# The Economic Value of Earth's Resources

Graciela Chichilnisky

## Introduction

What is the economic value of Earth's resources? The overall question of economic value is a central part of the discipline called market economics. According to market economics, the best way of assigning economic values is through the "marketplace." Economists say that a competitive market exists for a particular product when there are many producers and purchasers of the product and none of them controls its price.

Graciela Chichilnisky is UNESCO Chair of Mathematics and Economics and is Professor of Statistics at Columbia University.

Losing What Counts

Michael J. Novacek
Editor

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Wreathed hornbill (*Aceros undulatus*)

Instead, the price emerges through the interaction between buyers and sellers. (Good examples of what economists would call competitive markets are auctions and the New York Stock Exchange.) The resulting market price simultaneously reflects the costs of producing the product and the preferences shown by consumers when they choose between alternative products. In theory, a market price is set when the supply of the product equals the demand for the product.

Under ideal circumstances—which do not necessarily correspond with the real world—market prices lead to the "most efficient" distribution of the world's (scarce) resources. What economists mean by "most efficient" in this context is that no alternative distribution of these resources would improve the lot of some people without simultaneously making other people worse off. Economic theory and some economic evidence suggest that "free market" pricing works well for typical consumer products such as apples and popcorn. (Economists call products of this type "private goods." Once "consumed" by one person, a private good cannot be "consumed" by anyone else.) However, there is increasing unease today about whether the "free market" does a good job in setting prices for natural resources. Physical and biological scientists question economic wisdom in this regard, and the entire matter has become the subject of a popular debate.

Part of the problem of assigning value to many natural resources is that no organized markets exist for them. This problem is acute for air and water. Markets set the prices of mineral water or bottled oxygen gas; however, no markets or market prices exist for the vast bulk of air and water "consumed" by Earth's humans. Sometimes users pay for water; however, government, not competitive markets, typically sets the price for water. Consequently, the price does not lead to an "efficient" use of water. Indeed, the price of water is typically so low in the United States that people use it extremely wastefully. A further condition makes the possibility of a market for air even more unlikely than a market for water—people cannot choose to "consume" airs of different qualities or to "consume" differing amounts of air. Economists call goods such as air, water, roads, bridges, etc., "public goods" because, unlike private goods, they are available to everyone in about the same amount. Moreover, one person's "consumption" of a public good does not prevent anyone else from "consuming" the same public good. When it comes to establishing values, standard markets do not work well for public goods. Consequently, economic efficiency is lost. The problem of pricing resources is pervasive. In practice, many scarce and valuable resources are free (have prices of zero). For example, the achievement of cleaner water and air has zero economic value in all systems of economic accounting used today.

Obviously, a system of prices that holds that polluted air is just as valuable as clean air is faulty. Having such faulty prices for crucial resources clearly throws into doubt many traditional ways of assigning a quantitative value to economic progress. For example, we burn fossil fuels to produce industrial output. This output has an economic value (people pay for the output), but clean air does not (people do not pay for the air they breathe). Therefore, burning fossil fuels has an unequivocally positive economic value; it counts as economic progress even as it pollutes the air and increases the atmospheric concentration of greenhouse gases that could cause harmful climate change. A similar situation emerges with the world's forests. The destruction of a forest to extract its wood or to grow agricultural products has an unequivocally positive value

and counts as economic progress all over the world. In a world increasingly concerned with the survival of its forests and the deteriorating quality of its air and water, this vision of economic progress defies common sense. It is now under scrutiny.

Markets for environmental assets may never emerge, and, even if they do, they may not act efficiently (in the economic sense defined above). Some economists, myself included, are proposing wider notions of economic value in an attempt to reconcile equity ("economic fairness" among all the world's people) and efficiency; we are also attempting to balance the weight given to the interests of people living today with that given to the interests of people who will be living tomorrow. This essay cannot cover all the issues, important as they are. Instead, it concentrates on discussing basic needs and environmental markets. As an organizing theme, I propose that we must now focus on the choice between two, fundamentally different, patterns of economic growth: resource-intensive economic growth and knowledge-intensive economic growth. One works and the other doesn't. Economic progress is not doing more with more—it is doing more with less.

Before suggesting solutions, however, we should understand the nature of the problem. What is driving our unease? Why is the question of the economic valuation of Earth's resources now timely and controversial? What is the source of the problem? Answering these questions requires a brief review of the situation.

**The Global Environment Today**

We humans, or our immediate ancestors, have lived on Earth for several million years. Yet only in the past fifty years has human activity reached levels at which it has seriously degraded Earth's environment and decreased its overall biodiversity. On the whole, these harmful ecological effects result from the industrial countries (the North) overconsuming environmental resources, which are overextracted in the developing countries (the South). The North houses less than one third of humankind. However, it consumes most of the world's irreplaceable resources (such as fossil fuels, metals, and minerals). It also consumes most of the renewable resources obtained from fertile land (such as wood, livestock, and cotton).

Mineral fuels provide an extreme case of delivery of a primary, nonrenewable resource from developing countries to industrialized countries. The South sends nearly three-fourths of its exports of mineral fuels (coal, petroleum products, and natural gas) to the North; sixty percent of the North's consumption of mineral fuels comes from the South. Latin America exports mostly resources—about seventy percent of its exports are resources—and Africa does so almost exclusively. The United States alone, with less than five percent of the world's population, consumes an enormous quantity of materials. It has followed a voracious trend that accelerated after World War II. For example, the United States consumes yearly twenty-five percent of all the petroleum extracted worldwide.

The pricing of resources is a crucial aspect of the problem. The world's rapid rate of consumption of fossil fuels derives from the low international prices of petroleum. A similar problem is the overuse of forests to provide wood and wood pulp. The lower the prices, the higher the consumption. Why are the world's resources traded at such low prices? Do market prices fail to convey the true value of Earth's resources? If so, how can we improve this situation?

These questions led me in the mid-1970s to create and develop "basic needs" as a central

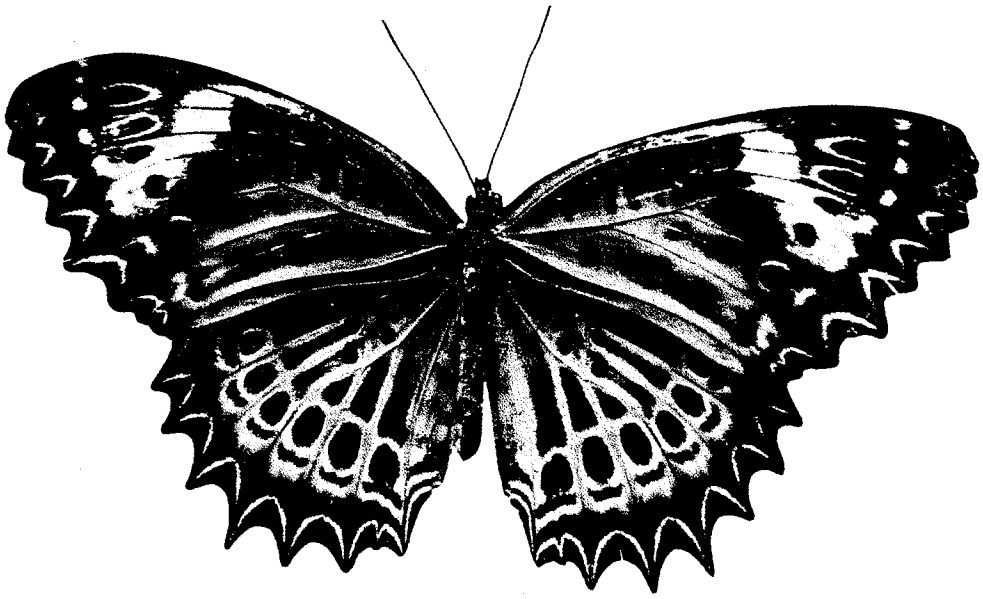
concept of economic development. This concept was to serve as an empirical measure of economic progress in five continents to complement and sharpen standard economic measures in the areas where these fail. Basic needs are those goods and services that humans need to fit into their societies effectively; examples are food, shelter, education, and health. To a certain extent, these needs vary from one culture to another. I proposed that the satisfaction of the basic needs of the population should be a minimum requirement for economic progress, and I explored the connection between basic needs and sustainable development across the world. Subsequently, my concept of basic needs became a standard aim of development: 150 nations adopted it as an explicit objective in the United Nations Agenda 21, at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. However, despite the international acceptance for development based on meeting basic needs, the problem persists. The question remains: Why have we reached this pattern of overproduction and overconsumption of the world's resources, beyond the point of sustainability?

**The Postwar World: Growth and Trade Based on "Inexpensive" Resources**

Today's acute global environmental problems first emerged during the past fifty years. Economic activity has been the driving force, the leading cause, of environmental degradation and the loss of biodiversity. The destruction of biodiversity over the past fifty years is leading to a mass extinction like the one in which all dinosaurs, other than birds, perished. The emissions of greenhouse gases followed a similar pattern. From 1860 to 1950, worldwide consumption of fossil fuels released an



*Cethosia cyane*, female



estimated 187 billion metric tons of carbon dioxide (an average of about 21 billion metric tons per decade); however, over the past four decades, the rate of emissions was seven times as high, amounting to a total of 559 billion metric tons of carbon dioxide (an average of about 140 billion metric tons per decade).

Today's unease reflects the awareness that the environmental problems we face are new, or at least much more severe than previously. What happened over the past fifty years, and why? Fifty years ago, World War II ended in a victory for the United States and its allies, and the United States became forty percent of the world's economy. After the war, the world community created several important international organizations. These included the United Nations, the International Monetary Fund (IMF), the World Bank, and the General Agreement on Tariffs and Trade (GATT). These organizations worked to establish the vision of economic growth of the leading nation, the United States. This vision involved a very resource-intensive pattern of growth corresponding to a rapidly expanding frontier economy, and to the domination of nature through technological change. After World War II, the world's economies adopted the gross national product (GNP) as a universal measure of economic progress. A country's GNP is the sum of the net value of production of all its goods and services computed at their market prices.

Today, all countries report their economic performance to the UN based on GNP. Yet some fundamental resources without which humans could not survive, such as water and fertile soil, have zero weight in the GNP. There are no organized markets for water and therefore no market prices. Nevertheless, according to World Bank reports, usable water is today one of the scarcest resources in developing countries. Similarly, there is no market, and therefore no market price, for atmospheric quality or for biomass. In GNP terms, critical resources—such as the whole biomass of the planet, its water bodies, and its atmospheric cover—have zero economic value.

International markets have contributed to the problem of misvaluing resources. Since the end of World War II, the world's economy has grown at a very rapid pace. However, international trade outstripped the overall growth of the world economy by a factor of three. This had important consequences, because most of the misvaluing of resources occurs through international markets. Petroleum is a case in point. In most of the world, petroleum is national property. Economists assign a positive value to its extraction and export, based on the market value of the exported grades of petroleum. However, there is no accounting for the exhaustion of the resource base, the depletion of the asset itself. Destroying a forest to export wood or pulp increases GNP and counts as economic progress. In a world concerned about the preservation of forests and their biodiversity, economics values deforestation and the destruction of biodiversity as unequivocal progress. Why?

After World War II, two major theories of economic growth and trade appeared and gained dominance. The "theory of optimal economic growth" held that a rapid population growth and a corresponding increase in the use of resources are economic ideals. The "theory of international trade based on comparative advantage" held that developing countries should emphasize exports of resources and labor-intensive products, while importing technology and capital-intensive goods. (According to the economic principle of "comparative advantage," trade between two regions will be mutually beneficial if each region specializes in those products in which it is most efficient. This is illustrated by the greatly oversimplified example of a world consisting of

two countries A and B. If country A can produce lumber twenty percent as efficiently as country B can but can produce computers only five percent as efficiently as country B can, then there will be a higher total value of global productivity in theory if country A produces only lumber exclusively and country B produces only computers.) Because resources can be obtained at lower prices in the developing countries, the World Bank and the IMF provided strong incentives to developing countries to follow resource-intensive development. As a precondition for loans and other important economic incentives, these organizations recommended that developing countries export more resource-intensive products.

The export patterns we observe in developing countries do not follow the law of comparative advantages (at least do not if resources have suitable prices); nor do they follow any other law of economic efficiency. Nor is the world better off in economic terms when the South specializes in the export of resource-intensive products that damage the environment. To understand why these harmful trading practices occur, we need to take a fresh look at why countries trade resources and at how the international economy assigns prices to these resources. We will see that this trade hinges on differences in property rights between the countries exporting their resources and those receiving these exports.

**Property Rights, Industrialization, Prices, and Trade**

Many traditional societies have successfully managed their common property resources, such as fisheries and forests, using traditional forms of governance. The term common property refers to ownership that a group shares, rather than individual ownership. An example is Valencia's Tribunal de Las Aguas, a local court in Spain that is 1,000 years old. This court still meets weekly to administer costs and allocate the use of the regions' water network. These traditional systems require a small and stable population, where penalties for antisocial overuse of resources can be administered effectively and, if necessary, across generations. Such traditional systems of resource management tend to break down in the period of industrialization, when outsiders move into the common property area. Lacking firm ties to the area, these outsiders can easily move out to avoid paying any penalties for their overuse of resources. Consequently, what was once well-managed common property changes into unmanaged "open access" resources, which can be had for the taking. A first come, first served system prevails.

When people extract a resource from a resource pool, such as a forest, to which there is open access, the only computed cost is that involved in the actual extraction. Often this is only the cost of the labor and energy it takes to cut and remove the trees. No one considers the cost of replacing the trees to ensure the continuation of the forest. No one computes the costs resulting from the loss of the services that the forest provides to human settlements; these services include providing an ecosystem for biodiversity, shelter, stable climate, and food. Because people undervalue these costs, they overestimate the net benefits from extraction. At each market price for a specific commodity, people extract more under open-access regimes than under private property regimes or under traditional managed systems. Therefore, they overextract the resource, which dwindles and often disappears.

As a result, the country with open property resources offers more of the resource to the international market than is economically efficient. At each market price, the quantity offered is greater in an economic system with open access than in a system with private property. This leads to an apparent

comparative advantage (as explained earlier) in the production of environmentally sensitive products, even when there is no real comparative advantage.

This explains why developing countries, which typically have ill-defined property rights for environmental resources, export resource-intensive products even if they have no real comparative advantage in such products. (For example, Mexico exports oil to the United States, but Mexico's oil reserves are small, and they are smaller than those of the United States.) It explains why resource-intensive products such as refined oil, wood, and food are exported at such low prices, prices that are below real costs. The countries with well-defined property rights (for example, the United States) have overconsumed resources, while countries with ill-defined property rights (for example, many developing countries) have overproduced them. As a result, the world economy consumes an inefficiently large quantity of resources, because it takes no account of the costs of the resource overuse. In brief, the process of industrialization itself leads to the inefficient patterns of North–South trade that are at the core of the environmental dilemma today. It leads to international prices for resources that are well below the actual costs to society.

**The Economic Value of Earth's Resources**

One proposal to correct this problem is to modify the way we account for resources. The idea is to report the costs of using the environment within the national accounts. We generally call this green accounting. The procedure requires, however, that environmental assets have proper prices.

Where will prices for forests, water, biodiversity, and clean air come from? Economists say from free markets. There is much merit and optimism in this premise. Under ideal conditions, market prices lead to economically efficient outcomes that represent the preferences of the population. Water markets are considered currently in California, the Chicago Board of Trade already trades rights to emit the air pollutant sulfur dioxide, and I recently proposed global markets for the right to emit specified quantities of the greenhouse gas carbon dioxide.

However, we cannot trade rights to use air and water and to harvest forests unless we know who owns what. We need property rights on forests, water, air, and biodiversity. Can we carefully parcel out the universe and assign property rights on each of its pieces? This seems a tall order, perhaps too tall for the urgency of the global environmental problem.

Theoretically, assigning property rights for Earth's resources among all its people does not affect overall economic efficiency. Rather it is a problem of equity (economic fairness or economic justice) and therefore, in theory, is more a matter of ethics than of economics. However, in reality, the neat separation of economic efficiency from equity may not work in markets in which people trade environmental assets. Understanding why is important. For markets to function efficiently (in classical economic terms), it must be possible for buyers to choose different quantities of the assets being sold. However, this is not possible for many environmental assets. For example, the concentration of carbon dioxide in Earth's atmosphere is relatively uniform and stable; everyone on Earth breathes the same concentration of carbon dioxide. Likewise, the total biodiversity on Earth is the same for us all. These constraints are physical, not economic or legal. For this reason, economists refer to biodiversity and carbon dioxide concentrations as "public goods" and to their sources as "global commons." (The term commons derives from the village green or village commons,

where all citizens had an equal right to graze their sheep.) These are, however, unusual public goods, because they are produced not by governments but by each individual in the economy. (For example, carbon emissions are "produced" privately, by people driving their cars, etc.)

A new discovery of classical economic theory (made by our group at Columbia University with colleagues at Stanford University) is that there can be economically efficient markets for privately produced public goods only when there is a particular equitable (fair) distribution of the total property rights corresponding to these goods. We must properly sort out property rights for environmental markets to achieve efficiency. This requires careful market design and will take some time. In emergencies, taxes or bans on the trading of species that are close to extinction may be necessary; for example, trade in elephant tusks, tiger hearts, and American box turtles.

**The Knowledge Revolution**

Is it possible to reorient patterns of trade and development without interfering with free trade? To a certain extent the answer is yes. The trade strategies followed by the Asian Tigers (Japan, Korea, Taiwan, Hong Kong, and Singapore) and more recently by the Little Tigers (such as Malaysia) provide good examples. These are very export-oriented countries that moved swiftly away from trade based on traditional comparative advantages—such as labor-intensive and resource-intensive products—to the trade of knowledge-intensive products, such as microprocessors, consumer electronics, communications, financial products, and many other technology-based products. Despite their current financial difficulties, these Asian economies have achieved extraordinary performance over the last twenty years and are way ahead of their African and Latin American counterparts in all economic indicators. They lead what we call the Knowledge Revolution.

A possible development strategy is to emphasize knowledge-intensive rather than resource-intensive sectors. This economic strategy was introduced formally a few years ago, by our Program on Information and Resources, and received impetus from the empirical evidence of world economic development.

The knowledge-intensive sectors mentioned require human capital and know-how rather than large plants and equipment. Moreover, these sectors are often highly competitive and therefore economically efficient. The computer hardware industry is a good example.

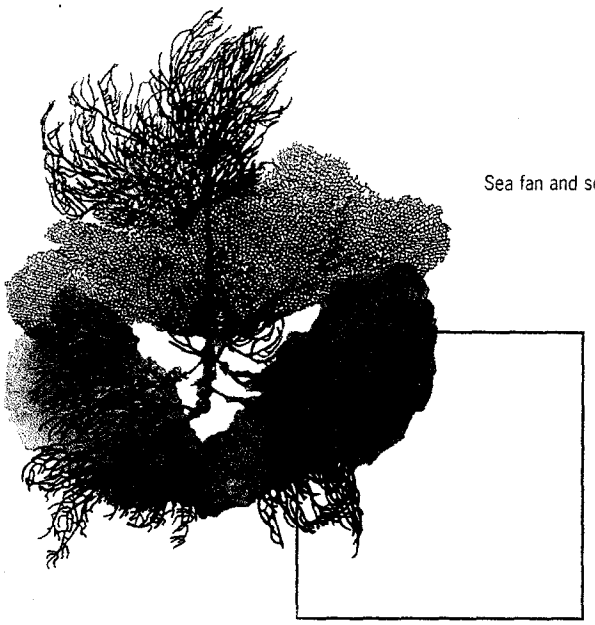
Many developing countries have the skilled labor required for knowledge-intensive sectors. Mexico is currently a producer of such electronic products as microchips and software, and India exports $1.5 billion worth of software a year. Software is very labor-intensive and suits the Indian and Mexican economies because its production does not require large capital outlays. And recently, Barbados's government announced its determination to transform the country into an information age society in less than a generation, based on its excellent educational system.

**Conclusions: Information and Resources**

Knowledge-intensive growth is successful in economic terms. It drives the most dynamic sectors in the world today. For the purposes of this article, however, its most important aspect is that knowledge-intensive growth does not require intensive use of the environment. It is intrinsically compatible with the continuing health of the global environment. Using information and managing resources may be the most important trends in the world economy

today, and if done wisely, they could lead to economic prosperity that is harmonious with the global environment.

How will all this affect the economic value of Earth's resources? As we change our emphasis away from resource production and exports, the world's available supply of resources that are for sale will decrease. Therefore, the prices of these resources will increase. This means that we will price these resources more accurately, and this is as it should be. By undervaluing Earth's resources, we undervalue ourselves.



Sea fan and sea rods (*Gorgonia* sp. and *Subgorgia* sp.)