Better safe than sorry

Is the precautionary principle a useful guide to action?

The Precautionary Principle in the 20th Century: Late Lessons from Early Warnings
edited by Poul Harremoës, David Gee, Malcolm MacGarvin, Andy Stirling, Jane Keys, Brian Wynne & Sofia Guedes Vaz
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Roger Pielke Jr

When President George W. Bush rejected US participation in the Kyoto Protocol, he stated: "We must be very careful not to take actions that could harm consumers." This statement reflects the application of the 'precautionary principle', defined by the editors of this book as "acting before there is strong proof of harm, particularly if the harm may be delayed and irreversible" — or, in the language of common sense, "better safe than sorry".

Bush's statement reflects his concern that policies focused on environmental protection may cause harm to the economy. By contrast, proponents of the Kyoto Protocol are concerned that policies focused on economic development may cause harm to the environment. This example illustrates the limited usefulness of the precautionary principle as a guide to action. Both Bush and his opponents can appropriately use 'better safe than sorry' to justify their perspectives on the Kyoto Protocol — it provides no mechanism to reconcile disputes about how to make trade-offs between competing values.

An alternative would be to specify in advance which 'harms' should trump others; for example, the economy should always win out against the environment, or vice versa. But when the precautionary principle is associated with only one set of valued outcomes, an inevitable outcome occurs, which Tim O'Riordian characterizes in the foreword: "Precaution is a fully politicised phenomenon."

The book is organized around 14 case studies: fisheries, radiation, benzene, asbestos, polychlorinated biphenyls, halocarbons, diethylstilboestrol, antimicrobials, sulphur dioxide, methyl tertiary-butyl ether, chemical contamination of the Great Lakes, trybutilin compounds, hormones and mad cow disease. Each case study addresses four key questions. When was the first credible scientific early warning of potential harm? When and what were the main actions or inactions on risk reduction taken by regulatory authorities or others? What were the resulting costs and benefits of the actions or inactions, including their distribution between groups across time? And what lessons can be drawn from the affair that may help future decision-making?

This organization leads to an extended exercise in affirming the consequent. Each of the short case-study chapters covers a subject that, with the availability of hindsight, involves some human activity (primarily the production and use of chemicals) that has since been proven to harm the environment and/or people. A lesson repeated at the end of most of the case studies is that we should have known better and acted more promptly to regulate the harmful activity.

But this approach to the selection of cases overlooks two critically important outcomes. First, what about cases in which uncertainty existed about a particular activity for which so far no harm has been detected that outweighs the benefits? How might the approach recommended by the authors have been implemented in such cases? If one objective of the book is to suggest an alternative mechanism of decision-making in the context of uncertain outcomes, it is a serious oversight to ignore cases that begin shrouded in uncertainty yet develop with benign outcomes.

By selecting only cases in which negative outcomes resulted, the authors imply either that uncertainty always results in harm (which it clearly does not), or that a precautionary approach makes sense only in those cases where harm eventually occurs. But estimating the potential for harm is the subject of quantitative risk assessment and prediction, the standard methods of business-as-usual that the authors claim to want to move beyond.

Second, what of the cases in which regulatory or other precautionary action was taken that turned out to be exceedingly costly or unnecessary? The editors rather unconvincingly dismiss the latter cases, claiming that despite their efforts, "no suitable examples emerged". This is a difficult claim to accept, as candidate examples of such cases are manifest. Examples found on the pages of newspapers recently include mammography, US federal flood insurance, oestrogen therapy, the medical use of marijuana and other illegal drugs, airport security screening and forest-management policies.

But even with the logical flaws and selective set of case studies, the 12 lessons recommended at the end of the book are eminently reasonable and do indeed suggest an alternative to business as usual. But there is no direct connection between the cases selected and the lessons. The reader might rightly wonder where these valuable lessons actually came from, and why the authors did not see fit to organize their work around such wisdom.

In trying to shoehorn the various cases into the ill-fitting precautionary principle,

RIC FIELD/AP

On the front line: tightening airport security in the war against terror creates queues but has yet to provide a solid return on its considerable investment.

rather than around a diverse set of practical lessons borne from experience, the authors have limited this book's contribution to an alternative view of how decision-makers might confront complex and contested environmental and science policies. ■

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Mind over matter?

The Ingredients: A Guided Tour of the Elements
by Philip Ball
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Gautam R. Desiraju

BETTMANN/CORBIS

Golden touch: the tale of King Midas highlights the allure of gold for human societies.

Another book on the chemical elements? It is daunting to write about such a familiar topic but Philip Ball has the credentials to do so. A consultant editor for *Nature*, he has written extensively about science in addition to broadcasting on television and radio.

The main hurdle to writing about the elements is that chemistry is all about molecules and not elements, just as a song is about tunes and not notes and a sentence is about words and not letters. There are those who feel that even molecules do not provide a full understanding of chemistry, and that molecular assemblies, rather than individual molecules, are the irreducible leitmotivs of function in both materials science and biology. In such a scenario, the 120 or so chemical elements belong more to physics than to chemistry and, in their austerity, remind us of a time when chemistry was closer to atomic physics than to functional biology.

So are the elements relevant today? Ball has deflected this question in two ways in this provocative book, which is surely worth a read by both general readers and chemists. He has been quite subjective in his choice of elements, and the book is clearly a 'guided' tour. Secondly, he has taken poetic licence in defining the term 'element'.

The first of these two approaches cannot be questioned. So much has been written about the elements that a new book need not be just descriptive or comprehensive. To a physicist, the formation of any of the known elements is merely a reaffirmation of the rules of quantum mechanics. Yet the distribution of the 92 elements found naturally on the surface of our planet is quite skewed. No more than 30 are of widespread occurrence in the mineral world. The entry of an element into the 'biological club' is even more stringent, being largely restricted to around six members of moderate temperament that have low atomic number and a prime location in the middle of the periodic table. These attributes lead readily to covalency, which in turn favours specificity and reversibility in the reactions in which the corresponding molecules can participate. Carbon, cerium and californium are not equal partners, and Ball has done well in not treating them in the same way.

The elements that the author has chosen to highlight are excellent selections. Gold and oxygen would have been my choices, too. Gold has always fascinated humans and will always continue to do so. Ball's account of this "most useless of metals" is arresting as it brings together alchemy, chemistry, physics, metallurgy, a little biology, history, geography, economics, sociology and culture, in what is truly the best chapter of the book. The author reiterates that it is metals, rather than any of the other elements, that have so definitively encouraged or limited the scope of human activity. Coinage metals fascinated man long ago, then in the twentieth century the focus shifted to metals such as chromium, tungsten and the platinum group. Today, geopolitical strategy is driven by the availability or accessibility of titanium, zirconium and thorium. Clearly, nature has bestowed her favours unequally in her distribution of the metallic elements, and we can expect that humans will continue to be as unprincipled, as ruthless and in the end as silly as they always have been in their quest to gain access and control of metals.

But if gold is the sovereign of the periodic table, oxygen is surely the prime minister. Ball's account of this element is mostly historical, however, and much of what he says about the scientific interactions or otherwise between Antoine Lavoisier, Joseph Priestley and Carl Scheele, for example, has been described elsewhere. The role of oxygen in maintaining the various biochemical cycles is also well known. I would have liked to have seen more in this chapter. Oxygen is too pivotal an element to be treated lightly and needs to have been addressed from a modern viewpoint. It is the only element, apart from fluorine, that can react with so many others. Unlike fluorine, however, it is not so reactive as to become exotic, and it is more flexible than fluorine in the kinds of bonds it forms. Oxygen can, in effect, feel the pulse of the rest of the elements quite accurately, and it does this in increasingly subtle ways, such as by participating in hydrogen bonds.

The organization of the elements into the periodic table is treated competently, as is the synthesis of new elements in the 'atom factories' in Berkeley and Dubna, and these chapters contain a lot of information. Ball's description of isotopes is particularly good, and I do not believe that I have seen such an imaginative handling of this usually stodgy topic. His breezy journey through the landscape of some technologically important elements (iron, silicon, palladium, the lanthanides and the noble gases) provides a lively end to the guided tour.

It is in the second of his stratagems that Ball becomes more controversial. When he states that "the story of the elements is not simply a tale of a hundred or so different types of atoms… it is a story about our cultural interactions with the nature and composition of matter", he moves beyond what is strictly scientific towards a looser and softer mode of thought. The holistic approach of Aristotle led to the quartet of earth, fire, air and water. Add a fifth — ether — and we obtain the 'panchabhoota', or five elements, of the Hindu canon; the Absolute is worshipped in these manifestations to this day.

Ball refers to Plato, Galen, Leonardo, Shakespeare and T. S. Eliot to illustrate that these holistic concepts have satisfied humankind's needs over time. But it is an absolute fact that these interpretations are scientifically wrong, just as Dmitry Mendeleyev, Lothar Meyer and the scientists who preceded them for a hundred or so years were scientifically correct about the nature of the elements. The periodic table is one of the grandest intellectual accomplishments of the scientific world, and in trying to make the story of the elements more inclusive by interpreting a scientific subject from the viewpoint of the humanities, Ball is treading on unexplored and possibly treacherous ground. Conversely, critics of physics and chemistry maintain that all of the important problems in these subjects are essentially solved. Is this book then an implicit recognition of this fact? ■

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Stories of the Invisible: A Guided Tour of Molecules (Oxford University Press, £7.99), also by Philip Ball, is now published in paperback.