The Global Trajectory*

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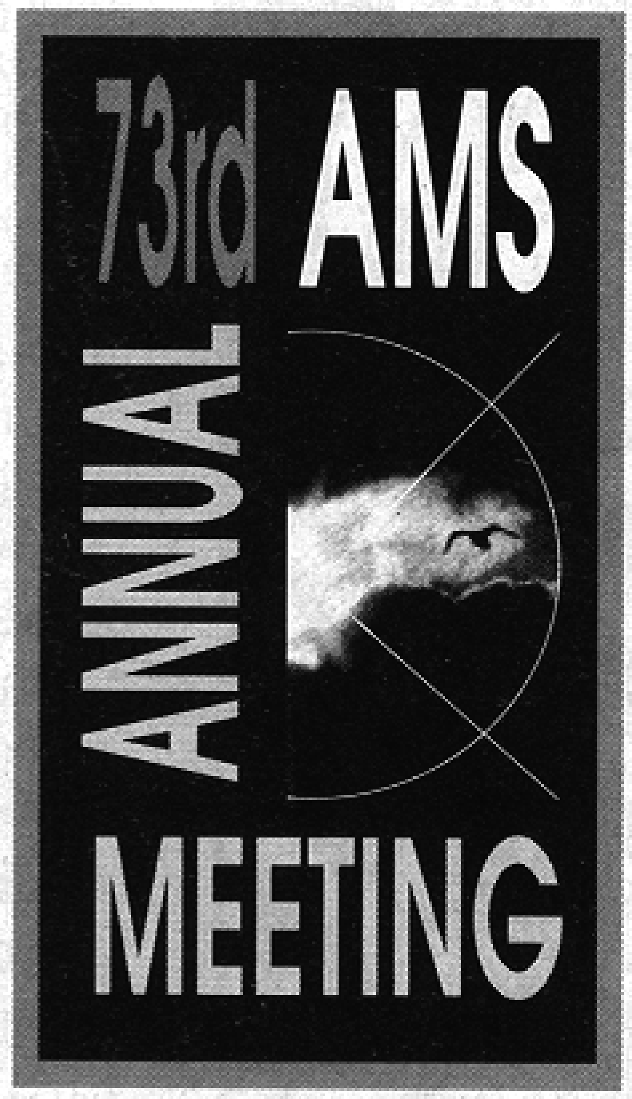
SPEECH



Abstract

The author argues for environmental scientists to take activist roles in defining and promoting future global environmental policies and practices to avert the current path of overpopulation, unsustainable economic development, poverty, and environmental degradation.

If we do not change our direction, we are likely to end up where we are headed.—Chinese proverb

1. Introduction

As president of the University Corporation for Atmospheric Research, I have become increasingly aware that the atmospheric sciences are only part of a global change drama that is unfolding around the globe at an ever-increasing pace. Therefore, the purpose of this paper is not to recite the good things that atmospheric sciences has done for society in the past, nor all of the exciting potential for the future, including improved forecasts and warnings as a result of the modernization of the National Weather Service; the exciting science under way in the universities, the National Center for Atmospheric Research (NCAR), and other laboratories; the likelihood of global models with fine-scale resolution; and the marvelous observations of the atmosphere, oceans, and land to come from the Earth Observing System (EOS) early in the next century. Instead, I want to offer some thoughts about global change, very broadly defined, of which environmental science, weather, and climate are significant parts—but only parts—and how environmental science fits into the larger picture of our global society. Many of the ideas in this essay, including the title, were developed, borrowed, or stolen shamelessly from scores of articles and reports that I have studied over the past year.

In fact, the very title of this essay—"The Global Trajectory"—is borrowed from the 1991 Sigma Xi Forum on Global Change (Malone 1992b). "Global trajectory" refers to the projected quality of human life on earth in the twenty-first century and beyond. The results from this forum, "Global Change and the Human Prospect: Issues in Population, Science, Technology, and Equity," do not make for comfortable reading, but I am convinced that the seriousness of the times argues against comfort, complacence, and business as usual. Lester Brown, in the just-published *State of the World 1992,* calls for an environmental revolution, a revolution that will rank with the Agricultural Revolution of 10 000 years ago and the Industrial Revolution, which began 200 years ago, in changing society forever. The scientific community, as well as every segment of society, must participate in this revolution, and I argue that scientists should be among its leaders.

Table 1 lists some facts of our present-day condition. The overwhelming point of consensus in the many related documents and discussions is that the health of the planet's environment, taken as a whole, has never been worse in human history, and the global trajectory we are now on is toward an increasingly unsustainable state. In just the past few decades, humanity has become a planetary force that many believe is out of control.

2. The four horsemen of the Apocalypse

And I looked, and behold a pale horse: and his name that sat on him was Death, and Hell followed with him. And power was given unto them over the fourth part of the earth, to kill with sword, and with death, and with the beasts of the earth.
Revelation 6:8

The Biblical chapter Revelation is also known as the Apocalypse. The "four horsemen of the Apocalypse" were war, conquest, famine, and death (Fig. 1). A

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*This paper is based on a presentation given at the annual meeting of the American Meteorological Society, 18 January 1993.

FIG. 1. "The Four Horsemen," Albrect Dürer, 1471–1528.

modern version of these four death dealers might be overpopulation, unsustainable economic development, poverty, and environmental degradation.

a. Overpopulation

Maximum welfare, not maximum population, is our human objective.—Arnold Toynbee (1963), *Man and Hunger*

It has been almost 200 years since Thomas Robert Malthus wrote his 1798 classic, *An Essay on the Principles of Population.* Malthus argued that population tends to grow exponentially, while food supplies grow only arithmetically, and hence there is and always will be stress associated with overpopulation in human societies. Perhaps because Malthus's arguments were by his own admission based mainly if not exclusively on his opinions rather than facts, for years the potential dangers of overpopulation were ignored or countered with arguments that "technology" or "agricultural revolutions" would solve the problem. And for years advances in technology, including the "green revolution," did increase the standard of living for growing numbers of people, and the apocalypse predicted by Malthus seemed avoidable forever, or at least comfortably distant in the future.

But the Malthusian clock is still ticking, and the evidence that we are running out of time grows daily. As shown in Fig. 2, global population continues to increase exponentially, a trajectory that is clearly unsustainable in our finite world.

A colleague at the University of Colorado in Boulder (Bartlett 1978) emphasizes this actuality with a parable that I call "The Bugs in a Bottle." It goes like this. Suppose a hypothetical colony of bugs, which doubles every minute, is in a bottle and at 11:00 A.M. there are two bugs; at 11:01 four bugs, etc. By 12:00 noon it is observed that the bottle is full. Consider three questions:

1) At what time is the bottle half full? *Answer:* 11:59 A.M.!

2) If you were a bug in the bottle, at what time would you first realize you were running out of space? Of course, this depends on how smart you are and how many data are available to you, but let's consider 11:55 A.M., when the bottle is 3% full and 97% is "open space." I can easily imagine some bugs in the colony making arguments such as "technology will take care of us," "the data are incomplete," "uncertainties in future predictions exist," and, *therefore,* "it is premature to take action." However, suppose that at 11:58 A.M. some far-sighted inhabitants of the bottle discover new data that indicate—with certainty—that there are

only two minutes left, and devote all their resources and energies to a search for a new bottle. Miraculously, at 11:59, not *one* but *three* new empty bottles are discovered. Great celebrations ensue because the discovery produces three times the amount of space previously known. This leads to the third question . . .

3) How much more time does this great discovery give the colony? *Answer:* Two more minutes!

So, what does this have to do with today's human population? I will not attempt to define an optimum total human population but I will give you a view of an upper bound. Most people will agree that a density of one person per square meter of land surface (excluding Antarctica) is an extreme upper limit to human population. At the present growth rate of 1.8% yr^{-1}, this limit will be reached in about 600 years, about one-fifth the span of human civilization. This is not to suggest that I believe this limit to be a realistic one, or that the population will continue to increase at its present rate—it almost certainly cannot. The point is that since no one knows the capacity of the earth to sustain human population with a *reasonable quality of life,* it is very dangerous to determine that capacity experimentally—which is what we are now doing.

TABLE 1. Some facts about our present condition.

•	The present world population is 5.4 billion and growing at a rate of 1.8% per year.
•	At this growth rate, the population is increased annually by more than 90 million people (equivalent to a population the size of Mexico) and will double in 40 years.
•	For every one person added in the north, 20 persons are added to the south (Malone 1992a).
•	The north contains 20% of the world's population but consumes 80% of all the goods and services each year (Malone 1992a).
•	The average person in the North consumes 16 times the amount of resources as the average person in the south.
•	Forests are vanishing at a rate of 15 million hectares yr^{-1}, an area about half the size of Finland (Aldhous 1993).
•	The present concentration of CO_2 in the atmosphere is higher than it has been for the last 160 000 years.
•	The United States is spending about \$4.5 billion on environmental *research*—about 86 cents for every man, woman, and child on earth. Coincidentally, this is the same amount of money spent on family planning worldwide.
•	The United States spent \$115 billion in direct costs on environmental *regulations* in 1991; this cost is expected to increase by 50% by 2000 (Abelson 1993; Carnegie Commission 1992).
•	Since 1970, the number of automobiles has more than doubled to 540 million and air travel tripled globally (Carnegie Commission 1992).

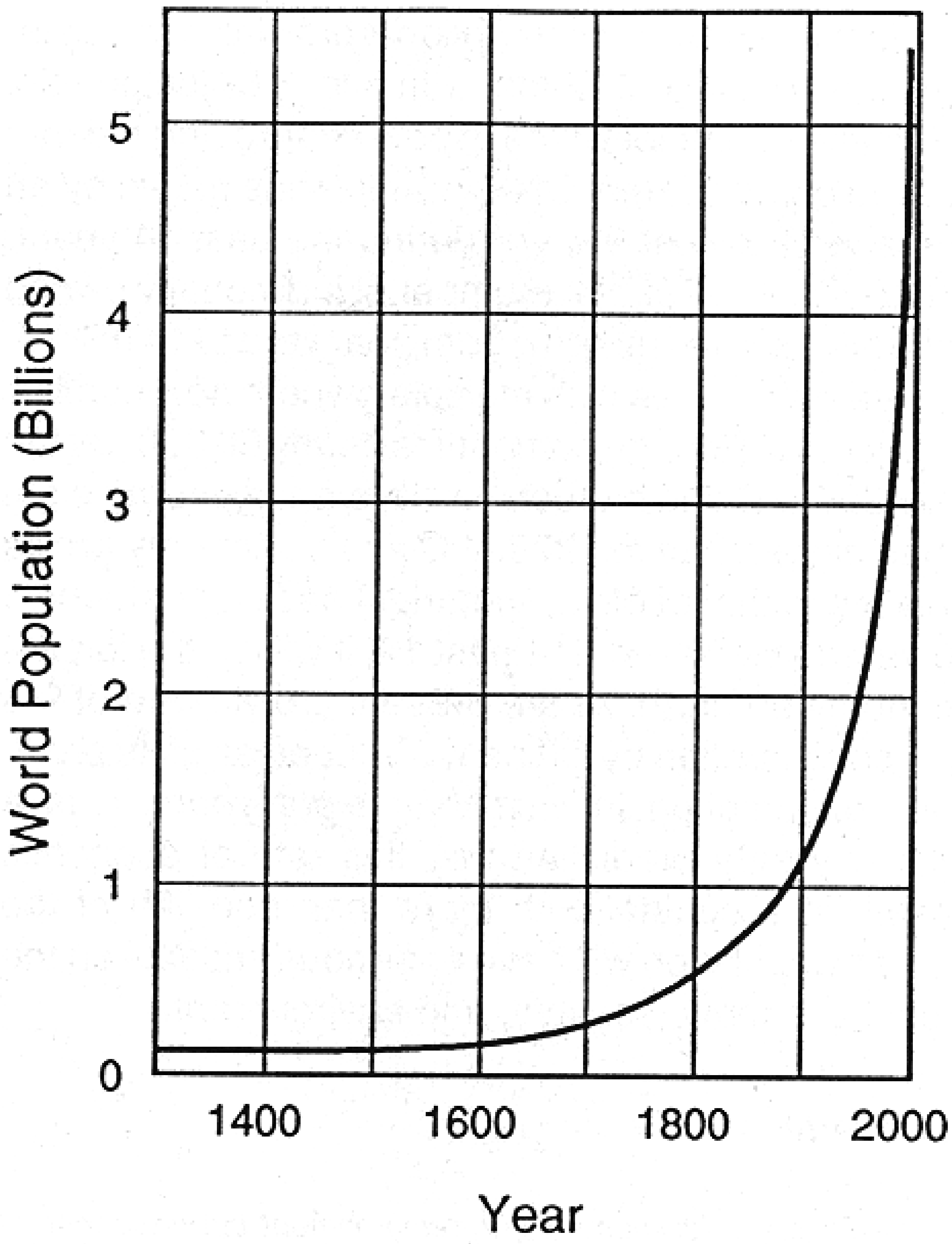

FIG. 2. Growth of the human population.

b. Unsustainable economic development

People properly and understandably wish to improve their standard of living. These improvements almost always have involved increased consumption of unrenewable or slowly renewable resources such as fossil energy and raw materials. Furthermore, humans have generally pursued their quest for improved living standards without regard to the welfare of others, most particularly future generations, much less other species. Garrett Hardin's (1968) essay, *The Tragedy of the Commons,* compares the international environmental predicament with the degradation of medieval common grazing lands—individual herders, believing that a single person's effort to conserve the resource of the commons would be overwhelmed by the actions of others, pursue individual gains that are realized to the detriment of the community. This appears to be the rule rather than the exception in human history to date; it cannot remain the rule of the future.

Globally, energy consumption is growing even faster than the population. China, with over 1 billion people, is a prime example. China is now undergoing a boom in development. Real GNP in China has grown by an average of almost 9% yr^{-1} during the past 14 years. From 1979 to 1992, the number of individually owned enterprises in China grew from near zero to 14 million. Private enterprises with multiple owners now number 6 million, and foreign companies nearly 60 000. By the year 2002, China expects to have an economy eight times bigger than in 1978. If China's economy grows (relative to that of other countries) as fast for the next 20 years as it has for the past 14, it will be the largest economy on earth. At the present growth rate of 9% yr^{-1}, consumption by China will exceed all of its previous consumption in *less than eight years.* It is a relatively safe prediction that this rate of economic growth in a country with more than one-fifth of the world's population will have enormous impacts on the global economy, security, and environment.

TABLE 2. Examples of environmental degradation.

• Local air and water pollution—ozone, smog, carbon monoxide, dust, nitrogen oxides. Breathing in Bombay is equivalent to smoking 10 cigarettes a day.
• Regional air pollution and acid rain
• Land pollution—toxic waste, heavy metals; e.g., Hanford Research site in Washington State, Love Canal
• Chernobyl
• Lake Baikal
• Aral Sea
• Loss of stratospheric ozone
• Possible climate change at an unprecedented rate
• Species extinction and resulting loss of biodiversity. According to Harvard biologist E. O. Wilson, approximately 140 plants and animals are being exterminated every day, an unprecedented rate that is accelerating (Ryan 1992).
• Serious degradation of more than 3 billion acres of land—an area the size of China and India combined—since World War II (World Resources Institute;Stone 1992).
• Increased vulnerability to floods, drought, and tropical cyclones as populations grow rapidly in risk-prone areas such as flood plains and low-lying coastal regions
• Groundwater contamination by salt, pesticides, and industrial waste

c. Poverty

We do not wish to impoverish the environment, but we cannot forget poverty. Are not poverty and need the greatest polluters?—Indira Gandhi (Malone 1992b)

About 20% of the world's population, or one billion people, live today in severe poverty, earning less than \$1 per day (Postel 1992). Chronic illness and starvation accompany this poverty. For these people, the apocalypse has arrived.

The inequities of this widespread poverty create a global instability that, if it persists, is sufficient to make a sustainable global trajectory impossible. We should ask ourselves: If the 20% of the world population currently impoverished and starving is not sufficient to spur the remaining 80% of us into action, what fraction would be sufficient to trigger the kind of environmental revolution Brown calls for?

d. Environmental degradation

Driven by the first three horsemen, despite local examples of improvements, the global environment taken as a whole has worsened demonstrably over the two decades since the first Earth Summit meeting in Stockholm in 1972. Some well-known examples are listed in Table 2. The most significant and disturbing example by far is the rapid rate at which we are losing species, thereby depleting the planet's biodiversity. Compared to global warming, for example, this is a fast-moving and irreversible process. No amount of scientific research, no amount of money or technology, will ever bring lost species back. This is not merely an academic or abstract tragedy; these losses eliminate present and future life-saving drugs. Of the 20 largest-selling prescription drugs in the world, *all* either came from natural sources or the molecules of the drug were patterned after natural sources (Malone 1992b).

3. Implications for science

Science, by itself, provides no panacea for individual, social, and economic ills. It can be effective in the national welfare only as a member of a team, whether the conditions be peace or war. But without scientific progress, no amount of achievement in other directions can insure our health, prosperity and security as a nation.—Vannevar Bush (1945), *Science—The Endless Frontier*

We need more societal transformation than we need science. The time for a paradigm shift is upon us.—U.S. Rep. George E. Brown, Jr., 1992

Vannevar Bush believed that science and technology will make society better and, therefore, that society should support science. In fact, society has supported science generously in this country, in particular during the past 50 years, but there are signs that the halcyon days are at an end. Influential people like Congressman George Brown have been asking hard questions of scientists, such as: Why, in spite of the enormous increases in knowledge gained from the past 50 years of public support, are the global environment and the people of the world in many ways worse off now than then?

Brown goes on to urge us to "begin to think of science and technology in entirely different terms—not as mechanisms to increase our wealth and comfort through exploitation of material resources, but as sources of innovation that can drive us to less consumption, less pollution, less depletion of virgin resources, and lower rates of population growth."

I contend that it is time for scientists . . . to take a more holistic and activist role in defining and changing our global trajectory. We must not just forecast it, as if we were innocent and powerless bystanders along for the ride—we are neither!—we must help change it.

Science can help define a sustainable global trajectory, and technology can move us onto it. However, the concept of a sustainable trajectory contains many unknowns, and uncertainty will exist as we move along the trajectory. Surprises like the ozone hole and AIDS will occur. While scientists strive to eliminate the unknowns and reduce the uncertainties, societies must build in flexibility to adapt to new knowledge, to cope with uncertainty, and to adjust to surprises.

4. Scientists as global citizens

The concept of tithing is central to the involvement of busy scientists and engineers in the process of influencing the forces that determine global change.—Tom Malone (1992b)

As for the future, your task is not to foresee, but to enable it.—Antoine de Saint-Exupery (1950), *The Wisdom of the Sands*

I contend that it is time for scientists, who are among the brightest, most educated, and best informed people in the world, to take a more holistic and activist role in defining and changing our global trajectory. We must not just forecast it, as if we were innocent and powerless bystanders along for the ride—we are neither!—we must help change it.

It is a truism that the atmosphere and the oceans do not respect political boundaries; they connect the environments of all regions of the earth. Thus, the people of the United States or any other country cannot be assured environmental security unless the rich and poor of the world cooperatively address issues of population growth, industrial practice, land and energy use, poverty, and environmental degradation. While there is fear among many that something is terribly wrong with the direction we are presently heading, there is a consensus among even the most concerned that this direction is changeable, though the change will require major shifts of values, attitudes, and morals on the part of individuals and governments. Moving our current trajectory from one headed toward smothering overpopulation, stark poverty, rampant disease and famine, and environmental ruin toward a target of an equitable and sustainable global society with a decent quality of life for everyone will require an unprecedented level of effort and sacrifice by individuals, and by governmental, academic, private, and religious institutions throughout the world. Fine tuning or "muddling along" will not work. It's a tough job, but *everybody* must do it. Global survivability is not a spectator sport.

In Tom Malone's concept of tithing, each scientist would devote some fraction of his or her research time to becoming informed on human development issues and to participating in policy-relevant or strategic research. This will not be an easy change for some scientists, who tend to be conservative in many respects. We emphasize uncertainties in our knowledge rather than certainties. Some of us treat science, particularly the "hard" sciences, as pure and everything else, including "soft" sciences, applied science, engineering, politics, and policy making, as intellectually inferior activities. We generally avoid using science to influence the public or leaders of society, and those that do, like Paul Ehrlich, Steve Schneider, or Carl Sagan, to give three examples, are often criticized strongly by colleagues.

Difficult as it may be, there must be change; the scientific and political systems and cultures in the United States and elsewhere are so dissimilar that the amazing increase in knowledge produced by the research done over the past several decades has had far less of a positive impact than its potential. Congressman Brown, in an address to a meeting of Sigma Xi, states it eloquently: "The siren song of scientific objectivity can draw us onto the rocks of legislative inaction, by creating rhetorical gridlock on the one hand, and by perpetuating the illusory expectation of better prediction through more research on the other" (Brown 1993). Referring to the efficacy of communication between scientists and policy makers, Brown goes on to say, "Science advice to Congress often falls on deaf ears because it is not user friendly. In a vain effort to be accurate, measured, unbiased, and comprehensive, science advice can also be irrelevant, impractical, untimely, and incomprehensible."

We must also be aware that increased scientific understanding, even to the point of near certainty, does not guarantee that the knowledge will be used by policy makers, the private sector, or by the public, all of whom make decisions based upon many other factors than level of scientific knowledge. Ludwig et al. (1993) point out that scientific certainty and consensus in itself does not prevent overexploitation of resources and environmentally destructive activities. They provide as an example the use of irrigation in arid lands and the inevitable degradation of the soil through salification. Approximately 3000 years ago in Sumer, the once highly productive wheat crop had to be replaced by less productive barley, because barley was more salt resistant and, through irrigation, the soil had become too salty for wheat. In 1899, E. W. Hilgard pointed out that the effects of irrigation in California would be similar. His warnings were not heeded; thus, 3000 years of experience and a thorough scientific understanding of the process did not prevent a repeat of an environmentally destructive activity. Thus, more research and less scientific uncertainty will not necessarily address the environmental problems of today or the future. In fact, the call by many for more research may be used by others to avoid or delay dealing directly with difficult and sensitive problems.

Walt Roberts, the founder of UCAR and NCAR, believed strongly in the concept of "science in the service of society." Behind Walt's concept and Tom Malone's notion of tithing is the assumption that there is much socially useful research that scientists can do. I suggest that atmospheric scientists ask themselves the following question: If I were to be 100% successful in my research, would it contribute in any positive way to society? Any negative way? Is there any way to modify the project to increase the probability of positive impacts, and decrease the probability of negative ones? These questions clearly require conscious consideration of values and ethics in the scientific process.

I believe the call for scientists to devote an increasing fraction of their efforts toward solving global environmental problems, and the choice made by many scientists to follow Walt Roberts' "science in the service of society" path, will lead to a new paradigm for environmental science. I list some probable characteristics of this paradigm in Table 3. (As an aside, it is interesting to note that the history of operational numerical weather prediction has already followed, to a great extent, this paradigm.)

However, for scientists to be effective in solving goal-oriented problems, it is necessary that society develop well-articulated goals. We need simple yet profound environmental goals analogous to the goal President Kennedy set in 1960:

> *I believe this nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to earth.*

The environment is a strong candidate for a compelling new organizing principle for the nation and the world. Following the environmental revolution, a sustainable environment should be a unifying vision of all people forever.

Examples of the actions that many believe are necessary parts of an environmental revolution include the following.

1) Set realistic but meaningful national and global goals, and establish policies and incentives to meet these goals. An overall goal should be to get the planet on a sustainable trajectory, one that plans for and ensures the environmental security of future generations.

2) Develop new national and global priorities. Redirect scarce resources from, for example, the military, extravagant and meaningless health care for a few, expensive and marginally effective environmental regulation, and excessive litigation and size of settlements, to, for example, education, reduction of poverty, contraception, and development of energy conservation and other environmentally benign technologies. Figures 3 and 4 show military and health spending statistics, while Figs. 5 and 6 demonstrate the size of entitlement programs and the federal deficit. The deficit is depicted even more graphically in Fig. 7, which shows

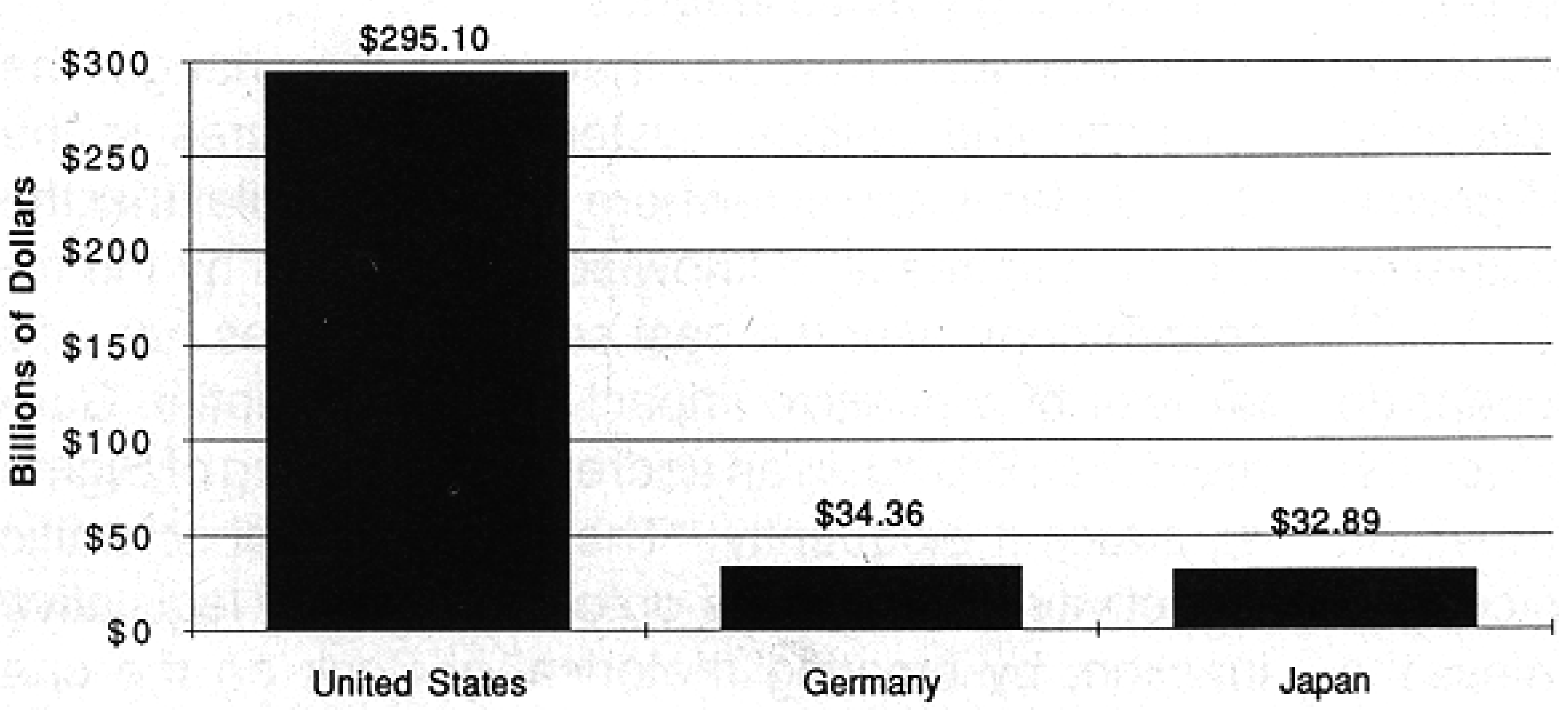

FIG. 3. 1991 military spending.

the *annual* deficit from 1947 through 1992.

3) Monitor and publish widely and on a regular basis objective indicators of environmental trends on all scales, as we now do with economic and political trends. In monitoring and accounting for progress, development, and growth, assign realistic values to the environment and natural resources such as minerals, energy, topsoil, and forests. In accounting for quality of life, account for extinction of plant and animal species, health costs of air and water pollution, increased UV radiation, etc.

4) Improve the education, standard of living, and human rights, especially the rights of women, in all parts of the world.

5) Educate the public about global environmental issues. Emphasize what we know rather than what we do not know. A society that doesn't understand exponential growth in a finite world cannot be expected to make sacrifices and wise decisions.

6) Stabilize population on all scales—individuals, families, cities, regions, nations, and the world. Table 4 shows what some countries are already doing in this direction.

7) Recycle on all scales where possible and practical. Except for incoming solar radiation, all other resources are finite and must be recycled in a sustainable world.

8) Include all real costs, including those to the environment and human health, of environmentally destructive activities, including unrenewable energy consumption, generation of hazardous waste, and use of virgin materials. Figure 8 compares gasoline prices in several countries.

9) Create environmentally sustainable jobs—the choice does not have to be between jobs and owls. The Organization for Economic Cooperation and Development estimates that in 1990 the market for environmental goods and services was $200 billion and projects a 50% growth in this market by 2000.

10) Adopt wise environmental regulations based on scientific knowledge and acceptance of reasonable risks and uncertainties.

11) Implement the slogan "Think globally/Act locally." This means all of us! Conserve, recycle, take a bus, ride a bicycle, have fewer children . . .

There is evidence that some countries, especially in Europe, are making serious attempts to address environmental problems. Table 5 lists some encouraging examples.

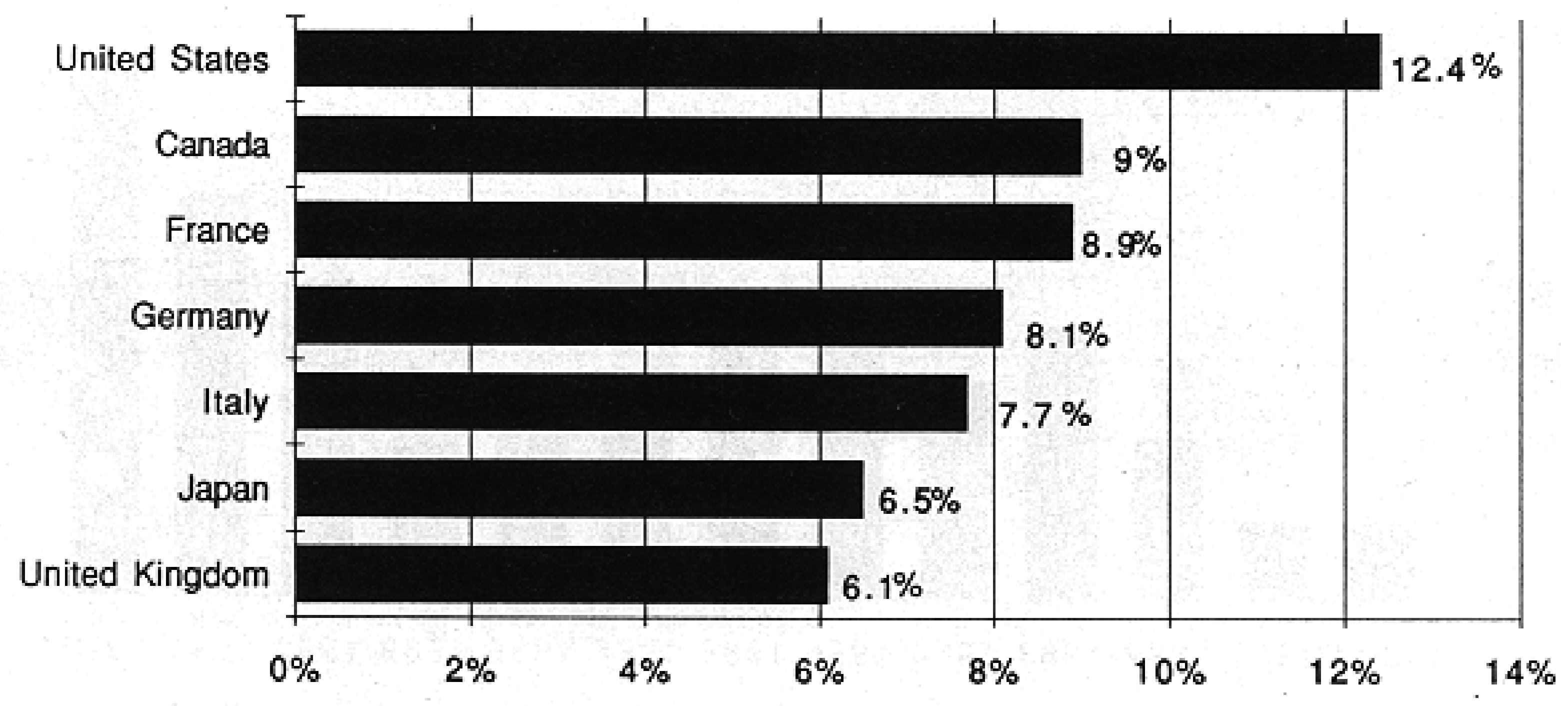

FIG. 4. Health care spending as a percent of GNP in 1990.

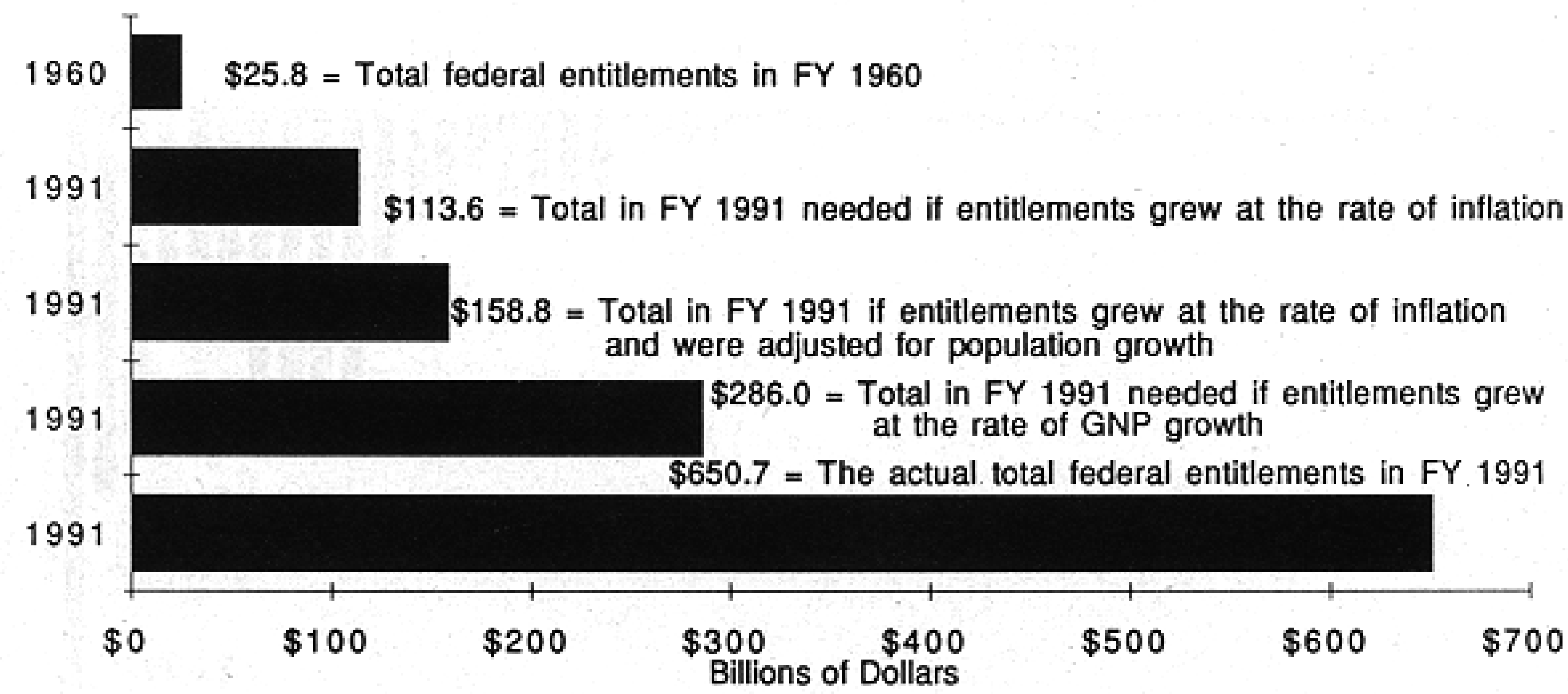

FIG. 5. Federal entitlement growth.

TABLE 3. Characteristics of future science.

- Increasingly goal oriented
- Increasingly whole-problem oriented
- More pragmatic
- Interdisciplinary
- Collaborative
- Distributed
- Will tolerate greater uncertainty
- Will educate and train students of all ages and the general public
- Will involve a greater component of technology transfer
- Will interact more closely with policy makers
- Will consider values and ethics to greater extent

5. The atmospheric sciences

Let me turn briefly to my own field, atmospheric sciences. Although the global situation calls for action now, research must continue while we begin to take actions that are benign and positive in and of them-

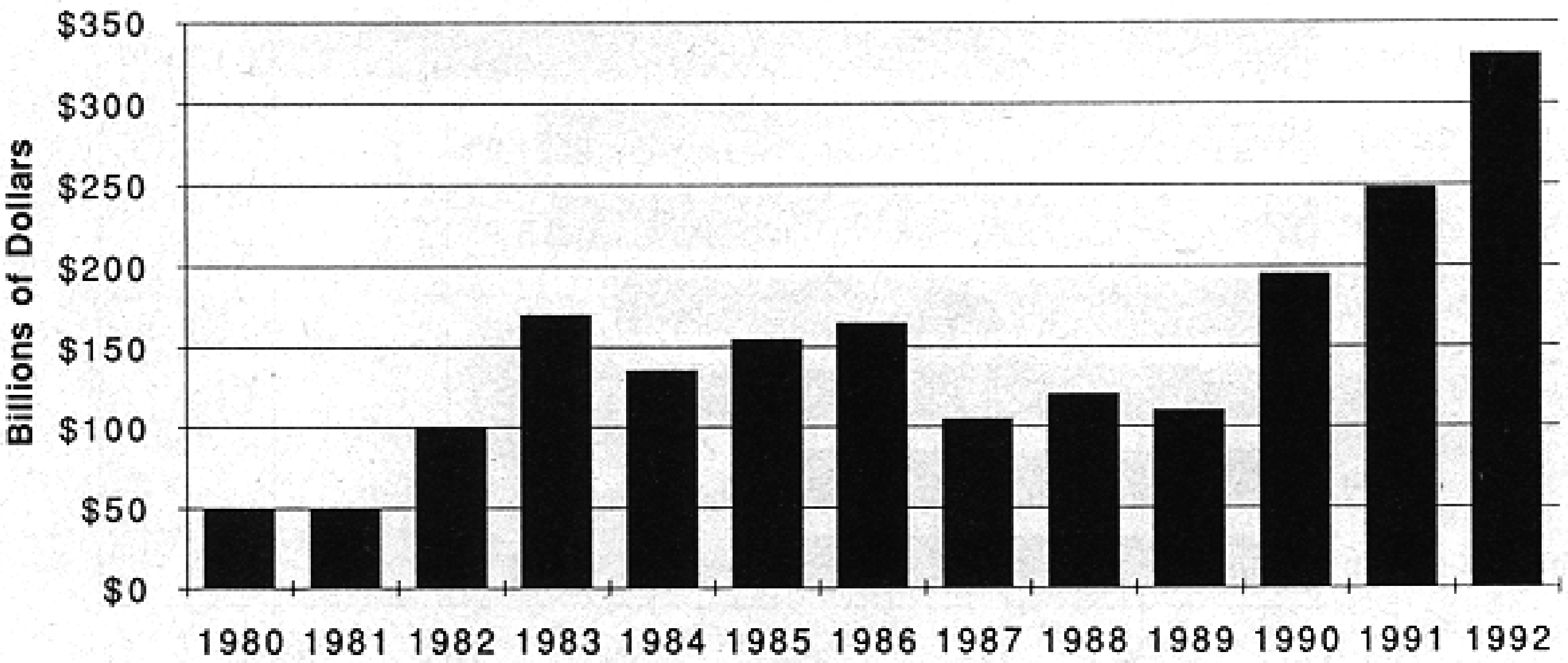

FIG. 6. Federal deficit.

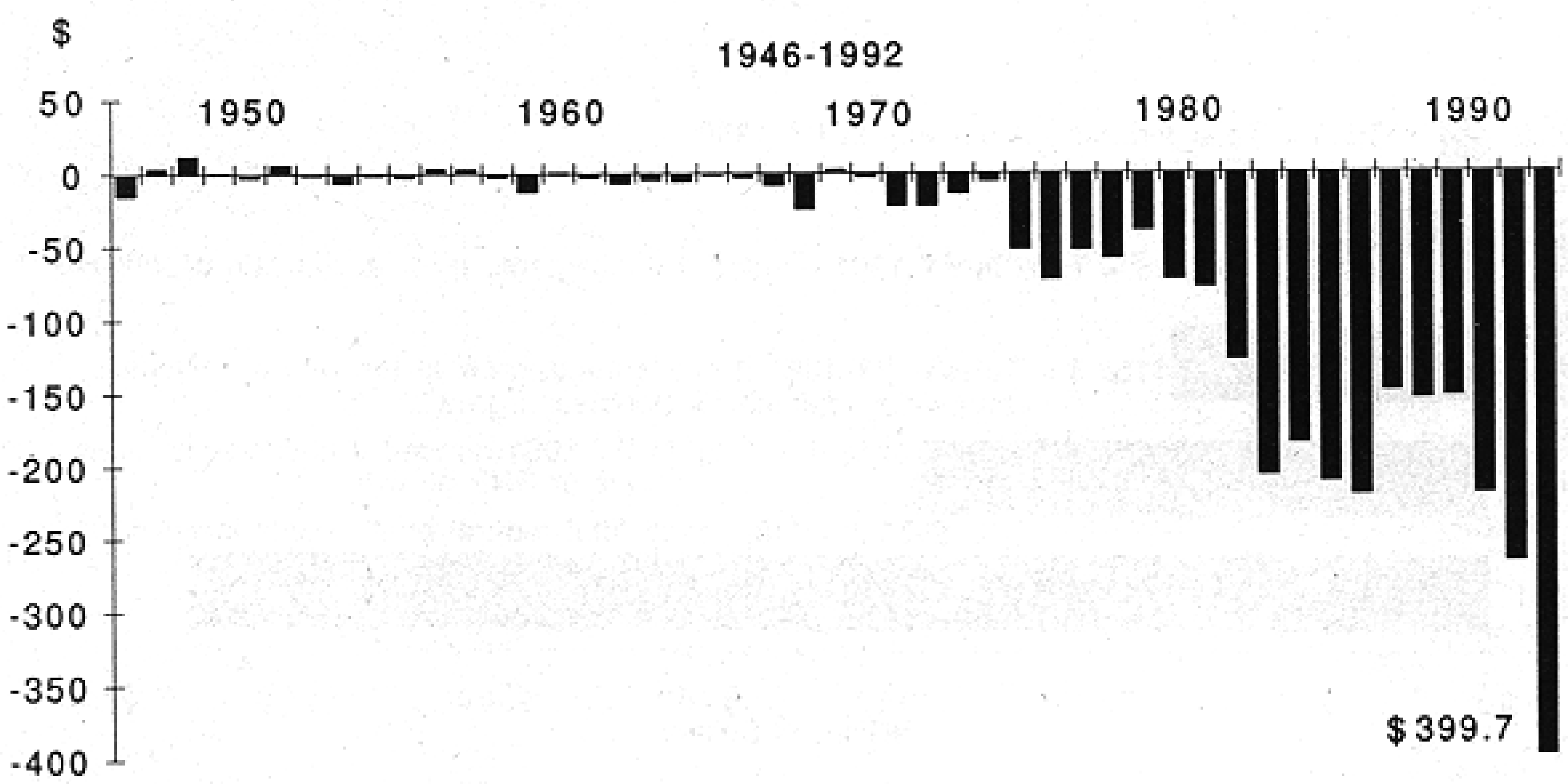

FIG. 7. U.S. annual deficit (billions of dollars).

munity can contribute is an important and urgent challenge.

We can and should continue to make cogent arguments why environmental sciences, including atmospheric sciences, should receive more resources. The United States is presently spending about $25 on environmental *regulations* for every dollar spent on environmental *research*. Much of this regulation is based on inadequate science and demands of a society that does not understand how to accept reasonable levels of uncertainty and risk. This argument alone suggests that increased research on the environment would be cost effective. But other factors, global and national, suggest that growth in atmospheric sciences will be difficult. These factors include the national deficit, competition for new funds from other more popular causes such as health care, retirement, and veterans' benefits, and big-science projects such as the space station *Freedom*. Therefore, while continuing to make the best case possible for increased support for justifiable and well-reviewed atmospheric sciences programs, I believe that we must plan for level or near-level funds. I believe that much can be accomplished under such a scenario, especially with farsighted and careful planning. I suggest five elements of a "sustainable atmospheric sciences" construct:

1) Establish real priorities based on the most important and tractable problems.

2) Stop pork-barrel science. Scientific pork is growing rapidly; Fig. 9 shows how particular interests have influenced federal appropriations over the past 13 years. During this period Congress earmarked $2.5 billion for special research and development projects, half of it in 1991 and 1992 alone. This kind of funding is damaging because it circumvents the priority setting, planning, and peer-review process and takes away from programs justified on these bases.

3) Develop real long-range plans in a no-growth scenario, with an appropriate balance among support for people, acquiring and maintaining state-of-the-art scientific facilities, field programs, and education. A major part of this long-range planning will be carefully scheduling big-ticket items such as upgrades in research aircraft, ships, computers, and field programs.

4) Develop stronger partnerships with the international community, among universities and national laboratories, between research and operational institutions and universities, and with the government and

selves, and that can be taken on the basis of what we already know. However, there is much we do not know, and science and technology must play a major role in getting us on a sustainable trajectory. Atmospheric sciences in particular can help support that trajectory by protecting life and property; helping society operate more efficiently, thereby conserving resources; providing climatological information for planning; developing a scientific basis for wise and effective environmental regulations; and predicting future consequences of human actions on the environment. Identifying other ways the atmospheric sciences com-

TABLE 4. Population growth rate reduction goals.[1]

Country	Actual ratio of children/women, 1990	Goal by 2000
Bangladesh	4.9	2.3
Nigeria	6.2	4
Mexico		Cut growth rate in half

[1]Source: Brown (1992)

industry. Partnerships and collaborations reduce unnecessary duplication and create efficiencies, and can thereby increase the return for each dollar spent.

5) Make use of and strengthen the existing infrastructure and high-quality institutions wherever possible, rather than creating new ones. There is an increasing tendency to create new programs and institutions to address environmental science when existing, high-quality institutions are increasingly strapped for resources.

With serious efforts by the community along the lines proposed above, I am confident that the atmospheric and related environmental sciences can thrive in the years ahead and continue to make powerful contributions to all societies of the world.

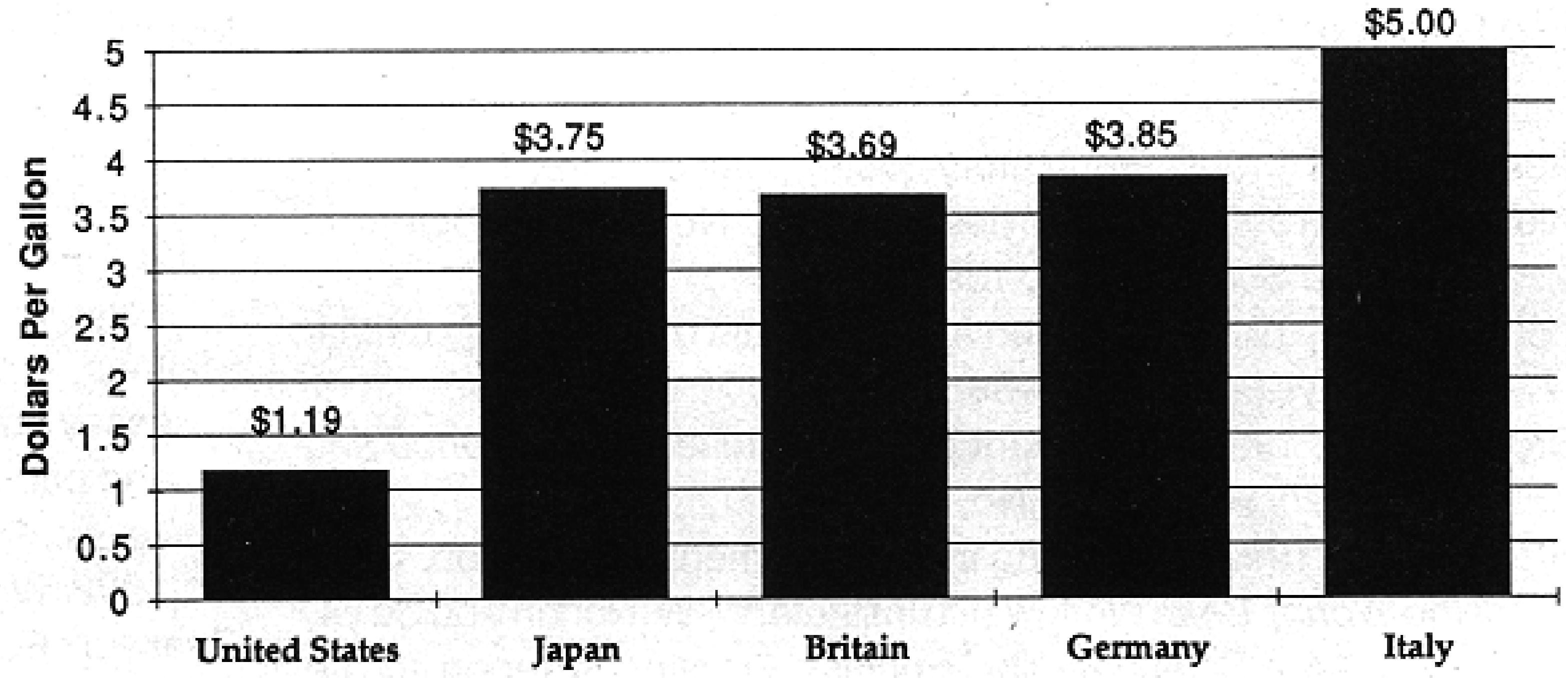

FIG. 8. Gasoline prices in selected countries.

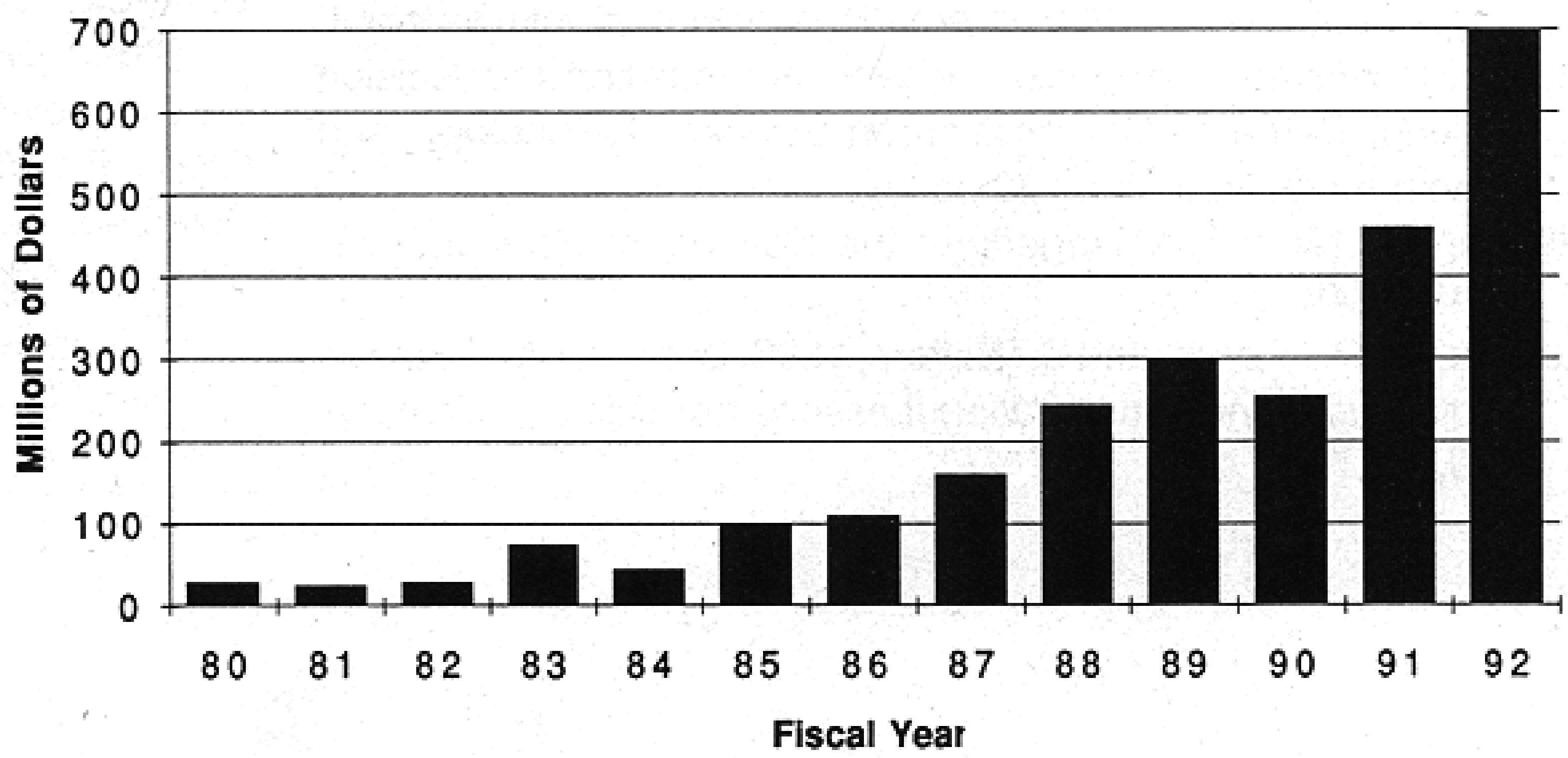

FIG. 9. Academic earmarks, 1980–1992.

6. Conclusion

We are like the bugs in the bottle. What time is it: 11:50, 11:55, or 11:58? It doesn't really matter; it is late and there are a lot of difficult choices and changes that must be made before noon. We have a new administration and I believe it has the potential to place a high priority on the global environment. Let us help shape the agenda for the rest of this century and the one after that, and begin to make the shift to a sustainable global trajectory that will ensure the survival and quality of life of humans and the other species that share the planet with us.

TABLE 5. Toward environmental restoration.[2]

• In September 1991, the European Community proposed an energy tax equal to $10 per barrel of oil.	• Denmark, by banning throwaway beverage containers, has cut the energy used to produce the containers by two-thirds and sharply reduced garbage generation.
• In 1991, Germany boosted gasoline tax from $1.35 to $1.85 per gallon to rebuild the transportation and telephone system of former East Germany.	• Netherlands has an active bicycle fleet of 12 million for its population of 15 million. It has twice as many bicycles as cars. In Groningen, the largest city in the northern Netherlands, bicycles account for more than half of the trips.
• In the late 1970s, California adopted tax write-offs to supplement the federal subsidy of investments in renewable energy resources. Today, California generates more electricity from wind and solar farms than does the rest of the world combined.	• Netherlands has the goal of reducing by half the amount of nitrogen and phosphorous flowing into rivers from fertilizer runoff, sewage, and industrial discharge by 2000.
• Germany has committed itself to a 25% reduction in carbon emissions by 2005. Australia, Austria, Denmark, and New Zealand have pledged 20% reductions over this same period.	• Australia has a goal of planting 1 billion trees by 2000. [2]Source: Brown (1992)

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