply paper, wood products, and energy, even as we continue to decrease the amount of forest by expanding agricultural lands? The current trend is to replace natural forests with tree plantations which make it easier to select and plant only the species we "need," to control growth and age structure and therefore to make harvesting easier. Some argue that growing trees in

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[36] R.A. Houghton, "Terrestrial carbon storage: Global lessons from Amazonian research." Ciencia e Cultura 1997, 49: 58-72.
[37] Steinfeld et al "Livestock's Long Shadow: Environmental issues and options." FAO, 2006 http://www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf
[38] "State of the Worlds Forests" FAO, 2007, http://www.fao.org/docrep/009/a0773e/a0773e00.htm
[39] "Banks, Pulp and People: a primer on upcoming international pulp projects." Urgenwald http://chrislang.org/2007/06/30/banks-pulp-people-2/
[40] "State of the Worlds Forests" FAO, 2007, http://www.fao.org/docrep/009/a0773e/a0773e00.htm
[41] "State of the Worlds Forests" FAO, 2007, http://www.fao.org/docrep/009/a0773e/a0773e00.htm

monoculture stands of genetically engineered or cloned trees will in fact "save forests" by increasing yields and reducing the need to harvest from natural forests. But with so much demand, and so little recognition of the unique value of native forests, the trend towards replacing forests with monoculture tree plantations will continue. Along with them will go the biodiversity they support and the important ecosystem functions they provide.

In 2005, the Millennium Ecosystem Assessment warned that the degradation of ecosystems is increasing the risk of non-linear, abrupt and accelerating climate change.[42] Climate scientists point out the possibility that global warming beyond about 1.8-2 degrees C could result in an abrupt destabilization and release into the atmosphere of carbon that is currently locked up in soils and vegetation. If this happens, and it is increasingly likely that it will if we destroy yet more carbon sinks, warming would rapidly escalate beyond our capacity to cope with it. Recent droughts and fires in the Amazon and Paraguay raise serious concerns that we may have already reached such a "tipping point" (see chapter 3).

Meanwhile, agrofuels, promoted as a solution to global warming, are in fact driving more deforestation. A recent study published in *Science* points out that "two issues need to be addressed before the efficacy of biofuels can be assessed: the net reduction in fossil carbon emissions (avoided emissions) arising from use of agriculturally-derived biofuels and the effect of alternative land-use strategies on carbon stores in the biosphere." The study concludes that in all cases, when the impacts of forestation of land is compared to the impact of growing and using agrofuels, the forested lands were capable of sequestering anywhere from two-nine times more carbon over a 30 year period. [43] Clearly, if we are serious about protecting the global climate, agrofuels are not a solution: they are instead driving an expansion of industrial agriculture that is destructive to forests, the people who depend on them and the global climate.

Soil

Certified forest. Photo: Wally Menne

"We stand, in most places on earth, only six inches from desolation, for that is the thickness of the topsoil layer upon which the entire life of the planet depends."[1]

Andres Arnalds, chair of a recent international forum on the problem of land degradation and desertification stated, "Land degradation and desertification may be regarded as the silent crisis of the world, a genuine threat to the future of humankind.[2]" Another participant in the forum, Zafar Adeel, Director of the United Nations University's Canadian-based International Network on Water, Environment and Health said, "Policy changes that result in improved conservation of soil and vegetation and restoration of degraded land are fundamental to humanity's future livelihood. This is an urgent task, as the quality of the land for food production, as well as water storage, is fundamental to future peace. Securing food and reducing poverty, especially in the drylands, can have a strong impact on efforts to curb the flow of people, popularly termed `environmental refugees' inside countries as well as across national borders.[3]" The UN Millennium Ecosystem Assessment ranked land degradation as among the world's greatest environmental challenges, reducing environmental security, destabilizing societies, endangering food security and increasing poverty.[4]

Soils are complex ecosystems. Fungal micorrhizae aid plants to take up nutrients, soil microbes, of which thousands of species can exist in just a handful of soil, and digest organic material into a form that can be utilized by plants. Healthy soils grow healthy plants and reduce the need to use pesticides. Healthy soils are well aerated and capable

[42] "Millennium Ecosystem Assessment" 2005 http://www.millenniumassessment.org/documents/document.356.aspx.pdf

[43] R. Rhigelato, and D. Spracklen, " Carbon Mitigation by Biofuels or by Saving and Restoring Forests?" Science 2007, 317. pp. 902

of retaining moisture. Repeated tilling, compaction from heavy equipment, failure to regenerate organic matter, poisoning of soil microbes by agrichemicals...all contribute to soil degradation. Industrial agriculture as it is practiced today is extremely destructive to soils. Crops like soy and corn are among the most destructive of all, leading to depletion of nutrients and erosion. Clearcutting, overgrazing and overplowing, all decrease protective vegetation and contribute to soils erosion. Severe degradation results in desertification, and a virtually complete loss of capacity to support the growth of vegetation. Given that close to 24% of the earth's terrestrial surface is already under cultivation, it makes good sense to nurture and conserve soils.

Conserving soils should be a global high priority. Our capacity to grow food depends upon it. Yet soils are treated as merely a substrate that can be "mined" and then "replenished" with synthetic fertilizers. This mentality is fundamental to the concept of growing crops for automobile fuels. The approach is well illustrated by the concept of removing crop residues to use for agrofuel production. Crop residues left to decompose in agricultural soils are an important means of regenerating and stabilizing soils. Removing them, even a portion, will decrease the soil organic content, alter soil texture, increase erosion, decrease water retention, and lead to an overall decline in productivity and further degradation of agricultural soils.

The UN FAO reports that soil degradation affects two-thirds of the countries in the world, more than four billion hectares of land, or a third of the land surface, and more than a billion people. By 2020, an estimated 135 billion people may be driven from their land as a result of soil degradation, with 60 million in Sub Saharan Africa alone, where productivity declines 1%/yr, 20% over last 40 yrs. Desertification has also taken a toll in Latin America and the Caribbean, where about one-fourth of the land surface is degraded. In Spain, about one-fifth of the land area is degraded and China has lost 700.000 hectares of cultivated land, 2.35 million hectares of rangeland, and 6.4 million hectares of forest to desertification. China is faced with a crisis given the severe land degradation in combination with a huge population to feed and rising income and is now paying farmers in the threatened provinces to plant trees in their cropland. The goal is to plant trees on ten million hectares of grainland, easily one tenth of China's current grainland area. Worldwide, about 70% of the worlds dry lands (5.2 billion hec.) used for agriculture are degraded and at risk of desertification.[5]

In the U.S., some of the best agricultural soils occur in Iowa, but these have declined from an average of 18 to 10 inches depth over the past century due to erosion. Erosion rates exceeded soil regeneration rates on close to 30% of agricultural lands in the U.S. in 2001.[6] This loss of topsoil and organic residues results directly in declining productivity. In an effort to stem the tide of erosion, the U.S. Conservation Reserve Program was introduced in 1985 and paid farmers to plant lands sensitive to erosion with grass or tree cover protection and to use no-till farming, terracing and contour strip farming.

Soils play a critical role in global carbon balances. Soil carbon is stored in the bodies of vast populations of soil microbes and bound in mineral forms. Industrial agriculture, by disturbing and degrading soils, causes the disruption and decomposition of soil microbes, which release their carbon into the atmosphere. Converting forest soils to agriculture reduces soil carbon stores by an estimated 40%.[7] Old-growth forests have long been considered relatively insignificant in terms of their function as carbon sinks because they are no longer growing rapidly and the absorption of atmospheric carbon was thought to be approximately balanced by respiration emissions. This has been used as a rationale for the development of plantations of fast-growing trees as sinks in carbon trade schemes. A recent study by Zhou et. Al. looked at soil carbon changes in an old-growth forest in southern China. They found carbon within the top 20 cm of soil layer increased an average .35% each year between 1979 and 2003. In other words, old growth forest soils are acting as a very significant carbon sink. Zhou et. al. state that although "the driving forces for this observed high rate of soil organic carbon increase in the old-growth forests are not clear at present," their study "suggests that the carbon cycle processes in the belowground system of these forests are changing in response to the changing environment."[8] Alterations in atmospheric carbon and increasing deposition of nitrogen (from fertilizer use), are likely changing forest dynamics in ways that we do not yet comprehend and the consequences of which are unknown. A recent study published in PNAS reported that when phosphorus or nitrogen (fertilizer) is added to tropical forest soils it causes an increase in carbon dioxide emissions to the atmosphere of about 20% annually.[9]

In light of these concerns and findings, does it make sense to expand industrial agriculture, to clear, till, plant, spray, and harvest the soils even more intensively in order to grow crops for automobile fuel?

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1 R. Sampson, Farmland or Wasteland: A Time to Choose. Overcoming the threat to America's farm and food future. (1981, Rodale Press)

[2] "More food needed now than in all recorded history. Restoring Soils vital to feed world, forestall climate change: experts. "August 30, 2007. OneWorld.net http://us.oneworld.net/article/view/152674/1/3319

[3] ibid

[4] "UN Millennium Ecosystem Assessment. Ecosystems and Human Health" http://www.millenniumassessment.org/documents/document.356.aspx.pdf

[5] [1] "State of the Worlds Forests" FAO, 2007, http://www.fao.org/docrep/009/a0773e/a0773e00.htm, pp 75-6

[6] "Soil Erosion Brief" Natural Resource Conservation Service/USDA, 2006, http://www.nrcs.usda.gov/feature/outlook/Soil%20Erosion.pdf

[7] R.P.Detwiler and C.A.S.Hall, "Tropical forests and the global carbon cycle." Science 1988, 239: 42-47

[8] [1] G. Zhou, S. Liu, Z. Li, X. Tang, C. Zhou, J. Yan, and J. Mo, "Old Growth Forests can Accumulate Carbon in Soils." Science 2006, 314: 1417

[9] C. Cleveland and A. Townsend "Nutrient additions to a tropical rain forest drive substantial soil carbon dioxide losses to the atmosphere." Proceedings of the National Academy of Sciences. July 5, 2006. Vol. 103 no. 27. pp 10316-10321 http://www.pnas.org/cgi/content/abstract/103/27/10316

III: The expansion of agrofuels

Industrial agriculture has already transformed many native landscapes into vast, barren expanses containing just a handful of 'useful' crops, including soy, maize, rapeseed, sugar cane, palm oil and wheat. These are grown on a massive scale and in a highly mechanized manner, using artificial fertilizers, herbicides and pesticides.

Industrial monocrops are almost universally grown by or for large multinational agribusinesses, such as Cargill, Bunge and Archer Daniels Midland, and - especially in developing countries - are generally destined for export to wealthier industrialized countries, not for local consumption.

The resulting corporate consolidation of land, resources and profits has been monumental: agriculture, and even economies, have been restructured in ways that have discouraged and in some cases all but eliminated small-scale producers. Landscapes on virtually every continent have been leveled, simplified and poisoned by this 'green revolution.' Before the advent of industrial monocultures, these lands were not empty. They were diverse ecosystems, some of them forests with a great wealth of biodiversity and home to indigenous peoples with their own diverse agricultural systems, fine-tuned to local environmental conditions and cultural preferences.

Demand for crops that can be used for ethanol production is now pushing an even more massive expansion of these industrial monocultures. Sweeping statements about global capacity to produce agrofuels paint a rosy picture of a world where happy farmers make a decent living, tending lush and thriving crops, so that others may drive guilt-free through a world free of global warming. Because the growing season is longer, rainfall more consistent, and land and labor less expensive, the global south is 'favored' for growing these energy crops. Brazil's president, Luiz Ignacio Lula da Silva, has enthusiastically embraced the concept, exclaiming that "God gave us sun, land and hard-working people".[44]

One study analyzing global bioenergy potential, by Hoogwijk (2004)[45], concludes that the 'best' result comes from production in a globally oriented 'world' that is also socially and environmentally concerned. Hoogwijk argues that, in this scenario, the production of bioenergy could even exceed demand. Hoogwijk examines multiple scenarios for meeting energy demand, based on various dimensions of social, economic, technological, environmental and policy developments. However, the study fails to question the likelihood of a globalized world actually being socially and environmentally benign.

Another study, by Smeets et al (2006)[46], also models several scenarios for the global production of bioenergy (including agrofuels and other uses of biomass for energy). This study concludes that the regions with the greatest production potential include Latin America and sub-Saharan Africa, because they have large amounts of 'surplus' cropland, and Eastern Europe. Oceania, East Asia and Northeast Asia are also viewed as having considerable potential should they be able to increase productivity. The authors point out that the global potential for agrofuels can only be met by displacing subsistence farming and livestock pasture.

The Inter-American Development Bank's Blueprint for Green Energy in the Americas[47], outlines a 'vision' in which a huge investment in capacity expansion (more infrastructure, developing markets and the promotion of technological innovations) will enable countries in the south - Latin America in this case - to ramp up production on a massive scale, in order to meet 5% of global transport fuel demand.

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[44] "Brazil to be world's leading biodiesel producer: president." People's Daily Online, Nov 19, 2005 http://english.people.com.cn/200511/19/eng20051119_222585.html

[45] Monique Hoogwijk, André Faaij, Richard van den Broek, Göran Berndes, Dolf Gielen and Wim Turkenburg, "Exploration of the Ranges of the Global Potential of Biomass for Energy," Biomass & Bioenergy, 2003, 25, pp. 119 – 133

[46] E. Smeets, A. Faaij, I. Lewandowski and Turkenburg, "A bottom up assessment and review of global bio-energy potentials to 2050." Progress in Energy and Combustion Science. 2006, Vol. 33, issue 1. pp 56-106 http://www.bioenergytrade.org/t40reportspapers/otherreportspublications/fairbiotradeproject20012004/00000098ae0d94705.html

[47] Garten Rothkopf, "A Blueprint for Green Energy in the Americas", prepared for the Inter-American Development Bank. http://tinyurl.com/39e67b

Another recent analysis of agrofuels potential concludes that Colombia, Ghana, Malaysia, Thailand and Uruguay rank as the top five countries for biodiesel production, because of their strong agricultural industries, relative stability and low levels of debt. The authors estimate that if the 119 countries in their analysis converted all of their currently exported vegetable oil to biodiesel, they could collectively meet 4–5 % of the current demand for petroleum diesel.[48]

Completely lacking from these analyses is any question of whether people living in these 'high potential' areas want to produce agrofuels instead of food, given that the demand for these fuels generally comes from wealthier urban segments of national populations and from industrialized countries of the north, rather than those who actually live and depend on these 'surplus' lands. Also missing is an honest and accurate assessment of whether such a scenario would actually fulfill its purported intent, namely to mitigate global warming.

The corporations who stand to profit from agrofuels have eagerly promoted them, and their 'greenwash' has so far been swallowed hook, line and sinker. Promises that agrofuel production will bring prosperity to the world's rural poor are flaunted alongside promises of green and secure energy. The push to bring these grandiose visions to fruition is blundering ahead at breakneck speed, promoted and sustained by a combination of national and international policies, incentives and trade agreements, and the enormous corporate pressures created by powerful and united agribusiness, oil, biotechnology and auto industries. (See Corporate Consolidation)

Many countries are rapidly and eagerly embracing this new 'opportunity.' Colombia, which had hardly any oil palm a few decades ago, is now aiming to reach a million hectares over the next few years. Indonesia had about 500,000 hectares of palm oil in the mid 1980's, but now has over six million with plans for another 20 million over the coming two decades. Brazil, with soy covering 21% of its cultivated land - over 20 million hectares - is planning to plant another 60 million, and bring about a fivefold increase in sugar cane production as well. India aims to plant some 14 million hectares of jatropha by 2012.[49]

A major impetus for all this comes from the mandatory targets being put in place by governments, especially in major transport fuel consuming countries, like the U.S. and the EU. In the EU a mandated target requires that agrofuels replace 5.75% of transport fuel by 2010 and 10% by 2020. Individual countries have even loftier aspirations: Sweden, for example, is aiming for 100% agrofuels use for transport by 2020. In the U.S., a Renewable Fuel Standard enacted under the 2005 Energy Policy Act mandated 28.4 billion liters of agrofuels by 2012, while offering tax breaks, refinery and biomass R&D funding, loan guarantees and other incentives.[50] In December 2007, President Bush signed into law the Energy Independence and Security Act, which provided a fivefold increase in the mandate for agrofuels, up to 136 billion liters by 2022 along with increased funding for research and development and infrastructure. Several U.S. states have adopted incentives for agrofuels: Minnesota, for example, mandates that 20% of transport fuel consist of ethanol by 2013. The U.S. Farm Bill now has an Energy Title with further provisions to promote agrofuels. Numerous other countries, including Brazil, China and India also have adopted targets which virtually mandate expansion of the agrofuels industry.[51]

Global expansion

In 2006 alone, global ethanol production increased by 22%, with the U.S. and Brazil accounting for about 90% of that production[52], a total of about 38.2 billion liters of ethanol.[53] Biodiesel (which currently has a much smaller share of the overall agrofuels market) jumped a whopping 80%.

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[48] M. Johnston, and T. Holloway, "A Global Comparison of National Biodiesel Production Potentials." Environmental Science and Technology Online, 24 Oct 2007 http://pubs.acs.org/cgibin/abstract.cgi/esthag/asap/abs/es062459k.html

[49] "Stop the Agrofuels Craze." Seedling, July 2007, http://www.grain.org/seedling/?id=477

[50] See for example: "Bush Administration Establishes Program to Reduce Foreign Oil Dependency, Greenhouse Gases. US Department of Energy," April 10, 2007, http://www.energy.gov/news/4940.htm

[51] See: "Biofuels For Transport: global potential and implications for sustainable energy and agriculture." Worldwatch Institute 2007. table 17.1, pg 281

[52] "Christopher Berg, senior analyst F.O. Licht, Agra Informa Ltd. Kent, cited in Biofuels for Transport: global potential and impilications for sustainable energy and agriculture." Worldwatch Institute 2007.

[53] F.O Licht, "World Ethanol and Biofuels Report," 2006

The rapid growth in U.S. biodiesel production is a good illustration of just how quickly agrofuels have taken off. In 1995, the U.S. produced 1.9 million liters of biodiesel. By 2005, production had risen to 284 million liters and by the beginning of 2006 it stood at 852 million liters. By mid-2006 biodiesel production had jumped to 1.2 billion liters, produced in 42 facilities, with 21 new refineries under construction.[54] According to U.S. research consultancy Clean Edge, the global market for agrofuels is set to grow from US$20.5 billion in 2006 to US$80.9 billion by 2016.[55]

The United States

The United States, as a major consumer of transportation energy, and home to much of the world's corporate agribusiness, biotechnology, oil and automobile industries, has been vigorously promoting agrofuels, both domestically and overseas. Initially, ethanol was viewed as an oxygenated fuel additive, and a viable substitute for the more toxic MTBE, but now it has become the "alternative" fuel of choice.

In 2006, half of the world's ethanol came from U.S. corn (accounting for 2-3% of the country's non-diesel fuel). This amounted to about 18 billion liters.[56] The U.S. Department of Energy hopes that biomass will, by 2030, provide 5% of the nation's power, 20% of its transportation fuel and 25% of the fuel needed for chemical production (all in all, replacing about 30% of current petroleum use).[57]

Agricultural fires set in the humid forests of Madagascar.
Photo: Monongabay.com

Lobbying on behalf of ethanol industry proponents, organizations like '25x25', Renewable Fuels Association and the National Biodiesel Board have been very powerful. Virtually all mainstream environmental organizations, including Environmental Defense, the Sierra Club, Natural Resources Defense Council and the National Wildlife Foundation, have promoted biofuels as a viable solution, assuming some sustainability criteria are in place.

The farm lobby has chimed in with enthusiasm. Seen as a means of reinvigorating the failing economies of Midwestern farm country, and simultaneously facilitating energy independence, growing corn for ethanol has become a patriotic duty! Auto manufacturers like GM, Ford and DaimlerChrysler support agrofuels as an 'easy' alternative to selling fewer cars or increasing fuel efficiency.

Agrofuels have received yet more support from a slew of celebrities. Al Gore has consistently promoted agrofuels (and carbon trade) as part of his solution to the "Inconvenient Truth" of global warming. Singer/songwriter Willie Nelson started up his own biodiesel company, and the glamorous actress Darryl Hannah has scored green points for driving a biofuel-powered car. Musicians travel in agrofuel-powered transport and offer carbon offsets for fans attending their concerts.

Ethanol has become a political issue, appealing to the American psyche in a quite fundamental way. As one journalist put it, "in barren counties with shuttered stores on Main Street, people see a renaissance. They see a biorefinery every 50 miles or so, turning

[54] "Biofuels for Transport: global potential and implications for sustainable energy and agriculture." Worldwatch Institute 2007
[55] J. Makower, R. Pernick, and C. Wilder, "Clean Energy Trends" 2007, http://www.cleanedge.com/reports/Trends2007.pdf
[56] "Biofuels for Transport: global potential and implications for sustainable energy and agriculture." Worldwatch Institute. 2007. (Table 1.1 pg 6)
[57] "Roadmap for Agriculture Biomass Feedstock Supply in the United States." U.S. Department of Energy. 2003. DOE/NE-ID-11129.

out American fuel for American drivers from American crops. No more dependence on shady Arab sheiks.[58]

Against such a backdrop of patriotism, virtually every politician who is running or will run for re-election in the near future has promoted ethanol as part of a strategy for maintaining a 'green' image, and winning over votes from important corn-growing states. This is an especially important strategy for any presidential candidates, as the Iowa caucuses are an important testing ground located in the heart of corn country.

Subsidies for U.S. corn ethanol production are enormous, and this issue has received increasingly critical attention, both nationally and internationally. Subsidies come from both state and federal level. In 2005, according to the Environmental Working Group, the U.S. provided US$9.4 billion in corn subsidies, dwarfing all other agricultural subsidies.[59] On top of this are subsidies for the production of ethanol from that corn. A report by the International Institute for Sustainable Development estimated that subsidies for ethanol production could, collectively amount to a startling 92 billion between 2006 and 2012.[60] Add to this state and local subsidies, and the tariff (54 cents/gallon) on imported ethanol, and the figure will be even higher. It is absurd to lay out this sort of money in return for what will amount to a small contribution towards transport fuel. According to the author: "There is an urgent need to examine the claimed benefits from biofuel subsidies, and to compare them with the costs of meeting the same goals in other ways. Until then, we suggest that the U.S. Congress and the States declare a moratorium on programs that would increase or extend subsidies to liquid biofuels, with a view to developing a plan for phasing out subsidies to all transport fuels as quickly as possible."

Benefiting from these subsidies are companies like Archer Daniels Midland (ADM), the company that first sold the idea of corn-derived ethanol as an auto fuel to Congress, in the late 1970s. ADM has doubled its stock price and profits over the last two years and currently controls close to a quarter of U.S. ethanol fuel production. The company recently hired a former Chevron executive as its CEO.[61] Bioenergy and VeraSun are also major U.S. ethanol producers.

Meanwhile, the ecological costs of corn ethanol are mounting. Corn is an especially destructive crop.[62] It requires more water, insecticides and fertilizer than most other common crops.[63] Planted in rows, it permits soil erosion because soil between rows is left exposed.[64] It also depletes soil nutrients rapidly and so requires a huge amount of fertilizer. (See nitrogen sidebar) Corn also needs consistent water in order to grow, so in some places it needs to be irrigated. Finally, more than 50% of the corn grown in the U.S. is genetically engineered.

With ethanol production escalating, demand for corn is intense. In 2007, the U.S. Department of Agriculture expects the corn harvest to have increased by 24% over 2006. The agricultural lobby is pushing to have some of the 37 million acres of lands currently enrolled in the Conservation Reserve Program released from contract, in order to expand corn production further. These are generally lands that have been taken out of production to preserve waterways, control erosion or provide wildlife habitat. The demand and rising price of corn has prompted farmers to substitute corn for other crops even in arid areas of the Western Plains, for example, that are not well suited for corn.[65] Similarly, U.S. soy production has declined, pushing up production and hence deforestation in South American soy producing areas.

Ethanol is polluting. Engine exhaust from gasoline and ethanol mixtures result in the

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[58] P. Newcomb, "Life on the Ethanol –Guzzling Prairie." New York Times, 2007 http://topics.nytimes.com/top/reference/timestopics/people/e/timothy_egan/index.html?inline=nyt-per

[59] Environmental Working Group Farm Subsidy Database 2005. http://farm.ewg.org/farm/progdetail.php?fips=00000&progcode=corn

[60] D. Koplow, "Biofuels: at what cost? Government support for ethanol and biodiesel in the U.S. Global Subsidies Initiative (GSI)" October 2006 http://www.globalsubsidies.org/IMG/pdf/Brochure_-_US_Update.pdf

[61] A. Barrionuevo, "A Bet on Ethanol, With a Convert at the Helm." New York Times. October 8, 2006.

[62] S. Powers, "Quantifying Cradle-to-Farm Gate Life-Cycle Impacts Associated with Fertilizer Used for Corn, Soybean, and Stover Production." NREL May, 2005.

[63] D. Pimentel, "Ethanol fuels: Energy balance, economics and environmental impacts are negative." Natural Resources Research. 2003. 12:127-134.

[64] Preston Sullivan, "Sustainable Soil management. Soil Systems Guide." National Sustainable Agriculture Information Service. May 2004, http://www.attra.org/attra-pub/PDF/soilmgmt.pdf

[65] A. Barrionuevo, "Crop Rotation in the Grain Belt." New York Times, September 16th, 2006

release of NOx, acetaldehyde, and peroxy-acetyl-nitrate (PAN).[66] Using E85 ethanol mixtures (in which ethanol constitutes 85% of the fuel mix) results in decreased emissions of the carcinogens benzene and butadiene, but increased emissions of acetaldehyde and formaldehyde, which are also carcinogenic. E85 mixtures also raise ground level ozone levels beyond those that occur with petroleum fuels.[67]

As the number of ethanol refineries in use and under construction has skyrocketed, so have community conflicts over the siting of these facilities, especially because of impacts on air and water. In Iowa, for example, 394 instances where ethanol refineries were responsible for violating health regulations and creating pollution problems occurred during a six year period.[68]

Many ethanol refineries are powered by coal, which results in emissions of mercury and other toxins, as well as greenhouse gases. In April 2007, the U.S. Environmental Protection Agency (EPA) relaxed air release regulations on fuel ethanol refineries, which release particulate matter, ethanol vapors, carbon monoxide, volatile organic compounds (VOCs) and several carcinogens, requiring them only to meet the lower standards in place for refineries that produce ethanol for consumption.[69]

Refineries also place immense demands on water supplies (See water sidebar) which causes major problems in many regions of the U.S. where groundwater supplies are already being depleted by agriculture faster than they are recharged.

To top it off, by any measure, corn is massively inefficient in terms of its energy balance. Life cycle analyses incorporating inputs from agriculture and processing, show that corn ethanol production produces an energy surplus of approximately 25%, which is quite low by comparison with other major fuel sources.[70] One study of corn ethanol revealed that in 2005, 14% of the U.S. corn harvest was used to produce some 3.9 billion gallons (over 14 million liters) of ethanol, equivalent to 1.7% of current gasoline usage. About 1.5 % of the soy harvest produced 68 million gallons (257 million liters) of biodiesel, equivalent to less than one tenth of one percent of gasoline usage. This means that if all of the country's corn harvest was used to make ethanol, it would displace 12% of our gasoline; all of the country's soybeans would displace about 6% of diesel use. But if the energy used in producing these biofuels is taken into account, the picture becomes worse still. It requires roughly eight units of gasoline to produce 10 units of ethanol, and five units of gasoline to produce 10 units of biodiesel; hence the net is only two units of ethanol or five units of biodiesel. Therefore the entire soy and corn crops combined would really displace only less than 3% of current gasoline and diesel use.[71]

The overall energy and economic inefficiency of corn ethanol prompted Brazil's president Lula to state, with respect to U.S corn production: "Why make ethanol out of corn? Why don't we feed the corn to the chickens?"[72]

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[66] D.W. Rice, et al. « Health and Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate – Report to the California Environmental Council in Response to Executive Order" D-5-99UCRL-AR-135949. Lawrence Livermore Laboratory: Air Resources Board. 1999

[67] M. Jacobson, "Addressing Global Warming, Air Pollution Health Damage and Long Term Energy Needs Simultaneously." Stanford University: Dept of civil and environmental engineering. 2006. April 18 online edition of the journal Environmental Science & Technology (ES&T).
http://www.stanford.edu/group/efmh/jacobson/ClimateHealth4.pdf

[68] P. Beeman, "Biofuel plants generate new air, water, soil problems for Iowa." Des Moines Register. 2006.
http://www.desmoinesregister.com/apps/pbcs.dll/article?AID=/20070603/BUSINESS01/706030325/-1/biofuels&template=printart

[69] "Air Pollution Rules Relaxed for U.S. Ethanol Producers, Environment News Service," April 12, 2007
http://www.ens-newswire.com/ens/apr2007/2007-04-12-02.asp

[70] J. Hill, et al., "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels," PNAS vol. 103 no. 30, pp. 11206 –11210 July 25, 2006.

[71] J. Hill, et al., "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels," PNAS vol. 103 no. 30, pp. 11206 –11210 July 25, 2006.

[72] "Bush seeks ethanol alliance with Brazil, the world's renewable energy leader." International Herald Tribune, March 3 2007. Associated Press. http://www.iht.com/articles/ap/2007/03/04/business/LA-FIN-Brazil-US-Ethanol.php

Brazil and Latin America

Brazil's national ethanol program, Proalcool, has successfully pushed the development of refineries, cane production and automobile technologies, to the point where cane ethanol has now displaced close to 60% of the country's gasoline consumption.[73]

In 2006, more than 425 million tons of sugarcane was produced, on about 6 million hectares of land. The majority was used to produce a record 17.4 billion liters of ethanol. The Ministry of Agriculture predicts a 10% increase in production in 2007. It has been estimated that Brazil will boost its production of ethanol to 35 billion liters by 2012. [74]

According to Brazil's agriculture minister, Reinhold Stephanes, "Brazil could double its ethanol production in the next 10 years and meet increased demand without causing environmental damage. There are about six million hectares of sugar cane plantations and about 150 million hectares still available for agriculture."[75] Brazil is moving towards a fivefold increase in production, ultimately requiring 30 million hectares of land.[76]

Cane expansion has so far mostly had an indirect, but still very significant, impact on deforestation. By usurping agricultural lands previously used for other purposes, cane expansion has pushed those other uses, especially cattle-raising, into forest frontier areas.

Rainforest cleared for maize.
Location: Puerto Maldanado. Photo: Monongabay.com

In addition to its cane ethanol industry, Brazil is also the world's second largest producer of soy (after the U.S.), with over 20 million hectares of land in production, accounting for a full 21% of cultivated land.[77] Brazilian soy is exported for animal feed to China, and the EU. Soy is now increasingly in demand for biodiesel, and soy production is predicted to grow 4.5% in 2007.[78] Brazil claims to have the potential to expand soy production into another 60 million hectares in the coming decade, to become the world's leading producer of soy for biodiesel and animal feed.[79]

Soy monocultures are notorious for depleting soils and nutrients. Furthermore, the use of industrial fertilizers to replace lost nutrients has caused a rise in nitrogen and phosphorus levels in important river basins in parts of Latin America.[80] Soy also results in climate-damaging emissions of nitrous oxide. Much of the soy grown throughout Latin America is Monsanto's genetically engineered 'Roundup Ready' soy. Hence there is massive spraying of this herbicide, in spite of mounting evidence concerning its harmful effects.[81]

The U.S. is also a major producer of soy. But as demand for corn ethanol has risen in the U.S., farmers there have started planting more corn and less soy, contributing to a rise in the price of soy.[82] The price of soy continues to rise (and this is unlikely to change if

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[73] L.C.C. Carvalho and U.A. Alegre, "Brazil-state of the ethanol industry, Presentation to the First World Summit on Ethanol for Transportation." Quebec, Canada, 2-4 November 2007
[74] "Agroenergy: Myths and Impacts in Latin America," Network for Social Justice and Human Rights and Pastoral Land Commission, 2007
[75] "Brazil Could Double Ethanol Production in 10 Years, Official says." International Herald Tribune, AP, April 17,2007 http://www.iht.com/articles/ap/2007/04/17/business/LA-FIN-Brazil-Ethanol.php
[76] M. Altieri, and E. Bravo, "The ecological and social tragedy of crop based biofuel production in the Americas", April 2007. http://tinyurl.com/3dkpto
[77] Ibid.
[78] Soy industry association (Abiove) statistics available at: http://www.abiove.com.br/english/mapa_us.html
[79] E. Bravo, "Biocombustibles, cutlivos energeticos y soberania alimentaria: encendiendo el debate sobre biocommustibles." Accion Ecologica, 2006, Quito, Ecuador.
[80] W. Pengue, "Transgenic crops in Argentina: the ecological and social debt. Bulletin of Science, Technology and Society" 2006, 25: 314-322.
[81] P.P. Motavalli, et al., "Impacts of genetically modified crops and their management on soil microbially mediated plant nutrient transformations." J. Environ. 2004, Qual 33: 816-824.
[82] "US ethanol may drive Amazon deforestation," Mongabay, 17th May 2007, http://news.mongabay.com/2007/0516-ethanol_amazon.html. See also: Corn acres expected to soar in 2007, USDA says, United States Department of Agriculture, 30th March 2007, http://www.nass.usda.gov/Newsroom/2007/03_30_2007.asp

demand for agrofuels continues to intensify). The U.S. Foreign Agricultural Service reports that soy prices rose 13% between December 2006 and April 2007, even with an 8% increase in production in Argentina, Brazil and Paraguay.[83] A study published in the *Proceedings of the National Academy of Science* found that the area deforested for cropland and mean annual soybean price in the year of forest clearing were directly correlated (R^2 = 0.72). This means that deforestation rates could return to higher levels with a rebound of crop prices in international markets.[84] The recent dramatic increase in deforestation, (discussed below), is therefore a predicted result of increasing demand for agrofuels.

Making biodiesel from soy is relatively inefficient.[85] Nevertheless, the Brazilian Business for Agricultural Research (Embrapa) enthusiastically states that "The cultivation of soy sticks out like a jewel on the crown of Brazilian agribusiness. Soy could be considered the cradle for the opening of biofuel markets."[86]

To meet projected demand for soy biodiesel, Brazil will need, by the end of 2035, 900 large-scale plants, with a total production capacity of over 100 million liters per year, along with almost 20 million hectares of new oilseed plantations.[87] Much of this expansion is slated to occur in the biodiverse savannah-woodland Cerrado ecosystem, which is considered ideal, because it is relatively flat with favorable soils.

Meanwhile, Brazil is also considering using land in the Amazon to cultivate palm oil, claiming that there is 70 million hectares of suitable land available.

Lula and agrofuel politics

The massive economic boom that agrofuels is creating in Brazil has become the envy of many other agrofuel-promoting leaders. President Bush traveled to Brazil in early 2007, to meet with Brazil's president, Ignacio Lula da Silva. The result was a memorandum of understanding between the two countries, aimed at expanding ethanol production and markets into Central America and the Caribbean (and referred to by some as an attempt to develop an 'OPEC of ethanol').

Lula has in general promoted Brazilian agrofuels and technologies extremely aggressively and worked to break down barriers to trade in the sector. In an editorial in the Washington Post, he announced that: "Brazil and the United States joined India, China, South Africa and the European Union in launching the International Forum on Biofuels this month. Its goal is to ensure conditions for ethanol, and later biodiesel, to become globally marketed commodities. This will be achieved only if trade in biofuels is not hindered by protectionist policies." [88]

The U.S. tariff on Brazilian ethanol, at US0.54 cents/gallon, remains in place for the time being. Lula has recently requested a WTO investigation into U.S. subsidies for ethanol production. [89] Brazil is also attempting to remove barriers to its agrofuel exports through the WTO, by arguing that agrofuels are an environmental good and should therefore be completely liberalized (which would give a significant economic boost to Brazil's agrofuels

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See also: International trade, biofuel initiatives reshaping the soybean sector, United States Department of Agriculture, September 2006, http://www.ers.usda.gov/AmberWaves/September06/PDF/InternationalFindingSeptember06.pdf

[83] USDA FAS, http://www.fas.usda.gov/Newsroom/currwmt,asp

[84] D. Morton, et al. "Cropland expansion changes deforestation dynamics in the southern Brazilian Amazon." September 14, 2006, 10.1073/pnas.0606377103 http://www.pnas.org/cgi/content/abstract/0606377103v1?ck=nck

[85] D. Pimentel, and T.W. Patzek, "Ethanol Production Using Corn, Switchgrass and Wood; Biodiesel Production Using Soybean and Sunflower." Natural Resources Research. 2005, Vol 14, no. 1

[86] "Agroenergy: Myths and Impacts in Latin America, Network for Social Justice and Human Rights and Pastoral Land Commission" 2007, pp. 13

[87] "Plano Nacional de Agroenergia" MDA – MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO. 2006-2011. Brasília/DF: Embrapa Informação Tecnológica, 2005. (ref. from Depolluting Doubts)

[88] "Our Biofuels Partnership," Washington Post, March 30,2007 http://www.washingtonpost.com/wp-dyn/content/article/2007/03/29/AR2007032902019.html

[89] B. Klapper, "Brazil Wants Probe of U.S. Farm Aid." AP http://www.nowpublic.com/politics/brazil-wants-probe-u-s-farm-aid

industry). The U.S. and the EU are, however, blocking Brazil's proposals.[90]

In spite of these differences, new alliances are being formed between the U.S. government and sympathetic governments in the region, with a view to converting Latin America into a major source of agrofuels. This benefits transnational corporations and big business engaged in the sector, but also has political implications: Raul Zibechi, analyst with the Center for International Policy Americas Program, says the U.S. is "using Brazil to consolidate a strategic alliance that seeks to isolate Venezuela and the countries that follow its policies of Latin American unity."[91]

On a visit to Africa, Lula stated "I am convinced that biofuels should be at the centre of a planetary strategy to preserve the environment. Agreements like that signed by Brazil and the U.S. and now being negotiated with European countries would provide for the creation of three-way projects in Central America, the Caribbean, and Africa, combining Brazilian technology with these regions' favorable climates and soils… Biofuels offer us a way to allow all humanity to prosper without mortgaging the future of generations to come. This is the message I will carry to the World Conference on Biofuels that Brazil is organizing for 2008. Together Brazil and Africa can help forge a just, lasting, and truly global solution to the major challenges of the 21st century."[92]

As a result of these efforts, Brazil now has trade and technology transfer agreements with many different countries in Africa, Latin America, the Caribbean, and Asia. Within Brazil, government support for the agrofuels industry comes via the state-owned oil company, Petrobras, which is investing US$750 million in a pipeline to transport ethanol between the sugar growing regions of the interior and the coast, so that it can be exported. Japan, among other countries, intends to become a major importer of Brazilian ethanol.

The expansion of Brazil's agrofuel industry has resulted in a flow of investment into the country, exceeding US$9 billion in 2006 alone.[93] This investment is coming from various sources, including private investors like George Soros, backing Adecoagro, and investment firms like Goldman Sachs and the Carlyle Group.[94] Lending agencies have also chipped in. The Inter-American Development Bank (IDB) claims Brazil should utilize its "enormous potential in arable land, climatic conditions, and labor costs" and announced its intention to invest US$3 billion in private agroenergy projects.[95]

The massive inflow of investment has permitted the 'sugar barons' (a handful of very wealthy land-owning sugar producers) to consolidate and expand their control over Brazilian sugar and ethanol production in partnership with multinational agribusiness. Companies like Archer Daniels Midland, Bunge and Cargill (which now owns the country's biggest ethanol refinery in Sao Paulo, along with an associated 36,000 hectares of plantation) control much of Brazil's sugar production.

The inequitable distribution of land and wealth in Brazil is an escalating problem, made worse by the drive to produce agrofuels. About three percent of the population, the wealthy landowners, own two thirds of the land on which crops are grown.[96] Between 1985 and 1996, over 5.3 million people were forced off their land, with the closure of 941,000 small and medium sized farms.[97] Close to 50 million people in Brazil live in absolute poverty, on less than US$1.06/day.[98] The Landless Rural Workers Movement (MST) has identified agrofuel expansion as a major threat: in the words of one member, it is "the

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[90] "US, EU block Brazilian attempt to slash biofuel tariffs." International Herald Tribune November 5, 2007. http://www.iht.com/articles/ap/2007/11/05/business/EU-FIN-ECO-WTO-US-Biofuels.php

[91] "United States and Brazil: The New Ethanol Alliance." Americas Program Policy Report. March 7, 2007 http://americas.irc-online.org/am/4051

[92] Luiz Ignacio Lula da Silva, "Africa, Latin America and the Biofuel Revolution." Accra Daily Mail, July 16th, 2007 http://www.accra-mail.com/mailnews.asp?id=1730

[93] J, Reardon, "Agrofuel Production is the 'Principal Enemy of the Movement,'" 29 September 2007. http://www.mstbrazil.org/?q=reardononagrofuelsasprincipalenemyofmst

[94] "Stop the Agrofuels Craze." Seedling. June 2007. www.GRAIN.org

[95] "Agro-Energy: Myths and Impacts in Latin America," Pastoral Land Commission and the Network for Social Justice and Human Rights, October, 2007, pp 9 http://www.focusweb.org/images/stories/pdf/agro_fuels_in_la_english.pdf

[96] J. Reardon, "Agrofuel Production is the 'Principal Enemy of the Movement,'" 29 September 2007. http://www.mstbrazil.org/?q=reardononagrofuelsasprincipalenemyofmst

[97] Folha de S. Paulo 18 June 1998. http://tinyurl.com/2sdtjn (Referenced in Seedling: Stop the Agrofuels Craze, pg 4, ref 12)

[98] "Brazil: The Hunger of the Missed Meal." FAO. 14 February 2003. http://www.fao.org/english/newsroom/news/2003/13320-en.html

principal enemy" of agrarian reform.[99]

Increasingly, small scale farmers (often under intense pressure) are agreeing to lease out their lands to large sugar cane producers. In theory, lands considered 'unproductive' are supposed to be made available for agrarian resettlement projects. However, more and more of these lands are being hastily occupied by cane producers. This means that they are, after all, considered 'productive' and no longer qualify for the agrarian reform program. Once the cane producers are finished, the land is often severely degraded. In this state, it qualifies as 'unproductive' once again, but it takes a huge amount of time and effort to restore the land.

As one resident of a resettlement project stated, "The arrival of cane is damaging. They want to get rid of everything. After the plants arrived the cane belt closed in around the settlement, and that compromises our future. It's scary, we're threatened here…soon you'll be able to travel 100, 200 kilometers in this region without seeing a single bean, corn or cassava plant. The land becomes degraded, and after the ethanol plants have used it up, only then the land can be bought for agrarian reform. This settlement right here used to be sugar cane land. It took a lot of sweat to get this piece of land productive again."[100]

Some resettlement programs, for example, in Iturama (in the Minas Gerais Triangle area) are completely surrounded by cane monoculture. Such close proximity to cane monoculture results in exposure to agrichemicals like Roundup (glyphosate) and also the introduction of pests that move from the cane into family farm plots.[101]

Working conditions within the cane sector in Brazil are notoriously dismal. Much of the work in cane production is automated, so relatively few jobs are created, but harvesting is largely manual and this accounts for most of the 'rural employment' afforded by cane. Approximately 200,000 men work as cane harvesters.[102] They are recruited from outside areas by hired 'cats', and offered promises that are often broken once the workers arrive at the plantations. It is extremely physical, demanding work. Because labor is compensated on the basis of productivity, workers are under pressure to harvest as much as possible, in some cases as much as 10-15 tons per day. This work is done using a machete, seldom with protective clothing, in very hot and humid conditions, for as little as US $1.20 per ton.[103]

Cane fields are frequently burned off, making air quality very poor and respiratory problems common. When health issues arise, workers may be discouraged from seeking medical help. Some literally die from exhaustion. Between 2005 and 2006, 17 deaths were registered due to exhaustion from cutting sugarcane, and many others died from accidents, including burns, and illnesses associated with working conditions.[104] In some areas, housing is set up in the middle of the cane plantations: these have been likened to prisons because they isolate workers from towns, and from any form of social protection.

Conditions are crowded and isolated, with poor hygiene and poor food. Workers even report being beaten by security guards employed by plantation owners. Many are virtually enslaved within a form of debt peonage, as they are forced to pay exorbitant costs for transportation, accommodation and food to their employers: hence the use of the term 'sugar slaves' to describe workers in Brazil's 'green energy' industry.

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[99] Marina dos Santos, quoted in: J. Reardon, "Agrofuel Production is the 'Principal Enemy of the Movement,'" 29 September 2007. http://www.mstbrazil.org/?q=reardononagrofuelsasprincipalenemyofmst

[100] Interview with a land reform settler, Nova Alvorada do Sul, Mato Grosso do Sul, 04/12/2006, in: Assis, W.F.T. and M.C. Zucarelli, "De-polluting Doubts: Territorial Impacts of the Expansion of Energy Monocultures in Brazil, Marcos Wendell Ficher Teixeira Assis and Cristiano Zucarelli," 2007. coordinated by Lucia Ortiz and based on a study by Friends of the Earth Brazil, Vitae Civilis Institute and Ecoa – Ecologia & Ação. http://www.natbrasil.org.br/Docs/biocombustiveis/depolluting_doubts.pdf

[101] W.F.T. Assis, and M.C. Zucarelli, 2007, ibid

[102] T. Phillips, "Brazil's ethanol slaves: 200,000 migrant sugar cutters who prop up the renewable energy boom." The Guardian. March 9, 2007. http://www.guardian.co.uk/brazil/story/0,,2029962,00.html

[103] "Agroenergy: Myths and Impacts in Latin America," Network for Social Justice and Human Rights and Pastoral Land Commission 2007

[104] "Agroenergy: Myths and Impacts in Latin America," Network for Social Justice and Human Rights and Pastoral Land Commission 2007

Impacts on forests and other ecosystems in Latin America

The Amazon River Basin covers an area of about 4.5 million km^2, making it the world's largest contiguous tropical forest. Since 1970, Brazil has lost close to 600,000 km^2 of its forest, much of it due to the expansion of cattle ranching and agriculture.[105] For example, a study by the U.S. National Aeronautics and Space Administration (NASA) revealed that in 2003, more than 20% of the forests in the state of Mato Grosso had been converted to cropland.[106] This conversion often begins with the clearing of land for cattle grazing followed subsequently by agricultural crops.[107]During the past few years, Brazil boasted a 30% drop in deforestation rates, but this was short lived. In October 2007, Brazil's space agency, INPE, revealed a very dramatic and alarming escalation of deforestation.

In response to concerns expressed about the further damage agrofuels will cause to Brazil's ecosystems, Brazil has maintained that the lands that will be used are "already degraded" - that is, they have already been cleared for cattle raising or other uses and are now unused. However, this fails to account for indirect impacts. Even when soy and cane expansion takes place in areas that have already been cleared, people who are living on those lands are forced elsewhere, often into the forest frontier.[108]

Philip Fearnside, of the National Institute for Research in the Amazon, stated that; "Brazil's 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."[109]

The indirect impacts are also encapsulated in this quote from Forum Brasiliero de ONG's e Movimentos Sociais (FBOMS), a coalition of more than 550 social movements, NGOs and other organizations within Brazil, in response to a statement from the Brazilian Ministry of Agriculture, Livestock and Supply:

"The Ministry claims there is absolutely no relation between the production of ethanol and the deforestation of the Amazon region. While it is true that climatic and soil conditions of the Amazon are generally not conducive to growing sugarcane, the Ministry failed to acknowledge that expansion of sugarcane for ethanol production in Brazil is contributing to deforestation in the Amazon through the expansion of the agricultural frontier. As the prime lands in the center-south are planted to the monoculture of sugarcane, soy production and cattle ranching are driven further into the Amazon. Additionally, while ethanol is produced from sugarcane, 60% of biodiesel in Brazil is produced from soy, a crop which is directly contributing to deforestation in the Amazon."[110]

2007 has been an alarming year for those concerned with the Amazon forests. Ranchers and settlers set fires deliberately to clear land for agriculture and cattle grazing. This year, fires have been raging out of control over large parts of the Brazil, Paraguay and Bolivia. Rising prices for both cattle and soy for animal feed appear to be the major factor driving the demand for more land. Soy prices rose 23% last year, in part because U.S. farmers are shifting from soy to corn production for ethanol. Brazil has been "filling the vacuum" while also expanding production of soy for biodiesel.

Satellite imagery reveals that overall, for the June to October period of 2007, there was an 8% increase in deforestation in the Amazon over the same period in 2006. Specific regions showed very alarming increases, including a 59% increase in the state of Para, an 84% increase in Mato Grosso, and a 602% increase in Rondonia.

The possibility that deforestation has pushed the Amazon to a 'tipping point' beyond which non-linear feedback will cause a massive die back, remained a theoretical possibility until

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[105] http://www.mongabay.com/brazil.html
[106] See at: http://visibleearth.nasa.gov/view_rec.php?id=20945
[107] Roberto and May Smeraldi, H. Peter T"he Cattle Realm: A new phase in the livestock colonization of Brazilian Amazonia." 2008
[108] W.F.T. Assis, and M.C. Zucarelli, 2007, ibid
[109] P. Fearnside quoted at: http://news.mongabay.com/2007/0821-cerrado.html
[110] T. Marcelos, "Rainforests pay price of ethanol." The Independent, 6 April 2007, http://comment.independent.co.uk/letters/article2426210.ece

recently. However, forest dieback has already been observed in some areas and the recent droughts in 2005 and 2006 were unprecedented in living memory. In 2005, a large fire (7000 square km) burned for the first time in the southwestern Amazon, Acre State. In 2007, the southern Amazon is undergoing an extreme drought. Hylton Murray Philipson, from the London-based charity Rainforest Concern comments that; "These fires are the suicide note of mankind."[111]

Meanwhile, construction of two asphalt roads linking the western Brazilian Amazon to the Pacific coast of Peru is underway, and will dramatically shorten the export route to China. An ongoing US$37.4 billion project, the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA) seeks to develop roadways and river outlets across Latin America to overcome 'obstacles' such as the Andes mountains, Pantanal wetlands and the Amazon rainforest, and to provide easy access to ocean ports. In the words of Tim Killeen, author of a report on the project by Conservation International "Failure to foresee the full impact of IIRSA investments, particularly in the context of climate change and global markets could lead to a perfect storm of environmental destruction."[112]

The loss of biodiversity that is associated with the expansion of agriculture and deforestation in Brazil is astonishing. The rainforests of the Amazon Basin, for example, contain at least 40,000 plant species, with 30,000 endemic species not found anywhere else. These include a huge variety of primate species, with nine new species recognized just in the past ten years. In a single tree, scientists have found as many as 94 species of ants, more than is found in the entire country of Germany. Blue macaws, harpy eagles, poison dart frogs…these are a few of the more well known species, but many, many species remain still unknown.

The Amazon is also home to many diverse indigenous peoples dependent upon this biodiversity for their livelihoods and culture. As many as 50 different tribes living in the Amazon have yet to be contacted.[113] Almost a quarter of the medicines used worldwide are derived from rainforest sources, many from the Amazon rainforest.

The Cerrado originally occupied close to 20% of the area of Brazil, an area of 204 million hectares in the center of the country. It is an extremely diverse ecosystem, with areas of grassland interspersed with woodlands supporting at least 10,000 species of plants (4,400 of which are endemic), 847 species of birds, and almost 300 mammal species. The Cerrado is home to jaguars, armadillos, blue macaws, maned wolves and anteaters. It provides important watershed services and plays an integral role in the carbon cycle.

Deforestation of the Cerrado is proceeding even faster than in the Amazon. More than half of this biome has already been turned over to cattle grazing and soy production, and it is now being considered as a promising area for sugar cane as well. Carlo Lovatelli, corporate affairs director for Bunge, who represents an association of the companies responsible for 93 % of Brazil's soy trade (Abiove), says "Brazil is the only country with a vast amount of land available for immediate expansion of sustainable agriculture. If the U.S. races after ethanol, soybean prices tend to climb and demand will be supplied by Brazil. Cerrado is perfect for agriculture and will be used -- there is no question about it."[114] It is perhaps unsurprising that it has been predicted that the entire Cerrado ecosystem will be gone by 2030.[115]

Similarly, the Mata Atlantica, which once covered 1,300,000 km^2, and contained close to 7% of all known species of plants on Earth, has been decimated. Only about 8% of the original forest remains, most has already been converted to agricultural use. Even so, it is

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[111] D. Howden, and J.S. La Paz, "South America Chokes as Amazon Burns." The Independent. 10 Nov. 2007. http://news.independent.co.uk/world/americas/article3028701.ece

[112] T. Killeen, "A Perfect Storm in the Amazon Wilderness: Development and Conservation in the Context of the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA)." Advances in Applied Biodiversity Science 2007, Number 7. Conservation International. http://web.conservation.org/ImageCache/CIWEB/content/downloads/perfect_5fstorm_5fenglish_2epdf/v1/perfect_5fstorm_5fenglish.pdf

[113] J. Roach, "Amazon Tribes: Isolated by Choice?" 2003, National Geographic News. http://news.nationalgeographic.com/news/2003/03/0310_030310_invisible1.html

[114] S. Valle, "Losing Forests to Fuel Cars; Ethanol Sugarcane Threatens Brazil;s Wooded Savanna." Washington Post, July 31, 2007

[115] See analysis at: http://news.mongabay.com/2007/0821-cerrado.html

still ranked as one of the world's most important biodiversity hotspots and is home to a tremendous amount of biodiversity, now clinging to survival within the remaining fragments. Researchers have, for example, counted as many as 450 tree species per hectare.

Another threatened region is the Pantanal, the world's largest wetland, covering over 140,000 km^2, mostly in the Brazilian states of Mato Grosso and Mato Grosso do Sul but straddling the borders of Brazil, Paraguay and Bolivia. The Pantanal is made up of tropical forest and savannah, together with rivers, lakes and swamps fed by the Paraguay River. The biodiversity of this region is extremely rich, and includes at least 260 species of fish and 650 species of birds, including the hyacinth macaw. The spectacled cayman, rhea, giant river otters, tapirs and jaguars can also be found in the Pantanal.

Ethanol refineries now being constructed in Mato Grosso will require massive areas for feedstock supply and will inevitably lead to large scale deforestation and drainage of the Pantanal.[116] Two years ago, in despair, Brazilian conservation activist Francisco Anselmo de Barros set himself on fire in protest, and subsequently died.[117]

Even some fairly isolated forest dwelling indigenous people in Brazil are threatened by the expansion of industrial monocultures. For example, the Xingu Indigenous Reserve is a 26,000 square kilometer reserve that is home to 14 indigenous groups totaling more than 4000 people. The reserve is located in one of the major soy producing regions of Brazil, Mato Grosso, and is increasingly enveloped by soy monocultures. As a result, the rivers on which these indigenous people depend have become polluted with chemicals and runoff from surrounding plantations.[118]

Other Latin American countries

Agrofuel expansion in Latin America is not limited to Brazil; other countries, with even lower production costs (cheaper labor and land) and strategic trade arrangements with the U.S. and/or EU, have jumped on the bandwagon.

Soybeans

Ecuador, for example, which maintains special trade status with both the U.S. and the EU, is beginning to develop a sugarcane ethanol industry and is also growing large quantities of oil palm for export. Similarly, Guyana, which has its own sea-ports, cane growing potential and special trade access to the U.S., sees promise in ethanol.

Some countries, like Jamaica, for example, are providing a tariff-free means of exporting Brazilian ethanol to the U.S.. These countries, as members of the Caribbean Basin Initiative, have special trade access to the U.S. and so are importing ethanol from Brazil, dehydrating it, and then re-exporting it to the U.S..[119]

A few Latin American countries already have budding agrofuel industries, and several - already major producers of soy, sugar and oil palm - may move in that direction in the near future or are already doing so. This trend is shepherded along by the InterAmerican Development Bank and the Interamerican Ethanol Commission (co-chaired by Jeb Bush, Roberto Rodrigues, Brazil's former Minister of Agriculture and agribusiness leader, and Luis Moreno, the President of the Inter-American Development Bank). This Commission aims to encourage the promotion and marketing of ethanol throughout the region.

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[116] "Pantanal declared 'Threatened lake of the year 2007,'" Global Nature Fund and Ecotropia, 2 February 2007, http://www.ramsar.org/wwd/7/wwd2007_rpts_germany_gnf.htm

[117] "Fires Burning Across Brazil Put Biodiversity at Risk." Environment News Service. October 8 2007. http://www.ens-newswire.com/ens/oct2007/2007-10-08-02.asp

[118] "Agribusiness impacts on indigenous communities. Rainforest Action Network" (Based on an Interview with Letícia Yawanawa 8/13/07, Rio Branco, Brazil)

[119] L. Etter and J. Milman, "Ethanol Tariff Loophole Sparks a Boom in Caribbean." Wall Street Journal, 09 March 2007. http://hughbartling.blogspot.com/2007/03/ethanol-tariff-loophole-sparks-boom-in.html

At a recent assembly of the Organization of American States, Condoleeza Rice stated that "El Salvador, the Dominican Republic, Haiti and St. Kitts will be the initial focus of the U.S. - Brazil Biofuels Partnership's outreach program, which is eager to expand cooperation to more countries, particularly in the Western Hemisphere…our goal should be nothing less than to usher in a new era of inter-American security in energy."[120]

Argentina already has more than 16 million hectares under soy cultivation and this figure is increasing rapidly, leading to the deforestation of the Gran Chaco and Yungas forests ecosystems. Tellingly, national deforestation rates have increased since 1996, when Monsanto's genetically engineered soy beans were introduced.[121]

Argentina's Entre Rios region, bordered by two rivers, once hosted a diversity of agriculture including dairy, citrus, rice and wheat, as well as a large area of intact primary forest. A report on the expansion of soy production in the province describes uncontrolled felling and the subsequent burning of primary forest, as soy monocultures have expanded from about 600,000 hectares in 1994 to over 1,200,000 hectares in 2003. In addition, the use of agrichemicals including glyphosate, endosulphan, 2-4D, atrazine and a host of other fungicides, herbicides and pesticides has severely contaminated waterways, causing the disappearance of fish and wildlife and untold damage to the health of people living in the area.[122]

Argentina is already experiencing more severe droughts, regional warming and flash floods as a result of turning so much land over to soy cultivation. Yet the country is now embracing agrofuels and further expansion is planned. Agricultural companies announced 13 different biodiesel projects in Argentina last year, with investments totaling US$285 million. Investment in the sector is expected to reach US$1 billion over the coming four years, according to the regional group Abeceb Consultancy.[123]

Neighboring Paraguay has about 2.5 million hectares under soy cultivation, with plans to expand to four million hectares within the next two years. Paraguay had the second highest deforestation rate in the world prior to 2004 when the Zero Deforestation Law came into effect in the most threatened Eastern half of the country. Forest cover extended over 85% of the country, but now only about 10% remains.

As in the rest of Latin America, monoculture expansion is a leading cause of rural depopulation, as well as deforestation. Land reform is desperately needed. Over 95% of the land in Paraguay is held by a small number of very large private estates, while more than 100,000 families have been forced off their lands, sometimes violently.

Where intimidation has not worked, people frequently find that they have to leave anyway because of the risk of repeated exposure to toxic agrichemicals. Soy cultivation uses more than 24 million liters of agro-chemicals in Paraguay every year including pesticides classified as extremely and moderately hazardous by the World Health Organization (that is, Class I and II). These include Paraquat (a chemical that has no antidote if ingested), 2,4-D, Gramoxone, Metamidofos (proven to reduce sperm count and health in exposed males), and Endosulfan (a teratogenic substance that causes birth defects in the infants of repeatedly exposed mothers, according to the U.S. Environmental Protection Agency). Paraguayans refer to these chemicals, not as pesticides or herbicides, but as venoms.[124]

Petrona Villasboa, from Itapua, has become something of an icon for speaking out after her 11 year old son, Silvino Talavera, was killed when he was engulfed in a cloud of Roundup intended for nearby soy fields, on his way home from the grocery store. Those responsible for Silvino's death were sentenced to two years for homicide, but sadly, this is

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[120] A. Zwaniecki, "United States, Brazil Seek a Central America Driven by Biofuels.U.S." Info June 8 2007 http://usinfo.state.gov/xarchives/display.html?p=washfile english&y=2007&m=June&x=20070607152537saikceinawz0.6091577

[121] http://www.greenpeace.org/international/campaigns/forests/south-america

[122] S. Semino, L. Joensen, Wijnstra, "Unsustainable Proposal: The production of raw materials for future biofuel processing plants in Entre Rios." Grupo de Reflexion Rural, Argentina. 2007 http:/www.grr.org.ar

[123] S. Romig, "Argentina Confronts Biofuels Craze" May 11, 2007 AP http://www.iht.com/articles/ap/2007/05/11/business/LA-FIN-Argentina-Biofuels-Craze.php

[124] A. Howard, and B. Dangl, "Soy Cultivation Spells Doom for Paraguayan Campesinos." In These Times. 2007, Vol. 31 Issue 4 http://www.inthesetimes.com/article/3093/the_multinational_beanfield_war/

most definitely the exception that proves the rule; most cases of poisoning with agrichemicals go unchallenged.[125]

The exodus is a reluctant one. As campesino farmer, Meriton Ramirez said "I didn't want to leave. I built my farm and raised my children here. I planted fruit trees. For the first time in my life I had good land. Then the soy farmers arrived and we couldn't stand the fumigation…on the days following a fumigation we had terrible headaches, nausea and skin rashes, problems seeing, and respiratory infections. The chickens died. The cows aborted their calves and their milk dried up." In 2001, when Meriton and his family left, their neighborhood had been reduced to nothing but soy fields.[126]

Colombia is currently the fifth largest producer of palm oil worldwide, exporting much of its oil to Europe. Massive expansion of monoculture plantations of oil palm and sugar cane are underway throughout the Cauca Valley, the Pacific region, the eastern plains and the Carribean region, spurred on by demand for agrofuels. This includes the Choco forests, among the last remaining coastal lowland rainforests in the world and also one of the most biodiverse regions.

Over six million hectares of land in Colombia are deemed 'suitable' for growing oil palm. According to Fedepalma, 275,000 hectares are being cultivated for oil palm, with about 185,000 hectares already in production by 2006. Establishing palm oil plantations requires an initial investment followed by a wait of three to four years until the trees mature. This makes it very difficult for campesinos to participate in these schemes.

Colombia has a notoriously dismal history of human rights violations. The UN High Commission for Refugees reports that over 200,000 people are displaced each year in Colombia and over 6 million hectares of land has been expropriated for monoculture expansion. Agrofuels are now 'fueling the fires' of this expansion. This trend is especially disturbing given that Colombia granted territory rights to Afro Colombian indigenous communities in 1991, stating that traditional territories could not be legally sold, appropriated or bought.

To gain access to lands, U.S.-funded military personnel, working with Colombian paramilitary operators, are violently expelling people. At least 113 murders have been documented, and entire communities displaced and threatened. In the case of Tumaco, in Narino Province, for example, the entire community was displaced. The area was then clear cut and a palm oil plantation installed. A recent report on human rights and palm oil expansion in Colombia details a long list of abuses, and points out that the expansion of palm oil plantations in Colombia is a complex mix of regional tensions and pressures from international corporations and government policies.[127]

According to human rights workers, "Since the beginning of the decade, all the areas of expansion of palm plantations have coincided geographically with paramilitary areas of expansion and presence, to the extent that some of the new plantations being developed have been financed as farming projects for the same demobilized soldiers from the AUC (Autodefensas Unidas de Colombia – United Self-Defense Force of Colombia) who had previously made incursions into these very areas. Thus, there is a range of agroindustrial farming projects including oil palm, which are of central importance to the strategy of paramilitary territorial control." [128]

Similarly, in Choco hundreds of Afro-Colombians were forced off their lands and the area was planted with oil palms, to be administered by Urapalma, a Colombian company. The U.S. Agency for International Development also came close to granting US$700,000 in anti-drug funding for the plantation, under the guise of encouraging and subsidizing the

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[125] "Legal victory: Justice for soy victim Silvino! The soy farmers responsible for the death of Silvino will go to Jail, Wednesday" A SEED 1 November 2006
http://www.aseed.net/index.php?option=com_content&task=view&id=338&Itemid=127

[126] . Howard, and B. Dangl, "Soy Cultivation Spells Doom for Paraguayan Campesinos." In These Times. 2007, Vol. 31 Issue 4 http://www.inthesetimes.com/article/3093/the_multinational_beanfield_war/

[127] Fidel Mingorance, "The Flow of Palm Oil Colombia-Belgium/Europe: A study from a human rights perspective." Human Rights Everywhere (HREV) and Coordination Belge por la Colombe (CBC), 2006
http://www.hrev.org/hrev/media/flujoPalma/informe_en_v3.pdf

[128] Fidel Mingorance, "The Flow of Palm Oil Colombia-Belgium/Europe: A study from a human rights perspective." Human Rights Everywhere (HREV) and Coordination Belge por la Colombe (CBC), 2006
http://www.hrev.org/hrev/media/flujoPalma/informe_en_v3.pdf

production of crops other than coca.[129] These strong synergies between the expansion of industrial monoculture and the socio/political situation in Colombia are deeply disturbing and render claims that agrofuels 'provide green fuel' and 'enhance the lives of rural poor,' ludicrous.

Asia

The horrific impacts of the push for agrofuels are nowhere more evident than in the Southeast Asian palm oil sector, where deforestation and peatland degradation are so severe that they make a mockery of the entire concept of growing plant biomass to mitigate climate change.

Indonesia and Malaysia are the world's largest producers of palm oil, supplying about 85% of the world market. Historically, palm oil has been used for food, and a variety of other consumer products. It is now the world's leading vegetable oil, surpassing soy oil. It is now also considered an efficient feedstock for biodiesel and is increasingly in demand for heat and energy production, especially in Germany and Netherlands. Much of Southeast Asia's palm oil is exported to Europe and China.

With the rapid addition of demand for palm oil for biodiesel production, demand is currently outstripping supply. In response, governments and industry are planning huge expansions throughout Indonesia and Malaysia. By 2006, Malaysia, the world's largest palm oil exporter, responsible for about 45% of global production, had established more than four million hectares of palm plantation, and is expanding rapidly into Sabah and Sarawak (the Malaysian part of the island of Borneo). Indonesia, in 2004 had about 6.5 million hectares of oil palm plantations in Sumatra and Kalimantan, with potential for significant growth.[130] The country plans a staggering 43-fold expansion in the area dedicated to oil palm, an additional 20 million hectares of plantations, which would bring the country's total up to 26 million hectares by 2025.[131]

Plans to develop the Kalimantan Border Oil Palm Mega-Project, for example, would convert an additional three million hectares to oil palm in Borneo. In the process, this will "trash the primary forest of three National Parks, cut through rugged slopes and mountains utterly unsuitable for oil palm cultivation and annihilate the customary land rights of the indigenous Dayak communities in the border area."[132]

The expansion of palm oil is bolstered by tax breaks, subsidies, domestic targets and massive investments, including the US$5.5 billion deal between Sinar Mas Group (PT Smart) and China National Offshore Oil Corporation[133] and a US$4 billion dollar investment in a refinery and plantations in Sumatra by Raja Garuda Mas. PT Wilmar Bioenergy is developing 150,000 hectares of plantations in Riau and East Kalimantan. Many new refineries are under construction and international investment is flowing in from China, Japan, India, Brazil and South Korea.[134] Oil and agribusiness companies are also investing in palm oil, including Shell, Neste Oil, Greenergy International, BioX, Cargill and Archer Daniels Midland.

Impact on people and the environment in Asia

[129] I. Gomez, and G. Reyes, "Anti-terrorism Funds Enlisted in War on Drugs: Afro-Colombians Slaughtered For Their Land." Center for Public Integrity June 7, 2007. http://www.publicintegrity.org/MilitaryAid/report.aspx?aid=881
[130] "The Oil for Ape Scandal: How Palm Oil is Threatening Orangutan Survival." Friends of the Earth, The Ape Alliance, The Bornean Orangutan Survival Foundation, The Sumatran Orangutan Foundation, The Orangutan Foundation. http://www.foe.co.uk/resource/reports/oil_for_ape_summary.pdf
[131] M. Klute, "Green Gold Biodiesel: Players in Indonesia." 2007, www.Biofuelwatch.org
[132] E. Wakker, "The Kalimantan Border Oil Palm Mega-Project." Commissioned by Milieudefensie-Friends of the Earth Netherlands and the Swedish Society for Nature Conservation (SSNC), April 2006, Amsterdam, http://www.foe.co.uk/resource/reports/palm_oil_mega_project.pdf
[133] "PT Sinar Mas enters agreement for renewable energy project." Renewable Energy Today, Jan. 10, 2007 http://findarticles.com/p/articles/mi_m0OXD/is_2007_Jan_10/ai_n17156182
[134] M. Klute, "Green Gold Biodiesel: Players in Indonesia." 2007, www.Biofuelwatch.org

Asia's tropical forests are mostly found in Malaysia, Indonesia and Papua New Guinea and cover an area of about 136 million hectares, a large proportion of which has already been or is currently being cut. A recent UN report predicted, for example, that at current rates, 98% of the forest cover of Borneo and Sumatra will be severely degraded by 2012, and completely gone by 2022.[135]

Illegal logging in Indonesia is out of control. An estimated 73-88% of logged timber is extracted illegally and the government's capacity to control it is minimal. Milling capacity in the country exceeds legal limits by two to five times and illegal logging has been uncovered in 37 out of 41 of Indonesia's national parks.[136] Logging is often carried out as a precursor to establishing oil palm plantations. Indonesia had about 6.5 million hectares of oil palm plantations by 2006. This had expanded to 7.3 million hectares by 2008. An additional 18 million hectares had been cleared for palm oil, but never planted. [137]. Timber extraction is lucrative and yields immediate rewards, providing profits while the oil palms require investment and take several years to mature.

Meanwhile, the destruction of South East Asian peatland forests, found mostly within Indonesia, is a major source of carbon emissions. The peatland forests cover some 27 million hectares of peatland and are estimated to contain at least 42,000 megatons of carbon.[138] About 45% of these forests (12 million hectares) have already been cleared and drained, a process which began with Suharto's failed 'mega rice program.' As they are drained, the peatlands dry out and oxidation causes emissions. Further emissions occur if, once dried, the peat then burns.

Fires are frequently set deliberately, to clear woody debris in preparation for installing palm oil plantations. Thousands of fires burn annually now, with the worst 'fire years' to date being 1997, 2002 and 2006. Over 60,000 hotspots were observed in each of those years, and smoke created a haze over much of SE Asia, causing widespread respiratory problems. Once set, they are difficult to contain.

Emissions from oxidation and the burning of Indonesia's peatlands are difficult to measure precisely, but it is estimated that as much as 2.57 billion tons of carbon were released by fires in 1997 alone.[139] The total emissions resulting from loss of forest vegetation, soil emissions, peat oxidation and burning are in the order of 562 million tons per year, and even more during a bad fire year.[140] These massive emissions make peatland destruction responsible for close to 8% of annual global greenhouse gas emissions, and are the reason that Indonesia is the world's third largest contributor to global greenhouse gas emissions, topped only by the U.S. and China.

Reflooding and restoring South East Asia's peatlands must be made a priority for governments seeking to mitigate climate change. Promoting the use of biodiesel from palm oil is worsening the situation and thereby contributing to global warming, rather than serving as a solution. One study estimates that using palm oil for biodiesel results in as much as two to eight times more carbon emissions than are saved from replacing mineral diesel.[141]

Within Indonesia alone, at least 45 million indigenous people depend on the forests for their livelihood.[142] Throughout South East Asia, forest dwelling people - including the Dayak in Indonesia, the Senoi in West Malaysia and the Asmat in Papua New Guinea -

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[135] "Last Stand of the Orangutan. State of Emergency: Illegal Logging, Fire and Palm Oil in Indonesia's National Parks." UNEP, 2007. http://www.grida.no/products.aspx?m=23&amid=571

[136] "Last Stand of the Orangutan. State of Emergency: Illegal Logging, Fire and Palm Oil in Indonesia's National Parks." UNEP, 2007. http://www.grida.no/products.aspx?m=23&amid=571

[137] Marti, Serge, "Losing Ground: the human rights impacts of oil palm plantation expansion in Indonesia. Friends of the Earth," Life Mosaic, Sawit Watch

[138] A. Hooijer, M. Silvius, H. Wösten, and S. Page, "PEAT-CO2, Assessment of CO2 emissions from drained peatlands in SE Asia. Delft Hydraulics report Q3943" 2006 http://www.wetlands.org/publication.aspx?id=51a80e5f-4479-4200-9be0-66f1aa9f9ca9

[139] S.E. Page, F. Siegert, J. O. Rieley, V. Boehm Hans-Dieter, A. Jaya, and S. Limin. "The amount of carbon released from peat and forest fires in Indonesia during 1997." Nature 2002, 420: 61. 65

[140] "Southeast Asia's Peat Fires and Global Warming." Factsheet 1, www.biofuelwatch.org

[141] J. Roland, "An estimation of the expected CO2 emissions caused by producing South East Asian palm oil for biodiesel, compared with the avoided diesel emissions." Biofuelwatch, February 2007, www.biofuelwatch.org.uk/SE_Asia_palm_biodiesel_analysis.doc

[142] M. Colchester, N. Jiwan, et al. "Promised Land: Palm Oil and Land Acquisition in Indonesia -Implications for Local Communities and Indigenous Peoples," 2006, Forest Peoples Programme, Perkumpulan Sawit Watch, HuMA and the World Agroforestry Centre. http://www.forestpeoples.org/documents/prv_sector/oil_palm/promised_land_eng.pdf

have struggled for decades to protect their customary lands from timber extraction industries. But these people rarely hold formal land rights and if they resist eviction, they are often faced with police, military and government officials who are paid to quell unrest, in some cases violently. There is little regulation and the remoteness of many of the areas concerned makes it virtually impossible to enforce any control.[143]

As demand for palm oil rises, so do pressures for access to indigenous lands. Malaysia is planning palm expansion into an area of about one million hectares of land held under Native Customary Rights in Sarawak. Indonesia, which formally recognizes customary land rights, but is also under tremendous pressure to make more land accessible for timber and oil palm, seems willing to overlook these rights. In West Kalimantan alone, over five million forest-dependent indigenous people are at risk of being displaced by palm oil expansion.[144]

A recent report to the United Nations Committee on the Elimination of Racial Discrimination states: "Experience with existing and extensive oil palm plantations in other parts of Indonesia conclusively demonstrates that Indigenous peoples' property and other rights are disregarded, their right to consent is not respected, some are displaced, and they are left with no alternative but to become de facto bonded laborers gathering oil palm fruit for the companies that manage the plantations."[145]

The plantation sector is the most conflict-prone sector in Indonesia. The Consortium for Agrarian Reform (KPA) reports that plantation-related social conflicts account for more than a third of land conflicts in the country and very often involve military intervention. In a 2002 report, the KPA found that 480 people had been tortured, 12 killed, 134 shot, 25 abducted and 936 arrested.[146] Close to 308,000 hectares of peasant-occupied lands had been damaged and 284 houses burned. In 2006, Sawit Watch reported that over 350 communities were engaged in conflicts over land access for palm expansion.[147]

Corruption is rampant, and when illegal activities on the part of palm oil producers are detected, authorities are reluctant to enforce laws, often accepting bribes. Indigenous peoples have few resources and little or no recourse to justice. They are left to cope with the situation on their own, and are often forced into blockading roads, sabotaging machinery and harassing workers as a last resort.

As in Latin America, working conditions on palm plantations are extremely poor. Daily wages are very low, and exposure to agrichemicals is a major cause of health problems. At least 25 different chemicals are in use, including paraquat, which is potentially fatal if inhaled, ingested or absorbed through the skin. In Malaysia, a ban on paraquat was imposed in 2002, but then lifted again in 2006. Indonesia has never imposed any ban and only requires 'training' prior to use (which is loosely defined and even more loosely enforced). Most sprayers are women: approximately 30,000 women work daily as pesticide sprayers in Malaysia alone.[148] Because of the hot, humid climate, wearing protective clothing is impractical. Many sprayers develop acute paraquat poisoning symptoms, including nosebleeds, eye irritation, contact dermatitis, skin irritation and sores, nail discoloration and loss, and abdominal ulceration.[149]

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[143] A. Ernsting, "Agrofuels in Asia: Fueling poverty, conflict, deforestation and climate change," Seedling, Grain, July 2007, www.grain.org/seedling_files/seed-07-07-4-en.pdf

[144] Victoria Tauli-Corpuz and Parshuram Tamang, "United Nations Permanent Forum on Indigenous Issues: Oil Palm and Other Commercial Tree Plantations, Monocropping: Impacts on Indigenous Peoples' Land Tenure and Resource management Systems and Livelihoods," 7 May 2007 http://www.un.org/esa/socdev/unpfii/en/special_rapporteurs.html

[145] "Request for Consideration of the Situation of Indigenous Peoples in Kalimantan, Indonesia, under the United Nations Committee on the Elimination of Racial Discrimination's Urgent Action and Early Warning Procedures Committee on the Elimination of Racial Discrimination," Seventy-First Session, June 25, 2007

[146] Data from Coalition for Agrarian Reform (KPA Indonesia) referred to in: E. Wakker, "Greasy Palms: The Social and Ecological Impacts of Large Scale Oil Palm Plantation Development in Southeast Asia." Friends of the Earth UK, Sawit Watch. 2005 http://www.foe.co.uk/resource/reports/greasy_palms_impacts.pdf

[147] "Palm oil for Biofuels Increases Social Conflicts and Undermines Land Reform in Indonesia. An Open Letter to the European Parliament, European Commission and citizens of the European Union." Sawit Watch. January 26th, 2007. (available at: www.biofuelwatch.org)

[148] E. Wakker, "Greasy Palms: The Social and Ecological Impacts of Large Scale Oil Palm Plantation Development in Southeast Asia." Friends of the Earth, 2005 pp.25

[149] R. Isenring, "Paraquat: Unacceptable Health Risks for Users." Pesticide Action Network, (UK and Asia and Pacific) and Berne Declaration. 2006. http://www.evb.ch/en/p10285.html

Palm oil plantations are mostly under the control of a small number of very large producers. Indonesia, for example, promotes a system in which large plantations form a core, surrounded by smallholders. The smallholders have to rely on the large plantations for services like pressing and marketing their oil. Because they must first invest and then wait for their trees to mature, they frequently become indebted.

The rainforests of South East Asia are also among the most biodiverse on earth. Borneo, for example, is considered one of the world's threatened 'biodiversity hotspots'. The destruction of these forests has resulted in a cataclysmic loss of biodiversity. Most oil palm has been planted on lowland evergreen tropical forest, the most diverse of terrestrial ecosystems. Indonesia, which covers only 1.3% of the earth's surface, is home to about 10% of all species of flowering plants, 17% of all bird species, 12% of all mammals and 16% of reptiles and amphibians. The destruction of this unbelievably rich biological diversity in exchange for palm oil to fuel automobiles is nothing short of criminal.

Among the better known creatures that are being pushed to extinction are the Bornean and Sumatran orangutans, the Sumatran tiger (about 400 remaining), the Asian elephant and the Sumatran rhinoceros (only 300 remaining). Oil palm plantations can support, at very best, about 20% of the biodiversity found in primary rainforest.[150]

The fires in 1997-8 alone probably killed as much as a third of the orangutan population in Kalimantan. Orangutans are long-lived and slow to reproduce. With increasing encroachment into their habitat, they are forced into more and more contact with humans. This is often fatal. Because they will eat young oil palm shoots, they are considered a threat to plantations and are often exterminated. The outlook for their future at this point is bleak.

Again due to habitat loss, conflicts between elephants and people are also on the rise: elephants are responsible for over US$100 million damage per year in Riau Province alone. These elephants are often starved due to loss of their native habitat, making them especially unpredictable. They are shot, poisoned and sometimes captured and transported to 'training centers.'[151]

While the destruction in Indonesia and Malaysia proceeds, other Asian countries are also developing agrofuel industries, setting mandatory blending targets, and investing in supply and technology transfer deals.

China is facing a massive loss of agricultural lands to desertification (as a result of poor agricultural practices) and at the same time is also experiencing a rapid rise in living standards. Thus it is faced with a stark choice, between using lands for food or fuel crop production. Still, the country exported an estimated 8-900,000 tons of ethanol, mostly to the U.S., and new refineries are under construction. The trend is towards importing feedstocks from other countries, including Nigeria, Malaysia, Indonesia and the Philippines, and investing in refineries in Indonesia and Malaysia. China aims to replace 16% of energy use with "renewable" sources by 2020, and is negotiating an agreement with the U.S. to exchange technologies and expertise.[152]

Japan has invested heavily in securing supplies of agrofuels, especially from Brazil, and also has plans for a jatropha biodiesel plant in South Africa, a coconut biodiesel plant in the Philippines and cassava ethanol plants in Indonesia, Thailand and Vietnam.

India is producing ethanol from sugar cane and importing Brazilian ethanol. However, many vehicles in India run on diesel, and the country is looking to expand production of Jatropha. Already the government is planning 14 million hectares of jatropha.[153] In August

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[150] R.K. Laidlaw, "A Comparison Between Populations of Primates, Squirrels, Tree Shrews and Other Mammals Inhabiting Virgin, Logged, Fragmented and Plantation Forests in Malaysia." Conservation Management and Development of Forest Resources. Proceedings of the Malaysia-U.S. Programme Workshop, 21-24 Oct 1996.
[151] "Elephants Made Homeless on Indonesian Island of Sumatra." WWF March 23 2006.
http://www.panda.org/news_facts/newsroom/news/index.cfm?uNewsID=64520
[152] "U.S.-China biofuel agreement being discussed." November 17, 2007.
http://news.xinhuanet.com/english/2007-11/16/content_7090748.htm
[153] J. Vidal, "Global food crisis looms as climate change and fuel shortages bite." The Guardian. 3rd November 2007.
http://www.guardian.co.uk/environment/2007/nov/03/food.climatechange?gusrc=rss&feed=networkfront

2007 farmers rioted in opposition to the plan which has resulted in them being displaced from traditional lands, and about which they were not consulted.[154]

Village woman. Location: Kenya.
Photo: Orin Langelle

Plantation workers. Location: South Africa
Photo: Wally Menne

Africa

Africa is sometimes referred to as the 'Green OPEC' because it possesses so much land considered 'suitable' for agrofuel production. Agrofuels are being heavily promoted throughout Africa, as a solution to poverty and as a means to provide energy to local communities. There is, however, "...lack of clarity at all levels about the difference in scale and impact between meeting local energy needs and production for export."[155] Since agrofuel prices will be determined in large part by global oil prices, many Africans may also find that they are not able to afford it.

In reality, agrofuels are being developed primarily for export, in the process usurping agricultural lands and the lands and livelihoods of people and biodiversity. Aptly stated in a recent report by GRAIN, the "new scramble for agrofuels is...paved with diplomats. A daily parade of foreign politicians stalks the continent negotiating agrofuel deals wherever possible.'[156] Brazil, as the up-and-coming agrofuel power, has negotiated agreements for ethanol importation and technology transfer with several African countries, and international investors seek to standardize policies and incentives that will support the profitability of their developments.

Nigeria is one of the world's leading oil producing nations, with oil accounting for 95% of government revenues. Yet the oil industry is in the hands of multinational oil companies and most oil is exported: Nigeria actually imports 70% of the oil used domestically. Under the absurd guise of improving energy security, Nigeria is now moving to develop agrofuel production, using cassava, palm oil and sugar cane, which will most probably increase food insecurity.

Uganda has a number of agrofuel projects under development, with national and international backing, using feedstocks of jatropha, castor bean, sunflower and oil palm. A U.S.-based company, DSK Ltd, has expressed intentions to produce biodiesel in Uganda. Two projects, one involving the clearing of a large piece of the Mabira Forest Reserve for cane production and another clearing rainforest from the Lake Victoria islands of Bugala and Kalangala, have been the subject of massive opposition and protest.[157]

The Mabira Forest Reserve is a rich and diverse forest on the edge of Lake Victoria. The

[154] M. Olden, "Growing Concern." New Statesmen, October 25, 2007. http://www.newstatesman.com/200710250020
[155] T. Byakola, "Agrofuels in Africa: The Impacts on Land, Food and Forests." African Biodiversity Network, July 2007 http://www.biofuelwatch.org.uk/docs/ABN_Agro.pdf
[156] "Stop the Agrofuels Craze." Seedling, July 2007, www.GRAIN.org pp.36
[157] T. Byakola, ibid.

reserve is an important watershed for two rivers that feed into the Nile, thereby supporting downstream agriculture and livelihoods. It is also home to many indigenous species, including at least 312 species of trees, 287 bird species, 199 species of butterflies, several monkey species, and many other rare plants and animals. The local communities depend upon the forest for many forest products. It is also an important tourist attraction and therefore a source of revenue. The sugar producer, SCOUL (Sugar Company of Uganda Ltd) developed an agrofuels development plan with the support of Uganda's President Musaveni to clear 7,100 hectares of the forest for cane production, to use for ethanol. After much deliberation and under pressure from international activists, the decision was made in October 2007 to leave Mabira intact.[158]

Meanwhile, another company, BIDCO, began clearing land on the rainforested Bugala and Kalangala Islands in Lake Victoria - also home to a wide range of rare and endangered species - with plans to develop oil palm plantations. Public opposition, local and international, to these plans has been extremely strong. An April 2007 protest sparked rioting, which also led to several deaths and arrests. It has, however, brought a halt to the development, at least temporarily, (though 6,000 hectares of land on Bugala islands has already been cleared).

Benin is also moving rapidly towards the large scale production of agrofuel crops for export. These plans have strong government support through the country's Agricultural Revival Program and there have already been negotiations with and visits from investors from Malaysia, China and Saudi Arabia. Benin has also signed a biofuels cooperation agreement with Brazil.[159] In the southern part of the country, 3-400,000 hectares of important and biodiverse wetlands are deemed to be appropriate for conversion to palm oil production, and it is claimed that over three million hectares of land in the south may be 'available' for agrofuel crops. Southern Benin is home to 50% of the country's population, living on less than 8% of the land area. Using these lands for agrofuel monoculture will force people off the land and have severe repercussions for food security. In addition, there is pressure from the US backed African Growth and Opportunity Act (also known to its critics as the Africa Recolonization Act) to develop jatropha, ostensibly for local needs. It is projected that over 240,000 hectares will be in production by 2012.[160]

Benin has a history of failed agricultural schemes, touted as opportunities for poor rural farmers, which have in fact driven people off the land and into deeper poverty. A large part of the expanding population already depends on food aid from international agencies. The diversion of agriculture into fuel production for export in this context could make this situation much worse.

In Tanzania, as in other African counties, agrofuels, especially sugar cane ethanol, are being promoted as a means to bring energy to rural communities. Paradoxically, these same communities are being displaced to make room for energy crop monocultures. Agrofuel projects in Tanzania are being supported by international development agencies like the World Bank and USAID, in conjunction with foreign-owned companies. Tanzania recently announced that it was in negotiations with no fewer than eleven foreign companies seeking to invest in agrofuel production. Among these is a British Company, Sun Biofuels which recently announced plans to grow jatropha for biodiesel on 9000 acres in the Kisarawe district, displacing over 11,000 peasants.[161]

Meanwhile, the country has been experiencing increasing periods of drought and is thus accepting more food aid. The diversion of agricultural lands into fuel production in this context does not bode well for the future of food sovereignty in the country. A 'Biofuels Task Force' was created in 2006, with the goal of assessing various prospects for Tanzanian agrofuel production. One area targeted by a Swiss company includes 400,000

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[158] "Uganda Scraps Controversial Rainforest Plan." Reuters, Oct 18, 2007. http://www.planetark.org/avantgo/dailynewsstory.cfm?newsid=44876

[159] "Benin, Brazil sign biofuel cooperation." African Agriculture, Friday August 17, 2007. http://africanagriculture.blogspot.com/2007/08/benin-brazil-sign-biofuel-cooperation.html

[160] Josea Doussou Bodjenou, "Agrofuels in Africa: The Impacts on Land, Food and Forests." African Biodiversity Network, July 2007 http://www.biofuelwatch.org.uk/docs/ABN_Agro.pdf

[161] "Thousands of Tnazanian peasants to be displaced for biofuel farm." http://www.afriquenligne.fr/news/daily_news/thousands_of_tanzanian_peasants_to_be_displaced_for_biofuel_farm_200708125667/

hectares in the Wami Basin, currently used by small scale rice farmers, over a thousand of whom would be displaced. A number of other agrofuel projects are already underway, including palm oil plantations and diesel refineries. Some utilize 'outgrower' systems (in which a large, central company exercises control over smallholders) to grow jatropha, sunflower seed and other feedstocks. Farmers growing these crops previously grew food for human consumption.

The most fertile lands with access to water are best for growing both food and agrofuels and, inevitably, there is competition between them for the best land. Even the formerly undeveloped region of Malagarasi in western Tanzania, an area especially rich in biodiversity, is being considered for palm oil and sugar cane production. The Rufiji Basin has been targeted for a 100,000 hectare sugar cane ethanol project, by a Swedish Company, SEKAB) that will impact river flow and local communities. In contrast to the rhetoric, and as in other African countries, Tanzanian agrofuels are not being developed for the benefit of rural poor, but for export.[162]

In Zambia, the agrofuel industry is still in its infancy; and there is also, as in other countries, a lack of clarity about whether the agrofuels produced will be for domestic use or for export. The 'Biofuels Association' of Zambia is lobbying for incentives and several companies, including D1 Oils and Marli Investments (which has invested US$16 million in Zambian agrofuels), are promoting development. These companies are working with 'out growers,' supplying them with Jatropha seedlings and other supplies, but also, again, creating a system whereby the farmers become indebted to and controlled by the company, through long term (30-year) contracts. With a projected 185,000 hectares of agrofuel production planned, many indigenous peasants will be displaced from their customary lands. And as lands used to grow food are diverted into agrofuel production, more forest and woodland areas are likely to be cleared. [163]

South Africa already has a 4.5% domestic agrofuel target and began an agrofuels initiative based on a surplus production of sugar cane and maize. Unfortunately, the surplus was short lived. It quickly became clear that it would be necessary to have growers contracted specifically to supply feedstocks, that this would compete with food production, and that the lack of government subsidies and lower crop yields would make the South African ethanol industry less viable than expected.

In May 2007, the South African government announced plans for 3 million hectares of former homelands to be put to agrofuel crop production. As usual, this plan is touted as a means to reinvigorate rural farm economies.[164]

Swaziland is experiencing famine as a result of drought conditions, and receiving emergency food aid. Yet the government just allocated several thousand hectares of land for production of cassava to manufacture ethanol.[165] This, writer George Monbiot calls an "agricultural crime against humanity."[166]

In Ethiopia, more than four million people suffer from food insecurity. Over 85% of the population lives directly off the land and the population is growing. Yet the country now has over 1.15 million hectares of land in production or under negotiation for agrofuel crops. Land is easy for foreign companies to acquire because few Ethiopians have secure land titles.

Conflict is now emerging over access to lands in the Babile Elephant Sanctuary, which was set aside to protect a rare and endangered population of elephants. A German company, Flora Ecopower, invested US$77 million in the Oromia Regional State, purchasing 13,000 hectares of land for biodiesel production. After considerable preparations had been made,

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[162] Abdallah Mkindee, In: "Agrofuels in Africa: The Impacts on Land, Food and Forests." African Biodiversity Network, July 2007 http://www.biofuelwatch.org.uk/docs/ABN_Agro.pdf

[163] Matongo Mundia, Clement Chipokolo. In: "Agrofuels in Africa: The Impacts on Land, Food and Forests." African Biodiversity Network, July 2007 http://www.biofuelwatch.org.uk/docs/ABN_Agro.pdf

[164] B. Webb, "Three million hectares of former homelands earmarked for biofuels production." Cape Times. May 17th 2007 (reprinted in: Wally Menne 2007. "The Social impacts of certified timber plantations in south Africa and the implications thereof for agrofuel crops." Global Forest Coalition).

[165] "Swaziland Joins Biofuel Drive Despite Mounting Food Crisis." http://www.energycurrent.com/index.php?id=3&storyid=6359

[166] G. Monbiot, "An Agricultural Crime Against Humanity." Guardian, 6 Nov. 2007. http://www.monbiot.com/archives/2007/11/06/an-agricultural-crime-against-humanity/

however, it was recognized that 87% of this land fell within the boundaries of the elephant reserve. The local community has become increasingly vocal in their opposition to the development, the forest clearing and the impact on elephants.[167]

Agrofuel expansion in Central Africa, which hosts the Congo Basin Rainforest, is of particular concern. The Congo Basin Rainforest accounts for about 18% of the world's rainforest, and is the second largest contiguous rainforest after the Amazon. It covers an area of about 388 million hectares in six countries, especially the Democratic Republic of Congo. It also contains about 70% of Africa's vegetation. Partly as a result of a major post conflict loan from the World Bank, commercial logging - legal and illegal - is developing rapidly and new roads are facilitating incursions into the forest.

The European Commission recently launched a major initiative to 'open up' the Central African Republic, which includes plans to develop agrofuels production.[168] In fact, the study determined that "the CAR has a total land area of 45.3 million hectares suitable for agriculture, out of a total territory of 61.8 million hectares. Of this land base, 29.8 million hectares are very suitable and suitable, 11 million are moderately suitable and 4.5 million are marginally suitable for rainfed agriculture under high inputs. The suitable area does not change much as inputs decrease (meaning low-input agriculture is feasible on a large scale). The crops suggested include sweet potato, cassava, sorghum, sugar cane, soy and trees (eucalyptus and acacia).

The Democratic Republic of Congo is expanding production of oil palm plantations, with recent investment from the Spanish company Aurantia and from a Chinese company, ZTE International, which is investing US$1 billion into a three million hectare oil palm plantation.

The DRC is also moving into the production of wood energy, expanding plantations of eucalyptus and other fast growing trees. A study commissioned by the EU and carried out by CIRAD (a French agricultural research centre) determined that there are 12 million hectares of land available for bioenergy production within the country. How these developments will contribute to deforestation in the Congo Basin remains to be seen. The destruction of these forests would be catastrophic for the global climate. The Congo Basin forests are estimated to contain 25-30 billion tons of carbon in vegetation alone. They also play a crucial role in determining rainfall and weather patterns both regionally over much of West Africa and also on a global scale.[169]

In country after country within Africa, the development of agrofuels is promoted as a means of alleviating poverty and encouraging 'sustainable' development, while in reality people are displaced and food-growing lands are usurped. The scale of production and investment is clearly intended to serve the export market, and investors find an unregulated climate with few obstacles to obtaining large amounts of arable land. The Congo Basin rainforests are of particular concern as they are increasingly viewed as a source of wood energy and as suitable environment for monoculture plantations.

Europe

Europe has played a key role in the development of agrofuels, shaped by the fact that it is a major consumer of transport fuels and is embracing mandatory targets for agrofuels use, even though limited land area and high production costs make importing feedstocks essential.

The majority of agrofuel used in the EU is biodiesel rather than ethanol. In 2005, the EU accounted for about 80% of global biodiesel production, much of it from rapeseed and sunflower and produced in Germany, Italy and France. Ethanol is produced, especially in Spain, Sweden, Germany and France, largely from sugar beet, wheat and other crops.

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[167] "Stop the Agrofuels Craze" Seedling, July 2007. www.GRAIN.org
[168] "EU Commission launches major program to "open up" Central African Republic." Biopact March 19, 2007.http://biopact.com/2007/03/eu-commission-launches-major-program-to.html
[169] Hoare, A. Clouds on the Horizon: The Congo Basin's Forests and Climate Change. Rainforest Foundation. 2007. http://www.rainforestfoundationuk.org/s-Clouds%20on%20the%20Horizon

European biodiesel production capacity has grown very rapidly (averaging 35% per year over the past five years) and now exceeds feedstock supplies. In 2005, about 4.7% of biodiesel was produced using imported soy and palm oil and this is projected to increase rapidly over the next few years.

The European transition to agrofuels has been set in motion by various policies and incentives: In 2003, the EU set an "indicative" target of replacing 2% of road transport fuel with agrofuels by 2005, and 5.75% by 2010. Subsidies from the Common Agricultural Policy, and various tax incentives, which vary by Member State, support the development of the EU industry and crop production. These targets and incentives (i.e. public money) are currently driving the use of agrofuels and biomass, yet there are no mechanisms in place to make available information on where the fuel feedstocks are grown, how they are refined or whether or not they actually provide emissions benefits.

In 2006, the European Council adopted a "Biomass Action Plan", which provided overall guidelines for adopting biomass energy. In 2006, the European Parliament adopted a resolution on strategy, followed by the European Commission's proposed "Energy Policy for Europe". This included a higher (10%) mandated biofuel target, supported by Heads of State in March 2007, but only on the condition that the fuels be sustainably produced, that 'second generation' fuels become commercially available, and that the Fuel Quality Directive be amended to enable adequate mixing.

The agrofuels mandate is part of the EU wide Renewables Directive, still in draft form at the time of writing. This directive will likely set an overall target for 20% of Europe's energy be produced from renewables, met in part by the replacement of 10% of transport fuel needs be met with agrofuels. The use of biomass is also being supported for electricity and heat generation and biomass derived aviation fuels are being explored. Meanwhile, a second major push for agrofuels is embodied in the revised Fuel Quality Directive, which has introduced a target to reduce greenhouse gas emissions from transport fuels. These reductions could be met by decreased emissions from fossil fuel extraction and processing, but likely will be more easily met by increasing use of agrofuels, hence they could result in a massive new demand. In the meantime, the automobile industry lobby effectively watered down a proposal by the Commission, which would have required more fuel efficient engines. The proposal would have limited automobiles to 120 gr/km CO2, but the industry pushed it up to 130 gr/km CO2, arguing that the difference would be made up for by agrofuel blending.

These mandates are being set in place even though it is unlikely that the agricultural lands required to grow feedstock on this scale exist within the EU, which already relies heavily on food and feed imports. In 2005, 2.6 million hectares of EU lands were under production for energy crops, yet the EU failed to meet its 2% goal.

The Commission's DG Agriculture assessment reported that 15% of EU arable lands could provide enough feedstock to meet the 10% target, and supported drawing this land from protected "set aside" areas (like Conservation Reserve Program lands in the U.S., these are areas set out of agricultural production to protect soils, waterways and biodiversity). Converting set aside lands into crop production, along with the intensification of agricultural practice throughout Europe will have dire consequences for dwindling biodiversity.[170] Second generation agrofuels like wood-based ethanol might have negative consequences on European forests, as they will intensify timber exploitation leading to an expansion of monoculture tree plantations and a decrease in biodiversity values in secondary forests.

The extent to which Europe can in fact produce it's own feedstocks remains to be seen, but there is no question that it will be heavily reliant on imports, and that the impacts of decisions concerning biomass will therefore be born largely by the global south.

Under pressure from a well organized activist community, public support appears to be waning somewhat as more people recognize the negative impacts of growing crops for fuel.[171] As the Renewable Energy Directive is still being drafted, two key Commissioners

[170] "How will large scale agrofuel production affect biodiversity?" In; "Agrofuels: Towards a reality check in nine key areas," June 2007

171 J.W. Miller, "Europe's biodiesel drive sputters: Industry's woes endanger EU goal for using fossil fuel

have made strong if somewhat belated statements against agrofuels. Commissioner Michel (Development) stated that he, in fact, supported the idea of a moratorium on new targets; and Commissioner Dimas (Environment) stated that the environmental and social problems with agrofuels are *"bigger than we thought"* and urged caution. These statements followed on the heels of a report by the Royal Society warning of the negative impacts of agrofuels. Meanwhile, in the UK, a report from the Parliament's Environmental Audit Committee outlined numerous problems with agrofuels, stating that "The stimulation of biofuels production by the government and EU is reckless in the absence of effective mechanisms to prevent the destruction of carbon sinks internationally."[172] The Commission's Joint Research Centre conducted a cost-benefit study of EU agrofuels policy and reported that they will be costly and provide little in terms of greenhouse gas savings or job creation.

Dawning recognition of the negative impacts of agrofuels has prompted ongoing discussions of sustainability criteria for biomass production, particularly given that acceptance of the mandatory 10% target is contingent upon agrofuels being 'sustainable.' The question now is exactly what will count as 'sustainable.' Dutch, German and UK bodies have worked to develop criteria with respect to greenhouse gas balances and environmental and social impacts, with the goal of making these more widely applicable across the EU as well as internationally. However, when it came to implementation, the UK and Netherlands fell back to extremely weak reporting requirements, and Germany eliminated consideration of all social issues.

Even after extensive consultation, debate, and discussion regarding the feasibility and form of proposed sustainability criteria within the Renewables Directive, it appears that only very weak provisions will be put in place at the EU level. Land with "high carbon stocks" or "high biodiversity" should not be converted for fuel crop production, and minimal positive greenhouse gas balances should be achieved. How the terms "high carbon stocks" and "high biodiversity" are defined will be critical. Also critical will be whether greenhouse gas emissions from indirect land use will be incorporated into greenhouse gas balance calculations. It has been repeatedly pointed out that indirect impacts of agrofuels production are enormous, and virtually impossible to address. A recent study by Searchinger et al. demonstrated this, showing that indirect impacts on land use can result in greenhouse gas emissions (i.e. from deforestation and peatland degradation). When taken into account these emissions make some agrofuels contribute to, rather than reduce, greenhouse gases. Yet indirect impacts on land use have not been incorporated in previous calculations. Currently there are no sufficient methods for adequately assessing or avoiding such indirect impacts as they result from complex interactions within a globalized economy. Criteria for addressing indirect land use change so far involve little more than monitoring and contain no plan concerning how to respond to negative findings.

The Renewables Directive has been further criticized because:

- The target will cause expansion of monocultures, at great cost of livelihoods and ecosystems. Displacement and other macro-impacts are not addressed, therefore making any set of criteria ineffective.

- Most environmental issues (water use, soil degradation, etc.), and all social issues (land conflicts, human rights abuses, working conditions, etc) are excluded from the proposed 'sustainability criteria.'

- Non-liquid biomass (wood, palm kernel) are excluded from criteria altogether for the next few years, which is unacceptable given very rapid increase in the use of solid biomass use for heat and power.

- The Commission excludes the implementation of greenhouse gas saving criteria until 1 April, 2013 for all agrofuels produced by installations that were operational in January, 2008.

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alternatives." Wall Street Journal, December 27, 2007.
http://online.wsj.com/article/SB119871178911851507.html?mod=googlenews_wsj

[172] "How will large scale agrofuel production affect biodiversity?" In; "Agrofuels: Towards a reality check in nine key areas," June 2007

- Voluntary schemes and bilateral and multilateral agreements may be taken as proof that environmental sustainability criteria have been fulfilled; but these voluntary schemes are not necessarily widely supported by civil society in producer countries, and should not be used to legitimize the expansion of plantations by certifying agrofuels and agro-energy.

- Member States are not allowed to set stronger or broader sustainability criteria.

- The minimum greenhouse gas saving criteria for bioliquids and other agro-fuels, has been set at a very low level of 35% greenhouse gas saving.

Even if it is accepted that viable sustainability criteria can be devised in principle, it is not likely that they can be implemented in many producing countries where the rule of law and resources for enforcement are minimal. Developing effective criteria for agrofuel production will be especially difficult given the very diverse feedstocks, agriculture and trade practices involved.[173] The processes for developing these criteria have been harshly criticized for failing to engage stakeholders in producing countries, where impacts are most strongly felt. So far there has been resistance to incorporating social criteria, hence impacts on land rights, food sovereignty, working conditions etc. are ignored. This is in part due to the perceived incompatibility of social criteria with WTO regulations (the "chilling" effect of WTO).

The European discussions on sustainability of agrofuels are precedent-setting, as they have advanced much further than anywhere else in the world. The outcome is likely to have global impact as other countries may follow suit in adopting or rejecting the feasibility of such standards. Under continuing pressure from activists, and a barrage of negative reports, EU Member States are reconsidering their positions with respect to mandated targets for biofuels, although the Commission overall appears to remain committed.

Meanwhile, the EU biodiesel industry now shows signs of slowing. There is a production glut, the costs of feedstocks are rising and tax incentives are being phased out. Importation of highly subsidized U.S. biodiesel is also threatening the industry. The Industry Board filed a complaint to the European Commission with regards to importation of highly subsidized U.S. "B99" imports.

Currently responsible for about 18% of global greenhouse gas emissions, and a signatory to the Kyoto Protocol, the EU has committed to reducing emissions to 8% of 1990 levels by 2010. Agrofuels are viewed as a means to help reach this goal, as is the use of biomass for producing heat and electricity, a practice that is also increasing rapidly within Europe. In effect, the EU is reducing its own emissions by raising emissions in developing countries that produce the feedstock oils (through increased deforestation and land use change, for example) and are not bound by emissions reduction targets, especially Indonesia and countries in Latin America. The massive emissions resulting from palm oil production, for example, should more appropriately be part of the EU's carbon accounting rather than Indonesia's. (Europe also imports massive quantities of palm oil for food and uses other than agroenergy). In any case, the resulting emissions grossly undermine the intended rationale for using agrofuels as a means to protect the climate.

Countries that are major consumers of transport fuels, like the EU and the U.S., are playing a critical role in driving the demand for agrofuels with mandated targets and incentives. This demand, viewed by corporate agribusiness as a godsend, is pushing the expansion of industrial monocultures. In the process it is creating a dire threat to food security, land rights and livelihoods of rural and indigenous peoples around the globe while further degrading native ecosystems and the global climate.

173 see: T. Gilbertson, N. Holland, S. Semino, K. and Smith, " Paving the Way For Agrofuels: EU Policy, Sustainability Criteria and Climate Calculations." 2007
http://www.corporateeurope.org/docs/agrofuelpush.pdf

Corporate control and consolidation

Photo: Orin Langelle

"Agrofuel development has arrived on the global stage. Just this year, the number of declarations, dollars, and development plans that have gone to agrofuels are unparalleled in any other sector. An idea that languished for decades has suddenly become the darling of politicians, big business, international financiers and the media. This fact alone should make us worry. Since when has an ecological response to fossil-fuel use found favor with governments and corporations alike?"[1]

Few issues have created such a swift and massive consolidation of corporate control. National and multinational agribusiness corporations like Cargill, Monsanto, Archer Daniels Midland and Bunge are all focused on ramping up their profits as demand for commodity crops shoots up: they are investing heavily in every level of production from seeds through to agrichemicals and refineries. Meanwhile, biotechnology companies, Monsanto, Syngenta, Bayer, Dow, for example, also stand to profit from research and development of genetically engineered feedstock varieties, and view agrofuels as a means to sidestep the opposition to genetically engineered foods that has hindered the industry.

Automobile companies, like Volvo, VW, GM and Ford support and are investing in agrofuels development because they view the substitution of fossil fuels as a better option than selling fewer cars or being forced to design and construct more fuel efficient ones. Finally, the oil industry transnationals, especially BP (which now controls about 10% of the world's agrofuel industry), Shell and Chevron, support agrofuels because they foresee that oil supplies will dwindle just as demand for transportation energy increases, and substituting agrofuels for fossil fuels will enable them to continue profiting from the vast infrastructure that they already have in place for delivery and transport.

All of these corporate players have recognized their common interest and are building new partnerships to pursue and commercialize them while using their power to influence policy, research and funding. In the words of Food First's Eric Holt Gimenez: "Behind the scenes, under the noses of most national antitrust laws, giant oil, grain, auto and genetic engineering corporations are forming partnerships, and they are consolidating the research, production, processing and distribution chains of food and fuel systems under one industrial roof."[2]

A few examples of the "partnerships" being formed underneath that roof are illustrative:

Chevron and Weyerhauser announced their intention to collaborate in order to explore the possibilities of producing cellulosic ethanol from wood fibers.[3] This is one of several collaborative ventures Chevron has forged. Others include working with Texas A&M University, the U.S. Department of Energy National Renewable Energy Lab (NREL), Georgia Institute of Technology and the University of California at Davis.

Diversa, long engaged in bioprospecting and the genetic manipulation of rare microbes, recently merged with Celunol, owner of the first US-based cellulosic pilot facility, also engaged in a licensing agreement with Japan's Marubeni Corporation.[4]

ADM (who's current CEO worked her way up the ranks at Chevron)[5] is partnering with ConocoPhillips to develop cellulosic fuels. Conoco's CEO stated that: "We are hopeful that this collaboration will provide innovative technology toward the large-scale production of biofuels that can be moved efficiently and affordably through existing infrastructure."[6]

The EU has established a Biofuels Research Advisory Council (BIOFRAC) to develop a vision for EU agrofuels and to advise regarding funding needs to achieve this vision. According to the Communication and Information Resource Centre, BIOFRAC "is a High-level Advisory Council, consisting of members who represent a balance of the major European biofuels stakeholders, including the agricultural and forestry sectors, food industry, biofuels industry, oil companies and fuel distributors, car manufacturers and research institutes." The council, made up almost entirely of industry representatives, is chaired by the CEO of Volvo.[7]

In March 2006, European car manufacturers DaimlerChrysler, Renault and Volkswagen together with oil companies Sasol Chevron and Shell formed the 'Alliance for Synthetic Fuels in Europe' (ASFE).[8]

Shell, which claims that it is the world largest distributor of transport agrofuels, partnered with Iogen (a Canadian biotech also backed by Goldman Sachs), to create cellulosic ethanol from straw using enzymes. In 2006 Shell, Iogen and Volkswagen joined in a cellulose ethanol project in Germany.[9] German biofuel company CHOREN Industries is also working with DaimlerChrysler, Volkswagen and Shell to produce SunDiesel, a synthetic fuel or Biomass to Liquid fuel (BTL).

Since 2003, BP has been collaborating with DuPont in a biobutanol project, exploring technologies and ways to reduce costs along with Ford and British Sugar.

The insinuation of corporate agendas into education institutions is a deeply troubling issue that should be openly and honestly addressed:

The Colorado Center for Biorefining and Biofuels (C2B2) was formed as an alliance between the University of Colorado, Colorado State University, the Colorado School of Mines and U.S. Department of Energy NREL, Dow Chemical, Chevron, ConocoPhillips and Shell oil.[10]

DuPont is dumping money into Purdue University for genetic improvement of crops and plant nutrition, and to "educate the next generation of plant breeders and geneticists", and also announced a $US2 million scholarship fund.[11] Monsanto and BASF are collaborating in and effort to "bring a greater number of traits to market at a faster speed."[12]

In February 2007, BP announced it was signing a $500 million deal with the University of Berkeley, California (UCB) and its partners (University of Illinois Urbana-Champaign and the Lawrence Berkeley National Laboratory) to create the Energy Bioscience Institute.[13] This would be the largest academia-industry research alliance in U.S. history, spanning 25 labs at three campuses. Around 50 BP staff will lease commercial research space on campus to work in conjunction with University faculty on biotechnology for agrofuels. On the academic side, all research is publishable, but on the BP side, research is proprietary with no obligation to publish. Tadeusz Patzek, an engineering professor at Berkeley who formerly worked as a scientist at Shell, points out that such deals will compromise the objective pursuit of real solutions by creating incentives for researchers to align their efforts with industry interests and funding. Opposition to this industry takeover of a public institute of learning is ongoing. It has recently come to light that a "secret signing" may have taken place on Nov 12, 2007.[14]

The biotech industry hopes to overcome the fierce public resistance to genetically engineered crops, by capitalizing on public concern over climate change and developing 'improved' crops for agrofuel production. Berkeley professor Miguel Altieri and Food First executive director Eric Holt-Gimenez warn that the agrofuel agenda offers biotech companies like Monsanto "the opportunity to irreversibly convert agriculture to genetically engineered crops. Presently 52% of corn, 89% of soy and 50% of canola in the US is genetically modified." The authors argue, "the expansion of corn genetically tailored for special ethanol processing plants will remove all practical barriers to the permanent contamination of all non-GMO crops."[15]

DuPont indicates annual revenues from the global agrofuel markets, largely from agricultural inputs to fuel ethanol of about US$300 million.[16] Last February the company announced a US$100 million reinvestment plan to shorten the time to market for new seed products for Pioneer, DuPont's subsidiary. According to Bill Niebur, Vice President for genetics research and development, "Demand for ethanol means that the race is on to rapidly ramp up grain yields."[17]

Monsanto, the world's largest developer of genetically modified seeds also announced record profits resulting from growing ethanol demand, and intends to boost seed production capacity.[18]

The future of "consolidation" may be foreshadowed by the recent alliance between the Oak Ridge National Laboratory, the Georgia Institute of Technology and Imperial College of London, called the "Atlantic Alliance for BioPower, BioFuels and Biomaterials" which has as its mission the development of "integrated biorefineries" to produce fuels, chemicals, foods, materials (like plastic substitutes), heat and just about anything else that can possibly be made from biomass. These will "compliment well established petroleum refinery processes using systems integration of genomics and biotechnology, advanced separation science and engineering, catalysis, nanotechnology and polymer science, lignin, polysaccharide and green chemistry, process chemistry and engineering, power generation and life-cycle analysis."[19]

Associate Professor Sam Shelton, former director of Georgia Institute of Technology's Strategic Energy Institute, says, "The integrated biorefinery offers great long-term potential utilization of biomass and dovetails nicely with Georgia Tech's near-term development of southern pine-to-ethanol technology using the existing southeastern pine pulpwood resource, infrastructure and technology." [20]

Activist and writer George Monbiot stated "It used to be a matter of good intentions gone awry. Now it is plain fraud. The governments [and industries] using biofuels to tackle global warming know that it causes more harm than good. But they plough on regardless."[21]

Given the enormous profits to be gained…this should come as no surprise...

[1] Laura Carlsen. The Agrofuels Trap Sept 10, 2007, Foreign Policy In Focus.
http://www.fpif.org/fpiftxt/4533

[2] Eric Holt-Gimenez, 2007, The Myth of Biofuels, Food First. (Agence Global)

[3] Chevron and Weyerhauser Create Biofuels Alliance. Chevron Press Release. April 12, 2007
http://www.renewableenergyaccess.com/rea/news/story?id=48109

[4] Giles Clark, "Merger creates a major player for the biofuels market," February 13, 2007, at
http://www.checkbiotech.org/root/index.cfm?fuseaction=news&doc_id=14408&start=1&control=201&page_start=1&page_nr=101&pg=1

[5] Margy Fischer. October 17 2007. New Oil and Ag Blend. AgWeb.com

[6] Biofuels in the European Union. A vision for 2030 and beyond. Final report of the Biofuels Research Advisory Council, Directorate-General for Research, Sustainable Energy Systems, 2006. http://circa.europa.eu/Public/irc/rtd/biofrac/home

[7] The EU's Agrofuel Folly: Policy Capture by Corporate Interests. Briefieng Paper, Corporate Europe Observatory, June 2007

[8] StopBP-Berkeley Campaign Website: http://www.stopbp-berkeley.org/

[9] Iogen corporation Press Release.January 8 2006. Volkswagen, Shell and Iogen to study feasibility of producing cellulose ethanol in Germany. http://www.iogen.ca/news_events/press_releases/2006_01_08.html

[10] McCoy, M. Biofuels Center Grows In West. March 19, 2007 American Chemical Society Vol 85, no.12
http://pubs.acs.org/cen/news/85/i12/8512notw2.html

[11] DuPont Makes $2.175 million investment in plant breeding research and education. Oct 31, 2007. PR Newswire.
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[12] Lorraine Heller, April 12, 2007. DuPont funds plant breeding research.
http://www.foodnavigator-usa.com/news/ng.asp?id=75677-dupont-plant-breeding-grain

[13] "BP selects UC Berkeley to lead $500 million energy research consortium with partners Lawrence Berkeley National Lab, University of Illinois," UC Berkeley press release, February 1. 2007, at
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[15] Altieri, M. and Holtz-Gimenez, E. News Analysis: UC's Biotech Benefactors, by Berkeley Daily Planet, 6 February 2007.

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17 DuPont sees key GMO role in ethanol corn challenge. Reuters, 9 February 2007.
http://www.reuters.com/article/scienceNews/idUSN0923169520070210

[18] Kaskey, J.Monsanto Net Rises 23% on Corn Seeds: Forecast Raised. 4 April 2007, Bloomberg.
http://www.bloomberg.com/apps/news?pid=20601103&sid=alw3g10MRPj8&refer=news

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http://www.sciencemag.org/cgi/content/abstract/311/5760/484

[20] Ragauskas et al. Addressing Transportation Fuel Challenges. Horizons Research, Spring/Summer 2006
http://gtresearchnews.gatech.edu/reshor/rh-ss06/ragauskas.html

[21] Monbiot, G. If you want to save the planet, we need a five year freeze on biofuels. The Guardian, 27 March 2007. http://www.guardian.co.uk/Columnists/Column/0,,2043725,00.html

IV: Food, land & promises for the future

The impacts of agrofuels expansion on food sovereignty and food availability have already been monumental. Food prices have risen as grains formerly used to feed people and livestock have been diverted into fuel production, and people and indigenous agricultural systems have been displaced from productive lands. A recent report to the UN General Assembly on the Right to Food expressed "grave concerns" that agrofuels production…"presents serious risks of creating a battle between food and fuel that will leave the poor and hungry in developing countries at the mercy of rapidly rising prices for food, land and water."[174] The author of the report, the UN's Special Rapporteur on the Right to Food, Jean Ziegler, called for a five-year moratorium on the production of agrofuels using current methods. [175] According to the UN's World Food Program, 854 million people are already chronically hungry and six million children under the age of five die of starvation every year: one child every five seconds.[176] This situation needs to be resolved urgently, not made worse by false solutions to climate change.

With world population set to rise from six to nine billion people by 2050, food production will need to increase dramatically. At the same time, agricultural lands are becoming degraded and desertified on a massive scale with one projected impact of global warming being a decline in agricultural productivity as a result of droughts, declining freshwater reserves etc. Decisions about using land - any land - for fuel crop production, must be placed within this framework.

The International Food Policy Research Institute, in Washington, D.C., published sobering estimates of the potential global impact of rising demand for agrofuels. They predicted that given continued high oil prices, the rapid increase in global agrofuels production will push global corn prices up 20% by 2010 and 41% by 2020. The prices of oilseeds, including soybean, rapeseed, and sunflower seed, are also projected to jump by 26% by 2010 and 76% by 2020. Wheat prices are expected to rise 11% by 2010 and 30% by 2020. In the poorest parts of sub-Saharan Africa, Asia and Latin America, where cassava is a staple, its price is expected to increase 33% by 2010 and a startling 135% by 2020. Overall, the number of people suffering from undernourishment globally could increase by 16 million people for each percentage point increase in the real price of staple food. This could mean that 1.2 billion people would be suffering from hunger by 2025.[177]

The UN Food and Agriculture Organization reports that over the past year, world prices for most staple foods have risen rapidly, with 18% food price inflation in China, 13% in Indonesia and Pakistan, and 10% or more in Latin America, Russia and India. Wheat has doubled in price, maize prices are nearly 50% higher and rice 20% higher.[178]

In April 2008, the World Bank reported that food prices have risen by close to 80% over the past three years. In the first week of April, rice prices rose by 50%.[179] Resulting

[174] J. Ziegler, "Special Report on the Right to Food to the UN General Assembly," 62nd session. Oct 2007.
[175] "UN rapporteur calls for biofuel moratorium," Swissinfo, October 11, 2007, www.swissinfo.org/eng/swissinfo.html?siteSect=881&sid=8305080
[176] http://www.wfp.org/aboutwfp/introduction/hunger_what.asp?section=1&sub_section=1
[177] M. Rosengrant, et al, "Bioenergy and Agriculture: Promises and Challenges," International Food Policy Research Institute, December 2006. http://www.ifpri.org/2020/focus/focus14/focus14_03.pdf
[178] "FAO Outlook: High Prices and Volatility in Prices of Commodities." FAO, November 2007. http://www.fao.org/docrep/010/ah876e/ah876e13.htm
[179] Javier Blas and Roel Landingin, "Rice Jumps as Africa Joins Race for Supplies." Financial Times, April 4, 2008. http://www.ft.com/cms/s/0/4813b3c4-0250-11dd-9388-000077b07658.html?nclick_check=1

insecurity as food becomes increasingly difficult to afford has caused social unrest in 33 countries, with riots in Guinea, Egypt, Morrocco, Uzbekistan, Yemen, Burkina Faso, Mauritania, Niger, Senegal, Haiti, Bolivia, and Indonesia. Many countries are putting in place policies to discourage exports and control prices for staples.

The UN's World Food Program also warns that the rise in food prices could mean that they will no longer be able to provide sufficient food aid to the 90 million people that currently depend on it.[180] In March 2008, the WFP requested an increased $500 million support to avoid having to cut aid rations. This does not bode well for the UN Millennium Development Goals established in 2000. Governments vowed to halve the proportion of the world's chronically underfed population from 16% in 1990 to 8% by 2015. So far, progress towards that goal has been meager, especially in places like Africa, but it could be completely stymied if food becomes inextricably linked to fuel production and oil prices.

The UN FAO's 2007 Agricultural Outlook warns that "increased demand for biofuels is causing fundamental changes to agricultural markets that could drive up world prices for many farm products" and predicts a further 20% to 50% rise in prices by 2016.[181] The FAO announced in October 2007 that global food reserves are at their lowest in 25 years, threatening "a very serious crisis."[182] In December 2007 the FAO reported the global food price index had risen 40% during the year, resulting in serious food shortages in over 40 countries.

Meanwhile, human population is growing at a rate of about 100 million people per year, largely in developing countries where resources are already strained. Climate change and soil degradation are also reducing agricultural productivity in some areas. For example, melting of high altitude glaciers in Asia which provide water to the Ganges, Yellow and Yangtze river basins is projected to severely diminish agricultural productivity in Asia, the world's leading producer of wheat and rice. (see water box)

Lester Brown, president of the Earth Policy Institute sums up the situation succinctly, in a statement on the impact of agrofuels on food supply in which he stated, "The stage is now set for direct competition for grain between the 800 million people who own automobiles, and the world's 2 billion poorest people."[183]

Similarly, a number of civil society groups from the south, where the impacts of agrofuels production are most immediately tangible, have made powerful statements opposing agrofuels on the grounds of their impacts on food sovereignty: "We, representatives of organizations and social movements of Brazil, Bolivia, Costa Rica, Colombia, Guatemala, and the Dominican Republic, gathered at a forum on the expansion of the sugarcane industry in Latin America, declare that: the current model of production of bioenergy is sustained by the same elements that have always caused the oppression of our peoples: appropriation of territory, of natural resources, and the labor force...Our principal objective is to guarantee food sovereignty, as the expansion of the production of biofuels aggravates hunger in the world. We cannot maintain our tanks full while stomachs go empty." (signed Sao Paulo, February 28, 2007, Comissao Pastoral da Terra (CPT),Grito dos Excluidos, Movimento SemTerra (MST), Servico Pastoral dos Migrantes (SPM), Rede Social de Justica e Direitos Humanos, Via Campesina).[184]

In an open letter to the European Parliament, the European Commission and governments

[180] J. Blas, and J.Wiggins, "Surge in Biofuel Production Pushes up Food Prices." Financial Times July 16, 2007
[181] "Agricultural Outlook 2007-2016," OECD/FAO, 2007, Paris, Rome
[182] "Global food crisis looms as climate change and fuel shortages bite." The Guardian, Nov 3. 2007 http://www.heatisonline.org/contentserver/objecthandlers/index.cfm?ID=6698&Method=Full
[183] L. Brown, "Massive diversion of U.S. grain to fuel cars is raising world food prices." Earth Policy Institute, March 2007, http://www.earth-policy.org/Updates/2007/Update65.htm
[184] "Full Tanks at the Cost of Empty Stomachs: The Expansion of the Sugarcane Industry in Latin America"

and citizens in Europe, Latin American activist networks straightforwardly state: "We Want Food Sovereignty Not Agrofuels," the letter closes with "land must be used to feed people, not cars."[185] A number of other, similar statements have been made by local communities and organizations in Brazil, Argentina, Paraguay, Ecuador, Indonesia and South Africa. All are united in their opposition to agrofuels and the urgent need to put food first.[186]

Promises for the future

Concerns over the impact of diverting agriculture from food to fuel production are almost universally responded to with optimistic statements about the promise of 'second generation' cellulosic technologies. Proponents claim that the feedstocks, agricultural "wastes" like corn stover (leaves and stems) and straw, high yield grasses such as miscanthus and switch grass, coppiced willow, and fast growing trees can be grown on "marginal" lands, rather than prime agricultural lands already dedicated to food crops. In theory, these "next generation" technologies are expected to provide higher energy yields than current technologies based on starch and sugar crops. However, regardless of whether this will occur in practice, the potential is being used as a reason to accelerate the use and development of the current agrofuel technologies even in the face of obvious and mounting concerns that they are doing far more damage than good. Matt Hartwig, spokesman for the Renewable Fuels Association, says "ethanol is still a young and developing industry. The government needs to keep supporting it if Americans want to "sniff the dream" of commercializing cellulosic ethanol, which can be made from materials including wood or switchgrass."[187]

But what exactly is it that governments are banking on? How long will it take before these technologies are available? And will they really provide a way around the problems created by the first generation of agrofuels?

"Next generation" technologies are not simple and not ready

Cellulose makes up more than half of the total organic carbon in the biosphere, and is the major structural component of plant cell walls.[188] It consists of a regular, extensively cross-linked, three-dimensional matrix of thousands of polymerized glucose molecules, and is highly resistant to biological degradation. The stems of woody plants contain about 50% cellulose and nearly 25% lignin. Lignin is a relatively stable polymer of various aromatic alcohols with a considerably less regular and more variable structure.[189] It is even more resistant than cellulose to biological digestion, and it has historically been viewed as an obstacle to the efficient processing of wood pulp into paper. Lignin is only broken down by specialized species of bacteria and fungi, and thus provides trees with considerable resistance to decay and disease. It is also a significant contributor to the combustion energy of wood.

The sugar residues in cellulose can be fermented into simple alcohols such as ethanol once the polymer matrix is broken down and digested. The methoxylated phenolic components of lignin, on the other hand, are significant obstacles to chemically accessing those sugars.

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http://tech.groups.yahoo.com/group/biofuelwatch/message/339
[185] "We Want Food Sovereignty, Not Biofuels", Open letter to EU, http://tech.groups.yahoo.com/group/biofuelwatch/message/212
[186] Various other statements available at <www.Biofuelwatch.org>
[187] L. Etter, "Ethanol Industry is Losing Clout in Congress As Food Prices Climb" Wall Street Journal, Oct 11, 2007.
[188] A.L. Lehninger, Biochemistry (New York: Worth Publishers, 1970, p. 231.)
[189] ibid., pp. 231-232.

So while lignin represents a large portion of the energy content of wood and grasses, extracting ethanol from plants requires the expenditure of energy in order to break down and remove the lignin. Reducing lignin content has been a goal of tree geneticists for many years as this would reduce production costs for the pulp and paper industry.[190] This goal is now shared by those intent on producing cellulosic ethanol. However, due to lignin's central role in insect and disease resistance, experimental low- lignin plants have so far been found to be highly susceptible to a variety of fungal diseases.[191]

GE trees protest. Photo: Orin Langelle

The extraction of ethanol from wood, grasses and high-cellulose crop residues is a complex, energy-consuming process involving many stages of enzymatic digestion, the purification of breakdown products and the fermentation of glucose into ethanol. Officials with the U.S. Department of Agriculture's Economic Research Service, writing in the Department's monthly magazine *Amber Waves*, wrote that optimistic predictions for the efficient digestion of cellulose are "in the neighborhood of 5-10 years."[192] A year later, *The Economist* confirmed that production of cellulosic ethanol remains "much more difficult and expensive" than distilling ethanol from crops such as corn and sugarcane.[193]

Existing refineries, such as Iogen's cellulosic ethanol plant in Ottawa, are relatively inefficient, requiring inputs of considerably more energy than the facilities actually produce.[194] Biotechnology companies such as Diversa and Genencor in the U.S., and Novozymes in Denmark, are working to simplify the production of the enzymes needed to digest cellulose through research efforts that include modification of the often slow-acting enzymes used by termites to break down woody material. Novozymes, in particular, is seeking to genetically engineer microorganisms that can perform several stages of digestion simultaneously.[195] Others are investigating microbes that live in extreme environments, from volcanoes to insects' digestive tracts, hoping to find organisms with unique digestive properties, and synthetic biologists are pursuing the disturbing idea of creating an entirely human-made fuel-producing organism (see Synthetic Biology sidebar).[196] While projections of the future energy return from cellulosic ethanol rely on exploiting the heat content of the lignin and other byproducts,[197] the current process still requires significant inputs of energy. Processing also requires very large quantities of water.[198]

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[190] See, for example, Wen-Jing Hu, et al., "Repression of lignin biosynthesis promotes cellulose accumulation and growth in transgenic trees," Nature Biotechnology vol. 17, 1999, pp. 808-812.
[191] Joe Cummins, "Low Lignin Trees and Forage Crops," London: Institute of Science and Society, May 6, 2004.
[192] A. Baker, and S. Zahniser, "Ethanol Reshapes the Corn Market," Amber Waves, Vol. 4, No. 2, Washington, DC: USDA, April 2006, p. 35.
[193] Bacon, D. "Woodstock revisited: Could new techniques for producing ethanol make old-fashioned trees the biofuel of the future?" THE ECONOMIST Mar 8th 2007 http://www.economist.com/science/tq/displayStory.cfm?story_id=8766061
[194] "Fuel Ethanol Production," US Department of Energy, Genomics: GTL http://genomicsgtl.energy.gov/biofuels/ethanolproduction.shtml#improve
[195] "Rush to Ethanol: Not all biofuels are created equal." Food and Water Watch and Network for New Energy Choices. 2007, p. 55. www.newenergychoices.org/uploads/RushToEthanol-rep.pdf
[196] "Agrofuels: Towards a reality check in nine key areas," pp. 14-15; Nicholas Wade, "Scientists Transplant Genome of Bacteria," New York Times, June 29, 2007.
[197] See, for example, D. Morris, "The Carbohydrate Economy, Biofuels and the Net Energy Debate, "Minneapolis: Institute for Local Self Reliance, August 2005, p. 19.
[198] S. Leahy, "Cellulosic ethanol – Clean but worth unproven," InterPress Service, June 30, 2007 http://www.speroforum.com/site/article.asp?idarticle=10142

An alternative process, known as Fischer-Tropsch gasification, was developed in Germany prior to World War II to produce diesel fuel from coal, but it can also use cellulosic material as a feedstock. The material is broken down by chemicals at a high temperature, instead of by microbes or microbial enzymes, resulting in a mixture of carbon monoxide and hydrogen known as "synthesis gas." This is also a costly and highly energy-intensive process; critics suggest that improvements in this process would mainly serve to increase the use of coal.[199] The complex supply issues described below for various sources of cellulosic material apply to gasification as well as fermentation-based technologies.

Clearly, there is much basic research to be done before we can anticipate the efficient extraction of usable fuel from cellulosic sources. The U.S. Department of Energy stated that "one important barrier is the heterogeneous and recalcitrant nature of cellulosic biomass…and the mix of sugars generated from hemicellulose hydrolysis." This is a rather broad though honest statement of the realities that face proponents of cellulosic technology. Plants have basically evolved over millions of years to protect their energy stores. If the sugars in cellulose were readily accessible, naturally voracious animals and microbes would quickly strip the earth bare. So far only select microbes and some fungi can access these sugars, along with cows and termites that contain such microbes in their digestive tracts.

The head of the U.S. House Agriculture Committee stated "I really think the more I look at this whole cellulosic issue, there is a lot bigger problem to overcome here than people realize in terms of the feedstocks. We have a lot of work to do in that regard," he said. "I'm not sure cellulosic ethanol will ever get off the ground." Similarly, the head of the U.S. Energy Information Administration recently admitted that "While the situation is very uncertain at this early date, our current view is that available quantities of cellulosic biofuels prior to 2022 will be insufficient to meet the new Renewable Fuel Standard targets.[200]"

A recent comprehensive modeling study from the University of Iowa indicates that cellulosic feedstocks such as switchgrass will not alleviate competition for food production, as is so often claimed, and may even worsen it because of demand for land area, in addition to requiring massive subsidies.[201]

They will impact land use and biodiversity in many ways

The likely sources of cellulosic material, (which are often described as easily accessible waste products from marginal lands), also raise concerns about habitat destruction. The potential scale of demand for biomass virtually guarantees that whatever feedstock is used, there will be serious and widespread impacts on land use. According to a 2005 report by the USDA/DOE, a 1.3 billion ton per year supply would be required in the U.S. alone. This would mean processing most existing agricultural residues, using more than 22 million hectares of land to grow dedicated perennial energy crops, utilizing massive

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[191] H. Paul, and A. Ernsting, "Second Generation Biofuels: An Unproven Future Technology with Unknown Risks," in: "Agrofuels: Towards a reality check in nine key areas," Biofuelwatch, et al., June 2007, p. 14

[199] www.biofuelwatch.org.uk/inf_paper_2g-bfs.pdf

[200] Tom Doggett , "U.S. won't meet ethanol goal due to shortfall," Reuters, Tuesday, March 4, 2008 http://uk.reuters.com/article/environmentNews/idUKN0449308620080304

[201] M.L. Hayes, D.J. and B.A. Babcock, "Crop Based Biofuel Production under Acreage Constraints and Uncertainty." Center for Agricultural and Rural Development, Iowa State University., Working Paper 08 WP 460 February 2008.

quantities of manure (more than current EPA limits) and putting all U.S. cropland into "no-tillage" agriculture.[202]

The most often cited cellulosic feedstocks are grasses, particularly varieties of switch grass (*Panicum virgatum*) as mentioned in U.S. President Bush's 2006 State of the Union address. However, grass monocultures are dependent on nitrogen fertilizers, which release nitrous oxides.[203] Highly diverse grasslands, with healthy populations of leguminous plants, are far more productive and far better at sequestering carbon dioxide.[204] But using mixed feedstocks adds significant new complexity to the enterprise and monocultures are likely to be favored.

Moreover, U.S. advocates for grass-based agrofuels have suggested that suitable species could be harvested from grasslands now allocated to the Agriculture Department's Conservation Reserve Program (CRP). However, in June 2006, representatives of 22 leading conservation and hunting advocacy groups wrote to the U.S. Congress challenging this proposal, saying--"[W]e urge you to carefully consider the impacts of increased stubble removal and diminished vegetative cover as they relate to wildlife, soil, water and air quality." These groups, led by the venerable Izaak Walton League, together with organizations as diverse as the Nature Conservancy, the National Wildlife Federation, and advocates of duck, pheasants, deer, elk and bear hunting, highlighted the Reserve Program's remarkable success in reducing soil erosion and preserving wetlands. The letter continued, "Most at risk are the wildlife benefits of CRP, which to a great extent are simply not compatible with frequent harvesting."[205] The idea that harvesting grasslands could simulate the periodic fire disturbances that are necessary for the sustenance of prairie ecosystems is especially flawed: few nutrients are returned to the soil, and harvesting equipment may prove far more disruptive to wildlife habitat than the spread of wildfire.

Furthermore, a group of university-based researchers from five U.S. states published a paper in *Science* in 2006 warning about the invasiveness of those grass species that are thought to be the most suitable for fuel production. "[T]raits deemed ideal in a bioenergy crop," they wrote, "are also commonly found among invasive species."[206] Such traits, including lack of known pests or diseases, highly efficient water use and photosynthesis, rapid growth, and the ability to out-compete weeds in the spring, are observed in proposed agrofuel species such as switch grass and miscanthus hybrids. Giant reeds (*Arundo donax*), also under consideration as an agrofuel crop in many regions of the world, are amongst the world's most chronically invasive species, hazardous to riparian habitat on three continents. Other frequently proposed agrofuel species, including jatropha, poplar and willow, are considered noxious weeds in Australia and other locations.[207] Efforts to develop faster-growing genetically engineered varieties of these grasses raise even greater alarm.[208] For example, a California-based biotechnology company called Ceres, a frequent business partner of Monsanto, is currently engaged in efforts to increase the yields, drought resistance and digestibility of various prairie grasses.[209]

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[202] Perlack et al. "Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply." USDA /DOE, 2005 http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf

[203] K.P. Vogel, et al., "Switchgrass Biomass Production in Midwest USA: Harvest and Nitrogen Management," Agronomy Journal, Vol. 94, 2002, pp. 413-420.

[204] D. Tilman, et al., "Carbon-Negative Biofuels from Low-Input High-Diversity Grassland Biomass," Science Vol. 314, December 8, 2006, p. 1598.

[205] I.W. League, et al., Letter to Congress, June 14, 2006, at http://www.iwla.org/index.php?id=325

[206] S. Raghu, et al., "Adding Biofuels to the Invasive Species Fire?" Science Vol. 313, September 22, 2006, p. 1742.

[207] T. Low, and C. Booth, "The Weedy Truth About Biofuels," Melbourne: Invasive Species Council, October 2007, at http://www.invasives.org.au/downloads/isc_weedybiofuels_oct07.pdf

[208] A. Pollack, "Redesigning Crops to Harvest Fuel," New York Times, September 8, 2006, p. C1.

[209] ibid.

Mother Nature does not know the meaning of "waste"

The use of crop residues such as straw and corn stover for agrofuel production is often described as the most foolproof solution, requiring no additional land. Four out of six experimental cellulosic agrofuel plants recently funded by the U.S. Department of Energy are already slated to rely on crop residues for all or part of their feedstock.[210] But these residues already play a crucial role in agronomic cycles and are essential for soil conservation. The vast majority of farmers till crop residues back into the soil after harvest. Their decomposition is crucial to the maintenance of soil health. The remaining growers, practicing "no till" cultivation, rely on the same residues as a mulch and for protection against soil erosion. Soil erosion is already seen as a major threat to the long-term sustainability of large-scale agriculture, particularly in the Midwestern U.S..[211] Clearly the use of agricultural wastes for agrofuels production would significantly increase this threat.

Collecting corn stover and other residues would also create added costs and logistical problems for farmers.[212] The development and acquisition of redesigned, and probably heavier, combine harvester would be required in order to collect and separate the stover and grain, adding to farmers' costs and to soil compaction. A 2007 study by researchers at the Oak Ridge National Laboratory in Tennessee and the U.S. National Renewable Energy Laboratory in Colorado concluded that no more than 30% of crop residues could be removed without significantly increasing soil erosion and impairing the retention of organic matter in the soil.[213]

Virtually guarantees the use of large monocultures to ensure adequate supplies for refineries

Current methods for processing cellulosic ethanol cannot accommodate mixed feedstocks, as the enzyme balances differ for different feedstocks. This means feedstock monocultures of one form or another will be favored. Transporting massive quantities of straw, wood and grasses also requires energy, thus decreasing the overall energy efficiency of refineries. The longer the haul, the worse the damage. Maintaining a yearlong, nearby, consistent supply of massive quantities of biomass is a major obstacle, and once again favors the development of industrial monocultures.

Requires the use of genetically engineered (GE) feedstocks and microorganisms

The rush to develop cellulosic agrofuels has provided a large boost to the biotechnology industry. EuropaBio, for example, claims that the EU will not be able to meet emissions reduction targets without biotechnology.[214]Similarly, Michael Pragnell, CEO of Syngenta, states that "Without green biotechnology, the C02 and agrofuel targets of the EU and those laid down by the U.S. will be impossible to attain...and people in Europe too will be

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[210] L. Irwin, "Cellulosic Wave Set in Motion," Ethanol Producer, June 2007, pp. 106-111.
[211] A. Friedemann, "Peak Soil," Culture Change, April 10, 2007, at http://www.culturechange.org/cms/index.php?option=com_content&task=view&id=107&Itemid=1
[212] R. Barron, "Q&A: Harvesting Cellulosic Ethanol," Greentech Media, September 21, 2007, http://www.greentechmedia.com/articles/harvesting-cellulosic-ethanol-097.html
[213] R.L.Graham, et al. "Current and Potential U.S. Corn Stover Supplies." Agronomy Journal. January 2007. Abstract available at: http://agron.scijournals.org/cgi/content/abstract/99/1/1
[214]"Biofuels in Europe,". EuropaBio. 2007 http://www.europabio.org/positions/Biofuels_EuropaBio%20position_Final.pdf

obliged to acknowledge that fact."[215] This comment was directed at EU resistance towards genetically engineered food crops. The industry is obviously concerned that resistance to GE foods, based on health concerns, will carry over to GE agrofuel feedstocks and microbes. The industry aims to break down that resistance. Africa, for example has also rejected the introduction of GE food crops. South Africa is the only African country that grows GE crops commercially. However, most African countries have yet to develop biosafety policies on GE crops, and are cautious about the difficulties of regulating and monitoring GE crops to prevent contamination of native agriculture. The Biotechnology Industry sees agrofuels as an opportunity to break down African resistance.[216] But South Africa has already rejected a maize variety developed by Syngenta for ethanol production and also rejected field testing of a GE cassava variety for ethanol. [217]

Vincent Chang of North Carolina State University told *The Economist* in May of 2007 that "transgenic wood can drastically improve ethanol production economics;" however long-time GE tree researcher Steven Strauss of Oregon State University says that screening of existing varieties rather than genetic engineering could prove equally effective.[218] Efforts to improve the productivity of extracted enzymes, engineer microbes for increased efficiency, reduce the lignin content of trees, make grasses more digestible, and even to create novel synthetic organisms, are all benefiting from the widely publicized link between these technologies and improved agrofuel production. Yet the creation of genetically engineered microbes, and alterations in the genetics of grasses and trees, raise the specter of unprecedented potential environmental hazards. (See chapter six)

But the money keeps on flowing

Despite these obstacles, corporate and public investment in cellulosic agrofuels continues to climb. For example, six new cellulosic refineries in the U.S. plus several new research facilities, are benefiting from major funding from the U.S. Department of Energy, which also sought to double funding for biomass and biorefinery systems, while cutting funding for geothermal and hydropower programs.[219] U.S. President Bush has also proposed an additional US$2.1 billion in loan guarantees for companies building cellulosic ethanol plants.[220] Interest in agrofuels is also driving an unprecedented merging of interests from different very powerful industrial sectors, including agribusiness, biotechnology, oil and automobile industries (see corporate consolidation sidebar).

The U.S. 2008 federal budget provided $179 million for the Biofuels Initiative, the goal of which was to reduce costs and accelerate commercialization of cellulosic ethanol. The Energy Policy Act of 2005 had already set a target of 250 million gallons of cellulosic fuels to be produced by 2013, and had established funding for research development and demonstration projects. The recently enacted Energy Independence and Security Act, which mandates 36 billion gallons (136 billion liters) per year of agrofuels, specifies that an increasing portion of those fuels be derived from "non-corn" sources. Further support for cellulosic technologies is likely to come via the U.S. Farm Bill's Energy Title, which is currently up for reauthorization, and has tremendous bearing on agriculture worldwide.

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[215] M. Stadeli, "Michael Pragnell: Without Biotechnology, CO2 and Biofuel Targets EU and USA will be impossible to attain" April 1 2007 http://www.eu-digest.com/2007/04/checkbiotechorg-michael-pragnell.html
[216] M. Mayet, "Opening Pandora's Box: GMO's Fuelish Paradigms and South Africa's Biofuels Strategy." African Centre for Biosafety February 2007. http://www.biosafetyafrica.net/portal/DOCS/biofuels_and_GMOs.pdf
[217] "African Centre for Biosafety and GRAIN, press release" March 20 2007
[218] D. Bacon, "Woodstock revisited: Could new techniques for producing ethanol make old-fashioned trees the biofuel of the future?" THE ECONOMIST Mar 8th 2007
http://www.economist.com/science/tq/displayStory.cfm?story_id=8766061
[219] M. Clayton, "Where Bush Would Steer Energy R&D." Christian Science Monitor. Feb. 23, 2007.
http://www.csmonitor.com/2007/0223/p01s01-usec.html
[220] E.L. Andrews, "Bush Makes a Pitch for Amber Waves of Homegrown Fuel," New York Times, February 23, 2007.

Measures are under consideration to promote cellulosic ethanol including $100 million in direct support to producers, loan guarantees, a Biomass Reserve Program within the Conservation Reserve Program, research funding, and funding for Forest Service research to encourage wood energy. In addition, incentives are offered to producers within supply region of an existing or proposed refinery, to produce cellulose crops (under five-year contracts) and local ownership of facilities is encouraged.

Perhaps the most serious threat to forests posed by cellulosic agrofuels is the proposed use of wood in bioethanol or diesel fuel production. One of the experimental facilities supported by the U.S. Department of Energy's $385 million cellulosic fuel initiative is the Range Fuels facility proposed for Soperton, Georgia, a gasification plant that is slated to rely entirely on wood residues and "wood-based energy crops."[221] The Georgia Forestry Commission claims that the supply of pine from plantations in Georgia will be able to sustain the plant indefinitely.

What are these residues and crops?

Researchers at Pennsylvania State University have proposed the harvesting of "small diameter trees that are overcrowded, under-utilized, and inhibit the opportunity for professional management."[222] They estimate that some 500 million tons of such trees could be harvested from about six million hectares of forestland in the state of Pennsylvania alone. The U.S. Forest Service Chief, Abigail Kimbell, enthusiastically claims that "we could replace as much as 15 percent of our current gasoline consumption with ethanol from wood - and not just any wood, but wood that is not now being used for other purposes.[223] But what are the costs, logistical complications and, most important, the ecological consequences of such massive-scale tree thinning? German researchers found that the removal of dead and dying trees and branches, even from managed forests, reduced carbon sequestration and threatened the habitat of numerous insects, lichens, birds, mammals and fungi.[224] Lumber mill wastes are another commonly proposed feedstock. A small wood-to-ethanol plant near Osaka, Japan relies entirely on salvaged wood, but can only fuel 101 pre-registered vehicles.[225]

Poplar, eucalyptus and some willow species are the varieties of choice. The U.S. Department of Energy states that; "gaining a better understanding of genes and regulatory mechanisms that control growth, carbon allocation, and other relevant traits in the poplar tree (*Populus trichocarpa*) may lead to its use as a major biomass feedstock for conversion to bioethanol."[226]

Towards this end, the poplar genome has been sequenced in it's entirety, a project involving 108 co-authors from 34 different institutions. Enthusing over the possibilities, one researcher stated; "This is nothing short of revolutionary. We now have the entire complement of genes ready for the taking. People have the tools in hand to look for different functions and to tailor trees for different purposes."[227]

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[221] L. Irwin, "Cellulosic Wave Set in Motion," Ethanol Producer, June 2007, pp. 111.
[222] P. Pacchioli, "Researchers at the new Biomass Energy Center are Honing in on Future Fuels," Penn State University, September 24, 2007, at http://www.rps.psu.edu/indepth/bioeneergy1.html.
[223] John Heilprin "Forest Service Chief Urges Using Forests to Power Cars and Fight Global Warming," AP Press, Sept 10, 2007 http://climate.weather.com/articles/forest091007.html
[224] S. Hermann and J. Bauhus, "Totholz-Bedeutung, Situation Dynamik," Albert Ludwigs University, Freiburg, Germany, March 2007, quoted in "Second Generation Biofuels"
[225] Asahi Shimbun "Biofuel test sales begin after delays." October 10, 2007, http://www.asahi.com/english/Herald-asahi/TKY200710100066.html.
[226] From: DOE http://genomicsgtl.energy.gov/biofuels/2005workshop/2005low_feedstocks.pdf
[227] T. Templeton, "Knowing Poplar's DNA is expected to yield biofuel advances and more." Pittsburgh Post Gazette, Sept 27, 2007.

ArborGen, a company formed from a partnership among International Paper, Mead-Westvaco and New Zealand-based Rubicon, is banking on the use of trees for fuel. CEO Barbara Wells (a former Monsanto CEO) says the company "fits into both the paper and biofuels industries from a feedstock standpoint."[228]

With paper pulp and agrofuels in mind, ArborGen is working to genetically modify low-lignin, cold-tolerant eucalyptus and low lignin poplars and pines in the U.S. Southeast and in Brazil they are testing low-lignin eucalyptus and pine as well as eucalyptus with increased wood content.[229] According to *Ethanol Producer*, ArborGen is seeking to engineer traits that are of use both to the timber industry and to fuel producers. CEO Barbara Wells described ArborGen's GE eucalyptus as "truly a biomass machine" in a recent interview with *Fortune* Magazine.[230] The company believes it may generate an income of US$40 million per year from this one product in Brazil alone.[231]

In August 2007, the company acquired major new U.S.-based seed, orchard, and nursery businesses, along with breeding programs from its corporate sponsors.[232] ArborGen is also allied with several other corporations and universities to develop a $125 million agrofuels research center at Oak Ridge National Laboratory in Tennessee, with funds from the U.S. Department of Energy.[233]

Despite all of the unknowns and potential ecological and social consequences of GE trees , ArborGen is determined to "advance regulatory and public acceptance in priority markets"[234] and is keen to be seen as a "green" company. As such its public relations messaging focuses on the alleged potential of GE trees to reduce deforestation; "Production forestry maximizes the yield per acre and protects native woodlands…Any product, whether it be structural lumber, pulp or ethanol- we want to produce more wood with a smaller footprint. In the future, trees that will supply the vast majority of the world's needs will come from highly productive, managed tree populations rather than natural stands."[235]

Unfortunately, these PR sound bites bear no resemblance to reality. To get a sense of what "highly productive, managed tree populations" look like, we need only look closely at industrial tree monocultures already established in many countries, Brazil, Argentina, Uruguay, Chile, Venezuela, Indonesia, Malaysia, Thailand, Vietnam, China, South Africa, Swaziland, Kenya, Papua New Guinea, Australia, New Zealand…they are already replacing native forests and creating a host of social and ecological problems in their wake.

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[228] N. Zeman, "Growing Forests of Fuel," Ethanol Producer, April 2007
[229] Stephen Kasnet and Luke Moriarty, "Rubicon Interim Report," Rubicon. 02/28/
[230] M. Gunther, "Super trees: The latest in genetic engineering," Fortune, August 2007, at http://money.cnn.com/2007/07/31/technology/pluggedin_gunther_supertrees.fortune/index.htm
[231] Luke Moriarty, Rubicon Annual Shareholder's Meeting, (CEO) http://www.rubicon-nz.com/pdf/CEO_Address_Rubicon_ASM_6_Nov_2006.pdf
[232] Arborgen press release: "ArborGen Signs Agreement to Acquire World-Class Commercial Tree Operations," via BusinessWire, August 24, 2007.
[233] M. Gunther, "Super trees: The latest in genetic engineering," Fortune, August 2007, at http://money.cnn.com/2007/07/31/technology/pluggedin_gunther_supertrees.fortune/index.htm
[234] Rubicon 2006 Review, August 25, 2006. http://www.scoop.co.nz/stories/BU0608/S00439.htm
[235] N. Zeman, "Growing Forests of Fuel," Ethanol Producer Magazine, April 2007

Water

Swamp forest, Borneo. Photo: Mongabay.com

"Without major changes in water management, how are we going to feed a growing population, satisfy increasing demand for meat, and, on top of that, use crops as a major source of fuel?" (David Molden, International Water Management Institute.)[1]

Peter McCornick, Director of the International Water Management Institute, Asia, has pointed out that freshwater usage worldwide has increased six fold over the past 100 years, largely for irrigation, that water resources are dwindling, and that the price of water is predicted to double or triple at least over the coming two decades. Meanwhile, severe droughts are resulting in water shortages in Australia, India and South Central China.[2] Droughts and ice melting at high altitudes are likely to result in declining water supplies in many regions of the world. Against this backdrop, does it make sense to expand agrofuel production? Not only will fuel crops need to be irrigated in many situations, but refineries place heavy demands on water resources as well.

In the U.S., The National Academy of Sciences recently published an analysis of "Water Implications of Biofuels Production in the United States." The report begins by pointing out that water resources in the U.S. are already stressed in many agricultural areas. For example, large portions of the Ogallala (or High Plains) aquifer, which extends from west Texas up into South Dakota and Wyoming, have declined by over 100 feet. Reservoirs along the Colorado River are also at their lowest levels in about 40 years, while over irrigation in the San Joaquin Valley of California has led to salinization of the soils. Changing agricultural practices, including increased production of corn and the construction of a large number of biorefineries will contribute more pressure on these water resources[3] Corn requires a large quantity of water to grow properly. For example, it takes about 2,900 gallons of irrigated water for each corn bushel produced in the state of Oklahoma.[4] This is just for irrigation: refining corn into ethanol requires yet more water.

Water use in refineries is largely from evaporation during the cooling process and during distillation. For every gallon of ethanol produced, about 4 gallons of water are used in the refinery process.[5] A refinery producing 100 million gallons of ethanol per year therefore requires about 400 million gallons of water. Cellulosic ethanol, if it becomes feasible, will likely place even greater demands on water.[6]

In the town of Madrid, Nebraska, for example, 100 residents draw about 10 million gallons of water per year out of the Oglalla aquifer, while two ethanol plants in town draw as much as a billion gallons per year. The state has 16 ethanol refineries operating, another 11 under construction and 30 more proposed. In many communities, refineries are not welcomed, partly because of concerns over water use, as well as emissions and traffic.

China, the third largest producer of ethanol (after the U.S. and Brazil) now has over 400 cities facing water shortages and farmers are forgoing millions of tons of grain production every year. Per-capita availability of water is expected to shrink to alarming levels by 2030. India also faces severe water shortages: 1/6 of food production is irrigated with water pumped from underground aquifers that are depleting. Growing crops for fuels will only make matters worse. Charlotte de Fraiture, an International Water Management Institute (IWMI) scientist and lead author of a study on the water impacts of agrofuels production points out that "Even without increased biofuel production, water scarcity in these countries will worsen, as rising incomes and growing populations boost food demand."[7]

Nestle SA Chief Executive Officer Peter Brabeck-Letmathe said last month at the World Economic Forum in Davos, Switzerland: "If water would have its correct price, then we wouldn't even be thinking about biofuels…If I had to identify one resource I'm worried about, that's water.'"[8]

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[1] M. Casey, "Biofuels plans may cause water shortage." Associated Press, October 10,2007. http://www.wtop.com/?nid=220&pid=0&sid=1265137&page=2

[2] M. McCornick, "Demand For Biofuel Irrigation Worsens Global Water Crisis." Keynote address at "Linkages Between Energy and Water Management for Agriculture in Developing Countries." Hyderabad, India, January 2007.

[3] "Water Implications of Biofuels Production in the United States," the October 2007 Report in Brief, at this site of The National Academies: http://dels.nas.edu/dels/rpt_briefs/biofuels_brief_final.pdf

[4] N. Gollehon, quoted in: Jaclyn, Houghton, "Climatologist: Biofuel production could lead to dust bowl." , October 17,2007 CNHI News Service. http://www.tuttletimes.com/statenews/cnhinsall_story_290133919.html

[5] R. Pate, M.Hightower, C. Cameron, and W. Einfeld. "Overview of Energy-Water Interdependencies and the Emerging Energy Demands on Water Resources." Report SAND 2007-1349C. 2007. Los Alamos, NM: Sandia National Laboratories.

[6] Ibid

[7] C. De Fraiture, M. Giordano, and L. Yongsong, "Biofuels and implications for agricultural water use: blue impacts of green energy" International Water Management Institute. 2007 http://www.iwmi.cgiar.org/EWMA/files/papers/Biofuels%20-%20Charlotte.pdf see also: Charlotte de Fraiture, "Biofuel crops could drain developing world dry." Fro SciDevNet, May 11, 2007, available at: http://www.checkbiotech.org/green_News_Biofuels.aspx?Name=biofuels&infoId=14648

[8] M. Carr, "U.S. Energy Policy may strain water supplies, Nestle Chief says." Bloomberg. January 26, 2007. http://www.bloomberg.com/apps/news?pid=20601170&sid=azVALr2RixlQ&refer=home

V: Plantations, pulp mills & carbon offsets

"Modern industrial forestry aims at the production of ever increasing volumes of wood per hectare regardless of its impacts on people, soils, water or biodiversity."[236]

The Center for International Forestry Research estimates that as of 2003, there were some ten million hectares of 'fast-wood' plantations worldwide (trees that can be harvested within ten years), an area that is increasing by about one million hectares a year. Slower growing (mostly pine) plantations cover another 20-30 million hectares in New Zealand, the southern U.S., Brazil, Chile, Australia, Spain, South Africa and Uruguay.[237]

Tree monocultures supply the pulp and paper industry and manufacturers of specific products (rubber, teak, charcoal, etc). They are also increasingly used for the newly created 'carbon offset' forestry projects. These are tree plantations that are grown specifically for their carbon sequestering capacity, which is bought and sold on carbon markets. Tree plantations are also established to supply fuel wood or for protective reasons, like stabilizing erosion. Forests are frequently logged by timber interests, prior to being converted into plantations.

Global paper use grew 423% between 1961 and 2002.[238] In 2005, world consumption of paper and paperboard was more than 352 million metric tons.[239] Over one-fifth of all wood harvested ends up as paper and it takes 2-3.5 tons of trees to make one ton of paper. The majority of paper products - packaging, newsprint and mail order catalogues, for example - are thrown away quickly, releasing their carbon stores as they decompose. These products account for up to 40% of the rubbish thrown into municipal solid waste dumps in northern countries.[240]

Pulp mill pollute and poison the environment.
Photo: Wally Menne

The pulp and paper industry is also the fifth largest industrial consumer of energy. The revenues of large multinational corporations like International Paper rank higher than national GDP in at least 75 countries, and they thus yield tremendous power and influence.

The U.S. is the largest producer and consumer of paper products, much of which comes from the southern part of the country, the largest paper producing region in the world. In fact, 60% of the logging in the U.S. occurs in the South. As a result, the area of natural forest across the southern U.S., which used to cover over 142 million hectares, has

[236] "Pulp Mills: from monoculture to industrial pollution." World Rainforest Movement 2005, pg 12
[237] C. Cossalter and C. Pye-Smith, "Fast Wood Forestry: Myths and Realities." CIFOR 2003 http://research.yale.edu/gisf/assets/pdf/tfd/ifm/Cossalter%20and%20Pye-Smith%202003.pdf
[238] "Pulp Mills: from monoculture to industrial pollution." World Rainforest Movement 2005, pg 15
[239] http://earthtrends.wri.org/searchable_db/index.php?theme=9&variable_ID=571&action=select_countries
[240] "Pulp Mills: from monoculture to industrial pollution." World Rainforest Movement 2005, pg 17

declined dramatically to about 74 million hectares. It is projected to be reduced to only 62 million hectares by 2040.[241] In the past 50 years, 13 million hectares have been converted to pine plantations.

If U.S. Forest Service projections hold true, over the next 40 years, a total of 109 million hectares of southern forests will be logged, approximately 26 million hectares will be sprayed with toxic chemicals, and an additional nine million hectares will be converted to industrial plantations.[242]

This has come at great expense to biodiversity. Forests in the southern U.S. contain some of the most biologically rich ecosystems in North America: many of the region's plant and aquatic species can be found nowhere else in the world. Southern forests contain the highest concentration of tree species diversity in North America, the highest concentration of aquatic species diversity in the continental U.S., including the richest freshwater ecosystem in the world, the highest concentration of wetlands in the U.S. (75% of which are forested) and the world's most biodiverse temperate forests. Half of the forested wetlands of the South (14 million hectares) have already been lost, and fourteen forest communities (such as the longleaf pine ecosystem) have declined to occupy only 2% of their original range. There are more threatened forested ecosystems in the southern U.S. than any other region of the country.

Worldwide, the pulp industry is growing extremely fast. Plans are underway for a massive increase in production over the next five years (over 25 million tons). This is an average expansion of five million tons per year, compared to a rate of expansion of about one million tons per year between 1994 and 2004. This expansion is slated to occur mainly in the Global South and is driven in large part by the very rapidly growing market for paper products in China.[243] Massive new industrial tree plantations and pulp mills are planned in Brazil, Uruguay, Chile, Australia, South Africa, Vietnam, Indonesia, India, Laos and Russia.

The pulp industry operates by harvesting trees from native forest, and/or establishing plantations to ensure a continued supply. Establishing plantations involves clearing all remaining vegetation (sometimes burning it off) and then 'preparing' the soil. This results in massive releases of carbon from vegetation and soils. Trees are then planted (usually introduced eucalyptus, acacia or pine). These trees, planted in rows and all of the same species and age, are particularly vulnerable to disease and pest infestations, and require applications of fertilizers, pesticides and herbicides. In the U.S., for example, from the North Carolina to Texas coasts, there has been a documented 800% increase in the use of chemical fertilizers in plantations since 1990; and a doubling in the use of chemical fertilizers is projected through to 2040.[244]

Meanwhile, people who lived on or used the lands prior to the arrival of the pulp industry are displaced. The various species that once inhabited the native forest or grasslands disappear and soils and waterways are depleted and contaminated.

The trees themselves bring one set of problems, and the pulp mills bring another. Pulp mills are among the most polluting of industrial facilities. They require a large amount of energy and water. The pulp is bleached using chlorine gas, chlorine dioxide, oxygen and hydrogen peroxide or ozone. Chlorine is extremely dangerous and in some forms can be explosive, corrosive and toxic: it binds with other organic compounds to create a family of

[241] "Southern Forests Research Assessment." US Forest Service, http://www.dogwoodalliance.org/content/view/56/47/
[242] "Southern Forests Research Assessment." US Forest Service, http://www.dogwoodalliance.org/content/view/56/47/
[243] C. Lang, "Banks, Pulp and People." http://chrislang.org/2007/06/30/banks-pulp-people-2/
[244] "USDA Forest Service Southern Forest Resource Assessment" http://www.srs.fs.usda.gov/sustain/

toxins, including the notorious dioxins, furans and other organochlorines. A large pulp mill requires a huge amount of water and creates massive amounts of heated effluent (1,000 liters per second for a 600,000 metric ton plant).[245] The toxins released are persistent and have been shown to be lethal to fish populations, causing masculinization, hormone disruption, liver and cell function disorders, and a host of other problems. At the same time, pulp mills also create air pollution, as residues are burned for energy production. This releases yet another suite of chemicals known to cause cancer, disrupt hormone functioning and cause respiratory infections.

The pulp industry is highly mechanized and does not provide many job opportunities. For example, in the U.S., the Southern Forest Resource Assessment verifies that despite expansions in the industry and increased logging across the South, the wood products industry's share of employment in the South dropped from 3.5% in 1969, to 1.93% in 1997.[246]

In Brazil, the Veracel mill in Bahia, co-owned by Stora-Enso (Finnish) and Aracruz Cellulose (Brazilian), operates in an area with an extremely high rate of rural exodus, as small scale farmers and cattle producers have been forced out. Between 1970 and 1985, Bahia state lost more than 70% of its native forest to pulp companies. Today, only about 4% of the biodiverse Mata Atlantica forest remains. The Veracel pulp mill cost US$1.25 billion to construct, with plantations and facilities covering 105,000 hectares of land, yet it employs less than 750 people.[247] Working conditions are poor. The company has been engaged in numerous labor-related lawsuits and has been responsible for contamination of waterways and destruction of biodiversity through agrochemical use. Work in tree plantations in general is considered to be among the most dangerous forms of employment. It is usually seasonal, outsourced and poorly paid.

Protests against pulp mills are ongoing in Thailand, Indonesia, Brazil, Chile and Uruguay, to mention just a few. The essence of these conflicts is captured in the following quote from a spokesman for the Community Forest Recovery Committee in Nong Yak village in Thailand: "We began to protest when we realized that a eucalyptus plantation is not a forest. Before, the natural forest was very important to us. We gathered mushrooms, bamboo shoots, insects and herbs for food. There was water and there were animals and birds. The forest was cool and peaceful. Eucalyptus plantations give us no benefits, there is nothing to eat. For fifteen years we lived with the eucalyptus, protesting against it. We went to the sub-district council, to the district chief, to the provincial government, and then to Bangkok. We told them the problems. They said they understood but could not see a solution. They said they would solve the problems then they did nothing. For 15 years we had this problem. I wondered, were they stupid? They could not see simple solutions. If there is no forest we cannot live. Three years ago we decided to solve the problem by ourselves. We cut down the Forest Industry Organization's eucalyptus trees on 35 rai (5.6 hectares) of land. The police tried to arrest us, but they couldn't –there were too many of us."[248]

In August of 2007, Tupinikim and Guarani peoples living in Brazil were given back more than 18,000 hectares of land that had been taken from them over 40 years earlier and illegally occupied by Aracruz Cellulose. Aracruz is the world's largest producer of bleached eucalyptus pulp, with a production capacity of close to 3 million tons per year, supported

[245] "Pulp Mills: from monoculture to industrial pollution." World Rainforest Movement 2005, pg 20
[246] "USDA Forest Service Southern Forest Resource Assessment" http://www.srs.fs.usda.gov/sustain/
[247] "Arguments to show that Veracel should not receive certification." World Rainforest Movement, August 14, 2007, http://www.wrm.org.uy/
[248] Spokesman quoted from Community Forest Recovery Committee in Nong Yak village, Thailand. In: Watershed Magazine 35 1998.(reprinted on pg 21 in "Pulp Mills: from monoculture to industrial pollution," World Rainforest Movement)

by over 220,000 hectares of monoculture eucalyptus plantations. When Aracruz moved into the area, it expropriated lands and then systematically destroyed villages.[249] Native forests were cut and replaced with eucalyptus plantations, and waterways and soils were contaminated. The livelihoods of the Tupinikim and Guarani people were destroyed.

After a long series of failed negotiations, reoccupations and often violent re-evictions involving interventions by the company, the Brazilian government and police finally acceded to the successful restoration of land rights. The land, now covered in eucalyptus, is no longer the rich ecosystem it once was, and restoring it will take considerable effort and time, but the victory is an important one.

Replacing native forest ecosystems with monoculture plantations of soy, oil palm, maize, eucalyptus and pine, creates health problems that should serve as an indication of their failure to support life. These stem not only from the outright displacement of peoples, and declining living standards, but also from contamination due to the excessive use of agrichemicals like Roundup, paraquat and various other pesticides and herbicides, and the overall depletion of water and soil resources.

However, there are many other less obvious impacts on human health. Deforestation and land use change are increasingly viewed as important factors affecting the distribution of disease agents, and the health of human and animal populations.[250]

As inroads into forests make them accessible and habitats are destroyed, contact between humans and animals becomes more common, resulting in increased instances of zoonotic disease transmission (between animals and people). Ebola virus, for example, is thought to have crossed over from primates to humans, as a result of wild habitats being destroyed.[251] Similarly, the Nipah virus, found in Asian fruit bats, has crossed over to humans as a result of impingement on the bats' habitat by logging and palm oil plantations. Diseases like Malaria, Dengue fever, Leishmaniasis and Hantavirus have all increased due to changes in land use, and consequent resettlement patterns and favoring of host habitats.[252]

Many of the human health impacts of industrial plantations remain unremarked however. For example, there is a known association between some species of eucalyptus, commonly used for pulp and fuel wood plantations, and the fungus *Cryptococcus gattii*, which can cause fatal meningitis. The possible implications for people living near eucalyptus plantations, which are widespread, have only recently been pointed out.[253]

Carbon offset forestry

Yet more demand for monoculture tree plantations comes from the burgeoning and somewhat mysterious market for carbon offsets. The idea is that trees' ability to sequester carbon during growth can be bought and sold as a commodity. Corporations and

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[249] "Brazil: Historic Indigenous Peoples' Victory: Tupinikin and Guarani peoples reconquer their lands." World Rainforest Movement Bulletin. Issue 122, September 2007. http://www.wrm.org.uy/

[250] J.A. Patz, et al. « Unhealthy Landscapes: Policy recommendations on land use change and infectious disease emergence." Environmental Health Perspectives: 2004. 112: 1092-1098

[251] D. Quammen, "Deadly Contact. How animals and humans exchange disease." National Geographic Magazine. October 2007. http://magma.nationalgeographic.com/ngm/2007-10/infectious-animals/quammentext.html?fs=www7.nationalgeographic.com

[252] C. Bryson Hall, "Environmental change may be boosting diseases UN." Reuters, 2005 http://www.planetark.com/avantgo/dailynewsstory.cfm?newsid=29656

[253] Comments submitted to U.S. Animal and Plant Health Inspection Service (APHIS 2007-0027-0226). See also: Carman et al. "Groups Ask U.S. Health and Environmental Agencies to Investigate Potential Link Between Pathogenic Fungus and Introduced Genetically Engineered Trees." 2007. SayNoToGMO. http://www.saynotogmos.org/ud2007/ujun07a.php

individuals who emit too much greenhouse gas (usually in the industrialized countries of the North), can 'offset' their emissions by planting trees elsewhere to absorb their excess (usually in the developing countries of the South). This is attractive to countries and industries where emission reductions are mandated by the Kyoto Protocol and to individuals and businesses that want to minimize their 'carbon footprint.'

Missing from this logic, however, is a basic understanding of the global carbon cycle. Global warming is fundamentally caused by bringing fossil carbon that has been safely sequestered in the earth's crust out of its resting place and dumping it into above-ground circulation, where it cycles between the atmosphere and biosphere and contributes to global warming. The only real way to address global warming is to stop drawing more fossil carbon from underground reserves as the above ground carbon pool is overflowing. Offsetting fossil-fuel emissions by planting trees does not address the cause of climate change, because it only affects the above ground carbon cycle, with trees acting as a 'temporary' carbon sink - trees do absorb during growth, but re-release it when they decay or burn. Trees are thus a 'fragile' means of storing carbon, not least because it is impossible to know and predict when and how that release will occur.

The absurdity of carbon offset plantations is made yet more obvious given the fact that it is virtually impossible to calibrate equivalencies between carbon that is stored relatively permanently in underground fossil fuel deposits and carbon that is held temporarily in a tree or circulating in the atmosphere. Such measurements are essential to an effective offset scheme. But making them would, in the words of Larry Lohmann, require precise knowledge "of the intercoupling of ecological, social, geological, political, hydrological, bureaucratic, biochemical, economic, and atmospheric systems."[254] The fact that this simply isn't possible, however, has not stopped the development and marketing of carbon offset forestry projects.

Under the current system, a utility company, or an individual person, no matter how excessive their emissions can claim to be 'carbon neutral' by planting trees (or simply paying someone else to do so). Unfortunately, these planted trees bring with them the same problems as plantations for pulp mills: displacement of indigenous people, little if any employment opportunities, destruction of native ecosystems and biodiversity, and the contamination and depletion of waterways.[255] Finally, to add insult to injury, if a full account of all the energy inputs involved is undertaken including indirect and direct effects on land use, soil impacts, and emissions from the displaced ecosystem etc. carbon offset plantations often result in a net increase in greenhouse gas emissions.[256]

One classic example of a carbon offset forestry project granted credits under the Kyoto Protocol's Clean Development Mechanism (CDM) is that of Plantar, a company in Brazil that produces pig iron for automobile construction. Plantar applied for CDM funding for its operations in Minas Gerais, where eucalyptus is grown to produce charcoal to fuel the iron production. Plantar claimed that they were going to switch from using charcoal to coal unless they were granted CDM funding through the World Bank's Prototype Carbon Fund. The company also claimed to be deserving of further funding on the basis of the carbon stored temporarily by the monoculture eucalyptus plantations required for charcoal production, even though the trees are harvested after about seven years and burned,

[254] L. Lohman, "The Carbon Shop: Planting New Problems." World Rainforest Movement Briefing Paper, 2000, http://www.wrm.org.uy/
[255] See WRM Plantations Campaign Briefings 1. Pulpwood plantations: a growing problem and 2. Ten replies to ten lies.
[256] See for example: "Carbon Sink Plantations in the Ecuadorian Andes: Impacts of the Dutch FACE-PROFAFOR monoculture tree plantations project on indigenous and peasant communities." Acción Ecológica Ecuador May 2005, World Rainforest Movement. http://www.wrm.org.uy/

releasing their stored carbon back into the atmosphere.[257]

The tactic of claiming 'avoided emissions' is clearly fraught with loopholes, but even so, the carbon storage potential of eucalyptus plantations cannot be substantiated. Nonetheless, the Plantar project was still supported. For people living in the area, the reality of Plantar's operations could not be further from the 'green' image conveyed by the company. The lands on which Plantar operates, amounting to thousands of hectares, are 'devolutas,' meaning lands without title. They were granted to Plantar in the late 1960's and seventies, by the military dictatorship that ruled Brazil at the time, even though Brazilian law stipulates that such lands cannot be granted to corporations, only to peasants.

When Plantar arrived, the indigenous peoples, including Quilombolas communities, were displaced, as was the native Cerrado ecosystem upon which their livelihoods depended. Some took jobs with the company, but working conditions are poor. The extraordinarily biodiverse Cerrado has now been mostly replaced by an industrial monoculture of exotic and invasive eucalyptus.

Another example involves the Dutch FACE (Forests Absorbing Carbon Emissions) Foundation. Established by a consortium of Dutch utility companies, to offset emissions from their facilities by planting trees in various locales, including the Ecuadorian Andes, FACE now operates as an independent non-profit-making organization. The Ecuadorian project was sold as a means to "improve degraded lands" in high-altitude Sierra. The local people were contracted to plant and tend the trees, mostly a pine species not native to the area. The trees did not grow well and people found themselves burdened with 20 to 30-year contracts for a failing project that ended up costing the communities money, labor and lands, rather than providing any benefit.[258]

The high-altitude Ecuadorian Paramos are an ecosystem comprised of deep volcanic soils that retain a large amount of water and are therefore critical to water supply downstream. They are also extremely delicate, in that disturbance can result in loss of water retention and the drying and decomposition of organic materials, hence large releases of stored soil carbon. Planting pine trees not only damages the soils but increases the risk of forest fire: thus the project may well have resulted in a net increase in carbon emissions. In sum, "the common land, community labor and much of the paltry but crucial savings of peasant communities have been transferred to a private firm for production of a new commodity, which, though largely notional, has the material effect of shoring up an anachronistic pattern of fossil fuel use in the Netherlands."[259]

These carbon offset forestry projects are just a few examples of a new and growing market in tree growth. In essence, they are a new brand of colonialism, in which lands in the South are usurped into the service of 'offsetting' the excessive consumption patterns of people in the North. Indigenous people and biodiversity are pushed aside, and a false mirage of 'climate protection' is presented, to bolster a new market based yet again on large-scale industrial monoculture tree plantations.

FSC Certification of monoculture tree plantations

The Forest Stewardship Council (FSC) was established to "promote environmentally responsible, socially beneficial and economically viable management of the world's forests,

[257] L. Lohman, "Carbon Trading: a Critical Conversation on Climate Change, Privatization and Power." Development Dialogue no.48, Cornerhouse, Sept 2006
[258] Ibid.
L. Lohman, "Carbon Trading: a Critical Conversation on Climate Change, Privatization and Power." Development Dialogue no.48, Cornerhouse, Sept 2006. pp 235-6

by establishing a worldwide standard of recognized and respected Principles of Forest Stewardship".[260]

Unfortunately, the FSC has undermined its own intent by granting certification to large scale industrial monoculture tree plantations which bear very little resemblance to forests and are in fact a cause of both deforestation and the displacement of indigenous peoples. Certified as 'ecologically and socially sustainable forests,' these plantations are often areas in excess of 100,000 hectares, all a single species, and often exotic introduced species. They are grown on lands that were formerly occupied by indigenous peoples who relied on healthy, diverse forests for food, materials, medicines, and clean water.

The World Rainforest Movement (WRM) has detailed several case studies, from Brazil, Thailand and South Africa, which lay out in detail how and why certification of monoculture plantations is untenable and what the effects of false certification are.[261] FSC's plantation certifications have often been awarded without adequate knowledge of on-the-ground circumstances and without proper consultation with, or the participation of affected communities. They have legitimized industrial monoculture tree plantations, undermined local and regional efforts to pursue environmental and social improvements, closed the door on community-based forest management, inappropriately rewarded industry, and ultimately, made it impossible for consumers to exercise meaningful choices.

Burned Eucalyptus plantation, Kenya.
Photo: Rhett A Butler

For example, South Africa currently has about 1.8 million hectares of timber plantations. Another 1.6 million hectares are planted, even though they are not formally managed or licensed and the timber industry takes no responsibility for managing or rehabilitating.[262] These plantations were initially planted with the 'intention' of supplementing natural timber resources for local use, and reducing the need for imports. The scenario shifted however, and now they are used to provide exports for pulp, paper and woodchips. South Africa's plantations have resulted in a litany of problems, including social disruption; displacement and the dispossession of people; the destruction of biodiversity resources and natural landscapes; the drying out of water resources; the contamination of rivers, streams and wetlands with pesticides, oils and fertilizers; and damage to soils from compaction, contamination and erosion.[263] These are basically the problems of industrial tree monocultures the world over.

Employment on South African plantations is typically sparse, as companies find it more profitable to outsource, hiring contract labor at a lower cost, avoiding payments for medical assistance schemes, insurance, pensions and housing. They also avoid the 'problem' of having to deal with labor unions. This, in combination with an increasing reliance on mechanization and chemical use, rather than manual labor, make plantations a

[260] "FSC Certification of Tree Plantations in Thailand and Brazil: Certifying the Uncertifiable." World Rainforest Movement 2003 (pp 105, cite FSC 2000:1)
[261] "FSC Certification of Tree Plantations in Thailand and Brazil: Certifying the Uncertifiable." World Rainforest Movement 2003; see also: R. Carrere, "Greenwash: A Critical analysis of FSC certification of industrial tree monoculture in Uruguay." 2006 http://www.wrm.org.uy/actors/FSC/index.html.; See also: "The People or the Paper Industry?" (and other materials) at FSC-Watch http://www.fsc-watch.org/archives/?policy~=Plantations
[262] W. Menne, "The Social Impacts of Certified Timber Plantation in South Africa and the Implications Thereof for Agrofuel Crops." Global Forest Coalition 2007
[263] Ibid

poor source of rural employment.

In spite of these problems, over 80% of South Africa's plantations have been granted FSC certification as 'responsibly managed, economically viable and socially and ecologically sustainable forests'. Even Plantar's plantations of eucalyptus for charcoal production in Brazil have been granted FSC certification; and Veracel is currently seeking certification.

By granting certification, FSC gives a 'green light' to industrial monoculture tree production, a stamp of approval that is good for business (companies flaunt these certificates as much as possible), but bad for indigenous peoples, biodiversity, and for well-intentioned consumers, who purchase certified products under the mistaken impression that they are doing something 'good for the environment.' The failure of FSC to fulfill its intended purpose casts severe doubts on the potential for other certification schemes to succeed, including those now under development for agrofuel production, as pointed out in a recent report from the OECD.[264]

Defining plantations as forests

Semantics is also a key issue in the world of industrial tree monocultures. The FAO, assigned the task of assessing the status of the world's forests, defines industrial monocultures as 'productive plantations,' one of a variety of types of 'planted forest' (that is, forests of introduced and/or native species established through planting or seeding, mainly for production of wood or non-wood goods).

There is little resemblance between a tree plantation and a forest, yet plantations are not only granted status as 'forests,' but also indiscriminately included in tallies of forest cover. This leads to misconceptions that are convenient for industry, but disastrous for forests and indigenous people.

For example, in their reporting on the state of the world's forests, the FAO claims that Asia is experiencing an increase in forest cover. The reality is that native forests are rapidly being replaced by monoculture plantations of acacia and palm oil (Indonesia and Malaysia) and pine and poplar (China). Replacing native forests with plantations, which often follows on the heels of logging concessions, is a global trend that is largely obscured by the FAO's definition of plantations as forests.

This simple matter of definition has a massive impact by concealing the many negative realities of deforestation and degradation that result from tree plantations. According to the World Rainforest Movement, "Governments, consultants, multilateral agencies, aid agencies and, more importantly, large corporations use this concept of 'planted forests' as a means of hiding the impacts of these plantations from the broader public. People in Finland are told that Metsa Botnia is 'planting forests' in Uruguay or that Stora Enso is 'planting forests' in Brazil and are in this way convinced that those companies are doing something positive abroad. It would be much more difficult to convince them that planting 'green deserts' or 'dead forests' in southern countries is acceptable. But this is precisely what they are doing. [265]"

The fact that large amounts of land are given over to industries for corporate use and

[264] "OECD: timber certification sets bad example for biofuels. FSC also under attack from Australia, Finland, Canada, U.S.?" FSC-Watch http://www.fscwatch.org/archives/2007/09/26/OECD_timber_certification_sets_bad_example_for_biofuels_FSC_also_under_attack_from_Australia_Finland_Canada_US

[265] "When will the FAO stop calling fast wood plantations "forests"?" World Rainforest Bulletin, Issue 117, April 2007.

profit, that people are displaced from those lands, that native ecosystems are destroyed…all are concealed within the sterile and completely misleading definition of 'planted forests.'

Additionally, this definition caters to the mistaken idea that trees, wood and wood products are an infinitely renewable resource. Clearly humans can plant, grow and harvest trees, but this cannot be equated with creating a forest with all of its biodiverse elements and ecosystem functions! The misconception that wood can be infinitely renewable is a critical part of the current trend to develop capacity for using wood to produce electricity, heat homes, provide cooking fuel, power industries, provide materials for plastics, chemicals and transport fuel as well. The U.S. Department of Energy's Biomass Program enthusiastically promotes the idea that, "instead of using fossil fuels to produce energy and industrial products, our vast domestic biomass resources can be used." And they go on to describe what they consider to be "the ultimate deployment strategy," an "integrated biorefinery… that uses biomass to make a range of fuels, combined heat and power, chemicals, and materials in order to maximize the value of biomass."[266]

Towards this end, the U.S. DOE is involved in research on feedstocks and supply (including genetically engineered trees and grasses), enzymes (again genetically engineered), and into products that can be made from residues. If the U.S. moves in the direction of using forest resources for energy and fuel production, this could result in the 'export' of the less-lucrative pulp industry to other areas, possibly in the Global South, resulting in even more deforestation and the further replacement of native forests with monoculture tree plantations. The problem, of course, is one of scaling. Substituting biomass as a source of energy to replace fossil fuels simply cannot be achieved sustainably without a massive scale-back of demand. But incentives and policies to date have focused on developing these 'renewable alternative energies' rather than on reducing demand. If wood is to fulfill so many demands, the replacement of native forest ecosystems by industrial tree monocultures will accelerate dramatically. What this will mean for people and biodiversity is perhaps best summed up in the names given to industrial tree monocultures by those who live alongside them: "dead forests", "green cancer", "planted soldiers" or "selfish trees".

[266] "U.S. Department of Energy, energy efficiency and renewable energy biomass program." http://www1.eere.energy.gov/biomass/printable_versions/program_areas.html

Nitrogen and agrofuels

The impacts of nitrogen compounds produced as a result of fertilizer use and from exhaust emissions are vastly, dangerously overlooked. Nitrous oxide (N20), for example, is 296 times more potent as a greenhouse gas than carbon dioxide, and persists for an average of 100 years. It also contributes to the formation of nitric oxides (NOx), which play a role in ozone depletion. According to a 2007 United Nations report -"Human Alteration of the Nitrogen Cycle", human activity now releases around 125 million metric tons of nitrogen from agricultural activities and fossil fuel combustion a year, on top of approximately 113 million metric tons that are emitted annually from natural sources.[1] Atmospheric concentrations of N2O have risen about 17% since the industrial revolution.

As most crops deplete soil nitrogen, a necessary plant nutrient, it is necessary to add fertilizer unless careful soil management is practiced. A recent study of the rising demand for fertilizers as a result of the agrofuels boom predicts that, by 2012, agrofuels will increase demand for fertilizers by 6.4 million tons, 42% of it for use in the U.S. and 31% in the EU for maize and rapeseed cultivation.[2]

Fossil fuels and nitrogen fertilizers

Nitrogen fertilizers are manufactured using natural gas. As natural gas reserves in the U.S. and other countries have been depleted and prices have risen, fertilizer manufacturing has moved elsewhere. As a result, nitrogen fertilizers must be imported in the U.S. and some other countries.[3] The fossil fuel emissions resulting from the manufacture and transport of these fertilizers are often overlooked in Life Cycle Analyses of agrofuels. They are also overlooked in discussions of "energy independence." Agriculture as it is practiced now, with heavy reliance on fertilizers and agrichemicals, depends heavily on fossil fuels.

Nitrogen and water pollution

Fertilizers are washed out in runoff from farmlands and into streams, rivers, lakes, ponds, and eventually into coastal waters. Adding fertilizers to waterways causes excessive algae growth (good for mosquito larvae), and when the algae die and decay, depletion of oxygen is held in the water (the process of eutrophication). The water becomes "dead." The United Nations Environment Program warned that hypoxic 'dead zones' in oceans, linked to runoff of nitrates from agricultural practices are increasing rapidly.[4] In 2007, the U.S. National Oceanic and Atmospheric Administration (NOAA) reported that the Dead Zone spreading from the mouth of the Mississippi River into the Gulf of Mexico had achieved record size, at 24,990 sq km[5]. As the river runs its course, it collects runoff, including large quantities of fertilizer, from farming areas all along its banks and those of tributaries. The increased production of corn, one of the most fertilizer intensive crops grown (currently about 40% of nitrogen fertilizers used are for corn production[6]), has increased fertilizer runoff and thus contributed to the expansion of the dead zone.[7] The same is occurring in the Chesapeake Bay, as mid Atlantic farmers switch to growing more corn.[8,9] Over the past 40 years, the volume of the Chesapeake Bay's hypoxic zone has more than tripled. Nitrogen from fertilizers, as well as pesticides and herbicides contaminate groundwater and can lead to toxic levels of nitrite and nitrate levels in drinking water.

Soil bacteria and nitrogen

Bacteria in soils metabolize nitrogen, releasing nitrogen oxides into the atmosphere. Soil emissions of nitrogenous compounds are dramatically increased when soils are disturbed, and when nitrogen compounds are added. This effect is much larger in tropical soils, which is precisely where agrofuel monoculture crops are likely to expand most. No-till methods and the cultivation of nitrogen fixing legumes such as soy are also linked to higher N2O emissions.[10,11] Major soy producing countries like Argentina and Paraguay practice no-till soy production, and are now expanding to fulfill demand for biodiesel.

Nitrogen and rainfall

Nitrogen compounds become airborne and are deposited with rainfall. This has resulted indirectly in fertilization of the entire surface of the globe. The effects of such a disruption of the global nitrogen cycle are poorly understood, but could be monumental and complex. Invasive weeds can thrive in soils that were once too poor for them to grow. For example, in the Mojave and Sonoran Deserts of the southwestern U.S., non-native grasses have spread prolifically at the expense of plant species adapted to poorer soil. This has created a fire hazard in an ecosystem poorly equipped to regenerate after fire.[12] Similarly, populations of fungi and lichen, which play a critical role in sustaining healthy ecosystems, are negatively impacted by nitrogen.[13] Recently it was discovered that nitrogen from rainfall causes peatlands to release carbon. Given the massive amounts of carbon held in peat, this is a very alarming discovery.[14]

Nitrogen and climate change

A recent study of N_2O emissions from agrofuels revealed that some contribute up to 70% more to global warming via N_2O emissions than they do to cooling via avoided CO_2. emissions. This is especially true for fuels derived from rapeseed (about 80% of European production) and corn (virtually all production in the U.S.). In the author's words: "Here we have concentrated on the climate effects due to required N fertilization and we have shown that the use of several agricultural crops with high N/C ratios for energy production can readily lead to N_2O emissions, large enough for several crops to cause net climate warming instead of cooling by saved fossil CO_2."[15]

Dr Dave Reay, of the University of Edinburgh, used the findings to calculate that with the U.S. Senate aiming to increase maize ethanol production sevenfold by 2022, greenhouse gas emissions from transport will rise by six percent.

In sum, with the impacts of nitrogen use rightfully incorporated into calculations, it is clear that growing agrofuels intensively to mitigate climate change could be completely counterproductive.

[1] "Human Alteration of the Nitrogen Cycle, threats, benefits and opportunities." UNESCO-SCOPE Policy Brief: April 2007. http://unesdoc.unesco.org/images/0015/001509/150916E.pdf
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[3] M.M. Baker, and C. Craig, "From Food Shocks to Famine: The Impact of Biofoolery and 'Global Sourcing'." Executive Intelligence Review. June 7 2007. http://www.larouchepub.com/other/2007/3435food_inflation.html
[4] "Dead Zones Emerging as Big Threat to 21st Century Fish Stocks", UNEP News Release 2004/14, http://www.unep.org/GC/GCSS-VIII/PressRelease_E2.as
[5] T. Cox, "As ethanol demand grows, so does 'Dead Zone" in Gulf of Mexico." Bloomberg News. International Herald Tribune. July 23, 2007. http://www.iht.com/articles/2007/07/22/bloomberg/bxdead.php; See also: (From: N. Rabalais, Louisiana Universities Marine Consortium.) http://www.gulfhypoxia.net/shelfwide07/PressRelease07.pdf.
[6] C.R. Frink, P.E. Waggoner and J.H. Ausubel, "Nitrogen Fertilizer: Retrospect and Prospect." Washington D.C. PNAS 1999, 96: 1175-1180
[7] Tony, Cox, "Ethanol Demand Seen Harming U.S. Fishermen." Bloomberg, July 23, 2007.
[8] Tom Simpson and Daphne Pee, "How Corn Ethanol Could Pollute the Bay." Washington Post, Aug 26, 2007
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[10] Haydée S. Steinbach* and Roberto Alvarez, "Changes in Soil Organic Carbon Contents and Nitrous Oxide Emissions after Introduction of No-Till in Pampean Agroecosystems", J Environ Qual 35:3-13 (2006), http://jeq.scijournals.org/cgi/content/abstract/35/1/3].
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[12] "Potential Effects of Atmospheric Nitrogen Deposition on Alien Annual Plants in the Mojave Desert." US Geological Service, Western Ecological Research Center, April 2003, http://www.werc.usgs.gov/pubbriefs/brookspbapr2003.pdf
[13] K.K. Treseder and K.M. Turner, "Sequestration of Carbon Mycorrhizhal Fungi Under Nitrogen Fertilization." American Geophysical Union, 2005, abstract # B51A-0183. http://adsabs.harvard.edu/abs/2005AGUFM.B51A0183T
[14] Håkan Rydin, "Nitrogen rain makes bogs contribute to climate change," 2006, http://www.chemlin.net/news/2006/dec2006/nitrogen.htm
[15] P.J.Crutzen, A.R. Mosier, K.A. Smith, W. Winiwarter, "N2O release from agro-biofuel production negates climate effect of fossil-fuel derived "Co2" savings." Atmos. Chem. Phys. Discuss., 2007, 7, 11191

VI: Cellulosic fuels, GE trees and the contamination of native forests

With concerns mounting about the competition between food and fuel due to crop-based agrofuels, the agrofuels industry is heavily promoting fuel produced from woody sources (such as trees) as the solution to this conflict.

The claim that these so-called 'second generation' cellulosic feedstocks will eliminate food-fuel competition, however, is false. In many countries of the world, industrial timber plantations already compete with agricultural land. The rising incentive to grow tree plantations to feed the rising global demand for timber caused by producing fuel from trees will only exacerbate this competition for land between timber plantations and agriculture.

In the Lumaco District of Chile, for example, the expansion of pine and eucalyptus plantations is taking over agricultural land used by indigenous Mapuche communities. Since 1988, plantations in this region increased from 14% of the land to over 52% in 2002. This farmland conversion is forcing people off their land and leading to escalating rates of poverty. In the Lumaco District, 60% of the people live in poverty, with one-third in extreme poverty. The government of Chile provides financial incentives to encourage people to stop growing food and grow trees instead. Lucio Cuenca B., the National Coordinator for the Observatorio Latinamericano de Conflictos Ambientales in Santiago, Chile explains:

> *The response by the State has been to provide favorable legal and social conditions to enable the forestry companies to fulfill their production goals and continue their expansion. One the one hand, repression and criminalization [of Mapuche opposition], on the other … rerouting subsidies formerly aimed at the large forestry companies towards the small farmers and indigenous land owners [that] oblige them to convert to forestry activities. Thus the strategy for expansion becomes more complex, operating through political and economic blackmail that leaves no alternatives*.[267]

The rising economic incentive to grow trees resulting from the enormous increase in demand for wood generated by use of trees for cellulosic fuels will only worsen the conflicts between communities who need land for food, and companies who want the land to grow trees.

Another consequence of the rising emphasis on cellulosic fuels as the next generation of biofuels technology is the accelerated promotion of fast-growing, easily-digested genetically engineered (also called genetically modified or GMO) trees. Genetically engineered (GE) trees have been widely promoted as a future feedstock for cellulose-based fuels. Additional genetic research is targeting oil palm and jatropha for greater and higher quality oil production for biodiesel.

In the U.S., GE low-lignin poplar plantations for ethanol production are being proposed for 'unused' agricultural land. A statement by Purdue University in the U.S. touts the possibilities: "Researchers believe that using the hybrid poplar in its present form could produce about … 700 gallons of ethanol [per acre annually]. Changing the lignin composition could increase the annual yield to 1,000 gallons of ethanol per acre, according to experts. Planted on 110 million acres of unused farm land, this could replace 80 percent of the transportation fossil fuel consumed in the United States each year."[268] Besides greatly exaggerating the potential benefits of low-lignin trees, this statement encourages us to accept the widely peddled myth that any "unused" farmland is better suited to

[267] Lucio Cuenca, "Observatorio Latinoamericano de Conflictos Ambientales," presentation at the Vitoria Meeting Against Monoculture Timber Plantations, November 2005, Vitoria, Brazil.
[268] "GM Tree Could be Used for Cellulosic Ethanol, Fast-Growing Trees Could Take Root as Future Energy Source", Purdue University Release, August 24, 2006
http://www.purdue.edu/UNS/html4ever/2006/060823.Chapple.poplar.html

fueling motor vehicles in the U.S. than to feeding people or providing habitat for wildlife. It also ignores the tremendous impacts on water.

GE trees & contamination of wild forests

Beyond the threats to food are the threats to forests. Richard Meilan, a faculty member at Purdue University points out that "The genus Populus includes about 30 species that grow across a wide climatic range from the subtropics in Florida to subalpine areas in Alaska, northern Canada and Europe."[269] While he makes this point to demonstrate the flexibility of the poplar as an energy crop, he also raises a serious red flag concerning the potential genetic contamination that could be caused by the commercial release of a GE tree that has such a large and widespread population of wild relatives. According to The Economist, countries like Sweden are also considering use of GE poplars for cellulosic ethanol.[270] Even the use of non-native tree species, such as GE eucalyptus in the southeastern U.S., raises serious concerns about the impacts that the escape of genetic material from GE trees could have on native forests.

Our understanding of the contamination potential from future plantings of GE trees is largely based on known contamination incidents from GE food crops and experimental plantings of engineered grasses.[271] While there has not yet been a fully comprehensive study of crop contamination from GE varieties, several well-documented incidents have alerted the world to the seriousness of this problem (see sidebar).

Additionally, two further incidents of transgenic contamination of wild relatives have been studied in some detail - the transmission of an herbicide-tolerance gene from oilseed rape (canola) to weedy wild turnip hybrids in Canada; and the detection of herbicide-tolerant grasses up to 21 kilometers from a test site in the U.S. state of Oregon.

There have also been two attempts to systematically address the contamination potential of GE crops. Since 2005, Greenpeace, in collaboration with GeneWatch in the UK, has maintained an online database of GMO (genetically modified organism) contamination incidents, known as the GMO Contamination Register.[272] Their 2006 report lists 142 publicly documented incidents, in 43 countries, since the introduction of commercial GE crops in 1996. These include instances of contamination of food, seed, animal feeds and wild relatives of crops, as well as illegal releases of unapproved GE varieties and documented negative agricultural side effects.[273] Also in 2006, the U.S.-based Center for Food Safety released a report on the contamination potential from field trials of new, experimental GE crop varieties, reviewing the prevalence of field trials of GMOs with known wild relatives across the U.S.[274]

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[269] ibid.
[270] Derek Bacon, "Woodstock Revisited", The Economist, 8 March 2007.
[271] While 'contamination' is the preferred terminology for this phenomenon in most non-technical literature, advocates of genetic engineering have sought to replace it with the less familiar and more ambiguous term 'adventitious presence'. The research literature is mainly concerned with the 'introgression' of novel traits, *ie* the successful and inheritable incorporation of transgenic DNA into the genome of a population of native organisms or non-modified crops.
[272] http://www.gmcontaminationregister.org/
[273] "GM Contamination Register Report: Annual review of cases of contamination, illegal planting and negative side effects of genetically modified organisms," *Greenpeace International*, February 2007, at http://www.genewatch.org/uploads/f03c6d66a9b354535738483c1c3d49e4/gm_contamination_report_2006.pdf
[274] Doug Gurian-Sherman, "Contaminating the Wild? Gene Flow from Experimental Field Trials of Genetically Engineered Crops to Related Wild Plants," Washington, D.C.: Center for Food Safety, 2006.

Key instances of GMO contamination in the U.S., Canada, Mexico and Thailand

Photo: Orin Langelle

In 2001, researchers in the state of Oaxaca, Mexico documented the presence of transgenes from GM maize varieties in indigenous landraces of maize.[1] While a scientific dispute over the extent of contamination within the maize genome led the journal *Nature* to withdraw the original research paper, widespread maize contamination in Mexico has since been confirmed by several independent and governmental studies.[2]

In 2000, U.S. domestic maize supplies were widely contaminated with a GM trait, known as Starlink (*B. thuringiensis* insecticidal protein Cry9C), for which regulators had denied approval for human consumption. Some 300 consumer products were recalled, costing the food industry approximately US$1 billion, including US$110 million to settle claims from maize growers resulting from persistent marketing difficulties. Over 400 million bushels of maize were found to have been contaminated with the Starlink trait, even though less than 40 million bushels of Starlink maize were actually planted the previous year: in total, 8.6% of all U.S. maize tested in 2000 was found to have been contaminated with and contain the Starlink trait.[3] Contaminated grain was even found in 1% of samples taken three years after this GM variety was withdrawn from the market.[4]

Researchers in the Canadian province of Alberta identified plots of oilseed rape (canola) that were simultaneously resistant to three common herbicide varieties: glyphosate (Monsanto's 'Roundup'), glufosinate (Aventis, currently Bayer's 'Liberty') and imidazolinones (Cyanamid's imazethapyr formulations, 'Pursuit' and 'Odyssey'). It transpired that a nearby grower had been cultivating GM varieties demonstrating the first two resistances, as well as non-GM rape tolerant to imidazolinones.[5] A follow-up study detected resistant plants as far as 500m from the original plantings, and confirmed - via DNA extraction and restriction fragment length polymorphism (RFLP) analysis - that the multi-resistant plants "were hybrids resulting from pollen transfer rather than inadvertent seed movement between fields".[6]

In 2006, the U.S. Secretary of Agriculture announced that the U.S. long-grain rice crop had been contaminated with an experimental glufosinate tolerant variety (LL601), developed and field tested by Bayer CropScience. Even though no variety of GM rice had yet been deregulated by the U.S. Department of Agriculture for commercial production, and field trials were reportedly less than one acre in size, glufosinate tolerance and two other GM traits were subsequently identified in rice exported to Europe, the Middle East, Asia and Africa.[7] The U.S. rice grower Riceland reported that the contamination was "geographically dispersed and random" throughout the long grain rice growing areas of the southeastern U.S.[8]

In at least two documented incidents, crops in the U.S. Midwest were contaminated with residues from prior year experimental plantings of crops that had been genetically engineered to produce pharmaceutical ingredients. In Nebraska, 500,000 bushels of soybeans had to be destroyed and 155 acres of maize burned, when residues were detected from an experimental maize variety that had been engineered to produce a pig vaccine. In Iowa, commercial maize crops were contaminated by residues of a previously grown GM variety that produced an experimental drug for cystic fibrosis.[9] These two incidents raised widespread concerns amongst U.S. food producers about potential pharmaceutical contamination of food. This in turn bankrupted the company (ProdiGene) responsible for these two incidents, and led others in the U.S. biotech industry to question the strategy of producing pharmaceuticals in GM food crops.[10]

A GM papaya variety resistant to the ringspot virus was planted in Hawaii, leading to widespread contamination of the islands' papaya crop. A sampling of 20,000 seeds from organic and wild papaya plantings found that 50% of the sampling sites were contaminated with the GM trait. Along with marketing problems that drove the Hawaiian papaya crop to a 25-year low, and contamination of many traditional papaya varieties, the engineered papayas were found to be unusually susceptible to other viral and fungal diseases.[11] Large-scale GM contamination of papayas was also documented in Thailand, most likely from unapproved GMO research trials.[12]

A study of commercial seed supplies in the U.S. Midwest revealed extensive GM contamination of popular non-GMO varieties of maize, rapeseed and soybeans that are widely sold to farmers for planting. The 2004 study by the Washington-based Union of Concerned Scientists detected transgenic DNA in 50-80% of the maize seed that was tested, 50-80% of the soybeans and 80-100% of the rapeseed.[13] Contamination levels, in the range of 0.05-1%, were determined to be sufficiently high to cast doubt on the future of non-GM and organic seed supplies.

[1] D.Quist and I. Chapela, "Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico", Nature, Vol. 414, pp. 541-543, November 29, 2001.
[2] See, for example, "Genetic Pollution in Mexico's Center of Maize Diversity," ETC Group, Food First Backgrounder, Vol., 8, no. 2, Spring 2002, at http://www.foodfirst.org/pubs/backgrdrs/2002/sp02v8n2.html; E. Ortiz and J. Mainero, "Evidence of Gene "Flow from Transgenic Maize to Local Varieties in Mexico," in OECD, LMOS and the Environment: Proceedings of an International Conference, OECD 2002, pp. 289-295, at http://www.oecd.org/document/18/0,2340,en_2649_34385_2509330_1_1_1_1,00.html.
3 "StarLink found in more foods", United Press International, April 25, 2001; Paul Jacobs, "Banished biotech corn not gone yet", San Jose Mercury News, December 1, 2003.
[4] B. Jacobs, ibid.
[5] M. MacArthur, "Triple-Resistant Canola Weeds Found in Albert," Western Producer, February 10, 2000, at http://www.producer.com/articles/20000210/news/20000210news01.html.
[6] L. Hall, et al., "Pollen flow between herbicide-resistant Brassica Napus is the cause of multiple-resistant B. Napus volunteers" , Weed Science, Vol. 48, no. 6, pp. 688-694, November 2000.
[7] "GM Contamination Register Report (supra note 3)", pp.15-19; J. Lean, "Rice contaminated by GM has been on sale for months," The Independent, August 27, 2006, at http://news.independent.co.uk/environment/article1222081.ece; R. Weiss, "Rice Industry Troubled by Genetic Contamination," Washington Post, March 11, 2007
[8] ibid. p. 15.
[9] J. Gillis, "'Drug-Making Crops' Potential Hindered by Fear of Tainted Food," Washington Post, December 23, 2002;
[10] "Drugs in crops - the unpalatable truth," Editorial, Nature Biotechnology, Vol. 22 No. 2, p. 133, February 2004.
[11] "Genetic Traits Spread to Non-Engineered Papayas in Hawaii", Environment News Service, September 10, 2004.
[12] S. Hao, "Papaya production taking a tumble", Honolulu Adviser, March 19, 2006; A.D. McNarie, "Papaya Problems: Scientists square off over how safe Hawaii's genetically modified papaya is for consumers", Hawaii Island Journal, April 1, 2003, at http://hawaiiislandjournal.com.
[13] "GE papaya scandal in Thailand: Illegal GE seeds found in packages sold by Department of Agriculture", at http://www.greenpeace.org/news/details?item_id=547563.

The incidents of contamination listed in the side box show that gene escape and GE contamination cannot be prevented once GE crops are released. This in turn suggests that the widespread planting of GE trees would over time lead to a persistent contamination of the world's native forests, with disruptive ecological consequences.

An additional problem with GE trees grown for agrofuels extraction is that (unlike most crops) they are likely to be grown in the vicinity of genetically similar native and uncultivated tree populations. In these instances, well-documented cases of GE contamination of wild relatives are of particular relevance.

In one example, herbicide tolerance genes from GE oilseed rape were found in a weedy wild turnip hybrid species in Canada, as well as in a sample of charlock, a weedy related plant in the United Kingdom.[275] Charlock is considered to be a significant weed of oilseed rape, and was previously believed to be incapable of spontaneous hybridization with domesticated rape varieties.

Further complicating the situation, several common weedy plants in agricultural regions of the U.S. have evolved resistance to glyphosate as a result of continued exposure to elevated levels of this herbicide by growers of Monsanto's 'Roundup Ready' GE crop varieties.[276] These include important weed species such as horseweed (marestail or *Conyza canadensis*), common ragweed (*Ambrosia artemisiifolia*) and rigid ryegrass (*Lolium rigidum*).[277]

Also highly relevant to our understanding of the potential threat from GE trees is a carefully studied instance of native grass contamination in the U.S. state of Oregon, from a test plot of creeping bentgrass genetically engineered for glyphosate resistance. In 2004, researchers from the U.S. Environmental Protection Agency found numerous grasses within two kilometers of the experimental plot—as well as two samples 14 and 21

[275] http://www.gmcontaminationregister.org/index.php?content=re_detail&gw_id=35, and references therein.
[276] Andrew Pollack, "Widely Used Crop Herbicide Is Losing Weed Resistance", New York Times, January 14, 2003.
[277] These specific examples are from the Monsanto-originated site at http://www.weedresistancemanagement.com.

kilometers away—that were tolerant to glyphosate. Upon genetic analysis, they were found to contain one of the major components of the inserted DNA that imparts this trait.[278] In a follow-up study two years later, researchers determined that the transgene had established itself in resident grass populations, as well as in a non-GE bentgrass that had been planted nearby to facilitate monitoring of potential gene flow.[279]

With their investigation limited to publicly accessible areas within 310 km^2 of the test plot, the researchers found nine established transgenic plants downwind, "spread over an appreciable distance beyond the border of the control area."[280] Through further DNA analysis, they determined that the contamination had been caused by a combination of pollen and GE seed dispersal. This is a highly significant result, given the fact that glyphosate tolerance would not be particularly advantageous for plants outside the test zone. As tree pollens can potentially travel two orders of magnitude farther than grass pollen, these experiments suggest that effective containment of contamination from GE trees would be highly improbable. This study is also relevant to non-native GE tree species in biofuel plantations, since contamination was not only by pollen, but by seed as well.

What these studies reveal then, is the virtual impossibility of preventing contamination of native forests with pollen from native tree species that have been genetically engineered. The impacts of this contamination, however, would depend to a large extent on the traits involved. Nevertheless, irrespective of the specific traits, the genetic manipulation itself gives rise to risks. Several researchers have reviewed the ecologically disruptive character of genetic modifications, in terms of gene expression, ecological fitness and the production of potentially dangerous new metabolites. In one brief review, Allison Snow of Ohio State University writes:

> *Although crops and weeds have exchanged genes for centuries, genetic engineering raises additional concerns because it not only enables introduction into ecosystems of genes that confer novel fitness-related traits, but also allows novel genes to be introduced into many diverse types of crops, each with its own specific potential to outcross.*[281]

David Schubert of the Salk Institute also writes that:

> *unintended consequences arising from the random and extensive mutagenesis caused by GE techniques opens far wider possibilities of producing novel, toxic or mutagenic compounds in all sorts of crops.*[282]

In a detailed analysis of over 200 published studies, researchers at EcoNexus in the United Kingdom documented significant increases in genetic instability, higher mutation rates, large-scale deletions and translocations of DNA, and other disturbing effects at the site of artificial gene insertion.[283] These disruptions in gene expression are also likely to impact on native species that become contaminated via cross-pollination with GE varieties.

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[278] Lidia S. Watrud, *et al.*, "Evidence for landscape-level, pollen-mediated gene flow from genetically modified creeping bentgrass with CP4 EPSPS as a marker", Proceedings of the National Academy of Sciences, USA, Vol. 101, No. 40, pp. 14533-14538, October 5, 2004.
[279] Jay R. Reichman, *et al.*, "Establishment of transgenic herbicide-resistant creeping bentgrass (Agrostis stolonifera L.) in nonagronomic habitats", Molecular Ecology Vol. 15, pp. 4243–4255, 2006.
[280] *ibid.* p. 4252.
[281] Allison Snow, "Transgenic crops—why gene flow matters", Nature Biotechnology Vol. 20, p. 542, June 2002.
[282] David Schubert, "Regulatory regimes for transgenic crops", Nature Biotechnology Vol. 23, pp. 785 – 787, July 2005.
[283] Allison Wilson, *et al.*, "Genome Scrambling - Myth or Reality? Transformation-Induced Mutations in Transgenic Crop Plants", Brighton, UK: Econexus, October 2004, at www.econexus.info. See also Jonathan R. Latham, et al., "The Mutational Consequences of Plant Transformation", Journal of Biomedicine and Biotechnology, Vol. 2006, pp. 1-7, 2006.

Low-Lignin trees

These studies underscore the serious likelihood of contamination of native forests from plantings of GE trees, and the resulting consequences for the earth's living ecosystems. This is especially serious in the case of trees genetically manipulated for decreased lignin production, to facilitate the production of agrofuels from tree feedstocks. As described earlier, lignin is an important structural polymer that is also significantly responsible for trees' high levels of insect and disease resistance. The very fact that it is difficult to break down lignin has been shown to be essential to the resiliency of native tree species in the wild. Thus the consequences of a reduced lignin trait spreading from agrofuel plantations to native forests could be severe and irreversible.

Fast growing, reduced lignin GE trees, growing undetected in a native forest setting as the result of gene escape, could die off at an early age due to their inability to cope with environmental stresses. Their reduced lignin would cause them to decompose rapidly, damaging soil structure and emitting carbon. Their faster growth at the seedling and sapling stage, however, could give them an evolutionary advantage over their non-modified cousins, resulting in a domination of GE low-lignin trees in the forest. How this will affect the forest ecosystem as it evolves is impossible to predict. Low-lignin trees also have implications for the climate, according to the Institute for Science in Society:

> *Aspen (*Populus tremuloides*) modified for reduced stem lignin had normal cellulose content accompanied by reduced lignin content. The transgenic aspen had reduced root carbon and greatly reduced soil carbon accumulation compared to unmodified aspen. The trees accumulated 30% less plant carbon and 70% less new soil carbon than unmodified trees.*[284] *This makes the transgenic tree highly undesirable in terms of reducing carbon in the atmosphere, hence defeating the whole purpose of switching from fossil fuels to biofuels.*[285]

In addition to reducing the lignin in trees, researchers are investigating altering the structure of lignin to enhance its digestability to microbes. In one line of research, proteins are being introduced into plant cell walls to create protein-lignin linkages that could be digested using protease enzymes. In another scheme, researchers are looking at incorporating a particular plant protein called expansin into trees, as well as cellulase enzymes that would essentially enable the tree to begin to digest itself prior to harvest.[286]

Once again the threat of these traits escaping into forest ecosystems, is dire. Assessments of the risks posed, however, are not being done.

Disease and insect resistance

Because lignin naturally protects trees from insects and disease, trees with modified lignin will probably have to be engineered with additional traits for disease and insect resistance, which leads on to additional concerns, should these genes escape.

The UK research organization, The Corner House, notes that; "trees genetically modified for resistance to disease are likely to cause fresh epidemics"[287] by encouraging the survival of other diseases resistant to the genetic modification. They go on to assert that; "fungicide production engineered into GM trees to help them counter such afflictions as leaf rust and leaf spot diseases may dangerously alter soil ecology, decay processes and the ability for the GM trees to efficiently take up nutrients…" Mycorrhizal fungus and other

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[284] Hancock J.E., et. al., "Plant growth, biomass partitioning and soil carbon formation in response to altered lignin biosynthesis in Populus tremuloides," New Phytol., 2007, 173(4), 732-42.
[285] Cummins J. and Ho, Mae-Wan, "Unregulated Release of GM Poplars and Hybrids", report submitted to the USDA APHIS in response to a permit application (06-250-01r) from Oregon State University for field tests of transgenic Populus Alba and Populus hybrids, August, 2007.
[286] David Pacchioli, "Researchers at the new biomass energy center are homing in on future fuels", Penn State University, State College, Pennsylvania release 9/24/07 http://www.rps.psu.edu/indepth/bioenergy1.html
[287] Viola Sampson and Larry Lohmann, Corner House Briefing 21: Genetically Modified Trees, December, 2000, p. 8

soil fungi are a critical part of forest ecology. Fungicides engineered into trees are likely to be exuded by the roots into the soil, killing beneficial soil fungi and damaging soil ecology.

Another significant concern is that the evolution of new, more pathogenic viruses may be accelerated by GE tree viral resistance traits. Ricarda Steinbrecher elaborates on the potential for genetically engineered viruses to recombine with other viruses to create new and more deadly viruses:

> *The potential of such newly recombined viruses to overcome the defenses of related wild plants, or even be able to infect new host plants, is a serious concern. In laboratory experiments infecting viruses have also swapped their protein coat for that of another virus that had been engineered into a plant...the new coat enabled a virus to travel between plants, carried by aphids.*[288]

Insect resistance also conveys serious concerns. In China, the problem of desertification was tackled through the planting of huge monoculture plantations of poplars. These poplars, however, fell victim to predation by caterpillars, and great numbers of them died. Insect-resistant poplars were then introduced. These GE poplars were genetically engineered for the production of the *Bacillus thuringiensis* (Bt) toxin, an insecticide that targets the caterpillars of *Lepidoptera* (butterflies and moths). The project was started in 2002 and today more than one million GE poplars have been planted across ten provinces. However, no-one knows exactly where they are.[289] The Nanjing Institute of Environmental Science in 2004 reported that the Bt poplars were already contaminating native poplars,[290] but it is not known how far this contamination has spread.

The escape of the Bt trait into native forests is problematic for numerous reasons. Insects have evolved with forest ecosystems for millions of years and the ecological implications of eradicating certain species of insects has not been assessed. These impacts, however, are likely to be wide-ranging. For example, the insects targeted by Bt trees are an important food source for nesting songbirds, as well as other wildlife. At least one study has found that Bt-toxin remains active and lethal after ingested and can make its way up the food chain and will actually bind to the intestines of non-target organisms, causing "significant structural disturbances and intestinal growths."[291]

The Bt trait is expressed in every cell of the modified tree, including the pollen. This is a major concern in relation to pollinators such as bees and butterflies. Bee populations in some regions have recently experienced serious decline. Deployment of Bt trees on a large scale could devastate pollinator populations.[292] A new study released late in 2007 demonstrated that pollen and other plant tissues containing Bt toxins are washing into streams near cornfields, and that the Bt toxin is lethal to caddisflies, the most diverse order of aquatic insects and an important food source for fish and amphibians.[293]

Bt-toxin also exudes from the roots of GE plants and into the soil, where it can affect organisms present in the soil or the soil community as a whole. It can thus impact on beneficial soil microbes and pathogen interactions, nutrient cycling and uptake, and other little-understood soil processes. Little is known about the way in which Bt-toxin production alters the rotting process of dead Bt trees. Use of Bt-toxin also raises concerns about the

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[288] Ricarda Steinbrecher, "The Ecological Consequences of Genetic Engineering", in Brian Tokar, ed.., Redesigning Life? The Worldwide Challenge to Genetic Engineering, (London: Zed Books, 2001, p. 89-90.)

[289] Huoran Wang, "The state of genetically modified forest trees in China", Preliminary review of biotechnology in forestry, including genetic modification, UN FAO, December 2004

[290] F. Pearce "Altered Trees Hide Out with the Poplars", New Scientist, 9/19/04, P.7

[291] C. Brown, S. Connor and M. McCarthy, "The End for GM Crops: Final British Trial Confirms Threat to Wildlife," 3/22/05, http://news.independent.co.uk/ low_res/story.jsp?story=622479&host=3&dir=58

[292] J. Losey et. al., "Transgenic pollen harms monarch larvae," Nature 399, 1999, p. 6733; and Hansen L. and Obrycki, J., "non-target effects of Bt-corn pollen on the Monarch butterfly (Lepidoptera: Danaidae), Abstract, North Central Branch meeting of the Entomological Society of America, March 1999; and Malone, L.A. et al., "In vivo responses of honey bee midgut proteases to two protease inhibitors from potato," Journal of Insect Physiology 44(2), 1998, pp. 141-147.

[293] E. J. Rosi-Marshall, et al., "Toxins in transgenic crop byproducts may affect headwater stream ecosystems," Proc. Nat. Acad. Sci. USA vol. 104 no. 41, October 9, 2007, pp. 16204 –16208.

creation of *"super-pests"* and killing of beneficial insects, as well as the displacement of insect pests from GE trees to more vulnerable species. [294], [295]

Beyond the impacts on forests and wildlife, however, are the impacts of Bt pollen on humans. Airborne Bt pollen may be toxic when inhaled. [296],[297],[298] This could have serious ramifications for communities living in the proximity of GE tree plantations. This potential health impact has not been adequately studied.

In summary, the long-term consequences of the use of Bt trees or the escape of this trait into forests has not been adequately assessed.

Genetically modified poplars used in biofuel plantations may also be engineered to become sterile. Proponents of genetic engineering claim that adding a sterility trait to GE trees would help prevent contamination of non-engineered trees. Because of the complex nature of plant reproduction and gene regulation, however, and the genetic changes trees experience as they age, it is highly unlikely that any sterility in trees can be reliably sustained. This means that contamination by seed or pollen would continue to be a threat. It also means there is the potential for stands of native trees themselves to become partially sterile through cross-pollination, or become impaired in their development of flowers or seeds. Sterile trees would also be able to spread their transgenes through vegetative propagation.

Furthermore, the sterility modification itself has ramifications. Foremost are the likely impacts on native wildlife. Sterile trees do not provide food (seeds, pollen or nectar) for insects, animals or birds, which means that large monocultures of GE trees will displace a wide variety of native species. In addition, the trees themselves may be toxic.[299]

Introduction of non-native invasive plants for cellulosic fuels

GE tree escape, via seed or vegetative propagation, is possible even from non-native species without wild relatives. The case of bentgrass contamination is instructive here, as it describes contamination resulting from seed dispersal. GE eucalyptus is one non-native tree being proposed by tree engineers as a potential feedstock for cellulosic fuels.

Eucalyptus, native only to Australia, is a favorite species for pulpwood plantations worldwide. It is a notoriously invasive tree species that often out-competes native plant species. In the U.S. state of California, eucalyptus was introduced in 1856, and is now widespread throughout the coastal and southern regions of the state. Because eucalyptus are also extremely fire-prone, California spends millions of dollars every year trying to eradicate these invasive plants.

The Introduced Species Summary Project of Columbia University found eucalyptus to be a great threat to California ecosystems: "The loss of biodiversity and habitat is a great threat from the … eucalyptus. It creates virtual monocultures and can rapidly take over surrounding compatible areas, completely changing the ecosystem. That monoculture creates a loss of

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[294] F. Gould, cited in J. L. Fox, "Bt Cotton Infestations Renew Resistance Concerns", Nature Biotechnology 14, 1996, p. 1070

[295] A. Hilbeck et. al., "Effects of transgenic Bacillus thuringiensis corn-fed prey on mortality and development time of immature Chrysoperla carnea (Neuroptera: Chrysopidae)", Environmental Entomology vol. 27, no. 2, 1998, pp. 480-87; Hilbeck, A. et al., "Toxicity of Bacillus Thuringiensis Cry1Ab toxin to the predator Chrysoperla carnea (Neuroptera: Chrysopidae)," Environmental Entomology vol. 27, no. 5, 1998, pp. 1255-63; Hilbeck, A. et al., "Prey-mediated effects of Cry1Ab toxin and protoxin and Cry2A protoxin on the predator Chrysoperla carnea," Entomologia Experimentalis Et Applicata Vol. 91, no. 2, 1999, pp. 305-16.

[296] Kleter, G.A. and A.A.C.M Peijnenburg. "Screening of transgenic proteins expressed in transgenic food crops for the presence of short amino acid sequences identical to potential, IgE-binding linear epitopes of allergens." BMC Structural Biology, 2002. 2: 8. At www.biomedcentral.com/1472-6807/2/8

[297] Vazque-Padron, R.I., et al., « Cry1Ac protoxin from Bacillus thuringiensis sp. kurstaki HD73 binds to surface proteins in the mouse small intestine." Biochemical and Biophysical Research Communications . 2000. 271, pp. 54-58

[298] Vazquez-Padron RI, et.al. "b. Bacillus thuringiensis Cry1Ac protoxin is a potent systemic and mucosal adjuvant." Scandinavian J Immunology, 1999, 49: 578-584

[299] J. Cummins et. al.,

habitats for many species that relied on the previous system. Due to its great capacity for taking over a wide variety of habitats, the … eucalyptus could possibly spread to a great range of systems where there is enough water content and create huge monocultures."[300]

The U.S. Forest Service also reported concerns about the ability of eucalyptus to suppress the growth of other plants: "The leaves of … eucalyptus release a number of terpenes and phenolic acids. These chemicals may be responsible for the paucity of accompanying vegetation in plantations. Natural fog drip from … eucalyptus inhibits the growth of annual grass seedlings in bioassays, suggesting that such inhibition occurs naturally. At least one leaf extract has been shown to strongly inhibit root growth of seedlings of other species."[301]

While eucalyptus has been a favorite species for monoculture tree plantations throughout the tropics and subtropics, their temperature requirements have made other cooler climates, as well as higher altitudes, off limits to eucalyptus.

The company ArborGen, however, is currently engineering eucalyptus for cold tolerance so that it could survive at temperatures as low as -20ºc, which will greatly expand its potential range.[302] This transformation of eucalyptus into a species that can survive in colder climates creates significant threats to forests in those climates. Extending the range of eucalyptus also makes it possible for companies to replace slower-growing (but carbon rich) native forests with fast-growing (but carbon poor) eucalyptus plantations, considered more valuable for the production of cellulosic fuels. In his 2006 year-end report to stockholders, Rubicon CEO Luke Moriarty explains the economic potential of the cold-tolerant GE eucalyptus: "The excellent results of the best performers in the field trials would suggest that the level of cold tolerance can be extended even further, thus offering a broader geographic market for this new hardwood product than originally anticipated."[303]

Besides wiping out native forests for eucalyptus plantations, the commercial use of cold-adapted eucalyptus could result in the escape of these GE trees (via seed or asexual vegetative reproduction) into ecosystems and forests where they could out-compete native vegetation and displace wildlife. Furthermore, the southern U.S., where establishment of commercial GE eucalyptus biofuel feedstock plantations is now being considered, is known to be subject to strong storms, including tornadoes and hurricanes, which have the potential to distribute eucalyptus seeds over very large areas from tens to hundreds of kilometres.

Development of second-generation biofuels in Brazil is also a concern. Efforts are currently focusing on the use of bagasse—the biomass left over from the production of sugar cane-based ethanol. Denmark-based Novozymes is cooperating with Centro de Tecnologia to develop facilities to utilize all parts of the sugarcane plant for ethanol production. Novozymes CEO Steen Riisgaard explained that "the research agreement is part of our efforts to identify economically profitable processes within the development of biofuels from plant waste and other biomass."[304] While these facilities may be developed under the guise of reducing "waste" in the production of ethanol, they are also a step towards acceptance of other cellulosic feedstocks.

ArborGen is already developing GE low-lignin eucalyptus in Brazil, as is pulpwood giant Aracruz Cellulose. The emergence of cellulosic ethanol in Brazil opens up another market for their reduced lignin trees and ArborGen forsees millions of dollars in profits from sale of its GE low-lignin eucalyptus pulp, due to the fact that it is projected to be less expensive to process.[305] Eucalyptus is already a serious problem in Brazil, where plantations have replaced vast stretches of the *Mata Atlantica* coastal forest ecosystem. Increasing demand for

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[300] "Introduced Species Summary Project, Tasmanian Blue Gum (Eucalyptus globulusLabill.)" http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/Eucalyptus_globulus.html

[301] Lora L. Esser "Eucalyptus globulus. In: Fire Effects Information System," [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). 1993. Available: http://www.fs.fed.us/database/feis/ 2007, November 5

[302] Stephen Kasnet and Luke Moriarty, "Rubicon Interim Report", Rubicon. 02/28/07 (Rubicon is a joint owner of ArborGen)

[303] ibid.

[304] Michael Shirek, "Novozymes concludes agreement in Brazil regarding second-generation biofuels", Ethanol Producer Magazine, September 2007.

[305] ibid.

eucalyptus for cellulosic ethanol, in addition to paper pulp, will most probably lead to the expansion of these eucalyptus plantations and the use of GE low-lignin eucalyptus, posing yet further threat to ecosystems like the *Mata Atlantica*.

The destructive nature of eucalyptus led Mexico's *La Jornada* journalist, Jaime Aviles, to call eucalyptus *"The perfect neoliberal tree"* noting that it *"grows quickly, turns a quick profit in the global market and destroys the earth."* [306]

GE jatropha and oil palm

Beyond genetically engineering trees for cellulosic fuel production, researchers are also exploring ways to engineer jatropha and oil palm trees so that their oil-bearing seeds produce better biodiesel, as well as other oil-based products.

African oil palm is native to tropical Africa, where it grows from the Congo to Sierra Leone, while American oil palm is native to Central and South America. However, it is now widely cultivated in tropical areas around the world. Jatropha is native to Central America and the Caribbean; and it too is being cultivated or planned for cultivation in huge monocultures in India, China, Africa, Latin America and elsewhere.

BP is investing US$76 million in jatropha cultivation. India has identified eleven million hectares of land for future jatropha plantations. China is moving forward with plans for more than 13 million hectares of jatropha and other biofuel feedstocks, on sensitive, biologically rich native forestlands in southwestern China.[307] In western Australia, however, jatropha has been banned due to the fact that it is extremely invasive and highly toxic to animals and people (ingesting three untreated seeds can be fatal to humans).[308]

Scientists are engineering these two trees for a variety of traits. Oil palm is being modified in Indonesia and Malaysia to change the composition of its oil. Food industry researchers are seeking to modify it for reduced saturated fatty acid content. Others are working to make the oil adaptable to new uses, as a source of biodegradable plastics, for example, and other products currently manufactured with petrochemicals. They also want to increase the oil content of the seeds. Because of its susceptibility to some insects, oil palm is also being engineered for insect resistance (with all of the potential consequences previously mentioned); and is being engineered for resistance to the herbicide glufosinate.[309] Jatropha is being engineered to increase production and improve the oil content of the seeds.[310]

The pursuit of a global-energy strategy that features wood as a major agrofuel feedstock clearly poses a variety of potential problems. Use of genetically engineered trees for agrofuel production would significantly increase this risk, with serious implications for the world's forests and forest-dependent peoples.

In the U.S., for example, efforts are underway to use the monoculture loblolly pine plantations of the Southeast U.S. for cellulosic ethanol production. A company called Range Fuels is developing an ethanol production facility specifically for this purpose, with funds from the U.S. Department of Energy. The U.S. state of Georgia has been quoted as seeking to become the *"biofuels Saudi Arabia",* using their pine plantations as the feedstock.[311] These same plantations, however, are the world's largest source of paper pulp.

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[306] John Ross, "Big Pulp vs. the Zapatistas: Cellulose Dreams in Southern Mexico", Multinational Monitor, April, 1998, p.9
[307] Yingling Liu, "Chinese Biofuels Expansion Threatens Ecological Disaster", Worldwatch Institute, March 13, 2007, http://www.worldwatch.org/node/4959
[308] Ben Macintyre, "Weed moves from bowels to biofuel", The Australian, 07/30/2007.
[309] UN FAO GMO registry.
[310] Qing Liu, Surinder Singh and Allan Green, "Genetic Modification of Vegetable Oils for Potential Use as Biodiesel," CSIRO Plant Industry presentation, May 2007, http://www.thaijatropha.com/9.pdf
[311] David Adams, "Biofuel Push May Take Root in Georgia", St Petersburg Times, 02/08/07.

Taking these plantations out of paper production and transitioning them into fuel production will have global implications. As the raw materials to feed the world's increasing appetite for paper are no longer available from plantations, they will increasingly come from the world's remaining forests. In addition, the rapidly rising demand for wood, triggered by cellulosic fuel production, will accelerate the conversion of native forests into fast-growing tree plantations and escalate rates of illegal logging. This skyrocketing demand for wood will also further the pressure to commercially develop genetically engineered tree plantations, which will in turn threaten the ecological integrity of native forests.

The massive increase in deforestation that will accompany the rise of wood-based fuels production will also have significant impacts on climate, belying the argument that cellulosic fuels will be part of the solution to global warming.

In conclusion, the massive increase in logging and the planned use of genetically engineered trees that will accompany the production of wood-based "second generation" agrofuels make this so-called "alternative energy" one of the foremost threats to forests and forest-dependent peoples across the globe.

Synthetic Biology: new technologies for agrofuel production

As advocates increasingly pin their hopes on a fabled 'second generation' of agrofuels, attention is rapidly shifting to a new set of extreme genetic engineering tools, known collectively as Synthetic Biology.

Synthetic Biology (or SynBio) involves chemically building synthetic (that is human-made) strands of DNA - the molecule that instructs living cells how to grow. The DNA is built from scratch using a machine called a DNA synthesizer and synthetic biologists attempt to rationally 'program' the DNA as if it were a computer language. Unlike more established `transgenic' genetic engineering where already-existing genes are identified in nature and then transferred between organisms, the practice of Synthetic Biology allows genetic engineers to invent entirely new genetic sequences that may never have existed before, and to combine them into new sets of genetic instructions. These synthetic DNA instructions are then engineered into yeast, bacteria and other microbes which in turn are transformed into microbial production units for churning out drugs, chemicals, plastics and of course fuels.

Although the field is barely out of diapers in terms of technological maturity, Synthetic Biology has witnessed a breathtaking avalanche of government, corporate and venture capital funding in the last few years mostly targeted towards agrofuels. Companies ranging from BP, Chevron and Shell to Virgin Fuels, DuPont and Cargill are each placing multi-million dollar bets that synthetic biology can deliver them custom-made microbes and powerful designer enzymes that will dismantle the technical barriers to the "second generation" dream. There are already around a dozen pure-play synthetic biology companies racing for the marketplace and some already have agrofuel products to show off.

Consider for example the work of Jay Keasling, a leading synthetic biologist from Berkeley California, who founded Amyris Biotech, one of the hottest new tech startups in Silicon Valley. Keasling has figured out a set of genetic sequences that instruct microbial cells to ferment sugars, such as corn sugar, into new hydrocarbon fuels that could replace diesel, gasoline and even jet fuel. According to interviews with the New York Times these gasoline-producing microorganisms already exist in Amyris' labs. Amyris, whose CEO John Melo was formerly U.S. president of fuel operations at oil major BP, is now in the first stages of building a full biorefinery that will ferment agricultural sugars into these fuels using synthetic microbes and is reported to be exploring partnerships with Virgin Fuels and Costco to deliver their syn-bio-fuel to supermarket forecourts across North America - possibly as early as 2010. Jay Keasling meanwhile is one of the key players in BP's 500 million dollar deal with Berkeley University to develop new biofuels - the largest corporate buy-up of a university in history.

It's not just Amyris. Direct competitors include LS9 - a synthetic biology company that brands itself "the renewable petroleum company" and has also developed synthetic microbes that turn agricultural sugars into high-performance fuels. As Stephen Del Cardayre, vice president of R&D for LS9 explains, "our goal was to produce petroleum replacements: fuels that look, smell and taste exactly like today's gasoline, diesel and jetfuel. That's what we set out to do and that's what we've done." Others in the same market include chemical giant DuPont and a small startup called Gevo, backed by Virgin Fuels, both of whom are using synthetic biology to make butanol, which has a lower energy density than gasoline but is still a much more efficient fuel than ethanol.

Craig Venter, the maverick gene mogul who sold genomic data to pharmaceutical companies in the race to decode the human genome, has founded yet another Synthetic Biology company - again focused on developing advanced agrofuels. Synthetic Genomics Inc., whose major investor is BP, is constructing the world first synthetic organism whose entire DNA instructions are manmade - a bacteria dubbed `Synthia'. Venter claims that Synthia will work as a living operating system into which DNA programs can be added so that Synthia will produce different fuels ranging from gasoline replacements to hydrogen. In recent speeches and interviews Venter has also claimed that his company already has a new form of `green jet fuel' in production in their labs using synthetic microbes.

Venter is also developing microbes that will turn sewage and algae into agrofuel - a feat that Synthetic Biology company Solazyme claims to have mastered. In January 2008 Solazyme drove two cars to the Sundance film festival that ran on biodiesel from synthetically altered algae. Using synthetic biology Solazyme had modified algae to produce oil from sugar without needing sunlight so that large quantities could be produced in vats. On the same day Solazyme announced a deal with Chevron, the second largest oil company in the U.S. to develop and commercialize the technology. Solazyme is now working to bring the cost of its algal biodiesel to below fifty dollars a barrel and claims that it should be at a commercial scale "in two to three years."

While the buzz around synthetic biology is partly about turning sugar to hydrocarbons, what may prove to be the bigger impact of synbio is the step before that: turning plant matter to sugars. Many of the leading enzyme companies such as Genencor, Novozymes, Codexis and Verenium Corporation (formerly Diversa) are also using synthetic biology techniques to produce designer enzymes to break down the natural lignocellulose found in wood chips or corn stalks. These enzymes act to liberate cellulose and hemicellulose sugars, making them available for further fermentation into fuel. Verenium, for example, is working to build microbes that secrete the enzymes found in the guts of termites. Meanwhile, Codexis has teamed up with oil company Shell to develop "super enzymes to convert biomass to fuel." The dream of synthetic biology fuel companies is to develop microbes that achieve both steps in one single synthetic organism (i.e. turning woody material to sugar and also turning that sugar into hydrocarbon fuel). As Ari Patrinos, president of Synthetic Genomics Inc. explains "The ideal situation would essentially just be one big vat, where in one place you could just stick the raw material - it could be switch grass- and out the other end comes fuel…"

If genetic modification has raised biosafety concerns, those pale in comparison to the safety and ecological risks of synthetic organisms. Like GMO's, synthetic organisms are alive, meaning they can reproduce, mutate and escape, but unlike earlier genetic engineering where genes are sourced from existing organisms, synthetic DNA sequences may have no known analogue in nature. This makes any biosafety assessment a shot in the dark since these organisms are in no way `substantially equivalent' to anything we know. Much of synthetic biology involves adding not one genetic trait, but a whole `pathway' of genetic mechanisms, so the potential for disruption and unanticipated side effects is much higher. Furthermore, synthetic biologists tend to treat the task of building novel life-forms as a hard information technology or engineering discipline but practitioners are increasingly finding that the wet and living materials they are working with are not as predictable as electronic circuits or computer code.

Despite the vacuum in knowledge of how to assess synthetic biology, safety commercial applications are already in the marketplace. DuPont, for example, has a working synthetic biology refinery in Loudon, Tennessee turning hundreds of millions of pounds of corn sugar into bioplastics. `Synthusiasts,' who talk up the technology, envision thousands of such biorefineries dotted across the landscape turning plant matter into plastics, fuels and drugs. In such a scenario environmental escape of synthetic microorganisms through waste streams or human error is almost inevitable.

Nor will developments in synthetic biology stop at agrofuels. The same technology that allows synthetic biologists to build designer DNA for agrofuel has already been used to build working versions of dangerous bioweapons. In 2001 a synthetic biologist called Eckard Wimmer built a working version of the polio virus using genome instructions from the internet, and in 2005 U.S. military scientists built a working version of the previously extinct `Spanish flu' virus which killed up to 50 million people at the end of World War I. As the synthetic biology industry accelerates, driven mostly by agrofuel funding, the ability to build dangerous and deadly microbes becomes ever cheaper, easier and harder to control.

Endnotes

For a simple introduction to Synthetic Biology see ETC Group: Extreme Genetic Engineering - An Introduction to Synthetic Biology. January 2007.
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VII: Conclusions

Article 4.1(d) of the Framework Convention on Climate Change obliges all Parties to conserve forests and other carbon sinks. The Intergovernmental Panel on Climate Change has also pointed out that reducing deforestation is one of the most important and cost-efficient methods of mitigating climate change. The need for policies and incentives to reduce deforestation is therefore high on the agendas of the Conference of the Parties of the Framework Convention on Climate Change.

Meanwhile it has become very clear over the last year that agrofuel expansion is one of the main factors triggering a world-wide boom in agricultural commodity prices, and that this is in turn driving a rapid expansion of agricultural monocultures into tropical forests and other ecosystems. Yet, instead of fulfilling their obligations under the Climate Convention, governments are giving large subsidies to agrofuel-producing industries and ignoring the devastating direct and indirect impacts on forests, biodiversity and people.

As the Special Rapporteur of the UN Permanent Forum on Indigenous Issues' states: "The Recommendations adopted by the Climate Change Convention on global warming are a classic case of providing a solution to one specific problem while simultaneously creating a host of other problems. Expanding plantations for biofuels or energy crops and for carbon sinks are recreating and worsening the same problems faced by indigenous peoples with large-scale monocropping, agriculture and tree plantations."[312]

Indeed, forest-dependent indigenous peoples have been under siege for most of the past century, as logging and pulp production have increasingly impinged upon their lands. The fundamental conflict over land tenure is essentially a worldwide extension of the colonial system: indigenous customary rights are not recognized, and concessions for access to forests are granted to industry. Logging begins and once the forest is cleared, plantations dedicated to pulp or oil palm production often follow. A small number of indigenous people may be hired for labor and the rest are forced to move elsewhere.

The Intergovernmental Panel on Forests (the predecessor of the United Nations Forum on Forests) identified the failure of governments and other institutions to recognize and respect the rights of indigenous peoples and other forest-dependent peoples in regards to their territorial lands, forests and other resources, as well as government policies that substitute forests with industrial tree-plantations, as key underlying causes of deforestation and forest degradation.

It is not only the livelihoods of indigenous peoples that are at stake. The production of industrial agrofuels is part of an inequitable and unsustainable system of production and consumption that threatens the very life-support systems of the planet. In 2005, the Millennium Ecosystem Assessment concluded that 60% of the world's ecosystems are in decline.[313] Last year, the World Conservation Union (IUCN) Red List of Threatened Species revealed that two out of every five species known to science could face extinction, including one in eight birds, a quarter of all mammals and one-third of amphibian

[312] V. Tauli-Corpuz, and P. Tamang, "United Nations Permanent Forum on Indigenous Issues: Oil Palm and Other Commercial Tree Plantations, Monocropping: Impacts on Indigenous Peoples' Land Tenure and Resource management Systems and Livelihoods." http://www.un.org/esa/socdev/unpfii/en/special_rapporteurs.html
[313] "Millennium Ecosystem Assessment," 2005, http://www.millenniumassessment.org/documents/document.356.aspx.pdf

species.[314] The 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report has also confirmed that; "global warming is affecting biological systems around the globe, with between 20% and 30% of plant and animal species facing increased risk of extinction as global average temperatures rise. These estimates do not include the myriad life forms yet to be catalogued, whose role in the finely tuned balance of ecosystems, or whose value to human society as sources of medicines, foodstuffs or other uses, may never be known. That, ultimately, is the tragedy of extinction. Unlike some other types of ecosystem degradation, extinction cannot be reversed. Once a species has gone, it is gone forever." [315]

These statements should shock us into radical and immediate action to reverse these trends: we are completely dependent upon these life-support systems, along with all of the other species that are disappearing. Yet, large agro-industrial farms and tree plantation companies continue to replace biodiverse forests with destructive 'green deserts' because it is profitable for them to do so. They exterminate even our close relatives, the orangutans, to make room for monocultures of palm oil in order to market "green fuel" to the small wealthy minority who can afford it. They replace grasslands, woodlands, wetlands and forests with vast oceans of soy, oil palm, maize, pine and eucalyptus, and spray a torrent of toxic chemicals over them. In the process they force out indigenous peoples, with their diverse cultures, agricultural systems, languages, knowledge and traditions, along with all the biodiversity contained within these ecosystems.

This corporate profit-driven model of agricultural production has resulted in an unprecedented concentration of land ownership and wealth, with most commodity production in the hands of just a few multinational corporations that control seed, crop production, agrichemicals, processing, trade, export and distribution. Individual small scale producers are left without access to land, food, livelihood or markets, while soils, forests, waterways and ecosystems are despoiled.

Cellulosic technologies are unlikely to solve these problems because they will require large areas of land, whatever the feedstock, and competition for land use will be fierce given increasing demand for energy. If trees are the feedstock of choice, there will be yet more pressure to replace natural forests with monoculture tree plantations, which contain nowhere near the same degree of biodiversity, are poor carbon stores, and are unable to provide decent livelihoods for indigenous people and local communities. Unregulated market forces are also likely to lead to the widespread use of genetically engineered trees, which will contaminate remaining native forests with potentially disastrous consequences.

Investment, state support and governmental policy processes must shift away from the production of agrofuels; and instead be directed towards processes, technologies, transport systems and regulations that will reduce energy consumption, increase energy efficiency and provide social and ecological benefits. There are clearly many opportunities for such a shift to take place. What is missing at present is the necessary political will. Opportunities include:

- protecting forests and practicing land-use patterns that preserve carbon sequestration capacities.
- converting to more sustainable wind and solar energy sources.
- massive investment in efficient and affordable public-transport systems.

[314] "World Conservation Union Red List of Threatened and Endangered Species." http://www.iucn.org/themes/ssc/redlist2007/index_redlist2007.htm
[315] "IPCC Fourth Assessment Report." http://www.ipcc.ch/ See also: http://www.4ecotips.com/eco/article_show.php?aid=1271&id=286

- local control over production and distribution of food.
- reducing consumption of meat.
- mandating efficiency standards for buildings.
- raising automobile fuel efficiency standards, and
- lowering overall consumption rates in some regions.

Virtually any of these measures would provide far greater climate protection benefit at lower cost (economically and environmentally) than would accrue from a transition to agrofuels. Even a brief analysis of transportation systems and energy use (See "reducing the impact of transportation" sidebar) clearly reveals that agrofuels are not, and cannot be a viable solution.

Nevertheless, in the words of one commentator, "Global warming, which is a social and environmental problem has become a business endeavor which offers opportunities to gain new property rights, assets and openings for capital accumulation."[316] Unfortunately, this 'business of global warming,' which includes the expansion of agrofuel production and carbon-trade forestry serves to develop new markets rather than protect the global climate.

Market-based schemes for dealing with global warming, perhaps more than anything else, highlight the impacts of economic globalization and the inequitable distribution of resources and rights on poorer people and the environment. Currently the top 2% of the world's population controls 50% of the world's financial assets, while the bottom 50% of the world's population controls only 1% of global assets. The World Bank has estimated that in 2001, 2.7 billion people in the world were living on the equivalent of less than $2 a day. They are not automobile owners. Most do not have electricity or running water.

Should we now look to the South, where most of these people live, to convert the invaluable and biodiverse forests and agricultural systems on which they depend into monoculture plantations of eucalyptus, pine, soy, sugar cane and oil palm, to satisfy the appetite of a small wealthy minority for disposable paper products, automobile travel and carbon offsets? Can we justify buying and selling carbon and atmospheric rights? Or are these fundamentally not "ownable" commodities? What do we really achieve by creating markets which essentially do no more than create an illusion of offsetting negative impacts on the planet for those with the money to spend?

The Earth has limited resources. How these are distributed is an issue that is moving increasingly to the fore, as social and ecological pressures are mounting. We must ask ourselves a fairly simple question: can we continue to permit wasteful and excessive consumption and corporate profiteering by a few at the expense of virtually everyone else? The answer clearly is no.

On 13 September 2007, after more than twenty years of negotiations, the UN General Assembly adopted the Declaration on the Rights of Indigenous Peoples.[317] The Declaration affirms, amongst other matters, that "Indigenous peoples have the right to the lands, territories and resources which they have traditionally owned, occupied or otherwise used or acquired" (Article 26) and that they have the right to "maintain and strengthen their distinctive spiritual relationship with their traditionally owned or otherwise occupied and

[316] L. Lohmann, "Carbon Trading: a critical conversation on climate change, privatization and power." Development Dialogue no. 48. 2006, pg 89.
[317] "United Nations Declaration on the Rights of Indigenous People." See: http://www.iwgia.org/sw248.asp

used lands, territories, waters and coastal seas and other resources and to uphold their responsibilities to future generations in this regard." (Article 25)

The declaration reaffirms the rights of Indigenous Peoples to pursue development in keeping with their own visions and aspirations, and also seeks to guarantee their rights to full participation in matters concerning them. In line with these statements, it is time to step back from technological and reductionist discussions of carbon, corporations, ecosystems and economies. We must turn away from spiritually bankrupt and ecologically-destructive consumerism cultures, and fully acknowledge and adopt the fundamental and essential value that indigenous people place upon the forests and ecosystems from which they derive their sustenance.

Discussions and policies that will direct our path into the future must acknowledge the real value of cool shade, clean water, rainfall, diverse fruits, foods and fibers and wildlife, and the diversity of cultures and languages that healthy forests and ecosystems, not industrial monocultures, support. Forest-dependent peoples recognize these values because their lives depend upon them. But it is precisely the failure to respect and value these fundamental links between ecology and humanity that has created the dire crisis of ecological degradation we are now faced with. As one supporter of the forty year-long struggle of the Tupinikim and Guarani people against the usurpation of their lands by Aracuz Cellulose stated aptly, "We could say that they, the indigenous peoples, are the new civilizers."[318]

The urgent need to act swiftly and dramatically to reduce emissions and protect forests and other ecosystems could not be more obvious or more serious. The future of the planet depends upon it. The time to reject false "market-friendly" solutions like agrofuels and carbon trading and focus on real solutions that truly and dramatically reduce energy use, is NOW.

[318] World Rainforest Movement Bulletin, Issue 122, September 2007. http://www.wrm.org.uy/bulletin/122/viewpoint.html

Transportation, Climate Change and Agrofuels

Photo: Orin Langelle

Car ownership remains beyond the means of the vast majority of people in the world. Yet global car manufacture increased by four percent in 2006 (Worldwatch) and automobile ownership and use is the most rapidly growing sector of energy/oil consumption. China alone, with a rapidly growing economy, is projected to add 50 million cars (80 million vehicles) by 2015, and yet per capita rates remain low in comparison to some other countries. [1] Almost a third of the world's motorized vehicles are in the U.S. which has more privately owned personal vehicles than there are commercial vehicles in the rest of the world combined.[2]

The impact of this burgeoning automobile use on climate is vast. Thirty percent of worldwide energy use is for transport, mostly derived from oil. Transport contributes about 20-30% of CO2 emissions from fossil fuel burning, but that figure does not even include emissions resulting from manufacture, road construction and maintenance, disposal, emissions resulting from petroleum extraction and nitric oxides. (and other air pollutants in exhaust). Some projections hold that there could be a total of 3.5 billion automobiles on the roads by 2050, which assuming average fuel consumption rates would increase world oil consumption by about 70% above current levels.[3]

Substituting agrofuels for fossil fuels to power this vast and rapidly expanding automobile fleet is simply not viable given the scale of demand. There is simply not enough agricultural land available to grow enough fuel crops to significantly offset fossil fuel use. In 2005, approximately 15 % of the U.S. corn crop yielded only about 2% of the country's non-diesel transport fuel. In Europe more than 20% of the rapeseed crop yielded only 1% of transport fuel.[4] This is particularly outrageous given that human population is enormous and rising, as are standards of living in some regions. Feeding people must be a priority.

Given the enormous amount of land required, and the many direct and indirect impacts of agrofuel production, it is clear that agrofuels can only feasibly contribute a small portion of overall transport energy demand. Meanwhile, the impacts of their production contribute more to destabilizing climate than they do to protecting it. Narrowly focused calculations of energy returns on energy invested (EROEI) are used to promote the concept that agrofuels will reduce emissions. But these fail to take into account the huge costs involved in industrial agriculture, deforestation, soil degradation etc. Results of these studies are highly variable and inconsistent, and few have been peer-reviewed or independently verified. [5]

A full assessment of the impacts of agrofuels leads to the conclusion that they are contributing to, rather than reducing, greenhouse gas emissions. Meanwhile, there are many other real and effective strategies for reducing emissions that also do not entail the many social and environmental disruption that agrofuels create. Some involve rather minor adjustments, for example: avoiding engine idling (estimated to cost 753 million gallons of gasoline/year in the U.S. alone); keeping tires inflated and engines tuned for maximum fuel efficiency; lowering speed limits; and most importantly, improving and using public transportation systems, and dramatically raising fuel efficiency standards.

Estimates are that raising fuel economy standards for cars and light trucks in the United States to 40 mpg over the next decade would yield cumulative oil savings of 3 to 4 billion barrels by 2012, and 15 billion barrels by 2020. That's more oil than what is currently imported from the Persian Gulf, and nearly ten times the oil that could be recovered from the Arctic National Wildlife Refuge.[6]

Automobile manufacturers have consistently and adamantly opposed such standards, arguing that it is not technically feasible, even though there are already cars that achieve more than 40 mpg on the road. Technological advances continually improve acceleration and other performance aspects besides fuel efficiency. As a result, light trucks today get fewer miles from a gallon of gasoline per pound of vehicle weight and per engine horsepower than those made 20 years ago. Auto manufacturers argue that increasing fuel efficiency standards would compromise safety as cars would need to be lighter and smaller. Yet, according to the National Research Council "Cost efficient fuel economy increases of 12 to 27 percent for cars and 25 to 42 percent for light trucks were estimated to be possible without any loss of performance characteristics . . . [or] degradation of safety."[7]

Given that automobiles are a major cause of death (about 125,000 people per year are killed and many more seriously injured)[8] and roads and transportation infrastructure are major consumers of land (40% in urban areas of the OECD countries), and create numerous health and environmental problems, it is clear that we need to transition away from personal automobile use altogether rather than a transition to agrofuels. This means improving public transportation systems and revamping our land use practices to avoid sprawl and favor lifestyles that are less reliant on automobile use. Public transportation systems would be far more effective as a long-term solution to transportation energy use. The American Public Transportation Association reports that an individual switching to public transit can reduce their daily carbon emissions by more than 4,800 pounds in a year (based on a 20 mile commute distance). This is far greater than the many actions people are typically encouraged to take, like adjusting thermostats or switching over to efficient light bulbs or appliances.[9]

These measures for reducing the impact of transportation are real and effective strategies. Agrofuels are a corporate, profit-driven false solution that only distracts attention and resources from pursuing them.

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[1] J. Dargay and D. Gately, "Income's Effects on Car and Vehicle Ownership, Worldwide" 1997, 1960-2015. C.V.Starr Center for Applied Economics. N.Y.University.
[2] P. Wiedeker and N. Caid, "Transport Troubles." OECD Observer 2002 http://www.oecdobserver.org/news/printpage.php/aid/754/Transport_troubles.html
[3] A. McKillop, "The Chinese Car Bomb." http://www.serendipity.li/fe/ch_car_bomb.htm
[4] Figures from: "Biofuels for Transport: global potential and implications for sustainable energy and agriculture." Worldwatch Institute 2007. (Preface)
[5] See for example: A. Ernsting, "How Meaningful Are Greenhouse Gas Standards for Biofuels in a Global Market?" Available at www.Biofuelwatch.org
[6] "The Facts About Raising Auto Fuel Efficiency." National Environmental Trust. http://www.net.org/proactive/newsroom/release.vtml?id=27517
[7] "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards." National Research Council, National Academy Press. 2002, pp. 76
[8] P. Wiedeker and N. Caid, "Transport Troubles." OECD Observer 2002 http://www.oecdobserver.org/news/printpage.php/aid/754/Transport_troubles.html
[9] T. Davis, and M.Hale, "Public Transportation's Contribution to Greenhouse Gas Reduction." American Public Transportation Association. 2007, http://apta.com/research/info/online/climate_change.cfm

"Expanding plantations for biofuels or energy crops and for carbon sinks are re-creating and worsening the same problems faced by indigenous peoples with large-scale monocropping, agriculture and tree plantations."

Special Rapporteur, UN Permanent Forum on Indigenous Issues

Global Justice Ecology Project builds local, national and international alliances with action to address the root causes of social injustice, economic domination and environmental destruction.

The Global Forest Coalition (GFC) is an international coalition of NGOs and Indigenous Peoples' Organizations involved in international forest policy. It was founded in the year 2000 by 19 NGOs and Indigenous Peoples' Organizations (IPOs) from all over the world. It is a successor to the NGO Forest Working Group, which was originally established in 1995 to participate in international forest policy meetings and organized joint advocacy campaigns on issues like Indigenous Peoples' rights, the need for socially-just forest policy and the need to address the underlying causes of forest loss.

For further information, visit the following:

Global Justice Ecology Project www.globaljusticeecology.org

Global Forest Coalition www.globalforestcoalition.org