THIS WEEK

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Not-so-open data

Too many funding agencies resist supporting the sharing of data and too many research communities struggle with its practicalities. The result is empty rhetoric and slow science.

Everyone agrees that there are good reasons for having open data. It speeds research, allowing others to build promptly on results. It improves replicability. It enables scientists to test whether claims in a paper truly reflect the whole data set. It helps them to find incorrect data. And it improves the attribution of credit to the data's originators. But who will pay? And who will host?

Only rarely does a research-funding agency step up to both of these plates. Examples include NASA and the US National Institutes of Health, and the European Bioinformatics Institute. The National Natural Science Foundation of China has ambitions to host the outputs of those that it supports. The European Commission hopes to offer such platforms with its European Open Science Cloud. The UK Data Archive for the social sciences and humanities, and DANS, the Netherlands Institute for Permanent Access to Digital Research Resources, represent other good models of support from governments.

But in too many cases, government agencies lack the funds to build platforms for data sharing and resist taking responsibility for such infrastructure. They may hope that universities will host data, but the development of institutional repositories is patchy, and to rely on them is effectively to discourage common data standards and curation.

There are commercial data platforms, including figshare (which shares a common owner with *Nature*, through Holtzbrinck Publishing Group). Given their usefulness, it is surely misguided for funding agencies — for instance, the Swiss National Science Foundation — to prohibit their use by grant-holders. There are also not-for-profit repositories such as Dryad.

As *Nature* well knows, being a host — or publisher — of data is expensive. Keeping a platform technologically up to date is costly, as are data validation and curation. The running costs of the preprint server arXiv in 2017 are about US$1.3 million, for example, and the 2015 budget of the UK Data Archive was about £5.5 million ($8.2 million). For too long, public discussions have overlooked the true costs of data openness. More tangible support from governments and funders would work wonders.

Bottom-up motivation from researchers to share data is also crucial — and needs encouragement.

Genomics and structural biology have an honourable history of insisting on the prompt deposition of open data and providing facilities for doing so. Other communities also have strong customs surrounding data ownership. For example, astronomers who have developed instruments for satellites often have proprietary access to new data for a year, but many astronomical facilities create their own rules. Even when journals insist on immediate access for readers to the data included in a research publication, the full data set and the software required to analyse it may be kept from readers for months. Given the diversity of data and conventions, it is up to funders, researchers and journals to keep up the pressure towards the openness of complete data sets and any source code required to use them.

So which fields need to raise their data-access game? *Nature* suggests that the geodesy and seismology communities should consider reducing their current two-year embargoes. The microbiome community places great value on open data but, as a relatively young field, is struggling to establish standards.

Thumbs up for two communities that are making progress in this realm. In pathogen genomics, the authors of the Zika virus genome papers we publish in this issue (see pages 401, 406 and 411) made the sequences openly available as soon as they were generated.

> ***"For too long, public discussions have overlooked the true costs of data openness."***

Credit should also be given to palaeontologists in their pursuit of an open strategy for 3D data. A recent paper, 'Open data and digital morphology' (T. G. Davies *et al. Proc. R. Soc. B* **284,** 20170194; 2017), proposes best practice for the creation, storage, publication and dissemination of large 3D data sets, including recommended file formats and data repositories. The conclusion is that 3D data should be available at the time of article publication, accompanied by as much detail as possible on its nature and the circumstances of its collection.

Where researchers establish clear standards and repositories, *Nature* will be delighted to help mandate their use as a condition of publication. Where such coherence is lacking, we necessarily take a more piecemeal approach. Despite years of discussion, funders, researchers and journals have much work to do to improve the transparency and reproducibility of research by means of data accessibility. ■

Speak now

Seize the chance to comment on US regulation of genetically engineered plants and animals.

In January this year, two US agencies proposed the first substantial overhaul in 30 years of how they regulate genetically altered crops and livestock. Some plant scientists expressed relief. Some animal researchers used more colourful language.

The proposals — one to govern plants, the other to govern animals — came to wildly different conclusions. The US Department of Agriculture (USDA) suggests that many plants whose genomes have been altered by a single DNA letter change should not need approval before being released in the field. However, the US Food and Drug Administration (FDA) contends that animals whose genomes have been similarly changed might have to go through a rigorous evaluation before being released onto the market.

For the two agencies to evaluate the same problem and come to

opposite conclusions is worrisome. The deadline for public comment is 19 June — researchers should seize this chance to push for a scientific and harmonized approach.

The USDA oversees the transport and release of plants that could pose a threat to the nation's agricultural system. The agency used that remit to cover plants that have been genetically altered using molecular tools harvested from plant pathogens. A form of the bacterium *Agrobacterium tumefaciens*, for example, was often used to shuttle genes into plant genomes. But even as the regulations were being crafted, technology was marching ahead. Researchers developed ways to express foreign genes in plants without using a pest. By 2011, the USDA found itself unable to oversee a host of new crops because they were engineered by other techniques and could not be classified as potential plant pests.

The FDA, meanwhile, has co-opted regulations that are designed to govern the approval of animal drugs. FDA oversight is triggered by the genetic engineering of an animal (generally taken to mean the splicing together of DNA sequences from different sources). This has left researchers in industry and academia uncertain as to whether the FDA would regulate animals that have been developed using modern gene-editing techniques, which don't necessarily insert foreign DNA. Such techniques are already being used in the lab to develop disease-resistant pigs, among other animals. One company, Recombinetics of St Paul, Minnesota, which is hoping to bring its hornless dairy cattle to market, filed a notification to the FDA a month before the proposals were released.

Almost any gene-edited livestock could be encompassed by the FDA's regulations. Yet gene-edited plants would be regulated only if they are pests or noxious weeds.

It might be asking too much to demand complete consistency across agencies. USDA or FDA staffers are not free to conjure regulations as they see fit: they are also confined by agency-specific statutes. This is why some definitions differ, and some approaches — such as treating the engineered genome of a goat as an animal drug — do not seem intuitive.

Gene-editing and other technologies clearly pose a challenge for regulators. Legislative definitions can quickly expire with the next technological development. Regulators in Europe, for example, have been struggling for years to incorporate new technologies into their framework. Canada, which regulates its crops on the basis of their attributes rather than the process used to generate them, is one of the few countries with a system that is able to adapt to advances. Meanwhile, it is still hard to tell how consumers will view gene-edited foods when they reach the market.

"For the two agencies to evaluate the same problem and come to opposite conclusions is worrisome."

But both the solutions proposed in the United States have the potential to err, albeit in opposite directions. Regulating all gene-edited animals may make little sense for a change that merely reproduces a DNA sequence found in nature, or that could be recreated by using chemicals to randomly mutate DNA. Conversely, waving through many edited crops could under-regulate some with the potential to alter agricultural ecosystems. For example, a herbicide-tolerant plant could lead to changes in spraying that generate herbicide-resistant weeds.

It is unclear whether or how President Donald Trump's appointees will influence the development of these regulations. But researchers should take the opportunity to be heard, to scrutinize proposed definitions, look for loopholes and suggest alternatives to reduce the likelihood that the regulations will soon become outdated. Above all, they should push for regulations that are consistent across agencies, with an emphasis on evaluating the risks posed by the final product. Some researchers may feel that simple gene edits, such as those that reproduce a naturally occurring mutation, deserve no scrutiny. Others may have reservations about those same products. Let all of those voices be heard — or endure another 30 years of ill-fitting regulations. ■

Dam statistics

Governments must minimize the impact of hundreds of hydroelectric dams in the Amazon.

The sheer size of the Amazon and its tributaries is beguiling. The basin spans 6.1 million square kilometres from the Atlantic Ocean to the Andes mountains, discharging 17% of the world's fresh water. It's a tempting resource, but a push by Brazil and its neighbours to build hundreds of dams in the region could irrevocably alter one of Earth's most precious landscapes. It's time to reassess.

In this week's *Nature* (see page 363), an international team presents a scientific framework and a series of reforms that could help policymakers across the region to do just that. The heart of the pitch is an environmental index that tallies the impacts that these new and planned dams could have on their respective tributaries and the larger Amazon ecosystem, extending to the mouth of the river and beyond.

The framework avoids the common pitfall of evaluating each dam in isolation. A tributary might be able to handle one well-placed hydroelectric dam; fish might even be able to move up and down river if it is designed properly. But the impacts add up. So far, 140 dams have been installed or are under construction, with another 288 planned.

The team's Dam Environmental Vulnerability Index (DEVI) includes a measure of how much of a river a given dam is likely to impact. It captures changes to hydrology and sediment transport, which are crucial for downstream flood plains, the estuary and coastal ecosystems. It also includes the impact of roads, deforestation and the ever-advancing agricultural frontier.

The most-threatened areas are in the south, where development pressures are highest. The index also maps the risks along the Andean foothills, where 136 dams are proposed on the rivers that provide most of the nutrients that flow downstream.

Nor are dams the only threat. Rising temperatures and deforestation could eventually cause irreversible change to the forest. At worst, some researchers fear that the southern fringe of the forest could revert to savannah, rendering many of the new dams obsolete.

Safeguarding this complex environment raises institutional challenges across several countries, including Peru, Bolivia and Ecuador. The researchers propose a framework for providing independent assessments of the environmental threats from dams, while addressing energy and economic development.

The bulk of the electricity generated by all the dams, including those in Peru and Bolivia, is destined for Brazil. But the nation has other options. With plenty of sun and wind, it could diversify its impressive clean-energy portfolio without falling back on fossil fuels.

The bad news is that the Brazilian Congress is moving in the opposite direction. A coalition of conservative lawmakers is pushing for legislation to loosen the requirement for environmental assessments for agriculture and infrastructure projects, including dams.

This movement is partly a backlash against the previous government's curbs on deforestation, which plunged by more than 80% from 2004 to 2014. Brazil has shown that change is possible, and it is cooperating with other countries to reduce deforestation. But establishing order in the Amazon is not easy. Deforestation is on the rise again, and the ongoing political corruption scandal in Brazil only increases the likelihood that efforts to stymie regulation and push development will prevail.

Scientists and environmentalists are pushing back, and rightly so. What Brazil, and the entire Amazon, needs is an evidence-based plan for the future. Governments must invest in research that can fill the knowledge gaps, and then think strategically — and collectively — about a sustainable path forward. ■