PRESENTATIONS

OPENING REMARKS

Amb. Fernando Gonzalez Guyer
Chairman
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I should like first of all to extend a cordial welcome to the participants in this Seminar on Natural-Resource and Environmental Accounts.

I also want to take this opportunity to express our appreciation for the invaluable collaboration and technical support provided by both the Department of Regional Development and Environment (represented by its Director, our friend Kirk Rodgers) and the World Resources Institute (represented by Robert Repetto), without which this event would not even have been conceivable.

I wish to share with you my impression that today we are attending the opening of a truly novel experience. We have gathered a select group of high-level technical experts and representatives of international and nongovernmental agencies around the same table with the people directly responsible for formulating national accounts in more than 30 nations of this hemisphere. As Chairman of the Committee on the Environment, which has sponsored this event, I am gratified to see the OAS serving as the host and venue for such a significant meeting.

As you probably know, the OAS is not a newcomer to environmental matters. As we like to recall, by 1963 the OAS already had a Natural Resources Unit, now the Department of Regional Development and Environment, which for the past 30 years has been providing technical assistance in Latin America and the Caribbean. This means--to give you a general idea of our precocity in this area--that the OAS institutionalized its activities in environmental matters 10 years before the Stockholm Conference. Thus we bring to bear considerable history and experience accumulated over three long decades, which to some degree explains the origins of this unique meeting.

More recently, a very important milestone in this extensive history is undoubtedly the Inter-American Program of Action for Environmental Protection, formally adopted in June 1991 during the OAS General Assembly in Santiago, Chile, which contains a detailed list of objectives and action measures directed to the member states and guidelines for regional cooperation in environmental matters. I have asked the Secretariat to make the text of this Program available to all participants because I think it will be very helpful in providing the broader context of our concerns and activities in this sphere.

As you will see from this document, the third action measure recommends that the member states study "the possibility of revising national accounts in light of the experience of countries that keep national environmental accounts, so as incorporate into them the impact produced by natural resource use." That is to say, this seminar falls squarely within the objectives established in our environmental action plan and represents a very specific contribution to the attainment of the goals that the General Assembly set out in Santiago in June 1991.

Then came the Rio Conference on Environment and Development (UNCED), a monumental event. The documents from that meeting reflect the same concerns. Thus, for example, Principle 16 of the Rio Declaration establishes that "national authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the costs of pollution," a concept that is repeated later in various chapters of Agenda 21.

We are faced, it seems, with a true categorical imperative that assails us from all directions: from regional forums and from the highest universal forum, UNCED, in which all our presidents participated, but also from public opinion and from the nongovernmental organizations that speak for a genuine universal demand to conceive and put into practice new models for development that will allow all of us to enjoy a full life without endangering our very survival on this earth. An individual's lifetime is notoriously brief, as we all know, but the species displays a stubborn longevity.

The central question of this era, and one that echoed throughout the Rio Conference in June of last year, seems to be how to make the transition to a sustainable global future. A sustainable society would be one capable of perpetuating itself for generations--in other words, not one devoted to gorging upon itself, as modern societies seem to be doing with a passion that is surely worthy of a better cause.

It has been said that a sustainable society is (1) a society whose rate of consumption of renewable resources does not exceed the rate of regeneration of ecosystems; (2) a society whose rate of consumption of nonrenewable resources does not exceed the rate of generation of renewable substitutes; and (3) a society whose rate of pollution does not exceed the environment's capacity for assimilating it. This would give us six "rates" or "indicators" to be used more or less systematically in our accounts if we are trying to define with some degree of precision what we mean by a "model for a sustainable society."

The challenge facing us now is to include real environmental costs in economic prices, to "internalize" them, as the Rio Declaration says, and to revise or reinvent the economic indicators so as to avoid confusing costs with benefits and depredation of natural capital with income.

All moderately well-informed citizens of our countries keep up with and understand the trends in macroeconomic indicators such as the "gross domestic product," the "fiscal deficit," the "trade deficit," or the "foreign debt" because they know or at least guess what effect these figures will have on their everyday lives in the medium or long term. Our hope should be that in the not-too-distant future notions like "environmental deficit," "ecological debt," or others that we shall be discovering or inventing in the course of time will arouse the same kind of attention in the public at large with respect to the economic health of our societies and the quality of life of our people, both present and future generations.

The concept of gross national product and the economic accounting related to it are among the most significant inventions of the 20th century. Its political and economic impact are still difficult to gauge accurately. But what is certain is that current accounting systems, starting with the System of National Accounts codified by the United Nations, which gained almost unanimous acceptance and which treats natural resources differently from other tangible goods, merely send the wrong signals to political decision makers by ignoring the destruction of nature in the name of economic progress. Using these accounting methods, a country may appear to be in a state of blissful prosperity even if it is irreversibly depleting the sources of its well-being and seriously compromising its future economic survival.

This is true to some extent for all countries, without exception. Even though since the Stockholm Conference in 1972 more than 100 environmental ministries or their equivalent have been established, even though thousands of laws and decrees have been enacted, even though countless legal instruments have been signed at the global and regional levels and just as many international declarations have been issued, it is still unfortunately true that in all countries, those who are too concerned about the environment are still excluded or isolated from the decision-making process in key areas, particularly with regard to economic decisions.

Explicitly or implicitly, the environment continues to be perceived as a constraint on economic development. Perhaps the time has come to acknowledge fully the substantive difference between the concepts of development and growth, because a sustainable society is, precisely, a society more concerned with development than with growth, much more interested in becoming "better and more complete" and not just "bigger." Under this approach, the idea of the effort to overcome this traditional dichotomy would not be to create a new breed of "environmental accountants" or "natural-resource bookkeepers" operating as a kind of specialized police charged with poking here and there into the national accounts books, but rather to integrate the environment naturally into the economic orbit and the economy into the environmental orbit, not in a spirit of confrontation but rather of perfect harmony--in other words, to establish a new "eco-nomy."

It is for this that we are meeting here in Washington. We are gathered here to begin to design economic indicators for the next century. But it is not my intention, nor is it my place, to broach the technical aspects of the topic, but rather to turn the floor over as soon as possible to the specialists, who will be better qualified to enlighten us as to the long and rocky road that lies ahead.

To conclude my performance of the role assigned to me, I feel called upon to say that the backdrop of this joint effort that brings us together in Washington is fundamentally political. Political in the most genuine and noble sense of the word--a clarification that seems imperative these days, when anything political is universally disparaged. Political as referring to affairs of the "polis," i.e., of the city, the community, and the common good.

This attempt to integrate nature into the economy, and by extension into national accounts, has a profound ethical basis. It requires considerable amounts of ingenuity and technical capacity but, most of all, an enormous amount of solidarity and brotherly love, without which the effort will be meaningless and surely condemned to failure.

The most optimistic among us hold that the world still contains enough energy, materials, money, and environmental flexibility, and above all enough human virtue, that the necessary movement towards that sustainable society we are seeking is still possible. It is now up to us to ensure that the optimists are not proved wrong.

INTRODUCTORY REMARKS

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It is a great honor to me to have been invited to this meeting, because I truly believe that this meeting could not be more critical in terms of contributing substantive elements to the future study of natural-resource and environmental accounts. I should like to suddenly have the gift of eloquence, of being able to say things clearly and succinctly, so that I could tell you how important it is to develop these methodologies, these approaches--in short, this new practice. As the Ambassador said earlier, the real import of this meeting is that today we undertake this task.

I feel deeply honored to share this table with Ambassador Fernando González, who presides over the Committee on the Environment of the OAS Permanent Council and who, as he mentioned, has been deeply concerned with these matters for a long time. I also feel greatly honored to be able to express briefly some views, some theories, on some specific generalities, as colleague said, in the company of Robert Repetto, who is the Vice President of the World Resources Institute, an institution that has lately been doing extraordinary and very interesting work in defense of the environment and biodiversity.

I see this meeting (I may be repeating the Ambassador here) as the beginning of a new phase of work, in which governments and nongovernmental institutions, international organizations both regional and global, seek to take the first steps in the formidable task of inventorying, studying, and evaluating the potential of our environment to ensure that the future use of species, natural resources, and ecosystems will be more equitable and sustainable.

I could perhaps spend a good deal of time describing the experiences I have witnessed both in our center and elsewhere relating to the development of these new methodologies, the search for this new system. But I especially wish to point out that in the absence of adequate information or criteria for valuing our natural resources properly, the national accounts on production and income that most of our countries are now using will inexorably continue to lead us to analyses and evaluations of our economies that do not reflect the true level of sustainability of the economic development process.

It would take me a long time to list all the disadvantages of the current national accounts systems. One omission is that there are no economic indicators to measure sustainable economic growth and economic development in the long term. Conventional economic statistics do not send correct signals to decision makers, including negative and positive consequences, even when the negative consequences to our countries are, frankly, disastrous.

More specifically, natural resources are not considered capital goods that may be subject to depreciation, and therefore the depletion of these resources is not recorded. Secondly, economic indicators do not reflect the deterioration in environmental quality and its consequent effect on human welfare. What is most incredible is that the costs of environmental protection, of preventing or undoing the damage done to the environment, are recorded in such a way that they tend to increase the national product or income--when in fact they represent a social cost that often yields no results in the maintenance of environmental quality until much later.

As has been recalled here, some time ago, in response to this situation, the United Nations Statistical Office in New York, in cooperation with many international agencies and the statistical offices of many countries, initiated what I would call the major effort to formulate methodologies for integrated economic environmental accounting. This effort, which seeks to improve the interrelationship between the environment and development, is in my judgment a great step forward that has been a long time in the making. Nevertheless, it represents only the first step in developing methodologies to better measure the role of the environment as a natural capital resource and also a sink for the by-products of production processes.

Only with these first steps can we later tie these methodologies to the systems of national accounts without modifying the central nucleus of the current system. This indicates, to some extent, that after so many years of effort, so many meetings, and so much discussion, the process is slow-moving and even more time is needed to achieve the proper integration we seek between environment and development.

The current revision of the United Nations System of National Accounts includes a revision of many concepts, definitions, and classifications of environmental accounting. Nonetheless, when I say that the central nucleus of the system has not yet been changed, it is because there is still no consensus on how to incorporate environmental costs and benefits into it. Nor is there a universally accepted method for valuing natural resources in monetary terms. This indicates the objective limitations we often face in our work, which today are leading towards the establishment of a system of satellite accounts that will permit close ties with the national accounts system without altering the basic framework. For this reason, many countries are working on sectoral accounts as a more specific, defined objective that will give policymakers a clear, focused vision in each of the areas of economic activity.

A minimal comment on the present situation, then, is that the status quo is clearly unacceptable and that a fundamental and crucial condition of this new, reformulated system we seek is first of all that it generate statistics on environmental resources. Only afterwards will come the possibility of linking these statistics with the economic and financial statistics. Nothing can be done in our countries without your assistance in first establishing a base of statistics on natural resources and the environment, which is why I believe that this meeting is so critical. The integrated, harmonized system can then be established, once the bases for natural-resource and environmental accounting is in place.

A second point I wish to make is that the most important element of this major effort carried out by the United Nations Statistical Office and all the international agencies and countries that have cooperated in this undertaking is not so much the new mechanisms or techniques it introduces as the new concept of development it represents. On one hand, the concepts involved in this system can undoubtedly make it easier to improve the measurement of the real product in our economies by beginning to take into consideration the scarcity of natural resources and the effect of environmental changes. But on the other hand, they are laying what I would call the bases for a new direction for development, which should now be sustainable not only in the conventional economic sense but in the environmental aspect, which is our greatest concern.

There is another result of these initiatives to establish natural-resource and environmental accounts. All of us have seen that in our countries we usually move to protect the environment after the fact, or when the situation has already become a serious problem. In most cases, our authorities and politicians claim that there was nothing they could have done, when they were not even aware of the economic significance of investing resources in advance because they had no criteria or indicators to show them what this would mean later.

Thus, I would say that establishing an accounting system that begins to take the environment into consideration will make it explicit that failing to address environmental problems now will result in having to do so later, usually with significantly greater effort and expense and often at greater risk of failure. Establishing this accounting system will help us to determine what I would call the high cost of inaction. That is, we will now be able to establish much more accurately the price our societies must pay for doing nothing, which almost always turns out to be quite a bit higher than preventive measures.

For this reason, I am convinced that this is a critical task and that we must set about it without delay. Having said that, I should add that we must particularly bear in mind that when we apply methods to gather and analyze environmental data to track environmental trends and estimate environmental costs, what we are doing is reformulating the bases of economic policy in a manner that now begins to encompass all the effects of development, negative as well as positive. We are, in short, doing nothing less than transforming the bases upon which policymakers take their decisions. We must understand that we are not merely applying new methodologies and tools; we are dealing with the nucleus of a new strategy that, first and foremost, will take biodiversity and environment into consideration and will make our development somewhat more humane.

I should perhaps share with you my persistent observation of recent years that the problem is not so much inaction as inadequacy. That is, there is a dearth of statistics with which to begin the work. This is what I consider the crucial point of this meeting.

What lies ahead basically depends on your will to initiate this task. Thus, the institutions represented here are of the utmost significance in making available to us, before too long, an accounting of our natural resources that will enable us to speak more substantively and

pertinently. I consider this meeting an extraordinarily important occasion because I see here professionals and technical experts from all the countries of the region, which means that in one way or another this issue has reached every corner of the hemisphere.

Secondly, I also find it encouraging to see so many participants, which means that this issue now enjoys strong and substantially more extensive support than it had twenty or even ten years ago. But, even so, it is important to keep in mind, as this meeting shows, that this is not a task just for a handful of intellectuals or for a single government or for one or another national or international agency. This profound change can only be achieved with the participation of all of you. Nothing can be accomplished without the cooperation of each and every one of you and of each of your institutions.

I must confess that I am tremendously pleased that this meeting is being held here at the Organization of American States, because it is our home. Despite having limited resources, as was mentioned earlier, it has participated in and contributed to this undertaking for many years now. But material resources are not all that counts. We have gathered a group of professionals and technical experts who have also worked in these areas, on these issues, for many years and who--which is perhaps even more important--are deeply interested in collaborating to make things better in our region than they were yesterday.

In short, I believe that we are here, as the Ambassador said, because a great change is ahead for us. Not just change for the sake of change. I was reminded this morning of a German poet who said, "To be better I know I must change, but even if I change I do not know whether I will be better." In our case, I would say that, first of all, we need a change that will rescue us from our present antiquated mode of development, which has caused so much poverty and environmental degradation in our countries.

The challenge we face is to succeed, all of us together, in charting the course for this change, in setting a new direction for development in our countries that will be economically and environmentally sustainable: that will go beyond considerations of growth, investment, employment, balance of payments, and many other indicators that do not always represent the natural resources or the life of our countries. What we must do now, in fact, is incorporate our biodiversity--our rivers, our forests, our natural resources, in sum, the entire generous planet that sustains life for current and future generations.

WHAT CAN POLICYMAKERS LEARN FROM NATURAL-RESOURCE ACCOUNTING?

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I. THE NEED FOR NATURAL-RESOURCE ACCOUNTING

Whatever their shortcomings, and however little their construction is understood by the general public, national income accounts are undoubtedly one of the most significant social inventions of the twentieth century. Their political and economic impact can scarcely be overestimated. However inappropriately, they serve to divide the world into "developed" and "less developed" countries. In the "developed" countries, whenever the quarterly GNP figures emerge, policymakers stir. Should they be lower, even marginally, than those of the preceding three months, a recession is declared, the strategies and competence of the administration are impugned, and public political debate ensues. In the "developing" countries the rate of growth of GDP is the principal measure of economic progress and transformation.

The national accounts have become so much a part of our life that it is hard to remember that they are scarcely 50 years old. They were first published in the United States in the year 1942. It is no coincidence that the period during which these measures have been available, with all their imperfections, has been the period within which governments in all major countries have taken responsibility for the growth and stability of their economies, and during which enormous investments of talent and energy have been made in understanding how economies can be better managed. Forecasting the next few quarterly estimates of these statistics has become, with no exaggeration, a hundred-million-dollar industry.

The aim of national income accounting is to provide an information framework suitable for analyzing the performance of the economic system. The current system of national accounts reflects the Keynesian macroeconomic model that was dominant when the system was developed, largely through the work of Richard Stone, Simon Kuznets, and other economists writing in the English tradition. The great aggregates of Keynesian analysis-- consumption, savings, investment, and government expenditures-- are carefully defined and measured. But Keynes and his contemporaries were preoccupied with the Great Depression and the business cycle; specifically, with explaining how an economy could remain for long periods of time at less than full employment. The least of their worries was a scarcity of natural resources. Unfortunately, as Keynesian analysis largely ignored the productive role of natural resources, so does the current system of national accounts.

In fact, natural-resource scarcity was of little concern to 19th-century neoclassical economics, from which tradition Keynesian and most contemporary economic theories are derived. Gone were the dismal predictions of Ricardo, Malthus, Marx, and other earlier

classical economists that scarcity of agricultural land in industrial economies would cause stagnation or collapse because of rising rents and falling real wages. In 19th-century Europe, steamships and railroads were markedly lowering transport costs, while food grains and raw materials were flooding in from North America, Argentina, Australia, Russia, and the imperial colonies. What mattered to England and other industrializing nations was the pace of investment and technological change.

The classical economists had regarded income as the return on three kinds of assets: natural resources, human resources, and invested capital (land, labor, and capital, in their vocabulary). The neoclassical economists virtually dropped natural resources from their model, and concentrated on labor and invested capital. When these theories were applied after World War II to problems of economic development in the Third World, human resources were also left out, on the ground that labor was always "surplus," and development was seen almost entirely as a matter of savings and investment in physical capital. Ironically, low-income countries, which are typically most dependent on natural resources for employment, revenues, and foreign-exchange earnings, are instructed to use a system for national accounting and macroeconomic analysis that almost completely ignores their principal assets. It is not far from the truth that the system of national accounts represents one of the last vestiges of British colonialism.

As a result, there is a dangerous asymmetry in the way we measure, and hence the way we think about, the value of natural resources. Man-made assets--buildings and equipment, for example--are valued as productive capital. The increase in the stock is recorded as capital formation. Decreases in the stock through use are written off against the value of production as depreciation. This practice recognizes that a consumption level maintained by drawing down the stock of capital exceeds the sustainable level of income. Natural-resource assets are not so valued, and their loss entails no debit charge against current income that would account for the decrease in potential future production. A country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife and fisheries to extinction, but measured income would not be affected as these assets disappeared.

The proper definition of income encompasses the notion of sustainability. In accounting textbooks and economics principles, income is defined as the maximum amount that the recipient could consume in a given period without reducing the amount of possible consumption in a future period. This income concept encompasses not only current earnings but also changes in asset positions. The depreciation accounts reflect the fact that unless the capital stock is maintained and replaced, future consumption possibilities will inevitably decline. Thus, proper evaluation of changes in the stock of assets is crucial as a way of evaluating the sustainability of an economic development strategy. In resource-dependent countries, failure to extend this concept to the capital stock embodied in natural resources, which are such a significant source of income and consumption, is a major omission and inconsistency.

Underlying this anomaly is the implicit and inappropriate assumption that natural resources are so abundant that they have no marginal value. This is a misunderstanding.

Whether they enter the marketplace directly or not, natural resources make important contributions to long-term economic productivity, and so are, strictly speaking, economic assets. Many are under increasing pressure from human activities and are deteriorating in quantity or quality.

Another misunderstanding underlies the contention that natural resources are "free gifts of nature," so that there are no investment costs to be "written off." The value of an asset is not its investment cost, but the present value of its income potential. Many billion-dollar companies have as their principal assets the brilliant ideas and inventions of their founders: the Polaroid camera, the Apple computer, the Lotus spreadsheet, for example. These inspired inventions are worth vastly more than any measurable cost to their inventors in developing them, and could also be regarded as the products of genius--free gifts of nature. Common formulas for calculating depreciation by "writing off" investment costs (e.g., straight-line depreciation) are just convenient rules of thumb, or artifacts of tax legislation. The true measure of depreciation, which statisticians have tried to adopt for fixed capital in the national accounts, is the capitalized present value of the reduced future income stream obtainable from an asset because of its decay or obsolescence. Thus, in the same sense that a machine depreciates, soils depreciate as their fertility is diminished, since they can produce only at higher costs or lower yields.

Codified in the United Nations system of national accounts closely followed by most countries, this bias provides false signals to policymakers. It reinforces the false dichotomy between the economy and the "environment" that leads policymakers to ignore or destroy the latter in the name of economic development. It confuses the depletion of valuable assets with the generation of income. Thus it promotes and seems to validate the idea that rapid rates of economic growth can be achieved and sustained by exploiting the resource base. The result can be illusory gains in income and permanent losses in wealth.

The United Nations System of National Accounts (SNA) recognizes certain natural resources, such as forests, land, and subsoil minerals, as assets in national balance sheets, the "stock" accounts. The recommended treatment for natural resources in the balance sheet accounts is very similar to the recommended treatment of other capital assets. If possible, the assets' values should be derived from market transactions; otherwise, the accounts should be based on the discounted present value of estimated future income flows derived from the assets. However, the income and product accounts are not treated consistently with these balance-sheet accounts. On the income side, for example, the total value added from resource extraction is included in wages and salaries, in rental incomes, and in company profits. In other words, the total value of natural-resources current production, net of purchased inputs, is imputed to current income.

The problem is that, in contrast to the treatment of man-made capital assets, there are no accounting entries in the flow accounts for changes in natural-resource stocks. Notwithstanding the economic significance of wasting natural resources, the SNA does not provide a debit on the product side of the national income accounts to show that depreciation of

natural resources is a form of disinvestment. And it does not provide a depreciation factor on the income side to show that consumption of productive natural-resource assets must be excluded from gross income.

Indeed, natural-resource assets are legitimately drawn upon to finance economic growth, especially in resource-dependent countries. The revenues derived from resource extraction finance investments in industrial capacity, infrastructure, and education. A reasonable accounting representation of the process, however, would recognize that one kind of asset has been exchanged for another, which is expected to yield a higher return. Should a farmer cut and sell the timber in his woods to raise money for a new barn, his private accounts would reflect the acquisition of a new asset, the barn, and the loss of an old asset, the timber. He thinks himself better off because the barn is worth more to him than the timber. In the national accounts, however, income and investment would rise as the barn is built, but income would also rise as the wood is cut. Nowhere is the loss of a valuable asset reflected. This can lead to serious misestimation of the development potential of resource-dependent economies, by confusing gross and net capital formation. Even worse, should the proceeds of resource depletion be used to finance current consumption, then the economic path is ultimately unsustainable, whatever the national accounts say. If the same farmer used the proceeds from his timber sale to finance a winter vacation, he would be poorer on his return, and no longer able to afford the barn, but national income would only register a gain, not a loss, in wealth.

Consider the sad exemplary tale of Kiribati, the small atoll republic in Micronesia, which depended throughout the 20th century on its phosphate mines for income and government revenues. While the mines ran, gross domestic product was high and rising, but the mining proceeds were treated as current income rather than as capital consumption. When the deposits were mined out in the 1970s, income and government revenues declined drastically, because far too little had been set aside for investment in other assets that would replace the lost revenues.

II. THE SCOPE OF NATURAL-RESOURCE ACCOUNTING

A growing body of expert opinion has recognized the need to correct the SNA's environmental blind spots. Many leading economists, including several Nobel prizewinners, have identified the need for better accounting for natural resource assets. A number of member nations of the Organization for Economic Cooperation and Development, including Canada, France, Germany, the Netherlands, Japan, Norway, and the United States, have set up or are working on systems of environmental accounts.

The French natural-patrimony accounts, for example, are intended as a comprehensive statistical framework to provide authorities with the data they need to monitor changes in "that subsystem of the terrestrial ecosphere that can be quantitatively and qualitatively altered by

human activity."[1] Like their Norwegian counterparts, these accounts cover nonrenewables, the physical environment, and living organisms. Since material and energy flows to and from economic activities form only a subset of these accounts, they are conceptually much broader than the national income accounts, and are compiled largely in physical terms.

Such environmental statistics may well encourage decision-makers to consider the impacts of specific policies on the national stock of natural resources. However, physical accounting by itself has considerable shortcomings. It does not lend itself to useful aggregation: aggregating wood from various tree species in cubic meters obscures wide differences in the economic value of different species. Aggregating mineral reserves in tons obscures vast differences in the value of different deposits due to grade and recovery costs. Yet maintaining separate physical accounts for particular species or deposits yields a mountain of statistics that are not easily summarized or used.

A further problem is that accounts maintained only in physical units do not enable economic planners to understand the impact of economic policies on natural resources and thereby integrate resource considerations into economic decisions-- presumably the main point of the exercise. Yet there is no conflict between accounting in physical and in economic units because physical accounts are necessary prerequisites to economic accounts. If the measurement of economic depreciation is extended to natural resources, physical accounts are inevitable by-products.

The limits to monetary valuation are set mainly by the remoteness of the resource in question from the market economy.[2] Some resources, such as minerals, enter directly. Others, such as groundwater, contribute to market production and can readily be assigned a monetary value although they are rarely bought or sold. Others, such as noncommercial wild species, do not contribute directly to production and can be assigned a monetary value only through quite roundabout methods involving many somewhat questionable assumptions. While research into the economic value of resources that are remote from the market is to be encouraged, common sense suggests that highly speculative values should not be included in official accounts.

In industrial countries where pollution and congestion are mounting while economies are becoming less dependent on agriculture, mining, and other forms of primary production, the focus has been on "environmental accounting" rather than natural- resource accounting. Several approaches to developing more comprehensive systems of national income accounting go well beyond the scope of natural-resource accounting.

1 P. Cornière, "Natural Resource Accounts in France. An Example Inland Water," in Organization for Economic Cooperation and Development, Information and Natural Resources, Paris, 1986.

2 Ibid.

There are sound reasons to begin by focusing on accounting for natural resources: the principal natural resources, such as land, timber, and minerals, are already listed in the SNA as economic assets, although not treated like other tangible capital, and their physical and economic values can be readily established. Demonstrating the enormous costs to a national economy of natural-resource degradation is an important first step in establishing the need for revamping national policy.

Developing countries whose economies are dependent on natural resources are becoming particularly interested in developing an accounting framework that accounts for these assets more adequately. Work is already under way in the Philippines, China, Thailand, India, Brazil, Chile, Colombia, Costa Rica, El Salvador, and other countries.

III. SETTING UP NATURAL-RESOURCE ACCOUNTS

Physical Accounts

Natural-resource physical stocks at any time and changes in those stocks during an accounting period can be recorded in physical units appropriate to the particular resource. The basic accounting identity is that opening stocks plus all growth, increase, or addition less all extraction, destruction, or diminution equals closing stocks. Although the following discussion refers to petroleum reserves and timber stocks as examples, the principles are applicable to many other resources.

Petroleum resources consist of identified reserves and other resources: identified reserves can be divided into proven reserves and probable reserves. Proven reserves are the estimated quantities of crude oil, natural gas, and natural gas liquids that geological and engineering data indicate with reasonable certainty are recoverable from known reservoirs under existing market and operating conditions; i.e., prices and costs as of the date the estimate is made. Probable reserves are quantities of recoverable reserves that are less certain than proven reserves. Thus, one limit on the stock of reserves is informational. Additional proven reserves can usually be generated by drilling additional test wells or undertaking other exploratory investments to reduce uncertainty about the extent of known fields. The boundary between reserves and other resources is basically economic. Vast quantities of known hydrocarbon deposits cannot be extracted profitably under current conditions. They are thus known resources, but cannot be counted as current reserves, although price increases or technological improvements might transform them into reserves in the future.

For other mining industries, geological characteristics tend to be known with more certainty, so there is less distinction between proven and probable reserves but a sharp division between economic reserves and total resources. Many minerals are present at very low concentrations in the earth's crust in almost infinite total amounts. Technological changes in mining and refining processes have markedly reduced the minimum ore concentrations that can be profitably mined, correspondingly expanding mineral reserves.

Changes in oil and gas stocks may be classified under various headings: "discoveries," the quantity of proven reserves that exploratory drilling finds in new oil and gas fields, or in new reservoirs in oil fields; "extensions," increases in proven reserves because of subsequent drilling showing that discovered reservoirs are larger than originally estimated; and "revisions," increases in proven reserves because oil or gas firms acquire new information on market conditions or new technology. Extensions of and revisions to oil and gas reserves have historically been significantly larger than new discoveries. Reserve statistics generally produce very conservative estimates of the total resource stocks that will ultimately enter the economic system: actual production from new U.S. fields and reservoirs was over seven times the amount initially reported as discovered.

Reserve levels fall because of extraction and downward revisions. In the United States, oil and gas companies are required by the Securities and Exchange Commission to disclose net annual changes in estimated quantities of oil and gas reserves, showing separately the opening and closing balances, revisions of previous estimates (from new information), improved recovery (resulting from improved techniques), purchases and sales of minerals in place, extensions and discoveries, and production.[3]

The accounting framework for timber resources in physical units could be expressed in hectares, in tons of biomass, or in cubic meters of available wood, although the last is probably the most important economic measure. As in the case of minerals, the total resource is larger than the economic reserve, since a substantial part of the total stock of standing timber in any country cannot be profitably harvested and marketed with current technologies and market conditions.

Additions to the timber stock can originate from growth and regeneration of the initial stock and from reforestation and afforestation. Reductions can be classified into production (harvesting), natural degradation (fire, earthquake, etc.), and deforestation by man. Separate accounts might be established for different categories of timber stands--for example, virgin forests, logged (secondary) forests, unproductive or protected forests, and plantations. In temperate forests, where species diversity is limited, timber stocks are further disaggregated by species.

Physical accounts can be constructed along similar lines for agricultural land. Land and soil maps and classification systems are used to disaggregate land into productivity categories. Changes in stocks of each land category within a period reflect various phenomena: conversion to nonagricultural uses; conversion to lower productivity classes through physical deterioration by erosion, salinization, or waterlogging; and conversions to higher productivity classes through physical improvements by irrigation, drainage, and other investments. A set of physical accounts for agricultural land would record stocks of land at each accounting date by productivity class, and flows among classes and to other land uses according to cause.

3 Financial Accounting Standards Board, working paper, 1982.

Similarly, physical accounts can be set up for other biological resources, such as wildlife or fish populations. The principles are essentially those of demography. Additions to initial populations are attributed to fertility, estimated from reproduction rates and the size of the breeding population, and in-migration. Subtractions from stocks are attributed to natural mortality, estimated from age-specific or general mortality rates, harvesting operations, other special sources of mortality, and out-migration.

Valuation Principles

The concept of economic rent is central to natural-resource valuation. Economic rent is defined as the return to any production input over the minimum amount required to retain it in its present use. It is broadly equivalent to the profit that can be derived or earned from a factor of production (for example, a natural-resource stock) beyond its normal supply cost. For example, if a barrel of crude oil can be sold for $10 and costs a total of $6 to discover, extract, and bring to market, a rent of $4 can be assigned to each barrel. In forest economics, the concept of "stumpage value" is very close to that of economic rent. Stumpage value represents timber sale proceeds less the costs of logging, transportation, and processing. Better-quality and more accessible timber stands will command a higher stumpage value.

Rents to natural resources arise from their scarcity, and from locational and other cost advantages of particular stocks. In principle, rents can be determined as the international resource commodity price less all factor costs incurred in extraction, including a normal return to capital but excluding taxes, duties, and royalties. Thus, the economic rent is equivalent to the net price.

This is equivalent to the economic rent in a Ricardian scarcity model, which assumes that resources from different "deposits" will be supplied at a rising incremental cost until profit on the marginal source of supply is completely exhausted. In this Ricardian model, rents rise on relatively low-cost, infra-marginal sources of supply.

It is also equivalent to a user cost in a Malthusian stock- scarcity model, which assumes that a homogeneous exhaustible resource is exploited at an economically efficient rate, a rate such that the profit on the marginal amount brought to market is equal to the expected return derived from holding the asset in stock for future capital gain. In such a Malthusian model, if the resource is being extracted at an efficient rate, the current rent on the last unit of resources extracted is thus equal to the discounted present value of future returns from a unit remaining in stock.

The gross operating surplus of the extractive sector in the SNA, represented by the sum of the profits made by all the different enterprises involved in resource-extraction activities, does not represent true rewards to factors of production alone but also reflects rents from a "one time only" irredeemable sale of a nonrenewable natural asset. The basic definition of

income as the amount that can be consumed without becoming worse off is clearly being infringed as the value of the asset base declines.

Asset transactions in natural resources, such as competitive auction sales of rights to extract timber or minerals, closely follow estimated stumpage values or rents, with allowance for risk. Because holders of those rights can usually hold the resources in stock or bring them to market immediately, the current rent or stumpage value tends to reflect the present value of the expected net income that can be derived from them in the future. This principle is readily extended to other resources: agricultural land can be valued directly on the basis of its current market worth, or indirectly as the present value of the future stream of net income, or annual rent, that can be derived from it. The value of subsurface irrigation water deposits can be estimated from market transactions in "water rights," or from a comparison of the value of agricultural land overlaying a usable known aquifer with that of otherwise equivalent land without subsurface water. Alternatively, it can be estimated as the present value of future rents, calculated as the difference between the costs (per cubic meter) of supplying the water for irrigation and the incremental net farm income attributable to the use of the water for irrigation.

In order for adjustments to national income accounts for changes in natural-resource stock to attain broad acceptance, a credible standard technique for valuing natural resources must be adopted that can be applied to a variety of resources by statisticians in different countries. That method must be as free as possible from speculative estimates (about future market prices, for example), and must depend on underlying data that are reasonably available to statistical agencies.

The three principal methods for estimating the value of natural-resource stocks are (1) the present value of future net revenues; (2) the transaction value of market purchases and sales of the resource in situ; and (3) the net price, or unit rent, of the resource multiplied by the relevant quantity of the reserve. The present-value method requires that future prices, operating costs, production levels, and interest rates be forecast over the life of a given field after its discovery. The present value of the stream of net revenue is then calculated, net revenue representing the total revenue from the resource less all extraction costs. The United Nations Statistical Office has recommended use of the present-value method when market values for transactions in resource stock are not available.

The net-price method applies the prevailing average net price per unit of the resource (current revenues less current production costs) to the physical quantities of proven reserves and changes in their levels. While the net-price method requires only current data on prices and costs, it will be equivalent to the other two methods if output prices behave in accordance with long-run competitive market equilibrium. The assumption here is derived from the theory of optimal depletion of exhaustible resources-- that resource owners will tend to arbitrage returns from holding the stock into future periods with returns from bringing it immediately to market, adjusting current and future supplies until price changes equate those returns.