Weathering a storm of global statistics

Sir — Another El Niño 'event of the century' has come and gone, and with it a wide variety of estimates of how much damage the world has incurred, ranging from US$14 billion to $69 billion[1–3]. Damage from all natural disasters in 1998 alone is believed to have cost some $93 billion[4]. Of greater concern than this lack of accuracy is a general tendency to describe impacts through a few global totals.

By aggregating impacts into a single estimate, much of the knowledge of and insight into the human–climate interface is lost. The environment does not affect us in simple, one-number packages. Only recently have we begun to measure quantitatively the varied losses and benefits (impacts) associated with climate variability, and these estimates have yet to be referenced to a baseline of impacts occurring in 'normal' years[5].

Regional variations in reported damages, for example, do not inherently represent the reality of losses. Burton *et al.*[6] note that biases exist "toward overestimating losses from industrialized countries and underestimating losses in developing countries or in areas remote from centers of government and mass media". It is not easy to attribute and distinguish between losses associated with climate variability and maintenance costs. Although biases and uncertainties do exist, other factors need to be accounted for, for example the use of a prejudiced vocabulary to describe losses. Many estimators are unfortunately tempted to represent a globally perceived value rather than inter-regional functionality, for example. A thatched house may not fetch a global market value, but its loss during a flood is nonetheless an impediment to livelihood maintenance or to development.

Climate impacts are also largely a function of perception and scale. What is devastating to an individual is not likely to register on an international scale, except in extreme calamities. The incentives, disincentives and cultural preferences of an affected area often guide this perception of impact, which influences the reporting and visibility of climate events. It is likely that incentives such as 'relief aid' have increased the number of reported events. There are many other complex variables that need to be taken into account.

Not all impacts associated with climate variability are disastrous or even negative. To better understand the interaction between humans and climate, the popular vocabulary used to describe and record impacts of climate variability must move beyond deaths and dollar losses.

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Colonial adventures

Sir — Walter Gratzer, in his review of Freeman Dyson's book, writes: "Dyson's guess, based on a typical interval between discovery of a new land (America in 1492) and its settlement by outsiders (the arrival of the *Mayflower*), is that colonization of space could begin in about 2085" (*Nature* **398,** 770; 1999). This perpetuates a mistaken view of the early settlement of the Americas. The first lasting European colony in the Americas was established by Nicolás de Ovando in Hispaniola in the West Indies in 1502, only ten years after Christopher Columbus's first voyage and more than a century before the *Mayflower*.

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Modern museums are far from fossilized

Sir — In his review of Steven Conn's book *Museums and American Intellectual Life, 1876–1926*, Thomas Gieryn asserts that long ago "museums ceased to be centres of intellectual work" (*Nature* **399,** 31–32; 1999). He offers reasons for this decline, which, among other things, "made natural history collections . . . almost irrelevant to the production of new knowledge".

While these and similar comments may accurately portray the changing role of many museums earlier this century, they fail to acknowledge the predominant and vital role that is played by both public and private research museums in contemporary intellectual life. This is especially true in the United States, where several prominent universities (such as Berkeley, Harvard, Kansas and Michigan) have wisely continued to support, and even expand, their research museums.

The result of this investment is that many such museums now constitute the centres of intellectual enquiry in several fields, including evolutionary biology, anthropology and human biology. Knowledge of the past offers many important lessons, but it is not an infallible guide to the present or future.

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Secondary metabolism and the risks of GMOs

Sir — The potential problems of altering the chemical composition of crops were discussed in your Briefing[1]. One aspect of this debate relates to secondary metabolism, which is an attractive area to exploit because of the importance of such compounds in resistance, defence and product quality. In our view, the rules governing the evolution and role of secondary metabolites need to be discussed and understood in order to understand the risks associated with the genetic modification of crops.

We have previously proposed[2,3] a model based on the well-known fact that potent, specific biological activity is a rare property for a molecule to possess. In this model, organisms with a rich secondary metabolism (most plants and many microbes) have gained fitness by possessing metabolic traits that enhance the production and retention of chemical diversity. Two such traits could be a broad substrate tolerance of some of the enzymes involved in secondary metabolism, and the utilization of matrix pathways.

Two examples from terpenoid metabolism illustrate the metabolic flexibility proposed. In spearmint (*Mentha gracilis*), a mutation caused an enzyme to produce a new product, but several other new compounds were also made, at least one of which was unpredictable[4]. In the grand fir (*Abies grandis*), two enzymes can make multiple products from a single substrate (one produces 52 and the other 34)[5]. If such metabolic properties exist in all organisms with a rich secondary metabolism, the introduction of a gene could potentially have quite unpredictable outcomes, as in the following examples.

First, the introduction of an enzyme

expected to produce a single new chemical could also produce other new compounds owing to the substrate tolerance of existing enzymes. Second, the introduction into a new organism of a gene encoding an enzyme involved in secondary metabolism could produce more than one product owing to the substrate tolerance of the introduced enzyme.

Third, the introduction of a gene into an organism could disturb secondary metabolite production simply as a consequence of the random gene insertion, with unplanned and unexpected increases in the content of some compounds, owing to changes in the metabolic flux through matrix pathways.

In the Briefing[1] it was suggested that metabolite profiling or clinical trials might help address the issue of the unknown consequences of manipulating food composition. Both these approaches might be very helpful when assessing the consequences of introducing a single major product, but they would be less productive when assessing the consequences of interfering with secondary metabolism.

Of major concern is the fact that the secondary metabolite profiles of plants can vary considerably, so the effect of introducing a gene into a plant might be predictable only under defined conditions that may not be achievable in the field. The secondary metabolite profile is complex, and extremely small amounts of highly potent compounds can have profound biological consequences — how complete would metabolite profiling have to be?

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Making sense of GM tomatoes

Sir — Your Briefing on genetically modified (GM) crops[1] refers to Zeneca's GM tomato puree. Hans-Jörg Buhk is reported as saying that "the best performing line was caused by an unpredicted 'sense' event (gene activation). This was a rare event, either a contamination or a chance turnaround [in the genome]". This is wrong.

The phenomenon of sense down-regulation by short sense constructs was discovered in earlier research[2]. It has nothing to do with gene activation. Subsequently, for commercial development, genetic modification of a processing cultivar of tomato was carried out with a short sense construct; 210 individual transgenics were produced and these formed the basis for further selection, breeding and development. All the development work has been rigorously reviewed in the United States and United Kingdom by the regulatory bodies. It is wrong to describe the development of this product as being due to "contamination or a chance turnaround". It is misleading to claim this as evidence that GM products are somehow unpredictable.

You show a picture of a can of GM tomato paste with a prominent label. The product was labelled voluntarily in line with our policy of openness, as has been widely reported. Labelling was not a requirement for commercialization. The caption "Backlash: consumer concerns forced action on labelling" is clearly misleading.

Our target was not 'shelf life' as this is a product sold in a can.

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Winners and losers in Framework programme

Sir — We have examined the performance of the countries included in the recently completed fourth Framework programme of research and technology in the European Union (EU). We found that this programme cost about 3% of total research and development (R&D) expenditure within the EU, but exceeded 6% of the national expenditure of countries that devote a small share (less than 1%) of their gross domestic product (GDP) to R&D (Greece, Portugal and Spain).

Austria, Italy, France and Germany were net donors of funds, particularly Germany, whose scientists received only 18% of the funds for their country's 30% contribution to the budget (Fig. 1). Most other countries were net recipients of funds, with excess funds received by the United Kingdom and Greece representing 30% and 140% of their contributions, respectively.

The success rate for grant applications was similar among all countries at 27% of the proposals filed, except for the remarkable 39% success rate of UK scientists. Hence the roles of the member states as net donors or recipients of funds largely depended on the involvement of their scientists in the programme. This varied, in per capita terms, 10-fold between Germany, where scientists filed the fewest proposals, and Greece.

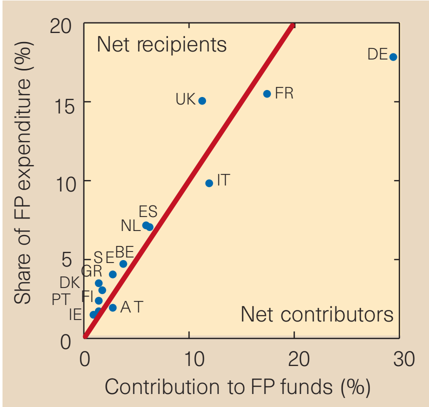

Figure 1 **Relationship between contributions and receipts of EU member states participating in the fourth Framework programme (FP). Participants: Austria (AT), Belgium (BE), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), The Netherlands (NL), Portugal (PT), Sweden (SE), and United Kingdom (UK). Data derived from information on funding decisions by the programme's committees. Data are not available for Luxembourg and non-member participants.**

Proposals to the Framework programme require the coordination of multinational research groups and the preparation of thorough management plans, which often outweigh the scientific or technical merits of the proposal in the evaluation process. These difficulties deter researchers who can obtain funds from less complex sources. The resources provided by the programme are far more attractive to scientists from countries where R&D resources are scarce (Greece, Portugal and Spain) than to those in countries where R&D investment is comparatively abundant (for example, Germany and France).

The substantial economic benefits the R&D systems of the EU countries with the lowest per capita GDP obtained from their participation in the programme should be of general benefit to the EU. The development of a stronger R&D capacity in countries where this sector has been relatively weak should deliver tangible mid-term benefits to the entire partnership at a time when countries' economies are linked through a common currency.

The fifth Framework programme (1999–2004) will improve the EU's R&D capacity further if the application procedure is simplified and the member states allocate more resources to assist scientists, thereby achieving greater participation and overall quality.

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