

Biofuels: the answer to peak oil and climate change?

Can we have our cake and eat it?

Peter Bunyard

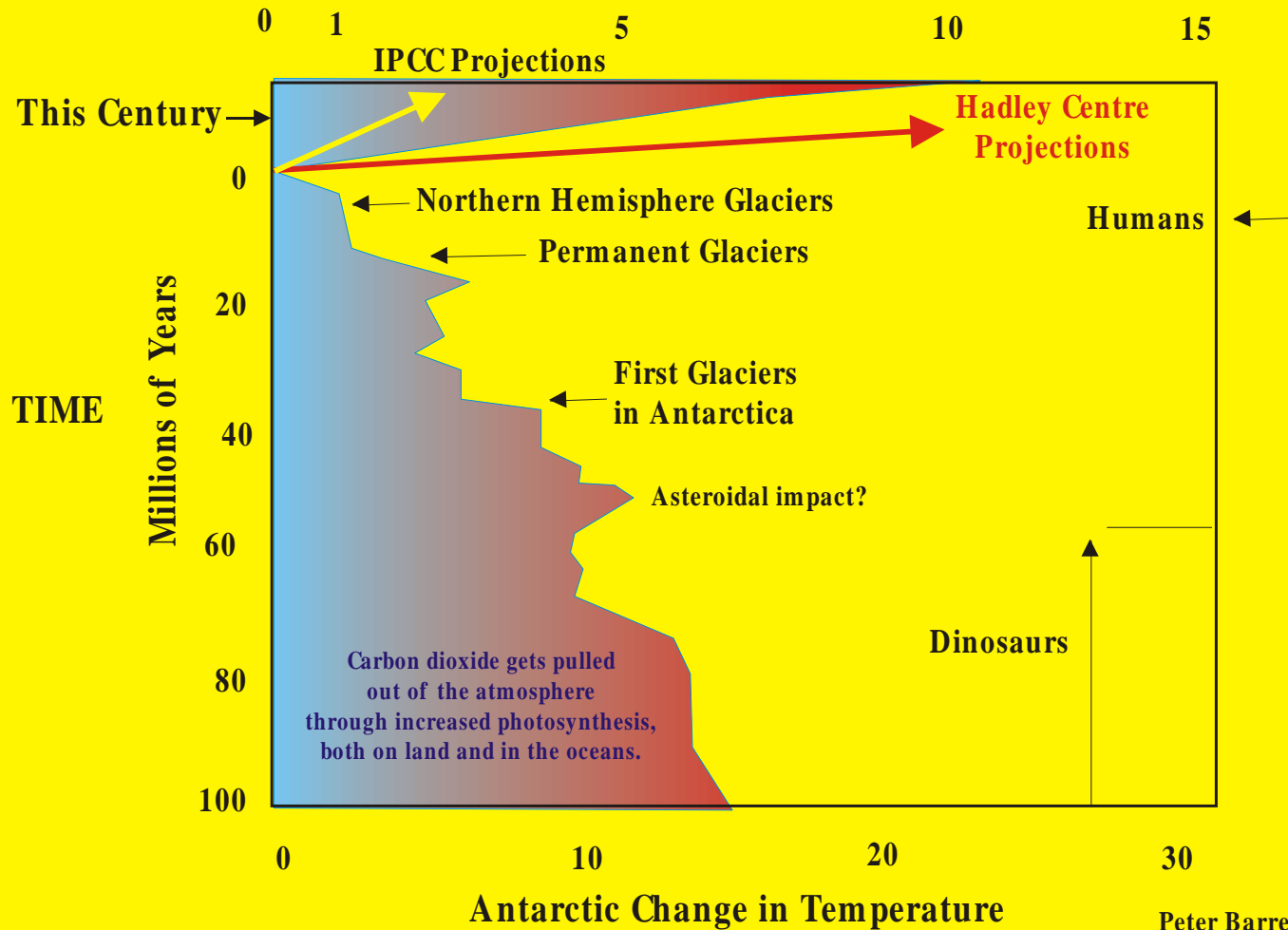
Bogotá

Abril 15, 2008

**My thanks to Biofuelwatch UK for
ideas/inspiration and facts.**

Degree Centigrade Change in Global Temperature

Global Change in Temperature



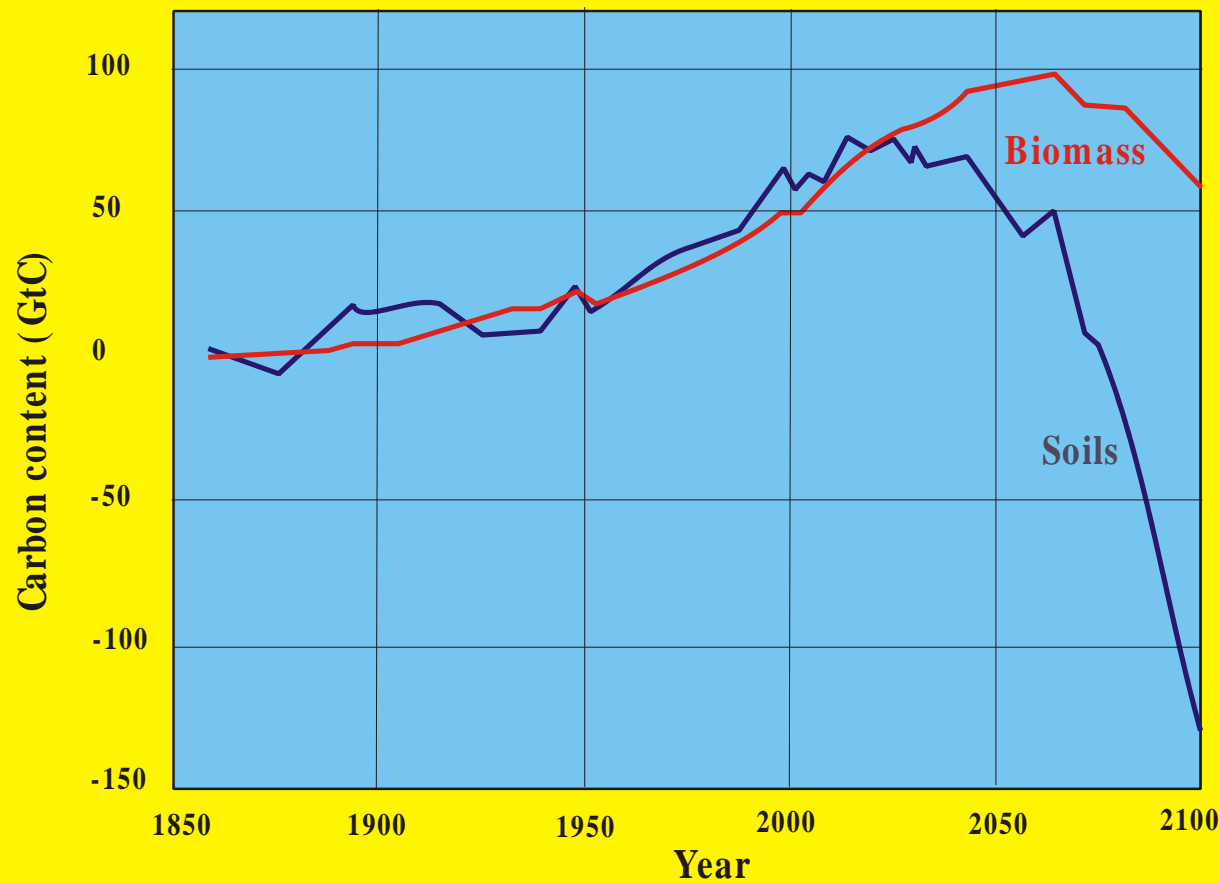
Peter Barrett
(NZ Antarctic Survey)

**With
biofuels
can we
repeat
within a
century
what
Nature
achieved
over
100million
years?**

**The power of vegetation to bring down
CO₂ and thereby cool the planet!**

Changes in the global quantities of carbon stored in vegetation and soils. (Hadley Centre)

Changes in global soil and vegetation carbon



Change in the global amount of carbon stored in vegetation and soils, simulated by the Hadley Centre climate model coupled to a dynamic vegetation and carbon cycle model.



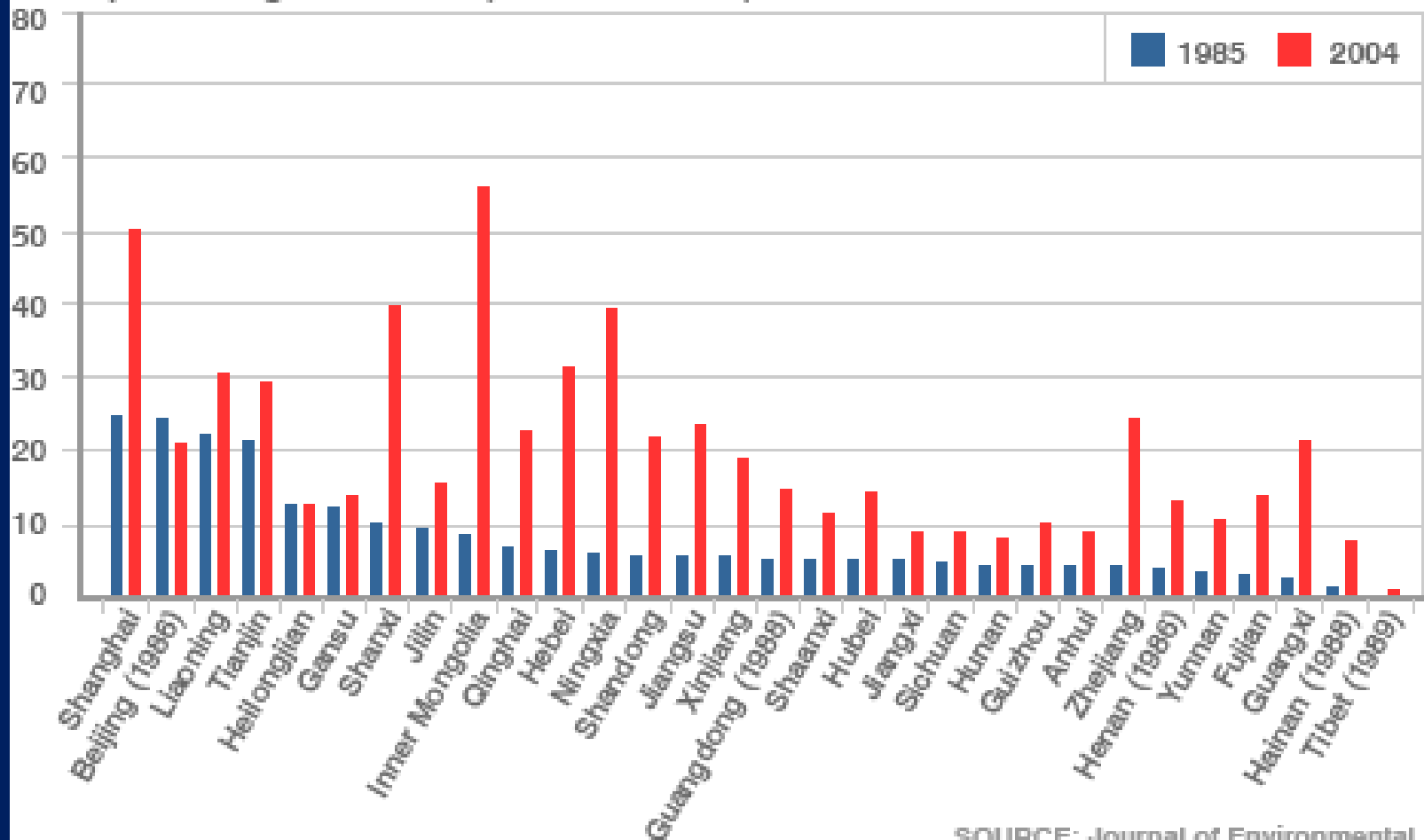
In 2006 the New Economics (UK) Foundation found that global consumption levels pushed the world into "ecological debt" on 9 October.

By 2007 we were in debt three days earlier.

Ecological debt means that our demands exceed the Earth's ability to supply resources and absorb the demands placed upon it.

CHINESE WASTE GAS EMISSIONS

Per capita waste gas emissions (thousands of m³)



SOURCE: Journal of Environmental Economics and Management

China now surpasses the USA in GHG emissions. The likely increases in emissions will exceed several times over the 'committed' Kyoto reductions of the industrialized nations, including their rush to the biofuels.

Fossil Fuel Use

Use of coal increased from 15 million tonnes in 1800 to 700 million tonnes by 1900, when it accounted for 95 per cent of the world's energy production.

Today 40 per cent of primary energy is from oil, 33 per cent from coal and 18 per cent from natural gas.

Total energy use amounts to some 13 Terrawatts (13×10^{12} watts or 13,000 times more than one gigawatt power station).

Human-induced Warming:

What biofuels are being called upon to combat

- Fossil-fuel and associated emissions 7.9 Gt/yr (approx 2/3)
- Biological carbon (ecosystem) emissions 3-4 Gt/yr (approx 1/3)

**Direct Carbon Fluxes
caused by Human Activity**

**Fossil Fuel Combustion
and Cement Production**

8 ± 0.5

**Land-use Change,
mainly Tropical
Deforestation**

2 ± 0.3

**Net Increase
in Atmospheric
CO₂**

5 ± 0.1

Indirect Carbon Fluxes

**Carbon Flux from
Atmosphere to Oceans**

1.7 ± 0.5

**Sink in
Tropical Vegetation**

1.9 ± 1.3

**Sink in Temperate
and Boreal Vegetation**

1.3 ± 0.9

**Units are gigatonnes of carbon
(1000 million tonnes)**

Revised from *Forests, Carbon & Global Climate*
Yadvinder Malhi *et al.* Earthscan, 2002.

What are biofuels?

Energy derived from biomass that is still living at the time of the harvesting. For example:

Wood (production of charcoal) and simple burning.

Methane derived from animal wastes etc through anaerobic digestion.

Waste from crops, i.e. the bagasse of sugar cane, straw.

Crops grown especially for their calorific content, e.g. Soya, sugar cane, Jatropha, African Palm, rape (canola), maize.

Algae?

What are the goals?

Aim to replace 70 per cent of oil imports in USA from 'unstable parts of world' by 2025 with biofuels. US currently imports more than 60 per cent of oil used, up from 53 per cent since President Bush took office.

In 2007, the United States used a quarter of its corn harvests for ethanol. In 2008, this will increase to a third. The US supplies more than 60 percent of the world's corn exports and 40 percent of all cereal exports .

The European Union projects 10% substitution of fossil fuel use with biofuels by 2020.

As of 14th April 2008, the UK demands via its Renewable Transport Fuel Obligation that 2.5% of all fuel sold in the 'petrol forecourts' must be biofuel derived. By 2010 to be 5.75%. The Fuel Quality Directive, which becomes law next month, calls for 20% biofuel use in UK by 2020.

An impossible task?

If the whole US corn crop were used for ethanol production it would currently satisfy 11.5 per cent of gasoline demand in the US.

To fulfill President Bush's target of 20 per cent bio-ethanol by 2020 will require a significant proportion to come from outside the US (namely tropical countries such as Indonesia, Malaysia, Brazil and Colombia).

The United States

Do the numbers add up?

Claim that substituting switchgrass for coal would reduce GHGs by about 1.7 tons of CO₂ per ton of switchgrass.

At a yield of 15 tonne/ha, some 250 GJ/ha of raw energy would be produced.

If as much as 70 per cent of that energy could be converted into electricity, ethanol and methanol, it would take about 460 million hectares to substitute for the 80EJ (Exajoule = 10¹⁸ J) fossil fuel energy used in the USA each year.

Total farmland in USA is 380 million hectares of which 175 mha is cropland.

What are the aims behind the conversion of land for biofuel production?

1. To provide a substitute for petroleum products such as gasoline and diesel.
2. To reduce the GHG emissions from consuming carbon-based fuels on the basis that the regrowth or replanting of the energy crop will absorb a relatively large proportion of the GHGs emitted - thereby promoting an equilibrium in carbon recycling between the atmosphere and vegetation .
3. Energy inputs in the production of biofuels must be several fold **less** than the useful energy output. Otherwise, the energy deficit has to be made up from other sources (fossil fuels?).
4. Biofuel plantations of whatever kind must **not** result in expulsions and disappropriations.
5. Biofuels should **not** be grown at the expense of food security.

Advantages of Biofuels.

- Can be local, when used in local public transport systems and energy generation systems, thus reducing transportation costs, both of raw material and then of refined fuel.
- Greenhouse gases generated are reabsorbed in the re-growth of the crop, thereby leading to zero emissions.
- Are theoretically sustainable.
- Can give security of supply.
- Waste products from fuel generation can be fed back into the system; eg fertiliser from methane production.

Disadvantages of Biofuels

- **Highly diffuse production (i.e. inefficient use of land).**
- **Mass production of industrial product, for instance ethanol as petrol substitute, requires considerable energy and material investment. Therefore not greenhouse gas free.**
- **Declining soil fertility and impacts on soil structure, as well as on the hydrological cycle, countering sustainability.**
- **Taking land space away from food production leading both to increases in food prices and the need to import food, thus jeopardising 'security of supply'.**

More disadvantages of biofuels

- Use of waste materials, e.g. cellulose, to generate biofuels, can reduce soil fertility by depriving the land of organic humus-making material and resultant nutrients.
- Use of biofuels, as currently envisaged, may encourage non-sustainable systems such as the global increase in private transportation. At cost of food production. Also pressure on marginal lands.
- Will accelerate loss of biodiversity and hence extinctions (more than 100 species at risk in Colombia's Vichada province in Los Llanos).

Growing concern with the use of biofuels

1. Their role in adding to the current global food crisis.
2. Loss of native forests and vegetation.
3. Loss of biodiversity, including endemic species.
4. Displacement of rural population (eg. Brazil, Indonesia and Colombia).
5. Degeneration of soils.
6. Poor energy returns, especially when viewed against carbon losses from soils and biomass (eg. Tropical rainforests).
7. Rogue subsidy: "splash and dash" scam. Biodiesel shipped from Europe to the US where a dash of fuel is added, allowing traders to claim 11p a litre of US subsidy for the entire cargo. Economically viable because of cheap shipping.
8. Myth that we can continue 'Business-as-usual'.

Carbon Debt including land-use change for biofuels

Sugar cane creates a carbon debt of 17 years.

Palm oil displacing tropical rainforest growing in peat creates a carbon debt of some 840 years.

Ethanol from maize takes 48 years to repay the carbon debt.

Switchgrass creates a carbon debt of 52 years.

The US government proposes that 75% of annual crop residues should be harvested. However, the removal of crop residues can increase the rate of soil erosion a hundredfold.

A recent paper by the Nobel laureate Paul Crutzen suggests that emissions of nitrous oxide (N_2O , a greenhouse gas 296 times more powerful than CO_2) from nitrogen fertilisers wipe out all the carbon savings biofuels produce, even before you take the changes in land use into account.

The IMF (International Monetary Fund) warns that using food to produce biofuels "might further strain already tight supplies of arable land and water all over the world, thereby pushing food prices up even further".

April 2008,, the UN Food and Agriculture Organisation (FAO) announces the lowest global food reserves in 25 years, threatening what it calls "a very serious crisis".

Even when the price of food was low, 850 million people went hungry because they could not afford to buy it.

With every increment in the price of flour or grain, several million more are pushed below the breadline.

The cost of rice has risen by 20% over the past year, maize by 50%, wheat by 100%.

Monday, 14 April, 2008, the World Bank has announced emergency measures to tackle rising food prices around the world.

The UN Secretary-General, Ban Ki-moon, has called for a comprehensive review of the policy on biofuels as the crisis in world food prices threatens to trigger global instability.

Former UK Labour Environment Minister Elliot Morley has called upon the government to delay the new biofuel requirement until 'comprehensive certification and assessment schemes are put in place', echoing criticism by the Environment Department's chief scientific adviser, Professor Robert Watson.

The chairman of the UN's Intergovernmental Panel on Climate Change, Dr Rajendra Pachauri, has also spoken out against the risk of biofuels, especially of growing corn for ethanol in the US.

The Guardian, Thursday April 10 2008:

Gordon Brown, UK Prime Minister, expressed his concerns about the way in which the rush towards environmentally questionable biofuels might displace much-needed food production.

In a letter to the Japanese prime minister, Yasuo Fukuda, setting out a plan to address the food crisis, Brown wrote: "There is a growing consensus that we need urgently to examine the impact on food prices of different kinds and production methods of biofuels, and ensure that their use is responsible and sustainable."

Britain is introducing subsidies for biofuels, but acknowledged the concerns of environmentalists when the transport secretary, Ruth Kelly, commissioned a review into their impact in February.

A World Bank report (9 April, 2008) claimed that biofuel consumption had helped push global food prices up by 83% in the past three years, and would drive inflation and strain developing economies into the next decade.

Sainsbury's, a leading UK supermarket chain, announced on November 21st, 2007, that it would phase out the use of palm oil from unsustainable sources in its own-brand food, after pressure from campaigners and customers.

It is estimated that the oil is used in one in 10 of all products sold in Britain.

Sainsbury's says it intends to accept palm oil only from certified sustainable sources, starting with plantations in Colombia.



From this

To that?

The Mumias Sugar Company in Kenya is planning to plant 20,000 hectares of the Tana delta to grow sugar cane for biofuels and food. The £165m project, including an ethanol refinery and food-processing plant, promises to create thousands of jobs in an area dominated by traditional cattle herding, small-scale rice and subsistence farming.

Environmental campaigners claim that the scheme would destroy the wetlands - home to 345 species of birds, including the threatened Basra reed warbler, the Tana river cisticola, and 22 species of waterbirds such as slender-billed gulls and Caspian terns.

Some Opinions

The EU dependent on external sources for 50% of its energy needs. Could rise to 70% by 2030. The transport sector is responsible for nearly one third of CO2 emissions. Targets of 20% renewables in the EU's energy mix and 10% biofuels in vehicle fuel by 2020. (José Manuel Barroso, President of European Commission)

Lester Brown, director of the Earth Policy Institute in Washington: land turned to biofuels in the US in the last two years would have fed nearly 250 million people with average grain needs. Already the US has diverted 60m tonnes of food to fuel.

Robert Zoellick, president of the World Bank: prices of all staple food has risen 80% in three years: 33 countries face unrest because of the price rises.

Robert Zeigler, director-general of the International Rice Research Institute: "The whole market could become paralysed. Who's going to sell rice at \$750 a tonne when they think it's going to hit \$1,000?"

Josette Sheeran, director of the World Food Programme: "The cost of Ethiopian food has doubled in just the last nine months. We are seeing more urban hunger than ever before. We are seeing food on the shelves but people being unable to afford it."

Sugar Cane in Brazil

CLAIM THAT:

Sugarcane ethanol allows for a 90% reduction in emissions, with an energy balance of 8.3 to one.

Brazil now produces enough ethanol to power 45% of its passenger vehicles using only 3.4m hectares, or 1%, of its arable land.

Production is located mainly in the centre-south of Brazil, 2,500km, distant from the Amazon.

Brazil's ethanol production is expected to triple by 2020, from 6m additional hectares.

Thanks to hydroelectric power and to biofuels, approximately 45% of Brazil's total energy mix is comprised of renewable sources, compared with the EU's average of 6.7% and the UK's 2%.

Felipe Costa, Embassy of Brazil, London, UK (January 2008)

SUGAR CANE

Power density of ethanol produced from sugarcane in Brazil is about 2.9 kW/ha... equivalent to about a thousandth part of incident solar radiation.

To satisfy the annual increase in transportation energy demand resulting from population growth in the US some 5 million hectares a year extra would have to be put down to sugarcane.

(Andrew R.B. Ferguson, *Optimum Population Trust Journal* Vol 7, No 2, October 2007).

**Power Density of ethanol from US corn is 1.9 kW/ha.
(Wind power can give 14 kW/ha, though we must bear in mind that wind power sites are limited).**

Filling the 25 gallon tank of a SUV with ethanol is derived from approx 246 kg of corn... enough calories to feed one person for a year.

Energy density of ethanol is about 21 MJ/litre compared to 33 MJ/litre for gasoline... therefore,

25 gallons of ethanol is equivalent to about 16 gallons of gasoline.

More fossil fuel energy input to produce the equivalent energy output in the biofuel.

Energy output/Energy input
= 0.778 maize ethanol;
= 0.688 switchgrass ethanol;
= 0.636 wood ethanol;
= 0.534 soya biodiesel
(David Pimental and Tad Patzek)

Corn ethanol costs US\$7.12/gallon-equivalent of gasoline (\$1.88/litre), compared to 2006 cost of \$0.33/litre for gasoline production.

Current trends indicate that the US would be consuming 290,000 million gallons a year of gasoline by 2050.

With better fuel consumption (50 mpg) and better public transport that amount could be reduced to 108,000 million gallons.



Are we putting our eggs into the wrong basket?

1. Total energía solar disponible para la Tierra: 3.85×10^{24} joules
2. Capturado por la biomasa: 1.8×10^{21} joules (0.05%)
3. Energía global (usado antropogenicamente: 0.471×10^{21} joules (0.012%)
4. Usado por el ciclo hídrico amazónico: 20×10^{21} joules (0.50% & 45 veces mas del uso de energía global)
5. Solar thermal station will give as much as 100 times better power density than biomass. Colombia might well think about putting parts of its Guajira to good use. (Plus wind?). Obvious need for infrastructure ..Hydrogen production?

“Every year, each square kilometre of desert receives solar energy equivalent to 1.5 million barrels of oil. Multiplying by the area of deserts world-wide, this is nearly a thousand times the entire current energy consumption of the world.”



African Palm in Indonesia is putting paid to the last vestiges of forest there.

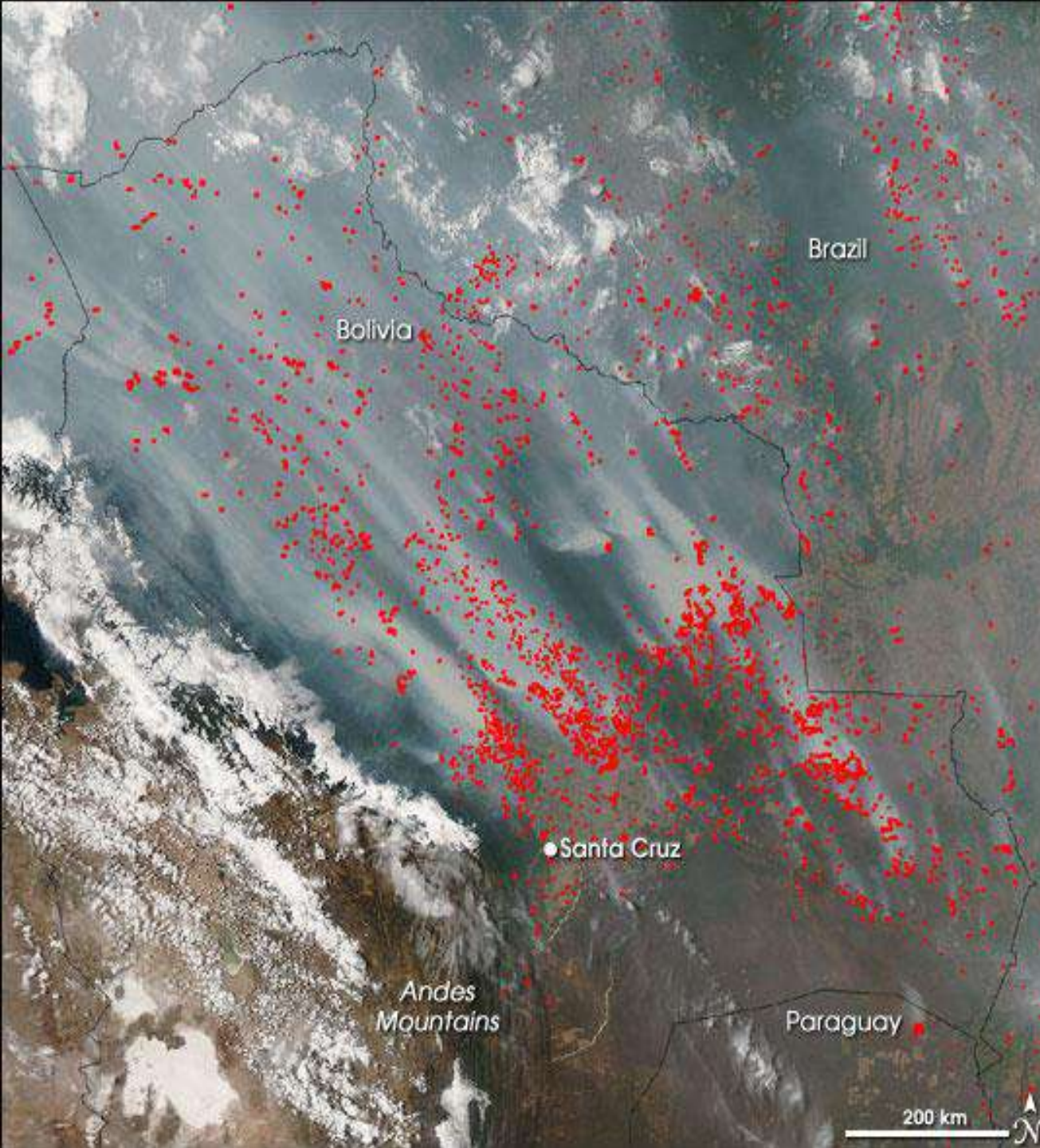
Greenhouse gas emissions from the destruction and burning of forests worldwide amounts to as much as one third of global emissions from all sources.



Rainforest fires

Tropical rainforest





Bolivia

September 2007

**Thousands of
fires.**

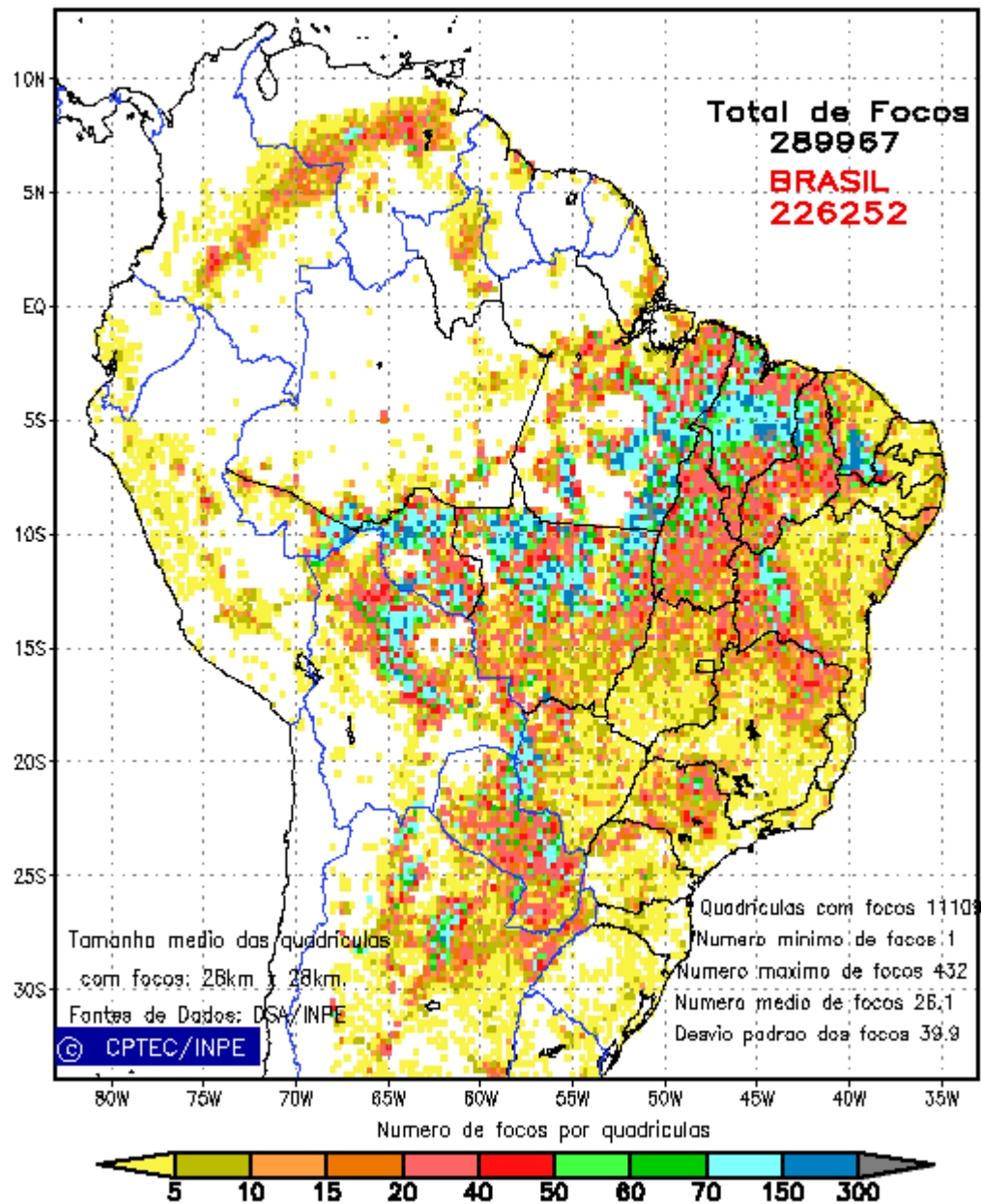
**Parallels with
2005?**

Leticia/Tabatinga

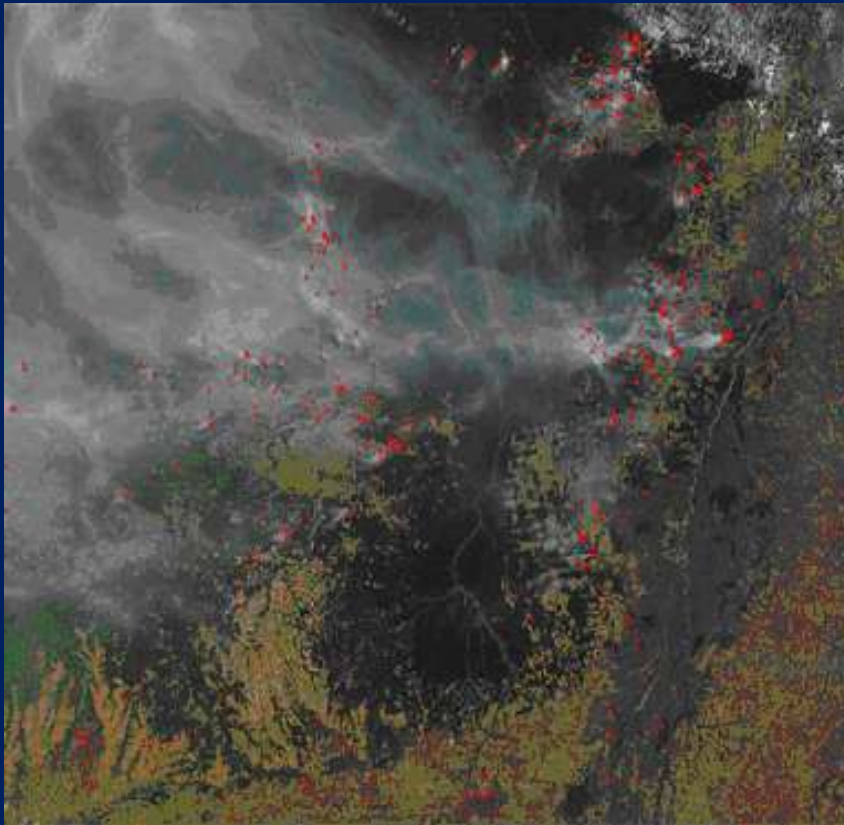
**The air filled with
smoke.**

Focos de Queima

Acumulado de 2005/01/01 a 2005/12/31
NOAA12 - passagem as 21GMT



Tropical Forest Destruction



Forest fires in Mato Grosso

*Satellite image from Earth Observatory, NASA,
credited Jacques Desdoitres, NASA GFSC*

***According to a 2006 study by
NASA scientists:***

***The rate of Amazon
destruction correlates with
the market price of soya.***

***2007: Soya prices rising fast,
largely due to biofuel
expansion:***



26.000 Km² en 2004

**Soya, now the
prime cause of
deforestation in
the Brazilian
Amazon, as in
Bolivia.**

Tropical Rainforest Functions

- 1. Carbon dioxide absorption**
- 2. Maintenance of hydrological cycle**
- 3. Energy transfer system**
- 4. Sustainer of biodiversity**
- 5. Living for forest peoples**
- 6. A vital component of nutrient recycling**
- 7. Maintenance of atmospheric composition**

Loss of Tropical Rainforest

1.CO₂ Emissions (up to 200 tonnes C per hectare)

2.Reduction in evapotranspiration

3.Nutrient Loss and soil deterioration

4.Failure to transfer energy in the form of water vapour

5.Rising Surface Temperatures (up to 10° C)

6.Failure of hydrological cycle

7.Serious decline in rainfall (Colombia loss 60%?)

8.Savannization leading to desertification

9.Suppression of teleconnections

10. Loss in biodiversity and therefore in ability of forest to recover

Every hectare of tropical humid rainforest destroyed will release up to 200 tonnes of carbon in the form of GHGs over the course of several years (via fire and decomposition).

A Palm Oil plantation replacing the Chocó rainforests of Colombia or those of Kalimantan in Indonesia will not regain the carbon lost. (According to Oxford University study, it would take many hundred years)

It is therefore a fundamental and pernicious deception to describe such fuels as 'green biofuels' with zero GHG emissions.

Climate change mitigation?



- South-east Asia's peatlands contain up to 50 thousand million tonnes of carbon. This carbon will be released as the peat is drained. **45% has been drained** – the rest is likely to be destroyed largely to meet global demand for biodiesel.

Peat drainage for oil palms, Sarawak,
Photo www.air-co.org

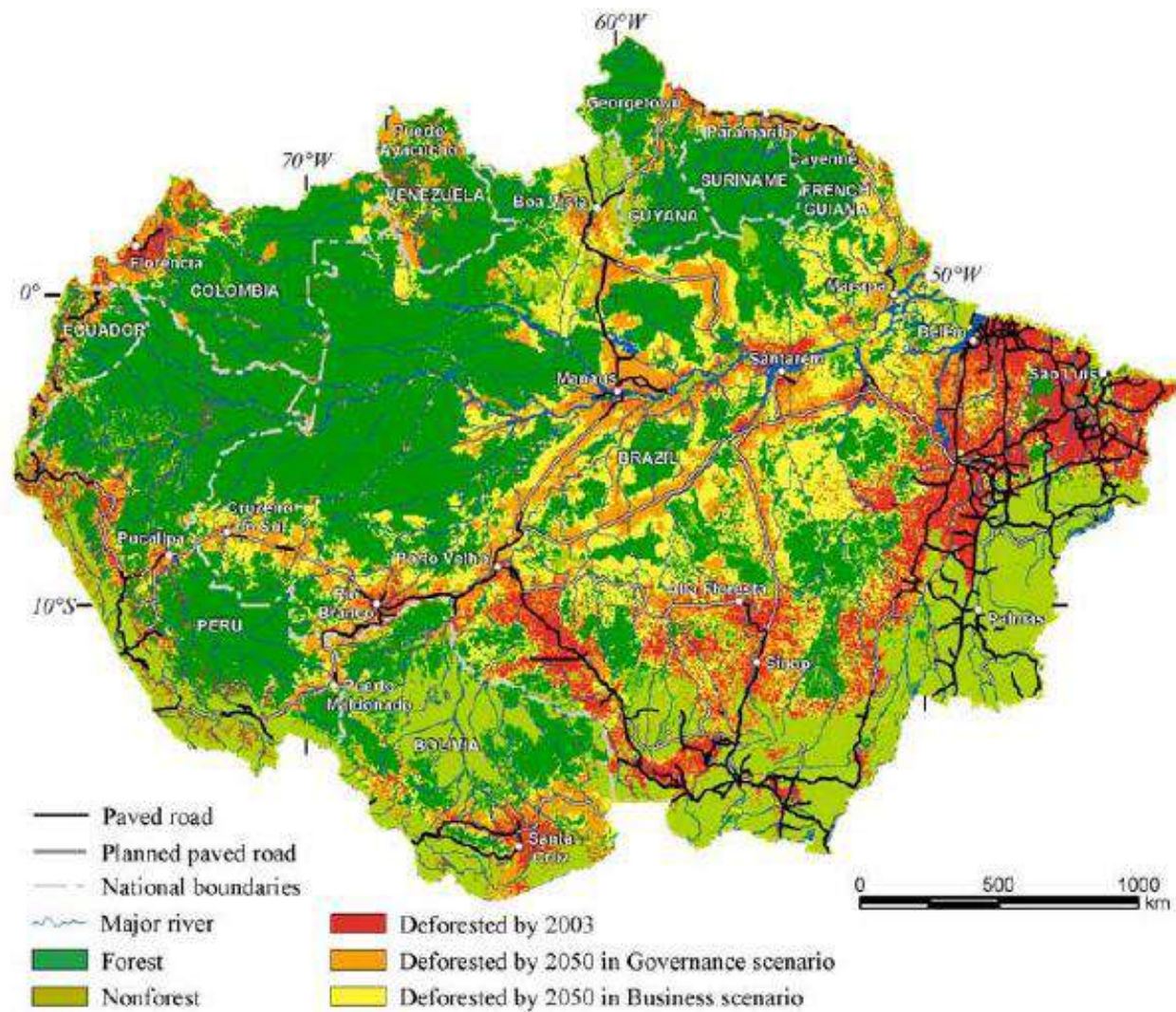
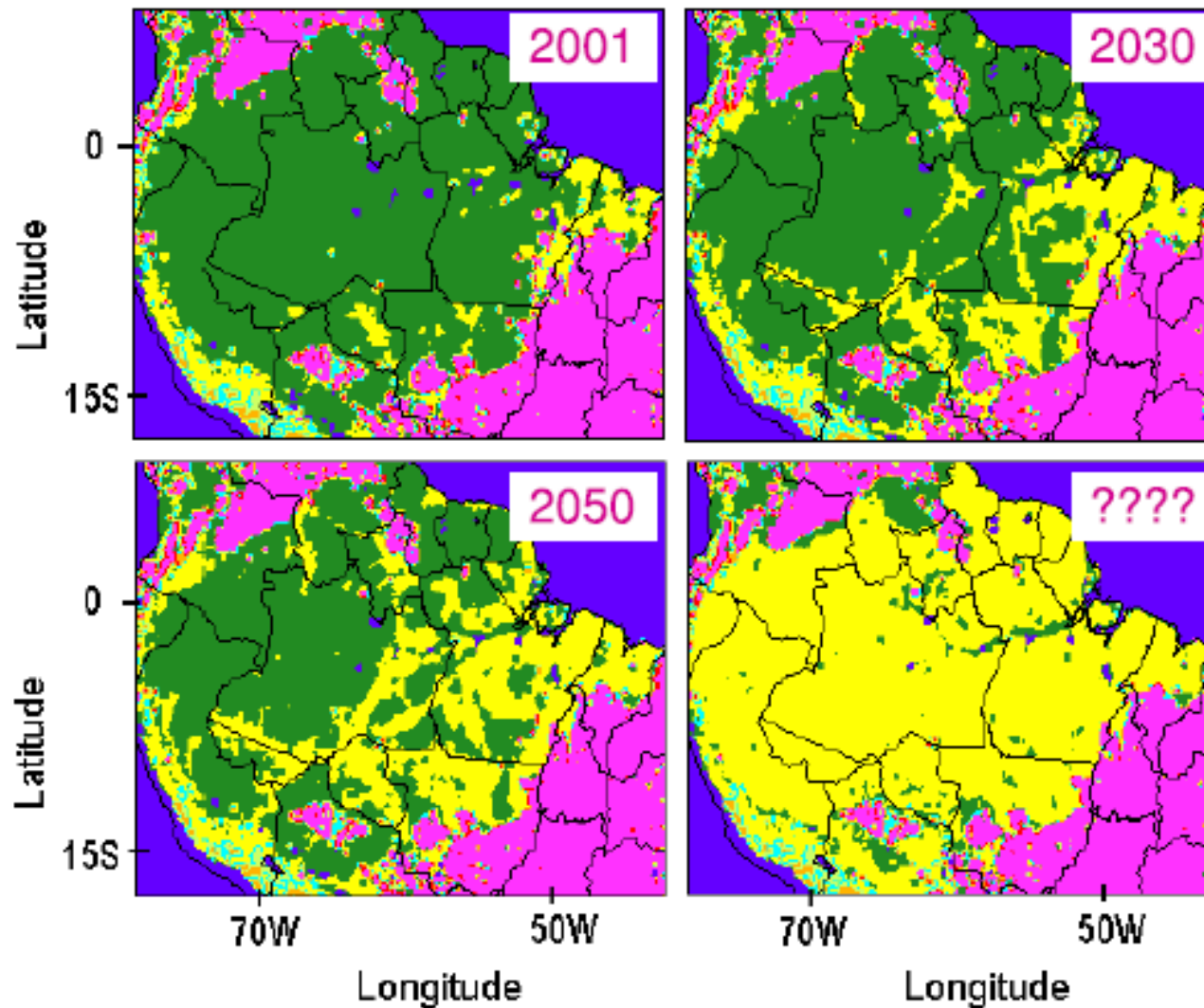
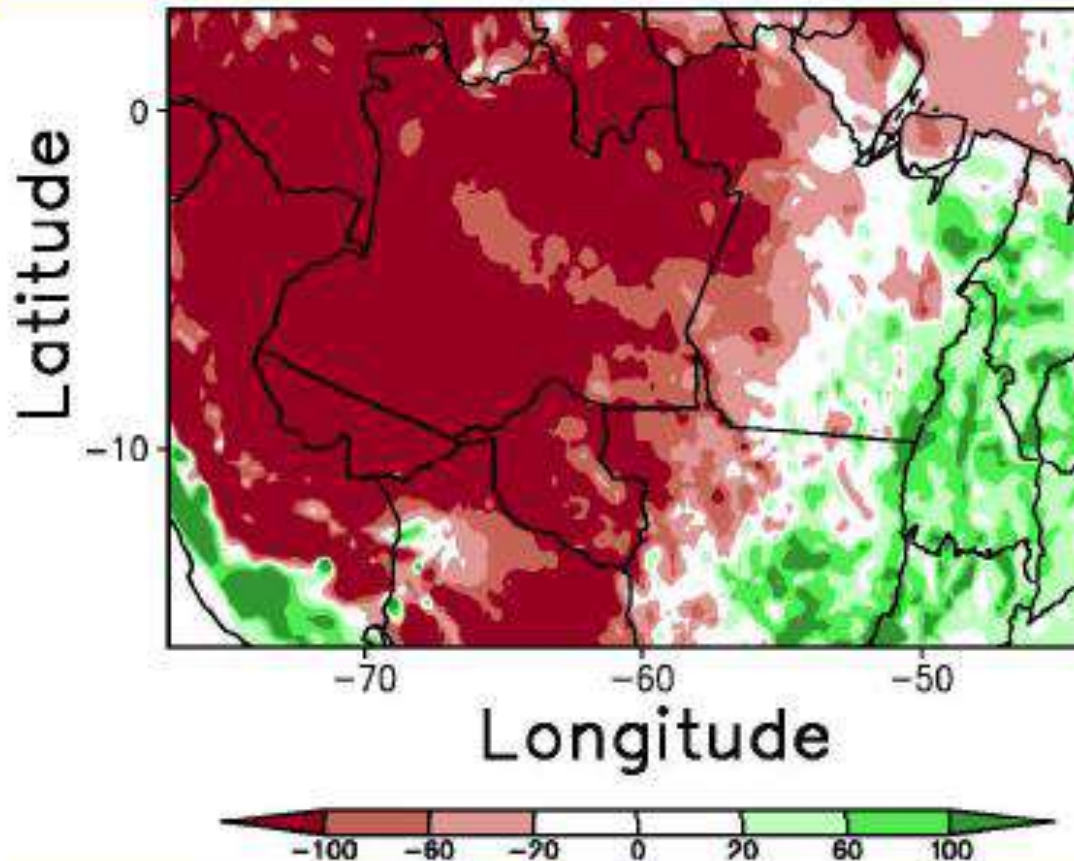


Figure 1: Land-use map of the Amazon Basin based on socio-economic development of that region by 2050.

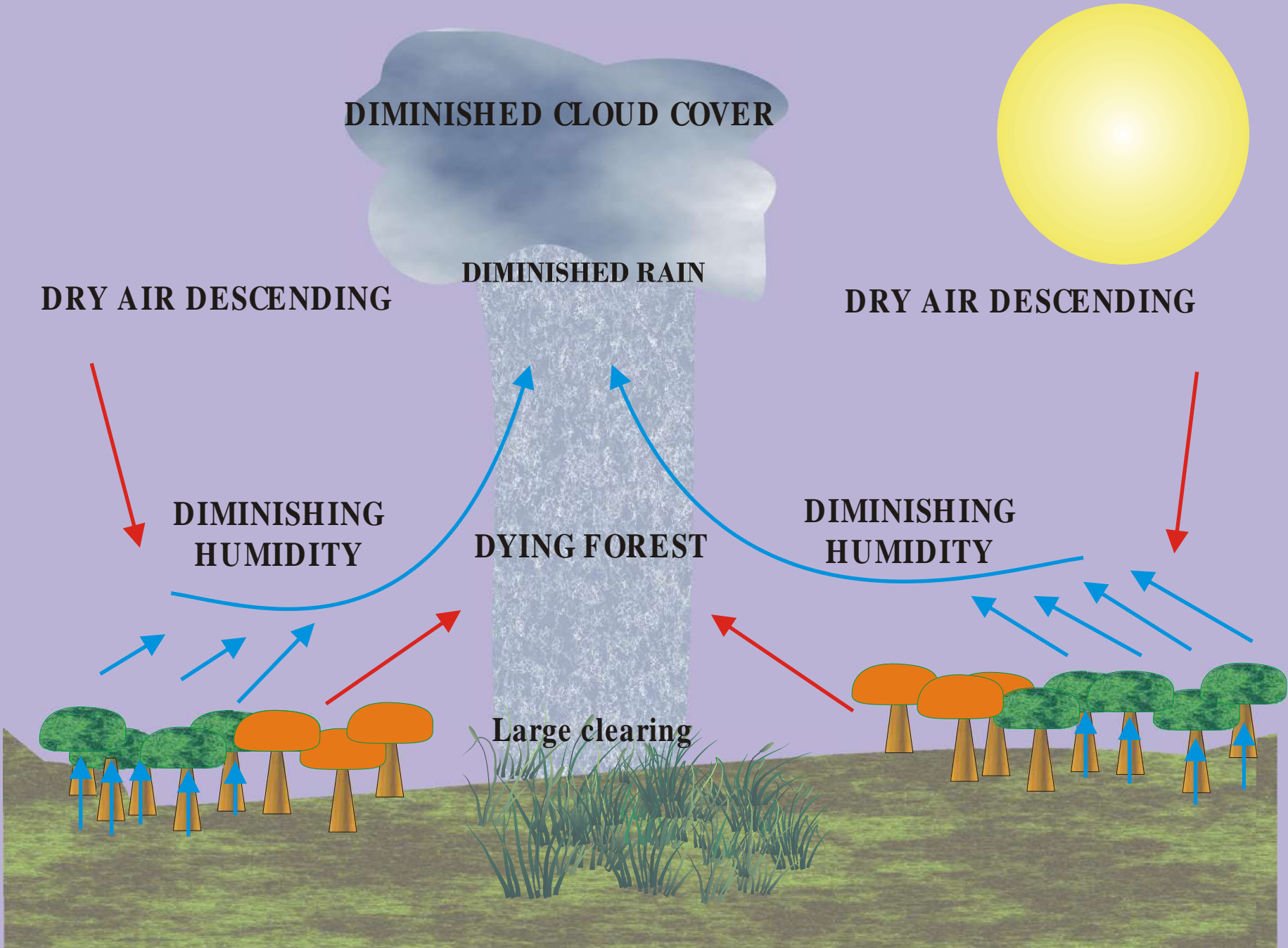
RAMS model scenarios of deforestation



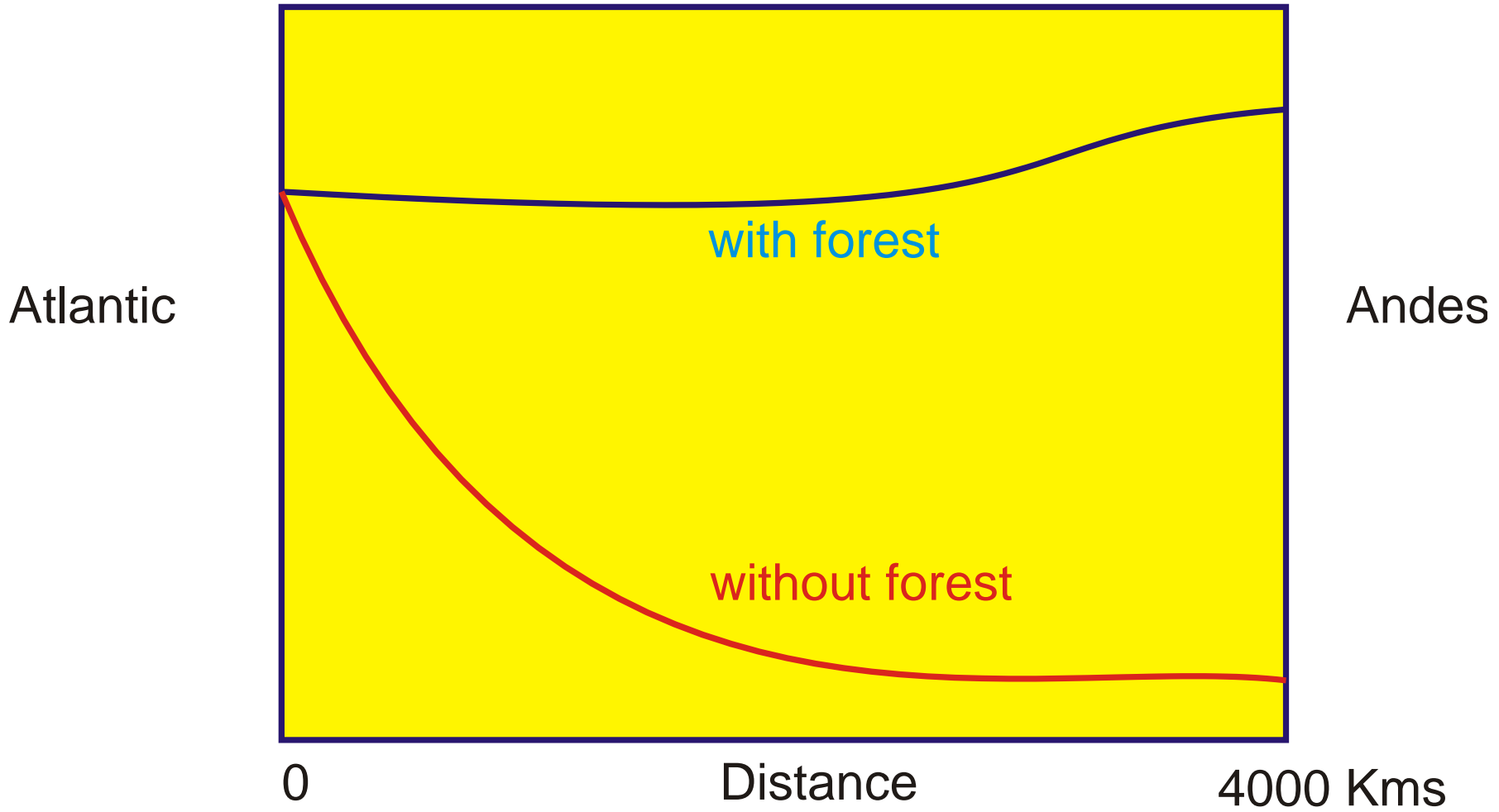
RAMS Impacts of total deforestation on rainfall



The Amazon Basin drives weather systems around the world



Rainfall



From A.M.Markarieva & V.G. Gorshkov



The Amazon's Role in Global Climate


Aside from concern over the GHG emissions (up to 20 per cent of the global total) the fundamental importance of the Basin to climate has been largely overlooked.

Turning the Amazon, at least 50 per cent of it, into a fuel factory for European and US motor vehicles could lead to a climate catastrophe on an enormous scale.

20,000 million tonnes of water are evapo-transpired every day over the Brazilian Amazon, compared to 17,000 million tonnes flushed into the Atlantic Ocean.

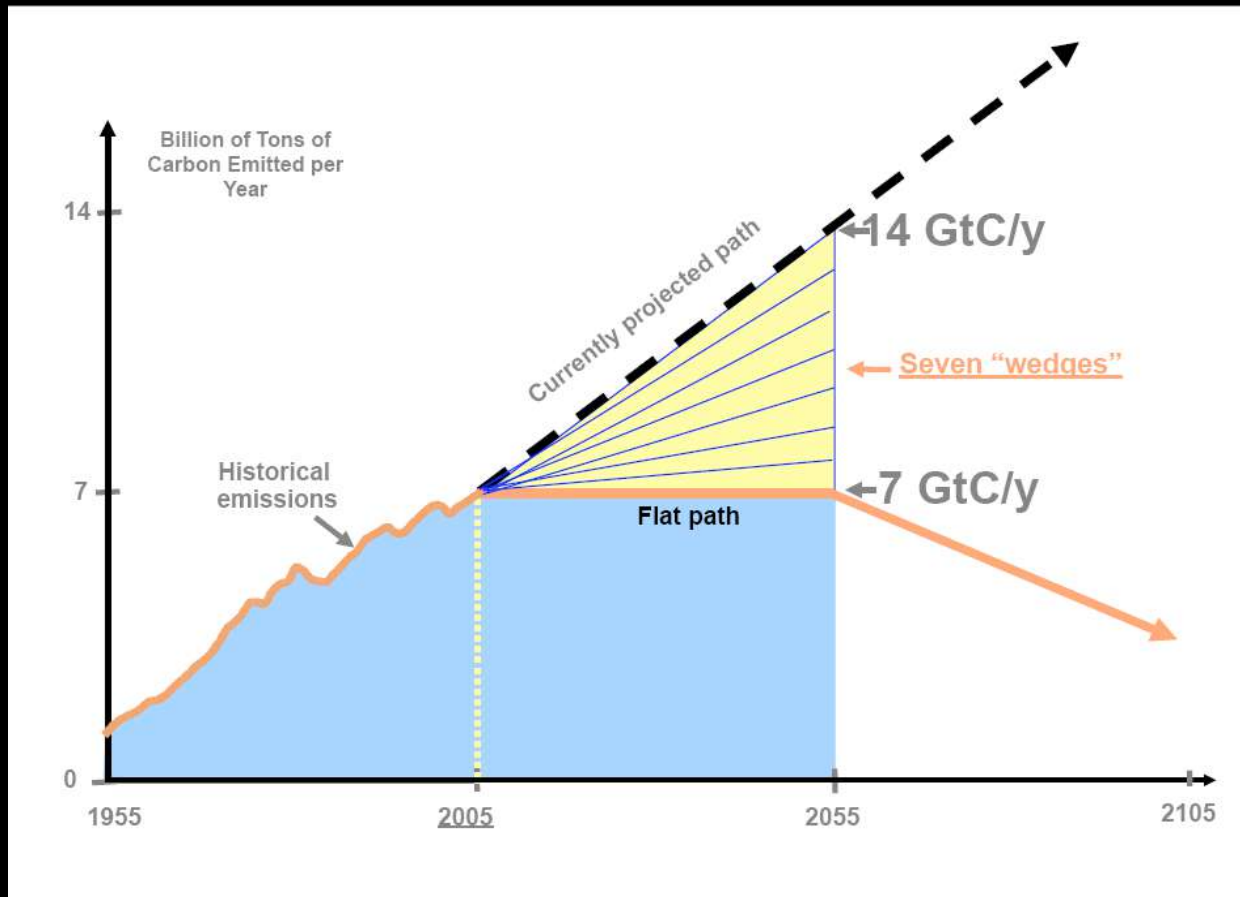
Energy required for that evapo-transpiration is equivalent to the summed output of Itaipú, the world's largest Hydroelectric dam for a period of 135 years.

(personal communication, Antonio Nobre)

An aerial photograph showing three yellow combine harvesters moving through a vast, green soybean field. The rows of crops are straight and extend far into the distance. The harvesters are positioned in a line, moving away from the viewer. The sky is clear and blue in the background.

Las Tele-conexiones. Los EEUU está en negocio con Brasil para bio-diesel derivado de Soya. Pero, la soya rompe el ciclo hídrico y, sin bosques amazónicos, el cinturón dorado de los EEUU, donde se siembran maíz para el etanol, no recibirá sus lluvias primaverales.

Techno-fix under the Kyoto Protocol?

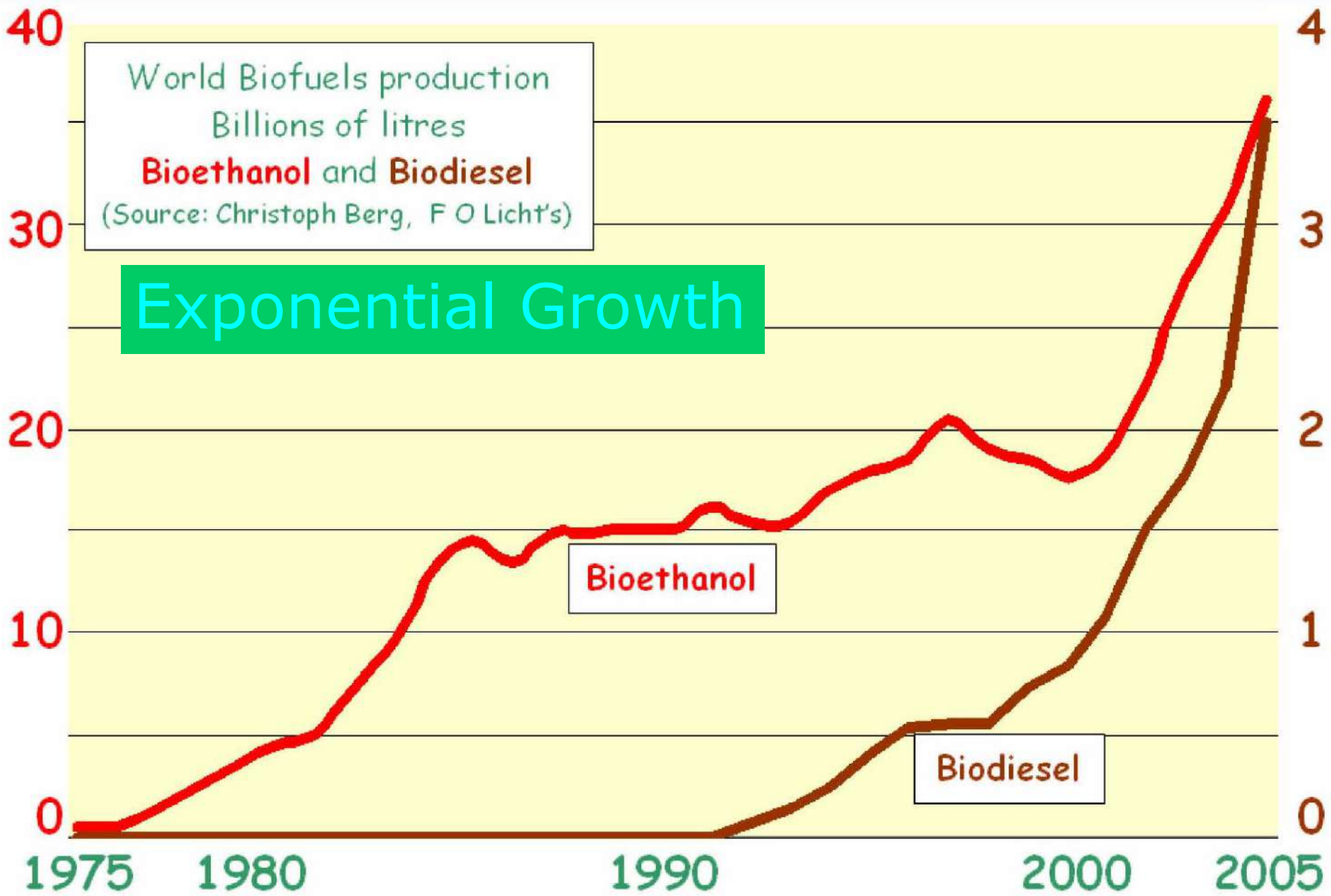


An IPCC proposal for stabilising CO₂: the Pascala and Socolow wedges. Each wedge saves 25 billion tonnes of emissions between now and 2050.

Replacing Oil with Biofuels

- **Bioethanol, Biodiesel, Biobutanol**
- **1 Wedge = 24m barrels/day of bioethanol replacing gasoline by 2055**
- **Requires 250m Ha of high yield plantation**
- **Or 1/6 of global cropland = land mass of India**

NREL



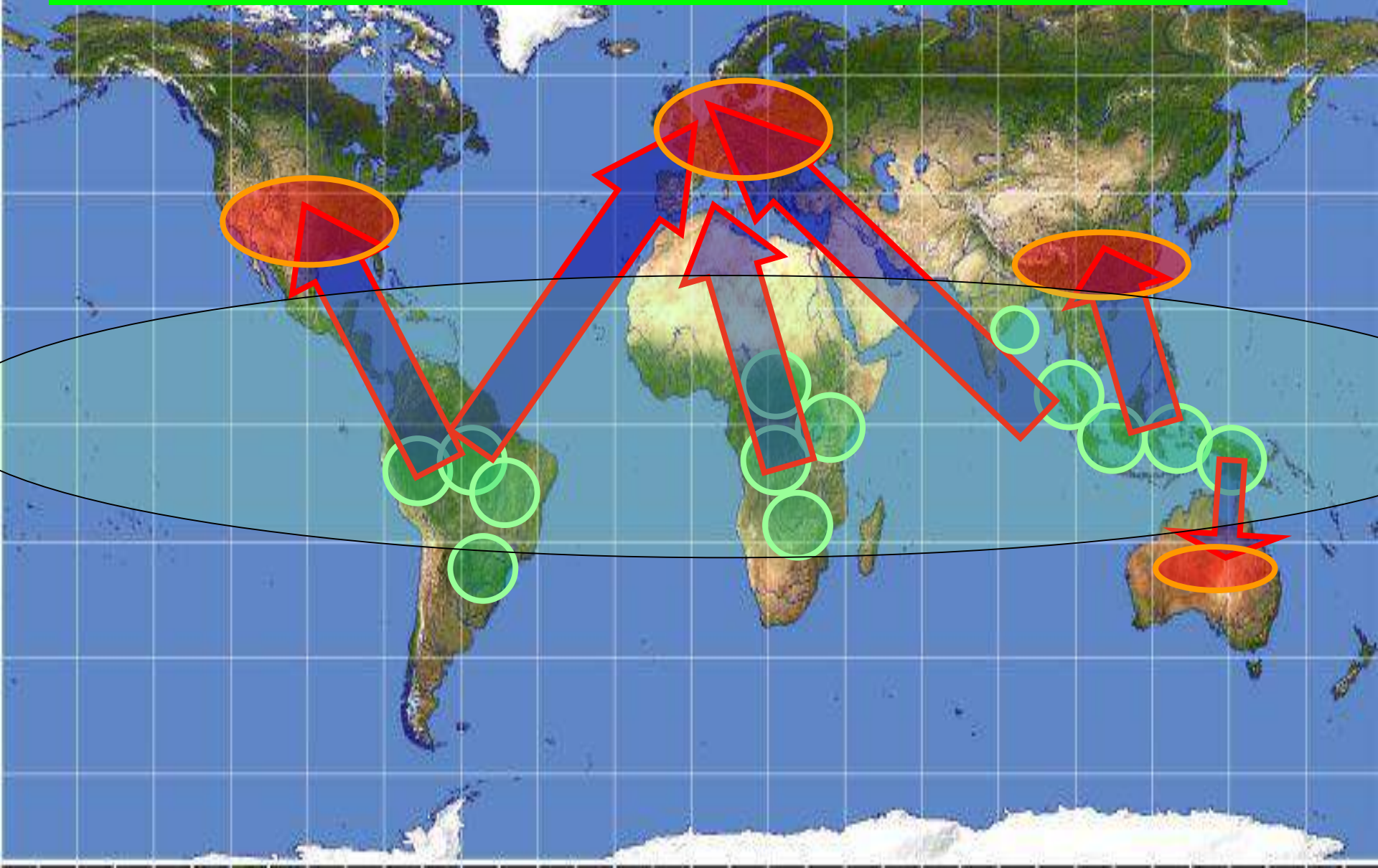
US / EU Policy – going off the graph

EU – 10% by
2020 (1% now)

US – 20% by
2020 (4% now)



Massive land-use change in global South



Agrofuel expansion = Loss of land rights and food sovereignty



Soya expansion in Paraguay has driven 90,000 families off their land -

Agrofuel expansion is triggering a new wave of soya expansion.

Landless People's Camp in Front of Large Industrial Agriculture Estate, Paraguay

Photo: www.grr.org.ar

Agrofuel expansion and human rights: The Indonesian example



Protests against destruction of forests and community lands for palm oil, pulp and timber in Sumatra

Photo by Feri Irawan, WALHI Jambi

**West Kalimantan
(Indonesia), 5
million indigenous
people are likely to
be displaced by
agrofuel expansion**

**(Chair of the UN
Permanent Forum on
Indigenous Issues)**

EU Moratorium Call

Call for an immediate moratorium on

EU incentives for agrofuels,

EU imports of agrofuels and

EU agro-energy monocultures