Lake-sediment record of late Holocene hurricane activities from coastal Alabama: Comment and Reply

COMMENT

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Liu and Fearn (1993) presented a sedimentological analysis of recent and near-recent hurricanes as recorded in an Alabama coastal lake. They concluded from the sedimentary record that category 4 or 5 hurricanes show a recurrence interval of ~600 yr and that the last storm of this size occurred more than 700 yr ago. On the basis of this estimate, they inferred that another such storm will occur within the next 100 yr. The first conclusion appears supported by the paper, but the second, as presented, is fallacious.

Liu and Fearn (1993) presented no mechanism (i.e., cause) controlling the hurricane recurrence interval, but, rather, reported it as, essentially, an effect. Given this, all that can be said logically is that at any moment there is a likelihood of a magnitude 4 event every 600 yr. It does not matter when that moment is, and therefore, even given a millenium without a hurricane of 600 yr recurrence (or in analogous studies, a 100-yr flood, an epochal mass extinction event, an asteroid impact, etc.), all one may say is that such an event is likely some time in the next 600 yr. Time passing by without a recurrent event is not significant unless a driving mechanism forces the recurrence (as in some earthquake models). This is the classical "coin toss" fallacy: toss ten coins, the odds are 1:1 heads to tails. Toss 9 heads in a row, the odds of heads or tails is still and forever 1:1.

REFERENCE CITED
Liu, K.-B., and Fearn, M.L., 1993, Lake-sediment record of late Holocene hurricane activities from coastal Alabama: Geology, v. 21, p. 793–796.

REPLY

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The Comment by Schwimmer and Frazier is very well taken. We are keenly aware of the statistical implications in the calculation and interpretation of recurrence intervals; thus, we refrained from using such terms as "overdue" or predicting when the next major hurricane will occur. All we were saying was that the Alabama coast is *likely* to be struck by a category 4 or 5 hurricane within the next century—without predicting that this must occur or specifying how likely it is to occur within this time interval. A century is a convenient time scale that most people, including land use planners and politicians, can easily relate to.

LETTER

Craig Bond Hatfield's Opinion piece in the January 1993 *Geology* merely underscores that bad assumptions, even with impeccable arithmetic, still yield bad results. Hatfield further concluded with a non sequitur when he said that decreasing fuel usage involves attacking economic growth.

The worst assumption in the Club of Rome models, on which Hatfield relied, was that they dismissed the ultimate significance of technological improvements in resource extraction, as they assumed that exploitation of lower and lower grade resources must inevitably lead to greater and greater pollution. Thus, they implicitly assumed what might be called the "thermal paradigm": the reliance of traditional extraction technologies on phase changes driven by the prodigious application and extraction of heat, such as the separation of molten iron and slag as immiscible liquids. (Indeed, the huge energy demand of much current technology results mostly from its pervasive use of heat.) Such techniques also require fairly concentrated feedstocks, because the partition coefficients of elements between coexisting phases are not infinite. The only point in favor of such techniques is their simplicity—which, of course, accounts for their pervasive use in an era in which energy sources are cheap, natural concentrated feedstocks exist, and technical sophistication is low.

For this is hardly the only conceivable way to extract desired elements (or to extract undesired ones, as in pollution control). Natural counterexamples abound in biological systems. Plant roots, which can extract needed elements from the environment at extremely low concentrations, are one example. The kidneys of higher animals are another: they extract, isothermally and at high efficiency, certain electrolytes out of a background of many other electrolytes at an energy cost very close to ΔG.

So we are left with the implication that although natural selection can stumble into molecular mechanisms that can extract elements at very low concentrations at close to the reversible limit, our

extraction technology is forever limited by the cumbersome and thermally intensive processes we currently employ. This is so overconservative as to be preposterous. For one alternative approach, see Drexler (1992).

Moreover, energy is not the ultimate limiting factor on industrial civilization that is often claimed. Not only is the theoretical limiting energy for extracting elements far less than that currently consumed, large alternative energy sources are possible. Aside from standbys like D fusion there are concepts such as solar-power satellites, which are the subject of an entire refereed technical journal—*Space Power*.

Even ground-based solar power should not be dismissed. Green plants work just fine, even though they reflect sunlight in the wavelength region where it's most intense! Thus, the alleged inadequacy of solar power as a source of energy for an industrial civilization is merely a statement about the level of our technology; from the present limitations on our ability to manipulate matter at the molecular scale, and on the requirement of much current technology for large amounts of raw heat.

We also could use fuels far more efficiently. All current petroleum-based engines, for example, are fundamentally limited by the Carnot cycle and so are intrinsically wasteful. Fuel cells that could oxidize hydrocarbon fuels to water and CO_2 while producing electricity directly would at least double the oil supply, since a fuel cell–electric motor combination is not Carnot-limited. Such cells would also generate no partial-combustion products such as CO or NO_x.

Finally, of course, much of the current transportation of people, with its enormous attendant energy cost, is done merely to move information. A great deal of current office work could be replaced by telecommuting. Such concepts as telepresence (e.g., Taylor and Spudis, 1990) suggest that ultimately even much commuting for "hands-on" sorts of jobs could be replaced.

So economic growth will not stop. It will, however, be redirected into more and more information-intensive forms, in which large blocks of information are transferred at very low energy costs, and in which *small* amounts of matter are more and more highly organized, ultimately (like living things) at molecular scales. (What differentiates a computer chip, for example, from any blob of slightly impure silicon is its high degree of internal organization.) We can also expect that the routine use of large amounts of heat, which so pervades our present technology, will vanish.

Last, no one maintains that population can rise indefinitely. But birthrates have been falling in Western Europe for over a century (e.g., Coale, 1986), and are now below the replacement level in all the industrialized countries. Children were valuable assets on a traditional, labor-intensive farm, but even before modern medicine they were not nearly so valuable in an urban setting; indeed, rural populations have been the source of population increase historically.

In conclusion: yes, sooner or later we will have to move away from fossil fuels, and thus it may be, as Hatfield noted, that the concern about the greenhouse effect is overstated. And it certainly is true that population cannot rise indefinitely. But his conclusion that this means that "economic growth" must stop is simply false: it will instead be redirected. Which is fortunate, as human beings do not choose poverty voluntarily, especially at the say-so of those who are not poor!

References Cited

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Taylor, G.J., and Spudis, P.D., 1990, A teleoperated robotic field geologist, *in* Johnson, S., and Wetzel, J.P., eds., Engineering, construction, and operations in space II, Volume 1 (Proceedings of Space 90, Albuquerque, New Mexico, April 1990): New York, American Society of Civil Engineers, p. 246–255.

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