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Purveyors of water, consumers of carbon, treasure-houses of species, the world's forests are ecological miracles. They must not be allowed to vanish, says James Astill

DAYBREAK is a heavenly time to look on the Amazonian canopy. From a Brazilian research tower high above it, a fuzzy grey sylvan view emerges from the thinning gloom, vastly undulating, more granular than a cloud. It is mind-bendingly beautiful. Chirruping and squawking, a few early risers—collared puffbirds, chestnut-rumped woodcreepers and the tautologous curve-billed scythebill—open up for the planet's biggest avian choir.

In a slick of molten gold, dawn breaks and the trees awaken. In every leaf, chlorophyll molecules are seizing the day for photosynthesis. Using sunlight to ship electrons, they split water molecules and combine the resulting hydrogen with carbon dioxide extracted from the air. This produces carbohydrates that the trees turn into sugars, to be burnt off in respiration or, by another chemical process, turned into new plant-matter. The main waste product, oxygen, they emit through their stomata in a watery belch. Hence the rainforest's high level of humidity, visible from the observation tower in diaphanous cloudlets drifting over the canopy.

That plants emit oxygen has long been known—since 1774, in fact, when Joseph Priestley, a British chemist, found a mouse not too “inconvenienced” by being trapped inside a bell-jar with a mint plant. Yet the importance of plants' ability to store carbon in making the planet habitable is still not widely appreciated. On two

previous occasions when the atmosphere contained very high levels of carbon dioxide, the early Carboniferous and Cretaceous periods, beginning about 350m and 150m years ago respectively, they were reduced by the expansion of carbon-sequestering plants. Industrial burning of the fossil fuels laid down in the Carboniferous period, in the form of decaying plant-matter, is the main reason why there is now more carbon in the atmosphere than there has been for 4m years.

Carbon calculations

This is the latest reason—and it is a big one—why destroying forests is a bad idea. Roughly half the dry weight of a tree is made up of stored carbon, most of which is released when the tree rots or is burned. For at least the past 10,000 years man has been contributing to this process by hacking and burning forests to make way for agriculture. About half the Earth's original forest area has been cleared. Until the 1960s, by one estimate, changes in land use, which mostly means deforestation, accounted for most historic man-made emissions. And its contribution to emissions is still large: say 15-17% of the total, more than the share of all the world's ships, cars, trains and planes.

But this underestimates the damage done by the clearance. It also discounts a geological-time-honoured way to sequester carbon. That growing forests, natural or ▶▶

▶ planted, do this is obvious. But there is increasing evidence to suggest that primary, or old-growth, forests are seizing the opportunity of a carbon-heavy atmosphere to suck up more carbon than they did previously, a process known as “carbon fertilisation”. By one estimate the Amazon rainforest is sequestering an additional 1.3 gigatonnes a year, roughly matching the recent annual emissions produced by clearing it. Across the world, forests and the soil beneath them absorb about a quarter of all carbon emissions.

This is an indispensable contribution to life as we know it, and forests offer many others, too. They house more than half the world’s species of animals, birds and insects. In the Amazon rainforest this biodiversity is staggering: even its small gullies and runnels often have unique sub-species of monkeys, birds, creatures of all kinds. Forests are also the source of most staple foods and many modern medicines. They provide livelihoods, wholly or partly, for about 400m of the world’s poorest people. They have always touched the imaginations of more privileged ones: “A culture is no better than its woods,” wrote W.H. Auden. Indeed, the more that people learn about forests, the more perilous their mismanagement seems.

They also make rain

That forests regulate water run-off, mitigating risks of flooding and drought, has been recognised since ancient times. The ancients also understood that trees can increase rainfall and deforestation can reduce it. Cutting down trees leads to a reduction in evapotranspiration, which results in less downwind precipitation. In the case of the Amazon rainforest this has huge implications for the agriculture of the whole of the Americas. That of southern Brazil, northern Argentina and Paraguay, in particular, depends for rainfall on the moist Atlantic trade winds, which cross the Amazon basin and then are deflected southwards by the Andes. There are also indications that the American Midwest is watered from the same source, by the moisture deflected northwards. The forest, by recycling the water that falls on it through evapotranspiration, plays an important part in this system.

Between a quarter and half of the water molecules that fall in the western Amazon have previously fallen on the rainforest. In its absence, it would be reasonable to expect a corresponding decrease in regional precipitation, which would be calamitous, but the actual effect could be

much worse. Two Russian physicists, Victor Gorshkov and Anastassia Makarieva, claim that forests, not temperature, are the main drivers of winds. They base this on the previously unconsidered drop in pressure that occurs when water passes from gas to liquid state in condensation. So ecosystems that maintain a moist atmosphere—as rainforest does—draw in air and moisture from elsewhere. This could explain the curious fact that precipitation in the western Amazon is higher than it is upwind, despite leakage in run-off at every revolution of the local water cycle.

The theory caused a stir in Western academia last year when it was put forward in the journal *Biosphere* and is considered far-fetched by many. But it should reinforce the point that, on hydrological grounds alone, conserving forest is often essential.

And still they are being chopped down. According to the main compiler of forest data, the UN’s Food and Agriculture Organisation, about 4 billion hectares (10 billion acres) of forest remain, covering 31% of the Earth’s land surface. Only a third is primary. Much of the rest is seriously degraded: the FAO’s definition of a forest takes in areas with as little as 10% tree cover.

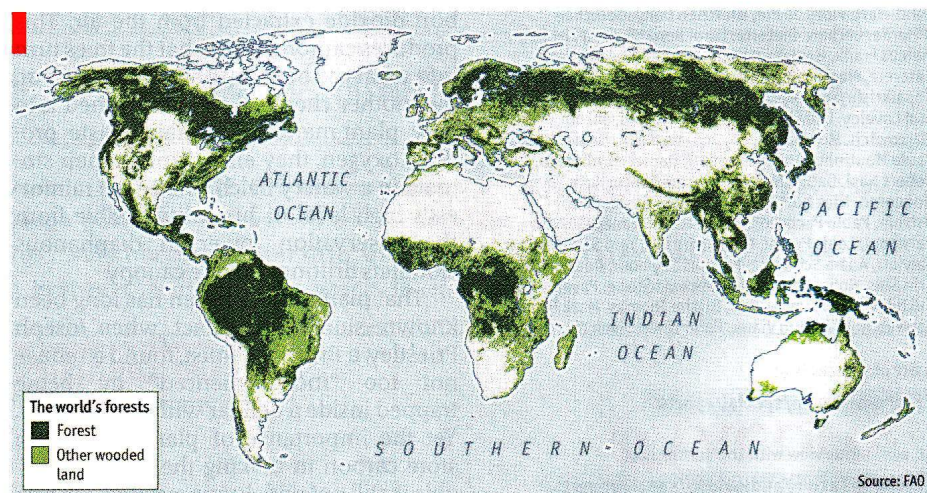
Almost half of the forest that remains is in the tropics, mostly as rainforest which, by almost any measure, is most precious of all. Nearly a third of that rainforest is in Brazil, which has two-thirds of the Amazon basin; and a fifth is in Congo and Indonesia. The second-biggest forest area, about a third of the total, is in the boreal, or *taiga*, biome: a belt of spruce, birch, fir and aspen that encircles the far northern hemisphere, mostly in Russia, Scandinavia, Finland, Canada and a small part of America. Just 11% of forest is in the temperate zone, dominated by America, which cleared al-

most half its massive forests in the 19th century, and Europe and China, which ate into theirs much earlier. Europe razed almost half its temperate oak-, beech- and birchwoods in the Middle Ages, an onslaught only briefly reversed by an outbreak of bubonic plague in the 14th century. Now temperate forests are creeping back. Over 7m hectares a year are currently being planted or allowed to regrow, according to the FAO, mostly in China and America.

A tropical problem

The current onslaught is mainly in the tropics. In the past six decades the rainforest has been reduced by over 60% and two-thirds of what remains is fragmented, which makes it even more liable to be cleared. And despite many campaigns by NGOs, vigils and rock concerts for the rainforest and efforts to buy it, lease it, log it and not log it, the destruction proceeds at a furious clip. In the past decade, the FAO records, around 13m hectares of the world’s forests, an area the size of England, have been lost each year. Most of this was tropical forest, razed for agriculture. But Russia, which has more forest than any other country, also lost a lot, which the FAO’s figures do not capture because its clearance did not involve a permanent change in land use. Between 2000 and 2005 some 144,000 sq km (55,500 square miles) of Russian forest—14% of the total—was incinerated or felled, much of it illegally.

This represents progress, of a sort. In the 1990s, when the candle-holding for the rainforest was at its height, over 16m hectares a year was lost. Most of the slowdown is because of reduced rates of clearance in the world’s biggest deforesters, Brazil and Indonesia, and to some degree this reflects their former gluttony: both have masses of ▶▶



► cleared land to spare. But in both countries efforts to reduce the destruction have also helped, especially in Brazil, which has a fast-growing agricultural sector and is increasingly worried about deforestation. Over the past decade it has given protected status to 500,000 sq km of the Amazon rainforest. According to a recent report by the Royal Institute of International Affairs, a British think-tank, illegal logging has been greatly reduced in Brazil, Indonesia and Cameroon.

A few smaller rainforest countries are also showing more regard for their trees. Costa Rica, which in the late 1980s lost around 4% of its forest each year, has reduced its deforestation almost to zero. Gabon and Guyana, almost three-quarters of which are covered by trees, say that, with foreign help, they would be happy to keep it that way. Western consumers, increasingly sensitive to the notion of sustainability, have a small hand in these improvements. Alarmed by their bad press, Canadian timber companies announced in May this year that they would work with greens to improve the management of 72m hectares of boreal forest.

Yet such progress tends to be exaggerated, and even if it were real it would be insufficient because of two huge threats to the forest. The first is climate change, which is expected to redraw the map of forest ecosystems. The boreal forest will creep northwards, for example, as the permafrost thaws and carbon fertilisation increases. By one estimate, Finland's forests could grow 44% faster as a result. But that is nothing to celebrate, because melting permafrost will release billions of tonnes of methane, an especially potent greenhouse gas. It will also be offset by an increase in forest dieback elsewhere, caused by rising aridity, drought, pests and fires—all symptoms of global warming. Deforestation, which causes local warming, exacerbates this. All this could make much of the current forest area inhospitable to trees.

Such damage is already more common than most climate models had predicted, with the boreal belt especially hard hit. Between 2000 and 2005 it lost 351,000 sq km of forest, mostly to fire and pests. Again, this loss does not show up in the FAO's figures, and the resulting emissions are considered to be natural, not man-made. But the distinction is getting blurred. Setting aside its reforestation efforts, Canada, the world's third-most-forested country, lost 5.2% of its tree cover in that five-year period. This was partly because of a plague of bark-beetles in its temperate and boreal



Too many beetles in the boreal

zones, a record number of which have been surviving the recent mild winters. By 2009 they had devastated over 16m hectares of Canadian pine forest.

The outlook for the Amazon is also grave. Recent modelling suggests that the mutually reinforcing effects of increasing temperatures and aridity, forest fires and deforestation could bring the rainforest far closer than previously thought to "tipping points" at which it becomes ecologically unviable. So far 18% of the rainforest has been cleared. The loss of another 2%, according to a World Bank study last year, could start to trigger dieback in the forest's relatively dry southern and south-eastern parts. A global temperature increase of 3.5%, comfortably within the current range of estimates for the end of this century, would put paid to half the rainforest. This would release much of the 50 gigatonnes of carbon it is estimated to contain—equivalent to ten years of global emissions from burning fossil fuels.

Too many hungry mouths

The second great threat is human. The Earth's population is expected to increase by half over the next four decades, to around 9 billion, and most of the additional 3 billion-odd hungry mouths will be in developing countries, especially tropical ones. The population of Congo, now 70m, will double in that time. Demand for food in these countries will also double, which, at their current low levels of agricultural productivity, will drive up demand for forest land.

As in most central African countries, Congo's deforestation is currently minor, caused largely by small-scale shifting cultivation and over-harvesting of wood for

fuel. At present the country has little commercial agriculture or logging because of the state of its infrastructure, ruined by war and misrule. Indeed, the decay of Congo's Belgian-built roads, which in 1960 ran to over 100,000km, must rank as one of the greatest boons to forests since the Black Death. In the thick forest-savannah mosaic of northern Congo, many days' walk from any tarmac, your correspondent unearthed a milestone, half-buried in the leaf-litter, pointing to the small town of Badai, 15km to the east. Buried deeper was the gravel highway that once led there.

But Africa is an outlier. Most tropical deforestation is the result of expanding commercial ranching and agriculture, driven by rocketing domestic and global demand for food, fibre and biofuel. In Indonesia, oil palm, a productive source of cooking oil and biodiesel, offers the biggest reason to clear. Between 2000 and 2006 Indonesia planted roughly half a million hectares of oil palm a year, mostly on recently deforested land. The clearance in Brazil, which is mostly illegal, is mainly for pasture; the Amazonian cattle-herd has grown by over 40m head in the past two decades. The explosive recent growth in the cultivation of another oil seed, soyabean, has led to an onslaught on Brazil's dryland *cerrado* savannah, which is often disregarded as a forest, though it contains two-thirds as much carbon as the rainforest, mostly in its roots. By moving northwards into the Amazon basin, soya farmers are also driving ranchers deeper into the rainforest.

Grim climate predictions and recent food-price inflation have led to growing fears for food security, adding to the pressure. Foreign governments and investors are increasingly on the lookout to buy cheap, well-watered tropical land. Last year the Saudi Binladin Group tried, unsuccessfully, to secure land in Indonesia's island of Papua where it wanted to invest \$4.3 billion in rice cultivation. China, which has agreed to build and renovate 6,000km of roads in Congo, reportedly wants to cultivate oil palm there on a massive scale. It is the world's biggest importer of palm oil and global demand for the stuff is soaring, even before much is getting converted into biodiesel, as increasingly it will. And wherever there is such demand for tropical agribusiness, forests are being razed to meet it. Securing a licence to clear rainforest is often easier than buying up and consolidating smallholdings.

What hope of survival have forests, especially the tropical sort, most precious and most threatened? Large-scale defences ►►

are now being marshalled by governments, NGOs, scientists and investors, chief among them an international endeavour known as Reduced Emissions from Deforestation and Forest Degradation, or REDD. Launched with \$4.5 billion, it is based on the idea that rich countries should pay poorer ones not to cut down trees. Yet there is a big risk that REDD will deliver much less than is required.

The Earth's need for forests to soak up carbon emissions is almost limitless. Saving the forest that is left should therefore be considered a modest aim. But even that

will require huge improvements in forest management, such as reforming land registries and tightening up law enforcement. Above all, it will require governments to prize forest very much more highly than they do now. Otherwise there will be no chance of the many reforms required outside the forestry sector: in land-use planning and rural development, in agriculture, energy and infrastructure policies, and much else. It will also require politicians to get serious about climate change. All that amounts to a revolution, which is a lot to hope for. But if anything can help

bring it about, forests might.

They are crucial in all sorts of ways because of the manifold services they provide. Western taxpayers need the Amazon rainforest to control their climate. Brazil needs it to help feed its rivers and generate hydro-power. Amazonian soya farmers need it to guarantee them decent rainfall. Yet policies at every level conspire to wreak its destruction. Changing them, in Brazil and across the tropical world, is a daunting task. But it is not impossible—and it must be done. The cost of failure would simply be too great. ■

Money can grow on trees

Forests are disappearing because they are undervalued

FROM a helicopter, East Kalimantan, a province in the Indonesian part of the island of Borneo, presents a dreary view. Where little over a decade ago rainforest transpired under a vaporous haze, the ground has been cleared, raked and gouged. Every few minutes, a black smudge, smattered with muddy puddles, denotes a coalmine. Angular plantations, 10km and more across, are studded with dark green oil palms. Tin roofs glitter on the shacks of loggers, miners and planters, each with a smallholding hacked out around it. Just a few straggly patches of forest remain, with greying logs scattered at their edges.

As often in Indonesia, commercial loggers in East Kalimantan have grossly exceeded their quota in a small fraction of their allotted time. Prematurely abandoned, the degraded forest then falls to illegal loggers or it is cleared for agriculture, often by fire. In dry spells, which are becoming more common, the flames get out of hand. In 1998 fires devastated more than 5m hectares of Indonesian forest.

Yet in the national accounts the clearance is recorded as progress. About a quarter of Indonesian output comes from forestry, agriculture and mining, all of which, in a country more than half-covered in trees, involve felling. But this is bad accounting. It captures very few of the multiple costs exacted by the clearance, which fall not so much on loggers and planters but on poor locals, all Indonesians and the world at large.

The Indonesian exchequer, for one, is missing out. Illegal logging is estimated to

cost it \$2 billion a year in lost revenues. But that can be fixed by policing. A bigger problem is that most of the goods and services the country's forests provide are invisible to the bean-counters. Many of them are public goods: things like clean air and reliable rains that everyone wants and nobody is prepared to pay for. And where they are traded, they are often undervalued because their worth or scarcity is not fully appreciated.

Forest economics is plagued by these problems, partly because forests provide so many benefits. A UN-backed project in 2005, the Millennium Ecosystem Assessment, identified 24 main ecosystem services, most of which are found in forests:

from preventing natural hazards, such as landslides, to providing the eco- in ecotourism. Yet most relate to forests' role in the carbon and water cycles and in safeguarding biodiversity. And almost none is priced on markets. Forests are usually valued solely for their main commercial resource, timber, which is why they are so wantonly logged and cleared.

This leads to a profusion of damaging outcomes such as forest fires and lost ecotourism revenue that happen because those responsible are not obliged to pick up the tab. The inferno in 1998 is estimated to have cost over \$5 billion in timber alone. According to another UN-backed effort, The Economics of Ecosystems and Biodi- ▶▶



Rainforest into cooking oil

iversity (TEEB), “negative externalities” from forest loss and degradation cost between \$2 trillion and \$4.5 trillion a year.

To tackle both problems, it may help to come up with a better evaluation of what forests are worth. That could open up new markets for their bounties through payment for ecosystem services (PES), in the jargon. Or the valuation alone may be sufficient to give pause to the axeman, or the taxman. TEEB’s experts are now putting price tags on forests and other natural boons, typically by calculating the opportunity cost of cutting them down and selling them off.

A draft TEEB report on the Amazon rainforest exemplifies its approach. It estimates the forest’s contribution to the livelihood of poor forest-dwellers, of whom there are at least 10m in Brazil alone, at between \$500m and \$1 billion a year. That is based on the estimated market value of the fish and thatch they take to subsist, and the gums, oils and other goods they harvest for cash. On a regional scale, TEEB estimates that the rainforest’s role in avoiding siltation in hydro-power reservoirs is worth anything from \$60m to \$600m a year.

A superior insurance policy

TEEB puts the rainforest’s contribution to South America’s agricultural output, through regulating the continental water cycle, at \$1 billion-3 billion. That is based on a guesstimate of the drop in output that might result from even a small deforestation-related decline in precipitation. But Pavan Sukhdev, an economist with Deutsche Bank who heads TEEB, reckons the real figure might be ten times as much, given what Amazonian farmers seem willing to spend on insurance against rain failure.

As such wide-ranging numbers suggest, trying to price ecosystem services on such a big scale can be a mug’s game. The risks associated with ecosystem collapse are not well enough understood for any hope of precision. And whatever huge figure is arrived at will be notional, because no one can afford to pay it, which can invite feelings of helplessness. Yet the idea is that no one should need to pay it. And there is evidence that such valuations can indeed spur remedial action costing very much less. That was the effect of Lord Stern’s influential 2006 paper on the economics of climate change. And if the dream of international co-operation it elicited has generally faded, it still hangs, vaporously, over the forests. REDD, the nascent effort to persuade tropical countries to leave their forests be, is an effort at PES on a global scale.



The world is richer for them

In forest economics, that is the Holy Grail.

At a lower level, bean-counters are becoming a bit less blind to nature’s bounty. For example, to mitigate inland flooding, Vietnam chose to spend \$1.1m on planting some 12,000 hectares of mangrove forest, thereby saving \$7.3m a year on dyke upkeep. To encourage such decisions, American scientists have developed an ingenious piece of software called Integrated Valuation of Ecosystem Services and Tradeoffs (INVEST). In handy colour-coded maps it predicts the economic and environmental fallout of any proposed land-use change. This could revolutionise land-use planning. China is already using it to pick the best places for new protected areas on a quarter of its territory.

China has one of the world’s biggest PES schemes, a decade-old reforestation effort that has delivered 9m hectares of new forest. Launched in response to flooding of the Yangzi river, it involves paying farmers \$450 a year per reforested hectare. Costa Rica is another PES trailblazer. Since 1997 it has made payments of \$45-163 a hectare to encourage forest conservation, planting and agro-forestry. The money comes from a hydroelectric power company which is keen to protect its watershed; the World Bank, which reckons Costa Rica’s forest biodiversity is a global good; and a 15% surcharge on petrol. The country’s deforestation rate is now negligible.

Perhaps ominously for REDD, however, this scheme may have been less effective than many suppose. Costa Rica’s clearance was also reduced by better law enforcement and a shrinking national beef industry. Work by Rodrigo Arriagada of North Carolina State University and his colleagues suggests that the PES scheme was responsible for only 10% of the reduced deforestation on farms that took part.

As Costa Rica shows, there are many

ways to raise PES money. In America and Australia, for example, markets have been established to help companies countervail the ecosystem destruction they cause, especially to wetlands. Through habitat banking, as this is known, a developer who drains a hectare of marshland can pay to restore a bigger area elsewhere. This is considered an apt form of PES for protecting biodiversity, the third great forest boon, because the services associated with it are especially hard to collect on. An obvious example is bioprospecting, the perusal of nature’s genetic library for new food, medicine and pesticide ingredients.

This alone should justify conserving forests, given how many useful discoveries they yield. Aspirin, derived from willow-bark, Taxol, a breast-cancer drug, derived from Pacific Yew bark, and an emerging class of cancer drugs known as mTOR inhibitors, derived from a molecule found in soil bacteria, are examples of ground-breaking medicines that originated in nature. “Plants, bacteria and fungi make a wealth of complex biologically active molecules that would be extremely difficult for us to match,” says Samuel Blackman, associate director of experimental medicine at Merck, a large pharmaceutical company. “We’re smart, but we’re not that smart.”

The price of ethics

But bioprospecting has done almost nothing to raise the value of standing forests. This is partly because of difficulties in attaching property rights to species. Most tropical countries find it hard enough to attach them to forests. And even if the ownership of biodiscoveries is established, charging for them is tricky. The value of new discoveries is uncertain, and they are swiftly synthesised. The value of old ones, like aspirin, is never paid retrospectively. “When you talk of biodiversity, it’s always about potential,” grumbles Aloiso Melo, of the Brazilian finance ministry. Potential can still be realised. But the strongest argument for protecting other species is often ethical. That helps swell the coffers of Western conservation NGOs, but it has few takers among tropical governments.

Still, understanding biodiversity can make it an important adjunct to conservation motivated by other concerns. For example, forests with high biodiversity will be more resilient to climate change. That is one reason why planting new forests—such as China’s vast stands of eucalyptus—though good, is not nearly as good as saving natural ones. ■

Better REDD than dead

Tropical forests' best hope

NORTH of East Kalimantan's scarified waste is an area where the extractive juggernaut has not yet reached. Beneath the helicopter's blades, the woods thicken and the terrain rises to a seam of limestone crag, dripping with trees. Beyond it is the district of Berau, 70% of which is still covered in forest.

It is lovely to behold, its multi-greened canopy like a vast head of broccoli, speckled with orange and yellow where an iron-wood tree or a liana has forced itself up to the light. Borneo's forest has more tree species per hectare than anywhere else. It is also packed with carbon: up to 400 tonnes per hectare. Yet much of this forest is doomed. It provides no tax revenues for the government, which owns it, and only a modest income for the local Dayaks, in rattan, honey and game. Failing a remarkable intervention, it too will get cleared.

To expect deforestation to be halted not only in Berau but across the tropical world takes a big leap of faith. Yet that is what is being attempted under REDD. Envisaged as a giant PES scheme for which over 70 developing forest countries could be eligible, it comes with an ambition to halve deforestation by 2020. So far it is visible, in a couple of dozen countries, mainly in the form of small pilot projects run by the UN and NGOs. But it is gathering pace.

A commitment to launch REDD, with "substantial finance", was the only obvious success of last year's Copenhagen summit on climate change. It led to the inaugural meeting in Oslo in May of a 58-nation group, the REDD Partnership, which will hammer out the details for a global REDD deal. To get things moving, half a dozen rich countries, including Norway and Britain, have pledged to provide \$4.5 billion by 2012.

How REDD will be funded after that is unclear. It had been assumed that carbon markets would provide, with "forest-carbon credits", equivalent to a tonne of avoided emissions, being bought to offset industrial countries' emissions. For the moment the main compulsory market, Europe's emissions-trading scheme, does not accept forest-carbon credits. But assuming the ETS survives, that is likely to change, and if America ever adopted an equivalent

cap-and-trade arrangement, forest carbon would be part of it.

The chances of that have recently receded, following the United States Senate's failure in July to approve a proposed cap-and-trade scheme. REDD might instead be funded through rich-world carbon taxes. However, it is accepted that REDD's beneficiary countries must be guaranteed long-term funding, perhaps tens of billions of dollars a year, and that these payments will be performance-based.

How much is required? No one knows, because no one has ever done anything like this before. Countries generally do not stop deforesting until they industrialise and urbanise, reducing their rural population, or they cut down their forests to such an extent that timber scarcity or environmental disasters lead to urgent protection, as in China. Known as the forest transition, this can be visualised as a curve in the shape of a ski-jump, first sloping down steeply and then turning up gently as the forest creeps back. REDD is an attempt to bridge that dip.

Estimates based on the opportunity costs of not felling, which will often make up the bulk of the total, suggest it can be done relatively cheaply. According to the

most recent one, by the Informal Working Group on Interim Financing for REDD, an international quango, an investment of \$17 billion-30 billion between now and 2015 could cut deforestation by a quarter. That would save 3m hectares of forest, or 7 gigatonnes-worth of carbon emissions, a year.

It's a gift

This suggests a cost range for REDD of \$2-4 per tonne of avoided emissions: a steal. Other estimates are higher. Indonesia's National Council on Climate Change puts the opportunity cost of forgoing an oil-palm plantation at \$30 a tonne. But even that would be cheaper than many other sorts of mitigation. Capturing and storing emissions from power stations is estimated to cost \$75-115 per tonne. With REDD as an offset option, industrial countries could therefore be expected to undertake deeper cuts than they would have done otherwise. That is why most developing countries, which previously viewed REDD with suspicion, now support it.

There are many concerns. One of them is that avoided deforestation may not be permanent—especially where there is a risk of climate-induced forest dieback. Another is that REDD money will inevitably ▶▶



Dripping with good things

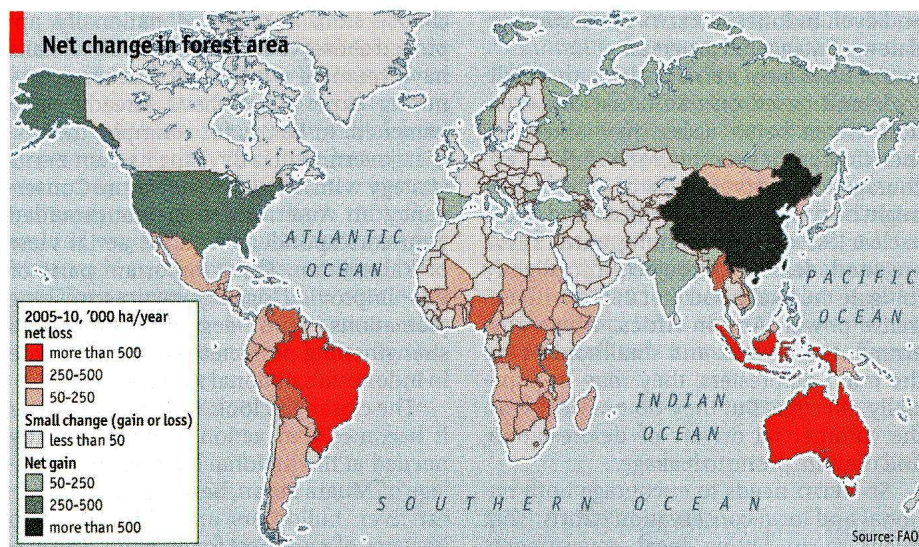
flow to the most egregious deforesters, such as Indonesia, which may create an incentive for others to take up their chainsaws. Or demand for forest land, no longer met in Indonesia, may shift to non-participants in the scheme. That is why REDD has to be done on a large scale, even if the payments will vary. Brazil, which has been developing REDD for two years, with \$1 billion from Norway, has a payment formula that favours Amazon states with high deforestation rates over those with low ones. But, to reward the virtuous, it also takes into account the states' record on meeting REDD commitments.

The biggest worry, however, is that REDD may not be possible at all—at least not on the scale that climate modellers assume. Forest conservationists, schooled in failure, rattle off a list of possible reasons why. Forest title, or the lack of it, is one. Unowned forests are unprotected, which is why the *grileiros*, or land-grabbers, of the Brazilian Amazon rainforest can so easily turn it to pasture. But even where governments claim a forest, the result can be the same; 63% of the lowland parts of West Kalimantan's national parks were illegally cleared by loggers between 1985 and 2001.

At least it was obvious who was to blame for the clearance. Where forest ownership is contested, because local rights are vague or there are competing title deeds, for example, that becomes more difficult. Unclear ownership also raises a big obstacle to the improvements in land-use planning that REDD must bring about. In Indonesia this would mean putting palm-oil plantations not on forest land but on degraded land, of which it has perhaps 40m hectares available.

That, in turn, will mean facing down the planters, who prefer to bag forest land for a windfall of timber. Between 1990 and 2005 Indonesia planted over 3m hectares with oil palms, over half of it on freshly cleared land. The crop is now coming to Berau. Beneath the hovering helicopter, an ugly mud-orange clearing has been cut for it from the lush green forest.

When the forest is on peat, as in much of central Kalimantan, Sumatra and Papua, the cost of Indonesia's messy land use becomes epic. Peatland can store over 5,000 tonnes of carbon per hectare, and when drained for cultivation emits it for decades. Frances Seymour, head of the Centre for International Forestry Research (CIFOR), ruefully calls this "the gift that keeps on giving". Indonesia's peat-based plantations, a quarter of the total, contribute less than 1% to the country's GDP but nearly



20% of the national emissions.

With Indonesia committed to doubling its area under oil palm, there is a risk that its emissions could soar—but also an opportunity for REDD. Restricting the expansion to degraded land would achieve a huge mitigation. Assuming REDD delivers, Indonesia has vowed to reduce its forecast 2020 emissions by up to 41%. In May President Susilo Bambang Yudhoyono announced a two-year moratorium on commercial deforestation. In response, Norway promised Indonesia \$1 billion for REDD.

There are many other risks to REDD, of which corruption is the most prominent. Much of Indonesia's forestry ministry—which claims control over 75% of the country's area—and its logging industry are crooked. That is why wildlife sanctuaries disappear without a whisper. In the 1990s over \$5 billion was looted from a national reforestation fund. If that happened to REDD, the effect would be devastating. REDD's stress on performance should make it unlikely, and Indonesia's forestry is getting less mucky. But its greedy elite will still try to manipulate the scheme.

Even if the safeguards work, reforming weak states is hard. Land-use planning for oil palm, for example, might involve not only the ministry of forestry but also those of agriculture, finance, energy and infrastructure as well as the army and the police. All have their own priorities, and saving trees is not among them. Kuntoro Mangkusubroto, the boss of Indonesia's new REDD agency, was previously in charge of rebuilding Aceh after the tsunami. Asked to compare his old and his new job, he says: "In Aceh the government had totally collapsed, we were working from

zero. That was much easier."

But his appointment is encouraging. He is Indonesia's most respected official, which suggests presidential support for REDD. That is essential. For REDD to be sustainable, it will have to be more than life support for the rainforest. It must provide ways for tropical countries to develop growth strategies that do not involve razing forest. In East Kalimantan 39% of jobs are in forestry, mining or agriculture. To bridge the transition, Indonesia will have to create many more jobs elsewhere.

REDD alert

Across the developing world, changes of that kind would entail a complete overhaul of some of the world's least capable and most corrupt states: to make them rational in their land use, honest in their accounting, responsive to their citizens. That is not going to happen fast, as the sorry history of development assistance suggests. But REDD, provided its design holds firm, can do better. Its rewards must be sufficiently large and long-term to persuade rainforest countries to straighten themselves out. And they must be results-based.

That may be especially difficult to achieve in Africa. For example, Congo's government does not know, to the nearest million, how many people have died in its continuing civil war. How will it provide an inventory of its forest-carbon stock? Who would buy its subprime credits? It will take it years to bring a national REDD programme to market, and meanwhile its REDD efforts will probably have to be funded with foreign public money. That makes it even more important to push ahead where the way is clearer, in Brazil ►►

▶ and even Indonesia. REDD can accommodate such staggered progress.

For now, most REDD projects are small-scale and based on traditional conservation. Given better access to markets for their timber, for example, forest folk are encouraged to harvest less of it. Or they might be supplied with fertiliser and asked to clear less forest for planting maize. These are good ideas. Such projects also slightly mitigate the likelihood that REDD will centralise power. And in Africa, where governments are weak and smallholders are the main deforesters, they may be especially effective. But they do not deal with the commercial drivers of deforestation, and they are prone to leakage.

So REDD needs to encourage both national and local conservation efforts. That might mean letting local governments

choose from a range of nationally approved conservation measures. The details have yet to be worked out, but some promising experiments have already been launched. In Berau, for example, the district government is devising its own REDD strategy with help from the Nature Conservancy, an American NGO that provided your correspondent with his aerial view of Kalimantan. Three important parts of this—improving logging practices, pushing plantations onto degraded land and strengthening protected areas—will figure in Indonesia's national REDD strategy.

The closer you look, though, the clearer it becomes that action is most urgently needed at the national level. Near the village of Muara Lesan, beside a gurgling forest river, bulldozers are clearing 10,000 hectares of rainforest for oil palm. The eth-

nic Malay villagers gave their blessing to the scheme and say they are pleased with it, having been promised a small rent by the planters. REDD payments might have given them much more. But their weak right to the forest did not extend to its timber or carbon. Having been identified as the forest's owners, up to a point, these locals cannot profit from it until it is gone.

That makes it all the more striking that three nearby villages have refused permission for a plantation on their 30,000-hectare forest. A local notable, Hang Long, explains the decision: "Oil palm destroys the forest and leaves nothing for our children." This is heroic but probably futile. So long as it is worth so little to its executioners, this forest, too, may go. REDD looks extremely uncertain, but without it massive tropical deforestation is inevitable. ■

Keeping it in the community

Well-organised locals often make the best forest managers, but they need help

AT A sawmill in the misty hills of Michoacán in central Mexico, loggers sporting damp sombreros and droopy moustaches are working through a drizzle, hauling pine logs. With iron spikes they lever them into position, hack out any stones embedded in the pungent orange flesh and heave the logs on to a runner. A bullnecked lumberman guides them through a buzzing circular saw, slicing them into rough boards. Another cuts them into planks, which his mate tosses onto a rising stack. It barely takes a minute to transform giant trunks into building material.

Most of it will be sold locally. The loggers, who belong to a rural co-operative (or *ejido*) that owns 680 hectares of the nearby Ocampo forest, will use the rest to make simple furniture. The business provides jobs for 20 of the *ejido*'s 138 members, hauling lumber, turning lathes and planting trees, and each member gets an annual profit share of around 15,000 pesos (\$1,150).

Over 75% of Mexico's forests, which range from temperate spruce and fir to tropical rainforest, are controlled by local communities, either *ejidos* or indigenous groups. Most were parcelled out in the 1920s, in a spate of land reform after Mexico's 1910-20 revolution. Though much of this forest is technically owned by the state, the communities have strong rights to it. They won control of logging permits

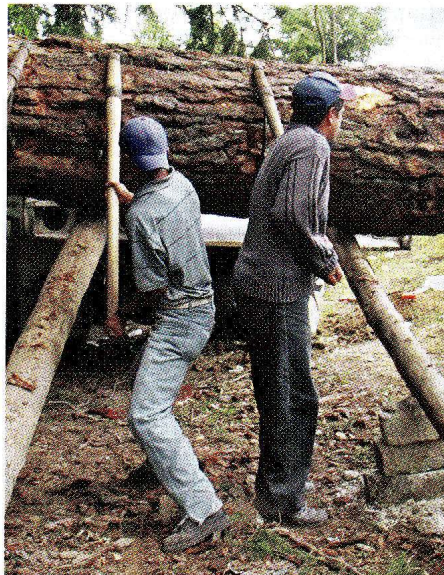
in the late 1970s after protests by *ejidatarios* against commercial loggers had brought Mexico's timber industry to its knees. The communities are not allowed to clear or sell their woods; otherwise they can do with them more or less as they please.

This makes Mexico a remarkable case study in what some consider as the best form of forest management. Most forests are claimed and mismanaged by govern-

ments. That can also mean dispossessing local people who, denied ownership of a forest they may have considered their own for centuries, tend to become protagonists in its destruction. An obvious solution is to put the forest back in local hands. Once they have tenure, it is argued, local people will regain their incentive to manage the forest sustainably, and trees and people will both flourish.

This is more radical than it may sound. Not long ago it was widely accepted that communally owned resources inevitably get overexploited because a few spoilers, or even a suspicion of them, are sufficient to make other users abandon prudential rules. Known as the "tragedy of the commons", after a hugely influential 1968 essay by an American ecologist, Garrett Hardin, this theory was often cited by governments to justify their takeover of forests in the 1970s and 1980s.

But the tide may be turning. In the past two decades the area of forest in developing countries that is wholly or partly controlled locally has more than doubled, to over 400m hectares, or 27% of the total. That is partly due to a growing recognition that most governments make lousy forest conservationists, and a corresponding hope that locals will do better. That helps explain why 450,000 hectares of Guatemala's Maya rainforest have been made ▶▶



Pushing together in Michoacán

over to 13 communities living there. But other factors have also contributed to the shift, including efforts to deal with the grievances of dispossessed indigenous people, especially in Latin America, and political decentralisation schemes, especially in Africa and Asia. Tanzania, for example, has devolved rights to about 2m hectares of its dryland forest. And in India a combination of political devolution, tree-hugging judges and activists for tribal folk has helped 275m people win more rights to their nearby forests.

With such diverse origins, the reforms now in progress vary greatly in scope, design and implementation. Yet most share three features: an emphasis on conserving forest; a prohibition on selling or clearing it; and a tendency to deliver less change than they promise. That is often because governments try to claw back control, in myriad ways. They may restrict forest pursuits such as collecting firewood or hunting. They may make it hard to obtain logging licences and other permits, either through incompetence or spite, or they

may invent new ones for fun. In Nepal community foresters are not allowed to sell timber on the open market until they have offered it to neighbouring villagers.

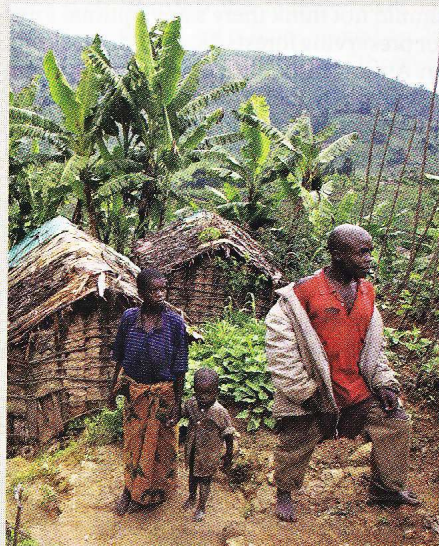
Governments also like to keep the more valuable forests for themselves. In Cameroon this is policy. Moreover, even with strong rights to a potentially rich resource, naive villagers generally need advice, training and access to credit to manage it on a commercial basis, and that is rarely forthcoming. More often the forest's new owners are undermined by petty officials' ►►

Not a small problem

ON A scrubby hillside in southern Uganda sit waist-high mounds of grass and twigs. They are the huts of Twa pygmies, the oldest residents of the Great Lakes region. Until recently they inhabited the nearby Bwindi Impenetrable Forest, but around 4,000 were expelled in 1991 after the forest was turned into a national park to protect its population of mountain gorillas. Now the pygmies languish outside it, unskilled at cultivating crops and often inebriated.

For longer than history records, the Twa inhabited the high-altitude rainforest near the western edge of the Rift Valley, hunting antelopes and harvesting honey. "There was no digging then," recalls James Barangirana, an 80-year-old pygmy, "just hunting, gathering, eating and celebrating." But in one of Africa's most populous regions, the rainforest has been badly reduced. And so have the Twa. Perhaps 100,000 remain, in Uganda, Rwanda, Burundi and Congo, almost everywhere wretched. Their Rutwa language, religion, songs and story-telling are dying. As in Bwindi, most are barred from their ancestral forests.

Other forest folk have fared even worse. Five centuries ago there were perhaps 10m Amazonian Indians; now there are 700,000. Most traditional forest people have no legal entitlements to their woods, so their rights are easily abused. That is what is happening to Ecuador's Tageri and Russia's Khanty, who are threatened by oil exploration; Paraguay's Ayoreo and Brazil's Guarani, who are losing their forest to ranching; and Canada's



No honey, no rights

dispossessed Innu.

But things are improving slightly. Brazil has allotted 10m hectares of rainforest to its surviving Indians, who include an estimated 69 "uncontacted" groups. Many "First Nation" Canadians have also won land settlements. Even reluctant Indonesia has nodded acknowledgment to the rights of 50m forest dwellers. Now REDD threatens to reverse this progress by launching governments on a carbon-rush for the woods, say champions for indigenous folk. A prominent activist calls the scheme "potentially genocidal".

This has become one of the thorniest issues in the REDD negotiations. It is now accepted that the "free, prior and in-

Will REDD trample on the rights of traditional forest folk?

formed consent" of local people will be a condition for any REDD project, but activists suspect this is lip-service. A leader of Papua New Guinea's Kamula Dosa tribe says he was forced at gunpoint to sign away the carbon rights to his people's forest. Kenyan Ogiek hunter-gatherers claim to have been expelled from their Mau forest after a UN REDD pilot project was launched there.

Early initiatives to certify REDD projects do include safeguards for local people. Brazil's draft national REDD law also states that indigenous people own the forest carbon of their reserves. That promises to make the uncontacted groups' first brush with civilisation even more surprising. But if the activists expect a transformation of indigenous people's lowly lot, they will be disappointed. Rainforest countries are not easily shamed on the issue, and developed ones are more concerned to get REDD moving. Standing on the whispering edge of the Impenetrable Forest, Mr Barangirana asks: "Where is the god who will give us back our forest?"

It is at least worth noting, however, that forest people are not always the tree-huggers they are cracked up to be. With a taste of modernity, they can seem much like the rest of us. British Columbia's Lax Kw'alaams First Nation are in trouble with greens for exporting their ancestral woods to China in log form. And at a gathering of Brazilian indigenous leaders in Amazonas, one said he would build roads with his REDD loot: "Let's face reality, we Indians now have cars, so we need roads and other infrastructure."

▶ preference for dealing with local elites. In Ghana and Cameroon this has allowed venal village chiefs to steal logging revenues.

Most of these troubles are evident in India. Its recent reform, passed in 2006 after an outcry over a court-ordered policy of forest enclosure, grants each household the right to four hectares of agricultural land and a share in local forest produce. But its implementation requires diligent officials, so not much has happened. And the record of an earlier Indian scheme, joint forest management, in which locals were promised a small share of timber revenues in return for deterring illegal logging and planting trees, is discouraging. It offered a few brilliant examples of co-operation between organised communities and motivated officials, but in many of the 85,000 communities covered by the scheme corrupt and controlling officials made participation hard. India-wide it did little for people or trees.

It all depends

Recent research by CIFOR on community forest management in 11 tropical countries suggests that such outcomes are not uncommon. In most of the examples studied, at least some benefit had accrued to some community members, but local control was not in itself a guarantee of better forest management. Where communities were given degraded forest and instructed to regenerate it, they generally did so. But where devolving forest rights provoked local conflict, as quite often happens, the forest usually suffered.

This does not mean that community forest management is no good. There is rarely a better way to balance the interests of poor people and forests. But to do a good job, communities need strong property rights and often technical help. Such assistance should not stifle their ideas on forest management, which are often, though not always, based on a deep understanding of the local ecosystem. Outcomes that are good for both trees and people will also depend on external factors such as law enforcement and access to timber markets. And in the way of forests, these conditions will vary greatly from place to place.

The state of the Maya forest is a good illustration. Where the local foresters get tourism revenue from Mayan archaeological sites, it is thick with trees. In some other places, where the same indigenous communities have the same legal rights to the same sort of forest, it is degraded. "We should not think there's any optimal form for preserving forests," says Elinor Ostrom, an American political scientist who won last year's Nobel prize for economics for her work on common property and collective action. "We find government forests that work and community forests that work and those that don't," she adds. "Panaaceas, like thinking 'community forests are always great', are dangerous."

That is true even of Mexico's community forests. The Ocampo *ejido* is inspiring. Its members began logging their forest in 1989, and with the profits they made they bought their sawmill two years later. The forest, most of which is inside a famous

butterfly reserve, has also thrived. Illegal logging has fallen—despite the recent entry into the trade of a cultish local mafia, La Familia. Yet such examples are rare. Around 80% of Mexico's community forests are not managed at all because the locals are unskilled or unorganised or their forest is difficult to log. The dry forests of southern Chiapas and Yucatán require expert management which is beyond the local *indigenas*. They are among Mexico's poorest, most unlettered and most rebellious people, with weak property rights and rapidly disappearing forests.

And even in Michoacán, community forestry faces an uncertain future because it is inefficient. The Ocampo loggers' sawmill is old, yet they are loth to upgrade it for a less labour-intensive model. They also confess to lacking the nous to find the niche markets their pine requires. It is of high quality, but at least 30% more expensive to produce than the sappy Chilean alternative. Overall, Mexico's timber production has fallen by a third in the past decade, despite a \$400m annual subsidy to the industry. To remedy this, the government is establishing a big plantation forestry which will make it even harder for the *ejidatarios* to compete.

"In terms of economics, community forestry doesn't make much sense," says Juan Manuel Torres Rojo, director-general of the Mexican forestry department. "But in terms of equity, and perhaps conservation, it's the way to go." He reckons community forest revenues need topping up by a third, and is looking to REDD. ■

The long road to sustainability

Western consciences can do only so much to conserve forests

IN JUNE last year Daniel Avelino, the public prosecutor of Brazil's state of Pará, the home of most of the Amazon cattle-herd, probably saved more rainforest than many conservation groups ever will. He identified 20 big ranches operating on illegally cleared land and traced the slaughterhouses buying their cattle. He then established that some of the world's best-known retailers, including Wal-Mart and Carrefour, were buying meat from them. He fined the ranchers and abattoirs 2 billion reais (\$1.2 billion) and told the retailers that unless they cleaned up their supply chains he would fine them, too.

The response was dramatic. Overnight, the retailers stopped buying meat from Pará and the slaughterhouses closed. To get themselves off the hook, and cows back on it, the abattoirs vowed that in future they would deal only with ranchers who had registered their names and property details and promised not to deforest illegally. Over 20,000 have done so. In the absence of a reliable land registry, Mr Avelino says this will make it much easier to bring illegal deforesters to book. "Once I know who owns the farm, I can send the fine through the post," he says.

Around the same time Greenpeace

waded in with a report on the role of Amazon beef in deforestation. That, too, hit at the rich end of the industry's supply chain, linking beef and leather from the Amazon to companies such as Adidas, Nike, Toyota, Gucci and Kraft. Many have since agreed to work with Greenpeace against illegal deforestation. And Wal-Mart has promised to trace its products from the manger to the refrigerator.

That is the upside of growing global demand for tropical food, timber and bio-fuels: pressure for Western standards to be adopted up the supply chain. This is driven by the eco-worries of Western consum- ▶▶

►ers—and the activists who play on them. Having been long since given the brush-off by rainforest governments, they are finding companies that operate in tropical countries and sell to Western markets much more responsive.

Nestlé, a giant food company, is another of Greenpeace's recent targets. The environmentalists made a spoof advertisement for one of the company's chocolate bars, KitKat, which contains palm oil, and published it on the internet. The ad shows an office worker munching on a chocolate bar which turns out to be the bloody severed finger of an orang-utan. This scored more than 1.5m online hits and put Nestlé in a panic. It stopped buying palm oil from its main Indonesian supplier, Sinar Mas, a big conglomerate with a reputation for chewing up rainforest, and said it would purge from its supply chain any producer linked to illegal deforestation. It has since promised to get 50% of its palm oil from sustainable sources next year. And unconvinced by the standard of most of this "sustainable" oil, Nestlé is setting its own.

Three reasons for pessimism

But there are three black clouds over this sunny scene. The first is financial: eco-concerned consumers may want sustainable products, but they do not want to pay more for them. That does not matter much to Nestlé because it buys only 320,000 tonnes of palm oil a year, just 0.7% of global output. It is a bigger problem for Wal-Mart, which deals in bulk and has tight margins. It expects to charge no more for its green beef than for its current offering. That will raise questions about how green it really is. To track an animal efficiently in the Amazon might well involve expensive technologies. Uruguay, for example, has a system of microchipping calves that costs about \$20 a head. That may be beyond Wal-Mart's budget.

The same problem haunts the main forest-related certification scheme, for timber. It dates back to 1993, when the Forest Stewardship Council, an alliance of greens and loggers, drew up a list of rules for sustainable forestry. The hope was that consumer demand for FSC-certified wood products would force logging companies to adopt the scheme. But only about 15% of timber globally, and less than 2% of tropical timber, is covered by it. Getting certified is expensive, costing about \$50,000 per concession, and the returns are often meagre. Tests by the Home Depot, America's biggest purveyor of FSC-stamped products, suggest that barely a third of customers

would pay a premium of 2% for a certified product, not enough to green even Western retailers.

The second cloud over tropical certification schemes, as Wal-Mart may find, is doubt about their reliability. Some also say that sustainable tropical logging is impossible. Remove 200-year-old Amazon mahogany or Congolese sapele trees and the species may go locally extinct. And although it is true, as loggers argue, that extracting old, slow-growing trees and preserving their carbon in expensive furniture may represent a net sequestration opportunity, high levels of wastage make the argument less convincing. So does the fact that a logged forest can be much less permanent than a mahogany table.

Loggers do most harm to forests not by removing trees but by building roads that give land-grabbers access to them. To get FSC certification, companies need to prevent such trespass. But logging roads remain long after loggers have moved on. In Africa they represent a particular threat to precious forest fauna, including chimpanzees, bonobos and gorillas, by connecting forests to the fast-growing cities where bushmeat is prized. Along a fresh logging road in southern Cameroon, your correspondent once saw many hunters—and the half-eaten remains of two gorillas.



Sustainable, or just nuts?

In messy countries like Cameroon, certification schemes get corrupted. At best, certifiers may struggle to examine vast concessions on brief visits, as the guests of loggers who are also paying their fee. Further down the supply chain, timber-dealers and factories are often certified largely on the strength of documents which may be illegally bought. This also allows inventories to be inflated and illegal wood to enter the supply chain. And there is still plenty about, despite the recent reduction reported in Cameroon and elsewhere.

Who cares?

The third factor undermining certification schemes is the most important: the majority of tropical commodities are not consumed in eco-sensitive markets. Most rainforest timber is used locally. In Brazil, for instance, the proportion is 80%. And the biggest importers of tropical timber, China and India, show scant concern for its provenance (though China, the biggest exporter of wood-based products to Western markets, has recently seemed to care a bit more). China and India are also the biggest importers of palm oil. Brazilian beef goes mainly to Russia, Iran, Hong Kong and Egypt. They are not tree-huggers.

This highlights one of the biggest problems in forest conservation. Most of the changes it requires, such as rational land-use planning, law enforcement and the rest, have to be led by governments. Market-led schemes can succeed up to a point, as Greenpeace has often shown, but without government support they soon hit their limits. On the other hand, when governments put their weight behind conservation, a fair bit of progress is possible.

Western governments are starting to do their bit. A 2008 amendment to America's Lacey act has made it an offence to import illegal timber. This puts the onus on federal authorities to prove illegality, which can be difficult, especially when the wood is from a dodgy place, like Cameroon, and processed by a less dodgy one, like China. Nor is legality the same as sustainability, but often they are close. Gibson Guitar, an iconic American company, is at risk of becoming the first victim of this reform. It is being investigated on suspicion of knowingly importing illegal Madagascan rosewood.

In July the EU also passed a law criminalising the import of illegal timber. Its strict rules on beef imports, which demand traceability in producer countries, could one day help reform Brazil's cattle practice. But it would be far better if Brazil were to decide to take such steps itself. ■

Less smoke, less ire

Brazil, long the world's deforester-in-chief, is mending its ways

THE Amazon's dry season, from July to September, is when the *grileiros* cut and burn the rainforest. The smoke is so thick it can be seen from space. It also stops rainclouds forming, so the flames burn higher. But on a recent surveillance flight over the forest frontier in Brazil's state of Pará, there was hardly a wisp of smoke in the sky. Even the people from Greenpeace, whose flight this was, were impressed.

They can take some credit, thanks to their Amazon beef campaign. But even before that Brazil's deforestation rate had slumped. Between 1996 and 2005 some 19,500 sq km of the Brazilian Amazon were cleared each year. At that rate, a third would be gone by 2050 and the rest might wither. But the rate of clearance has been reduced drastically and in 2008-09 it was at its lowest level for two decades, at a mere 7,008 sq km. This is partly because of tumbling prices for agricultural commodities, the reason for previous downward blips in 2006 and 2008. But it is also because of government action. When soya and beef prices briefly began to climb at the end of 2007 there was a renewed spurt of hacking and burning. But it was swiftly quashed.

What has changed? First, there has been a big expansion in the area of rainforest designated as national park or indigenous reserve, or zoned exclusively for logging. Between 2002 and 2009 Brazil committed 709,000 sq km of the Amazon to such use. The idea was that, even where the state cannot police the rainforest, as it mostly cannot, straightening out who owns it would deter land-grabbing. It seems to have worked. An analysis of the reduced clearance up to 2006 attributes it, in order of importance, to the expansion of protected areas, low commodity prices and other factors, including a modest improvement in policing.

That has since become more discernible. In 2008 the government confiscated 3,000 cattle from a protected area, an unprecedented step. In May this year the former environment secretary of Mato Grosso was arrested over an illegal-logging scam. Ranchers linked to illegal deforestation or slavery, another curse of Brazil's wild frontier, have been blacklisted, re-

stricting their access to credit. Brazil's monitoring capability has also improved. Since 2004 the national space agency, INPE, has released bi-weekly deforestation reports which makes it impossible to hide the clearing of mega-ranches. Most Amazonian deforestation is now reckoned to be small-scale and gradual. Carlos Nobre, one of INPE's top scientists, says he will soon be able to detect this, too.

The government is also discouraging the cultivation in the Amazon of sugar-



Can Brazil kick the habit?

cane, a source of bioethanol, demand for which is soaring. More important, it has launched an effort to finish cleaning up the land registry, following the passage last year of a law to formalise all pre-2004 land claims for holdings of 2,500 hectares or less. Pará's state government has appointed the foremost expert on Amazonian land law, José Benatti, to manage what amounts to an amnesty; so far he has issued over 30,000 title deeds.

The government promises to go further. Before its billion-dollar deal with the Norwegians in 2008, it vowed to reduce deforestation in the Amazon by 80% by 2020.

That would mean an annual loss of 3,250 sq km a year, a good chunk of rainforest but less than the area of discarded pasture that returns to forest each year. Many policymakers now talk of ending deforestation by 2030, or even reversing it. To reduce the risk of rainforest die-back, the World Bank recommends reforesting 40m hectares of Amazonian land that had been illegally cleared.

It is hard to exaggerate the benefits this would bring. It would help avoid manifold predicted catastrophes to do with climate, weather and the survival prospects of millions of species. It would suggest that this effort was being taken seriously by the biggest rainforest country and a large emerging power. It might even suggest that success is possible. But the caveats attached to this hope are large.

First clear the hurdles

Almost all Brazil's new tree-hugging efforts need a push. Law enforcement, though greatly improved, is still sporadic; IBAMA, the main environmental-protection agency, owns just six helicopters. And though more illegal deforesters have recently been convicted, less than 10% of them are actually paying their fines. Given such impunity, why not grab more land? There is a fair chance, after all, of another land amnesty sooner or later.

Meanwhile the inevitable backlash from landowners and their political sponsors has begun. They are now demanding a big reduction in the stipulated area of tree cover on private land. That is not unreasonable. The requirement for Amazonian holdings—80% tree cover—is bad for business, as well as unenforceable. Yet there is a serious risk that such safeguards could be lowered too much, especially in an election year: Brazil is due to hold a presidential poll next month and the front-runner, Dilma Rousseff, has a record of favouring destructive infrastructure projects in the Amazon.

Moreover, far too many Brazilian policies—in agriculture, infrastructure and elsewhere—encourage deforestation. Reversing this trend would be difficult and time-consuming even with political support. Yet ending deforestation in the Ama- ►►

► zon would be in Brazil's interest, and many Brazilians are demanding it, which is why it is now imaginable.

It will not be at the expense of Brazilian farmers. Agriculture and livestock contribute about 30% of national output, and in absolute terms will grow steeply in the medium to long term. Exploding global demand for food, of which Brazil is already the biggest exporter in a dozen categories, will make sure of that, and recent investments in Brazilian agriculture point in the same direction. For example, BrasilAgro, a firm controlled by one of Argentina's biggest agribusinesses, Cresud, has acquired close to 200,000 hectares in four years and is trying to buy much more.

More from less

But Brazil should not need to clear more rainforest to accommodate this growth. Brazilian cattle-ranching, which occupies 209m hectares, is staggeringly unproductive, with an average stocking rate of less than a head of cattle per hectare. By periodically turning the soil and scattering fertiliser, that rate could be doubled or even tripled. Already the world's biggest beef exporter, Brazil could hugely ramp up its production on half the land it currently reserves for grazing. That would free up space for crops, which are far more profitable. The World Bank suggests it could provide 70m hectares, more than Brazil now has under cultivation.

The obvious risk is that making ranching more productive will raise the incentive to grab more of the rainforest, but there are mitigating factors. Deforestation is inextricably linked to low-productivity ranching. Because most Amazonian ranches are illegal, or their ownership is contested, ranchers and banks are reluctant to invest in them. And even where the land is legally owned, Brazil's complicated land-use laws, which are most strict and most flouted in the Amazon, often put it beyond the pale. According to BrasilAgro's Julio Piza, "the system conspires to keep reputable companies away from the Amazon." To bring them in, and so raise the productivity of Amazonian ranching, it needs to become legal.

That is why Brazil is trying to fix the land registry. It is also why Amazonian state governments are rezoning their territories, which will allow a more modest reduction in the stipulated tree cover than the lawmakers are demanding. Legitimising the Amazon's economy could benefit trees in several ways. More profitable ranches, farms and plantations would

yield tax revenues for cash-strapped law-enforcement agencies and create jobs for the 5m-odd smallholders and landless peasants currently responsible for much of the clearance.

Luis Prates Maia is one of them. A temporarily retired *grileiro*, he is currently squatting with other landless folk on a vast ranch in southern Pará, demanding a piece of it for himself and his eight sons. That is probably illegal; but so, Mr Maia points out, is the ranch.

Until Brazil provides jobs for such people, politicians will use them to justify turning a blind eye to deforestation—from which commercial deforesters will profit more. As President Luiz Inácio Lula da Silva said before last December's Copenhagen summit on climate change, "I don't want any gringo asking us to let an Amazon resident die of hunger under a tree."

But it is not only gringos who clamour to stop deforestation. In fact, the charge is led by Brazilian scientists, who fear that a rainforest tipping-point is nigh. They are backed by most Amazon state governors, who sniff REDD bucks but also fear the effect deforestation will have on the region's water supply. A former governor of Mato Grosso, Blairo Maggi, is also the world's biggest soya farmer. He used to argue in favour of clearing forest for agriculture but now wants to save it.

So do Brazilian businessmen. Some of the biggest wrote to Lula last year to urge him to make a tough emissions-cutting

commitment. He did so, pledging Brazil to cut up to 39% of its projected emissions by 2020. Many Brazilian businessmen consider this an opportunity. With around 40% of its emissions coming from avoidable deforestation, Brazil can curb them much more cheaply than any other big emerging economy. Its current alignment on climate with high-polluting, coal-dependent China and India is a triumph of developing-world solidarity over self-interest.

Colour me green

Brazil's great advantage is its abundance of land, water and sunlight, combined with an increasing ability to use them to best advantage. It gets over 40% of its energy from renewable sources and is successfully developing green technology. Braskem, a big Brazilian petrochemical firm, has developed a technique to make ethylene from bioethanol and is about to open the world's first "green plastic" plant. Rebranding Brazil as an eco-friendly producer could give it dominance of the most lucrative markets for its many agricultural products. Rubens Ricupero, a former finance minister who sits on the board of Braskem's parent company, dares to imagine his country as an "environmental power".

There are a few hurdles in the way of that. But if Brazil's leaders chose to clear them, rather than the rainforest, they would not only do the world a favour; they would benefit their own country's economy too. ■



Cram them in and stop felling



Something stirs

But to save the forests, the world needs to find somewhere else to grow its food

WHEN Michael Williams, a British geographer, sat down in 1994 to write a chronicle of deforestation, “Deforesting the Earth”, he had a useful aide-memoire. Flashing near his study, outside the Los Angeles branch of the Hard Rock Café, was an ever-diminishing neon number, representing the remaining area of rainforest. It counted down at about 20 hectares a minute, at which rate no rainforest would be left by the end of this century.

Despite a faddish Western concern for tropical forests, more were cleared in the ensuing decade than ever before. Most tropical countries, being poor and weak, could not have prevented that even if they had wanted to, and most did not. Anxious greens switched to another losing cause, mitigating climate change, and the Hard Rock Café took down its sign.

The world is now doing better by its forests. It is protecting more of them, logging them a bit less riotously. Above all, there is REDD. As a serious effort to make standing forests more valuable than razing them for agriculture, it is unprecedented. And unusually in the fractious UN climate negotiations from which it sprang, REDD has the backing of both rich and poor countries. Indonesia’s recent vow to suspend commercial clearance, in anticipation of its billion-dollar gift from Norway, was a big boost.

But if REDD is unprecedented, it is because so is the threatened climate calamity, and forests have a lead part in that. They are the cheapest large-scale carbon-sequestration option available: they actually consume the stuff. This presents a big opportunity. Through afforestation, reforestation and cutting down agricultural emissions, by one estimate, carbon dioxide equivalent to 40 parts per million could be extracted from the atmosphere by 2050. That would roughly match global emissions over the past three decades.

Conversely, when forests are cleared or die back because of global warming, they

emit carbon. Canada’s beetle-plagued forests are a net carbon source. Since forests hold half of all terrestrial carbon, this presents a huge threat.

To mitigate it, natural forests must be conserved. This is an excellent thing to do anyway. Forests provide myriad other benefits, especially in hydrology and by hosting millions of species. Appreciating forests just for their carbon, says Tom Lovejoy, an American biologist, “is like valuing a computer chip only for its silicon”.

Does the recent push on forest conservation stand much chance? That will depend, firstly, on REDD delivering the promised cash. Indonesia’s decision to stop clearing, which will slow the growth of its palm-oil industry, was not just for the good of the planet. The country hopes to collect perhaps \$10 billion a year from REDD.

But even if REDD money flows in spate, it will not be enough to stop the clearance on its own. Large-scale forest conservation is difficult because no two forests are alike. And it can be impossible without a state that operates at a minimum level of efficiency, which many tropical countries fall

short of. They are also the places where most forest is most directly threatened by an exploding human population.

Limiting the damage will require a global rethink of land use, which capable countries must lead. Above all, with the human population set to increase by half over the next 40 years, the world needs to work out where its food is going to be produced. There is enough degraded land available—maybe a billion hectares—to ramp up production without clearing forests. But this is hard to pull off in weak states teeming with peasants in search of somewhere to plant their crops. And it is made harder by undiscerning foreign-trade and investment policies. It is no good China planting kingdoms of eucalyptus at home while bulldozing Congo’s rainforest to grow palm oil.

A philosophical shift is required, to recognise how precious forests are. It will probably happen as climate crises multiply. But it may not come fast enough to save what remains, in Michael Williams’s phrase, of “the incomparable green mantle that clothes the Earth”. ■

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The world's lungs

There is hope for forests, but mankind needs to move faster if they are to be saved



THE summer dry-season, now drawing to an end, is when the Amazon rainforest gets cut and burned. The smoke this causes can often be seen from space. But not this year. Brazil's deforestation rate has dropped astoundingly fast. In 2004 some 2.8m hectares (10,700 square miles) of the Amazon were razed; last year only around 750,000 hectares were.

This progress is not isolated. Many of the world's biggest clearers of trees have started to hug them. Over the past decade, the UN records, nearly 8m hectares of forest a year were allowed to re-grow or were planted anew. This was mostly in richer places, such as North America and in Europe, where dwindling rural populations have taken the pressure off forestland. But a couple of big poorer countries, notably China, have launched huge tree-planting schemes in a bid to prevent deforestation-related environmental disasters. Even in tropical countries, where most deforestation takes place, Brazil is not alone in becoming more reluctant to chop down trees.

The progress made in recent years shows that mankind is not doomed to strip the planet of its forest cover. But the transition from tree-chopper to tree-hugger is not happening fast enough. Over the past decade, according to UN figures, around 13m hectares of forestland—an area the size of England—was converted each year to other uses, mostly agriculture. If the world is to keep the protective covering that helps it breathe, waters its crops, keeps it cool and nurtures its biodiversity, it is going to have to move fast (see our special report this week).

A bad old habit

For at least 10,000 years, since the ice last retreated and forests took back the earth, people have destroyed them. In medieval Europe an exploding population and hard-working monks put paid to perhaps half its temperate oak and beech woods—mostly, as is usually the case, to clear space for crops. Some 100m hectares of America's forests went in the 19th century, in an arboreal slaughter similarly reinforced by a belief in the godliness of thus “improving” the land. That spirit survives. It is no coincidence that George Bush junior, one of America's more god-fearing presidents, relaxed by clearing brush.

In most rich countries the pressure on forests has eased; but in many tropical ones—home to around half the remaining forest, including the planet's green rainforest girdle—the demand for land is increasing as populations rise. In Congo, which has more rainforest than any country except Brazil, the clearance is mostly driven by smallholders, whose number is about to double. Rising global demand for food and biofuels adds even more to the heat. So will climate change. That may already be happening in Canada, where recent warm winters have unleashed a plague of bark beetles, and in Australia, whose forests have been devastated by drought and forest fires.

Clearing forests may enrich those who are doing it, but over the long run it impoverishes the planet as a whole. Rainforests are an important prop to continental water-cycles. Losing the

Amazon rainforest could reduce rainfall across the Americas, with potentially dire consequences for farmers as far away as Texas. By regulating run-off, trees help guarantee water-supplies and prevent natural disasters, like landslides and floods. Losing the rainforest would mean losing millions of species; forests contain 80% of terrestrial biodiversity. And for those concerned about the probable effects of climate change, forests contain twice as much carbon as the atmosphere, in plant-matter and the soils they cover, and when they are razed and their soils disturbed most is emitted. If the Amazon went up in smoke—a scenario which a bit more clearance and a bit more warming makes conceivable—it would spew out more than a decade's worth of fossil-fuel emissions.

REDDy, steady, grow

Economic development both causes deforestation and slows it. In the early stages of development people destroy forests for a meagre living. Globalisation is speeding up the process by boosting the demand for agricultural goods produced in tropical countries. At the same time, as people in emerging countries become more prosperous, they start thinking about issues beyond their family's welfare; their governments begin to pass and slowly enforce laws to conserve the environment. Trade can also allow the greener concerns of rich-world consumers to influence developing-world producers.

The transition from clearing to protecting, however, is occurring too slowly. The main international effort to speed it up is an idea known as REDD (Reducing Emissions from Deforestation and Forest Degradation), which pays people in developing countries to leave trees standing. This is not an outlandish concept. It is increasingly common for governments and companies to pay for forest and other ecosystem services. To protect its watershed, New York pays farmers in the Catskills not to develop their land. REDD schemes aspire to do this on a much larger scale. The only notable success of the Copenhagen climate-change conference last year was a commitment to pursue them. Half a dozen rich countries, including Norway, America and Britain, have promised \$4.5 billion for starters.

The difficulties are immense. REDD projects will be effective only in places where the government sort-of works, and the tropical countries with the most important forests include some of the world's worst-run places. Even in countries with functioning states, some of the money is bound to be stolen. Yet with sufficient attention to monitoring, verification and, crucially, making sure the cash goes to the people who can actually protect the forest, REDD could work. That will cost much more than has so far been pledged. The most obvious source of extra cash is the carbon market, or preferably a carbon tax. Since saving forests is often the cheapest way to tackle carbon emissions, funding it this way makes sense.

With global climate-change negotiations foundering, the prospects of raising cash for REDD that way look poor. But the money must be found from somewhere. Without a serious effort to solve this problem, the risk from climate change will be vastly increased and the planet will lose one of its most valuable, and most beautiful, assets. That would be a tragedy. ■