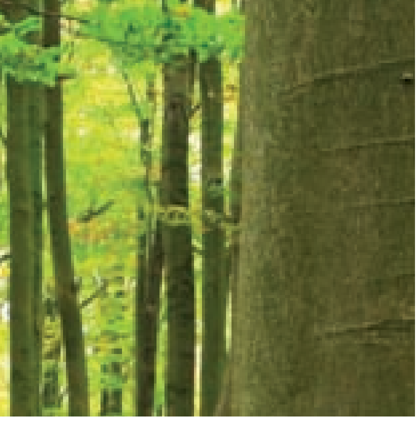

The Root of the Matter

Carbon Sequestration in Forests and Peatlands

Dominick Spracklen, Gil Yaron, Tara Singh,
Renton Righelato and Thomas Sweetman
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Contents

Executive Summary

In tackling climate change, policy makers often overlook the role of the natural world in regulating greenhouse gases in the atmosphere: specifically, the unique role that forests and peatlands have to play in the battle against rising emissions. Changing approach would significantly reduce the cost of tackling climate change and deliver a variety of other benefits.

As forests grow, carbon dioxide is taken out of the air. However, this carbon is released during deforestation. Similarly, peatlands have accumulated carbon from plant matter over millennia and when they dry out – often as a result of deforestation – release vast quantities of carbon. In other words, living forests and peatlands can sequester carbon emissions, whilst dying ones release previously stored carbon.

In this report, we argue that preventing deforestation, promoting afforestation/reforestation and stopping peatland destruction are some of the cheapest and most effective ways of reducing global greenhouse gas (GHG) emissions. We propose the introduction of market mechanisms that can ensure investment is directed into these areas and a strategy to make this happen as quickly as possible.

Every year the destruction of forests and peatlands generates more than the entire GHG emissions from the global transport sector or a similar amount to that emitted by the United States or China. Stopping their destruction can be done comparatively quickly and cheaply. The prevention of deforestation and peatland destruction requires no technological development and little capital investment. This method of reducing GHG emissions is dramatically cheaper than all other mitigation technologies currently available–as low as US$0.1 per tonne of CO_2. The table and graph overleaf set out the relative costs of the different mitigation options.

The economics is startling – if developed countries spent the same amount of money on preventing deforestation and the destruction of peatlands as they do on biofuel subsidies (US$15 billion), this would halve the total costs of tackling climate change. In addition to this, the protection of these habitats yields a plethora of valuable eco-system services, particularly in the poorest countries.

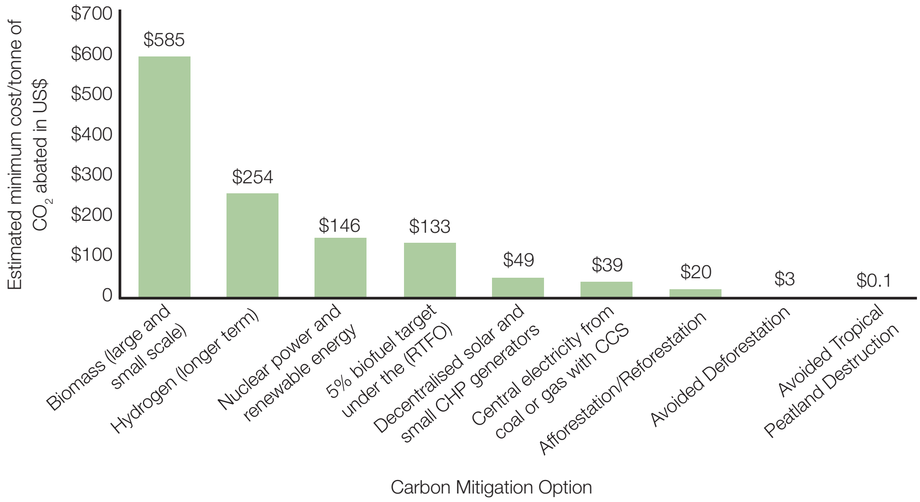
Yet current government policy places no value on protecting our forests and peatlands. The protection of these habitats is not included in the European Union's Emissions Trading Scheme (EU ETS) and is seriously neglected by the UN Kyoto Protocol. For example, only one forestry project has been approved by the Kyoto Protocol's Clean Development Mechanism (CDM).

In order to promote forest and peatland protection and policies such as afforestation and habitat restoration, the following policies should be introduced.

Policies the UK can introduce immediately:

1. *Abandon biofuel targets and subsidies.* Biofuel targets are responsible for the creation of price mechanisms that encourage biofuel crops to replace natural forests. This has led to an increase in both food prices and deforestation. This misjudged policy should be suspended until second-generation biofuels are tested and shown to provide net emission reductions without directly or indirectly causing deforestation. In the UK the 5% biofuel target under the Renewable Transport Fuel Obligation (RTFO) at £0.20 per litre will cost the

Figure 1: Cost comparison of carbon mitigation options[1]



Carbon Mitigation Option	Estimated minimum cost per tonne of CO_2 abated in US$	Estimated maximum cost per tonne of CO_2 abated in US$
Biomass (large and small scale)	$585	$644
Hydrogen (longer term)	$254	N/A
Nuclear power and renewable energy	$146	N/A
5% biofuel target under the Renewable Transport Fuel Obligation (RTFO)	$133	$292
Decentralised generation from solar and small CHP generators	$49	N/A
Central electricity from coal or gas with CCS	$39	$59
Afforestation/Reforestation	$20	$100
Avoided Deforestation	$3	$30
Avoided Tropical Peatland Destruction	$0.1	$4

Treasury £550 million annually in foregone revenue. The RTFO saves 2.6-3.0 $MtCO_2$/year, equivalent to only a tenth of the emissions of one UK power station and at a cost of £68-150 per tonne of CO_2.[2] A similar investment in preventing deforestation and peatland destruction could result in avoided emissions of 40-200 $MtCO_2$/year or a 50 times greater amount of avoided emissions. In 2005 alone, this would have offset the equivalent of up to 37% of all UK CO_2 emissions.

1 IPCC, 2007; Angus, F. et al, *Reducing Emissions from Peatland Deforestation and Degradation: Carbon Emission and Opportunity Costs, International Symposium and Workshop on Peatland Carbon-Climate – Human Interaction – Carbon pools, fire, mitigation, restoration, and wise use*, Yogyakarta, Indonesia, 27-31st August 2007; http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm; http://www.berr.gov.uk/files/file36782.pdf

2 http://www.opsi.gov.uk/si/si2007/em/uksiem_20073072_en.pdf

2. *Support immediate action to reduce peatland destruction in South-east Asia.*
   One of the lowest-hanging fruits of climate change mitigation are Indonesia's peat swamp forests, which contain millions of tonnes of carbon per sq km and where vast amounts of GHGs are now being released by logging, drainage and fire. Measures focused on illegal logging and canal building, and on blocking canals before swamps dry out, are among the best possible investments that can be made in avoiding GHG emissions.

3. *Build capacity in developing countries to prepare for avoided deforestation.*
   Avoided deforestation (AD) will be held back if developing countries do not have the capacity to support and monitor forest conservation. Government can contribute by helping developing countries to establish this capacity through financial support and technology, knowledge and experience transfer.

4. *Provide financial support to kick-start pilot avoided deforestation projects.*
   Large-scale pilot projects are urgently needed to inform policy development. The reduced deforestation that results would be profoundly beneficial and cost-effective. Government can help by contributing to the World Bank's Forest Carbon Partnership Facility, and by funding exemplary avoided deforestation projects such as the US$160 million Australian fund for reducing deforestation in South-east Asia.

Policies the UK can promote at European and international levels:

5. *Introduce forest carbon credits to give a realistic price for ecosystem services.*
   Current market failures mean that forest and peatland carbon services are undervalued relative to other uses. This can be corrected through a forest carbon market that recognises existing afforestation/reforestation credits, including those in developing countries and also avoided deforestation credits when they come on-line. The post-Kyoto climate policy and EU ETS should be developed/amended accordingly.

6. *Encourage immediate action to slow deforestation before 2012.*
   Every day of inaction results in further deforestation and the emission of GHGs with little benefit to the global economy and significant damage to the climate. Governments can help by developing clear long-term policies to encourage private sector-investment in avoided deforestation. Providing certainty that avoided deforestation credits will be recognized in future climate change mitigation policy will encourage the development of a pre-2012 market in Reduced Emissions from Deforestation and Degradation (REDD) credits.

7. *Recognise avoided deforestation in future international climate mitigation.*
   Avoided deforestation contributes 50-70% of the total forestry mitigation potential. However, it is excluded from the Kyoto Protocol and the EU ETS. Many challenges must be overcome before avoided deforestation can be integrated into future international climate change mitigation policy. Immediate targets are the 15th Conference of Parties meeting in Copenhagen in 2009, where substantial progress must be made if avoided deforestation is to commence in 2012 in time for a successor to Kyoto.

8. *Encourage development of the voluntary carbon/ecosystem services market.*
   The voluntary carbon market has huge potential and is already driving emission

reductions through forest restoration and avoided deforestation. Suitably encouraged and regulated it could help reduce deforestation immediately, years before avoided deforestation compliance mechanisms, such as an appropriately designed successor to Kyoto, are likely to be in place.

List of Terms

Anthropogenic – of human origin or caused by people.

Avoided deforestation (AD) – A loss of forest that is expected but does not occur, such as a loss that is less than that expected under 'business as usual' scenarios, and which could generate credits to reflect avoided carbon emissions.

Biomass - The amount of living material that exists in a particular area (usually expressed as kg per hectare or tonnes per sq km).

Biosphere – all parts of the Earth where life occurs, comprising the atmosphere, oceans, fresh waters, soils, and their underlying sediments and rock layers.

Carbon markets – A market that handles trade in carbon emission reduction credits and other carbon-related derivatives, thereby creating a price and ultimately an economic incentive for reducing carbon emissions.

Clean Development Mechanism (CDM) – An arrangement under the Kyoto Protocol that allows certain developed ('Annex I') countries to meet some of their emission reduction targets by investing in cheaper projects in developing countries as opposed to more expensive ones at home.

CO_2 equivalent (CO_2e) – a measure of the warming effect of mixtures of greenhouse gases, expressed as a standard concentration of CO_2. Thus in 1998 CO_2 concentration was 365 ppm of dry air, but the effects of methane, nitrous oxide and other GHGs in the air at that time were in warming terms equivalent to another 47 ppm of CO_2; the result is a CO_2e of 412 ppm. Throughout this report, 'CO_2' means 'CO_2e' unless otherwise stated.

CO_2 sink – An ecosystem or mechanism which, as it grows or operates, absorbs or 'sequesters' (i.e. isolates) CO_2 from the atmosphere.

CO_2 source – An ecosystem or mechanism which, as it decays or operates, releases CO_2 into the atmosphere.

CO_2 store – An ecosystem or artificial containment which holds carbon from previous growth or operation, but is now absorbing no new carbon. A store therefore has no direct effect on the atmosphere until it is destroyed or emptied. The destruction of ecosystems such as coral reefs, peatlands and primary forests that are CO_2 stores now accounts for about a quarter of anthropogenic carbon emissions.

Ecosystem – All the organisms living in a place and time, all the relationships amongst them, all the physical features of light, heat, moisture, wind, waves and chemistry that affect them, and the history of the place as well.

Ecosystem services – All behaviours and functions of ecosystems that contribute to human well-being, including water catchment services (regular supplies of clean fresh water coupled with the prevention of droughts, flash-floods and landslides), coastal protection services (safe absorption of energy delivered by floods, waves and wind), and carbon storage (reduced GHG emissions).

European Union Emissions Trading Scheme (EU ETS) – A carbon market based on 'cap and trade', whereby binding emission targets are set by the EU and tradeable allowances to emit up to these targets are then offered to emitters (as gifts or sold). Companies that pollute more can then buy surplus credits from those who pollute less, ensuring that overall emissions do not exceed the cap.

Forests, forest loss and forest planting – Forests are ecosystems dominated by trees. Deforestation means removing so many trees that the ecosystem becomes dominated by grasses or other low-stature vegetation, or bare ground. Afforestation means planting a forest in an area that was not previously forested. Reforestation means planting a forest in an area that has been deforested previously. Although nature can deforest (e.g. in volcanic eruptions), afforest (in areas that climate change has newly made hospitable to trees) and reforest (through colonisation and ecological succession), these terms usually refer to human actions.

Forest Carbon Partnership Facility – A proposed World Bank initiative to help developing countries reduce emissions from deforestation and [forest/land] degradation (REDD), with the two aims of building capacity for REDD, and testing performance-based incentive payments in some pilot countries, in order to prepare for a much larger system of incentives in the future.

Forest die-back – A process in which forests are gradually killed by parasites or drought.

Frontier Forests – About 40% of the world's forests that remain largely undisturbed and beyond the advancing 'frontier' of human exploitation and settlement.

Fungible – Mutually interchangeable, for example fungible REDD credits can be exchanged for other carbon credits, such as those achieved through the use of renewable energy.

Greenhouse effect – Warming of the Earth's surface by trapping solar radiation due to components of the atmosphere known as greenhouse gases (GHGs). Without this effect, the Earth would be a frozen and probably lifeless desert. The current biosphere is adapted to a greenhouse effect set by the composition of the atmosphere that has prevailed for millennia, but this is now changing due to anthropogenic emissions of additional GHGs, especially CO_2. The current CO_2 concentration is about 387 ppm (or 0.0387% of dry air), up from 315 ppm in 1960, and under 'business as usual' scenarios will reach around 700 ppm by 2100. This would result in an increase in the Earth's average surface temperature by several degrees more than would be needed to stimulate catastrophic change in all ecosystems. Policy efforts are focused on limiting the rise of CO_2 concentration to 450-550 ppm by 2050, and to stabilise or reduce it thereafter. This might avoid more than a 2°C rise, which will still have numerous adverse impacts.

Greenhouse Gas (GHG) – In the atmosphere, GHGs such as CO_2 trap sunlight as heat, thus contributing to the greenhouse effect which keeps the Earth's surface warmer than it would otherwise be. The six GHGs defined by the IPCC comprise carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).

$GtCO_2$ – a thousand million tonnes of CO_2, also known as a billion tonnes or one gigatonne. Estimates put worldwide CO_2 emissions at 31.1 $GtCO_2$ by 2010.

IPCC – The Inter-governmental Panel on Climate Change was established in 1988 by the United Nations Environment Programme and the World Meteorological Organisation, to evaluate scientific evidence and risks. It published its first assessment report in 1990, and a supplement in 1992 to inform the 'Rio Earth Summit'. As knowledge of climate change improved it produced further assessments in 1995, 2001, and 2007, all based on reviewing published scientific papers. The reports were prepared and reviewed by hundreds of professional scientists, and in the case of the 2007 report by nearly 4,000 of them. They have consistently firmed up our understanding of the processes involved in climate change, and reduced our uncertainty of the likely consequences.

Kyoto Protocol – A 1997 protocol of the UNFCCC, entering into force in 2005, by which parties agreed to engage in emissions monitoring, reduction and/or trading with an overall objective of reducing overall greenhouse gas inputs into the atmosphere, thus helping to prevent climate change. By the end of 2007, 175 countries had ratified the protocol. See also: UNFCCC.

$MtCO_2$ – a million tonnes of CO_2, also known as one megatonne.

Parts per million (ppm) – A measure of concentration often used for greenhouse gases in the atmosphere. One thousand parts per million is equivalent to 0.1% of dry air.

Peat and peatlands – Peat is a layer of dead vegetation that is only partly decayed because decomposition is slowed by waterlogging, lack of oxygen, high concentrations of tannins and/or by low temperatures. Thus, peat accumulates in swampy conditions beneath tropical forests, and at high altitudes and latitudes. Peaty soils are those that contain abundant peat as well as mineral components, such as sand and mud. Peatlands are all areas with pure peat or peaty soils, which amount to about 400 million hectares, most of which are in Canada (37%) and Russia (30%) although there are large areas of rainforest growing on deep peat swamps in the Amazon Basin, Sumatra, Borneo, New Guinea and elsewhere.

Plantation forests – Artificial forests usually planted for timber production, or as windbreaks or for water catchment purposes. These forests are often low-stature monocultures and function far less well than natural forests for biodiversity and ecosystem services including carbon storage.

Primary Forest – A forest stand that predates human interference or one that has undergone all known stages of ecological succession and is now mature and stable. Such a forest has as high a standing biomass as it ever will under the physical conditions where it grows (i.e. some mature forests are taller and/or denser and heavier than others), so it has stored a maximum amount of carbon and accretes very little or no new carbon each year, other than through reversible seasonal growth and leaf fall. Major expanses of primary forest occur in the sub-Arctic zones of Eurasia and North America, and across the moist equatorial tropics (principally the Amazon and Congo Basins and the Malay Archipelago), with lesser and/or more fragmented stands elsewhere.

Primary production – The amount of biomass that is formed from non-living matter and solar energy in a particular area during a specified time (expressed as kg per hectare per year).

REDD – Reduced Emissions from Deforestation and [forest/land] Degradation. A scheme to reward avoided deforestation proposed by the Coalition of Rainforest Nations and discussed at the climate change conference in Bali.

Secondary Forest – An area of forest which has re-grown after a major disturbance such as a fire or severe timber harvest. Due to their relative youth these store less carbon than primary forests but absorb more on a yearly basis. Most forests in the USA and Europe are secondary.

Silviculture – The applied science of controlling the establishment, growth, composition, health and quality of forests, usually with the aim of promoting the growth of harvestable timber.

UNFCCC – The United Nations Framework Convention on Climate Change, which came into effect in 1994, was one of three international conventions that were opened for signature at the 1992 'Rio Earth Summit'. The others were the Convention on Biological Diversity and the Convention to Combat Desertification, and involve matters strongly affected by climate change. The UNFCCC provides the legal basis for its Kyoto Protocol, which sets binding targets for industrialized countries and the European community for reducing GHG emissions.

1

Overview

Forests and peatlands play a critical role in maintaining the Earth's climate. Despite decades of conservation effort, these ecosystems continue to be destroyed - the tropics alone is losing an area almost half the size of the UK each year. These ecosystems weigh up to hundreds of thousands of tonnes per square kilometre even when dry, or up to millions in the case of deep peat deposits, and are largely composed of carbon-rich compounds such as lignin and cellulose. When these are burnt or decay, they release greenhouse gases (GHGs) such as carbon dioxide (CO_2) and methane (CH_4).

> Destruction of forests and peatlands account for about 20% of humanity's total GHG emissions; greater than the total released from every truck, car, train and aeroplane in the world

Aside from their role in global climate change, forests and peatlands influence local and regional climates. Tropical moist forests are rainfall generators that recycle billions of tonnes of water into the atmosphere, whilst peatlands help to regulate drainage and absorb floods. Deforestation and peatland destruction can change rainfall patterns, resulting in droughts with serious economic and social consequences. Thus forests and peatlands contribute billions of dollars to the global economy via these and other ecosystem services. Such services are often taken for granted rather than being economically recognised, and forests and peatlands are cleared because their economic values are not recognised by those doing the clearing or those accountable to them. The trivial financial gains to be made by such uses contrast with the potential value of stored carbon that could be realised were there to be a way to generate income from this global service function. If carbon storage could be charged for at realistic prices, then forests and peatlands would become much more valuable alive than dead. Hence the central question in this report is how can forests and peatlands be priced effectively and through that and other policies, conserved.

Forests and peatlands as global carbon stores

Forests cover more than a quarter of the Earth's land surface or some 4 billion hectares[3], with each hectare containing 360-1450 tonnes of carbon dioxide equivalent[4] and therefore about 4,000 billion tonnes ($GtCO_2e$) in total. To put this in perspective, the average UK resident produces about 10 tCO_2e each year, so one hectare of forest stores the annual GHG emissions of up to 145 British people. Peatlands cover a tenth of the world's forest area but are much denser carbon stores and are estimated to contain a worldwide total of about 2,200 $GtCO_2e$. Between them, forests and peatlands contain twice or more of the CO_2 equivalent contained in the atmosphere[5], or more than 100 years' worth of human-caused GHG emissions.[6] As well as acting as carbon stores, forests also act as carbon sinks by absorbing carbon from the air as they grow. Each year, forests absorb

3 FAO, State of the World's Forests, Food and Agriculture Organisation of the United Nations, Rome, 2007.

4 Fearnside PM, Global warming and tropical land-use change: Greenhouse gas emissions from biomass burning, decomposition and soils in forest conversion, shifting cultivation and secondary vegetation, Climate Change, 46: 115–145, 2000.

5 Prentice et al., Intergovernmental Panel on Climate Change (IPCC), Third Assessment Report, 2001.

6 With greenhouse gas emissions in 2004 of 49 $GtCO_2$ equivalent/year, IPCC, Fourth Assessment Report, 2007.

11 $GtCO_2e$ from the atmosphere, which is about 25% of total anthropogenic emissions.

Emissions from tropical deforestation and peatland destruction

Deforestation and peatland destruction release carbon into the atmosphere. Every year about 12 million hectares of tropical forests are logged, cleared or burnt.[7] In 1990-2005 deforestation reduced global forest cover by 3% and tropical forest cover by 8%[8], with about half of this occurring in Brazil and Indonesia. The IPCC's Fourth Assessment report calculated that tropical deforestation results in annual emissions of between 3.7 and 8.1 $GtCO_2e$[9], or 15-25% of total anthropogenic GHG emissions. This is greater than the emissions from the global transport sector and is similar to the amount emitted by the USA or China.

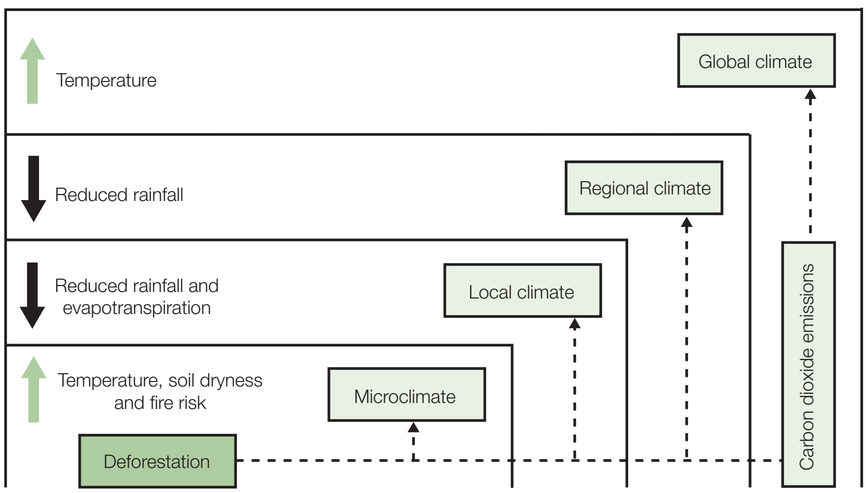
Peatlands are also being quickly destroyed, by melting and decay in circumpolar regions, and elsewhere by draining, land conversion, logging and fire. The high carbon density of tropical peatlands combined with its rapid depletion has helped Indonesia to become the world's third-largest GHG emitter, despite the country's relatively modest industrial activity. Drainage channels that cut through tropical peatlands to allow timber exploitation are often left open after use, causing the peat to 'bleed out' until it is completely dry, allowing it to decay or making it fire prone. This problem can be solved by blocking drainage channels so that the peat remains waterlogged, or (better) by preventing logging in the first place. Many peat swamps in Indonesia are being drained for oil palm plantations to meet food oil and biofuel demand.

> "The average UK resident produces about 10 tCO_2e each year, so one hectare of forest stores the annual GHG emissions of up to 145 British people"

The effect of deforestation on climate

The climate system is very sensitive to changes in land-use and the impacts of deforestation are complex and occur on local to global scales (Figure 2). Locally, tropical deforestation leads to increased temperatures and reduced humidity as more sunlight reaches the earth's surface[10],

Figure 2: Impacts of deforestation on climate at local and global scales.



7 FAO, *Global Forest Resources Assessment*, Food and Agriculture Organisation of the United Nations, Rome, 2005.

8 FAO, *State of the World's Forests*, Food and Agriculture Organisation of the United Nations, Rome, 2007.

9 IPCC, Fourth Assessment Report, 2007. The range of estimates is due to uncertainty in deforestation rates especially in some tropical regions and uncertainty in the amount of carbon stored per unit area of forest.

10 Didham RK. & Lawton JH, Edge structure determines the magnitude of changes in microclimate and vegetation structure in tropical forest fragments, *Biotropica*, 31: 17-30, 1999

while smoke from forests fires results in reduced rainfall downwind[11]. Deforestation can result in greatly reduced regional rainfall[12] due to decreased evapotranspiration.[13] Tropical deforestation can also modify global rainfall patterns through complex links in the climate system known as 'atmospheric teleconnections'. Thus, deforestation in the Amazon and central Africa results in reduced rainfall in the Midwestern USA and likewise, deforestation in South-east Asia results in reduced rainfall in China.[14]

Deforestation in the Amazon basin is estimated to reduce Amazon-wide rainfall by 10-25%[15] and could increase average Amazon-wide temperatures by up to 4ºC[16].

Deforestation is also predicted to cause similar reductions in regional rainfall in central Africa[17] and South-east Asia[18]. Thus large deforested areas can desiccate their surroundings and promote desertification. Of profound concern is that the Amazon may have an ecological 'tipping point', where so much forest is lost that reduced rainfall causes remaining forest to dry out and become vulnerable to fire and conversion to scrub and grassland. It is not yet known how much deforestation would need to occur before the tipping point is reached, but the mechanism has the potential to destroy the entire Amazon ecosystem. The resulting feedback system would involve a damaging spiral of deforestation reducing rainfall, causing forest dieback, increasing carbon emissions, amplifying climate change, and driving more forest dieback.[19] These complex ecosystem-climate feedbacks emphasize the importance of maintaining large areas of intact tropical forest.

Causes of tropical deforestation

The causes of tropical deforestation vary from region to region[20]. Subsistence farming is a major driver in Africa, parts of mainland South-east Asia and Central America, aggravated historically by weak institutions, poverty, disorder and in many places war. By contrast the main drivers in other parts of South-east Asia and much of South America are commercial agriculture and logging. Here, and more generally wherever powerful institutions drive change, it is the opportunity to capture supernormal profits from forest conversion that drive policies towards it, often aided by corruption and the official rejection of traditional land claims that might have preserved the forests[21]. Thus deforestation rates are influenced by policy, institutions, economics and technology, as well as by cultural and demographic factors. Infrastructure development is also important, as new roads open up formerly inaccessible forests and peatlands to agriculture and logging[22].

The national and international demand for commodities also drives a very large proportion of deforestation. The main areas are as follows:

- **Beef** – Cattle ranches cover 50 million hectares of the Amazon (more than twice the size of the UK) and accounted for 60% of deforestation in the 1970s and 1980s.[23]
- **Soya** – At least five million hectares of the Amazon are now farmed for soya.
- **Palm oil and rubber** – Plantations cover more than seven million hectares in South-east Asia and this is rapidly expanding.
- **Oil and minerals** – Exploration, mining, drilling, roads and pipelines all contribute strongly to the extension of infrastructure networks into forest areas.
- **Industrial logging** – Forest exports from the developing world are worth US$39 billion per year including US$10 billion annually in Southeast Asia[24], illegal logging results in a US$4 billion revenue loss in Indonesia.[25]

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24 FAO, Global Forest Resources Assessment 2005: Progress towards sustainable forest management. FAO, Rome, 2005.

25 Phat NK et. al., Appropriate measures for conservation of terrestrial carbon stocks - Analysis of trends of forest management for S.E. Asia. *Forest Ecology and Management* 191, 283-299, 2004.

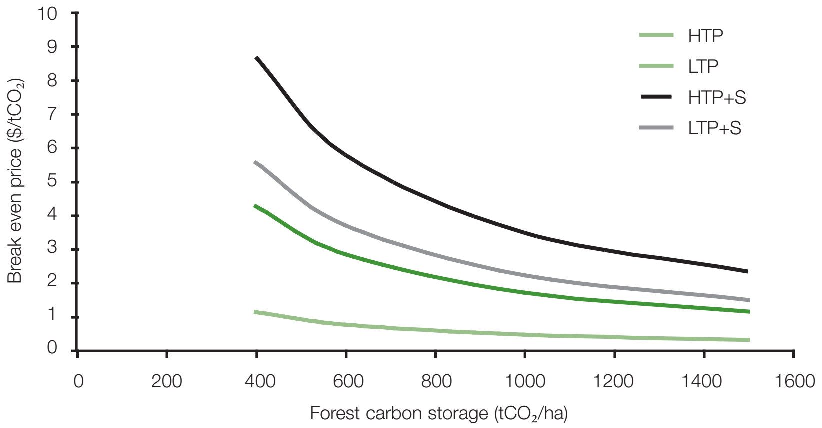
Quite simply, tropical forests are deforested and peatlands destroyed because this generates short-term financial rewards that can be captured by individuals and corporations, even though it makes no sense at an economic level. Leaving aside the majority of economically-important services including carbon storage, most tropical deforestation generates a return of less than US$5/t$CO_2$e, while in peatland returns of less than US$0.20/t$CO_2$e are common.[26] This is a serious market failure that reflects the difficulty of determining a price for untraded goods and services, especially in this case the ecosystem service known as carbon storage. Figure 3 shows the 'break-even price' – the price of carbon at which forest conservation becomes financially attractive compared to logging and agriculture. If the return from conservation can be increased above this level, then conserving peatlands and forests will become more attractive than destroying them.

All this might seem odd, when forests and peatlands provide ecosystem services that have an estimated global benefit of US$4.7 trillion annually.[27] However, many of these services are difficult to value and are often viewed as free benefits to global society (Box 1). With no market for these services, forests are undervalued and marginally profitable activities can result in their destruction.

> “Each year, forests absorb 11 GtCO_2e from the atmosphere, which is about 25% of total anthropogenic emissions”

Of all the ecosystem services, carbon storage is the most easy to quantify. Carbon markets could value a hectare of forest (containing 360-1450 tCO_2e) at US$500-3,500 (at US$5.5/tCO_2e) or US$2,500-20,000 (at US$27/tCO_2e). As shown in Figure 3, even carbon prices below US$10/t$CO_2$e would in many cases provide sufficient incentive to prevent deforestation. A funding mechanism for avoided deforestation could directly generate up to US$30 billion per year, comparable to revenues from industrial logging and additional to all the other benefits that intact forests and peatlands provide.

Figure 3: The carbon price at which forest conservation becomes financially attractive compared to logging (High Timber Price, HTP; Low Timber Price, LTP) and logging followed by soy-bean production (S) in the Amazon.[28]



26 Swallow BM et al., *Opportunities for Avoided Deforestation with Sustainable Benefits*. An Interim Report by the ASB Partnership for the Tropical Forest Margins. ASB Partnership for the Tropical Forest Margins, Nairobi, Kenya, 2007.

27 Costanza R et al., The Value of the World's Ecosystem Services and Natural Capital, *Nature*, 387, 253-260, 1997.

28 Diaz MCV & Schwartzman S, Carbon offsets and land use in the Brazilian Amazon. In: *Tropical Deforestation and Climate Change* (P Moutinho & S Schwartzman eds), pp. 93–98. Instituto de Pesquisa Ambiental da Amazonia, Belem, Brazil, 2005.

Box 1: Ecosystem Services

Forests and peatlands do not just store carbon - these big, biodiverse ecosystems offer many other essential services to humanity. They are home to upwards of 300 million people, including at least 100 million indigenous people, and more than a billion of the world's poorest rely heavily on forest products for food, fuel and subsistence income (an accounting that is amplified if marine fisheries that depend on coastal forests such as mangroves are included). It is not always easy to give a quantified economic value to forest and peatland services, but two of the best known concern biodiversity and water catchments.

"Tropical forests contain 40% of the Earth's biodiversity"[29] and as such they provide important services such as pollination, pest control, disease buffering and the source of medicinal products.

- Tropical forests provide the source of 40-50% of marketed pharmaceutical drugs[30] with an estimated value of US$108 billion a year.[31]
- Pollination is essential for 35% of global crop production[32] with an estimated value of US$112 billion annually.[33] Deforestation in Indonesia over the next two decades will cause coffee yields there to decline by 14%.[34] Farms near forest fragments in Costa Rica have 20% higher productivity due to pollination with a value estimated at US$20-380 per hectare of forest.[35]
- Malarial outbreaks increase after tropical deforestation even after increases in population have been accounted for.[36] In deforested regions of the Amazon, malarial carrying mosquitoes have a bite rate nearly 300 times higher than in forested areas.[37]

Forested water catchments protect against disaster and improve water supplies, improving downstream water quality and reliability and recharging aquifers, while preventing landslides. Deforestation in the semi-arid Alwar district of Rajasthan, for example, had starved groundwater resources and desiccated the climate to the point that the river Aravari was almost always dry and the people had to abandon their farms. A systematic effort by youth activists together with 700 village councils led to restoration of forests and traditional means to capture water and recharge aquifers, recreating a functional ecology, a moist climate and halting desertification.[38] Urban examples in the West include New York City's unique relationship with forested water catchments that supply its water to a high enough quality that the city avoided having to invest US$6-8 billion on a new water filtration plant while still complying with Federal law[39]. Meanwhile, the floods that can occur when catchment forests are damaged caused US$1 trillion damage in the 1990s, taking 100,000 lives and creating 300 million refugees. A global-scale analysis of historical flooding events suggests that deforesting 10% of remaining natural forest cover would increase flood frequency by 4-28% and flood duration by 4-8%.[40] Mangrove forests, many of which have been cleared for development, buffer coastal areas from sea surges caused by typhoons and tsunamis.

The future for forests and peatlands

Despite more than 30 years of conservation effort, deforestation continues unabated and is increasing in many tropical forest regions. Deforestation in the Brazilian Amazon increased by 30% between 2001 (1.8 million ha/yr) and 2004 (2.3 million ha/yr)[41]. The continued expansion of the paved road network in the Amazon Basin means this trend is likely to continue. Deforestation is also increasing in Indonesia: deforestation of 1.7 million ha/yr between 1987 and 1997 increased to 2.1 million ha in 2003. In both countries, despite intense efforts and policy commitments to prevent it at the highest levels of government since the mid-2000s, there is little evidence that deforestation (and related factors such as illegal logging in national parks) is being brought under control. In Indonesia's case, this has not been

29 Ozanne C et al., Biodiversity Meets the Atmosphere: A global view on forest canopy research. *Nature,* 301, 2003

30 http://www.fic.nih.gov/programs/research_grants/icbg/index.htm

31 Newman DJ, Kilama J, Bernstein A. & Chivian E. Medicines from Nature. In *Sustaining Life: How Human Health Depends on Biodiversity* (E Chivian & A Bernstein, eds), pp 117-161. Oxford University Press, 2008.

32 Klein AM et al., Importance of pollinators in changing landscapes for world crops, Proceedings of the Royal Society B, 274 (1608): 303-313, 2007.

33 DeMarco P & Coelho FM, Services performed by the ecosystem: forest remnants influence agricultural cultures' pollination and production, *Biodiversity and Conservation*, 13(7):1245-1255, 2004

34 Priess JA et al., Linking deforestation scenarios to pollination services and economic returns in coffee agroforestry systems, *Ecological Applications*, 17(2):402-417, 2007.

35 Ricketts TH et al., Economic value of tropical forest to coffee production, *Proceedings of the National Academy of Sciences*, 101(34):12579-12585, 2004.

36 Patz JA., et al., Unhealthy landscapes: Policy recommendations on land use change and infectious disease emergence, *Environ. Health Perspectives*. 112:1092, 2004.

37 Vittor AY et al., The effect of deforestation on the human-biting rate of Anopheles darlingi, the primary vector of falciparum malaria in the Peruvian Amazon, *American Journal of Tropical Medicine and Hygiene*, 74(1): 3-11, 2007.

38 UNEP, *Green Breakthroughs: Solving Environmental Problems through Innovative Policies and Laws*, United Nations Environment Programme, Nairobi, 2008.

39 Foley, J. et al., Global consequences of Land Use, *Science*, 309: 570, 2005.

40 Bradshaw, CJA. et al., Global evidence that deforestation amplifies flood risk and severity in the developing world, *Global Change Biology*, 13(11): 2379-2395, 2007.

41 Brazilian National Institute for Space Research (INPE), 2004.

helped by the international community's abandonment of the country's forest sector as an object of assistance. And now, the recent increase in global food prices is driving a new wave of arable conversion in South America and South-east Asia[42]. Part of it is certainly due to the fact that 'deforestation crops' such as sugar, soya and palm oil are increasingly in demand for biofuel as well as being sought-after subsistence and feedstock commodities.

The net result so far is that half of the world's forests have already been destroyed. In the Amazon, 16% of the forests have been cleared (equivalent to an area the size of France), while 25-40% of Indonesia's land area has been deforested over the past 50 years, and Central America has lost 40% of its forests. These figures are for complete removal of natural forest ecosystems, and additional to them are very large areas of forest that have been heavily logged, often repeatedly, or fragmented, but which are still recorded as 'forest' in UN Food and Agriculture Organisation statistics. In any case, even without counting heavily logged areas this deforestation is now estimated to have contributed around 30% of the total cumulative anthropogenic emissions of GHGs. Without significant change, emissions from deforestation will continue contributing massively to climate change. Over the 21st century, under the 'business-as-usual' scenario, deforestation is expected to:

- release 320-480 $GtCO_2e$, or 10-20% of total predicted anthropogenic emissions over the same period.[43]
- release GHGs equivalent to 50% of the total fossil-fuel emissions that have occurred between the start of the industrial revolution and the present day.
- consume 10-35% of the 'allowance' of GHGs that we can emit over the 21st century if we are to avoid dangerous climate change.[44] Stopping climate change in a deforesting world will be almost impossible.

Response of forests to a changing climate

Forests are living through a period of unprecedented environmental change, as indicated by these three observations:

> "Stopping climate change in a deforesting world will be almost impossible"

- Tropical forest regions have been warming by about 0.25°C per decade since the 1970s[45] and are predicted to warm by a further 3-8°C over the 21st century.
- The same regions will experience a 20-40% reduction in dry-season rainfall over the 21st century if business continues as usual.[46]
- These regions are also experiencing increased CO_2 concentrations and increased air pollution (especially exposure to ozone and nitrogen compounds).[47]

The impacts of such changes on forest ecosystems are not well known, and may have important impacts on the carbon stored in forests. Carbon sinks may initially increase due to carbon dioxide fertilization, but will probably reverse under a business-as-usual climate change regime in the 21st century.[48] The carbon stored in forests can also be released due to fire or insect outbreaks. Undisturbed tropical rainforests are not normally affected by fire, but logging and fragmentation combined with changes in climate can result in fire becoming a major threat.[49] This is already occurring, with massive tropical forest fires occurring in El Nino years in Indonesia and the Amazon. Increased wildfire and pest outbreaks are also occurring in Canada and North America.

42 Searchinger et al., Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change, *Science* 318: 1238–1240, 2008.

43 Sitch S et al., Impacts of future land cover changes on atmospheric CO_2 and climate, *Global Biogeochemical Cycles*, 19, GB2013, 2005.

44 To stabilize carbon dioxide at a concentration of 450 ppm, the total carbon that can emitted between 2001-2100 is estimated to be between 1340-2700 $GtCO_2e$ (e.g., IPCC, TAR, 2001). This depends on the CO_2 uptake by oceans and terrestrial biosphere and the range of values represents the uncertainty in these processes.

45 Malhi Y & Wright J, Spatial patterns and recent trends in the climate of tropical rainforest regions, *Phil. Trans. R. Soc.* B. 359 (1443): 311-329, 2004.

46 Malhi Y et al., Climate Change, Deforestation, and the Fate of the Amazon, *Science*, 319: 169, 2008.

47 Sitch S et al., Indirect radiative forcing of climate change through ozone effects on the land-carbon sink, *Nature*, 448 (7155: 79-794, 2007

48 Friedlingstein et al., Climate-carbon cycle feedback analysis: Results from the (CMIP)-M-4 model intercomparison, *Journal of Climate*, 9(14): 3337-3353, 2006

49 Cochrane MA & Laurance WF, Fire as a large-scale edge effect in Amazonian forests, *Journal of Tropical Ecology*, 18: 311-325, 2002

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The scope for action

How are current policies failing forests and peatlands?

Efforts to conserve tropical forests have been aptly described as a 'long defeat'[50]. Isolated fragments have been set aside as protected areas, but these are vulnerable to regional desiccation and climate change and elsewhere destruction proceeds unabated. Despite their significance in terms of GHG emission reductions, avoided deforestation and peatland loss are not rewarded under the Clean Development Mechanism (CDM) created under the 1997 Kyoto Protocol. Afforestation and reforestation projects are covered, but have been discouraged by the complex rules and high costs involved under the CDM and to date account for only one of a thousand CDM projects.[51]

Avoided deforestation and the Kyoto Protocol

In June 2001, the Parties to the Kyoto Protocol decided to exclude avoided deforestation - meaning a rate of deforestation below the 'business as usual' baseline - from the first Commitment Period (2008-2012). There were several reasons for this:

- There was concern that the so called 'flexible mechanisms' of the Kyoto Protocol (i.e. CDM and Joint Implementation) would allow developed countries to reach their targets without stringent controls on domestic fossil fuel use. Avoided deforestation was expected to yield large reductions in emissions at relatively low cost, potentially providing all the reductions required under Kyoto with no need for countries to control domestic emissions. There was also concern that avoided deforestation would distract attention from what was seen as the real business of reducing emissions from fossil fuel use.
- There was strong opposition from some developing nations worried about the potential loss of sovereignty and constraints on their future development. For example, Brazil was in favour of carbon credits being earned for reforestation but not avoided deforestation. The sub-text was that Amazonian deforestation was out of government control so targets to reduce deforestation would be difficult or impossible to meet.
- Methodological and technical issues made accurate accounting for emission reductions from forest lands very difficult. Many developing countries had little or no capacity to monitor deforestation or ensure that forests were protected permanently.

An underlying constraint was the notion - already embedded in the thinking of the Global Environment Facility (GEF), which finances only the 'incremental costs' of actions to yield global rather than national benefits - that avoided deforestation was already in the interests of forested nations (because of national benefits received from ecosystem services). Simply transferring wealth to countries to pay for things that those countries should be doing anyway was unattractive to many potential donor governments.

50 Caldecott J, Money deals offer a chance to halt the 'long defeat' of the forests, *The Independent* 1 December 2005.

51 http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html

Voluntary carbon markets and charitable activities

The failure of Kyoto mechanisms to stimulate a market in carbon credits from protection of forests and peatlands has not prevented a voluntary carbon market from making significant progress, in financial terms and in driving innovation and the development of best practices. Thus 36-45% of credits in the voluntary market are generated through forest management[52], and this market is an important financing mechanism for avoided deforestation. Verified Emission Reduction (VER) prices from forestry activities (US$0.5-45/t$CO_2$e) compare favourably with the costs of projects from the energy sector (US$0.5-20/t$CO_2$e).

Important early actors in the voluntary carbon market were non-profit NGOs, which introduced many forest protection and restoration projects. Most such projects are aimed at conserving biodiversity, but they also mitigate climate change by preventing deforestation and encouraging reforestation. These are supported by private and corporate donations, and from the sale of voluntary carbon offsets. Examples include: projects financed by the Royal Society for the Protection of Birds in Indonesia (100,000 hectares) and Sierra Leone (75,000 hectares); projects supported by the World Land Trust in South America and Asia (around 150,000 hectares), plus a joint initiative with the government of Paraguay to protect a million hectares of dry Chaco forest; a million-hectare forest restoration project supported by The Nature Conservancy in Brazil; and a project involving Fauna and Flora International, local government and private companies which aims to reduce deforestation by 85% in 750,000 hectares of Indonesia to avoid the emission of 3.3 million tonnes of CO_2 annually[53]. Numerous private trusts have also bought land for conservation.

The voluntary market is also driving interest and investment in ecosystem services. In March 2008, Canopy Capital, a private equity firm, announced a deal with Guyana's Iwokrama International Centre for Rainforest Conservation and Development, to fund conservation and research in Iwokrama's 370,000 hectares of forest in exchange for the right to market the forest's ecosystem services. In the absence of detailed figures for all such activities worldwide, it is estimated that charities and their for-profit allies have protected at least 100 million hectares and are responsible for restoring up to a million hectares per year.

> “ Carbon markets are demonstrably able to mobilise tens of billions of dollars annually and can strongly motivate forest conservation ”

Despite objections from most offset providers, in February 2008 Defra announced the framework for the Code of Best Practice for Carbon Offsetting. The Code is voluntary and offset providers can choose whether to seek accreditation for some or all of their offsetting products. The Code initially covers only Certified Emission Reductions (CERs) that are compliant with the Kyoto Protocol. The Code cannot be complied with by the offsets offered by voluntary bodies to fund forest restoration or avoided deforestation, which may as a result suffer. Defra has also challenged offset providers to develop a standard for VERs which could be included in the Code in the future, subject to acceptable levels of robustness. Standards appropriate to forest credits are being introduced, notably the "Voluntary Carbon Standard"[54], and adopted by some offset providers on a voluntary basis.

What more can be done?

Trade in carbon-based derivatives linked to forest and peatland conservation are likely to be a very effective way of protecting these

52 Harris E, *The Voluntary Carbon Market: Current & Future Market Status, and Implications for Development Benefits*, International Institute for Environment and Development, Working Paper, 26 October, 2006, see: http://www.iied.org/CC/documents/FINAL_WorkingpaperforIIEDnefRoundtable_ElizabethHarris_2610061.pdf

53 http://www.rainforest-alliance.org/news.cfm?id=carbon_ccb

54 http://www.v-c-s.org/docs/VCS%202007.pdf

Table 1: The climate mitigation potential from all forestry activities, estimated for 2030.

Source	Mitigation potential in 2030 ($GtCO_2e$/yr)	Cost (US$/$tCO_2e$/)
IPCC FAR, regional studies	2.9	<US$100
IPCC FAR, regional studies	1.6	<US$20
IPCC FAR, global studies	13.8	<US$27
McKinsey Quarterly	6.7	<US$50 (40 euro)

ecosystems, since carbon markets are demonstrably able to mobilise tens of billions of dollars annually and can strongly motivate forest conservation. The costs of climate-change mitigation through forestry are driven by a variety of factors (Box 2), but are typically US$0.1-22/$tCO_2e$, which compares well to mitigation costs in the energy sector where US$0.5-20/$tCO_2e$ are typical. In comparison, the projected prices for 2008 carbon credits are US$34-39/$tCO_2e$. The IPCC's Fourth Assessment Report (FAR) estimated that all forestry activities had an economic potential of 1.6 $GtCO_2e$ per year at costs of less than US$20/$tCO_2e$ rising to 2.9 $GtCO_2e$ at prices under US$100/$tCO_2e$ (Table 1). The envisioned scale of avoided emissions is the same as the total emissions by EU Member States combined. By comparison, an article in an international corporate journal, the *McKinsey Quarterly*[55], calculated a greater potential of as much as 6.7 $GtCO_2e$ at costs less than US$50/$tCO_2e$.

A large proportion, estimated at 60-70%, of total forestry mitigation potential is within tropical countries. This is due to:

- Lower mitigation costs in tropical (US$0.1 - US$7/tCO_2) compared to developed countries (US$1.4 - US$22/tCO_2)[56] due to lower labour and opportunity costs.
- Deforestation occurs mainly in the tropics, which means that avoided deforestation has the greatest potential there;
- Forests in the tropics store large amounts of carbon, and trees grow and absorb carbon more quickly there.

The costs and benefits of avoided deforestation

All studies that have so far been published agree that avoided deforestation contributes 50-70% of the forest sector's potential ability to mitigate climate change. Despite this,

Box 2: The costs of carbon mitigation through forestry

Cost centres include:

- Opportunity costs – Stakeholders (landowners, leaseholders and indigenous people) must be provided with equivalent income to compensate for lost opportunities (timber, grazing or arable use returns).
- Management, maintenance and enforcement costs.
- Monitoring costs.
- Transaction, registration and administration costs.
- Provision for leakage and non-permanence.
- Education, training and support for sustainable forest use.
- For afforestation and reforestation projects, additional costs for tree planting and aftercare.

55 Enkvist, P.A, et al. A cost curve for greenhouse gas reduction. *McKinsey Quarterly* No 1., 2007

56 Richard, K.R. and Stokes, C. A review of forest carbon sequestration cost studies: A dozen years of research, Climatic Change, 63, 1-48, 2004

avoided deforestation is currently excluded from climate mitigation policy. Each year, some 13 million hectares of forests are cleared, releasing 5.5 $GtCO_2$. If the global deforestation rate were to be halved, by 2050 GHG emissions would be reduced by 180 $GtCO_2$. This would also save about 300 million hectares of forest with all the other environmental benefits implied by this. Such a reduction in deforestation would contribute about 12% of the total needed to meet an 80% reduction in global GHG emissions by 2050 (relative to 1990 levels).[57]

If carbon credits were generated through avoided deforestation, their effect would depend on the value of those credits. At a price of US\$3-20/tCO_2, avoided deforestation would be expected to contribute emission reductions of 0.3-1.6 $GtCO_2$/yr, equivalent to a 5-30% reduction in deforestation. The Stern report estimated that cutting deforestation by 50% would cost US\$15 billion per year, the same amount that the OECD spends of biofuel subsidies. At higher carbon credit prices, of say US\$27/tCO_2, however, deforestation can be virtually eliminated saving up to 5.5 $GtCO_2$/yr. This is almost enough to offset the fossil fuel emissions of the United States. Avoiding the deforestation and drainage of South-east Asian forest peatlands alone could reduce emissions by up to 2 $GtCO_2$ per year.[58] This is greater than the combined fossil fuel emissions from the UK, France, Spain and Germany.

Avoiding deforestation on such scales will require policy changes, institutional reform, capacity building, public education, enforcement and monitoring, as well as finance to fund the project-delivery mechanisms involved. Indicative costs and outcomes are given in Table 2.

“ Avoiding the deforestation and drainage of South-east Asian forest peatlands alone could reduce emissions by up to 2 $GtCO_2$ per year.[58] This is greater than the combined fossil fuel emissions from the UK, France, Spain and Germany ”

Table 2: Emission reductions and costs of avoided deforestation

Source	Cost (US\$/tCO_2)	Avoided deforestation (%)	Annual avoided emission ($GtCO_2$)	Cumulative avoided emission by 2050 ($GtCO_2$)
IPCC FAR	US\$20	50	1.6	
Greig-Gran (2006) compiled for the Stern Review	US\$1-2	50	3.5-4.9	154-216
World Bank	US\$7-42	10-20	0.3-0.6	
McKinsey Report	US\$50 (40 euro)	Unspecified	3	
Sohngen and Beach (2006)	US\$1.36	8-15	0.4	18
Sohngen and Beach (2006)	US\$27.2	95-100	5.5	280

57 Gullison RE et al., Tropical forests and climate policy, *Science* 316: 985–6, 2007.

58 Hooijer, A., Silvius, M., Wösten, H. D Page, S. 2006. PEAT-CO2, Assessment of CO_2 emissions from drained peatlands in SE Asia. Delft Hydraulics report Q3943 2006.

Table 3: Potential income resulting from 100% avoided deforestation at US$60/t$CO_2$e, compared to gross domestic product in countries accounting for more than 90% of global deforestation (from World Resources Institute CAIT database)

Country	GDP in 2005 (US$ billions)	Potential Avoided Deforestation revenue (US$ billions)	Share of GDP (%)
Indonesia	370	79	21
Brazil	1030	47	5
Malaysia	167	22	13
Burma/Myanmar	12.4	12.4	100
DR Congo	9.3	9.3	100

Climate-change mitigation through avoided deforestation offers a significant financial resource to those developing countries that still possess abundant forest resources. If countries in the Amazon Basin reduced their deforestation rate by 50%, for example, they could potentially receive US$5-31 billion each year at a carbon price of US$7.5-45/t$CO_2$e. Table 3 shows some other potential avoided deforestation revenues for key forested countries in the tropics.

> "It is crucial that climate-change policies do not encourage the conversion of primary forest to plantations"

Better afforestation and reforestation

Growing trees absorb carbon, so afforestation and reforestation can remove carbon from the atmosphere. In the tropics, where the rate of plant growth is especially fast, growing forests can absorb 20-30 tonnes of CO_2 per hectare per year. Forest creation is already occurring on a large scale in China (4 million ha/year), Spain (0.3 million ha/year), Vietnam (0.2 million ha/year) and the United States (0.15 million ha/year).[59] China established 28 million hectares of plantations between 2001 and 2007, offsetting about 20% of national fossil fuel emissions in the year 2000.[60]

Most of this reforestation, however, involved monocultures of trees planted for timber, which is not an ideal model for afforestation and reforestation. Artificial forests of this kind contain far less carbon and biodiversity, and yield far fewer ecosystem services, than old-growth primary forest or well-restored secondary forest.[61] Hence it is crucial that climate-change policies do not encourage the conversion of primary forest to plantations. Instead native tree species should be encouraged and the approach to reforestation should be site specific. Where forest fragments remain, natural regeneration is often the most effective and cheapest mechanism to restore forest cover [62]. If seed sources are absent, tree planting can speed forest recovery. This should incorporate local knowledge and use a wide range of predominately native species of local provenance. Much more site-specific research is needed in this area.

Proposals to fund forests

Evolving policy on avoided deforestation

The climate mitigation potential of forests and peatlands is clearly substantial, and

59 FAO, Global Forest Resources Assessment, 2005.

60 Wang S. et al., *Journal of Environmental Management*, 85:524, 2007.

61 Jackson RB et al., Trading water for carbon with biological sequestration. *Science*, 310 (5756): 1944-1947, 2005.

62 Lamb D, Erskine PD & Parrotta J, Restoration of degraded tropical forest landscapes, Science, 310, 5754,1628-1632, 2005

Box 3: The potential for carbon absorption through forest planting in the UK

The potential for carbon sequestration in the UK is limited by the small amounts of available land. UK annual CO_2 emissions in 2005 were 540 $MtCO_2$[63]; the options below could reduce these emissions by about 2.5%.

- Newly-planted UK forests are young and provide a carbon sink of 9 $MtCO_2$ per year, which is likely to last until about 2025. To maintain this rate after 2025 would require additional afforestation and reforestation of an area of about 30,000 ha per year[64]. This would cost between £240 million to £450 million per year.
- Peatlands in the UK are important carbon stores containing 10 $GtCO_2$[65], more than the forests of the UK and France combined. There are 225,000 ha of peatlands in the UK that have been damaged by drainage, excessive burning, over-grazing and afforestation[66]. Under more sympathetic management, these peatlands could absorb an additional 1.4 $MtCO_2$ per year[67].
- From the 1930s until the 1980s, hundreds of thousands of hectares of the UK's ancient woodland (storing 670 tCO_2/ha[68]) were cleared and replanted with commercial conifer plantations (storing on average 270 tCO_2/ha over a timber cycle[69]). Many of these conifer plantations are reaching maturity and are being clear felled. Restoring 100,000 ha of these sites owned by the Forestry Commission (or about 6% of existing UK conifer plantations) would absorb an additional 40 $MtCO_2$ over the next 100 years (or 0.4 $MtCO_2$/yr).
- Uplands cover 40% of the UK and are largely deforested. Large-scale restoration of these uplands could take up large quantities of carbon[70]. The Scottish Forestry Alliance is restoring 10,000 hectares to a natural state, which is expected to absorb 1 $MtCO_2$ over the lifetime of the project[71]. Restoration of 10% of UK uplands through appropriate natural regeneration could remove from the atmosphere as much as 3 $MtCO_2$/yr.

while avoided deforestation is excluded from the Kyoto Protocol, ways to include it in future climate policy are now being sought. Some of the reasons why it was neglected under Kyoto have now been addressed. Technological advances, for example, now make monitoring deforestation emissions less uncertain, and developing countries with forest resources have understood the scale of financial gain they might receive if avoided deforestation was properly rewarded. In 2005, the Coalition of Rainforest Nations[72] submitted a proposal to reinvestigate the potential for including avoided deforestation in a future global climate change mitigation strategy. The proposal contained the following ideas:

- The UNFCCC should acknowledge the "climatic importance of deforestation" and "open dialogue to develop scientific, technical, policy and capacity responses" to address deforestation emissions.
- Avoiding dangerous climate change will be "more difficult and costly unless both industrialized and developing countries actively contribute to emission reductions from all sources".
- Developing nations currently have no way "to engage with the Kyoto Protocol for emission reductions".
- "In the absence of revenue streams from standing forests, communities and governments in many developing nations have little incentive to prevent deforestation."
- Climate change mitigation should not operate separately from achieving other Millennium Development Goals.

The proposal was widely supported and the UNFCCC launched a two-year initiative to

63 UK Emissions of Carbon Dioxide, Methane and Nitrous Oxide by National Communication Source Category, AEA Energy & Environment (AEA), Environment Statistics Office, 200

64 Cannell MGR & Dewar RC, The Carbon sink provided by plantation forests and their produces in Britain, *Forestry Journal*, 68: 1, 1995.

65 Cannell MGR et al., Conifer plantation on drained in Britain – a net gain or loss of carbon, *Forestry*, 66(4): 353-369, 1993.

66 The uplands - Time to Change?, RSPB, 2007.

67 Soil and water conservation, Opportunities to combat climate change, Sustainable Uplands and Moors for the Future Research Note No. 15, 2007.

68 Patenaude GL et al., The Carbon pool in British semi-natural woodland, *Forestry*, 76:109-119, 2003.

69 Cannell MGR & Dewar RC, The Carbon sink provided by plantation forests and their produces in Britain, *Forestry Journal*, 68: 1, 1995.

70 Taylor P, Beyond conservation: shifting the paradigm of upland land use, ESRC seminar, 2006.

71 www.scottishforestalliance.org.uk/default.asp?page=carbon sequestration

72 The Coalition of Rainforest Nations is an intergovernmental organization with the objective of "collaborating to reconcile forest stewardship with economic development". The members are developing countries with rainforest resources and currently includes Bolivia, Central Africa Republic, Chile, DR Congo, Costa Rica, Dominican Republic, Fiji, Gabon, Guatemala, Nicaragua, Panama, Papua New Guinea, Solomon Islands and Vanuatu.

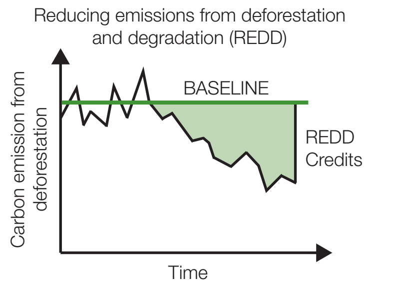
study the scientific, technical and political challenges in implementing an avoided deforestation policy to fulfil a diverse range of requirements. As a result, it is now becoming clear that to meet the needs of the various stakeholders a future policy on avoided deforestation (see Box 4) should:

- result in immediate and sustained reduction in carbon emissions from deforestation and forest degradation that are additional to those achievable from other sectors (e.g., reductions in fossil fuel use);
- avoid destabilisation of existing carbon markets;
- include as many developed and developing nations as possible;
- develop transparent and cost effective methods for monitoring and verifying emission reductions;
- account for the semi-permanent nature of forestry carbon storage without devaluing forest carbon assets;
- attract sufficient funding by mobilizing private and public resources, and equitably distribute such funds to forest users and indigenous people;
- maximize synergy between different forest ecosystem services (including the conventions on Desertification and Biological Diversity);
- build effective mechanisms to control deforestation through good governance and capacity building; and

Box 4: Avoided deforestation policy options

- *Reduced Emissions from Deforestation and Degradation (REDD)*
  Proposed by the Coalition of Rainforest Nations. Countries that voluntarily reduce their national rate of deforestation below a baseline (determined from historical national deforestation rates) are offered financial compensation (see Figure 4). Funding could be derived from the sale of carbon credits, non-market funds and/or taxes on post-2012 emission allowances. Similar plans were also put forward under the title of 'Compensated Reduction' and the 'Forest Retention Incentive Scheme', unique details of which are being absorbed into REDD discussions and planning.

Figure 4: Potential REDD mechanism



1. Define a baseline on average deforestation rate.
2. Countries voluntarily agree to reduce deforestation below the baseline.
3. Any reduction below the baseline issued with REDD credits.
4. Baseline revised (downwards) at some future point.

- *International non-market fund*
  Brazil proposed a non-market international fund to support avoided deforestation. There would be no carbon trading or targets. Developed countries would share the cost of the scheme. Payments could be made to developing nations based on the reductions in deforestation below a baseline in a similar way to REDD. The essential difference to REDD is that this proposal does not include carbon markets. In the summer of 2008 the Brazilian president launched an international fund to protect the Amazon rainforest with the aim of raising $21 billion by 2021.

- promote sustainable development and respect the rights and wishes of forest communities.

The 'Bali roadmap'

The thirteenth Conference of Parties to the UNFCCC (CoP-13) held in Bali, Indonesia, during December 2007, agreed to include forest conservation and avoided deforestation in a future global climate change mitigation strategy. The 'Bali roadmap'[73] was adopted and includes mobilising resources with which:

- to support capacity building and technology transfers to meet methodological, technical and institutional needs in developing countries; and
- to explore a range of actions, identify options and undertake demonstration activities to address drivers of deforestation relevant to each country's national circumstances.

Scientific and technical challenges are now being studied and a range of policy options are under discussion (see Box 4). There is, however, a great deal of uncertainty and ongoing debate over the best mechanisms to employ. The leading contenders are to reward REDD countries for voluntarily reducing their deforestation rate (e.g. from sale of carbon credits), to establish a non-market international fund to pay for forest conservation, or to set up some kind of hybrid system.

Priorities and options

Financing a significant reduction in deforestation is estimated to require at least US$10-15 billion annually and there is some controversy over the best funding mechanism to raise this finance. The key difference between REDD and an international non-market fund is that the former aims to harness the power of the carbon market to oppose deforestation, whereas the other relies on donations to a fund from which grants will go to countries that make a convincing show of reducing deforestation. Market failures cannot be ruled out and may undermine the impact of the REDD system, while the other scheme is vulnerable to parsimony (i.e. will donors be willing to give enough?), moral hazard (i.e. will developing countries misrepresent their levels of success?) and inefficiency (i.e. can international technobureaucratic mechanisms spend money wisely and well enough to achieve good results?). Given the nature of the risk that is being addressed, getting the answer right is not unimportant.

> "The backbone of anti-deforestation financing should come from the carbon market but an international fund should also be set up specifically to correct market failures"

The poor record of intergovernmental non-market funding mechanisms such as the GEF is hardly reassuring, and donor governments may not see another such fund as the best use of tax-payers' money. On the other hand, the carbon market can mobilise abundant financing at low political cost, with more than US$30 billion traded in the carbon market in 2006 alone under the Kyoto Protocol and the EU ETS[74]. One disadvantage of a market-based system is that it may allow some countries, with efficient institutions and lower marginal costs, to dominate the REDD market. Another is that market failures under REDD may well prove to be just as significant as they are in other market-based systems. An obvious conclusion is that the backbone of anti-deforestation financing should come from the carbon market but an international fund should *also* be set up specifically to correct market failures.

73 http://unfccc.int/files/meetings/cop_13/application/pdf/close_stat_cop13_president.pdf

74 Hasselknippe H & Røine K (editors) Carbon 2007 – A new climate for carbon trading. Copenhagen: Point Carbon, 2007.

Such a fund should be designed to synergise with other governmental and non-governmental technical assistance and financing flows in areas that also oppose deforestation.

> “Efforts now need to be directed to ensure that avoided deforestation is integrated into post-Kyoto climate policy”

Efforts now need to be directed to ensure that avoided deforestation is integrated into post-Kyoto climate policy. Assuming that the REDD mechanism will be the eventual core of a market-based mechanism to reduce deforestation, Figure 5 shows a potential timeline for REDD over the next five years. Despite the progress that was made in Bali, many outstanding policy issues remain (see Box 5). Negotiations for REDD policy need to be complete by Cop-15 in Copenhagen in 2009, and this should be the primary focus for policy makers. Leaving action on avoided deforestation until the end of the Kyoto's first commitment period would sacrifice significant potential emission reductions. Deforestation during the first commitment period is expected to be greater than the total historical and future emissions from aviation until at least 2025. Getting REDD organised and operational as soon as possible must therefore be an urgent priority.

Fungible REDD credits?

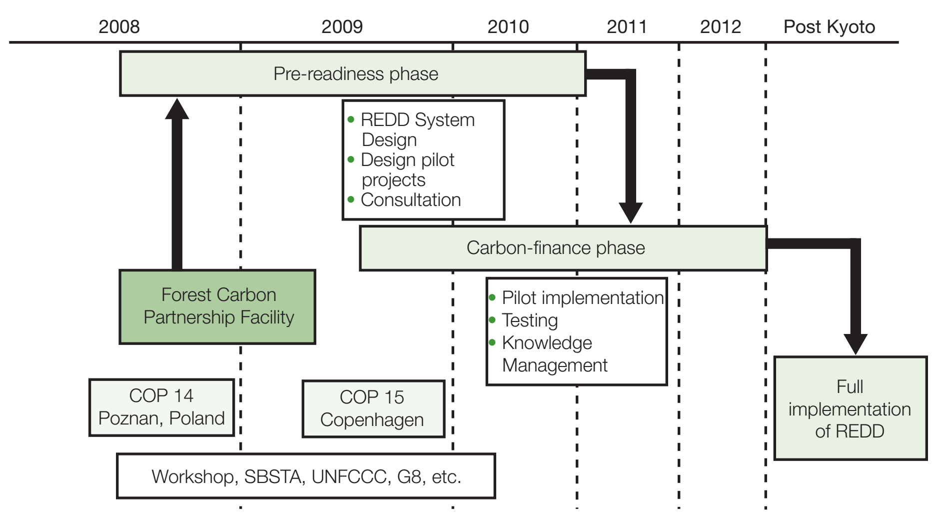
Under a market based system, forestry carbon credits could either be fully fungible with existing carbon markets, that is freely tradable with fossil fuel emission reductions, or could operate through a separate system. Fungible avoided deforestation or REDD credits could limit the incentive to reduce emissions from fossil fuels. There is a legitimate concern that REDD credits could flood the market and destabilise the carbon price in existing markets. To prevent this, stricter overall emission reduction targets are required to ensure REDD credits are additional to fossil fuel reductions.

Preparing for forest conservation

Not all countries are equally well prepared to implement avoided deforestation policy. Those that are least prepared will need support in areas that include:

- Calculating national carbon stocks and emission baselines.

Figure 5: Possible timeline for implementation of REDD[75]



75 Redrawn from REDD Developments in Indonesia, Training Course, Nov 19 2007, http://carbonfinance.org/Router.cfm?Page=FCPF&FID=34267&ItemID=34267&ft=DocLib&CatalogID=36935

- Developing the institutional and technical capacity for monitoring and reporting.
- Evaluating the drivers of deforestation and successful policies for slowing deforestation.
- Quantifying the opportunity costs of forest conservation.
- Developing a participatory process to include all the stakeholders impacted by avoided deforestation policy.
- Establishing institutional and legal frameworks.

These steps are estimated to only cost US$1-3 million per developing country. Costs could be met through a "REDD Enabling fund"[76]; a non-market mechanism with contributions from multilateral financing institutions and developed nations. Large-scale pilot projects are also required to inform the policy development process and offer countries practical experience in implementing avoided deforestation. The Stern report called for such pilot projects. They are needed immediately.

The World Bank's Forest Carbon Partnership Facility (FCPF)[77] is an example of a commitment that will develop and test a REDD framework. The facility will work with about 20 tropical and sub-tropical nations to build institutional and technical capacity including preparation of a reduced deforestation strategy, establishing forest monitoring systems and calculating reference deforestation rates (the baseline). These countries will be ideally-placed to take advantage of REDD mechanisms post-2012 and several will be selected to operate

Box 5: Outstanding issues from Bali.

1. *Should a market or non-market approach to avoided deforestation be used?*
2. *If a market approach is chosen should forestry carbon credits be fully fungible (i.e. tradable) with existing carbon credits?*
3. *Should sub-national activities be allowed as a stepping stone to national level programmes?* National-level accounting minimises the potential for leakage and reduces overall costs but restricts access to countries with the necessary capacity. A nested approach that allows project activities to be credited directly could be allowed.
4. *What are the technical challenges to implementing avoided deforestation and how should they be overcome?* This was a major stumbling block to pre-Kyoto attempts to account for avoided deforestation. Significant technological advances in remote sensing techniques have been made in the past 10 years and carbon stocks can now be measured with an error of less than 5%. Brazil and India successfully monitor deforestation on a routine basis. The major challenge now is ensuring this technology is available to other developing countries.
5. *Should forest degradation (reduction in carbon stocks, but not forest area) be included as well as deforestation?* Forest degradation can result in significant emissions, but monitoring is more difficult and expensive, and the uncertainties are greater than for deforestation.
6. *How should countries (a) with large forest resources but little deforestation or (b) that have already made major efforts in the past decade to reduce deforestation be rewarded?*
7. *How can it be ensured that avoided deforestation policy recognizes the role of forest communities and indigenous peoples?*
8. *How will avoided deforestation be possible in face of growing demand for timber and agricultural products?*
9. *When should avoided deforestation start?* Options include: immediately, or after 2012 when the first Kyoto commitment period ends.

76 UNFCCC 2007c Views on issues related to further steps under the convention related to reducing emissions from deforestation in developing countries: approaches to stimulate action *Submissions from Parties* http://unfccc.int/resource/docs/2007/sbsta/eng/misc14.pdf

77 http://carbonfinance.org/docs/FCPF_Booklet_English_Revised.pdf

a pilot REDD finance scheme receiving payments for reducing deforestation below their baseline. The facility has a targeted volume of US$300 million, of which US$82 million has so far been received from 9 developed countries, including a pledge of US$30 million from the UK government.[78] The facility became operational in June

Box 6: Biofuel subsidies

Fiscal measures aimed at meeting targets for the production and use of biofuels cost OECD countries US$11 billion in 2006 (rising to US$15 billion in 2008[79]), and are likely to cost EU countries US$11-22 billion annually by 2020[80]. The 5% biofuel target under the Renewable Transport Fuel Obligation (RTFO) at £0.20 per litre will cost the UK treasury US$1 billion annually in foregone revenue.[81] In the March 2008 budget the decision was taken to remove this biofuel duty exemption from 2010. These are expensive ways to cut emissions of carbon dioxide. The RTFO in the UK may save 2.6-3.0 million tCO_2/year but at a cost of £68-150 per tonne of CO_2.[82] A similar investment in REDD could result in avoided emissions of 40-200 million tCO_2/year or a 50 times greater amount of avoided emissions.

Box 7: Protecting Frontier Forests

Frontier forests are large, relatively undisturbed tracts of forest, on or beyond the 'frontier' of human settlement and exploitation[83]. Half of all frontier forests exist in the boreal forest zone of Russia, Alaska and Canada; the rest is in the tropics mostly in the Amazon (see Figure 6). These forests are very important because:

- they are significant stores of carbon that can be protected cheaply due to low opportunity costs;
- they are large enough to be resilient to natural disturbance (such as forest fires, pest outbreaks and hurricane damage);
- due to their large size they offer the best opportunity for ecosystem adaptation to future climate change; and
- many of the world's indigenous people live there.

The planned expansion of transport infrastructure means that 75% of frontier forests in the tropics will be threatened by logging, mining and agriculture in the near future. The recent paving of the 1000 km highway from Manaus in Brazil to Venezuela, for example, is bringing a new wave of colonization, logging and agricultural expansion to previously remote and unfragmented forest[84].

Boreal forests are also threatened by logging and mineral extraction; 45% of Canadian boreal forests are under licence to logging companies and nearly one million hectares are cut each year[85]. Although this land is normally replanted, carbon-rich old growth forests are replaced with new plantations which even 40 years later store less than one half of the carbon[86]. A reduction of logging in China has already pushed demand for timber products into the Russian boreal forests[87]. In the USA most old-growth forests are on public lands. Maintaining and enhancing protection of these forests is required, for which the controversial Roadless Area Conservation Rule (a policy limiting new road construction and subsequent logging on 24 million ha of public land in the US) is an important mechanism[88].

78 http://www.dfid.gov.uk/news/files/15million-deforestation.asp

79 http://www.globalsubsidies.org/IMG/pdf/biofuel_synthesis_report_26_9_07_master_2_.pdf

80 Open Europe, What works? How to cut emissions at the lowest cost, March 2008. http://www.openeurope.org.uk/research/whatworks.pdf

81 http://www.opsi.gov.uk/si/si2007/em/uksiem_20073072_en.pdf

82 http://www.opsi.gov.uk/si/si2007/em/uksiem_20073072_en.pdf

83 WRI, The last frontier forests.

84 Laurance, W & Luizao R, Driving a wedge into the Amazon, *Nature*, 448, 2007

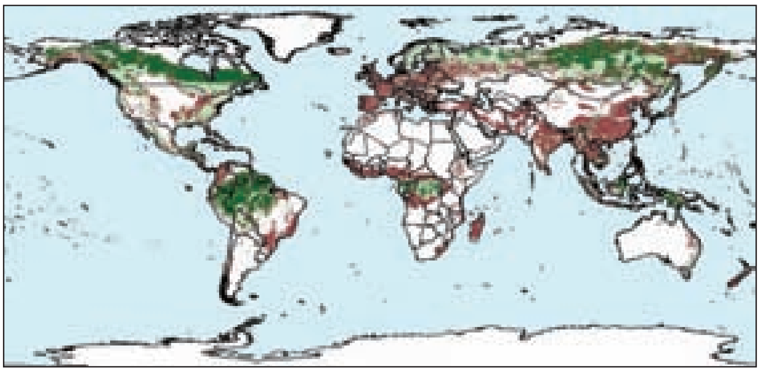
85 Ferguson, C. et al., Turning up the Heat, Global Warming and the Degradation of Canada's Boreal Forest, Greenpeace Canada.

86 Fredeen AL, Bois CH, Janzen DT, Sanborn PT, Comparison of coniferous forest carbon stocks between old-growth and young second-growth forests on two soil types in central British Columbia, Canada. *Canadian Journal of Forest Research* 35: 1411-1421, 2005

87 http://news.bbc.co.uk/2/hi/programmes/crossing_continents/7338623.stm

88 www.roadless.fs.fed.us/

Figure 6: Global forest cover; original pre-human forest cover (dark brown + light brown + green) and remaining forest (light brown + green). Only one fifth of the frontier forest (green) remains mainly in the Amazon, Papua New Guinea, Canada, Alaska and Siberia[89].



2008 and in July the first fourteen developing countries were chosen to receive grant support from the FCPF.

REDD issues

Correctly designed, new forest and peatland carbon credits and markets could be powerful tools to reduce GHG emissions, as well as protect important ecosystem services and biodiversity. But there are several areas of concern. First, the areas that will benefit most from REDD, are not necessarily priorities for protecting biodiversity or ecosystem services. To resolve this, REDD mechanisms can be coupled with other Payments for Environmental Services (PES). PES is a mechanism where the providers of ecosystem services are financially compensated by those who benefit from the service. PES has great potential to encourage sustainable resource management. Second, REDD projects may result in local people being sidelined[90]. There is the risk that poorly managed afforestation and reforestation projects may not adequately consult or compensate forest users and indigenous groups. Finally, many African countries have both urgent development needs and extensive forest resources, but have played a very limited role in the development of REDD. This is a serious concern because deforestation and habitat degradation are rapidly increasing in Africa, releasing large amounts of GHGs and undermining local economic development. African countries should, therefore, be encouraged to play a central role in developing future REDD policy.

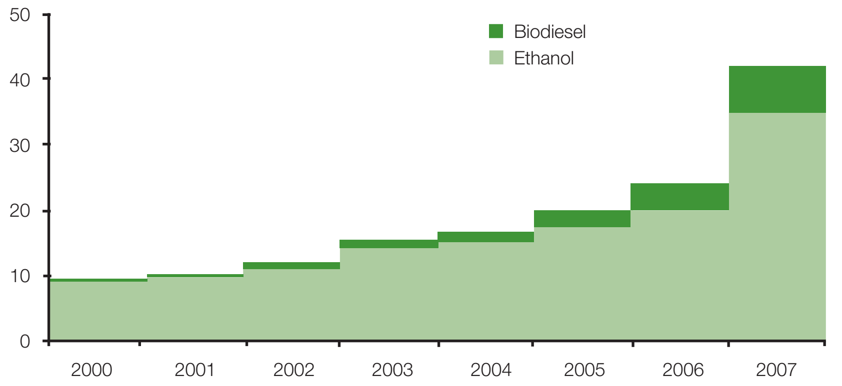
Box 8: Biofuels or Forests?

The last few years have seen a dramatic growth in biofuels: bioethanol from sugar cane in the tropics and maize in North America, and smaller amounts of biodiesel from oilseed rape in Europe and oil palm in the tropics. Total production now exceeds 50 million tonnes of oil equivalent, meeting about 1.5% of global transport needs. Around 25 million hectares of arable land is required to produce this, equivalent to the total land area of the UK or 1.5% of global arable land. The demand for crops for biofuel has helped to drive up land and commodity crop prices globally.

89 Bryant, D., Nielsen, D. and Tangley, L. 1997 The Last Frontier Forests: Ecosystems and Economies on the Edge. World Resources Institute: Washington, DC.

90 Grffiths, T., Seeing "RED", Forest Peoples' Program, 2007

Figure 7: Biofuel production: millions of tonnes of oil equivalent[91].



When arable land is restored to forest instead of being used for biofuel production, carbon stores build up in the soil and vegetation. This absorbs more carbon than the emissions avoided by using biofuel[92]. Converting cropland to tropical forest can absorb 20-30 tCO_2/ha/year, a rate 3-4 times higher than the emissions avoided by using bioethanol. In temperate regions forest regrowth is slower, but the rates of carbon absorption are still 2-3 times higher than the avoided emissions from biofuels produced from temperate crops. Where, directly or indirectly, natural forests or grasslands are converted to arable land to permit the production of the fuel crop, the loss of carbon stored in the original ecosystem has to be factored in.

In the tropics, the amount of carbon released into the atmosphere by the conversion of forest into cropland is 600-1,500 tCO_2/ha. Most of these GHG emissions are the result of burning and biodegradation in the months following the initial clearance. The impact on global GHG levels and warming is immediate. The negative impacts of biofuel policy are increasingly recognized throughout the EU; in February 2008 the UK government announced a review of biofuels, and in March 2008 the EU's Environment Council questioned the 10% biofuel target.

91 (a) Coyle, W. The future of biofuels. Amber Waves, 5,5, November 2007, USDA Economic Research Service; (b) Anon. Biofuel Production. IEA Technology Essentials. January 2007 IE

92 (a) Righelato R & Spracklen DV, Carbon Mitigation by Biofuels or by Saving and restoring forests? *Science* 317: 902, 2007; (b) Fargione et al., Land clearing and the biofuel carbon debt, *Science* 319:1235-1237, 2008

3

Recommendations

Forests and peatlands are large-scale ecosystems that occupy worldwide about 4 billion and 400 million hectares of land respectively. They provide many essential environmental services especially in the areas of biodiversity, water catchments and floodplains, regulation of local and regional climates, and carbon storage. Forests contain carbon mainly in the standing biomass at a density of 360-1450 tonnes of carbon dioxide equivalent (tCO_2e) per hectare, and therefore store somewhere around 4000 billion tonnes or gigatonnes ($GtCO_2e$) in total, worldwide. Peatlands contain carbon mainly in the form of accumulated dead and partly decayed vegetation, often waterlogged or frozen and up to 20 metres deep in some tropical peat swamps. They are much denser carbon stores than forests, and are thought to hold a worldwide total of about 2,200 $GtCO_2e$.

These ecosystems are largely composed of carbon-rich compounds such as lignin and cellulose, which when they burn or decay release greenhouse gases (GHGs) such as carbon dioxide (CO_2) and methane (CH_4). Every year about 12 million hectares of tropical forests are logged, cleared or burnt. In 1990-2005 deforestation reduced global forest cover by 3% and tropical forest cover by 8%. Tropical deforestation results in an annual emission of 3.7-8.1 $GtCO_2e$, or 15-25% of all GHG emissions for which people are responsible. This is greater than the emissions from the global transport sector and is similar to the amount emitted by the USA or China.

Peatlands are also being quickly destroyed, by melting and decay in circumpolar regions, and elsewhere more directly by draining, land conversion, logging and fire. The carbon density of tropical peatland combined with its rapid depletion has helped Indonesia to become the world's third-largest GHG emitter, despite the country's relatively modest industrial activity. Between them, destruction of forests and peatlands account for around 20% of humanity's total GHG emissions.

“Tropical deforestation results in an annual emission of 3.7-8.1 $GtCO_2e$, or 15-25% of all GHG emissions for which people are responsible. This is greater than the emissions from the global transport sector and is similar to the amount emitted by the USA or China”

The drivers of deforestation and peatland loss are complex and powerful, but if they could be disabled then reduced rates of ecosystem destruction would amount to major avoided GHG emissions. Some 50-70% of this potential lies in avoided deforestation, but since growing ecosystems absorb and store carbon (a process often called carbon sequestration), replanting forests can also reduce net GHG emissions. Such avoided deforestation and reforestation would be beneficial in terms of mitigating global climate change, as well as contributing local and regional ecosystem services. This report explores mechanisms by which the UK and international community can encourage this to happen. It focuses on the weaknesses in resource accounts, institutions and markets that have undervalued forests and peatlands as carbon stores. To correct this, it advocates the inclusion of avoided deforestation and reforestation in systems that generate tradeable carbon credits, and that could therefore bring the power of the carbon market to bear in support of the world's forests and peatlands.

Forestry and peatland protection and restoration could mitigate 10-33% of the total reductions needed by 2030 to avoid catastrophic climate change. The costs and benefits per hectare vary among sites and circumstances, the greatest gains at lowest costs being likely from preventing the drainage of deep tropical peat beds, whilst avoided deforestation is much more variable. It is thought that with a carbon price of US$16/t$CO_2$e, deforestation can be reduced by 10-50%, resulting in emission reductions of 0.3-1.6 GtCO_2e per year for an estimated global cost of US$2-32 billion a year, equivalent to US$1.0-5.5/t$CO_2$e, while reforestation and afforestation can absorb and store an additional 1.2 GtCO_2e per year. With a carbon price of up to US$27/t$CO_2$, however, tropical deforestation could almost be halted, mitigating up to 6.0 GtCO_2e per year.

> "Forestry and peatland protection and restoration could mitigate 10-33% of the total reductions needed by 2030 to avoid catastrophic climate change"

Thus, avoided deforestation could reduce the overall costs of climate mitigation by up to 50%, and be dramatically cheaper than any other means of achieving the same result. But all of this depends upon there being an effective pricing mechanism, and so far the regulatory arrangements that could allow the market to set a price for emission savings have been unable to include avoided deforestation. There are proposals to correct this through a scheme known as REDD (Reduced Emissions from Deforestation and [forest/land] Degradation); under which countries that voluntarily reduce their rate of deforestation below a baseline (determined from historical deforestation rates) would obtain financial compensation. The exact mechanism is still under negotiation, but introducing REDD as soon as possible is essential, as is sufficient certainty that REDD will be included in future climate policy to encourage early action by governments and the private sector. Finance is urgently required to begin large scale pilot projects that can inform the REDD development process.

After examining the alternatives to REDD, and reviewing some of the other approaches to emissions reduction (such as the misguided biofuels policies that currently prevail), this paper concludes by making the following policy recommendations to the UK government. Together, implementation of these policies will significantly reduce GHG emissions and shift our approach towards the protection of forests and peatlands. To be truly effective, a global response is needed, but the UK has an opportunity to lead the way. We can dramatically increase funding for forest and peatland projects domestically and with key partners, especially in South-east Asia, as well as lobbying at an international level for the right global policies. All this can be done within our current budget, by ending wasteful and damaging biofuel subsides. For the sake of our future prosperity we can and must achieve massive global GHG emission reductions. Forest and peatland conservation is one of the few methods at our disposal, where we can do this now and at low cost.

Policies the UK can introduce immediately:

1. *Abandon biofuel targets and subsidies.* Biofuel targets are responsible for the creation of price mechanisms that

encourage biofuel crops to replace natural forests. This has led to an increase in both food prices and deforestation. This misjudged policy should be suspended until second-generation biofuels are tested and shown to provide net emission reductions without directly or indirectly causing deforestation. In the UK the 5% biofuel target under the Renewable Transport Fuel Obligation (RTFO) at £0.20 per litre will cost the Treasury £550 million annually in foregone revenue. The RTFO saves 2.6-3.0 $MtCO_2$/year, equivalent to only a tenth of the emissions of one UK power station and at a cost of £68-150 per tonne of CO_2.[93] A similar investment in preventing deforestation and peatland destruction could result in avoided emissions of 40-200 $MtCO_2$/year or a 50 times greater amount of avoided emissions. In 2005 alone, this would have offset the equivalent of up to 37% of all UK CO_2 emissions.

2. *Support immediate action to reduce peatland destruction in South-east Asia.*
   One of the lowest-hanging fruits of climate change mitigation are Indonesia's peat swamp forests, which contain millions of tonnes of carbon per sq km and where vast amounts of GHGs are now being released by logging, drainage and fire. Measures focused on illegal logging and canal building, and on blocking canals before swamps dry out, are among the best possible investments that can be made in avoiding GHG emissions.

3. *Build capacity in developing countries to prepare for avoided deforestation.*
   Avoided deforestation (AD) will be held back if developing countries do not have the capacity to support and monitor forest conservation. Government can contribute by helping developing countries to establish this capacity through financial support and technology, knowledge and experience transfer.

4. *Provide financial support to kick-start pilot avoided deforestation projects.*
   Large-scale pilot projects are urgently needed to inform policy development. The reduced deforestation that results would be profoundly beneficial and cost-effective. Government can help by contributing to the World Bank's Forest Carbon Partnership Facility, and by funding exemplary avoided deforestation projects such as the US$160 million Australian fund for reducing deforestation in South-east Asia.

> “Avoided deforestation could reduce the overall costs of climate mitigation by up to 50%, and be dramatically cheaper than any other means of achieving the same result”

Policies the UK can promote at European and international levels:

5. *Introduce forest carbon credits to give a realistic price for ecosystem services.*
   Current market failures mean that forest and peatland carbon services are undervalued relative to other uses. This can be corrected through a forest carbon market that recognises existing afforestation/reforestation credits, including those in developing countries and also avoided deforestation credits when they come on-line. The post-Kyoto climate policy and EU ETS should be developed/amended accordingly.

6. *Encourage immediate action to slow deforestation before 2012.*
   Every day of inaction results in further deforestation and the emission of

93 http://www.opsi.gov.uk/si/si2007/em/uksiem_20073072_en.pdf

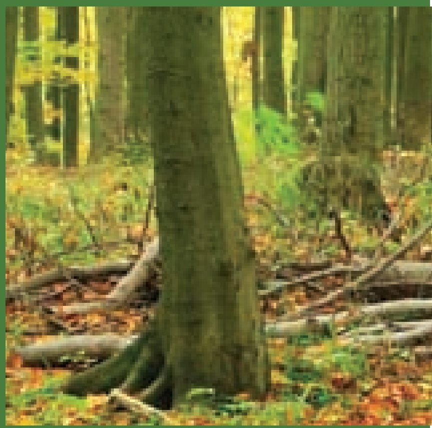
GHGs with little benefit to the global economy and significant damage to the climate. Governments can help by developing clear long-term policies to encourage private sector-investment in avoided deforestation. Providing certainty that avoided deforestation credits will be recognized in future climate change mitigation policy will encourage the development of a pre-2012 market in Reduced Emissions from Deforestation and Degradation (REDD) credits.

7. *Recognise avoided deforestation in future international climate mitigation.*
   Avoided deforestation contributes 50-70% of the total forestry mitigation potential. However, it is excluded from the Kyoto Protocol and the EU ETS. Many challenges must be overcome before avoided deforestation can be integrated into future international climate change mitigation policy. Immediate targets are the 15th Conference of Parties meeting in Copenhagen in 2009, where substantial progress must be made if avoided deforestation is to commence in 2012 in time for a successor to Kyoto.

8. *Encourage development of the voluntary carbon/ecosystem services market.*
   The voluntary carbon market has huge potential and is already driving emission reductions through forest restoration and avoided deforestation. Suitably encouraged and regulated it could help reduce deforestation immediately, years before avoided deforestation compliance mechanisms, such as an appropriately designed successor to Kyoto, are likely to be in place.

In tackling climate change, policy makers often overlook the role of the natural world in regulating greenhouse gases in the atmosphere: specifically, the unique role that forests and peatlands have to play in the battle against rising emissions. Changing approach would significantly reduce the cost of tackling climate change and deliver a variety of other benefits.

In this report, we argue that preventing deforestation, promoting afforestation/reforestation and stopping peatland destruction are some of the cheapest and most effective ways of reducing global emissions. We propose the introduction of market mechanisms that can ensure investment is directed into these areas and a strategy to make this happen as quickly as possible.



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