The CO2 Newsletter, created, published, and edited by William N. Barbat, ran from 1979 to 1982.

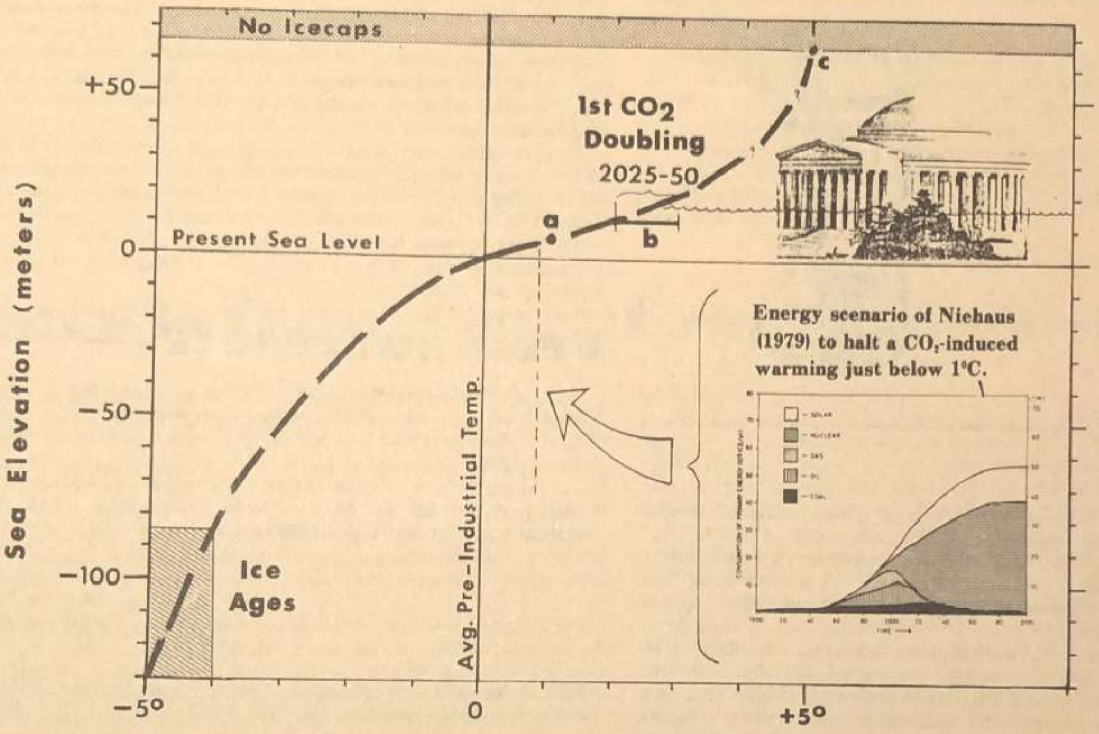
In 2025, the family of Mr. Barbat donated an original set of all issues to Dr. Marc Hudson, and agreed that these could be digitised and placed online as a resource for anyone who wants to understand how long we've known about the carbon dioxide and global warming problem.

CO_2 Newsletter©

Volume 1, number 5 **June-July, 1980**

A bimonthly summary of advances in knowledge of the CO2-greenhouse problem, and of the social, political, and economic implications.

EQUILIBRIUM SEA ELEVATIONS VS. GLOBAL TEMPERATURE (ESTIMATED)



A sense of urgency was introduced to the CO_2-greenhouse problem July 30, 1979, when Wallace Broecker (Lamont-Doherty Geological Observatory) explained to the U.S. Senate Committee on Governmental Affairs, "We have good evidence that during the peak of the last interglacial period, the sea level did indeed stand 6 meters (20 feet) higher than it does now, and we don't think the temperature of the globe was any more than 1 degree Celsius warmer than now."

A 1 degree C warming is generally expected to be reached shortly after the turn of the century if the CO_2 buildup continues as in the past. The energy scenario of F. Niehaus (International Atomic Energy Agency) which might halt a CO_2-induced global warming just short of 1 degree C, as shown in the inset, would call for a rapid phase-out of fossil mostly by nuclear. This scenario was presented at the same Senate hearing.

Broecker's 6 meter rise (point 'a') does not appear unreasonable on a plot of temperatures vs. sea elevations ranging from ice ages to no-icecap conditions. Global average temperatures of 4 degrees to 5 degrees C cooler than now are shown for the ice ages, as used by Svante Arrhenius in his CO_2-greenhouse model of 1896. Corresponding to these periods of maximum glacial advance are vestiges of shorelines 85 to 130 meters lower than now as shown by bar 'b'. (Lag in destruction of the Laurentide ice sheet precludes other equilibrium values for conditions cooler than now.)

An approximation of the pre-glacial global temperature as shown here 5 degrees C greater than now (point 'c') is derived from Eocene and early Oligocene subtropical and tropical sea-surface temperatures in the literature. These sea temperatures were based on oxygen isotope measurements made on shells of pelagic foraminifera which grew at that time.

Arrhenius had also judged that the average Arctic temperatures prior to the existence of ice sheets in that hemisphere were about 8 degrees to 9 degrees C warmer than modern temperatures, based on observations of vegetation and animal life. Allowing for 3X to 4X polar amplification, this would correspond to an average global temperature 2 degrees to 3 degrees C warmer than now, which essentially matches the consensus of estimates for global warming which may accompany a CO_2 doubling. Such a doubling is expected to be reached about 2025-2050 if growth of CO_2 production continues its historical rise.

Because the West Antarctic icecap is believed by John Mercer (Institute of Polar Studies, Ohio State) to have formed at cooler temperatures than the Greenland icecap, the potential sea elevation corresponding to the absence of the Greenland ice is shown here as the sum of the rise if both icecaps were absent, that is, 12 meters higher than persent. This 12 meter height—if valid—can be considered to be a minimum value, for it is likely that the great East Antarctic ice cap was smaller than its present size when global average temperature was 2 degrees to 3 degrees C warmer.

No estimates have been published yet for how fast the Greenland ice sheet might disappear with a CO_2-induced warming, and much controversy still surrounds estimates of how fast the West Antarctic ice sheet may disappear due to a lack of precedents. If the CO_2 buildup continues unabated, the expected warming over the next half century may take place in about one-tenth the time that a similar temperature rise occurred about 10,300 years before present, during which time sea level was rising about 0.2 to 0.3 meters per decade according to the compilations of Rhodes Fairbridge.

To illustrate the seriousness of a potential sea level rise which may be in equilibrium with the warmness of a CO_2 doubling, the Jefferson Memorial is depicted on the same elevation scale. For other comparisons, the absence of icecaps would correspond to sea level at the clock face of London's Big Ben and up to the roadway of San Francisco's Golden Gate Bridge.

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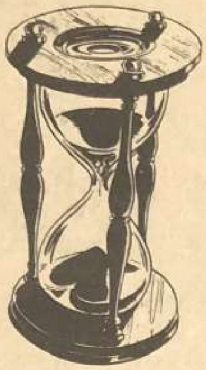
"... we theorize with a pistol to our head; we are confronted with a new set of conditions on which we have not only to pass judgment, but to take action, before the hour is at an end."

—Robert Louis Stevenson



Editorial

Science and technology have come increasingly under political direction ever since world-reknowned scientists promoted and assisted the development of nuclear weapons in World War II. Political control of scientific effort was expressed in principle by John F. Kennedy: "Scientists alone can establish the objectives of their research, but society, in extending support must take account of its needs."

Massive funding of politically favored projects can create a bandwagon effect among scientists to give the public the impression that scientific priorities coincide with certain political preferences. Rather than turn as a weather vane in response to scientific leadership, some political leaders would steer the wind. Political 'vectoring' may also occur where persons with favored leanings are appointed as scientific advisors or editors. Worse yet, the interjection of the adversary system from the political world can foster polarized opinions and can encourage the use of biased evidence—the bane of honest scientific inquiry.

While scientific logic as a driving force in the affairs of civilization may be delayed, it certainly cannot be suppressed. Many people pursue scientific careers out of a great respect for clear rational thought conditioned by consideration of human values. Hence, profound ideas eventually speak louder than vast appropriations spent at cross purposes.

One such profound idea—recognized more than a century ago—is that a buildup of CO_2 in the atmosphere can be expected to cause significant global warming and climate change. Despite the very small funding of research on this idea during the 'environmental decade' of the 1970s, the CO_2-greenhouse problem is now beginning to receive serious attention in several countries at high levels.

But will timely recognition of the greenhouse problem prevent the U.S. government from foreclosing the nuclear energy option? And will it deter the government from investing heavily in a long-lived synfuels industry which would sustain high growth rates for CO_2 production even if energy growth declines? *Groundswell* quotes Anthony Roisman as saying, "The battle against nuclear power has basically been won." Investment analysts in the U.S. generally share this view.

Total nuclear capacity operable or being built increased by only 2.3% in the U.S. over the last 30 months, compared to a 25% increase outside the U.S. Simultaneously, reactors on order by U.S. utilities decreased 60%, and uranium stocks held for cancelled reactors are being sold at depressed prices to foreign buyers.

The proposed 1981 DoE budget authorization for research, development and applications of nuclear fission represent a 20% decrease from 1980, while the proposed budget authority for all fossil energy increased 30% to place fossil ahead of nuclear. When the $100 million additional funds appropriated this year for synfuels feasibility studies is contrasted with the sum of only $6 million for all of DoE's CO_2-greenhouse research as the lead organization, a bandwagon effect may begin to show.

However, the anti-CO_2 effort may receive a boost if the synfuels program should fail to be launched. The current political moves to create a national synfuels industry seems to lack support from the grass roots and from most of industry. The hastily conceived synfuels program may be abandoned with equal haste if polticial leaders are called on to justify the economic penalties of the program and environmental penalties *other* than CO_2 in this recession and election year. Also a fair chance exists that the intended source of the vast funds for a synfuels program—the Windfall Profits Tax law—may be ruled to conflict with that section of the U.S. Constitution which bars direct, non-uniform taxation.

Thus the stage may be set for a major and sudden change in the direction of U.S. energy policy. Whether the CO_2 threat is then recognized as a major determinant of a new energy policy will likely depend upon the publicity given the CO_2 problem by the scientific community.

The bitter contest between idealism and pragmatism—which has sapped the nation's resolve—might be lessened at the same time if some measure of altruism can be regained.

From our readers

"The Climatic Research Unit Library is interested in receiving 'CO_2 Newsletter' and suggest an exchange arrangement with our publication 'Climate Monitor' which is produced five times a year at subscription cost of Sterling £20.

" 'Climate Monitor' may be of direct interest to you because it contains up-to-date information on high latitude (north and south) temperature trends—in part as a *possible* indicator of CO_2 warming trends. . . ."

Mrs. B. Harris
Administrative Assistant
Climatic Research Unit
University of East Anglia
Norwich, U.K.

[We look forward to receiving the first issue of this new periodical, and we publish this letter to inform our readers of its availability. Ed.]

"It is a; great pleasure to me confirming receipt of the first three issues of the CO_2 Newsletter. . . . I am very impressed by this provoking and doubtless most important publication.

"In particular I am delighted by your suggestion to prepare an article on the CO_2 problem for publication in GeoJournal. In fact, your idea meets with the preparation of an entire issue devoted to this far reaching problem including the most important consequences thereof. . . ."

Wolf Tietze
Editor-in-Chief, *GeoJournal*
Helmstedt FR Germany

"I recently had the good fortune to come across an issue of your 'CO_2 Newsletter' (Volume 1, Number 4), and was extremely impressed with its content. . . .

"I would like to propose that we exchange publications on a regular basis. . ."

Eric M. Fersht
Editor, *Groundswell*
Nuclear Information and Resource Service
Washington, D.C.

New publication available:

SCOPE 13

The Global Carbon Cycle

Edited by B. Bolin, E.T. Degens, S. Kempe and P. Ketner, published on behalf of the Scientific Committee on Problems of the Environment (SCOPE) of the International Council of Scientific Unions (ICSU) by John Wiley & Sons. $45.

DoE Defines Goals for CO_2-Greenhouse Research

Research issues are currently being defined over a broad spectrum of scientific, social, political and economic topics for DoE's 'National Carbon Dioxide Effects Research and Assessment Program'. The overall goal of the program is:

"To develop the ability to predict the environmental, economic, social, and political costs and/or benefits of the increasing atmospheric concentrations of carbon dioxide with sufficient confidence to permit policy decisions to be made on the future global use of fossil fuels."

The 5-year plan which is being drafted for the program under the direction of David H. Slade is reportedly based on an overall budget of $6 million this year, $14 million for fiscal 1981, and $21 million each for 1982, 1983 and 1984. Nearly half of the annual expenditures are tentatively designated for research on the carbon cycle.

Two main objectives of the carbon-cycle research are stated as 'removal of controversy over the role of the biosphere as a carbon source or sink' and 'development of acceptable fossil fuel use scenarios'. Carbon cycle projects will continue to be funded also by other agencies (notably NOAA and NSF) which have sponsored most of this work in the past.

As reported in *Science* 8 May 1980, DoE has contracted with the AAAS Climate Project under the project leadership of Roger Revelle (University of California, San Diego) to prepare detailed background material to help in formulating the National Program's research plan. The AAAS group is concerned with the effects of a CO_2 increase on the oceans, cryosphere and biosphere; social and institutional responses; and economic and geopolitical consequences.

Agricultural research is contemplated on major food crops and forest crops to seek ways to escape or moderate effects of climate change. Research is also under consideration for the design and management of crop pests under changed climatic conditions.

A sense of urgency for the many varied problems is apparent in an early draft of the research issues. Of the 30 projects which had been assigned priorities so far by various authors, 26 of them had been rated as 'high', 'very high' and 'highest'.

Excerpts from recent reports

From **Hearings on the CO_2 problem by the Senate Committee on Energy and Natural Resoruces**, Paul Tsongas, Chairman, April 3, 1980 (to be released in late July) -

Testimony of Gus Speth, Chairman, Council on Environmental Quality:

". . . I am pleased to be here to discuss with you the sobering prospect that the continued buildup of carbon dioxide (CO_2) in the atmosphere could result in important changes in the earth's climate and weather patterns over the next several decades. The environmental and socio-economic consequences of these changes could be very serious.

"The President has expressed his Administration's concern regarding the CO_2 problem on several occasions. In his February 29, 1980 address to environmental leaders in the East Room he identified CO_2 as one of the most serious global environmental threats that we face. His August 2, 1979 Environmental Message addressed the CO_2 problem in two contexts.

"Fossil fuel combustion now appears to be the principal source of CO_2 buildup in the atmosphere. The President addressed the environmental effects of new fossil fuel energy technologies directly when he pledged in his 1979 Environmental Message to:

" 'examine not only the impact of new energy technologies on land and water and the effects of toxic chemicals, but also the longer term implications of increasing carbon dioxide concentration in the atmosphere.'

"Continued large-scale deforestation also poses a serious global environmental threat. One of the reasons, as the President noted, is that 'forest loss may adversely alter the global climate through production of carbon dioxide.'

"Our analysis efforts are nearing completion. I would like to share with you some of our preliminary views.

". . . the principal contributor of CO_2 to the atmosphere appears to be a combustion of fossil fuels. Accordingly, an assessment of how and at what cost global CO_2 production can be controlled must focus significantly on energy policies and use patterns. . . .

"The possible climatic and socio-economic effects of a global warming that could result from a doubling of the atmospheric concentration of CO_2 are profound. Wind direction and speed, ocean currents, and precipitation patterns could be altered. Large and comparatively sudden climate changes could have serious consequences for world agriculture; farming regions might warm up, dry out, and become less productive; dust bowls could be created. These consequences could render human settlement patterns and capital infrastructures obsolete. The sea level could rise due to melting of polar glacial ice sheets. The resulting coastal inundation could force eventual evacuation of lands now considered to be among the world's most desirable. The Arctic snow might gradually melt, changing profoundly the whole Arctic ecology. While these results are not certain, they are truly grave possibilities to consider. Some regions, however, might experience certain benefits, such as improved agricultural output, as a result of elevated levels of both CO_2 and temperature.

Based on the available assessments, our view is that the possible consequences of a doubling of atmospheric CO_2 concentration over the preindustrial level appear unacceptably large and outweigh by far any possible benefits that might result from such a doubling. I should also add that traditional benefit-cost analysis is ill-suited to problems like this where the uncertainties are so great, the stakes are so high, and the welfare of countless generations who cannot participate in our decisions is involved.

"The Detection Problem

"The insidious nature of the CO_2 problem is that if a response is postponed until significant and harmful climate changes are actually observed or until scientific uncertainties are largely resolved, it may be too late to avoid even more severe climate changes. Once the effects of increased CO_2 concentrations are visible enough to arouse concern throughout the world, they may be virtually irreversible for centuries. . . .

"Implications of the CO_2 Problem

"It seems reasonably clear that the basic uncertainties will not be resolved in the near future. In addition, it may require up to 20 years to confirm that observed climate changes are due to increased levels of atmospheric CO_2, rather than the result of normal climatic fluctuations. However, by the time CO_2-induced climatic effects become clearly visible, two results will have probably occurred.

"The nations of the world are likely to have committed themselves to an energy future in which fossil fuel combustion plays an increasing role. For both political and economic reasons, once a large-scale commitment to increased use of fossil fuel has begun, it will be hard to reverse, even if climatic changes make reversal appear necessary.

"Also, over that same period, the world would have produced still higher atmospheric concentrations of CO_2, which would continue to affect climate long after human-caused releases of CO_2 are reduced. For example, if fossil fuels were used at the historical growth rate of 4 percent per year, atmospheric CO_2 would be twice the preindustrial level by about 2025. If other factors that could affect climate remain unchanged during the period of increased fossil fuel use and CO_2 emissions, the oceans would have stored a significant amount of thermal energy.

"Thus, once it is confirmed that CO_2-induced climate effects are occurring, it would first be necessary to reduce atmospheric CO_2 and then to dissipate the heat stored in the oceans, in order to reverse the climate effects. Throughout this period of change and recovery, the world would continue to suffer from adverse climatic consequences caused by higher global temperatures. It would probably take several hundred years to regain a climate similar to our present climate, which forms the basis of socio-economic patterns in the world today. Indeed, given the complexity of the global climate system, it might be impossible to return to a state approaching present conditions.

"Thus for a number of reasons it seems clear that the CO_2 issue should be

considered now as a major factor in developing energy policies in the United States and abroad . . . .

"In responding to the global nature of the CO_2 problem, the U.S. should consider its responsibility to demonstrate a commitment to reducing the risks of inadvertent climate modification. Because it is the largest single consumer of energy in the world, it is appropriate for the U.S. to exercise leadership in addressing the CO_2 problem."

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From **Report of Meeting on Response of the West Antarctic Ice Sheet to CO_2-Induced Climatic Warming, by Charles R. Bentley** (to be published in full in GEOTIMES in August 1980):

"There has in recent years been a rapidly increasing interest in the possibility that West Antarctic ice sheet . . . may shrink rapidly in size in the near future. The West Antarctic ice sheet is in principle more vulnerable than the East Antarctic or Greenland ice sheets because its bedrock lies far below sea level. Simplified theoretical analyses have suggested that there is no stable position for such an ice sheet between an extension all the way to the edge of the continental shelf, and complete disappearance. Such analyses, however, do not take into account the probably stabilizing influence of the great floating ice shelves that fringe the grounded ice sheet along most of its perimeter.

"Models put forward within the last decade have suggested . . . that the West Antarctic ice could disappear in a matter of a very few hundred years.

". . . The question then becomes how it may respond to a man-made warming of the polar atmosphere. . . .

"To examine the problem further, a meeting of glaciologists, glacial geologists, oceanographers, and meterologists was held on 8-10 April 1980 at the University of Maine in Orono. . . Participants came not only from the United States, but from Canada, the United Kingdom, Switzerland, France, and even Australia.

". . . It can be agreed that in historical times, during which oceanic tide gauges have been in operation, the ice sheet has not been melting at a rate corresponding to its complete disappearance in 200 years, since the implied rate of sea level rise is an order of magnitude greater than that observed. It is possible, however, that an ice sheet can change its size relatively slowly throughout most of a major retreat, with the final stages occurring at a very rapid rate. This may have occurred with Laurentide ice sheet . . . .

". . . it was agreed emphatically that the possibility of a rapid shrinkage is serious enough to warrant further research. . . .

"A report citing the conclusions of the conference on the important lines of research to be followed will be submitted soon to AAAS, where it will be included as part of a larger study on the effects on the environment and society of a CO_2-induced climate change. David M. Burns, Director of the Climate Project at AAAS, hopes to have the overall report completed by next fall."

●

From **Climatic Change, by T.M.L. Wigley, NATURE, 24 April 1980:**

"On the premise that the climate has changed in the past and thus may well change in the future, a Government 'think tank'—the Interdepartmental Group on Climatology—was set up to 'consider whether the United Kingdom was putting sufficient effort into studying the climate'. This group under the chairmanship of Sir Kenneth Berrill has just delivered its first report. (*Climatic change: Its potential effects on the United Kingdom and the implications for research*, London, Her Majesty's Stationery Office, 1980.)

"The review of the present state of knowledge on climatic change (with special reference to the United Kingdom) is clear, succinct and realistic, but restricted to short-term changes. Major emphasis is given to the carbon dioxide issue (fossil fuel burning and deforestation leading to increased atmospheric carbon dioxide leading to possible global warming), and interesting estimates are given of the economic effects of a 1 degree C warming (a saving of £250 million per year through reduced energy demand), and the cost of a single severe winter (in excess of £80 million). This section ends with the rather optimistic statement that 'within a few years sufficient progress will be made' in predicting the effects of global climatic change on the United Kingdom that climate trends will be able to be considered in future Government planning. This statement . . . would be viewed with scepticism in some circles. . . .

"The report's emphasis on the instrumental record and computer modelling tends to reflect the work on climatic change which is being conducted in the U.K. Meterological Office. As such it creates an unbalanced impression of work in progress in the U.K. as a whole. . . ."

Bonnie Timmons

Kenneth Boulding: Economist, pacifist, dreamer

From **Kenneth Boulding: Economist, pacifist, dreamer, by Patricia Kent Gilmore, The Denver Post, April 13, 1980:**

". . . [Boulding] has agonized over the "Tragedy of the Commons,"—ecologist Garrett Hardin's sad tale of what happens when individuals' interest in grazing their sheep on the commons clashes with the group's interest in conserving the commons.

"Last year he studied energy questions in his role as a member of the committee on nuclear and alternative energy systems of the National Academy of Sciences.

"Comparing the use of coal with the dangers of nuclear reactors, he has concluded that coal is more dangerous ecologically. He finds nuclear the least of available evils over the short run, filling a role that solar energy is not ready to assume.

"In an interview, he elaborated: 'I was at a fascinating meeting (last year) and nobody agreed about anything. Some climatologists argue that if we start burning out the coal, the Middle West would turn into a desert in a hundred years, and the climatic belts would shift. The only thing they all agree on is that it will certainly warm us up—the greenhouse effect.

" 'In 100 years it could alter the temperature of the earth by 14 degrees with quite incalculable consequences. If, for example, the Antarctic ice cap slipped, the ocean would rise 25 feet almost overnight,' wiping out many of the world's major cities.

" 'The critical question is whether (carbon dioxide) is worse than plutonium, and we really don't know. My own feeling is that a couple off great pyramids of plutonium could be put away somewhere without mucking up the earth too much. But with carbon dioxide there's nothing you can do about it. It alters the whole ecosystem of the earth irretrievably. . . .'

"Acknowledging some of the very real dangers of nuclear power, he said it is probable that 'eventually there will be a major catastrophe, no question about it.'

"But he believes lessons could be learned from it, just as at Three Mile Island.

"Originally Boulding was opposed to nuclear energy, having found Margaret Mead's attack on its development very persuasive. . . .

"He suggested Americans are obsessed with a kind of demonology where nuclear energy is concerned.

" 'It seems a little hypocritical to drive a car to an anti-nuclear power meeting, because after all the automobile kills 50,000 people a year very nastily and unpleasantly. There just seems to be a little moral inconsistency there. Our whole attitude toward risk is very strange.' "

●

From **CO_2 could increase global tensions, unsigned, NATURE, 8 May 1980:**

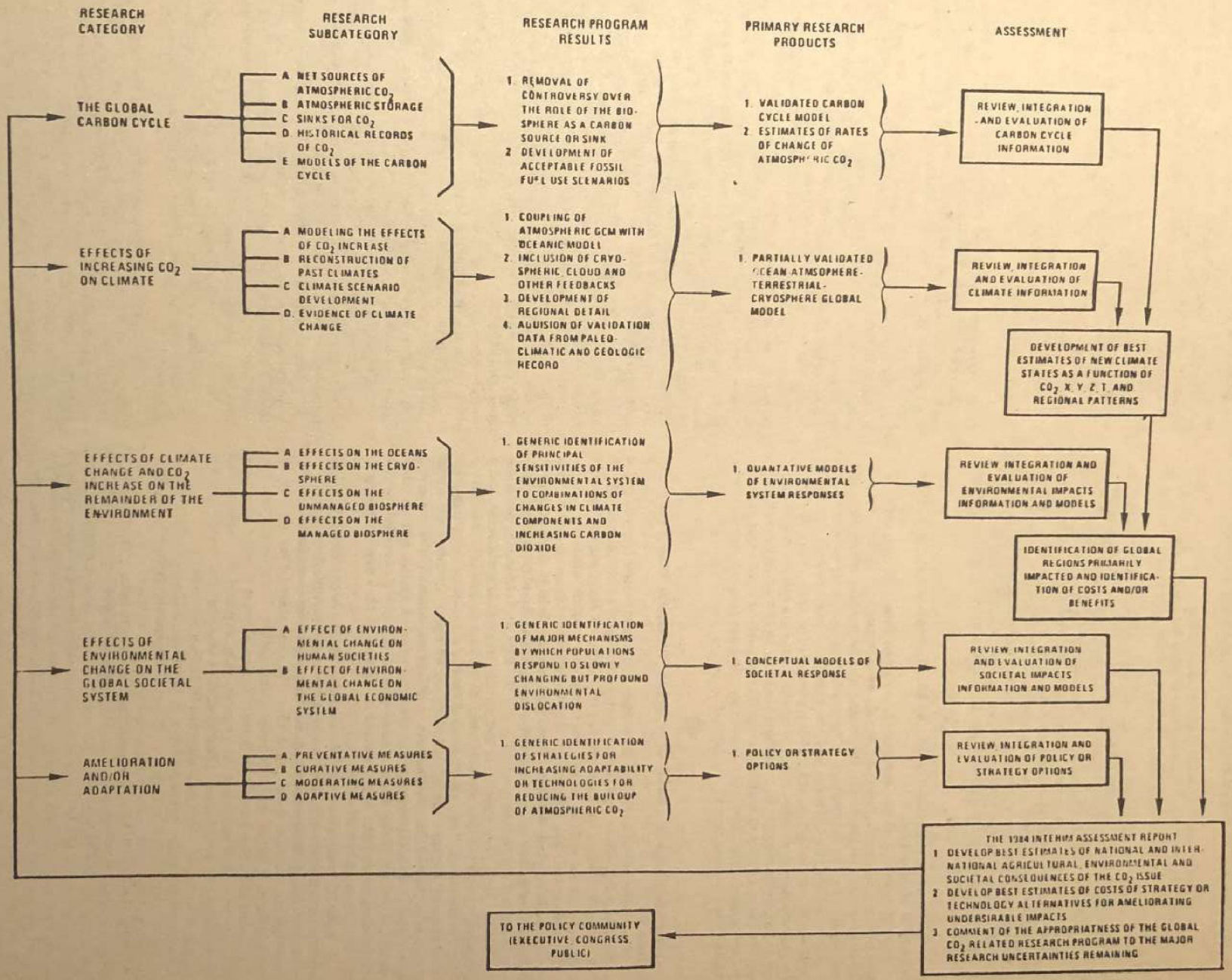
"A strong warning that, since the global build-up of atmospheric carbon dioxide will have varying climatic effects on different parts of the world, it could lead to increased tension between rich and poor nations, has come from a special committee of the Academy of Sciences.

"In a report prepared for President Carter's Science Adviser, Dr. Frank Press, the committee says that such a build-up will only be minimized by international agreement to reduce the use of fossil fuels and develop alternative energy sources. And in view of the potential divisiveness of the CO_2 issue, it recommends that 'in the near term emphasis should be on research with as low a political profile as possible'.

"The committee, which was chaired by Dr. Thomas C. Schelling, professor of political economy at Harvard University, was asked by Dr. Press to look at the social and economic consequences of increased atmospheric CO_2. Accepting the scientific consensus that such an increase is likely to take place, the committee concentrates on . . . the relative distribution of the resultant gains and losses throughout the world.

continued on page 6

A NATIONAL PROGRAM ON CARBON DIOXIDE, ENVIRONMENT AND SOCIETY (DRAFT)



Proposed National Program on CO_2-greenhouse Research, U.S. Department of Energy - Draft of January 8, 1980.

". . . countries with temperate climates are not only the largest consumers of fossil fuels, but may also benefit from the climatic effects, with raised temperatures and rates of photosynthesis leading to increased agricultural yields.

". . . countries in subtropical arid zones could suffer a decline in rainfall and possible droughts with decreased food production and resultant shifts in population distribution – as well as potential demands for international compensation.

". . . it recommends efforts to improve the resilience of agriculture to climatic change. And in particular suggests that ways should begin to be explored of protecting low-lying land areas from the possible elevation of ocean levels due to the disintegration of the West Antarctic ice sheet.

"Finally responding to two recent reports in the scientific literature which suggest that the rate of carbon dioxide build-up may be an order of magnitude less than most scientists now fear – reports which have become the centre of fierce controversy in the climate research community – the committee says it agrees with the views of experts it consulted that 'these are based on incomplete assessments that unrealistically omit important feedback processes.'"

●

From **Oil Shales and Carbon Dioxide, by Eric T. Sundquist and G.A. Miller, SCIENCE 16 May 1980:**

"During retorting of oil shales in the western United States, carbonate minerals are calcined, releasing significant amounts of carbon dioxide. Residual organic matter in the shales may also be burned, adding more carbon dioxide to the atmosphere. The amount of carbon dioxide produced depends on the retort process and the grade and mineralogy of the shale. Preliminary calculations suggest that retorting of oil shales from the Green River Formation and burning of the product oil could release one and one-half to five times more carbon dioxide than burning of conventional oil to obtain the same amount of usable energy. The largest carbon dioxide releases are associated with retorting processes that operate at temperatures greater than 600 degrees C." - Abstract

●

From **Carbon Budget No So out of Whack, by Richard A. Kerr, SCIENCE, 20 June 1980:**

"Every year plants exchange more than 100 billion metric tons of carbon with the atmosphere in the form of carbon dioxide. The ocean spews forth and reabsorbs almost as much carbon dioxide as it churns up its deepest waters and as its surface waters warm and cool with the seasons.

". . . researchers are trying to determine whether human activities each year are releasing only 5 billion tons (5 gigatons) or perhaps as much as 10 or 15 gigatons of carbon as carbon dioxide to the atmosphere. Everyone agrees that an amount equivalent to about half of the 5 gigatons of fossil fuel carbon now burned each year ends up in the atmosphere as carbon dioxide. Many oceanographers have thought that most of the rest dissolves in the surface waters of the ocean. That would leave all of the anthropogenic carbon dioxide accounted for and the cycle balanced, except that some terrestrial biologists suggested that the destruction of forests, especially the increasing exploitation of tropical forests, adds even more carbon dioxide to the cycle. . . Initial estimates of the land's contribution ranged as high as twice the size of fossil fuel source, but oceanographers recoiled at the suggestion of putting all of that carbon into the ocean.

". . . more leisurely analyses of the available data have narrowed the range of disagreement, primarily by shrinking the possible terrestrial source.

". . . (Wolfgang) Seiler and (Paul) Crutzen tried to account for the carbon preserved as charcoal following a fire. They estimated that this decay-resistant form of carbon might provide a sink, rather than a source for 0.5 to 1.7 gigatons of carbon burned each year. Taking account of other losses and gains, such as the oxidation of organic soils exposed by farming and reforestation of cleared areas, they concluded that the land could be either gaining or losing as much as 2 gigatons of carbon per year.

In a summary paper presented at a D partment of Energy research conference in Washington in May . . . . (George) Woodwell's best, but not final, estimate for the 1970 release is 2 to 4 gigatons of carbon.

". . . Jerry Olson of the Environmental Sciences Division of the Oak Ridge National Laboratory estimates that living land plants contain only 560 gigatons of carbon rather than the once generally accepted 800 gigatons, which would mean lower fluxes of carbon dioxide from the exploitation of forests. The mass of plants actually being converted into carbon dioxide may be even smaller, according to Charles Hall of Cornell University, because as much as half of the forest being cleared in the tropics may not be dense virgin stands of trees but rather thinner stands that grew back since an earlier clearing. In addition, the carbon dioxide that is being released in the tropics is probably partially compensated for by the growth of temperate forests, according to the final report of a workshop conducted by the Institute of Ecology in Indianapolis. The temperate forests, which were extensively cleared in the 19th century, now appear to be regrowing fast enough to store about 1 gigaton of carbon per year, according to the workshop report.

". . . Although oceanographers no longer suggest that the terrestrial biosphere must absorb much carbon dioxide, they cannot find much room in the ocean to place carbon dioxide from a terrestrial source. By tracing the path of nuclear bomb debris from the surface into deeper waters, and by using other techniques Wallace Broecker of the Lamont-Doherty Geological Observatory has calculated that about 37 percent of the fossil fuel carbon dioxide released since 1958 could have been absorbed. . . . Broecker concedes that as much as 0.5 gigaton per year from a terrestrial source might be accommodated in the ocean. . . Robert Bacastow of Scripps Institute of Oceanography reports that the ocean models he and Charles Keeling of Scripps work with do not allow a much larger terrestrial source than Broecker's does.

". . . researchers now realize that a land source could become a major factor as increasing population and the increasing cost of fossil fuels put greater pressure on the world's forests."

●

From **Statement before the Senate Committee on Energy and Natural Resources by William Alston Hayne, Deputy Assistant Secretary of State for Environment, Health and Natural Resources on Climatic Effects of Carbon Dioxide Buildup in the Atmosphere, April 3, 1980** (to be released in late July):

". . . International attention to the carbon dioxide problem resembles what we have done in the United States and what we are doing here today. Attention is focussed on the problem of measuring the increases of carbon dioxide, on determining what effect carbon dioxide has on climate, on the likely timing of critical changes in climate, and on the inter-relationships between the oceans, the atmosphere and biosphere.

"I assure you this is a matter of great international interest and I have attached to my statement a list of some of the more important recent and scheduled future meetings on this topic.

"The Department of State working with other interested agencies, has played an active role. In November 1978, we took the lead in getting interagency agreement on what the U.S. should do internationally to deal with the impact of carbon dioxide on climate, society, and the environment. The U.S. position was then further developed with the help of the National Academy of Sciences Climate Research Board and developed further in connection with U.S. participation in the World Climate Conference (February 1979). The U.S. delegation to the 7th Session of the United Nations Environment Program (UNEP), May 1979, introduced a resolution 'Activities Related to Carbon Dioxide' which requested UNEP's Execuive Director to consult with the WMO and the International Council of Scientific Unions (ICSU) on the development of a plan on carbon dioxide. This resolution passed unanimously. The United States also initiated similar action with the WMO Congress in the framework of the World Climate Program. Subsequently, UNEP met with WMO and ICSU in February 1980 in Nairobi. The Nairobi meeting recommended a three-state approach to the carbon dioxide problem on the international level.

"1. **Fall 1980** - A meeting of government-designated experts to develop a plan of action for research in working toward a more definitive assessment and filling in gaps in knowledge, finding out what more we need to know, convened by WMO, UNEP and ICSU.

"2. **Early 1981** - A meeting of government-designated experts to develop a plan of action for research in working toward a more definitive assessment and filling in gaps in knowledge, finding out what more we need to know, convened by WMO, UNEP and ICSU.

"3. **Later in 1981** - A large scale carbon dioxide conference on broad technical and socio-economic implications, filling the need for an internationally sponsored scientific forum on the details of the carbon dioxide problem. The conference would flesh out the plan of action and would fulfill the need for international cooperation.

". . . While it is fair to say that the problem of carbon dioxide does not yet get sufficient weight in most discussions of international energy questions, it is considered in all our discussions of energy issues with major developed countries.

". . . U.S. agencies under the leadership of the Department of State have initiated an active international program to combat the destruction of tropical forests. Though our effort here is primarily to protect the fertility of soils and the conservation of the ecosystems needed for economic development, this action, to the extent it is successful, slows down the release of carbon dioxide and protects the biosphere as a sink for carbon dioxide. Both to protect tropical forests and to help save needed foreign exchange, AID has $40 million allocated to develop alternative fuel sources. The United States is participating actively in preparations for the August 1981 UN Conference on New and Renewable Fuels. We are trying to help find solutions to the disposal of radioactive wastes which have slowed down the development of nuclear energy. All of these measures, taken together, should slow down the release of carbon dioxide into the atmosphere and buy a little more time to study the matter and to develop alternative sources of energy."

Some Functions and Merits of Energy

Energy strategies commonly are chosen subjectively or on an economic basis without any truly scientific means of appraising the social and environmental merits to balance them against drawbacks. Some recent studies have sought to fill this scientific void by merely being couched in scientific language. Despite their lack of empirical verification, certain studies of this type have received much publicity and acceptance.

In *World Dynamics* by Jay W. Forrester (1971) and the subsequently popularized version of the same studies, *The Limits to Growth* by D.H. Meadows, *et al* (1972)—the latter of which is referred to as the 'Club of Rome' studies—the authors advanced the hypothesis that energy growth would automatically cause an acceleration of population growth worldwide. With such an assumed linkage, every energy growth scenario examined in these studies naturally led to runaway population growth, and the resulting conclusions were used to reinforce the original premise.

The fatalistic projections of the Club of Rome studies are similar to projections proposed by the theologian Thomas Malthus in 1798, based on Malthus' preconception that population would be held in check at the biological subsistence level only by misery, pestilence and famine unless the population checks were 'moral restraint' (sexual continence and deferred marriage unions). The modern equivalent holds that a steady state world can only result from 'energy continence' and from the harnessing of naturally regenerated diffuse sources of energy.

Thus a popularized view has evolved which considers energy growth as undesirable on a *moral* basis—comparable to lust and greed—while energy continence is portrayed as a morally desirable alternative. Diffuse energy sources as solar, wind and biomass are considered 'morally' desirable despite their excessively large consumption of finite, non-renewable mineral resources and human labor; nuclear energy is considered taboo; and the duty of the citizenry toward this philosophy has been described as 'the moral equivalent of war'. Militant advocacy of this philosophy has virtually shut off further scientific inquiry and rational debate.

The opposing philosophy to Malthus's dismal theory has evolved to what is now termed the 'demographic transition theory'. Richard Cantillon, a businessman, had observed in the early 1700s that population grows at a decelerating rate as the standard of living improves. Cantillon's idea was contrary to the prevalent view (as expressed a few years later by Robert Wallace) which considered it dangerous to raise the standard of living of the poor because it would encourage them to bear more children and result in overpopulation. This prevailing view, which was essentially formalized later by Malthus, helped to serve for two centuries to justify colonial exploitation of less developed populations.

The demographic transition theory relates the commonly observed decline in average family size and birthrates which countries normally experience with increased industrial development, to some vague motivation of birth control. Recent expressions of the demographic transition theory have emphasized the close relationship observed between declining birthrates and increases in the Gross National Product. Detractors relate the same declining birthrates to increases in 'gross national pollution'.

As United Nations population studies pointed out in 1973, while certain correlations exist to support the demographic transition theory, it had not been possible to determine the precise relationship of particular economic and social changes to fertility decline. By the systematical use of population ecology studies (the discipline by which the size and growth of population groups are related to environmental events), each measurable factor of affluence that might influence birthrates can now be analyzed statistically to identify the real determinant(s).

One such study published in 1973 by this author found that no significant correlation exists throughout the world between the amount of parent's education beyond literacy, and the parent's fertility or average family size. The relationship of U.S. family size on the average to the father's occupation is seen not to relate to the educational level associated with the respective occupations, but rather to the amount of **physical labor** associated with the occupations. Clerical and sales workers are seen to have smaller families on the average than the professional and managerial classes, and farmers are seen to have larger families on the average than unskilled and semi-skilled laborers.

A complete discussion of these statistical analyses is beyond the scope of this article, but the most significant relationship developed so far has been the worldwide correlation between declining birthrates and increased utilization of **electric energy** per capita, as shown in the accompanying graph which was developed from readily available U.N. statistics. Electric energy serves in this case as an index of the **utilitarian** energy employed to reduce human physical labor in all countries, because the overall energy consumption per capita would incorporate widely differing amounts of energy used in vehicles solely for pleasure. The first increments of electric energy replace the greatest amounts of human labor and the last increments replace the least, which apparently accounts for the logarithmic nature of the birthrate/energy relationship.

The birthrate/energy relationship has come under criticism for lacking cause-effect verification and because early developing countries have shown little decline in birthrates with increases in electricity use. It can be noted, however, that the diametrically opposed Club of Rome relationship has been widely accepted without having even empirical verification such as the birthrate/energy plot provides. The apparent lack of fit for early developing countries is seen to be an artifact of the mixing of urban and rural populations in census figures. Combining a 90% rural population (low energy use—high birthrate, Point A), with 10% urban population, (high energy use—low birthrates, Point B), yields a mix at Point C which does not fall on a logarithmic straight line between A and B. Early developing countries usually exhibit mixing of this nature.

The best-fit line derived from the data shown (heavy arrow) was chosen to minimize the population inhomogeneity by using only data below 4% birthrate. This fit satisfies the 99% confidence level. If this empirical relationship would be used in the Club of Rome computer models instead of the curve which starts at low birthrates—low energy use and ends at high birthrates—high energy use, a steady-state world might result when energy growth rises to a value corresponding to zero population growth. Side benefits to be expected for developing countries in such a case are reduced infant mortality (with increased sanitation) and greater longevity.

While energy growth moved for a long time in lockstep fashion with GNP

growth, recently GNP has grown at a more rapid rate than energy. This recent divergence may result frm the inclusion of some large factors in the GNP which do not reflect a net gain of the goods and services that are actually sought by most of the population. Repeated resale of land and existing buildings reflects an activity which adds no real worth to the economy but increases GNP. Rapidly escalating costs of crime, the trials of criminals, and the detention of criminals actually represent a decrease in the *net* national product while the salaries paid and goods transferred represent an increase in GNP. Also, excessive regulation of business may be counter-productive with respect to desired goods and services, but an increase of the regulating activity itself shows up as an increase in GNP.

At the 1974 World Population Conference in Bucharest, which was attended by delegates from 135 countries, the views of developing countries clashed sharply with the views of delegates from the affluent industrialized nations over the preferred means of slowing population growth. The affluent view was that the motivation for limiting births could be transplanted 'intelligently' to the laboring classes of undeveloped countries. The third world delegates generally dismissed the industrialized countries' draft World Population Plan of Action, which relied on greater contraception or 'family planning', as 'neo-Malthusian'. They argued instead that the root cause of the third world's rapid population growth was underdevelopment, not overpopulation itself.

The industrial development sought by the third world would, of course, have to be powered by manufactured energy. This has been emphasized by China's plight of not having enough electric energy to institute large new industries. As the developing nations can be expected to increase their energy consumption, the problems of halting the CO_2 buildup become increasingly great.

- W . N . B .