The Economist

SPECIAL EDITION

REVALUING ECOSYSTEMS

From The Economist 2013

In this issue:

Rockefeller Foundation
Innovation for the Next 100 Years

WORLD RESOURCES INSTITUTE

Contents

For more information about "Revaluing ecosystems" please go to

www.VisionariesUnbound.com

Revaluing ecosystems:

Natural capital is a missing asset in our balance sheets

Environmental, economic and political circles around the world are rethinking how they value the services ecosystems provide. Some forests are now protected for the benefits they bring communities and companies, ranging from carbon capture to biodiversity. Watersheds—and the terrestrial and freshwater ecosystems they contain—are increasingly recognized not just because they supply clean water and generate energy, but also because they reduce the impact of natural disasters, and are the site of many leisure and sports activities in a rapidly urbanizing world. Some farm- and pasturelands are now managed to boost productivity while minimizing the negative environmental impact of food production.

Still, despite our growing appreciation of the complex and interdependent relationship between humanity and ecosystems, and the accompanying advances in natural-resource accounting, we have yet to fairly value the world's precious natural capital. As a result, ecosystems are all too often managed for the short-term gain of a few at the expense of broader, long-term societal benefits. Fixing the equation is all the more urgent because rising affluence and population growth are pushing ecosystems toward a tipping point that threatens to permanently alter their capacity to support human well-being - in countries across all stages of development. To ensure a more sustainable and equitable future we need more accurate and integrated tools to measure the contributions of ecosystems, better incentives for their sustainable management, improved tenure and governance, and creative business models that fairly reward investment in restoring and managing ecosystems.

Our failure to effectively value and protect ecosystems risks impeding future economic growth and social progress. But the impact of ecosystem degradation is not evenly shared. The world's poor are most exposed to threats such as climate change, shrinking water resources, land degradation, and the loss of pollinators and ecosystem-based pest control. Small-holder farmers feel the impact most acutely because they depend directly on healthy ecosystems for their livelihoods. But the stability of the global food system is also at risk. Climate-driven shocks to the global food system are already triggering price spikes that threaten stability and prosperity, particularly in cities.

The urban poor face their own set of ecosystem-linked challenges. They are the most likely to be pushed to the least desirable areas of cities, with the least reliable access to food, energy, clean water, housing, open space and other basic needs. Degraded ecosystems may lose their capacity to buffer storms and floods, affecting poor, low-lying settlements most intensely.

Communities that rely on forests for their well-being and preservation of their cultural traditions are similarly vulnerable to growing pressure on the planet's resources. Soaring demand for timber, minerals and agricultural land are leading to the felling of forests at an unprecedented rate, threatening the income, food, homes and gathering places of indigenous communities. Deforestation also deprives the global community of vital ecosystem functions, such as capturing and storing carbon, regulating water flows, mitigating natural hazards and controlling erosion.

Oceans, which humanity needs for both a steady food supply and their ability to absorb waste, are also bumping up against their limits. Most of the world's oceans are already overfished. Fertilizers, pesticides and other chemicals are degrading coastal and marine areas, endangering coral reefs and other ecosystems that support coastal fisheries. These are a vital source of protein to millions of people.

Finally, industry relies on ecosystems to sustain global food, beverage, pharmaceuticals and building-materials production. Ecosystems providing core inputs to global supply chains require fair valuing to ensure that they are properly protected and sustained.

Amid these daunting challenges, we see significant opportunity to effectively value global ecosystems and, in so doing, lay the foundation of true human, economic and planetary sustainability. Innovative business models, policy interventions, and governance and incentive structures can help build the planet's natural-capital base. By improving the quality of the ecosystems on which we all depend, communities, countries and companies all benefit. Integrating natural, or "green," infrastructure with traditional hard, or "grey," infrastructure generates more flexible, fair and efficient water supply and waste treatment, mitigates natural disasters, and boosts the resilience of our communities, cities, economies and planet.

This special edition of the Economist, with the theme of "Revaluing Ecosystems," features provocative articles from recent editions of the magazine, to spark dialogue among the participants brought together by the World Resources Institute, the Forum for the Future, the Economist Intelligence Unit and the Rockefeller Foundation at the Foundation's Bellagio Center in November 2013. We hope that this publication and the post-meeting reports will galvanize new thinking and action across the private, public and civil-society sectors. The creative solutions they propose and the work they pursue are critical to effectively identify, capture and ensure the enduring value of the planet's ecosystems. ■

Robert Garris
Managing Director
Bellagio Programs
Rockefeller Foundation

Lauretta Burke
Senior Associate
People and Ecosystems Program
World Resources Institute

Green growth

Shoots, greens and leaves

Reprinted from The Economist, Jun 16th 2012

Rich countries prospered without worrying much about the environment. Poor and middle-income countries do not have that luxury.

ON THE southern shore of Lake Naivasha, Kenya's lush Rift Valley holds an unexpected scent of English summer. For inside vast plastic greenhouses grow mile upon mile of roses. Exported to Europe, they account for a fifth of the commercial roses sold there and provide a tenth of Kenya's foreign exchange. But the business is a victim of its own success.

Attracted by a scent more pungent than flowers, a quarter of a million Kenyans followed the rose growers into the valley, hoping to make money. To feed themselves, they ploughed the surrounding hills, felling the trees that filter and constrain the streams that flow into the lake; it is now polluted by silt and run-off.

That might seem a classic story of development choked by the environmental damage it causes. But this one has a twist. The rose growers have started lending money to the smallholders, encouraging modern farming methods which leave the trees in place. Though it is early days, the results are promising; they benefit growers, small farmers and the lake.

Paying for environmental services is not a new idea. Pioneered in Mexico and Costa Rica, such projects keep clean the water supplies of many of Latin America's giant cities. In China's north-west, the Loess plateau, an area the size of France, was brought back from near-desert by paying farmers to stop uncontrolled grazing and to look after terraces and waterways. Local incomes doubled in a decade.

These schemes have a wider significance. They are examples of "green growth", an attempt to improve the often destructive relationship between economic development and the environment. In the run-up to the "Rio+20" conference on sustainable development in Brazil on June 20th-22nd, it has become the new mantra for business people and policymakers. But does it work?

The central claim of "green growth" is that the course of industrialisation taken by Europe, America and other rich countries will not work for the rest of the world. Their route was "grow first, clean up later". Environmental concerns played almost no role in the early stages of industrialisation and remained weak until at least the 1960s. The Cuyahoga river in Ohio was so polluted that it caught fire as recently as 1969. That spurred the creation of America's Environmental Protection Agency.

The idea that environmental concerns are mainly for the rich is still powerful and persistent. It shapes parts of diplomacy. The Kyoto protocol on climate change exempted China and other developing polluters from obligations to cut greenhouse-gas emissions. It affects domestic politics. Costa Rica's former environment minister, Carlos Manuel Rodríguez, says Latin America's politicians can mess up on health, literacy and the environment but if they provide jobs and growth, they will get re-elected. And it influences economics, which long ignored the environment in its models of how economies work. In 1991 the chief economist of the World Bank, Larry Summers, even sent out a memo saying poor countries ought to import pollution from rich ones because the damage it did there would be less costly. (He said his sarcasm had been misunderstood.)

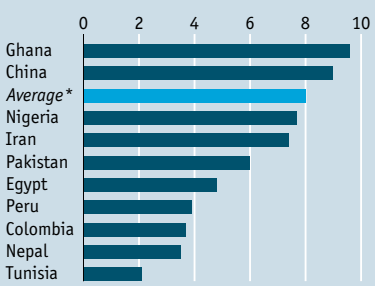
But the costs of waiting for a clean-up are rising, undermining the argument that poor countries cannot afford to go green. The Chinese Academy of Social Sciences reckons the total annual damage to China's economy from environment degradation is the equivalent of 9% of GDP (see chart). The World Bank says bad sanitation and water pollution cost India 6% of national income. Even ignoring the global impact of rising temperatures and falling biodiversity, therefore, the local and national costs of environmental damage are alarming. Nicholas (now Lord) Stern, a British economist, said in a big report in 2006 that climate change would be a brake on growth. That prediction may already be coming true.

The brake is likely to get worse as countries grow richer. Most of the world's population increase in the next 40 years will be in developing countries. Two or three billion people will move into the middle class. This is two or three times as many as have achieved that status in the past 150 years. Many will want big cars, large air-conditioned houses and to eat meat, which uses up more water and land than grain does. This will put more stress on the environment in ways that will curtail growth. That would leave a lot of people poor and polluted—the worst of all possible worlds. Avoiding such an outcome is a problem for today, not tomorrow.

To see why, look at the implications of different sorts of urban design on pollution (cities account for 80% of all pollution so the way they are arranged matters a lot). Atlanta and Barcelona have roughly the same population. But in 1990 Atlanta sprawled over an area 26 times larger, and has expanded since. As a result, it produces far more pollution (see chart 2). The difference between a sprawling city and a compact one is fixed early in a city's development; once sprawl begins, it is hard to reverse. Choices about urban design last centuries (or for many decades in the case of roads and power stations). Asked to name the main cause of climate change, the mayors of São Paulo, Mexico City and Dar-es-Salaam replied urban design. Countries can no longer afford to wait until they get ▸▸

Eat your greens 1

Cost of environmental degradation as % of GDP
2012 or latest



Source: World Bank *Of 21 countries

rich before worrying about urban design, or their energy mix. By then, it will be too late.

So though the advice to "grow first, then go green" may have made sense in an era when the industrialising population was 500m and growth relatively slow, it will not work when billions of people are following suit and economies are growing by up to 8% a year. Development has to be green from the start. In recognition of that, "green growth" plans are proliferating in poor and middle-income countries. Ethiopia hopes to double GDP by 2025, while keeping its greenhouse-gas emissions at 2015 levels. Lord Stern describes China's five-year plan (which hopes for growth of 7% a year in 2011-15) as the biggest contribution to greenhouse-gas reduction by any country. Green policies are no longer the preserve of the rich.

But just because something is fashionable does not make it useful. The real question about green growth is whether it can fulfil its promise that poor countries canhave both greenery and prosperity.

The core idea is that the environment is another kind of capital. It makes a measurable contribution to output and should be accounted for, invested in, exploited efficiently and (ideally) increased in value.

This is controversial. Many do-gooding outfits are horrified at the idea of exploiting the environment, however efficiently. (Indeed, some might think exploiting it efficiently is worse.) They accuse green-growth proponents of "greenwashing capitalism" and insist the only way to safeguard the world's natural resources is to cut consumption.

Some large countries resist green growth for the opposite reason. They think it means imposing Western environmental standards on them by stealth, stifling job creation and exports. Both sides agree on one thing: that greenery and growth are in conflict. A subtler criticism is that green growth is merely good economic housekeeping, with a lot of fuss about environmental costs that should be factored in anyway. To these critics, green growth is more like a slogan than a distinctive policy.

In response, green-growth advocates argue, in essence, that the evidence is on their side. Marianne Fay, the principal author of "Inclusive Green Growth", a new World Bank report, likens economists and environmentalists now to economists and anti-poverty campaigners in the 1990s. Then, she says, the campaigners stopped arguing for incentive-destroying policies like high minimum wages and instead started to promote social reforms like conditional cash-transfer schemes. These encouraged growth and cut poverty at the same time. In a similar way, green-growth advocates are now starting to abandon incentive-destroying demands about "degrowth", and are seeking policies that might work better.

Claire Melamed of the Overseas Development Institute, a think tank in London, expects this to mean that environmentalists will learn from anti-poverty campaigners. On the face of it, these two look different. Environmentalists set store by science, particularly the study of climate change. They have long-term goals (aiming to limit the rise in global temperatures over 50 years). They often adopt a hair-shirt approach to economics. In contrast, anti-poverty campaigners say poverty is a moral matter: it is wrong that a billion people should be hungry in a world of surplus food. They have shorter time horizons (the United Nations' millennium development goals span 15 years). And their economic policies aim to expand economic opportunities for the poor and for companies.

In some ways, green growth applies development-like features to environmentalism. It recommends fairly short-term projects, such as the reclamation works in Kenya's Lake Naivasha or China's Loess plateau. It pays a lot of attention to market and co-ordination failures, usually seen solely as economic matters. And it encourages the private sector

In practice, this means looking for investment-hungry projects that bring high returns in broad environmental and narrow commercial terms. These are more numerous than the trade-off view of growth would suggest. McKinsey, a business consultancy, drew a cost-curve (see chart 3) for projects to cut carbon emissions. Those at the bottom are cheap as well as good for the environment (though ensuring that the people who pay for the investment reap the benefits is not straightforward). The biggest gains are in things influenced by consumer choice: hybrid cars, energy-efficient light bulbs and fridges. The International Finance Corporation, the private-sector arm of the World Bank, reckons that a 1% increase in building costs can cut energy and water bills by 20%. Other examples include drought-resistant crops and "no-take zones" in overfished waters. Drought-resistant crops (including genetically modified ones) reduce the amount of water plants draw from the soil—an environmental plus—and are hardier, raising returns to farmers in bad years. "No-take zones" let fish stocks recover and have been found to boost the incomes of fishermen in the surrounding area.

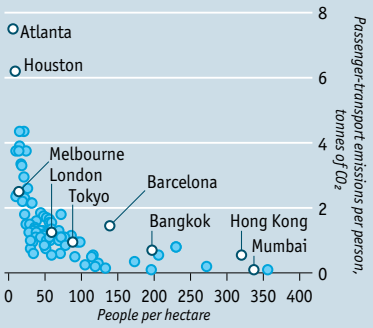
At the other end of the spectrum—where the environmentally friendly action is costly—are carbon capture and storage and generating solar power. These are a reminder that, however much policies can redirect resources towards greener growth, they cannot magically transform everything into a win-win. Trade-offs remain. But at least green-growth accounting should make them more open and explicit.

If so many profitable but green activities exist, why aren't companies rushing in? Part of the answer is that they are beginning to. According to a study for the United Nations Environment Programme, investment in renewable energy rose to $257 billion in 2011, twice as much as in 2007. Over a third of that goes to poor and middle-income countries.

Some investment has doubtless been pulled in by special subsidies. Some reflects companies' fear of future higher oil prices, encouraging them to diversify into alternative energy as insurance. But a genuinely green private sector seems to be emerging slowly. Suntech, a Chinese company floated in New York in 2005, is now the world's largest supplier of solar panels. Khosla Ventures, an Indian venture capital company founded in 2004 has a portfolio of clean-energy investments ▸▸

Houston has a problem too 2

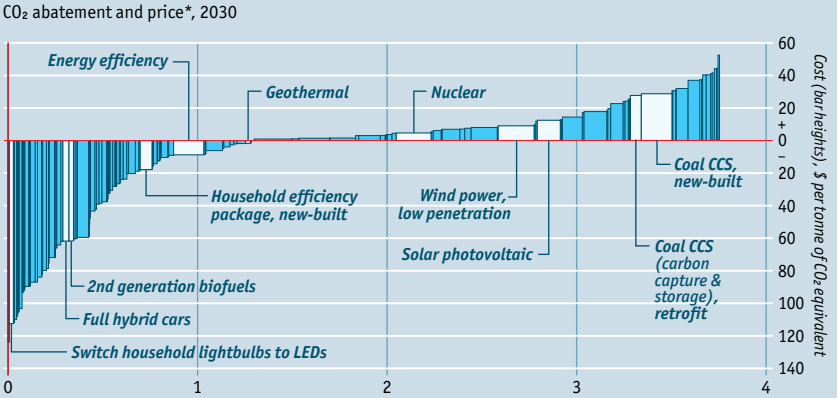
Urban transport emissions and population density*



Source: World Bank *Latest available figures

Culprits and targets 3

CO_2 abatement and price*, 2030



Source: McKinsey *157 measures (annual operating cost, including depreciation, less potential savings divided by emissions avoided)

ranging from power utilities to batteries and low-emission engines. Between 2000 and 2010, green-growth enthusiasts like to point out, the number of hybrid electric-car models increased from two to 30 and the number of "green buildings" certified by LEED, an international rating organisation, rose from three to 8,000.

The other part of the answer is that market failures, co-ordination problems and government subsidies deter businesses from choosing green growth. Lack of property rights can make it (apparently) rational to overuse resources such as the open sea or tropical forests, leading to over-exploitation and collapse (the so-called tragedy of the commons). A classic co-ordination problem appears in rented property. It should make sense for a landlord to insulate his house, since that would reduce electricity bills for a trivial outlay. But if his tenants pay the bills, they would capture the gains, so he does not bother.

At a national scale, developing a comparative advantage in one area can depend on public spending money in another. For example, Morocco ought to be able to create a solar-power business but that seems to require building power lines in poor parts of the country. Such institutional and market failures catch the attention of green-growth policymakers because they often explain why growth has harmed the environment.

The subsidy blight

But these problems pale into insignificance compared with the impact of subsidies. The World Bank reckons governments subsidise environmentally and economically harmful activities to the tune of about $1.2 trillion a year: $500 billion on cheap fossil fuels; $300 billion on cheap or free water; $400 billion on fishing and farm subsidies (though not all of these are environmentally harmful).

To take one example: subsidies in China make fertilisers so cheap that farmers slather them on their fields. The crops cannot absorb them all; the excess runs into rivers and lakes, causing dreadful pollution (some Chinese lakes are bright green with algae). It would obviously save farmers money to use less fertiliser; the crops would not suffer; the water system would be healthier; so would the public purse: a win-win-win. But the clout of the fertiliser lobby and their agricultural allies in government resist that.

State subsidies are a $1 trillion political-economy problem, rather than the result of an inescapable conflict between growth and the environment. That does not make them easy to solve. But green-growth proponents are betting that countries will be more likely to cut subsidies if their economies are growing and they have money to buy off the opposition, than if economic growth is flat and there is nothing to soften the blow.

In principle, green-growth policies should boost productivity and permit longer-term growth than other approaches. Using natural resources more efficiently ought to divert wasted capital to more productive investment. Spending on things like clean energy should boost innovation, which is good for the economy as a whole. And, in theory, enhancing the value of natural capital is good for growth, just as any other sort of capital increase would be.

Still, doubts remain about green growth. First, it is not clear how far any policies rooted in improving efficiency can really go without proper prices for carbon, water and (in most poor countries) land. It is true that even the threat of carbon or water prices in itself making a difference, because companies cannot afford to find themselves suddenly having to pay, say, $40 a tonne for carbon, without any preparation. They are therefore starting to use shadow prices. Still, no one has yet found a way to price basic inputs properly. And without them most green-growth policies will always be second-best.

Next, green-growth policies deal with local environmental problems better than global ones. The benefits of, say, watershed management can be captured nationally now, but the future benefits of lower greenhouse-gas emissions are dispersed in place and time. So worries about how far green growth can deal with climate change are partially justified.

Moreover, green growth depends on the idea that it is possible to value the environment accurately enough for companies to take proper account of environmental costs. That is a nice idea. But "natural capital accounting" has some way to go. Statisticians and accountants have agreed on general auditing principles but these are not yet detailed enough for companies.

All that said, green growth remains an improvement both on what exists now (which in many poor countries is practically nothing) and what environmentalists have often demanded in the past. Poor and middle-income countries know full well that their environment is degraded, their cities sprawling and their water supplies running out. They also know that to try to solve such problems by cutting growth would be to commit political suicide and condemn today's poor to a hopeless future. Green growth offers the best hope that the countries facing the sharpest conflicts between prosperity and preserving the environment can square the circle. ■

Forests

Money can grow on trees

Reprinted from The Economist, Sep 23rd 2010

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 Biodiversity (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. In forest economics, ▸▸

The world is richer for them

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 Aloísio 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. ■

Water

Sin aqua non

Reprinted from The Economist, Apr 8th 2009

Water shortages are a growing problem, but not for the reasons most people think

THE overthrow of Madagascar's president in mid-March was partly caused by water problems—in South Korea. Worried by the difficulties of increasing food supplies in its water-stressed homeland, Daewoo, a South Korean conglomerate, signed a deal to lease no less than half Madagascar's arable land to grow grain for South Koreans. Widespread anger at the terms of the deal (the island's people would have received practically nothing) contributed to the president's unpopularity. One of the new leader's first acts was to scrap the agreement.

Three weeks before that, on the other side of the world, Governor Arnold Schwarzenegger of California declared a state of emergency. Not for the first time, he threatened water rationing in the state. "It is clear," says a recent report by the United Nations World Water Assessment Programme, "that urgent action is needed if we are to avoid a global water crisis."

Local water shortages are multiplying. Australia has suffered a decade-long drought. Brazil and South Africa, which depend on hydroelectric power, have suffered repeated brownouts because there is not enough water to drive the turbines properly. So much has been pumped out of the rivers that feed the Aral Sea in Central Asia that it collapsed in the 1980s and has barely begun to recover.

Yet local shortages, caused by individual acts of mismanagement or regional problems, are one thing. A global water crisis, which impinges on supplies of food and other goods, or affects rivers and lakes everywhere, is quite another. Does the world really face a global problem?

Water, water everywhere...

Not on the face of it. There is plenty of water to go around and human beings are not using all that much. Every year, thousands of cubic kilometres (km3) of fresh water fall as rain or snow or come from melting ice. According to a study in 2007, most nations outside the Gulf were using a fifth or less of the water they receive—at least in 2000, the only year for which figures are available. The global average withdrawal of fresh water was 9% of the amount that flowed through the world's hydrologic cycle. Both Latin America and Africa used less than 6% (see table). On this evidence, it would seem that all water problems are local.

The trouble with this conclusion is that no one knows how much water people can safely use. It is certainly not 100% (the amount taken in Gulf states) because the rest of creation also has to live off the water. In many places the maximum may well be less than one fifth, the average for Asia as a whole. It depends on how water is returned to the system, how much is taken from underground aquifers, and so on.

But there is some admittedly patchy evidence that, given current patterns of use and abuse, the amount now being withdrawn is moving dangerously close to the limit of safety—and in some places beyond it. An alarming number of the world's great rivers no longer reach the sea. They include the Indus, Rio Grande, Colorado, Murray-Darling and Yellow rivers. These are the arteries of the world's main grain-growing areas.

Freshwater fish populations are in precipitous decline. According to the World Wide Fund for Nature, fish stocks in lakes and rivers have fallen roughly 30% since 1970. This is a bigger population fall than that suffered by animals in jungles, temperate forests, savannahs and any other large ecosystem. Half the world's wetlands, on one estimate, were drained, damaged or destroyed in the 20th century, mainly because, as the volume of fresh water in rivers falls, salt water invades the delta, changing the balance between fresh and salt water. On this evidence, there may be systemic water problems, as well as local disruptions.

Two global trends have added to the pressure on water. Both are likely to accelerate over coming decades.

The first is demography. Over the past 50 years, as the world's population rose from 3 billion to 6.5 billion, water use roughly trebled. On current estimates, the population is likely to rise by a further 2 billion by 2025 and by 3 billion by 2050. Demand for water will rise accordingly.

Or rather, by more. Possibly a lot more. It is not the absolute number of people that makes the biggest difference to water use but changing habits and diet. Diet matters more than any single factor because agriculture is the modern Agasthya, the mythical Indian giant who drank the seas dry. Farmers use about three-quarters of the world's water; industry uses less than a fifth and domestic or municipal use accounts for a mere tenth.

Different foods require radically different amounts of water. To grow a kilogram of wheat requires around 1,000 litres. But it takes as much as 15,000 litres of water to produce a kilo of beef. The meaty diet of Americans and Europeans requires around 5,000 litres of water a day to produce. The vegetarian diets of Africa and Asia use about 2,000 litres a day (for comparison, Westerners use just 100-250 litres a day in drinking and washing).

So the shift from vegetarian diets to meaty ones—which contributed to the food-price ▸▸

Waterworld

Water resources and withdrawals
km³ per year, 2000

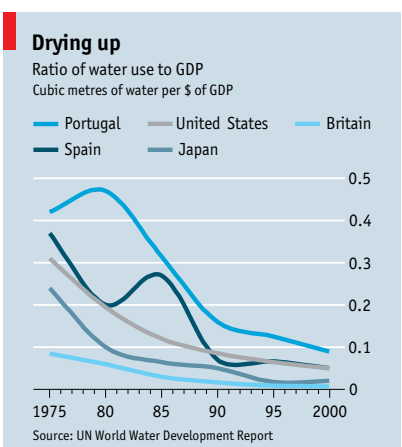
	Renewable resources	Withdrawals total	Withdrawals % of renewable resources	Withdrawals per person*
North America	6,253	525	8.4	1,664
Asia	13,297	2,404	18.1	644
Europe	6,603	418	6.4	574
Latin America & Caribbean	13,570	265	2.0	507
Africa	3,936	217	5.6	265
World	43,659	3,829	8.8	626

Source: UN World Water Development Report *Cubic metres

rise of 2007-08—has big implications for water, too. In 1985 Chinese people ate, on average, 20kg of meat; this year, they will eat around 50kg. This difference translates into 390km3 (1km3 is 1 trillion litres) of water—almost as much as total water use in Europe.

The shift of diet will be impossible to reverse since it is a product of rising wealth and urbanisation. In general, "water intensity" in food increases fastest as people begin to climb out of poverty, because that is when they start eating more meat. So if living standards in the poorest countries start to rise again, water use is likely to soar. Moreover, almost all the 2 billion people who will be added to the world's population between now and 2030 are going to be third-world city dwellers—and city people use more water than rural folk. The Food and Agriculture Organisation reckons that, without changes in efficiency, the world will need as much as 60% more water for agriculture to feed those 2 billion extra mouths. That is roughly 1,500km3 of the stuff—as much as is currently used for all purposes in the world outside Asia.

The other long-term trend affecting water is climate change. There is growing evidence that global warming is speeding up the hydrologic cycle—that is, the rate at which water evaporates and falls again as rain or snow. This higher

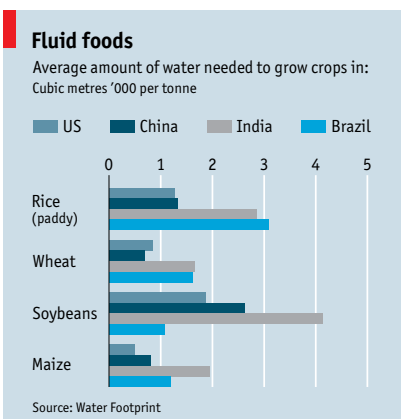


rate seems to make wet regions more sodden, and arid ones drier. It brings longer droughts between more intense periods of rain.

Climate change has three big implications for water use. First, it changes the way plants grow. Trees, for example, react to downpours with a spurt of growth. During the longer droughts that follow, the extra biomass then dries up so that if lightning strikes, forests burn more spectacularly. Similarly crops grow too fast, then wilt.

Second, climate change increases problems of water management. Larger floods overwhelm existing controls. Reservoirs do not store enough to get people or plants through longer droughts. In addition, global warming melts glaciers and causes snow to fall as rain. Since snow and ice are natural regulators, storing water in winter and releasing it in summer, countries are swinging more violently between flood and drought. That is one big reason why dams, once a dirty word in development, have been making a comeback, especially in African countries with plenty of water but no storage capacity. The number of large dams (more than 15 metres high) has been increasing and the order books of dam builders are bulging.

Third, climate change has persuaded western governments to subsidise biofuels, which could prove as big a disaster for water as they already



have been for food. At the moment, about 2% of irrigated water is used to grow crops for energy, or 44km3. But if all the national plans and policies to increase biofuels were to be implemented, reckons the UN, they would require an extra 180km3 of water. Though small compared with the increase required to feed the additional 2 billion people, the biofuels' premium is still substantial.

In short, more water will be needed to feed and heat a world that is already showing signs of using too much. How to square that circle? The answer is by improving the efficiency with which water is used. The good news is that this is possible: vast inefficiencies exist which can be wrung out. The bad news is it will be difficult both because it will require people to change their habits and because governments, which might cajole them to make the changes, are peculiarly bad at water policy.

...nor any drop to drink

Improving efficiency is doable and industrial users have done it, cutting the amount of water needed to make each tonne of steel and each extra unit of GDP in most rich countries (see first chart). This can make a difference. The Pacific Institute reckons that, merely by using current water-saving practices (ie, no technological breakthroughs) California, a water-poor state, could meet all its needs for decades to come without using a drop more.

Still, industry consumes less than a fifth of the world's water and the big question is how to get farmers, who use 70-80%, to follow suit. It takes at least three times as much water to grow maize in India, for example, as it does in America or China (see second chart). In some countries, you need 1,500 litres of water to produce a kilo of wheat; in others, only 750 litres. It does not necessarily follow that water is being used unsustainably in the one place and not the other; perhaps the high-usage places have plenty of water to spare. But it does suggest that better management could reduce the amount of water used in farming, and that the world could be better off if farmers did so. Changing irrigation practices can improve water efficiency by 30%, says Chandra Madramootoo, of the International Commission on Irrigation and Drainage. One can, for example, ensure water evaporates from the leaves of the plant, rather than from the soil. Or one can genetically modify crops so they stop growing when water runs dry, but do not die—they simply resume growth later when the rains return.

The world might also be better off, at least in terms of water, if trade patterns more closely reflected the amount of water embedded in traded goods (a concept called "virtual water" invented by Tony Allan of King's College London). Some benign effects happen already: Mexico imports cereals from America which use 7 billion cubic metres (m3) of water. If it grew these cereals itself, it would use 16 billion m3, so trade "saves" 9 billion m3 of water. But such beneficial exchanges occur more by chance than design. Because most water use is not measured, let alone priced, trade rarely reflects water scarcities.

To make water use more efficient, says Koichiro Matsuura, the head of UNESCO, the main UN agency dealing with water, will require fundamental changes of behaviour. That means changing incentives, improving information flows, and improving the way water use is governed. All that will be hard.

Water is rarely priced in ways that reflect supply and demand. Usually, water pricing simply means that city dwellers pay for the cost of the pipes that transport it and the sewerage plants that clean it.

Basic information about who uses how much water is lacking. Rainwater and river flows can be measured with some accuracy. But the amount pumped out of lakes is a matter of guesswork and information on how much is taken from underground aquifers is almost completely lacking.

The governance of water is also a mess. Until recently, few poor countries treated it as a scarce resource, nor did they think about how it would affect their development projects. They took it for granted.

Alongside this insouciance goes a Balkanised decision-making process, with numerous overlapping authorities responsible for different watersheds, sanitation plants and irrigation. To take a small example, the modest town of Charlottesville in Virginia has 13 water authorities.

Not surprisingly, investment in water has been patchy and neglected. Aid to developing countries for water was flat in real terms ▸▸

between 1990 and 2005. Within that period, there was a big shift from irrigation to drinking water and sanitation—understandable no doubt, but this meant less aid was going to the main users of water, farmers in poor countries. Aid for irrigation projects in 2002-05 was less than half what it had been in 1978-81. Angel Gurría, the head of the Organisation for Economic Co-operation and Development, talks of "a crisis in water financing".

As is often the way, business is ahead of governments in getting to grips with waste. Big drinks companies such as Coca Cola have set themselves targets to reduce the amount of water they use in making their products (in Coke's case, by 20% by 2012). The Nature Conservancy, an ecologically-minded NGO, is working on a certification plan which aims to give companies and businesses seals of approval (a bit like the Fairtrade symbol) according to how efficiently they use water. The plan is supposed to get going in 2010. That sort of thing is a good start, but just one step in a long process that has barely begun. ■

A survey of agriculture and technology

Farming the garden of Eden

Reprinted from The Economist, Mar 23rd 2000

Can agriculture be made friendlier to the environment?

THERE are few more powerful reminders of the fragility of human endeavour than a storm which sweeps away half a country. In October 1998, Hurricane Mitch roared through Honduras, Nicaragua and Guatemala, taking with it 10,000 lives and $5.5 billion-worth of the region's economy. Agriculture was hard hit, but not all farmers suffered in equal measure. "Conventional" farms using the industrial model of chemical-intensive monoculture had 60-80% more soil erosion, crop damage and water loss than those that had practised "traditional" methods such as crop mixing, biological pest control, water conservation and agroforestry.

Proof positive that agriculture defies nature at its peril? Not quite. Agriculture is inherently unnatural, tethering the land to a single purpose, but some forms are more unnatural than others. Since the second world war, agriculture in the developed world has become increasingly intensive, relying heavily on machines, chemicals, irrigation and selectively bred plants and animals to coax more output from each unit of land. This system has spread widely across the third of the world's land given over to agriculture. It is the dominant model in North America, Europe and Australia, and sits uncomfortably alongside traditional farming practices in sub-Saharan Africa, Asia and Latin America. The model has been remarkably successful in what it set out to do: to produce more abundant, less expensive food. But such productivity has come at a price, much of it paid for in four kinds of environmental damage:

1. Soil degradation
Almost two-thirds of all the world's agricultural land is degraded to some degree, according to Stanley Wood at the International Food Policy Research Institute in Washington, DC. Its sorry state is due to compaction from running machinery over it; water and wind erosion; and depletion of minerals and organic matter through overplanting and overgrazing.

Salt, too, is building up through over-irrigation and poor soil drainage. Roughly 20% of the world's irrigated land suffers from salinisation, which makes it less productive. The most dramatic evidence of the perils of excessive irrigation is the Aral Sea, where the water level has fallen by two-thirds over the past 40 years, causing large-scale environmental destruction and human misery. The recipient of its watery wealth—an 8m-hectare expanse of irrigated cotton in Central Asia—is losing fertility because of growing salinisation.

2. Pollution
Although the use of synthetic fertiliser has declined in the developed world over the past decade, the world still spreads 135m tonnes a year, most of it in developing countries. The problem is not just how much is used, but how it is applied. Much of it runs off to contaminate aquifers, rivers and lakes.

The use of pesticide is running at roughly 2.5m tonnes a year, more than double the figure 30 years ago. The use of a group of pesticides including aldrin and DDT, known as the "dirty dozen", is restricted in many countries, but they are still liberally applied in parts of the developing world. Such persistent organic pollutants both linger and concentrate throughout food chains, causing reproductive, developmental and immune-system problems in both man and beast. And resistance to chemical pesticides is growing among the organisms they are designed to kill.

Nor is it just synthetic chemicals that are a problem. Manure from intensive livestock rearing which makes its way into soil and water is just as damaging. Just look at the algal blooms now choking America's Chesapeake Bay, largely ▸▸

thanks to nitrogen and phosphorus leaking into groundwater from farms in Delaware, Maryland and Virginia. Even organic agriculture is less innocent than it looks. Although it does without synthetic pesticides and fertilisers, some of its "natural" alternatives, such as copper sulphate, can be equally harmful.

3. Water scarcity
Roughly 40% of the world's food comes from the 5% of the agricultural land that is irrigated. But the water is running out. According to Sandra Postel, director of the Global Water Project based in Amherst, Massachusetts, water is being pumped out of the ground faster than it can be replenished, mainly because of the farmland thirst of America, North Africa and the Arabian Peninsula, as well as China and India. Much of this water is wasted through inefficient use, and agriculture is finding it increasingly difficult to compete with new urban and industrial demands.

4. Biodiversity loss
The rich mix of creatures that make up ecosystems is often irrevocably shaken up by intensive agriculture. According to the Food and Agriculture Organisation, at least 13m hectares of forest—providing control of watersheds and a repository of potentially useful industrial and medicinal compounds in plants, animals and micro-organisms—is lost to agriculture every year in developing countries.

Intensive monoculture also reduces genetic diversity. Some 7,000 crop species are available for cultivation, but 90% of the world's food comes from only 30 of them. Breeding programmes for much of the past half-century have concentrated on high-yielding, pest-resistant, fast-growing crop varieties, which now dominate over half of all the land planted to rice, maize and wheat. The story is much the same in animal breeding, where over a sixth of the 3,800 breeds of domestic animal that existed a century ago have disappeared. This narrows the room for manoeuvre if disease strikes and different strains are needed.

A quick fix
The tension between agriculture and ecology shows up clearly in the current debate over transgenic crops. In 1999, about 40m hectares of genetically engineered crops were grown by a dozen countries, a 44% increase on the previous year (see chart 7). Most of the crops were bred to resist herbicides, such as Monsanto's Roundup, or to produce insecticidal proteins, known as Bacillus thuringiensis, or Bt, toxins. Such genes are now found in a variety of commercial crops, such as soyabeans, maize, canola (oil seed rape) and cotton, increasingly put together in one plant. Their corporate purveyors promised higher yields with better pest control and lower expenditure on chemicals.

The technology has yet to deliver on all its promises, but has provided enough benefit to keep farmers planting. Four years after their launch, these crops have been taken up by farmers far more rapidly than the previous wonder, hybrid corn. Whether the inbuilt chemical protection of such genetically modified crops has reduced the use of pesticide is highly contested. A new study by Leonard Gianessi and Janet Carpenter at the National Centre for Food and Agricultural Policy in Washington, DC, seems to bear out both the hopes of farmers and the fears of environmentalists. It finds that in 13 American states that have been growing transgenic soyabeans, herbicide applications per acre have fallen by 9%, but 14% more herbicide is being used in total because acreages have expanded as well. And genetic modification has not increased yields.

"Post-emergence" herbicides such as Roundup, also known as glyphosate, work by killing all the plants in the field, both weeds and crop: the point of the genetic modification is to make the crop plants resistant to the chemical. This should eliminate the need for tillage, thus reducing mechanical damage to the soil. Gordon Wassenaar, who has been growing soyabeans in Iowa since the 1950s and remembers the bad old days of the highly toxic pestkiller DDT, is puzzled by the objections to GM crops. Like other farmers, he finds glyphosate much safer. "It beats me how to please these environmentalists. As soon as we meet one bar, another goes up."

Ecologists such as Margaret Mellon at the Union of Concerned Scientists worry that genetic modification not only perpetuates the problems of intensive agriculture but also adds new ones. They fret about the dominance of one "broad-spectrum" herbicide that both reduces the biodiversity in a field by killing all the plants and causes a few hardy weeds to develop resistance. They also fear, not unreasonably, that the added gene might be transferred from the crop plant to relatives in the field.

American maize farmers like Bt plants, crediting them with keeping levels of their chief pest, the European corn borer, so low as to benefit both GM and unmodified varieties. But such transgenic crops are even more troubling to environmentalists who fear they will also make pests more resistant. Last year, the news that pollen containing one of the Bt genes can stunt or kill Monarch caterpillars enraged butterfly enthusiasts around the world. The equally lethal effects on green lacewings got much less publicity, yet these insects do a useful job by feeding on the corn borer. Researchers have also shown that Bt toxins of the sort produced by the transgenic plants stay in the ground longer than expected, and may kill local insects and soil organisms. But these experiments were carried out in the laboratory. Real-life results are less alarming, but more tests are needed.

Some of agriculture's most serious environmental problems—such as lack of water—can be eased with technical solutions. Parched countries like Israel have mastered a number of neat tricks—such as using a continuous drip of salt or waste water—to make crops grow better. But how to encourage others to adopt such practices?

Most countries have relied on a mixture of regulation and prohibition to deal with environmental offences, such as taxing pesticides, penalising the discharge of manure and removing fertiliser subsidies. Both the European Union and America make direct payments to promote the use of less intrusive forms of cultivation and the setting aside of land. This is designed to cut production but has welcome environmental side-effects. On the whole, however, carrots for good ecological behaviour are less common than sticks for bad.

An exception is water marketing. Irrigation water is rarely priced at its real value, but without a price tag it is often wasted. In Chile, Mexico and California, however, farmers are able to trade "water rights"—allocated by the state—to those in need, such as industry. This seems to encourage farmers to invest in water-saving technologies so they can sell some of their rights, rather than quit altogether.

Having it all
Many ecologists, not content with improvements in conventional farming, would like to see completely new ways of farming adopted. Or, rather, old ways, going back to the traditions of half a century ago, when yields in the industrialised West depended more on nature and labour, and less on artificial aids. A mix of crops, trees and ground cover, rather than monocultures, helped buffer pest infestations and severe weather. Nutrients were recycled from livestock to crops. Nitrogen was introduced into the soil by rotating the main field crops with pulses. Rotation also helped keep down insects, weeds and diseases by breaking their life cycles. This kind of farming caused less environmental degradation than today's intensive, highly specialised agriculture, which produces much higher yields but may prove hard to sustain in the long term.

Those who advocate going back to agriculture's roots argue that their approach—known as agro-ecology—is just as scientific as the latest GM technology, because it relies on a detailed understanding of the complex interactions between soil, water, plants and animals. Miguel Altieri, an agro-ecologist at the University of California at Berkeley, points out that this is not the same as much of modern organic agriculture, which still largely relies on monoculture.

But in a world of industrialised farming, agro-ecology is hard to put into practice, if only because of the vested interests of agribusiness. One company that is easing itself towards encouraging this kind of agriculture is Unilever. For the past two years the Anglo-Dutch giant has been running pilot projects with growers to spread expertise around the world. It has found, for example, that natural forest left among its Kenyan tea plantations harbours insects that keep nasty bugs in check and acts as a windbreak, as well as providing fuel for the locals. This technique is now being passed on to the firm's plantations in India. ▸▸

Producers venturing into agro-ecology hope that it will lower their costs in the long run. But conversion is expensive, and although consumers say they want "clean, green and pristine" agriculture, they are not always willing to pay a higher price for it. ■

Hurricane Sandy

Costs to come

Reprinted from The Economist, Oct 31st 2012

THE economic approach to global warming is relatively straightforward. The emission of greenhouse gases generates a negative spillover—global warming—that harms others. Someone driving a car emits carbon dioxide into the atmosphere which contributes to climate change, but because most of the cost of the car's contribution to warming will be felt by people other than the driver, he has an incentive to drive too much. Aggregate that decision to emit too much across all of the world's population, and you get a serious economic problem.

Luckily, there is a solution. By taxing the emission of greenhouse gases, one can align private and public costs. The cost of the driver's emissions will be "internalised", he'll drive less, emissions will fall, and warming will slow. All that remains is to tot up an estimate of the "social cost of carbon" and convert that into an optimal tax rate. And in fact, many models reckon the tax need not be too high, as it makes sense to accommodate quite a lot of warming. The costs of climate change will mount over time, but so too will global income, the thinking goes. Economic actors are resilient and will be able to adapt. All in all, we shouldn't expect global warming to dent expected GDP growth so much that a stifling tax rate is necessary.

There is some wisdom in this analysis. Remarkably, Americans have adopted what is effectively an even more sanguine view of the harm from warming, by refusing to tax carbon and investing quite conservatively in green technology and research. But as the devastation from Hurricane Sandy makes clear, the economic approach is a bit too antiseptic and simplistic a way of understanding and responding to an incredibly complex and potentially catastrophic climate phenomenon. The American approach is out-and-out reckless.

With the superstorm now dissipating, estimates of its economic impact are beginning to emerge. Kate Mackenzie comments on some of them here. Goldman Sachs economist Jan Hatzius notes that damage estimates of $10 billion to $20 billion look small and may well be revised up (Hurricane Katrina was responsible for roughly $113 billion in damage). Yet the observed impact of the storm on economic numbers could be even smaller. October data will probably take a hit, but much of the shortfall may be made up in November and December such that fourth-quarter GDP will hardly register the event. Pimco's Mohamed El-Erian reckons that the storm will show up in the fourth-quarter data, but mostly because state and federal governments are less fiscally willing and able to provide support. Still, the fact that such an epic storm might not even knock the GDP statistics off track lends credence to those who argue, for instance, that things like a massively expensive sea wall to protect New York City or an Apollo programme for green energy would represent useless waste.

But there are two problems with this mode of thinking. One is that the economic resiliency that allows us to shift economic activity across time and geography, holding down the cost of such storms, has its limits. People cluster together in New York City, despite the high cost of living, because of the extraordinary advantages of being there, surrounded by other skilled professionals. There are "returns to scale" that hold New York together—productivity per person rises with population and density. Given limited disruption, the city will quickly bounce back, but a larger disaster could disperse enough of the city's people and businesses to undermine the scale that acts as New York's gravity. That could generate very large economic losses. New York can't easily be replaced, and even if it were logistically possible to create another megacity there's no guarantee that resources would re-congeal there. They might stick, instead, to lots of smaller cities: a much less productive distribution.

The more serious issue, however, is simply that GDP is not capturing everything we care about. GDP is a flow of income, for one thing. A storm that destroys existing wealth could actually raise the flow of production in the short term as people rebuild, such that higher GDP growth might nonetheless mean less wealth overall. Moreover, GDP is a very imperfect measure of human welfare. Even if GDP and wealth were relatively unharmed by the storm, we might nonetheless want to prevent a great deal of human suffering. The damage to America's northeast pales in comparison with the destruction wrought in Haiti, but because Haitians are so poor the economic cost of the damage there is almost imperceptible. The fact that the average Haitian emits about a hundredth as much carbon dioxide each year as the typical American suggests that unaccounted-for economic injustice may be at least as big a concern with global warming as underestimated human costs.

And so it would be entirely appropriate if the damage done by Sandy shakes Americans out of complacency on the issue of global warming, despite the relatively tolerable price tag of the storm. The storm is costlier than the estimated bill reflects. And future storms will be costlier still.

Many scientists and journalists are cautious in listing climate change as a causal factor behind a storm like Sandy. Understandably so: weather emerges as part of a complex system, and it would be impossible to say whether a storm would or would not have materialised without global warming. But scientists are becoming ever less shy in drawing a line between a higher frequency of "extreme" weather events and a warming climate. Climate shifts the probability distribution of such events, and so global warming may not have "caused" Sandy, but it makes Sandy-like storms more probable. As the ever-less-funny joke goes, 500-year weather events seem to pop up every one or two years these days. Frequency and intensity of storms aside, future hurricanes that hit the east coast will do so atop rising sea levels. Contemplate the images of seawater rushing over Manhattan streets and into subway and highway tunnels. Then consider that sea levels are rising. And then reflect on the fact that New York is very much like a typical megacity in being located on the water; tracing a finger around America's coastlines leads one past most of the country's largest and richest cities.

Americans may absorb all of this and decide that the smart choice continues to be a course of inaction. They may continue to believe that the storms—and droughts and heat waves and blizzards and floods—to come will be manageable because they'll be richer and well-equipped to adapt. Hopefully, there will at least be a better sense of what that is likely to mean and the trade-offs it will involve. Adaptation will be an ongoing, costly slog, with a side order of substantial human suffering. It will be one American icon after another threatened. Adaptation is not going to be easy. Hopefully Americans will ask themselves whether it's so much worse than the alternatives—high carbon taxes or large public investments or both—after all. ■

Price fixing

Why it is important to put a price on nature

Reprinted from The Economist, Jan 18th 2010

THE insight that nature provides services to mankind is not a new one. In 360BC Plato remarked on the helpful role that forests play in preserving fertile soil; in their absence, he noted, the land was turned into desert, like the bones of a wasted body. The idea that the value provided by such "ecosystem services" can be represented by ecologists in a way that economists can get to grips with, though, is rather newer. A number of the thinkers who have made it a hot topic in the past decade gathered at a meeting on biodiversity and ecosystem services held by the Royal Society, in London, on January 13th and 14th. They looked at the progress and prospects of their attempts to argue for the preservation of nature by better capturing the value of the things – such as pollination, air quality and carbon storage – that it seemingly does for free.

Environmental valuations aim to solve a problem that troubles both economists and ecologists: the misallocation of resources. Take mangrove swamps. Over the past two decades around a third of the world's mangrove swamps have been converted for human use, with many turned into valuable shrimp farms. In 2007 an economic study of such shrimp farms in Thailand showed that the commercial profits per hectare were $9,632. If that were the only factor, conversion would seem an excellent idea.

However, proper accounting shows that for each hectare government subsidies formed $8,412 of this figure and there were costs, too: $1,000 for pollution and $12,392 for losses to ecosystem services. These comprised damage to the supply of foods and medicines that people had taken from the forest, the loss of habitats for fish, and less buffering against storms. And because a given shrimp farm only stays productive for three or four years, there was the additional cost of restoring them afterwards: if you do so with mangroves themselves, add another $9,318 per hectare. The overall lesson is that what looks beneficial only does so because the profits are retained by the private sector, while the problems are spread out across society at large, appearing on no specific balance sheet.

Ecosystem-services researchers are now providing such balance sheets in more and more of the world. Poor countries such as South Africa and Tanzania have realised that if they study the provision of such services sensibly, they can make more rational decisions and avoid some of the costly mistakes made by those places that have already developed. To this end, the Natural Capital Project, a group based at Stanford University, California, has developed a suite of computer programs called InVEST, which will analyse and map ecosystem services. InVEST allows farmers, landowners and government officials to make better-informed decisions about the current and future costs of an activity.

In the Eastern Arc mountains in Tanzania, for example, deforestation is reducing river flows, which leaves the people and industries of Dar es Salaam, the country's largest city, short of both water and hydroelectricity. InVEST is being used to find the least bad places for further upstream development, and to pinpoint those areas where paying the locals to maintain the environment will yield the greatest dividends downstream. Meanwhile, in Colombia, funds have been created by water users, particularly the thirsty sugarcane industry, to pay for investment in watershed conservation and restoration. Again, the priority areas for such funds are being discovered by mapping the ecosystem services.

The move to put a price on nature has its critics. Some think the notion is an affront to those who place cultural, spiritual or aesthetic value on biodiversity for its own sake. It would be a mistake to look at things this way. In valuing a particular service – such as the cost of erosion to Greek hillsides – which can be quantified with a reasonable degree of certainty, you do not exhaust the reasons for preserving the groves where the dryads play.

The other concern, among nature lovers, is that valuations may not always give the answers that they want. Humans are fond of pandas and elephants: yet the species that provide the greatest utility may turn out to be dung beetles, bacteria and trees. To others, though, including many who come from economics, this is a feature, not a bug (or a beetle). It means that the service approach really is trying to measure something useful, rather than confirming prejudices about what needs saving.

Partha Dasgupta, an economist at Cambridge University who gave the Royal Society meeting's opening address, stressed that the ecosystem approach has still more to offer: it can go beyond being a decision tool to becoming a key part of macroeconomic thinking. Dr Dasgupta wants a new measure of national wealth that captures the state of a country's environment in ways that GDP cannot, a measure he calls "Inclusive Wealth". Pavan Sukhdev, an economist at the United Nations Environment Programme, agreed. By way of example, he offered the observation that although GDP incorporates increases in medical spending on respiratory diseases, it does not incorporate the value of reducing air pollution. GDP, he concludes, is an imperfect measure of progress.

Ecologists, then, need to remember that the ultimate prize in ecological economics is not just an increase in the extent to which the environment is a factor in decision-making, but to find ways of weaving it into the fabric of economic thinking. If that results in a better and fuller approximation of the truth, economists should be pleased, too. ■

Environmental values

How to ensure the environment is properly accounted for

Reprinted from The Economist, Apr 13th 2009

ANY attempt to put an economic value on fresh air, clean water or tropical rainforests can offend the delicate sensibilities of those who argue that the conservation of nature is a moral duty. Yet although the best things in life appear to be free, that does not mean they are without financial value. It simply means that nobody asks you to pay when, for example, you watch a beautiful sunset over the hills.

Putting a financial value on the environment, however, may be the most important thing that people can do to help nature conservation. When governments allocate money, they do so according to where it will bring benefit. If a government is unaware of the value of a landscape to its tourism, or of a swamp to its fishing industry—and thus its foreign-exchange income—then it will invest too little in managing these resources. Worse, if the true value of a forest or swamp is hidden, governments may destroy it by subsidising the conversion of the land to agriculture. The costs are unknown for now, but may appear eventually as the price of building a filtration plant to remove the sediment from the water that the forest once took care of, or the price of importing food when fish vanish.

Some estimates of the annual contribution of coastal and marine ecosystems to the global economy exceed $20 trillion, over a third of the total gross national product (GNP) of all the countries of the world. Even so, says Katherine Sierra of the World Bank, such ecosystems are typically much undervalued when governments made decisions about development.

Glenn-Marie Lange, also of the World Bank, attended a meeting in Washington DC organised by her employer to launch its report "Environment Matters" on April 6th. She told participants that one of the reasons why ecosystems become degraded is that their value to local people is often small. As a result, these people do not have much reason to manage their resources carefully. She estimates, for example, that only 36% of the income generated by the coastal and marine environments in Zanzibar goes to locals. Most of this comes from fishing; only a tiny fraction of the money from tourism ends up local hands.

More broadly, Dr Lange wants the value of the environment to be integrated into national and local accounting. She argues that governments should identify the contributions that marine ecosystems make to their countries' GNPs and foreign-exchange earnings. She also wants them to examine whether or not they are running down their countries' "natural capital".

Emily Cooper of the World Resources Institute, an environmental think-tank, put some figures on the value of tourism, recreation, fisheries and shoreline protection in Belize. It was an impressive $395m to $559m. The entire economy was worth about $1.3 billion in 2007. These figures, she thinks, have allowed environmentalists to protect Belize's threatened mangrove forests better.

For too long, an absence of proper green accounting has allowed people to privatise the gains from the environment but socialise the costs, to paraphrase Carl Safina, an American scientist and environmentalist at the meeting. As Dr Safina puts it, "conservation is not a trade-off between the economy and the environment. It is a trade off between the short and long term." ■

Environmental economics

Are you being served?

Reprinted from The Economist, Apr 21st 2005

Environmental entries are starting to appear on the balance sheet. Perhaps soon, the best things in life will not be free

AT THE Miraflores lock on the Panama Canal it is possible to watch the heartbeat of international trade in action. One by one, giant ships piled high with multi-coloured containers creep through the lock's narrow confines and are disgorged neatly on the other side. If it were not for the canal, these ships would have to make a two-to-three-week detour around South America. That would have a significant effect on the price of goods around much of the world. It is therefore sobering to consider that each ship requires 200m litres of fresh water to operate the locks of the canal and that, over the years, this water has been drying up.

Scientists at the Smithsonian Tropical Research Institute, in Panama, think that reforesting the canal's denuded watershed would help regulate the supply. One of them, Robert Stallard, a hydrologist and biogeochemist who also works for the United States Geological Survey in Boulder, Colorado, has operated in the country for two decades, and knows the terrain well. A deforested, grass-covered watershed would release far more water in total than a forested one, he admits, but that water would arrive in useless surges rather than as a useful steady stream. A forested watershed makes a lot more sense.

Another problem caused by deforestation is that it allows more sediment and nutrients to flow into the canal. Sediment clogs the channel directly. Nutrients do so indirectly, by stimulating the growth of waterweeds. Both phenomena require regular, and expensive, dredging. More trees would ameliorate these difficulties, trapping sediments and nutrients as well as regulating the supply of fresh water. Planting forests around the Panama Canal would thus have the same effect as building vast reservoirs and filtration beds.

Viewed this way, any scheme to reforest the canal's watershed is, in fact, an investment in infrastructure. Normally, this would be provided by the owner. But in this case the owner is the Panamanian government, and Panama is in debt, has a poor credit rating and finds it expensive to borrow money. And yet investing in the canal's watershed clearly makes economic sense. Who will pay?

In the case of the Panama Canal, the answer may turn out to be John Forgach, an entrepreneur, banker and chairman of ForestRe, a forestry insurance company based in London. Mr Forgach's plan is to use the financial markets to arrange for companies dependent on the canal to pay for the reforestation. Working in collaboration with several as-yet-unnamed insurance and reinsurance companies, Mr Forgach is trying to put together a deal in which these companies would underwrite a 25-year bond that would pay for the forest to be replanted. The companies would then ask those of their big clients who use the canal to buy the bond. Firms such as Wal-Mart, and a number of Asian carmakers, which currently insure against the huge losses they would suffer if the canal were closed, would pay a reduced premium if they bought forest bonds.

This is meant to be a good business deal, but it is structured in a way that brings environmental and social benefits, too. The forest will have a diverse mixture of species that the Smithsonian's scientists have demonstrated grow well (thus pleasing environmentalists), are valuable, and which local people have deemed to be useful for food and medicine. It is also a test case for Mr Forgach. If he succeeds, he will try it elsewhere because he thinks there is an opportunity in treating the regulation of water and climate as a utility—in other words, as a service for which people will pay money. This, he says, should be a perfectly viable investment.

In from the cold

In the case of the canal, the financial value of reforestation is clear even if who pays for it is not. But putting a cash value on what are called variously "environmental", "ecosystem" or "ecological" services has, historically, been a fraught process.

Early attempts at such valuation resulted in impressive but unsound figures that were seized on by environmental advocates and then, when they were discredited, used by opponents to tar the whole idea. Now, though, things have improved.

First of all, science is producing abundant evidence that the natural environment provides a wide range of economic benefits beyond the obvious ones of timber and fish. Ecologists now know a great deal more than they used to about how ecosystems work, which habitats deliver which services, and in what quantity those services are supplied. Last month, for example, saw the publication of the Millennium Ecosystem Assessment, the first global survey of ecological services. Its authors warn that attention will have to be paid to these services if global development goals are to be met.

But the only way this can happen is if ecological services have sound, real (and realistic) values attached to them. As "Valuing Ecosystem Services", a report written recently for America's National Research Council, points out, the difficult part is providing a precise description of the links between the structures and functions of various bits of the environment, so that proper values can be calculated. What this means is that the more there is known about the ecology of, say, a forest, the better the valuation of the services it provides will be. Fortunately, according to two reports published by the World Bank at the end of 2004, significant progress has been made towards developing techniques for valuing environmental costs and benefits. There is, says one of these reports, no longer any excuse for considering them unquantifiable.

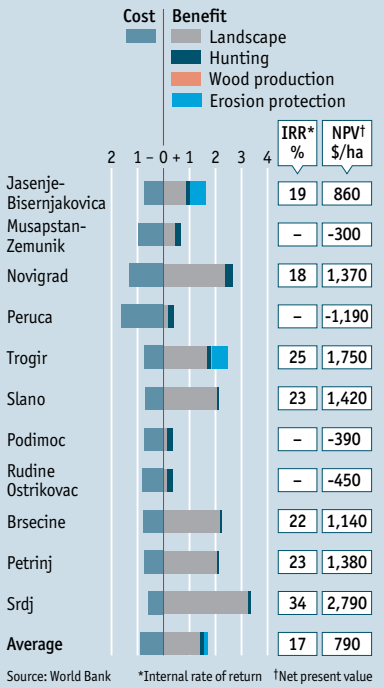
The turning point for this way of looking at things was in 1997. In that year, the city government of New York realised that changing agricultural practices meant it would need to act to preserve the quality of the city's drinking water. One way to have done this would have been to install new water-filtration plants, but that would have cost $4 billion-6 billion up front, together with annual running costs of $250m. Instead, the government is paying to preserve the rural nature of the Catskill Mountains from which New York gets most of its water. It is spending $250m on buying land to prevent development, and paying farmers $100m a year to minimise water pollution.

Many of the valuation studies done since then have involved water, probably because it is so obviously a valuable ecological service. Forests and swamps (or "wetlands", to give the latter their politically correct modern moniker) filter and purify water, and act as reservoirs to capture rain and melting snow. When such areas become degraded, it may be necessary to make expensive investments in treatment plants, dams and other flood-control measures. Several other American cities, following in New York's footsteps, have calculated that every ▸▸

Growing assets

Reforestation, costs and benefits of selected sites in coastal Croatia

$'000 per hectare



dollar invested in environmental protection would save anywhere from $7.50 to $200 on the cost of what would otherwise have to be spent on filtration and water-treatment facilities.

Nor it is it only rich countries that benefit. In 2003, Muthurajawela wetland sanctuary, just north of Colombo in Sri Lanka, was calculated by the World Conservation Union to be providing services worth $8m a year—or $260,000 per square kilometre. These services include the cleaning of sewage and waste water from industry, as well as flood attenuation and the support of downstream fisheries. At the same time, the waste-water-processing capacity of a swamp in Uganda was calculated to be even more valuable than this, at least per unit area. Its 5.5 square kilometres provided a service worth $2m.

When valuation has been done, payment can follow. In Cape Town, South Africa, for example, it proved cheaper to restore the town's watershed to its native vegetation than to divert water from elsewhere, or to create reservoirs. And there are a wide range of other cities and towns in the poor world that use ecological payments to protect their water supplies—from Quito in Ecuador with 1.2m people to Yamabal in El Salvador with only 3,800.

More complex benefits can be paid for in more complex ways. A scheme in Costa Rica, which costs $57m a year, is paid for partly by hydroelectric-power producers, who receive services such as stream-flow regulation, sediment retention and erosion control, partly by private consumers of water, who use it for irrigation, and partly by the country's government, in order to supply towns with water and maintain the area's scenic beauty for recreation and ecotourism.

Meanwhile in Colombia and France, there are schemes financed entirely by the private sector. Large agricultural producers in the Cauca Valley pay fees for watershed-management projects, such as erosion control and reforestation. And Perrier-Vittel, a bottler of mineral water, has found it necessary to reforest parts of heavily farmed watersheds and also to pay farmers to switch to modern facilities and organic farming in order to preserve the quality of some of its products.

Valuing ecosystem services can also point to places where inaction is best. After fires in Croatia had damaged many forests, a study was done to see if restoration was worthwhile given their value to the tourist industry. Examination of 11 sites revealed that the net benefits varied significantly (see chart). Some sites were not worthy candidates and were dropped.

As scientific understanding of ecological services improves, new financial opportunities emerge. For example, the importance of insect pollination to the quality and quantity of agricultural crops such as coffee, almonds and apples, has only recently become appreciated. Last year, a study in Costa Rica found that on one farm alone the natural pollination of coffee by insects was worth $60,000. Coffee yields were 20% higher on plots that lay within a kilometre of natural forest.

Simply having this kind of information could change the way that coffee farmers view areas such as forest and wild grasslands on or near their property. Looked at another way, it might encourage owners of forests that help to pollinate a neighbour's crops to demand payment. Indeed, a version of this sort of blackmail already happens on an international scale. Elliot Morley, Britain's minister for the environment, says that developing countries sometimes say to him, "give us the money or the forest gets it".

The bee's knees

Putting a proper value on ecological services is bound up with another economic anomaly that haunts environmental economics. This is the creation of what economists term externalities—economic impacts made when those taking a decision do not bear all the costs (or reap all the gains) of their actions. When a piece of natural habitat is ploughed, for example, the conversion may make sense to the land owner, but it may also damage fisheries downstream, increase flooding and clog rivers with sediment. This makes those who lose out angry. It can also, in some circumstances, subtract from, rather than add to, a country's total wealth.

The problems discussed above all involve externalities as well as the need to price ecological services correctly. If Catskill farmers had not changed their methods, for example, New York City's government would not have faced the question of how to keep its water potable. But when an externality affects only a relatively small, recognisable group of people, negotiation between the parties can often resolve the matter. If, however, an externality is a public "bad" (ie, the opposite of a public good), such deals are not possible.

Public goods are those which are in everybody's interest to have, but in no one's interest to provide. Clean air, for example, or, more controversially, the preservation of rare species of plant or animal.

In such situations, the first reaction is frequently to legislate to try to ban the externality. But a more efficient solution can often be what is known as a cap and trade scheme, in which legislation creates both an overall limit to the amount of the externality in question, whether it be a polluting chemical or the destruction of a type of habitat, and a market in the right to impose the externality within that limit.

Cap and trade schemes are best known in the context of polluting gases. Sulphur-dioxide-emission rights have been traded in America for years, and in countries that have signed up to the Kyoto protocol on climate change a market is starting to develop in carbon dioxide. But cap and trade can work in other contexts as well. Fisheries are a well-tested example, while in Australia, farmers who use irrigation (which increases soil salinity) can buy "transpiration credits" from forest owners whose trees, by sucking up water in the process known as transpiration, reduce salinity.

In America, similar markets in wetlands and endangered species have arisen. These are run through so-called mitigation banks. Such banks are created by permanently protecting privately owned swamps, or land that is inhabited by endangered species. This creates a supply of environmental "credits". Those who want to destroy wetlands, or species-rich habitats, for agricultural or development purposes are able to buy credits from a mitigation bank allowing them to do so. New federal guidelines mean that mitigation banking is becoming popular in many American states. Indeed, it is even starting to finance the emergence of companies dedicated to restoring wetlands, or building them from scratch.

Such liquid markets are different from the fee-for-service arrangements that pertain to such things as watershed management. And, as if to underscore the arrival of environmental trading in the marketplace, two recent publications have been launched to track the field. Platts, best known for newsletters that report prices in energy markets, started a newsletter called Emissions Daily in February. This covers the carbon-dioxide market in Europe, and the sulphur-dioxide and nitrogen-oxide markets in America, publishing daily price assessments for the leading contracts. The second publication is a website called the Ecosystem Marketplace, which tracks markets and payment schemes for ecological services such as water quality, carbon sequestration (planting trees as a ▸▸

way of absorbing carbon dioxide from the atmosphere) and habitat preservation.

The principle having been established, traders are now looking for other opportunities to arbitrage pollution. One promising area is the trading of nitrate emissions between factories and farmers. Farmers' emissions are generally less regulated than those of factories but—probably because of that—farmers can often reduce their nitrate output at a fraction of the cost that a factory would have to incur. Trading between the two means that pollution standards can be met more cheaply.

The greening of the City

All these payments and new markets have not gone unnoticed in the City of London, and other financial centres. People there are watching closely for new financial opportunities, particularly within carbon-dioxide markets—and banks such as ABN AMRO plan to start selling "new environmental financial products". While the City has little interest these days in specifically "green" investments, there is something of a greenward shift in the way its firms handle large-scale project finance. Almost two years ago, ten of the world's largest banks signed an agreement to address the social and environmental impacts of the projects they financed (at least, those worth more than $50m). The rules were dubbed "The Equator Principles", and 29 financial institutions have now adopted them. An article published this year in a Euromoney handbook estimated that such "Equator" banks represented about 75% of the project-finance market in 2003. In its sustainability report for 2004, ABN AMRO reviewed 16 deals that had been subjected to the Equator principles. One had been rejected. Four were approved. The rest were modified to fit in with the principles.

Is it working? Of course, banks are not keen to discuss their businesses in any detail, so there is no real way of knowing. It is easy to be cynical about the principles as little more than "greenwash". Nevertheless, Mr Forgach explains that when projects are under consideration they have to be screened with a "green check". He describes this as a series of questions, analyses and consultations on the impact a project will have on biodiversity, the climate and "footprint stuff" (a measure of the consumption of ecological resources).

From the perspective of someone wanting to borrow money, this means that green issues have to be considered from the beginning, and possibly even acted on. So, the proposers of a mining project might have to consider damage to the river and to downstream fisheries of any additional sediment the mine would produce. Borrowers may have to change their plans (as they did in 11 of ABN AMRO's deals last year) so that they are more environmentally friendly, or offset damage by protecting land elsewhere.

In effect, this means that the environment has been brought on to the balance sheet. Furthermore, because insurance companies recognise that the environment can be a huge portion of the risk in a project, there may be a financial incentive for paying to protect it.

Valuation is only ever part of the answer, because not everything is for sale. Mr Forgach says he has calculated that the Panamanians could get far more for their lovely fresh water by shutting down the canal, bottling the water and selling it. Running a canal is a crazy waste of water, he says, but America would not let Panama shut the canal.

Still, many conservationists dislike valuation. Some misunderstand it as an approach that ignores cultural and spiritual values. It does not. It simply converts these values into monetary units that can highlight the cost of a course of action. Of course, it might not be appropriate in some cases for this value to be a factor in making a conservation decision. For example, closing the canal and selling water, or building tower blocks on the site of St Paul's cathedral in London, might be perfectly rational from an economic perspective, but also very unlikely to happen.

The valuation of ecosystem services is not without its difficulties. Nevertheless, the fact that there is a growing consensus about how and where it is appropriate is an important step forward for economists and environmentalists. In 1817, David Ricardo, a pioneering economist, noted that abundance in nature was rarely rewarded: "where she is munificently beneficent she always works gratis." But if nature pays, who then will pay for nature? ■

Climate bonds

If it's green and folds

Reprinted from The Economist, Jun 22nd 2012

GREENING the world economy is not going to come cheap. The International Energy Agency reckons that investment in low-carbon energy technologies will have to rise from an annual $165 billion in recent years to an eye-popping $750 billion each year by 2030 and $1.6 trillion per annum by 2050. HSBC, an investment bank, has even higher estimates. It sees $10 trillion being spent during this decade alone.

As these green technologies mature and become less risky, HSBC points out, we should expect them to be financed mostly by bonds not equity. (The historical split is 60% bonds and 40% equity). The bank commissioned a report by the Climate Bonds Initiative, a non-profit organisation trying to encourage green investment. The results showed that the market for such "climate bonds" is surprisingly well-developed.

The market includes $174 billion of climate-themed bonds issued since 2005 (the year the Kyoto Protocol came into force). An additional $577 billion of bonds are more or less closely related to green projects. The vast majority (82%) are issued by corporations, with financial institutions (including development banks) making up most of the remainder.

The bonds are concentrated in certain sectors. Almost all of the pure climate bonds are in transport, energy and "climate finance", which is mostly the green projects of development banks. The broader pool of greenish bonds are concentrated in energy projects, water, waste and pollution control.

Unsurprisingly Europe leads the world market, accounting for two-thirds of the global total. Four out of the top five countries, ranked by issuance, are from Europe, with Britain and France topping the list. Almost all British and French climate bonds are in transport, as are about 80% of the German variety. In America and Japan transport-sector bonds are only around half of the total. The other half are in energy in Japan, and in mostly energy and climate finance in America. Chinese climate bonds, however, are heavily dominated by energy investment, which accounts for around 80% of the total. Bond issuance by renewable energy companies in China quadrupled in 2011.

All of this is an encouraging start. But given the need for investment in coming decades continued bond issuance is crucial. Bonds need to be bigger and trustworthier if they are to reach investment-grade status and lure in the big bucks. The folks at the Climate Bonds Initiative think government involvement can help to kick-start the market. Governments could issue climate bonds themselves, as the Australian and Indian government have done, or they could support greener bonds through tax incentives, providing the kind of breaks America's federal government offers for local-government bonds. As the climate warms, climate bonds may become quite hot. ■

Valuing oceans

The $2 trillion question

Reprinted from The Economist, Mar 28th 2012

PUTTING a price on something that is priceless is, well, tricky. It is, however, possible to assign a number to how much damage is being done to that thing. In the case of the oceans, a conservative estimate of the cost of climate change is that by the year 2100 it will amount to nearly $2 trillion annually in 2010 dollars, or about 0.4% of global GDP. Any number that purports to describe an economy nine decades hence must be taken with a dollop of salt, of course. But it should not be dismissed out of hand.

Frank Ackerman and Elizabeth Stanton, economists at the Stockholm Environment Institute (SEI), a non-profit research organisation, arrived at their figure by looking at five measures: how much fisheries and tourism stand to lose and what the economic impact would be of rising sea levels, more storms and less carbon being absorbed by oceans. If the world continues to warm at its present rate and temperatures rise by 4°C by 2100, they reckon, the total will come to $1.98 trillion. If drastic measures are taken to cut emissions and they rise by only 2.2°C, it will be $612 billion.

This does not take into account unexpected catastrophic events. What happens if Greenland's ice-sheet collapses? What if all the methane stored in the Arctic is released? The researchers prefer not to contemplate such scenarios. As a result, their's could be viewed as a conservative estimate. The economic argument of the SEI's new book, "Valuing the Ocean", is that the world stands to save at least $1 trillion every year by doing something about climate change.

Estimates of the world's GDP a century from now depend on too many variables to calculate with any precision. Ditto for the true rise in temperature by 2100. And the damage done to economic prospects is based on estimates of, for example, growth in income and demand for fish and tourism. All this makes SEI's figure look a bit too accurate for its own good. But treat it as a rough measure, and the picture it paints is stark.

The point of the exercise is, of course, to make policymakers—and the public—take notice. Dr Ackerman would like to see climate change become as much a piece of furniture in people's heads as is airport security or the risk that their house might catch fire. He has long been a vociferous critic of the cost-benefit analyses used in policy-making. Instead, Dr Ackerman suggests looking at combating climate change as a form of insurance.

People insure against things that are not likely to happen but would cause enormous damage if they did. The chances of a house fire or of a young couple dying suddenly and leaving their offspring without any support are miniscule (at least in most cases). Yet, people pay insurance companies large amounts of money every year on the off chance that they are among the unlucky few. The same thinking, he says, should apply to climate change: it is better to guard against an awful fate than blithely assume that it will not happen.

The insurance analogy is imperfect. Insurance is about pooling individual risks; it is by definition impossible to pool a risk that affects the whole world. In that respect fighting global warming more akin to defence spending—stumping up now to fend of an uncertain future threat—which few question as unreasonable even in the most peacable of times.

People notice some problems more than others. Air pollution has a direct impact on quality of life. Cutting down on fossil fuels, most of which are also dirty in other ways, means less carbon as well as less of the nasty stuff that wreaks havoc with people's lungs. But reduced carbon emissions would also stem ocean acidification which, for all its effects on pretty coral reefs, is both abstract and imperceptible to most people. Making the oceans a topic of conversation is difficult; $2 trillion ought to concentrate minds. ■

Growing on trees

A profitable rainforest

Reprinted from The Economist, May 18th 2009

A MOST unusual document landed on your correspondent's desk recently: a financial report from a rainforest. Iwokrama, a 370,000-hectare rainforest in central Guyana, announced that it was in profit. It added, more intriguingly, that rainforests had entered the "global economy".

Iwokrama is part of the largest expanse of undisturbed rainforest in the world, which overlies the Guiana Shield. It has a unique history. In 1989 the president of Guyana had the foresight to give the forest as a gift to the Commonwealth for research into global warming. Today it is administered by an international board of trustees, who have devolved the day-to-day management to the Iwokrama International Centre. It is this centre that has been working to exploit the forest sustainably.

Edward Glover, one of Iwokrama's board of trustees, says that it became clear more than a decade ago that the forest could not rely on donor funding to survive, so it had to look elsewhere for finance. The centre's first job was to identify the forest's assets and to exploit them. It seems to have perfected its art. Today the centre makes money in areas such as ecotourism, timber-extraction, forest-products such as honey and oils, bio-prospecting and forestry research. Its results for 2008 reveal that it made a surplus for the first time that year, with revenues of $2.4m and a profit of $800,000. The previous year it had lost $200,000. Revenues from timber were up by 44%, ecotourism by 26% and training by 22%.

There should be more money to come. Eighteen months ago, it sold a licence for the measurement and valuation of the forest's "ecosystem services". This is not to say that the forest has actually sold these rights, but that an investment company, Canopy Capital, based in London, has bought the rights to create a financial deal for the forest's services.

Ecosystem services are what a forest provides merely by existing. A standing forest can generate rainfall, prevent flooding, regulate the soil, provide biodiversity and store carbon. These benefits are received by everyone in society, but no one pays for them. Such environmental services are often termed "externalities" because they are not included in the price of the forest. When forests are traded in a traditional way, their price usually depends only on the value of the timber and the land on which it grows. No account is taken of the broader services to society. The result is that forests are being cut down because an incorrect price is put on them.

When forests vanish, people suffer. That is why many believe that there is an urgent need to bring forests onto the global financial balance sheet. Last year Pavan Sukhdev, an economist at Deutsche Bank, reported that the world was losing natural capital worth between $2 trillion and $5 trillion every year as a result of deforestation alone. If money could be made by selling these ecosystem services, then the financial equation for forests would change.

At the moment, nobody wants to give too much detail about what an eventual deal for Iwokrama's ecosystem services might look like, as it is currently being negotiated. Mr Glover says they want to create a new class of asset management, one that includes all of Iwokrama's services. It is not just about carbon emissions trading, he says, "we want something different and imaginative and forward-looking". Rather unusually for a clever financial deal, Hylton Murray-Philipson of Canopy Capital says that when it is completed, they will reveal how they did it so that other people can copy it.

Looking at the value of the carbon sequestration alone, there is a deal to be done. Mr Murray-Philipson asks "why pay BP $100 a tonne to take carbon dioxide out of the atmosphere and bury it when you can do the same with a rainforest for a fraction of a dollar?". He adds that the science of forest carbon sequestration is "definitive" and that standing forests are responding to higher carbon dioxide levels by "bulking up", and are sequestering between one and four tonnes of the gas per hectare per year. Even taking the lower figure, with one billion hectares of forest in the world, if the rights to the sequestration of carbon dioxide are sold for just $10 a tonne—that would generate $10 billion a year.

Iwokrama is making money now, before it has even sold its ecosystem services. It is already part of the global economy. But with sustainable forestry and ecosystem services, the lesson of Iwokrama is that rainforests present an opportunity. For a few bright sparks out there, financial innovation and engineering combined with science will let them generate wealth in a whole new way. There is money in the forest. It is growing on trees. ■

Water-saving in the north-east

Trees grow in Brooklyn

Reprinted from The Economist, Nov 11th 2010

LIKE other post-industrial areas in the city, New York's Gowanus neighbourhood is getting stylish. But those who venture there after a heavy rainstorm might rethink their plans to buy that loft. When the city's ageing sewerage system is overwhelmed, untreated storm-water and sewage flood into local waterways, including the Gowanus Canal. The resulting whiff is sure to keep property prices at a level starving Brooklyn artists can afford.

New York has a serious sewer problem. The city spills more than 27 billion gallons (102 ▸▸

billion litres) of untreated overflow into its harbour each year, according to Riverkeeper, a local advocacy group. And New York is not alone. Nearly 800 American cities rely on decrepit systems that collect storm-water run-off, industrial waste and human sewage in the same pipes. Usually these pipes take waste water to treatment plants. But any overflow is released into rivers and streams.

Time, erosion and increasingly erratic weather have made this a national issue. The Environmental Protection Agency (EPA), the federal body in charge of monitoring water standards, says the country needs to invest $300 billion over the next 20 years to update or replace existing sewer infrastructure. But except for the money for improvements set aside in the 2009 stimulus bill—a not-ungenerous $6 billion—the federal government has left states to their own devices. Some cash-strapped cities have decided to get creative.

New York recently unveiled a grand plan to clean up its waterways. Instead of spending billions on new tanks and pipes (ie, "grey infrastructure"), which take years to build and never quite address the problem, the city intends to invest in "green infrastructure", such as roofs covered with vegetation, porous pavements and kerbside gardens. The scheme involves a fundamental shift in approach: instead of treating rainfall as waste to be whisked away as quickly as possible, New York will let it sink usefully into the ground: thereby helping to make the city greener, improve air quality, raise property values, increase jobs and lower water and energy costs, according to studies by the EPA and others.

This is no unfunded pipe-dream. The city is already required to spend $6.8 billion over 20 years to meet harbour-quality standards. The greener plan would cost government a third less, with $2.9 billion for tunnels and tanks and $1.5 billion for green innovations. New buildings would also have to meet run-off regulations.

This is a way of achieving more than one thing with tax dollars, says Carter Strickland, a deputy commissioner in New York's Department of Environmental Protection. Unlike a sewage works or a new pipeline, which take years to build and which no one wants nearby, green infrastructure projects offer benefits the moment the first tree is planted or a rain barrel is installed. "Isn't it nice?" observes Mr Strickland as he shows off one of the city's 30 pilot projects, a little roadside garden deep in Brooklyn, with a tree and some flowers. It is indeed, and it can capture nearly 1,000 gallons of storm-water that would otherwise pour into a nearby drain.

Green-infrastructure ideas are also taking root in places as far apart as Kansas City, Milwaukee, Portland and Washington, DC. In California, where droughts make salvaging rainwater especially wise, a new statewide green building code will take effect on January 1st 2011. But the most comprehensive scheme so far comes from Philadelphia, which is seeking EPA approval for its 25-year, $2 billion approach to "green" at least a third of the city's impervious cover. If approval is granted, this will be the first plan that officially meets federal clean-water guidelines.

The city has gone some way towards meeting its green goals. In 2006 it began regulating the way new constructions manage storm-water on its property. The city's water department has adjusted its rate structure, levelling the highest charges at the biggest polluters (eg, car parks) instead of the biggest water consumers. The idea is to prod the private sector to improve its environmental record.

Green-infrastructure plans face some obstacles. They are often at the mercy of local zoning and building codes, and many cities are reluctant to change. Yet David Beckman at the National Resources Defense Council is optimistic. "Usually we're plaintiffs," he says, "but here we're collaborators, working with the city." Finally cities are finding ways to handle storm-water that needn't involve holding one's nose. ■

It doesn't have to be complicated

Fishing and conservation

A rising tide

Reprinted from The Economist, Sep 18th 2008

Scientists find proof that privatising fishing stocks can avert a disaster

FOR three years, from an office overlooking the Atlantic in Nova Scotia, Boris Worm, a marine scientist, studied what could prevent a fishery from collapsing. By 2006 Dr Worm and his team had worked out that although biodiversity might slow down an erosion of fish stocks, it could not prevent it. Their gloomy prediction was that by 2048 all the world's commercial fisheries would have collapsed.

Now two economists and a marine biologist have looked at an idea that might prevent such a catastrophe. This is the privatisation of commercial fisheries through what are known as catch shares or Individual Transferable Quotas (ITQs).

Christopher Costello and Steven Gaines (the biologist) of the University of California and John Lynham of the University of Hawaii assembled a database of the world's commercial fisheries, their catches and whether or not they were managed with ITQs. As these fisheries were not chosen at random and without having any experimental control, they borrowed techniques from medical literature—known as propensity-score matching and fixed-effects estimation—to support their analysis. The first method compared fisheries that are similar in all respects other than the use of ITQs; the second averaged the impact of ITQs over many fisheries and examined what happened after the quotas were introduced. Whichever way they analysed the data, they found that ITQs halted the collapse of fisheries (and according to one analysis even reversed the trend). The overall finding was that fisheries that were managed with ITQs were half as likely to collapse as those that were not.

For years economists and green groups such as Environmental Defense, in Washington, DC, have argued in favour of ITQs. Until now, individual fisheries have provided only anecdotal evidence of the system's worth. But by lumping all of them together the new study, published this week in Science, is a powerful demonstration that it really works. It also helps to undermine the argument that ITQ fisheries do better only because they are more valuable in terms of their fish stocks to begin with, says Dr Worm. The new data show that before their conversion, fisheries with ITQs were on exactly the same path to oblivion as those without.

Racing to fish

Encouraging as the results are, ITQ fisheries are in the minority. Most fisheries have an annual quota of what can be caught and other restrictions, such as the length of the season or the type of nets. But this can result in a "race to fish" the quota. Fishermen have an incentive to work harder and travel farther, which can lead to overfishing: a classic tragedy of the commons.

The use of ITQs changes this by dividing the quota up and giving shares to fishermen as a long-term right. Fishermen therefore have an interest in good management and conservation because both increase the value of their fishery and of their share in it. And because shares can be traded, fishermen who want to catch more can buy additional rights rather than resorting to brutal fishing tactics.

The Alaskan halibut and king crab fisheries illustrate how ITQs can change behaviour. Fishing in these waters had turned into a race so intense that the season had shrunk to just two to three frantic days. Overfishing was common. And when the catch was landed, prices plummeted because the market was flooded. Serious injury and death became so frequent in the king crab fishery that it turned into one of America's most dangerous professions (and spawned its own television series, "The Deadliest Catch").

After a decade of using ITQs in the halibut fishery, the average fishing season now lasts for eight months. The number of search-and-rescue missions that are launched is down by more than 70% and deaths by 15%. And fish can be sold at the most lucrative time of year—and fresh, so that they fetch a better price.

In a report on this fishery, Dan Flavey, a fisherman himself, says some of his colleagues have even pushed for the quota to be reduced by 40%. "Most fishermen will now support cuts in quota because they feel guaranteed that in the future, when the stocks recover, they would be the ones to benefit," he says.

Although governing authorities are important in setting up ITQs, so is policing of the system by the fishermen themselves. In the Atlantic lobster fishery a property-based system has arisen spontaneously, says Dr Worm. Families claim ownership over parcels of sea and keep others out. Anyone trying to muscle in on the action risks being threatened; their gear may be cut loose or their boat could vanish.

Jeremy Prince, a fisheries scientist at Murdoch University in Australia, has been involved in ITQs since they were pioneered in the early 1980s by Australia, New Zealand and Iceland. In Australia they are only one way of managing with property rights, he says. Depending on the nature of a fishery, other methods may work better. These might divide up and sell lobster pots, numbers of fish, numbers of boats, bits of the ocean or even individual reefs. The best choice will depend on the value and underlying biology of each fishery, and in some places they may not work at all. In a fishery with a large, unproductive stock that grows slowly, fishermen may prefer short-term profit to the promise of low long-term income and catch all the fish straight away. Nevertheless, Dr Prince believes that, overall, market-based mechanisms are the way forward.

The most difficult place to introduce market-based conservation methods is in international waters. Attempts to do so have ended in failure. One problem is that there is simply too much cheating in the open ocean. Some scientists think a renegotiation of the law of the sea through the United Nations is the only way forward—or a complete ban on fishing in international waters. Although a dramatic course of action, the effects may not be so huge. Dr Worm reckons that 90% of the world's fish are caught in national waters.

So, if Dr Costello and his colleagues are right and the profit motive can drive the sustainability of fisheries, why do the world's 10,000-plus fisheries contain only 121 ITQs? Allocating catch shares is a difficult and often fraught process. In America it can take from

five to 15 years, says Joe Sullivan, a partner in Mundt MacGregor, a law firm based in Seattle. The public, he says, sometimes resists the privatisation of a public resource and if government gets too involved in the details of the privatisation (rather than leaving it to the fishermen to work out), it can end up politically messy. But evidence that ITQs work is a powerful new hook to capture the political will and public attention needed to spread an idea that could avert an ecological disaster. ■

Brazil's agricultural miracle

How to feed the world

Reprinted from The Economist, Aug 26th 2010

The emerging conventional wisdom about world farming is gloomy. There is an alternative

THE world is planting a vigorous new crop: "agro-pessimism", or fear that mankind will not be able to feed itself except by wrecking the environment. The current harvest of this variety of whine will be a bumper one. Natural disasters—fire in Russia and flood in Pakistan, which are the world's fifth- and eighth-largest wheat producers respectively—have added a Biblical colouring to an unfolding fear of famine. By 2050 world grain output will have to rise by half and meat production must double to meet demand. And that cannot easily happen because growth in grain yields is flattening out, there is little extra farmland and renewable water is running short.

The world has been here before. In 1967 Paul Ehrlich, a Malthusian, wrote that "the battle to feed all of humanity is over... In the 1970s and 1980s hundreds of millions of people will starve to death." Five years later, in "The Limits to Growth", the Club of Rome (a group of business people and academics) argued that the world was running out of raw materials and that societies would probably collapse in the 21st century.

A year after "The Limits to Growth" appeared, however, and at a time when soaring oil prices seemed to confirm the Club of Rome's worst fears, a country which was then a large net food importer decided to change the way it farmed. Driven partly by fear that it would not be able to import enough food, it decided to expand domestic production through scientific research, not subsidies. Instead of trying to protect farmers from international competition—as much of the world still does—it opened up to trade and let inefficient farms go to the wall. This was all the more remarkable because most of the country was then regarded as unfit for agricultural production.

The country was Brazil. In the four decades since, it has become the first tropical agricultural giant and the first to challenge the dominance of the "big five" food exporters (America, Canada, Australia, Argentina and the European Union).

Even more striking than the fact of its success has been the manner of it. Brazil has followed more or less the opposite of the agro-pessimists' prescription. For them, sustainability is the greatest virtue and is best achieved by encouraging small farms and organic practices. They frown on monocultures and chemical fertilisers. They like agricultural research but loathe genetically modified (GM) plants. They think it is more important for food to be sold on local than on international markets. Brazil's farms are sustainable, too, thanks to abundant land and water. But they are many times the size even of American ones. Farmers buy inputs and sell crops on a scale that makes sense only if there are world markets for them. And they depend critically on new technology. As the briefing explains, Brazil's progress has been underpinned by the state agricultural-research company and pushed forward by GM crops. Brazil represents a clear alternative to the growing belief that, in farming, small and organic are beautiful.

That alternative commands respect for three reasons. First, it is magnificently productive. It is not too much to talk about a miracle, and one that has been achieved without the huge state subsidies that prop up farmers in Europe and America. Second, the Brazilian way of farming is more likely to do good in the poorest countries of Africa and Asia. Brazil's climate is tropical, like theirs. Its success was built partly on improving grasses from Africa and cattle from India. Of course there are myriad reasons why its way of farming will not translate easily, notably that its success was achieved at a time when the climate was relatively stable whereas now uncertainty looms. Still, the basic ingredients of Brazil's success—agricultural research, capital-intensive large farms, openness to trade and to new farming techniques—should work elsewhere.

Plant the plains, save the forests

Third, Brazil shows a different way of striking a balance between farming and the environment. The country is accused of promoting agriculture by razing the Amazon forest. And it is true that there has been too much destructive farming there. But most of the revolution of the past 40 years has taken place in the cerrado, hundreds of miles away. Norman Borlaug, who is often called the father of the Green Revolution, said the best way to save the world's imperilled ecosystems would be to grow so much food elsewhere that nobody would need to touch the natural wonders. Brazil shows that can be done.

It also shows that change will not come about by itself. Four decades ago, the country faced a farm crisis and responded with decisive boldness. The world is facing a slow-motion food crisis now. It should learn from Brazil. ■

Carbon footprints

Following the footprints

Reprinted from The Economist, Jun 2nd 2011

Environment: Carbon-footprint labels, which indicate a product's environmental impact, are quietly spreading. Consumers may not have noticed them yet, but there is a lot going on behind the scenes

DO YOU look for carbon-footprint labels on goods when shopping? If you do, you are in a small minority. The practice of adding labels to foods and other products, showing the quantity (in grams) of carbon-dioxide emissions associated with making and transporting them, began in 2007 when the world's first such labels were applied to a handful of products sold in Britain. The idea was that carbon labels would let shoppers identify products with the smallest carbon footprints, just as other labels already indicate dolphin-friendly tuna, organic milk or Fairtrade coffee. Producers would compete to reduce the carbon footprints of their products, and consumers would be able to tell whether, for example, locally made goods really were greener than imported ones.

Carbon labels have yet to become as widely recognised by consumers as other eco-labels, however. A survey carried out in 2010 by Which?, a British consumer group, found that just a fifth of British shoppers recognised the carbon footprint label, compared with recognition rates of 82% for Fairtrade and 54% for organic labelling. This is understandable, because carbon labelling is a much more recent development—organic labelling dates back to the 1970s, and Fairtrade to the late 1980s—and the right ways to do it are still being worked out. Adding a carbon label to a product is a complex and often costly process that involves tracing its ingredients back up their respective supply chains and through their manufacturing processes, to work out their associated emissions. According to 3M, an American industrial giant that makes over 55,000 different products, this can cost $30,000 for a single product. To further confuse matters, different carbon footprinting and labelling standards have emerged in different countries, preventing direct comparisons between the various types of label.

Even so, proponents of carbon labels now see encouraging signs of progress. In Britain, a pioneer in carbon labelling, nine out of ten households bought products with carbon labels last year, albeit mostly unwittingly, and total sales of such products exceeded £2 billion ($3.1 billion). This exceeded the total sales of organic products (£1.5 billion) or Fairtrade products (£800m) and is largely due to the addition by Tesco, Britain's biggest retailer, of carbon labels to more than 100 of its own-brand products, including pasta, milk, orange juice and toilet paper. (Tesco said in 2007 that it would put carbon labels on every one of the 70,000 products it sells; so far it has managed to label 500 products.)

"In the last 12 months, carbon footprinting has become common currency," says Harry Morrison of the Carbon Trust, a consultancy funded by the British government which has footprinted more than 5,000 products worldwide, from building materials to pharmaceuticals. Similar carbon-labelling initiatives have been launched in many countries, measurement techniques are gradually being formalised and a global standard is in the works. Although consumers have yet to embrace the idea, the quiet spread of carbon labels is being driven by companies, which have come to see the value of determining the carbon footprints of their products.

Footprinting's first steps

The earliest carbon-footprint labels, which appeared in 2007, indicated the promise of the idea but also highlighted the complexity of making it work. Among the first products to have carbon labels applied were the cheese-and-onion potato crisps made by Walkers, a brand owned by PepsiCo, which were found by the Carbon Trust to have a footprint of 75 grams per packet. This figure, printed on the packet with the Carbon Trust's "black footprint" logo, included the emissions associated with growing the potatoes, turning them into crisps, packaging them, delivering them to shops and disposing of the packaging after use. National averages were used to calculate the transport and disposal emissions.

Carbon labels need not just measure carbon-dioxide emissions. Where appropriate, emissions of other greenhouse gases, such as nitrous-oxide from soils and methane emissions from animals, are also taken into account. These are turned into "carbon-dioxide equivalent" emissions using suitable conversion factors: 1g of methane is commonly taken to have the same global-warming potential as 21g of carbon dioxide, for example.

The process of calculating the carbon footprint for Walkers crisps revealed an unexpected opportunity to save energy. It turned out that because Walkers was buying its potatoes by gross weight, farmers were keeping their potatoes in humidified sheds to increase the water content. Walkers then had to fry the sliced potatoes for longer to drive out the extra moisture. By switching to buying potatoes by dry weight, Walkers could reduce frying time by 10% and farmers could avoid the cost of humidification. Both measures saved money ▸▸

and energy and reduced the carbon footprint of the final product.

The value of carbon footprinting and labelling lies in identifying these sorts of savings, rather than informing consumers or making companies look green. According to a report issued in 2009 by the Tyndall Centre for Climate Change Research at the University of Manchester, in England, "the main benefits of carbon labelling are likely to be incurred not via communication of emissions values to consumers, but upstream via manufacturers looking for additional ways to reduce emissions." It is not so much the label itself that matters, in other words, but the process that must be gone through to create it. Walkers has reduced the footprint of its crisps by 7% since the introduction of its first carbon labels. Indeed, to use the Carbon Trust's label, companies must do more than just measure the footprint of a product: they must commit themselves to reducing it.

Another of the early products to receive a carbon label was a shampoo sold by Boots, a British pharmacy chain. Shampoo is an example of a product where the footprint associated with using the product—the so-called "use phase" emissions—can be comparable to, or even greater than, the manufacturing footprint. Initially, says Mr Morrison, the Carbon Trust's carbon labels did not include use-phase emissions, because these can vary enormously depending on consumer behaviour. The emissions associated with a bottle of shampoo depend on how long you spend in the shower, how hot the water is and what sort of boiler you have.

For many products, in short, the manufacturing footprint does not give the full picture. This is particularly true for electrical goods that are designed to use less energy. Improving energy-efficiency often involves more elaborate manufacturing processes that increase the product's manufacturing footprint. But in use, such products use less energy, so their overall footprint, considered over their entire life cycle, is smaller. A good example is flat-screen LCD televisions compared with old-style cathode-ray-tube models. "The energy consumption in use has got much better, but the manufacturing process has got more complicated," says Mr Morrison. As a result, the Carbon Trust's carbon labels now include use-phase emissions. These are estimated by making statistical assumptions about consumer behaviour.

For some goods, customer behaviour can make a dramatic difference to the use-phase emissions. A life cycle analysis carried out for Levi Strauss, an American maker of casual wear, found that 57% of the carbon footprint of its 501 jeans was due to the emissions associated with washing them—assuming, that is, that the jeans were washed in warm water and machine-dried. Washing them in cold water and drying them on a line, however, reduces the use-phase emissions by 90%. Adding this sort of information to product labels can encourage buyers to minimise the use-phase emissions—but only if they actually read the label and act on its advice.

Given such wide variations, so-called "product category" rules are needed to ensure comparability between carbon labels on similar products. Those product-category rules, in turn, must be harmonised between countries to ensure compatibility between carbon-labelling schemes, which are growing in number and diversity.

In Japan the Ministry of Economy, Trade and Industry launched a calculation and labelling programme in 2008 which has signed up more than 300 retailers and manufacturers. As part of this scheme METI has established product-category rules for 53 products. South Korea's environment ministry has introduced a "CooL label", now sported by over 220 products, including furniture, rice and consumer electronics. In Thailand the government is piloting labels on 65 products from T-shirts to ceramic tiles, and is developing product-category rules for rice, textiles and chicken.

Other labels have been launched in America, Canada, Switzerland and Sweden.

But the country that is now making the running is France. Casino, a French retail chain, introduced carbon labels on 100 of its own-brand products in 2008 and has since added labels to another 400 items. Its Carbon Index labels show the carbon footprint per 100g of final product (use-phase emissions are not included). E. Leclerc, another French retailer, has pioneered two novel twists on carbon labelling in a handful of its stores. It has fixed labels to store shelves showing the carbon emissions per kilogram of produce next to the usual price tags showing cost per kilogram. And by roughly estimating the carbon footprints of 20,000 of its products (by dividing them into 600 generic categories) it can produce a total footprint for an entire trolley of goods that appears on the store receipt. Signs show consumers how their trolley's footprint compares with the average.

The French exception

These initiatives by French retailers are being backed by government action. A year-long experiment will begin in July, involving 168 firms in a range of industries, to apply carbon labels to products including clothing, furniture and cleaning products. An accompanying campaign will try to raise awareness of carbon labels among consumers. This is a prelude to the planned introduction of compulsory carbon-labelling rules, possibly as soon as 2012, which will apply to imported goods as well as those made in France. The new rules, devised by AFNOR, the French Standards Agency, require labels to show more than just the carbon footprint. Depending on the product category, they must also include other environmental data, such as the product's water footprint and impact on biodiversity. Product-category rules have already been drawn up by AFNOR and the French environment ministry for shoes, wood, furniture, shampoo and fabric chairs. The project is the result of Grenelle 2, a law passed in 2010 which marks the first time a government has tried to make environmental labelling mandatory.

Other European countries will be watching the French experiment closely, not least because their own exporters may soon have to adhere to the French rules. Inevitably this has led to calls for a European standard for carbon labelling. Last year the European Commission asked Ernst & Young, a consultancy, to evaluate and compare the various footprinting schemes in use in Europe. It found wide variation between them. "We are definitely at the early stage," says Eric Mugnier, E&Y's director of environment and sustainability. Not all carbon-labelling schemes are verified by independent third parties, for example, or include use-phase emissions. The European Commission's Institute for Environment and Sustainability is about to launch an analysis of footprinting methods.

Meanwhile, efforts to refine and harmonise carbon footprinting and labelling at a global level are advancing. Britain's standard, called PAS 2050, which was published in 2008, is highly regarded and has influenced standard-setting elsewhere. In France, Casino is adjusting its footprinting methodology to bring it into line with PAS 2050 by including use-phase emissions, for example. The British standard has also helped shape the two global product-footprinting standards that are now in the works: ISO 14067, being drawn up by the International Organisation for Standardisation, based in Geneva, and the GHG Protocol, a project backed by two environmental groups, the World Resources Institute and the World Business Council for Sustainable Development.

The ISO standard is expected to be finalised in 2012, and the GHG Protocol standards will be released in September. Co-operation between the two bodies should ensure that their standards are highly compatible. "The marketplace is asking for one standard—not different ways in different countries. Otherwise, it becomes a trade barrier," says Pankaj Bhatia, ▸▸

director of the GHG Protocol. There will still be details to fill in. But the movement towards a global set of standards is clear.

That will be reassuring for companies worried about multiple sets of standards and a growing carbon-counting bureaucracy. The difficult part remains, however: working with their networks of suppliers to determine, and then reduce, the carbon footprints of their products. This is a tricky area, says Mr Morrison, because suppliers may worry that revealing information about their processes for carbon-measurement purposes "becomes a back door to a debate about price". Yet engaging suppliers is vital, because many firms have direct control over only a small part of their products' footprints. Gold'n Plump Poultry, a large American chicken producer, found that its own operations accounted for just 22% of the footprint of each chicken; 50% of the footprint came from the production of corn- and soya-based chicken feed.

For some firms, such as food companies and retailers, the lion's share of their emissions takes the form of these "indirect" emissions produced elsewhere. Tesco, for example, reckons its supply chain produces ten times the emissions of its direct operations (heating and lighting stores and offices, and so forth), and that consumer emissions may be ten times as big again. Similarly, Walmart, the world's largest retailer, estimates that 90% of its emissions emanate from its supply chain of over 120,000 companies.

Only by working closely with suppliers, and encouraging them to collaborate and pool expertise, will it be possible to streamline the footprinting process and label hundreds or thousands of products, says David North, director of corporate affairs at Tesco. His firm is working with Unilever, Procter & Gamble, PepsiCo and Coca-Cola, under the auspices of the Consumer Goods Forum, an industry body, to make carbon measurement easier for suppliers. "The process has to be simplified for us and others to get to scale," he says.

Existing footprinting standards already allow for some simplification. Emissions from building factories or manufacturing capital equipment are not included, for example."We have tried to strike a pragmatic balance, to do this in enough detail that you can find efficiencies and inform consumers, but not go to the extreme that this is so expensive that it can't be deployed at scale," says Mr Morrison.

Dieter Helm, an energy-policy expert at the University of Oxford, proposes a colour-coded scheme that lets consumers see which products in a given category have bigger-than-average footprints, and which have smaller-than-average footprints. Unlike precise figures in grams, this would be easier for consumers to understand and for companies to compile. And arguments between retailers and suppliers about whose products were greener would helpfully raise consumer awareness, he says.

The power of the label

Given the international nature of many supply chains, the process of working out products' carbon footprints is also helping to change the way carbon emissions are reckoned. Rather than totting up national totals, it makes more sense to think about cross-border carbon flows. "This helps you understand our emissions are happening around the world," says Mr Morrison.

Between 1990 and 2008, for example, European Union countries reduced total carbon emissions in their own territories by 6%. But this improvement was almost exactly cancelled out by the extra emissions associated with goods imported into the EU from China, according to a recent study by Glen Peters at the Centre for International Climate and Environment Research, in Oslo, and his colleagues. Add in other imports of such "embodied" carbon emissions from other countries, and Europe's overall carbon emissions actually increased by 6% over that period.

By getting firms to assess and reduce the emissions of products with imported inputs, however, carbon footprinting gives firms in the rich world a motive to cut emissions in the developing world, through efficiencies and investment in clean technologies. Carbon labels promise to make carbon footprints and carbon flows visible. But making them work on a large scale will involve striking the right balance between accuracy and practicality. ■

Notes

The Economist

For more information
about "Revaluing ecosystems"
please go to:

www.VisionariesUnbound.com

Rockefeller Foundation
Innovation for the Next 100 Years

WORLD
RESOURCES
INSTITUTE