senators to select the prime minister, could favour a military leader.

Although science took a back seat to the economy in the election campaign, researchers hope that the new government — whoever leads it — will continue to fund research and the initiatives set up by the junta.

### MILITARY SUPPORT

Under the junta, spending on research and development (R&D) as a percentage of gross domestic product (GDP) more than doubled to 1% between 2014 and 2017, with the number of people involved in R&D increasing by 65%, according to government statistics.

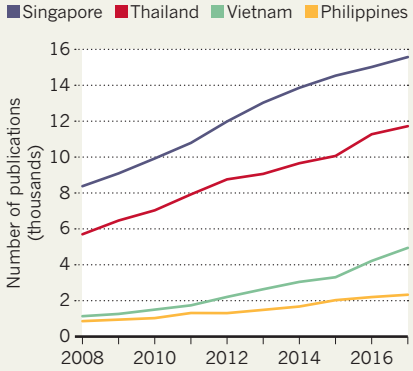
New agencies, budgets and programmes that favour scientists and research often emerge under military regimes, says Patarapong Intarakumnerd, an innovation-policy analyst at the National Graduate Research Institute for Policy Studies in Tokyo. Thailand's largest public research institute, the National Science and Technology Development Agency, based north of Bangkok, was established in 1991 by an administration that was set up following a military coup. And the law introducing the National Science Technology and Innovation Policy Office (STI) was enacted after a coup in 2006. "There is a kind of collusion between the military, economic technocrats and scientific technocrats," says Intarakumnerd.

Last year, the junta launched a 20-year national strategy prioritizing aspects of science and technology that contribute to industry, such as automotive science, robotics, bioenergy and medicine.

"It is likely that the newly elected government will follow this already set strategy," says Numpon Mahayotsanun, a mechanical engineer at Khon Kaen University, who is also chair of the Thai Young Scientists Academy.

**ARTICLE OUTPUT**

Thailand's research output, as tracked in the Scopus database, has grown steadily over the past decade. Neighbouring Singapore is a leading producer of scientific research in southeast Asia.




SOURCE: SCIVAL

Changing the strategy will be difficult, he says, because of the time and administrative processes required to get new policies approved.

Weeks before the election, the parliament also passed a law to establish a ministry of higher education, science, research and innovation, which is expected to receive royal approval within a few months. The new ministry will combine the Ministry of Science and Technology, the Office of Higher Education Commission, the National Research Council of Thailand and the Thailand Research Fund.

The ministry will be run by a board chaired by the prime minister. The board will determine policies and allocate the science budget, which is set at 16 billion Thai baht (US$500 million) for 2019. It will have autonomy to push for the commercialization of research and to coordinate national policies, says Kitipong Promwong, secretary general of the STI in Bangkok who will be in charge of the board's secretariat. Previously, there was little synergy between the policies of individual organizations, with duplication of projects, and limited monitoring and evaluation, he says.

Promwong's team has already started setting priorities for the new ministry, including the transfer of technologies to industries such as tourism, food, biomaterials and health. Investment will focus on Earth and space science, nuclear fusion, quantum science, social science and 'omics' technologies, used in the large-scale analysis of biological molecules such as genes and proteins. The team will also propose that the country's R&D spending should be increased to 1.5% of GDP by 2021, and to 2% by 2026.

The ministry restructuring will be positive for science in Thailand, says Bhumiratana. Innovation and commercialization of research will help to boost the country's income while also helping to improve access to technology, he says.

But Intarakumnerd is not convinced that the restructure will boost research commercialization. He says that countries in the region that have already undergone a technological transformation, such as South Korea, invested significantly in companies but not in universities and public research institutions.

Another criticism of the new strategy is that scientists not working in focus areas feel left behind by the push for economic development, says Titipol Phakdeewanich, a political scientist at Ubon Ratchathani University. Humanities, social sciences and environmental sciences have been neglected in recent years, he says. And, if Thailand ends up with another junta-backed government, social scientists such as himself who study human rights face an uncertain future. "The military sees freedom of expression and human rights as a threat to their power," he says. ■

SCIENCE DIPLOMACY

# North Korea strikes rare exchange deal

*Physicists will study neuroscience at leading Italian institute.*

BY ALISON ABBOTT

Researchers at North Korea's leading university have struck an unusual agreement with an Italian institute that will enable physicists from the isolated state to be trained in neuroscience.

The agreement is a rare opportunity for North Korean physicists. Sanctions normally prevent them from being trained by foreign scientists, because of their field's association with nuclear research. The arrangement will enable North Korean physicists to apply their quantitative abilities to another research field: computational neuroscience.

The deal, forged earlier this month and approved by the Italian foreign ministry, is between the physics department at Kim Il-sung University in Pyongyang and the International School for Advanced Studies (SISSA), a university in Trieste, Italy, which has previously hosted North Korean researchers on an ad hoc basis.

The deal formalizes the institutes' relationship and makes it easier for Kim Il-sung physicists to go to Italy to study under and collaborate with SISSA researchers. The arrangement also makes it easier for SISSA scientists to go to the North Korean university, for example to teach. SISSA researchers expect two or three North Korean students to come each year.

Hak-Chol Pak, head of physics at Kim Il-sung, which publishes nearly half of the isolated state's modest scientific output, told *Nature* that his university wanted to create a neuroscience institute and needed to develop expertise that isn't available in his country. The agreement was independent of politics, he says. "We are scientists, motivated only by science."

SISSA's director, physicist Stefano Ruffo, says he is happy to help students train in the university's cognitive-neuroscience department.

The roots of the agreement go back to 2016, when the United Nations declared international sanctions against North Korea aimed at quelling

the nation's nuclear programme. The restrictions prevent other nations from training the Asian state's researchers in the nebulous field of "advanced physics".

SISSA became concerned that the sanctions covered the PhD topics of four North Korean students who were studying cosmology there. To prevent the students having to return home, Ruffo arranged for them to switch their subjects. "Emotionally it was a very tough moment for me," he says. "These were all exceptional students."

Two students switched to study neuroscience. One of them, Chol Jun Kang, joined the group of computational neuroscientist Alessandro Treves at SISSA. After receiving his PhD, Kang returned to Kim Il-sung University.

Treves helped to broker the new deal when he visited Pyongyang last September. He was there to attend a rare international conference at the university on science, and found himself one of only a few Western scientists attending.

Treves says that the deal is valuable for science diplomacy, but also offers extra benefits for both parties. It gives young scientists from North Korea "opportunities to grow in a booming field of research", he says. They represent talent that "selfishly, I would like to bring to SISSA before their country opens up and they are snatched by our competitors".

In a speech last April, leader Kim Jong-un said he wished to boost the economy through science and education. ■

POLICY

# Pollution rules under siege at US environment agency

*Adviser attacks EPA decision-making ahead of major review of air-pollution standards.*

**BY JEFF TOLLEFSON**

A quarter of a century of research has shown that breathing in fine airborne particles emitted by cars, power plants and other sources shortens people's lifespans. But that scientific consensus is now under attack from a top adviser to the US Environmental Protection Agency (EPA), just as the agency is rushing to revise the national air-quality standard for such pollution before the end of President Donald Trump's first term. Scientists fear that the result could be weaker rules on air pollution — based on politics, not science — that are bad for public health.

The national air-quality standards are designed to limit the amounts of six common pollutants — including airborne particles — in the air that people breathe. The EPA must review the science and, if necessary, revise the standard for each pollutant every five years, although the process often takes longer.

The current review began in 2015, but delays had pushed the deadline to 2022. Then former EPA head Scott Pruitt announced early last year that the agency would push to complete the task by December 2020. To meet that deadline, the EPA will have to curtail its normal review and revision process. In October 2018, the agency also dismantled a scientific advisory panel that works in parallel with the EPA's Clean Air Scientific Advisory Committee (CASAC), which advises officials on air-quality standards.

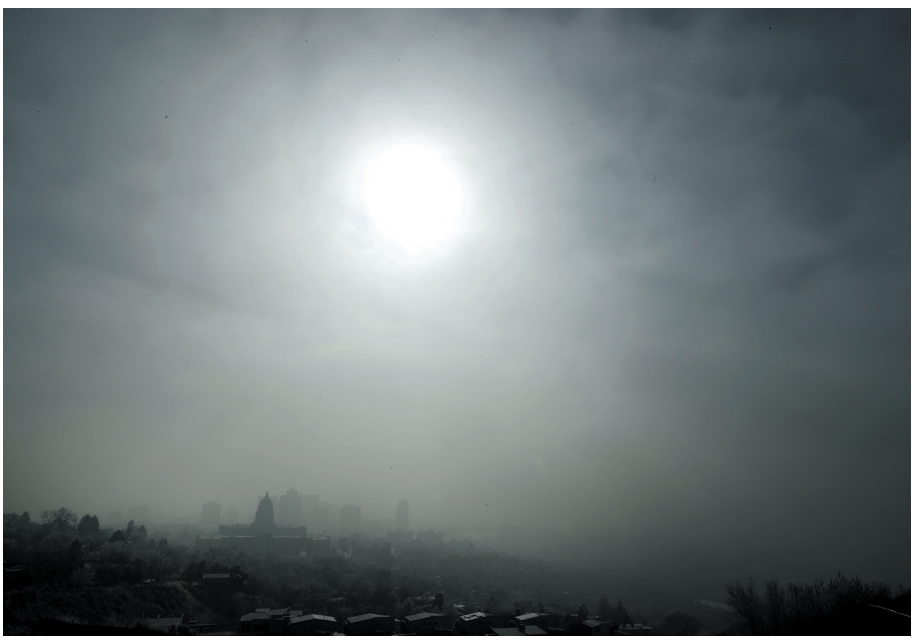
The latest development came on 28 March, when CASAC met to discuss a draft letter it had released several weeks earlier that blasted agency scientists for relying on "subjective judgments" and "unverifiable opinions" in their evaluation of particulate-pollution research. The head of CASAC, Tony Cox, is a statistician who has long questioned the evidence linking fine particulate pollution to premature deaths, and the draft letter reflected this scepticism. It also called on the EPA to do another research assessment looking at the uncertainties and inconsistencies in the scientific literature on air pollution.

CASAC removed a lot of the controversial language from the draft letter during its 28 March meeting. But the members remain divided on the link between fine-particle pollution and premature death. The final text of the letter will reflect that division.

The scepticism from some CASAC members towards the link between particulate pollution and public health has alarmed agency scientists, academics and environmental groups.

"They are just completely dismissing the science," says Gretchen Goldman, an environmental engineer in Washington DC who tracks the issue for the Union of Concerned Scientists. She co-wrote a guest editorial published on 21 March in *Science* urging the EPA not to abandon the scientific evidence on air pollution (G. T. Goldman and F. Dominici *Science* **363**, 1398–1400; 2019). "Without independent science, we risk having public-health decisions made for political reasons."

Cox defended his views in an e-mail to ▶



GEORGE FREY/REUTERS

**Weakening the rules that limit the amount of particles in the air could adversely affect public health.**