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MAKING THE ENVIRONMENT COUNT

HEARINGS

BEFORE THE

JOINT ECONOMIC COMMITTEE
CONGRESS OF THE UNITED STATES

ONE HUNDRED SECOND CONGRESS

FIRST SESSION

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JOINT ECONOMIC COMMITTEE

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WEDNESDAY, OCTOBER 9, 1991

MAKING THE ENVIRONMENT COUNT

MONDAY, SEPTEMBER 16, 1991

CONGRESS OF THE UNITED STATES,
JOINT ECONOMIC COMMITTEE,
Washington, DC.

The Committee met, pursuant to notice, at 3:05 p.m., in room SD–628, Dirksen Senate Office Building, Honorable Albert Gore, Jr. (member of the Committee) presiding.

Present: Senator Gore.

Also present: Marc Chupka and Charla Warsham, professional staff members.

OPENING STATEMENT OF SENATOR GORE, MEMBER

SENATOR GORE. The hearing will come to order.

I would like to thank our witnesses and guests for attending today, and also I would like to thank Senator Sarbanes for responding positively to my suggestion that we have this series of hearings.

I have been looking forward to them and, as this is the first of a series, let me say that I am quite optimistic that we will be able to develop a better understanding of the relationship between the environment and the economy.

I think it is appropriate that we begin the series with this morning's hearing, "Making the Environment Count," to examine how we can most effectively measure the environmental consequences of our economic actions. Our goal is not only to establish a new set of environmental benchmarks, but also to ensure that these environmental considerations become a part of our economic decisionmaking.

Environmental concerns simply must play a larger role in governing national economic policy. A clean and healthy environment does more than contribute to our material and spiritual well-being; it is at the very core of our way of life.

There is a growing awareness at every level of the critical need to safeguard our environment. We see that awareness in our own neighborhoods, at recycling centers, and we see it in international efforts to protect the global environment.There is a new sense of urgency to this awareness, and a strong dedication to global environmental advocacy that is shaping a vast array of policy decisions—both here and abroad—on everything from energy and transportation to agriculture and international trade.

Congress and the Administration must take environmental effects into account when economic policy decisions are being made. Crucial to this task is information about natural resources, pollutants, exposures, and ecological impacts. Today, there is a dangerous imbalance between the abundance of economic data we collect and analyze and the relatively sparse and inaccessible data collected about the environment. More environmental data is certainly available today than two decades ago, but our need for information has far outpaced our efforts to get that information and to analyze it. We simply do not know enough about what our economic decisions are doing to our environment.

This is, as I mentioned, the first in a set of hearings to address the connection between the state of the economy and the state of the environment in which it operates. Today's hearing will focus on the natural resource base that sustains our economy. Are we incurring environmental deficits that could undermine long-term prosperity? How do we measure and account for the depletion and degradation of our natural resources? What are the benefits of developing more and better information about the environmental consequences of economic activity?

The quality of natural resources information will determine how accurately environmental costs can be reflected in economic decisions. This information is a valuable public asset that should be maintained and enhanced. Timely and accurate information on the environment should guide economic decisions for everyone; from homeowners to national leaders; from small businesses to large corporations; from local, state, and federal governments to international and global environmental organizations and efforts.

For example, better information on the environment would allow the United States and other nations to account for the depletion and degradation of natural assets when calculating national measures, such as the gross national product. Current national income accounting essentially ignores these impacts, in part because there is not enough information about the environmental consequences of economic activity. But economic policies based on the single-minded pursuit of higher GNP invites long-run ecological disaster, which is sure to undermine our quality of life, not to mention the strength of our economy.

In the words of economist Herman Daly, "There is something fundamentally wrong in treating the Earth as if it were a business in liquidation."

Just two days ago, the Space Shuttle Discovery deployed the Upper Atmosphere Research Satellite to monitor the depletion of the stratospheric ozone layer, and to collect data about the impact of human activity on the atmosphere. What will we do with the information that we gain? Are we ready to translate data into knowledge, and then knowledge into action?

Today, we are fortunate to have an excellent group of witnesses to address these issues. These three individuals direct the three leading periodic assessments of the U.S. and the global environment.

Our first witness is the Chairman of the Council for Environmental Quality, Michael Deland. CEQ is charged with reporting environmental status and trends.

Quoting from Section 204 of the National Environmental Policy Act, CEQ shall:

> ... conduct investigations, studies, surveys, research and analysis relating to ecological systems and environmental quality, and document and define changes in the natural environment.

The annual CEQ Volume, *Environmental Quality*, assesses the state of the environment and progress made toward attaining the goals of environment policy.

Our second witness, Dr. Lester Brown, President of Worldwatch Institute, has given nature a voice in the policy arena. In many respects, he has acted as an ecological conscience. Through the annual *State of the World* volume, Mr. Brown and his colleagues describe the impact of human activities on the earth's environment. In addition to monitoring the earth's vital signs, the *State of the World* also offers prescriptions for improving the health of the environment.

Our third witness, Daniel Tunstall, has analyzed environmental data and trends for more than 15 years. His work on the Council on Environmental Quality, and now as Senior Associate and previously an author of the biannual *World Resources Report* at the World Resources Institute, gives Mr. Tunstall a unique perspective on the task of collecting, analyzing, and developing useful environmental indicators.

I want to welcome all of our witnesses to today's hearing and thank them for sharing their insight and experience with us.

At this point in the record, without objection, I would like to insert the written opening statement of Congressman Dick Armey, who is Ranking Republican of the Joint Economic Committee.

[The written opening statement of Representative Armey follows:]

WRITTEN OPENING STATEMENT OF REPRESENTATIVE ARMEY

Good afternoon. I am pleased to welcome our panel of witnesses today to the first in a series of hearings on the "Environmental Impact of Economic Activity." Environmental awareness is ever increasing as a we further realize how precious and irreplaceable our natural resources are. We all believe it is extremely important to protect our resources, yet, few find merit in finding effective ways of doing that.

We must seek to find new market-based approaches that work to mitigate the negative impact of industrial progress on our environment. We all want our children and grandchildren to be able to enjoy the beauty of a natural environment without having to go to a museum to experience it.

However, we must continue to promote the economic growth that makes possible careful stewardship of our precious environment. The latest cutting edge effect to protect our resources must be structure so that it will not undercut the economic prosperity that makes that stewardship possible. Natural resource accounting, or environmental accounting, needs to be integrated into the current System of National Accounts, so as not to introduce dramatic price distortions into the market economy.

New and innovative market-based solutions to encourage socially responsible and cost-effective environmental policies need to be expanded.

SENATOR GORE. I very much look forward to the statement of our first witness.

Mr. Deland, welcome. We are certainly glad to hear from you, and please proceed.

PREPARED STATEMENT OF MICHAEL DELAND, CHAIRMAN COUNCIL ON ENVIRONMENTAL QUALITY; ACCOMPANIED BY COLONEL FRANK SKIDMORE, DIRECTOR, ENVIRONMENTAL TRENDS AND STATISTICS, COUNCIL ON ENVIRONMENTAL QUALITY; SCOTT FARROW, SENIOR ECONOMIST, CEQ; AND LARRY FLICK, DIRECTOR, LEGISLATIVE AFFAIRS, CEQ,

MR. DELAND. Thank you, Senator.

It is a pleasure to see you and to be before you and the Committee today.

At the outset, I would like to commend you and the Joint Economic Committee for its inquiry into these important emerging environmental issues; for clearly, economic and environmental issues are becoming inextricably intertwined.

Before proceeding, I would like to introduce three colleagues who are here with me.

Colonel Frank Skidmore, who is directly behind me, is the Director of CEQ's Environmental Trends Initiatives. Scott Farrow is our Senior Economist and was the author of the chapter in this year's Annual Report entitled "Making the Environment Count," and I am delighted to see that he has been helpful in setting the title for this hearing. And on his right is Larry Flick, the Director of Legislative Affairs for CEQ.

In the words of President Bush: "To those who suggest we are only trying to balance economic growth and environmental protection, I say they're missing the point. We are calling for an entirely new way of thinking to achieve both, while compromising neither."

All too often in the past, business interests have believed that environmental regulations were a drain on their productivity. But since the enactment of our first environmental statutes in the early 1970s, we have demonstrated that environmental cleanup and a growing economy can indeed go hand-in-hand.

For example, since 1970 and the advent of our current environmental, legal, and regulatory structure, we have made both substantial environmental and economic progress. During that period, SO_2 emissions in the United States declined by 26 percent; particulates are down over 60 percent, and lead is down by 90-plus percent; all while the U.S. gross national product grew by more than 50 percent in real terms.

But the environmental challenges that lie ahead are vastly more complex than the gross pollution we faced 20-plus years ago. We now understand that we must prevent pollution before it occurs, and we recognize that we live in an increasingly diminishing-in-size global environment.

I strongly believe that for the United States to meet our future environmental challenges, we need first to do a better job of compiling and interpreting environmental statistics and trends. And second, we need to do a better job integrating our economic interests with our environmental interests.

ENVIRONMENTAL STATISTICS AND DATA

The National Environmental Policy Act of 1969 is a constitution-like document—the "Magna Charta," if you will—of U.S. environmental statutes. When drafting this bill in 1969, the Congress had the foresight to understand the need to establish the means to measure our environmental quality and trends. NEPA requires the President's Council on Environmental Quality to "gather timely and authoritative information concerning the conditions and trends in the quality of the environment."

Since CEQ was established in 1970, it has studied and reported on trends in air and water quality, natural resources, and on many other environmental topics. However, I am the first to admit that more, much more, needs to be done in this area.

CEQ first published an environmental statistical report in 1975. This was the first attempt to compile the federal environmental statistics in one place. A second report was filed in 1978. In 1981, a major departure was achieved in the third CEQ Statistical Report, which used numerous maps and graphs to predict the conditions and trends in the environment. And the *1989 Environmental Trends Report* is the latest in this series.

The indicators displayed in these reports were chosen for several reasons:

- To reflect some meaningful condition or variation in environmental quality;
- To allow for aggregation of data up to the national level; and
- To show conditions at a point in time, or a time series of sufficient length to reveal trends.

In addition to these occasional reports, CEQ has published the latest environmental statistics and indicators in its Annual Reports to the Congress since 1975. Our most recent Annual Report, released in April of this year, includes some 84 tables and 50 figures portraying the status of the environment. A recent survey of users of the Annual Report revealed that the data and trends section is among the most useful.

Environmental data can and should be defined broadly, including the chemical, the physical, or ecological conditions of our Earth, as well as human health, energy, economic, and social parameters.

It is not surprising, given this broad definition, that data is collected across federal, state, and local agencies. To provide you with some sense of the extent of environmental data programs, using OMB's fiscal 1991 Statistical Programs document, one can roughly estimate that funding for Statistical Programs by the resource agencies is approximately a half a billion dollars.

These ongoing efforts within the various departments and agencies are important. However, they are usually conducted in support of specific missions and may not necessarily capture the bigger picture.

In the President's view, we need an overall framework, a cooperative interagency approach that integrates data in ways that avoid gaps and paints a clear picture for policymakers. In this regard, CEQ has convened an interagency committee to improve the collection and coordination of environmental data and trends within a cross-cutting framework.

This group, which meets for the second time on Thursday of this week, will focus on several issues; including the identification of more meaningful environmental quality indicators and improved conceptual frameworks, better integration of social and economic data with environmental indicators, and a network for the exchange of environmental data among all of the various agencies.

INTEGRATING ECONOMICS INTO ENVIRONMENTAL POLICY

The principle of integrating economics with environmental quality is a cornerstone of the President's environmental strategy. Our most recent CEQ Annual Report devoted, as I mentioned, an entire chapter to this entitled "Making the Environment Count."

In CEQ's Annual Report of this year, we stated that environmental accounting is still in its early stages at all levels. We concluded that a vision of comprehensive national environmental accounting far exceeds our measurement capabilities. But we also indicated that this Administration is committed to a better integration of environmental and economic accounting.

In the macro sense, environmental accounting seeks to link environmental changes in terms of assets and our accounting of monetary wealth.

As the United States joins the world community in adopting an international system of environmental accounts for reporting GNP and other data, the accounting for assets is likely to be extended in supplemental accounts to environmental assets.

Initial efforts in natural resources accounting focuses on the depletion of the effect of using resources, such as energy or timber. In part, this is because markets exist for these resources. The accounting problems, however, become far more complex when environmental resources are not exchanged in a marketplace.

Individuals in both the National Bureau of Economic Research and in the Bureau of Economic Analysis within the Department of Commerce have initiated work on natural resource accounting, as have several other organizations.

At the international level, natural resources accounting is a major topic as we prepare for the 1992 U.N. Conference on the Environment and Development. In preparation for that conference, the U.S. Government has stated that we "support efforts now underway in the United Nations, OECD, and other fora to augment standard economic accounts with satellite accounts that provide information on environmental and natural resources." This position implements the direction of Congress as expressed in the Supplemental Appropriations Act of 1989.

To shift from the grand scheme of national accounting to the programmatic level for a moment, if I may, there are a number of important federal efforts underway to integrate scientific and economic information for decisionmaking.

Agency-specific programs include the OCS' Environmental Studies Program in the Department of the Interior; Natural Resource Damage Assessment Program in NOAA; the Ecosystem Valuation Forum sponsored by EPA; work by the Bureau of Economic Analysis and the Center for Economic Studies in the Department of Commerce; and such interagency programs as the Global Climate Change Research Program, and the National Acid Precipitation and Assessment Program.

As for consumers, business, and the environmental community, the President has asked that I bring together private-sector innovators to find ways to integrate economics and the environment. Toward that end, we have formed a new President's Commission on Environmental Quality that has convened and is developing an action agenda to promote the best environmental practices throughout the private sector to reap long-lasting economic and environmental returns.

In CEQ's recent Annual Report, numerous examples are presented of innovative ways that the environment and economics are increasingly being integrated. Examples range from changes in consumer preferences for environmentally sound products to waste accounting at various companies, such as Polaroid and DuPont, to new ways of measuring productivity in electric utilities.

I will conclude by observing that policymakers, and most particularly the Congress, need more than ever before to understand environmental trends and make informed policy decisions. People in this country and around the world want economic development that does not jeopardize the environment for future generations. That, I submit, is our common agenda.

Again, I appreciate your personal, and this Committee's leadership in this area.

Thank you, Senator.

[The prepared statement of Mr. Deland follows:]

PREPARED STATEMENT OF MICHAEL R. DELAND

Our nation's efforts at keeping track of our wealth -- of our economic well-being -- date back to colonial times. Our analytical tools have become more sophisticated, but the tradition -- indeed, the necessity -- of being able to identify, interpret, and forecast economic trends has been one of the bedrock functions of our federal government.

That effort included the legendary expeditions into the interior -- the exploration of Lewis and Clark, of John Charles Fremont and John Wesley Powell -- to determine what resources were there: minerals, waterways, land. So even back then we see efforts to assess the quality and value of the nation's environmental resources.

Over time, bureaucracies were formed here in Washington and elsewhere to collect statistics of these natural resources: hectares of forest, quantities of minerals, tons of fish caught. It was important to know, as a nation, not only what we had, but trends in how they were being used. The link between our vast natural resources and the nation's economic growth was obvious.

Yet as recently as a quarter century ago, little thought was given -- or, one might argue, was needed -- about trends in environmental quality. It was obvious to human senses that things were getting worse. Something needed to be done, and a national effort was launched to reverse a trend of declining environmental quality.

It was a pioneering effort of sorts in the early 1970s when I and other new lawyers at the fledgling EPA literally launched rowboats into polluted waters to collect "evidence" for some of the first federal pollution lawsuits. The United States has come a long way since then. Rivers that were once little more than open sewers are now, for the most part, fishable and swimmable due to the success of the Clean Water Act. Cities where air quality was approaching hazardous to human health have significantly improved.

And just as our ability to understand the world's largest and most complex national economy has improved over time, so too has our understanding of our environmental resources. The environment is increasingly being recognized as a living, breathing system which provides goods and services of economic value. The nation's economic wealth and environmental health are merging as never before.

Today we can no longer track trends in environmental quality from rowboats any more than we can assess the nation's resources from a birchbark canoe or the back of a horse. The kinds of environmental challenges that lay ahead are vastly different and more complex than the kinds of gross pollution we faced 25 years ago. We now understand that environmental protection means much more than just cleaning up discharges at the end of a pipe or smokestack: We must prevent pollution before it occurs. We must use our resources wisely and efficiently. And we must recognize that we live in a global environment.

I strongly believe that for the U.S. to meet our future environmental challenges, we need first to do a more comprehensive, more sophisticated job of understanding current and future environmental risks, including the costs and benefits of reducing them. To do that we need to improve our capabilities to compile and interpret environmental statistics and trends. And second, we need to do a much better job integrating our economic interests with our environmental interests.

I would like to commend this Committee, the Joint Economic Committee, for its insight into these important emerging environmental issues. All too often in the past, when couched in economic terms, businesses have believed that environmental regulations were a drain on their productivity, and certainly in some cases they may have been. But, since enactment of our first environmental statutes in the early seventies, we have demonstrated that environmental cleanup and a healthy, growing economy can go hand-in-hand.

For example, since 1970 and the advent of our current environmental legal and regulatory system, the U.S. GNP grew by more than 50 percent in real terms. The positive link between economic development and environmental trends is still a new way of thinking for many. But in fact, strong environmental laws can be turned to our competitive advantage.

For example, Professor Michael Porter of Harvard Business School, in his recent book The Competitive Advantage of Nations asserted that countries with the most rigorous requirements often lead in exports of affected products. For example, in the mid-1980s while both Germany and Japan implemented strict air pollution laws, they surpassed the U.S. in the growth of GNP and productivity, and they gained in exports of air pollution equipment. Right here in the U.S. several industries that face strict environmental laws, such as the chemical industry, have improved their trading performance. Of course, using environmental policies to boost competitiveness requires that we establish the right kind of policies. As I stated earlier, they must stress efficiency and pollution prevention in every sector, rather than spending billions on cleanups at the discharge end of the pipe. They should emphasize performance standards and market incentives, and encourage innovation -- not just compliance -- by the private sector.

Clearly, it's time for Americans and American businesses to stop viewing environmental quality and economic growth as always being mutually exclusive. In the words of President Bush, "To those who suggest we're only trying to balance economic growth and environmental protection, I say they're missing the point. We are calling for a new way of thinking to achieve both while compromising neither."

ENVIRONMENTAL TRENDS AND STATISTICS

I have often referred to the National Environmental Policy Act of 1969 (NEPA) as the "magna carta" of U.S. environmental statutes. When drafting this bill back in 1969, the Congress had the foresight to understand the need to establish the means to measure our environmental quality and trends. NEPA requires the President's Council on Environmental Quality (CEQ) to "gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information...and to report at least once each year to the President on the state and condition of the environment."

Since the Council on Environmental Quality (CEQ) was established in 1970, we have studied and reported on trends in air and water quality, on natural resources, and on many other environmental topics. However, I am the first to admit that more needs to be done in this area, and I believe more of it needs to be done with an eye toward the policymaker -- federal, state and local -- as the ultimate user of this environmental information.

Past Efforts --

CEQ efforts to enlist the cooperation of the data producing agencies, and to form a synthesis of environmental information, date back to 1975 when we sponsored and published the National Environmental Statistical Report. This was the first attempt to capture the many federal environmental statistics in one place.

A second report, Environmental Statistics, followed in 1978.

In 1981, a major departure was achieved in the third CEQ environmental statistics report, Environmental Trends, which used numerous maps and graphs to depict the conditions and trends in the environment. The supporting data for that document was published by the U.S. Geological Survey in 1983.

The 1989 Environmental Trends report is the latest document in this series. It comprises nine chapters containing maps, graphics and text, pulling together information published separately by the Federal agencies in the areas of: Minerals & Energy; Water; Climate & Air Quality; Land Resources; Wetlands & Wildlife; Protected Areas; Population; Transportation; and Environmental Risks & Hazards.

The indicators displayed in these reports were chosen for several purposes:

- to reflect some meaningful condition or variation in environmental quality;
- to allow for aggregation of data up to the national level; and
- to show conditions at a point in time, or a time series of sufficient length to reveal trends.

These indicators are good summaries of environmental conditions and trends as now measurable.

In addition to this series of occasional reports, CEQ has published the latest environmental statistics and indicators in its annual reports to Congress. For example, environmental conditions and trends first appeared in our Annual Report in 1975. In 1980, we published the results of our Interagency Task Force on Environmental Data and Monitoring, which proposed a comprehensive approach to improving data throughout the environmental community. The 1985 Annual Report contains the results of our study of environmental indicators, and tables of environmental data and trends have appeared in each report since 1986. CEQ's twentieth Annual Report released in 1990 contains a forty page chapter titled "Environmental Data and Trends" that summarizes progress in environmental data collection and trends assessment since 1970. And our most recent Annual report released in April of this year includes 84 tables and 50 figures portraying the status of the environment.

A recent survey of users of the Annual Report, conducted by CEQ, demonstrated that the environmental data and trends section was considered the most useful.

The Status of Environmental Data Efforts --

Compiling and maintaining a comprehensive set of environmental data and statistics is an immense and complex proposition. Measurements of pollutants or the resource base immediately come to mind when one raises the topic of the environment. However, environmental data includes much more. It includes the chemical, physical or ecological conditions of our earth, as well as data on human health, energy, economic, and social parameters. These are all interlinked and crucial when developing environmental policies. It is not surprising, given the very broad and all-encompassing nature of this subject area, that relevant data is collected across federal, state and local agencies.

To provide you with some sense of the extent of environmental data programs, I would refer you to a compilation of 75 key environmental data programs in 20 different federal agencies prepared by World Resources Institute with financial support from Department of Interior and the Environmental Protection Agency. And using OMB's FY 1991 Statistical Programs of the United States Government document, one can roughly estimate that federal funding for statistical programs for the resource agencies was in the neighborhood of one-half billion dollars.

These on-going efforts within the various agencies are important. However, they usually are conducted in support of their specific missions and may not necessarily capture the big picture and interconnections among environmental trends needed for many policy decisions. In my view we need to develop an overall, coordinated federal framework under which all of the federal agencies involved in environmental data and statistics can work. In short, we need a cooperative, interagency approach which better integrates existing data in technically reliable and consistent ways, avoiding gaps, and in ways that paint a clear picture for, and will be helpful to, policymakers.

In this regard, the Council on Environmental Quality has convened an interagency committee to address environmental data and trends on an interagency basis and to provide such a cross-cutting framework. This committee -- the Interagency Committee on Environmental Trends (ICET) -- is still in its formative stages. I see its focus in the direction of helping to define the big picture needs for policymakers, both domestically and in an international context, through:

- the identification of more meaningful environmental quality indicators, including improved conceptual frameworks;
- better integration of social and economic data with environmental indicators; and
- a network for the exchange of environmental data among all of the various agencies.

This interagency group is comprised of experts in the field of environmental data and trends from all of the interested federal agencies. They will be having their second meeting on September 19 to undertake a workshop to identify their goals and objectives.

The management of our nation's environmental data programs is decentralized among the many agencies I have described by necessity -- each has its own missions to fulfill. That said, CEQ under NEPA serves as an interagency coordinator and facilitator among all of the various agencies and departments. With the formation of this interagency committee, we believe we are on the correct road to advancing our nation's environmental statistics capabilities.

INTEGRATING ECONOMICS AND THE ENVIRONMENT

The principal of integrating economics with environmental quality is a cornerstone of this administration's environmental strategy. Our most recent CEQ Annual Report devoted an entire special report chapter called "Making the Environment Count" to this very topic.

An economy with fully integrated environmental concerns must start with the microeconomic behavior of consumers and industries for whom the environment is accurately reflected in the prices and costs of goods and services, and end with the macroeconomic behavior of consumption, investment, government, and trade that reflects changes in the quality and quantity of environmental resources.

In CEQ's 1990 annual report we stated that such accounting for the environment is still in its early stages at all levels but that getting such accounting correct is akin to getting modern software as an aid for making business and government decisions. But we concluded that "A vision of comprehensive national environmental accounting far exceeds current measurement capabilities."

What I will try to convey, and which our Annual Report goes into some detail on, is the importance of integrating the economy and the environment, the difficulties that lie before us in achieving that integration, and some of the steps that we are taking to achieve that vision.

<u>Macroeconomics of Natural Resource Accounting</u> --

Fundamentally, our environmental data such as ambient air concentrations, measures of water quality, numbers of species, and resources of trees and minerals are attempts to inventory the environment in both quantity and quality. We hope to identify changes in the environment and their causes. Environmental or natural resource accounting seeks to link these changes in environmental assets with our accounting of monetary wealth.

As the United States joins the world community in adopting an international System of National Accounts for reporting GNP and other data, the accounting for assets becomes more important than it is in our current framework. This increased concern for everyday assets like buildings and equipment, is likely to be extended in supplemental accounts to environmental assets. But as we have found in our decades of intense environmental focus, environmental measurements contain new complexities and new uncertainties.

Initial efforts in natural resource accounting focus on the depletion effects of using natural resources such as energy or timber. In part this is because markets exist for many of these resources. Even so, there are still theoretical issues to be addressed such as the appropriate method of incorporating depletion into natural resource accounts. There are estimation issues to be addressed--even as basic as the amount of petroleum resources available--because we are well aware that new information on natural resources is itself costly. The accounting problems become increasingly complex when environmental resources are not exchanged in a marketplace.

The complexity of addressing these environmental issues brings to mind the early efforts at national income accounting. In the 1920's, a non-governmental group called the National Bureau of Economic Research (NBER) began work on national income accounts. Over a decade later, the U.S. Senate asked for an official government estimate of the national income and the Department of Commerce asked the NBER for help. The NBER has continued work on issues related to the national income accounts to the present day, though its primary focus on the topic lasted several decades.

Individuals in both the NBER and in the Bureau of Economic Analysis within the department of Commerce have initiated work on natural resource accounting as have several other organizations.

Of particular interest os the study and practice of natural resource accounting is growing among many economists who have not typically been associated with the issue. For example, my esteemed colleague Dr. Boskin, Chairman of the Council of Economic Advisors, has made a significant contribution to studying the value of natural resources owned by the federal government. Nobel Prize winner Robert Solow has suggested that one of the few ways to address sustainability in a concrete way is to begin to compute the "pure profit" or economic rent from natural resources.

At the international level, natural resource accounting is a major topic as we prepare for the 1992 UN Conference on the

Environment and Development. In preparation for that conference the U.S. asserted that "New approaches now being discussed for integrated economic-environmental accounting can help us all understand the interaction of environment and development...The U.S. Government supports efforts now underway in the UN, OECD, and other fora to augment standard national economic accounts with satellite accounts that provide information on environmental and natural resources." This position is implementing the direction of Congress as specified in the Supplemental Appropriations Act of 1989.

Microeconomics of Natural Resource Accounting --

I now want to shift from the grand scheme of national accounting to the bread and butter issues of individual economic decisions and of federal programs.

At the programmatic level there are important efforts that are working in an evolutionary way to integrate scientific and economic information for decision making. Agency specific programs include the Outer Continental Shelf Environmental Studies Program (DOI), the natural resource damage assessment program (NOAA), the ecosystem valuation forum sponsored by the EPA, work by the Bureau of Economic Analysis and the Center for Economic Studies in the Department of Commerce, and such interagency programs as the Global Climate Change Research program and the National Acid Precipitation and Assessment Program.

As for consumers and business, the President has asked that

I bring together the private sector innovators in ways to integrate economics and the environment. The resulting President's Commission on Environmental Quality has already convened and is developing its agenda of how the best practices in the private sector can be sown throughout the economy to reap long lasting economic and environmental returns.

In CEQ's recent special report on this subject, numerous examples are presented of the innovative ways that the environment and economics could be and are being integrated--examples that ranged from changes in consumer preferences for environmentally sound products, to waste accounting at Polaroid and DuPont, to new ways of measuring productivity in electric utilities. I would be pleased to provide additional copies of this report to the committee.

I will conclude by observing that environmental statistics, trends and accounting is a really a balance between two well known proverbs: One proverb states that those who do not study history are bound to repeat it." The second proverb tells us that "trend is not destiny." If we are wise, we must look back over time and study our environmental history and trends. But that history -- our past environmental trends -- need not define our destiny with respect to the future of our environment. Policymakers -- most particularly the Congress -- need now more than ever to understand our environmental trends so that we can move forward with economic development which does not jeopardize the environment for future generations.

SENATOR GORE. Well, thank you very much, Mr. Deland.

I have a bunch of questions, and other members of the Committee may submit questions in writing. If you and your staff would be willing to respond to those, that would be helpful to us.

I am going to do my best to resist the urge to debate you on the larger question of what the Administration is doing and not doing. We have had that debate on many occasions, and you know that I have very strongly held views, and I really think it is a great tragedy that the Administration is not following the kind of policies that they might perhaps follow if you had your total say in what you might recommend.

But I have debated with you enough times to know that you will vigorously defend the President even when reason and logic point in the opposite direction. So, I am going to resist more than that.

I do want to focus in this first hearing of this series on what we know and need to know about the trends in the environment; how we relate the information we do have to our economic decisions; and how we can do a better job of integrating the two.

First of all, just a general question. How would you assess the overall trends in the global environment? Favorable? Unfavorable? Positive? Negative? Stable? How would you describe them?

MR. DELAND. I would describe the trend overall as favorable, but——

SENATOR GORE. You think the global environment is getting better?

MR. DELAND. ——but very quickly couch that by saying that the magnitude of the problems is increasing and increasing dramatically.

When I use the word "favorable," I use it in the context of the United States as but one example, ratcheting down dramatically on emissions during a time when the economy is growing.

SENATOR GORE. No, please. If you would let me interject, because I do not want you to answer a question that I have not asked.

I am going to resist debating you about the Bush Administration's policies. I hope you will resist the urge to put forward a lot of laudatory comments about what they are doing.

MR. DELAND. The figures I was using, Senator, or were to use, are over the course of the last 20 years, speaking beyond any given Administration.

SENATOR GORE. I know, but I am not asking about U.S. policy. We could have a vigorous debate about that, but I want to focus on the subject of the hearing.

The initial question is about the global environment. Do you believe that the trends are in a positive direction? I am not talking about policies. I am talking about the quality of the global environment; the risks being posed to the global environment; the overall trends with respect to the atmosphere, the oceans, the topsoil, the diversity of species, the rain forests, and the ecological system as a whole. Do you believe that the overall trends are positive now, or negative now?

MR. DELAND. Well, when presented in those terms, Senator, I would say that the risks posed to the global environment are at a far greater level now than heretofore in history. I think that is driven largely because the world economies are developing.

Not only do we in the "developed world" continue to develop, but we see a whole host of other nations joining that developed group. Obviously, as a China, or an India, or Eastern Europe, or Latin American economies begin to burgeon and grow—as we would all like to see—the world's resources are ever increasingly strained.

SENATOR GORE. Do you think the trend is negative? You say that the risks are greater today than they have ever been. I would agree with that. Would you also agree that the trends are toward risks that are greater still? And tomorrow and the next day the risks that you describe as presently greater than at any time in prior history, will be even greater than they are today?

MR. DELAND. I think there is a trend toward greater and greater risk to the global environment. Quite frankly, I do not think anyone can predict with any certainty when we might be able to stabilize and hopefully reverse that trend. It is clearly going to take a concerted effort by the community of world nations.

SENATOR GORE. What are the markers of this negative trend that you describe? What signals tell you that things are getting worse and not better? What about soil erosion? Would that be one of them?

MR. DELAND. Soil erosion would be one. Continuing loss of species at an ever-greater rate would be another. There are a number of indicators.

SENATOR GORE. What about loss of tropical rain forests?

MR. DELAND. The loss of tropical rain forests. The list, as you well know, is long.

SENATOR GORE. What about loss of temperate forests?

MR. DELAND. Yes.

SENATOR GORE. What about increasing concentrations of greenhouse gases?

MR. DELAND. That is another potential risk, as you and I have discussed. I think the jury is still out as to the rate and magnitude of global climate change, but that is clearly a subject that we need to be very concerned about.

SENATOR GORE. Well, again, I am really going to resist making that topic also topic A as the subject of the hearing. But just to come back to this point briefly, in describing an overall negative trend and listing the markers that convince you that that is the case, you would or would not include among those markers the increasing concentration of greenhouse gases?

MR. DELAND. I would include that as a marker, yes.

SENATOR GORE. Would you also include, in spite of the Montreal Protocol, the continuing increase in the concentrations of ozone-destroying compounds in the atmosphere?

MR. DELAND. I would, but I would couch that response by saying that numbers of nations around the world are making laudable and, I think, productive efforts to cut back and indeed, as you know, phase out the use of CFCs.

SENATOR GORE. Would you include rapid increases in population among those measures?

MR. DELAND. I would, just as increased economic development strains the world's environment, so too does increased population.

SENATOR GORE. Would you include the depletion of the world fisheries?

MR. DELAND. I would, yes.

SENATOR GORE. Are there other measures that come to mind?

MR. DELAND. I think you have given a fairly comprehensive list, Senator. There are clearly other indicators, and in almost any area of the environment in which you choose to look.

SENATOR GORE. There are, indeed. A comprehensive list would be much longer than the one you and I have cobbled together in this exchange.

With respect to the items we have listed, how do you measure the trends that you believe are negative in each of the cases we have mentioned? Do you have a diverse set of sources for the information that you base your analysis on? How would you describe the way you go about monitoring these trends?

MR. DELAND. I obviously have a diverse set of sources, depending on the particular issue that you allude to. I think that gets to the heart of a concern that I believe you and I share; namely, to consolidate the data banks upon which we all draw to come to the conclusion that we just have together in the indicators that you have mentioned.

SENATOR GORE. Well, gathering general information of the kind that will support a general assertion that things are getting worse is one thing; but gathering specific information that can be quantified in a reliable way, tracked from year-to-year, and presented in a format that makes it useful for economists and policy makers, that is something else again.

You and I agree that the kind of data we collect should move more toward that second category and not remain in the first one.

When the information is related to economic decisionmaking, there are really two challenges. One has to do with the quality of the information, and the nature of the information. Then, the second challenge has to do with the conceptual framework that is used to relate issues in the environment to issues in the economy. A lot of those will be discussed in further detail at later hearings, although we will get into it a little bit today.

What progress have you made on the congressional directive to encourage natural resource accounting for the United Nations, OECD, and the U.S. Development Agency? That is one specific directive that you have been given to relate environmental information to economic decision-making, and you referred to it a little bit in your statement, but if you could briefly summarize that.

MR. DELAND. I think the progress has been by consolidation or assimilation of the various entities that are in the data collection business, first. And then second, trying to come to grips—although we have by no means met this challenge—with the concept of natural resource accounting. How do you indeed quantify, measure, and evaluate the various components that are part of the risk areas that you and I have just discussed? That is an art or a science that is very much in its formative stages.

SENATOR GORE. You mentioned that the Bush Administration has supported the construction of satellite accounts by the United Nations to accompany the same old definition of gross national product. Why not change the definition of "gross national product"?

MR. DELAND. Well, I think that is something that, in my judgment, ought to be evaluated and seriously examined. I do not think we are at a stage, at this point, when either this Administration or this Congress is prepared to implement that, but I think that that is a question that is a valid one, and a serious one, and ought to be pursued.

SENATOR GORE. Well, I have given similar answers at times when I did not want to give a "yes" or a "no."

The fact is that it is not up to the Administration or the Congress to change the way the United Nations constructs its accounts, but the position of the United States Government within the United Nations is extremely important to what happens there.

When you say it ought to be evaluated, you know, of course, that the United Nations has a regular procedure for evaluating changes in the definition of "gross national product," and it comes around every 20 years. We are in the midst of one such evaluation right now, and some have argued that gross national product should be changed. The way it is defined completely ignores the environment, and it is ridiculous to continue with the current definition. And the United Nations says, you know, you have a good point. Twenty years from now we will get around to that. If the United States says that we should simply evaluate it, is that not the equivalent of saying we do not support a change in the definition for another 20 years?

MR. DELAND. No, I do not think that is equivalent, because I think before making a change of that magnitude one does need to give it careful scrutiny.

Now, clearly I would be among those that would feel very strongly that the indicators of the type you allude to ought to be included. But I represent an environmental voice, not an economic voice. There are other sides of this equation that ought to be heard. I think this is a subject that does deserve very careful consideration.

SENATOR GORE. Just to translate the issue into common, everyday English, as I understand it, if you are a small country with a million acres of rain forest, and you decide to cut it all down this year and sell the lumber, the money you get for selling the lumber is included on your national balance sheet as income. Your expenses will include depreciation on the chain saws that you used to cut down the rain forests and the truck you used to take it to the port, but it will not include depreciation on the rain forest itself. And nowhere on that national balance sheet called "GNP" will there be an entry reflecting the fact that it is gone. If you want to cut it down next year and sell it again, you cannot do it.

Since the United States Government and the World Bank and a lot of other international institutions use gross national product as a guide for deciding what is a good loan and what is a bad loan; what policy on the part of a developing country it will support and what policy it will not; why should we continue using such a ridiculous measure?

MR. DELAND. Well I think as I said, Senator, that we need to "evaluate"—which is the best word that comes to my mind—that practice and to have an open and honest and forthright discussion on it.

SENATOR GORE. Well, let us do that.

MR. DELAND. We are clearly in agreement that the rain forests need to be preserved. There are numbers of ways of doing that. The change in the accounting system that you have mentioned is but one.

Others include sensitizing, as is happening, happily, in the World Bank, as it makes its loans around the world to environmental concerns, and numbers of other methods that need to be drawn into the overall equation on a day-to-day basis.

SENATOR GORE. Well, in order to evaluate it and discuss it forthrightly, let us just do that right now. That is one of the things this hearing is all about.

First of all, in terms of the plain-English example that I used, do you have any quarrel with the description that I have given you?

MR. DELAND. I do not have a quarrel with the description, but I again reiterate that I, as Chairman of the Council on Environmental Quality, represent but one of the many interests that needs to be factored in when one looks at a change of the magnitude, such as reorienting the way we, as a group of nations, consider gross national product.

I would want to talk to some economists who know more about the economic aspects than I do, for example.

SENATOR GORE. Well, but you, as head of CEQ, would agree that it is ridiculous to ignore the depreciation of that rain forest in calculating the gross national product in the example I gave, would you not?

Mr. Deland. I would agree that we need to very carefully consider the depreciation of that resource, yes.

SENATOR GORE. And include it in the calculation of gross national product?

MR. DELAND. Yes, I would be one who would advocate that. But as I said, I am but one——

SENATOR GORE. You are but one voice in the Administration.

MR. DELAND. Well, not just the Administration. I am but one voice in a world community, all of which needs to look at it in concert.

SENATOR GORE. Now, is your voice heard when the final review of environmental regulations comes? Are you on the Council for Competitiveness?

MR. DELAND. I am not a formal member of the Council. I attend and participate in its meetings. The formal membership, I believe, is five or six.

SENATOR GORE. They have the final word on environmental regulations, do they not?

MR. DELAND. No, that is not the case. They have a voice, and a strong voice, but not the final word.

SENATOR GORE. Well, I guess that is another one of those issues that would be best for us to avoid debating because it would take some time. But the CEQ is supposed to play a key role. If these decisions are made with respect to environmental regulations when economists say, well, economic policy has to override environmental considerations, it seems to me that the person who is in charge of articulating the environmental concerns ought to be at the table, as a member of the group, which is passing judgment on whether these regulations are allowed to go forward or not.

MR. DELAND. I am at the table, Senator.

SENATOR GORE. Well——

MR. DELAND. And to——

SENATOR GORE. Have you had any victories you could point to with that Council?

MR. DELAND. ——to amplify, if I may, when economists state that natural resource accounting is not a known science—and as I mentioned earlier—when resources are traded in a market place, yes, there is some understanding. But when they are not traded in the market place, we have great difficulty in knowing how to quantify both values and functions. We are just in the formative stages of developing that line of thinking, either conceptually or scientifically.

At the risk of raising an issue that you and I may differ on, on the specifics, in the President's recent proposal on wetlands, there is a provision for the categorization of wetlands, and also for banking and trading wetlands, somewhat similar to the acid rain component of the Clean Air Act. Clearly, that poses a substantial challenge to policymakers over the course of the next 18 months to come up with a specific operating framework. I would hope that we could work with you and your colleagues to do just that.

But assuming, for example, that you are able to categorize wetlands in say, for example, three categories, then do you allow banking of wetlands across categories? And if you do, is a Class B wetland worth one acre of Class B, or worth 2, 4, 6 acres of Class C? How do you quantify?

SENATOR GORE. Well, now those decisions were made by the Council on Competitiveness, right?

MR. DELAND. No, that is——

SENATOR GORE. Well, did they not play a key role in that?

MR. DELAND. I think you may be confusing, Senator, the Delineation Manual on the one hand, and the President's policy proposals on the other.

SENATOR GORE. I am talking about the policy.

MR. DELAND. Well, the policy sets forth a new scheme to protect wetlands in this country.

SENATOR GORE. But did not the Council on Competitiveness play a key role in establishing that policy?

MR. DELAND. It had "a" role. It was not the dominant role in that policy.

SENATOR GORE. What about with respect to the recent lead exposure decision?

MR. DELAND. I am not sure to which one you refer.

SENATOR GORE. The policy that was announced on how to deal with lead exposure.

MR. DELAND. I would have to check on that, Senator. I am not——

SENATOR GORE. Did you play a role in that?

MR. DELAND. I have been instrumental in looking at lead risk across the Federal Government in working with HUD, HHS, EPA, and various other agencies, but I do not recall the specific to which you refer.

SENATOR GORE. It was an EPA release of regulations on levels of lead. You are familiar with that, are you not?

[Pause.]

MR. DELAND. I am not sure whether you are referring to lead in soil, or lead in houses. There are numbers of different lead initiatives.

SENATOR GORE. Well, an aggressive program was recommended, but the Administration's policy, where houses were concerned, was to remove it from the Vice President's house, but that was the only one, as far as I can tell.

But the overall policy was really what I am getting at here. I do not want to digress too much on this. The narrow point I am pursuing here is that when environmental policy and economic policy are brought together, one place where they are brought together is in the Council on Competitiveness.

Often they are brought together in the review of regulations that the Administration passes judgment on. When that takes place, you are not a formal member of that group.

Now, if they say, hey, Mike, why do you not come in and sit and listen to what we are talking about here, that is not the same thing as being a member of the group and having a formal role to play.

Similarly, if you say, on the Administration's policy with respect to environmental accounting at the United Nations, your voice is only one of many in the Administration. When the Administration's policy is presented to the United Nations, it is not presented as eight different opinions on this.

The Administration's policy is a single opinion adopted by the President. The opinion expressed on that issue was evidently contrary to what your opinion is. What I am getting at is, how does the environmental perspective that you represent within the Administration get reconciled with the other perspectives that are so frequently hostile, or seem to me to be hostile to the environmental perspective?

MR. DELAND. Well, as I mentioned, Senator, if you are referring just to the Council on Competitiveness, it is a small group, as formally constituted, and I think rightly so. I am not a formal member, nor is Administrator Reilly, nor is Jim Watkins, Secretary of Energy. But the reason for that is simple, that we represent particular areas that are, yes, critical but are on occasion narrow in scope.

What I can say is that the Competitive Council does not, contrary to some misinformation, have the final say over environmental policy, and in every instance in which the environment is being discussed, Bill Reilly and Mike Deland are at the table, just as is Jim Watkins, when energy issues are being discussed. So, I do not think it is accurate to say that there is a lack of input from those of us who have a responsibility to look at particular pieces of the government-wide regulatory structure.

SENATOR GORE. What improvements in environmental information-gathering would you like to see?

MR. DELAND. Well, first I would like to see increased coordination of environmental information-gathering on the issue that you and I discussed earlier, that of global climate change research.

When this Administration took office, there was much research being done throughout the Federal Government in various pockets—at NOAA, at NASA, and many, many others, but not being done with coordination. It is now being coordinated, as you well know, by Alan Bromley, the President's Science Adviser.

Similarly, in other areas of the environment, I would submit that there ought to be that kind of coordination. I think that CEQ is a natural entity to do much of it. I think if we were to look much more exhaustively, as I strongly feel we should, across the government that we would find areas in which there is a duplication of resource, and hence a waste of taxpayer dollars.

I submit we also might well find pockets of gross omission that we really ought to be focusing our attention on, and we are moving in that direction. But we are a long way from where I would like to see us as a government.

SENATOR GORE. Are you aware of any cases within the Administration where environmental information has been suppressed or presented in a less than candid way?

MR. DELAND. No, I am not.

SENATOR GORE. If information resulting from environmental monitoring is presented candidly, sometimes it carries with it implications that disconcert people who do not want to have to do anything to s8top the trend reflected in the data. You understand what I am talking about there.

How do you protect the integrity of the process by which environmental information is collected and presented from the kind of backdoor influence that special interests can exert if they feel threatened by the implications of newly gathered information?

MR. DELAND. Well I think that gets to the heart—or to use an analysis that Bill Ruckelshaus often spoke to—the distinction between "risk assessment" and "risk management."

Clearly, we in this Government, any government, have a responsibility to collect solid, scientific information, and that information ought to be disseminated widely, so it can be scrutinized and criticized from all quarters.

However, when you get to the next step—namely, making policy decisions that are predicated upon that information—that then is quite a different process.

Just as two scientists could differ, and often do differ on information collected, policymakers differ on how to use that information. But I think all of it needs to be done in the open, so that all parties have an opportunity to make their views known.

SENATOR GORE. Well, yet another issue that we could debate, and will not hear today, involves the way in which one might politically insulate this Bureau of Environmental Statistics and the new cabinet-level EPA.

There are so many issues that would get us into a heated discussion. I am not shying away from them because I would not enjoy that, but simply because we will have plenty of opportunities to do that other than today, and I want to try to keep——

MR. DELAND. I know you have never shied away from heated discussions, Senator.

[Laughter.]

SENATOR GORE. Well, no, not at all. But I do want to keep right on the track of this hearing today.

I am quite concerned about the way in which environmental information is used in the Administration. Now, you say it needs to be collected and disseminated. Do you feel an obligation to present it forthrightly? I assume that you do.

MR. DELAND. Of course I do.

SENATOR GORE. Now, I was concerned about the way the Administration presented its analysis of the environmental trends that would flow as a result of the climate change strategy. For example, when the meeting was held at Chantilly, the U.S. presented some environmental statistics that purported to describe the results of CEQ's analysis of what would happen to greenhouse gas emissions, as a result of the policy changes recommended in the President's plan.

You said, and I quote:

> The actions that are currently included in the U.S. climate change strategy will result in U.S. greenhouse gas emissions in the year 2000 being equal to or below the 1987 level.

That is an accurate quote, is it not?

MR. DELAND. Yes.

SENATOR GORE. That implies that the greenhouse gas emissions will be stabilized by the year 2000 at the 1987 level. Does that not imply that?

MR. DELAND. It clearly does, yes. And I——

SENATOR GORE. But actually, the statistics do not support that statement.

As head of CEQ, when you present your interpretation of the environmental statistics at a world forum representing the position of the United States of America, it seems to me that it is wrong to be misleading in your presentation. It is my understanding that——

MR. DELAND. Well, Senator, I certainly was not misleading.

SENATOR GORE. Let me finish my statement——

MR. DELAND. I would like to hear what——

SENATOR GORE. ——and then I want you to respond fully. The statistics showed that the decrease in CFCs, mandated by the Montreal Protocol, that will come most sharply by the year 2000 will, as an incidental and important side effect, reduce total greenhouse gas emissions in that one year to the 1987 level, but that immediately after the year 2000—indeed, in the year 2001, because that easy gain will be out of the way—the greenhouse gas emissions will shoot right back up again. And that, in fact, in the year 1999 they will be above the 1987 level. And in the year 2001, they will be above the 1987 level. And in every year after 2000, under the Administration's strategy, they will continue climbing rapidly, but——

MR. DELAND. Senator——

SENATOR GORE. If I could just finish, briefly.

But in the year 2000—the preposition "in" being yours, and apparently carefully selected—the emissions will be equal to or below the 1987 level. But that is the only year for which that is true. Now, is that an unfair analysis?

MR. DELAND. It is an inaccurate analysis, Senator.

SENATOR GORE. All right.

MR. DELAND. In that I was very careful to couch, and will reiterate now, that as part of the overall greenhouse gas emission equation and reduction of them is the President's proposed National Energy Strategy. And if that strategy is adopted as presented to the Congress, not only will the greenhouse gas emissions be equivalent to or below those of the 1987 levels, they will be equivalent to or below the 1987 levels in the year 2030, which is about as far as any of us can project. So, I stand by that statement, Senator.

SENATOR GORE. What about the year 2010?

MR. DELAND. If the NES is implemented, as proposed——

SENATOR GORE. No, no. What about the year 2001 through 2020? Will they be below the 1987 levels then?

MR. DELAND. I would have to get back to you on specific years.

SENATOR GORE. I have your specific years here. I mean, I have your documents. Your own documents indicate that that is not the case; that in fact the way I described it was accurate, and that your amendment to my description that focuses on the year 2030 assumes not only that the Administration's program is adopted, but that a lot of things are done that are not in the Administration's policy, such as dramatic decreases in auto and truck mileage that the Administration's own analysis says in the report will not be accomplished without measures, which were specifically rejected in the formulation of the plan.

I mean, I will provide your people with the analysis that I am using here. It is from the Administration. Let us leave aside the 2030 business, and let me come back to the years, let us say, 1995 and 2005—the 5 years prior to 2000 and the 5 years after 2000. Is your statement true of either of those years? You see, what this is about is how environmental statistics are used and how they are related to economic decisionmaking.

If the relationship between environmental statistics and economic policy is one in which environmental statistics get wrapped up in a shell game and are simply obscured and used in a real tricky fashion to try to justify economic decisions that are made for completely different reasons unrelated to the environment, then that is the kind of practice that ought to stop. I think this is an example of that.

MR. DELAND. Well clearly, Senator, it is not a shell game, and it is not a tricky practice. You well know, as you have stated, that when CFC's are phased out, that there will be a reduction in a given year. But if you look at the statistics, and you look at the trend, the statement that I made holds true looking out to 2030——

SENATOR GORE. OK——

MR. DELAND. ——and I do not think there is anything misleading about that.

SENATOR GORE. OK. Wait a minute, Mr. Deland. What environmental statistics are you using as the basis for your statement, that greenhouse gas emissions will remain stabilized at 1987 levels after the year 2000? Is that what you are saying?

MR. DELAND. What I am saying is that in the year 2030—and there will be some fluctuations——

SENATOR GORE. Let's stay off 2030 for a minute. OK?

In the year 2001, are you saying that in the years immediately following the year 2000 that greenhouse gas emissions will remain stabilized at 1987 levels, or not? Are you saying that?

MR. DELAND. I would have to recheck the figures on that. Clearly——

SENATOR GORE. OK, let's——

MR. DELAND. ——if the economy continues to grow, as we would all like to see and as is projected, there is the potential for an increase of emissions. But the overall trend, as I just asserted, looking out to the long term, is one of either stabilization or of decline.

SENATOR GORE. OK. I will pause while you recheck the figures.

MR. DELAND. I do not happen to have the figures available here, Senator. I will have to get back to you.

SENATOR GORE. How do you know, if you have not asked your staff? Why do you not take a couple of minutes to recheck the figures?

MR. DELAND. I do not happen to have those figures, I do not believe, with me. They were developed by the Department of Energy, and I would be glad to respond to you. I was not aware of this line of questioning when I arrived today.

SENATOR GORE. I do not think the statistics that the CEQ has supports the statement that you are making. I think it serves as an example of how environmental statistics are misused to support economic policy decisions that are made for reasons that have little at all to do with the environment. Moreover——

MR. DELAND. Senator, I agree that statistics can be misused, but I will stand by the statements that I have made. I would be glad to supply you with that information from the Department of Energy and other government entities that do verify the statements that I have made.

SENATOR GORE. Well, Mr. Deland, the reason I am pursuing this is because I do not think it is right for you or the Administration to misuse these statistics to mislead the rest of the world that was gathered at that conference and the American people into believing that the policy announced at that conference was a step forward, when actually it was a step backward.

MR. DELAND. Senator, I beg to differ with you. Number one, I would submit it is not misleading; second, I would assert that it is a step forward; and third, I would assert that if one were to compare the record of the United States Government in this area and look not at the rhetoric but at the reality of the situation, you would find that our policy stacks up favorably with any nation in the world. Let me use but one example.

SENATOR GORE. I do not want to get into a lengthy discussion on comparative analysis of our policy and the policies around the world.

MR. DELAND. Well, Senator, you have opened that up. You have questioned the integrity of the use of statistics by the United States Government, and I assert that you are simply inaccurate in that assertion.

SENATOR GORE. All I am asking you to do is to produce the statistics upon which you base the statement.

MR. DELAND. And I told you I would, Senator, and I will.

SENATOR GORE. Well, you said at the same moment, when your staff was leaning forward to consult with you, that you did not have the statistics before you. I have your statistics right here. This is not a big mystery.

MR. DELAND. I was prepared, at your request, to discuss natural resource issues, and I did not come up here with statistics on global warming.

I would be glad to go back to the office and get them, and I will, but I do not have them here.

SENATOR GORE. Well, we will look forward to your supplementary answers on this. But as I said before, we have the statistics right here. I wish to reiterate that they were misused.

Insofar as it is your responsibility to advise the President on the environmental statistics that form the basis of statements like this, this showed up in a statement by President Bush himself to the delegates from around the world who were gathered to begin this negotiation, and I quote:

> U.S. greenhouse emissions ... The actions that are included in America's climate change strategy are projected to result in U.S. greenhouse gas emissions in the year 2000 being equal to or below the 1987 level.

Now, I personally am embarrassed when the President of the United States presents a document that is worthy of a fast-talking funeral insurance salesman; misleading, because it is carefully constructed to conceal rather than to illuminate, and I think we have a right to expect that the agency within the Federal Government responsible for the integrity of environmental statistics prevent this kind of shell game.

Now, when I asked you about it, you said you do not have the statistics. You will have to go back and check. You do not know.

What I would like to see is a new approach, where this kind of information is not just used to sell something, but is really integrated into the decisionmaking process. I do not think that was done in this case.

MR. DELAND. Well, Senator, I beg to differ with you, and I can assure you that there was no intent to mislead. The statement, as presented, is an accurate statement. And when you put it in conjunction with the projection out to the year 2030, I do not think it is a misleading statement at all.

SENATOR GORE. Well, I am not going to beat a dead horse on that because I think the record is clear, and I will look forward to your supplement.

MR. DELAND. Well, you and I obviously differ on what is clear or is not clear in the record, Senator.

SENATOR GORE. Why does the CEQ disagree with the need for a Bureau of Environmental Statistics in the Cabinet-level Department of the Environment?

MR. DELAND. The CEQ does not disagree with that. We have voiced, in the past, the possibility that such a Bureau might well be housed—and I realize this is a parochial, provincial statement—in CEQ. But we clearly feel strongly that there ought to be a Bureau, and I think there is a reasonable difference of opinion as to where it ought to be. I think it could be in an EPA, but one can make an argument that it ought to be an entity that reaches beyond the boundaries of just any one given agency.

If you are looking at environmental statistics, you need to look, yes, at those from EPA, but also those from the Department of Interior, NOAA, NASA, and from numerous other entities. And so, I think the case can be made to house it in an entity that has overview responsibilities. One could also make a case that it ought to be housed in a totally new, different, independent entity.

But CEQ does not disagree, if that was your question, Senator, that such a Bureau ought to be created and created soon.

SENATOR GORE. Do you think it should be insulated from political influence on the part of the White House?

MR. DELAND. As I stated earlier, clearly, when you are collecting scientific information, it ought to be collected in a scientific setting, drawing upon the best science; and there should not be economic, or political, or any other intervening considerations. It ought to be dominated by science.

SENATOR GORE. And in a perfect world, it would be without any institutional mechanisms. But do you think this office should be formally insulated from political influence exerted by the White House?

MR. DELAND. I do not think a formal insulation needs to be made, because I do not think there is any undue influence being exerted by this Administration or indeed past Administrations; that the science speaks for itself. Information that is collected is collected openly and is available for all to scrutinize and to evaluate.

SENATOR GORE. Well, I think it ought to be insulated, because I think the integrity of the statistics is vulnerable if economic decisions are pending that would be influenced by information that implies the need for tougher regulations.

MR. DELAND. I think, Senator, what you are driving at, and I am not sure that we have really come to grips with it, is at which point in a process of policy considerations do scientific data come to bear.

I think, whether it be this government or any government, whether it be a private entity, that at some point policy determinations need to be made.

For example, when the National Wildlife Federation is making a policy statement, it is predicated first on scientific information. But then Jay Hair, and others of a policy nature, have an input, as they should.

SENATOR GORE. Well, the information itself, as soon as it is gathered, sometimes carries powerful implications for policy. You would agree with that, would you not?

MR. DELAND. Well, of course, it does. But information, when it is gathered, as I said, is open to all to view. If there are gaps in that information-gathering process, any that have noticed them or feel that they are, have ample opportunity to register their views.

SENATOR GORE. Well, the process of data collection, analysis, and dissemination is a complex process not confined to a mere clerical role of writing down numbers as they are read off the instruments. The design of the questions is fraught with political implications on many occasions. And the way in which the preliminary analysis is conducted, similarly, has many implications. I just feel that that process should not be open to political manipulation.

MR. DELAND. I agree with you wholeheartedly, Senator.

SENATOR GORE. And I do not think it can be protected by good intentions, alone. I think that some institutional insulation is necessary.

Now, you talked earlier about the U.S. position on the United Nations reformation of "gross national product," and you said your voice was only one. When will the U.S. position be expressed?

[Pause.]

MR. DELAND. I can't give you a specific answer on that, Senator. It's in its formative stages right now.

SENATOR GORE. Will it be expressed before this 20-year review is over with? Or will it have to wait for the next 20-year cycle?

MR. DELAND. I would clearly hope that it would be expressed before then, but I can't say with certainty that it will be.

SENATOR GORE. Do you know when that process will be concluded?

MR. DELAND. I don't, Senator, no.

SENATOR GORE. But you would like to see the U.S. position expressed before it is concluded for this 20-year cycle?

MR. DELAND. I personally would, yes.

Senator Gore. How will you go about pressing that view, or will you? Or is it just a private view?

MR. DELAND. No, it's not a private view. As this issue is discussed, I will have ample opportunity to make my views known and will do so.

SENATOR GORE. Where will it be discussed?

MR. DELAND. I can't give you the final forum on it. As I said, it's still very much in the early stages.

SENATOR GORE. Is it the kind of thing where the President would say, Mike, come on in; I want to get Dick Darman in here, and the Secretary of the Treasury, and Bill Reilly. Let's finalize our position on this thing. That's not going to happen, is it?

MR. DELAND. It could. Given the other demands at the moment on the President's time, I don't see that as a likely scenario in the next——

SENATOR GORE. Nor do I. So, clearly, there has to be some institutional mechanism below the Oval Office. Is there one?

MR. DELAND. Well, there are numbers of mechanisms, depending on the issue. The Competitiveness Council, as you well know——

SENATOR GORE. But you're not on that.

MR. DELAND. Well, as I said, Senator——

SENATOR GORE. You're invited to come in, but since you're not on it, you have to wait for them to invite you. So, presumably, you can't put this on the agenda of the Council.

MR. DELAND. That's not so. I can go to the director, executive director of the Council and make known my wishes to put this or any other issue on the agenda.

SENATOR GORE. Is there an alternative route open to you?

MR. DELAND. There are several policy avenues within an Administration that ad hoc discussions between myself and Bill Reilly and any number of people, whether it be Secretary Watkins or Mosbacher or whomever, could lead to focused attention on a given issue, and that happens on a regular basis. There is no set established mechanism that dominates policy development in this or, to my knowledge, any other administration.

SENATOR GORE. I'm not getting a feeling that this is going to happen. Am I on the right track there?

MR. DELAND. As I said, I can't tell you with any certainty, Senator. It's an issue that I know is of increasing interest. Whether, indeed, there is a decision in the timeframe that you would like to see, I simply cannot state with certainty.

SENATOR GORE. Well, it's the time that you said you would like to see.

MR. DELAND. And the timeframe that I would like to see.

SENATOR GORE. Are you going to do anything about it?

MR. DELAND. I will, yes.

SENATOR GORE. OK. Let me say that we're going to move on to our next two witnesses as a panel. I feel very strongly about these issues, Mr. Deland. I do feel, as you know, that the Administration has been mishandling them and I do have a great deal of respect for you as an individual, and I wish you well. But as you can tell from our many debates and today as well, I feel that these issues are not getting the kind of advocacy and attention within the Administration that I would like to see.

I appreciate your appearance here today. And I hope that, as this series of hearings continues and focuses on specific examples of how the environmental statistics and economic policymaking can be integrated, your office will continue to provide input on these issues. And I appreciate your appearance here today.

MR. DELAND. Thank you, Senator, and I appreciate the opportunity. And I will just say, in leaving, that there has never, nor will there ever be, an attempt on my part to be misleading. And on any issue, whether environmental or other. And I can look you in the eye and say with certainty that I or, to my knowledge, nobody else in the Administration was misleading on the issues we have discussed.

So, the Bush Administration simply does not work that way. As I think you know, the President is an honest, straightforward person, and he would have the head of anybody that he felt was being misleading. We simply have not done that, nor would we ever. Nor would I personally ever.

I do look forward to continuing to work with you, and we will do our very best to make available to you any and all that CEQ, or the govemment has that is of interest to you.

SENATOR GORE. I am prepared to believe that the President supposed that the environmental information available within the Administration supported the statement that was written for him. Unfortunately, he was mistaken if that's what he believed.

MR. DELAND. Well, Senator, I can't resist. We differ——

SENATOR GORE. We'll hold the record open. We've made that abundantly clear.

MR. DELAND. ——on that conclusion.

SENATOR GORE. We will hold the record open, let me make it clear, for your supplementary responses, after you have had a chance to consult with your staff, look at the statistics, and attempt to support the assertion that the greenhouse gas emissions will remain stabilized under the plan after the year 2000.

Thank you very much.

MR. DELAND. Thank you, Senator.

[The following supplementary responses were subsequently supplied the for record:]

MR. DELAND'S RESPONSE FOR THE RECORD

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
WASHINGTON, D.C. 20500

Michael R. Deland
Chairman

(202) 395-5080

January 10, 1992

The Honorable Al Gore, Jr.
Joint Economic Committee
United States Congress
Washington, DC 20510-6602

Dear Senator Gore:

This is in response to your letter of September 27, 1991, concerning issues you raised at a hearing of the Joint Economic Committee on the subject of incorporating environmental quality concerns into economic indicators. At that hearing and in your follow-up letter, you suggested that the Administration was presenting selected, confusing, and even contradictory information to the American public on the components and projected yields of the US climate strategy.

While this subject is complex, and while these complexities are compounded by continuing evolution of the underlying science, the Administration has never and will never attempt to obfuscate the record. Rather, the Administration has rejected efforts of some to oversimplify these issues and has created policy based on the most current scientific information.

To respond to the comments in your letter, I would note the following: There is no basis for the suggestion that the measures outlined in the brochure "America's Climate Change Strategy: An Action Agenda" conflict with the measures outlined in the Administration's National Energy Strategy (NES). Rather, as is clearly indicated in the NES document, the NES analysis incorporates all policies outlined in the brochure. The results of the two analyses are consistent for the period of time and set of measures that the two documents have in common.

To underscore the methodological soundness of the NES, I would call to your attention the fact that the Congressional Research Service (CRS) recently reviewed the Administration's analysis of the energy implications of S. 1220. This analysis was used to provide estimates of the global warming potential of these actions and was the same methodology used for the NES. CRS found the Administration's estimates to be sound.

You will find attached answers to the four specific questions posed in your letter. I hope that they will be of use to you and your colleagues on the Joint Economic Committee.

Sincerely,

Michael R. Deland

1. **What elements are shared by the Climate Change Strategy and the National Energy Strategy, and which are unique to each proposal?**

All of the specific actions included in the brochure "America's Climate Change Strategy: An Action Agenda" are incorporated in the analysis in the National Energy Strategy (NES). The NES also includes additional actions -- for example, natural gas regulatory reforms, renewable energy research and development, and nuclear regulatory reform -- that were projected to result further decreases in net greenhouse gas (GHG) emissions. Many of these decreases are greater in the longer term (after the year 2000).

Although the climate strategy publication and the NES incorporate many of the same actions, they differ somewhat in their methodology. For example, the greenhouse gases used in modeling the two strategies are different. The climate strategy brochure considers the greenhouse gas role of volatile organic compounds and nitrogen oxides, whereas the NES does not. Moreover, the economic assumptions used in the two analyses differ slightly. For these reasons, the results reported for the year 2000 differ slightly in the two documents.

Additionally, both documents apply the Global Warming potential (GWP) coefficients (and the 100-year integration period) developed by the IPCC and published in its 1990 report. The science underlying these GWP values continues to evolve and change, and in some cases new scientific developments will require subsequent refinement of projections for future greenhouse gas emissions. Some changes will be developed as part of the IPCC 1992 assessment update (due to be released in February 1992). Other changes will require more protracted analysis. (See discussion of this issue in remarks of Professor Bert Bolin, Chairman of IPCC, at the December 9 opening session of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change -- page 3 of attached text.)

2. Which gases are included in the Global Warming Potential index described in the NES, and what weights are used in its construction?

The NES uses the GWP coefficients for the 100-year integration period, as published in the UN Intergovernmental Panel on Climate Change's 1990 Scientific Assessment. The IPCC values are:

Carbon dioxide	1
Methane	21
Nitrous oxide	290
CFC-11	3500
CFC-12	7300
HCFC-22	1500
CFC-113	4200
CFC-114	6900
CFC-115	6900
HCFC-123	85
HCFC-124	430
HCFC-125	2500
HFC-134a	1200
HCFC-141b	440
HCFC-142b	1600
HFC-143a	2900
HFC-152a	140
CCL4	1300
CH3CCL3	100
CF3Br	5800
CO as CO2	2

3. What are the numerical values for all of the GWP components in the years 1990, 2000, 2010, 2020, and 2030?

NES Actions Scenario
(Energy-related emissions in TgCO2e)

	1990	2000	2010	2020	2030
CO_2	4527	5096	5506	5747	5737
CO	455	512	553	577	576
CH_4	626	556	605	608	569
N_2O	17	20	23	24	26
CFC[a]	1689	360	179	5	2
HCFC[b]	144	299	366	470	172
Total	7458	6843	7233	7431	7082

[a] Includes halons
[b] Includes HFC

TgCO2e means terra grams of carbon dioxide equivalent.

As noted in the response to question 1, the NES analysis is based on the IPCC GWPs. These values are likely to change. Figures shown above reflect the best available science at the time of the NES analysis.

Attachment

REDUCTIONS IN GREENHOUSE GAS EMISSIONS
DUE TO INDIVIDUAL NES ACTIONS
(GWP weighted energy related emissions, Tg CO^2 equivalent)

	YEAR	Greenhouse Gases CO^2	CO	CH^4	N^2O
Current Policy Base Case Emissions	2000	5313	534	728	21
	2030	8649	869	789	42
EMISSIONS REDUCTION RESULTING FROM:*					
Natural Gas Reforms	2000	40	4	0	0
	2030	44	4	0	1
Waste to Energy	2000	26	3	9	0
	2030	164	16	14	2
Alternative Fuels	2000	41	4	6	0
	2030	751	75	3	2
Integrated Resource Planning	2000	47	5	11	0
	2030	485	49	29	3
Industrial Efficiency	2000	0	0	0	0
	2030	347	35	20	2
Nuclear Power	2000	1	0	0	0
	2030	1013	102	51	7
All NES Actions Combined**	2000	217	22	172	1
	2030	2912	293	220.	16

*Note: Reductions due to individual actions are not addictive. This table does not include CFC or HCFC estimates; most of the reduction of these gases is included in the Current Policies Case.

** Includes a projected action to control volatile organic emissions from landfills that also results in methane emission reductions.

Mr. President, Distinguished delegates, Ladies and Gentlemen

I have been given the opportunity to present to the Committee the status of the continuing work of the IPCC at all previous sessions of the INC. I am happy to be back once again and to talk about the ongoing work of the IPCC.

Since the INC met last time in Nairobi in September this year, the IPCC has had its sixth session (29-31 October 1991 in Geneva). Also, the preparation of an IPCC Supplementary Report, that was agreed upon at the fifth meeting in March, is well under way. I will briefly inform you on the work so far. It would, however, be premature to give a more detailed account, since the IPCC Working Groups have not yet had their final meetings aimed at consolidating the various parts of their respective reports, nor has the IPCC had the opportunity to consider the work of the working groups as a whole. The following account accordingly is preliminary.

The Working Group meetings are planned as shown below and will be followed by the seventh plenary meeting of the IPCC:

Working Group I	13-15 January 1992 in Guangzhou, China
Working Group II	6-7 February 1992 in Geneva
Working Group III	5-7 February 1992 in Geneva

Task Force on IPCC structure - 8 February 1992, Geneva
IPCC Seventh plenary session - 10-12 February 1992 in Geneva.

IPCC has agreed to concentrate its short-term assessment on six tasks as was presented to the INC at the September meeting. The following is a progress report as of today:

1. Assessment of the national net greenhouse gas emissions.

As clarified to you at the September meeting, it will not be possible for quite some time to provide a listing of the magnitudes of the national net contributions to the total emissions of the various greenhouse gases. The careful examination of the different methodologies that are being used is a tedious but necessary step. I find it, however, essential to have discussions about this technical matter before negotiations on related matters and wish to seek agreement with the national representatives in this ~~process. It is, for example, not possible to check~~ the sum of the national assessments against the overall increase of atmospheric concentrations that can be measured independently, until the individual contributions from all nations have become available. Questions of how to consider sources and sinks (terrestrial and oceanic) in the negotiation process is then, of course a political issue. The IPCC hopefully will be able to provide the basic information on which the INC will be able to deal with matters of this kind.

It has become clear in the course of the ongoing work that the Global Warming Potential for NO_x (Table 2.8, Page 60, First Scientific Assessment Report) is too high by a factor of five due to an arithmetic error. Because of the uncertainty of the estimates (that was recognized before) the importance of NO_x (in any case comparatively small) was not included in the Policymaker Summaries of the IPCC First Assessment Report. The correction now introduced implies that air pollution (in the common meaning of the expression) is somewhat less important for the global warming issue than implied in Chapter 2 of the First Scientific Assessment Report.

I have the following brief comments on a few new findings since their interpretation is not quite straightforward.

i) A reassessment of the ozone issue has recently been completed by the scientific advisory committee to the Vienna Convention for protection of the Ozone Layer. The full report will be available in January 1992. It is clear that in addition to the annually occurring major ozone depletion ("Ozone Hole") in Antarctica a significant decrease of stratospheric ozone has been taking place for some time now, poleward of about latitude 30° in both hemispheres with a maximum in polar regions (about 10%). This change also affects previous estimates of greenhouse warming. The radiative forcing at the levels of the ozone layer is reduced significantly. The coupling between the increase of CFC-gas concentrations and the decrease of stratospheric ozone is close and rapid. Thus the greenhouse effect of the CFC-gases may be partly compensated for by the associated decrease of ozone. It should, however, be stressed that full 3-dimensional climate model experiments must be completed before more firm conclusions can be drawn.

ii) The emissions of sulphur dioxide into the atmosphere increase the sulphate aerosol loading of the atmosphere, primarily in the northern hemisphere, where about 90% of the emissions take place. A first assessment of the radiative effects of these aerosols shows that their backscattering of solar radiation to space in the northern hemisphere is equivalent to about 40% of the present greenhouse warming, but negligible in the southern hemisphere. Further, the observed increase of the mean surface temperature during the last 100 years seems to have been less in the northern hemisphere than in the southern one, which qualitatively supports the idea that an aerosol cooling may be real. It should be further noted that the residence time of aerosol particles in the atmosphere is of the order of one month, while enhanced carbon dioxide concentrations will remain there for many decades to centuries.

iii) The compensating effects described above, although not yet possible to quantify more precisely, could be two reasons why the observed change of the global mean temperature has been rather small and, corresponds to a temperature increase of merely about 1.5 °C for doubling of equivalent carbon dioxide, as compared with model computations of the greenhouse gas warming yielding values between 1.5 and 4.5 °C.

iv) It is noteworthy how closely the three global environmental issues of decreasing concentrations of stratospheric ozone, acidification and global warming, seem to be coupled. Internationally coordinated attempts to decrease the sulphur emissions to reduce or even stop acidification are under way. If realized, the global warming may be enhanced as compared with what the observed warming so far seems to be indicating. It is also important to recognize that this complexity of the climate system makes it very difficult to assess the full implication of taking steps that imply injection of other agents into the atmosphere or the sea that have been proposed as preventive measures.

2. Prediction of the regional distributions of climate change and associated impact studies.

The climate issue is receiving rapidly increasing attention from the scientific community. Almost 200 publications have been reviewed by the subgroup on modelling in the preparation of an update of the 1990 IPCC Report. Four modelling groups have run atmosphere-ocean coupled models for periods of 50-100 years with gradually increasing CO_2 (typically about 1% increase per year, which is about equivalent to the present increase of greenhouse gases in the atmosphere). Results from the four models are similar and broadly confirm results as presented in the IPCC 1990 Report.

Lead Authors' drafting session for "Climate Observations" was held in Melbourne 25-26 November 1991. Findings of the 1990 report are broadly confirmed, but some further details are added. It is worth noting that the global mean temperature for 1990 and for the part of 1991 that is behind us remain at a level at or above the warmest years during the 1980's, although no further conclusion can be drawn on the basis of just a few additional years of observations.

As models become increasingly sophisticated they show more ability to simulate details of the current climate and therefore build further confidence in that they also can simulate large-scale features of future climate change. Substantial uncertainties remain, however, in the magnitude of cloud/radiation feedback and in the details of the influence of ocean circulation. Still, it is becoming clear that the interplay with the oceans seems to bring about a delay in the warming process around Antarctica and in the northern-most Atlantic region in comparison with change elsewhere, in particular over the continents.

With regard to impact studies, emphasis is given to methodological questions. It is indeed important that national assessments of impacts can be compared adequately. As long as more precise assessments of likely regional changes of climate are not available, it is of course not possible to improve much the earlier impact assessment. The IPCC has also agreed to put more emphasis on possible changes of water resources and risks of desertification, and also on extreme events and disasters, that are effects which probably will be most immediately understood by people concerned.

3. Vulnerability to sea-level rise

Data to ascertain more precise assessments of the likely impacts on nations of a sea level rise as foreseen in the IPCC First Assessment Report, including the development of appropriate methodologies, are being assembled. This will of course also be of prime importance for the later development of management plans.

4. Emission scenarios

In my presentation to the INC in September, I discussed in some detail the problem of how to use emission scenarios properly. I refer to the outline given on that occasion. The IPCC has decided that an update of the IPCC reference scenario be made. The precise assumptions on which such an update of the earlier emission scenario should be based are still subject for discussions.

I wish once again to underline that any emission scenario that may emerge from the IPCC process is going to be quite uncertain and the more so the further into the future the projection is extended.

It is therefore once again important to underline that a scenario is not a prediction. Rather, a set of scenarios, that embraces alternative developments should be considered and can serve as a basis for judging the necessity of possible preventive actions and their kind and characteristics. Therefore the alternative scenarios (A, B, C and D) as presented in the IPCC First Assessment Report still are relevant in showing rather clearly the magnitude of the efforts required in order to reduce substantially the rates of increase of the atmospheric greenhouse gas concentrations, in particular that of carbon dioxide.

I wish finally to inform the INC on the decision taken by the IPCC at its sixth session in October, to form a Task Force that I chair, to discuss and propose to the IPCC desirable structural changes of the IPCC. A first meeting of the Task Force will be held in February 1992. Awaiting the outcome of these discussions, the IPCC extended the mandates of the IPCC Vice-Chairman and the IPCC Rapporteur, whose terms expired this fall, until the eighth session of the IPCC tentatively scheduled for August 1992. Also, as an interim measure five additional vice-chairmen of the Working Groups - four of them from developing nations - were elected in order to achieve a better balance between developed and developing countries.

I was myself re-elected as chairman for the IPCC for another term and wish to conclude these my remarks by saying that I will do my best to see to it that the IPCC serves this negotiating process and possible future development of protocols as well as it can.

Thank you for your attention.

SENATOR GORE. I'd like to call our next two witnesses as a panel: Lester Brown, President of Worldwatch Institute; and Daniel Tunstall, former Director of Research for the *World Resources Report* at the World Resources Institute. If both of you can join us together, we will hear from Mr. Brown first and Mr. Tunstall after just a brief recess here of one or two minutes.

[Brief Recess.]

I think we're going to go ahead and begin, Mr. Brown, while Mr. Tunstall is returning to the hearing room.

I introduced you formally in my opening statement. I will not do so again, except to underscore the respect I have for your dedication and hard work in this area. We look forward to hearing from you on this topic, particularly, because I don't think anyone in the world has devoted more time to this whole question. And we very much look forward to what you have to say. So, if you want to proceed, please do so.

PREPARED STATEMENT OF LESTER BROWN, PRESIDENT WORLDWATCH INSTITUTE

MR. BROWN. Thank you, Mr. Chairman.

As I indicated in the introduction to my remarks, I would like to submit two pieces that we've done at the Institute that bear on this question, and then I would like to sum up briefly some of the principal concerns that we have with the existing accounting system.

As you were asking Chairman Deland whether things had gotten better or worse in the world, it occurred to me that asking that question elicits very different responses from different people. And having observed this over time, I have been tempted to look at the world almost as though it were two separate cultures.

If you ask economists how things are going, you usually get a rather upbeat response. If you ask ecologists how things are going, you get a very different idea.

If you read the business sections of our major newspapers, you do come across problems from time to time, whether it's a savings and loan scandal or the fiscal deficit or third world debt, but by and large those papers are fairly upbeat in their reporting of trends over the long term. And those who are influenced by the set of indicators that appear on those pages generally have a fairly positive view of where the world is heading.

Take a look at indicators like GWP, the gross world product that, over the past decade, has increased nearly 30 percent. International trade, which is another widely used basic indicator of world progress, has increased by something like half during the decade of the 1980s. We look at stock prices, which is what investors are most concerned about, and we see that on the Tokyo Stock Exchange, if I recall correctly, prices nearly tripled during the 1980s. The New York Stock Exchange roughly doubled. You look at these indicators and see that they all go in the same direction. You have to feel pretty good about where the world is headed.

This view permeates the business community, the councils of governments, many international development agencies, and corporate headquarters around the world. These are the indicators that dominate their thinking and their view of the world.

If, however, you are a scientist, perhaps an ecologist, and you read the scientific journals—*Nature, Science*, the *Journal of Soil and Water Conservation*—meteorological journals, and go down the list, you get a very different sense of where the world is and where it's headed. You read the reports from various research agencies from around the world, and some reports from government agencies that give a very different idea.

If I had been sitting here when you asked Mr. Deland how the world was doing environmentally, I would have said that by every major indicator, things have deteriorated over the last decade. The forests are getting smaller by roughly 17 million hectares a year. That's an area the size of Austria. We're losing about 24 billion tons of topsoil from our cropland each year. That's roughly the amount of topsoil in Australia's wheat lands, so it's not an inconsequential loss.

With climate, there are two indicators you can look at. One is the concentration of greenhouse gases, and we know that the level of CO_2 in the atmosphere is going up every year. It doesn't miss. It's one of the most predictable trends that we know. And we're now beginning to see temperatures behave in somewhat the same way. We know that at least five out of the eight warmest years since records began a century or so ago occurred during the 1980s.

Now, that might be a coincidence, but I doubt it. And 1990 is the warmest year on record. If we asked most meteorologists, I think they would say that the odds are that we're seeing the beginning of global warming in global average temperatures.

As for the stratosphere ozone layer, when CEQ was formed, we didn't even know that depletion was a problem. It's a very recent sort of thing in historical terms.

A report from NASA, which was released back in March, indicates that the depletion of the ozone layer over the continental United States is proceeding much faster than we had earlier thought. We originally thought we had lost perhaps 2 or 3 percent of the ozone. We now know it's more like 4 or 5 percent.

SENATOR GORE. May I interject a point there? That figure is very commonly used and is accurate, of course, But if reflects the loss of ozone since 1978, when the satellite measurements began.

Sherwood Rowland, who you know extremely well and was the discoverer of the ozone depletion problem, made a point in another hearing a few months ago that—and this illustrates how statistics have to be put in context—5 percent figure, which is double the 2.5 percent figure that was being used, since it measures only the loss since 1978, drastically understates the loss since 1950, when the accumulation of ozone destroying chemicals in the atmosphere began destroying ozone. And that actually the loss since World War II is 10 percent, not 5 percent. And that the 5 percent is since 1978.

Not from me, of course. Rowland and Molina and others like Bob Watson, who you know very well, who specialize in this area. I am sorry to interject that. It is an example of it being twice as bad.

MR. BROWN. Well, one of the disturbing things about this, which is very consistent with the intent of these hearings, is that when I asked who was looking at the effects of stratospheric ozone depletion on crop production, the answer was no one. Who is trying to figure out what all this is going to mean for us as we move down the road? The answer is no one. It's not being done in the U.S. Department of Agriculture. It's not being done at the World Bank. It's not being done at FAO—United National Food and Agriculture Organization—headquartered in Rome.

We know scientific experimental evidence indicates very clearly that crop production is effected by the increased ultraviolet radiation that results from the depletion of the ozone layer. This is an excellent example of where we really need some new indicators and that we simply do not now have.

Looking at another indicator, air quality, we have made progress in reducing SO_2 emissions in this country and in some other industrial countries. But around the world, air quality in hundreds of cities has reached health-threatening levels.

Regarding plant and animal species, every year we're losing thousands of them. No one even knows quite how many we have, much less how many we're losing. This is another big data gap that Dan Tunstall will probably refer to in a few minutes.

We are now in a situation where we can no longer separate the future of the environment and the future of the economy. We can now begin to see all too clearly the social and economic effects of the degradation, the physical degradation of the planet.

I will just cite very quickly three of them. And, again, we don't have very systematic monitoring on this at all. But we know that human health is being effected. We know that in the Los Angeles basin in southern California there are thousands of youngsters that by the age of 10 have permanently impaired respiratory systems simply because they have been breathing the air in that region.

We look at the Soviet Union and see official reports from Moscow that there are now 300,000 people being treated for radiation sickness, only part of whom are the result of Chernobyl. Clearly, there is a form of degradation under way in the Soviet Union that is having an enormous effect on human health.

When the NASA report we were talking about a few minutes earlier was released back in March, the epidemiologists of the EPA looked at that increase from 2 or 3 percent loss to the 4 or 5 percent, and that increase would lead to 200,000 skin cancer fatalities over the next 50 years. That's just the increase. That's not the total, and it's not the effect of the losses from 1950 up until now. So, we are not talking about trivial numbers any more. We're talking about hundreds of thousands and worldwide, millions of people.

We're also seeing the effect of environmental degradation showing up at harvest time now in virtually every country in the world, in the form of soil erosion, air pollution, acid rain, hotter summers. They are taking a toll and are one of the reasons why the growth in world grain output has slowed to about 1 percent per year since 1984. My sense is that the world's farmers are going to have trouble keeping up with population growth, which is still expanding at close to 2 percent a year, as it will continue to do as we move through the rest of this decade.

The World Bank, in its 1991 development report, released not too many weeks ago, indicates that there are more than 40 countries in the world where incomes dropped during the 1980s. Most of these countries were in Africa and Latin America. A few were in Asia. But almost every one of them had three things in common: rapid population growth, widespread environmental degradation, and rising external debt. These three things coming together have lowered living standards in more than 40 countries, which have a total of over 800 million people. That's three times the population of North America.

That says to me that we're in some trouble economically, in part, because of environmental degradation. And it's not at all clear that we're going to be able to reverse these trends in the 1990s. Indeed, if we continue with something like business as usual, the number of countries in this category may well increase, and we could see the Indian subcontinent, for example, included. Then we would have close to half the world in this category.

We look at the need for more comprehensive indicators, and we're seeing here and there a little bit of progress. We've seen the U.N. Development Program come up with its Human Development index, which includes social as well as economic factors. That's progress. But it's not nearly enough, because social gains can be financed by the depletion of national capital and, indeed, in some countries that's exactly what's happening.

I think the most comprehensive indicator that I have seen thus far would be the Daly-Cobb Index of Sustainable Economic Welfare, simply because it makes a first effort to incorporate the costs of things like soil erosion, the depreciation of natural capital—an entire range of issues that are not normally in the national economic accounts. What this more comprehensive system says for the United States is that our welfare peaked in 1978 and has been gradually going down since then.

It seems to me that there is a reluctance to broaden the accounting system because the results are not going to look particularly good. And I think you see this in the World Bank, in the U.S. Government, and in the governments of many countries, because a comprehensive accounting system would not yield very many political benefits at this point.

In three sessions I've had with senior staff at the World Bank this year, I have been encouraged to see that they're beginning to wrestle with this question, at least in an intellectual sense. And they are beginning to realize that the accounting system is not complete. They are beginning to realize that we somehow have to begin getting the externalities, as the economists call them, integrated into the system.

What I think we need to be thinking about is estimating the costs of the externalities and then incorporating them into the economic system in the form of environmental taxes. Then, I think we would have an accounting and economic system that would be reasonably comprehensive, accurate, and honest. Whereas, now we leave out so many important things that we're getting misleading readings.

I would argue that an accounting system that is as faulty as ours can only lead to faulty economic policies. It cannot be otherwise.

In some areas, we're getting enough data that I think we can begin to incorporate these costs. I think as a result of the National Resources Inventory that Congress passed back in the late 1970s, we now have a system in this country to track how much soil we're losing from our crop lands through erosion. I think the last survey involved more than a million readings around the country. It's down to the farm in some cases, even to the field level. Indeed, that information made it possible to come up with the Conservation Reserve Program, which is one of the environmental success stories that we have to point to in this country.

SENATOR GORE. And an agricultural policy success, I might say.

MR. BROWN. Exactly. If we look at global warming, which is a much more difficult thing to cost out and factor in, we know that each of the computer models that simulates the global climatic system indicates that global warming will bring higher temperatures in the middle part of North America, including the corn belt area. If we were to lose the corn belt, we probably would not produce an exportable surplus of grain. We would lose both the domestic income and the foreign exchange that now comes from being the world's bread basket.

As for health costs, I don't know if anyone's even begun to think through the health costs of stratospheric ozone depletion, for example, but they're very real. They take the form of things like skin cancer, eye damage in the form of cataracts, suppressed immune systems, and increased vulnerability to infectious diseases.

This is the kind of thinking that we ought to be doing, the sort of analyses that should be front and center in the main stream of government research; they're so important.

We got started a dozen years ago in this direction with the *Global 2000* study on which Dan Tunstall worked. But that was it.

It seems to me that we should be doing something like this every few years and just keep pushing it into the future so that we have some sense of where we're going, where we want to go, and where we don't want to go. But right now we're more or less flying blind on these issues, without the information that's needed to guide policy.

If we look at agriculture, for example, we know from joint studies by EPA and USDA that air pollution is taking a toll in U.S. agriculture. It has reduced our annual harvest by at least 5 percent, perhaps as much as 10 percent. Again, that's not an inconsequential thing. But the people who are causing the air pollution are not the ones who are suffering the reduced yield.

So, we have to restructure the system so that those who are responsible also pay the costs for the damage.

I mentioned the idea of introducing environmental taxes. We can substitute them for income taxes. These don't have to be additional taxes. Then, we have a means of getting these costs back into the system. Therefore, we need to know what the real costs of things are and not the costs as currently derived from the market.

One of the interesting examples of something in this direction was a decision by the government of Canada to introduce a tax on cigarettes, which is, as I recall, roughly $5.00 a pack. This means that cigarettes in Canada now cost more than $6.00 a pack. But that cost happens to be roughly what the economists estimate to be the social costs, in terms of increased lung cancer, heart disease, emphysema, strokes, etc., associated with smoking. There, we have an example of something that actually is the kind of thing I think we need to be thinking of throughout the economy so that we have a more honest economic system.

Mr. Chairman, those are some of the thoughts that come quickly to mind as we think about the questions associated with how we can improve the accounting system so that it will give us a much more realistic sense of what's happening, not only in this country but in the world.

[The prepared statement of Mr. Brown, together with attachments, follows:]

PREPARED STATEMENT OF LESTER R. BROWN

Thank you for the opportunity to testify on the need to devise a more complete system of national economic accounting. The existing method of measuring economic progress widely used throughout the world is seriously flawed, largely because it is fails to include the depreciation of natural capital. As a result, economic and environmental policies, based on this accounting system, are also flawed.

Expanding the ledger to include environmental indicators will be a difficult undertaking. Often the necessary data do not exist—a problem that has long troubled us at the Institute as we try to measure progress around the world. Any steps the U.S. Government can take to improve ecological information collection and then integrate it into our national economic balance sheets will give us a more realistic measure of change.

For the record, I would like to submit chapter I of "State of the World 1991," which I authored, and an article from *World Watch* magazine by my colleague Sandra Postel, entitled 'Towards a New "Eco"-omics.' These are perhaps the two most useful pieces we have on what is needed to provide a more realistic and accurate system of economic accounts.

1

The New World Order

Lester R. Brown

As the nineties begin, the world is on the edge of a new age. The cold war that dominated international affairs for four decades and led to an unprecedented militarization of the world economy is over. With its end comes an end to the world order it spawned.

The East-West ideological conflict was so intense that it dictated the shape of the world order for more than a generation. It provided a clear organizing principle for the foreign policies of the two superpowers and, to a lesser degree, of other governments as well. But with old priorities and military alliances becoming irrelevant, we are now at one of those rare points in history—a time of great change, a time when change is as unpredictable as it is inevitable.[1]

No one can say with certainty what the new order will look like. But if we are to fashion a promising future for the next generation, then the enormous effort required to reverse the environmental degradation of the planet will dominate world affairs for decades to come. In effect, the battle to save the planet will replace the battle over ideology as the organizing theme of the new world order.

Units of measure are metric unless common usage dictates otherwise.

As the dust from the cold war settles, both the extent of the environmental damage to the planet and the inadequacy of efforts to cope with it are becoming all too apparent. During the 20 years since the first Earth Day, in 1970, the world lost nearly 200 million hectares of tree cover, an area roughly the size of the United States east of the Mississippi River. Deserts expanded by some 120 million hectares, claiming more land than is currently planted to crops in China. Thousands of plant and animal species with which we shared the planet in 1970 no longer exist. Over two decades, some 1.6 billion people were added to the world's population—more than inhabited the planet in 1900. And the world's farmers lost an estimated 480 billion tons of topsoil, roughly equivalent to the amount on India's cropland.[2]

This planetary degradation proceeded despite the environmental protection efforts of national governments over the past 20 years. During this time nearly all countries created environmental agencies. National legislatures passed thousands of laws to protect the environment. Tens of thousands of grassroots environmental groups sprung up in response to locally destructive activities. Membership in national environmental organizations soared. But as Earth Day 1990 chairman Denis Hayes asks, "How could we have fought so hard, and won so many battles, only to find ourselves now on the verge of losing the war?"[5]

One reason for this failure is that although governments have professed concern with environmental deterioration, few have been willing to make the basic changes needed to reverse it. Stabilizing climate, for example, depends on restructuring national energy economies. Getting the brakes on population growth requires massive changes in human reproductive behavior. But public understanding of the consequences of continuously rising global temperatures or rapid population growth is not yet sufficient to support effective policy responses.

The goal of the cold war was to get others to change their values and behavior, but winning the battle to save the planet depends on changing our own values and behavior.

The battle to save the earth's environmental support systems will differ from the battle for ideological supremacy in some important ways. The cold war was largely an abstraction, a campaign waged by strategic planners. Except for bearing the economic costs, which were very real, most people in the United States and the Soviet Union did not directly take part. In the new struggle, however, people everywhere will need to be involved: individuals trying to recycle their garbage, couples trying to decide whether to have a second child, and energy ministers trying to fashion an environmentally sustainable energy system. The goal of the cold war was to get others to change their values and behavior, but winning the battle to save the planet depends on changing our own values and behavior.

The parallel with the recent stunningly rapid changes in Eastern Europe is instructive. At some point, it became clear to nearly everyone that centrally planned economies were not only not working, but that they are inherently unworkable. Empty shelves in shops and long lines outside them demonstrated all too convincingly that a centrally controlled socialist economy could not even satisfy basic needs, much less deliver the abundance it promised. Once enough people, including Mikhail Gorbachev, realized that socialist planners could not resolve this contradiction within the existing system, reform became inevitable.

Likewise, the contradiction between the indicators that measure the health of the global economy and those that gauge the health of its environmental support systems is becoming more visible. This inherent conflict affects all economic systems today: the industrialized economies of the West, the reforming economies of the East, and the developing economies of the Third World. As with the contradictions in Eastern Europe, those between economic and environmental indicators can be resolved only by economic reform, in effect by reshaping the world economy so that it is environmentally sustainable. (See Chapter 10.)

Two Views of the World

Anyone who regularly reads the financial papers or business weeklies would conclude that the world is in reasonably good shape and that long-term economic trends are promising. Obviously there are still problems—the U.S. budget deficit, Third World debt, and the unsettling effect of rising oil prices—but to an economist, things appear manageable. Even those predicting a severe global recession in 1991 are bullish about the longer term economic prospects for the nineties.

Yet on the environmental front, the situation could hardly be worse. Anyone who regularly reads scientific journals has to be concerned with the earth's changing physical condition. Every major indicator shows a deterioration in natural systems: forests are shrinking, deserts are expanding, croplands are losing topsoil, the stratospheric ozone layer continues to thin, greenhouse gases are accumulating, the number of plant and animal species is diminishing, air pollution has reached health-threatening levels in hundreds of cities, and damage from acid rain can be seen on every continent.

These contrasting views of the state of the world have their roots in economics and ecology—two disciplines with intellectual frameworks so different that their practitioners often have difficulty talking to each other. Economists interpret and analyze trends in terms of savings, investment, and growth. They are guided largely by economic theory and indicators, seeing the future more or less as an extrapolation of the recent past. From their vantage point, there is little reason to worry about natural constraints on human economic activity; rare is the economic text that mentions the carrying capacity principle that is so fundamental to ecology. Advancing technology, economists believe, can push back any limits. Their view prevails in the worlds of industry and finance, and in national governments and international development agencies.[4]

In contrast, ecologists study the relationship of living things with each other and their environments. They see growth in terms of S-shaped curves, a concept commonly illustrated in high school biology classes by introducing a few algae into a petri dish. Carefully cultured at optimum temperature and with unlimited supplies of food, the algae multiply slowly at first, and then more rapidly, until growth eventually slows and then stops, usually because of waste accumulation. Charting this process over time yields the familiar S-shaped curve to which all biological growth processes in a finite environment conform.

Ecologists think in terms of closed cycles—the hydrological cycle, the carbon cycle, and the nitrogen cycle, to name a few. For them, all growth processes are limited, confined within the natural parameters of the earth's ecosystem. They see more clearly than others the damage to natural systems and resources from expanding economic activity.

Although the intellectual foundations of this view originate in biology, other scientific fields such as meteorology, geology, and hydrology also contribute. The ecological perspective prevails in most national academies of science, in international scientific bodies, and in environmental organizations. Indeed, it is environmentalists who are actively voicing this view, urging the use of principles of ecology to restructure national economies and to shape the emerging world order.

These divergent views of the world are producing a certain global schizophrenia, a loss of contact with reality. The events of 1990 typify this unhealthy condition. The celebration of Earth Day 1990 symbolized the growing concern for the environmental health of the planet. Estimates indicate that at least 100 million people in 141 countries participated in events on Sunday, April 22. Soon after, at the Group of Seven economic summit in Houston, national leaders from Europe, reflecting the mounting concern with global warming, urged the United States to adopt a climate-sensitive energy policy.[5]

A few weeks later, Iraq invaded Kuwait, unsettling oil markets. Almost overnight, concerns about energy shifted from the long-term climatic consequences of burning oil and other fossil fuels to a short-term preoccupation with prices at the local gasoline pump. More traditional views of energy security resurfaced, eclipsing, at least temporarily, the concern with fossil fuel use and rising global temperatures.

The ecological view holds that continuing the single-minded pursuit of growth will eventually lead to economic collapse.

This schizophrenic perspective is translating into intense political conflict in economic policymaking. To the extent that constraints on economic expansion are discussed on the business pages, it is usually in terms of inadequate demand growth rather than supply-side constraints imposed by the earth's natural systems and resources. In contrast, the ecological view, represented by the environmental public interest community, holds that continuing the single-minded pursuit of growth will eventually lead to economic collapse. Ecologists see the need to restructure economic systems so that progress can be sustained.

Both visions are competing for the attention of policymakers and, as more environmentally minded candidates run for office, for the support of voters. The different views are strikingly evident in the indicators used to measure progress and assess future prospects. The basic evidence cited by economists shows a remarkable performance over the last decade. (See Table 1-1.) The value of all goods produced and services rendered grew steadily during the eighties, expanding some 3 percent a year and adding more than $4.5 trillion to the gross world product by 1990, an amount that exceeded the entire world product in 1950. In other words, growth in global economic output during the eighties was greater than that during the several thousand years from the beginning of civilization until 1950.[6]

International trade, another widely used measure of global economic progress, grew even more rapidly, expanding by nearly half during the eighties. This record was dominated by the expanding commerce in industrial products, while growth in the trade of agricultural commodities and minerals lagged. Although the exports of some countries, such as those in East Asia, increased much more than others, all but a relatively small number of nations contributed to the rising tide of commerce.[7]

On the employment front, the International Labour Organization reports that the economically active population increased from 1.96 billion to 2.36 billion during the decade. Although impressive gains in employment were made in some regions, the growth in new jobs in the Third World did not keep pace with the number of new entrants, making this one of the least satisfying of the leading economic indicators.[8]

Using stock prices as a gauge, the eighties was a remarkable decade. Investors on the New York Stock Exchange saw the value of their portfolios growing by leaps and bounds, a pattern only occasionally interrupted, as in October 1987. The Standard and Poor Index of 500 widely held stocks showed stock values nearly tripling during the decade. Pension funds, mutual funds, and individual investors all benefited. (See Figure 1-1.) The value of stocks traded on the Tokyo Exchange climbed even more rapidly.[9]

The contrast between these basic

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Table 1-1. Selected Global Economic and Environmental Indicators

Indicator	Observation
The Economy	
Gross World Product	Global output of goods and services totalled roughly $20 trillion in 1990, up from $15.5 trillion in 1980 (1990 dollars).
International Trade	World exports of all goods—agricultural commodities, industrial products, and minerals—expanded 4 percent a year during the eighties, reaching more than $3 trillion in 1990.
Employment	In a typical year, growth of the global economy creates millions of new jobs, but unfortunately job creation lags far behind the number of new entrants into the labor force.
Stock Prices	A key indicator of investor confidence, prices on the Tokyo and New York stock exchanges climbed to all-time highs in late 1989 and early 1990, respectively.
The Environment	
Forests	Each year the earth's tree cover diminishes by some 17 million hectares, an area the size of Austria. Forests are cleared for farming, harvests of lumber and firewood exceed sustainable yields, and air pollution and acid rain take a growing toll on every continent.
Land	Annual losses of topsoil from cropland are estimated at 24 billion tons, roughly the amount on Australia's wheatland. Degradation of grazing land is widespread throughout the Third World, North America, and Australia.
Climate System	The amount of carbon dioxide, the principal greenhouse gas in the atmosphere, is now rising 0.4 percent per year from fossil fuel burning and deforestation. Record hot summers of the eighties may well be exceeded during the nineties.
Air Quality	Air pollution reached health-threatening levels in hundreds of cities and crop-damaging levels in scores of countries.
Plant and Animal Life	As the number of humans inhabiting the planet rises, the number of plant and animal species drops. Habitat destruction and pollution are reducing the earth's biological diversity. Rising temperatures and ozone layer depletion could add to losses.

SOURCE: Worldwatch Institute, based on sources documented in endnote 6.

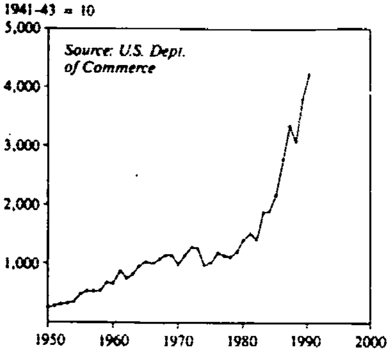

Figure 1-1. Index of Stock Prices, 500 Common Stocks, 1950-90

global economic indicators and those measuring the earth's environmental health could not be greater. While these particular leading economic measurements are overwhelmingly positive, all the principal environmental indicators are consistently negative. As the need for cropland led to the clearing of forests, for example, and as the demand for firewood, lumber, and paper soared, deforestation gained momentum. By the end of the decade, the world's forests were shrinking by an estimated 17 million hectares each year. Some countries, such as Mauritania and Ethiopia, have lost nearly all their tree cover.[10]

Closely paralleling this is the loss of topsoil from wind and water erosion, and the associated degradation of land. Deforestation and overgrazing, both widespread throughout the Third World, have also led to wholesale land degradation. Each year, some 6 million hectares of land are so severely degraded that they lose their productive capacity, becoming wasteland.[11]

During the eighties, the amount of carbon pumped into the atmosphere from the burning of fossil fuels climbed to a new high, reaching nearly 6 billion tons in 1990. In a decade in which stock prices climbed to record highs, so too did the mean temperature, making the eighties the warmest decade since recordkeeping began more than a century ago. The temperature rise was most pronounced in western North America and western Siberia. Preliminary climate data for 1990 indicate it will be the hottest year on record, with snow cover in the northern hemisphere the lightest since the satellite record began in 1970.[12]

Air and water pollution also worsened in most of the world during the last 10 years. By 1990, the air in hundreds of cities contained health-threatening levels of pollutants. In large areas of North America, Europe, and Asia, crops were being damaged as well. And despite widespread reduction in water pollution in the United States, the Environmental Protection Agency reported in 1988 that groundwater in 39 states contained pesticides. In Poland, at least half the river water was too polluted even for industrial use.[13]

These changes in the earth's physical condition are having a devastating effect on the biological diversity of the planet. Although no one knows how many plant and animal species were lost during the eighties, leading biologists estimate that one fifth of the species on earth may well disappear during this century's last two decades. What they cannot estimate is how long such a rate of extinction can continue without leading to the wholesale collapse of ecosystems.[14]

How can one set of widely used indicators be so consistently positive and another so consistently negative? One reason the economic measures are so encouraging is that national accounting systems—which produce figures on gross national product—miss entirely the environmental debts the world is incurring. The result is a disguised form of deficit financing. In sector after sector, we are consuming our natural capital at an alarming rate—the opposite of an environmentally sustainable economy, one that satisfies current needs without jeopardizing the prospects of future generations. As economist Herman Daly so aptly puts it, "there is something fundamentally wrong in treating the earth as if it were a business in liquidation."[15]

To extend this analogy, it is as though a vast industrial corporation quietly sold off a few of its factories each year, using an incomplete accounting system that did not reflect these sales. As a result, its cash flow would be strong and profits would rise. Stockholders would be pleased with the annual reports, not realizing that the profits were coming at the expense of the corporation's assets. But once all the factories were sold off, corporate officers would have to inform stockholders that their shares were worthless.

In effect, this is what we are doing with the earth. Relying on a similarly incomplete accounting system, we are depleting our productive assets, satisfying our needs today at the expense of our children.

New Measures of Progress

Fortunately, there is a growing recognition of the need for new ways of measuring progress. Ever since national accounting systems were adopted a half-century ago, per capita income has been the most widely used measure of economic progress. In the early stages of economic development, expanded output translated rather directly into rising living standards. Thus it became customary and not illogical to equate progress with economic growth.

Over time, however, average income has become less satisfactory as a measure of well-being: it does not reflect either environmental degradation or how additional wealth is distributed. Mounting dissatisfaction has led to the development of alternative yardsticks. Two interesting recent efforts are the Human Development Index (HDI) devised by the United Nations and the Index of Sustainable Economic Welfare (ISEW) developed by Herman Daly and theologian John Cobb. A third indicator, grain consumption per person, is a particularly sensitive measure of changes in well-being in low-income countries.[16]

Average income does not reflect either environmental degradation or how additional wealth is distributed.

The Human Development Index, measured on a scale of 0 to 1, is an aggregate of three indicators: longevity, knowledge, and the command over resources needed for a decent life. For longevity, the U.N. team used life expectancy at birth. For knowledge, they used literacy rates, since reading is the key to acquiring information and understanding. And for the command over resources, they used gross domestic product (GDP) per person after adjusting it for purchasing power. Because these indicators are national averages, they do not deal directly with distribution inequality, but by including longevity and literacy they do reflect indirectly the distribution of resources. A high average life expectancy, for example, indicates broad access to health care and to adequate supplies of food.[17]

A comparison of countries ranked by both adjusted per capita gross domestic product and HDI reveals some wide disparities: some with low average incomes have relatively high HDIs, and vice versa. In Sri Lanka, for instance, per capita GDP is only $2,053, while the HDI is 0.79. But in Brazil, where GDP is twice as high at $4,307 per person, the HDI is 0.78, slightly lower. This is because wealth is rather evenly distributed in Sri Lanka, along with access to food and social services, whereas in Brazil it is largely concentrated among the wealthiest one fifth of the population. The United States, which leads the world in adjusted income per capita at $17,615, is 19th in the HDI column, below such countries as Australia, Canada, and Spain.[18]

Per capita grain consumption looks at the satisfaction of a basic human need and is far less vulnerable to distortion by inequities of purchasing power.

While the HDI represents a distinct improvement over income figures as a measure of changes in human well-being, it says nothing about environmental degradation. As a result, the HDI can rise through gains in literacy, life expectancy, or purchasing power that are financed by the depletion of natural support systems, setting the stage for a longer term deterioration in living conditions.

The Daly-Cobb Index of Sustainable Economic Welfare is the most comprehensive indicator of well-being available, taking into account not only average consumption but also distribution and environmental degradation. After adjusting the consumption component of the index for distributional inequality, the authors factor in several environmental costs associated with economic mismanagement, such as depletion of nonrenewable resources, loss of farmland from soil erosion and urbanization, loss of wetlands, and the cost of air and water pollution. They also incorporate what they call "long-term environmental damage," a figure that attempts to take into account such large-scale changes as the effects of global warming and of damage to the ozone layer.[19]

Applying this comprehensive measure to the United States shows a rise in welfare per person of some 42 percent between 1950 and 1976. (See Figure 1-2.) But after that the ISEW began to decline, falling by just over 12 percent by 1988, the last year for which it was calculated. Simply put, about 15 years ago the net benefits associated with economic growth in the United States fell below the growth of population, leading to a decline in individual welfare.[20]

The principal weakness of the ISEW, which has been calculated only for the United States, is its dependence on information that is available in only a handful of nations. For example, few developing countries have comprehensive data on the extent of air and water pollution, not to mention information on year-to-year changes. The same drawback applies to the HDI, since life expectancy data depend heavily on infant mortality information that is collected at

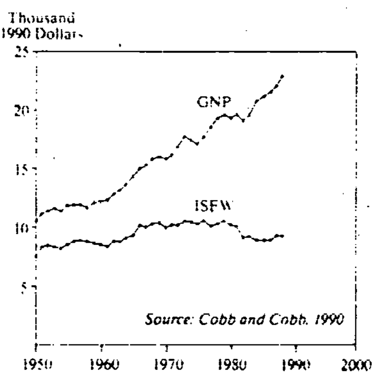

Figure 1-2. GNP and Index of Sustainable Economic Welfare (ISEW) Per Capita, United States, 1950-88

best once a decade in most of the Third World.

A measure in many ways more relevant to well-being in low-income countries is per capita grain consumption. It looks at the satisfaction of a basic human need and is far less vulnerable to distortion by inequities of purchasing power. The distribution of wealth between the richest one fifth of a country and the poorest one fifth can be as great as 20 to 1, as indeed it is in Algeria, Brazil, or Mexico, but the per capita consumption of grain by these same groups cannot vary by more than 4 to 1. Among more affluent countries, this figure peaks at about 800 kilograms a year, with the limit set by the quantity of grain-fed livestock products that can be consumed. At the lower end, people cannot survive if annual grain consumption drops much below 180 kilograms (about 1 pound a day) for an extended period. Thus, a gain in average grain consumption in a country typically means a gain in welfare.[21]

At the top end of this scale, the figure can be used to measure threats to health. Beyond a certain point—a point well below the level of consumption in the more affluent countries—rising grain consumption per person, most of it in the form of fat-rich livestock products, leads to increases in heart disease, certain types of cancer, and an overall reduction in life expectancy.

Grain production is also a more sensitive barometer of environmental degradation than income is, since it is affected more immediately by environmentally destructive activities outside agriculture, such as air pollution, the hotter summers that accompany global warming, and increased flooding as a result of deforestation.

In summary, the Index of Sustainable Economic Welfare is by far the most sophisticated indicator of progress now available, although its use is constrained by lack of data. In low-income countries where the relevant data to calculate the ISEW are not available, changes in grain consumption per person can tell more than income figures about improvements—or deterioration—in well-being.

WHAT FOOD INDICATORS SAY

Of all the sectors in the world economy, it is agriculture where the contrast between the economic and environmental indicators is most obvious. It is in the relentless push to produce more food that several decades of borrowing from the future are beginning to take a toll. In many countries, growth in the farm sector is pressing against the limits of land and water supplies. And in some, the backlog of technology available for farmers to raise food output is shrinking.

By traditional measures, world agriculture appears to be doing well. Western Europe worries about surpluses, particularly of dairy products, and the United States still idles cropland to control production. Grain-exporting countries use subsidies to compete for markets that never seem large enough. For an economist, there may be distribution problems in the world food economy, but not a production problem.

To an ecologist who sees a substantial fraction of current world food output being produced on highly erodible land that will soon be abandoned or by overpumping groundwater, which cannot continue indefinitely, the prospect is far less promising. As world agriculture presses against natural limits imposed by the area of productive land, by the amount of fresh water produced by the hydrological cycle, and by the geophysical processes that produce soil, growth in output is beginning to slow. Modest new additions to the cropland base are offset by the conversion of land to nonfarm uses and by the abandonment of severely degraded land.[22]

The scarcity of fresh water is imposing limits on crop production in many agricultural regions. Competition among countries for the water from internationally shared rivers, such as the Tigris-Euphrates, Jordan, and Nile in the Middle East, is a source of growing political tension. In Soviet central Asia, the Amu Darya, the source of most of the region's irrigation water, now runs dry long before it reaches the Aral Sea. Falling water tables are now commonplace in heavily populated countries such as India and China, which are overpumping aquifers in their effort to satisfy the growing need for irrigation water. Under parts of the North China Plain, water tables are dropping up to a meter per year. And the vast Ogallala aquifer, which supplies irrigation water to U.S. farmers and ranchers from central Nebraska to the Texas panhandle, is gradually being depleted. Cities such as Denver and Phoenix are outbidding farmers in the intensifying competition for water.[23]

In addition to the degradation of land by farming practices, outside forces are also beginning to take a little-acknowledged toll on agriculture. Air pollution is reducing U.S. crop production by an officially estimated 5–10 percent, and is probably having a similar effect in the coal-burning economies of Eastern Europe and China. As deforestation progresses in the mountainous areas of the world, the term "flood-damaged harvests" appears with increasing frequency in world crop reports.[24]

Even as these environmental and resource constraints slow world food output growth, the backlog of unused agricultural technology is diminishing. In Asia, for example, the highest yielding rice varieties available to farmers were released in 1966, a quarter-century ago. The International Rice Research Institute, the world's premier research facility in this field, observed in a strategy paper released for 1990 that "during the past five years, growth in rice yields has virtually ceased."[25]

One way of assessing the technological prospect for boosting food output during the nineties is to look at trends in fertilizer use, since the phenomenal growth in world food output from 1950 to 1984 was due largely to the ninefold growth in fertilizer use. In large measure, other major advances in agriculture, such as the near-tripling of irrigated area and the adoption of ever higher yielding varieties, greatly enhanced the potential to use more fertilizer profitably. But as the nineties begin many countries have reached the point where using additional fertilizer does little to boost food output.[26]

Nowhere was this potential for expanding the use of fertilizer more evident than in the United States, where fertilizer use multiplied five times between 1950 and 1981. (See Figure 1-3.) After three decades of extraordinary increase, the growth in fertilizer use abruptly stopped during the eighties, contributing to a levelling off of grain

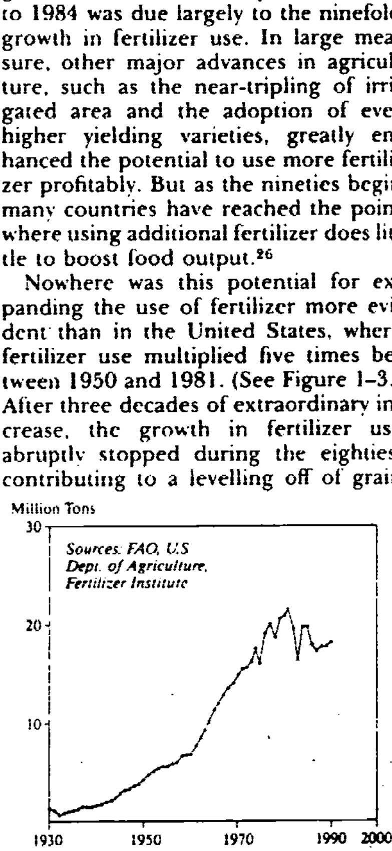

Figure 1-3. U.S. Fertilizer Consumption, 1930–90

output. A similar trend is unfolding in Western Europe. And in the Soviet Union, where fertilizer use has been heavily subsidized, the economic reforms leading to adoption of world market prices reduced its use nearly 10 percent between 1987 and 1990 as wasteful practices were minimized. In China, where the use of this agricultural input climbed even more rapidly than in the United States, growth is also slowing.[27]

There are still some countries, such as India—now a distant fourth among the big four grain producers—where there is a large potential for profitably boosting fertilizer use. But the worldwide opportunities for doing so are diminishing. Just as the enormous growth in fertilizer use goes a long way toward explaining the unprecedented growth in grain output from 1950 to 1984, so the slower growth in its use since then helps explain the slower growth in grain output. The Paris-based International Fertilizer Industry Association projects that the annual growth in world fertilizer use, which dropped from nearly 6 percent during the seventies to 2.6 percent in the eighties, will fall to 1.5 percent in the early nineties.[28]

Beyond the growing scarcity of productive cropland and fresh water, the yield-reducing effects of environmental degradation, and the shrinking backlog of new agricultural technologies, farmers are now in a period of consolidation. As noted, some of the growth in world food output during the late seventies and early eighties came from plowing highly erodible land and overpumping aquifers. By the mid-eighties, farmers were beginning to retrench, pulling back from the unsustainable margins. As they did so, they contributed to the slower growth in world grain output, dropping the increase in production per person to scarcely 6 percent between 1984 and 1990, or roughly 1 percent per year.[29]

The global downturn in per capita grain output reflects downturns in each geographic region, though the exact timing and the principal reasons vary. (See Table 1-2.) The worldwide rise that started following World War II was reversed first in Africa, where grain output per person peaked at 169 kilograms in 1967. By 1990, a combination of record population growth, land degradation, and economic mismanagement had dropped it to 121 kilograms, a fall of 28 percent.

The next region to peak was Eastern Europe and the Soviet Union, where production is dominated by the the latter. The regional high in 1978 coincided with the end of the rapid expansion in

Table 1-2. Regional and World Grain Production Per Person, Peak Year and 1990

Region	Peak Production		1990 Production	Change Since Peak Year
	(year)	(kilograms)	(kilograms)	(percent)
Africa	1967	169	121	−28
E. Europe and Soviet Union	1978	826	763	− 8
Latin America	1981	250	210	−16
North America	1981	1,509	1,324	−12
Western Europe	1984	538	496	− 8
Asia	1984	227	217	− 4
World	1984	343	329	− 4

SOURCE: Based on U.S. Department of Agriculture, Economic Research Service, *World Grain Database* (unpublished printouts) (Washington, D.C.: 1990), with updates for 1990 harvest.

Soviet grain area that followed the massive crop shortfall of 1972. Since then, that nation's grain harvested area has shrunk by 10 percent as land in alternate-year fallow has been increased to restore moisture and stabilize yields and as eroded land has been abandoned. For the region, grain production per person has fallen 8 percent since 1978.[30]

Per capita grain production in both Latin and North America peaked in 1981. In Latin America, the debt crisis that emerged in force in 1982 weakened consumer purchasing power and reduced the availability of foreign exchange to import needed inputs such as fertilizer. These economic stresses, combined with rapid population growth and land degradation, have dropped grain output per person 16 percent since 1981.[31]

By 1990, word carryover stocks of grain had dropped to 290 million tons, enough for just 62 days.

In North America, there were no restrictions on planting in 1981, and large amounts of highly erodible land came under the plow. After that year, land was again taken out under government set-aside programs to reduce "surpluses." Beginning in 1986, farmers began to retire highly erodible land under the new Conservation Reserve Program, returning nearly 14 million hectares to grass or trees by 1990. Even though the area in the more traditional "set-aside" program was sharply reduced in 1990 to meet expanding demand, the harvest per person was 12 percent below the peak of 1981.[32]

In the two remaining regions, Western Europe and Asia, production per person peaked in 1984. In Western Europe, where high price supports and advancing technology have led to a long sustained rise in yields, farmers are now experiencing difficulty in maintaining the rapid rise. If the Uruguay Round of General Agreement on Tariffs and Trade negotiations finally ends with an agreement to lower Europe's farm price supports, then the recent decline could continue for a few years. Fortunately for the region, which produces an exportable surplus of grain, food consumption levels are high and population growth is approaching zero.[33]

For Asia, which has over half the world's people and produces over 90 percent of its rice, grain yield per hectare is continuing to rise, but more slowly than a decade ago. Within East Asia, dominated by China, Japan, and Indonesia, population growth has slowed to 1.4 percent per year. It is in West Asia, where most of the 1.1 billion people in the Indian subcontinent live at subsistence levels, that the imbalance between food and people is greatest and likely to get worse.[34]

For the world as a whole, the annual growth in grain production from 1984 to 1990 was 1 percent, while that of population was nearly 2. The diminishing crop response to the additional use of fertilizer, the negative effect of environmental degradation on harvests, and the lack of any new technology to replace fertilizer as the engine of agricultural growth are each contributing to a potentially hungry future for much of humanity. In both 1984 and 1990, per hectare yields of the three grains that dominate the world diet—wheat, rice, and corn—set new records, indicating unusually favorable growing conditions in all the major grain-growing regions. If these two years are broadly comparable weatherwise, as they appear to be, then this slower growth in world grain output may indeed be a new trend.[35]

The slowdown in world food output since 1984 would have had even more severe consequences if it had not been for the record grain stores accumulated in the mid-eighties. World carryover stocks, perhaps the best short-term measure of food security, totaled a record 461 million tons of grain in 1987, enough to feed the world for 102 days. (See Figure 1–4.) But in each of the next three years, world grain consumption exceeded production, leading to a 173-million-ton drop in stocks to compensate for the downturn in per capita grain production. By 1990, carryover stocks had dropped to 290 million tons, enough for just 62 days. With the bumper grain harvest of 1990, carryover stocks in 1991 are projected to increase, but only to 66 days of consumption.[36]

When stocks drop below 60 days of consumption, roughly the amount of grain needed to maintain an uninterrupted flow from the farmer to the consumer, prices become highly volatile, rising and falling on the strength of weekly weather forecasts. The last time this happened, when only 55 days' worth of consumption were available in 1973, grain prices doubled in a matter of months. In 1990, stocks fell precariously close to this trigger point.[37]

The prospective shrinkage of cropland and fresh water per person during the nineties, along with the prospect of a likely reduction in per capita fertilizer use, raises basic questions of future food security. Buttressing this concern is the failure in 1990, a year of record harvests, to appreciably rebuild grain stocks. If stocks cannot be replenished in such an exceptionally good year, when can they be? What happens to stocks and world grain prices if we have an unusually poor harvest? Both these questions are likely to be answered within the next few years.[38]

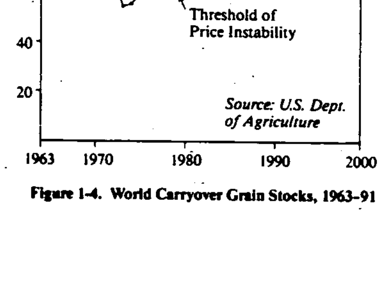

Figure 1-4. World Carryover Grain Stocks, 1963–91

In our modern, post-industrial information economy, where few of us remain on the land, we are largely isolated from the economy's agricultural foundations. We tend to take the land's capacity to satisfy our needs for granted. But the superficial economic indicators we rely on so heavily do mask serious underlying problems. As Harvard ecological anthropologist Timothy Weiskel quite rightly notes, "We live in a highly industrialized, urban culture, but it is important to remember that there is no such thing as a 'post-agricultural' society." As the agricultural foundations of the global economy weaken, so will the global economy itself. In effect, agriculture is likely to be the sector that first illustrates how profoundly environmental degradation will eventually shape global economic trends.[39]

Population: The Neglected Issue

Nowhere is the conceptual contrast between economists and ecologists more evident than in the way they view population growth. In assessing its effect, economists typically have not seen it as a particularly serious threat. In their view, if a nation's economy is growing at

5 percent per year and its population at 3 percent, this leads to a steady 2-percent gain in living standards. Relying on economic variables alone, this situation seemed to be tenable, one that could be extrapolated indefinitely into the future.

Ecologists looking at biological indicators in the same situation see rising human demand, driven by population growth and rising affluence, surpassing the carrying capacity of local forests, grasslands, and soils in country after country. They see sustainable yield thresholds of the economy's natural support systems being breached throughout the Third World. And as a result, they see the natural resource base diminishing even as population growth is expanding.

The world is projected to add at least 960 million people during this decade.

Against this backdrop, biologists find recent population trends profoundly disturbing. Accelerating sharply during the recovery period after World War II, the annual growth of world population peaked at about 1.9 percent in 1970. It then slowed gradually, declining to 1.7 percent in the early eighties. But during the late eighties it again began to accelerate, reaching 1.8 percent, largely because of a modest rise of the birth rate in China and a decrease in the death rate in India. With fertility turning upward in the late eighties instead of declining, as some had expected and many had hoped, the world is projected to add at least 960 million people during this decade, up from 840 million in the eighties and 750 million in the seventies.[40]

Concern with the effects of population growth is not new. Nearly two centuries have passed since Malthus published his famous treatise in which he argued that population tends to grow exponentially while food production grows arithmetically. He argued that unless profligate childbearing was checked, preferably through abstinence, famine and hunger would be inevitable. Malthus was wrong in the sense that he did not anticipate the enormous potential of advancing technology to raise land productivity. He was writing before Mendel formulated the basic principles of genetics and before Von Leibeg demonstrated that all the nutrients taken from the soil by plants could be returned in mineral form.[41]

Malthus was correct, however, in anticipating the difficulty of expanding food output as fast as population growth. Today, hundreds of millions of the earth's inhabitants are hungry, partly because of inequitable distribution, but increasingly because of falling per capita food production. And as the nineties begin, the ranks of the hungry are swelling.

Malthus was concerned with the relationship between population growth and the earth's food-producing capacity. We now know that increasing numbers and economic activity affect many other natural capacities, such as the earth's ability to absorb waste. At any given level of per capita pollution, more people means more pollution. As the discharge of various industrial and agricultural wastes overwhelms the waste-absorptive capacity of natural systems, the cumulative effects of toxic materials in the environment begins to affect human health.

Another consequence of continuing population growth in much of the Third World is a shortage of firewood, the primary fuel. As the local demand for firewood for cooking exceeds the sustainable yield of local woodlands, the forests recede from the villages. Women, who gather most of the firewood, often find themselves trekking long distances to find enough to prepare meals. In some situations, families are reduced to only one hot meal a day. Malthus worried about whether there would be enough food, but he never reckoned that finding the fuel to prepare it would become part of the daily struggle for survival.[42]

The record population growth projected for the nineties means the per capita availability of key resources such as land, water, and wood will also shrink at an unprecedented rate. (See Table 1–3.) Since the total cropland area is not expected to change during the decade, the land available per person to produce our basic staples will shrink by 1.7 percent a year. This means that grainland per person, averaging 0.13 hectares in 1990, will be reduced by one sixth during the nineties. And with a projected growth in overall irrigated land of less than 1 percent per year, the irrigated area per person will decline by nearly a tenth.

Forested area per person, reduced both by the overall loss in forests and by population growth, is likely to decline by one fifth or more during this decade. The 0.61 hectares per person of grazing land, which produces much of our milk, meat, and cheese, is also projected to drop by one fifth by the year 2000 as population grows and desertification spreads. Maintaining an improvement in living conditions with this reduction in per capita natural resources will not be easy.[43]

Table 1-3. Availability of Basic Natural Resources Per Person in 1990 and 2000

Resource	1990	2000
	(hectares)	
Grain land	0.13	0.11
Irrigated land	0.045	0.04
Forest land	0.79	0.64
Grazing land	0.61	0.50

SOURCE: Based on U.S. Department of Agriculture, Economic Research Service, *World Grain Database* (unpublished printouts) (Washington, D.C.: 1990); U.N. Food and Agriculture Organization, *Production Yearbook* (Rome: various years); and U.N. Department of International Economic and Social Affairs, *World Population Prospects 1988* (New York: 1989).

One reason the world is now facing such dramatic per capita resource declines is the policy of benign neglect that seems to have affected family planning programs both at the national level and within the international development community. After two decades of strong U.S. leadership in international family planning efforts, the Reagan administration withdrew all U.S. funding from the United Nations Population Fund and the International Planned Parenthood Federation, the two principal sources of international family planning assistance. Yielding to pressures from the political far right, which used opposition to abortion to cut off this financing, the administration effectively forfeited leadership. Ironically, as a result more and more Third World women are denied access to family planning services and forced to resort to abortion. (See Chapter 7.)[44]

Within the international development community, leadership on population policy continues to be weak. The World Bank officially recognizes the need to slow population growth, but contributes little to doing so. The Secretary-General of the United Nations rarely mentions population, much less provides leadership on the issue. Deep-seated religious resistance in the Catholic church and in many Moslem societies has fostered this climate of neglect.

One of the rare family planning success stories during the eighties among the more populous countries was Brazil, where the average number of children per woman dropped from 4.4 in 1980 to 3.3 in 1990. Prominent among the causes was an expansion of government family planning services and growing access to modern contraceptives in commercial markets.[45]

Overall, however, the eighties was not a happy decade for efforts to achieve a sustainable balance between people and their natural support systems. Continuing rapid population growth and spreading environmental degradation trapped hundreds of millions in a downward spiral of falling incomes and growing hunger. With the number of people caught in this life-threatening cycle increasing each year, the world may soon be forced to reckon with the consequence of years of population policy neglect.

A New Agenda, A New Order

With the end of the ideological conflict that dominated a generation of international affairs, a new world order, shaped by a new agenda, will emerge. If the physical degradation of the planet becomes the principal preoccupation of the global community, then environmental sustainability will become the organizing principle of this new order. (For a discussion of the rough outline of an environmentally sustainable global economy, see Chapter 10 in *State of the World 1990*.) The world's agenda will be more ecological than ideological, dominated less by relationships among nations and more by the relationship between nations and nature. For the first time since the emergence of the nation-state, all countries can unite around a common theme. All societies have an interest in satisfying the needs of the current generation without compromising the ability of future generations to meet their needs. It is in the interest of everyone to protect the earth's life-support systems, for we all have a stake in the future habitability of the planet.

This is not to suggest, by any means, that all international initiatives will be conflict-free. Issues of who assumes how much responsibility for achieving a given goal, such as climate stabilization, will plague international negotiations long after agreement is reached on the goal itself. Do those in wealthy countries have an obligation to reduce carbon emissions to the same level as those living in poor countries? If preservation of the earth's biological diversity is a goal, should the cost be borne by those who live in the tropical countries that contain the vast majority of the earth's plant and animal species, or is this the responsibility of the international community?

In the new age, diplomacy will be more concerned with environmental security than with military security. To be effective, diplomats will need a solid grounding in ecology as well as economics and politics. Toxic waste disposal, endangered species protection, carbon efficiencies, water-sharing agreements, substitutes for chlorofluorocarbons (CFCs), achievement of replacement-fertility levels, and the latest solar energy technologies are but a few of the matters that will command diplomatic attention in the battle to save the planet.

Although it is premature to describe the shape of the post–cold war world order, its determining characteristics can now be identified. A commitment to the long-term improvement in the human condition is contingent on substituting environmental sustainability for growth as the overriding goal of national economic policymaking and international development. Political influence will derive more from environmental and economic leadership than from military strength. And in the new order, the political stresses between East and West are likely to be replaced by the economic stresses between North and South, including such issues as the need to reduce Third World debt, access to markets in the industrial North, and how the costs of environmental protection initiatives are allocated between rich and poor.

In the emerging order, the United Nations seems certain to figure much more prominently in world affairs, particularly in peacekeeping, where its role is likely to be closer to that envisaged by its founders. Evidence of this new capacity emerged in 1990 as the United Nations took a leading and decisive role in the international response to Iraq's invasion of Kuwait. It was also evident in the U.N.-negotiated Kampuchean peace settlement of mid-1990. If the United Nations can effectively play the envisaged peacekeeping role, it will speed demilitarization and the shift of resources to environmental security.

Another indication of the expanding U.N. role was the June 1990 international agreement on a rapid phaseout of CFCs, to minimize further losses from the stratospheric ozone layer. Some 93 countries agreed to halt CFC production by the end of the nineties, going far beyond the 1987 Montreal Accord that called for a 50-percent cut by 1998. This essential advance hinged on the establishment of an international fund that will provide $240 million of technical assistance over the next three years to help the Third World obtain CFC substitutes. The funding mechanism was essential to broadening support for the phaseout among developing countries, importantly India and China, the world's two most populous countries.[46]

Reaching international agreement on a plan to stabilize climate, which in effect requires a restructuring of the world energy economy, will be far more difficult. (See Chapter 2.) The current schedule, designed to produce a draft agreement for the U.N. Conference on Environment and Development in June 1992, will be the first major test of the new world order.

Environmental alliances to deal with specific transnational threats are likely to become commonplace and far more numerous than the military alliances that have featured so prominently since World War II. To cite a few examples, European countries could work together to save the region's deteriorating forests, nations bordering the Baltic Sea could join together to reverse its degradation, and countries in the Indian subcontinent could combine forces to reforest the Himalayas and reduce the frequency of crop-damaging floods. New North-South alliances to save migratory birds, whether songbirds within the western hemisphere or waterfowl that migrate from Europe to Africa, are increasingly probable.

Political influence will derive more from environmental and economic leadership than from military strength.

As noted earlier, leadership in the new order is likely to derive less from military power and more from success in building environmentally sustainable economies. The United States and the Soviet Union, the traditional military superpowers, are lagging badly in this effort and are thus likely to lose ground to those governments that can provide leadership in such a shift. For example, the path-breaking June 1990 decision by the West German cabinet to reduce carbon emissions 25 percent by 2005, along with other ambitious environmental initiatives in material reuse and recycling (see Chapter 3), may cast the newly unified Germany in a leadership role.[47]

With time running out in the effort to reverse the environmental destruction of the earth, there is an obvious need for initiatives that will quickly convert our environmentally unsustainable global economy into one that is sustainable. The many means of achieving this transformation range from voluntary lifestyle changes, such as limiting family size or reducing waste, to regulated changes such as laws boosting the fuel efficiencies of automobiles and household appliances. But the most effective instrument of all promises to be tax policy—specifically, the partial replacement of income taxes with those that discourage environmentally destructive activities. Prominent among the activities to tax are carbon emissions, the use of virgin materials, and the generation of toxic waste. (See Chapter 10.)

We can see what environmentally unsustainable growth does to the earth. And we know what the outlines of an environmentally sustainable economy look like. If the move toward the latter is not speeded up, we risk being overwhelmed by the economic and social consequences of planetary degradation. This in turn depends on more of us becoming environmental activists, working on behalf of the future of the planet and our children. Unless we can reverse quickly some of the environmental trends that are undermining our economy, our dream of a better life for our children and grandchildren will remain just that.

Notes

Chapter 1. The New World Order

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6. Data in Table 1-1 based on the following: gross world economic output in 1990 from the 1988 gross world product from Central Intelligence Agency (CIA), *Handbook of Economic Statistics, 1989* (Washington, D.C.: 1989), with Soviet and Eastern Europe gross national products extrapolated from Paul Marer, *Dollar GNP's of the USSR and Eastern Europe* (Baltimore: Johns Hopkins University Press, 1985), with adjustments to 1990 based on growth rates from International Monetary Fund (IMF), *World Economic Outlook* (Washington, D.C.: October 1990), and CIA, *Handbook of Economic Statistics*, and with the composite deflator from Office of Management and Budget, *Historical Tables, Budget of the United States Government, Fiscal Year 1990* (Washington, D.C.: U.S. Government Printing Office, 1989); historical estimates based on Angus Maddison, *The World Economy in the 20th Century* (Paris: Organisation for Economic Co-operation and Development, 1989); international trade increase is Worldwatch Institute estimate based on IMF, *International Financial Statistics*, October 1990, and *Yearbook* (Washington, D.C.: 1990); U.S. Department of Commerce, Bureau of Economic Analysis, "Standard and Poor Index of 500 Widely Held Stocks," Washington, D.C., 1990; Tokyo Stock Exchange, *Monthly Statistics Report*, June 1990; deforestation figure from FAO, which is in the midst of preparing

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TOWARD A NEW "ECO"-NOMICS

Modern economics, blind to natural limits, is hastening the Earth's demise. A major restructuring of economic rules and practices is crucial to the future health of the planet.

BY SANDRA POSTEL

When World Bank economist Herman Daly searched through the indexes of three leading macroeconomic textbooks, he turned up no entries for the terms "pollution," "environment," "natural resources," or "depletion." These glaring omissions help to illustrate what a handful of economists now see as a fundamental flaw in their discipline: an almost complete lack of regard for the environment.

While the environment and the economy are tightly interwoven in reality, they are almost completely divorced from one another in economic structures and institutions. Modern economics has barely heard of the natural world, no less begun to incorporate environmental concerns into its everyday workings.

This oversight traces back to the work of John Maynard Keynes, the father of modern economics, who, troubled by the Great Depression, focused on unemployment, inflation, and other elements of the money cycle. For Keynes and his contemporaries, natural resources appeared so abundant that notions of scarcity, depletion, and environmental damage did not even appear in their picture of how the economy functions.

A tiny cube inside a large sphere just a few decades ago, the global economy is no longer small relative to the earth's natural systems. It now takes only 15 days to produce what it took an entire year to produce in 1900. Increasingly, the corners of the cube have begun to puncture the sphere—and the damage appears in the form of acid rain, holes in the ozone shield, and the buildup of greenhouse gases.

"Progress," as defined by our modern economic system, is not only perpetuating environmental deterioration, but accelerating it. Reconciling our economic rules and practices with the dictates of environmental sustainability is now much more than a purely academic interest; it is essential for human survival.

Gaining Income, Losing Wealth

No single economic indicator is more popular than the Gross National Product (GNP). A measure of the total output of goods and services in an economy, the GNP is the basis upon which countries are ranked from rich to poor. Almost universally, a climbing GNP is taken to mean that a country's health is improving—and that its people are becoming better off.

But a closer look at the accounting system used to produce the GNP shows major failings in its ability to assess both economic performance and human welfare. A country's economic bookkeeping consists of income accounts, which when tallied produce the GNP figure, and capital accounts, which track changes in wealth.

As lumber factories, textile mills, office buildings and other artifacts age and fall into disrepair, a subtraction is made from the capital accounts to reflect their depreciation in value. No similar subtraction is made, however, for the deterioration of forests, soils, air quality, and other natural endowments. Natural wealth of all kinds is whittled away with no losses appearing in the national accounts.

When trees are cut and sold for timber, for example, the proceeds are counted as income, and thus added to the GNP. But no subtraction is made for the deterioration of the forest, an economic asset that, if managed well, could provide revenue long into the future. The result is an inflated sense of both income and wealth, creating the illusion that a country is better off than it really is and can sustain higher levels of consumption than is actually possible.

As economist Robert Repetto of the World Resources Institute points out, this failure to distinguish between natural asset destruction and income generation makes the GNP "a false beacon, and can draw those who steer by it onto the rocks."

Most in danger of running aground are developing countries whose economies remain closely tied to primary resources, such as fuels, timber, minerals, and agricultural crops. Bolivia, Colombia, Ethiopia, Ghana, Indonesia, Kenya, and Nigeria are among the countries that depend on primary products for 75 percent or more of their exports.

Nigeria is an example of a country that overspent its natural account. Once among the world's largest tropical log exporters, the

country's timber shipments fell off dramatically after many years of overcutting forests. In 1988, Nigeria earned only $6 million from forestry exports while spending $100 million on forest product imports. During

To enter the future with economic indicators that ignore the environment is like steering an aircraft toward a fog-shrouded runway without instruments to guide the landing.

the period of rapid logging, Nigeria's accounts failed to warn of the impending downturn. Indeed, a country can be headed toward ecological bankruptcy and still register GNP growth.

Repetto and his colleagues have examined the implications for Indonesia's resource-based economy of more accurately measuring income and wealth. Taking into account the depletion of just three natural resources —forests, soils, and petroleum—the researchers found the average annual growth in Indonesia's GNP from 1971 to 1984 dropped from 7.1 percent to 4 percent. If the exploitation of coal, mineral ores, and other nonrenewable resources had been included, along with the deterioration of fisheries and other renewable assets, the drop would have been even steeper.

Pollution Pays

Besides being blind to the destruction of natural wealth, the GNP as currently calculated has another major failing: it counts as income many of the expenditures made to combat pollution and its adverse consequences. The Alaskan oil spill of March 1989, the most environmentally damaging accident in U.S. history, actually created a rise in the GNP, since much of the $2 billion spent on labor and equipment for the cleanup was added to income.

Equally perverse, much of the $40 billion in health care expenses and other damages incurred by U.S. citizens annually as a result of air pollution is counted on the plus side of the national income ledger. Although the nation certainly would be better off had the Alaskan oil spill never happened and if people didn't suffer respiratory ailments from air pollution, the GNP suggests otherwise.

As the environment deteriorates further, the discrepancy between the GNP's measure of progress and actual human well-being is widening. Over the next several decades, global temperatures will rise, biologically damaging ultraviolet radiation will increase, thousands of plant and animal species will become extinct, vast tracts of tropical rain forest will disappear, and several billion people will be added to a planet already overtaxed by humans. To enter such a period with economic indicators that ignore environmental deterioration is like steering an aircraft toward a fog-shrouded, windswept runway with no instruments to guide the landing.

Clear-Cut Economics

Given a choice, people prefer to receive $100 today over the same amount made available next year. The reason is obvious enough. That money can purchase a radio or a bicycle offering a year's worth of enjoyment that would be forgone if the payment is delayed. Put in a bank, the money earns interest, which would be lost if the payment is pushed back a year.

Economists capture this time-preference for money in a decision-making tool called the discount rate. It is used to determine the present value of a future stream of costs and benefits, and thereby helps investors choose among a range of profit-making options. But by denominating all investment choices in money terms, and weighing future benefits much less heavily than those nearer the present, the practice of discounting—especially at the high rates used today—makes sustainable management of most natural resources impossible. Under the economic logic of discounting, it is perfectly rational to drive a resource to extinction if its growth rate lags behind the market rate of interest. As Colin Clark, professor of applied mathematics at the University of British Columbia in Vancouver, puts it: "If dollars in banks are growing faster than a timber company's forests, it is more profitable (indeed, more economical) to chop down the trees, sell them, and invest the proceeds elsewhere." Clear-cutting a forest and slaughtering a marine species thus make, in Clark's words, "a certain mathematical sense."

The upshot has been the systematic destruction of forests, fisheries, groundwater supplies and other biological resources in the name of increasing capital wealth. Not only are private investors responsible, but public ones as well. The World Bank, the largest funder of development projects in the Third World, with an annual lending portfolio totaling some \$20 billion, currently uses a discount rate of 10 percent. A forest growing at a rate of 2 or 3 percent per year simply doesn't stand a chance against a required rate-of-return that high. Viewed another way, if greenhouse warming is estimated to cause \$100 billion in damage in the year 2075, today's valuation of that damage using a discount rate of 10 percent is a mere \$30 million, hardly worth worrying about.

Killing the Goose

Today's investment rules also assume that natural capital and human-made capital are interchangeable, and what matters is only that total capital is increasing. But natural and human-made assets are substitutes only up to a point. Without any forests to supply it with timber, for instance, a \$50-million lumber mill is useless.

More important, there are no known replacements for some life-supporting natural systems. Scientists can offer no substitutes for the radiation-absorbing ozone layer, the earth's thin mantle of topsoil, or the current climate to which agriculture and other human activities have carefully adapted. Driven by the economic calculus of discounting, these vital natural assets are being destroyed irreversibly, leaving our children and grandchildren to fend for themselves.

Economic decision making also fails to account adequately for the many functions natural systems perform that are difficult to quantify. Compared with a clothing factory or a steel mill, which both produce tangible, easily valued products, only some of the products and services provided by renewable resources are valued in the marketplace. A forest producing wood for timber is also protecting upland soils from erosion, safeguarding downstream croplands from flooding, providing habitat for countless plant and animal species, and storing carbon that would hasten global warming if released to the atmosphere. But because these are social benefits, a private investor doesn't take them into account. And because they are difficult to quantify, they are often left out of public investors' decisions as well.

Under the economic logic of discounting, it is perfectly rational to drive a resource to extinction if its growth rate lags behind the market rate of interest.

As a result, a small measurable private gain can result in a large unquantified social loss, and the economic rules will detect nothing wrong. As Herman Daly and John Cobb write in their book, *For the Common Good:* "The fact that individual capitalists are made better off by killing the goose and putting their money in a faster-growing asset does not alter the fact that society has lost a perpetual stream of golden eggs."

Who is Better Off?

The economic models guiding the development process are virtually silent on questions of distributive justice and equity. If a particular investment will result in a net gain, but the relatively well-off will get richer and the poor will become more impoverished as a result, should the investment be made? Does such a project promote progress?

A growing body of knowledge suggests that answering these questions is vital to promoting sustainable development. Some 1.2 billion people—more than a fifth of humanity—remain largely untouched by economic growth. Since they often subsist outside the market economy, their livelihoods depend on the abundance and quality of the natural resources around them.

When a natural forest is converted to a cash-crop tree plantation, the new plantation owner profits and the GNP registers a net gain. But the poor rural families who had been using the forest as a source of cooking fuel suffer. Rarely is a cost even counted for the women who now must trek four hours instead of two to gather fuelwood for the evening meal.

As the poor are driven into greater deprivation, the environment degrades further. With fewer areas of natural forest from which to collect their cooking fuel, they are forced to overcut the remaining wood resources, which in turn compounds their hardship. In this way, as economists Partha Dasgupta of Stanford University and the University of Cambridge and Karl-Goran Maler of the Stockholm School of Economics point out, separating the goals of economic development from the quality of the natural environment "has proved to be enormously costly in terms of wasted and lost lives."

Since poverty breeds environmental destruction and vice versa, a necessary condition for sustainable development is that the poorest of the poor benefit. Keeping vigilant watch over the welfare of the most destitute will, in turn, be a good barometer of environmental quality. Yet the economic rules and indicators followed by national governments and development institutions, including the World Bank, do nothing of the kind.

Honest Income

Recalculating the GNP so that it takes account of the depletion and deterioration of forests, fisheries, water supplies, and other natural assets is a critical first step toward bridging the growing gap between illusory and real economic gains. Some initiatives in this direction are under way, but the pace of change is far too slow.

Australia, Canada, France, the Netherlands, and Norway are among the countries that have begun compiling inventories of their natural resources, a prerequisite to making the needed accounting adjustments. But these figures have not been integrated into the standard national capital and income accounts, so they have not led to improved GNP estimates.

So far, two countries—West Germany and the United States—have plans to calculate an alternative GNP figure that takes environmental damage into account. But these new indicators probably will not be produced on a regular basis until the mid-1990s. Statisticians in both countries will continue to compute the conventional GNP as well, offering the opportunity to show how far from sustainability their economies have wandered, but also leaving open the possibility that the new indicators will be largely ignored.

The pace of GNP reform could be greatly quickened by a push from the United Nations Statistical Commission. Currently, the commission is in the process of revising its System of National Accounts, something that happens only once every twenty years. Because most market economies follow the U.N.'s accounting procedures, altering them to reflect environmental deterioration could widely improve the GNP's reliability.

Unfortunately, the U.N. Statistical Commission has decided to make only limited reforms this round. It agreed to draft guidelines for countries wishing to develop environmental and resource accounts, along with procedures for calculating a new GNP. But the traditional approach to figuring the GNP still will be deemed acceptable. A stronger stand is needed. By the time the commission begins the next round of revisions, presumably around 2010, an increasing number of countries will be trapped in economic decline from the destruction of their natural assets.

Progress Properly Measured

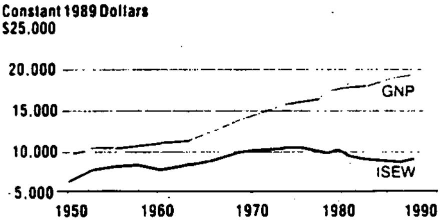
More accurate estimates of national income and GNP, while important, would still be insufficient to determine whether or not human welfare is improving—the ultimate aim in assessing progress. A better approach is to supplement a recalculated GNP with a basket of other indicators that monitor literacy, infant mortality, housing, income equality and other areas affecting societal health. If these indices were publicized and used frequently, as the GNP currently is, a broader and more accurate picture of progress—or the lack of it—would result.

"Progress," as defined by our modern economic system, is not only perpetuating environmental deterioriation, but accelerating it.

The United Nations Development Program (UNDP) has come up with a "Human Development Index" (HDI) derived from three components: life expectancy, literacy, and purchasing power. A comparison between the traditional GNP and the HDI makes clear that high levels of economic output do not always correspond with high levels of human development. The United States, for instance, ranks second in 1987 per-capita GNP, but comes in 19th on the HDI scale, largely because of its comparatively high illiteracy rate. The people of Sri Lanka, on the other hand, appear better off according to the UNDP index than the traditional GNP since the nation's life expectancy of 71 years and adult literacy rate of 87 percent—both high among developing countries—somewhat offset the low percapita annual income of $400. Economist Herman Daly and theologian John Cobb have developed an "Index of Sustainable Economic Welfare" (ISEW) that not only accounts for air and water pollution, cropland and wetland losses, and other forms of environmental deterioration, but also for the costs of commuting and car accidents, for income inequality, and a range of other factors affecting human welfare.

A calculation of this index for the United States over the period 1950-86 shows that during the 1950s and early 1960s, it tracks closely with the traditional GNP (see Figure

Figure 1: GNP Per Capita and Index of Sustainable Economic Welfare Per Capita in the United States, 1950-1986



Source: Herman E. Daly and John B. Cobb, Jr., *For the Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future* (Boston: Beacon Press, 1990).

1). After that period, however, the two indices diverge markedly. Per-capita economic welfare on the ISEW scale peaked in 1976, and by 1986 had dropped 10 percent. By contrast, the standard per-capita GNP rose 21 percent over the same 10-year period.

The most speculative factor in the ISEW is that of long-term environmental damage from climate change and other unfolding global threats. But whether the estimate is a bit high or low matters less than the contribution it makes to a more complete picture of economic welfare. Completely ignoring such costs perpetuates the illusion of progress and allows political leaders to escape the hard choices needed to put the economy on an environmentally sound track.

New Rules of the Game

Reshaping investment criteria to conform with the principles of environmental sustainability is no small task; currently, they are stacked solidly against future generations.

Among the first priorities is to make public investments place more weight on the future rather than systematically undervaluing it. One solution is to lower the discount rate to a level closer to the real rate of capital productivity, around 1 to 3 percent. This would allow investments offering benefits long into the future, such as tree planting, to stand a better chance against those that turn a quick profit. Having eliminated much of the bias against the future, public investors can then select those projects that offer the highest long-term rate of return.

Government and public agencies can also influence private investors' decisions by issuing grants or tax breaks to compensate for the lower short-term profits yielded by some renewable resources. Robert Goodland, an ecologist at the World Bank, argues that such incentives are critical to slowing the pace of tropical forest destruction until more tree plantations can be developed to take the pressure off of virgin stands.

In addition, a more thorough analysis of costs and benefits would make economically unattractive many of the environmentally destructive projects now being promoted and funded. In a detailed examination of a small plot of Peruvian rain forest, Charles Peters of the New York Botanical Garden and colleagues found that the long-term revenues from sustainably harvesting fruits and rubber from the plot were double those from converting it into a fast-growing tree plantation or a cattle pasture: $2,562 per acre compared with $1,289 for the plantation and $1,198 for the pasture. Logging and selling all the merchantable timber in one quick cut would yield net revenues of only $405 per acre.

The findings are even more impressive given the researchers' generous assumption that the plantation and the pasture would be sustainable and thus provide income forever. In reality, many such projects in the tropics fail after several years because of rapid declines in soil fertility. Had the researchers also included potential income from products such as medicinal plants, as well as the forest's environmental services (such as the protection of biodiversity and climate), the case for preserving the forest would be even stronger.

A Natural *Quid Pro Quo*

With many parts of the world sliding toward ecological bankruptcy, one overarching investment criterion now seems warranted: no net loss of natural capital. Requiring that future development protect biological productivity rather than perpetuate its decline would ensure that the next generation inherits an undiminished stock of natural assets.

In practical terms, this criterion would preclude projects that destroy forests, drain wetlands, or pave over croplands unless additional investments were made to compensate for the resource damaged or lost. For instance, if construction of a new road eliminated an area of forest, the road developer would pay to reforest a parcel of degraded land somewhere else. The new tree plantation would not provide as many benefits as the original forest (indeed, this criterion is insufficient for irreplaceable values, such as biodiversity, which are far more pronounced in original ecosystems), but it would at least partially make up for the loss. If the cost of reforestation rendered the whole project unprofitable, the road would not be built.

An initiative along these lines was put forth last April by the government of the Netherlands. It proposes planting a total of 625,000 acres of trees in five Latin American countries over the next 25 years to offset the estimated carbon emissions from two coal-fired power plants to be built in Holland during the 1990s. Besides their many other functions, trees absorb carbon from the atmosphere through photosynthesis, so planting more of them can counteract emissions from fossil fuels and help lessen the risk of greenhouse warming.

Making such compensating investments mandatory—for both public and private investors—would ensure that future economic activity does less overall harm to the environment. Those who profit from development would automatically plow some of their expected proceeds back into safeguarding the natural systems they have placed in greater jeopardy.

Shifting the Tax Base

Along with establishing new investment criteria, "green taxes" appear to be a promising way of making private decisions take environmental costs into account. The idea is by no means new. Japan and at least a half dozen European countries already have various kinds of pollution or resources taxes. In late 1989, the U.S. Congress passed a tax on the sale of ozone-depleting chlorofluorocarbons (CFCs). The most widely used CFCs are initially being taxed at $1.37 per pound, roughly twice their current price, with the tax rising to $3.10 per pound by 1995 and to $4.90 by 1999.

Tax policy, however, can be a far broader and more effective instrument for environmental protection. Most governments raise the bulk of their revenues by taxing personal and corporate income, a convenient way of

collecting money that serves little inherent social purpose. By systematically taxing economic activities that pollute, deplete or otherwise degrade the environment, governments can raise revenue in a way that promotes environmentally sound practices. To avoid the dampening effect such taxes might have on the economy, income taxes could be reduced so that the total level of taxation remains the same. And credits or payments could be given to poor people hit hard by a particular tax, such as one that raises gasoline prices or heating costs.

The Alaskan oil spill of March 1989, the most environmentally damaging accident in U.S. history, actually created a rise in GNP.

By placing a tax of $85 per ton on the carbon content of fossil fuels, the United States could cut current emissions of carbon dioxide (the leading greenhouse gas) by 14 to 20 percent, according to William U. Chandler and Andrew K. Nicholls, researchers at the Battelle Memorial Institute, a policy research group in Washington, D.C. Such a tax would initially generate $112 billion in annual receipts, which would fall somewhat after energy efficiency improvements and other adjustments had been made. The government then could reduce federal income taxes in the range of 15 to 25 percent—and ease the threat of global warming at the same time.

A comprehensive set of environmental taxes would do much more. It would penalize the use of virgin rather than recycled materials, generation of toxic waste, emission of acid rain-forming pollutants, and overpumping of groundwater. It would tax agricultural chemicals, and thus lessen the risks of their contaminating food and drinking water. In the United States, a 1 percent tax on pesticides and fertilizers would initially raise more than $100 million annually.

By making environmentally damaging practices economically unattractive, such a change in tax policy would speed the transition to an ecologically sound economy. With the public increasingly in favor of spending more on the environment, but naturally averse to higher income taxes, the moment seems ripe to launch this reform.

A Question of Scale

Time to build the needed bridges between the economy and the natural systems on which it depends is disconcertingly short. Continued economic growth of the sort engineered in recent decades—far from being the answer to society's varied ills—will usher in a period of widespread environmental deterioration and social disruption.

With politicians of all stripes espousing ever more growth, it is easy to overlook the fact that the economy's optimum size is not its maximum size. Anyone who has lost a favorite park to a new housing subdivision knows that not all economic growth enhances the quality of life. As ecologist and philosopher Garrett Hardin says: "For a statesman to try to maximize the GNP is about as sensible as for a composer of music to try to maximize the number of notes in a symphony." Unfortunately, decision makers have not yet grasped that at some point growth begins to cost more than it is worth.

As long as our economies and those who steer them remain blind to the earth's natural limits, indicators of economic performance will bear less and less relation to human welfare. Reversing the tide of environmental destruction will require fundamental shifts in other realms besides economics—most importantly in individual values, the driving force of social change. But a major overhaul of the rules, measures, and goals of our economic systems would be a giant step off the road to ruin and toward the path of sustainable progress. ●

Sandra Postel is vice president for research at the Worldwatch Institute.

SENATOR GORE. Well, thank you very much. That was excellent.

But I am going to hold off my questions until we have heard from Dan Tunstall, who has already been introduced at the beginning of the hearing.

Thank you very much for joining us, and we look forward to hearing from you.

PREPARED STATEMENT OF DANIEL B. TUNSTALL, SENIOR ASSOCIATE, WORLD RESOURCES INSTITUTE

MR. TUNSTALL. Thank you very much. Thank you, Senator, for the invitation.

As I said in discussion with your staff, my testimony today is based in large part on a recent article that Jessica Matthews, who is vice president of the WRI, and I prepared. Copies of that article and copies of a separate written testimony are available. I will try to keep my presentation short.

This is the only hearing I know of that links concerns for environment, concerns for economics, and concerns for information that is really the life blood of our public policy and our environmental and economic system.

If policymakers are going to have the information they need, and I think they need information for a number of reasons—including, to identify problems; to assess the conditions and trends of problems; to grasp underlying causes for management purposes; and finally, for evaluation—we need to hold government and other large institutions accountable. If this is true, and I think it is, then we have to be concerned with environmental information as a resource in itself. That means that our actual statistical system becomes an important infrastructure, and the data and information themselves become an important resource. Important and valuable resources need to be husbanded; they need to be invested in and managed wisely.

Basically, I have a very simple message today: it is time to rethink the role that environmental information plays in economic development. I think in the past we have seen environmental information as separate from economic information, and I think now we have to reintegrate it. We need to make economists into environmentalists, and environmentalists into economists, and get them to work together.

Three areas of rethinking need to be carried out. First, is the conceptual: what is important to collect, analyze, and use. Second, are information policies. And, third, are the institutions, particularly the governmental institutions that help to set the tone and incentives.

I would like to talk about each of these. And, then if we have time later, answer questions about them and possibly give some examples.

A colleague of mine, Michael Colby, recently completed a paper for the World Bank in which he wrote about environmental management and development as an evolution of paradigms. He likes to use this word, "paradigms," which I then, of course, had to look up. I don't know if you all know what it means, but we've heard it misused.

He uses paradigms to mean a constellation of beliefs, values, and techniques. In this case, we want to look at a constellation of beliefs and techniques and values that link environmental management to economic development. In his view, there has been a rapid evolution in how we relate environmental management to our economy over the past few decades.

The first paradigm, he calls "frontier economics," where we consume natural resources as if they are infinite, and we use the natural environment as a sink for wastes. In the second, to environmental protection, human health becomes very important. We see that externalities are causing problems, and we want to control pollution and protect humans. Resource management is increasingly the paradigm many believe is the more progressive paradigm of today, where we value nature by expanding the economic measurement of nature. The last, he calls ecodevelopment, which is a concept that we are struggling to define more fully. It may be the paradigm of the future, where we integrate economic and ecological thinking, and we actually try to anticipate how our actions influence the global system.

Briefly, what happens when we look at this shift in paradigms, is that the needs for information and statistics changes. We go from statistics on our resource base, which we have a great deal of in the United States, to statistics on pollution and its impacts, which we are gathering in great detail, and we finally get to the point where we are now struggling with resource accounting, which you and Mike Deland talked about today.

Finally, we get to ecodevelopment, where we want to integrate our environmental statistics within economic indicators and vice versa, and really want to integrate our economic data into measures of ecosystem health and change, and to make sure that these are done in an harmonious fashion.

I gave a reference in the paper to make this statistical transition more explicit. It is found in Box 1 of the article, where we discussed agricultural statistics. This is really Lester Brown's area of expertise, and I haven't shown it to him yet, so if he has comments or criticisms, go lightly on me.

We took one sector—agriculture—and identified what statistics are needed when you move through these four paradigms. I won't go into the details on that now. We can talk about that later. I think this gives us an idea of what we need to do in the United States and internationally, and that is to look at these different paradigms; see what kinds of data are being collected; why do people want this information; and then try to make our case for moving up the scale to indicators of resource management and ecodevelopment.

Let me mention a couple of things that I think can be done to try to improve statistics, looking at the policy side first of all and taking these four paradigms into consideration. The first time has been mentioned by both of the previous speakers, and it's not surprising. We need to develop better indicators.

By indicators, we mean those key statistical series that capture trends in ways that are understandable to the public and policymakers. Indicators are our rules of thumb. We use them to communicate, both informally and formally. Formally, because there are statistics behind them. Informally, in that everyone knows generally what they mean, even if they don't know the specifics.

We're familiar with economic indicators, such as GNP prices, unemployment rates, trade balances, debt, and many others. And I think it is our point here that we need to be much more familiar with and develop the information to support indicators of ecosystem change, of biological diversity and conservation of biological diversity, of land capacity and degradation, and particularly of resource wealth, production, and consumption. And a whole range of pollutant emissions.

I believe that we have made a good start here in the United States. We've expended a considerable amount of effort over the last 20 or 30 years. But I think we've only scratched the surface when we get into these concepts of resource accounting and ecosystem development.

Second, and here we have more difficulty, is that we need to put in place the surveys and monitoring systems required to prepare better indicators. Good indicators depend on good data. They also depend on good models, good analysis, and they depend on policymakers who want this information. All of this information must be policy relevant. It is science-based but relevant to policy.

As I said in testimony given in the early 1980s, we lost momentum on environmental data and monitoring in the United States. There is no doubt in my mind about that.

Fortunately, in the late 1980s, in EPA, there have been new initiatives, such as the EMAP program, the Environmental Monitoring and Assessment Program—a multiyear, multiagency, and multimillion dollar program to assess the health of ecosystems. It's not fully operational yet. It needs support and attention. It needs to be responsive to demands on the part of policymakers to make it relevant to their needs. We can't just allow the scientists to run off and collect a lot of data. The policymakers need to be there to put their input onto it.

The third point in this area is to make environmental statistics and indicators more readily accessible and useful to policymakers. The Council on Environmental Quality, our lead agency in the government, is now beginning to be interested in this again after a hiatus of about 11 years. They are supporting the work of EPA to produce a "Guide to Key Environmental Statistics in the Federal Government." They are interested in updating, "Environmental Trends," a report that was first prepared in 1981 and again in 1989. They want to produce it more frequently, and I give them credit for this. This is an important development. The Council on Environmental Quality has the mandate; it is legislated by Congress to do these things, and it's time now that we hold them accountable.

How are we going to change the policies, the three broad information policies that I talked about? In my own mind, changing the policies won't happen until we change some of the institutions. We need a rearrangement and refocusing of our statistical institutions in the U.S. Government. First, is to establish a national commission on environmental data and assessment. We have never really had this. We have never really had the public sector, the private sector, the resource economists, and the environmental scientists get together and advise the government on what environmental information it should be collecting over the next 5, 10, and 20 years. And that could go very far to answering the kinds of discussions you had with Mr. Deland.

There was an Interagency Task Force on Environmental Data and Monitoring established back in 1978. It came out with a brief report in 1980 and, as you can imagine, nothing has been done. We could actually pick up that report and go pretty far in doing some of the things we'd like to see done by the year 2000.

Second, reinvigorate CEQ's environmental data and monitoring activities. They mention the workshop they're holding later this week. That's an important step forward but really only a beginning. At CEQ today, you may have a staff of about one-fourth of a person working on environmental data and monitoring. In 1980, they had up to five full-time staff professionals working on data and monitoring issues at the national and international levels.

I think if you now had that level of effort, Mr. Deland could have answered all those questions that you had asked about on what's happening to the resource accounting, and who do you talk to. They would know who those people are. They would be able to say exactly what the United States is going to do to change the national accounts. He was unable to do it because the staff is not there.

Third, we definitely need to legislate the establishment of the Bureau of Environmental Statistics. I don't think it belongs in CEQ. I think that would be the last place I would put the Bureau of Environmental Statistics. It belongs in EPA or in a new department of the environment. And in stead of making it totally independent, sir, I think I would give it rules and regulations to protect its independence. It still needs policy guidance, it needs a budget, it needs to be part of a policymaking process. But there are certain rules and regulations that Congress can give to a statistical agency to protect it from political interference.

SENATOR GORE. If I could interject on that point, a great deal of progress has been made by Senator Glenn's committee in discussions with the Administration to resolve some of the points in dispute on that particular issue. And I don't think that's likely to be the battle ground this coming year that it has been. I hope that's the case.

MR. TUNSTALL. Let me mention two other points.

As you know, at the World Resources Institute, most of our interest is not strictly U.S.-based. Most of it is worldwide. For our database, we compile information for all 166 members of the United Nations and many other smaller countries. We gather information from many international organizations and prepare estimates or improve the data whenever we can for these countries.

The United States is only one cell, one number. We have a single soil erosion number for the United States. We spend much of our time looking for soil erosion numbers for many other countries, as well as the United States.

But to improve statistics worldwide, and increasingly our environmental problems are international and worldwide, then we are going to have to strengthen a number of organizations. I think it is in the best interests of the United States to strengthen the environmental data and monitoring and assessment institutions of the United Nations and, obviously, its key specialized agencies, particularly FAO, WHO, WMO, and others. And to work with the growing number of international nongovernmental organizations, such as the Nature Conservency, that now works in 31 countries and the World Conservation Monitoring Center in Cambridge, England, that collects data worldwide on biodiversity.

The fifth institutional change, Mr. Chairman, and I am sorry I didn't put it in the written testimony, I would strongly recommend that this hearing be conducted on an annual basis and that, in addition to inviting people from the three organizations here, make it a joint hearing, and make it a hearing to assess what's happening to global economic change and the environment. We could be much better prepared; we could use materials out of the *World Resources Report* and our database. You could ask the CEQ, the Treasury Department to represent the World Bank, and others to come to this type of hearing and actually describe and assess what's happening to the trends worldwide.

But as I said in the testimony, we, in the United States, are 12, 13 years out of date. All of this should have been started in 1978, and we have a U.S. Government report called the *World Resources Report of the United States*, not just the *World Resources Institute Report* of the World Resources, nor just the *State of the World* by Lester Brown and his colleagues.

I think both of our reports do a good job, and I think we have done a lot of interesting work in the last 10 years, and we're going to keep doing it. And I think Lester would agree, we welcome the challenge of having the US government, with its thousands of analysts join the five in his institute and the five in ours in competition on what the global trends are.

Thank you very much.

[The prepared statement of Mr. Tunstall, together with attachment, follows:]

PREPARED STATEMENT OF DANIEL B. TUNSTALL

Mr. Chairman and members of the Committee, it is an honor to be asked to provide testimony on this important issue. I am presently a senior associate at the World Resources Institute, a policy research center located here in Washington D.C. The views I am presenting today are my own and do not necessarily represent those of the World Resources Institute. During this past summer Jessica Mathews and I prepared an article, "Moving Toward Eco-Development: Generating Environmental Information for Decisionmakers", which provides the background on which this testimony is based. Copies are available here for distribution. I am asking that this article supplement the written portion of my testimony.

Mr. Chairman: I have come with a very simple message this afternoon. It is time to rethink the role environmental information plays in economic development.

Increasingly, decisions that policymakers face deal with environmental quality and the use of natural resources. The decisions they make affect economic and ecological well-being at local, national, and global levels. Local decisions to drain a wetland may reduce the harvest of waterfowl thousands of miles away, directly affecting the wages and profits of others. Decisions to burn coal and other fossil fuels can contribute to acidic deposition and changes in climate patterns on a regional and global scale, which will have economic impacts worldwide. Treaties and other decisions made to limit international trade in wildlife or carbon emissions will directly influence local economies.

Because so many decisions like these touch everyday life and govern the future liveability of the Earth, they must be made based on the best information we can produce. And that means that environmental information itself needs to be seen as a valuable resource. Collecting, processing, storing, analyzing, and reporting data can be expensive, but investments in this process can more than pay for themselves. Only with ready access to up-to-date information can decisionmakers identify and assess environmental problems well, grasp their underlying causes, develop strategies for avoiding or remedying them, manage resources and wastes, and evaluate the performance of governments and other institutions in light of changing conditions and values.

How much and what kinds of environmental information are needed to make decisions? Basically, the answer to that question depends on a culture's development strategy and its view of man's relationship with nature.

Paradigms -- constellations of beliefs, values, and techniques -- help clarify what is important in a society. In this case, they help us understand the relationship between environmental management and economic development. They also provide us with a rationale for collecting and using certain kinds of environmental information.

Michael Colby and others have suggested that we are undergoing a rapid evolution in paradigms from **frontier economics** (in which nature is viewed as an infinite supply of resources and an infinite sink for wastes), to **environmental protection** (which views environment, and particularly human health, as needing protection from economic growth and is therefore perceived as a tradeoff), to **resource management** (which expands the economic view of resources and seeks to measure the value of natural resources to the national economy.)

Eco-development may be the paradigm of the future. In this worldview, economic systems are developed in harmony with ecological systems, with a convergence in values and goals among environmental management, economic development, and social welfare. Eco-development also takes account of scientists' growing belief that global systems and cycles -- long thought impervious to human influence -- are changing, perhaps unpredictably and irreversibly.

What does this ongoing paradigm shift suggest about information needs for policymakers?

As long as nature was treated as a free resource and a boundless sewer, the key indicator of successful development was production and productivity, measured in terms of output per unit of capital, labor, and land. Investment decisions were based principally on market prices and the amount of income that the available cropland, pasture, forest, fishery, wildlife or other natural resource could generate.

As pollution began impairing ecosystem functions and threatening human health (and remaining unused natural resources were beginning to disappear), the industrial world mounted extensive and costly programs to monitor air and water and living resources. Data on pollution discharges and emissions and ambient conditions were generated. Productivity was still the key indicator of successful development, but increasingly national reports on environmental quality were prepared that took human health and economic impacts into account.

The resource management approach further expands the need for information. Policymakers need a full accounting of renewable and nonrenewable resource stocks and flows. Getting the prices "right", that is making them reflect honestly the value of resources is essential. The goal is to modify the national income accounts to take natural resource wealth and pollution into consideration in macroeconomic decisions. This goal also requires improving sectoral environmental indicators, that is, indicators of the impact energy, agriculture, transportation, and even defense and international trade and debt have on the environment.

Moving toward eco-development will require an even more fundamental shift in environmental and economic information. Industries and communities, as well as national and global economies, will need to become fully accountable for all energy and materials used and wastes discharged, including products disposed of years later. This means developing monitoring programs and statistics on energy, materials, and ecological processing cycles that show flows from nature to the economy and degraded energy and pollution back.

We will still need information on productivity, environmental quality, and we'll need resource accounting, but to these will be added indicators of ecosystems (their extent, condition, services, restoration, and evolution) at the local, regional, national, and global levels. Institutionalized global-scale monitoring of the major biological and geological systems -- their patterns, discontinuities, chaotic nature, and expected and unexpected impacts on all life forms -- will be essential.

It is likely that the role of information gathering and reporting will change from one that has been government-dominated to one in which communities, corporations, NGOs, and other private sector organizations play an increasingly important role.

How can we begin to make environmental data and statistics an integral part of our national economic thinking? How can we move from an environmental protection and resource management approach to eco-development?

One of the first things we can do is to develop better indicators of eco-development.

Indicators are key statistical series that capture trends in ways that policymakers and the public can easily understand. We are used to using economic indicators of GNP, unemployment, and prices. We must become equally familiar with indicators of ecosystem stability and biodiversity conservation; of land capability and degradation; of natural resource wealth and consumption; of coastal pollution intensity; of national gaseous emissions; and more.

In order to produce scientifically valid and reliable indicators we must put in place the surveys and monitoring systems needed to produce these indicators. Good indicators depend on good data. The Federal government is still recovering from the substantial cuts made to environmental data and monitoring programs in the early 1980s. Only recently has EPA, for example, been able to initiate its environmental monitoring and assessment program (EMAP). This effort is designed as a nationwide, interagency environmental monitoring program that will focus on assessing the health of near-coastal, forests, surface waters, agroecosystems, wetlands, and arid ecosystems. This is a multiyear, multimillion dollar effort and should greatly expand our ability to track changes in ecosystem conditions and is a significant start toward developing the indicators we need.

I suspect environmental information policies and programs will change only with changes in institutions. Let me recommend four:

1. **Establish a National Commission on Environmental Data and Assessment.** The last major effort to assess and rationalize environmental data and monitoring within the U.S. Government was in 1978. (See the Final Report of the Interagency Task Force on Environmental Data and Monitoring, Council on Environmental Quality, 1980.) A Commission composed of representatives from government and the private sector (business, NGOs, academics) could be mandated to review current policies and practices in monitoring, analysis, and reporting. They should also be mandated to examine the role of government in international and global monitoring and assessment.

2. **Reinvigorate CEQ's environmental data and monitoring activities.** CEQ can play an important role in developing interagency plans and strategies for indicator development, environmental monitoring, and the integration of ecological and economic information. The president by memo or Executive Order could direct CEQ to establish a National Environmental Statistics Program requiring statistical and program agencies to assist CEQ in planning and setting priorities. CEQ can also promote the development of indicators for international and global assessments.

3. **Legislate the establishment of a Bureau of Environmental Statistics** within EPA or a new Department of the Environment to do the following:

- o develop guidelines and methods for environmental data collection;
- o collect and compile environmental statistics in cooperation with other agencies and bureaus;
- o develop a core set of environmental statistics and indicators;
- o analyze indicators and report on environmental conditions and trends;
- o participate in the development of plans and programs for international and global data collection;
- o develop the necessary guides to key statistics; and,
- o promote access and use of environmental data and statistics.

The Center for Environmental Statistics, currently operating within EPA, has made a good start at initiating activities that support theses functions, but it needs a substantial increase in staff and authority to do the kind of work that is required.

4. **Strengthen international and world data and assessment organizations.** It is in the United States' interest to see that global environmental monitoring programs are put in place over the next five years that will generate data needed to assess worldwide trends in environmental quality and sustainable development. In planning for the Earth Summit (UNCED) the U.S. can lend support for strength-

ening the monitoring and assessment programs of the United Nations, the Organization for Economic Cooperation and Development, the World Conservation Union and the World Conservation Monitoring Centre, and others. In addition, the United States should also work through the Agency for International Development to support improved data collection activities in developing countries and with the World Bank to support monitoring and assessment activities that have a global component.

No one wants to hear it, but it may be necessary to create new institutions for environmental monitoring and assessment. For example, it may be cost effective for the U.S. to work closely with its Latin American partners, and in particular with Brazil, to establish a regional data and analysis center that will become the foremost source of information on tropical forests.

It is clear that more accurate, more timely, and more credible information alone will not guarantee better decisions. It is also clear that guesswork and luck make poor foundations for policymaking. Let us work together to take actions now that will give environmental information the important role it must have in economic development if we are to have a sustainable world.

Thank you very much. I welcome your questions and comments.

WRI ISSUES AND IDEAS

AUGUST 1991

MOVING TOWARD ECO-DEVELOPMENT: GENERATING ENVIRONMENTAL INFORMATION FOR DECISIONMAKERS

by Jessica T. Mathews and Daniel B. Tunstall

With sustainable development as the fundamental goal of the 1990s, major changes will have to be made in the environmental and economic information collected and communicated to decisionmakers. Statistical data that were essential for making investments in farms, fisheries, forestry, mines, and even parks are no longer sufficient. It is not enough to know what is produced and consumed, as important as that information is. Also needed are data on the size and nature of the resource base, its integrity and health, the wastes generated by production and consumption, and the human influence—locally, nationally, and globally—on resources and the environment.

Increasingly, decisions have to be made that affect the environments and development opportunities of others. Local decisions to drain a wetland may reduce the harvest of fish and waterfowl thousands of kilometers away. Decisions to burn coal and other fossil fuels can contribute to acidic deposition and changes in climate patterns on a global scale. From the international perspective, treaties and other decisions made to limit international trade in wildlife and carbon emissions directly influence local behavior.

Because so many decisions like these touch everyday life and govern the future livability of the Earth, environmental information itself needs to be seen as a valuable resource. Collecting, processing, storing, analyzing, and reporting data can be expensive, but investments in data more than pay for themselves. Only with ready access to up-to-date information can decisionmakers identify and assess environmental problems well, grasp their underlying causes, develop strategies for avoiding or remedying them, manage resources and wastes on a daily basis, and evaluate the performance of governments and other institutions in light of changing conditions and values.

How much and what kinds of environmental information are needed to make decisions? At any particular time, that depends on a culture's development strategy and its view of man's relation with nature.

Any era's ruling paradigm—the constellation of beliefs, values, and techniques—clarifies what is important and provides a rationale for collecting and using information. In the twentieth century, paradigms have evolved rapidly. Like species competing for the same ecological niche, they tend to coexist until the better adapted one wins out. Michael Colby and Henry Regier, among others, have suggested how paradigms of environmental management and economic development are evolving.

Frontier economics is the paradigm that prevailed in industrial countries until the late 1960s—and it still governs policy in some less developed nations and sectors of industrialized countries today. In this worldview, nature is an infinite supply of resources and an infinite sink for wastes, and the economy exists almost apart from the physical universe. If the surrounding environment is ruined, this ethos suggests, just press on into fresh territory. Whatever environmental damage occurs as a by-product of economic development can be cleaned up later, when the economy can afford it better. Most developing countries have tried, with varying degrees of success, to follow this development path, though some now see the need to avoid repeating the industrial world's mistakes.

Environmental protection, a competing paradigm, began attracting followers in the 1960s, thanks in part to the appearance of Rachel Carson's *Silent Spring* and to the seminal works of Kenneth Boulding, René Dubos, Garrett Harding, Barry Commoner, and others. People in industrial nations were becoming increasingly concerned about pollution, but most assumed that a tradeoff had to be made between economic and environmental goals. Environmental impact statements were institutionalized to weigh the costs and benefits of development, and com-

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mand-and-control regulatory policies were instituted to set limits on pollution. As pollution grew, so did cleanup costs—and public concern.

Resource management, a third paradigm, began developing during the 1970s and remains the dominant mode of thinking about environment and development. According to this economic view, all major types of resources—biophysical, human, infrastructural, and monetary—should be incorporated into calculations of national wealth and development policies. Natural resource exhaustion—particularly loss of habitats and species—it thus follows, is a matter of policy. The interdependence and multiple values of resources are recognized and taken into consideration in making policy and managing resources. Pollution is no longer a mere economic externality, but a "negative resource." Climate and other global systems and the processes that regulate them are vital resources to be managed.

Eco-development may be the paradigm for the future. With unprecedented threats of global environmental change, the widespread degradation of natural resources, and the easing of cold war competition, conditions are ripe for another paradigm shift. The need to integrate ecology and economics is urgent. Eco-development represents a radical departure from the paradigm that reigned in the 1960s and a larger break than most people realize with conventional resource management—the paradigm of the 1980s.

As the ancient Greek root of both economics and ecology, "eco" signifies a reunification of these two disciplines in development planning. Born of both resource management and the principles of ecology, this approach reflects the beliefs that economic systems must harmonize with ecological systems and that synergy must reign between environmental management and economic development. Eco-development also takes account of scientists' growing belief that global systems and cycles—long thought impervious to human influence—are changing, perhaps unpredictably and irreversibly. This new reality calls for planetary risk assessment, management, and communication.

There is no one-to-one correlation between resource consumption and economic growth under this paradigm. Fewer and fewer natural resources are required to get more and more economic production—as demonstrated, for instance, in the falling ratio of energy per unit of gross national product (GNP) in such countries as Japan and Germany. Resource management's "polluter pays"

Box 1. Environmental Management and Development Paradigms in Practice: The Case of Information Requirements for Agricultural Management

1. **Frontier Economics**
   - statistics on the extent of cropland
   - cost of inputs—of labor, land, and technologies, including pesticides, fertilizers, energy, improved crop strains, and irrigation
   - market commodity prices
   - measures of crop and livestock production and productivity
2. **Environmental Protection**
   - all of the above, plus
   - statistics on soil loss, pesticide contamination in soils, wildlife and habitat, groundwater resources, salinization and alkalinization of croplands
   - statistics on water quality in rivers, streams, and lakes from nonpoint source runoff, destruction of beneficial wildlife from pesticide contamination, contamination of groundwater sources, other off-farm impacts
   - data on costs of conserving soils, water management, and managing highly toxic chemicals to control pests, but not harm wildlife
3. **Resource Management**
   - all of the above, plus
   - full accounting of stocks, flows, and stresses on land and water from agriculture
   - statistics on land cover, capability, use, and degradation in order to plan the best use of the land, including crop production
   - information to support integrated pest management, integrated fertilizer management, conservation tillage, and other methods of farming that conserve soils, water, and biological diversity
   - prices that reflect the value of natural resources and the costs of waste management
   - information on commodity subsidies, trade balances, and the effects of agricultural trade on other countries
4. **Eco-development**
   - all of the above, plus
   - data on agroecosystems—their extent, condition, services, inputs, outputs, health, restoration, evolution, and interactions with other ecosystems
   - data on recycling, waste minimization, etc.
   - data on the distribution and equity effects of resource ownership, control, management, and use
   - data on the agricultural performance of farms, agroecosystems, regions, and nations in achieving goals, standards, and targets of sustainable development
   - data on agricultural and other productive systems and their contribution to flows of toxic chemicals, nutrients, water, and other components of global biogeochemical systems

principle is replaced by "pollution prevention pays." In its simplest form, this paradigm suggests that natural resource consumption per unit of economic production should be reduced and the structure and functions of ecosystems, including global systems, maintained and even enhanced.

What does this ongoing paradigm shift suggest about changing information requirements? As long as nature was treated as a free resource and a boundless sewer, the key indicator of successful development was productivity, measured solely in terms of output per unit of land, energy, capital, and labor. (See Box 1.) Investment decisions were based principally on market prices and the amount of income that the available cropland, pasture, forest, fishery, or other natural resource could generate.

As pollution began impairing ecosystem functions and threatening human health, the industrial world mounted massive and costly programs to monitor air, water, land, and living resources, including people. Data on pollution discharges and emissions and ambient conditions were generated, though too often without sufficient rigor. At considerable cost, dose rates and impacts on humans and wildlife from exposure to pollution were documented. Productivity was still the key indicator of success, but annual reports and development plans that contained only measures of production came to be viewed skeptically by decisionmakers, who increasingly had to answer to environmental critics.

A data tithe of 10 percent would help developing countries improve their statistical operations and generate information of immediate use both to them and to the world community.

The resource management approach further expanded information horizons. Policymakers needed a full accounting of renewable and nonrenewable resource stocks and flows. Getting the prices "right"—that is, making them reflect honestly the value of resources—became essential. The goal was to modify national income accounts to take natural resource wealth and pollution into consideration and to require the agricultural, energy, housing, industrial, transport, and other sectors to respect environmental values in all plans and activities.

Moving toward eco-development will require an even more fundamental shift in the need for and use of information. Industries and communities will need to become fully accountable for all materials used and wastes discharged, including products disposed of years later. Better information on ecosystems (their extent, condition, services, restoration, and evolution) is needed to understand and monitor carrying capacity at the local, regional, national, and global levels. Data with which to maintain, restore, and enhance the stock and flow of natural resources and services in support of development will be required on a regular basis. Institutionalized global-scale monitoring of the major biological and geological systems—their irregularities, discontinuities, chaotic nature, and expected and unexpected impacts on all life forms—will be essential.

Given the growing demand for policy-relevant environmental information, how are we doing? Unfortunately, not very well. A report card on global environmental data for decisionmakers would look something like this, with 10 the highest or most useful for policymaking and 1 the lowest.

1. Agriculture: 8 (needed: measures of conservation of soil, water, wildlife).
2. Energy: 7 (needed: measures of fuelwood production and use and other renewable energy sources, measures of final energy consumption, etc.).
3. Human health: 7 (needed: in many developing countries, measures of mortality associated with environmental conditions, especially sanitation and human nutrition).
4. Economic development: 5 (needed: accurate price signals of natural resource scarcities; costs of environmental damages; government and private sector expenditures on environmental management; data on benefits to the public and private sectors from waste minimization, recycling, and reuse; measures of environmental productivity).
5. Climate change and stratospheric ozone: 5 (needed: data on average ocean temperatures, average atmospheric temperatures, sea-level changes, pack-ice thinning, flow of nitrogen oxides, albedo, measures of ultraviolet radiation, etc.).
6. Freshwater and oceans: 4 (needed: measures of groundwater resources and groundwater pollution, water use, water pollution, sediment flows, chronic sources of pollutants from land-based activities, coastal ocean quality, coastal biological resources, etc.).
7. Forests: 4 (needed: periodic measures of tropical and temperate forest areas and types, rates of deforestation, measures of nontimber forest products, etc.).
8. Toxins and hazardous wastes: 3 (needed: measures of amounts generated, transported, treated, disposed, and cleaned up, and contamination and impacts).
9. Land and soils: 3 (needed: measures of land degradation, soil erosion, land use and cover, urbanization, etc.).
10. Air quality: 3 (needed: measures of urban air quality, indoor air quality, tropospheric ozone, transboundary flows, acid deposition, etc.).
11. Biodiversity: 2 (needed: statistics on the number of species and their populations, communities, and habitats; measures of ecosystem health; measures of threatened and endangered species; economic values of species; etc.).

This list is merely a beginning. We know even less

Box 2. Major Global Environmental Monitoring Programs

1. **World Weather Watch (WWW)** (coordinated by the World Meteorological Organization [WMO] in Geneva) comprises an international network of observing systems (ground, sea, air, satellite-based), telecommunication links, and centers for computer-based analyses. It issues over 2,800 forecasts daily. WWW also reports on major climatic events, *El Niño* diagnostics, sea temperatures, and sea levels.

2. **Isotopes in Precipitation** (coordinated by the International Atomic Energy Agency and WMO) collects data from 80 monitoring stations on isotopes (tritium, deuterium, and heavy oxygen [^{18}O]). The analyses are used to indicate the presence of radioactive particles from nuclear testing, nuclear power generation, and other activities.

3. **GEMS/Air** (coordinated by the United Nations Environment Programme [UNEP] and the World Health Organization [WHO]) compiles data on the ambient concentrations of sulfur dioxide and suspended particulate matter from 50 cities in 31 countries. The analyses are used to monitor trends in and impacts of air quality. Few cities in developing countries participate, and the latest data published are for 1984.

4. **Global Atmosphere Watch** (coordinated by WMO and UNEP) maintains a network of 192 nationally run stations that monitor precipitation chemistry; [illegible] measure carbon dioxide, 22 measure surface ozone, and 5 measure chlorofluorocarbons; another 140 stations, along with satellite data, monitor stratospheric ozone. Analyses indicate trends in acid precipitation, global trends in carbon dioxide levels, and changes in the ozone layer.

5. **GEMS/Water** (WHO, WMO, and UNEP) gathers data from 341 river, lake, and groundwater stations in 41 countries. It covers 50 variables, among them dissolved oxygen, biological oxygen demand, temperature, etc.; 110 stations monitor for trace elements, including metals and pesticides. Data coverage for most developing countries is not sufficient to analyze trends or to make cross-country comparisons.

6. **Land Use and Cover** (Food and Agriculture Organization [FAO]) compiles data from questionnaires and decadal agricultural censuses. The data are updated annually by agricultural experts who focus on the amount of arable land dedicated to temporary or permanent crops, permanent pastures, forests, woodlands, and other lands. This program also provides some information about land ownership. FAO's Global Information and Early Warning System and the Famine Early Warning System of the U.S. Agency for International Development use satellite-based estimates of photosynthetic activity to draw inferences about crop potential. These programs are beginning to change the ways in which country-level crop information is collected and analyzed. Timely use of such data has led to dramatic advances in warnings of shortfalls in crop production, enabling earlier estimates of potential famines to be made.

7. **Flora and Fauna** (World Conservation Monitoring Centre [WCMC]) assembles statistics on species (numbers, threats, extinctions, communities) and habitats (protected areas by management type) from experts, various commissions on species and habitat, and national and regional wildlife organizations on a worldwide basis. WCMC also compiles detailed data on certain species marketed in international trade. Many of the data on species, other than major vertebrates and plants, are incomplete. The analyses are used to identify threatened species, indicate the need for habitat and community conservation, and monitor trading practices.

8. **Energy** (U.N. Statistical Office, World Energy Conference, and private petroleum companies) collects data from national energy offices, experts, trade associations, petroleum companies, and other energy operations on resources, reserves, and production (oil, gas, coal, hydropower, nuclear power, and renewable sources) and on trade, prices, and consumption for most countries of the world. However, renewable energy supplies in developing countries are not well monitored. The analyses help experts to track the use of energy imports, exports, self-sufficiency, and dependency, and are essential for projections.

9. **Population** (U.N. Statistical Office, U.N. Population Division, World Bank, and the U.S. Bureau of the Census) compiles data from all countries on population totals, age and sex distribution, deaths, births, and migration based on censuses and various population surveys and records. These analyses are essential for determining population growth rates, local and regional distribution, dependency ratios and fertility rates, and for making projections.

10. **Coastal Waters** (UNEP's Regional Seas Programme) compiles information on pollutant loadings, land-based sources of discharges, and contamination of water and living resources for selected seas and estuaries, but monitoring has not progressed enough to allow time series and cross-seas comparisons for most variables. These analyses are used to assess conditions and to plan for joint pollution abatement programs.

about distribution and equity issues—who controls resources? who suffers most from pollution? etc.—and less still about how governments, corporations, and other institutions charged with addressing environmental and developmental issues are performing.

Obviously, today's low marks are not acceptable. We can do far better. We know what many of the problems are and the constraints that have to be overcome. Specifically:

Many important variables are monitored poorly or irregularly. National governments' participation in international data collection activities is weak. Only 35 countries take part in the United Nations Environment Programme's (UNEP's) Global Environment Monitoring System's program on food contamination (GEMS/Food). While GEMS/Food examines 19 contaminants, not all countries submit data for these contaminants, time series data are incomplete, and results from a number of laboratories have been unsatisfactory. Like the GEMS/Food participants, most of the 41 countries that participate in GEMS/Water and the 50 in GEMS/Air are industrialized. (See Box 2.)

Few international organizations are structured or authorized to compile environmental data, and fewer still have the funds needed to do the job right. The Food and Agriculture Organization (FAO)—charged with compiling data on soils, water, forests, rangelands, and fisheries, as well as agricultural production—allocated only 5 percent of its $550 million 1990-91 budget and few of its 7,000 employees to data compilation, analysis, and interpretation. UNEP's Global Environment Monitoring System runs on about $5 million per year—barely enough to cover coordination and minimal data collection, but not enough to support monitoring programs in developing countries.

Many governments in developing countries lack the legislative mandate and administrative capacity to support environmental monitoring, assessment, and reporting. Capacity is particularly weak in the ministries of industry, energy, mines, transport, and agriculture, where it is needed most. A recent review of national environmental studies found that fewer than 10 percent of developing countries prepare periodic state-of-the-environment reports or similar documents.

Governments often politicize data collection and analysis or restrict access to data, invoking threats to national security, industrial secrets, or cultural sensitivities. Bureaucratic red tape and fear of facing unpleasant facts also limit access. Sometimes, GEMS/Air data are released more than four years after they are collected, partly because countries review the data repeatedly, hoping to recast them in a better light.

The donor community has earmarked very few resources for helping countries to develop capacity for collecting and analyzing data. Little support has been channeled toward improving developing countries' institutions and infrastructure so that they can monitor and assess environmental problems better—crucial in countries where urban pollution is growing even faster than the burgeoning urban population.

It would be easy to make this list much longer. Training, computer and telecommunications equipment and systems, and cooperation and coordination among countries and among sectors within countries are all in short supply. Lack of finances severely constrains the preparation of publications and the distribution of data and reports. Governments show little imagination in building new partnerships with nongovernmental organizations (NGOs) and research institutes to monitor and assess environmental conditions. Standard resource classifications, monitoring protocols, and measures of accuracy receive little attention. Most disturbing of all is the nagging suspicion that good information will not make a real difference in decisionmaking.

Given policymakers' pressing information needs and the obstacles to meeting them, what is to be done? As preliminaries, both producers and consumers of environmental information need to recognize its importance for decisionmaking and development planning. Then, countries need to extend and improve national and global monitoring systems, widen the accessibility of environmental reporting, and strengthen partnerships among institutions that produce, analyze, and disseminate environmental information. In this overhaul, four steps that can be undertaken over the next few years without a major shift in values or institutional relationships are particularly needed:

1. **Develop Better Indicators.** An essential first step is to quickly develop environmental indicators—key statistical series that capture trends in ways that policymakers and the general public can grasp immediately. (See Table 1.) Besides being scientifically valid, such indicators must be condensed and clear enough so that decisionmakers can use them to check the Earth's vital signs and so that the numbers show at a glance whether our planet's health is improving or declining. Economic planning would be unthinkable without GNP figures, unemployment rates, and the like; so would social planning without such indicators as life expectancy and rates of fertility, infant mortality, and literacy. Yet, environmental policymaking has no comparable measures today. Such environmental indicators need not be perfect to be useful: GNP and many other key economic indicators are deeply flawed instruments, but still enormously valuable. As for uses, these new indicators would help policymakers to assess environmental quality and to integrate economic and environmental initiatives. They could also be used to forecast trends in resource use and degradation, to help uncover and document new problems, and to monitor performance in achieving targets and goals. The databases required to develop useful environmental indicators could improve natural resource accounting too.

2. **Broaden Access to Information Resources.** Cost is the first barrier to be overcome. The FAO production yearbook—the premier world report on agricul-

Table 1. Developing Indicators of Sustainable Development

Table 1 contains a selection of data for a range of countries that could be used to assess sustainable development. Indicators of social and economic development are relatively well defined. Comparable environmental indicators do not exist. Data of the type suggested below are needed in order to construct indexes of ecosystem stability, biodiversity conservation, land degradation, resource consumption, emissions and impacts of pollution, and others.

Countries	1985-90 Population Growth Rate (%)	1985-89 GNP Growth Rate (%)	1991 Human Development Index [a]	1989 Energy Consumption [b] (gigajoules per capita)	1988 Carbon Emissions [c] (metric tons per capita)	Mid-1980s Production of Hazardous Wastes [d] (metric tons)	Annual Rate of Deforestation [e] (hectares)	1989 Protected Areas (% of country)	1990 Water Use (% of available supply)	Soil Erosion (metric tons per hectare per year)
Algeria	3.12	1.7	0.490	[illegible]	[illegible]	[illegible]	[illegible]	0.2	16	X
Botswana	3.51	11.4	0.524	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Brazil	2.07	3.9	0.759	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
China	1.39	7.9	0.614	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16	X
Costa Rica	2.64	4.6	0.876	15	0.2	X	42,000	12.0	1	X
France	0.36	3.2	0.971	116	1.6	2,000,000	X	8.2	18	X
Haiti	1.88	0.6	0.296	2	0.0	X	2,000	0.3	0	X
India	2.08	5.8	0.308	8	0.2	36,000,000	48,000 [f]	4.4	18	75 [g]
Jamaica	1.52	5.3	0.761	25	0.6	X	2,000	0.0	4	36 [h]
Mexico	2.20	0.9	0.838	49	1.0	X	595,000	2.9	15	X
Nigeria	3.43	2.9	0.242	6	[illegible]	X	300,000	1.1	1	14 [g]
[illegible]	2.51	-0.2	0.644	[illegible]	[illegible]	[illegible]	[illegible]	4.3	15	15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sierra Leone	2.49	2.3	0.048	2	0.6	X	6,000	1.4	0	X
Spain	0.38	5.3	0.951	73	1.3	1,700,000	X	5.1	24	X
Sweden	0.03	2.4	0.982	149	1.8	500,000	X	4.1	2	X
Thailand	1.53	10.2	0.713	19	0.3	X	158,000	9.1	18	X
USA	0.82	3.3	0.976	297	5.3	265,000,000	159,000 [f]	8.6	19	10 [h]
Zimbabwe	3.15	3.6	0.413	20	0.5	X	X	7.1	5	50 [g]

Sources: United Nations, World Bank, World Conservation Monitoring Centre, World Resources Institute.

Notes: X = Not available. 0 = Zero or less than half the unit of measure.

[a] The Human Development Index, constructed by the UNDP, combines, in one number, a measure of economic, educational, and health deprivation. Countries above 0.8 are considered to have high human development; 0.5 to 0.8, medium development; and below 0.5, low development.

[b] Energy consumption includes traditional fuels.

[c] Figures include carbon from energy consumption and other industrialized sources.

[d] Hazardous wastes are not defined consistently from country to country.

[e] All figures are from the Food and Agriculture Organization of the United Nations for the 1980s, except the following countries, which come from national sources for the years indicated: Brazil, 1990 (legal Amazon only); Costa Rica, 1973–89; India, 1983–87; and Thailand, 1985–88.

[f] These figures include open and closed forests; all others are for closed forests only.

[g] Figures are for seriously affected cropland only.

[h] Figures are for cropland.

ure—costs U.S. $75, and the United Nations 1988 Demographic Yearbook sells for U.S. $110. A computer tape of one Landsat Thematic Mapper image (185 kilometers square at 30 meters resolution), containing data that resource planners could use in assessing land use patterns and forest conditions, costs U.S. $3,200. Clearly, basic information on the condition of the world's environment and natural resources is out of the reach of most analysts in developing countries, whether in government or not. How are these countries going to design the policies and strategies needed to participate on an equal footing with the industrialized nations if they do not have access to such data? How will we be able to build consensus and negotiate legitimate treaties unless all citizens have representation in discussions on global issues?

Of course, increasing access to vital information requires additional programs. It means establishing environmental information centers in countries and provinces and charging them with distributing information to users. It means coordinating attempts by governments and NGOs to share existing data by compiling source directories and by making databases available to researchers and the public. Governments, international organizations, and corporations will need to expand efforts to accurately report to the public, stockholders, and employees how their operations influence environmental quality. Corporate environmental audits could be developed for internal use; and corporate environmental performance reports prepared and released publicly. Reports on the state of the environment and environmental action plans need to be prepared by all countries. Perhaps the experience gained preparing national reports for the upcoming United Nations Conference on Environment and Development (UNCED) will spur countries to institutionalize such efforts. (See Box 3.) At any rate, this activity should surely be included in Agenda 21—the blueprint for action that will emanate from UNCED.

3. **Fund Environmental Monitoring and Data Programs in Developing Countries.** To meet the information needs of decisionmakers in developing countries, the donor community first must help these countries build up their environmental information networks, facilities, and programs. The United Nations Environment Programme helps all countries coordinate the collection of global environmental information through its Global Environment Monitoring System, but does not have the means to help developing countries improve their own data collection.

It is high time that donors addressed this gap in their grants and lending operations directly. Such a strategy has a precedent. The U.S. Agency for International Development has poured millions of dollars into improving population censuses and surveys around the world and has seen demographic data and the ability to make population projections improve mightily as a result. Similar donor-assisted programs have helped U.N. agencies compile data on childhood diseases, agricultural production, and macroeconomic statistics. Specifically, the Organization

Box 3. Country Environmental Studies

In recent years, a considerable amount of new information has been compiled on the environment in developing countries, often with the support of the international donor community. Starting with Environmental Profiles supported by the United States Agency for International Development in the late 1970s, countries are participating increasingly in the preparation of country and regional natural resource and environmental assessments, strategies, and action plans. These reports are being prepared so that they appeal to development planners, resource policymakers, and even finance ministers and corporate planners. The list of countries is long and growing. The number of countries participating in these assessment programs is given in parentheses. (Note the substantial overlap among the various assessments supported in part by the donor organizations shown below—one reason the international community is struggling to coordinate its activities and requests for information.)

1. Environmental Strategies: Canadian International Development Agency (10).
2. Environmental Profiles: Denmark, Department of International Development Cooperation (5).
3. Environmental Profiles: The Netherlands, Ministry of Foreign Affairs (10).
4. Country Environmental Profiles: United States Agency for International Development (62).
5. Country Disaster Profiles: United States Agency for International Development (49).
6. Tropical Forest and Biodiversity Assessments: United States Agency for International Development (35).
7. State of the Environment Reports: United Nations Environment Programme and various national institutions (42).
8. National Plans to Combat Desertification: Permanent Interstate Committee for Drought Control in the Sahel (6).
9. Biological Diversity Profiles: World Conservation Monitoring Centre (48).
10. National Conservation Strategies: World Conservation Union (29).
11. Environment Action Plans: the World Bank (19).
12. Tropical Forestry Action Plans: Food and Agriculture Organization and other institutions (75).
13. Regional Seas Programme Studies and Reports: United Nations Environment Programme (45).
14. Environmental Synopses: United Kingdom (12).
15. National Reports for the United Nations Conference on Environment and Development: National Commissions (approximately 165 countries).
16. National Ecological Inventories: various organizations (5).

for Economic Co-operation and Development's Development Assistance Committee should be called upon to help assess the environmental information needs of developing countries, devise environmental data and monitoring strategies, and establish a joint fund to support environmental monitoring, assessments, and institution strengthening.

At the same time, the World Bank's Global Environment Facility, which has more than $1.5 billion to allocate to developing countries for projects in four areas of global concern (reducing greenhouse gas emissions, preserving biodiversity, protecting the ozone layer, and arresting the pollution of international waters), should consider earmarking money for monitoring and data collection. A data tithe of 10 percent would help developing countries improve their statistical operations and generate information of immediate use both to them and to the world community, thus benefitting the industrialized and the developing nations.

4. **Improve Data on Tropical Forests.** A special plea must be made for tropical forests. Knowledge of the extent and health of the world's tropical forests is limited, while change is extraordinarily rapid, affecting the conservation of biodiversity, emissions of carbon dioxide and methane, the maintenance of rainfall patterns, the harvest of wood and other forest products, and the well-being of a billion people.

The FAO, which is charged with maintaining information on the world's forests, has focused mainly on the production and trade of wood products. Its first systematic estimate of the world's tropical forests was completed in 1983 for the 1980 reference year. At that time, the agency assumed that the rate of deforestation of closed tropical forests in the early 1980s would change little from that estimated for the late 1970s—11 million hectares per year. But the assumption proved false, and nobody updated the information systematically in the late 1980s. As a result, forest policies were distorted and opportunities missed. Preliminary estimates from the 1990 assessment show that the actual rate of deforestation during the 1980s was more than 50 percent higher: 16.5 million hectares annually.

Decadal assessments are inadequate. What is needed are continuous assessments of the extent and condition of various types of forest, the degree of fragmentation, the amount and type of regeneration and reforestation, the extent of logging, and the health of major forest ecosystems, temperate as well as tropical. FAO has proposed converting the final version of its 1990 assessment into a Global Continuous Forest Resources Monitoring (GCFRM) system. However, no funds have been set aside for such a program, and the dedicated FAO project team will disband in early 1992 if money is not found.

By supporting the funding of the GCFRM, the U.N. Conference on Environment and Development and the Tropical Forestry Action Plan can take up the challenge of institutionalizing forest monitoring. To the extent that FAO funding cannot meet the challenge, other organizations should pitch in. Regional data and analysis centers with such mandates should be established in Latin America, Africa, and Asia. Brazil, the country with the largest amount of remaining tropical forest, in cooperation with its Amazon Basin neighbors, could sponsor a Latin American tropical forest monitoring and assessment center and become the foremost source of information on this remarkable natural heritage.

It is clear that more accurate, more timely, and more credible information alone will not guarantee better decisions. It is also clear that guesswork and luck make poor foundations for policymaking. Whether sustainable development will occur and whether its benefits will be shared equitably depend largely on the availability of accurate information.

Sometimes, the odds against success seem great: familiar ways of doing things and ignorance about their long-term impacts seem to have so much more momentum than the forces for change. But we can take heart from John Maynard Keynes' wise insight. "I am sure," he wrote, "that the power of vested interests is vastly exaggerated compared with the gradual encroachment of ideas." The idea of eco-development—that is, of embracing ecological principles and environmental values as essential underpinnings of long-term economic growth—is particularly powerful. It is inseparable from timely, accurate, focused information. With that information, and only with it, much that we hope for mankind will become possible.

We would like to express our appreciation to the Florence and John Schumann Foundation and the Environmental Protection Agency for their support of WRI's work on environmental information needs.

ABOUT WRI

World Resources Institute (WRI) is an independent research and policy institute founded in 1982 to help governments, environmental and development organizations, and private business address a fundamental question: How can societies meet basic human needs and nurture economic growth without undermining the natural resource base and environmental integrity?

WRI's work is carried out by a 95-member interdisciplinary staff, strong in the sciences and economics and augmented by a network of advisors, collaborators, international fellows, and cooperating institutions in more than 50 countries. WRI currently focuses on six broad areas—climate, energy, and pollution; forests and biodiversity; economics; technology; resource and environmental information; and institutions—and augments policy recommendations with field services and technical support for groups working in natural resource management.

WRI is a private, not-for-profit corporation that receives financial support from foundations, governmental and intergovernmental institutions, private corporations, and concerned individuals.

SENATOR GORE. Well, thank you very much.

We do have a lot of information in the Federal Government that could be used to give us a much better estimate on the questions that your two organizations address. I recently had a closed door session lasting four hours with the intelligence community on how the assets within the intelligence community can be brought to bear on improving our understanding of crop yields, desertification, forest loss, and the rest. And similarly, policy changes are needed at LANDSAT to make information more readily available and accessible there.

There are plenty of examples to support your suggestion, Mr. Tunstall, that the Federal Government could, if it approached this task seriously, make a serious contribution to improving the fine work that you and Mr. Brown and your respective colleagues do.

As for your suggestion that this hearing, or one like it, be an annual event, that's something that I will bring up with our chairman, Senator Sarbanes, and our vice chairman, Congressman Hamilton, and the ranking Republican members. I think that's an excellent suggestion.

We're going to focus now, though, on this series and try to find how we can improve the data collection, the monitoring, and the integration of the different information with economic policymaking.

Now, I heard from your statement, Mr. Tunstall, that we began to improve environmental data collection back in the late 1970s, but before it got started very well there was a policy change and we've lost, as you said, about 11 years. More precisely it would be 10 years and 9½ months. But now you're saying that the CEQ under Mr. Deland deserves some credit for beginning to revivify some of those data efforts that were abruptly terminated in January 1981. Am I hearing you correctly?

MR. TUNSTALL. Yes, I think so. Well, let me answer this in two ways.

One is, I don't fully know because we don't have a regular OMB review of environmental statistical programs; a good cross-cutting analysis. The half a billion dollar estimate that Mike Deland gave for expenditures on environmental statistics is the same one that we gave in 1975 and 1980. That half billion dollars has been around, so you can quote it.

SENATOR GORE. An artifact.

MR. TUNSTALL. It's a rule of thumb, without any other basis to it.

I took last year's statistical budget that is broken down by agency, not by environmental category, and I came up with an estimate of roughly 16 to 18 percent of our current reoccurring federal statistical program could be called environmental. But I wouldn't put a great deal of confidence behind these numbers until we did a study.

So, the first half of my answer is we don't fully know what has happened to our environmental statistics, because we haven't paid attention at CEA and OMB to those issues the way we should have. There has been no statistical analysis. There is no one in the Federal Government whose job it is to sit down today and review our environmental statistical program, and yet it represents 16 to 18, maybe 20 percent of all of our federal statistics, which is a $1.9 billion effort.

Second, has CEQ done something more positive recently? And the answer is definitely, yes. I think the last annual report is an improvement. I think releasing the environmental trends book in 1989 was worthwhile in getting the report and information out. And I think their attitude toward putting together an interagency task force or workshop on environmental statistics is a good one; that's a good start. I would say they are about where we were in 1974. The Federal Government, as an institution, is about 17 years behind in its policies toward environmental statistics. But it is positive.

SENATOR GORE. Well, insofar as that does reflect a change by this Administration, I think they do deserve credit for restarting that process of improving the statistics and the information gathering.

Would you agree, generally, Mr. Brown, with the assessment of a slight improvement in the late 1970s, and then a sudden halt to that improvement, and then only recently the first stirrings of bringing back a trend toward better statistics?

MR. BROWN. I would.

I was excited in the late 1970s by the work that was being done and that led to the production of the *Global 2000* report. That report was highly valued around the world, because it was the first time that someone had tried to pull these things together and relate environmental and economic and resource and population trends into one document, and run it into the future to see where things are going. Following that, a number of countries undertook National 2000 or 2010 studies of the same kind. They were inspired by it, and that was a very healthy development.

Dan, you may know the number of countries now, but it's probably 20 or 30 countries, I would guess, that have undertaken that kind of a study.

What I had hoped would happen is that it would be the beginning of a process and that we would continue every 2 or 3 or 4 years to update that study and extend the trends further into the future. I hoped that each one would be a basis for public discussion and debate involving the private sector as well, and that each one would take into account advances in technologies and new data on resources. We'd have a system that would just keep building and would increase the potential quality of decisionmaking in the public and private sectors in a way that we cannot now even imagine, because we have gone back, as Dan implied, to square one.

If I could cite a very simple example, in the United States when the *Global 2000* staff began to look at various resources and they pulled the agencies of government together, for many it was the first time that the agencies that work on water, for example, had gotten together. What they discovered was that there were different agencies assuming use of water for different purposes. Some of the water was going to be used in three different ways. The mining interests were planning to use it; agriculture thought they were going to continue to use it; and the cities were expecting to get it, because they knew they were going to get more water.

Well, this sort of planning can only illuminate the policymaking process, both in the public and private sectors, and increase the overall efficiency of resource use as this small example indicates.

SENATOR GORE. You mentioned, Mr. Tunstall, the EMAP program that the EPA Science Advisory Board recommended a few years ago. And you indicated it might be more effective if the Congress was more active in requesting data from it, or what exactly did you have in mind when you made that comment?

MR. TUNSTALL. By Congress, in this case, I meant both the Executive and Congress. I think any time you start off a new, major monitoring program with that much money and that much effort you need a policy advisory committee looking at what they're doing to make sure that the information that they're going to generate is useful and will generate the kinds of indicators that people, like yourself, need and that can be reported in national reports and international reports.

What you don't need is a separate major monitoring program for the data strictly useful for scientific study. I want to be careful with those words because our public policy information has to be supported by science. But we also have to be able to take that information and raise it to a different level, and do that in a scientific way, but then make it available to the policymakers.

SENATOR GORE. Well, we'll pursue that as this series of hearings continues. So, we will look at the role of EMAP in improving the statistics.

Mr. Brown, you listed a couple of examples of indicators you would like to see monitored carefully. One was the damage to crop yields that is associated with increases in ultraviolet radiation exposure. What other examples come to mind, indicators that you would like to see monitored?

MR. BROWN. There are any number of them. I mentioned that in this country we now have pretty good data on soil erosion. Partly because we have that data, we were able to put together a rather effective program to reduce soil erosion.

SENATOR GORE. Of course, that effort goes back to the 1930s with the establishment of local conservation districts and boards, and the collation of that data in the 1970s would not have been possible except for the four decades of experience.

MR. BROWN. We had the institution in place to gather the data on the scale and then the detail needed in the 1970s, that's quite right. Unfortunately, most countries in the world do not have this sort of data. Though, arguably, it's one of the most important economic resources that the world has. We know almost to the barrel how much we deplete our oil reserves, but can't come to the closest billion tons to how fast we're losing our soil reserves. And I would argue that civilization can survive the depletion of oil reserves, but not of our soil resources.

So, I think this is terribly important. It is something we ought to be pressing and supporting at the international level.

SENATOR GORE. OK.

MR. BROWN. Another complex of issues that I think desperately needs attention is the relationship between environmental degradation and health. I cited a few examples to illustrate this. But we know that we could probably fill several pages with a list of the health consequences of various forms of environmental degradation, from lead poisoning to radiation, to breathing polluted air, down the list. And there is, to my knowledge, no systematic effort in the world to gather data of this kind.

Here is an excellent example of how information gathering and analysis on a systematic basis can have an enormous impact. We have in this country the Surgeon General's report on the effects of cigarette smoking. I think the first one was done in 1963. Each year, we have a report that updates how cigarette smoking is affecting the health of Americans. We know how many kinds of cancer it contributes to and what the number is, as determined by epidemiologists. And that information has led to enormous behavioral changes in this population. I think it's a small example of how systematically gathering data and analyzing it by government can play an extraordinary role in changing attitudes and behavior.

My guess is that if we begin to systematically look at the effects of environmental degradation in its various forms on human health, we would begin to see a rather staggering picture. But, because there is no systematic global effort to look at the health effects of the various forms of degradation, we're really at a loss to know what the health costs of some of our economic policies are.

SENATOR GORE. If you would excuse me for one moment, we're going to take a 4- to 5-minute recess and come right back.

[Recess.]

SENATOR GORE. The hearing will come back to order.

Thank you very much.

Mr. Brown, I would like you to supplement your response to that last question for the record, if you're willing to do so.

After polling your colleagues, who help you produce your annual report, and if after doing so you have other recommendations in addition to the ones you listed in response to my question, we'd be very interested. And from you also, Mr. Tunstall, what specific indicators should we be attempting to construct to get a more accurate picture of trends in the environment—our own environment here in the United States and the global environment of which we are a part?

Shifting gears, do you two believe that we should be satisfied with the United Nations' policy of constructing satellite accounts that take the environment into consideration? Or should we be moving farther to integrate environmental values into the core accounts at the United Nations?

MR. BROWN. Dan, I'll let you take that first. You're closer to the satellite——

MR. TUNSTALL. Well, as I understand it, Senator, you're going to have additional hearings focused even more directly on resource accounting.

SENATOR GORE. Yes.

MR. TUNSTALL. And I have a couple of opinions. But I recommend that you trust the opinions of my colleagues who come to that session more than mine.

SENATOR GORE. OK. All right.

MR. TUNSTALL. My main point is the way the two are related, we probably have enough information today. We don't need to wait for what CEQ, in its annual report, called a comprehensive database to start this process.

Our economic indicators didn't come out fully blown in 1946 when we passed the full employment act. They came out of 100 years of work. In fact, they started in 1776 with Playfair's indicators of trade and economics. So, we can't wait. This idea of waiting 20 years before they change the System of National Accounts—the SNA—is something you may want to leave to the United Nations, but I don't think we in the United States want to stop there.

SENATOR GORE. No.

MR. TUNSTALL. So, I think we need alternative accounts, whether or not you first prepare satellite accounts, or national resource accounting, or environmental accounting independently. I would rather Bob Repetto and Willy Cruz from WRI respond to that more directly.

SENATOR GORE. Very good. Do you want to add something to that?

MR. BROWN. No, I think that says it all.

SENATOR GORE. You basically agree with that.

And, of course, one of the other hot budding issues in this area is productivity, and I was thinking of it when you mentioned the effect of air pollution, Mr. Brown, on crop yields. When the change in our Nation's productivity is calculated as a result of the predicted impacts of the new clean air act, the cost to the polluters of installing new equipment to cut down on the pollution is subtracted from their productivity gains and thus, to that extent, has a depressing effect on the national productivity. Whereas, the improved productivity of farmers, who no longer have yields that are suppressed by the pollution, are not added to the aggregate productivity, and thus we get a biased, one-sided view that serves to discourage policies designed to protect the environment, and serves to encourage policies that minimize the inconvenience imposed upon polluters.

And again, that will be explored in more depth at later hearings.

MR. BROWN. I've noticed on that that it's not only within the Administration but often private-sector economists will do the same thing; that is, take a very limited view of how they calculate the costs and benefits and conclude that the GNP may suffer as a result of adopting pollution controls, for example. And they can reach that conclusion because they haven't taken into effect the costs of crop losses or human health or what have you. This all argues, I think, rather desperately for much broader comprehensive set of accounts.

SENATOR GORE. Did you wish to comment, Mr. Tunstall?

MR. TUNSTALL. Actually, my only comment on both of these questions is I would like to see more work done and published and available to people like yourself, so you can use it.

At the World Resources Institute, we have worked with the Indonesians on a case study to adjust national accounts, also with Costa Rica and the Philippines. So, we now have a body of three studies, and we hope that the Chinese will also prepare a similar study.

We're doing more detailed case studies on resource costs and benefits for the agricultural sector in about six different countries. Those should be available early next year.

But if resource accounting is going to take off, if we're going to use this information, then we have to do more studies, and we have to see governments start to use them. And maybe the United States could play a leadership role in this area.

SENATOR GORE. What are your views on the relationship between environmental protection and competitiveness? Specifically, what kind of information would you like to see brought to bear in analyzing the extent to which these two goals might be compatible, and what information would you bring to bear in analyzing the potential conflict between stringent measures to protect the environment and our ability to be competitive in the world economy?

MR. BROWN. That's probably the easiest question you've asked today, Senator. There are a lot of issues that have to be folded into that. There is a tendency to assume that protecting the environment is going to make the country less competitive in world markets. I think it's quite the opposite.

If we can't protect the economy's environmental support systems, the economy itself is not going to be in very good shape, much less very competitive. I think some of the best examples at the international level—at the moment—are the countries that have seriously pursued the increased efficiency of energy use. And it turns out that those countries that are at the top of the list in energy efficiency are also, by far, the most competitive.

And I think, as a general matter, those things that are environmentally responsible include the more efficient use of resources to satisfy a given level of demand for goods and services. And more efficient resource use usually translates into a more competitive position, whether that is water efficiency in agriculture and crop production, or energy efficiency in industry or the transport system or what have you.

So, I think, overall, a strong case can now be made that the only competitiveness policy that will work over the long term is one that strengthens the protection of the environmental underpinnings of the economy and increases the efficiency of resource use in the process.

SENATOR GORE. Very good. Mr. Tunstall?

MR. TUNSTALL. I agree with that. I have one or two sentences to add, basically related to the fourth paradigm of ecodevelopment that I talked about.

I think if we can push the ideas of that paradigm and understand them better, then we would be able to say that there is no conflict between competitiveness and protection; in fact, just the opposite. We tend to look only at the cost side. What is a regulation on policy change going to cost us. And that's important to do. But we also ought to look at the benefit side. I think if we put the economy within an ecosystem framework and think of developing both the economy and the ecosystems, then you would be able to weigh benefits and costs, both economically and ecologically.

SENATOR GORE. Unfortunately, we are going to have to conclude this hearing because of developments on the floor. And I would like to submit additional questions, however, in writing. There are not too many. If you two would be willing to respond in writing, I would very much appreciate that. We plan to be in close communication with the two organizations that you represent in preparing for the continuation of this series and other groups as well.

I would like to close by thanking you for getting us off to a good start today, and I look forward to talking with you in a continuation of these hearings later on.

We stand adjourned. Thank you.

[Whereupon, at 5:33 p.m., the Committee adjourned, subject to the call of the Chair.]

[The following written questions and answers were subsequently supplied for the record:]

MR. TUNSTALL'S SUPPLEMENTARY RESPONSE FOR THE RECORD

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DEC 30 1991

December 19,1991

Senator Albert Gore, Jr.
Congress of the United States
Joint Economic Committee
Washington, DC 20510-6602

Dear Senator Gore,

I was very pleased to have an opportunity to offer testimony on the importance of environmental information and the role it plays in shaping national economic and development policy. This is an area that has long received little attention by our federal government.

In your letter of September 27 you raised three important questions concerning the development of indicators, the role of the United States in global environmental monitoring, and the need for future hearings on the global environment. I'd like to address each of these at this time.

1. Can we provide a short list of specific indicators that would be most useful in tracking environmental trends and identify what programs are needed to provide the necessary information?

During the past two months, we have undertaken a review of our indicator program here at WRI and a new consensus has emerged as to what needs to be done to develop better environmental indicators. I recommend that intensive effort be made to develop policy relevant indicators at three different levels.

First, substantial work needs to be undertaken to develop indicators at the subsector level. In the area of biodiversity conservation, for example, we need a better indicator of the risk to species of continuing habitat destruction; in coastal waters, we need a workable indicator of their susceptibility to eutrophication and destruction of habitat and species; in freshwater, we have long needed a better indicator of pollution that takes into account waters of different temperature and salinity; in toxic emissions, we need a better way to combine releases of the many different chemicals that are known to cause human and ecological harm.

Second, we need to begin to develop better indicators at the sectoral level. In our paper, "Moving Toward Eco-Development: Generating Environmental Information for Decisionmakers", Jessica Mathews and I suggest the need for indices of land degradation, resource wealth and consumption, national pollution emissions, and ecosystem integrity, to name a few. What is needed here is more than new data collection and conceptual breakthroughs. We are seeking indicators (or indices) that will convey to policy- makers both changes in the natural environment and explicit values these changes have for society. Policymakers know intuitively what the unemployment rate and life expectancy mean, even if they don't know how those statistics are collected and processed. We are looking for summary indicators of eco-development that can reflect the changing values we have for the natural environment and the way it is used.

Third, we need to address the problem of developing one or a few fully-aggregated, single indices. Is it possible, for example, to develop a human environment index that can be used in conjunction with UNDP's Human Development Index and the more traditional measures of economic production such as GNP and GDP? Is it possible to develop an index of the sustainable use of natural resources, both renewable and non-renewable? How are we going to manage our economies and societies in a resource sustainable fashion if we don't have measures of resource sustainability and environmental quality? Most of our resource indicators suggest that we are operating in an unsustainable manner, e.g., rates of soil erosion, deforestation, marine fish catch, species extinction and threats. Can we turn these indicators into a unified measure of sustainable use, which has meaning for the policymaker--locally, nationally, and globally?

There are a number of examples that can be worked out at each level and we recommend that EPA, CEQ, and other agencies join forces with NGOs, academics, and others to develop a national environmental indicator project that would identify opportunities for progress over the next couple of years.

2. Should the United States take the lead in monitoring and assessing worldwide trends in resource use and environmental quality, and if so, who in the government should take responsibility?

Although special studies had been done in the early 1970s suggesting the rapid acceleration in tropical deforestation is worldwide, it was the *Global 2000 Report to the President*, which contained new information compiled by U.S. agricultural attaches and foreign officers around the world that brought this issue into clearer focus. Only the U.S. maintains a Bureau of Mines that tracks the production, trade, reserves, and prices of minerals on a worldwide basis. Only the U.S. has the Foreign Agricultural Service that can predict global grain production on a timely basis. Similar statements can be made about global atmospheric monitoring, the compilation of data on marine fish catch, energy production and use, carbon dioxide and other greenhouse gas emissions, stratospheric ozone concentrations and carbon dioxide and other greenhouse gas concentrations, population growth and distribution, economic production, and many other vitally important statistics.

With the end of the cold war, the U.S. will lose its capacity to lead based principally on military and strategic interests. Therefore collecting data cannot be justified on a strictly national security basis. It remains in our national interest, however, to track and assess the world's resources and its environment. This information is required to develop opportunities for U.S. investment, to be aware of environment conditions and trends that may directly and indirectly affect our welfare, and to play a leadership role in maintaining the viability and livability of the planet. We will in many instances want to compile information on the quality of the environment of our close neighbors so that we and they can make honest comparisons when discussing trade issues and considering agreements.

The U.S. can lead, but not dominate in this field. In the environmental field, information is more valuable if it is shared than if it is restricted to a single use or user. CEQ in cooperation with the State Department and the major environmental and resource monitoring and assessment agencies should undertake a thorough review of U.S. monitoring and assessment capabilities on an international and global basis. The role of the intelligence agencies should be examined carefully. One study that should be done as soon as possible is to assess the monitoring and reporting aspects of international and global treaties. Are we collecting the right kinds of information and are countries providing the information to international secretariats? What kinds of information should be developed to improve the implementation of existing and planned treaties?

In addition to developing a concerted global environmental monitoring plan and program, the U.S. should immediately undertake the preparation of a periodic report on the state of the world's natural resources and environment. This report would provide our country with an opportunity to review the state of the world and assess whether our policies are moving us in the right direction.

3. How can Congressional hearings deepen our understanding of environmental trends and what kinds of monitoring and assessment policies could emerge from a comprehensive overview?

Congress can provide the stimulus and platform for a public review of our sustainable development policies. As I indicated during the question and answer period, I would like to see the Joint Economic Committee, in cooperation with other environmental committees, hold annual hearings on the state of the world's environment.

I believe both WRI's *World Resources Report* and Worldwatch Institute's *State of the World* provide a valuable service to the public. But, the public doesn't know what the U.S. is doing to pursue sustainable development in a global context. We have no consistent mechanism for judging U.S. policies. Annual hearings would provide a means for bringing leaders from various organizations and perspectives together to discuss and debate the state of the world's environment and the adequacy of U.S. policies in addressing global environmental problems.

Please let me know if we can be of further assistance in promoting the development and use of better environmental information.

Sincerely,

Daniel B. Tunstall

Daniel B. Tunstall
Senior Associate

MR. BROWN'S SUPPLEMENTARY RESPONSE FOR THE RECORD

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November 13, 1991

The Honorable Albert Gore, Jr.
Joint Economic Committee
Congress of the United States
Washington, DC 20510-6602

Dear Senator Gore:

In response to your letter of September 27, 1991, pursuant to the hearing held by the Joint Economic Committee on Monday, September 16, 1991, I am submitting the following list of environmental indicators for the hearing record. This set of indicators can serve as a guide in the effort to better track domestic and international environmental trends, as well as to expand and improve our national accounting system. I have also included a brief list of social indicators for the committee's consideration. Not only are these social measures central to the country's effort to improve the well-being of its citizens, but they are also related to the state of the environment. Simply stated, environmental decline affects our well-being, and conversely, poverty can drive people to destroy the environment. Of course we need to keep in mind that over-consumption can be a more potent force still.

Some of the basic data that make up these indicators already exist, while other data sets need to be researched and developed. Although data collection and analysis will take resources and personnel, perhaps the more difficult task lies in integrating this information into our national economic accounting system. Economists generally eschew environmental and social indicators because they are not easily monetized and integrated into an accountant's ledger. Nonetheless, because we now know that the health of the environment directly affects the health of individuals and the economy, politicians, business leaders, and citizens need indicators to help them understand the extent to which the state of our natural resource base is affecting the future of our country.

To this end, economist Herman E. Daly and theologian John B. Cobb, Jr., with Clifford W. Cobb, developed the Index of Sustainable Economic Welfare, the single most comprehensive indicator of well-being available. It takes into account not only average consumption but also distribution and environmental degradation. For inclusion in the hearing record, I have enclosed a copy of the appendix from their book <u>For the Common Good</u> (Boston: Beacon Press, 1989), which discusses the Index in detail. Our country, as well as the United Nations, would do well to adopt the concept if not the actual indicator itself.

Establishing a Bureau of Environmental Statistics to carefully monitor environmental trends in the U.S. and around the world would put the United States on the right track. Such a bureau would need to have enough autonomy to insure that its findings were based in science, not politics, and it would need a close working relationship with government bureaus that develop economic indicators.

I commend you and members of the committee for your leadership in this area, and thank you for this opportunity to share our research with the committee.

Sincerely,

Lester R. Brown
President

Enc.

Submitted by Lester R. Brown
President
Worldwatch Institute

For inclusion in the record of the Hearing on September 16, 1991, before the Joint Economic Committee U.S. Congress

Environmental Indicators

Agriculture

- Crop loss due to stratospheric ozone depletion, air pollution, soil erosion, and other environmental factors
- Cropland loss/conversion to cropland
- Pesticide transport and contamination of ground and surface water
- Percentage land area under integrated pest management
- Grassland deterioration
- Fishery status, by species

Biodiversity

- Inventories and loss of genetic, species, and ecosystem diversity
- Wilderness areas, parks, wildlife preserves

Energy

- Efficiency (unit energy per unit GNP), overall and by sector
- Renewable energy production as a percentage of energy consumption and of potential renewable energy production
- Air pollution emissions per unit energy production
- Percentage of passenger trips made by mass transit, bicycle or walking
- Nuclear waste production

Global change

- Temperature, rainfall, and stratospheric ozone trends
- Greenhouse and ozone-depleting gas emissions and disappearance
- Health effects of stratospheric ozone depletion
- Effects of global change on biodiversity
- Deforestation/reforestation rates
- Forest damage from air pollution and acid rain, including slower growth

Materials

- Efficiency of use by sector and per unit GNP
- Reuse, recycling, and disposal rates
- Resultant waste production and air and water pollution

Water

- Water use and efficiency by sector
- Per capita water use
- Aquifer depletion
- Water pollution and contamination by affected volume, area and cause

APPENDIX

The Index of Sustainable Economic Welfare

Introduction

Discussion in Chapters 3 and 19 pointed to the need for a way of measuring the economy that will give better guidance than the GNP to those interested in promoting economic welfare.

One response would be to bring up to date one of the welfare measures that has already been proposed. However, on closer examination, none of the available candidates seems adequate today. For example, Zolotas (1981) does not consider sustainability, whereas Nordhaus and Tobin (1972), who do take sustainability into account, do not consider environmental issues that have become increasingly important since they published their work. We find Zolotas more helpful on some points and Nordhaus and Tobin on others. We have learned something also from the Japanese measure of Net National Welfare. Accordingly, rather than revising and bringing up to date one of the existing measures, we propose to build on their accomplishments and propose a new one. This includes some elements not dealt with by any of the three indices that were discussed in Chapter 3 as well as fresh ways of treating topics that were included in them.

All welfare measures with which we are familiar overlap with the GNP by including personal consumption. But from that point on these measures differ from each other as well as from GNP. We begin with this figure. In the following pages we describe the major theoretical decisions that entered into our own proposed measure, the Index of Sustainable Economic Welfare. We then offer the table of ISEW statistics from 1950 to 1986 and certain other conclusions. The remainder of the Appendix explains in detail the columns composing the table.

We are especially grateful to Clifford W. Cobb for his painstaking work and leadership in preparing this Appendix.

Income Distribution

We have factored in income distribution on the assumption that an additional thousand dollars in income adds more to the welfare of a poor family than it does to a rich family. Though economists generally consider the question of distributional equity to be important, they regard it as a separate issue from the magnitude of economic welfare. Thus one might ask: If the aggregate quantity of benefits (units of welfare) decreases by *X* percent while the measure of income distribution improves by *Y* percent, are we better off or worse off? From the perspective of neoclassical economics, there is no way to answer this question. We are aware of the conceptual problems involved in including a distributional component in our Index of Sustainable Economic Welfare. Nevertheless, we believe that continuing to treat distribution as a separate issue has the effect of devaluing its importance in the analysis of economic welfare. We have chosen therefore to make it an integral part of our index.

Net Capital Growth

We have considerably altered what Nordhaus and Tobin did in the calculation of changes in net capital stock. Specifically, we have included only changes in the stock of fixed reproducible capital and excluded land and human capital in this calculation.

First, we have not treated changes in the value of land as increases in capital in the same way that Nordhaus and Tobin did. Rather than adding the value of land as part of the capital stock, we have assumed that, since the stock of land is fixed, its increased value represents merely the effect of growing demand for a fixed resource. In other words, rising land costs contribute to growth of GNP but not to welfare gains.

Second, we have excluded 'human capital' from our calculations of changes in the stock of capital even though we recognize its theoretical importance in sustainable economic welfare. Human capital—the characteristics of the workforce, such as health and skillfulness, that make it productive—certainly contributes to economic well-being. Yet having granted that general principle, we question the validity of measuring inputs such as expenditures on medical care or on schooling to derive meaningful estimates of the stock of human capital. We regard the actual sources of human capital formation as yet undefined and thus unmeasurable. To the extent that we include health and education expenditures in our calculations, we treat portions of them as consumption.

The relation between increased medical expenditures and improved health in a well-nourished society is tenuous, and we have not seen evidence that demonstrates any clear contribution of health expenditures to productivity. Intuitively, we might assume that more money spent on medical care will lead to a healthier population, which will in turn lead to lower absenteeism at work and higher productivity. Yet the record on this relationship is ambiguous. According to the U.S. National Center for Health Statistics (as reported in *Statistical Abstract*), the number of "restricted-activity days" per person increased from 16.4 in 1965 to 19.1 in 1980, a period during which real per capita expenditures on health care increased by over 70%. This does not mean that we were less healthy in 1980 than in 1965. Other statistics might indicate some degree of health improvement. We cite the "restricted-activity days" statistic merely to demonstrate the ambiguity of any presumed connection between health expenditures and enhancement of productivity. The effect of increased schooling on productivity is also far from definitive. In the work of economists Edward Denison and Theodore Schultz (the latter being a source for Nordhaus and Tobin's human capital calculations), the contribution of education to productivity is *assumed* to be correlated with inputs such as years of schooling and expenditures per pupil (Denison 1962, 68ff.; Schultz 1961). On its face, that assumption may seem plausible. However, both theoretical and empirical issues raise serious doubts about the validity of using these inputs to estimate "educational capital."

On a theoretical level, the correlation between levels of formal education and earned income differentials may not indicate a causal relation between them, or at least the cause may not fit the human capital model. Lester Thurow suggests that the correlation between education and income may be explained by a model of what he calls 'job competition' (Thurow 1975, pp. 170–84). In contrast to the usual concept of wage competition, in which workers receive wages according to the skills that they have when they seek employment, the jobs competition model proposes that workers are hired on the basis of their "relative position in the labor queue," which is determined more by their academic degrees than by their actual job-related skills. According to this model, job skills are learned primarily at work rather than through formal education. The higher earnings of college graduates compared to high school graduates is thus based not on their greater stock of knowledge or skills (human capital) but on the fact that employers use academic degrees as a device to screen out those they expect will require higher training costs. Thurow argues that, insofar as this model is valid,

> the function of education is not to confer skill and therefore increased productivity and higher wages on the worker: it is rather to certify his [or her] "trainability" and to confer upon him [or her] a certain status by virtue of this certification. Jobs and higher incomes are then distributed on the basis of this certified status. [Ibid., 172]

The model helps to explain why equalization of the distribution of education since 1950 has not led to a comparable equalization of income distribution and why overall levels of productivity growth have not kept pace with growth in educational expenditures. It also explains why investment in education continues to provide a relatively high rate of return for an individual even if it provides only a small return to society. The value of formal education lies not in imparting skills but in placing the individual higher in the labor queue than others: "*In effect, education becomes a defensive expenditure necessary to protect one's 'market share.'* The larger the class of educated labor and the more rapidly it grows, the more such defensive expenditures become imperative" (ibid., p. 182). In other words, an individual is forced to obtain a college degree to gain access to certain jobs simply because others have the degree. If much of what is spent on education is designed to preserve the relative positions of individuals, the massive increases in educational expenditures since 1950 cannot be counted as a significant factor in productivity gains or as a source of human capital.

Even if Thurow's model of jobs competition is completely invalid, other empirical evidence also casts doubt on the importance of formal education in the creation of human capital. In particular, the correlation between earned income and education appears to be very weak. Jacob Mincer, one of the leading analysts of investments in human capital, has shown that, among white, male, nonfarm workers, only 7% of the variation in earned income is accounted for by differences in their levels of education (Mincer 1974, p. 44).[1] (If the whole workforce were included, education would account for an even smaller portion of the variation because of discrimination based on race and gender.) In other words, 93% of the variation is due to other factors, ranging from luck and personal connections to ambition, native ability, and skills learned on the job.

As a consequence of these considerations, we have omitted any estimates of human capital from our calculations of changes in the stock of capital. In principle we agree that human capital should be included, but we believe that medical and educational expenditures vastly overstate actual changes in the stock of human capacities that enhance productivity.

In addition to removing the land and human capital components from the procedure used by Nordhaus and Tobin, we have also redefined the growth requirement as the growth of capital necessary to compensate for depreciation and population growth, without including any consideration of changes in labor productivity. It was not evident, even to Nordhaus and Tobin, why sustainability should mean growth rather than a steady state,

1. In the eighth year after completion of schooling, the level of education accounts for about one-third of variation in incomes, though this proportion falls rapidly in succeeding years.

i.e., why net capital should grow at the combined rate of population and productivity growth:

> The capital stock must be growing at the same rate as population and the labor force. This capital-widening requirement is as truly a cost of staying in the same position as outright capital consumption. This principle is clear enough when growth is simply increase in population and the labor force. Its application to an economy with technological progress is by no means clear. Indeed the concept of national income becomes fuzzy. [Ibid., p. 6]

When they proposed to include productivity growth as part of the growth requirement, Nordhaus and Tobin may not have foreseen the possibility that productivity would decline, which it has during many of the years since they published their paper. Using their procedure, the growth of sustainable MEW is enhanced by a fall in productivity, which is an absurd result.[2] Instead, declining productivity should expand the growth requirement, because capital must be used to compensate for reduced productivity if the same level of consumption is to be maintained. As a result, one reasonable way of calculating a growth requirement would be to subtract (rather than add) the percentage growth of productivity from the growth of population and the labor force. For our ISEW, we have chosen the more conservative method of leaving productivity changes out of calculations of sustainability altogether.

Foreign vs. Domestic Capital

Besides calculating whether net capital formation is sufficient to keep up with a growing population, we have included a category that takes into account whether the *source* of capital can be sustained. In the early stages of a nation's economic development, growth may depend on borrowing capital from other countries. However, when an advanced capitalist nation finances its capital accumulation by borrowing from foreign sources, we assume that that reflects a fundamental weakness in the long-term viability of that economy. We therefore add the change in the net U.S. investment position (or subtract it when negative) on the assumption that sustainability requires long-term national self-reliance.

Natural Resource Depletion

We have also extended the concern for sustainable production to include the availability of natural resources or "natural capital" rather than merely

2. Net capital growth, which is added to MEW, is equal to the change in the net capital stock minus the growth requirement, which is composed of changes in the labor force and

humanly created capital. Under the category of natural capital we include not only fuels and minerals but wetlands and farmland as well. Zolotas took this issue into account to some extent by correcting for what he regarded as the slight underpricing of fuels and minerals by the market. MEW omits the cost of depleting natural resources altogether; however, this is not an oversight. Instead, Nordhaus and Tobin explain why they believe that exhaustion of resources does not involve any threat to sustainability:

> The prevailing standard model of growth assumes that there are no limits on the feasibility of expanding the supplies of nonhuman agents of production. . . . Presumably the tacit justification has been that reproducible capital is a near-perfect substitute for land and other exhaustible resources. . . . If substitution is not possible in any given technology, or if a particular resource is exhausted, we tacitly assume that "land-augmenting" innovations will overcome the scarcity.
>
> These optimistic assumptions about technology stand in contrast to the tacit assumption of environmentalists that no substitutes are available for natural resources. Under this condition, it is easily seen that output will indeed stop growing or will decline. [Nordhaus and Tobin 1972, p. 14]

Thus the question of whether an adjustment for resource depletion needs to be made under the category of sustainability hinges on this issue of substitution and technological advance. In support of their optimistic view, Nordhaus and Tobin cite a study by Edward Denison that shows a declining proportion of national income being contributed by natural resources from 1909 to 1958 (Denison 1962, 13). They also refer to a 1963 study by Barnett and Morse which concluded that, with the exception of forest products, the price of resource-intensive goods had not risen more rapidly than the price of goods in general (Barnett and Morse 1963, pt. 3). Thus substitution and technological change had "come to the rescue of scarcity."

The faith in the infinite substitutability of nonrenewable resources is founded on the experience of a peculiar period in history, during which energy was extremely cheap. But now that that era is over, the cost of all resources will increase because of the increasing energy costs of extraction and processing. The falling price of natural resources during the first seventy years of this century was a one-time phenomenon upon which a faulty view of the future has been built.

The path-breaking book, *Beyond Oil: The Threat to Food and Fuel in the Coming Decades*, explains why economists have underestimated the consequences of resource depletion. The problem is that energy is now expensive, not merely in the financial sense of costing more money but also in

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productivity. If productivity decreases, the growth requirement would grow more slowly and MEW would grow more rapidly.

terms of requiring increasing amounts of energy to obtain useful energy. The energy output/input ratio—the amount of energy made available as output from a given input of energy for exploration, extraction, and processing—declined for oil from about 100 in the 1940s to 23 in the 1970s (Gever et al. 1986, p. 70).[3] A similar decline occurred for coal. Yet even when the energy cost of energy was rising (because the energy output/input ratio was falling), the cost of energy in dollars could continue to decline. This paradox was possible as long as the dollar price of fossil fuels was low relative to labor costs. Energy-intensive technologies for extraction and refining of energy reduced dollar costs as long as they cut labor requirements. Since the price of fossil fuels was falling, the unit price of other resources could be cut as well by the same process of substituting cheap energy inputs for expensive labor. Now that the energy output/input ratio for newly discovered oil has fallen to about 8 and for most other energy sources to less than 5, the days of declining resource costs are permanently at an end.[4]

Thus the money cost of energy rose in the 1970s and will continue to rise in the long run, not simply because of producers' cartels but because of the increasing energy inputs required for discovery and extraction and processing of new sources of energy. According to the authors of *Beyond Oil*, "by 2005 it will be pointless to continue exploring for oil and gas as energy sources in the United States: after that more energy would be used to look for these fuels than the oil and gas we found would contain" (ibid., p. 20). Moreover, even when expected new discoveries are included, their analysis shows that "domestic oil and gas stores . . . will be effectively empty by 2020 [while] . . . world oil and gas supplies will last perhaps three decades longer, or more if Third World economies fail to develop" (ibid.).

The point is not that resources are finite. Economists have long recognized that fact, but they have assumed that resources are *effectively* infinite if one is willing to pay a sufficiently high price to get them. Yet energy analysis allows us to see that a resource may be exhausted even when there are vast stocks in the ground, if the energy cost of extraction and processing exceeds the energy content of the unmined resource. Nor is the development of nonpetroleum-based energy sources likely to change the general outlook. Unless unproven technologies such as fusion provide cheap, unlimited energy (which seems doubtful given the track record of fission com-

3. *Beyond Oil* uses the term "energy profit ratio" to refer to the amount of output energy available relative to the amount of input energy used in a system. We have chosen the term "energy output/input ratio" instead to avoid the possible confusion that the term *profit* might refer to financial profit rather than surplus energy.

4. According to Gever and his associates (1986, p. 70), the energy output/input ratio of electricity production is 4 for nuclear power (less if the cost of reactor decommissioning is included) and 2.5 for Western strip-mined coal if the cost of using scrubbers is included.

pared to its initial promise), no technical changes will substantially alter the basic trend of declining energy resources and higher costs.[5] Even if technological breakthroughs cannot dramatically expand production, economists argue that rising prices will encourage technological improvements in energy efficiency as well as reduced energy consumption. The idea is that we will be able to maintain our standard of living and even continue to grow by using the dwindling supply of energy more efficiently. The authors of *Beyond Oil* explain why technology offers little hope of achieving this goal. First, they note that advances in the material standard of living have been dependent on two factors working in combination: knowledge and resources. Growth depended on the embodiment of new ideas in the form of capital, which required the use of energy. As long as energy was declining in cost, the limiting factor in material growth was knowledge. Under those circumstances, a certain degree of optimism that growth could be sustained indefinitely seemed justified. There was no obvious limit to increases in knowledge. However, in recent years, resources have become the limiting factor in growth. By having to spend a larger and larger amount of our resources just to make more resources available, less is left over for improvements in welfare. Thus Cleveland and his co-authors have calculated that "in the last ten years alone [1974–84], the fraction of GNP accounted for by natural resource extraction has grown from 4 percent to 10 percent" (cited in ibid., p. 101). We can now see that technological advances have traditionally involved a combination of inventiveness and cheap energy. New technology can marginally improve energy efficiency but, for the most part, material growth is a thing of the past.

Second, the authors of *Beyond Oil* point out that previous estimates of the nation's capacity to conserve energy were overly optimistic because much of what appeared to be conservation actually involved shifts of the kinds of fuels used for particular purposes (fuel efficiency rather than energy efficiency per se). In addition, optimistic estimates of possible improvements in energy efficiency have been based on extrapolations from individual sectors to the entire economy. Yet when the *indirect* energy costs of the technology used to increase energy efficiency are included, the gains in efficiency appear minimal:

5. As the authors of *Beyond Oil* note, there are already practical reasons for doubting that fusion will provide a technical fix: "Fusion technology is still decades away from commercial application. Moreover, at least one leading fusion researcher, Lawrence Lidsky of MIT, believes that the particular fusion technology that is being developed most intensively, the deuterium-tritium reaction, will *never* be commercially feasible. According to Lidsky, it produces large quantities of dangerous radiation that would force plants to be even more sophisticated and expensive, per units of energy produced, that today's fission reactors" (Gever et al. 1986, p. 72).

If *all* companies substituted labor and capital for fuel, more fuel would be needed somewhere in the economy to increase the amount of labor and capital, and the nation's net savings in energy are reduced. In agriculture, for example, the amount of fuel used *directly* on a cornfield to grow a kilogram of corn fell 14.6 percent between 1959 and 1970. However, when the calculation includes the fuel used elsewhere in the economy to build the tractors, make the fertilizers and pesticides, and so on, it turns out that the total energy cost of a kilogram of corn actually rose by 3 percent during that period. [Ibid., pp. 102–3][6]

Thus, technologically achieved energy conservation does not offer a comprehensive remedy for the declining stock of energy resources. The precise extent to which energy efficiency gains will be offset by indirect energy costs is not clear. In some sectors of the energy economy, such as household heating and automobile fuel consumption, Amory Lovins has calculated that tremendous energy savings can be achieved by shifting to technologies that are more energy efficient but require little more capital than current technologies. In the economy as a whole, however, *net* energy efficiency improvements (combining direct and indirect energy costs) are likely to be minimal.

Nevertheless, some economists have argued that resource depletion leaves future generations better off than our own if a sufficiently large proportion of those resources are transformed into capital rather than being consumed in the present.[7] According to this view, true intergenerational equity is not served by depriving ourselves of present enjoyment so that the future will have even more than we now have. The implicit assumption behind this view is that capital constitutes a perfect substitute for (or even an improvement upon) the natural resource base of a society. At one level this seems plausible. A machine made of steel might reasonably seem like a better gift to the next generation than the deposits of minerals that were used to make it. Yet as E. J. Mishan notes, "A common belief among economists, that the consumption of finite resources . . . is offset in value by the formation of other capital, is erroneous. Under familiar behaviour assumptions, no more than a fraction of the value of the finite resource is replaced, and this fraction could be negligible" (Mishan 1984, p. 13n.5). Even if the entire value of the finite resource were replaced with capital, this often would not benefit future generations as much as leaving the resource untapped. First, the production of the capital would consume resources that future generations might wish to use for other purposes. Second, capital

6. Cited from D. Pimentel et al., "Food production and the energy crisis," *Science* 182 (1973): 443.

7. See, for example, Robert Solow, "Intergenerational equity and exhaustible resources," *Review of Economic Studies* 41 (supplement 1974): 29–45 (Symposium on the Economics of Exhaustible Resources).

goods would deteriorate over time, imposing maintenance costs on future generations that would not occur if the resources were left in their natural state. (An example of this can be seen in the massive cost of restoring highways in the United States, a cost that would have been imposed by weathering even if they had never been used to carry traffic.) Third, capital cannot ultimately substitute for resources because capital itself is composed of resources. In other words, as discussed in Chapter 10, labor and capital complement the material resources that are transformed into a product. Capital provided for future generations must be accompanied by natural resources to be of any value.

We have already begun to pay the price of profligate use of resources that made possible rapid economic growth in the past. The decline in real wages since 1972 and the stagnation of productivity for about a decade are signs of the effect of rising real resource costs, particularly energy resources.

The implications of this prospect of diminishing resources and rising costs for Nordhaus and Tobin's study are clear. The issue of resource exhaustion needed to be included in their measurement of sustainable welfare. Current welfare should have been reduced to the extent that present enjoyment deprives the future of the potential for the same level of economic welfare. Having introduced the idea of sustainability with respect to net capital accumulation, they should have carried over the same logic to the depletion of "natural capital."

Yet even if Nordhaus and Tobin had entertained the notion that depletion of resources in the present would impoverish future generations, they would likely have minimized the significance of this intergenerational conflict by suggesting that the effects on the future be discounted at the real interest rate. From the perspective of neoclassical economic theory, the damage caused by exhaustion of resources (either renewable or nonrenewable) should be counted in the present only after it has been discounted (reduced) in proportion to the long-term interest rate. In effect, this theory says that a resource should be exhausted as long as the rate of increase in its price *in situ* is less than the interest rate. We regard this process of discounting the effects of our present policies on future generations as socially inappropriate, even though the practice is reasonable on an individual level. In other words, the rational procedure for an individual, given the existing set of incentives, is not necessarily a rational policy for a society as a whole. Thus we reject in principle the idea of discounting the effects of resource depletion (and environmental damage) on the future. Instead we propose the view that any reduction in economic welfare in the future below the level currently enjoyed should be counted as if the cost occurred in the present.

The attitude of benign neglect toward the future implicit in the concept of discounting has troubled some leading members of the economics profession. As A. C. Pigou noted in 1924:

> There is wide agreement that the state should protect the interests of the future in some degree against the effects of our irrational discounting, and of our preference for ourselves over our descendants. The whole movement for "conservation" in the United States is based upon this conviction. It is the clear duty of government which is the trustee for unborn generations as well as for its present citizens, to watch over and if need be, by legislative enactment, to defend exhaustible natural resources of the country from rash and reckless spoliation. [Pigou 1924; quoted in Batie 1986, p. 10]

Yet, in effect, Pigou merely recognized the problem without suggesting an appropriate basis for addressing it. By implying that consideration of the distant future lies outside the bounds of economic theory, he washed his hands of any professional responsibility for thinking about the issue of sustainability.

In our ISEW, we have thus deducted an estimate of the amount that would need to be set aside in a perpetual income stream to compensate future generations for the loss of services from nonrenewable energy resources (as well as other exhaustible mineral resources). In addition, we have deducted for the loss of biological resources such as wetlands and croplands (due to shifts in land use and to erosion and compaction). This may be thought of as an accounting device for depreciation of "natural capital" similar to the depreciation of capital subtracted from GNP to arrive at NNP.

Environmental Damage

In the studies by Nordhaus and Tobin and by Zolotas, there is some recognition of the fact that pollution and other environmental damages should be deducted in the calculation of economic welfare. In the area of air and water pollution, we have updated Zolotas's estimates using more recent data and different methodologies for constructing time series. We have also included an estimate for noise pollution. The most important change, however, is the addition of a rather speculative estimate of long-term environmental damages, particularly from climate modification. We have assumed that those damages are cumulative and directly related to energy consumption. Also, as in the case of resource depletion, we have not discounted future costs.

Value of Leisure

We have omitted any imputation of the value of leisure from our Index of Sustainable Economic Welfare because the rather arbitrary assumptions upon which such a calculation are based strike us as being particularly problematic.[8]

To begin with, the meaning of leisure is not entirely clear. Does it simply mean all time spent on activities for which there is no remuneration? In that case, it would include the time of all those who are unemployed, underemployed, or involuntarily retired and who would like to be working. Does it include time spent in such activities as child care and cooking, which may fall into the categories of either work or pleasure within the same household under various circumstances? Finally, how should the value of leisure time be calculated in dollar terms? As Nordhaus and Tobin explain, "in general, time is to be valued at its opportunity cost, the wage rate" (Nordhaus and Tobin 1972, p. 44). Yet is it appropriate to value the leisure of women and minorities as less than that of white males because the hourly earnings of the former are smaller because of discrimination? These are just a few of the imponderables that make any measurement of the value of leisure conceptually doubtful.

Turning to the empirical evidence on leisure, we find that the growth in the value of leisure, at least since the 1954 survey used by Nordhaus and Tobin, has been due almost exclusively to an increase in the real wage rate, not to any decrease in the number of hours of work being performed. As Zolotas explains:

> For the period prior to 1965, leisure data from a sample survey by Robinson and Converse suggest that there has been no change in the amount of free time available to the four major population segments, namel male workers, male non-workers, female workers and female non-workers. This conclusion coincides with the findings of a 1954 survey, which have been used by Tobin and Nordhaus. [Zolotas 1981, p. 95][9]

8. The imputation for leisure also tends to be so large that variations in the assumptions about how to calculate it have an enormous impact on any welfare index that includes it. The rate of growth of the MEW, for example, varies by approximately a factor of 2 according to which assumption one makes about the relation of technological progress to the value of leisure and nonmarket labor. Nevertheless, in each variant, the value of leisure is by far the largest item in the index, constituting from half to three-fifths of total MEW. Excluding leisure raises the growth of per capita sustainable MEW to 0.86% per year during the period 1947–65 compared to 0.40% per year when it is included. The omission of leisure significantly reduces the gap between the growth of MEW and GNP (the latter of which grew annually by 2.2% during this period). We suspect that the inclusion of an imputation for leisure in the ISEW would have similarly widened the gap between its growth rate and that of GNP, thus strengthening our conclusion that an alternative measure of sustainable economic welfare is needed. However, we did not attempt this calculation because we could not find a conceptually sound and empirically well-grounded basis for imputing the value of leisure. In the absence of a solid framework, the massive contribution of leisure to the outcome of welfare measurements is not justified.

9. The survey Zolotas cites comes from Robinson and Converse 1967.

He later adds that the findings of a 1975 survey show that the number of weekly hours devoted to paid employment had "remained virtually unchanged over the period 1965–1975." He concludes that the reason for the rise in total hours of leisure during that decade (from 34.8 hours per week to 38.5) "is mainly attributable to a decrease in hours devoted to family care from 25.4 a week in 1965 to 20.5 a week in 1975" (ibid., 97). The extent to which the rise of leisure time is a function of declining fertility rather than a change in child-care patterns is not clear. Nevertheless, since the trade-off here is not between work and leisure, to count this change as a welfare gain is dubious.

Rather than allowing us to work less and enjoy more leisure, increased market activity has merely intensified status competition. As Zolotas so aptly observes:

> It was originally believed that economic growth would eventually shorten working time. This belief has not been confirmed in today's advanced economies. The implication is that mankind is constantly being driven farther away from the point of long term equilibrium, where it could sit back and enjoy the fruits of civilization in peace and quiet. The reason is that the growth of the physical product, in the way it takes place in modern economies, is a source of constant stress and compels people to work harder in order to be able to afford the unending stream of "new" goods being supplied by the system. [Ibid., p. 94]

If this image of perpetual striving is in fact correct, then the absence of significant growth in leisure should come as no surprise.

Given the difficulties of knowing precisely what is meant by the term *leisure* as well as the problem of being able to measure changes in it over time, we regard the inclusion of leisure time in a welfare measure as inappropriate. If, in the future, the average work week were to decline significantly (as it apparently did between 1929 and 1954), some imputation for leisure might be called for. Even then, conceptual problems of valuing the leisure time of the underemployed and unemployed and of men and women at their various real wage rates would continue to plague the effort. For now, at least, we omit the imputation for leisure because of the dubious calculations involved in it and because it would outweigh all other components in a measure of welfare.

Value of Unpaid Household Labor

The imputation for the value of household services has many of the same problems as the imputation for leisure, yet the warrant is so strong for including nonmarket labor that we could not omit it. The idea that the production of services by members of the household should be included alongside services produced in and for the market is intuitively compelling. In addition, because the figure is much smaller than the imputation for leisure, it does not overwhelm the index. Nevertheless, it, too, has serious problems, and it is a large enough factor that questionable judgments about it have a major effect on the total outcome. After the removal of leisure, the imputation for household services constitutes between a third and a half of the total MEW for Nordhaus and Tobin.

Though we agree in principle that the value of housework should be included in an indicator of economic welfare, the conceptual and empirical difficulties of measuring it are formidable. Conceptually, the main difficulty is in the definition of housework or household production. Which of the activities within the household should be classified as work as opposed to leisure or an intrinsically satisfying activity? Those who have studied this issue in some detail, particularly the Berks, have discussed some of the rather subtle issues that interfere with any simple calculation of the value of time spent on housework because of these definitional quandaries. For example, when survey respondents are asked to specify whether household activities are work or leisure, some activities (notably cooking and child care) are frequently classified as both (Berk and Berk 1979). Moreover, how should those who are assigned the ultimate responsibility for managing the household (generally women, by virtue of gender expectations) be regarded with respect to those who merely carry out specific tasks under supervision?[10] If the distinction between management and labor is important in the market, it should also be considered significant in the home. The time of women, who bear the brunt of this burden, should then be valued not at their wage rate but on the basis of a managerial salary from which the market generally precludes them.

The foregoing comments should clarify why empirical measurement of either "household production functions" or even time spent in housework presents enormous difficulties. Yet even though researchers have not known exactly what they were measuring, the few studies that have taken place of household time allocation have shown surprisingly similar results in terms of time spent in housework. Despite all of the "labor-saving" devices introduced into the household in the past eighty years, their effect on the number of hours spent in housework has been trivial or perhaps nonexistent. Whereas housewives spent an average of 56 hours per week doing housework in the 1910s, they still spent about 53 hours per week in 1965–66. Similar findings were discovered by studies in 1924–25 and 1930–31 (Cowan 1983).[11] For the 1980s, Berk's study showed that the average num-

10. "The accomplishment of household labor involves thinking about or planning for the task, as well as the actual work demanded by the task itself. . . . Our early research . . . revealed a clear distinction between 'help' with and 'responsibility' for household labor" (Berk 1985, p. 69).

11. For the 1910s, Cowan cites (on p. 159) an unpublished doctoral dissertation by Leeds

ber of *weekday* hours devoted to housework was 8.5 for housewives and 7 for women who were employed (Berk 1985, p. 64). Since this study required respondents to keep diaries only of weekday activities, it is not precisely comparable to previous studies. Nevertheless, it suggests that average weekly hours devoted by women to housework are probably still in the neighborhood of fifty. Berk also notes that the widely touted increase in men's level of housework is largely a mirage, not confirmed by any large-scale studies (ibid., p. 8).

Despite the enormous difficulties in defining the exact boundaries of nonmarket household labor and in measuring its contribution to economic welfare, we could not ignore it. We have chosen to use the rather conservative estimates derived by Robert Eisner, who computes the value of time spent on unpaid household work on the basis of the average wage rate of household domestic workers (Eisner 1985, p. 30). Though this undervalues the managerial element of household production, it avoids the problem of using differential market wage rates for men and women.

Caveats and Limitations

Nothing is better calculated to make one realize the difficulty of estimating economic welfare over time than the effort to devise an index. Consider the limitations of this one.

First, it relies for its base on personal consumption, which is certainly a more appropriate measure of welfare than production, though it is still questionable. There are many questions one could raise about the extent to which human beings become better off as a result of increased consumption. Above all, it seems likely that there are diminishing returns with respect to the satisfaction gained by marginal increases in consumption. In fact, by using distribution of income to weight consumption, we have implicitly assumed that marginal increases in consumption by the poor are of greater value than marginal increases by the rich.

On the other hand, our calculus of economic well-being has failed to take into account the fact that happiness is apparently correlated with relative rather than absolute levels of wealth or consumption. Having more is less important than having more than the "Joneses" (Easterlin 1974). Yet in the absence of any way to quantify this sense of relative well-being, we have ignored this important finding in our index, just as others have.

Second, there are many possible categories of additions and deductions that we have omitted. To the extent that unreported income from the "under-

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from 1917. For the 1920s and 1930s she refers (on p. 178) to U.S. Department of Agriculture surveys that found a range of hours spent in housework from a high of 61 to a low of 48. For the 1960s, she cites John P. Robinson, *How Americans use time: A social-psychological analysis of everyday behavior* (New York: Praeger Publishers, 1977), pp. 63–64.

ground economy" (excluding illegal activities) is not already imputed in NIPA, we would like to include it in a measure of welfare. Changes in working conditions should also be included, if there were some reasonable way to calculate such a change.[12] On the deletion side, one might be tempted to subtract expenditures for junk food, tobacco, pornography, and innumerable other items that make questionable contributions to genuine economic welfare. We recognize that this would lead to highly subjective judgments, though we suspect that a consensus might be formed around certain items.

Third, we have been forced to make some heroic assumptions in the process of compiling the ISEW. In some cases, we have included estimates of quantities that are inherently unmeasurable, as in the imputation of the cost imposed on future generations by the depletion of natural resources. In the case of long-term environmental damages, the estimation of costs is clouded by a high degree of uncertainty about the precise physical effects of human actions. (How high will temperatures rise as a result of the greenhouse effect and what will the ecological ramifications be? Are there *any* geological structures that can *permanently* hold high-level radioactive wastes and prevent them from contaminating the environment?) We certainly do not presume to have any definitive answers to these and other questions. We have merely made what we regard as moderate conjectures, ones that do not overwhelm the index, but which play a substantial role in its final outcome.

Nevertheless, because the methodologies for estimating the costs of depletion of natural resources and of long-term environmental damage (columns T and U in table A.1) are more speculative than the procedures used for other estimates, we have also calculated the Index of Sustainable Economic Welfare excluding those columns. (In other words, we added the amount in columns T and U to the amount in column X in table A.1 because they were originally subtracted in the calculation of column X.) Although we have not shown this calculation in table A.1, we have included a revised estimate of per capita ISEW, which we label PC-ISEW*, in figure A.1 (following table A.1) and in table A.12. In the latter, we have calculated annual growth rates of three alternative measures of economic welfare: per capita GNP, ISEW, and ISEW*.

Explanation of Columns in Table A.1

Column A: Year.

Column B: The value of personal consumption expenditures comes from table 1.2 of the *National Income and Product Accounts* (*NIPA*) and July issues of *Survey of Current Business*, both published by the Bureau of Economic

12. We are indebted to comments by C. O. Matthews on Nordhaus and Tobin's study for this idea. See Nordhaus and Tobin 1972, pp. 88–89.

Analysis, U.S. Commerce Department. Up to 1984, this was available in 1972 dollars. Since the inflation adjustment for 1985 and 1986 is in 1982 dollars, we estimated personal consumption for 1985 and 1986 in 1972 dollars by calculating the percentage increase in 1982 dollars from 1984 to 1985 and to 1986, then adding that proportional increase to the 1984 figure in 1972 dollars.

Column C: The "index of distributional inequality" was derived from *Current Population Reports: Consumer Income*, series P-60, no. 159, table 12, page 39, "Income at Selected Positions and Percentage Share of Aggregate Income in 1947 to 1986 Received by Each Fifth and Top 5 Percent of Families and Unrelated Individuals by Race of Householder." We created an index of inequality that is similar to the Gini Coefficient except that our index assigns weights according to the degree of difference between each of the four lowest quintiles (fifths) of income and the highest (richest) quintile. In 1975, for example, the top quintile received about 7.6 times as much income as the lowest quintile, 3.5 times as much as the second quintile, 2.3 times as much as the third quintile, and 1.7 times as much as the fourth quintile. We then added those four numbers (plus 1 to represent the highest quintile's relation to itself) and divided by 5 (that being the number that would be obtained by perfectly uniform distribution of income). The lowest possible number for a given year is 1 (5 divided by 5), but there is no upper maximum (unlike the Gini Coefficient, which varies between 0 and 1). We then used the numbers we derived from this procedure (numbers which ranged from 3.1 to 3.75) to make an index, setting the 1951 value at 100. (See table A.2 below.)

The income figures we used may not accurately reflect actual income differences for two reasons. First, they may overestimate inequalities to the extent that they do not include transfer payments made to the poor in the form of AFDC, food stamps, public housing, and other welfare programs. On the other hand, the disproportionate benefits received by the middle and upper classes from government services offset the modest transfer payments to the poor. Second, the before-tax income reported in the surveys we used does not take into account the graduated scale of income taxes, thereby overestimating inequalities. At the same time, however, tax benefits to the middle and upper income brackets (such as the write-off of mortgage interest payments) tilt the distributional balance the other way. We encourage a thorough study of this very complex issue of income inequality, net of all taxes, transfer payments, and hidden benefits. In the meantime, we must use the data available to us.

Column D: Weighted personal consumption is column B (personal consumption) divided by column C (index of distributional inequality) multi-

Appendix

Table A.1
Index of Sustainable Economic Welfare, 1950–86

Year A	Personal consumption B	Distributional inequality C	Weighted personal consumption (B/C) D	Services: household labor E(+)	Services: consumer durables F(+)	Services: streets & highways G(+)	Public expenditures on health & education (consumption) H(+)	Expenditures on consumer durables I(−)	Defensive private expenditures/ health & education J(−)	Expenditures on national advertising K(−)	Costs of commuting L(−)	Cost of Urbanization M(−)
1950	337.3	109.0	309.5	311.4	13.4	6.4	1.1	42.6	2.8	6.9	9.0	5.8
1951	341.6	100.0	341.6	315.4	14.6	6.6	1.2	39.1	3.3	7.4	8.5	6.2
1952	350.1	102.0	343.2	319.5	15.5	6.8	1.4	38.0	3.8	7.8	8.4	6.6
1953	363.4	100.8	360.4	323.6	16.6	7.0	1.5	42.1	4.4	8.2	9.3	7.0
1954	370.0	106.2	348.5	327.8	17.5	7.3	1.7	42.5	5.0	8.4	9.6	7.3
1955	394.1	101.2	389.3	332.0	18.8	7.7	2.1	51.1	5.8	9.3	10.9	7.7
1956	405.4	98.1	413.2	336.3	19.6	8.0	2.4	48.8	6.8	9.9	10.4	8.8
1957	413.8	95.3	434.0	340.6	20.3	8.3	2.8	48.6	7.8	10.1	10.5	9.2
1958	418.0	97.1	430.6	345.0	20.6	8.8	3.1	45.3	8.4	9.9	9.9	9.7
1959	440.4	99.6	442.1	349.5	21.2	9.2	3.5	50.7	9.2	10.4	10.7	10.2
1960	452.0	101.3	446.3	354.0	21.7	9.6	4.0	51.4	10.0	10.8	11.3	11.6
1961	461.4	105.3	438.1	358.5	22.0	10.0	4.8	49.3	11.8	10.5	10.9	12.1
1962	482.0	99.6	484.2	363.2	22.7	10.5	5.7	54.7	13.7	10.9	11.7	12.8
1963	500.5	99.2	504.3	367.9	23.6	11.0	6.7	59.7	15.5	11.4	12.4	13.3
1964	528.0	98.5	536.3	372.6	25.0	11.5	7.6	64.8	17.3	12.0	12.8	14.0
1965	557.5	96.5	577.7	377.4	26.8	12.0	8.5	72.6	19.0	12.7	14.3	14.7
1966	585.7	92.0	636.5	382.3	29.0	12.5	11.4	78.4	20.7	13.4	14.9	17.1
1967	602.7	92.5	651.7	387.2	30.9	13.1	13.8	79.5	21.4	13.0	15.2	17.8
1968	634.4	92.0	689.6	392.2	33.4	13.6	15.5	88.3	22.5	13.3	16.7	18.7
1969	657.9	92.4	712.3	397.2	35.7	14.1	17.0	91.8	23.0	13.4	17.7	19.6
1970	672.1	95.0	707.8	402.4	37.3	14.6	18.7	89.1	23.4	12.7	17.4	20.4
1971	696.8	94.9	734.2	407.5	39.3	15.1	20.1	98.2	24.7	12.3	19.5	21.3
1972	737.1	96.6	763.1	412.8	42.1	15.5	21.7	111.1	26.8	12.9	21.6	22.5
1973	767.9	95.1	807.7	418.1	45.3	15.9	23.3	121.3	28.8	13.1	23.1	24.4
1974	762.8	94.7	805.6	423.5	47.2	16.3	25.3	112.3	28.5	13.1	22.4	25.6
1975	779.4	95.9	812.3	429.0	48.8	16.5	26.0	112.7	28.4	12.5	22.4	26.5
1976	823.1	95.9	857.9	434.5	51.1	16.7	27.6	126.6	29.7	14.3	25.0	29.5
1977	864.3	99.0	873.2	440.1	54.1	17.0	28.1	138.0	31.0	15.1	27.2	32.6
1978	903.2	99.0	912.1	445.8	57.3	17.1	29.3	146.8	32.3	15.8	28.2	36.0
1979	927.6	99.5	932.5	451.5	60.0	17.3	30.5	147.2	33.7	16.5	29.2	39.3
1980	931.8	100.1	930.9	457.3	61.3	17.5	32.2	137.5	35.1	16.7	28.6	41.4
1981	950.5	102.4	928.6	463.2	62.7	17.6	33.4	140.9	37.0	17.2	29.0	45.4
1982	963.3	107.9	892.4	469.2	63.8	17.8	33.0	140.5	38.1	17.7	27.7	40.9
1983	1009.2	108.1	933.5	475.3	66.1	17.9	33.2	157.5	39.7	18.8	30.2	46.4
1984	1058.6	108.9	975.9	481.4	69.6	18.1	33.6	177.9	41.6	20.1	32.8	47.4
1985	1108.2	111.9	990.3	487.6	74.3	18.3	34.9	195.5	42.8	20.6	35.3	48.8
1986	1155.5	112.8	1024.4	493.9	79.8	18.5	34.9	212.0	44.2	20.9	33.5	51.5

NOTES:

—All figures are in billions of inflation-adjusted (1972) dollars except column A (year), column C (an index number 1951 = 100), and columns Y and AA (dollars, not billions of dollars).

—The explanation of the columns in table A.1 is given on pages 416–43.

—Figure A.1 on page 420 compares, in graphic form, columns X and AA plus a revised estimate (not shown) of per capita ISEW excluding columns T and U.

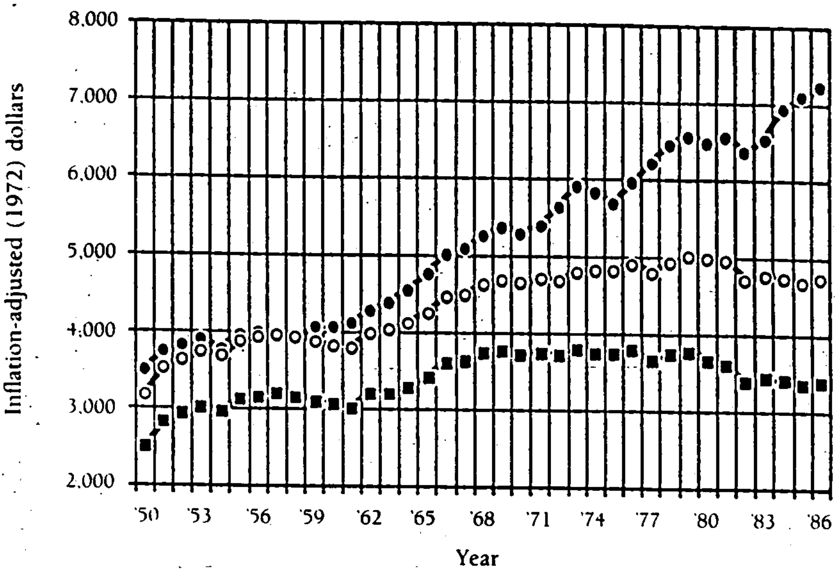
—Calculations of columns C, G, H, J, L, M, P, S, U, and V may be found in tables A.2–A.11 on pages 443–52.

—Calculations of the annual changes of per capita GNP and per capita ISEW (columns Y and AA) may be found in table A.12 on page 453.

The Index of Sustainable Economic Welfare

Cost of auto accidents N(−)	Costs of water pollution O(−)	Costs of air pollution P(−)	Costs of noise pollution Q(−)	Loss of wetlands R(−)	Loss of farm land S(−)	Depletion of nonrenewable resources T(−)	Long-term environmental damage U(−)	Net capital growth V(+)	Change in net international position W(+)	Index of sustainable economic welfare ISEW X(sum)	Per capita ISEW Y	Gross national product Z	Per capita GNP AA
11.6	9.0	25.2	2.0	10.0	7.2	20.6	84.0	−26.3	0.0	378.8	2488.0	534.8	3512.2
13.2	9.2	25.2	2.1	10.4	7.8	21.8	86.9	0.1	0.2	438.5	2831.2	579.4	3741.0
13.3	9.4	25.2	2.2	10.7	8.5	21.1	89.9	19.8	0.2	461.4	2928.7	600.8	3813.3
13.9	9.7	25.2	2.2	11.1	9.1	22.6	92.9	31.2	0.2	482.9	3014.9	623.6	3893.0
13.3	9.9	25.2	2.3	11.4	9.7	22.1	95.8	42.1	0.2	482.6	2960.0	616.1	3779.2
13.9	10.2	25.2	2.4	11.8	10.4	24.9	99.0	50.3	0.2	517.9	3121.2	657.5	3962.5
14.4	10.4	25.1	2.5	12.2	11.0	26.9	102.4	40.8	2.4	533.2	3156.9	671.6	3976.2
14.3	10.7	25.1	2.5	12.5	11.7	27.1	105.7	37.5	2.3	550.1	3198.7	683.8	3976.0
14.0	10.9	25.1	2.6	12.9	12.4	21.1	109.1	36.3	2.3	552.3	3158.3	680.9	3893.5
14.3	11.2	25.1	2.7	13.2	13.0	24.0	112.5	32.6	2.2	551.9	3103.5	721.7	4058.4
14.4	11.5	25.1	2.8	13.6	13.7	25.5	116.2	31.4	2.2	551.4	3051.9	737.2	4080.3
14.4	11.8	25.6	2.9	14.0	14.4	25.5	120.2	38.8	4.8	553.8	3014.7	756.6	4118.9
15.4	12.1	26.1	2.9	14.3	15.1	26.1	124.0	43.8	4.8	595.0	3189.7	800.3	4290.3
16.2	12.4	26.6	3.0	14.7	15.8	26.8	128.0	45.5	4.7	607.7	3211.5	832.5	4399.1
17.4	12.7	27.1	3.1	15.0	16.5	27.8	132.2	47.1	4.7	631.9	3293.1	876.4	4567.2
18.8	13.1	27.6	3.2	15.4	17.2	28.5	136.6	50.8	4.6	664.3	3419.0	929.3	4782.7
19.4	13.4	28.0	3.3	15.8	17.9	29.6	141.2	51.9	−0.9	709.5	3609.4	984.8	5010.2
19.5	13.8	28.5	3.4	16.1	18.7	29.7	146.0	47.3	−0.8	720.7	3626.9	1011.4	5089.8
20.8	14.1	29.0	3.5	16.5	19.4	30.0	151.0	49.8	−0.7	749.5	3734.4	1058.1	5271.9
23.0	14.5	29.5	3.7	16.8	20.1	30.7	156.3	50.1	−0.7	765.6	3777.4	1087.6	5366.2
25.3	14.9	30.0	3.8	17.2	20.9	30.9	161.8	51.1	0.7	763.4	3723.1	1085.6	5294.3
26.3	15.3	28.9	3.9	17.6	21.6	31.7	167.4	48.0	3.2	778.8	3750.4	1122.4	5405.0
28.7	15.3	28.9	4.0	17.9	22.4	32.2	173.3	40.2	3.1	780.7	3719.6	1185.9	5649.9
28.6	15.3	29.3	4.0	18.3	23.2	34.6	179.5	32.6	3.0	802.5	3786.8	1254.3	5919.1
25.8	15.3	27.4	4.1	18.5	24.0	46.8	185.4	27.6	2.8	799.1	3736.9	1246.3	5827.8
28.1	15.3	25.7	4.1	18.6	24.7	46.6	191.2	27.4	2.5	805.6	3730.1	1231.6	5702.6
30.1	15.3	26.2	4.2	18.8	25.5	48.4	197.4	22.3	7.1	826.2	3789.5	1298.2	5954.1
32.1	15.3	26.3	4.2	19.0	26.3	50.4	203.7	21.7	−7.8	805.2	3656.0	1369.7	6219.2
33.7	15.3	25.5	4.2	19.2	27.1	52.6	210.2	16.4	2.3	833.5	3744.6	1438.6	6463.1
32.5	15.3	25.4	4.3	19.4	27.8	61.6	216.7	15.5	11.3	849.9	3776.4	1479.4	6573.5
29.0	15.3	21.3	4.3	19.5	28.6	74.5	223.0	8.4	6.4	836.3	3672.0	1475.0	6476.7
27.0	15.3	23.6	4.4	19.7	29.4	86.1	229.1	8.7	17.9	828.0	3599.3	1512.2	6573.6
26.1	15.3	22.4	4.4	19.9	30.2	77.6	234.9	8.3	−2.0	786.8	3386.3	1480.0	6369.8
26.3	15.3	21.6	4.5	20.1	31.0	70.9	240.6	24.6	−22.0	806.0	3436.5	1534.7	6543.5
27.8	15.3	22.4	4.5	20.3	31.7	72.2	246.6	27.3	−38.2	807.0	3405.2	1642.5	6930.4
29.6	15.3	22.4	4.6	20.4	32.5	64.9	252.7	37.4	−49.6	807.9	3376.1	1697.5	7094.3
30.5	15.3	22.4	4.6	20.6	33.3	62.4	258.7	44.0	−63.4	822.1	3402.8	1745.9	7226.4

Figure A.1: Alternative Measures of Economic Welfare



-●- PC-GNP stands for per capita Gross National Product.

-■- PC-ISEW stands for per capita Index of Sustainable Welfare.

-o- PC-ISEW* is PC-ISEW excluding columns T and U in table A.1.

plied by 100. (The reason for division rather than multiplication is that in column C larger numbers indicate greater *inequality*.)

Column D is the base number from which other modifications are either added or subtracted. We first add four columns (E, F, G, and H) that represent streams of services that are not counted as part of personal consumption in the national income accounts. Next, we subtract nine columns (I through Q) that represent items intended to compensate for implicit overestimates of welfare in the measure of personal consumption. We then subtract four columns (R, S, T, and U) that represent our estimate of how present activities undermine the sustainability of our natural resource base. Finally, we add two columns (V and W) that represent the degree to which the level of capital accumulation and shifts in control of capital between domestic sources and foreign sources affect the sustainability of the U.S. economy. Thus columns R through W represent items that reflect the capacity of the economy to continue to provide the same level of welfare over a prolonged period.

Column E: Household services such as cooking, cleaning, and child care contribute to economic welfare even though they are not sold in the market at an observable price. On pages 414–15 we pointed to several theoretical and empirical problems involved in imputing the value of household, nonmarket labor. We have nevertheless included it because of its tremendous significance as a factor in overall economic welfare.

We have derived this column from figures presented by Robert Eisner in "The Total Incomes System of Accounts" (*Survey of Current Business*, January 1985). He provides estimates in 1972 dollars for 1946, 1956, 1966, 1971, 1976, and 1981. We have used a regression on the logarithm of those estimates to interpolate and extrapolate for other years. Eisner explains the methodology he used: "The value of unpaid household work is taken conservatively to be the product of annual hours in relevant household activities and the average hourly compensation of household domestic workers. The time estimates were derived from the Michigan Survey Research Center time use studies of 1965, 1975, and 1981, with the 1975 survey used as the benchmark" (Eisner 1985, p. 30).

Column F: In order to count only the value received each year from capital equipment rather than its initial purchase price, we add the value of the services that flow from consumer durables here and subtract the actual expenditures on consumer durables elsewhere (column I). To the extent that household equipment wears out more quickly than it might, it inflates the personal consumption account without contributing to welfare. If washing machines, on average, lasted 100 years rather than 15, fewer would be bought, and personal consumption would not rise as rapidly as it would otherwise, but welfare would not be diminished. By using the estimated value of the service from such equipment rather than its purchase price, we have attempted to overcome this distortion in current measures.

To calculate this column, we used the table entitled "Constant Dollar Net Stock of Consumer Durables" in the *Survey of Current Business*, March 1979, April 1981, October 1982, and August of 1983, 1984, and 1987. For each year we multiplied the total net stock by 10% to approximate the ratio of housing services to net housing stock given in the *National Income and Product Accounts* (*NIPA*). (Actual proportions for a sample of years are: 1950, 8.5%; 1955, 9.6%; 1960, 10.7%; 1965, 11.7%; 1971, 11.2%; 1974, 10.0%; 1977, 9.7%; 1980, 9.5%; and 1983, 11.3%)

Column G: With the exception of this column and column H (certain expenditures for health and education), we have not included government expenditures as adding to welfare because they are largely defensive in nature. That is, the growth of government programs does not so much add to net welfare as prevent deterioration of well-being by maintaining security, environmental health, and the capacity to continue commerce. In addition, some government enterprises, such as transit systems and sewer or water districts, provide services for a fee in a manner similar to private businesses. These payments already show up as personal consumption in the national income accounts. However, there are some services provided by the government that could theoretically be offered through the market but which are difficult to meter. The main item in that category is the provision of streets and highways. Since the annual value of services from roads is not calculated, we have imputed it from estimates of the value of the stock of streets and highways.

To calculate this column (see table A.3), we used the table entitled "Constant Dollar Gross Stock of Government-Owned Structures, Excluding Military, by Type of Structures" in the *Survey of Current Business,* March 1980, February 1981, October 1982, August 1983, and August 1984. (Because later estimates of the stock of government-owned structures—for 1984–86—were not disaggregated by type of structure, we had to make estimates for those years based on aggregated figures.) We added together the "highways and streets" columns for federal and state and local governments. We estimated the net stock as being two-thirds of the gross stock, based on the approximate ratio of net to gross for all government-owned nonmilitary structures. We then estimated that approximately three-fourths of all vehicle miles (for both passenger and freight travel) are for noncommuting travel and therefore contribute to welfare. The net stock of roadways that contributes to welfare is thus two-thirds times three-fourths—i.e., one-half—of the value of the gross stock in each year. To find the annual value of services from this stock, we multiplied by 10%, which is the approximate ratio of housing services to net housing stock that appears in the *NIPA*. (See the explanation of column F.)

Column H: We have excluded most government expenditures from our estimate (but see column G) because they measure inputs or costs rather than outputs or benefits. The correlation between increases in government spending and real increases in welfare is tenuous because of the difficulty of measuring the demand for the kinds of services that government offers. Nevertheless, we have assumed that a portion of the money spent on education and health contributes to welfare and should be added to personal consumption.

With the exception of one-half of public spending on higher education, we regarded most expenditures on education as being neither consumption nor investment. Earlier, we explained why we have not counted education as investment: the evidence suggests that it contributes little to productivity. On the other hand, it would be inappropriate to count education as consumption because most schooling appears to be defensive. In other words, people attend school because others are in school and the failure to attend would mean falling behind in the competition for diplomas or degrees that confer higher incomes on their recipients. (We assumed that compulsory attendance laws are not the primary motivation for going to school.) We assumed, nevertheless, as Zolotas did in his study, that one-half of post-secondary education is pure consumption in the sense that it is sought for its own sake rather than to serve another purpose. Thus, we have added one-half of public expenditures (federal, state, and local) for higher education from tables 3.15 and 3.16 of the *National Income and Product Accounts*. (See table A.4, column c.)

In the case of expenditures on health by the public sector, we have assumed that they are valued as highly as private expenditures for the same purpose. We have added only that portion of public health expenditures that are assumed to add to social welfare. (See table A.4, column e.) From the inflation-adjusted expenditure in each year, we subtracted the amount spent in 1950 (also in 1972 dollars) to determine the *increase* over the base year. We divided that difference by two to take into account the "defensive" expenditures necessary to compensate for the growth of environmental stresses on health (as we do for private health expenditures in column J). All figures are derived from the *Statistical Abstract of the United States* (1988, table 129, p. 86). Expenditures are adjusted for inflation using the "medical care" component of the Consumer Price Index in the *Statistical Abstract* (1988, table 738, p. 450). (Please note that for this and all later references to the *Statistical Abstract*, we have cited only the 1988 edition. In fact, we often referred to previous editions to fill in gaps in the data.)

Column I: The value of private expenditure on durable goods in constant (1972) dollars comes from the *National Income and Product Accounts*, table 1.2. The estimates for 1985 and 1986 were derived in the same manner as the estimates of personal consumption. The reason for subtracting expenditures on consumer durables is explained in the note on column F.

Column J: Here we *subtracted* the portions of *private* education and health expenditures that do not contribute to welfare. We subtracted them because they are included in column B, personal consumption.

We subtracted all expenditures on private education except one-half of private expenditures on higher education, based on the same rationale given in the explanation of column H. (See table A.5, column d.) The cost of private education, for both total and higher education, was taken from the *NIPA*, the table entitled "Personal Consumption Expenditures by Type of Expenditure" (table 2.4), and adjusted to 1972 dollars by the implicit price deflator for private education in table 7.12.

Similarly, we subtracted defensive private health expenditures from total welfare. As in the case of public expenditures on health, we assumed that half of the real growth in private health expenditures is purely defensive in nature, i.e., compensating for growing health risks due to urbanization and industrialization. We subtracted the inflation-adjusted expenditure level in 1950 from the expenditure in each subsequent year to determine the increased spending on health above a base level. We then divided the difference by two to represent the proportion of expenditures that are defensive in nature. (See table A.5, column f.) Total private health expenditures come from *Statistical Abstract* (1988, table 129, p. 86). Costs are adjusted for 1972 prices by the "medical care" component of the Consumer Price Index, from *Statistical Abstract* (1988, table 738, p. 450).

Column K: The value of national advertising expenditures comes from the *Statistical Abstract* (1988, table 896, p. 529), and is adjusted for inflation using the "Services Deflator" in the *National Income and Product Accounts* (table 7.12). We subtracted national, but not local, advertising expenditures (in contrast to Zolotas, who subtracted one-half of total advertising expenditures) because we reasoned that local advertising (especially in newspapers and on the radio) tends to offer information of value to consumers about the location and price of goods. By contrast, national advertising (especially on television and in magazines) tends to be aimed at creating demand for products and brand-name loyalty through the use of images that have little to do with the actual product.

Column L: The direct (out of pocket) costs of commuting were calculated as follows (see table A.6):

$$\begin{aligned} C &= 0.3\,(A - 0.3\,A) + 0.3\,B \\ &= 0.3\,(0.7\,A) + 0.3\,B \\ &= 0.21\,A + 0.3\,B \end{aligned}$$

where:

C is the direct cost of commuting.

A is the cost of user-operated transport (mainly cars) from the *National Income and Product Accounts* (table 2.4). This figure was adjusted to constant (1972) dollars with the implicit price deflator for personal consumption expenditures on motor vehicles and parts found in the *NIPA* (table 7.12).

$0.3\,A$ is the estimated cost of depreciation of private cars (which is excluded here to avoid double counting since it was already included as an element in column G) from the *Statistical Abstract* (1987, table 1040, p. 593).

0.3 is the estimated portion of total noncommercial vehicle miles used in commuting in 1983 (see *Statistical Abstract* 1987, table 1033, p. 591).

B is the price of purchased local transportation (see *National Income and Product Accounts*, table 2.4).

0.3 is the estimated portion of passenger miles on local public transportation used for commuting.

We did not include indirect costs of commuting (the value of the time lost in commuting) in our calculations because we lacked reliable data. In theory, we regard this as a significant cost of the presumably increased congestion that accompanies urban growth, but we could not find a time series showing changes in the amount of time spent commuting to work. Zolotas used an estimate made in 1965–66 of 52 minutes for men and 42 minutes for women. He then assumed an increase of 2 minutes per year after that period. That would indicate that commuting time in 1980 should have been 80 minutes for men and 70 minutes for women. In fact, according to the 1980 Census (vol. C 3.223/7 : 980, *General Social and Economic Characteristics*, p. 70), average commuting time in 1980 was 43 minutes, less than the combined average for men and women in 1965–66. Did commuting time actually decrease over time? Were the methodologies or populations of the two surveys sufficiently different to account for this difference? We simply do not know. Therefore, we have not subtracted the indirect costs of commuting, though doing so would certainly reduce economic welfare each year by tens of billions of dollars.

Column M: A partial measure of the cost of urbanization is the higher cost of living associated with increasing density. In other words, as population grows in urban areas, the cost of land increases without any compensating increase in welfare. In order to measure this aspect of the cost of urbanization, we computed the proportion of rental (and imputed rental) payments that reflect the price of land rather than structures built on land. To arrive at the figures in column M (see table A.7), we multiplied (a) the value of residential land as a percentage of the total value of residential property (land value divided by the combined value of land and improvements) times (b) aggregate annual expenditures on housing (including the imputed rental value of owner-occupied dwellings). The first part of the equation (value of land divided by total value of property) is derived from *Balance Sheets For the U.S. Economy 1947–86* (Federal Reserve Board, pp. 11–15, lines 4 and 9). The second part of the equation (aggregate housing expenditures, including imputed expenditures) comes from the *National Income and Product Accounts*, table 2.4, adjusted for 1972 prices by the implicit price deflator for housing, table 7.12.

Column N: Damage due to accidents represents a real cost of industrialization and higher traffic densities. Figures are available only for the damages due to motor vehicle accidents. They are derived from *Statistical Abstract* (1987, table 997, p. 579). They are adjusted for inflation using the Consumer Price Index.

Column O: The figures in this column are a composite of two estimates: (1) damages to water quality, primarily from point source discharges (sewage and industrial wastes), and (2) damages due to siltation resulting from erosion from farms, construction sites, and roadways. Although this may involve some double counting (insofar as siltation also damages water quality), we suspect that on the whole we have underestimated the first type of damage because of the lack of data on non-point sources of pollution. If they are marginally included under erosion costs, that only partially corrects for a more general underestimation of the total damage.

Damages due to point source discharges. We have estimated the cost of damage from water pollution as $12.0 billion in 1972 and derived estimates for earlier and later years based on subjective estimates and surveys. (We did not include the cost of building sewage treatment facilities because that is a public expenditure and therefore not included in our initial estimate of welfare, i.e., column B, "personal consumption.") The numbers in this column are of limited reliability, though we consider them reasonable and plausible.

A number of factors contribute to the difficulty of making reliable estimates of the dollar value of the damage caused by water pollution:

1. No universally acknowledged measure of "water quality" exists. A number of different elements may contribute to poor water quality, such as biological oxygen demand (or conversely, low dissolved oxygen levels), phosphorous, nitrogen, suspended solids, dissolved solids, turbidity, and temperature. With no means of developing a single composite measure of their joint effects, the term "water quality" has no precise meaning.

2. Even if we had a single composite measure of water quality, the actual measurement of water samples is not very reliable. Infrequent samples, measurement inaccuracy due to the imprecision of laboratory tests, and faulty monitoring and laboratory procedures all contribute to a low level of confidence in measured results.[13]

3. Precise numerical relations have not been established between the components of water quality (number 1 above) and the capacity of water to support fish or other wildlife or to support swimming and other recreational activities.

4. If a reliable estimate of water pollution could be devised for a particular water basin, aggregating data across regions would still elude us. Unlike the problem of air pollution, where the entire atmosphere serves as a "sink" for airborne wastes and where speaking of national air quality has some meaning, an aggregate measure of water quality is complicated by the fact that there may be improvements in one river basin or lake while another is becoming more polluted.

5. Even if a reliable baseline estimate could be derived for one year, we

13. See Gianessi and Peskin 1981, 803–21, and especially 813–17.

would still not know whether water quality were improving or deteriorating without comparable data for other years. Such data exist only in the form of highly subjective estimates.

6. Unlike the relatively direct estimation of air pollution damages (see the explanation of column P), many of the costs of water pollution must be calculated almost entirely from indirect evidence such as the loss of swimming, fishing, and boating opportunities. Thus, to determine recreation benefits of improving water quality, economists have had to rely on proxy measures such as changes in the amount of time and money spent on *transportation* to alternative recreation sites in response to changes in water quality. (In other words, the measure of pollution damage comes from estimating the additional money people are willing to spend to drive to a new recreational site if a closer one has been contaminated by pollution.) The outcome of these studies is heavily dependent on the assumptions about the magnitude of shifts in participation rates in water-based recreation in response to meeting the 1985 water quality objectives set by Congress.

7. Finally, estimates of the cost of water pollution generally attempt to measure only damages resulting from point source discharges (i.e., pollution coming out of municipal and industrial sewers). The cost of damage caused by urban and farmland runoff is not included. Since those non-point sources of pollution are often at least as serious as point sources, neglecting the impact of the former considerably underestimates the actual costs or damages from water pollution. As of the late 1970s, after several years of efforts to control point sources but with minimal control of non-point sources, the latter contributed 57% of BOD, 98% of suspended solids, 83% of dissolved solids, 87% of phosphorus, and 88% of nitrogen discharged into U.S. waterways. (These figures are derived from Gianessi and Peskin 1981, 804, table 1.)

Keeping those caveats and conditions in mind, we have estimated the total damage from water pollution in 1972 as approximately $12 billion. Our source is A. Myrick Freeman, *Air and Water Pollution Control: A Benefit-Cost Assessment*, chapter 9. Three of the studies he cites came to the conclusion that the upper limits of the range of estimated damages to recreation from point source pollution was around $18 billion in 1978 dollars. Freeman's own upper estimate of recreation benefits that would be realized by eliminating point source discharges is $8.7 billion in 1978 dollars (or about $6 billion in 1972 dollars). Adding damages to aesthetics, ecology, property values, and diversionary uses (household and industrial water supplies), his upper estimate of damages is $18.4 billion in 1978 dollars ($12 billion in 1972 dollars). Though Freeman's best estimate for damage from point source pollution is only $9.4 billion ($6 billion in 1972 dollars), we have used the less conservative figures on the assumption that the inclusion of non-point source pollution would at least double the *total* pollutant load in many river basins and increase it several-fold in others. Thus a $12 billion estimate of water pollution damage in 1972 may even be conservative.

In the absence of any reliable time series data about water pollution, our estimates of changes in pollution damages over time are not very reliable. Based on the Conservation Foundation's *State of the Environment: An Assessment at Mid-Decade,* "the years 1974 to 1981 saw little change in water quality with respect to the conventional pollution indicators." This finding is based on the U.S. Geological Survey's National Ambient Stream Quality Accounting Network. It is confirmed by a 1984 survey of the Association of State and Interstate Water Pollution Control Administrators and the 1982–83 National Fisheries Survey. (See page 109 of the Conservation Foundation report.) We assume that this overall lack of improvement means that the improvements that did take place as a result of more stringent pollution controls were offset by the growth of population and polluting activities. By contrast with the unvarying levels of the 1970s and 1980s, we have assumed that water quality declined during the 1950s and 1960s at 3% per year before a concerted national effort was undertaken to address the issue.

Damages due to siltation. In addition to the estimates of damage to water quality, we have included data on the effects of erosion from farmland as well as streambanks, roadbanks, and construction sites. We assume here that the deterioration of water quality due to these non-point sources has already been included in a general way in the calculations on point source discharges. Our estimate here is of the costs of dredging navigable rivers and the damages posed by siltation to dams and other water impoundments, as well as costs of sediment-related flooding and other off-stream effects. The Conservation Foundation estimated that these damages were in the range of $3.2 to $13.0 billion in 1980, with a best estimate of around $6.0 billion. That would be about $3.3 billion in 1972 dollars (using the implicit GNP deflator).

Estimating changes in these costs over time is difficult. Two point estimates of the amount of total erosion exist for 1977 and 1982, derived from the National Resources Inventory, which was undertaken in both of those years by the Soil Conservation Service in conjunction with Iowa State University. In both 1977 and 1982, total erosion was estimated at 6.5 billion tons. We have assumed that the five-year trend has remained constant until the present and that it began in 1972 when the massive growth of grain exports led to shifts in land use, particularly the plowing of marginal, erosion-prone soils, in an attempt to profit from the high levels of world demand. We have assumed that during the previous 22 years erosion increased by an average of 1% per year. We recognize that estimates for these previous years are essentially speculative and would prefer reliable data. We also realize that farmland erosion may have remained approximately constant during that period in the absence of data to the contrary. Nevertheless, we believe that the overall problem of sedimentation from erosion probably increased during this period as a function of general economic growth, particularly from urban construction and the development of the interstate highway system.

Column P: Following A. Myrick Freeman's analysis in *Air and Water Pollution Control* (cited in discussion of water pollution above), we have divided estimates of the costs of air pollution into six categories: (1) damage to agricultural vegetation; (2) materials damage; (3) costs of cleaning soiled goods; (4) acid rain damage; (5) urban disamenities; and (6) aesthetics.

1. We have estimated damage to agricultural vegetation at $4 billion. According to a study by Heintz, Herschaft, and Horak in 1976, entitled "National Damages of Air and Water Pollution," the level of damages to agricultural vegetation due to oxidants in 1973 was $2.8 billion. Freeman suggests this estimate is too low because it fails to reflect the fact that farmers have not only sustained crop damage from air pollution but that they have also shifted to less profitable crops. We have assumed this added cost would raise the total cost of air pollution damage to crops to approximately $4 billion in 1970 (in 1972 dollars).

2. We have estimated materials damage due to corrosion of paint, metals, rubber, and so on at $6 billion. Zolotas uses an estimate from Liu and Yu of $38.4 billion in 1970, and since that amount is only about 3% of the net stock of fixed reproducible wealth owned by households for that year (including all residential structures and durable equipment), that rate of deterioration due to air pollution may in fact be plausible. We have chosen $6 billion as our estimate to bring it more into line with Freeman's middle estimate of $3.2 billion.

3. We are using the same figure as Zolotas for our estimate of the cost of cleaning soiled materials as a result of air pollution—$5 billion. That figure is derived from Liu and Yu. It is confirmed by Freeman's estimate that a 20% reduction in airborne particulates would reduce cleaning costs by $0.6 to $3.8 billion. Though additional reductions in particulates would not have correspondingly dramatic results, this nevertheless suggests that an estimate of $5 billion for total damages in this category is reasonable and perhaps conservative.

4. Based on Freeman, we have conservatively estimated total damages to forests and aquatic ecosystems due to acid rain as $1.5 billion in 1972 dollars. (See Freeman 1982, p. 107).

5. We have estimated the total reduction in the quality of urban life as a result of air pollution to be approximately $9 billion. This involves two components: (1) a reduction in property values in proportion to the level of

pollution in an area and (2) the necessity of paying higher wages to attract people to work in areas with high levels of pollution. Freeman estimates reduced property values to be $4 billion as a result of stationary sources and $1.5 billion as a result of mobile sources (both in 1972 dollars). For wage differentials, he cites a study by Meyer and Leone that concluded that wage differentials necessary to attract workers to pollution prone areas were $6.1 billion for particulates, $2.1 billion for sulfur dioxide, and $5.1 billion for nitrogen oxides. If all of these factors (reduction in property values and wage differentials) were simply additive, the total reduction in quality of life would be $18.8 billion. Since there is overlap among their effects and with other damage estimates (such as between cleaning costs and property values), we have included only $9 billion, or approximately one-half of the total from this category.

6. We have assumed a total of $4.5 billion in damage to aesthetic values due to loss of visibility and enjoyment in national parks and other scenic areas. This is based on a study in the region surrounding the Four Corners Power Plant where residents said that they would be willing to pay $85 per year to improve the aesthetic conditions of the area considerably. Since our estimate of $4.5 billion amounts to about $20 per person per year to pay for visibility improvements, we believe that it is a plausible figure.

Adding these figures (vegetative damage, $4 billion; corrosion and materials damage, $6 billion; cleaning and soiling, $5 billion; acid rain, $1.5 billion; reduction in urban quality of life, $9 billion; and aesthetic costs, $4.5 billion) we arrive at a total of $30.0 billion in costs associated with air pollution for 1970 (in 1972 dollars).

If this $30 billion estimate seems excessive, we would like to point out that we consider it conservative because we have attempted to exclude from our calculations all estimates of damages to health due to air pollution. Those damages may be included indirectly in the estimate of wage differentials, but we have consciously avoided including health costs as a separate category. We have also excluded health costs because we have put in two other columns (H and J) that specifically eliminate "defensive" health expenditures from the estimation of health benefits. Despite this, we suspect that some portion of health damages due to air pollution *could* be included here without double counting because many respiratory ailments (such as colds, flu, bronchitis, etc.) do not require medical attention, yet they are exacerbated and prolonged by exposure to air pollution. Other chronic conditions that cause discomfort and reduce productivity but that do not require medical attention—from shortness of breath to headaches to burning eyes—would all constitute damages to health from air pollution that would not show up as "defensive" health expenditures. We suspect that these costs would amount to several billion dollars per year.

Furthermore, we have not included any estimate of the cost of increased mortality in our calculation of the costs of air pollution, in part because this might involve some double counting. We are also not entirely satisfied with the idea of setting a dollar value on human life. On the other hand, neglecting this category altogether, as we have done, implicitly places zero value on human life (or more precisely on the value of living a longer life). We are not entirely happy with that result either. Nevertheless, if we were to include some measure of the costs of increased mortality, we would base it on the value of life revealed in the willingness of people to pay to reduce the overall death rate in a large population. Since all of us make trade-offs between activities involving a higher probability of death and measurable benefits, this procedure reflects the value we implicitly place on the probability of remaining alive. If the value per death avoided (in this probabilistic sense) is approximately $1 million in our society as some studies suggest, we can determine the dollar cost of air pollution on mortality rates at least within an order of magnitude. With that dollar value as a baseline figure, it is possible to estimate the damage of air pollution once the physical relation between air pollution and mortality is known. Freeman cites a number of studies that derive estimates of the elasticity of mortality with respect to air pollution of between 0.01 and 0.09 (meaning a 1% increase in air pollution causes an increase in mortality of between 0.01% and 0.09%). Using those figures and Freeman's calculations, we arrived at a best estimate of the cost of increased mortality due to air pollution of about $13 billion (in 1972 dollars). This is based on estimates of mortality benefits of about $10.5 and $12 billion for 20% and 60% reductions in air pollution, respectively. We assume that elimination of the remaining 40% of air pollution would add only $1 billion in benefits. In any case, we assume that the addition of the costs of higher mortality associated with air pollution would add another $10 to $15 billion in 1970 to the $30 billion estimate we are in fact using.

Our estimate of time series for air pollution damages is based on EPA's *National Air Pollutant Emission Estimates*, as summarized in the *Statistical Abstract* (1988, table 332, p. 192). The volume of emissions in 1986 is an extrapolation from previous years since data were not available. We combined the emissions of particulates, sulfur oxides, and nitrogen oxides for each year and created an index number to show changes over time. (See table A.8.) A better model would calculate the damage from each type of pollutant each year and add the sum of those dollar figures together, but we do not have the sophistication to develop such a model.

Column Q: The damage caused by noise pollution in the United States in 1972 was estimated to be $4 billion by the World Health Organization (according to an article on noise pollution in the 1972 *Congressional Quarterly Almanac*, p. 980). We have assumed that increasing industrialization and expansion of the highway system and of the number of airports caused noise pollution to get worse during the period from 1950 to 1972 at 3% per year. We have assumed that since 1972 noise abatement regulations have slowed the rate of growth of the noise level to 1% per year.

Column R: To calculate the value of the loss of wetlands, we first estimated the value per acre of the flow of services from an acre of wetland at $600 (1972 dollars). This is approximately one-third more than the median value of $448 per acre per year estimated for flood protection, water purification, provision of wildlife habitat, and aesthetics by T. R. Gupta and J. H. Foster in "Economic Criteria for Freshwater Wetland Policy in Massachusetts."[14] We estimated a higher figure than Gupta and Foster because they did not account for what economists call "consumers' surplus" in their valuations. (Consumers' surplus means the amount that purchasers or beneficiaries of an item or service would have been willing to pay above and beyond the actual price. We do not know how much this would actually be in the case of wetland services, so we have made a reasonable estimate.) In addition, $600 is a relatively conservative figure since calculations of the value of saltwater wetlands have arrived at estimates 3 to 20 times as high. (See Lugo and Brinson, "Calculations of the Value of Saltwater Wetlands," in Greeson, Clark, and Clark 1979, p. 124.) The estimated loss of 600,000 acres per year through 1973 comes from the *Annual Report* of the Council on Environmental Quality (July 1982), and the estimated loss of 300,000 acres per year in subsequent years comes from the testimony of Robert A. Jantzen, director of the U.S. Interior Department's Fish and Wildlife Service before the Senate Environment and Public Works Committee on 20 November 1981.

The loss of the stream of benefits from wetlands is a cumulative process. In other words, if 600,000 acres of wetlands were filled or drained in two successive years, at the end of the second year the loss would equal the stream of benefits flowing from 1.2 million acres of wetlands. Thus we have added the loss of benefits from wetlands each year to the total from the previous year.

Our base figure of $10 billion for 1950 is largely arbitrary. We estimated that a total of approximately 100 million acres of wetlands were filled in North America to make way for farming and other activities from the colonial period to 1950. (This is based on a decline from approximately 215 million original acres to about 110 million in 1950, according to *Wetlands of the U.S.: Current Status and Recent Trends*, Fish and Wildlife Service, March 1984, p. 29.) We reasoned that the value of each of the initial tens of millions of acres of lost wetlands was lower than the marginal value of the

14. From *The American Journal of Agricultural Economics* 57 (1): 40–45; cited in Greeson, Clark, and Clark 1979, pp. 88.

remaining acres that were filled in recent decades. (Likewise, the value of the last million acres on the continent will be greater than $600 per acre because of the greater scarcity of the resource at that time.) Thus we multiplied an average value of $100 an acre of services from wetlands by 100 million acres to arrive at $10 billion as a plausible estimate of the cumulative loss to that time.

Column S: This column reflects two logically distinct ways in which the biologically productive capacity of farmland has been reduced. On the one hand, urban expansion (including the construction of highways) permanently removes land from production by paving it over. On the other hand, poor land management that destroys the soil through erosion, compaction, and decomposition of organic matter removes land gradually from production by lowering its productivity. Measuring either of these losses in dollar terms is both complicated and somewhat arbitrary, but because of the importance of food production in the long-run sustainability of the economy, we feel that it is imperative to make an attempt at measuring this loss.

As a result of the industrialization of agriculture, particularly since World War II, the productivity of labor and other nonenergy inputs (including farmland) increased steadily over time as those inputs were replaced by increasing amounts of energy (including embodied energy such as fertilizers or machines that themselves required energy to produce). This led to the assumption that crop yields would continue to increase indefinitely as new genetic strains were developed and new techniques were applied. From that perspective, the loss of a fraction of a percent of the cropland base to nonagricultural uses each year or a slight annual decline in productivity of the underlying soil base is insignificant if technological progress grows faster than those sources of decline.

In a world of continuously declining real energy costs, that perspective would be partially valid (though with some reservations because chemical inputs cannot entirely substitute for the organic content of the soil beyond a certain point). However, as we noted in the introduction, the real cost of energy is rising and will continue to rise in the future because of the increasing energy cost required for discovery and extraction and processing of new sources of energy. The implications of the rapid depletion of low-cost energy resources available for agriculture are staggering. For over forty years, the use of energy-intensive inputs to agriculture has masked the declining size and quality of the soil base upon which farming ultimately depends. Fertilizer has increased crop yields dramatically, but at a cost of breaking down the humus in the soil, oxidizing the soil carbon, and allowing farmers to ignore the effects of erosion. As long as fertilizer is relatively cheap, the effects of this degradation can be temporarily overcome by adding more fertilizer, though that merely exacerbates the problem in the long run. Likewise, irrigation can boost yields considerably as long as water can be pumped from rivers or aquifers at low cost. However, as energy (including embodied energy) costs rise and as aquifers are depleted, this source of growth in agriculture will be shown to be unsustainable. Moreover, the process of irrigation can itself lead to soil degradation if it increases either erosion or the salinity of the soil.

Economists also tend to downplay the reduction in quantity and quality of cropland by pointing out that there are over 100 million acres of land that are currently unused or are being used as rangelands or pasture that could be brought into crop production. Undoubtedly some of this land will in fact be brought into production in the future as energy inputs to agriculture become more expensive and as some of the land currently used for crops becomes exhausted from overuse. Nevertheless, this land is not already being used as cropland for economic reasons and because it has high erosion potential: "Most of the land with high or medium potential for conversion is in soil classes IIe, IIIe, or IVe, and 'e' stands for erodible. According to the 1980 RCA draft (p. 3–4), even the better of those soils are dangerously erodible when in crop production" (Healy 1982, p. 115). In other words, the sanguine view that the loss of valuable cropland can be compensated by conversion of other land to more intensive use is not supported by the facts.

Another pernicious idea in economics that downplays the significance of soil loss is the discounting of future costs and benefits. Thus the present value of farmland is based on the productivity of the land, but only after the value of future yields has been reduced by a compound interest formula. The damage caused by erosion or urbanization to future productivity thus appears as insignificant in conventional economic analyses. In effect, this theory says that the fertility of the soil *should* be exhausted as long as the expected rate of increase in the value of farmland is less than the interest rate. The farmer who does this will then be able to pass on greater total assets (higher profits alongside a lower land value) to the next generation than the farmer who is concerned primarily with maintaining a permanently viable farm.

Our purpose is to calculate the *sustainable* economic welfare of our activities. We have therefore subtracted the cumulative damages to long-term productivity of land that result from urbanization and poor land management. We would like to have estimated the undiscounted costs our current practices impose on our descendants who will no longer be able to make up for the loss of land area and declining soil quality with fossil fuels. However, we were forced to settle for estimates that are undoubtedly based only on the discounted value of lost productivity (especially in the discussion of losses due to deteriorating soil below). Thus we believe that our estimates understate the magnitude of the cost being imposed on the future as a result of unsustainable practices.

Losses due to urbanization. The amount of farmland that has been lost to urbanization is the subject of a great deal of controversy. The 1981 National Agricultural Lands Study (NALS) created a furor by arguing that the rate of farmland loss had grown from about one million acres per year in the period 1958–67 to about three million acres per year in the period 1967–75. Recognizing certain methodological and definitional problems in the study, we have chosen to assume that the one million acres per year figure has probably been constant throughout the period of our study (1950–84) and that the proportion of cropland being converted to urban uses has remained at about 30% of that. In other words, we have adopted a conservative estimate for cropland loss due to urbanization of 300,000 acres per year. (This compares to the estimate in the NALS of 600,000 acres per year of cropland or 800,000 acres per year of cropland plus potential cropland.)

We then estimated that the value of an average acre of converted cropland, based on its productivity in the absence of high applications of fertilizers and other energy-intensive inputs, would be $100 per acre per year or a capitalized value of $1,000 per acre (in 1972 dollars). We are assuming that the underlying value of farmland exceeds the market value today. Since our aim is to calculate *sustainable* economic welfare, we have chosen a figure that represents the value of land *as if* cheap energy sources had already been depleted. Without nitrogen fertilizer (derived from natural gas), for example, farm output would be lower and food prices would be higher. The demand by farmers for high-quality agricultural land would increase, raising its price. We regard that (unknown) price as the appropriate one to use when calculating the value of land lost to urbanization. We believe $1,000 per acre to be conservative, even if it seems high in terms of current market prices. It should be remembered that the best land for urban uses is generally the highest quality farmland in terms of slope, drainage, and other soil characteristics. Thus urbanization has generally caused the conversion of the most valuable croplands.

We began this calculation with an estimated accumulated loss of $1 billion to represent the value of services from farmland that had already been lost through urbanization by 1950. Since 15 million acres were in urban areas by that date and another 24 million had been transformed into highways and rights-of-way by then,[15] our estimate of $1 billion implies that the average value of the loss to agriculture was about $25 per acre per year. As in the case of wetlands, we have assumed that the marginal utility or value

15. *Statistical abstract* 1982, table 1154, p. 658, from U.S. Department of Agriculture, *Major uses of land in the United States: 1978.*

of the first acres removed from agriculture is lower than the value of the land most recently urbanized.

In summary, we have calculated that urbanization annually removes from the cropland base a stream of agricultural services worth $30 million (300,000 acres times $100 per acre) and that the total cost is an accumulation of these losses, beginning with a loss of $1 billion in 1950. (See table A.9, column d.)

Losses due to deteriorating soil. The visible loss of land to urbanization is probably not as serious a problem as the less evident reduction in the quality of land as a result of poor management practices. Economists tend to downplay productivity losses resulting from mismanagement because tangible productivity (in terms of yield per acre, though not in terms of yield per unit of energy input) has increased rapidly over the past forty years. In addition, productivity losses due to soil depletion are probably not linear, which means that the effects of erosion and compaction and loss of organic matter from the soil may not show up in yield reductions until the soil is irreversibly damaged. This is especially true, as noted above, when chemical fertilizers mask the effects of soil depletion temporarily, even as they contribute to it in the longer run.

As a result, calculation of the loss of soil productivity is difficult. We expect that our estimates of this cost are underestimates of the true cost of current practices because the impact on the future has presumably been discounted and because loss of productivity is measured only against yields inflated by energy-intensive inputs.

In 1980 economists at the Soil Conservation Service of the U.S. Department of Agriculture estimated that agricultural productivity losses resulting from erosion were approximately $1.3 billion (or about $0.7 billion in 1972 dollars).[16] Since we do not know the methodology for arriving at that result, we checked it using an alternative method of calculation and a different data source. The NALS estimated in 1977 that 1.7 million acre-equivalents of land were lost each year because of erosion. If we assume that about one-half of the serious erosion takes place on cropland, then a per-acre cost of about $800 for this eroded land would yield the same result as the SCS estimate. (Thus 1.7 million acre-equivalents divided by 2, times $800 per acre = $680 million or $0.68 billion.)

We have assumed, as we did in the discussion of erosion impacts on watercourses (see explanation of column O), that the rate of erosion has remained fairly constant since 1972 and that it increased by 1% per year from 1950 up to that point. We have also assumed that some damage had already

16. From "Background for 1985 farm legislation," Agricultural Information Bulletin 486 (January 1985); also cited in *Environmental quality* (1984), Fifteenth Annual Report of the Council on Environmental Quality.

occurred prior to 1950. Thus we have begun our calculation with a cumulative loss of $5 billion in 1949, with further costs added to that. (See table A.9, column b.)

The damage to soil from compaction by heavy machinery was estimated at $3.0 billion in 1980 ($1.67 billion in 1972 dollars) by R. Neil Sampson in *Farmland or Wasteland* (1981). We assume that that figure increased by 3% per year both before and after 1980. (See table A.9, column c.)

The amount in column S represents the total from the two types of soil loss: urbanization and deterioration, of which the latter is divided into two components. (See table A.9, column e.)

Column T: We consider the depletion of nonrenewable resources as a cost borne by future generations that should be subtracted from (debited to) the capital account of the present generation.

In order to estimate the proper amount to subtract for depletion of "natural capital," we have examined a procedure developed by Salah El Serafy of the World Bank in an article entitled "The Proper Calculation of Income from Depletable Natural Resources" (El Serafy 1988). El Serafy's approach is to estimate the amount of money that would need to be set aside from the proceeds of the liquidation of an asset (such as a mineral deposit) to generate a permanent income stream that would be as great in the future as the portion of receipts from the nonrenewable assets that are consumed in the present.

> An owner of a wasting asset, if he is to consume no more than his income, must relend some part of his receipts in order for the interest on it to make up for the expected failure of receipts from his wasting asset in the future. This proposition, which can be found in J. R. Hicks's *Value and Capital*, led me to convert the mineral asset concerned into a perpetual income stream. The finite series of earnings from the resource, say a 10-year series of annual extraction leading to the extinction of the resource, has to be converted to an infinite series of true income such that the capitalized value of the two series be equal. From the annual earnings from sale, an income portion has to be identified, capable of being spent on consumption, the remainder, the capital element, being set aside year after year to be invested in order to create a perpetual stream of income that would sustain the same level of "*true*" income, both during the life of the resource as well as after the resource had been exhausted. I set out to find the two constituent portions of current receipts: the capital portion and the income portion. Under certain assumptions which are neither too restricting nor unrealistic, I arrived at the ratio of true income to total receipts, viz.:
>
> $$X/R = 1 - \frac{1}{(1 + r)^{n+1}}$$
>
> where X is true income; R total receipts (net of extraction cost); r the rate of discount; and n the number of periods over which the resource is to be liquidated.

$R - X$ would be the "user cost" or "depletion factor" that should be set aside as a capital investment and totally excluded from GDP [or in this case from ISEW]. [El Serafy 1988.]

We applaud this model as the best attempt we have seen to come to grips with the proper method of accounting for depletion of nonrenewable resources or "natural capital." As a general principle, we agree with the capitalization of current income to yield a permanent income, but we are not entirely satisfied with the details of El Serafy's model.

First, the calculation of n, the number of years to exhaustion of a resource, poses some conceptual problems. The longevity of a mineral deposit at a specified rate of extraction is not a simple physical fact. The availability of the resource is a function not only of how much is "out there" but also of the intensity of the effort (in labor, capital, and energy) used to extract it. In other words, in El Serafy's equation, n (years to exhaustion of resource) is dependent on an exogenous variable, extraction costs. The equation is thus unspecified or indeterminate.[17]

Second, we replace the simplifying assumption in El Serafy's model that the price of nonrenewable resources in relation to the general price level will remain constant in the future. We do not do this in the way El Serafy suggests, but rather adopt a simpler expedient. From before 1900 to 1972, the declining cost of energy permitted resource prices to remain stable. During that period the proportion of GNP devoted to mineral resources fluctuated between 3% and 4%. However, that trend has shifted, presumably irreversibly. As noted above on page 408, the proportion of GNP devoted to mineral resources jumped from 4% to 10% from 1972 to 1982. Although this drastic increase has been somewhat reversed as a result of temporary declines in demand for oil and thus of oil prices, the analysis in *Beyond Oil* suggests that the real price of oil and other energy sources can be expected to begin climbing again in the 1990s, pushing up the price of all energy-intensive mineral exploration and mining as well.

As a result of rising resource prices, the amount set aside to maintain a permanent income stream in El Serafy's model should be some portion of the future price of extracted minerals, not of the current price. Otherwise the income stream would pay for less in the future than in the present, thus violating the avowed principle of creating equal real incomes in each time period. Consequently, using the R calculated on the simplifying assumption of constant prices would provide an insufficient amount to cover future

17. El Serafy suggests taking into account the conceptual problem of rising extraction costs by proposing that "reserves . . . be adjusted *downward* by a factor that would reflect the rising future costs of extraction" (El Serafy 1988, p. 22). This adjustment would reflect the closure of mines and wells when market prices are below extraction (and processing) costs. This is clearly an ad hoc adjustment that is exogenous to the basic model. Nevertheless, this is the most satisfactory treatment of it we have found.

claims against the income stream. However, since we cannot predict the future price of resources any more than El Serafy could, we cannot offer a specific way to replace *R* in the equation. Nevertheless, we are more inclined than El Serafy to say that future resource prices relative to general price levels will be higher than today.

Third, on a very practical level, we are not clear how one would estimate the value of *R* from existing sources, at least in the United States. The *Census of Minerals* provides data on the value of shipments, capital expenditures, cost of supplies, and value added in mining, and it defines value added as the sum of the first two values minus the third. Presumably, in El Serafy's equation, *R* is supposed to indicate rent, the return or "profit" to the enterprise holding the mineral rights. In principle, this could be calculated as a residual after subtracting wages, interest, and other production costs from value added, but in practice the data are not presented in a way that makes that possible.

Summarizing these criticisms of El Serafy's model, we can see that there is a great deal of arbitrariness in even the best effort to account for depletion of "natural capital." Our arguments suggest that the appropriate value of *R* might be several times as large as current market prices (to account for future price increases). The value of *n* cannot be specified in the equation without taking into account some estimate of extraction costs. In addition, since the availability of a resource is a function of both its cost of extraction as well as the limitation of its total quantity, *R* (receipts minus extraction costs) is not the proper figure for a welfare index. We have therefore used *R* plus extraction costs. Because extraction costs are "regrettable necessities," they should not be eliminated from this column, which will be subtracted to arrive at a welfare measure.

Consequently, we have chosen to subtract the *total* value of mineral production each year. We did not try to arrive at the figure of 100% of value through any precise means. Instead we offer several general considerations that lead to this result within the basic framework of El Serafy's model. First, with a zero discount rate we would always set aside 100% of receipts as capital, regardless of the life expectancy of the resource. Consequently, our earlier arguments against social (as opposed to individual) discounting may be invoked in this context. Combinations of low discount rates and low life expectancy of resources also produce a capital set-aside approaching 100%. A moderate discount rate of 4% combined with a life expectancy of 35 years, however, results in a 25% set-aside. Yet if we assume a fourfold increase in resource prices relative to prices in general over that period, which is not unreasonable, then the set-aside would again be 100%. For these reasons, we believe our procedure gains some support from El Serafy's method, although we recognize that our argument is suggestive rather than rigorous.

The source for the value of mineral production is *Historical Statistics: Colonial Times to 1970*, Series M 13-37, and updates in *Statistical Abstracts*. The original source is the *Minerals Yearbook*, and, for years after 1976, information on fuels comes from *Energy Data Reports*. For 1986, the value of fossil fuel production was unavailable, so we estimated it according to the quantity produced using 1985 prices.

The deflator we used is the Consumer Price Index (CPI) for all commodities. This may seem like an inappropriate index for this purpose, but we have chosen it deliberately. The more logical choice might seem to be the Producers Price Index (PPI) for energy (which is a fairly good proxy for price changes in all minerals). If our purpose were to determine changes over time in the physical quantity of energy produced, weighted by changes in energy sources (such as from coal to natural gas), the PPI would be the correct index. However, our purpose in selecting a deflator has to do with compensating for the effect of relative changes in price between minerals (especially energy resources) and the general price level that confronts consumers. In other words, we wish to separate out the rise in price of minerals due to general inflation from the price increases in this sector due to increased scarcity of particular resources. The use of CPI as a deflator has the effect of showing how much the price of minerals has grown in relation to prices in general.

We are far from satisfied with the arbitrary approach we have taken. Nevertheless, we regard the issue of resource depletion as too important to ignore. We hope, therefore, that others will pursue different approaches to this problem of estimating an amount that, subtracted from current welfare, would adequately compensate future generations for the resources we consume today. One way to do this might be to estimate the size of a tax on nonrenewable resources that would be high enough to prevent them from increasing in price faster than prices in general. The tax would achieve what Talbot Page calls the "conservation criterion" for equitable resource depletion (Page 1977, chap. 8). Nevertheless, we are not clear how to estimate the appropriate size of the hypothetical tax or how to incorporate it into the ISEW, so we have not followed this procedure.

Column U: In addition to using up mineral and fuel resources, our collective behavior also loads costs onto the future by dumping waste products into the environment that will have long-term consequences. The cost of keeping radioactive elements with long half-lives out of the environment for thousands of years is anybody's guess, since we have not yet devised a method of long-term storage. The costs to the future imposed by industrial activities that add carbon dioxide, nitrogen dioxide, and methane to the atmosphere (thereby contributing to the "greenhouse effect" and global climate change) and chlorofluorocarbons (which destroy ozone in the upper atmosphere) have only recently begun to be recognized. The full extent of the physical damage that has already been irreversibly inflicted on future generations is not yet known in each of these cases. The observable effects of flooded cities and completely eroded beaches as a result of higher sea levels as well as an exponential increase in cases of skin cancer from greater ultraviolet radiation represent only the first level of the threat. Even the disruption of established patterns of agriculture as a result of increased variations and unpredictability of weather will not be the most serious consequence of these changes. The greatest threat is ecological. The almost instantaneous change (on a geological scale) of the global climate and of ultraviolet radiation could have harmful effects on all but the most resilient species of plants and animals in those regions of the planet most drastically affected by climate change.

Almost no effort has been undertaken to estimate any of these damages in economic terms other than one EPA study which estimated that a sea-level increase of five feet would inundate 25% of Charleston, South Carolina, and increase storm damages in Galveston, Texas, by $82 million per year. Nevertheless, if we are to have a measure of net sustainable welfare, we cannot simply neglect the effect of these tremendous ecological catastrophes which our economic activities have begun to produce in such a short time.

We have assumed that the amount of damage to the future in terms of ecological disruption is directly proportional to the consumption of fossil fuels and nuclear energy—in effect to nonrenewable energy consumption. We have therefore begun by adding the total quantity of nonrenewable energy consumed each year in quadrillions of BTUs, starting in 1900.[18] Assuming that a barrel of crude oil contains approximately 5.8 million BTUs, we calculated the total barrel equivalents of energy consumed each year from 1900 to 1984. We then imagined that a tax or rent of $0.50 per barrel-equivalent had been levied on all nonrenewable energy consumed during that period and set aside to accumulate in a non-interest-bearing account, as in the case of resource depletion. (See table A.10.) That account might be thought of as a fund available to compensate future generations for the long-term damage caused by the use of fossil fuels and atomic energy. We are implicitly assuming that the cumulative undiscounted damages in the future caused by consuming a barrel of oil or its equivalent in the present are equal to $.50 in 1972 dollars. This is of course speculative, but considering the billions of dollars of property and recreational damage already caused by the rising of the oceans, it is not unreasonable. (See "Where's the Beach?" *Time* magazine, 10 August 1987, for anecdotal evidence.)

18. These figures are derived from the *Statistical abstract* 1988, table 904, p. 534, and from *Historical statistics of the U.S.: Colonial times to 1970*, supplemented with statistics from *Energy facts*, a Bureau of Mines annual publication.

Column V: In order for economic welfare to be sustained over time, the supply of capital must grow to meet the demands of increased population. More specifically, we have assumed that one element of economic sustainability is constant or increasing quantities of capital available for each worker. We have followed the general procedure used by Nordhaus and Tobin. However, unlike them, we have excluded human capital from our estimates for reasons explained earlier. We have thus calculated net capital growth by adding the amount of new capital stock (increases in fixed reproducible capital) minus the capital requirement, the amount necessary to maintain the same level of capital per worker. We estimated the capital requirement by multiplying the percentage change in the labor force by the stock of capital from the previous year. (See table A.11, column h.) Actually, we used a five-year rolling average of changes in labor force and capital to smooth out year-to-year fluctuations. (See table A.11, columns d and f.)

Fixed reproducible capital is derived from *Survey of Current Business*, August 1982 to August 1987. The size of the labor force comes from the *Economic Report of the President*, table B-29, which uses the estimates of the U.S. Bureau of Labor Statistics, *Employment and Earnings*.

Column W: The U.S. net international position measures the amount that Americans invest overseas minus the amount invested by foreigners in the United States. The annual change in the net international position indicates whether the United States is moving in the direction of net lending (if positive) or net borrowing (if negative). If the change is positive, the United States has in effect increased its capital assets. If it is negative, part of U.S. capital formation is in fact based on the borrowed wealth of foreign-owners that must eventually be repaid with interest. We have thus included annual changes in the net international position as a measure of the sustainability of the welfare of our economy. Some years from 1950 to 1975 have had to be interpolated. The figures each year have been adjusted for inflation using the implicit GNP deflator in the *National Income and Product Statistical Abstract* (1988, table 1330, p. 758) or *Survey of Current Business*.

Column X: The column marked ISEW or Index of Sustainable Economic Welfare starts with "Weighted personal consumption" (column C), adds the following 4 columns (D through G), subtracts the next 13 columns (H through T), and adds 2 columns (U and V).

Column Y: Per capita ISEW is calculated by dividing ISEW by the population for each year. For population, see *Statistical Abstract* (1988, table 2, p. 7).

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Column Z: The value of GNP in constant dollars comes from the *National Income and Product Accounts*, table 1.2. We made the same adjustment for 1985 and 1986 as we did for personal consumption. (See column B.)

Column AA: Per capita GNP is calculated by dividing GNP by the population for each year.

Table A.2
Index of Income Inequality

Year	Income received by 1st quintile	Income received by 2d quintile	Income received by 3d quintile	Income received by 4th quintile	Income received by top quintile	Sum [(f/b) + (f/c) + (f/d) + (f/e) + (f/f)] ÷ 5	Index of income inequality
a	b	c	d	e	f	g	h
50	4.5	12.0	17.4	23.4	42.7	3.67	109.0
51	5.0	12.4	17.6	23.4	41.6	3.36	100.0
52	4.9	12.3	17.4	23.4	41.9	3.43	102.0
53	4.7	12.5	18.0	23.9	40.9	3.39	100.8
54	4.5	12.1	17.7	23.9	41.8	3.57	106.2
55	4.8	12.3	17.8	23.7	41.3	3.40	101.2
56	5.0	12.5	17.9	23.7	41.0	3.30	98.1
57	5.1	12.7	18.1	23.8	40.4	3.21	95.3
58	5.0	12.5	18.0	23.9	40.6	3.26	97.1
59	4.9	12.3	17.9	23.8	41.1	3.35	99.6
60	4.8	12.2	17.8	24.0	41.3	3.41	101.3
61	4.7	11.9	17.5	23.8	42.2	3.54	105.3
62	5.0	12.1	17.6	24.0	41.3	3.35	99.6
63	5.0	12.1	17.7	24.0	41.2	3.34	99.2
64	5.1	12.0	17.7	24.0	41.2	3.31	98.5
65	5.2	12.2	17.8	23.9	40.9	3.25	96.5
66	5.6	12.4	17.8	23.8	40.5	3.10	92.0
67	5.5	12.4	17.9	23.9	40.4	3.11	92.5
68	5.6	12.4	17.9	23.7	40.5	3.09	92.0
69	5.6	12.4	17.7	23.7	40.6	3.11	92.4
70	5.4	12.2	17.6	23.8	40.9	3.19	95.0
71	5.5	12.0	17.6	23.8	41.1	3.19	94.9
72	5.4	11.9	17.5	23.9	41.4	3.25	96.6
73	5.5	11.9	17.5	24.0	41.1	3.20	95.1
74	5.5	12.0	17.5	24.0	41.0	3.18	94.7
75	5.4	11.8	17.6	24.1	41.1	3.23	95.9
76	5.4	11.8	17.6	24.1	41.1	3.23	95.9
77	5.2	11.6	17.5	24.2	41.5	3.33	99.0
78	5.2	11.6	17.5	24.1	41.5	3.33	99.0
79	5.2	11.6	17.5	24.1	41.7	3.35	99.5
80	5.1	11.6	17.5	24.3	41.6	3.37	100.1
81	5.0	11.3	17.4	24.4	41.9	3.44	102.4
82	4.7	11.2	17.1	24.3	42.7	3.63	107.9
83	4.7	11.1	17.1	24.4	42.7	3.64	108.1
84	4.7	11.0	17.0	24.4	42.9	3.66	108.9
85	4.6	10.9	16.9	24.2	43.5	3.76	111.9
86	4.6	10.8	16.8	24.0	43.7	3.79	112.8

Table A.3
Value of the Services of Highways and Streets

Year	Gross stock of federal highways	Gross stock of state & local highways	Imputed services of highways 5% (b + c)
a	b	c	d
50	2.3	126.6	6.4
51	2.4	130.0	6.6
52	2.4	133.7	6.8
53	2.5	138.2	7.0
54	2.7	144.2	7.3
55	2.8	150.5	7.7
56	2.9	157.0	8.0
57	3.1	163.8	8.3
58	3.3	171.7	8.8
59	3.4	180.0	9.2
60	3.6	188.0	9.6
61	3.8	196.6	10.0
62	4.1	205.7	10.5
63	4.4	215.4	11.0
64	4.6	225.1	11.5
65	4.9	235.1	12.0
66	5.2	245.5	12.5
67	5.6	255.7	13.1
68	5.9	266.3	13.6
69	6.1	275.9	14.1
70	6.4	285.2	14.6
71	6.7	294.4	15.1
72	6.9	302.7	15.5
73	7.2	310.9	15.9
74	7.4	317.7	16.3
75	7.6	322.7	16.5
76	7.8	327.1	16.7
77	8.1	331.0	17.0
78	8.3	334.4	17.1
79	8.5	337.3	17.3
80	8.6	340.4	17.5
81	8.9	343.1	17.6
82	9.1	346.1	17.8
83	9.3	349.6	17.9
84	9.5	352.6	18.1
85	9.7	356.0	18.3
86	9.9	360.0	18.5

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Table A.4
Public Expenditures on Health and Education Counted as Personal Consumption

Year	Public expenditures on higher education	Public expenditures on higher education for consumption (b/2)	Public expenditures on health	Public expenditures on improving health (d − 7.6)/2	Public expenditures on health and education for consumption (c + e)
a	b	c	d	e	f
50	2.2	1.1	7.6	0.0	1.1
51	2.0	1.0	7.9	0.1	1.2
52	2.2	1.1	8.1	0.2	1.4
53	2.2	1.1	8.4	0.4	1.5
54	2.4	1.2	8.7	0.6	1.7
55	2.6	1.3	9.0	0.7	2.1
56	2.9	1.4	9.5	1.0	2.4
57	3.2	1.6	9.9	1.2	2.8
58	3.6	1.8	10.1	1.3	3.1
59	4.1	2.1	10.4	1.4	3.5
60	4.8	2.4	10.7	1.6	4.0
61	5.4	2.7	11.8	2.1	4.8
62	6.0	3.0	12.9	2.7	5.7
63	7.0	3.5	13.9	3.2	6.7
64	7.8	3.9	14.9	3.7	7.6
65	8.8	4.4	15.9	4.1	8.5
66	10.3	5.1	20.0	6.2	11.4
67	12.0	6.0	23.2	7.8	13.8
68	12.4	6.2	26.2	9.3	15.5
69	13.0	6.5	28.5	10.5	17.0
70	14.5	7.3	30.5	11.5	18.7
71	15.3	7.7	32.4	12.4	20.1
72	16.1	8.0	35.0	13.7	21.7
73	16.9	8.4	37.3	14.9	23.3
74	16.7	8.3	41.5	17.0	25.3
75	17.6	8.8	41.9	17.2	26.0
76	17.6	8.8	45.1	18.8	27.6
77	17.9	8.9	45.9	19.2	28.1
78	18.1	9.0	48.1	20.2	29.3
79	18.6	9.3	50.0	21.2	30.5
80	19.6	9.8	52.4	22.4	32.2
81	19.8	9.9	54.5	23.5	33.4
82	19.0	9.5	54.5	23.5	33.0
83	19.3	9.6	54.7	23.6	33.2
84	19.1	9.6	55.7	24.1	33.6
85	19.5	9.7	57.8	25.1	34.9
86	19.4	9.7	58.0	25.2	34.9

Table A.5
Defensive Private Expenditures on Health and Education

Year	Private expenditures on education	Private expenditures on higher education	Defensive expenditures on private education b − (c/2)	Private expenditures on health	Defensive expenditures on private health (e − 22.1)/2	Defensive expenditures on private health and education (d + f)
a	b	c	d	e	f	g
50	3.6	1.7	2.8	22.1	0.0	2.8
51	3.7	1.6	2.9	22.9	0.4	3.3
52	3.9	1.6	3.1	23.6	0.7	3.8
53	4.1	1.8	3.2	24.5	1.2	4.4
54	4.3	1.7	3.4	25.3	1.6	5.0
55	4.6	1.9	3.6	26.4	2.1	5.8
56	4.8	2.0	3.8	28.0	3.0	6.8
57	5.1	2.1	4.1	29.4	3.7	7.8
58	5.4	2.4	4.3	30.5	4.2	8.4
59	5.6	2.3	4.5	31.5	4.7	9.2
60	6.0	2.4	4.8	32.6	5.2	10.0
61	6.3	2.7	4.9	35.9	6.9	11.8
62	6.6	2.8	5.2	39.0	8.5	13.7
63	7.0	2.8	5.5	42.0	10.0	15.5
64	7.4	3.2	5.8	45.1	11.5	17.3
65	8.1	3.9	6.1	47.8	12.8	19.0
66	8.8	4.1	6.7	50.1	14.0	20.7
67	9.3	4.2	7.1	50.7	14.3	21.4
68	10.0	4.4	7.8	51.5	14.7	22.5
69	10.6	4.7	8.2	51.7	14.8	23.0
70	10.9	4.8	8.5	51.9	14.9	23.4
71	11.2	5.0	8.7	54.1	16.0	24.7
72	11.7	5.2	9.1	57.7	17.8	26.8
73	11.9	5.2	9.3	61.2	19.5	28.8
74	11.7	5.2	9.1	61.0	19.4	28.5
75	12.1	5.2	9.5	60.0	18.9	28.4
76	12.2	5.2	9.6	62.2	20.0	29.7
77	12.2	5.3	9.6	64.9	21.4	31.0
78	12.7	5.3	10.1	66.5	22.2	32.3
79	13.1	5.5	10.4	68.6	23.3	33.7
80	13.3	5.6	10.5	71.2	24.6	35.1
81	13.7	5.8	10.7	74.6	26.2	37.0
82	14.1	5.7	11.2	75.9	26.9	38.1
83	14.8	5.8	11.9	77.7	27.8	39.7
84	15.4	6.0	12.4	80.5	29.2	41.6
85	16.4	6.2	13.4	81.1	29.5	42.8
86	17.4	6.3	14.2	82.1	30.0	44.2

Table A.6
Cost of Commuting

Year	User-operated transportation	Purchased local transportation	Cost of commuting (.21b + .3c)
a	b	c	d
50	34.2	6.1	9.0
51	32.4	5.6	8.5
52	32.3	5.4	8.4
53	37.1	5.1	9.3
54	39.2	4.7	9.6
55	45.7	4.4	10.9
56	43.3	4.3	10.4
57	43.8	4.2	10.5
58	41.8	3.9	9.9
59	45.6	3.9	10.7
60	48.4	3.9	11.3
61	46.6	3.6	10.9
62	50.5	3.6	11.7
63	53.9	3.5	12.4
64	56.2	3.4	12.8
65	63.2	3.3	14.3
66	66.5	3.3	14.9
67	67.5	3.2	15.2
68	74.7	3.3	16.7
69	79.2	3.5	17.7
70	78.3	3.4	17.4
71	87.8	3.4	19.5
72	97.8	3.4	21.6
73	105.3	3.4	23.1
74	101.5	3.5	22.4
75	101.8	3.5	22.4
76	113.8	3.6	25.0
77	124.4	3.6	27.2
78	129.0	3.7	28.2
79	133.4	3.8	29.2
80	131.2	3.5	28.6
81	133.6	3.2	29.0
82	127.8	3.0	27.7
83	139.4	3.0	30.2
84	152.1	3.0	32.8
85	163.6	3.0	35.3
86	155.2	3.1	33.5

Table A.7
Cost of Urbanization

Year	Value of residential land	Value of residential structures	Land as % of total b/(b + c)	Housing expenditures	Urbanization costs (d × e)
a	b	c	d	e	f
50	26.2	145.3	15.3%	38.1	5.8
51	29.5	163.8	15.3%	40.9	6.2
52	32.8	182.3	15.3%	43.4	6.6
53	34.9	194.1	15.3%	45.8	7.0
54	37.7	209.6	15.3%	47.9	7.3
55	41.6	231.0	15.3%	50.3	7.7
56	49.7	248.3	16.7%	52.8	8.8
57	52.3	261.3	16.7%	55.4	9.2
58	55.1	275.4	16.7%	57.9	9.7
59	58.3	291.5	16.7%	61.0	10.2
60	67.2	305.7	18.0%	64.1	11.6
61	70.0	318.0	18.0%	67.1	12.1
62	72.8	331.0	18.0%	70.7	12.8
63	74.8	339.9	18.0%	73.9	13.3
64	79.6	361.6	18.0%	77.4	14.0
65	83.3	378.8	18.0%	81.5	14.7
66	102.1	408.4	20.0%	85.3	17.1
67	107.4	429.6	20.0%	89.1	17.8
68	120.1	480.3	20.0%	93.6	18.7
69	131.1	524.4	20.0%	98.2	19.6
70	138.0	551.9	20.0%	102.0	20.4
71	153.6	614.3	20.0%	106.4	21.3
72	171.9	687.4	20.0%	112.5	22.5
73	205.8	791.7	20.6%	118.1	24.4
74	234.8	902.9	20.6%	124.2	25.6
75	254.4	978.6	20.6%	128.2	26.5
76	309.7	1106.1	21.9%	134.9	29.5
77	388.8	1296.1	23.1%	141.2	32.6
78	488.7	1527.1	24.2%	148.5	36.0
79	589.6	1734.0	25.4%	154.8	39.3
80	666.0	1902.9	25.9%	159.9	41.4
81	783.6	2062.1	27.5%	164.8	45.4
82	685.9	2017.5	25.4%	161.1	40.9
83	875.0	2187.5	28.6%	162.2	46.4
84	923.0	2307.5	28.6%	166.0	47.4
85	952.2	2380.5	28.6%	170.6	48.8
86	1087.6	2589.6	29.6%	174.0	51.5

Table A.8
Cost of Air Pollution

Year	Sum of NO_2 + SO_2 + particles	Index of air pollution	Cost of air pollution c × 30
a	b	c	d
50	54.1	84.0	25.2
51	54.1	84.0	25.2
52	54.1	83.9	25.2
53	54.0	83.9	25.2
54	54.0	83.9	25.2
55	54.0	83.9	25.2
56	54.0	83.8	25.1
57	54.0	83.8	25.1
58	53.9	83.8	25.1
59	53.9	83.7	25.1
60	53.9	83.7	25.1
61	55.0	85.3	25.6
62	56.0	87.0	26.1
63	57.1	88.6	26.6
64	58.1	90.2	27.1
65	59.2	91.8	27.6
66	60.2	93.5	28.0
67	61.2	95.1	28.5
68	62.3	96.7	29.0
69	63.3	98.4	29.5
70	64.4	100.0	30.0
71	62.0	96.3	28.9
72	62.1	96.4	28.9
73	62.8	97.5	29.3
74	58.8	91.3	27.4
75	55.2	85.7	25.7
76	56.2	87.3	26.2
77	56.4	87.6	26.3
78	54.7	84.9	25.5
79	54.6	84.8	25.4
80	52.1	80.9	24.3
81	50.7	78.7	23.6
82	48.0	74.5	22.4
83	46.4	72.0	21.6
84	48.1	74.7	22.4
85	48.0	74.5	22.4
86	48.0	74.5	22.4

Table A.9
Loss of Agricultural Land
(Erosion, Compaction, Urbanization)

Year	Erosion productivity loss	Compaction productivity loss	Agricultural land lost by urbanization	Total loss of agricultural land (b + c + d)
a	b	c	d	e
50	5.6	0.7	1.0	7.2
51	6.1	0.7	1.0	7.8
52	6.7	0.7	1.0	8.4
53	7.3	0.7	1.0	9.0
54	7.9	0.8	1.0	9.6
55	8.5	0.8	1.0	10.2
56	9.0	0.8	1.0	10.9
57	9.7	0.8	1.0	11.5
58	10.3	0.9	1.0	12.1
59	10.9	0.9	1.0	12.8
60	11.5	0.9	1.0	13.4
61	12.1	0.9	1.0	14.1
62	12.8	1.0	1.0	14.7
63	13.4	1.0	1.0	15.4
64	14.0	1.0	1.0	16.1
65	14.7	1.1	1.0	16.7
66	15.4	1.1	1.0	17.4
67	16.0	1.1	1.0	18.1
68	16.7	1.2	1.0	18.8
69	17.4	1.2	1.0	19.6
70	18.1	1.2	1.0	20.3
71	18.7	1.3	1.0	21.0
72	19.4	1.3	1.0	21.8
73	20.1	1.3	1.0	22.5
74	20.8	1.4	1.0	23.2
75	21.5	1.4	1.0	24.0
76	22.2	1.5	1.0	24.7
77	22.9	1.5	1.0	25.5
78	23.6	1.6	1.0	26.2
79	24.3	1.6	1.0	27.0
80	25.0	1.7	1.0	27.7
81	25.7	1.7	1.0	28.5
82	26.4	1.8	1.0	29.2
83	27.1	1.8	1.0	30.0
84	27.8	1.9	1.0	30.7
85	28.5	1.9	1.0	31.5
86	29.2	2.0	1.0	32.2

Table A.10
Energy Consumption as a Measure of Long-Term Environmental Damage

Year	Total energy consumption, quadrillions of BTUs	Barrel equivalents of energy consumed (b/5.8) (billions of barrels)	Cumulative $.50 tax per barrel (billions $)	Year	Total energy consumption, quadrillions of BTUs	Barrel equivalents of energy consumed (f/5.8) (billions of barrels)	Cumulative $.50 tax per barrel (billions $)
a	b	c	d	e	f	g	h
1900	7.3	1.3	0.6	1944	30.4	5.2	68.1
1901	8.0	1.4	1.3	1945	30.1	5.2	70.7
1902	8.4	1.5	2.0	1946	29.0	5.0	73.2
1903	9.9	1.7	2.9	1947	31.4	5.4	75.9
1904	9.8	1.7	3.7	1948	32.5	5.6	78.7
1905	11.0	1.9	4.7	1949	30.0	5.2	81.3
1906	11.5	2.0	5.7	1950	31.7	5.5	84.0
1907	13.4	2.3	6.8	1951	34.1	5.9	86.9
1908	11.8	2.0	7.9	1952	33.8	5.8	89.9
1909	13.0	2.2	9.0	1953	34.9	6.0	92.9
1910	14.3	2.5	10.2	1954	33.9	5.8	95.8
1911	14.0	2.4	11.4	1955	37.4	6.4	99.0
1912	15.1	2.6	12.7	1956	38.9	6.7	102.4
1913	16.1	2.8	14.1	1957	38.9	6.7	105.7
1914	14.9	2.6	15.4	1958	38.8	6.7	109.1
1915	15.4	2.7	16.7	1959	40.5	7.0	112.5
1916	17.1	2.9	18.2	1960	42.1	7.3	116.2
1917	18.8	3.2	19.8	1961	46.2	8.0	120.2
1918	19.7	3.4	21.5	1962	44.7	7.7	124.0
1919	16.8	2.9	22.9	1963	46.5	8.0	128.0
1920	19.0	3.3	24.6	1964	48.6	8.4	132.2
1921	15.8	2.7	25.9	1965	50.6	8.7	136.6
1922	16.5	2.9	27.4	1966	53.6	9.2	141.2
1923	21.0	3.6	29.2	1967	55.3	9.5	146.0
1924	19.8	3.4	30.9	1968	58.7	10.1	151.0
1925	20.2	3.5	32.6	1969	61.5	10.6	156.3
1926	21.7	3.7	34.5	1970	63.7	11.0	161.8
1927	21.0	3.6	36.3	1971	65.0	11.2	167.4
1928	21.5	3.7	38.2	1972	68.4	11.8	173.3
1929	22.9	4.0	40.1	1973	71.3	12.3	179.5
1930	21.5	3.7	42.0	1974	69.1	11.9	185.4
1931	18.1	3.1	43.6	1975	67.2	11.6	191.2
1932	15.7	2.7	44.9	1976	71.2	12.3	197.4
1933	16.2	2.8	46.3	1977	73.7	12.7	203.7
1934	17.2	3.0	47.8	1978	74.9	12.9	210.2
1935	18.3	3.2	49.4	1979	75.7	13.1	216.7
1936	20.6	3.6	51.1	1980	72.8	12.6	223.0
1937	21.9	3.8	53.0	1981	70.8	12.2	229.1
1938	19.0	3.3	54.7	1982	67.1	11.6	234.9
1939	20.8	3.6	56.4	1983	66.5	11.5	240.6
1940	23.0	4.0	58.4	1984	70.1	12.1	246.6
1941	25.7	4.4	60.6	1985	70.4	12.1	252.7
1942	26.7	4.6	62.9	1986	70.2	12.1	258.7
1943	29.1	5.0	65.5				

Table A.11

Net Capital Growth

Year	Labor force	% change in labor force	Rolling average % change in labor force	Net stock of fixed capital	Rolling average of net stock of fixed capital	Change in rolling average of capital stock $f - f_{t-1}$	Capital requirement for labor $d \times f_{t-1}$	Net capital growth (g − h)
a	b	c	d	e	f	g	h	i
45	53060			1170				
46	56720	6.90%		1183				
47	59350	4.64%		1196				
48	60621	2.14%		1203				
49	61286	1.10%	3.69%	1220	1194.4			
50	62208	1.50%	3.26%	1233	1207.0	12.6	38.9	−26.3
51	62017	−0.31%	1.81%	1291	1228.6	21.6	21.9	−0.3
52	62138	0.20%	0.93%	1350	1259.4	30.8	11.4	19.4
53	63015	1.41%	0.78%	1412	1301.2	41.8	9.8	32.0
54	63643	1.00%	0.76%	1480	1353.2	52.0	9.9	42.1
55	65023	2.17%	0.89%	1545	1415.6	62.4	12.1	50.3
56	66552	2.35%	1.42%	1596	1476.6	61.0	20.2	40.8
57	66929	0.57%	1.50%	1648	1536.2	59.6	22.1	37.5
58	67639	1.06%	1.43%	1703	1594.4	58.2	21.9	36.3
59	68369	1.08%	1.45%	1758	1650.0	55.6	23.0	32.6
60	69628	1.84%	1.38%	1816	1704.2	54.2	22.8	31.4
61	70459	1.19%	1.15%	1888	1762.6	58.4	19.6	38.8
62	70614	0.22%	1.08%	1962	1825.4	62.8	19.0	43.8
63	71833	1.73%	1.21%	2041	1893.0	67.6	22.1	45.5
64	73091	1.75%	1.35%	2121	1965.6	72.6	25.5	47.1
65	74455	1.87%	1.35%	2203	2043.0	77.4	26.6	50.8
66	75770	1.77%	1.47%	2297	2124.8	81.8	29.9	51.9
67	77347	2.08%	1.84%	2394	2211.2	86.4	39.1	47.3
68	78737	1.80%	1.85%	2495	2302.0	90.8	41.0	49.8
69	80734	2.54%	2.01%	2603	2398.4	96.4	46.3	50.1
70	82771	2.52%	2.14%	2715	2500.8	102.4	51.3	51.1
71	84382	1.95%	2.18%	2809	2603.2	102.4	54.4	48.0
72	87034	3.14%	2.39%	2906	2705.6	102.4	62.2	40.2
73	89429	2.75%	2.58%	3007	2808.0	102.4	69.8	32.6
74	91949	2.82%	2.64%	3111	2909.6	101.6	74.0	27.6
75	93775	1.99%	2.53%	3220	3010.6	101.0	73.6	27.4
76	96158	2.54%	2.65%	3319	3112.6	102.0	79.7	22.3
77	99009	2.96%	2.61%	3421	3215.6	103.0	81.3	21.7
78	102251	3.27%	2.72%	3526	3319.4	103.8	87.4	16.4
79	104962	2.65%	2.68%	3634	3424.0	104.6	89.1	15.5
80	106940	1.88%	2.66%	3718	3523.6	99.6	91.2	8.4
81	108670	1.62%	2.48%	3799	3619.6	96.0	87.3	8.7
82	110204	1.41%	2.17%	3855	3706.4	86.8	78.5	8.3
83	110550	0.31%	1.58%	3941	3789.4	83.0	58.4	24.6
84	113544	2.71%	1.59%	4071	3876.8	87.4	60.1	27.3
85	115461	1.69%	1.55%	4205	3974.2	97.4	60.0	37.4
86	117834	2.06%	1.64%	4344	4083.2	109.0	65.0	44.0

Conclusion

To the extent that the Index of Sustainable Economic Welfare measures the true health of our economy over the past thirty-six years, the results are rather discouraging. Per capita ISEW is only about 20% higher now than it was at the beginning of the period—approximately $3,403 per person in 1986 compared to $2,831 in 1951. (See the note to table A.12 about the choice of 1951 as the base year.) According to table A.12, the average annual increase from 1951 to 1986 was 0.53% per year.

The overall increase in ISEW masks a more important pattern of changes decade by decade. From 1951 to 1960, per capita ISEW increased by an average of 0.84% per year. From 1960 to 1970, however, it increased by about 2.01% per year, about one-half a percentage point slower than per capita GNP (which grew at a rate of 2.64% per year that decade). The period from 1970 to 1980 marked a very slight decline of per capita ISEW by 0.14% per year. The decline during the 1980s has thus far been 1.26% per year. Thus an overall increase during the period from 1951 to 1986 masks the leveling off of per capita ISEW during the 1970s and the decline of the 1980s.

Even when we exclude resource depletion and long-term environmental damage (columns T and U from table A.1) from the calculation of per capita ISEW, the results still show a similar pattern of improvements in the 1960s, little growth in the 1970s, and decline in the 1980s. This can be seen in table A.12 in the column labeled PC-ISEW*. Thus the general pattern of changes in economic welfare is not simply a function of the assumptions we have made about these relatively controversial issues.

Table A.12
Annual Per Capita Growth of ISEW and GNP

Years	PC-GNP	PC-ISEW	PC-ISEW*	Years	PC-GNP	PC-ISEW	PC-ISEW*
50–60	1.51%	2.06%	1.91%	51–60	0.97%	0.84%	0.92%
51–60	0.97%	0.84%	0.92%	60–70	2.64%	2.01%	1.97%
50–65	2.08%	2.14%	1.99%	70–80	2.04%	0.14%	0.66%
51–65	1.77%	1.36%	1.36%	80–86	1.84%	1.26%	−0.84%
50–77	2.14%	1.44%	1.55%				
51–77	1.97%	0.99%	1.19%				
50–86	2.02%	0.87%	1.11%				
51–86	1.90%	0.53%	0.84%				

NOTES:
—PC-ISEW* means PC-ISEW excluding column V (resource depletion) and column W (long-term environmental damage) of table A.1.
—We have given 1950 and 1951 as alternative base years for calculations of annual changes because the change in per capita ISEW between those years was greater than at any other time during the period from 1950 to 1985. (See table A.1, column AA.) Because of this anomaly, we consider 1951 to be the appropriate year from which to make comparisons.

We emphasize the variation in the decades and especially the rise during the 1960s in order to point out that we have not simply chosen components for the ISEW that create a pessimistic outlook. Even in the face of declining resources and growing environmental threats, ISEW was able to grow faster than GNP during at least one segment of the period of our study.

A major factor in the dramatic increase in per capita ISEW during the 1960s (and decline during later periods) was the change in income distribution. For example, whereas personal consumption increased by about 37.5% from 1961 to 1968, weighting personal consumption by changes in income distribution led to an increase of more than 57%. (This weighting factor—along with the jump in net capital growth from negative to positive—is also largely responsible for the anomalous increase in ISEW from 1950 to 1951.) By contrast, in the 1980s the growing gap in income inequality had a tremendous effect on the decline in economic welfare as measured by the ISEW. The almost 13% deepening of inequality caused weighted personal consumption to grow by only about 10%, while measured personal consumption grew by 24%.

Changes in net capital growth also had a strong influence on the shifts in ISEW. From the mid-1950s to the early 1970s, net capital growth advanced steadily. It has risen only slowly since then, except from 1983 to 1986. However, part of the apparent improvement in investments during that latter period was offset by the decline in the net international position from 1983 to 1986. The growth of net capital investment in recent years seems therefore to be largely based on borrowing capital from abroad and therefore not sustainable.

Efforts to control air pollution and to reduce accidents have paid off by improving economic welfare during the 1970s and 1980s. The cost of air pollution peaked in 1970 and the economic damages caused by car accidents peaked in 1978. Improvements in both areas since those dates have had the effect of countering the generally downward trend in ISEW. They offer evidence that the choice of policies by the government can indeed have a positive effect on economic welfare even if they do not increase physical output.

In order to compare the ISEW with the MEW by Nordhaus and Tobin as well as the EAW by Zolotas, we have calculated the annual growth of per capita ISEW from 1951 to 1965 and from 1951 to 1977. (We used 1951 rather than 1950 because the latter was so radically different from the results for the rest of that decade.) From 1951 to 1965, per capita ISEW increased by 1.36% per year, while per capita MEW grew at a rate of 0.40% per year from 1947 to 1965. Similarly, from 1951 to 1977 per capita ISEW grew at 0.99% per year while per capita EAW showed an increase of only

0.63% from 1950 to 1977. Thus ISEW suggests more improvement than either EAW or MEW during these comparable periods.

Despite the year-to-year variations in ISEW, it indicates a long-term trend from the late 1970s to the present that is indeed bleak. Economic welfare has been deteriorating for a decade, largely as a result of growing income inequality, the exhaustion of resources, and the failure to invest adequately to sustain the economy in the future. Although these three factors might be addressed through separate policy initiatives, they are in fact intertwined. The most fundamental problem in terms of sustainable economic welfare is the decline in the quality of energy resources as measured by the ratio of energy output to energy input. As a result of this entropic process, the discovery and extraction of oil will soon take more energy than is made available, thereby bringing to a close the era of cheap energy. This also means that the production of capital equipment will become increasingly expensive because capital is largely embodied energy. Thus efforts to reverse the trend toward decreasing net investment will be made more difficult. Finally, reductions in the amount of energy and capital available per worker will lead to a long-term decline in worker productivity, though improved management may be able to counter that trend for short periods. As increasing competition lowers the returns to labor, and as returns to scarce capital increase, the income gap is likely to worsen if actions are not taken to improve equality.

The purpose of an index that strives to measure economic well-being is not simply to show us how we are presently faring or are likely to fare. It should also reveal the kinds of policies that would enable a nation to improve its welfare. As we have seen, reductions in car accidents and in air pollution have made small but important contributions to raising the level of economic welfare. During the 1960s, the Great Society programs of President Johnson seem to have improved economic welfare by reducing income inequality. Economic welfare can thus be improved by enacting appropriate policies.

Clearly the important question then becomes whether our nation is going to continue in its efforts to increase total output or whether we are going to redirect our focus toward the enhancement of sustainable economic welfare. Are the policies of our government going to be guided by GNP or by ISEW or some other measure of sustainable welfare?

MAKING THE ENVIRONMENT COUNT: HOW WE APPRECIATE WHAT WE DEPRECIATE

WEDNESDAY, OCTOBER 9, 1991

CONGRESS OF THE UNITED STATES,
JOINT ECONOMIC COMMITTEE,
Washington, DC.

The Committee met, pursuant to notice, at 1:05 p.m., in room SD–562, Dirksen Senate Office Building, Honorable Albert Gore, Jr. (member of the Committee) presiding.

Present: Senators Gore and Sarbanes.

Also present: Marc Chupka, professional staff member.

OPENING STATEMENT OF SENATOR GORE, MEMBER

SENATOR GORE. The hearing will come to order. I understand that some of my colleagues on the Committee may be joining us later. But, as many of you know, the business on the floor is suspended until next Tuesday. So, we may have a light turnout up here on the dias today.

This is the second in a set of hearings entitled "Making The Environment Count." In our first hearing, the Committee heard testimony about the magnitude of the environmental risks threatening the Earth. Michael Deland, Chairman of the President's Council on Environmental Quality, said, and I quote:

> The risks posed to the global environment are at a far greater level now than heretofore in history.

These environmental threats are usually expressed in scientific rather than in economic terms. In fact, when many people think about the economy and the environment, they think about very narrow tradeoffs. For example, that environmental protection must exact a toll on economic performance, or that pollution controls on factories, power plants, and motor vehicles add to the measured cost of the goods and services produced in the economy.

But such views ignore the critical role and the real value of environmental quality in economic growth and strength. Investments in pollution controls can substantially reduce other production costs that aren't typically measured—the cost of respiratory diseases and other human health impacts, for example. The costs of lowered agricultural yields, reduced visibility, polluted rivers, contaminated groundwater, and the list goes on. It's often hard to measure these costs in money terms because they enter the marketplace indirectly, if they enter it at all. But in order to see the true relationship between the economy and the environment and to make reasoned economic decisions and measure the real life costs of our actions, we have to make the environment count. When we do, we recognize that economic prosperity is not only consistent with environmental protection, but that economic prosperity depends upon a clean and healthy environment.

Today's hearing will focus on ways that the United States and other nations can make the environment count, literally, by accounting for the environment. The conventional measures of aggregate economic activity—such as gross national product, disposable income, and corporate profits—shape our perceptions of economic welfare in profound ways. Indeed, when national economic indicators are published, the newspapers and air waves are crowded with pundits offering their views on the underlying causes and important implications of the recent trends.

Yet, these economic indicators do not incorporate even the most basic changes to our natural environment. They don't reflect depletion of natural resources, such as oil, gas, timber, or fish. They are not adjusted to account for environmental damages. Ecological catastrophes can actually appear to be economic windfalls, while the most prudent environmental investments can actually appear to be worthless. The analysis used to calculate many key economic indicators—the national income and product accounts—remains essentially detached from environmental reality.

Honest accounting can help a business manage its affairs and assess its long-run viability. The national income and product accounts were designed to help governments understand the processes that create current income and future wealth. Without considering natural resource and environmental impacts, however, indicators like the gross national product provide a distorted and potentially dangerous measure of economic progress.

The United States should, in my opinion, revise the national income and product accounts to correct these obvious deficiencies. Yet, while many share this concern, there is a lot of disagreement about how to proceed. The witnesses scheduled today are likely to offer three rather distinct views of the relevant opportunities and constraints. But the purpose of this hearing is not to intensify controversy or to judge which approach is best. Honest debate will continue over the quality of environmental data, the most useful conceptual frameworks, and the appropriate roles of government and other institutions. However, where consensus points towards practical steps, we should not allow these continuing debates to halt progress now.

We're fortunate to have several excellent witnesses today to address these issues. Our first witness will be Dr. Mark Plant, who is the Deputy Undersecretary for Economic Affairs at the Department of Commerce. He is accompanied by Dr. Carol Carson, Deputy Director of the Bureau of

Economic Analysis. Dr. Plant will describe current activities at BEA that will create a set of more realistic economic indicators.

Our second panel will address natural resource and environmental accounting programs in other countries and how they might influence our own accounting system, as well as our international economic development policies. The first witness on that second panel will be Dr. Henry Peskin, who has been constructing environmental accounts for nearly 20 years. He will provide an overview of the function and goals of environmental accounting systems. Our second witness on the panel will be Dr. Robert Repetto of the World Resources Institute. Dr. Repetto has been perhaps the foremost advocate of changing national accounting systems in developing nations to reflect natural resource depletion. He has recently finished a case study entitled "Accounts Overdue: Natural Resources Depreciation in Costa Rica."

We look forward to hearing about that. I look forward to hearing all of the testimony here today.

But, as noted, we're going to begin with you, Dr. Plant. Welcome.

Dr. Carson, welcome. We look forward to your testimony.

Without objection, your whole prepared statement will be included in the record. And, please proceed as you see fit.

STATEMENT OF MARK PLANT, ECONOMICS AND STATISTICS ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE; ACCOMPANIED BY CAROL CARSON, DEPUTY DIRECTOR, BUREAU OF ECONOMIC ANALYSIS

DR. PLANT. Thank you, Mr. Chairman. And thank you for the opportunity to be here today to discuss Natural Resource Accounting with you.

As you noted, Dr. Carol Carson, the Deputy Director of BEA, is accompanying me today. BEA is the agency responsible for keeping the nation's income and product accounts.

Dr. Carson is also participating in the international efforts to revise the U.N. System of National Accounts, and has been given management responsibility by the international organizations for ensuring that the 1993 SNA revision is, in fact, completed.

As a Nation, we are, indeed, fortunate to have Dr. Carson working at BEA.

SENATOR GORE. May I interrupt you to second that comment, and to publicly thank Dr. Carson for, among other things, taking the time to participate in a lengthy roundtable discussion that I had last year, which Dr. Peskin, Dr. Repetto, Herman Daly, and a number of others attended. Dr. Carson made a real contribution on that occasion, as she routinely does. And I wanted to second that.

Please proceed, Dr. Plant.

DR. PLANT. Thank you.

The Commerce Department is committed to playing an active role in the continuing development of natural resource accounting as a tool for aiding or understanding the interaction between the environment and economy in both the world and, more particularly, in the United States.

The Department has many roles to play through its various agencies in these efforts. But I'd like to concentrate on the statistical responsibilities vested in the Economics and Statistics Administration, particularly BEA.

In prospect of the Bush Administration's Economic Statistics Initiative, BEA began to lay the groundwork for modernizing and extending the Nation's economic accounts to the so-called System of National Accounts.

This fundamental change in our accounting framework will provide the necessary structure in which a coherent natural resource accounting can be done, which is consistent with the aggregate national accounts.

The first efforts in extending the National Accounts to include natural resource accounting have already begun at BEA.

The staff has begun to lay the groundwork by reviewing the literature, by participating in conferences and workshops, by arranging expert speakers for the staff seminars, and by preparing issue papers.

During the 1980s, it's fair to say that the world passed us by intellectually in the natural resource accounting area, and we have some homework to get done. This is not a reflection on the highly skilled professionals at BEA but, instead, a result of the interaction the agency faced between a quickly changing economy and a very tight budget.

The Administration's 1992 budget requested funding for a full-blown natural resource accounting project. The project described in the budget is to prepare a set of satellite accounts that would anticipate the movement of the entire national accounting system to the SNA.

It would provide the basis for national measures of income and product that reflect changes in the stock of natural resources.

Before I describe this Natural Resource Accounting Project in more detail, I'd like to mention another project included in our 1992 budget, because it, too, expresses the Department's recognition of the importance of economic measures of environmental activities.

It's a project to stop the deterioration in the quality of BEA's estimates of spending on pollution abatement and control. The qualities of these estimates that BEA pioneered in the 1970s has eroded over the last decade.

The fiscal year 1992 project emphasizes improved indirect estimates for nonmanufacturing, such as hospitals, sanitation services, dry cleaning services, and federal facilities.

Late last week, we received word about the conference report on our budget and these projects. They were part of a package to modernize and extend the National Accounts.

Congress allowed about 30 percent of the amount requested for that package. A proportionate share of the increase would give each of these two projects just under $100,000, disappointingly little given our interest in playing an active role in the continuing development of natural resource accounting.

We're still assessing how this limited amount, in fact, if enacted by Congress, would affect our efforts.

SENATOR GORE. Let me interject again. As you may know, I was very active in getting what was included there and will continue to work with you. And I hope that one of many outcomes from this set of hearings will be to elevate the importance of this set of initiatives to the point where we can get adequate funding for it.

So, please forgive me for interrupting you.

DR. PLANT. We're very appreciative of your efforts, Mr. Chairman. Thank you.

Let me turn to a detailed explanation of our approach to natural resource accounting. This approach has three elements.

First, for selected natural resources taken as case studies, BEA would develop an accounting framework in which to record the stocks of natural resources and the depletion and additions to those stocks.

Second, in developing this framework and implementing it, BEA would confront the general conceptual issues that, when resolved, would pave the way for the framework to be applied to other natural resources.

Third, in order to be incorporated into the national economic accounts, natural resources must be valued in monetary measures. Valuation issues confront any effort to move beyond physical quantity systems. For accounts that are to be extensions of the national economic accounts, valuation approaches used will need to be consistent with other parts of the accounts.

The view that natural resources should be treated as capital is gaining acceptance. For natural resources, such as minerals, oil, natural gas, and forests, the issues are about how changes in the quantity and value of the capital are to be recorded in the accounting framework.

I'd like to mention three issues that are most important, framing them as questions.

First, should the using up or depletion of natural resources as capital assets be fashioned after the treatment given working capital—that is, inventories—or the treatment given fixed capital?

A treatment fashioned after inventories would affect both the gross measures of national product—either GNP or GDP—and the net measures. A treatment fashioned after fixed capital would affect only the net measures.

A second question is how should the depletion be measured? Phrased more specifically, for some nonrenewable resources, this question is: Given the revenue that's generated from an extracted resource, how can you separate the income component from the capital depletion component?

The third important question is: Should discoveries or other increases in stocks of natural resources be recorded? And, again, if so, how? The quest for symmetry of treatment for depletion and discovery often yields very erratic time series, especially over the short term and anomalous results. The choice between symmetry and erratic time series is not an easy one for economic accountants.

These conceptual issues and others have occupied some powerful minds, including those of Drs. Peskin and Repetto. From what we at ESA see of the literature and from our participation in international conferences, we believe that consensus does not yet exist on at least these three important issues.

That's why the detailed case studies for particular resources are so important. They allow us to resolve basic conceptual questions before we move into any economy-wide accounting of natural resources.

The second element in our plan is for BEA to develop the framework for recording natural resources as satellite accounts. Let me first explain what the words "satellite accounts" mean to us, and then explain exactly why we take this approach.

Satellite account is an unfortunate appellation, but it seems to have caught on. The word perhaps suggests something that's tangential to the central accounts. This isn't at all the case.

Satellite accounts will become increasingly an integral part of the accounts as they are developed and refined. But the use of a satellite account approach serves several purposes.

First, they recognize the need for flexibility. That is, they recognize that there is no one single picture of the economy that can serve all purposes. Everything cannot be in focus at once.

Second, they provide a framework for arraying more comprehensive data for a specific field, or an analytic concern than can be shown in the main accounts without imposing undue burden on the main accounts.

Finally, they provide a stage on which to perform developmental work, as we preserve the validity and consistency of the traditional accounts.

By developing natural resource accounting in a satellite account, BEA will be able to move beyond the status quo, but do so without disturbing the GNP or GDP while progress is made.

Over time, progress may mean some combination of both the wider consensus on issues and wider acceptance of several measures. In fact, we feel that BEA will be able to move faster in making natural resource accounts available as satellite accounts than it could if it set out to modify the main accounts at the outset.

I mentioned earlier that BEA would undertake natural resource accounting when modernizing its National Accounts to the SNA system. This is the third element of our approach.

BEA's accounts are now undergoing the first major redesign since the 1950s. The redesign, which will be along the lines of the U.N. SNA, will feature an integrated set of current and capital accounts sector-by-sector. A fully developed capital account, including balance sheets, is of the essence for natural resource accounting. Thus, the conceptual and statistical work on capital accounts and the more specialized work on natural resource accounts will be mutually supporting, as will be the results that came out of that work.

For example, to make reasoned policy choices involving tradeoffs among kinds of capital, one would want a view of the total capital stock, at least natural and man-made capital, consistently covered and appropriately valued.

In summary, BEA's proposed natural resource accounting project reflects the state of the art, that some issues have yet to be resolved within the framework of a consistently integrated set of accounts, and that BEA's work on natural resource accounts should take best advantage of new developments in economic accounting and BEA's ongoing modernization of its accounts.

The high priority that the Commerce Department assigns to natural resource accounting is indicated by its place in the FY 1992 budget for BEA, a budget that, in addition to the modernization of its accounts, focuses on items that are musts for many of BEA's accounts.

Mr. Chairman, this completes my statement. Dr. Carson and I will be happy to answer any questions.

[The prepared statement Dr. Plant follows:]

PREPARED STATEMENT OF MARK PLANT

Mr. Chairman, thank you for the opportunity to be here today to discuss natural resource accounting with you. Accompanying me today is Dr. Carol Carson, Deputy Director of the Bureau of Economic Analysis (BEA), the agency responsible for keeping the nation's income and product accounts. Dr. Carson is also participating in the international efforts to revise the United Nations System of National Accounts (SNA) and has been given management responsibility by the international organizations for ensuring that the 1993 SNA revision is completed. As a nation, we are indeed fortunate to have
Dr. Carson working at BEA. She is an immensely talented and dedicated professional who is helping to lead BEA and the rest of the world's economic accounting agencies into the twenty-first century.

Mr. Chairman, the Commerce Department is committed to playing an active role in the continuing development of natural resource accounting as a tool for aiding our understanding of the interaction between the environment and the economy in both the world and more particularly in the United States. The Department has many roles to play through its various agencies in these efforts, but I would like to concentrate on the statistical responsibilities vested in the Economics and Statistics Administration (ESA), particularly BEA.

I would like to share with you ESA's plans for natural resource accounting. The lead in this work would go to the Bureau of Economic Analysis (BEA). However, the Census Bureau, would provide important support.

In prospect of the Administration's Economic Statistics Initiatives, BEA began to lay the groundwork for modernizing and extending the Nation's economic accounts. As I will explain more fully later, this effort is centered around a fundamental change in our economic accounts from the current system to the so-called System of National Accounts or SNA. This new system will provide the necessary structure in which a coherent natural resource accounting can be done that is consistent with the aggregate national accounts.

The first efforts in extending the national accounts to include natural resource accounting have begun already at BEA. The staff at BEA has begun to lay the groundwork for our future efforts — by reviewing the literature, by participating in conferences and workshops, by arranging expert speakers for staff seminars, and by preparing issues papers. It is fair to say that during the 1980's the world passed us by intellectually in the natural resource accounting area and we have some homework to get done. This is not a reflection on the highly-skilled professionals at BEA, but instead a result of the interaction the agency faced between a quickly changing economy and a very tight budget.

The Administration's 1992 budget requested funding for a full-blown natural resource accounting project. The project described in the budget is to prepare a set of satellite accounts which would anticipate the movement of the entire national accounting system to the SNA. The work would be undertaken by drawing upon, and perhaps contributing to, the work being done by international organizations, such as the United Nations and the World Bank, as well as work being done by other countries and by private groups in the United States. It would provide the basis for national measures of income and product that reflect changes in the stock of natural resources.

Before I describe this project in more detail, I should mention another project included in the budget because it too expresses the Department's recognition of the importance of economic measures of environmental activities.

It is a project to stop the deterioration in the quality of BEA's estimates of spending on pollution abatement and control. The quality of these estimates, which BEA pioneered in the 1970's, has eroded over the last decade. The erosion had occurred both because of the reduced availability of survey-based source data on pollution abatement spending and because BEA lacked resources to exploit fully the possibilities of using indirect methods of estimation. The fiscal year 1992 project emphasizes improved indirect estimates for nonmanufacturing, such as hospitals, sanitation services, dry cleaning services, and federal facilities. BEA would assemble an inventory of possible source data and use them in developing new and improved indirect estimates.

Late last week we received word about the Congressional action on these projects. They were part of a package to modernize and extend the national accounts. Congress allowed about 30 percent of the amount requested for the package. A proportionate share of the increase would give each project just under $100,000--disappointingly little given our interest in playing an active role in the continuing development of natural resource accounting. We are still assessing how this limited amount, if enacted by Congress, would affect our efforts.

Let me turn now to a detailed explanation of our approach to natural resource accounting which necessarily reflects ESA's views of the state of the art in that field and of the appropriate role for BEA, the official keeper of the Nation's economic accounts. The approach has three elements.

First, for selected natural resources taken as case studies, BEA would develop an accounting framework within which to record the stocks of natural resources and the depletion and the additions to those stocks. In developing this framework and implementing it, BEA would confront the general conceptual issues—those that, when resolved, would pave the way for the framework to be applied to other natural resources.

In order to be incorporated into the national economic accounts natural resources must be valued in monetary measures. Valuation issues confront any effort to move beyond physical quantity systems. For accounts that are to be extensions of the national economic accounts, valuation approaches used will need to be consistent with other parts of the accounts.

The view that natural resources should be treated as capital is gaining acceptance. For natural resources such as minerals, oil, natural gas, and forests, the issues are about how <u>changes</u> in the quantity and value of the capital are to be recorded in the accounting framework. I'll mention three of these issues that are most important, framing them as questions.

- o The first question is: Should the using up of natural resources as capital assets be fashioned after the treatment given working capital--that is, inventories--or the treatment given fixed capital? Basically, the question comes down to whether the using up of resources should affect <u>both</u> the gross and net measures of product or <u>only</u> the net measures. A treatment fashioned after inventories would affect both the gross measures--either gross national product (GNP) or gross domestic product (GDP)--and the net measures. A treatment fashioned after fixed capital would affect only the net measures.

- o The second question is: How should the depletion, be measured? Phrased more specifically for a nonrenewable resource, this question is: How, relative to the revenue from the sale of an extracted resource, can capital depletion be identified?

  -- Some put a price on the change in the physical unit of the resources, where the price is the average unit value (net of extraction costs). This whole amount is the capital depletion element, and accordingly the income element of the revenue is zero.

  -- Others, noting that owners of an asset are at an advantage such that an income element of zero is not appropriate, calculate an income element based on the rate of use and a discount rate, subtract the income element from revenue, and show the capital element (user cost) as the residual.

- o The third important question is: should discoveries or other increases in stocks of natural resources be recorded, and if so, how? The quest for symmetry of treatment for depletion and discovery often yields erratic time series and anomalous results.

These conceptual issues have occupied some powerful minds, including those of Drs. Peskin and Repetto. From what we at ESA see of the literature and from our participation in international conferences, we believe that consensus does not yet exist on at least these three important issues. Resolving these issues will be a major analytical and statistical challenge even for a small national economy, much less one as large and complex as the United States. That is why the detailed case studies for particular resources are so important. They will allow us to resolve basic conceptual questions before we move into any economy-wide accounting of natural resources.

The second element in our plan is for BEA to develop the framework for recording natural resources as a satellite account. Let me first explain what the words "satellite accounts" mean to us and then explain why we would take this approach.

"Satellite account" is an unfortunate appellation, but it seems to have caught on. The words perhaps suggest something that is tangential to the central account. This is not at all the case. Satellite accounts will become increasingly an integral part of economic accounts as they are developed and refined.

The use of a satellite account approach serves several purposes.

- o First, they recognize the need for flexibility--that is, they recognize that there is no one, single picture of the economy that can serve all purposes; everything cannot be in focus at once.

- o Second, they provide a framework for arraying more comprehensive data for a field or analytical concern than can be shown in the main accounts without unduly burdening them on the main accounts.

- o Finally, they provide a stage on which to perform developmental work as we preserve the validity of traditional economic accounts.

By developing natural resource accounting in a satellite account, BEA will be able to move beyond the status quo, but do so without disturbing the GNP or GDP while progress is made. Over time, progress may mean either obtaining a wider consensus on some of the conceptual issues involved in natural resource accounting or obtaining a wider acceptance for the idea that more than a single measure of economic activity is needed depending on the focus of the analysis or policy. Over time, progress may mean some combination of both the wider consensus on issues and wider acceptance of several measures.
In fact, we feel that BEA will be able to move faster in making natural resource accounts available as satellite accounts than it could if it set out to modify the main accounts at the outset. If it were to set out to modify the main accounts at the outset, concern for accuracy and consistency, appropriately conservative hallmarks of the official keeper of the Nation's accounts, would exert an even stronger influence.

I mentioned earlier that BEA would undertake natural resource accounting when modernizing its national economic accounts to the SNA system. This is the third element of the approach. BEA's accounts are now undergoing the first major redesign since the 1950's. The redesign, which will be along the lines of the United Nations System of National Accounts, will feature an integrated set of current and capital accounts, sector by sector. A fully developed capital account, including balance sheets, is of the essence for natural resource accounting. Thus, the conceptual work on capital accounts and the more specialized work on natural resources would be mutually supporting. For example, to make reasoned policy choices involving trade offs among kinds of capital, one would want a view of the total capital stock--at least natural and man-made capital, consistently covered and appropriately valued.

In summary, BEA's proposed natural resource accounting project reflects the state of the art—that some issues have yet to be resolved within the framework of a consistent and integrated set of accounts—and that BEA's work on natural resource accounts should take best advantage of new developments in economic accounting and BEA's ongoing modernization of its accounts.

The high priority that the Commerce Department assigns to natural resource accounting is indicated by its place in the fiscal year 1992 budget for BEA—a budget that, in addition to the modernization of its accounts, focuses on items that are "musts" for many users of BEA's accounts. These "musts" include stopping the deterioration in the quality of the national economic accounts and strengthening the measures of international capital flows to obtain a better view of the U.S. position in the world economy.

Mr. Chairman, this completes my prepared statement. I will be pleased to answer any questions that Committee members have.

Thank you.

SENATOR GORE. Well, thank you very much, Dr. Plant.

I understand, Dr. Carson, that you don't have an opening statement, but are prepared to respond to questions along with Dr. Plant.

May I say, first of all, I thought that was an excellent statement and I appreciate the time and thought that went into it. But before I ask any questions, I want to acknowledge the Chairman of the Committee, Senator Sarbanes, who has joined us, and invite him to make such comments as he cares to.

SENATOR SARBANES. Well, thank you very much, Mr. Chairman. I am delighted to be here. I am not sure I will be able to stay for the entire hearing, but I did want to come in order to underscore the importance that I think these hearings have, and to thank you for moving them forward and placing them in a more visible way on the public agenda.

If we can figure out a way to measure and record the environmental costs of economic activity, I think we are going to make a great contribution. It is the kind of project that the Joint Economic Committee ought to be addressing.

I am very grateful to you for your leadership in organizing this series in an undertaking to chair it. It is clear that the current accounting system enables us to do things that supposedly bring an economic benefit and may involve ecological devastation.

On the other hand, activities that may bring a significant environmental benefit are discounted because we haven't figured out a way to measure and count it into the overall measurement. And unless we can get our public accounting of this sort to be reflective of the costs and benefits in this area as well, the whole system is going to be skewed.

We pay a great deal of attention to "the GNP went up, the GNP went down." Very important measurements.

And, yet, we do not factor into it very important considerations about environmental impact in those measurements. In fact, others are ahead of us.

The United Nations is to some extent ahead of where the United States is. And so I'm very supportive of these hearings, and I look forward to staying as long as I possibly can.

SENATOR GORE. Well, thank you very much, Mr. Chairman.

In connection with your last comment about some being ahead of us, Dr. Plant was very forthright on page two of his statement in saying:

> It is fair to say that during the 1980s, the world passed us by, intellectually, in the natural resource accounting area and we have some homework to get done.

SENATOR SARBANES. Oh, yes.

SENATOR GORE. That is a refreshing, candid statement, and it is most welcome.

In connection with earlier comments by the Chairman, just to use a specific example that I have heard used before, is it, in fact, true that on an aggregate basis, even though the impact was not large in the National

Accounts, our U.S. gross national product was improved by the Exxon-Valdez oil spill?

DR. CARSON. There were expenditures in cleaning up. There were expenditures on the cleanup that were expenditures that would not have been made otherwise. To that extent, they added to GNP.

SENATOR GORE. Was there any aspect of the oil spill in Prince William Sound that subtracted from GNP?

DR. CARSON. I could hypothesize that something might not have been produced, as they held up the flow of oil. But I think the point that you're trying to make is there, yes. The accounts register cleanup as a positive in calculating GNP.

SENATOR GORE. So, if we want to boost our GNP, we can have lots of environmental catastrophes and get a really meaningful boost. As long as we are fouling the environment and spending a lot of money to clean up the mess, then the GNP reflects that as a terrific thing. That's just wonderful.

DR. PLANT. I think that would be, at best, a short-term boost.

SENATOR GORE. That is part of the point of the hearing. But in using that as a measure by which we decide which economic policies to follow, we are misled.

As for the way gross national product accounts for environmental catastrophe, let me use another example.

I'm informed by those who are expert in the area that approximately 50 percent of the topsoil in Iowa has floated down the Mississippi River in the last 150 years of intensive use with the techniques that are used.

The future productivity of that same area of the country will, if this trend continues, be substantially diminished. Is there any entry in our National Accounts that might signal to us that we have done some damage there?

We enter the sale of the grain and, to the extent that care doesn't have to be taken to preserve the topsoil, we get even more income. But nowhere is there an entry to reflect the fact that half of the topsoil is no good. Am I right on that?

DR. PLANT. That's correct. Yes, sir.

SENATOR GORE. Well, that's, again, an example of how we cannot rely upon our economic statistics and our System of National Accounts to tell us that we are making very poor decisions.

And people do rely on these facts and figures as proxies for considered thought. Rather than stating it, let me ask you both to respond.

Do you believe that the use of flawed accounting has contributed to the destruction of aspects of our environment?

DR. PLANT. I don't see any direct contribution. There may be very much an indirect contribution. I think the difficulty that anyone faces in using a single measure of GDP or GNP is that it summarizes a great deal of information.

And, appropriately, you have to synthesize information from many different places. Presumably, if you're going to make a decision solely based on GDP, you could be misled.

But, in fact, there are facts and figures that would allow you to make statements, such as you made about the topsoil in Iowa.

What is useful about what we're proposing is trying to bring all those things into one place.

SENATOR GORE. Yes.

DR. PLANT. And that's the real utility of what's ahead of us, is you get them centralized, you get them coordinated.

To this point, I think there's been a vast array of statistics that people have used, not in a haphazard way, but perhaps not in a full way.

The accounting framework gives you a means by which you can bring all these things together.

SENATOR GORE. Well, of course, it would have an indirect effect rather than a direct effect. But it's my impression that the indirect effect is actually quite large. We've had these analyses in developing countries, and we'll hear more about that. But, I think, that it's quite large here in the United States, as well.

Now, let me ask you one other question along this line.

You said, Dr. Carson, that expenditures to clean up a mess made in the environment, like the Exxon-Valdez oil spill, are included as income and reflected as a good, positive contribution to our economy.

If a corporation spends money, not for a cleanup, but for prevention of the pollution in the first place, is that reflected in the same way as a positive contribution to economic growth?

DR. CARSON. If a corporation spends ... I have to hypothesize different kinds of spending. If it's spending, for example, on a type of smokestack where it is capital spending, yes, that would be recorded.

If it were spending on wages to have an individual do something that prevented pollution, that, too, would be recorded as a kind of income.

If the question is the recording, yes, it's there. If it is a question of does it get into GNP, then it depends on the type of spending, whether it would actually be in the components that you would add up to get GNP.

SENATOR GORE. But defensive expenditures to prevent pollution, which do not come from capital accounts, are actually subtracted from GNP.

Is that the right way to say it?

DR. CARSON. Defensive expenditures by business that are an expense are subtracted out in getting their measure of profits.

SENATOR GORE. So, we have a situation where a company that is responsible for a Superfund site and has created a huge mess and spends money to clean it up, that's reflected as a great, positive event in our economic statistics.

But if that company spends defensively to hire people to take actions that prevent the creation of the Superfund site to begin with, that's reflected as a negative thing in our national system of accounts.

And we're falling behind, not making progress. So, by the measures that we use, we can be blamed for getting the impression from the numbers alone that we're much better off creating more Superfund sites than we are preventing them.

Let me go to a level of detail here now on a few questions.

An amendment to the 1989 Supplemental Appropriations Act gave three directives on natural resource accounting.

First, it directed the Secretary of State to encourage the United Nations and OECD to recognize natural resource depletion in their economic accounting systems.

Second, it directed the Secretary of the Treasury to instruct the multilateral development banks and the IMF to adopt natural resource accounting.

And, third, the act directed the Agency for International Development to use natural resource accounting to evaluate and project the economic performance of borrowing countries.

What progress, if any, has been made on the 1989 congressional directive to encourage natural resource accounting for the United Nations and OECD and the U.S. development agencies?

Dr. Carson?

DR. CARSON. I can mention what is going on in the international organizations. I'm not aware of what U.S. AID is doing.

SENATOR GORE. I don't mean to interrupt. In your answer, if you can respond to the specifics about what we, in the United States, have done in response to this congressional directive, rather than a generalized summary of what is going on in the international community.

DR. CARSON. And as part of this, I would like to mention, too, that at about the same time the Commerce Secretary was directed to cooperate with the international organizations and develop standardized techniques for natural resource accounting.

And this is how—

SENATOR GORE. And BEA is the logical implementing agency.

DR. CARSON. Right. And this is where the two fit together. Our role has been in working with the international organizations as they develop these international standards.

SENATOR GORE. Excuse me for interrupting again, but, just on this point, has the BEA been asked to help implement the changes? Have you officially been asked within the government?

DR. CARSON. I've certainly volunteered. BEA has been quite active. Let me just mention a couple of things in just this last year.

SENATOR GORE. Okay.

DR. CARSON. I've been participating in the technical group that is working in support of the United Nations' effort to put together their handbook on environmental accounting. This technical group is made up of national accountants like myself and people who I guess would be comfortable with the label "environmentalists." Its purpose is to bring people together, and get this thing done in a way that would be comfortable to all.

I've worked with them on that. Similarly, BEA participated in an international conference in May that, again, had the same purpose of bringing together national accountants, economists, and environmentalists to assess where we are, what can we do at this point.

This week we're having discussions with statisticians from Mexico, because Mexico has participated as one of the case studies in testing the World Bank/U.N. approach on environmental accounting. And we felt that the exchange of information from the two countries might further the work. And we're proposing, for example, that there might be something done jointly, either conceptually or statistically.

As well, let me just mention something that I think is relevant. The United States has contributed my time in working on the management of the SNA. That has been taken as an example by countries around the world, who, in turn, are contributing.

Germany has contributed the time of the person who was actually doing the drafting on the U.N. handbook on environmental accounting. And in doing so, they specifically noted that they were taking this approach because of the lead that the United States had taken in making an in-kind contribution.

So, in summary, I think that the United States is doing quite a bit to follow through with these congressional directives.

SENATOR GORE. More precisely, you are doing quite a bit.

DR. CARSON. I have BEA and ESA behind me. It makes a big difference.

SENATOR GORE. Do they have enough resources to help effectively?

DR. CARSON. If we had more resources, we could do more. That's an easy answer to that. I don't know what "enough" is. We're strapped for resources now, and if we get more, we could do more.

DR. PLANT. Clearly, we've asked for more in our 1992 budget than what was appropriated. And, again, Dr. Carson's time is a very valuable resource. Although we're happy to have her working on these U.N. efforts, to the extent that we can get more resources backing her up, we'll all be better off, I think.

SENATOR GORE. Mr. Chairman, I'll just note that earlier in Dr. Plant's statement he called our attention to the fact that the Congress cut back on the Administration's request in this key area. I promised my continued best efforts to try to remedy that. And I do think it's very important.

SENATOR SARBANES. This Committee has tried to be of assistance. You have been a part of the Boskin Initiatives in your proposals, I understand, and we have been trying to help you get the resources to implement it.

Unfortunately, we are dealing in a very constrained budget environment, as you well know. And we are fighting for the life of some of these statistical programs and agencies.

I happen to think it is a very important priority, but it's hard to make people perceive that because they have to have the kind of vision that Senator Gore has brought to these hearings to appreciate the importance of these statistical developments to the overall healthy functioning of the society.

We are trying to do all we can to help you. We got some money, but nowhere near what we were trying to get. We just have to keep working at it.

I certainly hope the Administration will come back at it very hard in their next budget submission. We have to keep pressing at this thing if we're going to get the results.

DR. PLANT. We very much appreciate your efforts and the efforts of Senator Gore. They have been instrumental, I know, in getting us the appropriations we have. And we're going to keep chipping away at it.

That's what we have to do. We'll come back every year. We'll come back with a little more. We'll keep revising our plans, and keep moving ahead as fast as we can, given what we are—

SENATOR SARBANES. Yes. We're fighting now for the BLS, which was really done in in its budget, because it was competing with drug and health and educational programs, and so forth.

But I know Janet Norwood, who I regard as an extraordinarily able professional—Dr. Carson, I'm delighted to see you here, because I have the same view of your contributions—is very deeply concerned.

Of course, she'll be stepping down at the end of the year. We'd like her to be able to leave her agency in good repair, so to speak. So, that conference is yet to complete. And we're working on that right now.

SENATOR GORE. Overall, this is so important for two reasons. Number one, the scale of human activity within the ecosphere has changed dramatically, just in this century, to the point where the consequences of our collective activities on the ecological system of the Earth are now very different than at any prior time in human history.

The systems of accounting for human activity—which began to emerge in the colonial area when natural resources were felt to be limitless, and our entire natural system was felt to be, for all practical purposes, infinite and immune to any lasting damage as a consequence of human activity—simply have to be revised to reflect reality.

Now, second, we've had a dramatic philosophical victory in the war of ideas between capitalism and communism, which has raged for 70 years, and has now come to a stunning conclusion in which market economics has been declared the winner almost everywhere in the world, with no serious rival to be found.

In the aftermath of that victory, it is critically important, as nations throughout the world turn with increasing fervor toward the United States or, perhaps more accurately, the Japanese modification of the U.S. model, that these nations have waiting for them a model that encompasses these revisions of the old inaccurate way of reflecting reality.

And so, it's not just numbers. It's not just theory. It's the most basic tool that we have for guiding the conduct of human civilization in the sphere of economic activity, which is the sphere where most people spend most of their waking hours, when you take into account the activities that have an impact on the environment. And so the efforts you're making are critically important.

I have just a couple more questions.

You mentioned, Dr. Plant, in your opening statement, the misunderstanding about the phrase "satellite accounts".

Do you feel that the satellite accounts for natural resources and environmental assets for the United States would receive the appropriate attention by policymakers, compared to a broader approach that was aimed at a sharper transition, a more complete supplementing of the current system of accounting?

DR. PLANT. Well, in fact, you're going to have that kind of supplanting. You'll see us moving to the U.N. System of National Accounts in the next four or five years, we hope, given budgetary constraints.

That will be a brand new way of doing accounting. It's a fundamentally different way of looking at the economies, a fundamentally more complete picture of the economy. And it has both the income flows and assets; a balance sheet, if you will.

The benefit of the satellite accounts for natural resourcing is that it fits directly into that framework. It gives you a way of looking at natural resources impact in that SNA framework.

If we had had a satellite account sitting out by itself, no, it probably wouldn't. It wouldn't get the attention. But given that you're putting the two together—

SENATOR GORE. You say that they're connected in. They're intended to be there, side-by-side, with the main accounts. Correct?

DR. PLANT. They're part of the total system of accounts.

SENATOR GORE. Yes. But isn't it possible, in spite of the way you stated the case in your statement—and I listened carefully and understand the logic you're urging upon us—that the inertia built into the current pattern of activity and the ways of measuring that activity and its consequences would create enormous incentives for policymakers throughout the world to look at the satellite accounts, simply ignore them, and continue to use the so-called main accounts, just as they do now?

DR. PLANT. The one thing I found in my tenure of dealing with statistical agencies is every statistic has its inertia. And every statistic, in fact, has its following, and people get used to that statistic and want to keep using it over and over again. There's a high value placed on consistency over time.

And the question is how do you get people to turn away from that highly valued, well-known statistic to something else?

Our expectation is that the satellite account is the easiest way to do that, because it allows you to set up an account that can be, by choice, integrated into the main set of accounts. You can take the information in that account and measure the effect of depletion on GDP, but it allows you to do it, at least, in an experimental way.

In fact, you can use different types of methods. You can see what works. You can see what gains broad acceptance. It gives you a flexibility to allow the work to go forward rather than, if you will, tampering with the sacrosanct.

SENATOR GORE. Okay. Now, let me challenge that. Partly, this anticipates the one thrust of the testimony that will be forthcoming from Dr. Repetto and Dr. Peskin later.

Dr. Repetto, for one, believes—and he'll speak for himself on this, and if I get it wrong, he'll correct me—that the satellite accounts might not be done or be ignored if they are.

You say there is a tremendous amount of inertia in accounting, and people get used to the numerical categories they're familiar with. I think the inertia in the activity measured by those numbers is stronger than the inertia in the accounting system itself. And that, so long as the old way of measuring the activity, the old way of evaluating the activity is available, it is likely to still be used in lieu of the satellite accounts if the inertia pushing the underlying pattern of activity is there.

Let me give you an example. Gorbachev and Yeltsin had different ideas about the transition from a communist system to a democratic system. And Gorbachev—you will not like this analogy—seemed to say that they could do both, and have a slow and comfortable transition as people got used to it.

He seemed particularly concerned about the inertia in the system and the intellectual and emotional attachment of so many in the Soviet Union to the old way of doing things.

And he, in effect, recommended a satellite system—a new system—that would gradually prove its superior value. And, yet, Yeltsin said—and he said it here in the Congress when he came to visit—we have to change. "We have to change." And he told his own countrymen, unless the change came in whole, it would not come in part.

Now, isn't there something to that analogy?

DR. PLANT. I think there's something to the analogy, but I think there's a critical difference. I think Mr. Yeltsin had, sitting around the world in different places, very good working examples that he could point to.

He had a proven system of one kind or another in the United States and various other countries, and could say, "See, there's exactly how it can work, and we can change to that."

I don't believe that we have that in natural resource accounting. There are lots of open questions. And what I want to distinguish here, I think, is between defender of the status quo, which we are not, and the appropriate conservativeness, if you will, that the keeper of the Nation's income account should have.

SENATOR GORE. Yes, but you work for the keeper of the status quo [laughing]. I mean, you're not. And I don't mean to sound too cute on that, but I believe there is some truth to that.

I believe that you, Dr. Carson, your colleagues, and also, incidentally, some folks in OMB are intellectually committed to the idea that we really have to improve these accounts. No question about it.

But the inertia in the underlying pattern of activity about which I spoke is one which really does have very fierce proponents.

I interrupted you, so you finish, and then we'll move on.

DR. PLANT. I think it's appropriate then to use a framework where we can experiment, where we can see what happens when we use different approaches. And then, when there is broad acceptance statistically, when there is a model that is functioning and working, we can incorporate it fully. We can marry the two together more closely. But until that point, I think it's not a good idea.

SENATOR GORE. Dr. Carson, please proceed.

DR. CARSON. I can put it this way, perhaps. I see it as the alternative. I see using satellite accounts as the alternative to going underground, having BEA work feverishly, and then putting forth something on which we've not educated the public.

Using the satellite account approach, we begin piecemeal to put it together. We begin an educational process. Meanwhile, people with concerns like yours are up there asking for it.

Working together, there's an educational process that seems to us to be part of the process of getting to the point that a different kind of measure would be available and used.

SENATOR GORE. Now, given the limited resources for government statistics in developing countries, what are the prospects for satellite accounts actually getting completed there? Is that going to happen?

DR. CARSON. BEA or the world?

SENATOR GORE. Developing countries.

You see, the satellite account approach is premised on the notion that these will be developed in parallel by nations all over the world, and the educational process you spoke of will continue. And then, at some point in the indeterminate future, all of these countries, having educated themselves, having gained experience with the satellite accounts, will switch over.

But if the satellite accounts are never built, much less used in the developing countries, then isn't there a flaw in that strategy?

DR. CARSON. Developing countries' statistical offices are strapped for resources. That is clear. What they are able to do is going to depend in part on what their policymakers think are the important questions.

I see what policymakers ask of them as much more important in determining what they do rather than whether a particular thing is recommended by the SNA or the United Nations.

The United Nations now has a large system, only part of which is done by a number of the developing countries. They do that part because that is what is relevant to them, in terms of answering the questions that their policymakers pose.

So, I think it's part of the process that we continue to work to make it clear that this is an important concern, raise the consciousness of the policymaker, so that they ask those questions; and, at the same time, continue to hone the national accounting approaches, so, when we are able to set forth a framework, it's a good one.

SENATOR GORE. This meeting is coming up in Brazil next summer—the UNCED meeting. This would be an ideal time for the United Sates to propose an environmental natural resource accounting program.

Are we planning to do that?

DR. PLANT. Not that I'm aware, no, sir.

SENATOR GORE. Do you agree that it would be a good idea?

DR. PLANT. I think it would, depending exactly on what the program was. I think that, in fact, drawing the attention of the developing countries to these kinds of problems, to work like Dr. Repetto's pointed out, and drawing also their attention to the fact that, within their accounting frameworks, they can look at these kind of problems, that's worthwhile, yes.

To propose the full incorporation into the U.N. System of National Accounts at this point, I'm not sure would be.

SENATOR GORE. I sure think Dr. Carson ought to go to Brazil.

DR. CARSON. Sounds great.

[Laughter.]

DR. PLANT. Dr. Carson's been around the world. We'll be happy to send her to Brazil.

SENATOR GORE. We have a proposal.

SENATOR SARBANES. What forces do you see as working against or trying to inhibit any move in the direction of the kind of accounting that we have been talking about?

DR. PLANT. The primary force that I see is budgetary.

SENATOR SARBANES. You don't see any forces in the private sector that are apprehensive about this kind of accounting?

DR. PLANT. Not to my knowledge.

SENATOR SARBANES. Now, Dr. Carson, what's your timetable at the United Nations on the SNA accounts?

DR. CARSON. The timetable is that we have to have a draft of the revised SNA ready next summer in order to have it printed and distributed to members of the United Nations' Statistical Commission.

The Statistical Commission has demanded—and I say that with kind of the words that they used—to have the SNA put before them in February 1993.

When we put it forward, it will be in recognition of the fact that we were given a deadline. We went as far as we could and had to stop. We will be explicitly pointing out that, in areas like natural resource accounting, it's work in progress.

Part of putting it forward to the Statistical Commission will be acknowledgment that work has to continue, meaning that the SNA will have to evolve.

I will suggest that the Statistical Commission is well aware of the fact that we cannot wait another 20 years, as some people say was the prospect, in order to have another revision that would take something like a variety of natural resource accounting into part of the SNA.

SENATOR SARBANES. Well, are the answers that are being raised as to how we should answer some of these important questions—which you had in your statement, Dr. Plant—going to be given at the U.N. level rather than at our national level?

DR. PLANT. I think some answers, to the extent that there's a world consensus, would be given at the United Nations.

I think we would look at each one of those answers, and make our own assessment of what would be appropriate for the United States economy.

SENATOR SARBANES. Was there any benefit from using the same accounting systems that are being used internationally by the United Nations?

DR. PLANT. Absolutely. That's one of the reasons.

SENATOR SARBANES. If the United Nations and other nations move ahead of us, to some degree they're going to be defining the framework in which we are going to work. Would not that be the case?

DR. PLANT. I think it will be a mutual definition. The people at BEA, as I said, are catching up. We expect that as we begin our case studies and begin to formulate our satellite accounts there will be an interaction with people at the United Nations.

Carol is one of the key players in all of this, and she's very much a leader in the U.N. SNA operation. So, we won't play a follower role; we'll play a mutual leader role, I would think.

DR. CARSON. If I may add a note to that, our ability to participate is enhanced when we move closer to the SNA, because any work that we do that moves the natural resource accounting effort forward will be in the context of the SNA. That's much more internationally transferrable than if we did it within the context of the accounts that we have now.

Most countries of the world follow the SNA. And the closer we are to doing our developmental work in that framework, the more useful our results will be to other countries. And, clearly, it will be easier to use their progress to incorporate into ours if we're working with it in the same framework.

SENATOR SARBANES. Is the Boskin Initiative going to carry forward into the next budget submission by the Administration? Do you know?

DR. PLANT. We're at the point of assessing the impact of the 1992 budget. Boskin and the people that have worked on it have said all along that it is a multiyear initiative. So, I expect it to carry forward.

SENATOR SARBANES. Well, I would encourage you to do so. This is an ongoing process, and the fact that not everything that was sought after in the Boskin Initiative has been realized ought not to deter you from pressing, not only the past initiatives forward, but supplementing them as you perceive.

We have finally found someone in the Administration who is prepared to take an interest in coordinating the role on this statistical issue, and we want to see that continue.

I think it's very important. I have a focal point. And it appears at least to have worked well in a collaborative way within the Administration, although I do think some of the health and educational statistics have been somewhat ignored.

But that's an issue that I have discussed with Chairman Boskin directly. But I do urge you to keep this initiative moving.

Mr. Chairman, I'm going to have to depart. I won't have a chance to hear Dr. Repetto and Dr. Peskin, and I regret that. I have their statements and I'll look at them.

Dr. Peskin has done some very interesting work for the EPA with respect to the Chesapeake Bay Region, which, of course, is a matter of very deep concern to me.

So, I certainly welcome them as witnesses and regret that I won't be able to stay. And I want to thank Dr. Plant and Dr. Carson for their testimony.

DR. PLANT. Thank you.

SENATOR GORE. Thank you very much, Mr. Chairman. And, again, let me thank you for chartering this set of hearings. They've been getting off to a very good start, and I'll look forward to the rest of them. And I certainly appreciate your support and encouragement.

SENATOR SARBANES. Well, we make a very singular contribution. You know, the Japanese have a month every year that they celebrate statistics. Of course, we helped to institute the——

[Laughter.]

SENATOR SARBANES. ——statistical system after World War II. And in one of those celebrations a few years ago, the theme for the monthly celebration was, "Statistics, the Beacon to a Happy Life." [Laughter.]

I'm not sure we'll ever get things to that state here, but it's indicative at least of the potential.

Thank you very much.

SENATOR GORE. Thank you, Mr. Chairman.

Dr. Plant and Dr. Carson, we may have some questions for the record. They're not lengthy or onerous, but we'd appreciate your attention to them.

And with that understanding, we'll conclude your part of the hearing today with our thanks. Thank you so much for coming.

DR. PLANT. Thank you, Mr. Chairman. Our pleasure.

SENATOR GORE. And, also, we'll continue to work with you on the budget matter to keep this initiative ongoing.

DR. PLANT. Thank you.

[Witnesses excused.]

[No information was requested.]

SENATOR GORE. We're very pleased to invite the second panel to come forward. Dr. Peskin, Dr. Repetto, if you two would join us at the witness table?

As I said earlier to Dr. Carson, I want to thank you two for helping me personally when I was venturing into this forbidden area last year and attempting to understand it better.

You were two excellent teachers, along with others. And I appreciate that very much and look forward to learning more from you here today.

Your prepared statements, as I noted earlier, will be a part of the record. I'm interested in whatever you have to say.

We will start with you, Dr. Peskin. Welcome. Please proceed.

DR. PESKIN. Thank you.

STATEMENT OF HENRY M. PESKIN, PRESIDENT, EDGEVALE ASSOCIATES, INC.

DR. PESKIN. Mr. Chairman, for about 20 years, I have been developing resource and environmental accounts; first as a consultant to the Norwegian Central Bureau of Statistics; later as a member of the staffs of the National Bureau of Economic Research and of Resources For The Future. More recently, I assisted the U.S. EPA in the development of a set of environmental accounts for the Chesapeake Bay Region, and I'm directing similar activities in the Philippines and in Indonesia for U.S. AID.

I appreciate the opportunity to discuss resource and environmental accounting with you today.

From the earliest days of modern national accounting systems, that is, those systems developed in the first half of the 20th century, economists have emphasized limitations of using monetary transactions to measure total economic activity, let alone to measure total societal well-being. Nevertheless, the National Accounts and especially certain subtotals drawn from these accounts, such as the gross national product, have gained popular status as a key measure—if not the key measure—if a nation's economic and social performance.

However, many citizens, especially members of the environmentalist community, have joined economists in expressing unhappiness with the status given to the National Accounts as a barometer of societal performance. Since the 1960s, environmentalists have been especially concerned that the accounts failed to reflect pollution and general environmental and natural resource deterioration. A further source of irritation is that efforts by the business sector to clean up the environment or to prevent resource degradation could actually lead to a reduction in measured gross product, even as environmental and resource conditions improved.

Perhaps, because of the GNP's neglect and even perverse treatment of environmental changes, environmentalists looked upon the economics profession as more enemy than ally. However, many resource economists are concerned about conventional economic accounting, although not necessarily because of their failure to measure social well-being. Rather, they find the accounts less useful for policy than they otherwise could be. In particular, the neglect of environmental activity means that the conventional accounts are unable to shed any light on potential economic environmental interactions. Furthermore, since the conventional national economic accounts also ignore the deterioration of the Nation's environmental and natural resource base, they paint a falsely optimistic picture of the Nation's prospects for sustainable economic growth.

In response to these concerns of resource economists, environmentalists, and the general public, there have been several efforts in both industrialized and developing countries to find ways of improving the ability of conventional economic accounting systems to respond to degradation of the natural environment and to reductions in the stock of natural resources.

Over the years, I've been an interested observer of these efforts. Many of my observations have been summarized in a World Bank survey of resource and environmental accounting efforts that are underway in industrialized countries. I would like to include this survey as part of the written record of these hearings.

SENATOR GORE. Without objection.

DR. PESKIN. Today, I would like to address the question of whether it is desirable and practical for the United States to undertake a major effort at resource and environmental accounting at this time. I believe the answer to this question depends on how one views the purposes of accounting. Differences of opinion on this score largely explain the wide variations in accounting approaches, which I have observed.

I have grouped these approaches into four categories. First, there are efforts to identify more clearly the consequences of environmental degradation and environmental protection activities that are already measured in conventional national economic accounts. In particular, there is an attempt to measure expenditures intended to defend against environmental insult—that is, those expenditures on paint, filters, preventive health care, etc. that are engendered by the deteriorating environment—as well as expenditures on pollution abatement and control. A program along these lines has been underway for sometime in the United States, namely, the BEA publications of Pollution Abatement Expenditures.

Second, there are efforts at supplementing the economic accounts with a physical accounting of changes in the stock of various natural resources, such as forests, minerals, fish, etc. While the Norwegians are leaders in these efforts, similar activities are underway in France, Germany, and a number of developing countries.

Third, there are efforts to measure the depreciation value of the depletion of various natural resources, such as timber, oil, and topsoil. My colleague, Robert Repetto, has been a pioneer in this approach. His work in Indonesia, Costa Rica, and China has had worldwide influence.

Finally, there are efforts to construct comprehensive frameworks that closely integrate environmental and natural resource activity with the ordinary economic activity already covered in the conventional economic accounts. Projects along these lines are underway at the U.N. Statistical Office in Austria and the Netherlands. I have, on a pilot basis, developed such accounts for the United States and the Chesapeake Bay Region.

While there is a wide variation in approach represented by these efforts, unhappiness with the way conventional income measures reflect the environment provides a common motivation. However, the general goal of improving the GNP may be outweighed by more specific policy objectives. These approaches do not necessarily represent different methods of attaining the same objective, but more likely, different methods of obtaining different objectives.

Accounting, whether it be resource and environmental accounting, national economic accounting or ordinary business accounting, serves two related but conceptually distinct functions. First, the process of accounting generates indicators—such as GNP, profits, net worth—that show how well the Nation or business is doing. I call this a scorekeeping function. At the same time, the accounting process serves to organize basic information that the Nation or business needs to manage its economic affairs. I call this a management function. Data on production, sales, and expenditures are the raw materials of the accounts. They are also essential inputs into the management process, whether for a nation or for a business.

Different approaches to resource and environmental accounting appear to reflect different emphases on the roles of scorekeeping and management. The Norwegians, as good managers, have developed an accounting system that provides information directly used in their economic planning models. As the data in this system measures only resource use and environmental conditions in physical terms, they cannot be used to adjust conventional economic indexes, such as the Norwegian GNP. And there appears to be no interest in Norway in doing so. In contrast, the approach of my colleague, Robert Repetto, with his emphasis on accounting for the depreciation of natural resources, serves scorekeeping needs. The intent is to produce an improved measure of sustainable economic activity.

Besides fulfilling different objectives, the two functional roles of the accounts make different demands on the accountant. For the scorekeeping function, the emphasis is on the production of a final set of accounts. For these accounts to generate meaningful indicators of the profitability of a business or of the economic status of a nation, data should be comprehensive and reasonably accurate, at least to a degree that would assure that the resulting indicators are not misleading.

For the management function, the emphasis is less on the final set of accounts than on the process of accounting. Indeed, the management functions might be well-served, even if lack of data or disagreement on measurement techniques delayed or even precluded the completion of the final accounts. In some businesses, for example, final accounts do not appear until long after the end of the fiscal year. Often, these accounts are infested with controversy, due perhaps to arbitrary depreciation practices, or to disputes over whether a particular expenditure is a current or capital cost. Nevertheless, the lack of a timely income statement or a noncontroversial balance sheet does not vitiate the accounting process. Its value as a scorekeeping tool may be overshadowed by its value as a management tool—the accounting process continually generates crucial information necessary for the operation of the business.

My survey of various resource and environmental accounting approaches, several visits to accounting workshops over the years, and exposure to a growing literature on the subject has uncovered a large amount of highly critical material. Authors do not appear reluctant to defend their systems by finding fault with the approaches of others. Yet, when one appreciates the distinct roles for accounting, the production of indicators in the support of the management process, much of this criticism seems to be misplaced.

If, for example, the purpose of a particular approach is to generate measures of resource depletion or indicators of sustainability of income—clearly, scorekeeping functions—it seems irrelevant to condemn the approach because it fails to provide the specific information needed for environmental policy management. Conversely, it seems equally irrelevant to criticize an approach whose primary purpose is to serve policy management because it fails to generate noncontroversial measures of economic performance.

I believe that both functions of resource and environmental accounting—scorekeeping and management—have important policy roles as nations continue to increase their pressure on the world's finite stock of environmental and natural resources. Imagine that we are involved in a serious athletic contest. To be successful, we have to know both, how well we are doing—that is, scorekeeping—as well as what actions to take if we do not like what we see—and that is, management. But unlike the case with most athletic contests, there is at present no consensus of how the environmental score should be kept. While many of us feel that the conventional GNP doesn't provide the right tally, there is no general agreement on methods to make it better.

Therefore, I do not believe that we are ready at this time to replace the conventional GNP. However, efforts to refine scorekeeping methods should continue. I would like to see these efforts take place within a comprehensive program of resource and environmental accounting, especially a program that develops data that show the interactions between environmental and conventional economic activity. Such a program, I believe, would, even in its earlier stages of development, generate information crucial for the support of rational, environmental and resource policy. In other words, the program would serve the management function. It would help to keep us in the contest between world economic

PREPARED STATEMENT OF HENRY M. PESKIN

Mr. Chairman and Members of the Committee, my name is Henry M. Peskin. I am president of Edgevale Associates, a small firm providing consulting services primarily to the U.S. EPA, the U.S. Agency for International Development, and the World Bank.

For about 20 years I have been developing resource and environmental accounts, first as a consultant to the Norwegian Central Bureau of Statistics and later as a member of the staffs of the National Bureau of Economic Research and of Resources for the Future. More recently, I assisted the U.S. EPA in the development of a set of environmental accounts for the Chesapeake Bay Region and I am directing similar activities in the Philippines and in Indonesia for U.S. AID.

I appreciate the opportunity to discuss resource and environmental accounting with you today.

From the earliest days of modern national accounting systems (that is, those systems developed in the first half of the 20th century), economists have emphasized the limitations of using monetary transactions to measure total economic activity, let alone to measure total societal well-being. Nevertheless, the national accounts—and especially certain sub-totals drawn from these accounts such as the Gross National Product—have gained popular status as a key measure, if not the key measure, of a nation's economic and social performance.

However, there are many, especially members of the environmentalist community, who have joined economists in expressing unhappiness with the status given to the national accounts as a barometer of societal performance. Since the 1960s, environmentalists have been especially concerned that the accounts fail to reflect pollution and general environmental and natural resource deterioration. A further source of irritation is that efforts to clean up the environment or to prevent resource degradation, if undertaken by the business sector, could actually lead to a reduction of measured real gross product even as environmental and resource conditions improved.

Perhaps because of the GNP's neglect and even perverse treatment of environmental changes, environmentalists looked upon the economics profession as more enemy than ally. There are, however, many resource economists who are also concerned about conventional economic accounting, although not necessarily because of their failure to measure social well-being. Rather, they find the accounts less useful for policy than they otherwise could be. In particular, the neglect of environmental activity means that the conventional accounts are unable to shed any light on potential economic-environmental interactions. Furthermore, since the conventional national economic accounts also ignore deterioration of the nation's environmental and natural resource base, they paint a falsely optimistic picture of a nation's prospects for sustainable economic growth.

In response to these concerns of resource economists, environmentalists, and the general public, there have been several efforts in both industrialized and developing countries to find ways of improving the ability of conventional economic accounting systems to respond to degradation of the natural environment and to reductions in the stock of natural resources. Over the years I have been an interested observer of these efforts. Many of my observations have been summarized in a World Bank survey of resource and environmental accounting efforts underway in industrialized countries. I would like to include this survey as part of the written record of these hearings.

Today, I would like to address the question of whether it is desirable and practical for the United States to undertake a major effort at resource and environmental accounting at this time. I believe the answer to this question depends on how one views the purposes of accounting. Differences of opinion on this score largely explain the wide variations in accounting approaches which I have observed.

I have grouped these approaches into four categories. First, there are efforts to identify more clearly the consequences of environmental degradation and environmental protection activities that are already measured in the conventional national economic accounts. In particular, there is the attempt to measure expenditures intended to "defend" against environmental insult—that is, those expenditures on paint, filters, preventive health care, etc. that are engendered by the deteriorating environment—as well as expenditures on pollution abatement and control. A program along these lines has been underway for some time in the United States: namely, the BEA publication of Pollution Abatement Expenditures. Secondly, there are efforts at supplementing the economic accounts with a physical accounting of changes in the stock of various natural resources such as forests, minerals, fish, etc. While the Norwegians are leaders in these efforts, similar activities are underway in France, Germany , and a number of developing countries. Thirdly, there are efforts to measure the depreciation value of the depletion of various natural resources such as timber, oil, and top soil. My colleague, Robert Repetto, has been a pioneer in this approach. His work in Indonesia, Costa Rica, and China has had influence world wide. Finally, there are efforts to construct comprehensive frameworks that closely integrate environmental and natural resource activity with the ordinary economic activity already covered in the conventional economic accounts. Projects along these lines are underway at the U.N. Statistical Office, in Austria, and in the Netherlands. I have, on a pilot basis, developed such accounts for the United States and for the Chesapeake Bay region.

While there is a wide variation in approach represented by these efforts, unhappiness with the way conventional income measures reflect the environment provides a common motivation. However, the general goal of improving the GNP may be outweighed by more specific policy objectives. These approaches do not necessarily represent different methods of attaining the same objective, but, more likely, different methods of attaining different objectives.

Accounting—whether it be resource and environmental accounting, national economic accounting, or ordinary business accounting—serves two related but conceptually distinct functions. First, the process of accounting generates indicators (e.g., the GNP, profits, net worth) that show how well the nation (or business) is doing—a "scorekeeping" function. At the same time, the accounting process serves to organize basic information the nation (or business) needs to manage its economic affairs—a "management" function. Data on production, sales, and expenditures are the raw materials of the accounts. They are also essential inputs into the management process, whether for a nation or for a business.

Different approaches to resource and environmental accounting appear to reflect different emphases on the roles of scorekeeping and management. The Norwegians, as good "managers", have developed an accounting system that provides information directly used in their economic planning models. As the data in this system only measure resource use and environmental conditions in physical terms, they cannot be used to adjust conventional economic indexes such as the Norwegian GNP and there appears to be no interest in Norway in doing so. In contrast, the approach of my colleague Robert Repetto, with its emphasis on accounting for the depreciation of natural resources, serves "scorekeeping" needs. The intent is to produce an improved measure of sustainable economic activity.

Besides fulfilling different objectives, the two functional roles of the accounts make different demands on the accountant. For the scorekeeping function, the emphasis is on the production of a final set of accounts. For these accounts to generate meaningful indicators of the profitability of a business or of the economic status of a nation, data should be comprehensive and reasonably accurate—at least to a degree that would assure that the resulting indicators are not misleading.

For the management function, the emphasis is less on the final set of accounts than on the process of accounting. Indeed, the management functions might be well served even if lack of data or disagreement on measurement techniques delayed or even precluded the completion of the final accounts. In some businesses, for example, final accounts do not appear until long after the end of the fiscal year. Often these accounts are infested with controversy due, perhaps, to arbitrary depreciation practices or to disputes over whether a particular expenditure is a current or capital cost. Nevertheless, the lack of a timely income statement or of a non-controversial balance sheet does not vitiate the accounting process. Its value as a scorekeeping tool may be overshadowed by its value as a management tool—the accounting process continually generates crucial information necessary for the operation of the business.

My survey of various resource and environmental accounting approaches, several visits to accounting workshops over the years, and exposure to a growing literature on the subject has uncovered a large amount of highly critical material. Authors do not appear reluctant to defend their systems by finding fault with the approaches of others. Yet, when one appreciates the distinct roles for accounting—the production of indicators and the support of the management process—much of this criticism seems misplaced. If, for example, the purpose of a particular approach is to generate measures of resource depletion or indicators of sustainability of income—clearly scorekeeping functions—it seems irrelevant to condemn the approach because it fails to provide the specific information needed for environmental policy management. Conversely, it seems equally irrelevant to criticize an approach whose primary purpose is to serve policy management because it fails to generate non-controversial measures of economic performance.

I believe that both functions of resource and environmental accounting—scorekeeping and management—have important policy roles as nations continue to increase their pressure on the world's finite stock of environmental and natural resources. Imagine we are involved in a serious athletic contest. To be successful, we have to know both how well we are doing (scorekeeping) as well as what actions to take if we do not like what we see (management). But unlike the case with most athletic contests, there is, at present, no consensus of how the environmental score should be kept. While many of us feel that the conventional GNP doesn't provide the right tally, there is no general agreement on methods to make it better.

Therefore, I do not believe we are ready at this time to replace the conventional GNP. However, efforts to refine scorekeeping methods should continue. I would like to see these efforts take place within a comprehensive program of resource and environmental accounting—especially a program that develops data showing the interactions between environmental activity and conventional economic activity. Such a program, I believe, would, even in its early stages of development, generate information crucial for the support of rational environmental and resource policy. The program would, in other words, serve the management function. It would help keep us in the contest between world economic growth and environmental degradation even while we are learning to keep score.

Thank you very much.

THE WORLD BANK
SECTOR POLICY AND RESEARCH STAFF

Environment Department

A Survey of Resource and Environmental Accounting in Industrialized Countries

Henry M. Peskin
with
Ernst Lutz

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A SURVEY OF RESOURCE AND ENVIRONMENTAL ACCOUNTING IN INDUSTRIALIZED COUNTRIES

Acknowledgements and Disclaimer

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The author benefited greatly from assistance provided by those directly involved in resource and environmental accounting projects in various countries. He appreciates their timely response to requests for information as well as comments on an earlier draft. He wishes particularly to thank Tony Friend, Kirk Hamilton, Roefie Hueting, David James, Lorents Lorentsen, Thorvald Moe, Michel Potier, Gary Rutledge, Per Schreiner, Udo E. Simonis, Carsten Stahmer, Jean-Louis Weber, Jan Wright, and Mike Young. Comments are also acknowledged from Salah El Serafy, John English, and Michael Ward of the World Bank. Of course, the characterizations of the various country efforts are those of the author and any conclusions or recommendations are solely his responsibility. The paper reports on findings that are particularly significant in the context of the overall work program of the Environmental Policy and Research Division.

A SURVEY OF RESOURCE AND ENVIRONMENTAL ACCOUNTING IN INDUSTRIALIZED COUNTRIES

Abstract

Several industrialized countries have explored or are in the process of developing alternative methods to account for the economic implications of environmental degradation and resource depletion. There is a general perception that the conventional national accounts reflect environmental and resource changes poorly and thus may generate estimates of income levels and growth that are not sustainable. Because of their often severe resource and environmental problems, similar concerns are being expressed in the developing world. Should these countries decide to undertake their own programs in resource and environmental accounting, they may benefit from the experience being gained in the industrialized countries.

The purpose of this report is to survey accounting efforts in several industrialized countries and to evaluate them to the extent possible, with the understanding that many of the programs are in their initial stages and are, thus, undergoing continual revision. All the approaches surveyed can be classified into four groups. The first approach involves the identification of pollution-abatement and other environmental expenditures. This approach characterizes official efforts in the United States, although similar statistics have been prepared in France, Germany, and the Netherlands. A second approach is to account for flows of and changes in the stocks of resources using physical units of measure. Most of the Norwegian resource accounting activities are along these lines. Similar physical accounts also exist in France. A third approach is to adjust GNP and NNP by subtracting out the value of natural resource depletion. This technique has been applied in Indonesia by Robert Repetto and his associates at the World Resources Institute. Similar activities are underway in China and Costa Rica. Finally, there are approaches that attempt a comprehensive resource and environmental accounting in both physical and value terms. Early Dutch efforts and the approaches of Peskin and of staff members of the U.N. Statistical Office fall into this category.

These various accounting approaches are described in terms of how they respond to perceived deficiencies in the standard economic accounts. Problems of implementation are also identified. The report then focuses more directly on the various country efforts and, in particular, their objectives and their data needs.

The principal findings of the survey are as follows:

1. Most approaches attempt to address one or both of the two major functions of conventional national accounting (performance measurement and data framework).

2. Regardless of the intent of the various approaches, they may better succeed in addressing one function more than the other. Thus, each approach should be judged on its actual as much as its intended outcome.

3. The approaches differ significantly in their complexity and coverage.

4. The differences in complexity and coverage reflect not only the relative emphasis on the two major functions of national accounting but also different policy objectives.

5. While the approaches may have different structures, reflecting their different emphases and policy objectives, they may be similar in their data requirements. Thus, extensive debate over the relative merits of each approach, as a prerequisite to implementation, may be unnecessary or even counterproductive.

6. Because of missing information--especially regarding data development costs--it was not possible to determine the cost-effectiveness of the various country efforts and the implications of these efforts for policy-making.

Because many resource and environmental accounting programs are still in their initial stages in the industrialized countries, there is, at present, little applicable experience that can be immediately transferred to developing countries. However, the findings suggest that, should a developing country wish pursue its own program of resource and environmental accounting, it need not make a firm commitment to any particular accounting approach before data development begins. Data collected to support an initial approach most likely will support alternative choices in the future and may be valuable for other purposes as well. A final decision regarding framework or system design and the depth to which the approach is implemented should reflect a comparison of the individual country's policy needs with the resources it can devote to data development.

A SURVEY OF RESOURCE AND ENVIRONMENTAL ACCOUNTING IN INDUSTRIALIZED COUNTRIES

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A SURVEY OF RESOURCE AND ENVIRONMENTAL ACCOUNTING IN INDUSTRIALIZED COUNTRIES

Introduction

In response to concerns about the ability of conventional national accounting systems to reflect adequately resource depletion and environmental degradation, several industrialized nations have embarked on programs of research with the objective of developing improved resource and environmental accounting approaches. The overall goal of these programs is to supplement the conventional economic accounts, which generally follow the accounting patterns recommended by the United Nations System of National Accounts (SNA), with supplementary or satellite accounts that will address the environmental and natural resource concerns.

Since many developing nations have both heavily resource-based economies and severe environmental quality problems, their need for improved resource and environmental accounting may even be greater than is the need in the industrialized world. While there is good reason to believe that there is no single resource and environmental accounting approach that is immediately transferable and is applicable to all developing nations, it is likely that the eventual choice will contain elements from one or more of the approaches being adopted in industrialized countries. Therefore, as developing countries formulate their own solutions, they should find the experience of the industrialized nations helpful.

Accordingly, the purpose of this report is to describe current and planned efforts to make national economic accounting systems more responsive to changes in the environment and natural resources, and to point out those aspects of alternative approaches that may or may not have relevance for the developing world. It should be emphasized that any comparisons made between approaches are for the purpose of exposition. The intent is not to "rank" the approaches. Nor is it the intent of this report to recommend any particular framework, system, or approach.

Scope of the Survey

There are no standard definitions of resource and environmental accounting approaches. The term "environmental accounting" could be used, for example, in the general sense of "taking account of the environment" or in the much more specific sense of setting up some sort of double-entry bookkeeping of environmental activity. This survey covers approaches that are less general than the former but not quite as specific as the latter. Specifically, it only covers those approaches that attempt to correct deficiencies in the conventional economic accounts. In principle, the approaches could range from those that require a major restructuring of the conventional economic accounts to those that only call for separate ("satellite") physical natural resource accounts with indirect links to the conventional economic accounts. In practice, most the surveyed approaches are closer to the latter than the former.

It should be noted that the perceived deficiencies in the standard economic accounts could refer to account aggregates that, because of their neglect of resources and the environment, appear misleading either as measures of economic activity or of economic well-being. On the other hand, the deficiencies could refer to possible weakness in the standard accounts in their role as an information system. Some of the surveyed approaches address the former, some the latter, and some both.

Indeed, before one makes any judgments about these approaches, the dual role of the national accounts should not be forgotten. Because these approaches can both generate alternative measures of economic performance and serve as an information system, it is possible to take exception to the way the approach is used to create new indexes of economic performance, but still rate the approach highly valuable in terms of its coverage of environmental and resource degradation.

In general, the focus of the survey is on those resource and environmental accounting efforts taking place, that have taken place, or will soon to take place within (or with support of) official governmental agencies of the following countries: Australia, Canada, France, Japan, The Netherlands, Norway, West Germany, and the United States.[1] However, because they provide useful points for comparison and because some of their features have been applied to developing countries or are under consideration for adoption, three other accounting approaches, which are not country-specific, will also be covered: the approaches of Peskin, Repetto, and the United Nations Statistical Office.

The survey depended primarily on written materials such as reports, letters, and official publications, and mainly those available in English. It is confined to more or less "official" accounting efforts. University-sponsored and private research by country nationals is not covered. To be considered "official", the work must be conducted under the auspices of as governmental agency--usually a statistical bureau--and be part of a governmental program. It is recognized, however, that the degree of commitment by countries may differ as evidenced by different staffing levels, financial support, and by different project longevity. By these criteria, one might conclude that the Norwegian effort is more "official" than, say, the Dutch or French effort, with the Japanese effort the least "official" of the group.

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[1] The selection of countries was partly based on our knowledge of existing approaches and on studies readily available to the World Bank and the author. Reviewers have pointed out that there are similar efforts underway in New Zealand, Sweden, Czechoslovakia, Hungary, Finland, Portugal, and Spain. Some of these efforts are briefly described in (ECE, 1990). Work is also underway in China using an approach similar to that of Robert Repetto (see Appendix II), but with far more reliance on labor-cost as opposed to market valuations.

Brief Overview of Country Approaches

This section provides a brief overview of the accounting approaches in place or under consideration in the countries surveyed. Also briefly described are other approaches suggested by Peskin, Repetto, and researchers in the United Nations Statistical Office. More detailed and critical assessments may be found in Appendices I and II.

Australia

Presently, there are no official resource and environmental accounting initiatives underway at the Federal or state level. However, there is extensive interest in several official agencies and commissions including the Department of the Environment, the Bureau of Rural Resources, and the Resource Assessment Commission. The Australian Bureau of Statistics supports the concept of satellite accounts to the SNA but is awaiting specific guidance from the United Nations.

Canada

Statistics Canada is initiating a program on resource and environmental accounting including the development of satellite accounts. The principal objectives are to assess resource quality and quantity, to provide a framework for the development of environmental data, and to improve measures of economic sustainability. There may be parallel efforts under consideration at Environment Canada.

Initial emphasis appears to be on the assembly of data on pollution-abatement expenditures and on the tracking of physical resource flows. There are also plans for the monetary valuation of physical resources. The exact form of the accounting framework has yet to be determined but could draw on earlier Canadian approaches including the STress Response Environmental Statistical System (STRESS) and the Population-Economy Process model (PEP).

France

Development of the French system of Natural Patrimony Accounts has been underway for several years, albeit with fairly modest levels of funding. In concept, this system is, by far, the most ambitious of the systems surveyed in this report in that its intent is to cover economic, ecological, and social environments. These accounts are intended to be part of a multi-level data system, with raw statistics and data summaries at the lowest levels and with aggregate indices of general welfare at the highest level. The Patrimony accounts are envisioned to occupy a level between these two extremes.

The Patrimony accounts are further subdivided into physical accounts, which describe physical resource stocks and flows; geographical accounts, which describe physical resources by region or by ecologic or land classes; and agent accounts, which describe utilization of resource stocks and flows by economic groups. The agent accounts are defined in both monetary and physical units.

While examples of all these different sub-accounts exist for a select group of "priority" sectors, the final form of the Patrimony system remains under development. The intent is to be flexible and pragmatic in order to reflect changing data availabilities and the needs of policy.

Japan

The last official Japanese effort to account for environmental degradation was completed in 1973 with the report of the Net National Welfare Development Committee. However, the estimates have recently been updated to 1985 by Prof. Kimio Uno of the University of Tsukuba.

The approach involves adjusting conventional GNP in a number of ways in order to make it better reflect changes in national welfare. Adjustments include an accounting for the services of governmental and human capital, the value of leisure time, household production, and the negative effects of urbanization and pollution. Environmental damages are measured by the costs necessary to meet governmental standards.

While there are no plans to continue this work at official levels, future resource and environmental accounting may be necessary to support environmental-economic models currently being developed by the Environment Agency.

Netherlands

While work on resource and environmental accounting, led by Roefie Hueting, has a long history in the Netherlands, official efforts to adjust the GNP for environmental losses and resource depletion have just been initiated. The intended approach is to subtract from GNP environmental damages, measured by the costs of technical procedures and reductions in economic activity necessary to attain a sustainable use of the environment. The concept of "sustainable use" refers to the ability of the environment to provide useful functions for the present and into the future. Hueting believes that objective standards to meet this goal can be established from the ecological literature.

To effect the intended adjustment to GNP, a 13-stage program of research is envisioned. This program covers such areas as problem identification, data collection, development of suitable technical measures, and costing.

Norway

The focus of the Norwegian approach has been on physical resource accounting: analyzing the flows of natural resources and pollutants and the relationships between these flows and economic activity. Physical accounts describing levels of stock, discoveries, depletion and deposition of the more important natural resources in Norway (e.g., fish, petroleum, forests) have been published since the early 1970s.

The intent of the Norwegian effort is not to adjust GNP. There is no attempt to convert physical measures into monetary units. The primary objective of the Norwegian effort, rather, is to provide data and information to support both the development of specific resource policy and the general needs of the Norwegian economic planning process. Therefore, the scope of the accounting effort and the specific content of individual accounts is determined by political and practical considerations.

United States

The principal emphasis of official environmental accounting efforts has been on the assembly of pollution-abatement expenditure data. For manufacturing establishments, the Bureau of the Census has been assembling expenditure data since 1972. Over the same time period, the Bureau of Economic Analysis (BEA) has been assembling similar data for more broadly defined national accounting sectors, relying primarily on a survey of companies. Due to budget reductions, the BEA survey was shifted to Census in 1989 and greatly reduced in scope.

So far, there are no plans to use these data to adjust conventional GNP. However, both the BEA and the U.S. Environmental Protection Agency are currently investigating the feasibility of developing more extensive resource and environmental accounts. These accounts may include GNP adjustments. They are likely to be viewed as supplements to, rather than substitutes for, the conventional accounts.

West Germany

The Federal Statistical Office is considering the development of satellite environmental accounts. The intent is to describe the physical state of the environment but to link changes in the physical state with economic activity.

The form of these accounts is yet to be determined. However, initial approaches are likely to reflect recent West German research on the effect on GNP of defensive expenditures and of pollution-abatement expenditures.

Peskin

The accounting framework developed by Henry M. Peskin is based on a neo-classical economic theory that treats environmental assets as if their contribution to economic activity were similar to that of conventional, marketed assets. The "environment" is thus viewed as a producer of inputs consumed by other productive economic sectors and as a generator of output services consumed by final demand. The accounting structure, consistent with this theory, has the input-output form of the conventional consolidated income and product account with several modifications.

On the input side are environmental services to producers (primarily waste disposal services) and on the output side are positive services to consumers (for example, recreation services) and negative damages (e.g., pollution), resulting from the use of environmental services by producers and from natural causes. The various services and damages are valued according to the estimated willingness-to-pay for these services by their users. Since the estimated input and output values may not equal, a balancing entry is required. The accounts also include on the input side an entry accounting for the economic depreciation of environmental assets and natural resources. This entry affects net product but not gross product.

As an experiment, the U.S. Environmental Protection Agency is currently applying this framework to the Chesapeake Bay region of the United States.

Repetto

The approach of Robert Repetto is to adjust gross and net income measures by subtracting out the value of the net depletion of natural resources. The depletion value is measured by the change over the accounting period in sales minus production costs or, equivalently, net economic rent. No adjustments are made to GNP for pollution damage, current environmental services, or for the costs of pollution abatement.

The procedures have been successfully applied in Indonesia and further applications are underway or are under consideration in China, Costa Rica, and the Philippines.

United Nations Statistical Office

Staff of the United Nations Statistical Office (UNSO) (with collaboration of Carsten Stahmer) have recently designed a system of environmental and natural resource accounts that closely follows the structure of the conventional U.N. System of National Accounts. The preliminary version of this system attempts to maintain the SNA definitions of productive sectors. The primary purposes of the system are to explicitly identify financial flows that are environmentally-related, show linkages between physical resource accounting and monetary accounting, allow for the comparison of environmental benefits and costs, and provide better indicators of income sustainability.

The UNSO system is currently under revision. Plans are for the preparation of a "handbook" to guide potential pilot projects that will test the feasibility of implementing the system in developing countries.

Modifying the Accounts to Include Resources and the Environment: Alternative Approaches

The survey of accounting activities in industrialized nations revealed a number of possible approaches to address one or more deficiencies in the conventional accounts with respect to their treatment of natural resources and the environment. These deficiencies involve perceived inadequacies in the ability of the accounts to measure economic and social performance, to treat all sources of income and wealth consistently, and to reflect fully all determinants of economic activity. Appendix III discusses these issues more fully. The proposed approaches will be discussed in turn, starting, more or less, with those measures that make modest or little demands on existing national accounting frameworks to those that would entail major changes in the existing structure.

1. Identification and reclassification of environmental expenditures

Expansion of the conventional accounts could mean something other than extending coverage to environmental and natural resource activities. It could also refer to changes in the definition and classification of accounting entries. In particular, one of the more-frequently-made suggestions for making environmental modifications to the accounts (put forth, for example, by the French and Japanese) is to reclassify final demand (consumption and investment) expenditures for pollution abatement as "intermediate," thereby subtracting them from the GNP.[2] The Germans have suggested taking this approach one step further by subtracting out (using input-output techniques) currently intermediate business expenditures on environmental control that may be embodied in the value of final output. While there has been no effort to adjust GNP in the United States for environmental expenditures, identifying them constitutes the principal environmental accounting activity by official U.S. agencies. Similar statistics are also generated in France, Germany, and the Netherlands.[3]

Closely related to the suggestion of removing "final demand" pollution-abatement expenditures from conventionally-measured income is the suggestion to remove from consumption certain purchases of goods whose only purpose is to "defend" against environmental externalities. The purchase of face masks, like those frequently worn in the polluted streets of Tokyo and Taipei, are examples of such "defensive" outlays. However, as desirable as may appear to deduct defensive outlays from output, to do so raises troublesome problems regarding the classification of "final" as opposed to intermediate input goods.[4]

The problem is that nearly all "final" expenditures can be interpreted as "defending" against something and thus be reclassified as inputs. As Jaszi

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[2] This approach has reasonably long historic roots. In the many conferences and workshops on national accounting improvements held since World War II, much more discussion has been directed towards definitional and classification issues that towards extensions to nonmarket activities. Typical of these conferences are those of the International Association for Research in Income and Wealth held every two years.

[3] According to Michel Potier, the OECD will review these efforts in a forthcoming publication.

[4] These problems were raised by George Jaszi in his comments on Juster's article. (Juster, 1973).

wrote, "... food expenditures defend against cold and rain, ... medical expenditures defend against sickness, and religious outlays against the fires of hell." (Jaszi comments on Juster, 1973). Indeed, one could imagine a simple economy without investment or governmental activity and where labor could be viewed as the "output" of the household sector and consumption, the "input" to this sector. Under such a view, there would be no "final" expenditures and none of the usual, well-known account aggregates such as GNP. Thus, even in a more complex economy, if all "final" expenditures were interpreted as "defending" against something, as Jaszi suggests they could be, there would be no GNP.

While Jaszi's rhetoric serves to highlight the extent of the problem, it doesn't provide much guidance as to what should determine whether a consumption outlay is or is not "final." In view of the above arguments, it clearly is not useful to declare all consumption as "intermediate." But simply following current practice, with its often arbitrary distinctions (e.g. a refrigerator installed in a home is a consumption good; installed in a supermarket, an investment good), is equally unsatisfactory. For example, the Japanese and Peskin accounting approaches both require a negatively signed final good entry that represents environmental damage. The magnitude of this entry equals the value of (environmental) defensive outlays plus the value of any remaining environmental damage.[5] If conventional practice is followed with respect to the treatment of defensive outlays as positive consumption items, it could lead to the following unfortunate result. Increases in environmental damage that engendered defensive outlays of the same magnitude would leave the GNP equal to what it would have been were there no increase in environmental insult.[6]

Data on both environmental damage and defensive outlays permit a comparison of environmental damage with actions taken in defense of this damage. These data also can be used for analysis of defensive expenditures on prices and general economic activity. Thus, identification of both pollution-abatement expenditures and environmental defensive outlays seems a worthwhile pursuit even if, as is the case in the United States, the resulting estimates are not used to make any adjustments in the conventional account aggregates.

2. Physical resource accounting approaches

One of the more practical suggestions for rectifying the deficiencies with the conventional economic accounts is to develop separate or "satellite" accounts that describe the flows of resources, materials (including pollutants), and energy that underlie any economic activity. Each one of these accounts

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[5] The value of air and water pollution damage was about $47 billion in 1978. See the discussion of the Peskin framework in Appendix II.

[6] This result, however, is preferable to the current situation. Conventional, unmodified GNP will increase as successfully-defended environmental damage increases.

would display input-output balances that are necessary consequences of physical conservation laws. Thus, in principle, such accounts could not only show the depletion of natural resources and additions to the resource base through discovery and natural growth, but also their transformation into goods and materials, some of which may find their way back to the environment in the form of pollutants. The material or energy accounts can be linked to the conventional economic accounts through the use of ratios (or input-output coefficients) that express units of energy or material use per unit of production or sales.

On a more or less "official" governmental level, this general approach is being tried in France[7] and especially in Norway, where a number of resource accounting tables have been published.[8]

There appear to be two types of physical accounts, both of which are found in the Norwegian and French systems. The first is a stock account, which typically indicates an "opening stock", any additions to the stock either through discoveries or growth, any subtractions due to exploitation or natural destruction, and, finally, a "closing stock." This type of account is typically applied to depletable resources, such as minerals, or to renewable resources, such as forests. The second type of physical account applies to pollutants. This account typically describes air and water pollution generation by polluting source. While there also have been some research efforts to trace the flow to final deposition as well as generation, typically the tables only provide some measures of resulting ambient environmental quality (e.g., air pollution concentrations, etc.). Many countries engage in this second type of physical accounting as part of their efforts to generate environmental quality reports.[9]

Because purely physical accounting approaches do not attempt to value material and energy flows in monetary terms, they can not directly provide the

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[7] As is apparent from the discussion in Appendix I, beginning on page A-I-8, the French system conceptually comprises more than just physical resource accounting. On the other hand, the scope of the physical resource accounting--that is, the number of individual resources covered--is actually far less extensive than suggested in the previous paragraph.

[8] The OECD also has a pilot project to develop forest and water resource physical accounts for several industrialized nations.

[9] One could argue that this second type of data should be more properly referred to as "environmental statistics" rather than "accounts." However, the definition of what constitutes environmental statistics as opposed to environmental accounts must remain unclear until there is, in the words of the UN Statistical Office, a "...generally accepted model or classification of the environment." See (United Nations, 1984).

information to correct social and economic indicators generated by the conventional accounts. Nor can they address the inconsistent treatment of depreciation between natural resource and marketed capital discussed above. Moreover, if they are to be very comprehensive, physical accounts can get large and unwieldy since it is hard to find a common physical unit of measure that would permit aggregation. The alternative is to be selective. Thus, the Norwegian accounts are confined to a very few sectors deemed important for the Norwegian economy: forests, fishing, hydro-power. However, even with limited coverage, the Norwegian experience indicates that these accounts can provide valuable information relating economic and environmental activity and, thus, go a long way towards filling in the missing items in the economy's production function.

3. Depreciation of marketed natural resources

Another approach to modifying the standard economic accounts is to focus on their failure to depreciate natural resource and environmental assets. This particular strategy has received recent popular attention through the work of Robert Repetto and his colleagues at the World Resources Institute.[10]

It is important to note that Repetto's focus is primarily on what the Norwegians refer to as "material resources": those resources, such as timber and petroleum, that either generate marketed product directly through harvesting or mining or attain their economic value by closing contributing to the production of marketed product. Top soil falls into the second category. Resources, such as rivers and lakes, which generate nonmarketed environmental services, are not covered. Forests in their role as providers of habitat or recreation or other services that fall into the nonmarketed category are also not covered by the Repetto approach.

Concentrating on the depreciation of material resources makes sense especially in resource-based developing countries and where resource problems may be quantitatively more important than environmental problems. Thus, Repetto's adjustments have been implemented in Indonesia and similar efforts are underway in Costa Rica and China.

The depreciation calculations depend on estimates of changes in the physical stock of the natural resource times the difference between the average unit price and extraction cost of the marketed resource over the accounting period. This procedure, due to Landefeld and Hines (1985), is only an approximation to true economic depreciation (the change in asset value over the accounting period, where the asset value equals the present value of the future

[10]See Repetto (1989).

stream of services).[11] Experts in forestry (e.g., Clarke and Dragun, 1989) have questioned this approximation for renewable resources. It is, for example, quite possible that physical reductions in the size of a forest could lead to larger long-run yields and, thus, increases in asset value (quite apart from any increases that may be due to asset revaluations).

In addition, the Repetto approach has also been questioned by those with strong interests in countries highly dependent on non-renewable resources such as petroleum (e.g., El Serafy, 1989). In this case, the criticism has to do not just with the method of calculating depreciation but, rather, with the entire procedure of defining net income as the difference between gross income and depreciation.[12] This criticism appears to stem from the observation that depletions of physical resources may not be welfare decreasing if some of the proceeds are re-invested such as to replace the eventually depleted physical resource with a new asset of equal value. Thus, if a country's wealth were totally dependent on, say, mineral reserves, its net income, calculated with the Repetto depreciation adjustment, could equal zero even though it might enjoy relatively high levels of consumption and end up with no diminution in wealth.[13]

A third criticism of the Repetto approach is related to this second criticism: namely, that the procedures thus far adopted have not captured all the creation of new wealth due to the destruction of natural resource wealth. Essentially, the analysis has been partial--focusing on one asset at a time. In developing countries especially, some of the new wealth will be in the public sector or it may be nonmarketed wealth. In either case, it may not be fully accounted as "investment" in the conventional income accounts.

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[11]Note also the implicit assumption that the difference between price and extraction cost is non-zero--that is, there is rent. With certain resources, such as open-access fisheries, free entry may reduce rent to zero or near zero.

[12]El Serafy would define the "true" income generated by natural resources as annual proceeds from its extraction less an amount that if invested would earn a return that would replace the resource when it is exhausted.

[13]This criticism, while valid, may be more a criticism of net income as an income or welfare measure than a criticism of depreciation accounting per se. Moreover, it is not clear that when a country totally depends on its mineral base, net income would necessarily equal zero. If, for example, the re-invested proceeds supported domestic production, net income would equal the value-added of this production less any depreciation of the stock of growing capital that supports this production. Thus, a more complete accounting framework--one that captured both the income generated by the depletable asset and any income deriving from investments of the proceeds from the depletion activity--should meet much of this criticism.

It does not appear that any of these criticisms are overly damaging. The first one could be met by using a more sophisticated depreciation calculation that better captured the long-run value of renewable resources. The third criticism and much of the second could be met by the use of a more general and more comprehensive accounting approach. Finally, information supporting the Repetto approach could also be used to define a new income aggregate if one wished to follow El Serafy's suggestion.

4. **Full environmental and natural resource accounts with valuation**

This final modification to the conventional accounts is the most ambitious since its intent is to accommodate all the elements of physical resource accounting and natural resource depreciation calculations but also to place monetary values on all physical entries. The Dutch (Hueting, 1980) system, the United Nations Statistical Office (Bartelmus, Stahmer, and van Tongeren, 1989) framework, and the Peskin (1989) framework provide three examples of this approach. However, while all three strive for monetary valuation, there are differences in coverage, presentation, and valuation methods.

The Dutch approach centers around the concept that there are various "functions" of the natural environment and that there is competition for these functions by various "agents" in the economic and environmental system. Each agent competes for a function (e.g., industry competing for water for waste disposal) against other agents competing for the same or different functions (e.g., households competing for drinking water). This competition may lead to a "loss of function" as perceived by competing agents. Hueting values this loss by the estimated cost of restoring the function to a "sustainable" level as determined by scientific standards. This cost plus any ex post environmental expenditures is deducted from conventionally measured gross product. It should be noted that Hueting does not value the functions themselves--only the losses in function due to competition. Thus, there is no positive adjustment to conventional product due to, for example, nonmarketed recreational services provided to households by the natural environment.

The proposed UNSO framework has a more conventional accounting appearance.[14] Indeed, it was designed to be a satellite account to the SNA and, therefore, attempts to follow SNA accounting conventions. In particular, the coverage is limited to those sectors (or "production boundary") defined by the SNA. Like Hueting, the UNSO framework also accounts for damages or losses in function. In addition, it covers the depletion of natural resources.

While it follows SNA sectoring, the UNSO framework treats the depreciation of natural resources quite differently from the standard SNA treatment of

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[14]The discussion of the proposed UNSO framework here and in Appendix II is based on currently available materials. It is the author's understanding that the proposal is undergoing substantial revision.

ordinary marketed capital. In particular, the depreciation of natural resources is treated as separate deduction from gross product, made before any deduction of ordinary depreciation. The gross income so adjusted is termed "sustainable gross income." Moreover, environmental damage estimates are entered into the accounts as if damage were another type of resource depletion. In effect, environmental damage is viewed as a destruction of environmental assets. Although one could take issue with both the accounting treatment of resource depreciation and with the accounting of environmental damage, it does not appear too difficult to rearrange these entries more conventionally.

As is the case with the Dutch approach, environmental damage values are estimated by the costs to eliminate the damage. Therefore, there is no way of comparing the value of damages with the opportunity cost of eliminating these damages. It is thus not possible for the accounts to generate data that could be used to investigate the economic efficiency of environmental policy.

A third version of a complete set of resource accounts with valuation is Peskin's neo-classical framework. This approach treats the services of environmental and resource capital as if these services were marketed. These services are entered into the accounts as inputs, if consumed by production sectors, or as output, if consumed by final demand sectors (such as households). Since the consumption of these services usually leads to dis-benefits (e.g., waste disposal services lead to pollution), the negative value of these dis-benefits (or "damages") is also entered into the output side of the accounts.

Input services and damages are valued as if the services and damages were traded in private markets. In particular, environmental input services to producers (for example, waste disposal services) are valued according to estimates of the producer's willingness-to-pay for the services. Similarly, resulting pollution damages are valued in terms of what damaged parties would be willing to pay to avoid the damages. In practice, these willingness-to-pay estimates rely on a number of approximation approaches drawn from the environmental benefit-cost literature.[15]

A major difference between the Peskin framework and that of the Dutch or the UNSO is that input services and any resulting damages are valued differently. Like the Dutch and the UNSO, data on the prospective costs of attaining standards are widely used--not, however, as estimates of damages but rather as proxy measures of the willingness-to-pay for the service by the consumer of the service (or "polluter"). Resulting damage valuations are also based on willingness-to-pay concepts. However, the estimates are based on results of cost-benefit studies that usually avoid the use of pollution control costs as willingness-to-pay proxies. Rather, these studies rely on such techniques as property-valuation, the travel cost method, contingent valuation, estimated productivity losses, etc. Thus, unlike the Dutch and UNSO framework,

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[15]See Freeman (1979) for an overview of these techniques.

data from Peskin's framework can be (and was) used to assess the relative efficiencies of environmental policies.

A very limited implementation of this framework was completed by Peskin and his colleagues at the National Bureau of Economic Research and Resources for the Future using U.S. data. This implementation excluded depreciation calculations and the only environmental services measured were those associated with the disposal of pollutants to air and water. However, the estimates did include both the positive and negative aspects of these pollution activities. In addition, data from this limited implementation was used by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture, and the U.S. National Oceanic and Atmospheric Administration in connection with a number of policy studies. (See Appendix II, page A-II-4 for references.) More recently, the U.S. Environmental Protection Agency, as a pilot study, is using the Peskin framework for the development of a set of resource and environmental accounts for the Chesapeake Bay.

As with the Dutch, Japanese, and UNSO frameworks, it is possible to use the Peskin accounting data to re-adjust conventionally-measured gross product. Adjusting U.S. GNP downward due to the negative value of pollution lowered GNP by about 2.5 percent in 1972 and by about 1.5 per cent in 1978, the lower figure being due to the effects of the pollution-control policies of the early 1970s.

Implementation Considerations

All these modifications to the standard accounts pose their own specific implementation challenges.

1. Difficulties in estimating pollution-control expenditures

The basic approach used in the United States to estimate pollution-control expenditures is to rely on surveys of firms and industrial establishments. Based on the written material available, it is not clear how the Germans and Japanese developed their own versions of such expenditure data. Besides the use of surveys, it is possible to estimate such expenditures by using engineering estimates of pollution-control costs along with assumptions concerning payment schedules and the amount of time needed to install control equipment. The Dutch use both approaches--that is, the Central Bureau of Statistics surveys enterprises and governments, but uses technical literature and statistical data to fill in gaps.

While surveys may be more accurate, their use presents difficulties. For example, the respondent may be unable to make a reliable cost estimate either because internal corporate accounts do not identify pollution-control outlays or because pollution control outlays cannot be separated from other expenditures. The latter problem often arises when the pollution control is brought about by process changes or by plant modernization. Also, it is not clear how "internal" transactions should be handled. A factory may use its own land for pollution control purposes while another might have to purchase the requisite land. Even though the first factory incurs no expenditure for land, it might be argued that an imputed expenditure value should be assigned anyway in order to maintain comparability.

If U.S. experience is any guide, poor response rates can be a source of additional statistical problems including bias. In past surveys, usable responses were often less that fifty percent of the total.[14] It is quite possible that the responses tend to come from the firms experiencing the relatively larger pollution-control expenditures. If so, the resulting estimates may be biased in the upward direction.

2. Difficulties with physical accounting

There are both practical and conceptual difficulties associated with physical resource accounting. In addition to the obvious problem of having to assemble data on the stock of physical resources, any changes in this stock, and their transformation into products and waste materials, there is the practical problem of just what to collect and in what detail. Lacking a common unit of measure, it may be difficult to make comparisons and to determine what is or is not important. As a result, even though the physical accounts of, for example, Norway are quite detailed, some may justifiably feel that relatively too much detail has been provided on, say, material resources (such as forests) and relatively too little on industrial pollution.

The lack of a common monetary unit of measure creates conceptual problems as well. With different physical units, aggregation, of course, is impossible. And while one could find a non-monetary unit of measure that would be applicable to a large number of different resources (e.g., weight or volume), it is not obvious which single measure will convey the most useful information. Indeed, even ignoring the aggregation problem, it is not obvious which unit of measure is appropriate for any individual natural resource. For example, the reduction in the size of a forest could be measured in terms of the reduction in the number of trees, the number of trees of a particular type of species (e.g., hardwoods), the volume of available timber, or the acreage.

The obvious response to this problem is to use a variety of units of measure. However, the greater the variety of units, the more complex the framework and, as Hueting points out (Hueting, 1988, p. 5), the greater are the difficulties in making aggregations useful to policymakers. Moreover, as Alfsen and Lorentsen (1989) have emphasized, the more complex the framework, the greater the costs of data development, and the greater the possibility that resource accounting costs will exceed the benefits of the effort. Perhaps, with more experience in actually implementing such accounts will come a satisfactory compromise.

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[14]See Peskin (1978).

3. Difficulties in estimating natural resource and environmental depreciation

As with physical resource accounting, depreciating natural and environmental resources presents both conceptual and practical problems. The principal conceptual problem involves an important distinction that must be made between physical deterioration and the loss of economic value. Only the latter, the true economic depreciation, is properly deducted from gross income to produce net income.

While physical deterioration of, say, a natural forest may imply that the forest depreciates in value terms, it need not necessarily be the case. For both economic and biological reasons, the smaller physical forest may show a gain in economic value--that is, it may show negative depreciation or "capital gain." Such apparent anomalous behavior can arise because the value of a resource depends not just on its short-term ability to generate output, but also on its ability to generate something of value over its entire life. While, for example, the smaller physical forest may generate less product in the near-term, it might be biologically and economically more productive than a larger, perhaps more crowded forest, over the long-term. Also, it might happen that the demand for the output from a smaller capital stock rapidly increases over time. If so, again its economic value could grow as its physical size diminishes.

The conceptual problem of estimating true economic depreciation may not create major practical difficulties if the capital stock is traded in well-functioning markets. In this case, observed market values may suitably reflect the long-run, future economic productivity of the asset--or, at least, a market consensus of its long-run productivity. However, most natural resource and environmental assets are not traded in markets, even though certain products generated by these assets (e.g., hardwoods from a rain forest) may have market-determined values. Thus, both the current value of many natural resources and most environmental resources and the change in this value, or depreciation, must be "imputed" or inferred. While market-observed prices may provide valuable information for these inferential estimates, focusing only on the marketed outputs of an environmental or natural resource asset can lead to substantial underestimates of value and incorrect estimates of depreciation. Put simply, the value of a rain forest is greater than the value of all its salable hardwoods.

4. Difficulties in estimating environmental and natural resource accounts with valuation

As suggested above, the most challenging modification to the conventional national accounts would not only be to include the above elements of physical and cost accounting but, in addition, to place monetary values on the services generated by natural and environmental assets.

The principal problem, of course, is to place values on the services and on any societal damages that may arise due to the consumption of these services (e.g., pollution from waste disposal services). There are a number of methods for doing this. For example, we have seen that both the Dutch and the Japanese approaches value damages by the costs of their elimination. However, many economists would prefer to rely on the "consumer-sovereignty" concept according to which the value of the environmental service is equal to what consumers of the service would be willing to pay for the service. Similarly, the value of any damages to society for, say, pollution, would be equal to what members of society would be willing to pay to avoid these damages.

While implementing this valuation principle presents many technical and data problems, estimation methods exist and are continually being refined. It is true that these techniques have been attacked as judgmental and subjective. But such criticism can be directed against any estimation method that is not commonly accepted. It is possible that as resource and environmental accounting becomes more widely adopted, techniques for estimating, say, the monetary value of health damage could become as accepted as the methods for estimating the depreciation of plant and equipment. (It should be noted that direct observation of true economic depreciation is not possible. Some estimation procedure is required.)

There is, however, a conceptual problem that has little to do with data and technique: namely, the appropriateness of the consumer-sovereignty principle for determining societal valuations. Many justifiably fear that many services of the environment are too socially important to be determined by willingness-to-pay techniques. In the first place, these techniques favor the rich over the poor, since the empirical evidence is often based on observed expenditures for environmentally-related goods. In addition, there may be services of the environment whose long-term value to society may be under-appreciated by present-day consumers. The long-term ecological value of certain species or the opportunities for future generations to have the option to enjoy the gifts of nature may be two examples. For these sorts of environmental and natural resource services, it may be necessary to find alternative valuation principles.

<u>Why Accounting Approaches Differ</u>

As has been discussed above, there has been a variety of responses to perceived inadequacies in conventional accounting systems in various countries. What has not been addressed is why particular approaches were chosen, as well as how successful, how cost-effective, and how policy-relevant the approaches were.

Undoubtedly the selection of approaches is affected by a number of capricious factors such as historical accident or simply the interests of the individuals responsible for developing the approaches. However, to the extent that the accounting approach is to serve policy needs, the selection probably also depends, to some extent, on an objective or subjective effort to balance policy goals against the costs of attaining these goals. Therefore, one would expect these approaches to differ to the extent that differences exist in the functions these approaches are expected to serve and in the costs of generating data.

Certainly the expressed purposes of the various accounting efforts differ. In addition, one can identify actual purposes to which the approaches have been put to the extent that, as is the case with Norway, there is a history of implementation. Also, it is possible to identify potential purposes based on considerations of the structure of the proposed framework or system. These same structural considerations might also suggest instances where the fulfillment of expressed purposes is extremely unlikely. Thus, if one expressed objective was to support cost-benefit analysis of policy, attainment of this objective may not be possible to the extent that, as is the case with several approaches, cost estimates were used as a proxy for benefits.

The following chart (Figure 2) attempts to compare various approaches in terms of functional objectives.

FIGURE 2: PRIMARY FUNCTIONS BY ACCOUNTING APPROACH

	CANADA	FRANCE	JAPAN	NETHERLANDS	NORWAY	UNITED STATES	W. GERMANY	PESKIN	REPETTO	UNSO
IMPROVED ECONOMIC PERFORMANCE MEASURES		*	*	*			*	*	*	*
IMPROVED MEASURES OF SUSTAINABLE INCOME AND GROWTH	*			*					*	*
IDENTIFICATION OF POTENTIAL ENVIRONMENTAL/ECONOMIC INTERACTIONS		*		*	*		*	*		*
SUPPORT OF MACRO-ECONOMIC OR SECTOR PLANNING MODELS		*			*	*		*		
SUPPORT OF EFFICIENT ENERGY OR ENVIRONMENTAL POLICY DESIGN					*			*		
RESOURCES ASSESSMENT	*	*		*	*		*		*	
ENVIRONMENTAL DATA FRAMEWORK	*	*						*	.	

Note that in some cases (e.g., the UNSO), the approach is only in the planning stage. Therefore, it was only possible to determine expressed or potential objectives. In other cases (e.g., Norway), the chart can rely on actual experience. Thus, while the box labeled "IMPROVED ECONOMIC PERFORMANCE MEASURES" is checked for both the French and the Repetto approach, only in the case of the Repetto approach is there actual evidence that it is being put to this purpose. For this reason, it is probably more illuminating to compare the approaches in terms of the indicated differences in function rather than the similarities. More specifically, it is apparent that certain approaches have very limited objectives (e.g., the United States), while others are far more ambitious (e.g., the French). Given these large differences, it is difficult to determine whether any one of these approaches is clearly superior as each one may outrank the others according to its own objectives.

The approaches differ also in terms of cost of data gathering and effort involved. Unfortunately, however, the available information does not permit any analysis of these costs.[17] As a result, analyzing these approaches, even informally, in terms of their cost-effectiveness will have to await the assembly of further information.

However, the written materials do give some indication of the types of data that are required to support the various approaches. Figure 3 describes the different data needs for actual and proposed country approaches. For comparison, the actual and prospective data needs of the Peskin, Repetto, and UNSO approaches are also shown.

The types of input data have been grouped into four categories. First, are those data that have to do with natural resources that generate marketable output or what the Norwegians refer to as "material resources." Second, there are those data that describe the state and use of environmental resources, resources such as air or water that generate nonmarketed environmental services. Third, there are data on environmental expenditures, divided into those ex post expenditures that already in the conventional national accounts (but usually not separately identified as such) and those ex ante costs of environmental control measures needed to reduce pollution or otherwise mitigate environmental damage. Finally, there are data on transnational pollution and on global damage.

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[17]In fact, one feature common to all the countries surveyed is the lack of detailed information on data was generally not possible to determine from the written materials how data were obtained or how such data will be obtained for those approaches still in the planning stage.

FIGURE 3: DATA COVERAGE BY ACCOUNTING APPROACH

	CANADA	FRANCE	JAPAN	NETHERLANDS	NORWAY	UNITED STATES	W. GERMANY	PESKIN	REPETTO	UNSO
MATERIAL RESOURCES										
STOCK LEVELS	•	•			•		•	•	•	
USE										
AS INPUT TO PRODUCTION	•	•			•					•
AS FINAL DEMAND	•	•			•					•
PHYSICAL CHANGE										
DEPLETION	•	•			•			•	•	•
DISCOVERY	•	•			•			•	•	•
NATURAL GROWTH	•	•			•			•	•	•
LIFETIME					•			• (1)		
ASSET VALUE	•	•			•			•	•	
DEPRECIATION	•							•	•	•
ENVIRONMENTAL RESOURCES										
CONDITION OR LEVEL	•	•		•	•			•		
USE										
AS INPUT TO PRODUCTION								•		
AS FINAL DEMAND								•		
PHYSICAL CHANGE										
DEGRADATION								•		
NATURAL RECOVERY/GROWTH								•		
ASSET VALUE								•		
DEPRECIATION								•		
POLLUTION DISCHARGES	•	•	•	•	•			•	• (2)	•
DAMAGES										
TO INDUSTRY	•			•						•
TO FINAL DEMAND	•			•						•
UNSPECIFIED	•			•				•		
ENVIRONMENTAL OUTLAYS										
EX POST EXPENDITURES	•		•	•		•	•			
EX ANTE COSTS	•		•	•				•		
EXTERNAL "TRADE"										
POLLUTION EXPORT				•						
POLLUTION IMPORT										
GLOBAL DAMAGE				•						

* SOME IMPLEMENTATION • FUTURE PLANS

(1) If required to estimate depreciation

(2) Sediments only

Consistent with the differences in objectives, there are differences in data coverage. Generally, the more ambitious the objectives, the wider the data coverage. However, wide coverage does not imply identical coverage. Both the French and the Dutch approaches have broad objectives and fairly wide coverage. However, the French appear to have relatively less interest in international environmental data and cost data, both of which are (or will be) priorities in the Dutch approach.

One important message that can be drawn from Figure 3 is that frameworks, which are structurally very different, can rely on similar data sets. Therefore, with respect to the "data framework" function of national accounting, some of the differences between these approaches may not be a great as they may first appear.

Principal Findings

Among the more important findings from this survey of resource and accounting in industrialized countries are the following:

1. Most approaches attempt to address one or both of the two major functions of conventional national accounting (performance measurement and data system).

   One major function of the national accounts is to provide measures of economic and social performance. The surveyed resource and environmental approaches address a deficiency in the conventional accounts as to their ability to fulfill this purpose. The conventional accounts misstate income and, perhaps, growth because of their neglect of environmental deterioration and the depletion of natural resources. A second major function of the national accounts is to provide for a coherent data base to support economic policy, research, and modeling. There is a perceived need for additional information that will better reflect environmental-economic interactions.

   The various approaches differ on their emphasis on each of these two broad functions. Thus, for example, the responsible governmental agencies in Norway and the United States have so far shown little interest in producing a "better GNP." Their emphasis, instead, is on producing a better data base for policy analysis and economic modeling. In contrast, Repetto's primary concern is to correct the tendency of conventional income indicators to overstate the rate of economic performance. It is difficult to be as clear as to the precise degree of relative emphasis of the other approaches, since they are in earlier stages of development.

2. **Regardless of the intent of the various approaches, they may better succeed in addressing one function more than the other. Thus, the approaches should be judged on their actual as much as their intended outcomes.**

   All the approaches depend on the assembly of one or more data bases. These data bases can all support to some degree the data-development function of income accounting. Therefore, even if outside observers are not interested in a particular aggregate income adjustment proposed by the approach, they still may find the assembled data to be of significant value.

3. **The approaches differ significantly in their complexity and coverage.**

   The U.S. (BEA) approach is narrowly focused on expenditure data while the Dutch, UNSO, and Peskin frameworks cover a wide range of data reflecting environmental-economic interaction and resource depletion. The Norwegian, French, and Repetto approaches appear to fall somewhere between these two extremes.

4. **The differences in complexity and coverage reflect not only the relative emphasis on the two major functions of national accounting but also different policy objectives.**

   Thus, for example, the Norwegian system is well suited to support the Norwegian desire to manage their resources of petroleum, timber, hydro-power, and fish. The U.S. approach, with its emphasis on expenditure data, supports the analysis of the macro-economic effects of environmental policy. The Repetto approach addresses sustainability issues in developing countries. The Dutch approach appears to be designed to address how detailed environmental-economic interactions may affect sustainable growth paths in a highly developed country.

5. **While these approaches may have very different structures, reflecting their different emphases and policy objectives, they may be very similar in their data requirements. Thus, extensive debate over the relative merits of each approach, as a prerequisite to implementation, may be unnecessary or even counterproductive.**

   The Dutch (Hueting) approach, the UNSO framework, and the Peskin framework, for example, appear to differ substantially in appearance. However, satisfying the data needs for any of these three approaches would automatically satisfy a large percentage of the data requirements for the other two (as well as the data needs of the less complex Norwegian and Repetto approaches). The implication of this finding is that efforts at implementation, for example, in developing countries, could begin before final decisions are made as to which approach will better suit the country's needs. The incremental costs of adjusting the data or gathering new data to satisfy the requirements of an alternative approach may not be so large as to justify delaying at least initial efforts at data gathering.

6. Because of missing information--especially regarding data development costs--it was not possible to determine the cost-effectiveness of the various country efforts and the implications of these efforts for policy-making.

Unfortunately, with respect to most of the approaches surveyed, the available written material is only suggestive of the data and analytical capabilities that are required to implement these approaches. These written materials fail to indicate the actual state of data gathering and implementation in the various countries. In particular, there is a lack of information on those data development processes that are required to support the "successful" approaches and those that would be required to support the systems still under development. In addition, with the notable exception of Norway, there is a lack of specifics as to how these systems contribute to the policy process.

Information on policy needs and costs are required in order to draw conclusions about the cost-effectiveness of an accounting approach. There may be a real possibility that some the of the suggested approaches are far more sophisticated and expensive than is necessary to meet policy needs in an efficient manner. Similarly, other, less sophisticated approaches may not be able to meet policy requirements. To determine whether either situation is the case, specific policy objectives should be linked to specific data needs and the costs of meeting these needs carefully estimated. The most appropriate accounting approach is the one which satisfies actual and potential policy needs at least cost.

Conclusions and Implications for Developing Countries

It is difficult to deduce clear messages for developing countries from this survey since most of the programs are still in early stages of development. Of course, one could draw an inference from the very fact that the only countries that have established empirical records of "success" over a significant period (i.e., ten or more years) are Norway and the United States--two countries with the least ambitious resource accounting programs (See Figure 2). (Japan could also be included, although the recent data sets are not official products of the Japanese government.) However, rather than concluding that "simpler is better," the more appropriate message for developing nations is to not let their ambitions outrun their capabilities in terms of data generation and analysis.

There are two reasons why "simpler may not be better." In the first place, there is no obvious connection between the complexity of the design of the framework or system and the effort required for its implementation. Implementation costs depend not only on design complexity but also on such factors as sectoring detail and desired accuracy. Initial implementations of the relatively complex Peskin framework were far less expensive than implementations of the rather straightforward cost accounting practiced at the U.S. Bureau of Economic Analysis (BEA), since the BEA placed a higher premium on data accuracy and sector detail.

A more important reason that "simpler may not be better" is that there is no obvious connection between the complexity of a system and its value as an efficient data framework. A simple, relatively inexpensive data system that fails to facilitate the policy process is no bargain. Similarly, a complex, relatively expensive accounting framework that generates far more data than are needed is no bargain either.

Presumably, valuable information for developing countries will emerge over time as resource and environmental programs mature in the industrialized countries. Of particular interest will be any successful valuation methods and data development techniques. However, since the best accounting approach for any particular developing country will depend on the country's information needs and on the resources the country is willing to devote to data development and implementation, the experience of the industrialized countries should not carry too much authority. Even if all of the efforts in industrialized countries were ultimately judged as unsuccessful, that fact alone carries only limited implications for a developing country with different policy objectives, arising, perhaps, from significantly greater resource and environmental problems. Similarly, a record of success in a wealthy industrialized country may have no implications in a country with meager data development resources.

Since the conditions for success in resource and environmental accounting are likely to be country-specific, there is little point in waiting for the industrialized-country experience to mature before a less-developed country decides to embark on its own program. There is also no particular reason to make a firm pre-commitment to any one of the industrialized country's chosen accounting approaches. The similarity in data coverage suggests that initial data collection can proceed before a country makes a final decision as to which approach is most appropriate. Given the relative severity of resource and environmental problems in the developing world and, therefore, the relative seriousness of the deficiencies in the standard economic accounts' ability to reflect these problems, a productive strategy for developing nations might be to initiate their own, low-cost pilot programs now.

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APPENDIX I

COUNTRY SUMMARIES

AUSTRALIA

Overview

Presently, there is no actual resource or environmental accounting project underway in Australia at either the Federal or state level. However, there is extensive interest in the subject as evidenced by two recent workshops on the subject held by the Department of the Arts, Sport, Environment, Tourism and Territories and by the Bureau of Rural Resources. In addition, the newly established Resource Assessment Commission plans to undertake some resource accounting for the purpose of developing an information system to support forestry models. (Letter from D. James to H. M. Peskin, Nov. 2, 1989).

In addition, there is some interest on the part of the Australian Environment Council (who sponsored a rather critical report on resource accounting by Clarke and Dragun, 1989) and the Commonwealth Scientific and Industrial Resource Organization (CSIRO).

Regarding possible implementation at an official level, the Australian Bureau of Statistics supports the development of satellite accounts as part of the revised SNA. However, they do not have plans to produce such Accounts for Australia at this time. (Letter from F.J. von Reibnitz to R. Chander, Nov. 15, 1989). Apparently, the Australian position is that only if the UN takes the lead and recommends satellite accounting, will they follow suit.

Discussion

There is clearly no official Australian position on resource and environmental accounting. A scan of several papers presented at the recent workshops indicates some caution on the part of the national accountants, which is not unexpected. However, as noted, the official statisticians do not oppose satellite accounts.

Perhaps more damaging to the prospects for resource and environmental accounting in Australia is the critical paper by Clarke and Dragun. This paper attacked the Repetto-Landefeld resource accounting approach as inappropriate for renewable-resource accounting. The principal criticism is that Repetto's approach equates depletion with true economic depreciation. With forests and fish stocks, however, it is well known that a reduction in physical size could imply an economic gain over the long run; and thus there could be economic appreciation rather than depreciation. While this criticism is valid, it does not prove the worthlessness of resource accounting. In the first place, the Repetto approach could be modified to accept other depreciation formulas. More importantly, as this survey indicates, Repetto's work does not represent the entire scope of resource accounting.

As far as future work is concerned, the Resource Assessment Commission plans to build a national multisectorial model with resources accounts providing some of the input data. Dr. David James will direct this effort. In addition, CSIRO is investigating the possibility of developing a set of resource accounts for agriculture in the Murray-Darling Basin and for forestry in Papua New Guinea. Both projects will be directed by Dr. Mike Young of the Division of Wildlife and Ecology in Canberra. Mike Young has also begun to prepare Repetto-type accounts for Australia from 1980 to 1989. Initial observations suggest that corrections for land and forest degradation are swamped by the inclusion of changes in stocks of mineral and other subsoil assets.

At a minimum, these studies should yield valuable data sets and, thus, fulfill, one of the major purposes of resource and environmental accounting. Practical results will go a long way towards offsetting academic criticism.

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CANADA

Overview

Statistics Canada is beginning a program on resource and environmental accounting with the following objectives:

- The design of a satellite account to the SNA which will cover both nonmarket, environmental resources and market resources.
- The construction of a natural resource account in physical terms, covering both economically recoverable reserves and ultimate reserves.
- The development of methods for valuing natural resources.
- The development of natural resource wealth accounts including measures of the value of depletion.
- Researching the role data on environmental quality might have on the proposed satellite account including valuation issues.
- Consideration of the including of environmental wealth "if sound imputations are possible."
- Consideration of "international practice" of altering national income aggregates to reflect resource depletion and environmental degradation.

(Letter from I.P. Fellegi to R. Chander, 11/6/89)

Working plans to implement these objectives consist of the following two elements:

1. Economic data on environmental protection will be deepened and broadened through new surveys. Existing data on capital expenditures for pollution abatement and control will be augmented with surveys on operating costs and costs per unit of abatement. Key sectors in environmental protection, such as integrated waste management firms, will be surveyed for the first time. (Funding is being sought for this work.)

2. A satellite accounting project on resources and environment has started. Its first products will be an annotated bibliography and a design paper for the accounts. The broad outline of the accounts can now be seen:

    - The base will be highly disaggregated data on quantity and quality of economic and environmental resources, covering stocks, stock changes (e.g. discoveries and net natural growth) and flows.
    - Valuation of these stocks and flows will permit construction of a satellite to the National Balance Sheet account that includes natural assets as part of national wealth. Imputing value for non-market assets will clearly require substantial research.

According to Kirk Hamilton, there are no plans to adjust any of the flow measurements in the SNA. That is, like most of the other national efforts, any new accounts will be viewed as "satellite" accounts, the purposes of which are "(i) to provide an assessment of resource quantity and quality; (ii) to provide a framework for environmental data; (iii) to improve measures of sustainability by extending the measure of wealth." (Letter from Kirk Hamilton to Ernst Lutz, 2/18/90.)

There may be parallel efforts under consideration at Environment Canada. A recommendation to undertake a "case study" to develop a "new accounts framework" along the lines suggested by Bartelmus et. al. (1989) was made in a consultant's report. (Potvin, 1989).

Discussion

The Canadian approach apparently will combine elements of pollution-abatement expenditure estimation, such as is practiced in the United States, with resource accounting as is practiced in Norway. However, unlike the Norwegians (and, perhaps, more like the Repetto approach) there will be efforts at monetary valuation. The focus will be more on adjusting the national wealth accounts (rather than the current or "flow" accounts). However, it is recognized that the valuation of flows may be a prerequisite for the valuation of stocks.

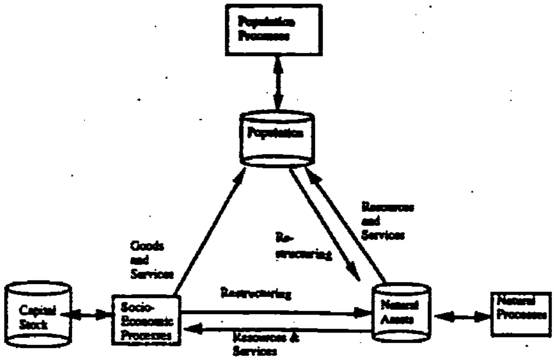
At this time, it is not clear how valuations will be made. In addition, the form of the accounting framework is yet to be determined. One possibility would be to base the framework on the Canadian Stress Response Environmental Statistical System (STRESS).

STRESS consists of 40 interrelated data sets consisting of "activity statistics", (causal) "stress indicators", (physical) "response indicators", "collective and individual responses", and "inventories of stocks" for eight activity categories: "generation of waste residuals", "permanent environment restructuring", "harvesting activity", "extraction of non-renewable resources", "environmental", "energy", "natural activity", and "population." (A. Friend, 1981).

While this system is quite comprehensive, it is important to note that all 40 activity-response data sets are in physical terms. As a result, while the system describes environmental-economic linkages, it does not do so in value terms. Therefore, it does not permit, nor was it intended for, direct modification of the SNA. However, it would appear that the STRESS system does provide much of the data needed to fulfill many of the intended resource accounting objectives of Statistics Canada.

A possible alternative to STRESS has recently been suggested by the Environment and Natural Resources Section of Statistics Canada (1990). This framework, known as the Population-Economy Process (PEP) model, views environmental-economic interaction of three classes of stocks (population, capital, and natural assets), each affected, in turn, by three types of processes: population processes, socio-economic processes, and natural processes. The following diagram describes these processes and their interactions:

Figure 1: Structural Diagram of PEP Framework



Source: Statistics Canada, 1990

This diagram suggests the need for three broad classes of data: data on stocks, data on processes, and data on interactions. Stock data require measurements on the state of certain variables such as population, ambient environmental quality, the size and quality of resources, etc. Process data, on the other hand, require measurements on the change in variables (e.g., population growth, economic growth, natural changes, etc.). Interaction data requires data on both the state and change in variables, but, in addition requires, what the authors refer to as "restructuring" information: analyses of the impact of human activities and population growth on the natural environment.

The view of environmental-economic interaction embodied in Figure 1 is reminiscent of the asset-based socio-economic framework suggested by Juster (1973). Juster also argues that all socio-economic activity can be traced back to the services of assets. In Juster's case, he defines five classes rather than the three in the PEP system: reproducible tangible wealth, reproducible intangible wealth, human wealth, natural resource wealth, and socio-political wealth.

While such broad approaches provide a general guide for the development of data and accounting systems, a much more specific framework is required to guide practical implementation. In particular, PEP leaves unresolved the critical question of how much detail is needed, both in terms of number variables to be measured and in the depth of analysis of "restructuring" interactions. Presumably, the Canadians will develop more pragmatic accounting approaches as they gain experience in their efforts to implement the PEP system.

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FRANCE

Overview

By far, the French have proposed the most ambitious resource and environmental accounting system: Les Comptes du Patrimoine Natural. Its ambitious structure stems from its two principal features. First, it is meant to cover, what is termed , the entire "natural patrimony", defined as ".the collection of the natural elements and of the system which they form and which are capable of being transmitted to future generations or of being transformed." (Archambault, p. 4) This definition is meant to exclude, at least, some portions of what is generally considered the natural environment--namely, those portions which cannot be transformed or appropriated by man. As examples of two such natural resources, Archambault suggests the deep ocean and the stratosphere. However, as both are undergoing some anthropogenic transformation, they could be justifiably included in the definition. The definition is also meant to exclude the "artificial patrimony", namely, man-made materials, buildings, etc. Yet, even man-made materials are covered if they have cultural significance or if they are closely connected to natural systems. Thus, ancient monuments, parks, and artificial lakes are included.

The second reason why the French approach is so ambitious is that each element in the above broadly-defined natural environment is meant to be described or analyzed in terms of its three basic functions: economic, ecological, and social. (Theys, p. 43) This broad descriptive coverage reflects the fact that the French approach is not merely an extension of social accounting to the realm of the natural environment, but is really meant to be part of a large environmental data system. This system is comprised of seven sections or "levels", ranging from sets of nonspecific data (Level I), to statistical breakdowns by air, water, and other sectors (Level II), to statistical summaries such as state of the environment reports (Level III), to the development and use of forecasting and simulation models (Level V), and eventually to the development of aggregate welfare indicators and a modified GNP (Level VI). Level V has only been partially implemented while Level VI has not been implemented at all. The Patrimony Accounts are placed in Level IV.

All the levels are intended to interrelate. Thus, the Patrimony Accounts are meant to use or, at least, be consistent with the same environmental data that support the state of the environment reports. At the same time, the Patrimony Accounts are intended to support both environmental and economic models.

To serve this role, the Patrimony Accounts consists of a number of separate sub-accounts, which, because they rely on a consistent data base, can be related to each other. These sub-accounts fall into three groups: physical accounts (comptes d'elements), geographical accounts (comptes d'ecozones), and "agent" accounts.

The physical accounts are rather like the Norwegian resource accounts in content. However, the presentation is different. The French have opted for a double entry system, showing sources one side of the account and uses on the other. The following simple example is drawn from Theys (1989, p. 43):

Figure 1: Example of Physical Account: Stock of a Commercial Forest, 1969 to 1979
(thousand of cubic meters)

Resource/asset	*Broadleaf*	*Coniferous*	*Total*	*Use*	*Broadleaf*	*Coniferous*	*Total*
Volume of growing stock in 1969	980.1	6,526.5	7,506.6	Natural reduction (mortality)	5.6	21.0	26.6
Natural growth of initial stock	401.0	2,583.5	2,985.4	Accidental reduction (breakage and windfall)	9.7	481.2	490.9
Natural growth by reproduction (recruitment)				Resource extraction (commercial felling)	92.0	1,474.0	1,566.0
				Self-consumption	13.6	395.0	408.6
				Adjustment	-29.4	+1,239.2	1,209.8
				Volume of growing stock in 1979	1,330.7	5,758.0	7,088.7
Total	1,422.2	9,368.4	10,790.6	Total	1,422.2	9,368.4	10,790.6

Source: Theys (1989), p. 43

The geographical accounts assemble data related either to ecosystems such as forests and wetlands or to some other areal definition such as geographical regions (e.g., coastal lands), political territories (e.g., provinces), or "abstract" concepts such as an imposed grid network. Archambault provides the following example using artificial data. The "Ecozones" could refer to, say, agricultural land, each broken down into three soil classes of different quality.

Figure 2: Example of Écozone account

Types d'écozones	Classes d'état	Stock initial	Réconci-liation	Stock initial réconcilié	Réaffectation nette des surfaces		Variations internes	Stock final
					Renouvellemt. natural	Pression des agents		
M1	Classe a	100		100		-20	-6	74
	Classe b	80		80	5	-10	4	79
	Classe c	30		30	20	10	2	62
	TOTAL M1	210		210	25	-20	0	215
M2	Classe a	1000		1000	-15	-10	20	995
	Classe b	800		800	-5		65	860
	Classe c	290	10	300	60		-85	275
	TOTAL M2	2090	10	2100	40	-10	0	2130
M3	Classe a	500		500	-65	30	3	468
	Classe b	400		400				400
	Classe c	160	-10	150			-3	147
	TOTAL M3	1060	-10	1050	-65	30	0	1015
TOTAL GENERAL		3360	0	3360	0	0	0	3360

Source: Archambault (1988), p. 10.

Finally the "agent" accounts refer to all accounting for those activities that link human activity to the natural environment. Agent accounts cover a wide range of stock or flow accounts. Their distinguishing feature is the identification of human owners and users. While certain accounts (e.g., water use accounts and pollution emission accounts) may be expressed only in physical terms, other accounts may include monetary values.

A simple example of a physical agent account is the following water use account. Similar "environmental satellite" accounts exist for the management of parks, hunting areas, maritime areas, and the generation and disposal of refuse.

Figure 3: Example of a (Physical) Agent Account

Amount withdrawn	Water: Ground water	Water: Surface water	TOTAL	Amount returned	Water: Ground water	Water: Surface water	TOTAL
General Public	1.7	2.6	4.3	General Public	1.0	3.3	4.3
Industry	2.1	3.4	5.5	Industry	1.5	4.0	5.5
Agriculture	1.1	4.1	5.2	Agriculture	4.0	1.2	5.2
Power stations		12.0	12.0	Power stations		12.0	12.0
Water bodies		2.0	2.0	Water bodies		2.0	2.0
	4.9	24.1	29.0		6.5	22.5	29.0

Source: French Delegation to OECD (1980), p. 27.

As an example of a more monetary-oriented account, the following accounting of land value is derived from data provided by Archambault. Similar accounts have been published in France since 1980. (Archambault, p.11)

Figure 4: Example of a (Monetary) Agent Account: Value of French land, January, 1980

	Area in millions of hectares	Average price per hectare (Jan. 1980)	Value in billions of francs
Agricultural land	32.1	22,200 F	712.9
Forests	14.6	14,000 F	203.7
Water, moors, quarries, etc.	4.3	5,300 F	22.8
Recreation land	0.2	68,000 F	10.8
Building sites	0.1	1,600,000 F	173.3
Railroad land	0.1	35,000 F	3.5
Indeveloped land	51.4	21,900 F	1,127.0
Developed land	1.5	800,000 F	1,200.0
Unregistered land	2.1	0	0
Total for France	55.0		2,327.0

Source: Archambault (1988), p. 12.

The plans are eventually to place similar monetary values on all physical stocks and flows.

Discussion

Not only is the French approach the most inclusive of those surveyed in terms of the elements of the environment and natural resources covered, it is also the most inclusive of accounting concepts. Virtually all the specific accounting concepts reviewed could be incorporated in the French system. Unfortunately, the available descriptive material does not indicate which accounting concepts will, in fact, be included. The problem is that this written material tends to focus on the broad structure of the French system, but it is short on specifics.

This lack of specificity is perhaps to be expected in a system still under development. It also reflects a desire to be "pragmatic" and "flexible." In the words of Theys, "The flexibility of the French system makes patrimony accounts resemble more of a general framework than a rigid system of accounts." (Theys, 1989, p. 44) However, as desirable as flexibility is, limited budgets require that some priorities be set for framework development. Accordingly, ".it was initially decided to confine the analysis to a few priority sectors (forests, water, soil, land use, and wildlife) and a few basic interactions." (Theys, 1989. p. 45)

Jean-Louis Weber suggests that these priorities reflect "present knowledge", the "willingness of policy makers", and the availability of "reliable, comprehensive, consistent, and regularly updated data sets." (Letter to Ernst Lutz 2/28/90) Thus, for the present at least, the patrimony accounts themselves do not play a role in the setting of priorities. However, it should be noted that one purpose of resource accounting is to help identify which environmental and resource sectors are the relatively more important in terms of their effect on the economy. Unfortunately, uncompleted and partial frameworks may not be able to serve this function to the extent that important links between the environment and the economy are missing. The question is whether the French system is so large and detailed that major gaps in coverage will persist. If so, the system may be of limited use in determining which environmental-economic interactions are the more important for French economic and environmental policy.

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JAPAN

Overview

Currently, there is no official resource and environmental accounting effort on the part of the Japanese government. The last official efforts along these lines was completed in 1973 with the report of the Net National Welfare Development Committee.

This Committee, over a two-year period, developed a set of Net National Welfare (NNW) accounts somewhat similar to the Measures Economic Welfare (MEW) accounts developed by Tobin and Nordhaus for the United States in 1972. Recently, the Development Committee's NNW estimates were updated to 1985 by Professor Uno of the University of Tsukuba. Thus, a consistent set of Japanese NNW accounts exist for the period 1955-1985 for five-year intervals.

The NNW adjusts the conventional GNP in six ways. First, all investment is subtracted on the grounds that it does not add to immediate welfare. Second, there is an imputation made for the services of both governmental capital and consumer capital (durable goods). Third, there is an imputation for leisure time. Fourth, there is an imputation for nonmarket activities (primarily household activities). Fifth, there is a deduction made for the effects of urbanization. Finally, there are deductions made for the effects of environmental pollution. This last adjustment, of course, is the relevant one for this survey.

Two pollution adjustments are made which are similar to those suggested by Hueting. First, pollution abatement expenditures are subtracted from GNP. The investment component of these expenditures is first annualized. Also, it should be noted that the investment component of municipal sewage treatment costs were previously subtracted from GNP along with other investment. However, the services component of this investment is actually added back along with the estimates of the services of governmental capital.

The second environmental adjustment is to subtract "damages", estimated by the cost to reach governmental environmental standards. This adjustment is recognized as an approximation to true environmental damages, the calculation of which in money terms was thought to be too difficult.

It is not clear whether Professor Uno's recent updating of the original Net National Welfare Development Committee's figures includes both environmental adjustments. Uno's description makes no mention of any adjustment for pollution abatement expenditures. (Uno, March, 1988)

Discussion

As has been noted before, one problem in estimating damages by the cost of meeting standards is that damages are underestimated to the extent that standards are not established. A related problem is that when standards are not established, data collection efforts may suffer. Thus, in the earlier Committee study, there were no estimates of damage due to stationary-source nitrogen oxides, ozone, heavy metals, etc. due to poor data. Data collection improved markedly in the 1970's , however. Therefore, it is not clear how much of the almost seven-fold increase in environmental damage report by Uno taking place between 1960 and 1970 is due to better data or to increased pollution.

There appear to be no plans to re-establish the work of the Net National Welfare Development Committee at an official level. This disinterest in resource and environmental accounting was addressed by Mr. A. Yoshikawa in a 1983 report to UNEP. Several explanations of past disinterest are offered. First, the lack of natural resource accounting is attributed to Japan's scarcity of natural resources. Second, there is disinterest among the environmentalist community perhaps due to an apparent fear that quantifying the economic impacts of environmental policy would be detrimental to that policy since "economics (gives) an indulgence to economic growth." (Yoshikawa, p. 4) Third, there is general disinterest among the community of economists as well due to (a) a reluctance to work on problems that won't impact on policy, (b) poor data bases, (c) limited publication opportunities, and (d) poor financial support. (Yoshikawa, p. 5)

However, while these factors may work against Japanese efforts to resume resource and environmental accounting, there is still some official interest in environmental-economic relationships as evidenced by some econometric modeling of environmental activity taking place within the Environment Agency. As is the case in Norway, there could be renewed support for resource and environmental accounting in order to provide a data base to support these modeling efforts.

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NETHERLANDS

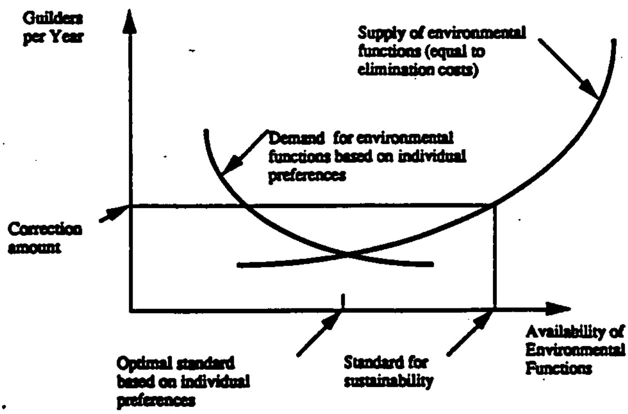
Overview

The Dutch are beginning to investigate ways to "make monetary estimates of environmental losses and depletion in order to confront the figures found with the figures of the standard national accounts." (W.F.M. De Vries' letter to E. Lutz, 07/20/90, and subsequent letter from Hueting to Lutz.) As this work is not scheduled to begin until later in 1990, there is, as yet, no official Dutch resource accounting approach. However, the approach they have in mind has been outlined in a paper by Roefie Hueting and Peter Bosch (Hueting and Bosch, 1989).

The scope of coverage is described in the Hueting book New Scarcity and Economic Growth (1980). In this book, Hueting attempted to construct shadow prices for environmental "functions" (or services of the environment), directly comparable to the prices of non-environmental goods and services that trade in ordinary markets. However, he did not succeed in his estimation of these shadow prices due to the inability to construct environmental demand curves that would be consistent with individual preferences for environmental functions. (Supply functions are supposedly easier to construct since they can be based on cost data.)

The Hueting-Bosch paper proposes to address this problem by replacing demand curves based on (unobservable) individual preferences with demand curves based on societal preferences consistent with sustainability goals as expressed by "politicians and organizations." These societal demand curves combined with supply curves will permit calculation of shadow prices and imputed values for the environmental functions. Basically, as shown in Figure 1, estimation of the intersection of the unobservable demand function based on individual preferences is replaced with a societal-determined curve. Furthermore, this curve is assume to be vertical, positioned at a level of control determined by scientific and technical considerations. In cases where sustainability considerations do not apply, the vertical standard is based on health considerations. Hueting believes this is the case with noise pollution.

Figure 1: Estimation of correction to GNP based on costs to meet sustainability standard



Hueting proposes to reduce GNP by subtracting the value of environmental damages or "losses" as measured by the costs of" technical measures and the reduction in activities necessary to meet the standards for a sustainable use of environmental functions." Reduction in activities is only taken into account when technical measures are not sufficient to meet the standard. While the cost estimates will include losses in value added of any curtailed economic activity necessary to achieve sustainability, there will be no offset for new activities that may come into being as a result of reduced threats to the environment. However, the contribution of induced new economic activity will be included in the future.

To effect these adjustments to the GNP, Hueting and Bosch envision the following 13-stage program:

1. Selection of activities causing most harm to the environment;
2. Compiling a framework for the calculation of the correction;
3. Inventory of data requirements and availability;
4. Selection of environmental problems to be analyzed (based on data availability) and selection of survey year;
5. Quantification of the source of the environmental problem in terms of emissions, use of space, soil, and the consumption of energy and other resources;
6. Quantification of the effect of the environmental problem on the environment;
7. Determining the level of environmental burden that is consistent with long-term sustainability (i.e., setting sustainability "standards");
8. Collecting data on cost-effective technical measures;
9. Determining necessary reduction in economic activities (if purely technical measures prove insufficient);
10. Determining the loss in value added for those activities that must be curtailed;
11. Determining the cost of both technical and activity-reduction measures, allowing for the fact that the elimination of economic activities may preclude the need for other technical measures;
12. Determining the extent that the costs of required environmental control measures are already included in the GNP; and
13. Comparing traditional national income with the estimated sustainable income level.

Discussion

As noted, this proposal, in its implementation, is a departure from the approach discussed in the New Scarcity book. Both approaches are based on the proposition that if economic activity results to losses of environmental function, the GNP should be reduced by these losses. In addition, in both cases the loss in functions are measured by the costs of restoring the functions to a level consistent with environmental standards--a pragmatic decision made in the belief that true environmental damage estimation is difficult or impossible.

The principal difference with this new proposal is in the determination of the standards. Exactly how standards should be determined and by whom are essentially unresolved issues in the Hueting book. With this new approach environmental damages and, by implication, environmental standards are defined in terms of the implications of these damages for the sustainability of environmental functions. Moreover, the presumption is that the standards to obtain these sustainable levels can be determined non-subjectively, based on technical and scientific analysis.

It should be noted that Hueting's sustainability objective may not be exactly the same as sustainability objectives stated by others. (For a discussion of alternative interpretations of the term "sustainability," see Pezzy (1989)). In particular, the focus is on the sustainability of environmental functions as opposed to the sustainability of income and growth. While it is tempting to assume that one implies the other, it is quite possible for a society to obtain long-term, sustainable income levels while, at the same time, permitting the loss of one or more environmental functions. Only the most committed environmentalist would maintain that sustainable income and growth require the maintenance of each and every resource, each and every animal or plant specie, and each and every environmental amenity. Certainly not all environmental functions are necessary to support human existence.

In private communication, Hueting proposes a flexible definition of sustainability that supports the above view:

> Sustainability means that functions must remain intact so that all present and future uses remain available. As for renewable resources such as forests, water, soil and air it holds that as long as the regenerative capacity remains intact the functions remain intact, e.g., the functions "supplier of wood", "provider of secondary forest products", gene reserve", "regulator of the water management", "preventer of erosion","regulator of the climate", and "buffer of CO_2 and heat" of forests, the function "drinking water" of water, the function "soil for raising crops" of soil and the function "air for physiological functioning" of air. Practically this means that, for instance, emissions of cumulating matters such as PCB's, heavy metals, nitrates and carbon dioxide may not exceed the natural buffering capacity of the environment and that the erosion rate may not exceed the regenerative power of the soil. As for non-renewable resources, such as oil and copper, "regeneration" takes the form of research and bringing into practice flow resources such as energy derived from the sun (wind, tidal, collectors, photovoltaic cells), the recycling of materials and the development of substitutes for these. (Private communication)

Yet, he also suggests that the ecological literature may provide the objective guidance for setting these technical standards. While this may be true in a general sense, it may be difficult for ecologic considerations alone to define standards in specific cases of environmental insult. For example, Hueting points out that the accumulation of toxics, heavy metals, and greenhouse gases is "incompatible with sustainability" and, according to the above quote, emissions should not exceed natural buffering capacity. But what if there is no natural buffering capacity?

Many of the very societies that have declared themselves in favor of a sustainable use of the environment have also called for increases in nuclear power generation. Unfortunately, a strict sustainability standard based on natural buffering capacity is incompatible with any nuclear power generation because even if entombed in lead and glass, nuclear wastes can never be totally "buffered" by the natural environment. Thus, avoidance of global warming may confront society with unpleasant choices that are not likely to be resolved solely on ecological grounds.

There is also a presumption in the Hueting-Bosch paper that a sustainability standard will be stricter than a standard based on current individual preferences of society. However, it is quite possible that for certain environmental problems, that a sustainability standard may be less strict than a standard based on current "wants." That is, the standard for sustainability could fall to the left of the individual preference "optimum" point in Figure 1.

An example might be provided by considering a sustainability standard for the discharge of BOD. Since the short-run negative effects of BOD discharges are often reversible, a standard based only on long-run sustainability or even health considerations may safely be quite weak but, nevertheless, socially disruptive in terms of what current BOD levels might mean for, say, recreational damage. Another example might be noise pollution.The level of noise level threatens health is possible to be much higher than the level most would find bothersome. Again, a standard simply based either on sustainability or even health considerations may be far weaker than most in the "current" generation would find desirable.

For these reasons, given the profound social implications of standard setting, one might hesitate before delegating the job of standard setting solely to technicians and scientists. And one might equally hesitate using cost estimates derived from such standards as a basis for adjusting the GNP.

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NORWAY

Overview

The Norwegian system of resource accounting is an example of physical accounting with links to economic activity. The system defines two types of natural resources: material resources and environmental resources. The former in further subdivided into mineral resources, biotic resources, and "inflowing" resources, by which is meant any resources immediately arising from the flux of solar energy (e.g., solar radiation, ocean currents) and the Earth's gravitational field. In addition, there are separate energy accounts that cover energy producing minerals (e.g., coal, oil, natural gas), certain energy producing biotic resources (e.g., fuel wood), and hydro-power, (that is, energy from the "inflowing" resource, flowing water).

Environmental resources mean those environmental assets that provide nonmarketed environmental services. The waste disposal services provided by the air and water would be an example of such environmental services. The corresponding environmental resources would be the troposphere and various water bodies. Both these assets, of course, generate other environmental services such as recreation opportunities, species life-support, etc.

As ambitious as the system may appear according to these very inclusive definitions, in practice the Norwegian system's coverage is far more modest. Thus, resources are confined to the major energy source, petroleum, and the minerals, iron, titanium, copper, zinc and lead; biotic resources are confined to forest products and fish, and the only inflowing resource covered is hydro-power. Moreover, the temporal coverage can be spotty depending on the particular resource: accounts for mineral resources exist for only a few selected years, while there appear to be uninterrupted yearly statistics on forests since 1970 and for fish since 1974.

The environmental resources accounts appear to be confined to a fairly rich set of land-use statistics and to data on the discharge of selected air pollutants (SO_2, NO_x, CO, CO_2, volatile organics, particulates and lead) and two water pollutants (nitrogen and phosphorus).

The following table describes the general format of the material resource accounts. However, different aspects of the table receive different emphasis depending on the resource being described. For example, Part III, describing the uses of the resource, is quite detailed for energy resources and is quite simple for fish. In contrast, the environmental resource accounts lack a standard structure. They merely serve to describe one or more attributes of the resource, such as land use or emission levels and concentrations.

Table 1: Structure of material resource accounts

I. Reserve accounts	
Beginning of period:	Resource base Reserves (Developed, Non-developed) Total gross extraction during period Adjustments of resource base (New discoveries, reappraisal of old discoveries) Adjustment of reserves (New technology, cost of extraction, transport etc., price of resource)
End of period:	Resource base Reserves (Developed, Non-developed)
II. Extraction, conversion, and trade accounts:	
	Gross extraction (by sector) - Use of resource in extraction sectors = Net extraction (by sector) Import (by sector) - Export (by sector) = Net import (by sector) Changes in stocks
For domestic use:	Net extraction + Net import +/- Changes in stock.
III. Consumption accounts:	
	Domestic use (final use category, commodity)

(Source: Alfsen, et. al. 1987)

Part II and Part III of the table provide the links to economic activity. Indeed, were the accounts confined to Part I, the Norwegian system would not have met the criteria for inclusion in this survey. The use and consumption sectors referred to in the table are the same as those defined in the Norwegian economic accounts (30 to 140 industrial and final demand sectors, depending on aggregation). Indeed, as shown by Longva (1981) this sectoring detail permits the construction of physical input-output tables which, in principle, can be formally linked to the input-output tables underlying the Norwegian economic accounting framework. In practice, however, such tables are exceedingly difficult to develop. Not only must all resource flows be identified by the same set of consuming sectors, these flows need to be measured in the same common units. Thus, coal, oil, gas, etc. would have to be measured in common energy units, perhaps feasible for energy substitutes but far more difficult for dissimilar minerals such as iron and titanium.

Discussion

As mentioned above, the actual Norwegian system is far more modest in scope than a brief description of its structure would indicate. The limitation in coverage is not a defect of the system, but rather reflects a clear view of just what functions the system is to serve (as well as a realistic appreciation of the costs of data development). (As noted in the main report, societal and policy objectives are one of the three principal factors that explain the unique characteristics of data or accounting systems.)

It is not the intent for the Norwegian resource accounts to provide a better indicator of social welfare. For this reason, collection of defensive and pollution control expenditure data and monetization of physical flows, both of which would permit GNP adjustments have not been a priority. Rather, the resource accounts are viewed as a tool to help policymakers better manage the natural environment. While Norway is a "free enterprise" economy, the government exercises some influence through a number of fiscal and monetary instruments. This direction is guided by a number of econometric planning models. The scope of the resource accounts is largely determined by those resource issues that are likely to be of economic and political importance and the ability of the resource information to conform to the input needs of the planning models. On these points, the remarks of Lorents Lorentsen are worth quoting. Mr. Lorentsen has the primary responsibility for the development of the Norwegian resource accounts at the Central Bureau of Statistics.

> The CBS's work on natural resource accounting started with a broad scope on which resources should be accounted, ideally within a common framework. The work is now more concentrated on economically and politically important categories (mainly energy and pollution) linked to national accounting and macroeconomic models. The emphasis is more on forecasting and policy analyses, e.g. how should Norway most efficiently comply to international conventions on air pollution reduction. This development is perhaps a sign of maturity, and a recognition that not all accounts/statistics are useful and valuable. (private communication)

This position reflects a cost-benefit view of information. While increasingly desirable, as accounting systems expand in scope, the incremental benefits may soon lose out to their incremental costs.

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UNITED STATES

Overview

Official environmental accounting in the U.S. has been restricted to the assembly of data on pollution-abatement expenditures. (However, very recently the U.S. Environmental Protection Agency initiated a pilot project with the goal of establishing a set of environmental and resource accounts for the Chesapeake Bay Region. Because it assembles information of direct relevance to policy assessment, EPA has opted for an accounting structure similar to the Peskin framework described in Appendix III. As this project is just underway, it will not be further discussed in this survey.)

Prior to 1989, the expenditure data were assembled in parallel by two separate branches of the Department of Commerce: the Bureau of Economic Analysis (BEA) and the Bureau of the Census (Census). Census drew its data from a survey of about 20 thousand establishments (plants) in the manufacturing sector (SIC 20 and 30), while BEA drew its data from a survey of about 9-14 thousand companies in both the manufacturing and non-manufacturing sectors. Since 1989, both surveys are conducted by Census. Due to budget reductions, the survey of companies has been greatly reduced. It now only covers a sample of about 600 firms in the petroleum, electric utilities, and mining sectors. Thus, data collection has ceased for a number of national accounting sectors that previously had significant pollution abatement expenditures. For example, not covered are transportation ($90 million of expenditures in 1986) and trade and services (whose $260 million of expenditures in 1986). For comparison, mining, which is covered, spent $250 million in 1986.

The establishment data are published annually in 4-digit SIC detail and geographically by state and by Standard Metropolitan Statistical Area. The data previously collected by BEA has also been published annually (in current and constant dollars) for all business and non-business sectors defined in the national accounts. Presumably, this series will continue although data quality must surely suffer as a result of the cutback in the survey.

In its publications, the BEA is careful to follow U.S. national accounting definitions. Thus, for example, purchases by home owners of septic tanks is considered a business (not a household) expense, since U.S. accounting convention places the (imputed) income of owner-occupied housing in the business sector. Similarly, there is no distinction made between current and capital outlays for pollution abatement by governments since the U.S. national accounts do not make this distinction. The basic national accounting categories covered in the publications are as follows:

Figure 1: Pollution Abatement Expenditures—National Accounts Categories Covered

- Personal consumption
  - Durables
  - Nondurables
- Business
  - On capital account
    - Motor vehicle emission abatement
    - Plant and equipment
    - Other
  - On current account
    - Motor vehicle emission abatement
    - Plant and equipment
    - Public sewer systems
    - Other
- Government
  - Public sewer system construction
  - Other

In addition, some of the published data provide a further breakdown of nonfarm business:

Figure 2: Pollution Abatement Expenditures—Nonfarm Business Breakdown

- Manufacturing
  - Durable goods
    - Primary metals
      - Blast furnaces, steel works
      - Nonferrous metals
    - Fabricated metals
    - Electrical machinery
    - Machinery, except electrical
    - Transportation equipment
      - Motor vehicles
      - Aircraft
    - Stone, clay, and glass
    - Other durables
  - Nondurable goods
    - Food including beverage
    - Textiles
    - Paper
    - Chemicals
    - Petroleum
    - Rubber
    - Other nondurables

Non-manufacturing
- Mining
- Transportation
- Railroad
- Air
- Other

Public utilities
- Electric
- Gas and other

Trade and services
Communication and other

Publishing more detail would be possible, but given the size of the survey sample, reliability would be a problem.

In addition to the above sector breakdowns, the cost estimates are also identified by air, water, and solid waste. The establishment survey further asks the respondent to allocate expenditures by type of air pollutant: particulates; sulfur oxides; nitrogen oxides, hydrocarbons, carbon monoxide; and heavy metals, radioactive and toxic substances, other. It should be noted that the costs of control for many of these substances are not separable. Presumably, the respondent must determine how to allocate such joint costs since the instructions on the questionnaire do not address the issue.

The instructions do address another joint cost problem: situations where the control of pollution is due to process change and the introduction of new equipment. In this case, the respondent is asked to estimate what the process change and new equipment costs would have been were they lacking in pollution-control features. Only the incremental pollution-control costs are to be reported.

Finally, in order to obtain a true cost baseline, the respondent is asked to estimate the value of any materials and energy reclaimed in the pollution-control process.

Discussion

Of all the possible modifications that one could make to the conventional national accounts, the separate identification of pollution control costs is the least radical. In the U.S., these data have been used as inputs to models that analyze the effect of economic policy on the economy and on productivity. In contrast to their intended use in the Dutch, German, and UNSO frameworks, these expenditures have not been labeled as "intermediate" in the U.S. accounts. It was never BEA's intent to employ these data to generate a downward-adjusted GNP.

As modest as the U.S. resource and environmental accounting effort has thus far been, recent budget reductions will make it even more modest. Although the situation may change in the future, the U.S. at present appears to be following Japan and Norway in de-emphasizing the role of resource and environmental accounting.

As another example of this de-emphasis, it should be noted that there had been an earlier BEA effort to do resource accounting. This work was conducted within the Measurement of Well-Being Branch of the Bureau of Economic Analysis in the late 1970s. However, the program ceased after only one environmental publication (Landefeld and Hines, 1982). (It should be noted that the program generated other publications in the general area of nonmarket accounting.) Yet, there is a significant legacy in that the Repetto resource accounting methods draw on the Landefeld-Hines methodology.

References and Sources

The BEA estimates are published periodically in the Survey of Current Business. Typical citations are:

Cremeans, John E. 1974. "Capital Expenditures by Business for Air and Water Pollution Abatement, 1973 and Planned 1974," Survey of Current Business, (July), pp. 58-64.

Farber, Kit D., Frederick J. Dreiling, and Gary L. Rutledge. 1984. "Pollution Abatement and Control Expenditures, 1972-82," Survey of Current Business (February), pp. 22-30.

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A typical citation for the annual publication of the Bureau of the Census data is:

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WEST GERMANY

Overview

The Federal Statistical Office of West Germany is "considering" the development of an environmental accounting system, independent of but capable of being linked to the national economic accounts. The FSO proposal memorandum of August, 1989, calls for a physical accounting of changes in the "actual state" of the environment. The economic linkage will be in terms of how economic activities affect the (physical) environment. Whether efforts will be made to value the physical accounts and generate adjusted GNP figures has not yet been decided, but it appears that a satellite approach will be preferred. Also, the FSO memorandum does not provide any information on the structure or coverage of these physical accounts except to indicate that they will include "spontaneous natural developments that are important for the environment and man." It is therefore not clear at this point what features the proposed environmental accounting system will have.

However, in private communication, Professor Udo E. Simonis of the Science Center in Berlin feels that the eventual system will reflect three different approaches: the Schafer-Stahmer approach (see below), the Leipert-Simonis "defensive expenditures approach," and the Wicke-Schultz "damage-cost approach."

The Schafer-Stahmer paper (March, 1988) focuses on the possible economic importance of environmental protection activities, broadly defined to include both pollution control activities and activities to defend against environmental insult. (Earlier work in Germany by Leipert also does not distinguish between both types of activities--a distinction that is made in the U.S. pollution-control literature.) Of particular concern to Schafer-Stahmer is the problem that expenditures for these activities may be double counted to the extent that these expenditures lead to indirect outlays for general economic goods and services. However, by identifying these environmental expenditures by consuming and producing sector, one can construct input-output matrices consisting only of these outlays and which are, thus, independent of the conventional input-output matrix. With these (sub-) matrices separately identified, and with the usual constant-coefficient assumptions, Schafer-Stahmer demonstrate that it is possible to distinguish between primary inputs devoted to environmental protection and total primary inputs or conventional value added. This value of primary inputs devoted to environmental protection could then be subtracted from GNP to yield an alternative GNP. However, even if one does not wish to make any GNP adjustments, the Schafer-Stahmer calculation is still useful in that it may provide a better indicator of the relative economic importance of environmental outlays than would a raw total of environmental expenditures, which will include double counting.

The accounting structure to support this model is reminiscent of the proposed UNSO environmental accounting structure. A distinction is made between external and internal environmental protection activities: that is, between environmental protection services purchased from others and environmental protection activities taking place within a sector. The former can be treated by introducing an additional row in the input-output table showing an environmental protection sector that delivers services to all other producing sectors. (Schafer-Stahmer, Table 1) However, the treatment of internal protection activities is more difficult since the requisite goods and materials used for this purpose by any sector are supplied by many sectors. Schafer-Stahmer have managed (for 1980) to distinguish these purchases from other ordinary inputs and, thus, have been able to construct a separate input-output table covering (internal) environmental expenditures, which also includes, the row describing the external protection services. (Schafer-Stahmer, Table 2).

In other words, Schafer-Stahmer have been able to isolate all environmental control expenditures (including final demand and primary input expenditures) from the conventional input-output matrix. If E is the conventional input-output matrix and G, the pollution-control input-output matrix, a matrix, F, can be defined as their difference. Each of these matrices can be typically partitioned as follows:

$$\begin{bmatrix} A_{(E,F,\text{ or } G)} & FD_{(E,F,\text{ or } G)} \\ VA_{(E,F,\text{ or } G)} & 0 \end{bmatrix}$$

where A is a square matrix of industry input-output flows; FD, a rectangular matrix of final demands (consumption, investment, exports, and governmental activities; and VA a rectangular matrix of value added inputs (labor, profits, capital consumption allowances, and imports). Dividing A by industry output totals yields the usual input-output coefficients. These are the conventional coefficients for A_E. That is, they measure input per unit of output. Obviously, for A_G, the pollution-control input-output matrix, these coefficients measure pollution-control input per unit of output.

The approach in the Leipert-Simonis paper (1990) is simpler in that pollution-control expenditure information is presented in tabular form rather than in matrices. However, as a trade-off, the data development effort is clearly easier and they are, thus, able to generate annual time series beginning in 1975. As is the case with the U.S. pollution-abatement expenditure series, both capital and operating expenses are estimated. The Leipert-Simonis paper also reproduces damage estimates using the Wicke-Schultz "damage-cost approach" (1986). These estimates are not further discussed here because the Wicke-Schultz paper is not available in English.

Discussion

As noted, the available written material (in English) does not provide any details of the proposed FSO accounting system. Therefore, it is not clear to what extent the concepts in the papers by Schafer-Stahmer, Leipert-Simonis, or

Wicke-Schultz will be adopted. On the assumption that some of these ideas will find their way into the German system, the following comments are in order.

Firstly, it should be noted that the Schafer-Stahmer or Leipert-Simonis adjustments to the conventional accounts are very conservative in that they cover economic activities that are already covered in the conventional accounts, although they are not separately identified. The adjustments do not cover any non-market services of the environment or any damages to these services ("loss of function" in the Hueting terminology). Nor do they cover natural and environmental resource depletion and degradation. Thus, these accounts only will partially meet the objectives of the FSO.

Although the suggested adjustments appear far less ambitious than those suggested, say, by the French, their implementation--especially the Schafer-Stahmer implementation--is hardly trivial. In particular, identifying the source (by sector) of "internal" environmental control outlays would seem a near impossible task since such separate identification is not a feature of ordinary business accounting. In fact, even if the accountant wishes to separate purchases according to whether they are for environmental control or for ordinary business purposes, it may not be possible to do so in principle. Often pollution control is accomplished by the introduction of more modern capital that jointly serves the purpose of pollution control and ordinary production. As the costs of such capital are, thus, "joint", it is not clear that anything other that an arbitrary separation is possible. In view of these problems, one is curious about the methods used to generate the data behind the input-output tables in the Schafer-Stahmer paper and whether these methods are feasible in developing countries. It appears that the Leipert-Simonis approach would be easier to adopt.

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APPENDIX II

OTHER APPROACHES[1]

Peskin

Overview

The accounting framework of Henry M. Peskin was developed as part of the now defunct Measurement of Economic and Social Performance program of the National Bureau of Economic Research. The purpose of this program was to develop improved measures of economic and social performance by expanding the national income and product accounts of the United States.

The Peskin framework (Peskin, 1989) thus is a modification of the U.S. accounting framework and, therefore, lacks the detail (and ambition) of the proposed UNSO approach of Bartelmus, van Tongeren, and Stahmer, which is more closely tied to the input-output style of the SNA.

Peskin's approach is to treat all assets--both marketed and nonmarketed--symmetrically. Thus, the environment is viewed as providing services to both intermediate and final demand sectors. At the same time, there may be negative output due to externalities associated with the consumption of these services (e.g., disposal services lead to pollution). This negative output is added (negatively) to final demand.

As with the Repetto approach, all assets are depreciated, including natural resource wealth. Along with marketed asset depreciation, this depreciation is subtracted from GNP to produce an adjusted NNP. The GNP, itself, is not affected by depreciation but it may be affected by the negative and positive values of nonmarketed environmental services. However, Peskin's primary interest is not in GNP adjustment. He demonstrates that several possible adjustments are consistent with the accounting framework, but he endorses none of them.

Instead, Peskin puts forth his framework as an information system for accounting for the linkages between environmental asset use and the use of other, marketed or nonmarketed, assets in the economy. Of critical importance is the fact that, lacking markets, the unit value of environmental asset services depends on the production and preference functions of the user. Thus, the consolidated framework allows for dual valuation--one for the input side and one

[1] As noted in the main report, these approaches are included for reasons of comparison and because they illustrate accounting approaches different from those surveyed in Appendix I. There are additional environmental and resource accounting efforts taking place in countries other than those surveyed. (See page 2, footnote 1). These are not described because the author is not knowledgeable about their details. While some of these efforts may duplicate approaches discussed in this paper, there is the possibility that some innovative ideas have been overlooked.

for the output side of the accounts. To maintain accounting balance, there is a balancing entry equal to the arithmetic difference between these two values. Peskin shows that the size of this balancing entry is proportional to the amount of economically inefficient allocation of environmental assets.

The valuations, in turn, are based in the neo-classical economic principal of consumer sovereignty. Thus, the value of input and final demand use is based on the willingness-to-pay for this use. Negative output or damage is estimated by the willingness-to-pay to avoid this damage. In practice, the willingness-to-pay estimates are based on procedures drawn from the benefit-cost literature.

The Peskin framework was implemented with U.S. data for two years, 1972 and 1978. However, the only environmental asset services covered were the disposal services to industry provided by air and water. Furthermore, the implementation did not include any calculation of natural resource depreciation. A typical example of the resulting consolidated income and product account is shown as follows:

1978 Consolidated National Income and Product Account
(billions of 1972 dollars)

Input			Output	
1. Compensation of employees and proprietors (incl. rental income)		1447.2	14. Personal consumption	1350.8
2. Profits with inventory valuation and capital consumption adjustment		167.7	15. Gross private domestic investment	351.5
a. Profits before tax	84.5		16. Exports	207.2
b. Profits after tax	121.5		17. Imports (-)	217.5
c. Inventory valuation & capital consumption adjustment	-38.3		18. Governmental goods &	435.6
3. Net interest		109.5		
NATIONAL INCOME		1724.3		
5. Transfer payments		9.2		
6. Indirect taxes		178.1		
7. Subsidies (-)		4.2		
8. Statistical discrepancy		3.3		
NET NATIONAL PRODUCT		1910.7		
9. Environmental depreciation (-)		NA		
MODIFIED NET NATIONAL PRODUCT				

10. Capital consumption	216.9		
11. Environmental depreciation (+)	NA		
CHARGES AGAINST GROSS NATIONAL PRODUCT	2127.6	GROSS NATIONAL PRODUCT	2127.6
12. Environmental services (-)	43.9	19. Environmental damages (-)	46.6
a. Air	29.6	a. Air	31.6
b. Water	14.3	b. Water	15.0
c. Land	NA	c. Land	NA
13. Net Environmental Benefit	-2.7		
MODIFIED CHARGES AGAINST GROSS NATIONAL PRODUCT	2081.0	MODIFIED GROSS NATIONAL PRODUCT	2081.0

The unaggregated data behind the consolidated accounts have been used by a number of U.S. governmental agencies to support various policy analyses. The fact that disposal and damage estimates are based on willingness-to-pay concept makes the data useful for benefit-cost assessments of policy. In addition, since the underlying data were identified in substantial geographical detail, they have proved useful for analyzing the distributional implications of policy alternatives.[1]

Discussion

Although not as detailed as the UNSO framework, the Peskin framework does make significant demands on data. For example, there must be complete coverage of environmental asset use by sector. For the U.S. implementation, this coverage required data on pollution discharges and prospective costs for avoiding these discharges by 3- and 4-digit Standard Industrial Classification. Adapting this framework to relatively data poor developing countries would probably require greater aggregation.

In addition, it is not clear that the neo-classical framework would meet developing country needs. In particular, the consumer sovereignty principle may underestimate the value of assets to the extent that this value derives from benefits to future generations. It may be necessary to find alternative valuation principles.

It should be noted that, like other systems surveyed (e.g., the Norwegian, French, and Repetto approach), the implementation procedure usually requires the

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[1] These analyses are in a number of government reports. However, some of the findings have been reproduced in journal articles. See, for example, Peskin (1986), Crosson, et al., (1986), Gianessi, Peskin, and Young (1981a and 1981b), Gianessi and Peskin (1980), and Gianessi, Peskin, and Wolff (1979).

assembly of physical data sets. Even without resolving valuation issues, these data sets can be valuable. In the case of the Peskin framework, financial support was provided by several policy agencies in the U.S. government who were primarily interested in these data sets. Since they were developed with a comprehensive accounting goal, the coverage of these sets was far more complete than the coverage of the sets readily available to these agencies.

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Repetto

Overview

The resource accounting activities of Robert Repetto and his colleagues at the World Resource Institute have relatively limited objectives: the accounting for the value of the depletion of those natural resources that generate marketed output. The intent is to adjust conventionally-measured income for this depletion in order to obtain a better estimate of sustainable income. Moreover, the intent is also to eliminate the asymmetrical treatment of capital depreciation between marketed capital and natural resource capital.

The focus is not on the general environment. No adjustments are made for pollution or environmental degradation. In addition, no subtractions to GNP are made for current environmental expenditures. Furthermore, the method used to calculate natural resource depletion, based on the method of Landefeld and Hines, is very simple. Essentially, estimates of the physical change in resource capital, through use, discovery, and (if applicable) natural growth over the accounting period is multiplied by the average net unit value of the resource. The net value is essentially equal to sales minus production costs and, thus, approximates economic rent.

Perhaps because of the modest objectives and the simplicity of the implementation approach, the Repetto approach has a record of successful implementation in Indonesia, and further studies are planned or are currently in progress in the Philippines, Costa Rica, and China.

Discussion

While the Repetto approach has been widely hailed in the popular press, it is not without its critics. Some (e.g., Clarke and Dragun, 1989) feel that the Landefeld-Hines approximation is inappropriate for renewable resources, since it is possible that short-run physical reductions in these resources could actually increase the value of remaining stock and, thus, yield negative depreciation or capital gain. As noted in the main report, El Serafy also finds the procedure inappropriate for non-renewable resources as well on the grounds that the depreciation procedure does not allow for re-investment of proceeds.[3] Because of this, El Serafy asserts that the calculated net income is too pessimistic in that it underestimates true sustainable income. Furthermore, he feels that the procedure fails to adjust gross income correctly. Several critics (e.g., Roger Sedjo (private communication) and Peskin) feel that Repetto's procedure is too partial in that it does not sufficiently capture the value of investment that may replace the depleted resource (a criticism that in certain respects is similar to El Serafy's). Thus, for example, depleted forests may be replaced with productive grazing lands. Finally, it should be noted that the procedure assumes the existence of economic rent that can be attributed to the

[3] See page 11 of the main report.

scarce natural resource. However, such a rent will not be observable if there is uncontrolled access to the resource--the so-called "commons" problem. Over-exploitation of the resource drives the market value of resource rents to zero.

None of these criticisms is "fatal." Clarke and Dragun's criticisms could be met with more sophisticated depreciation approaches and, in El Serafy's case, the use of alternative income aggregates. However, a response to the criticism that the approach is too partial would require the use of a much more comprehensive accounting framework: one that could trace both private and public investment that would replace depleted natural resource assets. Yet, adopting such a framework may have slowed the pace of or even prevented implementation. Finally, if there is a "commons" problem, the unobserved rent could be replaced with a rental value under an assumption of optimal restricted access. However, such an optimal value is not observable; it must be modeled.

Thus, Repetto's approach may illustrate a dilemma. One the one hand, we can make progress over the conventional accounts with respect to the treatment of natural resources and the risk of making misleading assessments of the true state of natural resource wealth. On the other hand, we can try to avoid making such misleading assessments by trying to be more comprehensive and by the development of models, but at the risk of making slower progress.

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United Nations Statistical Office

Overview

Staff from the United Nations Statistical Office (UNSO), with collaboration of Carsten Stahmer, have recently suggested the development of a system of satellite accounts, covering natural resource and environmental activity. (Bartelmus, Stahmer, and van Tongeren, 1989) These accounts are designed to link with the SNA and, if implemented, would permit the construction of several alternative measures of aggregate economic activity. As of now, these accounts do not have an official standing but the framework paper will be the basis for a draft manual and for two case studies to be undertaken jointly with the World Bank.

In contrast to the Norwegian effort and more like the French, the objectives are rather broad: "segregation and elaboration of all environment-related flows and stocks of assets of traditional accounts"; "assessment of environmental costs and benefits"; "elaboration and measurement of indicators of environmentally adjusted or sustainable income and product"; and "linkage of physical resource accounting with monetary environmental accounting and balance sheets." At the same time, the UNSO also wishes to follow "as far as possible the principles and rules established by the SNA." In particular, they wish to adhere to the SNA's (current) coverage of productive activity ("production boundary"). As will be discussed below, this goal may be in conflict with some of their broader objectives.

The essential features of the framework can be found in the following consolidated GDP account. (The figures are taken from the paper by Bartelmus, Stahmer, and van Tongeren, 1989.)

Figure 1 : Consolidated Adjusted UN GDP Satellite Accounts

GDP	293,337
{Consumption	217,437
Investment	76,630
Exports	73,797
(Imports)	(74,527)}
Environ. protect. services included in final demand	19,023
GDP adjusted	274,314
Environmental cost	51,839
{ Loss of non-renewable assets	25,322
Loss (gain) to renewable assets	(30,098)
Environ. assets used up	95,193
Natural disaster and degradation of private assets	(38,578)}
SUSTAINABLE GDP	222,475
Capital consumption	26,366
SUSTAINABLE NDP	196,110

As has been frequently suggested by others, final demand environmental protection activities are shown as intermediate and, thus, are subtracted from conventional GDP. However, household protection activities appear to be subtracted at two different places in the framework. If they are classified as "household environmental protection activities", they are subtracted from conventional GDP to yield "environmentally adjusted" GDP. On the other hand, if they are classified as "consumption of households required to deal with environmental change," they are apparently included with other "environmental costs" and are thus subtracted later. Specifically, consistent with the suggestions of the Dutch, Japanese, and Germans, "environmental costs" (or, in U.S. usage, "damages") are shown as a further reduction in conventional GDP to yield "sustainable" GDP. However, the composition of these "environmental costs" is somewhat unusual.

In the first place, along with pollution and other insults to the environment, these costs include environmental and natural resource asset consumption and degradation. Other investigators (e.g., Peskin, Repetto) would include such depreciation with the depreciation of ordinary assets. In the second place, the "costs" include natural growth of renewable assets and destruction of private assets due to natural disasters. Some may feel that defining these items as environmental costs (or "damages") is confusing. Finally, inspection of the subtotals reveals that all pollution damage and other environmental insults are treated as if their total effect is to reduce the quantity or productivity of environmental and natural resource assets. This treatment blurs a useful distinction between "direct-interaction" and "asset-utilization" environmental externality problems. (See below).

Supporting the above consolidated accounts is a large "use" table that breaks down many of the totals by producing and final demand sector. Of particular interest is the breakdown of environmental protection outlays by consuming sector and environmental "costs" by sector of origin.

However, not shown are those intermediate and final-demand sectors affected by environmental insults. In addition, there is no separate entry for the consumption of environmental services by sector. The implicit assumption appears to be that damages ("costs") are equivalent to these services. In other words, the value of waste disposal to the steel industry is assumed equal to the value of the damages caused by the steel industry's pollution. The implication of this assumption is discussed below.

It should be noted that the Bartelmus, Stahmer, and van Tongeren framework is not the only framework suggested by the U.N. In particular, the Population Division of the Department of International Economic and Social Affairs in 1982 suggested the introduction of environmental accounting through an expansion of a social accounting matrix (SAM). (U.N., 1982)

The SAM framework displays flows of expenditures and receipts by sectors, each of which can be grouped under "account" headings (e.g., factors of production, institutions, production sectors, commodities, rest-of-world). The proposal is to add to these groupings an environmental sector or "account" with an "output" row showing the demand for environmental goods and services by institutions, by production sectors, and by the rest of the world. There would also be an "input" row to this sector showing "expenditures" for these services by production and institutional sectors. Unfortunately, the paper lacks detail on how these "expenditures" would be determined. However, one could imagine that they might be based on imputed values of the environmental services to the consuming sectors. If so, the system would share a basic similarity with the Peskin framework.

Also consistent with the Peskin framework is the introduction of an explicit environmental sector. This approach is in contrast with that of Bartelmus, Stahmer, and van Tongeren who wish to adhere to the conventional SNA production boundary.

Discussion

The Bartelmus, Stahmer, and van Tongeren framework is a major advance over simpler, more consolidated frameworks in terms of its ability to trace inter-industry effects of environmental change. Of particular usefulness is the fact that reductions in environmental and natural resource capital are not viewed in isolation. Any offsetting increases in non-environmental capital are clearly displayed.

However, there are a number of potential problems with the framework that, hopefully, can be addressed in future revisions.

In the first place, while strict adherence to the SNA sector boundary has its value, one wishes that they would have taken the opportunity to introduce an explicit household production sector. While the neglect of nonmarket household production may not have serious consequences in industrialized countries, nonmarket production constitutes a major share of economic activity in developing countries. This household activity may have direct consequences for the environment and environmental policy. Fuelwood gathering is an obvious example.

Of equal importance, especially for practical implementation, is the lack of a "natural" sector. By not having such a sector, all environmental damages are, by definition, attributed solely to human activities. Unfortunately, when one is affected by poor air or water, the defensive actions taken are likely to be the same regardless of whether the pollution has natural or man-made origins. To neglect "nature" as a source of pollution overstates the likely benefits of policy actions directed against human activities.

Another possible problem with the framework is the failure to distinguish between services provided to economic sectors by the environment and damages (or "costs") to the environment by these sectors. The single "environmental cost" entry implies that these values are the same. Moreover, if, as the authors suggest, these damages are to be valued in terms of their cost of elimination, it implies that the opportunity cost of environmental policy is exactly equal to the policy benefits. These assumptions make it impossible for the authors to use the framework for an "assessment of environmental costs and benefits"--one of their stated objectives.

A third problem is the assumption that all environmental "costs" can be viewed as if their effect is to degrade environmental and natural resource capital. While many (some might say most) insults to the environment have this "asset-utilization" effect, many so-called environmental externalities have more of a "direct-interaction" effect. (The terminology is from Mohring and Boyd, 1971.) Thus, for example, noise pollution is probably more usefully analyzed in terms of its direct effect on individual utility functions than on its effect on the rate of depreciation on human and environmental capital. (Admittedly, it could be treated in terms of its affect on the depreciation of capital, but it would be awkward to do so.) It would be more useful for the interpretation of the damage data if Hueting's distinction between "quantitative competition" (e.g., asset utilization) and "qualitative competition" (e.g., direct interaction) for services of the environment could be maintained.

There is also the question of why the depreciation of environmental assets are treated differently from the depreciation of non-environmental assets. Of course, if economic activity destroys environmental and natural resource capital, GDP will not be sustainable. Thus, the motivation for defining (environmentally) "sustainable GDP" is understood. However, the GDP is equally un-sustainable if economic activity serves to destroy machines, factories, and, of course, human capital. The sustainability-distinction between natural resource capital and other economic capital is only meaningful if natural resources are assumed to have no substitutes--a highly controversial proposition. Moreover, maintaining this distinction may make it more difficult to get these ideas accepted by non-environmental economists. A better strategy might be to highlight the similarities between natural resource/environmental capital and ordinary marketed capital rather than their differences.

There are also a number of questions concerning data demands and implementation specifics that can be raised about the Bartelmus, Stahmer, and van Tongeren framework. For example, is the intention to distinguish between "internal" and "external" pollution-control activities along the lines of the German framework? How will household defensive expenditures be distinguished from ordinary consumption outlays? How easy will it be to apply such a comprehensive framework in data-poor developing countries? Presumably, these and other data and implementation issues will be addressed in the proposed World Bank pilot projects.

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APPENDIX III

DEFICIENCIES IN THE NATIONAL ACCOUNTS

National economic accounts, a framework for the systematic organization of economic data describing a nation's economic condition, exist in one form or another worldwide. Governments have found these accounts indispensable for purposes of organizing the data necessary for the analysis and design of economic policies and for gauging the success of these policies.

While national accounts have a long history, their initial widespread use by resulted from the policy demands engendered by the Great Depression and by World War II. As their popularity with Governments has grown, the general public has also begun to become more familiar with the accounts and especially certain aggregate totals drawn from the accounts such as the Gross National Product (GNP). GNP along with other economic data such as price and employment statistics are widely looked upon as indicators of how well a nation is doing.

However, along with the growth in popularity has been a growth in criticism of the accounts--not so much of their use as a data system but more often their use as indicators of national well-being. Coinciding with the surge of interest in the environment in the 1960s and early 1970s, alleged inadequacies regarding the GNP's ability to reflect the environment and, more generally, the "quality of life" were the subject of a number of articles and newspaper editorials. More recently, the criticism has shifted towards alleged weaknesses in the ability of the accounts to reflect the possible deterioration of a nation's resource base. As a result, the economic activity measured in the accounts may not represent sustainable activity over the long run.

There are three additional deficiencies with the standard national economic accounts that may result from their inadequate treatment of the environment and natural resources: the conventional accounts provide a poor measure of social and economic performance, the conventional accounts treat different forms of national economic wealth inconsistently, and the conventional accounts ignore important variables explaining economic activity. These three deficiencies will be discussed in turn.

1. Inadequacies as a measure of social and economic performance[1]

One of the most frequently heard criticisms of the conventional national accounts is that they respond poorly (some would say "perversely") to changes in environmental and resource conditions. Certainly, it is true that pollution, congestion of parks and wilderness areas, and the depletion of natural resources are often unfortunate side effects of economic growth. Thus, it is disturbing to much of the public that economic data drawn from the national accounts point in a positive direction. To make matters worse, often the conventional economic

[1] The author realizes that when used together, either the word "social" or "economic" may be redundant, depending on how broadly each term is defined.

indicators poorly reflect efforts to defend against environmental insult and efforts to clean up the environment. If, for example, resources in the economy are not fully employed, it is quite likely that any increased expenditures on medical services or for household cleaning due to increased pollution levels will result in an increase in economic activity and, thus, an increase in GNP. On the other hand, efforts to clean up the environment could lead to a decrease in GNP (measured in constant prices) to the extent that these expenditures are "current account" outlays borne by business and, thus, divert resources from ordinary output.

Of course, it could be argued that over the long-term, a clean working environment and a sufficient stock of natural resources are necessary for healthy and sustained economic growth. Thus, the potential "perversities" suggested above may only exist in the short- or medium-term. However, because of the popular fixation on the GNP as the indicator of current social and economic well-being, the argument that if environmental conditions become bad enough, GNP indeed will eventually go "in the right direction," will not satisfy the critics.

2. Inconsistent treatment of income and wealth.

Criticisms of the national accounts as indicators of well-being have been readily dismissed by academic economists and those national account statisticians who feel that the accounts are simply a record of a nation's production and were never intended to be an indicator of social and economic well-being. They may argue that if the press, the public, and the politicians persist in believing otherwise, the problem is with public attitudes and their lack of understanding, but not with how the conventional accounts treat the environment. On the other hand, the criticism that the standard accounts do not provide consistent treatment of income and wealth may have more support among economists.

More specifically, the assertion is that the standard accounts inconsistently exclude information needed to comply with conventional definitions of "income." Conventionally, income is defined as the sum of consumption expenditures plus investment (where "investment" also includes net foreign investment defined as exports less imports). However, the conventional definition further distinguishes between gross investment and investment less depreciation, or net investment. Accordingly, we distinguish between gross income and net income, where the latter is defined as consumption plus net investment.

While most economists feel that there is no income aggregate that fully measures economic well-being, many would argue that net income, as opposed to gross income, comes closer to the mark, since it better represents the amount society can consume after allowing for the production of resources necessary to maintain society's stock of capital. Gross income, in contrast, may not be sustainable to the extent that its level is supported by a diminishing capital stock and thus does not comply with the Hicksian definition of income adopted in most national accounting frameworks including the SNA.[1] Consequently, one important entry in the standard economic accounts is "depreciation," which allows the translation of gross income (or product) to net income (or product).

The inconsistency arises because the conventional national accounts measure the depreciation of certain forms of capital, such as plant and machinery, but neglect to account for the depreciation of other forms of capital such as natural resources and environmental capital, as represented by the nation's stock of clean air, water, soil, wilderness areas, non-renewable resources, etc. As both environmental and natural resource capital are crucial to the production of goods and services--especially in heavily resource-dependent developing countries--neglecting this sort of depreciation necessarily means that net income is overstated. Of course, one could point out that other forms of capital depreciation are also neglected in the standard accounts. Of particular importance is the neglect of the depreciation of (as well as investment in) human capital, even though the services of this capital (that is, "labor") accounts for most of a nation's income.

It should be pointed out that while several critics of conventional accounting practice wish to address the inconsistencies arising from the failure of the accounts to cover the depletion of natural resource and environmental capital, they still wish to treat such capital differently in their suggested accounting modifications. The issue of whether natural resource and environmental capital "deserve" special treatment is addressed in Appendix I.

3. **Neglect of important determinants of economic activity.**

An important function of the national accounts is that they serve as an information system containing those statistics that determine and define the nation's economic activity. Thus, even if one were unconcerned about the accounts failure to treat environmental concerns adequately or about possible inconsistencies in the definition of income, one might still fault the conventional accounts if it is believed that they are not fulfilling their informational role. Specifically, one could point to the neglect of the services of natural resources and the environment. After all, these services influence production and consumption activities in much the same way as the services of human capital, plant, and equipment, which are already measured in the accounts.

In its role as an information system, the economic accounts provide a snapshot of the economy's "production function": an instantaneous picture of the

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[1] See Hicks (1946). (References are found in main report.) It should be pointed out again that no single accounting aggregate--whether it measures gross income or net income--is entirely satisfactory for the measurement of economic performance. For example, two countries can have exactly the same net income but where one country consumers it entirely while the other saves half. The fact that the latter country has the potential for future growth, while the former does not, is not captured in the income aggregate.

transformation of factors of production into product and services. Neglecting environmental and natural resources distorts the picture of production in two ways. It overlooks the production of some undesirable outputs (e.g., pollution) and leaves out a number of crucial inputs to both desirable and undesirable product.

This lack of a full accounting of all inputs and outputs complicates the nation's economic and environmental policy process. The availability of key environmental and resource inputs may be crucial in determining whether economic goals will be reached, especially in less-developed, resource-based economies. Thus, neglecting these inputs in national income accounting could lead to less optimal policies than would otherwise be the case.

Yet, even in industrialized, non-resource based economies, while the neglect to account for environmental or natural resource inputs and outputs may not have as dire a result, it may hamper the ability to develop an integrated policy approach directed towards certain resource and environmentally dependent sectors. For example, we are unlikely to gain a full understanding of the response of the agricultural sector to agricultural policies without a complete accounting of all the significant inputs and outputs, both marketed and environmental, that are involved in agricultural production.[3]

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[3] For a discussion of nonmarket factors and agricultural productivity, as well as bibliography of related references, see Peskin (forthcoming).

APPENDIX IV

SHOULD ENVIRONMENTAL AND NATURAL RESOURCE WEALTH RECEIVE SPECIAL ACCOUNTING TREATMENT?

It is perhaps ironic that both defenders of conventional national accounting and many who feel the present system to be inadequate agree that natural resource and environmental wealth should be treated differently from other forms of wealth such as plant and equipment. Practitioners of conventional income accounting distinguish environmental and natural resource wealth from other forms of capital by excluding any measures of natural resource and environmental depreciation. Of course, this practice is not confined to natural resources and the environment. For example, depreciation of and investments in human capital also receive the same treatment.

On the other hand, while critics have complained about this treatment of natural resources and the environment in the conventional accounts, some of the suggested remedies still provide for special treatment for these assets. Thus, for example, El Serafy (1989)[1] has suggested a radical change in how one should define the (gross) income generated by depletable natural resources.[2] In addition, Bartelmus et al. (1989), with regard to their treatment of natural resource depletion, provide a new definition of gross income: "sustainable" gross income, defined as conventional gross income less environmental outlays and less the current consumption of natural resources. In contrast, both Peskin (1989) and Repetto, et al. (1989) call for a uniform treatment of all wealth, both conventional and environmental.

Of course, the natural environment and underground minerals are physically very different from factories and machines. Most notably, they are not easily reproduced by man. Do these differences justify special treatment? Apparently, the French Physiocrats of the 18th century thought so. Their accounting systems reserved a special role for land, thought to be the source of all national wealth.

However, more modern economic theories emphasize that in both the production of goods and in the generation of well-being, it is possible to substitute one form of capital for another. In this view, no particular form of capital is unique or essential. (Human capital is, of course, an exception.) Even if all of a nation's non-reproducible natural resources were exhausted,

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[1] References may be found at the end of the main report.

[2] Essentially he would distinguish between proceeds due to the extraction of minerals from "true income", where the difference between the two is defined as the amount that would have to be invested in order to just replace the value of the resource when it is fully exhausted. The "true income" would be included with other gross income originating in the economy.

production of goods and general well-being need not suffer if wise investments are made in another form of wealth.[3] Thus, while there may be tremendous physical differences between types of capital, there are no essential economic differences.

This sanguine view has been attached recently by those who feel that particular forms of environmental wealth--in particular the biosphere and the oceans--are indeed essential and that this wealth is under transnational attack by such factors as global warming, ocean dumping, and acid rain. These fears are behind recent concerns that both national and world-wide economic growth may not be "sustainable."[4]

The choice between the neo-classical economic view and the alternative view that natural resource and environmental capital has a special economic role and thus needs special accounting treatment is difficult to make on theoretical grounds. It is also difficult to rely on past empirical evidence. Certainly, the historical evidence suggests that many nations have survived and, indeed, prospered in spite of severe depletions in their stocks of natural resources. On the other hand, if the estimates of the potential increase in global warming, the depletion rates of rain forests, and the increase in world-wide generation of wastes are correct, we may be facing changes for which past empirical evidence provides little guidance.

Yet as difficult as it is to resolve the debate theoretically and empirically, the effort should be made. Whether there are essential economic features of natural resource and environmental capital that warrant special accounting treatment is, of course, important for the choice of accounting approach. Far more important is what the resolution of the debate will say about the future course of environmental and resource policy.

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[3] The neo-classical theory suggests that market behavior will assure that such wise investments will take place automatically. However, one can reject this theory and still believe that widely disparate forms of wealth are substitutable.

[4] It is not clear whether similar fears have motivated the views of El Serafy and Bartelmus, et al. In the paper by Bartelmus, et al. (1989), there is little discussion of why they chose to treat environmental and natural resource capital uniquely. El Serafy (1989) offers two explanations for his approach: the fact that GNP and not NNP is "the preferred quantity for macroeconomic analysis" and that nations with "marketable natural resources are evidently better off that those without such resources." It is hard to see why both arguments would not be just as applicable to countries relying solely on stocks of reproducible and human capital as to those relying primarily on exhaustible stocks of natural resources.

SENATOR GORE. Thank you very much. I appreciate it.
Dr. Repetto, please proceed.

STATEMENT OF ROBERT REPETTO, DIRECTOR, ECONOMIC PROGRAMS, WORLD RESOURCES INSTITUTE

DR. REPETTO. Thank you, Mr. Chairman.

It's not terribly comforting that the United States is moving over to the SNA, because the SNA is itself, at present, seriously flawed in its treatment of natural resources and environmental issues.

I think the basic problem with respect to natural resources was well-stated in your opening statement. And it's not necessary to dwell on it at great length here. It is that natural resources are not treated as economic assets. Activities that deplete or degrade them are not recorded as a charge against income but as an addition to income. Consequently, there is a fundamental confusion between income generation and impoverishment of national wealth.

The treatment of natural resources in the SNA is asymmetrical—that is, other forms of capital are not treated this way—and also inconsistent, because natural resources are not treated equivalently in the stock accounts—the national balance sheets—and in the flow accounts—the income and product statements.

The seriousness of this problem is well illustrated, I think, by the recent study that we have completed with the Costa Ricans. Incidentally, most of the work was done by Costa Rican analysts, using existing data that was already available in the country, that had to be dug out. According to the agency in Costa Rica responsible for doing their National Accounts, it's at least as well-grounded and, in fact, it is better grounded than the rest of the National Accounts in terms of the quality and reliability of the estimates.

If I might, I would like to bring in the question of cost. I was taught that gentlemen don't discuss money, but, I guess, that doesn't apply within the Congress. It costs about $250,000 to do this study in the course of a year. To me, that is a very minor amount of money compared to the hundreds of million dollars of losses in natural resource damage that Costa Rica has experienced.

I was interested to hear that it is considerably more than is available to the BEA, at this point, to do comparable work in the United States, which is a somewhat larger country. It's also much larger than the amount available to carry out the case studies that Dr. Carson alluded to in Mexico and Papua New Guinea. And then there was another one, or two of them—with the help of the World Bank and the U.N. Statistical Office—that were funded for about $30,000 apiece. So, it does underscore that there is a money issue involved in this.

I've included in this testimony a figure showing the famous Costa Rican strip tease, which is the loss of its forest cover over a 40-year period. Most of that forest land was converted for agriculture, mainly pasture. Heavily-sloped lands that should have remained under forest cover have been subjected to much higher rates of soil erosion, with considerable loss of soil productivity.

Fisheries have also been destroyed through pollution and overfishing. None of this asset loss has appeared in any of the core national income GNP investment and saving accounts in Costa Rica over the past 18 years, during which this process has taken place.

When we added it up, the loss has amounted to something like 5 percent of GDP per year. In the forestry sector, the value-added net of this depletion has been negative. It would be reduced by about 50 percent in agriculture due to soil erosion. The economic value of some of Costa Rica's principal fisheries has been totally eliminated. Had they been available, these indicators would have given unmistakable signs to policy-makers that something was very badly amiss. Gross capital formation, or net investment, would have been reduced by about a third, on average, over this period.

Now, any analysis of the prospects for growth and development in the Costa Rican economy that over-stated capital formation by that amount of money—that fraction—would necessarily have been erroneous and have led to mistaken forecasts and prognostications and diagnosis.

So, all of this illustrates that the existing system gives very—as you just pointed out—very misleading signals to policymakers. And a telling example is the recent experience of Costa Rica with the debt crisis. If a national balance sheet for Costa Rica had been available—and it wasn't because the Costa Ricans have never implemented that part of the SNA—it would have shown, on the asset side, natural resource assets declining by about 5 percent a year.

At the same time, liabilities in the form of foreign debt would have been increasing. The rate at which the assets were disappearing greatly outweighed the rate at which external debts were piling up. Basic balance of payments deficit was about 2 percent of GDP over the year.

But the problem was defined as a debt crisis. And while the IMF rushed South, with missions to stabilize the money supply, nobody came down with programs to stabilize the natural resource base.

Senator Gore. To the contrary, in a debt crisis, there is frequently increased pressure to speed up the exploitation of natural resources.

Dr. Repetto. As a matter of fact, that's precisely what happened. The IMF program called for a contraction, a reduction in expenditure. One of the consequences of the ensuing increase in unemployment—and we have numbers on this—was to send poor, unemployed workers into upper watersheds, trying to carve out subsistence holdings where they shouldn't have been; a big increase in migration into these forested areas; and a big influx of low-income workers into small-scale off-shore fisheries, which exacerbated the problem of the fishing. So, environmentally, the IMF program was, in fact, perverse.

As Henry Peskin has said, resource-dependent countries in the OECD have recognized the need to do work on it. Some, like the Norwegians, have worked for a long time. Others, like the Canadians and the Australians, are just beginning to work on it.

But more dramatic, it seems to me, has been the upsurge in interest among developing countries. We had a conference in Vancouver last spring, I guess it was, to try and create an opportunity for people from developing countries interested in starting this work or engaged in it to talk to each other.

We are aware of exercises now underway in the Philippines, Indonesia, and China. The China case is particularly interesting because it illustrates the point that you made—that here is a country trying to dramatically switch over to a completely different system and accounting framework, and they recognize the shortcomings of the SNA, with respect to environmental and resource issues. They're trying, on their own, to make some corrections.

Malaysia, New Guinea, India, Mexico, El Salvador, Bolivia, Chile, and most recently, the Brazilians have started, which I think is a very significant change. One of the things that emerged at that conference was their perception of the need for a standard methodology. Rather than have everybody experimenting and developing inconsistent frameworks, there are economies of standardization here—as Senator Sarbanes said—and they look to the United Nations for leadership in establishing that common methodology and framework.

The U.S. AID did help us with the Costa Rican study. They were one of the funders, along with the Dutch and the Canadians for that study. It is, to my knowledge, also supporting natural resource accounting in the Philippines and El Salvador, and Henry mentions Indonesia to that. But it seems clear that a more systematic and widespread effort by AID would be possible and useful, given this widespread interest.

My view is that the World Bank has so far taken only tentative and experimental steps to explore natural resource accounting, has supported a couple of very limited studies, organized some conferences on this subject, and published a set of conference papers; but it has not provided systematic support to countries attempting to reform their accounts, nor has it incorporated natural resource accounting into its own analytical work. The regional MDBs and the IMF, to my knowledge, have done little, if anything, on this front.

The U.N. Statistical Office and the Statistical Commission are key issues, because most countries, including the United States, increasingly conform to the System of National Accounts. It seems that—and we heard it from the testimony earlier—the thrust of the SNA revision is not to make the kind of changes in the core accounts that would unify the treatment of natural resources as economic assets, and adjust measures of national income, capital formation, value added, accordingly. This is unfortunate for several reasons. The SNA is now inconsistent in its treatment of natural resources. There are what they term stock accounts—national balance sheets—in which natural resources are recorded as assets. Land, timber, subsoil, mineral soils are already in there.

The valuation problems that Dr. Plant referred to are addressed in the compilation of national balance sheets. They must be addressed in order to value these as economic assets. The data needed to compile those accounts are already being collected by many countries. The question is how do you treat the data. The numbers are there. What box do you put them in?

But the stock accounts—the national balance sheets—are inconsistent with the flow accounts. They violate, in fact, one of the most fundamental rules of accounting. And that is that the change in stocks between the beginning and the end of a period is equal to the net flow within the period. A simple example would be the change in a person's net worth between the first day and the last day of the year is equal to his net savings within the year. It's a principle of all sorts of accounting systems, demography, the change in the population between the beginning and the end of the year is equal to the excess of births over deaths and in-migration over out-migration. It's a necessary relationship, but the U.N. System of National Accounts violates that because they do not treat the accumulation of natural resource assets as capital formation, nor do they treat the decumulation of natural resource assets as capital consumption.

So, had Costa Rica compiled national balance sheets in 1970, in 1988 they would have found that the assets worth one year's GDP had disappeared. But nowhere in the flow accounts for the intervening years would there be any trace of this.

Instead of making these sorts of revisions to eliminate this inconsistency and flaw in the SNA, the U.N. Statistical Office is compiling its manual of guidelines to assist those countries that wish to compile satellite natural resource environmental accounts. As one experienced U.N. official once explained to me, this is a compromise that enables the United Nations to assure those constituents who resist change that nothing will be changed, while assuring constituents who want action that they are taking steps to correct the problem.

I mean, it is a step in the right direction, but I reiterate that it is unlikely to have much effect. Huge statistical offices can afford at this point to implement the entire SNA, for example, with national balance sheets. It is highly unlikely that they are going to have the resources to implement a parallel set of satellite accounts.

Another thing, experience with the satellite accounts is that they have very little effect on the analysis of policy. I should qualify my statement in the text using the Norwegian example. In Norway, those accounts that were compiled for the energy sector, which were incorporated directly into policy modeling, have been influential. The ones that they have done for other natural resources, such as fisheries and forests, which have stood alone as satellite accounts, have been recognized as ineffectual. And it's doubtful whether they're going to continue to do it.

The U.N. position, at this point, makes no distinction between the steps that could be taken now, without fundamental changes in methodology and considerable new research, and more difficult and far-reaching changes. Making the treatment of natural resources, such as soil, timber, and subsoil minerals in the flow accounts consistent in the way that they are now treated in the stock accounts within the SNA could be done now. It introduces no new issues of valuation, nor does it extend the boundaries of the SNA in terms of what's in it, and what's outside it. Trying to value air pollution damages to consumers, for example, extends the boundary of the SNA. But the changes that we are talking about do not do that.

The U.N. manual does not distinguish between the changes that are of greater importance to the developing world and those of greater concern to industrialized countries. Developing country economies are resource-dependent. They think of the environment in terms of producing assets, not in terms of consumer amenities. Yet, the accounting framework prescribed for them in the SNA ignores their principal assets.

It seems to me that a desirable and feasible course of action would be to take advantage of the upcoming U.N. Conference on Environment and Development in mid-1992 to announce a definite timetable for changing the treatment of natural resources in the SNA.

A period of three years to carry out additional case studies, to hold consultations, and so on would seem to be quite adequate. If the Soviet Union and Eastern Europe can change over from 70 years of communism to a capitalist framework within a much shorter time, it would seem possible to change the definition of national income within that span of time.

If we can't do that, then the prospects for the survival of natural resources in such countries as Costa Rica, until the opportunity comes around again, seems very bleak.

Thank you.

[The prepared statment of Dr. Repetto, together with a report, follows:]

PREPARED STATEMENT OF ROBERT REPETTO

I. The Need for Reforming the National Income Accounts

The United Nations System of National Accounts, which most countries follow closely, is seriously flawed in its treatment of natural resources. Although most developing countries (and some developed countries) still depend heavily on agriculture, forestry, fishing and mining for income, employment and export earnings, natural resources are not treated as economic assets in the national income accounting system. Depletion or degradation of natural resources by economic use is not treated as capital consumption; development or enhancement of natural resources is not treated as capital formation.

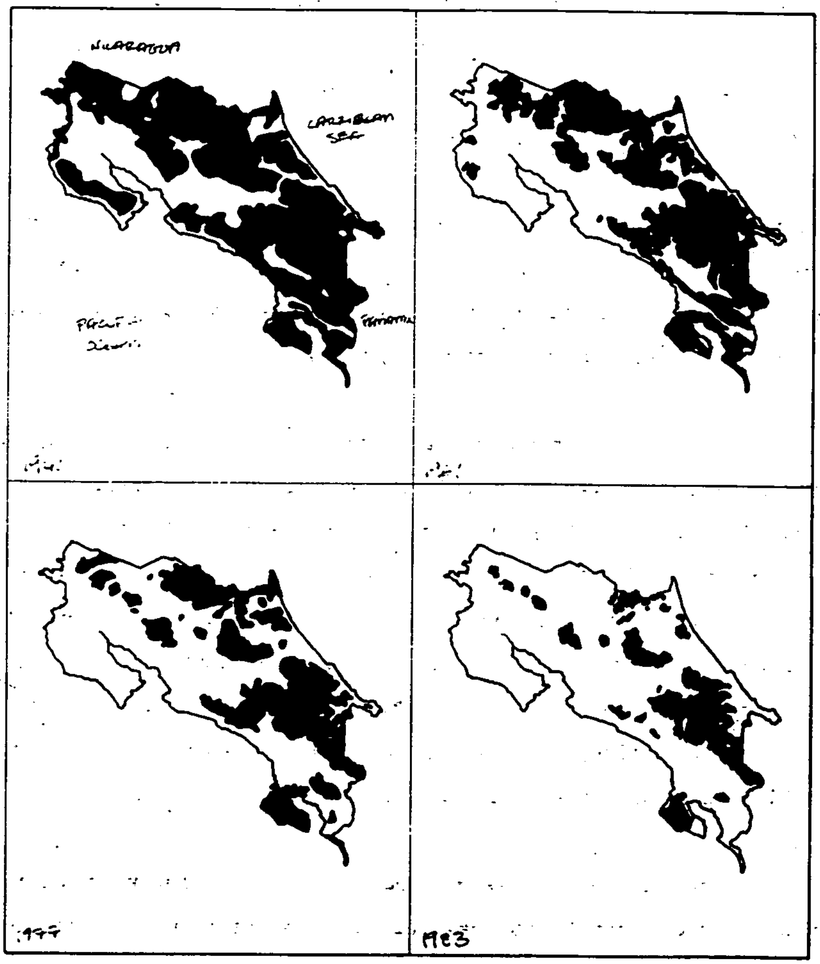
Depreciation of other forms of tangible capital, such as machinery and equipment, is recorded through a capital consumption allowance subtracted from gross value added. Income is what remains of value added after enough has been set aside to restore and maintain the capital stock. This accounting practice adheres to the fundamental definition of income as the maximum that can be consumed in the current period without reducing future consumption. This definition of income also captures the essential meaning of sustainable development. However, natural resources are not treated symmetrically, even though they are economic assets, capable of generating a stream of economic benefits over time.

The result has been that countries drawing down the quantity and quality of their natural resource base have recorded that process as raising their income, not as reducing their wealth. Countries have eroded their soils, destroyed their forests, polluted their waters, and depleted their fisheries, and their economic accounts show only a resulting rise in national income as these important assets have disappeared.

The natural resource accounts recently compiled for Costa Rica illustrate the severity of this problem. They cover forests, soils, and fisheries. Incidentally, they were compiled in Costa Rica by a team of Costa Rican researchers under the sponsorship of the Ministry of Natural Resources, with limited help from WRI. They relied only on already existing information, but are detailed and sophisticated. According to the Costa Rican national income accounting office, they are more solidly based than many other estimates in Costa Rica's current national accounts.

Figure 1 illustrates the continuing deforestation of Costa Rica, largely for livestock grazing. Most of the valuable timber was simply burned, and habitat rich in biological diversity has been lost. The denudation of slopes better left under forest cover

Figure 1 - DEFORESTATION IN COSTA RICA, 1940-83. DEFORESTED AREA IN WHITE



SOURCE: AUTHORS. "RECENT DEFORESTATION IN COSTA RICA," BIOTROPICA, VOL. 20, NO. 1 (1988) p. 13 (1983 DATA ONLY) has accelerated soil erosion, affecting soil fertility and off-site water quality. Other natural resources, such as fisheries, have also been degraded.

If calculated net of capital depletion, the forest sectors' contribution to income would have been negative virtually throughout the period (Figure 2): the agriculture sector's contribution would have been reduced by fifty percent by erosion losses (Figure 3), and the economic value of one of Costa Rica's main fisheries would be totally eliminated (Figure 4). These indicators would have demonstrated powerfully that natural resources were being unsustainably and unproductively managed. But, there is no place for them in the UN's current national income accounting framework.

The aggregate cost of this natural resource depletion, expressed as a capital consumption allowance, averaged about 5 percent of GDP per year over most of two decades. (See Table 1) Yet there is no inkling in the national accounts for any of these years between 1970 and 1988 that the country's wealth, its economic assets, were being lost at a rapid rate. Figure 5 shows the adjustment to aggregate capital formation implied by natural resource accounting. If the consumption of natural resource assets had been subtracted from gross domestic investment in the same way that other tangible capital is depreciated, then it the record would show that net capital formation was roughly one-third lower

TABLE 1
Gross and Net Domestic Product
Net of Natural Resource Depreciation

Year	Gross domestic product (GDP)	Conventional capital consumption allowance (CCA)	Conventional net domestic product (NPD)	Natural resource depreciation. (NRD)	Adjusted net domestic product (NDP)	N.R.D. / G.D.P.
1970	93,446	5,951	87,495	4,982	82,513	5.3
1971	94,382	5,947	88,435	6,577	81,858	7.0
1972	100,912	6,186	94,726	5,553	89,173	5.5
1973	116,525	6,503	110,022	6,656	103,366	5.7
1974	122,740	6,481	116,259	8,115	108,144	6.6
1975	125,393	6,655	118,738	7,583	111,155	6.1
1976	132,310	7,188	125,122	6,182	118,940	4.7
1977	143,990	7,394	136,596	6,311	130,285	4.4
1978	153,124	8,035	145,089	6,189	138,900	4.0
1979	160,598	8,571	152,027	8,750	143,277	5.5
1980	161,894	8,529	153,365	8,233	145,132	5.1
1981	158,237	7,511	150,726	5,510	145,216	3.5
1982	145,932	5,847	140,085	5,157	134,928	3.5
1983	154,481	5,029	149,452	9,637	139,815	6.2
1984	163,011	4,862	158,149	10,711	147,438	6.6
1985	169,299	4,694	164,605	11,231	153,374	6.6
1986	177,327	4,408	172,919	14,554	158,365	8.2
1987	186,019	4,651	181,368	10,522	170,846	5.7
1988	207,816	5,301	202,515	21,163	181,352	10.2
1989	231,289	5,323	225,966	20,604	205,362	8.9

Note: Gross Domestic Product values from Banco Central de Costa Rica (Estadísticas 1950-1985, San José, Costa Rica) and unpublished data were converted to constant colones. The GDP deflator used was taken from International Monetary Fund, *International Financial Statistics* 20:14 (15 July 1991). Net domestic product was developed in this study.

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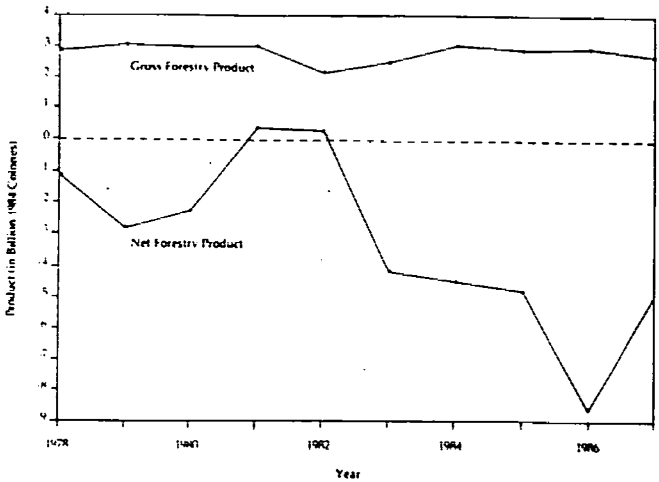
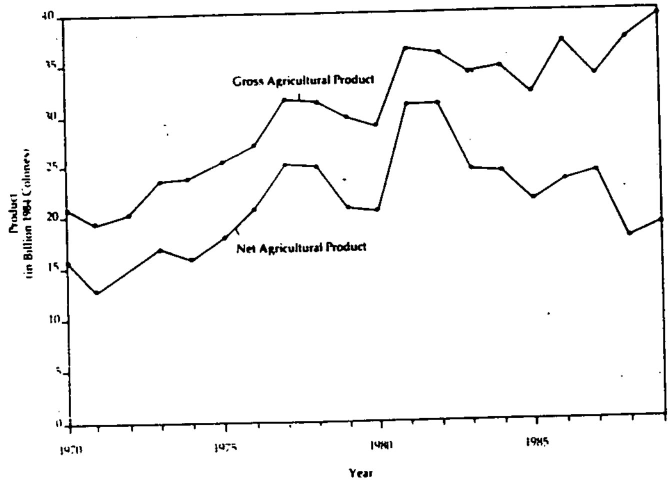
Figure 2 Gross and Net* Forestry Product



*Net only of the depreciation of the forest resource, and therefore does not include depreciation of man-made capital.

Figure 3 Costa Rica's Agricultural Product Before and After Natural Resource Depreciation



Decline in Fishery Asset Value with Increasing Effort
Gulf of Nicoya, Costa Rica, 1970-88

Figure 4

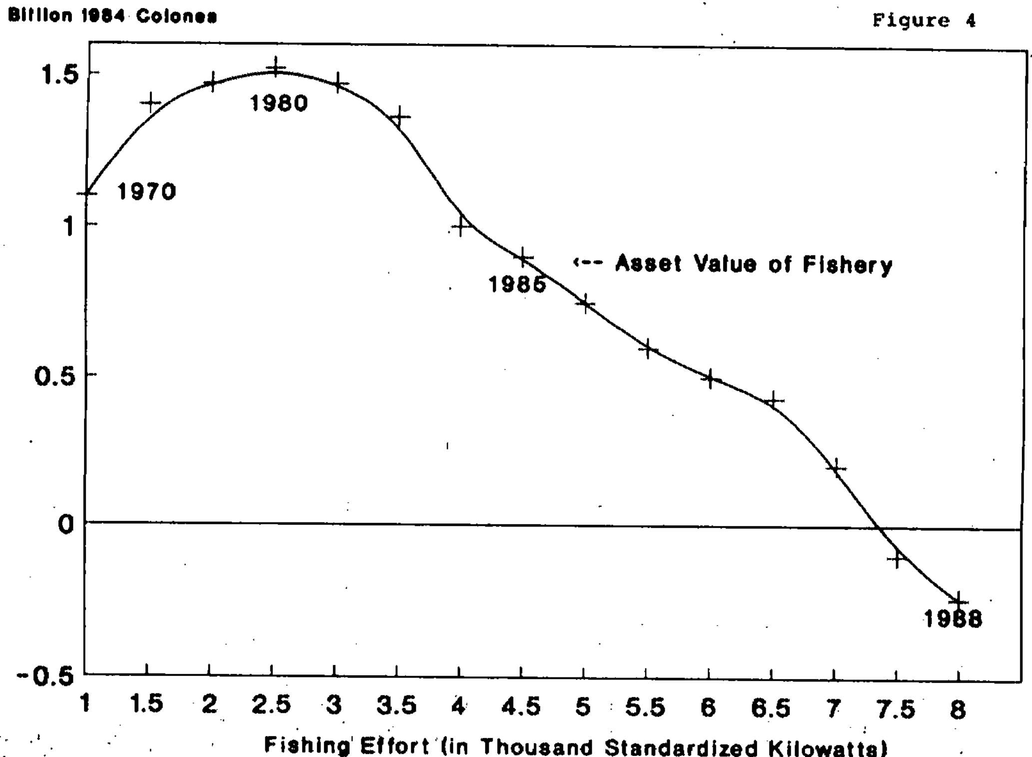
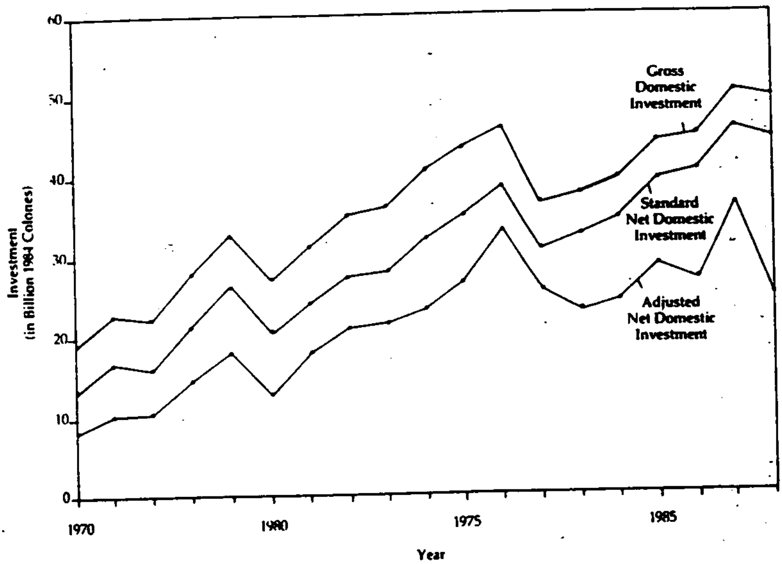


Figure 5 Gross Domestic Investment and Net Investment After Depreciation of Natural and Man-Made Resources



throughout the period. This is a significant difference, in terms of the economy's capacity for further growth and development. Any macroeconomic analysis or plan that ignored it would have been inaccurate.

Over the 1970s and 1980s Costa Rica's national balance sheet deteriorated rapidly as it lost natural resource assets and piled up external debt. The loss of natural resource assets, at a rate averaging 5 percent of GDP per year, greatly outweighed the accumulation of external indebtedness. (The balance of payments deficit on current account and official capital flows averaged about 2 percent of GDP.) Yet, when the economic crisis struck, it was labelled a "debt crisis", not an environmental crisis. IMF missions flew south to stabilize the money supply; nobody proposed a program to stabilize the natural resource base. The accumulation of liabilities was recorded and scrutinized; the much greater loss of assets was unrecorded and ignored.

II. The Response

Many resource-dependent countries, both developed and developing, have recognized the importance of natural resource accounting and compiling accounts. Some OECD countries, such as Norway, started many years ago, especially for the energy sector.

Others, such as Canada and Australia and some of their provincial governments, have begun more recently.

In the developing world, many countries have also recognized how vital these accounting changes are for them. The new administration in Costa Rica has incorporated natural resource accounting into its work program. WRI is aware of other accounting studies underway in the Philippines, Indonesia, China, Malaysia, Papua New Guinea, India, Mexico, El Salvador, Bolivia, Chile, and Brazil. At a recent conference WRI organized in Vancouver to foster communication among countries engaged in such analysis, many delegates spoke of the need for a standard methodology and technical assistance, looking to the UN Statistical Office to provide this leadership.

USAID, in response to earlier Congressional directives, has begun to provide support for natural resource accounting studies. It joined the Netherlands and Canadian development assistance programs and a private foundation in supporting the Costa Rican effort. AID is also supporting natural resource accounting in the Philippines and El Salvador, to my knowledge. A more systematic and widespread effort would clearly be possible.

The World Bank so far has taken only tentative and experimental steps to explore natural resource accounting. It has supported very limited studies, budgeted at approximately $30,000 apiece in Mexico, Papuan New Guinea, and perhaps one other country. It has also organized some conferences on the subject and published a set of conference papers. The World Bank has not provided systematic support to countries attempting to reform their accounts, nor has it yet incorporated natural resource accounting into its own country analytic work.

Neither the regional development banks nor the IMF, to my knowledge, have taken concrete steps to support natural resource accounting or assess its implications for their analyses and programs.

The United Nations Statistical Office and Statistical Commission are key institutions in this area, because countries, including the US, increasingly conform to the UN System of National Accounts (SNA). These institutions have been involved for the past two or three years in a periodic revision of the SNA. They are apparently planning <u>not</u> to make the changes indicated above in the GDP, national income, and investment accounts to treat natural resources consistently as economic assets.

This is unfortunate for several reasons. First, the SNA is now seriously flawed, misleading and inconsistent in this area. It is inconsistent because in the <u>stock</u> accounts within the SNA, the national asset and liability (balance sheet) accounts, such natural resources as timber, land, and sub-soil minerals are indeed treated as economic assets. Rules of accounting and valuation are set forth for the <u>stock</u> accounts that are fully in accord with those used in natural resource accounting studies. However, those same rules are ignored in the <u>flow</u> accounts, recording income and expenditures within a period. This violates a fundamental accounting identity, that the difference in a stock between two points in time must equal the net flow in the intervening period. (E.g., the difference in a person's net worth at the beginning and the end of a year equals the person's net savings during the year.)

In practical terms, this means that if Costa Rica had compiled national balance sheets in 1970 and again in 1988, conforming to current SNA rules, it would have found that natural resource assets worth one year's GDP had disappeared by 1988. But in none of the national income accounts for the years between 1970 and 1988 would there be any trace of disinvestment, capital consumption, depreciation to indicate that this loss was ongoing. This is both inconsistent and misleading.

Instead of making necessary revisions in the SNA, the UN Statistical Office is compiling a manual of methodological guidelines to assist those countries that wish to compile "satellite" natural resource and environmental accounts to do so. As an experienced UN official once explained to me, this is a compromise that enables the UN to assure those constituents who resist change that nothing will be changed, while assuring constituents who want action that they are taking steps to correct the problem.

A manual for satellite natural resource accounts is a step in the right direction but is unlikely to have much effect. For one thing, because of chronic budgetary and manpower shortages, few statistical offices can afford to work on satellite accounts. They can barely produce adequate "core" accounts. For example, few countries now produce national balance sheets, although they are already satellite accounts within the System of National Accounts. Countries with adequate statistical and budgetary capabilities to produce satellite accounts are usually among the richer countries (e.g., Germany and the Netherlands), in which the problems of resource degradation are not so acute.

For another thing, the experience with satellite accounts to date, in such countries as Norway, is that they have little effect on analysis or policy. They are ancillary tables published "in the back of the book" and don't affect the widely quoted and analysed statistical aggregates such as national income, GDP, and the investment rate. Thus they attract little attention. A change in definitions governing the treatment of natural resources in the core accounts would be much more effective.

Also, the UN manual makes no distinction between steps that could be taken now, without fundamental changes in accounting methodology and considerable new economic research, and more farreaching changes. Making the treatment of such natural resources as soil, timber, and subsoil minerals in the flow accounts consistent with the way they are now treated in the stock accounts of the SNA could be done now. It introduces no new issues of valuation, nor does it extend the production or asset boundary of the SNA. By contrast, other changes discussed in the SNA, such as accounting for the damages of air and water pollution to consumers, would introduce difficult problems of valuing non-market impacts. By lumping such issues together, the Manual implicitly argues for deferring action on them all.

The UN Manual also fails to distinguish between changes of great importance to the developing world, and those of greater concern to industrialized countries. Developing country economies are typically resource-dependent. Yet the accounting framework prescribed for them in the SNA ignores their principal assets. It is a framework based on Keynesian macroeconomics, devised to analyze the business cycle in industrial economies. (Ironically, defenders of the present SNA defend its value for analyzing the business cycle, while virtually the only thing contemporary macroeconomists agree on is that they don't understand the business cycle.)

Advanced countries think of the "environment" primarily as a consumer good (clean air, safe food, etc.), and are concerned with the value of environmental services and pollution damages to consumers. There are substantial problems in estimating consumers' willingness to pay for non-market goods. Developing countries think of the "environment" mainly as a producer good, and are concerned with the productivity and sustainability of natural resource endowments. These problems can best be approached through natural resource accounting.

A feasible and desirable course of action, in my view, would be to take advantage of the upcoming UN Conference on Environment and Development in Rio in mid-1992 to announce a definite timetable for changing the treatment of natural resources in the SNA. A period of three years to hold additional consultations, carry out additional case studies, etc. This would be one significant UNCED achievement, and a concrete step that the US could strongly support in concert with other developed and developing countries.

Should that not be done, we could possibly wait for another twenty years, until the next SNA revision, before the opportunity presents itself again. By that time, of course, many of the natural resources at risk in Costa Rica and elsewhere may well have disappeared altogether.

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PART I. OVERVIEW AND RECOMMENDATIONS

Background

The United Nations System of National Accounts (SNA) is the standard framework for measuring a country's macroeconomic performance. The SNA includes *stock accounts* that identify assets and liabilities at particular points in time, and *flow accounts* that keep track of transactions during intervals of time: purchases of goods and services, payments to wage and profit earners, import payments and export revenues for goods and services, for example. These national accounts have become the basis for almost all macroeconomic analysis, planning, and evaluation. Supposedly, the SNA is an integrated, comprehensive, and consistent accounting framework. Unfortunately, it is not.

Shortcomings of SNA

The present system of national accounts is a historical artifact, heavily influenced by the work of such statisticians as Simon Kuznets and Richard Stone in the 1930s and by the theories of John Maynard Keynes. It reflects the economic preoccupations of their time: the business cycle and persistent unemployment in industrial economies. Because raw material prices were at an all-time low in the 1930s, Keynesian economists paid little attention to natural resource scarcities. Consequently, the contribution that natural resources make to production and economic welfare is hardly acknowledged in the national income accounts. Capital formation is assigned a central role in economic growth theories, but natural resources are not treated like other tangible assets in the system of national accounts. Activities that deplete or degrade natural resources are not recorded as consuming capital. Nor are activities that increase the stock of natural resources defined as capital formation. According to the UN Statistical Office, ". . . non-reproducible physical assets such as soil or the natural growth of trees . . . are not included in the gross formation of capital, due to the fact that these assets are not exchanged in the marketplace" (UN, 1975). [1]

On the other hand, the SNA does classify as gross capital formation expenses incurred in "improving" land for pastures, developing or extending timber-producing areas, or creating infrastructure for the fishing industry. SNA records such actions as contributing to recorded income and investment, although they can destroy--and in Costa Rica manifestly have destroyed--valuable natural resource assets through deforestation, soil erosion, and overfishing.(See Part II, this study.) This loss of capital--as natural resources are used beyond their capacity to recover--is not recorded in the income and investment accounts. The national accounts thereby create the illusion of income development, when in fact national wealth is being destroyed. Economic disaster masquerades as progress.

In Costa Rica, as in many other developing countries, natural resources are the most important economic asset. If sustainably managed, they generate a perpetual stream of diverse and important economic benefits. Forests, fisheries, agriculture, and mines directly contribute 17 percent of income, 28 percent of employment, and 55 percent of export earnings.[2] Yet, the System of National Accounts, recommended by the United Nations to Costa Rica and to the developing world, not only ignores the importance of these assets, but also treats their destruction as an increase in income instead of as a loss of wealth. This distortion conceals from public and policymakers alike the gravity of the economy's deteriorating resource base.

That Costa Rica's natural resources have deteriorated seriously is indisputable, as shown by the figures in this report. But the loss is not reflected in the national accounts. On the contrary, the net revenues from overexploiting forest, soil, fishery, and water resources is treated as factor income, not as capital consumption. Even worse, the accounting system defines the conversion of land suitable only for forests into cattle pastures as a capital investment, even if cattle ruin the soil and the livestock enterprise is neither ecologically nor economically viable.

More than 60 percent of Costa Rica's territory is suitable only for forests. Slopes are too steep, rainfall too heavy, or soils too poor for more intensive uses. Yet, at most, only 40 percent of the land remains under forest cover. By contrast, cattle pasture has spread over 35 percent of the land, when only 8 percent of it is suitable for this use.[3] This expansion of the livestock frontier is squandering the country's natural resources and is draining its financial resources as well. Banks are losing 17 billion colones annually in uncollectible loans to the cattle industry.

As things are going, Costa Rica's commercial forests will be exhausted within the next five years, and the country will be forced to import forest products. Thousands of jobs will be lost, and a source of valuable fuelwood, non-wood products, and wildlife habitat will disappear.(Flores Rodas 1985). Meanwhile, where forests once stood, tons of soil wash away every year from dry, stripped, overgrazed pastures.

The current national accounting system serves Costa Rica poorly because it does not reflect the economic value of lost natural resources. Clearing forests for pasture is classified as investment. The loss of forest capital is simply ignored. Like the national accounts, society, and even forest owners have not recognized that the destruction of a forest today is a loss of income tomorrow. The results are devastating. Investments in unproductive pasture land are actively promoted, and the loss of forest capital is shrugged off. If the loss of potential forest income were taken into account, the true net value of conversion would often be negative--a decline in the value of the nation's assets.

Besides being conceptually flawed in its treatment of natural resources, the SNA is inconsistent. What is recognized as an economic asset in the SNA *stock* accounts is not treated as an asset in the SNA *flow* accounts. The stock accounts, or national balance sheets in the SNA, recognize land, timber, and subsoil minerals as economic assets, to be included in the national capital stock. Ironically, the UN guidelines for valuing natural resource assets in the stock accounts are entirely consistent with those used in this report. That is, the assets' market values are to be used if available; if not, the capitalized value of the stream of rents or net revenues from the asset is to be used instead. (UN, 1977.)

Logically, if a country's national balance sheets at two points in time indicate that a natural resource--say the forest--has been depleted, the flow accounts for the intervening years should show a capital consumption or depreciation allowance. If the forests have expanded, the accounts should show a corresponding amount of capital formation. This reflects perhaps the most basic identity in all of accounting: namely, that the difference in stocks between two points of time equals the net flow in the intervening period. For example, the difference in a person's net worth at the beginning and end of a year equals that person's net savings or dissavings during the year. The UN System of National

Accounts violates this basic accounting identity with respect to natural resource assets.

The inconsistency is highly misleading. Had Costa Rica constructed national balance sheets in 1970 and again in 1989, they would have shown that natural resource assets valued at more than one year's GDP had disappeared during those 20 years. Yet, in not one of those 20 years did the annual accounts of national income, expenditure, savings, and capital formation reflect that ongoing disinvestment. Instead, the accounts show only continuing growth in national income, and a high rate of capital formation, until the economy crashed in the 1980s. The national accounts gave no warning that the basis for continuing growth was being destroyed.

Even after economic crisis struck, it was labeled a "debt crisis," not an environmental crisis. The International Monetary Fund rushed south with programs to stabilize the monetary situation, but nobody spoke of stabilizing the natural resource base. Yet, throughout the previous decade, the depreciation of natural resource assets, as an annual percentage of GDP, dwarfed the balance-of-payments deficit.[4] The difference was that the balance-of-payments deficit and the accumulation of external liabilities was recorded, transparent, and scrutinized. The decumulation of domestic assets went unrecorded, unnoticed, and uncorrected.

Recommendations

The idea of sustainable development, which the World Commission on Environment and Development and the UN Commission on Environment and Development have labored to promote, is undermined by the UN System of National Accounts. In the World Commission's definition, *sustainable development* meets the current generation's needs without depriving future generations. Thus, current consumption must be matched by current earnings, without drawing down the productive assets for generating future income. Income itself, in the standard Hicksian definition, is the maximum consumption possible in the present period that does not reduce future consumption possibilities. Treating the depletion of natural resource capital as current income, as the SNA does, is inconsistent with this definition of income and incompatible with sustainable development. The UN system, as a timely and feasible contribution to the June 1992 meeting in Brazil of the UN Commission on Environment and Development, should announce that this distortion in the treatment of natural resources will be removed in the ongoing revisions to the SNA.

Costa Rica's national accounting system must also be changed so that economic policymakers no longer make misguided decisions based on inadequate and distorted information. Past failures to prevent natural resource degradation have already undermined efforts at development and poverty alleviation. This linkage is still not fully recognized by policymakers, who act as if natural resources were limitless or as if technology can always replace exhausted or degraded resources. Closer dialogue between policymakers and scientists can overcome this simplistic view of the natural environment. An economic accounting system that reflects the true condition of natural resources would provide an essential tool for use in the integrated analysis of environmental and economic policies in every sector of government.

Introducing such an accounting system will require that an authoritative international institution--the United Nations--define a standard, general methodological framework. Most countries adhere closely to the current SNA to increase the international comparability of their economic statistics. In addition, an official statistical agency in Costa Rica must take responsibility for organizing data bases, and a steady flow of information to them. The methodology presented in this report can then be used to confront economic development issues realistically.

TABLE I-1
Depreciation in
Value of Costa Rica's Natural Resources
(million 1984 colones)

	Deforestation			Soil erosion	Over-fishing	
Year	Loss of standing volume	Loss of future harvests	Growth of secondary forests	Total nutrient loss	Loss of resource value	Total
1970	2,997	214	(169)	1,940	--	4,982
1971	4,195	648	(147)	1,875	6	6,577
1972	3,279	409	(128)	1,986	7	5,553
1973	4,003	676	(110)	2,082	5	6,656
1974	4,091	934	(84)	3,180	(6)	8,115
1975	3,871	804	(61)	2,985	(16)	7,583
1976	3,212	512	(40)	2,531	(33)	6,182
1977	3,313	531	(21)	2,553	(65)	6,311
1978	3,407	548	(4)	2,350	(112)	6,189
1979	4,835	1,074	12	2,922	(93)	8,750
1980	4,356	901	26	3,088	(138)	8,233
1981	2,430	205	38	2,831	6	5,510
1982	1,854	35	49	3,120	99	5,157
1983	5,395	1,215	59	2,885	83	9,637
1984	6,010	1,439	68	3,028	166	10,711
1985	6,193	1,535	(35)	3,265	273	11,231
1986	9,224	2,575	(128)	2,497	386	14,554
1987	6,463	1,414	(212)	2,295	562	10,522
1988	14,175	4,003	(288)	2,623	650	21,163
1989	14,326	4,057	(355)	2,576	--	20,604

-- Not available.
Note: Figures in parentheses represent capital formation.

Overview of Results

The Costa Rican natural resource accounting study represents a substantial advance in methodology and data over previous efforts. Estimates of changes in forest cover, mangrove area, and other land uses were based on periodic surveys using remote sensing and satellite imaging. Data on forest type, volume, growth, and composition were based on detailed field studies using the Holdridge Life Zone classification system. Estimates of soil erosion were generated using GIS methodologies and mapping of topography, rainfall, soil type, and land use. The fishery accounts utilized scientific sampling studies of fish populations in the Bay of Nicoya. Thus, the empirical and analytical foundations of the physical accounts were detailed and systematic.

The economic analyses underlying the accounts are also relatively advanced. A detailed stumpage value model was constructed for the forestry accounts to estimate stumpage values separately for hard, soft, and medium density woods according to distance from processing mills, for each year in the period studied. For the fishery accounts, a comprehensive bioeconomic model was estimated econometrically to calculate the change in sustainable harvest levels and resource rents with increasing fishing effort. The accounts for mangrove estimate both consumptive use values (for charcoal and tanning bark) and nonconsumptive use values as habitat for mollusks and shrimp. These economic analyses also represent a significant methodological advance.

This study shows that Costa Rica has been rapidly using up its natural capital. In just two decades, from 1970 to 1989, Costa Rica's forests, soils, and fisheries have depreciated by more than 184 billion colones (US$4.1 billion).[5] (See Table I-1.) This sum exceeds the average value of one year's GDP during this period. The implications of this loss for development cannot be determined with any precision, but, in the simplest analysis, a capital loss averaging 5 percent of GDP a year could easily have reduced the potential growth rate of GDP by 1.5-2.0 percent a year.[6] Since the actual growth rate over this period averaged 4.6 percent, this would represent a 25-30 percent reduction in potential economic growth.

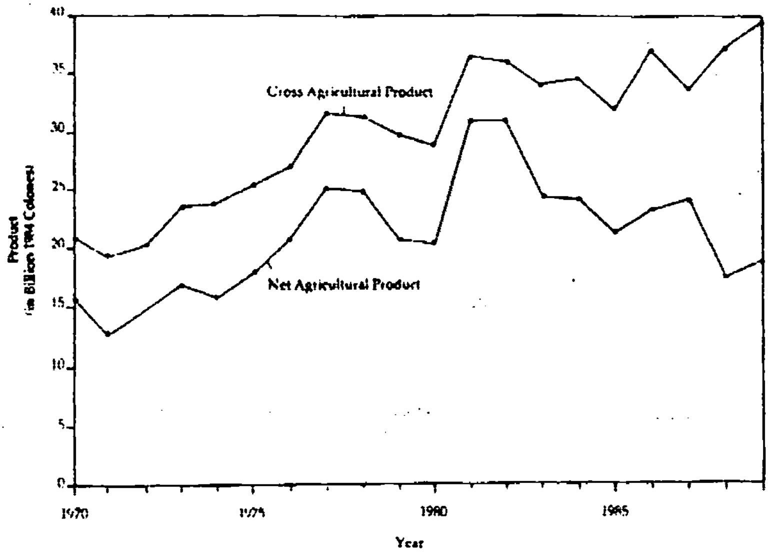
Because Costa Rica's forests, soils, and fisheries were exploited beyond their capacity to recover, these resources deteriorated both in quantity and quality, and their capacity to generate income was consequently diminished. The capitalized value of this income loss was quantified as the estimate of depreciation for each resource in this study. However, only part of the loss could be estimated. For forests, it was only the loss of immediate and future timber value. Other services provided by Costa Rican forests--wildlife habitat, tourist attraction, ecosystem regulator, and supplier of non-timber commodities--are important but their value has yet to be estimated. For soils, it was only the loss of principal nutrients for plant growth because of erosion. Other deleterious changes due to erosion were not captured--soil compaction, nutrient leaching, and other damage to the soil's physical and chemical condition. For fisheries, it was only the value of the principal species in one important fishing area lost through overfishing that entered the accounts. Therefore, the natural resource depreciation estimates presented in this report, large though they are, represent only a fraction of the losses that have taken place in Costa Rica.

The estimates give no reason for optimism that the losses are diminishing. In fact, during the last six years of the study period, from 1983 to 1989, the annual depreciation (in constant prices) averaged 11.2 billion colones, 70 percent greater than the average rate of 6.5 billion colones during the preceding dozen years. The increase is in part due to the increasing cost of deforestation as tropical timber becomes scarcer and more valuable.

Figure I-1 GOES HERE
Costa Rica's Agricultural Product
Before and After Natural Resource Depreciation
(billion 1984 colones)

Soil depreciation costs remained fairly constant at about 2.6 billion colones a year throughout the period. While this is considerably less than the losses of forest resources, it looms large when compared to the value of agricultural production. In a representative year, 1984, soil depreciation costs equaled 9

Figure I-1. Costa Rica's Agricultural Product Before and After Natural Resource Depreciation



percent of value added in agriculture. For some extensive agricultural activities, particularly livestock ranching, soil erosion losses represented a much larger fraction of the value of production.

The depreciation of the fishery resource, though numerically the smallest of the three sectors, is in some respects the most dramatic. The economic value of the resource was totally destroyed by unrestricted overfishing during the study period. If optimally managed, the fishery in the Gulf of Nicoya could have generated about US$2 million in annual resource rents. Instead, excess fishing pressure, mainly from underemployed rural workers displaced by economic crisis, had totally eliminated these returns by 1988. The fish biomass and the harvest both fell as fishing pressure continued to increase. Artisanal fishermen, already among Costa Rica's poorest workers, by that time were earning little more than welfare payments for their efforts.

TABLE I-2
Gross and Net Domestic Product
Net of Natural Resource Depreciation

Year	Gross domestic product (GDP)	Conventional capital consumption allowance (CCA)	Conventional net domestic product (NPD)	Natural resource depreciation. (NRD)	Adjusted net domestic product (NDP)	N.R.D. / G.D.P.
1970	93,446	5,951	87,495	4,982	82,513	5.3
1971	94,382	5,947	88,435	6,577	81,858	7.0
1972	100,912	6,186	94,726	5,553	89,173	5.5
1973	116,525	6,503	110,022	6,656	103,366	5.7
1974	122,740	6,481	116,259	8,115	108,144	6.6
1975	125,393	6,655	118,738	7,583	111,155	6.1
1976	132,310	7,188	125,122	6,182	118,940	4.7
1977	143,990	7,394	136,596	6,311	130,285	4.4
1978	153,124	8,035	145,089	6,189	138,900	4.0
1979	160,598	8,571	152,027	8,750	143,277	5.5
1980	161,894	8,529	153,365	8,233	145,132	5.1
1981	158,237	7,511	150,726	5,510	145,216	3.5
1982	145,932	5,847	140,085	5,157	134,928	3.5
1983	154,481	5,029	149,452	9,637	139,815	6.2
1984	163,011	4,862	158,149	10,711	147,438	6.6
1985	169,299	4,694	164,605	11,231	153,374	6.6
1986	177,327	4,408	172,919	14,554	158,365	8.2
1987	186,019	4,651	181,368	10,522	170,846	5.7
1988	207,816	5,301	202,515	21,163	181,352	10.2
1989	231,289	5,323	225,966	20,604	205,362	8.9

Note: Gross Domestic Product values from Banco Central de Costa Rica (Estadísticas 1950-1985, San José, Costa Rica) and unpublished data were converted to constant colones. The GDP deflator used was taken from International Monetary Fund, *International Financial Statistics* 20:14 (15 July 1991). Net domestic product was developed in this study.

The macroeconomic implications of resource depletion would be obvious if these resource accounts were integrated into the national income accounting framework. The appropriate adjustment would be to subtract from GDP the value of resource depreciation from GDP along with the conventional capital consumption allowance (on account of tangible reproducible capital) to calculate an adjusted estimate of net domestic product. (See Table I-2.) Over the period, natural resource depreciation grew at an average rate of 6.4 percent a year. Though at the outset smaller in value than the estimated capital consumption allowance for buildings and equipment, by 1989 natural resource depreciation had become three times as large. As a percentage of GDP, it grew from 5-6 percent in the early years to 8-9 percent in the most recent years. The growth rate of net domestic product fell from an average of 4.9 percent a year to 4.7 percent when natural resource depreciation is subtracted.

TABLE I-3
Gross and Net Domestic Capital Formation After Depreciation of Natural Resources
(billion 1984 colones)

Year	Gross domestic capital Formation (GDCF)	Conventional capital consumption allowance (CCA)	Conventional net capital formation (NCF)	Natural resource depreciation (NRD)	Adjusted net capital formation (NCF)	NRD / GDCF
1970	19,191	5,951	13,240	4,982	8,233	0.26
1971	22,969	5,947	17,022	6,577	10,445	0.29
1972	22,228	6,186	16,042	5,553	10,489	0.25
1973	27,958	6,503	21,455	6,656	14,799	0.24
1974	32,819	6,481	26,338	8,115	18,223	0.25
1975	27,136	6,655	20,481	7,583	12,898	0.28
1976	31,308	7,188	24,120	6,182	17,938	0.20
1977	34,946	7,394	27,552	6,311	21,241	0.18
1978	35,925	8,035	27,890	6,189	21,701	0.17
1979	40,654	8,571	32,083	8,750	23,333	0.11
1980	43,375	8,529	34,846	8,233	26,613	0.19
1981	45,931	7,511	38,420	5,510	32,910	0.12
1982	36,212	5,847	30,365	5,517	25,208	0.14
1983	37,356	5,029	32,327	9,637	22,690	0.26
1984	39,300	4,862	34,438	10,711	23,727	0.27
1985	43,830	4,694	39,136	11,231	27,905	0.26
1986	44,704	4,408	40,296	14,554	25,742	0.33
1987	50,335	4,651	45,684	10,522	35,162	0.21
1988	49,518	5,301	44,217	21,163	23,054	0.43

Source: National Income Components; Banco Central de Costa Rica, Estadísticas 1950-1985, Division Económica, San José; and unpublished BCCR data. Capital formation data available only up to 1988.

Figure I-2. Gross Domestic Investment and Net Investment After Depreciation of Natural and Man-Made Resources

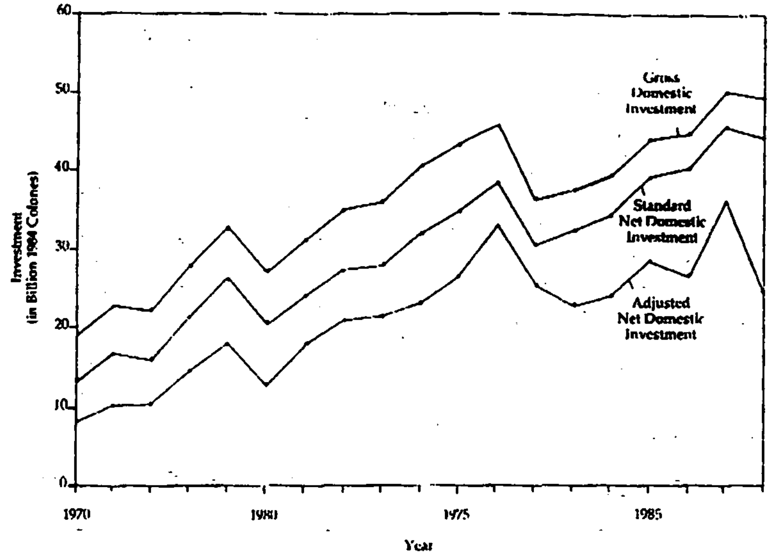


Figure I-2 Gross Domestic Investment and Net Investment After Depreciation of Natural and Man-Made Resources

Still more drastic are changes in the investment accounts. (See Table I-3 and Figure I-2.) Natural resource depreciation rose from 26 percent of gross capital formation at the beginning of the period to 42 percent at the end. The conventional accounting framework thus overstated actual net capital formation in the Costa Rican economy by more than 45 percent in 1988, by ignoring the disappearance of Costa Rica's most productive assets--natural resources. An accounting system so misleading about an economic process as important as capital formation can be of no use for economic analysis, planning, or evaluation.

Natural resources are disappearing with increasing speed, but national policymakers are not yet considering the implications for future economic productivity. The situation can be reversed if corrective environmental and economic policies are enacted. This is unlikely to happen unless leaders are provided with information that genuinely reflects the relationship between economic development and the natural environment and shows how the abuse of natural resources impoverishes the country. Costa Rica's wealth lies in its people, its land, its forests, and the surrounding seas. The economic "development" programs carried out to date have sacrificed three of these resources.

SENATOR GORE. Thank you very much. Very interesting statement. Both of them very interesting statements.

Just to follow up on one of your last comments, Dr. Repetto, about the UNCED Conference in Brazil next summer, you heard my exchange with the last panel. What is your reaction to that exchange, and how could we get the Administration to take the approach that you're recommending here?

DR. REPETTO. Well, it seems increasingly that achieving some important and specific results at this conference is quite difficult.

SENATOR GORE. In the area of accounting?

DR. REPETTO. In general.

SENATOR GORE. But you were referring to accounting, weren't you?

DR. REPETTO. With respect to accounting, I think this is one area where it would be feasible to get a significant and meaningful agreement, one to which the North and the South, the East and the West could agree, which would make a big difference.

I would think that the Administration would be eager to find some such measure that they can support and promote and that would lead to real accomplishment in that UNCED meeting.

SENATOR GORE. Do you think it's going to happen?

DR. REPETTO. I'm not sure.

SENATOR GORE. Do you have any thoughts on that, Dr. Peskin?

DR. PESKIN. Not on what the U.S. position is. But I understand that one of the interests that the Indonesians have in this project that we're getting underway in Jakarta is that they may well base their presentation in Brazil on resource environmental accounting.

SENATOR GORE. Indonesia might?

DR. PESKIN. Yes. It's one of the reasons that they're interested in the project.

SENATOR GORE. Very interesting. Well, they're not going to base it on their forest plan, that's for sure.

Have either of you looked at Haiti in this context?

DR. REPETTO. No, I have not, no.

DR. PESKIN. At one time, I looked at a World Bank request for a proposal to work down in Haiti, but it did not look like the most conducive environment for doing this kind of research.

DR. REPETTO. I know what one would find though. One would find an overwhelming loss of natural resource capital in the form of soil erosion and deforestation.

SENATOR GORE. Yes, of course. But I was interested for two reasons.

One, the current turmoil there has called attention, again, to the desperate circumstances of the people who live there, who are really in a worse situation than almost anywhere in this hemisphere.

And, indeed, if you look at the aerial photographs of Hispaniola, the boundary line between the Dominican Republic and Haiti is so clearly demarcated by the environmental devastation on the Haitian side of the border and a lesser amount of devastation on the Dominican Republican side. There's no place in the world that I'm aware of where a national boundary is so stark an indicator of the devastation that has taken place in the environment.

Haiti used to be called the Pearl of the Antilles, because it was the most luscious, most diverse, richest in life. And now they're trying to farm rocks. And it seems to me that the current turmoil and the earlier immigration to the United States was caused as much by the environmental devastation as by the political turmoil.

But with that as background, it seems to me that it would be an interesting case to look at prior efforts by the international community to rescue the economy of Haiti, and to assist them in their efforts to escape from this dilemma, and see to what extent those efforts have themselves buttressed and, perhaps, even magnified the degree of resource stripping and environmental devastation that has come about there. But that will have to wait for another day.

Now, the U.N. revision is supposed to wind up in 1993.

Dr. Peskin, do you think the problems that you are concerned with can be worked out by then in time for more than just satellite accounts to be established?

If so, what kind of effort would be necessary?

DR. PESKIN. I don't think a lot of the accounting problems that I work on are going to be resolved by then.

I also think it's extremely difficult to resolve them in the format that the U.N. Statistical Office is promoting. It is, indeed, based on the SNA, but it's based on a kind of rather elaborate formulation of the SNA, which is very information-intensive.

An awful lot of information would be required, some of which we would find very difficult to get even in this country. And so I'm a little bit skeptical of the ability to implement the system that they've been talking about in its full garb.

SENATOR GORE. So, you would disagree with Dr. Carson's approach to this?

DR. PESKIN. Well, I think it depends on what you mean when you say the SNA. The SNA can mean a lot of things. And if we're talking about the overview that the SNA provides—the summary type accounts—I think that's quite feasible, but that's not a great departure, except in technicalities, from what we do in this country now.

I think the problem is getting involved in the SNA matrix structure, which essentially requires a tremendous amount of information that we would have difficulty putting together in this country.

SENATOR GORE. Give me an example.

DR. PESKIN. I might know, for a particular sector, its generation of pollution. And I also might know overall its expenditures on pollution abatement. These are elements that you would need for the matrix system.

But they have to go further in that you have to able to break down the expenditures by delivering sector. You would have to know exactly which sector provided the valves, which sector the instruments, and so on. Sometimes, you just don't get the information in that kind of detail.

It is the same story with the damages that the sector might do. You would have to be able to identify all the other sectors that are on the receiving end of the damage. Sometimes, you just don't know that much detail. You just know that there's so much pollution coming from the sector. Often, its damage is really a function of what other sectors are doing.

So, the kind of additivity that's assumed in the matrix structure may, in fact, not be very realistic. I think it also would be very hard to implement. That's why I'm interested in the Mexican and Papua New Guinea studies, because it would at least force them to try to implement their system in a real world situation. But I am a little bit skeptical.

SENATOR GORE. Dr. Repetto, you think the SNA, as it's currently pursued, is just mistakenly formulated. Is that right?

DR. REPETTO. I think, in its treatment of natural resources, yes. Straight-out, not only is it mistaken, it's not even consistent, as I said.

Within that realm, we're not talking about the nonmarket effects. Even in the treatment of land, which is bought and sold, and timber, which is bought and sold, and minerals. They do not treat natural resources as they ought to, as economic assets.

And there's a history to it. We know why this has evolved. But it's counterproductive. It's not helpful either for scorekeeping purposes or for management purposes. All of macroeconomic analysis is based upon these accounts. I mean, if you are off that far in your measurement of such important economic variables as investment, capital stock, capital formation, income growth, value added, then, how can one possibly manage the economy sensibly? Yes, I think it's badly mistaken for natural resources.

SENATOR GORE. Go ahead, Dr. Peskin.

DR. PESKIN. I just want to point out also that it's also defective in its treatment of other kinds of assets, as well. There's an awful lot of work to be done on the SNA, even outside of the natural resource sector.

For example, consider the treatment of consumer durables, which is now treated as consumption rather than investment. This clearly is a weakness. The treatment of human capital is not consistent—education is considered consumption and not human capital investment. Household production is often not measured at all. And, yet, in certain countries, half of all economic activity, if not more, is taking place within the household sector.

So, there are a lot of other problems, as well. And I guess for that reason, maybe going back to your question about whether things are going to be done or fixed by 1993 with SNA revisions, I'm——

SENATOR GORE. You're not holding your breath?

DR. PESKIN. I'm not holding my breath.

SENATOR GORE. What would you do instead, Dr. Repetto? How would you approach it?

Dr. Repetto. Well, you know, sometimes, the statisticians take refuge in this argument: There's so much to fix that we just can't start anywhere.

And I don't buy that. I think some things are doable. And I think the things that we've outlined today are doable.

We're going to continue to use the macroaccounting framework. As you and Senator Sarbanes said, it's the principal economic tool that we have.

We can make it better. You know, the resources that it would take to work on this are paltry in an overall economic framework. We could afford to have a task force working on reforming the treatment of natural resources in the SNA.

We have task forces working on reforming the treatment of education. And we should be doing it. So, I would not do anything instead. I would do it.

Senator Gore. Go ahead.

Dr. Peskin. Excuse me. I guess I have two points. One is that the Bureau of Economic Analysis did have an effort for many years where they were looking into these areas, not as much into the environmental areas, but certainly into resource areas and into government capital and human capital areas. That program was started under Eliot Richardson, but ceased with the Reagan Administration.

Second, I think that it's quite feasible—I want to join with Bob on this—to get something underway. For example, the pilot project on the Chesapeake Bay Region cost probably in the neighborhood of $100,000. I mean, it's not overwhelmingly expensive.

Basically, one of the things that you have to realize is that a lot of the data you need for your ordinary economic accounting is not all that different from the data that you need to make these changes. It's not as if you have to go out and start new surveys.

Senator Gore. Yes. But with regard to accounting for energy-related resources, is it true that some countries, like Norway, have been making strides in accounting for resource depletion? You had a role in that, didn't you, in Norway?

Dr. Peskin. I did the first Norwegian report on that in 1971, while I was an employee—consultant, actually—to the Norwegian Central Bureau of Statistics.

That's when they essentially started that effort. And they've been going down the road since, with some ups and downs, as Bob has pointed out. But they have quite a lot of experience in doing resource accounting, and they find it very practical and useful for their economic planning.

Senator Gore. Well, rather than resource depletion, are you aware of any countries or any states in our own country that have made strides in accounting for the atmospheric pollution that results from the use of those resources?

DR. PESKIN. Well, again, I'll just mention Norway. Norway also does maintain a physical record of atmospheric loadings—a pretty good data series. Certainly, the U.S. Environmental Protection Agency has quite a lot of data on atmospheric pollution and on loadings to the environment.

The problems have always been, while there's a lot of scientific information out there, is a lack of information on the linkage between human activity and the scientific data. It's just like with the Chesapeake. There is a tremendous amount of biological information and information on the condition of the Bay, but it's extremely difficult to link that information to human activity. So, you're never quite sure whether the condition of the Bay is due to human activity, to EPA policy, or to a heavy rainfall.

And while I think that this is where there is the biggest data gap, hopefully, if you have a good accounting system, it forces the required integration. You can't get away with not trying to make that linkage between human activity and the scientific findings.

SENATOR GORE. I'm given to believe that some states have made a little progress in this area. For example, New York and some other states do recognize least-cost planning that includes a cost for CO_2 emissions.

Are either of you familiar with that?

DR. REPETTO. Yes. And it's a good try. It's certainly a step in the right direction. My understanding is that they have been forced to adopt fairly crude surrogates.

SENATOR GORE. Yes.

DR. REPETTO. For the numbers that they want, which are pollution damages, and in some instances have adopted the cost of pollution abatement, which is something else altogether.

SENATOR GORE. But do you believe that accounting for atmospheric pollution is possible?

DR. REPETTO. Yes.

SENATOR GORE. Anywhere you see it happening where you like it?

DR. REPETTO. Well, there's one study that we did that I kind of like.

DR. PESKIN. I've done one, too.

[Laughter.]

DR. REPETTO. We did a study that I hope there will be a chance to discuss at some point on productivity measurement.

SENATOR GORE. We're going to look at that issue later in this series of hearings.

DR. REPETTO. But it is an example of bringing in the air pollution damages from electric power within an appropriate accounting framework.

SENATOR GORE. I'm familiar with your study on that, yes.

DR. PESKIN. I did a pilot study, first at the National Bureau of Economic Research, and then with other funds provided by other agencies, when they saw the value of the data. It was an effort to make these environmental accounts for the United States as a whole.

As part of that accounting effort, we did look at air pollution benefits and costs on a national basis. In fact, we're able to make some estimates of the distribution of those benefits and costs, both geographically and by income class. That's in the published literature. We think that the accounting effort had some important policy results. Those of us who worked on it feel that maybe we had some influence on getting EPA and Congress to look more closely at nonpoint sources of pollution—that is, pollution from areal sources. The accounts showed that half of all the water pollution damage in this country probably comes from nonindustrial sources—from agricultural sources and urban runoff.

SENATOR GORE. What are your near-term recommendations for the United States in terms of integrating natural capital into its own national accounts?

Both witnesses.

DR. PESKIN. Do you mean just resource capital? Or environmental capital, or human capital?

SENATOR GORE. Natural.

DR. PESKIN. Natural capital.

SENATOR GORE. Yes.

DR. PESKIN. What are my recommendations in the near-term?

SENATOR GORE. Yes. For integrating natural capital into the U.S. Government's own national accounts.

DR. PESKIN. Well, I'd like to see the program or something like the program that did exist in BEA. I'd like to see that program resurrected because it covers some of the major elements of an accounting program.

A lot of the techniques that Dr. Repetto has applied have their origins in the work of Landefeld and Hines, which was done as part of that program. I would like to see the effort started again, to seriously try to get a consistent measure of national wealth or national assets, consistently linked with the increases and decreases in those assets.

SENATOR GORE. Dr. Repetto?

DR. REPETTO. I would make two points.

One, since we are moving toward the SNA, we can't do it unless the SNA is also changed appropriately if we're going to conform to the SNA. So, I think that the U.S. Government ought to be more strongly urging a quick resolution of the issue in the United Nations Statistical Commission.

Second, in terms of our own activities, I got the impression from listening to the previous testimony that there is a willingness within the Department of Commerce to move ahead. There doesn't seem to be any strong opposition in the private sector or elsewhere, certainly not in the environmental community, to moving ahead rapidly. The obstacles seem to be largely staff and money.

So, it would be constructive to have an adequately funded and staffed program with a definite timetable for making these changes. It seems to me that would be effective at this stage.

SENATOR GORE. How can the United States facilitate a natural resource accounting proposal for the UNCED conference in Brazil? We talked about this a little bit before, but I'm not sure that I understood your response.

DR. PESKIN. Well, I'm not sure I understand the UNCED process either, frankly. Are we, the United States, on the agenda on certain preparatory commissions?

SENATOR GORE. Yes.

DR. PESKIN. If we are represented in those preparatory commissions and also in the general secretariat, and so on, we could be putting forward that proposal. We could also recommend other channels, such as the UNCED.

SENATOR GORE. But we're not.

DR. PESKIN. It doesn't seem to be happening, that's right.

SENATOR GORE. It seems like a very high opportunity cost we'd be paying if we let Brazil '92 pass by without addressing the issue there.

I was going to ask about ways to further worldwide integration of economic and environmental indicators. And you'd bet your chips on the SNA.

DR. REPETTO. I think it's fundamental.

SENATOR GORE. Yes. Do you agree with that, Dr. Peskin?

DR. PESKIN. Well, in a sense, I do. I think that if you look at what's happening with the SNA worldwide, at the present, countries end up doing what they want to do.

There are the standard SNA recommendations. But some years ago, I believe it was Derek Blades, now with the OECD, who did a survey of what developing countries were doing with respect to the standard SNA. We weren't talking about nonstandard environmental accounting. And if I recall, half or more of the countries surveyed were doing things that were quite at odds with the standard SNA. I think we have to recognize that countries will do what they see in their best interest to do.

SENATOR GORE. What those in power see as their best interest.

DR. PESKIN. Well, that's right. And, you know, I'm not totally unsympathetic with that view, because data development is not costless, and I think countries do have to make choices.

It may be in the interests of the United Nations to have standardized statistics so that they can compare one country to another. I understand that motivation. Yet, if it comes at a cost where the country is not getting information, which it really needs to function, I can understand this country departing from the SNA.

The biggest change has to do with subsistence activity. And that is that——

SENATOR GORE. Household income.

DR. PESKIN. ——household activity. Now, the SNA revisioners are making some recommendations along those lines. But I understand they're very weak. One recommendation was that household production would be included if the goods being produced had a direct market counterpart. But that meant no services. So, for example, if a household provided any day-care services, that wasn't going to be included.

I understand even the recommendation for including goods may not be in the final set of recommendations. Now, this is not very meaningful for, let's say, a low-income African country.

SENATOR GORE. Let's say that I'm a low-income African country that wants to change their system of accounts, but I don't have the money in my budget. Where do I look? Where do I go? If I believe it's important, how do I remedy that problem?

DR. PESKIN. Well, I think you can get the money. I have much less experience in this than Bob does. But I have found, in my very limited experience, that U.S. AID missions do seem to respond to requests that come from the country governments. And if a country government really came into a U.S. AID mission and said we want X-thousands of dollars in order to set up a decent statistical program, I think they would get the money.

SENATOR GORE. Well, I'm not sure. I'm still speaking as that small country—I'm not really convinced that I need it. Would it make sense for you, the United States, to convince me that I should do this?

DR. PESKIN. Well, essentially, this is the genesis of the projects we have in the Philippines, the U.S. AID project in the Philippines, and the one we're getting underway in Indonesia. They are serving somewhat as a demonstration purpose.

But for these projects to be successful, we did have to get the agreement and the cooperation of the respective governments. So, it's a little bit tough. If a government really says they have no interest at all in statistics, it's very hard to get them to change their ways unless you have a lever. Like you say, we will give you X-millions of dollars for an irrigation program, providing X-fraction goes into statistical data development.

Now, that's a possibility.

SENATOR GORE. You're not about to propose a debt for statistics swap, are you?

[Laughter.]

DR. PESKIN. No. But I do think that there are some levers that we could use as part of our assistance programs to try to beef up some statistics. I mean, some countries are terrible, even with their conventional economic data. I was shocked to see the quality of statistics in the Cameroon, for example. Really, the ordinary GNP statistics are just terrible.

SENATOR GORE. Dr. Repetto.

DR. REPETTO. I would add that I think the directives to AID to support this kind of work have been effective. You know, from Washington to the missions, the word has gone out. And I believe that that is partially an explanation for the increasing willingness or eagerness of the AID missions in the field to even support these. I know that the climate is different now than it was several years ago when we sought support for these.

And within the developing country governments, our experience has been that those responsible for environmental and natural resource management strongly advocate these sorts of changes in these sorts of studies for the obvious reasons. I mean, they have to go in to the Cabinet and argue for resources, to argue against destructive projects or policies. And they feel that they need the kind of documentation within the framework of economic analysis. They have to be able to put this in terms of costs. So, in each of the countries where we've worked, the ministries for natural resources and environment have been strongly supportive. And as Henry says, Indonesia may, indeed, base its UNCED participation on this. So, it's always the internal policy debate that's relevant.

SENATOR GORE. Is there any role for NGOs and foundations in assisting specific countries like this hypothetical African country that we were discussing a moment ago, to adopt this new way of accounting?

DR. REPETTO. Have been and are. I mean, we're an NGO. We've received foundation support from more than one foundation to enable us to do this work.

SENATOR GORE. Now, you've been in Indonesia. You've been in Costa Rica. Anywhere else?

DR. REPETTO. We've been in China. We have—

SENATOR GORE. With marked effect?

DR. REPETTO. Well, actually, it was very interesting. The Chinese did a tremendous amount of work, and have compiled a set of accounts for 12 of their major sectors—energy, soils, forests, water, etc. And they gathered together a team from some 31 different agencies to do this tremendous amount of work. What was striking about this is the difficulty that they have in deciding what is an asset. A natural resource asset or any other kind of asset.

SENATOR GORE. Okay. Let me ask just one more question, and we'll conclude the hearing for today. And I'd like both of you to respond to this.

I'm interested in specific examples of counter-productive policies that were based on seriously incomplete and/or inaccurate economic indicators.

DR. REPETTO. Let me take a whack at that. I gave you one for Costa Rica and the IMF.

SENATOR GORE. Yes.

DR. REPETTO. There are others in Costa Rica. For example, much of the deforestation was for pasture development. And much of that expansion of the livestock industry was financed through long-term credits, backed by loans from the multilateral development banks.

Now, you know, that expansion of the livestock sector was thought earlier in the 1970s to be a highly profitable undertaking in Central America. Had they taken into account the asset losses from soils and forests that would accompany that expansion of pastures, it would have been unprofitable. That's one example.

In the fishery sector, they have wiped out a major fishery through overfishing. The government has subsidized the expansion of that fishing effort by subsidizing diesel fuel and motorization of the small-scale fishing fleet.

And that's happened all over the world. You mentioned agriculture in the United States. We've done a resource accounting study in U.S. agriculture, comparing the economic returns to conventional, high-input farming methods versus sustainable agricultural techniques for sites in Pennsylvania and Nebraska.

The results were that in the East Coast, where all the watersheds run into the Chesapeake Bay—where soils are shallow—organic and low-input sustainable agricultural techniques are more economical.

SENATOR GORE. Right.

DR. REPETTO. The thrust of our current farm commodity programs is to give the highest level of support to the crops with cropping patterns and rotations that are the most erosive and environmentally damaging. And also which, if you did the accounts correctly, are the least economical. If you trace that one step backwards, 95 percent of our agriculture research budget goes into the support of high-input intensive farming.

And what is almost unbelievable is that despite 75 years of research support for high-input agriculture, we can still go out there in the field and make a comparison, and find that organic and low-input farming, which has been almost completely ignored, is still more economical.

So, there has been, in our agricultural sectors, a history of mistaken policies, based on an improper accounting of the costs and benefits of different agricultural methods.

DR. PESKIN. Now, I don't have any examples of the adverse effects of incorrect, gross scorekeeping measures, such as the GNP or NNP. But I do have examples of management failure, due to not having the good supporting data that you would get out of an accounting framework. Again, the first study I did was in the United States where we were trying to trace all the economic activity and its impact on the environment.

You'll find situations, for example, in Houston, Texas where there was more heavy metals and toxics coming from street runoff than from all industries.

SENATOR GORE. Than from what?

DR. PESKIN. Than from the industries in the city. In terms of actually what was making it into the watershed. We found, as I alluded to earlier, that there was more of the conventional pollutants that were to be controlled under the 1972 Clean Water Act, more coming from agricultural sources and/or from other nonpoint sources than from the total of all industrial sources, including municipal sources.

In terms of international examples, you find in Africa that four to eight times more biomass is being cut for fuel wood than for all commercial timber. Fuel woodcutting is a major household, nonmarket activity.

It's not exclusively nonmarket, but largely it's nonmarket. Policies are being put in place, largely under World Bank pressure, and some people say from pressures from the United States, to get these countries to implement what they call structural adjustment programs. Largely, this often means devaluation of their currencies. And what happens in some of these countries when they devalue their currencies, it raises the price of purchased energy, such as kerosene. Then, they go back and cut more fuel wood. Kerosene is too expensive.

An analysis of that process to figure out exactly what is the relationship between purchased energy prices and fuel woodcutting, with all of the consequent environmental implications of fuel woodcutting, cannot be done within the current data systems we have. We do not collect the data on household activity, such as fuel wood activity. The kinds of comprehensive accounting systems for this management approach that I've been talking about would force you to cover all the activities that interact with the environment for all sectors—production sectors as well as household sectors.

I think there will be other examples. I know of a case in Sudan where there was a major central Sudanese irrigation program, where the opportunity cost of that program was grossly understated because they did not have good data on household production. They drew a lot of labor from animal husbandry, which was not in their accounts because it was a nonmarket activity. This labor went into the irrigation project. Protein intake went down as a result of that project, because nobody was taking care of animals.

So, no one knows for sure whether there would be better policies had they had better accounting, but one would like to hope, if they had the numbers, that somebody would have been able to at least ask the right questions and not assume automatically that because labor is in a nonmarket activity that it's, therefore, free.

SENATOR GORE. Well, very good.

We may have some other questions for the record, again, not many and not lengthy or onerous, but if you'd be willing to answer those, it would be appreciated.

[No additional information was requested.]

SENATOR GORE. I think that will conclude today's hearing. We'll continue the series forthwith. But for today, I want to close by thanking you, Dr. Repetto; you, Dr. Peskin; as well as our earlier witnesses, for an extremely interesting session, which moves us much farther along our road, closer to our goal of a better understanding of how we might improve the accounting system in these areas, and better integrate economics and environmental protection.

Thank you very much.

[Whereupon, at 3:16 p.m., the Committee adjourned, subject to the call of the Chair.]

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