

effect, in which the tunnelling of a Cooper pair across a gap between superconducting wires is associated with the transfer of magnetic flux through the gap. When a Josephson tunnelling device is irradiated by microwaves of a certain frequency, it produces a voltage step related to that frequency⁹. This is known as the a.c. Josephson effect, and is widely used as the basis for voltage metrology.

In the equivalent experiment using a quantum phase-slip device, microwaves applied to a superconducting nanowire drive the magnetic-flux tunnelling, periodically transferring Cooper pairs one by one with the same frequency as the microwaves. This process generates a quantized current equal to twice the elementary charge, multiplied by this frequency (Fig. 1b). And it can happen on a much faster timescale than that associated with electron transfer in single-electron pumps. Shaikhaidarov *et al.* observed current steps that were consistent with this quantization condition in the current–voltage characteristics of a niobium nitride wire. The wire had been embedded in a circuit that was carefully designed to protect it from external noise, and then cooled to 10 millikelvin.

Shaikhaidarov and co-workers' result is great news for metrologists. Instrument manufacturers and laboratories that calibrate measuring devices – as well as anyone tasked with measuring electric currents precisely – will benefit from the improved accuracy and sensitivity offered by this new approach. However, there is a caveat: the observed current steps are not completely flat with respect to the voltage applied to the device, so the accuracy of the quantized reference level is no more than 10% at present. The authors argue that improved noise filtering would allow the steps to be flat at a level of ten (or fewer) errors per billion cycles, as required for metrological applications. But the accuracy needs to be 10 million times better than that reported, which is a huge mountain to climb.

So the race is on: single-electron pumps or quantum phase-slip devices? Which would you bet on? As it turns out, there might be no need to choose. The guidelines for the International System of Units do not specify how the primary ampere standards should be built. Having multiple methods for primary standards has many advantages, such as providing ways to cross-check the results and covering a wide range of current magnitudes. These are benefits that the volt and ohm do not have at present. Measurements of the ampere might therefore one day become more accurate and more robust than those of the volt and ohm. On that day, the ampere will regain its pride of place as a base unit in the international system.

Masaya Kataoka is at the National Physical Laboratory, Teddington TW11 0LW, UK.
e-mail: masaya.kataoka@npl.co.uk

1. Taylor, B. N. & Witt, T. J. *Metrologia* **26**, 47–62 (1989).
2. Shaikhaidarov, R. S. *et al.* *Nature* **608**, 45–49 (2022).
3. Kouwenhoven, L. P., Johnson, A. T., van der Vaart, N. C., Harmans, C. J. P. M. & Foxon, C. T. *Phys. Rev. Lett.* **67**, 1626–1629 (1991).
4. Pothier, H., Lafarge, P., Urbina, C., Esteve, D. & Devoret, M. H. *Europhys. Lett.* **17**, 249–254 (1992).
5. Kaestner, B. & Kashcheyevs, V. *Rep. Prog. Phys.* **78**, 103901 (2015).
6. Stein, F. *et al.* *Metrologia* **54**, S1–S8 (2017).
7. Keller, M. W. *Metrologia* **45**, 102–109 (2008).
8. Astafiev, O. V. *et al.* *Nature* **484**, 355–358 (2012).
9. Josephson, B. D. *Phys. Lett.* **1**, 251–253 (1962).

The author declares no competing interests.
This article was published online on 25 July 2022.

Climate science

Risk management alone fails to limit hazard impact

Beth Tellman & Hallie Eakin

An analysis of floods or droughts that hit the same place twice shows that using risk management alone does not reduce the effect of extreme events. Addressing the social drivers of hazard impact, equitably, is essential. **See p.80**

Floods and droughts seem to be occurring with increasing frequency and severity, pushing the limits of society's ability to prepare for these extreme events through prediction and effective adaptation. We would like to believe that we learn from each disaster, and are thus better adapted to handle the next one. But is this really the case? On page 80, Kreibich *et al.*¹ examine 45 places where an extreme flood or drought happened twice, and determine whether risk-management strategies successfully reduced the impact of the second disaster. The authors' analysis suggests that adaptation is nearly always limited, and that the impact of a second event is not reduced by risk-management strategies when the event is more extreme than the first one.

Kreibich and her 91 co-authors from around the world documented 26 pairs of floods and 19 pairs of drought events occurring between 1947 and 2019 – with each pair having occurred in the same area. They compared the two events of each pair in the following ways: the severity of the hazard; the population's exposure (who or what were in harm's way) and vulnerability (the ability to cope with the disaster); the risk-management strategies in place (such as early-warning systems, reservoirs or levee construction); and the impact of the event (deaths and economic damage). Their extensive documentation and classification of each pair of events in terms of these factors has generated a valuable data set of the change in flood and drought impacts across time; this is now publicly available for further analysis. To ensure reliability, each event was classified by multiple scientists, including those familiar with the region in each case.

The authors' research shows that the impact of the second drought or flood was less than that of the first in 20 of the 45 cases. But in all

but 2 of these 20 cases, the second hazard was no more severe than the first, and the vulnerability of the population had decreased. In the 13 cases in which the impact of the second event was higher than that of the first, 12 had an increase in exposure relative to the first event, despite showing reduced vulnerability and improvements in risk management in many cases. In the remaining 12 cases, the impact of the two events was the same.

The most alarming finding of the study is that the impact of the second drought or flood was larger than that of the first in all but two cases in which it was the more extreme event – no matter how much risk management had been undertaken, or to what extent exposure and vulnerability had been reduced. The results imply that investments in managing risk and curbing vulnerability following one severe event might not make a society sufficiently adaptive to reduce the risk from unprecedented subsequent events, which are increasing in a changing climate.

Exposure and vulnerability are inextricably linked². It is well established that populations that are exposed to droughts and floods – often by necessity, as a last resort and through no choice of their own – are also especially vulnerable to these events³ (Fig. 1). This means that investing in risk management alone, by improving flood early-warning systems, for example, won't substantially reduce flood fatalities and damage if people continue to settle in floodplains. Managing flood risk by constructing levees, or drought risk by expanding irrigation infrastructure, can also backfire, because these developments incentivize people to settle in floodplains or start new agricultural activities in drought-prone areas.

Kreibich *et al.* also found that, unlike in



BRUNO KELLY/REUTERS

Figure 1 | The impact of flooding in Careiro da Várzea, Brazil, in May 2022.

cases of flooding, reducing vulnerability to drought through improved early-warning systems and aid does not necessarily decrease the impact of drought. These findings echo a previous drought-vulnerability study in Ceará, Brazil, in which researchers found that drought-management policies can create incentives that reduce a population's willingness or desire to adapt to disaster⁴. Furthermore, if individual landowners are not incentivized to make private investments in risk management, improving institutional-level risk-management strategies might be less effective⁵.

Unfortunately, exposure is increasing, especially for floods⁶, and this trend is expected to drive future increases in fatalities and damage as a result of flooding⁷. This means that, regardless of whether the changing climate increases the number of hazards, the impact of these hazards will increase if we do not directly tackle the socio-economic drivers that are putting human settlements and activities in harm's way.

Although Kreibich *et al.* focused on cases in which people adapted after a disaster, a study of 549 cities, reported earlier this year, showed that disasters do not catalyse urban adaptation⁸. Indeed, there is little evidence that adaptation ever offers more than incremental action to effectively reduce risk⁹. Effective and sustainable adaptation requires that we address the underlying social-economic conditions that are responsible for differences in exposure and vulnerability¹⁰. For example, the

discriminatory practice known as redlining, in which financial services were withheld from communities of colour in the United States – intentionally excluding them from access to capital investment – has led to inadequate flood-mitigation infrastructure in these communities and increased exposure to disaster (see go.nature.com/3cpp3mz).

Racism also underpins inequitable flood-recovery processes elsewhere in the United States, including in the Rio Grande Valley in South Texas, where exclusion from federal recovery funds compels residents to rely on predatory loans that can worsen their poverty¹¹. Adaptation strategies that reduce the impact of disaster in a changing climate must address the political processes that incentivize development patterns¹² and recovery processes that further entrench vulnerability and exposure.

Reducing exposure is essential, but must be managed equitably. Who gets moved, and how, matters. Effective relocation of communities whose members' livelihoods are no longer viable as a result of repeated floods or droughts, a practice known as managed retreat, can occur with planning, participation of residents who might need to move, and careful design¹³. Unmanaged retreat – or forced climate migration – can perpetuate vulnerability and inequality. There is always a danger that pre-existing social inequities will be replicated and reinforced through adaptation. In facing these challenges, it is not risk management that is needed, but rather transformation, a

concept embraced by the growing number of climate-justice activists and researchers¹⁴, as well as by the Intergovernmental Panel on Climate Change in this year's report on impacts, adaptation and vulnerability¹⁵.

Kreibich and colleagues' work gives some indication of what a transformative adaptation agenda should include. There is an urgent need to correct the underlying socio-political inequities that increase vulnerability and exposure. Those responsible for managing risk must also do more than learn from the past, but should rather anticipate and adapt to the prospect of an increasingly hazardous future. Transformative approaches to adaptation will undoubtedly be politically fraught, complex and time consuming. As we confront and overcome the social and financial barriers to such adaptation, we must also acknowledge the limits of adaptation, and manage the inequitable distribution of damage that cannot be avoided through adaptation in a changed climate.

A suite of actions – from expanding access to climate insurance¹⁶ to financing support for developing countries that experience irreversible loss and damage¹⁷ – has been proposed to deal with the limits of adaptation. Yet loss and damage financing was not included on the official agenda for this November's COP 27 meeting, the most important forum for global governance agreements on climate change (see go.nature.com/32dmura). Kreibich and colleagues' work adds to the mounting evidence that transformative adaptive

pathways⁹ are needed – and needed now. The hope is that this evidence will soon raise global recognition of the fact that unprecedented hazards require unprecedented adaptation.

Beth Tellman is in the School of Geography, Development & Environment, University of Arizona, Tucson, Arizona 85719, USA.

Hallie Eakin is in the School of Sustainability, Arizona State University, Tempe, Arizona 85287, USA.

e-mails: btellman@arizona.edu;

hallie.eakin@asu.edu

1. Kreibich, H. *et al.* *Nature* **608**, 80–86 (2022).
2. Ishaque, A., Estoque, R. C., Eakin, H., Parajuli, J. & Rabby, Y. W. *J. Environ. Mgmt* **303**, 114246 (2022).
3. Thomas, K. *et al.* *WIREs Clim. Change* **10**, e565 (2019).
4. Nelson, D. R. & Finan, T. *J. Am. Anthropol.* **111**, 302–316 (2009).
5. Nelson, D. R., Lemos, M. C., Eakin, H. & Lo, Y.-J. *Environ. Res. Lett.* **11**, 094011 (2016).
6. Tellman, B. *et al.* *Nature* **596**, 80–86 (2021).

Biochemistry

Cancer metabolism pumped up by Akt protein

Philipp Poeller & Almut Schulze

Mutated forms of the protein Akt can be central drivers of cancer metabolism. A mechanism by which Akt promotes synthesis of the metabolic molecule coenzyme A broadens our understanding of the protein's activity. **See p.192**

The protein Akt is part of a signalling cascade that is frequently activated in human cancer¹. In healthy cells, Akt regulates many metabolic processes, including glucose metabolism and the synthesis of fatty acids². These metabolic programs are enhanced in cancer to support rapid cell division, and so the role of Akt activation in these cancer-related changes is of great interest. Dibble *et al.*³ show on page 192 that Akt targets a central point of cellular metabolism, by inducing the synthesis of the metabolic molecule coenzyme A.

Coenzymes are small molecules that assist in chemical reactions and that have to be regenerated after the reaction has taken place. Coenzyme A (CoA) facilitates the coupling of acyl groups to other molecules and participates in multiple metabolic pathways, including the metabolism of glucose, amino acids and lipids⁴. In its most prominent form, as acetyl-CoA, it provides essential building blocks for lipid assembly. In addition, acetyl-CoA regulates protein function, for example by providing substrates for a process called histone acetylation, which modulates gene expression⁵. Rapidly dividing cancer cells need to replenish their

7. Wing, O. E. J. *et al.* *Nature Clim. Change* **12**, 156–162 (2022).
8. Nohrstedt, D., Hileman, J., Mazzoleni, M., Di Baldassarre, G. & Parker, C. F. *Nature Commun.* **13**, 3360 (2022).
9. Berrang-Ford, L. *et al.* *Nature Clim. Change* **11**, 989–1000 (2021).
10. Eriksen, S. *et al.* *World Dev.* **141**, 105383 (2021).
11. Belury, L. *Geogr. Rev.* <https://doi.org/10.1080/00167428.2022.2061858> (2022).
12. Eakin, H. *et al.* *Proc. Natl Acad. Sci. USA* **114**, 186–189 (2017).
13. Ajibade, I. J. & Siders, A. R. (eds) *Global Views on Climate Relocation and Social Justice: Navigating Retreat* (Routledge, 2021).
14. Newell, P., Srivastava, S., Naess, L. O., Torres Contreras, G. A. & Price, R. *WIREs Clim. Change* **12**, e733 (2021).
15. IPCC. *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report* (eds Pörtner, H.-O. *et al.*) (Cambridge Univ. Press, 2022).
16. Surminski, S., Bouwer, L. M. & Linnerooth-Bayer, J. *Nature Clim. Change* **6**, 333–334 (2016).
17. Huq, S., Roberts, E. & Fenton, A. *Nature Clim. Change* **3**, 947–949 (2013).

The authors declare no competing interests.

From the archive

A scientific society in Renaissance Italy, and concern about attempts to forge fingerprints.

50 years ago

The Experimenters: a Study of the Accademia del Cimento.

By W. E. Middleton – The Accademia del Cimento of Florence has always fascinated scientists. It existed for very little more than ten years (1657–1667, approximately), and during that period rumours of its devotion to experiment combined with some news of the experiments it performed caused the learned world to await with great eagerness its research report, published in 1667 under the title *Saggi di Naturali Esperienze* ... [T]he enterprise remains of interest, for the Accademia del Cimento was a fascinating blend of currents. The patron and, as it were, President of the Academy was Prince Leopold de' Medici, brother of Grand Duke Ferdinand of Tuscany ... Prince Leopold was energetic in designing experiments on freezing – a subject of perpetual fascination to Italians.

From *Nature* **4 August 1972**

100 years ago

It is disconcerting to learn from an article ... in ... the new publication, *Dactylography*, that the practice of forging finger-prints is increasing and will soon become a problem for New Scotland Yard. The criminal must first obtain specimens of the prints of the dupe on whom he intends that suspicion should fall. This he does by arranging that the dupe leaves his prints on a glass, or on a polished piece of furniture, after which the prints are photographed. One method of forging involves the use of a rubber stamp, where a facsimile of the original is reproduced on the rubber by means of transfer paper, and the surrounding rubber deftly pared away with a sharp knife. The second method is to take a negative cast of the finger to be forged by pressing it into a mould of soft wax, plaster of Paris, clay, or even bread. A third process involves photographing a photograph of the prints to be forged on a reversed plate.

From *Nature* **5 August 1922**

