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Incorporating Resource and Environmental Change in a Nation's Economic Accounts

Roles for Earth Science Applications

Joel Darmstadter

1616 P St. NW
Washington, DC 20036
202-328-5000 www.rff.org

RESOURCES FOR THE FUTURE

Incorporating Resource and Environmental Change in a Nation's Economic Accounts: Roles for Earth Science Applications

Joel Darmstadter

Abstract

Conventional measures of GDP and related social-accounting aggregates, essential as they continue to be, are seriously deficient in two respects. They largely fail to reflect depletion of natural resources, and they fail to measure damage to the environment. While these deficiencies have long been recognized, loss of tropical ecological assets has, in particular, intensified concern over flawed accounting practices. Increased ability—through remote sensing—to quantify such loss would be a starting point toward estimation of the corresponding economic cost in a national accounting framework.

Key Words: adjusted income-and-product accounts, green GDP, remote sensing, natural resource and environmental accounting

JEL Classification Numbers: O13, Q2, Q3, Q5

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Introduction

A recent issue of *The Economist* (March 15, 2008, pp. 13, 18), featuring a "special report on China's quest for resources," cites the judgment of a deputy minister at the government's environmental watchdog agency that the costs inflicted by pollution each year amount to some 10% of gross domestic product (GDP). The article cites similar conclusions reached by non-Chinese institutions, such as an Organisation for Economic Co-operation and Development (OECD) finding "that air pollution alone reduces the country's output by between 3% and 7% a year, mainly because of respiratory ailments that keep workers at home." Further, the article notes, a report from the World Bank indicates that health problems reduce rural output by 2%, and the costs to industry and agriculture of dirty and scarce water cause a GDP drop of another percentage point. The bottom line: "All told the [World Bank] put the price tag for China's air and water pollution at $100 billion a year, or about 5.8% of GDP."

Those are useful and telling observations, serving as an unambiguous reminder that there is no free lunch, in China or elsewhere; unchecked pollution exacts a tangible price—in China's case, an estimated reduction by a significant amount in the country's economic well-being, as measured by GDP, giving policymakers and society a ready metric by which to judge the downside of go-for-broke growth.

But what about those many instances in which the loss of a country's or region's assets, though no less real than China's deteriorating air quality, can't be reckoned in monetary terms easily—or at all? Think of a threatened habitat, a spoiled landscape, the depletion of critical subsoil resources, or—less fanciful than you might believe—the danger of growing antibiotic resistance. These aren't esoteric musings. Rather, the difficulty in putting a price on such losses

* Joel Darmstadter, Senior Fellow, Resources for the Future, 1616 P St. NW, Washington, DC, 20036. Email: darmstadter@rff.org. This issue brief was prepared with the financial support of the U.S. National Aeronautics and Space Administration and RFF. Responsibility for errors and opinions rests exclusively with the author. RFF Issue Briefs are research materials circulated by their authors for purposes of information and discussion. They have not necessarily undergone formal peer review. The author thanks Molly Macauley for comments on an earlier version of this brief.

explains why, in recent years, environmental activists, as well as some mainstream economists, have voiced dismay about the limitations of the GDP and related social-accounting aggregates as reliable measures of economic performance and thereby as a legitimate basis for important policy decisions. The criticism has focused in particular on the extent to which measured GDP fails to reflect two important phenomena: the depletion of renewable or nonrenewable natural resources—both biophysical and mineral—and damage to the ambient or global environment.

The National Accounts: Strengths and Weaknesses

Why, critics ask, do we make allowances in the national accounts for the depreciation of structures and industrial equipment, but not for the depletion of petroleum lifted from reservoirs? Why include damage to and losses of physical capital but not account for the degradation of, say, a region's forests or—at a global scale—the protective benefits of the earth's ozone shield or important climatic properties of the atmosphere? Hence, the call for an adjusted GDP (or, more precisely, NDP, or net domestic product; see Appendix 1 for clarification and an illustration) that would rectify these measurement weaknesses. In popular parlance, such an adjusted indicator is often labeled a *green GDP*, notwithstanding the inclusion in such improved accounting practices of resources ranging from tropical forests to coal seams. In this issue brief, I refer to *green GDP* for convenience. It is the rationale for an *adjusted GDP* of considerably wider scope with which I am concerned.

Quite apart from the deficiency of standard GDP measures resulting from their exclusion of natural resource and environmental change, economists have long recognized that such measures have certain inherent—virtually unavoidable—flaws. As a measure of a country's output of marketable goods and services, GDP should legitimately be viewed as a critical *contributor* to human welfare. However, GDP should not be judged as a *guarantor* of that elusive idea. (When persons voluntarily opt for leisure in preference to paid work, they most likely enjoy increased welfare even while contributing to diminished market output.) Then, too, the fact that two countries with comparable levels of per capita GDP can have strikingly different degrees of inequality raises profound ethical issues. It is also the case—especially in numerous developing countries—that certain nonmarket activities, such as household work by family members or crops grown and consumed on farms, tend to understate national output. Attempts to impute market values to some of these activities have, however, progressed. Finally, the need to measure real (i.e., inflation-adjusted) GDP change over time underscores the critical role that index numbers of price change play in obtaining data that permit meaningful economic analysis. (Somewhat analogously, just as inflation adjustments for a given country *over time* present a

formidable statistical challenge, so intercountry GDP comparisons *at a point in time* pose a challenge of their own. To be meaningful, such estimates require adjustments—by means of "purchasing power parity" factors—allowing countries with disparate compositions of output to be comparable with one another.)

The economics profession has hardly shrugged off such vexing conceptual and measurement problems. A landmark 1973 paper by Yale economists William Nordhaus and James Tobin sought to compare recorded U.S. output with an alternative, and superior, measure designed to reflect changes in economic welfare. They showed that, using such an economic-welfare measure, long-term growth markedly trailed the increase based on conventional accounting practice. They nonetheless added the critical observation that "progress indicated by conventional national accounts is not just a myth that vanishes when a welfare-oriented measure is substituted." That judgment, I believe, remains valid today: the desirability of a green GDP variant notwithstanding, existing national account aggregates, with all their defects, correlate well with a number of important indicators reflecting quality of life.

Dealing with Natural Resource and Environmental Assets

In spite of longstanding awareness of such quasi-philosophical and measurement issues and attempts to grapple with them in the United States and internationally, the unique dilemma posed by natural resource and environmental assets—and the "services" they provide society—is of much more recent origin. In the United States, the most ambitious effort to address these issues was an initiative launched by the Bureau of Economic Analysis (BEA) in the U.S. Department of Commerce with a set of initial and highly tentative findings—limited to selected mineral commodities—released in 1994. Although, regrettably, the BEA did not receive congressional authorization to continue its pathbreaking work, a number of valuable nongovernmental studies seem certain to strengthen research attention on the need for alternative GDP measures as well as the problems surrounding such measures. (See, e.g., National Research Council 1999; Hecht 2005.) In June 2008, the White House Council on Environmental Quality, Office of Management and Budget, and Office of Science and Technology Policy directed federal agencies to develop a set of National Environmental Status and Trends indicators, a step that formally recognized the importance of recording trends in the condition of natural and environmental resources (although not necessarily a step toward construction of GDP-like measures). The indicators are "envisioned as high quality, scientifically based statistical measures of selected conditions of our environment and natural resources that will facilitate

public discourse and decision-making" (see "Administration Announces Plan to Develop National Environmental Indicators," 17 June 2008, Executive Office of the President).[1]

The problems of green accounting beyond such indicator-like measures may dictate caution rather than an aggressive attempt to quantify natural resource and environmental degradation. Still, given the significant dimensions—claimed or feared—of such changes around the world, it is highly worthwhile to explore such issues on both a conceptual, and, where feasible, an empirical basis.

That valuing the annual services lost through destruction of a natural asset would be a formidable methodological and empirical challenge under the best of circumstances is readily apparent. Nonetheless, the capacity of advanced remote-sensing techniques to provide high-resolution imagery of natural assets could prospectively contribute meaningfully to such an effort. If categorized by discrete topographic and ecological characteristics, remote-sensing observations could prove to be one important building block in determining the benefits of sustaining—or the costs of losing—part of a country's endangered, and largely nonmarket, resource endowment.

With particular reference to tropical forests, researchers have made innumerable estimates—both scholarly and intuitive, yet highly aggregative—of the hundreds of thousands of hectares lost to, say, logging, cattle-raising, crop-production, or palm-oil exploitation. More specific data and information, prospectively strengthened through remote-sensing capabilities, would enable us to break down such totals in a way that would permit characterization of natural resource losses in terms of the beneficial attributes thereby surrendered: bioprospecting, erosion protection, ecotourism, carbon uptake, and other services. Some of these services do generate income through markets. But others do not; there, the market equivalent of services forgone—and they are arguably significant—would need to be imputed through indirect measurement techniques developed by economists in recent years.[2]

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[1] Also, in June 2008, the Heinz Center released its most recent report from the Center's longstanding research on indicators. *The State of the Nation's Ecosystems 2008* summarizes some 108 indicators on the state of farmland, forests, and other major ecosystems. See Stokstad (2008).

[2] Compared with other applications of remote sensing to generate economic valuation estimates, integrating spatial observations with yet-to-be-developed imputed economic data, as discussed here, is a goal, not a reality. By contrast, satellite mapping of, say, agricultural vegetation might even now help predict crop prices in remote regions of developing countries, serving thereby as a leading indicator of either abundant or famine-prone crop conditions. The coupling of clearly differentiated croplands with the presence of a market—however primitive—are the enabling factors in such circumstances.

Consider, in that respect, the fact that, when the threatened loss of, say, a tropical species translates into a corresponding loss of economic value, one faces a key reality: the species in question is likely to coexist in an area with innumerable other species of questionable economic value. Unless one argues that vast hectares of land (beyond an area dictated by minimum density requirements) must be saved to protect one or a limited number of valuable species, the goal must be to delineate, with as much precision as possible, the area containing the species of value needing protection. How sophisticated remote-sensing techniques can contribute to achieving that goal is therefore a question of major interest.

An International Digression

Estimation is not made any easier when a national asset—with carbon uptake perhaps the most prominent case—represents not only a hard-to-measure public good for one country, but also one whose loss would have consequences of varying severity around the world.

By the same token, the *intercountry* cross-sectional dimension parallels an *intertemporal* complexity. Suppose an episode of natural resource or environmental degradation forecloses consumption of that asset's future services. One would need to apply a discounting approach to determine a current adjustment to GDP. Forfeiting a forest's photosynthetic properties illustrates just one of numerous analytical complications.

Further, even where we have evidence of the dramatic loss of a prized natural asset and its associated services, society's well-being is, in many cases, likely to be a *net* loss. Converting a swath of rainforest to agriculture undoubtedly means surrendering the former's economic value—however elusive its measured magnitude. But at least that loss will be offset to a greater or lesser degree by income derived from the activity it replaces.[3] (For a less monumental but, arguably, equally logical U.S. example of this point, see Appendix 2.)

[3] This issue often slides into political discourse in which a related refrain alludes to the permanent loss of "national patrimony" visited upon a country through extraction of a nonrenewable resource. (The more such extraction can be ascribed to foreign "interests," the more potent, it seems, for opportunities to play this particular ideological card, to which current events in Venezuela and Bolivia attest.) One must remember that the proceeds of an activity that replaces a forfeited natural asset can be invested in private and public infrastructure that, on balance, strengthens a country's growth and well-being—a case where a netting calculation between a natural asset given up and a productive asset created comes into play. But of course, in a regrettable number of instances—Nigeria shows signs of this—that beneficial outcome is squandered.

Putting Things in Perspective

I have suggested that, with ever more sophisticated satellite remote-sensing techniques, the characterization of conditions of and changes in land use and other resources may become possible at a remarkably detailed spatial scale, as well as relevant temporal scales. That development may, in turn, provide data and information that would make it possible, through collaboration with physical and social scientists, to translate such changes into their implications for society's well-being—nationally and globally.[4] The application of remote sensing for explicit characterization of resource features to inform a system of indicators is a necessary step. Such information is helpful, even if the next steps—assessing the economically measurable dimensions and other features of the natural world—are difficult.

Below, I briefly catalogue the wider dimensions with which we need to come to grips.

- We need to keep in mind that the public-good value of a natural asset may be its dominant feature. But assigning a "shadow price" to that feature is a perplexing task, little informed by the empirical record or experience.
- The marketable potential of services generated by a sustainably preserved natural asset may be undermined because of a lack of information or flawed institutional and legal factors.
- An effective transnational governance regime, ensuring incentive, implementation, valuation, and enforcement provisions, does not exist but is likely to prove critical.
- One cannot dismiss instances in which the benefits (public-good or marketable) lost through natural resource exploitation are more than offset through alternative uses of those resources.
- The previous point reminds us that there is a point beyond which cost–benefit analysis proves futile. Although some skeptics of, say, petroleum development in the Arctic National Wildlife Refuge (ANWR) may compromise in their opposition if the magnitude of probable reserves appears to be unexpectedly large,

[4] The Heinz Center (see earlier footnote) reports that 40 out of 103 identified indicators for the United States have no data yet.

some others, regarding the area as literally priceless and inviolate, will not budge in their hostility to development. Here, the issue takes on a legitimate philosophical or spiritual dimension. No doubt, the position of some dedicated to an off-limits preservation of tropical forests verges on a similar belief system.

Suggested Readings

An extensive literature—by both academic scholars and international and national governmental institutions—has developed on alternative concepts and measures of GDP. The listing below cites just a few of such efforts, some of which I refer to in this issue brief.

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Appendix 1. A Terminological Clarification and Illustration

Clarification

The issue of incorporating "green" accounts into a nation's national income-and-product accounts (NIPA) can be clarified by reference to a few basic relationships. More than 60 years ago, Professor John Hicks, who later won the Nobel prize in economics, pointed out that a rising GDP does not ensure that new investment in a country's private and public infrastructure compensates for the depreciation of such physical capital. In other words, GDP could continue growing (at least for a while) even while the physical capital, on which future prosperity depended, was wearing out. Hence, a precondition for at least maintaining prevailing levels of economic well-being is constancy in the value of NDP, which equals gross output minus depreciation or, as NIPA labels it, "capital consumption allowances" (CCA). Critics of conventional NIPA measurement practices recognize the constant-NDP condition as a necessary, but insufficient, basis for sustained levels of economic activity because it fails to account for changes in the stock of environmental and natural resource assets. It is at this point where the seemingly dry question of NIPA measurement conventions links up with the deeper, more emotionally charged issue of society's prospects for a sustainable future.

Illustration—Case A

If a country produces $100 in oil from its proven oil reserves but does not replace it with development and validation of newly proved reserves, we obtain:

	Conventional measure	Adjusted measure
GDP	100	100
Minus: CCA	0	100
Equals: NDP	100	0

Illustration—Case B

If a country produces $100 in oil and also spends $100 replacing it with new reserves, we obtain:

GDP	200	200
Minus: CCA	0	100
Equals: NDP	200	100

Clearly, the country's failure to consider reserve depletion or replacement distorts its social accounting system by overstating changes in its real wealth (i.e., economic well-being), as represented by its NDP.

Appendix 2. Mountain-Top Removal in Appalachia: A "Green GDP" Issue?

A great deal of public discussion and controversy has taken place regarding the growing practice by coal companies of shearing off chunks of Appalachian mountainous terrain overlying underground coal deposits. Insofar as that practice reduces mining costs and enhances productivity, it is an unambiguous plus for the economy. On the other hand, and just on visibility grounds alone, it is easy to appreciate some people's dismay over this trend. To use this somwhat closer-to-home issue as an analogue to concept and measurement dilemmas discussed in this paper, consider the following two scenarios:

1. Impaired visibility may diminish proximate property values—say, by reducing the imputed rental value of owner-occupied housing, which is an estimated component of measured GDP. In this case, the effect of mountain-top removal is entirely mediated by the market, the economic outcome depending on how the benefit of cheaper coal compares with the loss of property values. (A plausible caveat to that outcome, not considered here, is the homeowner's recourse to a tort-law claim for compensation against the coal company.)
2. However, the market may not reflect the possibility of forgone benefits substantially exceeding the reduction in property values. Hikers, campers, and others treasuring the mere existence and beauty of what they perceive to be a now-degraded landscape may experience a loss which, if captured in an adjusted GDP, could wipe out any net benefits reckoned in the first scenario. To be sure, quantifying the approximate monetary equivalent of such a GDP penalty would be a devilishly difficult task. Yet economists have developed innovative approaches to similar measurement challenges that might be applicable to the kind of example posed here.

In both of the above scenarios, I have ignored possible environmental and health costs, such as groundwater contamination or streamflow degradation. If remediation of such conditions required public expenditures, this negative side to mountain-top removal would, appropriately, appear in a conventional accounting system. Without such mitigation, the economic benefits of the coal extraction practice would be overstated, pointing to the need for a corresponding "green GDP" adjustment to capture society's welfare loss.