plans. One DARPA grant recipient is a team at N.C. State, which includes Delborne. He is overseeing social engagement on a gene drive project that aims to remove invasive mice from remote islands to protect seabirds and other wildlife. Although the research is under way, Delborne says the partners "have been really clear since the very beginning that if people reject this technology for ethical reasons or because there are concerns about the risks—even if the scientists don't see it that way—there is essentially a pathway to no." Simply put, the scientists are willing to halt the project.

On the even more extreme end of this trend is Kevin Esvelt, an evolutionary engineer at the Massachusetts Institute of Technology. He's considering genetic technologies to alter wild mice so that they cannot carry and spread the pathogen that causes Lyme disease. Last year, before starting any work in the lab, Esvelt visited Lyme-plagued Nantucket, Mass., to gauge if residents would be interested in genetic approaches—including gene drives, although he advised against this option because he doesn't think it is suitable in this case. Nantucket followed Esvelt's lead on gene drives, although the community is exploring the possibility of an alternative technology to immunize mice against the pathogen.

Esvelt was addressing head-on a special ethical quandary of gene drives, which are designed to spread and persist in the shared environment: Who should get to decide whether and how to use such technology? "To me, it is mind-boggling that we got so much attention just for going to the communities before we did anything else," Esvelt says. "I think that says something about how science is typically done."

Whether the emergence of these efforts will reduce fear and skepticism "depends on how responsive the people listening to the engagement are to those concerns," says Jennifer Kuzma, co-director of the Genetic Engineering and Society Center at N.C. State. In other words, researchers must be willing not only to hear the public's confusion and pushback but also to adapt—even if that means shelving a technology they think could change the world.

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Continental Divide

Brexit is already destabilizing science in the U.K.—and all of Europe

By Inga Vesper

British society has always prized the scientific mind, producing such luminaries as engineering whiz Isambard Kingdom Brunel, developmental biologist Anne McLaren and World Wide Web inventor Tim Berners-Lee. But in June 2016 the U.K.'s reputation as a future-looking nation suffered a devastating blow. Fifty-two percent of voters decided they wanted to leave the European Union, a club of nations that foster peace and economic growth. On March 29 the government officially started the exit, or "Brexit," process: a tangle of 143 British and E.U. negotiators must make some 1,000 changes to existing laws and determine what to do with the three million Europeans living in the U.K.—and the 1.2 million Brits living in the E.U. David Davis, the Brexit minister, has called this endeavor "as complicated as the moon landings."

Brexit voters framed their choice as a move toward sovereignty. But for scientists caught in the fray, the referendum sparked an ongoing nightmare of depleting talent, funding uncertainty, and turmoil that is both political and personal. "There isn't a clear plan," says Mike Galsworthy, an anesthetics researcher who co-founded the London-based pressure group Scientists for EU in the run up to the vote. "Britain is fundamentally less stable, and that makes it hard for scientists to have a career or do any long-term planning." An ongoing survey by the group found that more than a fifth of scientists said they were considering leaving the country or knew someone who was. The consequences of a scientist diaspora from the U.K. could throw the entirety of European research into disarray.

Brexit is exposing how modern science is an increasingly interconnected system in which political and societal shocks reverberate. One country's instability has repercussions for all its partners, as well as for the scientists who reside there, regardless of whether they are citizens or foreigners. Scientific work depends on collaboration, yet a central theme of Brexit is limiting free movement. As politicians pander to right-wing views on immigration by suggesting open borders hurt the U.K.'s economy, many scientists are reporting that their European partners are wary about working with, or in, the country. For example, Anne Glover, a biologist at the University of Aberdeen in Scotland and a former chief scientific adviser to the president of the European Commission, says that student intake from the E.U. is markedly down at Aberdeen and that some European staff have already left. Cesare Terracciano, an Italian cardiologist at Imperial College London, reports that discussions about collaborations between his institution and European laboratories have been put on hold. U.K. heads of European projects, such as Gerry Gilmore, who leads the European Commission's Optical Infrared Coordination Network for Astronomy, could lose their roles as institutions move to mainland Europe.

These anecdotes are borne out in numbers that are a harbinger of the chaos to come. According to the U.K. Office for National Statistics, a total of 117,000 Europeans permanently left the nation in 2016, a 36 percent increase compared with the previous

year. The science world looks to be particularly hard-hit: around 18 percent of those who hold non-British E.U. postdoctoral positions in the U.K. are looking for jobs elsewhere, according to a report for the British government's Science and Technology Select Committee. With the fall of the pound, postdoc salaries are now less competitive, especially compared with compensation in the U.S. The Higher Education Workforce Survey, released on July 31, found that about a third of universities reported a negative impact from Brexit on recruiting or retaining E.U. staff.

The fallout goes beyond practical logistics: a flagrant expression of anti-immigrant sentiments is also on the rise. Scientists for EU says that some researchers have been abused in the streets and that their children have been bullied at school. "They are now mindful of their accent or the language that they speak with their kids, so it's a much more uncomfortable environment," Galsworthy says. For German-born Stefan Söldner-Rembold, who heads the particle physics department at the University of Manchester, these "soft" factors can be just as powerful as financial decisions when it comes to deciding where to pursue a career. "There are difficulties for colleagues, whose families are being told, 'Why are you still here?'" he says. "You want to make sure your kids and partner have a perspective in this country. Right now that's not clear."

EXPOSING FRAGILITY

A MAJOR THREAT to the continuity of European science is the question of the U.K.'s membership in the 33-year-old E.U. framework for funding research. Horizon 2020, the program's current installment, has a hefty budget of €80 billion to be allocated between 2014 and 2020; its successor, Framework Program 9, is pegged at €120 billion. The U.K. is one of its most successful participants and has received about 15.5 percent of Horizon 2020's total awarded funds so far.

Horizon 2020 is open only to E.U. member states or associated countries, such as Norway. If a non-E.U. country wants access, it must pay a share into the common pot based on its gross domestic product. The political mood in the U.K. is such that any payments to the E.U. post-Brexit will be aggressively opposed. Under Prime Minister Theresa May, the government has tried to reassure scientists by saying any potential loss of funding would be matched with homegrown money. But scientists are not buying it. "Looking at the state of the British economy, this funding will likely not be replaced in the same way," Söldner-Rembold says.

Glover, who has been involved in multiple Horizon 2020 projects, asserts that the program's value goes beyond money. When she works with the U.S., for instance, scientists from each country have to submit separate bids and hope that both get green-lit. But Horizon 2020 members can whip up a single application for each project. "It allows me to work seamlessly with colleagues in, say, Estonia or Italy," Glover says. "Science is an international pursuit. You can't hope to be at the leading edge of achievements if you cannot collaborate freely with the best in the world." And, Galsworthy adds, if freedom-of-movement restrictions affect permits and visas, "it could well mean we will be cut out of Horizon 2020."

With that potential outcome on the horizon, neighboring competitors—as well as emerging science giants such as China and India—are eager to welcome scientists fleeing from the U.K.

The nation may produce some of the highest-quality papers in the world, but other E.U. countries are catching up in terms of both publication volume and esteem. The E.U. now produces 34 percent of global research output, and countries such as Germany, France, Sweden and the Netherlands see Brexit as an opportunity to poach talent.

Indeed, the U.K.'s science is excellent but fragile. With a population of just 65 million, the country is fairly small, and its labs rely on teams of handpicked, international experts, with 20 percent of its scientists coming from the E.U. Lose one hyperspecialized expert, and an entire organization might fall apart. According to the lobby group Universities UK, more than half of the U.K.'s research output stems from international collaborations, compared with less than 40 percent in the U.S. Shocks to its system could destroy the country's leadership position.

The idea, however, that what hurts the U.K. will somehow elevate its neighbors is preposterous, says Thomas Jørgensen, senior policy coordinator at the European University Association, an interest group for universities. The U.K. hosts some of Europe's best scientific institutions, including the University of Oxford and the University of Cambridge, which regularly top global rankings. (Both universities get around 13 percent of their research funding from the E.U.) The British science system is unique in Europe, not least because it uses a language that nearly every European child learns in school. "Britain does well because its research environment relies on an infinite amount of variables that you cannot simply re-create," Jørgensen explains. "Science is not a factory. You cannot just take it somewhere else." He fears the damage from turning off the talent tap will weaken the scientific competitiveness of the entire continent: "On the systemic level, diminishing the strongest partner is bad for everybody."

Now many universities, often accused of being detached from the hullabaloo of emotionally driven politics, are acknowledging they are painfully dependent on it. Scientists for EU is pushing to ensure that the British government uses empirical facts to facilitate Brexit, but it is an uphill struggle in a political climate dominated by slogans and misinformation. Late last year the Science and Technology Select Committee recommended that the newly founded Department for Exiting the European Union take on a chief scientific adviser to provide fact-based evidence around Brexit. That post remains unfilled. Of course, Brexit was never about facts and logic. The referendum narrowly won on a narrative of hurt pride and citizens feeling shortchanged. Subsequently, in a strange reversal, frustrated European scientists are voting "leave" with their feet.

Terracciano, the cardiologist from Italy, has spent many sleepless nights worrying about British science, which, he fears, is on the brink of a vicious cycle. The potential loss of funding, coupled with a damaged reputation, makes the country less attractive for research, which will in turn compound the loss of talent, he says. Yet Terracciano understands what is motivating his fellow Europeans to seek new research homes. "People are leaving because their years of service and dedication are unrecognized," he says. "We are all angry that we have invested in the wrong horse."

Inga Vesper is a German-British journalist based in London who specializes in climate, environment and politics. She has covered E.U. science for 10 years.

China's Moment

Seeing a chance to lead, China is deploying clean energy, quantum satellites and genomics

By Lee Billings

In June, when U.S. president Donald Trump announced he would withdraw from the Paris climate accord, all eyes anxiously looked to China. Without participation from the nation that historically has been the world's biggest polluter, pundits worried President Xi Jinping would see a way out of his country's carbon-reduction pledge, and the deal would unravel. Instead Xi, a former chemist, staunchly reaffirmed his country's commitment to investing in renewable energy and meeting its emissions goals. In fact, China is already blowing past some of its targets.

Innovating with solar cells and next-generation nuclear reactors is just one part of China's massive investment in scientific research. If technological development is increasingly an engine for economic growth and national strength, then support for basic research and applied science is its fuel. For much of the past century the U.S. maintained dominance in this arena. But as the current administration attempts to reinvigorate the coal industry, slashes research budgets, questions the value of the Environmental Protection Agency and discounts evidence-based policy making—willfully ceding the mantle of global scientific leadership—China is rushing to fill the void, with potentially profound consequences for the world.

"The development of Chinese technology will have benefits for everyone," says Robert Daly, director of the Kissinger Institute on China and the United States at the Woodrow Wilson International Center for Scholars in Washington, D.C. "But as China increases its comprehensive national power, it is increasingly able to shape a global environment that is more amenable to the goals of the Chinese Communist Party and its illiberal ideas about how individuals, institutions and information relate to the state." That includes the thorny issues of regulation and intellectual property, which are much looser in China than in the West.

The backbone of China's rise in this realm is its 13th "Five-Year Plan," which counts on scientific research and technology to be key drivers of economic growth. The result is a staggering $1.2 trillion devoted to R&D between 2016 and 2020. Of that, $373 billion is slated to go to renewable energy alone. Additionally, a 10-year "Made in China 2025" initiative sup-