

LETTERS

edited by Jennifer Sills

Creating an Earth Atmospheric Trust

STABILIZING CONCENTRATIONS OF GREENHOUSE GASES IN THE EARTH'S ATMOSPHERE AT A level that will control climate change will require drastic departures from business as usual. Here, we introduce one response to this challenge that may seem visionary or idealistic today, but that could become realistic once we reach a tipping point that opens a window of opportunity for embracing major changes.

The core of this system is the idea of a common asset trust. Trusts are widely used and well-developed legal mechanisms designed to protect and manage assets on behalf of specific beneficiaries. Extending this idea to the management and protection of a global commons, such as the atmosphere, is a new but straightforward extension of this idea. Because the atmosphere is global, the Earth Atmospheric Trust would be global in scope; however, initial implementation at a regional or national scale may be necessary. We provide an outline of the steps that must be taken to create and manage such a system.

- (i) Create a global cap-and-trade system for all greenhouse gas emissions. We believe a cap-and-trade system is preferable to a tax, because the major goal is to cap and reduce the quantity of emissions in a predictable way. Caps set quantity and allow price to vary; taxes set price and allow quantity to vary.

Balancing act. Sustainable human well-being depends on a balance of built, human, social, and natural capital assets. An Earth Atmospheric Trust might better manage the atmospheric commons to control climate change.

- (ii) Auction off all emission permits, and allow trading among permit holders. This essential act will send the right price signals to emitters.

- (iii) Reduce the cap over time to stabilize concentrations of greenhouse gases in the atmosphere

at a level equivalent to 450 parts per million of carbon dioxide (or lower).

- (iv) Deposit all the revenues into an Earth Atmospheric Trust, administered by trustees serving long terms and provided with a clear mandate to protect Earth's climate system and atmosphere for the benefit of current and future generations.

- (v) Return a fraction of the revenues derived from auctioning permits to all people on Earth in the form of an annual per capita payment. This dividend will be insignificant to the rich but will be enough to be of real benefit to many of the world's poor people. At the current annual rate of global emissions of 45 gigatons CO₂ equivalent and an auction price of \$20 to \$80 per ton, the Trust's total annual revenues would be \$0.9 to \$3.6 trillion. If half the revenues were returned equally to all 6.3 billion people, payment would amount to

\$71 to \$285 per capita per year.

(vi) Use the remainder of the revenues to enhance and restore the atmospheric asset, to encourage both social and technological innovations, and to administer the Trust. These funds could be used to fund renewable energy projects, research and development on new energy sources, or payments for ecosystem services such as carbon sequestration.

No system is perfect. A system designed on these general principles would be fair; it would be efficient and relatively immune to political manipulation, and it would help to alleviate global poverty.

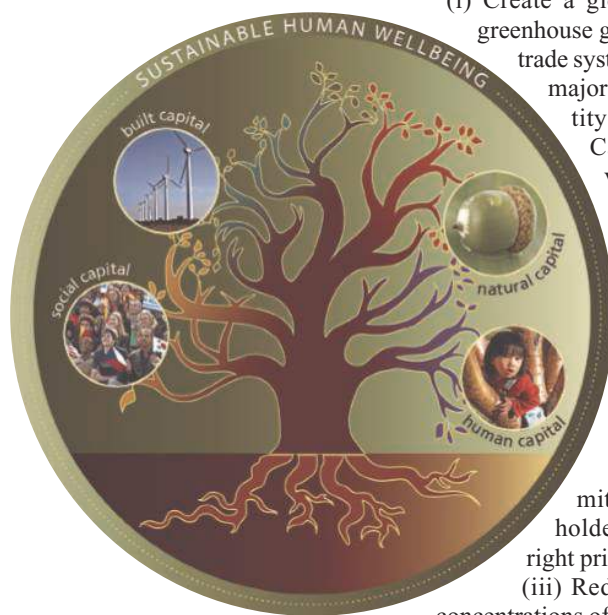
We encourage those interested in adding their name to a growing list of supporters of this idea to visit www.earthinc.org/earth_atmospheric_trust.php.

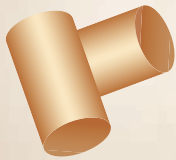
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The Latest Buzz About Colony Collapse Disorder

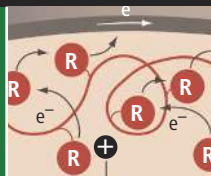
THE REPORT "A METAGENOMIC SURVEY OF microbes in honey bee colony collapse disorder" (D. L. Cox-Foster *et al.*, 12 October 2007, p. 283) identified Israeli acute paralysis virus (IAPV) as a putative marker for colony collapse disorder (CCD). It also purports to show a relationship between U.S. colony declines as early as 2004 and importations of Australian honeybees. We believe these links are tenuous for several reasons: (i) Importations of Australian honeybees to the United States did not commence until 2005. (ii) No evidence is presented for a causal link between IAPV and CCD. Koch's postulates, as modified for





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viruses by Rivers (1), were not demonstrated. Several CCD colonies were free of IAPV and the “shivering phenotype,” and the death of bees close to the hive associated with IAPV in Israel (2) was not observed in CCD colonies. (iii) The case definition for CCD is ambiguous, and the symptoms are indistinguishable from those of the normal winter colony collapse reported in the United States since the late 1980s and attributed to *Nosema* infection and/or the secondary effects of varroa (3). Many scientists are unconvinced that CCD is a new disorder (4). (iv) Members of the Kashmir bee virus complex (including IAPV) persist as nonacute (harmless) infections in honeybee colonies (5). They are opportunists and only cause acute infection in association with a primary pathogen (such as *Nosema apis*) (6). (v) Neither CCD nor large-scale, unexplained mortality events have occurred in the Australian bee industry. The implication that the absence of varroa in Australia may explain the absence of CCD is incorrect. Modeling has shown that fast-replicating viruses (such as IAPV) cannot cause colony collapse when associated with varroa (7). (vi) Other countries reporting CCD (such as Greece, Poland, and Spain) have not imported bees from Australia.

A followup paper by coauthors on the *Science* Report has now been published in the *American Bee Journal* (8) describing isolation of IAPV from specimens of *Apis mellifera* collected within the United States in 2002. This is more than 2 years prior to the commencement of importation of Australian packaged bees. It would now be appropriate for the authors of the *Science* Report to issue a retraction of the claims linking CCD to importation of Australian bees.

Future collaboration between United States and Australian scientists can only lead to a better understanding of colony collapse and IAPV and result in more secure trade for package honeybees to meet the growing demands of the United States polination industry.

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Response

IN THEIR LETTER, ANDERSON AND EAST suggest that CCD is an ambiguous disorder consistent with normal winter losses. We do not agree. CCD is characterized by a rapid loss of adult bees; excess brood, in all stages, abandoned in the hive; low levels of varroa; and a lack of dead bees in or near the hive. In CCD, levels of varroa do not reach those associated with normal winter losses, distinguishing CCD from colony declines attributed to parasitic mites. Although Anderson and East imply that we claim to have determined the cause of CCD, the final paragraph of our paper states, “We have not proven a causal relationship between any infectious agent and CCD...”

The notion that all viruses within a phylogenetic group can only present as a single syndrome is invalid. Differences in virulence are common even among closely related viruses (1) and may reflect differences in the host, the microbe, or both. Indeed, genetically distinct lineages of IAPV sequences found in Israel differ in pathogenicity (2). With regards to varroa, most evidence points to a link between bee viruses and varroa and indicates that varroa acts as both a vector and an activator of latent viruses (3). Finally, given work from Anderson describing “Disappearing Disorder,” it is not clear that Australia is free of unexplained losses of honey bees (4).

We appreciate that research on products important to international trade may lead into politically and economically sensitive territory. However, trade issues should not color research. Anderson and East note that subsequent work from our group indicates the presence of IAPV in bees in the United States as early as 2002 (5), predating recognition of CCD or the formal importation of bees from Australia. Infectious agents,

including IAPV, do not respect national boundaries. IAPV is not confined to the United States or Australia. It has also been found in bees in Israel and royal jelly from Manchuria. We anticipate that with the new focus on IAPV and the distribution of diagnostic reagents, we will learn that it is even more widely distributed. Nonetheless, IAPV lineages have now been found in U.S. bees; one of them correlates genetically with IAPV found in bees in Australian shipments. The presence of IAPV strains in older U.S. samples does not eliminate a role for this virus in CCD.

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More Toxin Tests Needed

IN HIS EDITORIAL “TOXIC DILEMMAS” (23 November 2007, p. 1217), D. Kennedy mentions tris(2,3-dibromopropyl) phosphate. In 1978, results published by the National Cancer Institute clearly showed that this flame retardant was carcinogenic in both sexes of rats and mice, causing cancers of the kidney, lung, liver, and forestomach (1).

Kennedy was an integral partner in the formation in 1978 of the National Toxicology Program (NTP), and as FDA Commissioner, he was an early chairman of the NTP Executive Committee (2). Since its inception, NTP has conducted nearly 600 chemical carcinogenesis bioassay studies,

nearly half of which have shown evidence of carcinogenic activity (3). However, this represents only about 0.6% of available chemicals on the market. Likewise, the International Agency for Research on Cancer has evaluated only about 950 chemicals for carcinogenic activity; of these, about 100 were found to be human carcinogens, another 69 were classified as probably carcinogenic to humans, and 246 were classified as possibly carcinogenic to humans (4). The number of chemicals that have not yet been tested is staggering, and it becomes even more formidable when one considers mixtures of chemicals, together with the thousands of new chemicals that enter the marketplace every year.

We live in a chemical soup, and alternative methods of testing chemicals, such as in vitro short-term testing, have failed at identifying carcinogens. The NTP, the major testing program in the world, starts at most only five new bioassays per year. We must test more chemicals for carcinogenicity than are currently being evaluated.

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References and Notes

1. National Toxicology Program, *TR-76 Bioassay of Tris (2,3-Dibromopropyl) Phosphate for Possible Carcinogenicity* (CAS No. 126-72-7); available online at <http://ntp.niehs.nih.gov/go/6907>.
2. The NTP Executive Committee was made up of governmental research and regulatory agencies, including the Centers for Disease Control and Prevention, Consumer Product Safety Commission, Environmental Protection Agency, Food and Drug Administration, National Cancer Institute, National Center for Toxicological Research, National Institute of Environmental Health Sciences, National Institutes of Health, National Institute for Occupational Safety and Health, and Occupational Safety and Health Administration.
3. National Toxicology Program, Department of Health and Human Services, Long-Term Study Reports and Abstracts; available online at <http://ntp-server.niehs.nih.gov/ntpweb/index.cfm?objectid=D16D6C59-F1F6-975E-7D23D1519B8CD7A5>.
4. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans; available online at <http://monographs.iarc.fr/ENG/Classification/crthall.php>.

The Inimitable Field of Cosmology

IN THE NEWS FOCUS ARTICLE "A SINGULAR conundrum: How odd is our universe?" (28 September 2007, p. 1848), A. Cho perpetuated misunderstanding of science with the statement, in part from James Gunn, that "'Cosmology may look like a science, but it isn't a science' because it's impossible to do repeatable experiments." In the truly natural

CORRECTIONS AND CLARIFICATIONS

Editors' Choice: "Cooler in the forest" (7 December 2007, p. 1525). The final sentence should have been "Thus, contrary to some assertions, conversion of open fields to wooded fields will not necessarily lead to local increases in temperature."

TECHNICAL COMMENT ABSTRACTS

COMMENT ON "Clustering by Passing Messages Between Data Points"

Michael J. Brusco and Hans-Friedrich Köhn

Frey and Dueck (Reports, 16 February 2007, p. 972) described an algorithm termed "affinity propagation" (AP) as a promising alternative to traditional data clustering procedures. We demonstrate that a well-established heuristic for the p -median problem often obtains clustering solutions with lower error than AP and produces these solutions in comparable computation time.

Full text at www.sciencemag.org/cgi/content/full/319/5864/726c

RESPONSE TO COMMENT ON "Clustering by Passing Messages Between Data Points"

Brendan J. Frey and Delbert Dueck

Affinity propagation (AP) can be viewed as a generalization of the vertex substitution heuristic (VSH), whereby probabilistic exemplar substitutions are performed concurrently. Although results on small data sets (≤ 900 points) demonstrate that VSH is competitive with AP, we found VSH to be prohibitively slow for moderate-to-large problems, whereas AP was much faster and could achieve lower error.

Full text at www.sciencemag.org/cgi/content/full/319/5864/726d

sciences (such as geology, oceanography, atmospheric science, and ecology), rigorous observation and interpretation are commonly used, rather than "repeatable experiments" à la Karl Popper—except in those few cases where a small-scale experiment is meaningful (1). It would be better to say that cosmology is science—it just isn't Popperian physics.

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1. C. M. Condit, L. B. Railsback, The Transience Project (www.gly.uga.edu/railsback/Transience/Transience.html).

Response

WITH ALL DUE RESPECT, I THINK THAT L. B. Railsback misses the point that I was attempting to make. The pursuit of understanding the cosmos is certainly a scientific pursuit and makes use of many of the most powerful tools of science. Unfortunately, there is only one observable universe, and while it is quite possible in principle, and probably in practice, to formulate theories that describe its observed behavior perfectly on the largest scales, those theories could well be unverifiable by any doable experiment.

In geophysics and astrophysics, the experimenter is nature, not the scientist, but repeated experiments can be done and the results can be observed. This is not so in cos-

mology for phenomena on the largest scales. Further confusion stems from our belief that the structure we are observing is stochastic on scales up to and beyond the current particle horizon. As discussed in the News Focus article, we may be unlucky enough to live in a volume in which some large-scale quantity assumes a very unlikely value within the framework of some otherwise seemingly successful theory. It then becomes a very subjective matter of whether this observation does or does not rule out the theory in question.

Whatever one's view on the Popperian definition, verification by whatever technique is a cornerstone of science; I am merely saying that this can be impossible for crucial and interesting aspects of cosmological inquiry.

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Letters to the Editor

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