was passed, but it ended up being more conservative than researchers had hoped.

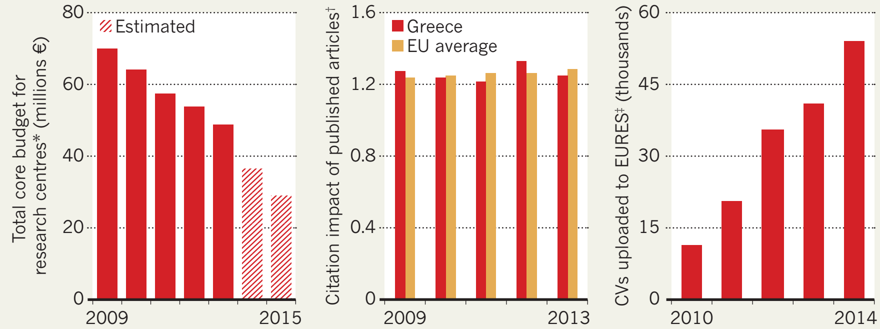
Its principle focus is on making it easier for scientists at universities and research centres to share facilities and to collaborate with industry, by removing bureaucratic obstacles. But researchers complain, for example, that the law did not create an independent grant agency to provide a source of regular support for basic research, akin to the US National Science Foundation or the UK research councils. Instead, Greek researchers depend almost entirely on external funders, such as the European Union, for grants.

Researchers also complain that they are subject to general public-sector rules for controlling public expenditure, even when that makes little sense. In one case that involved the centralization of payments within any public organization, the rules would have ended up costing the government money in grants lost. An appeal against those rules was successful. But the government then piled on extra bureaucracy: from January, researchers must report every expense higher than €1 (US$1.2) into a centralized online system. "The rules come at you like the Hydra," says Konstandopoulos. "You expend energy cutting off one of those heads, then another one grows back in its place."

Theodore Fortsakis, rector of the University of Athens, the country's largest university, says that if his budget is not increased, he will have to close some departments or centres in the second semester, which begins next month.

HEALTH OF GREEK SCIENCE IN NUMBERS

Government funding for research has plummeted (left) but scientists have maintained the quality of their research (middle). Still, qualified young people increasingly seek to leave (right).



*Does not include universities †Weighted by field and relative to global average ‡The European Job Mobility Portal

SOURCES (LEFT TO RIGHT): GSRT; SCIVAL; EURES

The University of Crete is faced with a 2015 budget that is barely twice the institution's 2014 electricity bill. Despite this, it came 48th in the *Times Higher Education* 2014 rankings of the world's top 100 universities under 50 years old, and 5th for natural science in Europe in 2014 according to the CWTS Leiden Ranking of universities' scientific performance.

Researchers say that the poor conditions are making it ever harder to recruit talented young scientists, even when positions arise. Economist Lois Labrianidis of the University of Macedonia in Thessaloniki has quantified the alarming rate at which qualified professionals are leaving the country. He calculates that 150,000 Greek professionals, including scientists, physicians and engineers — more than 50% of whom have a PhD — now work in the rest of Europe and the United States. He says that the most qualified will not come back, and tens of thousands of others are actively seeking to leave (see 'Health of Greek science in numbers').

Not everyone has lost faith. Neurobiologist Marios Chatzigeorgiou last year accepted a group-leader position that will move him from the luxury of the MRC Laboratory of Molecular Biology in Cambridge, UK, to the IMBB. The uncertainty, he admits, is very worrying. But he believes that the multidisciplinary environment in Crete — which has a concentration of research institutes with diverse focuses ranging from marine science to computing — will be exciting. There, the spirit of Athena, goddess of wisdom, is alive and well. ■

GENETICS

End of cancer atlas prompts rethink

Geneticists debate whether focus should shift from sequencing genomes to analysing function.

BY HEIDI LEDFORD

A mammoth US effort to genetically profile 10,000 tumours has officially come to an end. Started in 2006 as a US$100-million pilot, The Cancer Genome Atlas (TCGA) is now the biggest component of the International Cancer Genome Consortium, a collaboration of scientists from 16 nations that has discovered nearly 10 million cancer-related mutations.

The question is what to do next. Some researchers want to continue the focus on sequencing; others would rather expand their work to explore how the mutations that have been identified influence the development and progression of cancer.

"TCGA should be completed and declared a victory," says Bruce Stillman, president of Cold Spring Harbor Laboratory in New York. "There will always be new mutations found that are associated with a particular cancer. The question is: what is the cost–benefit ratio?"

Stillman was an early advocate for the project, even as some researchers feared that it would drain funds away from individual grants. Initially a three-year project, it was extended for five more years. In 2009, it received an additional $100 million from the US National Institutes of Health plus $175 million from stimulus funding that was intended to spur the US economy during the global economic recession.

The project initially struggled. At the time, the sequencing technology worked only on fresh tissue that had been frozen rapidly. Yet most clinical biopsies are fixed in paraffin and stained for examination by pathologists. Finding and paying for fresh tissue samples became the programme's largest expense, says Louis Staudt, director of the Office for Cancer Genomics at the National Cancer Institute (NCI) in Bethesda, Maryland.

Also a problem was the complexity of the data. Although a few 'drivers' stood out as likely contributors to the development of cancer, most of the mutations formed a bewildering hodgepodge of genetic oddities, with little commonality between tumours. Tests of drugs that targeted the drivers soon revealed another problem: cancers are often quick to become resistant, typically by activating different genes to bypass whatever cellular process is blocked by the treatment.

Despite those difficulties, nearly every aspect of cancer research has benefited from TCGA, says Bert Vogelstein, a cancer geneticist at Johns Hopkins University in Baltimore, Maryland. The data have yielded new ways to classify tumours and pointed to previously unrecognized drug targets and carcinogens. But some researchers think that sequencing still has a lot to offer. In January, a statistical analysis of the mutation data for 21 cancers showed that sequencing still has the potential to find clinically useful mutations (M. S. Lawrence *et al. Nature* **505,** 495–501; 2014).

On 2 December, Staudt announced that once TCGA is completed, the NCI will continue to intensively sequence tumours in three cancers: ovarian, colorectal and lung adenocarcinoma. It then plans to evaluate the fruits of this extra effort before deciding whether to add back more cancers.

EXPANDED SCOPE

But this time around, the studies will be able to incorporate detailed clinical information about the patient's health, treatment history and response to therapies. Because researchers can now use paraffin-embedded samples, they can tap into data from past clinical trials, and study how mutations affect a patient's prognosis and response to treatment. Staudt says that the NCI will be announcing a call for proposals to sequence samples taken during clinical trials using the methods and analysis pipelines established by the TCGA.

The rest of the International Cancer Gene Consortium, slated to release early plans for a second wave of projects in February, will probably take a similar tack, says co-founder Tom Hudson, president of the Ontario Institute for Cancer Research in Toronto, Canada. A focus on finding sequences that make a tumour responsive to therapy has already been embraced by government funders in several countries eager to rein in health-care costs, he says. "Cancer therapies are very expensive. It's a priority for us to address which patients would respond to an expensive drug."

The NCI is also backing the creation of a repository for data not only from its own projects, but also from international efforts. This is intended to bring data access and analysis tools to a wider swathe of researchers, says Staudt. At present, the cancer genomics data constitute about 20 petabytes (10^{15} bytes), and are so large and unwieldy that only institutions with significant computing power can access them. Even then, it can take four months just to download them.

Stimulus funding cannot be counted on to fuel these plans, acknowledges Staudt. But cheaper sequencing and the ability to use biobanked biopsies should bring down the cost, he says. "Genomics is at the centre of much of what we do in cancer research," he says. "Now we can ask questions in a more directed way." ■

SEOKYONG LEE/NYT/REDUX/EYEVINE

Marine biologist Sang-Mook Lee has pushed for academic involvement in South Korea's research ships.

OCEANOGRAPHY

Korea opens up its ocean science

Ships used mainly for seabed surveys will expand in focus.

BY MARK ZASTROW

South Korea's ocean-going research programme is changing tack. For more than two decades, it has focused on discovery and exploitation of minerals on the sea floor, but now a move is afoot to expand the research agenda. A 5,900-tonne ship — the *Isabu* — is being built with the capability to launch autonomous underwater vehicles, perform sea-floor-penetrating seismic surveys and collect sediment cores up to 40 metres long.

The current flagship, the 1,422-tonne *Onnuri*, spends about three-fifths of its time scouring the sea floor for mineral deposits under the direction of the deep-sea minerals group at the Korean Institute of Ocean Science and Technology (KIOST) in Ansan. That heavy economic emphasis is set by the Ministry of Oceans and Fisheries, which oversees KIOST as well as the nation's ports and shipping.

The ministry's hold is so complete that in 22 years of operation, no academic researcher outside KIOST has ever led a cruise. "This is really scandalous," says marine geophysicist Sang-Mook Lee of Seoul National University. Although scientists at his university and elsewhere have been able to work aboard the ship, they have been frustrated by a near-complete lack of say in where the *Onnuri* goes or what research questions it pursues.

In March, that is set to change: KIOST will start to make *Onnuri*'s upcoming cruise tracks public, and will invite outside researchers to propose projects that can be done along the way, says Gi-Hoon Hong, who became the institute's president in August and has supported broadening the constituency for its research vessels. Eventually, time on the ships, which currently costs up to US$12,000 per day, will be awarded through a merit-based system.

South Korea's focus on mineral exploration dates back to the founding of KIOST in the early 1970s, when the nation was in the middle of a decades-long economic boom. At the time, polymetallic nodules — balls of manganese and other metals such as iron, nickel and cobalt that accumulate on the sea floor — seemed a valuable potential resource. Although international interest in the minerals waned over subsequent decades, the South Korean government continued to fund research on the nodules and other sea-floor mineral deposits.

Securing marine mineral resources is "considered very important to the Korean people, because of the scarcity of land-based natural resources," says Jai-Woon Moon, the head of KIOST's deep-sea mineral research group. And rising prices for metals have renewed the world's interest: Nautilus Minerals of ▶