center are successfully coping with the variety of problems which are bound to develop in such a large pioneering project. In terms of the basic scientific value, scientific excellence, ethics, community and scientists' cooperation, administration, and fiscal prudence, MRFIT is maintaining successful progress toward its objectives.*

JOHN C. CASSEL
Department of Epidemiology, School of Public Health, University of North Carolina, Chapel Hill 27515
WILLIAM INSULL, JR.
Center for Prevention of Premature Arteriosclerosis, Rockefeller University, New York 10021
DAVID JENKINS
Department of Behavioral Epidemiology, School of Medicine, Boston University, Boston 02118
DONOVAN THOMPSON
Department of Biostatistics, School of Public Health, University of Washington, Seattle 98105
PARK W. WILLIS, III
Section of Cardiology, School of Medicine, University of Michigan, Ann Arbor 48104
CHARLOTTE M. YOUNG
Cornell University, Ithaca, New York 14850

*The undersigned are nonfederal scientists who comprise the MRFIT Policy Advisory Board.

Health Statistics

Horacio Fabrega's article, "The need for an ethnomedical science" (19 Sept. 1975, p. 969) and the comments by Bergner *et al.* (Letters, 9 Jan., p. 26) were indeed timely. This year's AAAS annual meeting included a symposium, Health Status Indexes—Their Role in Tomorrow, which addressed the same issues. Information was presented about the current applications of health indicators, such as morbidity and mortality, within the social indicator framework. Discussion focused on the methodology of measuring positive aspects of health, with implications for developing health indexes for policy purposes.

Measures of health are now becoming sufficiently developed to assist in the decision-making process. Various research efforts during the last 50 years have produced significant literature published in a variety of respected professional journals on the development of measurable concepts of health and disease. Much of this research has been supported by the U.S. federal health establishment, as well as by the United Nations and the World Health Organization.

To coordinate the dissemination of this information and to encourage communication and cooperation among health status researchers, the National Center for Health Statistics, Department of Health, Education, and Welfare, has established the Clearinghouse on Health Indexes. The Clearinghouse prepares annotated bibliographies of current information related to health measurement and generates bibliographies on specific subjects. These services are available without charge.

PENNIFER ERICKSON
Division of Analysis, Clearinghouse on Health Indexes, National Center for Health Statistics, Rockville, Maryland 20852

Climate Research

Among the host of warnings of environmental degradation now facing the public is the claim that disaster is in store if mankind fails to realize that his well-being depends on a stable global climate and that climatic change, either natural or man-made, is a real threat which must be attended to today.

As is true in the case of many environmental advocacy causes, some claims are gross exaggerations, thereby lending less credibility to the remainder. In addition, due in large measure to the degree of ignorance regarding the fundamentals of the nature of climatic variability and change, disagreements among climate experts concerning the plausibility of possible traumatic effects of climatic change have caused confusion on the part of the lay-public and within government circles, making it difficult to assess the true state of affairs.

However, these circumstances are hardly sufficient to account for the lack of federal funding of climate research in response, not just to the clamor of the doomsday prophets, but also to a series of highly authoritative and respectable reports (*1*), all of which have reiterated the need for a major increase in climate research activities. No doubt the demise last spring of the National Climate Program (*2*) can in part be ascribed to the nation's economic difficulties, but there is another more trenchant cause for the problem, specifically a failure to demonstrate to funders of such research the practical benefits that can result within a time frame of relevance to their mandate. For example, at its most ambitious, climate research would generate untold benefits if it could lead to a predictive capability; at present, however, this is more a hope than an expectation. Research funding with such an objective would be long-term, high-risk, and have a

high payoff. A conservative program would emphasize the collection and analysis of more data on climate the world over. Such knowledge would be of interest to planners in climate-sensitive sectors of the economy, for example, in determining the magnitude of buffer stocks of food. This type of research is easy to justify in terms of short-term goals but has attracted little attention from the research community, presumably because of its relatively mundane scientific content. Finally, there remains the very real possibility of an eventual man-made disturbance of the world's climate through any one of a variety of mechanisms, most of which were reviewed in the Study of Man's Impact on Climate report (*3*). The Climatic Impact Assessment Program (*4*), based on one such possibility, was in fact funded but ended without gaining the advances needed to predict the climatic consequences of a reduced ozone layer—its stated objective. Other man-induced impacts have been judged potentially serious, but far off, and thus those investigating them have not been able to compete for restricted research funds.

Within the last few months, new information has come to light: there is now a demonstrable case of a man-made global climatic change whose magnitude depends on planning decisions made today but which cannot be quantitatively assessed because of our ignorance of the dynamics of the climate system. The increase in global atmospheric carbon dioxide since the start of this century is well documented and the first-order climatic response well known (the "greenhouse" effect). Best estimates suggest an increase in global mean temperature of perhaps 2°C, with a doubling of ambient CO_2 levels above their preindustrial value (*5*), but reliable estimates are far from possible at present, due, not only to a lack of understanding of atmospheric dynamics, but to a wide variety of feedback mechanisms within the climate system that need to be investigated and taken into account. The latter, it should be pointed out, can result in diminution *or* enhancement of the climatic response (*6*). Projections have also been made of expected levels of atmospheric CO_2 by extrapolation of present-day trends of industrial generation. The recent report by Broecker (*7*) estimates a 50 percent increase by the year 2020, a figure that agrees with that used by Häfele and Sassin in an important new study (*8*) made for the International Institute for Applied Systems Analysis (IIASA). They assume a fully fossil-fuel energy production system for the world well into the next century (that is, insignificant nuclear or other forms of energy production) and report a date of 2035 for a doubling of the ambient CO_2 level. They also assume a 3 percent

energy growth rate for the world with an ultimate leveling off at 5 kilowatts per capita using 1974 U.N. population projection figures. The crucial new consideration introduced in the IIASA study is the juxtaposition of this fact with an assessment of our ability to massively deploy a new energy production technology. It points out that the "market penetration time" (that is, the time for a new energy production system to gain a 50 percent share of the total market, starting from a 1 percent level) is 60 years in the case of the United States and longer for the rest of the world. Moreover, this number appears to be an indigenous property of the economic forces that drive the market system and is difficult, if not impossible, to reduce materially. Thus, it so happens that the market penetration time just matches our current best estimate of the CO_2 doubling time, and if planning decisions for avoidance of possible CO_2 climatic impacts are to be effective, the time to make them appears to be now.

It the nation's energy planners take their public charge seriously, it is evident from these fundamental considerations that they should be pressing for assured predictions of the climatic consequences of their decisions on energy production deployment, as error could be disastrous. Understanding climatic change is a truly massive task; social responsibility dictates that we get on with the job diligently and expeditiously.

J. A. LAURMANN

3372 Martin Road,
Carmel, California 93921

References and Notes

1. Federal Council for Science and Technology, Interdepartmental Committee for Atmospheric Sciences, *Report of the Ad Hoc Panel on the Present Interglacial* (Government Printing Office, Washington, D.C., 1974); National Advisory Committee on Oceans and Atmosphere, *Third Annual Report* (Government Printing Office, Washington, D.C., 1974); U.S. Committee for the Global Atmospheric Research Program, *Understanding Climatic Change: A Program for Action* (National Academy of Sciences, Washington, D.C., 1974); Ocean Science Committee, *The Role of the Ocean in Predicting Climate* (National Academy of Sciences, Washington, D.C., 1975).
2. Environmental Resources Committee, Subcommittee on Climate Change, *A United States Climate Program* (Domestic Council, Washington, D.C., 1974).
3. *Inadvertent Climate Modification: Report of the Study of Man's Impact on Climate* (MIT Press, Cambridge, Mass., 1971).
4. A. J. Grobecker, S. C. Coroniti, R. H. Cannon, Jr., *The Effects of Stratospheric Pollution by Aircraft. Report of Findings* (National Technical Information Service, Springfield, Va., 1974).
5. S. H. Schneider and R. D. Dennett, *Ambio* **4**, 65 (1975).
6. There are, of course, other possible man-made as well as natural causes of climatic change. Particulates from industrialization have until recently been thought to *reduce* global temperature. This is no longer believed to be necessarily the case [see S. H. Schneider and C. Mass, *Science* **190**, 741 (1975)]
7. W. S. Broecker, *ibid.* **189**, 460 (1975). Broecker also makes estimates of global temperature response allowing for projected natural climate change, an important consideration in predicting increased global temperatures.
8. W. Häfele and W. Sassin, "Energy strategies", paper presented at the European Physical Society Annual Meeting, Bucharest, 1975.