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Water supplies are scarce in parts of the Democratic Republic of the Congo because of poor infrastructure.

LAB LIFE

Science and strife

Five researchers explain how they run productive labs in war-torn or resource-poor regions.

A well-equipped laboratory stocked with reagents and supplied with uninterrupted electricity and unlimited water might seem like a basic requirement for conducting research. But scientists who work in regions that have limited resources or that are riven by conflict cannot take such amenities for granted. They must perpetually seek scarce grants, publish their own journals, form their own scientific societies and — crucially — draw on their deep reserves of resilience. *Nature* asked five such researchers how they run productive labs in the face of electricity shortages, border-checkpoint closures, poor Internet connections and other challenges.

MARLO MENDOZA Engage with stakeholders

Forestry researcher, University of the Philippines, Los Baños

For the past 13 years, I have been profiling the contamination of the Marilao, Meycauayan and Obando River System (MMORS), which was on the 'Dirty 30' list of the most polluted places in the world in 2007, according to the

non-profit organization Pure Earth. There are many polluting industries upstream, including the largest lead smelter in the Philippines, gold smelters, jewellery workshops and tanneries. Downstream are fish farms. We found elevated levels of heavy metals in the water, in the sediments and in fish, especially shellfish, which are sold in the local markets (M. E. T. Mendoza *et al.* *J. Nat. Stud.* **11**, 1–18; 2012). At least 100,000 people in the municipalities of Marilao, Meycauayan and Obando, and in the metropolitan Manila area, are eating contaminated fish.

There are no toxicologists in the area who can accurately diagnose illnesses connected with heavy-metal ingestion. So when we looked ▶

► at medical records, there were no entries for heavy-metal poisoning. If we cannot prove that these metals are causing harm to people, it's very difficult to convince policymakers and local executives to take action. We have no local laboratories that can analyse heavy metals found in fish, or in water or blood samples.

Local officials, the governor and some of the mayors were really antagonistic because the fishing industry is a major source of income for these municipalities. I have been very careful, even from the outset, to always update the mayors on our projects, and I am accompanied by local and regional government representatives whenever I do my monitoring activities. I do nothing without their consent and am very transparent in my work.

One of my strategies was to build a network of stakeholders — including national agencies such as the Bureau of Fisheries and Aquatic Resources and the Department of Environment and Natural Resources — that share my concerns. I also built a good rapport with people who live in the region. There are several associations for fishers and leather-makers in these areas, and we work with them and include them in consultations and meetings about water-quality management. Our project helped to have the area declared as a legally designated water-quality management area. That's why we're able to continue our work.

We used funding from Pure Earth to do regular longitudinal sampling in sections of the river system, including of sediment, water, fish and other aquatic life. There's a problem collecting data and samples, because it is costly and the national and local governments have limited funds. There is also no single repository of data with which monitoring can be more effectively planned and analysed.

Our monitoring results were included in a Pure Earth database that was shared with other stakeholders, including regional environmental-management offices and local government units. In turn, this encouraged those agencies to conduct studies to complement our work and to share their data. So I was able to get money from the Asian Development Bank, Green Cross Switzerland and the Hong Kong Shanghai Banking Corporation, as well as a small amount from the Coca-Cola Company, to conduct environmental monitoring — including assessment of heavy metals in selected aquatic organisms.

EMMANUEL I. UNUABONAH

Use available resources

Materials chemist, Redeemer's University, Osun State, Nigeria

Potable water is a challenge for us here in Africa and across the world: around 1.8 billion

people worldwide get their drinking water from a source that is polluted with faeces. As part of our work, we are developing hybrid clay composites to adsorb enteric bacteria, such as *Escherichia coli*, *Salmonella* species and *Vibrio cholerae*, from water. We also use composites made from readily available materials such as kaolinite clay, papaya seeds and plantain peels to extract heavy metals from water.

We are not funded by the government. On average, for close to 100 days a year, we have no electricity. We have an alternative utility on campus, so when the power goes off at the national grid during work hours, the generator comes on. If we get lucky with timings, we are guaranteed 36 hours of uninterrupted power to run experiments. But when the generator isn't running and the grid power has gone off, we just have to wait.

Sometimes I use my salary to fund my research and to keep our students. Then I have to struggle to write international grants. I'm so grateful to The World Academy of Sciences in Trieste, Italy; the last grant it gave in 2014 (for US\$63,230) took care of stipends, school fees and research expenses for the students, and we used part of it to buy equipment. A colleague at the University of Edinburgh, UK, sent us a \$600 bacteria-testing kit last year, but we can't use it now because a related microscope part was damaged by a power surge.

We have a lot of wonderful ideas, wonderful theses just hanging about the shelves, but nobody's utilizing them. Some young scientists developed cheap electrical power systems from electronic waste materials, but they don't have the money to develop them further. Nigeria has a thriving oil industry, but the government's Petroleum Trust Development Fund uses oil-industry proceeds mostly to fund scholarships for Nigerian students abroad, and spends very little on scientific research.

KALULU MUZELE TABA

Aim for the possible

Organic chemist, University of Kinshasa, Democratic Republic of the Congo

Our research seeks to solve problems that have societal impacts, such as malaria, which is endemic in Kinshasa, the capital of the Democratic Republic of the Congo (DRC). People in the poorest areas of Kinshasa are growing about 55 different plants, including citronella and papaya, to try to treat the symptoms of the disease. We thought, why not investigate these plants? We tested eight of the most-used plants and showed that extracts and metabolites had considerable antimalarial activities. We have a small booklet in French and in the local language, Lingala, that we send to people to explain how to use these plants more

effectively. We are also studying plant extracts that can be used to treat antibiotic-resistant *Mycobacterium tuberculosis* (K. B. M. Jose *et al. Med. Clin. Rev.* 4, 5; 2018), using a grant from The World Academy of Sciences.

We don't get money from the state. In our lab, we don't have equipment. We don't have money to buy solvents. Water is available between 5 a.m. and 7 a.m., so we have a con-

“To scientists working in comparable circumstances, I would say that although it's hard, it's not impossible.”

tainer that collects water at night, and during the day we have a pump. For electricity it's much harder. In the middle of the day, it can come and go many times, and you hope it won't go while you're working.

We used to have a small generator as a backup for computers, but it's broken.

We don't fold our hands and cry and say that things will get better. We do whatever we can. Most of the time we buy our own reagents and solvents with our salaries. We try to motivate our master's and PhD students by finding a way to collaborate with the outside, writing to foreign labs to see whether our students can get overseas fellowships. One student, Joséphine Ntumba, went abroad three times, to the Catholic University of Louvain in Louvain-la-Neuve, Belgium. She has completed her PhD and teaches at the University of Kinshasa. I did my PhD at Northwestern University in Evanston, Illinois, and then went to the Max Planck Institute for Coal Research in Mülheim an der Ruhr, Germany. It was hard to come back. It was not only material, but mental too. I knew that some things would be impossible, but I feel that I have to contribute and inspire young people in science.

For the past five or six years, I have been the editor-in-chief of the journal *Congo Sciences*, which I co-founded. We started it because we wanted to bring visibility to research done in the country. The journal was financed for some time by the Academy of Research and Higher Education (ARES) in Brussels. The academy has stopped funding it now, but we are still publishing the journal.

For the past ten years, I've been trying to create an academy of sciences for the DRC, similar to the American Association for the Advancement of Science in Washington DC. We have to try to get scientists together and to speak as one voice, and then perhaps the state can start understanding that financing research at the university is important. These are some of the things that make me feel happy that I came back home. Maybe I lost a lot as a scientist, but as a Congolese, I hope I can do something for my place, and for the world.

To scientists working in comparable circumstances, I would say that although it's hard, it's not impossible. Know that you should find maybe not the best solution, but the least-worst one.



GGateway students on the training scheme in information technology funded by the Basque government.

MOHAMMED SAFIA

RASHA ABU-SAFIEH

Choose the positive

Computer engineer and co-founder of GGateway, Gaza Strip

I co-founded GGateway, a social-enterprise company in the Gaza Strip that provides outsourcing services for information and communications technology (ICT) around the world. We offer training and employment to recent university graduates in Gaza with ICT degrees. Our main goal with GGateway is to help people to have a source of income. With the shortage of clean water, the polluted sea and the blockade imposed by Israel and Egypt since 2007, living conditions here are dire.

We came up with the idea of GGateway in 2012. In November 2013 we launched a pilot, and in February 2015 we got the green light from the Korea International Cooperation Agency for a \$1.3-million grant to fund our plan. That was one of the biggest, happiest things that ever happened to us.

We were running a pilot project for the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA), but in July and August 2014 we had the 50 days of conflict with Israel. That was difficult: the bombing went on all day, there was no electricity and we had limited access to water and food. There was no safe zone, no safe area. So we had to stop our first project.

Two days after a ceasefire ended the conflict, we wrote up another eight new concepts for different projects, and the UNRWA agreed to operate three. We could either be positive or cry all day. We chose the positive side and to move on.

The cables that we use for all our technical networks are on the list of items that Israel does not allow to enter Gaza. With the support of the UNRWA, it took us nearly four months to bring them in from Israel. Without the UNRWA, it would have taken us a year or more. We also use a generator because most days we get electricity for two to four hours.

The overall unemployment rate among graduates in Gaza with ICT degrees is 70%. Among female ICT graduates, it's 92%. We applied for grants that focus on vulnerable women, and got one from the Basque government in Spain to train 60 female graduates for jobs. We also got a grant from the US-Middle East Partnership Initiative to empower and train 300 ICT graduates to become professional freelancers, and won a \$3-million grant in June from the World Bank to train students and software engineers. We have contracts with UN Women and UN Habitat.

We are able to travel outside Gaza only two to three times a year, maximum, and sometimes not at all; we need to apply for an exit permit from Israel with support of the UNRWA. Sometimes we are accepted, sometimes rejected; no reason is given. We often lose opportunities if we are registered for a conference, for example, or for training.

When we see what we are doing — that it's changing people's lives, despite all of the difficulties around us — it makes us feel good.

ELIZABETH TILLEY

Focus on small but crucial changes

Sanitation economics researcher, University of Malawi, The Polytechnic, Blantyre

I came to Malawi in 2015 after 9 years as a project officer and PhD student at the Swiss Federal Institute of Aquatic Science and Technology in Dübendorf. I had worked on sanitation projects in Nepal, South Africa, Tanzania and Nicaragua. Most of my work in Malawi now is teaching and supervising master's and PhD students on such projects as making fuel briquettes out of dried faecal sludge. We work on 'shit-flow diagrams' — trying to map and understand where excreta is being generated and how much of it is being treated.

We have a very bad Internet connection, and it's a barrier to downloading files or making Skype calls. We don't have subscriptions to journals. We have 30 computers for 4,000 students. Paper and photocopying are very expensive. We go days without water to even flush the toilets. At the university, we don't have toilet paper, so I bring my own each day and I keep a secret bottle of soap.

The research agenda in Malawi is driven by big donors from the global north, including national governments such as Norway and Japan, and private donors and non-governmental organizations. Very little funding goes to African researchers for work on topics that they've identified themselves. The fact that northern countries offer funding opportunities to those in the global south is an excellent form of development.

But some proposals call for the participation of a southern partner with no requirements for the division of funding. This means that the southern partner is sometimes given a limited budget for limited work that has limited impact.

I would encourage northern researchers to think about doing sabbaticals in African universities. It gives the southern researcher a chance to focus on publications or research, to be exposed to new ideas and methods, and to connect with a broader network, and the northern researcher can learn how things operate in the south and appreciate what works well at home.

When you start to think about how crushing the whole system is, you can go crazy. I had a student who just wrote to tell me that he got into a master's programme in the United States, and to thank me for the reference letter. He's so excited, and that's the kind of thing I can hold on to for a couple of months. ■

INTERVIEWS BY JOSIE GLAUSIUSZ

These interviews have been edited for clarity and length.