EDITORIALS

Something in the air

High levels of air pollution are dangerous, damaging and a global disgrace. Science can help by offering better models for monitoring and exposure.

Air pollution was once celebrated. Industrialists in Victorian Britain would point to the smoky streets of the Industrial Revolution and see only the signs of wealth and progress. Alerted in the 1960s to the stink of an Alabama paper mill some 30 kilometres away that was reaching the state capital, Governor George Wallace remarked: "Yeah, that's the smell of prosperity."

Public attitudes have changed. Clean air to breathe is widely recognized by the United Nations and others as a universal human right, essential to physical well-being. But a change in mindset about air does little to actually clean it. More than four million people still die each year from exposure to polluted outside air — an intolerable situation, and one that is perpetuated by urbanization and regulatory impotence.

Nine out of ten people live in places where outdoor air pollution exceeds guidelines set by the World Health Organization (WHO). Hotspots are congested urban areas in low- and middle-income countries such as India, Nigeria and China. In some megacities — Mexico City, for example — authorities have begun to adopt cleaner vehicle standards. But fine particulate matter and nitrogen dioxide from vehicular traffic, energy production, industry and heating remain a serious public-health risk in most built-up areas.

Even many cities in wealthy Europe fail to meet the WHO standards. A report last week by the European Court of Auditors, which regularly scrutinizes the effectiveness of European Union policies and programmes, concludes that action taken so far to improve air quality is not sufficiently protecting citizens from pollution. Cities that auditors visited for the report — including Brussels, Kraków, Milan and Sofia — have made little or no progress since 2009 in reducing particulate matter pollution (Kraków and Sofia) or since 2012 in reducing nitrogen dioxide levels (Brussels and Milan). Although emissions of air pollutants have been decreasing overall, most member states still do not fully comply with stringent EU air-quality standards set up in 2008.

The European Commission has already taken several member states to court over their failure to introduce appropriate measures. Meanwhile, a 2015 scandal over faked Volkswagen vehicle emission tests in the United States has helped to bring the problem to greater public and political attention by offering a corporate villain. Low-emission zones in London (a persistent offender when it comes to breaching clean-air regulations) and many other European cities now ban badly polluting vehicles or restrict their access. That is good news for some metropolitan neighbourhoods, but it is only a first step. Little overall benefit is gained, for example, if diesel cars that are no longer wanted in Europe are pushed by manufacturers into markets abroad.

Effectively tackling the causes and effects of air pollution requires a more joined-up approach. Air-quality regulations in the EU, for example, must be taken into account more fully when setting policies on climate, transport, enterprise, trade and innovation.

Science, too, can do more to mitigate health risks from poor air quality. It is important to unpick how different types and levels of pollution affect human health. The epidemiological research needed to do that requires more-consistent methodologies to monitor and report pollution and human exposure to it.

Scientists can also help to develop and provide well-tested modelling tools that local authorities can use to improve assessments of their specific circumstances, and to design action plans. The Forum for air quality modelling in Europe (FAIRMODE), a joint programme by scientists with the European Commission's Joint Research Centre and the European Environment Agency, is tasked with developing air-pollution models and is working to harmonize monitoring methods across the bloc. But as air-quality concerns continue to grow, the forum must liaise more with city leaders and health specialists to make sure they get the tools and data they need.

> ***"This environmental science should be shared with countries worldwide."***

The results of this environmental science should be shared with countries worldwide. The situation is bad in rich countries: the WHO says that about half of city dwellers in developed nations are exposed to air that does not meet its guidelines. In cities of more than 100,000 people in the developing world, that figure rises to include almost everybody (97%). India alone has nine of the world's ten most-polluted cities. Air is a shared resource. Research and tools to make it safe to breathe should be shared as well. ■

Fighting fraud

An Austrian success story shows one way to tackle misconduct.

Many countries are trying to clamp down on scientific misconduct. Last week, the UK government promised to look into setting up an independent body to oversee institutional investigations into research misconduct, and the Netherlands has revamped its research-integrity code. Last month, India said it would crack down on widespread academic plagiarism. And earlier this year, Chinese officials pledged to get tough on academic fraud with new laws that include a dedicated government agency to police misconduct.

The problem is that much of this renewed political attention is not translating into meaningful action. High-profile cases of exposed malpractice continue to pile up, and surveys of researchers regularly confirm that poor behaviour is shockingly more common than many who promote the values of science might want to accept.

So it is promising to report from a meeting in Vienna last week that was held to celebrate ten years of the Austrian Agency for Research Integrity. The organization is not perfect, but it has much to be proud of. Its work shows what can be achieved given the requisite political will. And it reveals some of the problems that remain, in Austria and elsewhere. Officials in countries that are looking for ways to tackle misconduct should pay close attention.

Lesson one: act quickly and decisively. The agency was born out of a scandal that rocked Austrian science to its core. In 2008, the Austrian Agency for Health and Food Safety deemed a clinical trial of an experimental therapy for urinary incontinence to be illegal and invalid. The trial, led by Hannes Strasser at the Medical University of Innsbruck, was conducted without appropriate approvals, and did not adequately inform or protect patients. But the university initially failed to investigate.

At the time, an Editorial in *Nature* lamented the sorry state of Austrian science, which was riddled with rigid hierarchies that deterred many from raising complaints and concerns (*Nature* **454**, 917–918; 2008). The article called for the nation to speed up the creation of an independent body to investigate cases of academic fraud, which it had been planning and discussing for some time.

It did so. Since June 2009, the agency has handled 144 allegations of research fraud, and confirmed 40 cases. Of the rest, 12 are ongoing. In 31 cases, it was not possible to determine whether misconduct had occurred, and for a further 37 the allegations were not within the remit of the agency (for the most part, these revolved around labour disputes). The remaining 24 were either not followed up or were investigated by the university in question.

Lesson two: institutions have nothing to fear. The Vienna agency offered a confidential route for research scientists to report concerns, but required institutions to buy in to the agency by becoming members. Initially, many universities were reluctant to sign up, fearing their reputations could be ruined if they were found to be harbouring fraudsters. But the ministry of higher education linked membership to funding, which quickly persuaded them to change their minds. All of the country's 22 public universities have now signed up. Sanctions against researchers found to have committed misconduct are left to the universities. According to the agency, these include sackings and retractions.

Lesson three: one size cannot fit all. Any investigatory system must consider unique aspects of a country's research system. The Austrian agency, for example, uses scientists working outside the country to assess the complaints. This is crucial for protecting the process from undue influence from strong local networks and loyalties within the small nation's academic research community of fewer than 20,000 people.

"Research misconduct is moving higher up the political agenda."

Lesson four: wider legal reforms are necessary to properly address cases of fraud. Much behaviour that science frowns on is not explicitly against the law, and findings of misconduct and associated penalties can themselves be challenged in court. In 2012, the Austrian agency concluded that protein crystallographer Robert Schwarzenbacher had faked the structure of a birch-pollen allergen. Schwarzenbacher lost his job at the University of Salzburg, but later sued the institution for unfair dismissal. The case was settled out of court. In 2011, an employment tribunal ordered that Hannes Strasser be readmitted to a teaching post at the Medical University of Innsbruck. (He lost that post in 2014 when a final criminal-court ruling sentenced him to jail for aggravated libel related to the case.)

The legal status of scientific fraud is a thorny issue — and one hotly debated. But Sweden, following Denmark, is already working to define research misconduct in law so that there are clear lines in place. Laws against misconduct would also compel more institutions, such as those that are privately funded, to act transparently.

Research misconduct is moving higher up the political agenda. And for countries that are in the process of creating systems, revamping old ones or assessing their achievements, Austria offers a good example to follow. Institutions that continue to drag their feet on the problem should take careful note, too. ■

False fuels

Clever chemistry brings synthetic kerosene and petrol closer.

Necessity is the mother of invention, and a century ago, nations needed petroleum. They could run ships on coal, but burning solid lumps of fuel was impractical for cars and tanks, and unsuited to aircraft. Unlike other countries, Germany had no access to crude oil, so two chemists there — Franz Fischer and Hans Tropsch — invented a way to make synthetic petroleum from coal in 1925.

Their Fischer–Tropsch (FT) process could now help countries and companies that want to phase out fossil fuels: if coal can be turned into liquid fuels, then, theoretically, greener alternatives such as biomass could be as well. But so far, efforts to do this have been inefficient, and certainly not cheap enough to compete with oil.

A study in *Nature Catalysis* this week points to a possible way forward. Chemists in Japan and China have boosted the FT process, and improved on how it can be steered to produce different liquid fuels (J. Li *et al. Nature Catal.* http://doi.org/ctxv; 2018).

Although the FT process is good at converting gases — used directly, or produced from solids such as coal or even ground-up peanut shells — it's rather unfussy about what it churns out. Mostly, that's a blend of synthetic-petroleum products, from light gases such as methane through to heavy waxes (think Vaseline). The most useful stuff, such as petrol, diesel and aviation fuel (kerosene), falls somewhere in the middle, and must be separated and purified. That typically makes large-scale FT synthesis of those fuels a two-step process, which increases costs, complexity and pollution.

As a consequence, it's usually used commercially to make synthetic liquid fuels only where the feedstock is unusually cheap (China operates some facilities that process coal), or where there is no alternative (the South African company Sasol developed an FT process to liquefy coal when access to foreign oil was denied by sanctions in the apartheid era).

The latest study shows that this conversion can be made more selective. With small tweaks to the composition of the catalyst used — a well-known porous material, called a zeolite, mixed with cobalt nanoparticles — the team steered the chemical reaction to produce significant quantities of the desired liquid fuel. For example, the chemists could tune it to make 74% pure petrol (gasoline) or 72% pure jet fuel. Conventionally, it was difficult to produce anything more than 50% using FT synthesis, in a process usually based on iron or cobalt catalysts supported on silica or aluminium oxide. This is one of a string of recent results to show that barrier can be overcome.

There remains some way to go. Zeolite-based catalysts are notorious for their fast deactivation, and the paper reports the synthesis of the fuels in a reactor the size of a thimble, using just a single gram of catalyst. To make it economical, the process would need to be run stably for much longer and scaled up to much larger reactors using at least 100 tonnes of catalyst. Enthusiasm for synthetic fuels ebbs and flows with the market: they were popular a decade ago when oil prices were at record levels, but not so much now. There is no guarantee that the market demand for these fuels will drive the necessary investment.

Noritatsu Tsubaki, a chemist at the University of Toyama in Japan who led the project, says a major advantage of the process is that it could be used to make 'one-step' direct synthesis of kerosene and petrol from FT reactions for the first time — with yields high enough to avoid needing the separation step. Several airlines are already looking into FT chemistry as a source of fuel, and Tsubaki says his team plans to contact airlines and aircraft manufacturers with the findings. The necessity is clearly there, and now, so is a possible invention. ■