

The education ministry has not released the names of the researchers involved in the cases, nor the journals in which they published. However, according to South Korean media reports, many of the papers appeared in journals included in the Science Citation Index (SCI). The ministry told *Nature* that the initial review relied on universities to self-report cases, and was not exhaustive because many staff members were on their winter holidays.

INDEXED PAPERS

In its continuing probe, the education ministry intends to examine papers by South Korean authors indexed in citation databases, including the SCI, Web of Science and Scopus, and to cross-check the names against the family relationships of 76,000 full-time faculty members. The investigation will run until 16 March.

The ministry intends to refer each case to the corresponding university's research-ethics committee to confirm whether it constitutes misconduct or legitimate authorship. If the student co-authors did not participate in the research, academics will face possible disciplinary action, including dismissal, the ministry said.

So far, the most-affected universities include some of Seoul's elite tertiary institutions: Sungkyunkwan University (eight cases), Yonsei University (seven cases), Seoul National University and Kookmin University (six each). A Sungkyunkwan spokesperson confirmed that the university would be opening probes as per the ministry's request, including possible penalties of dismissal.

Yonsei University declined to answer *Nature's* questions about the investigation, pending further information from the government. A Seoul National University spokesperson emphasized that there has not yet been any finding suggesting that actual misconduct had occurred, and that its research-integrity committee would investigate all cases.

A spokesperson for Kookmin University told *Nature* that an initial review of the institution's cases indicated that the collaborations were legitimate. "We have some records and notes that their children participated in a lot of activities. So we think we don't have any problem," he said.

The practice has sparked a national outcry. In an editorial, the *Korea Herald* called the acts "no less than fraud, which greatly threatens the integrity of universities and education as a whole in Korea".

The education ministry said that any students listed as co-authors who did not participate in the research would have their university admission revoked. ■



Most container ships burn heavy diesel fuel that produces black carbon.

AIR POLLUTION

UN targets black carbon from ships

Nations are advancing efforts to reduce sooty emissions.

BY JEFF TOLLEFSON

Governments are poised this week to begin discussing rules to curb black-carbon pollution from ships, after nearly seven years of preparation. The sooty emissions, which are produced by diesel engines, warm the climate and harm human health.

At a meeting in London, a panel of the United Nations International Maritime Organization (IMO) is expected to agree on measurement techniques to gather data that could support eventual regulations. That is the second step in a three-step process begun in 2011. Agreeing on a definition for black carbon took four years; the final step, writing rules, could take a few more.

Reducing the amount of black carbon emitted by ships could have a significant impact on the climate. The pollutant, a melange of particles and oil droplets that come in many shapes and sizes, is the second-largest driver of global warming — behind only carbon dioxide. Diesel engines, such as those in ships, account for around one-fifth of the world's black-carbon emissions, according to a study published in

2013 (T. C. Bond *et al.* *J. Geophys. Res. Atmos.* **118**, 5380–5552; 2013).

The pollution is also dangerous when inhaled, in part because black-carbon particles collect other contaminants — such as sulfuric acid and heavy metals — as they travel through the atmosphere. Advocates are pushing the IMO to speed up its negotiations, which involve more than 170 countries. "We really only have 90 minutes per year where we are actively discussing the topic, so it's easy to delay and to stall," says Bryan Comer, a senior researcher at the International Council on Clean Transportation, a non-profit research group in Washington DC.

Although global black-carbon emissions from diesel engines on land are roughly 20 times higher than those from ships' engines, the health and environmental impacts of shipping pollution hits many busy ports and coastal areas disproportionately hard, says Daniel Lack, an independent consultant in Brisbane, Australia. "When you concentrate all of these ships into specific areas, all of a sudden they become one of the most dominant sources of pollution."

One area of special concern is the rapidly melting Arctic. The region's shipping traffic ▶

► is projected to increase in the coming decades, as sea ice recedes — a thaw that could be exacerbated by particles of black carbon, which hasten melting when they land on snow and ice.

Measuring black-carbon emissions is not a trivial task, Lack says. The most accurate, and expensive, technology fires a laser pulse through exhaust samples in a tube. Black-carbon particles absorb and then release the energy from the pulse, creating a pressure wave whose strength is equivalent to the amount of light that was absorbed. The shipping industry is pushing for a cheaper, but less accurate, method that draws exhaust through a filter; measurements of the reflectivity of that filter before and after use are then used to determine how much pollution a ship emitted.

Both approaches could serve a purpose as the IMO moves forward with regulations, Comer says. But he adds that many of the regulatory actions that the organization could pursue to reduce black-carbon emissions do not require regular measurements from ships. Shifting from ‘heavy’ fuel oil to cleaner types — similar to those used in trucks — would reduce ships’ black-carbon output by 35–80%, depending on the engine. And installing filters on the vessels’ exhaust systems would cut emissions by at least 85%.

The shipping industry is under pressure to curb other types of pollution. The United States, Canada and the European Union already require ships to use lower-sulfur fuels in some coastal zones. And in 2016, the IMO agreed to reduce the sulfur content in all shipping fuels from 3.5% to 0.5% by 2020. That is good news for public health, but it could inadvertently exacerbate global warming, says James Corbett, an engineer at the University of Delaware’s School of Marine Science and Policy in Newark.

In a study this week (M. Sofiev *et al.* *Nature Commun.* **9**, 406; 2018), Corbett and his colleagues found that the IMO sulfur standard could reduce global cardiovascular and lung-cancer deaths attributable to fine particulate matter by 2.6%, and the incidence of childhood asthma by 3.6%. But the new standard could accelerate climate change by decreasing the number of bright, sulfur-containing particles in the atmosphere that cool the planet by reflecting sunlight back into space. The researchers estimate that this effect would increase the human contribution to warming by around 3%.

“We’re talking some big numbers,” says Corbett.

For Comer, that is all the more reason to press forward with black-carbon regulations. “It’s frustrating,” he says. “We already know how to control [black-carbon] emissions, but we’re stuck going through the three-step process.” ■



Cuts to Bulgaria’s science budget sparked strikes in November, following earlier protests by students.

BUDGETS

Funding cuts hit Bulgarian science

A push to attract investment in innovation has floundered.

BY INGA VESPER

European Union science ministers met on 2 February in their bloc’s poorest member state — Bulgaria — to discuss future EU research policy. For the host nation, it was supposed to be a chance to showcase ambitious plans to boost economic growth by attracting international research institutes to the country.

But the timing of the event was awkward, to say the least. In July 2017, Bulgaria had been due to receive €150 million (US\$186 million) from the EU to build facilities for research and innovation, under a programme that aims to boost economic growth in poor regions. The programme, which was expected to give Bulgaria €700 million between 2014 and 2020, is designed to help with the costs of research infrastructure.

However, EU authorities withheld the money after Bulgaria failed to identify enough sufficiently qualified scientists to evaluate the proposals. Then, in November 2017, the Bulgarian government cut its 2018 science and higher education budget by around 25%, a move it had planned in anticipation of the windfall.

The decision has frustrated scientists in Bulgaria, because they had wanted to use the new infrastructure to forge links with

researchers outside the country. “Now, we cannot prepare proposals because we are not going to have the infrastructure,” says Ana Proykova, a physicist at Sofia University and an adviser on European research infrastructure to Bulgaria’s government. She says that the government should reinstate the funds it cut from the 2018 budget. “We are still fighting very strongly for the funding procedure to be reopened, even if it is in the middle of this year. Otherwise, our budget is going to be very tiny.”

Bulgaria, which took over the six-month rotating presidency of the EU on 1 January, produces little science compared with the bloc’s other member states. The country’s output is low (see ‘Bulgaria’s output lags behind’), and more than 30% of PhD-holding Bulgarians are at present pursuing careers abroad. But scientists in Bulgaria hope for improvements. The country intends to bid for a proposed Balkan synchrotron particle accelerator, a light source that many hope will promote international diplomacy in the region.

Its universities still want to tap into EU infrastructure funds. During its presidency, Bulgaria is also in charge of negotiating Framework 9, the EU’s latest seven-year plan for science, which is due to be finalized in May. It sees the plan, in part, as an opportunity for Bulgarian companies to enter into

OLEG POPOV/REUTERS