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Bible lessons

'The Lord gave, and the Lord hath taken away,' cries a anguished Job in the eponymous book of the Bible.

Swap the Lord for energy secretary Chris Huhne, divine providence for the Government's new Annual Energy Statement, and the patient Job for a good environmental citizen, and you will come close to the experience of trying to digest the slew of policies, figures and analysis in the latest missive from the Department for Energy and Climate Change.

Huhne starts by whetting our appetite for renewable energy. Rolling out smart meters, committing to subsidise low carbon forms of heating, accelerating the roll-out of offshore wind turbines, a renewed drive to turn biomass waste (poo, food waste, etc) into energy.

And then the Lord taketh away.

'The low carbon economy must happen, but it will not happen tomorrow,' Huhne told Parliament. 'There are potentially twenty billion barrels of oil equivalent remaining in the UK Continental Shelf...we must maximise economic production while applying effective environmental and safety regulations.'

Ah yes, the continental shelf. How could we have forgotten? Then he begins to rain manna again. He promises to bolster the carbon price, introducing measures to stop it yo-yo-ing around like some fiscal toy and keep it at levels that might actually lead to confidence for those looking to build renewable energy technologies.

And then you stop to think about what other motives the Government might have for raising the carbon price. One of them comes in the shape of a particularly emotionally-charged word: nuclear.

From an officially ambivalent position on nuclear power in the early to mid-noughties, the Government (both past and present flavours) has now moved to adopt a position towards the technology which, if it were a person, is akin to kneeling on the floor of the marketplace with its hands outstretched in supplication. Yet still, the industry has not been particularly forthcoming with offers to build new power stations, at least, not on the scale desired.

So whilst promising absolutely not to subsidise nuclear power, the Government is instead offering to pump up the carbon price (making nuclear power relatively more attractive as an investment), and also working 'to ensure that there is a supply chain and skills base in place to enable new nuclear to happen'. It's not a subsidy, but it's sure as heck a greased runway.

Finally, the Government promises to continue its push for stricter EU carbon reduction limits, raising the bar from a 20 per cent cut by 2020 to 30 per cent. And yet, in announcing the policy, Huhne was forced to admit that the UK faces 'short-term challenges' to meet its own fairly meagre targets for 15 per cent of its energy to come from renewable sources by 2020. A case of do as I say and not as I do?

Mark Anslow, Editor

Putting communities back in charge of their forests

What can western countries learn from their less industrialised counterparts about returning woodlands and forests to productive, profitable, local control? By **Christopher Davey**

Most post-colonial governments have kept forests under their own guardianship. 'Colonial systems were modelled on forest management in Britain and Germany where departments were set up to serve national interests,' says Tom Blomley, a community forestry expert in East Africa. 'These ideas were transferred to Africa – lock, stock and barrel.'

Many post-colonial governments have also failed to manage their natural resources effectively. Typically, the few capture the benefits of forest resources and the many lose out. Politicians may access logging permits through 'influence' (at the expense of local people). Revenues from forestry sales may be remitted to central government while local people bear the burden of living next to forests they cannot use – losing their crops to forest wildlife.

To tackle rural poverty and reduce encroachment, some countries have looked to devolution. Tanzania is a leader in the move from centralised forest management. 'The country has unique circumstances,' Blomley says. 'Former president Julius Nyerere's socialism (Ujamaa) was based on the agrarian reforms of Chairman Mao. As a spin-off, Ujamaa created village governments with authority over local land and resources.'

Tanzania recognised the need to rationalise. There was, for example, little value in central government trying to manage low-value woodland when partnerships with village governments could be more efficient. Tanzania started shifting responsibilities in the 1990s, as forestry leaders shepherded through reforms.

A tale of two systems

Tanzania set up two community systems. The first allows villagers to actively manage their own forests. The second is for larger forests (run by national or local government) and allows communities living close-by to become joint managers and share benefits.

The seeds were planted, and now policy is being put into practice. 'Across Tanzania communities are slowly claiming back their forests,' says Blomley. 'Around 4.1 million hectares are now under (or transferring to) community management. This includes high value montane forests, coastal forests and mangroves, and miombo woodlands.'

'We have a vision for community forestry in Tanzania,' says Blomley. 'We aren't there yet, but the potential is incredible. By giving back these rights, community forestry can provide local people with a source of firewood and herbs, income from timber and poles, and payments for environmental services (like maintaining water catchments).'

'Communities are raising questions about the legitimacy of the state owning large tracts of forest,' Blomley continues, 'and community forestry can also be an engine to address land grabs and build accountability.'

Tanzania has a strong tenure system. Customary tenure was accepted, legitimised

and formalised. 'Africa is corrupt; but community forestry builds on tenurial rights and can help build accountability upwards – addressing the more macro issues around corruption. There are signs that this is beginning to happen. Villagers can decide what they want to do with revenues; they can hold elders to account.'

Making use of wood left to rot

So where is forestry on the evolutionary scale in the UK? Jon Hollingdale, Chief Executive of the Community Woodlands Association, says: 'forest management in Britain has multiple objectives but operational considerations are still driven by the multinational, downstream timber operations' – in other words, the process of providing timber for mills outweighs local needs.

On a typical plantation 'contractors cut timber and ship logs (and poor grade material) across the country'. There is no value to local people, and Forestry Commissions effectively operate at a loss – underpinning contractors. 'It's a mad situation,' says Hollingdale, 'the only way to break out of it is to re-localise (and reduce spending on diesel). It's best to ship just valuable bits to mills, and process the low-grade material locally. In Scotland there is chronic underemployment. Fundamental economic issues contrast with the national interest in centralising.'

Each hectare felled may produce 20 to 25 lorry loads of wood. Perhaps five loads worth is left on the hill to rot. Shifting the rest typically involves a round-trip of 200 to 300 kms. There's not a lot of labour in this system: it's mostly cutting and haulage (and the return trip is empty). Hollingdale figures that if only half of the quality timber is shipped, a useful volume is left for local work. Halve the diesel, and create a job. He estimates that two hectares could give one person employment for half the year – processing and distributing firewood during winter. That's realistic in a typical village of 50 to 100 homes.

Skewed funding

There are big differences between community-owned forests and community involvement in government-owned forest. 'We have a major difficulty in the way support to the private sector is structured,' says Hollingdale. 'Policy is supportive, but at a practical level the systems are not particularly effective.'

The reason for this is that forestry is funded together with support for agriculture. 'The money comes out of one pot, the system doesn't really support public ownership, and it concentrates on new woodland instead of managing existing forest. Anyone trying to do sustainable forestry is struggling because of slow release of payments and a bias towards farmers.'

Things are changing. Poor values and low trade are increasing the emphasis on diversification. More and more projects are in the early stages of promoting and supporting social enterprise businesses.

Anna Craigen is Community Liaison and Education Officer with the Borders Forest Trust. She says: 'the potential for increasing local firewood supply, timber enterprises and maximising community benefits is huge! We have a long way to go, but we are getting there!'

Community forestry is a growing movement in Scotland, but many factors have slowed progress. Large blocks of private land are still controlled by hierarchical figures that have no desire to hand over ownership or management. But without secure tenure, users have little incentive to invest.

Other areas are controlled by Forestry Commission Scotland. 'A large proportion of our forests are managed by the state on behalf of/for the general public's enjoyment,' Anna said. 'Here [forestry] is all about recreation and biodiversity rather than handing the land back to communities. There's not much economic activity in our projects yet.'

Learning from Nepal

When Anna Craigen went to a Nepalese symposium last year she tapped in to a huge amount of community forestry experience.

There were 200 or so participants from 32 countries at the meeting. She described the pitfalls for Scottish projects and was surprised to hear comments along the lines of, 'that sounds just like Nepal 20 years ago'.

Nepalese legislation allows user-groups to benefit from forest products and other businesses like tourism and trekking. 'Income also goes back into forest management and to livelihood and community projects,' Anna says. 'But in the 1970s Nepal was a very different place. Timber export, industrial use and fuelwood harvesting was causing degradation, landslides, poverty and disease.'

Initial schemes re-forested steep valleys and supported forest-farming. Second generation projects (in the 90s) started handing state land back to communities. About 15,000 groups (1.66 million families) now manage 1.3 million hectares of Nepal's forest.

Anna explains: 'It's important to adopt a 'bottom up' approach so communities "buy-in" to projects wholeheartedly'. The initiative must come from the people not the support agency, she says, and local people must be trained in forest management and business. Some projects also support lobbying for further community rights over minerals and higher quality forest.

'It's a mad situation. The only way to break out of it is to re-localise (and reduce spending on diesel)'

Horses for courses

But not everything is the same. Jon Hollingdale thinks there are important differences between Scotland and those less industrialised countries pioneering community development: 'A lot of great things are happening but I am hesitant to copy all of them. Livelihood issues are different. People's engagement with forests is different. And we have a very centralised government system. Here, local government is not particularly effective and the notion of local governance is not very strong.'

But there is a vision in Scotland: 'We want greater diversity, more species, different patterns of ownership and management, a range of forest products, lots of different businesses and loads of opportunities for recreation,' Craigen says. She believes this will lead to a more robust forest landscape and a better economic and social environment. 'Every community should have woodland – with jobs, orchards, firewood supplies, outdoor classrooms, craft businesses, venues for art, and opportunities for cultural and heritage events. Public bodies need to be more community minded. If they trust and support local people, our forests can flourish.'

Can people be interested in forestry if the forests don't seem to belong to them? Are we still stuck with our own colonial systems? Is British community forestry just a walk in the woods? Hollingdale says the Forestry Commissions are good at doing things for communities, especially recreational work, but says that 'this isn't real community forestry where local people take over and manage forests themselves'. Increasingly, people want more control.

North Sutherland Community Forestry Trust wants to take over 566 hectares of plantation near Forsinain. The trust is one of half a dozen or so local initiatives in Scotland acquiring sites. Forestry Commission Scotland has approved these purchases, but forest land is expensive and, like other communities at Aigas and at Clauchrie, the Sutherland trust is struggling to raise funds.

'These communities want to take over big conifer plantations for local economic objectives to create local businesses and jobs based on timber, woodfuel and recreation,' says Hollingdale. 'It's easy to say community forestry is just access and recreation, but there is far more to it than that.'

Christopher Davey is a freelance journalist

The Fresh Kills landfill site is in the process of a dramatic conversion to biodiverse meadows Photo: Nick Kimbrell

Can a landfill site ever return to nature?

One of the biggest landfill sites in the US is in the process of becoming a nature reserve and a recreation ground. Is this just papering over the cracks, or can our rubbish heaps really turn into something beautiful? By **Nick Kimbrell**

At its peak in the mid-1980s, the Fresh Kills landfill site received 29,000 tons of rubbish every day. Now much of the site, which sits on the western shore of New York City's Staten Island, could be mistaken for a coastal nature reserve. Wildflowers grow on the sides of grass-covered mounds, which not long ago were mountains of rotting garbage, and there have been sightings of whitetailed deer and red-tailed hawks. For over a year, bi-monthly bird-watching tours have been popular with local enthusiasts.

The ongoing transformation of what was once the world's largest landfill into what many hope will become New York's most versatile park is emblematic of worldwide efforts to transform landfills and other contaminated sites into parks and public open space. But the ambitious Fresh Kills project, underway now for almost a decade, has also raised new questions about the potential profitability of these sites and the extent to which they can actually be restored.

At 2,200 acres, Fresh Kills – the completed park is to be restyled 'Freshkills' – will be New York City's second largest park, about three times the size of Central Park. Located on the city's least populous borough, Staten Island, the site was originally coastal marshland and estuarine creeks, but it opened as a landfill in 1948 to receive New York's ever-growing supply of municipal solid waste.

According to the original plan the landfill was meant to be a temporary site, open for about three years as a dump and a land reclamation project. Nearly 50 years and 150 million tons of garbage later, Fresh Kills was the city's only landfill.

Long the bane of Staten Island, the landfill was officially closed in March 2001, only to be reopened after the September 11 attacks to accept debris from the World Trade Center and serve as home to an FBI-led crime scene investigation.

The plan to turn Fresh Kills into a park was drawn up by the local and state governments with the support of the Municipal Arts Society. This plan, much of which has yet to be enacted, set out to include key aspects of urban ecology: to rehabilitate the land, promote sustainability and engage the local community.

'There definitely are environmental benefits to transforming the site into something positive, returning it to productive use,' said Carrie Grassi, Land Use Review and Outreach Manager at Fresh Kills, during a Jeep-tour of the sprawling site. 'But there is a psychological and social aspect to it that is about righting this wrong for the people of Staten Island and turning what was a landfill into a real asset, turning it into a public park, turning it into the park of the twenty-first century.'

Accomplishing this task, however, will continue to take a great deal of time and treasure. Before the bike paths and bridle trails, the barge gardens and kayak launches,

much of the infrastructure to cap the landfill and capture the byproducts of the buried waste must be completed.

Of Fresh Kills' four massive mounds, only the North and South Mounds have been capped. The East Mound, where dozens of trucks deliver bed-loads of dirt daily, will be covered by the end of next year. And the West Mound, where the 9/11 recovery took place, is expected to be completed by 2016.

This extensive capping process involves putting down a layer of barrier soil, a venting layer, a plastic geo-membrane, a drainage layer, two feet of barrier protection material, planting soil, erosion mats and, finally, plants.

According to Ted Nabavi, New York City's director of Waste Management Engineering, the estimated cost for the 285-acre East Mound is around $250 million.

The site's infrastructure also includes systems to capture leachate, a liquid byproduct of garbage, and landfill gas, composed principally of the greenhouse gases methane and carbon dioxide. The landfill, Nabavi said, can produce up to 10 million cubic standard feet of gas and 800,000 gallons of leachate per day.

Making use of waste

Although the site was retrofitted in the 1990s, Nabavi said that extensive monitoring systems were in place to ensure that neither of the potential hazardous byproducts migrates. These systems include 220 ground water monitoring wells, 12 surface waters stations, along with 200 gas wells, instruments and probes.

But the landfill's byproducts are not just an environmental threat, they are a serious source of income. Leachate, which is separated into solids and liquids, cleaned and then sent to other landfills and into adjacent Arthur Kills River, is of little value. But landfill gas, about 50 percent of which is methane, brings in as much as $12 million per year after being upgraded to mains-gas quality at an on-site facility. Each mound at Fresh Kills can generate sizable amounts of methane for around three decades after being capped.

Other landfills, like Los Angeles' Puente Hills, which is now the nation's largest, use similar landfill gas collection systems. The Puente Hills Landfill captures the equivalent of 1,000 gallons of diesel fuel per day. But many landfills do not have this capacity, and are looking to acquire it.

'A lot of the interest that we get internationally is because we are making money from the gas. The city is getting money from the gas,' Grassi said, adding: 'We try to use that as a hook in, to get them to start thinking about the full life-cycle, about the site and other ways the site can be productive.'

The money from the landfill gas is a great benefit, but the real draw for the city and its residents is the prospect of thousands of rehabilitated acres of park in a city with limited opportunities to acquire new green space.

Dr Steven Handel a professor of Ecology at Rutgers University, who spent years researching at Fresh Kills and still advises the city of New York, marvelled at the nascent transformation of the landfill.

'There's no sense that I'm standing on over 100 feet of household garbage. There's no odour and there's no feeling that you're on anything except rolling meadow in New York,' he said.

But the site's rebirth does not mean that historic habit can or will be restored. 'We feel we can bring back many native species and many ecological services but a return to its historic state is not possible,' Dr Handel said, noting that the now-filled site had once been coastal marches.

Rather than a return to marshes, he said,

'If there are sufficient resources you can do a lot to return structure, function and ecological processes'

the plan calls for 'wildflower meadows, coastal woodlands and shrublands,' which are native to, but increasingly threatened on, the east coast. 'It's been done elsewhere, and I'm confident New York City can do it as well,' Dr Handel said, pointing to the success of similar efforts such as Liverpool's Stadt Moers Park in the UK.

A work in progress

The idea behind reclaiming Fresh Kills is not new. Indeed, in recent years, efforts to turn closed and active landfills into parks and public open space have spread across the globe, from a sprawling site in Hiriya, Israel to Hong Kong's Sai Tso Wan Recreation Ground, which showcases solar panels and wind turbines.

And despite fears that some landfill metals, like aluminum, will one day be valuable enough to mine, Nabavi and Handel each rejected that possibility for sites like Fresh Kills, which offer significant social and environmental benefits.

Portions of Fresh Kills already show extensive rehabilitation. Waist-high grass, native perennials and a growing number of trees dot the North and South Mounds. In the centre of Fresh Kills, at the junction of its creek system, there's a family of nesting ospreys.

But the transformation into parkland is still very much a work in progress. Ongoing construction and more permanent reminders of the site's past belie the pastoral scene: there is the string of trucks and earth-movers on the East Mound, the faint smell of landfill gas on top of North Mound, the several flare stations and occasional huts and gas gauges.

The good and the bad

Dr Lynne Westphal, a project leader and research social scientist for the US Forest Service, has worked extensively with hazardous, polluted and contaminated industrial sites. She noted that the extent of rehabilitation at such sites, known as brownfields, depends on the site and its unique variations. Depending on the nature of the site, she said, these variations may mean that all or only some areas get rehabilitated.

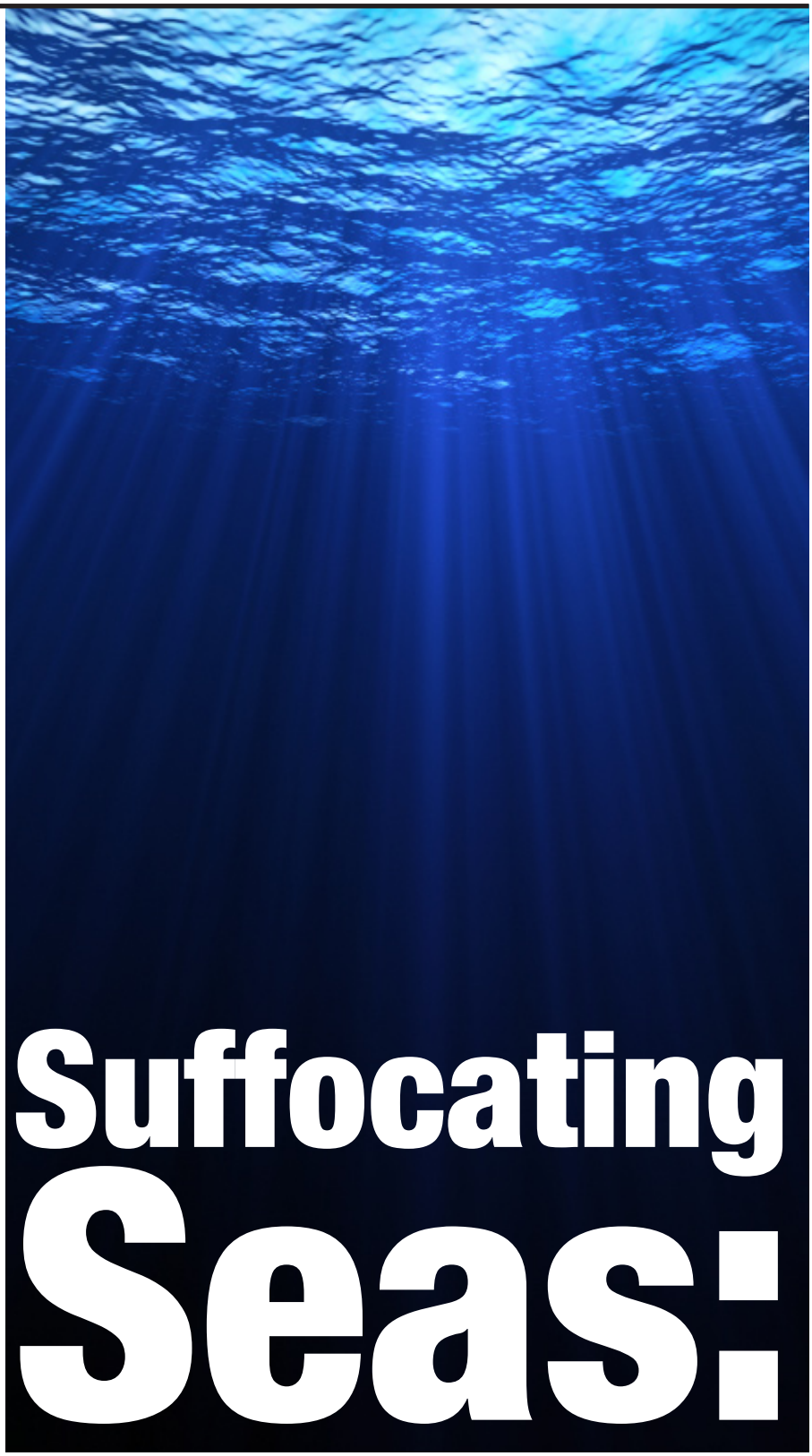
'Fresh Kills is a really good example,' she said. 'There's a lot of variation within Fresh Kills...there are big mounds with garbage but there are undisturbed areas as well.

'If there are sufficient resources you can do a whole lot to return structure and function and ecological processes,' Westphal added. 'One of the coolest examples is Crissy Field.'

This 100-acre former airfield in San Francisco was heavily contaminated after the military left the site but, thanks to donors and thousands of volunteers, it was largely restored to its historic tidal marsh and dune habitat. Now Crissy Field is exactly what Freshkills' planners hope their site will one day become: a dynamic and popular public park. Perhaps less like Crissy, the work at Fresh Kills, where the historic ecosystems have been permanently changed, appears to be less about restoring than what scientists and city planners have referred to as the 're-naturing' and 'healing' of severely damaged lands. But even those working to transform the landfill have no illusions about this process being a cure-all for the growing problem of waste.

'This park project is really worthwhile. [But] we haven't solved the garbage problem. And it's not meant to sort of pretend that we have,' Grassi said. 'From our perspective, building a park is not meant to cover up what this site was, but we want people to really think about land and our impact, how we use it and how we think about it. A lot of the education work with kids that we do is about: "Where does your trash go? How do you think about reducing that?"'

Nick Kimbrell is a freelance journalist based in New York



Suffocating Seas:

How climate change is reducing ocean oxygen levels

The main impacts of climate change – changing weather patterns, melting glaciers, sea level rise – are well known. But its ability to reduce oxygen levels in the deep ocean is little reported...

By **Carrie Madren**

Climate change's stealthy advance alters our oceans in two well-known ways: acidification and sea level rise. But our planet's subtle warming has had another, under-the-radar effect: oxygen depletion.

While oxygen depletion may not draw dramatic headlines or spark rallies, dipping oxygen levels pose a growing problem for marine life and fisheries. It works like this: first, as concentrations of greenhouse gases rise and the Earth warms, ocean temperatures rise. And since warmer water not only expands but also holds less oxygen than colder water, a rise in the mercury will leave fish and other marine life in certain areas without sufficient oxygen. Last July, global ocean surface temperature was the warmest on record: 1.06 degrees Fahrenheit above the 20th century average of 61.5 degrees.

Second, and more importantly, global warming stratifies the upper ocean, further limiting the oxygen supply to deeper waters. Scientists who study the ocean predict global ocean oxygen levels to drop anywhere from one to seven percent over the next century.

Expanding regions of low oxygen water have stressful and even deadly potential for marine life. In the most extreme situations, dead zones lack the oxygen levels sufficient to sustain life that once thrived there. Pockets of low oxygen waters can be found throughout the ocean, but for most worldwide waters, slightly sunken oxygen levels are not a disastrous problem — yet. But with the stakes so high for coastal fisheries and our oceans looming, can we still afford to ignore this climate change symptom?

Deep water

Dive down deep into a lake and you'll suddenly reach a layer of ice-cold water – the thermocline – where warmer water fails to mix with colder, denser water. 'The ocean is the same way, just on a bigger scale,' explains Scott Doney, oceanographer at the Woods Hole Oceanographic Institution in Woods

Hole, Mass. The farther down the ocean water column, the lower the temperatures plunge. Seawater near the bottom of the deep-sea circulates in from the poles at near-freezing temperatures and stays icy cold.

Even water at the sea floor near the Equator came from either the Arctic or Antarctica, says Doney. It's near the thermocline, between 400 and 1200 metres down, where oxygen minimum zones in the open ocean tend to lurk. 'In the future, most of the extra heat in the ocean will be trapped in the upper ocean, and so what you're doing is making that layering even stronger,' Doney explains. The result is sluggish circulation of high-oxygen water to lower depths.

The worst of the open ocean oxygen minimum zones can be found in the relatively stagnant cyclonic gyres that exist north and south of the equator in the subsurface layers of the Atlantic and Pacific oceans, according to a study by Ralph Keeling, Arne Körtzinger and Nicolas Gruber published in the *Annual Review of Marine Science*.

As mixing slows, climate change causes another serious problem: reduced nutrient cycling. In addition to supporting life, oxygen is key in the cycling of carbon, nitrogen and other elements. 'Expanded oxygen minimum zones can have the effect of stripping nutrients out of water,' Doney says. 'Over some time period, that may start to reduce productivity.'

So while lowered oxygen is in itself troublesome, it's one of many interconnected cogs slowly turning in a precise, calculated way that makes our ecosystem work. Disrupt one cog and the machine begins to break down.

A growing problem

Dropping oxygen levels aren't a new phenomenon: in the 1960s, oxygen levels were already beginning to fall in tropical oceans at depths of 300 to 700 meters. That's where oxygen is currently decreasing 0.09 to 0.34 micromoles per kilogram per year, according to a study by physical oceanographer Lothar Stramma of the Leibniz Institute of Marine Sciences in Germany, lead scientist on a 2008 study published in *Science*.

Aptly named 'dead zones', the most extreme end of the low-oxygen spectrum, already plague more than 400 coastal marine ecosystems in a total area spanning 245,000 square kilometers, according to marine biologist Robert Diaz of the Virginia Institute of Marine Science and lead scientist in a 2008 study published in Science. Each zone can cover anywhere from hundreds of square miles to thousands of square miles, and that dead zone coverage is expected to double each decade. Such extreme dead zones near the coast are mostly caused by eutrophication, fuelled by run-off from fields and sewage discharges. These dead zones could be made worse, however, by depressed oxygen levels in the open ocean, because coastal systems get

'Oxygen minimum zones are often next to poor countries where many rely on the sea for their livelihood'

some oxygen through seawater exchange with the open ocean.

Regions of low dissolved oxygen are also growing fathoms down in the ocean depths. Far below the ocean surface, dead zones span about 6.5 million square kilometers at a 500 metre depth, nearly the size of the lower 48 contiguous states, according to Gary Shaffer, professor of oceanography/climate at the University of Copenhagen and lead scientist for a study published in *Nature Geoscience* in January 2009. His team modelled projected global change over the next 100,000 years and found severe, long-term ocean oxygen depletion and expansion of ocean oxygen-poor zones. Even in the next 100 years, changes will be detectable. That 6.5 million square kilometers of dead zone may double in the next 100 years, and even more if ocean circulation is slowed by global warming, according to Shaffer.

Dead zones – including seasonal dead zones that worsen in the summer – have already formed in major fishery waters including the Gulf of Mexico, the Chesapeake Bay, the Baltic Sea, Kattegat, Black Sea, East China Sea and in the waters off the coast of Oregon, US. Faring nearly as badly, extensive oxygen minimum zones exist off the North American and South American coasts, the Arabian Sea, the Bay of Bengal and the west coast of Africa. Oxygen-poor waters from the open ocean can move into coastal waters through shifting currents, exacerbating human-caused dead zones in coastal areas.

The cost for ecosystems short on oxygen ranges from the death of bottom-dwelling benthic organisms to hindered spawning of cod in the central Baltic, according to Diaz. Marine life responds to low oxygen in many ways, and an organism's fate typically depends on its size – and diet. Fish and crustaceans are among the most sensitive to oxygen level drops.

'In the water column, fish and crustaceans are the most mobile, and tend to swim away first,' says Lisa Levin, a biological oceanographer at Scripps Institution of Oceanography in San Diego, California, followed by shrimp, crab and lobsters if oxygen decreases further. On the sea floor, many echinoderms – such as starfish, sea cucumbers and sea urchins – don't survive well when oxygen drops, says Levin, though brittle stars are the most tolerant of the echinoderms.

Near the coast, fish tend to prefer shallow, better oxygenated waters, which can mean higher densities of, and more competition between, fish in one area. Some fish have, however, learned to adapt. 'Anchovy and sardine, which normally live in upwelling areas, are affected but have evolved to live above oxygen minimum zones,' Levin says. A few species of bacteria have even evolved to live in anoxic conditions by oxidising sulphur, according to Levin. And, unfortunately for swimmers, jellyfish may flourish in low oxygen zones. Among the hardiest are organisms barely visible by the naked eye, such as nematode worms, which can survive with almost no oxygen.

Another tragedy of oxygen-minimum zones is lowered diversity in species. Habitat compression, too, can hurt diversity as areas of low oxygen expand and suitable habitat for shrinks, and animals must either move up in the water column or towards shores.

If marine life is forced to flee, animals would be concentrated in available habitat, as well as concentrated closer to shore, explains Levin, which would make them easier targets for fisherman. Such shore concentration could lead to an increased risk of over-fishing.

Climate Change

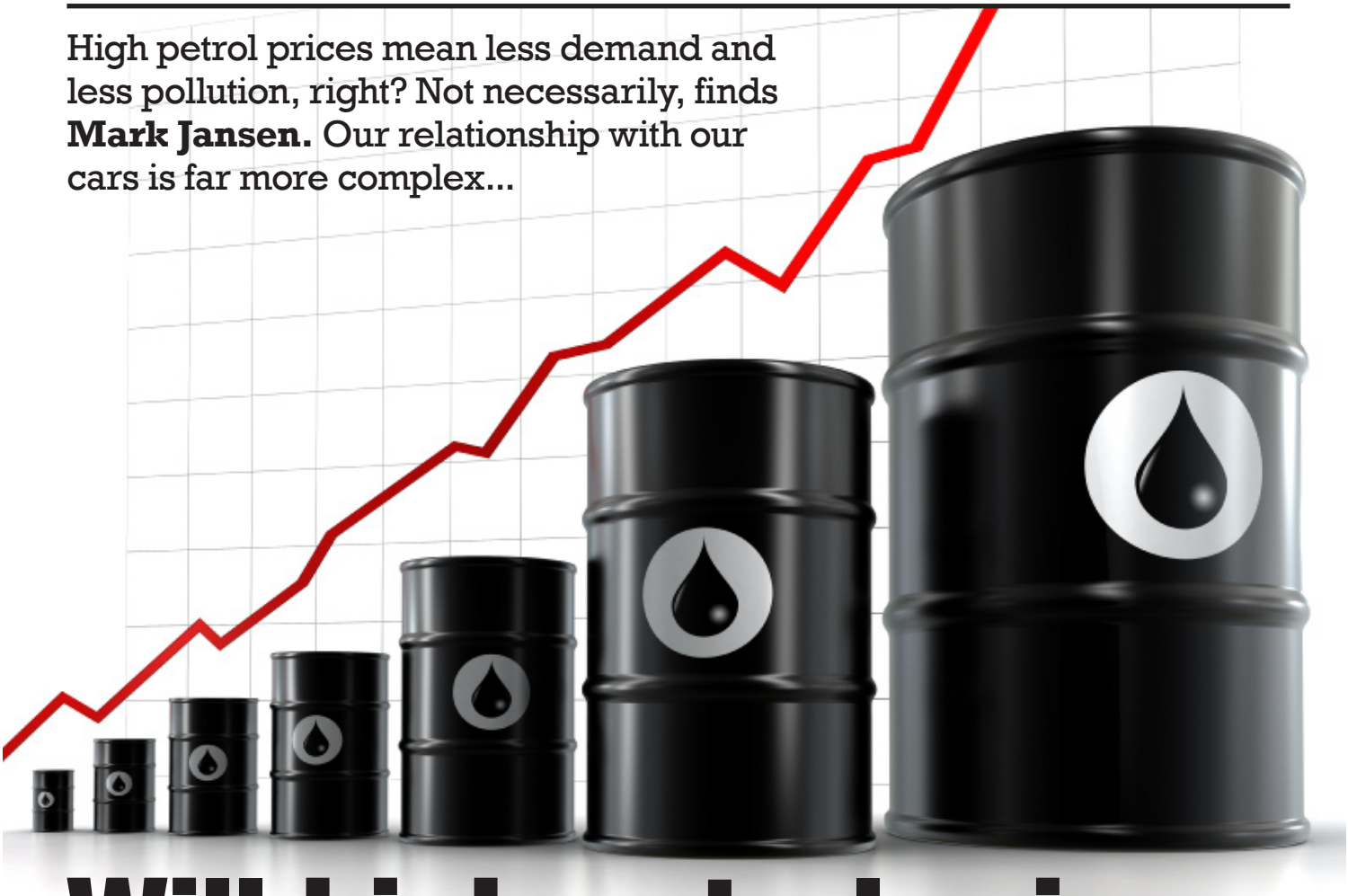
As oxygen levels drop, albeit slowly, in oceans worldwide, scientists finger climate change as the likely culprit. If we continue emitting greenhouse gases at current rates, future generations could see expanding ocean dead zones. But forecasting is a difficult science, with hundreds of variables, unknown factors and unforeseen outcomes. And there is much to be learned about how the ocean responds to climatic change. Even so, scientists are noting detectable changes in oxygen levels, and it's just a matter of how much, and how soon.

'People will feel it, especially in many fisheries along the coast,' Doney says. And, as with many problems caused by climate change, those with the fewest means may be hardest hit. 'Oxygen minimum zones are concentrated next to poor countries within which many depend upon the sea for their livelihoods,' Shaffer says. 'This is another blatant example, like that of sea level rise, where a problem created by the developed world will most affect the underdeveloped world.'

But like many symptoms of climate change, it's likely that these changes will be small at first, growing slowly over time. Curing coastal, human-caused dead zones, at least, is feasible: we could cut the amount of nutrients flowing into coastal waters by reducing the amount of nutrients allowed into local waterways. Next to the difficulties of curbing climate change, reducing nutrient run-off seems like easy pickings.

Carrie Madren is a freelance journalist

High petrol prices mean less demand and less pollution, right? Not necessarily, finds **Mark Jansen.** Our relationship with our cars is far more complex...



Will high petrol prices help the environment?

Petrol prices have been at a record high since April, when they hit £1.20 a litre for the first time.

High petrol prices are bad news for drivers, which means almost all of us, but those who care about carbon emissions may see some good in all this. Surely, the logic runs, if petrol prices are soaring, more car owners will use public transport instead, drive less and walk more, buy smaller and more efficient cars? By the same token, won't high petrol prices stimulate the development of alternative fuels?

Sadly, it doesn't work that way. Repeated studies have shown that petrol price rises have only a tiny impact on demand. The cost of petrol is comparatively low compared with life's other necessities, and rising incomes over the last 40 years have reduced petrol's share of household budgets. This is borne out by the continuing increase in car ownership in the UK. Transport experts even suggest that petrol prices would have to double before there is any discernible impact on carbon emissions.

Pump logic

Prices at the pump rose from 68p a litre in 1998 to 109p in 2008, according to the Department for Transport. That's a real-terms increase of almost 30 per cent, allowing for inflation. Yet motorists were completely undeterred, with the number of licensed vehicles in the UK rising from 27 million to 34 million over the same period. Although car engines are becoming more efficient, delivering more miles to the gallon, demand for fuel over same period rose 4 per cent, partly because big cars are becoming more popular than small ones. Between 1998 and 2008, the proportion of cars with engines smaller than 1.2 litres fell from 18.2 per cent to 11.6 per cent in the UK, while those over two litres rose from 8.5 per cent to 13.7 per cent.

With transport accounting for 23 per cent of UK carbon emissions, Jeremy Clarkson seems to have won the battle for hearts and minds. Dr Andreas Schafer, a lecturer in transport at Cambridge University and author of the book *Transportation in Climate Constrained World*, says research has proven again and again that price increases barely reduce demand for petrol. For example, US studies found that for every 10 per cent increase in fuel price, demand drops by less than 1 per cent. In other words, a doubling in fuel price would only reduce demand by around 10 per cent.

'The main reasons are that people have become richer and worry less about the price of fuel compared with two or three decades ago,' says Schafer. 'Cars have become more efficient, so fuel is a smaller part of total travel costs and we have become more dependent on cars – there are fewer alternatives.'

Managing without a car is also much easier in the city than in the country. In

London, for example, 43 per cent of households are car-less, compared with just 10 per cent in rural areas.

Crude currencies

Despite our rising wealth, petrol prices remain a sensitive political issue. In June, chancellor George Osborne announced a review of petrol duty and mooted the idea of a 'fuel duty stabiliser', whereby the amount of tax levied on petrol will go down whenever the price of crude oil goes up. Petrol taxes have fallen sharply over the last decade, from 82 per cent of the pump price in 1998 down to 62 per cent in 2008, according to the Department for Transport.

But it is the price of crude oil, rather than the price of petrol at the pumps, that will shape our energy future. Oil prices are extremely volatile, which undermines the willingness of industry to risk large sums of money on researching and developing cleaner fuels. They have no way of knowing whether their investment will be able to compete on price with petrol. For example, in 2008, the price of a barrel of oil reached almost $147 US dollars, before slumping to $47 and then staging a partial recovery to today's price of around $76. Shafer confirms that these price swings deter investment in green alternatives: 'The uncertainty about future prices is a big problem,' he says.

The reason UK petrol prices have not fallen in line with the price of crude is mostly to do with the weakness of the pound on the currency exchanges. Oil is traded in dollars and a weak pound will buy less of it. A spokesman for the motorists' lobby group the RAC says that wholesale oil prices charged by manufacturers to refiners and retailers have risen, for reasons that remain unclear.

Prices are only likely to fall further if the pound recovers and if there is a price war between big supermarket chains. In the meantime the increase in VAT to 20 per cent announced in January 2010, together with two more fuel duty rises scheduled for October and January, will add 3-4p a litre to the price of petrol, the RAC says. A spokesman is doubtful about the likely impact of Osborne's proposed fuel duty stabiliser: 'The world price of oil is just one factor affecting prices at the pump. It remains to be seen what difference it will make.'

To peak or not to peak?

In the past, big rises in the cost of oil have prompted massive investment in alternative fuels. The best example, Schafer says, is Brazil, which began investing heavily in biofuels during the oil crises of the 1970s, when it found it was achieving lower and lower prices for its sugar exports and paying more and more for oil. Today, ethanol derived from sugarcane accounts for more than half the fuel consumed by cars and vans in Brazil,

'The first oil crisis generated lots of research, but by the mid-1980s oil was back at $20 a barrel and it was all shelved'

Schafer says.

The US has also raised its ethanol production over the last decade, becoming the world's number one producer, although environmentalists are concerned that the fuel, which is derived from maize, uses significant amounts of fossil fuel in the production process. Ethanol only accounts for 3 per cent of US motor fuel consumption but this could double by 2012, thanks to incoming legislation passed under the Bush administration at a time when oil prices were rising.

For Shafer, the relationship between oil prices and the development of alternatives is clear: 'In the first oil crisis of 1973 the crude oil price went up from $12 per barrel to almost $50, adjusted for inflation, and during the second oil crisis in 1979 it rose from $50 to $100. The first oil crisis generated lots of research, in gas turbine engines for cars, electric vehicles, hydrogen fuel cell vehicles, but in the mid-1980s the oil price was back to $20 a barrel and all the research was shelved. And now, only recently because of our increasing concern about climate change, have we continued those studies.'

Despite this, Schafer does not believe that oil prices will rise sharply in future. 'My guess is that oil prices will not rise very much in the next 10 or 20 years, because there is still so much oil left in the ground,' he says. He does not believe the 'peak oil' theory, that rising demand for oil around the world will soon outstrip the available supply: 'I think there are enough oil resources to satisfy demand. If prices rise, more producers will come online, there will be more investment in new ways of exploiting the oil fields. We have heard the same stories again and again [about peak oil], yet there is no convincing evidence that we will soon run out.'

'I think we are reaching peak oil, so I think prices will rise. Demand from China, India and Brazil will also increase'

Emotional dependence

Not everyone agrees with Schafer's analysis. Dr David Bonilla, senior research fellow in transport and energy economics at Oxford University, says: 'I think we are reaching peak oil, so I would say that prices will rise. There is rising demand from emerging economies like China, India and Brazil, it is clear that oil companies are having problems finding new oil – the oil spill in the Gulf of Mexico will reduce drilling in that part of the world – so I would say the price is going to go up.'

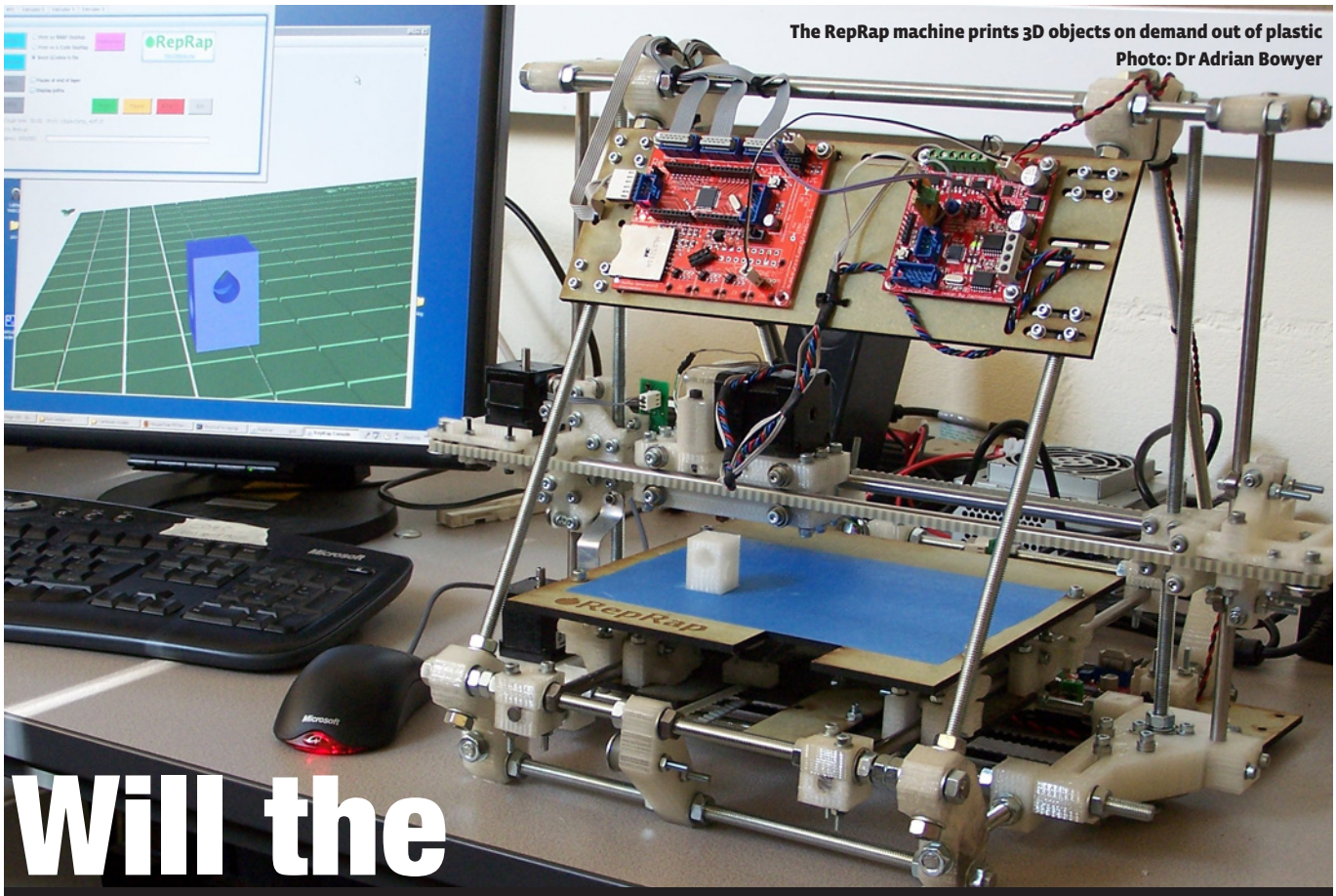
Unfortunately Bonilla believes petrol prices still have a long way to rise before there is any serious fall in demand. A useful analogy, he says, is to compare the price of petrol per litre with that of bottled water: 'They are about the same, and this tells you that energy is too cheap. The price of energy would have to at least double... to have some impact on consumption.'

However, Bonilla makes the intriguing point that emotions may play a much bigger role in reducing humanity's reliance on petrol than money alone. 'In the US, the government is talking about achieving energy independence, but this only started after the 9/11 terrorist attacks on the World Trade Center,' he says. 'It is an emotional response to US dependence on Middle Eastern oil.

There has been a political shift in the US and the role of emotion is very much underestimated.' Greg Marsden, senior lecturer and leader of the Sustainable Transport Policy Group at the University of Leeds, believes that taxes based on the amount of CO_2 emitted by different vehicles may be the most effective way to cut carbon emissions from transport. In 2003 the Company Car Tax Initiative levied higher taxes on the most polluting fleet cars. Within three years, emissions from fleet cars (owned by companies for their employees) had gone from being 5 per cent more polluting than the average privately-owned car to 5 per cent less. Road taxes for all cars have since been graduated to favour those with low emissions. 'If the Government doesn't want to clamp down on car ownership, incentives to make people buy the most efficient car could be quite effective,' says Marsden. 'Then again, people do tend to buy according to the fact that they love a Saab, or whatever it is.'

It seems that Jeremy Clarkson will continue to rule for a while yet.

Mark Jansen is a freelance journalist



The RepRap machine prints 3D objects on demand out of plastic
Photo: Dr Adrian Bowyer

Will the RepRap machine bring a new manufacturing and the end of consumerism?

3D printing machines such as the 'RepRap' already allow people to design and 'print out' products at home. Could this be the beginning of the end for traditional, capitalist manufacturing?
By **Ann Danylkiw**

Little Maddy is furious. Her face has gone bright red from holding her breath, multiple dried lines of tears on her plump toddler face.

Maddy is in the throes of a tantrum because she can't wear her favourite pair of shoes. She's outgrown them. Her mother has repeatedly bought the same pair of shoes as she's grown older – there are now four pairs in a box in the basement – but Maddy is now too big for the style. What's a mother to do?

Maddy's mother calms her daughter, and heads to her computer. She downloads the shoe specs from the shoe company's website onto a memory stick, takes the old shoes and some empty plastic bottles from the recycling bin and heads to the techshop that's just opened on the high-street. It has a 3D printer available for public use, and can turn out a new pair of shoes 'while-u-wait'.

This is the intermediate future, according to Dr Adrian Bowyer of the University of Bath's Innovative Design and Manufacturing Research Centre. Bowyer was one of the principle contributors to the RepRap open source project. RepRap is an innovative 3D printing machine that's not only capable of almost completely replicating itself but also building its own extension modules. The machine was developed through the mutual effort of a community of users – any user can innovate on the design, and share it on the community's website.

Bowyer imagines the day when we will have 3D printers in our homes. The intermediate stage he says, is akin to the corner photo printing shop.

'When my child's feet grow, I just take [her old shoes], run them through the shredder

with a little bit of extra plastic and print out a new pair of shoes 1.1 times as big and the child has got a new pair of shoes that fit again.'

The proliferation of the technology will in time give start-up entrepreneurs and individual consumers the ability to print 3D items at home, much in the way we print colour pages now.

Although the technology was initially limited to simply printing plastics, it can now also construct clay and ceramic molds for metallurgical use, and work with pastes that conduct electricity – a key step towards the ability to produce electronic components.

The end goal of the technology is that the RepRap and its ilk can entirely replicate themselves – at the moment, it can print the majority of its own parts, but not all. Bowyer is currently working on the plastic shredder head that will allow users to recycle plastic, and will probably use the RepRap machine itself to manufacture the part.

A new business economics

More than just a cool new bit of kit, the RepRap and machines like it offer a paradigm shift in the 'story of stuff'. The technology nicely fits into the brave new green world we are entering, and demonstrates that it doesn't have to be austere. Our notion of prosperity linked to economic growth could be turned on its head by the consumption shift that 3D printing machines offer: the ability to make, in a small co-operative business or at home, highly bespoke goods, to re-make or repair goods you already own rather than buying new – in essence, the creation of 'guerilla manufacturing.'

Dr. Andre Reichel, a researcher at the University of Stuttgart is one of very few academics addressing ecological, low/non-profit manufacturing models.

'Profit and growth need not be connected, because the only thing needed for a company... is to see that their revenue matches their [operating] costs. If they exactly match these costs, the economists say that they have a actual profit of zero. Everything else is nice to have and it's just that: nice to have.'

It's a radical idea: that a new economic paradigm will emerge in which the central idea becomes the product lifecycle rather than producing goods of just-good-enough quality that must be replaced in their entirety every few years. For companies, this means switching to operating models of low-to-no profit. Reichel believes companies need to think about what profits mean qualitatively – and how much profit is enough as economies move from primarily ones of scale to ones of scope.

'It's all about appropriate technology – if you're travelling 1 km, the right technology is the bicycle'

Daniel Paterson, founder of ManufacturingChange.org (a social network that supports organisations aiming to bring about social change through manufacturing) has worked in manufacturing in both the developed and developing worlds and sees very clearly how 3D printing technologies have the potential to transform global consumption patterns. He believes that the traditional Marxist model of manufacture – which requires a capitalist's 'capital' to get things started – will be challenged.

'The capital question is much less when you start breaking things down. What happens when you have a local community making things for themselves is that they only make what is needed. When we need a new bicycle, we make a new bicycle, we don't make a thousand of them and try and flog them to people,' he explains. 'So it's inherently much more efficient and that is what will drive it economically, that's what will take the switch from where we are now to open source space.

'It's all about appropriate technology. Use the right technology for the job at hand. If you're going to go one kilometer away from your house, a car is not the appropriate technology – a bicycle is the appropriate piece of technology.... once you take into account the full value chain, it's never going to be more efficient than doing things locally.'

Paterson sees 3D printing technologies, especially the RepRap project, as bridging that behavioural and practical gap towards appropriate technology.

Make do and mend

Bowyer gives another example of the technology's potential for minimal input use. His daughter recently needed a repair to the grill plate on her car. She went to her local garage and was told that in order to repair the grill, she'd have to have an entire part replaced for a cost of £120. Defiant, Bowyer fired up the RepRap machine that sits in his spare room and printed out a simple bracket for the repair. 'It took us about 20 minutes or a half an hour all together – less time than she'd taken to go to the garage – and fixed it up to the car. It cost about 10 pence and it's still driving around with it today.'

Beyond making only what we need, 3D printing technology has the potential be more sustainable than conventional plastic manufacturing. Bowyer says that the primary feedstock used by the RepRap machine is a polylactic acid derived from biological materials. So not only is it biodegradable, but in the production process stores up CO_2. Bowyer explains: 'What that means is that you don't even need to have transportation of the raw materials. Anyone with a few square metres of land can grow a plant crop and thereby produce the material that their machine requires.'

The importance of open source

This dream scenario for decentralised manufacture does require more than just raw material and clever machine, however: it needs a continued open source spirit and more free data. Bowyer expects that the spread of RepRap-like technology will do to the patent what mp3 files did to copyright. 'There'll be an enormous exchange of information, such as shapes of brackets that are needed by people, and people will be able to share that sort of information over the web in the way that they currently share other information.'

How and if that information remains proprietary will, of course, become the subject of sore debate. Companies may well have to shift from manufacturing end products to simply producing saleable 'blueprints' for desirable products.

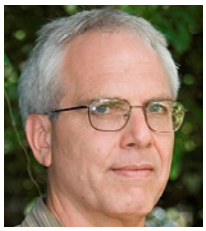
Reichel suggests that a new buzzword will find its way into business practice: sufficiency. 'Sufficiency aims not at technological innovation but at behavioural innovation – so changing what people are actually doing, how they use a product, what kinds of products they're actually buying. Or for companies, what kinds of products they are really selling,' he says.

Sufficiency should have the knock-on benefit of seeing companies shift their focus to entire product life-cycles – it's not a far stretch to see that for guerilla manufacturing, or even personal manufacturing, bits of product plans for repair can be made available for download.

Reichel's suggestion of a sufficiency paradigm and product life-cycle focus can accomplish this, if companies are willing to re-envision manufacturing products so that they can be repaired at home by making previously proprietary information available to the consumer on the website – and manufacturing products in such a way that they can be easily repaired.

As to the full implications of 3D printers, we can only speculate. But it's easy to see how 3D printing technology, especially 3D printers that can self-replicate and self-expand and work across different types of material inputs from plastics to clays to electrically conducting pastes may make it possible for anybody to be an entrepreneur. The paradigm shift may well be at hand; the RepRap technology, a catalyst.

Ann Danylkiw is a freelance journalist



I applaud Norway's $1bn funding offer to Indonesia. But where will that money go?

Professor Bill Laurance wants to know if the Norway's groundbreaking cash injection will reach the right people

Indonesia is probably the world's most biologically bountiful nation but no country is losing forest faster. Vast expanses of Indonesian Borneo, Sumatra and New Guinea have been denuded in recent years. Beyond imperiling countless species, the rampant destruction of Indonesian rainforests and carbon-rich peat-forests is spewing enormous quantities of greenhouse gases into the atmosphere.

Is there a way to halt this ecological Armageddon? Countries like Indonesia need to develop economically, so one can hardly expect them to stop logging and felling forests off their own bat. Fortunately, a ray of light has appeared on the horizon. Norway recently offered Indonesia up to $1 billion if it substantially slows its forest loss over the next two years, on top of $1.2 billion Norway has already committed to curb deforestation in other tropical nations. These deals are an effort to kick-start 'REDD' – Reducing Emissions from Deforestation and forest Degradation.

Around a fifth of all human-caused greenhouse gases come from the rapid felling of tropical forests. Under plans for the successor to the Kyoto Protocol, which should commence in 2012, industrial nations like Norway will be able to pay developing countries like Indonesia to slow forest destruction. In return, the industrial nation could then claim carbon credits for the reduced emissions, helping it to meet its international obligations to slow climate change. It's potentially a win-win deal for both parties. At the moment, however, Norway isn't even asking Indonesia for carbon credits – just showing tremendous global leadership in promoting REDD.

International concerns

But don't pop the champagne corks just yet – big challenges lie ahead. Most worrying is Indonesia's patchy record in forest conservation. Immediately before the Bali climate conference in 2007, for instance, the country trumpeted a ban on the draining and clearing of its peat-swamp forests, which create massive carbon emissions. Just two years later the ban was quietly dropped to allow two million hectares of peat-forest to be cleared.

Forestry expert Jeff Sayer cautions that over one billion dollars has already been spent by international donors to promote forest conservation in Indonesia, but so far there is little to show for it. For example, despite a government pledge in 2007 to cut destructive forest burning by half, the number of fires leapt by 59 per cent across the country from 2008 to 2009.

Some worry that Indonesia is trying to have its cake and eat it too. For instance, while no new permits to log or clear forest will be issued, existing permits will be allowed to proceed. These permits cover vast expanses of land – as of 2008, around 26 million hectares for industrial selective logging and at least 11 million hectares for oil palm, rubber and pulpwood plantations.

Collectively, this is over 1.5 times the size of the entire United Kingdom, providing much scope for forest loss and degradation to continue.

One way around this conundrum is for the Indonesian government to implement land-swapping – requiring permit holders to establish their new plantations on degraded land, rather than clearing old-growth rainforest. This could yield real benefits, but caution is needed because the Indonesian Ministry of Forestry has often classified even lightly logged forests as 'degraded land' as a pretext for allowing them to be cleared. Other areas of ostensibly degraded land are actually high-value agroforestry plots controlled by local communities, and these also must be protected.

Independent monitoring

A particularly welcome feature of the Norway agreement is that it will establish an independent forest monitoring agency outside the Indonesian Ministry of Forestry, which has long had close ties to industry-political elites in Indonesia. These elites own or control many of the industrial timber firms that are major drivers of forest disruption. An independent monitoring agency should also help to combat illegal logging and forest clearing, which is an enormous problem in the country. Forest experts were pleased when Indonesian President Yudhoyono openly acknowledged the enormous problem of illegal logging and land clearing in the country.

One of the biggest challenges facing the Norway deal is the need to distribute the conservation funds in Indonesia fairly. In addition to compensating the central government, substantial funds must also reach local authorities in forest-rich regions. These authorities control most permits for forest clearing, and those that slow deforestation will have to justly rewarded. In practice this could be difficult, because the funds might become tied up in bureaucratic tangles or the central government might simply absorb the lion's share.

Yet for all the potential hurdles involved, the Norway agreement is truly groundbreaking. It could reduce the influence of the powerful Ministry of Forestry with its pro-industry bias and help place forests more firmly in the control of Indonesian civil society. More broadly, it is helping to show developing nations that forest conservation really can pay important dividends.

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