A Forum on Sustainability, Well-Being, and Environmental Protection: What's an Agency to Do?

Panelist Précis Papers

The Office of Research and Development (ORD) of the U.S. Environmental Protection Agency (EPA) hosted a forum in the Ronald Reagan Building and International Trade Center in Washington, D.C. on December 2, 2005 to explore the relevance of sustainability to an environmental protection mission and how it can be carried out. More than 100 EPA managers and staff and other professionals with interests in economics, environmental sustainability and human well being heard four panel discussions that featured distinguished economists and other experts and their interaction with the attendees.

The first panel grappled with conceptual issues, e.g., whether sustainability is tantamount to intergenerational equity and what sustainability's relationship is to environmental protection. The remaining panels discussed what the mainstreaming of sustainability might engender at the ground level: How might policy design and assessment be affected? What about how environmental quality and societal well-being at measured at the national level?

Following the agenda are brief papers prepared by Forum panelists which summarize some of the central points in their thinking about the issues discussed. The papers have been edited for consistency of style.

Panel 1: Basis

Moderator:	Herman Daly	University of Maryland	
Panelists:	Geoffrey Heal	Columbia University	
	Tony Janetos	The Heinz Center	*(Forthcoming)*
	Bryan Norton	Georgia Institute of Technology	

Panel 2: Measurement

Moderator:	Kirk Hamilton	The World Bank	
Panelists:	Mark Anielski	Independent Consultant	
	Bhavik Bakshi	Ohio State University	
	Joy Hecht	Independent Consultant	
	Lisa Wainger	University of Maryland	

Panel 3: Policy Options

Moderator:	Jay Benforado	EPA	
Panelists:	Meghan Chapple-Brown	SustainAbility	
	Rich Howarth	Dartmouth College	
	Bryan Norton	Georgia Institute of Technology	*(See Panel 1)*

Panel 4: Policy Assessment

Moderator:	Tom Tietenberg	Colby College	
Panelists:	John Gowdy	Rensselaer Polytechnic Institute	
	Rich Howarth	Dartmouth College	*(See Panel 3)*
	Billy Pizer	Resources for the Future	
	Mike Toman	Johns Hopkins University	

Panel 1: Basis

Geoffrey Heal
Columbia University, New York, N.Y.

What is sustainability?

There are two elements to a satisfactory definition of sustainability: one is a fair distribution of benefits of economic activity between present and future and the other is controlling impact of economic activity on the environment. Both are classic issues in economics with literature going back a century or more. So "sustainable development" is that which treats all generations "fairly" and "controls" the impact of development on the environment. Let's look at each of these issues in more detail.

Distribution over time

A general ethical principle is that all generations should be treated equally – futurity in itself does not have ethical implications. However wealth and income do – and later generations have historically been richer than current ones. This suggests that we should not ask relatively poor present generations to sacrifice for their richer successors, at least in the economic sphere. (This is an implication of Utilitarian and Rawlsian ethical systems.) This is interesting as many people believe that sustainability is about asking present to make sacrifices for the future.

The policy implications of such issues revolve mainly over the choice of a discount rate in long-term investments. There are two elements in a discount rate - the pure rate of time preference, which controls the relative weighting of different generations: there is general agreement that this should be zero (Heal 2005), and the consumption discount rate, reflecting changing marginal valuation of consumption as a result of changing economic circumstances, such as rising income levels or falling environmental amenities. This may be positive or negative (Heal 2005).

Economy-Environment Interactions

The key issue here is that environment provides services, ecosystem services, which benefit humans. Although we think of ourselves as dependent on high-tech devices, are actually much more dependent on basic bio-geo-chemical cycles that are run by ecosystems (Heal 2000, National Academy 2004). An external effect of economic activity is often to damage these services or the ecosystems providing them. The standard policy response is to raise the prices of activities that affect the environment, examples being a carbon tax, or a cap & trade system on carbon. These should raise the price to the point where the private cost reflects the total social cost. To do this we have to place a $ value on the destruction of environmental systems. Fortunately the valuation of non-market ecosystem goods and services is an active field: the National Academy (2004) recently published the report "Valuing Ecosystem Services" and the EPA's own SAB is drafting a report on "Valuing the Preservation of Ecosystem Services."

Policy Implications

One policy implication of seeking sustainability is that we should tax (or put cap and trade systems on) activities that affect our ecological infrastructure negatively. The tax or permit price should reflect external costs of environmental impacts, which means valuing these services. Another implication is that we must use the right discount rate: there is a presumption this is zero unless income will be growing (in which case it is positive) or unless diminishing environmental amenities will reduce well-being (in which case the discount rate is negative).

References:

Geoffrey Heal. 2000. *Nature and the Marketplace: Capturing the Value of Ecosystem Services*, Island Press.

______. 2005. "Intertemporal Welfare Economics and the Environment, *Handbook of Environmental Economics*, Vol. 3, Karl-Goran Maler and Jeffrey R. Vincent, eds. North-Holland.

National Academy of Sciences Press. 2004. *Valuing Ecosystem Services*.

Panel 1: Basis

Tony Janetos
The Heintz Center, Washington, D.C.

(Placeholder)

Panel 1: Basis
Panel 3: Policy Options

Bryan Norton
Georgia Institute of Technology, Atlanta, Ga.

Although intergenerational equity identifies an important aspect of sustainability, this specification is only the starting point in defining the term, because there are several possible ways in which "equity" might be interpreted.

These include equity comparisons understood as measures of welfare of populations that exist at different times. But this concept is also ambiguous:

1a. Equity = a relation of fairness measured as no declining, societal wealth (just savings rates), aggregated cross all people ("fair"/"just" savings rate?).

1b. Equity = a relation between the average buying power of people at different times.

2. Equity = a matter of just deserts: x and y are treated equitably when x and y receive equal returns on efforts expended, as compared across individuals living at different times.

3. Equity = fair access to governance by procedurally just institutions.

4. Equity = "capacity" (Sen).

5. Equity = access to non-declining stock of opportunities (and there may be many variations on defining this). 5 maintains independence of 1a or 1b by defining opportunities in non-economic terms. (Norton, 2005, makes one attempt at combining 3 and 5, and encourages further contributions from 4.)

Below, I will argue for a hybrid of 3 and 5, which also encourages a contribution from 4.

Although many economists and philosophers <u>assume</u> either 1a or 1b will best represent equity across generations, some allude to additional conditions evocative of 2, 3, 4, and 5. 1b is worth further thought; it would, however, be tougher to measure, so 1a is usually chosen as a stand-in for the more plausible 1b, because there is assumed to be a significant "causal" relationship between the amount of capital available for investment in increased productivity and associated opportunities. 1a, however, is problematic for several reasons:

- Solow (1993) uses this conception to derive a "paradox of sustainability" and uses this as an argument that sustainability advocates are "faintly phony" and morally inconsistent. When philosophers encounter paradoxes based on definitions and assumptions, they usually see this as a "reductio ad absurdum" of the definitions and assumptions propounded.

- Accepting either version of 1 implies that, in order to assess impacts on their welfare, we must know what people in the future will need/prefer, It thus leads, when coupled with consumer sovereignty, to the "ignorance argument," which is used by Solow to undermine otherwise reasonable attempts to specify what *should* be saved or avoided. Lacking some such specification, Solow's system suffers from obvious counter-examples:
  - Toxic time-bomb cases.
  - Arguments that future people would not be harmed by gratuitous destruction of spectacular natural features and special places (because we don't know if they will like them).
  - The claim that what people in the future will want is "none of our business" = nihilism.

Given these problems, it makes more sense to treat cross-generational comparisons of welfare measures ("intergenerational equity") as one aspect of "intergenerational fairness, in order to assess impacts on their welfare in order to assess impacts on their welfare" and then treat the broader intergenerational fairness as what is at stake in sustainability. Or, we should seek another definition altogether.

I prefer the latter alternative. Accordingly, I seek a definition of intergenerational fairness in terms of some combination of (3) and (5) (perhaps further illuminated by (4)). But (5) requires that we ask, given what we now know and can know, what we SHOULD save for the future—which results in a normative, not just descriptive, notion of intergenerational fairness and of sustainability. (3) requires that we begin today to create more equitable and sustainable institutions governing access to resources, which resolves Solow's paradox by implying that addressing the plight of the poor today is simply the first step in building fair and sustainable institutions to govern access to resources. To ignore the present and invest in the future would violate the fairness principle today, just as failing to secure access to resources for future people would be unfair to them. On this view, there is no conflict between the present and the future: to protect access in the future, we must develop fair institutions that can be accessed today.

Panel 2: Measurement

Mark Anielski
Anielski Management, Inc., Edmonton, Alberta

1. *How do we know if we are progressing toward sustainability and/or when it is achieved?*

To answer this question requires a firm philosophical foundation in what we mean by sustainability. Sustainability is sometimes narrowly defined in physical terms as environmental sustainability and refers to maintaining environmental functions. Economists prefer a broader definition and see sustainability as the requirement to maintain the value of total stock of capital intact or non-declining where capital assets include manufactured capital, human capital, natural capital and sometimes social capital. Another definition of sustainability in economics is non-declining utility or well-being over time (Neumayer, 2004) or that intertemporal social welfare must not decrease over time (Arrow et. al., 2004).

A more comprehensive perspective sees sustainability as the requirement to maintain the capacity *to provide non-declining well-being over time. I prefer this latter definition and use it as the basis of the sustainable well-being measurement and reporting systems I have called "Genuine Wealth" accounting.* The Genuine Wealth accounting model is based on the words "genuine," meaning to be true or authentic to one's values and "wealth" from the original Old English definition meaning "the conditions of well-being." The Genuine Wealth model was designed as a process and tool by which governments, communities, and business could measure the physical and monetary conditions and, thus, sustainability of their five key capital assets: human, natural, social, manufactured, and capital, using both citizen quality of life value to weight indicators in the creation of both composite qualitative indices (Genuine Well-being Index) of sustainability and full-cost monetary estimates (e.g., the original US GPI).

Sustainability in the Genuine Wealth model is achieved when there is non-declining overall well-being measured by a composite qualitative Genuine Well-being Index (GWI) and a monetary Genuine Progress Indicator (GPI)—a full-cost accounting sustainable income statement. In the Genuine Wealth model, sustainability is being achieved when the overall integrity of the five core capital assets of a community or organization (human, social, natural, built and financial capital) are non-declining in their overall physical and qualitative "condition." In this model, the conditions of the capital stocks and flows can be reported both in physical/qualitative terms (composite indices) and monetary (full cost) accounting terms.

The Genuine Wealth model is grounded in traditional double-entry accounting conventions that include a full account of a community's "assets," its "liabilities" (i.e., risks or threats to future well-being and sustainability), and an analysis of equity and distribution of "wealth" in the community. The result is a new "genuine wealth" balance sheet. The model also incorporates Ecological Footprint analysis to show the relationship between household demands on natural capital and nature's capacity to supply our human needs with non-declining flows of ecological goods and services. As long as the ecological footprint of a community, state, or nation does not exceed the available biocapacity of natural systems it depends upon for well-being, then sustainability is being achieved.

I am also a strong advocate for The Natural Step's (TNS) four system conditions, which provides the best principle-based framework for sustainability planning and measurement. In plain language, the TNS system conditions for sustainability include living off the interest of nature's renewable natural capital, avoiding toxic emissions to waste into air, land, and water that is toxic (not food) for nature (i.e., waste = food), and ensuring the basic needs of all species and people in society are ensured and equitably distributed. Progress towards sustainability can be measured in terms of the progress a community, state/province or nation is making towards meeting these four system conditions. There are a plethora of tools and indicators to measure progress including Genuine Progress Indicator (GPI)/ISEW (Index for Sustainable Economic Welfare), natural capital accounting, "green" GDP accounting, Genuine Savings Rate, quality of life indicators, Ecological Footprint

Analysis, Living Planet Index, Human Development Index, Life Cycle Analysis (LCA), and other systems for sustainability accounting.

2. *What is the relationship between national income accounts and sustainability?*

National income accounts are only marginally beneficial in accounting for sustainability. Although they do account for the financial flows in an economy measured by the monetary value of all goods and services produced and traded in an economy (i.e., the GDP or GNP), they only represent the "income statement" of a nation. They do not provide the more important account, which is a "balance sheet" of the natural, human, social and built capital "conditions" of a nation or community. Moreover, the national income accounts that are used to derive measures of economic progress, like the GDP, do not distinguish between consumption expenditures by households; for example, that actually contribute to improved well-being and those that may be regrettable expenditures which detract from well-being and hence sustainability (e.g., the depreciation of human, social and natural capital assets). National accounts must thus be revised, in my opinion, along the lines proposed by the United Nations System of Integrated Environmental and Economic Accounting (SEEA), to include accounts for natural capital and ecosystem service values. Although SEEA is an important step, it still does not provide us with the new "balance sheet" for the five capital assets (and liabilities) that nations will need to manage a genuinely sustainable path.

3. *To what degree has environmental reporting reflected sustainability?*

Environmental reporting (e.g., State of the Environment reporting) has provided mixed results with respect to providing a holistic and integrated portrait of sustainability. The reason, in my opinion, is that such reporting is not grounded in a solid conceptual framework of sustainability (e.g., like TNS). Without such a foundation the set of indicators used to assess environmental conditions are simply a potpourri of measures that, although interesting in and of themselves, still do not provide us with a holistic and integrated portrait of overall sustainability.

4. *Do holistic measures to measure sustainability exist?*

Holistic measures of sustainability do exist or are emerging. These include the Genuine Progress Indicator (GPI) or Index for Sustainable Economic Welfare (ISEW), Genuine Savings Rate, Ecological Footprint Analysis, and the Genuine Well-being Index that I have been developing based on the integrated-five-capital/wealth model. I do not believe we have achieved the ideal holistic index, which may be illusive, that will suit everyone's needs. I believe that the first order of business is the development of a new accounting system, building on the experience of the System of National Accounts, along the lines of the Genuine Wealth integrated/consolidated, five-capital sustainability accounting system.

Kirk Hamilton's Questions:

1. *What frameworks for sustainable development indicators (national accounts, material flows, etc.) are likely to be most useful for decision-makers?*

I like the proposed SEEA framework developed by the United Nations, World Bank, and other international leaders in natural capital accounting. It provides the most conceptually rigorous framework for measuring natural capital stocks, flows, material and energy flows, natural capital productivity, and environmental expenditures. However, SEEA does not address the shortcomings of the SNA, which includes inadequate accounting for human/social capital.

I recently produced the following table for the Chinese Government (National Academy of Sciences) in August 2005, when advising them on what I believed were the best frameworks for sustainability indicators and reporting:

Definition of Sustainable Development	Name of Indicator	Type of Measure	Sources
Enhance social well-being/welfare now and safeguard welfare for future generations whilst providing within and between generations and protecting biological diversity and maintaining essential ecological processes.	Australia National Strategy for Ecological Sustain-able Development Indicators; Canada's national Environment and Sustainable Development Indicators; UK Sustainable Development Strategy Indicators	Flow-multiple indicators	Environment Australia (2002), Canada's National Round Table on the Environment and the Economy (2003)
Measures the change in social well-being, through several economic, social and environmental indicators, covering consumption (broader GDP) and value of capital stocks. A larger number signifies greater sustainability.	Genuine Progress Indicator (GPI); Index for Sustainable Economic Welfare (ISEW); Index of Economic Wellbeing (IEW)	Flow/stock aggregated indicator	GPI Atlantic (Canada) Anielski/Pembina Institute (Alberta GPI) Hamilton 1998 (Australia GPI) Redefining Progress (US GPI) Daly and Cobb 1989 (ISEW) ISEWs calculated for Australia, Austria, S. Korea, Chile, Germany, Italy, Netherlands, Scotland Sweden, Thailand, the UK IEW (Osberg and Sharpe 2002)
Measures national income or output adjusted for the depletion of natural resources and degradation of the environment. A large number signifies greater sustainability.	Green GDP	Flow-adjustment to national accounts	SEEA 2003
Measures the net change in national assets including natural and human capital. A larger number signifies greater sustainability.	Genuine Savings Genuine Investment	Flow-adjustment to national accounts	Hamilton and Clemens 1999
Measures an economy's capital stocks, using weights from the estimation of shadow prices for each capital component (human, natural and manufactured capital). Non-declining net (weighted) capital stocks indicate that the current set of development activities is sustainable.	Inclusive Wealth	Stock-aggregated measure	Arrow, Dasgupta and Mäler 2003
Measures the physical and monetary conditions of each capital component (human, natural, social and manufactured capital) of an economy, community or region, using both citizen quality f life value weights and shadow prices of each capital component. Non-declining overall well-being, using an aggregate Genuine Well-being Index (measured both in qualitative and monetary terms) indicates that current development activities are sustainable.	Genuine Wealth	Combination of flow-multiple indicators and stock/flow aggregated indicators	Anielski 2004

2. *What are the roles and strengths/weaknesses of biophysical, economic and social indicators related to sustainable development?*

Indicators are simply proxies for the conditions of "wealth"—properly defined as "the conditions of well-being," which would include the conditions of human, social, natural, and built capital. Indicators are only as good as how to reflect these conditions (strengths and weaknesses) of the nation's overall capital assets. Within an ecological economic framework (where the economy is a subset and dependent on the ecosystem), priority of indicators would be aligned with a spectrum of needs versus wants or according to Herman Daly's proposed hierarchy from ultimate means (natural capital), to intermediate means (built and human capital), to intermediate ends (human and social capital) to ultimate ends (well-being). (See diagram)

3. *Are there assets that are non-substitutable (i.e., strong sustainability holds), and how should this affect measurement?*

From my perspective as an ecological economist, there are many natural capital assets and ecosystems that are non-substitutable. Indeed, one could argue that all natural ecosystems (in their natural state of homeostasis) have no suitable human-built replacement (e.g., Biosphere II, whose massive financial investment on a per acre basis failed to replicate a naturally functioning ecosystem). The bottom line is that we cannot live without natural ecosystems that provide a steady flow of ecological goods and services for very long. However, on a practical basis, the question is what level of human pressure on ecosystems is acceptable before potential "tipping points" emerge that threaten both the integrity of the ecosystem and future human well-being. The issue is one of determining the relationship between human demands (needs) on ecological goods and services from ecosystems and the state of ecosystem integrity.

4. *Will aggregate sustainability indicators be useful for environmental agencies, given that environment is just part of the sustainable development puzzle?*

Aggregate indices are possible to construct. The key is that the accounting system is transparent so that even if we aggregate individual indicators into a composite sustainability profile/index, each individual indicator that makes up a composite index can be examined. The challenge of aggregation is one of weighting of respective indicators; that is, determining which indicators are more important than others in defining sustainability and well-being. This challenge of weighting and tradeoffs requires sound science, economics, and politics.

Panel 2: Measurement

Bhavik Bakshi
Ohio State University, Columbus, Ohio

I define sustainability as the conservation of the total economic, natural, and social capital over temporal and spatial scales, without going below their respective critical limits. This definition allows for limited substitution between different types of capital, provided that critical limits are not violated. Using this definition requires better understanding of the relevant systems, better data about these systems and interdisciplinary methodological advances. Currently, some aspects of this definition can be quantified, as is done by many existing sustainability metrics, including my own research.

My research focuses mainly on considering the economic and ecological aspects of industrial products and processes. Thus, my position is least influenced by social considerations, not because I don't consider them to be important, but because I have not included them in my work except via economic considerations. I have been developing biophysical methods for quantifying the contribution of ecosystem goods and services for industrial activities, and have used thermodynamic methods for meeting this goal. These methods use the concept of exergy or available energy, are scientifically rigorous, and can address the following challenges that are often inadequately addressed by existing methods and metrics:

1. Fusion of diverse material and energy flow data can be accomplished via their exergy content. This also quantifies the quality differences between different sources of energy or materials. The use of exergy can avoid the type of "apples to oranges" comparison that is common in many environmental reports or sustainability metrics.

2. Exergy is the ultimate limiting resource for all activities. Ecosystems transform global energy inputs to ecosystem goods and services, which are transformed by industrial systems to economic goods and services. Thus, exergy provides a common currency for joint analysis of industrial and ecological systems and should form the core of environmental sustainability metrics.

3. Exergy of ecosystem goods and services provides information about the work that is done in ecosystems to make human and industrial activities possible. This information should be combined with valuation methods to obtain monetary values of natural capital. This will permit combination of biophysical and economic methods and may result in holistic metrics that combine economic and ecological aspects.

My position regarding sustainability metrics is that if they are calculated over narrow boundaries, as is commonly done by corporations or cities, they may encourage a shift of unsustainable activities outside the selected boundary. Hierarchical metrics at multiple spatial scales based on a life cycle view are essential for these metrics to be meaningful. The use of exergy for quantifying material and energy flows can avoid misleading results, as mentioned in the previous paragraph.

Another area that I think can result in fundamental advances in assessing sustainability is the understanding and analysis of industrial and ecological systems as complex networks. Resilience of such systems to human and other disturbances is essential for their sustainability. Resilience is also a property that is more oriented towards the dynamics of systems, and avoids the usual steady-state connotations of most definitions of sustainability. Much more work is required for understanding the characteristics of complex industrial-ecological networks and identifying characteristics that ensure resilience and sustainability.

I feel that EPA should use achieving sustainability as its overall mission and reorient existing and new activities under this theme. In collaboration with various government agencies, industry and academia, EPA should develop tools and techniques for evaluating technologies and policies from the viewpoint of sustainability.

Panel 2: Measurement

Joy E. Hecht
Consultant on Environmental Economics and Policy, Washington, D.C.

Sustainability and sustainability indicators have become big business. At the global, national, state or provincial, and municipal levels, elaborate systems of sustainability indicators have been developed. But, do they actually tell us anything about sustainability? If public policy moves those indicators in the "right" direction (when we know what the right direction is—will we really be sustainable, and will we know it?

Since it came into common parlance after the Rio conference in 1992, the word "sustainability" has been used to describe everything from keeping our air and water clean, to finding new economic activity for towns whose old industries are gone, to ensuring that people in small African villages can retain their traditional way of life. We speak of the three "pillars" of sustainability—economic, environmental, and social—and the need for all of them to be sustainable in order for the system as a whole to be sustainable.

Sustainability has a reasonably clear definition in economics; a sustainable economy is one in which the ability to generate income is maintained, usually because assets retain their value. The term can also have a reasonably clear meaning in biology; an ecosystem is sustainable if at some level the species within it continue to exist and interact with each other, with only gradual evolution of species or the niches they occupy. Social sustainability is harder to define, however. Many advocates argue that to be sustainable, a society must be equitable, participatory, and democratic. But inequitable and dictatorial societies have been sustained very effectively for millennia; this interpretation doesn't hold up to an ordinary understanding of the English word "sustainability." It may be more appropriate to think of the third pillar of sustainability in terms of what we *want* to sustain; society might be considered sustainable if it is economically and biologically sustainable while achieving desired social values such as equity.

How Do Indicators Relate to Sustainability?

Sustainability indicators track progress in the economic, environmental, and social arenas. The United Nations' system, which often serves as a model, has 58 indicators.[1] The economic indicators include familiar measures such as GDP per capita, as well as measures of consumption and waste generation. The environmental ones look at ambient air and water quality, greenhouse gas emissions, land use and land cover, and species diversity. The social indicators track life span, nutritional status, education, population, and child mortality. Clearly these indicators cover a range of issues that we care about. However, the real question is what they tell us about *sustainability,* above and beyond economic well-being, environmental quality, or public health. If the value added from thinking in terms of sustainability is that it forces us to be holistic, can our indicators do the same?

Individual Sustainability Measures

Only a few individual indicators actually capture sustainability even a single arena. If we know the ambient concentration of air pollutant that is safe to breathe, air quality is a direct measure of sustainability, because we know that if it exceeds the safe level, people will sicken. However this single indicator only addresses environmental health, so it is only a partial measure of sustainability. Moreover, if we exceed the standard, we know we are *not* sustainable, but if we fall within it, we don't know that we *are* sustainable. This is a common quality of sustainability indicators; it can be easy to determine that we are not sustainable, but it is very hard to determine that we are.

[1] Details are on the web at www.un.org/esa/sustdev/isd.htm.

Sustainability Indices

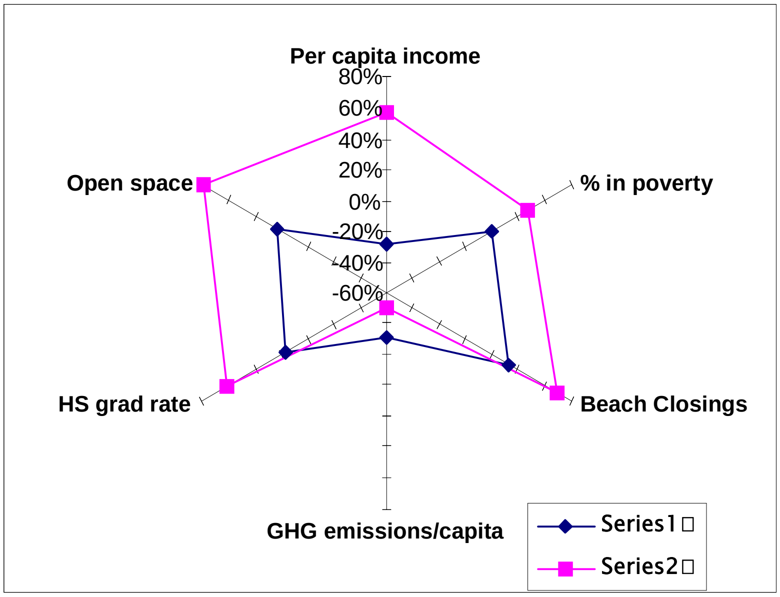
Some measures combine many indicators into a single index that includes components from all three pillars. The Genuine Progress Indicator (GPI), the ecological footprint (EF), and Genuine Savings (GS) are among the best known of such indices.[2] They add together a complex of "progress," "footprint," or savings indicators to obtain a single index quantified in monetary terms (in the case of GPI and GS) or land (in the case of the ecological footprint).

Such indices provide a simple view of the overall sustainability of the society, but raise questions about how tradeoffs are handled. Genuine Savings, for example, takes the savings rate, a basic measure of economic sustainability, as its point of departure, modifying it to bring in change in the value of natural resources and human capital, all valued in monetary terms. A positive GS measure is considered sustainable and a negative one is unsustainable.

This is simple and elegant. However, it assumes that assets can be traded off against each other at will and the society may be considered sustainable as long as the result is positive. It is an excellent measure of "weakly sustainable income." The word "weak" here means that different income sources can be traded off against each other, whereas in "strong" sustainability each income source must be protected and tradeoffs are not acceptable. Even if we do feel tradeoffs are acceptable, a composite index like GS doesn't explicitly show us what the tradeoffs are or allow us to decide which ones to make. A genuine savings figure based on cutting down forests to invest in education can be the same as one based on sustainable forest management with less investment in schools or industry. The choice between the two strategies gets lost in the aggregation.

Indicator Suites

An alternative to indices is to maintain a set of discrete indicators, presenting them in a way that highlights tradeoffs among them and clearly shows how well each is doing relative to some agreed-on target. The key issue in this kind of presentation, and the way in which it differs from the UN indicators, is that the indicators are not used alone; they are always part of a suite of values tracked in relation to each other. If any one value lags behind, the whole system is considered unsustainable.



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[2] For information on GPI and EF, see www.rprogress.org/projects. For the World Bank's most current information on GS, use "Google" to search "Adjusted Net Savings."

Visual presentation can help understand these measures, as the spider web graphic (called a "radar chart" in Excel) shows. This example provides data on six indicators, for a baseline and two subsequent series. The baseline is at 0 percent for each value (which is not the center of the graph). The inner polygon on the chart represents Series 1 and the outer polygon Series 2. In this example, four indicators improved continuously from the baseline through Series 2, as shown by the Series 1 data point being outside of 0 percent and the Series 2 point outside of Series 1. Per capita income declined between the baseline and Series 1, and was considerably better by Series 2. Greenhouse gas emissions became steadily worse (higher) throughout the time period.

A graphic like this gives a quick visual check of whether the overall system is becoming better or worse; movement towards the outside of the graph always means improvement, while creep to the center means we are becoming less sustainable. If we had a full time series, however, this presentation would become very hard to follow; moreover, this picture will only show tradeoffs among indicators if they are very simple.

Conclusions

Sustainability indicator systems will not give a definitive answer as to whether society is sustainable. They can, however, track sustainability in ways that go beyond what the underlying indicators could do outside of the system.

- Some individual indicators, such as pollution or savings, flag when our system is unsustainable even if they can't clearly tell us whether it is fully sustainable.

- Such indicators also show whether we are moving in the right direction with respect to individual issues.

- Where there is agreement that tradeoffs are acceptable among the elements of sustainability, composite indices are a simple and elegant flag to draw attention to big-picture trends in the evolution of the society.

- Where trade-offs are not acceptable, indicator suites presented in a format such as the spider web give us a sense of the whole system rather than considering one value at a time, drawing quick attention to both successes and failures.

Panel 2: Measurement

Lisa A. Wainger
University of Maryland Center for Environmental Science, Solomons, Md.

Sustainability implies a goal of allocating resources between current and future generations so that production opportunities for future generations are preserved. The concept works as a guiding principle, yet generally fails when we try to develop comprehensive measures of sustainability. Much disagreement exists regarding what assumptions to make in our analyses of sustainability in terms of potential technological advances, preferences of future generations, equity among different groups of people or countries, and acceptable levels of risk. Scientific analysis alone does not address these general questions regarding equity or other social concerns.

While a vague definition of sustainability does not directly lead us to a set of measurements applicable to EPA's mandate to protect human health and the environment, we can break the problem down into component parts for analysis. We may define indicators that assess components of sustainability, if we are willing to make certain value judgments. We must typically decide what consumption levels we are sustaining and for whom, but in specific cases, we can reasonably expect to arrive at societal consensus for concern, if not action. For example, observable connections can be drawn between land use decisions and negative consequences such as water quality degradation, flooding, air pollution, etc. From this type of understanding, indicators (derived from models) can demonstrate enhanced probability of negative consequences due to changes in natural resources. These types of measures of enhanced risk from resource use decisions provide a reasonable method to assess the likelihood of systems providing a stream of services into the future.

A great deal of environmental information has been collected, but it is not clear that information is used or understood by decision-makers. Desirable indicators are those that are cost-effective for managers to use yet most environmental indicators take a great deal of effort to understand and still do not provide clear guidance for making resource use trade-offs. If the reason to develop sustainability indicators is to influence decisions, then indicators must be part of a framework of human goals and desires.

To understand the connections between the ecosystem indicators that are typically measured and outcomes that can be valued by people, we can use the concept of a production function that connects natural resources to the production of an ecosystem service. Ideally, an equation would be developed to describe the relationship between production of an ecosystem good or service and: (1) the characteristics of an ecosystem needed to produce a biophysical function (e.g., presence of particular vegetation in a given topographic setting that generates aquifer recharge), and (2) the complementary built or human components needed to turn that biophysical function into a service (e.g., presence of homes with wells using that aquifer). Such production functions will be service-specific and change scale with the service of interest. Our level of understanding of natural systems will typically not allow us to create exact quantitative production functions and, further, may prevent us from assigning dollar values to such services. However, our current best understanding can be applied to derive general but still useful relationships between ecosystems and the services they generate. Such general relationships lend themselves to development of indicators that reflect risks to human welfare and can be assessed for robustness for making management decisions.

Sustainability as Risk Management

Sustainability has been defined as the maintenance of the fundamental services provided by the environment at or above some minimum levels. This definition frames the sustainability analysis as one of evaluating how far certain resources can be depleted and at what rate pollution can be emitted (or total stock of a pollutant allowed to accumulate) before life-support systems are undermined. In order to use indicators as measures of this definition of sustainability, we must recognize the uncertainties inherent in predicting how ecosystems and people will respond to change. Acknowledging the uncertainty alters our sustainability framework from a purely technical focus to one of risk management considering our collective risk tolerance.

Risk can be defined as the variability of returns and/or the potential for large losses. Risk tolerance then has two aspects: the ability to absorb risk and the willingness to take risks. The ability to absorb risk is measured, in part, as the proportion of all wealth in risky assets. The willingness to take risks can be measured by examining how much higher the potential return has to be for a risky investment in order for the investor to be indifferent between a risky and non-risky investment. Similarly, a strategy for investing in (e.g., preserving or restoring) natural resources can be based on a region's risk tolerance. Existing assets can be examined for status and vulnerability to stressors in order for a region to understand its capacity to absorb risk. Institutions tasked with managing risk should have a clear idea of the effective institutional willingness to take risks and ensure that it conforms to the public's risk aversion.

Regional policymakers with the role of protecting the public interest need a set of indicators that helps them to understand the cumulative effects of individual actions and what incentives might be used to change those actions. Such a system of measures should …

- Address management (investment) goals that are defined in terms of returns to society
- Use meaningful scales to assess assets and services
- Reflect socially acceptable risk levels for different services
- Manage risk by considering whether assets are vulnerable to the same risks and whether investments can be diversified among those with inversely correlated risks
- Dynamically manage investments using all available policy tools (e.g., regulation, taxes, trading, and incentive systems)

Ecological indicators are evolving from a purely technical focus on documenting changes in ecosystems to include social and economic concepts like equity, scarcity, risk, and cost-effectiveness, which will enhance their ability to support management decisions. However, most reporting of ecological condition still has a limited focus on deviation from historical norms. Resource managers not only need information about degradation, but also need to understand how that degradation impacts people, what alternatives are available to maintain services through restoration and mitigation, and what opportunities or outcomes will be sacrificed in exchange for taking various actions. Our current ad hoc collection of environmental indicators, which is based on the needs of particular government programs, could be enhanced to maximize the cost-effectiveness of environmental monitoring. With forethought and planning, flexible data sets can be created that can feed into a variety of biological, physical, economic, and social analyses that better support decisions on how to sustainably use our resources.

Panel 3: Policy Options

Meghan Chapple-Brown,
SustainAbility, Washington, D.C.

SustainAbility sees a need for EPA to address some of the United States' and thus the world's most pressing environmental issues from a perspective of sustainable development. EPA activities, networks, and policies will need to consider not only end-of-pipe approaches, but also pre-emptive solutions that involve multiple stakeholders and employ creative market strategies.

During the panel session, I offered examples of current market dynamics and corporate practices. It is my hope that these real-life cases provided insight into the development process of EPA's sustainability policy. Given our experience in helping organizations evolve from one stage to another, I also provided intelligence on institutional and group dynamics during change and suggested some options to encourage a change process within EPA.

My perspective is based on my definition of sustainability policy and how it is different from environmental protection policy. In simplified terms, the first phase of environmental protection policy has meant setting and enforcing limits to damaging inputs into the air, water, and land. The intent has been to control damaging effects on our surroundings in the midst of industrial activity, urban growth, and agriculture and forestry development. These policies have been successful in curbing end-of-pipe pollution of existing corporate and municipal practices and raising awareness of environmental dangers.

Recently (1990s), environmental protection has entered a new evolutionary phase beyond command and control regulation and into eco-efficiency solutions. EPA has worked with industry through programs such as Performance Track to identify companies developing systems to reduce or replace inputs such as water, materials, and electricity. This results in pollution prevention at the source, lower costs, and lower environmental impacts. However, in comparison to the large scale of negative environmental impacts that are growing at exponential rates, the positive impacts of eco-efficiency are incremental and cost-savings are limited.

Thus, pressing questions remain. How do we increase levels of protection such that we are stewards of the environment? How do we provide incentives for large organizations to address the root causes of environmental problems? How do we ensure that all people benefit from sustainable development equally, regardless of social and economic strata? And, beyond companies and municipalities, how do we change individual behavior such that citizen consumers take into account the environmental implications of their decisions?

The next phase of environmental protection is likely sustainability, and it aims to address these questions. Sustainability policy, in contrast to environmental protection policy, promotes proactive, collaborative, and systemic actions such that development benefits people across economic, geographic, and generational strata.

These facets of sustainability policy are based on new realities of the 21st century, including greater global connectedness, a need for transformational change, and complex human and social dynamics in the environmental arena.

The world is more connected than ever. Globalization is here to stay. People, materials, and ideas are transcending geographic boundaries. As a result, environmental issues are becoming more international and require a systems approach that cuts across geographic regions, ecosystems, disciplines (such as socio-cultural interests, economics, science), materials (such as water, land, air), and time (taking into account future trends and impacts that are significantly delayed). EPA's future sustainability policy will need to be more systemic and forward-looking than the environmental protection policy of the past.

Given booming rates of resource use and environmental degradation, sustainability policy must focus on transformational change, as opposed to incremental improvements. To be transformational, policy must go beyond regulating existing industrial production and municipal waste treatment processes, and encourage the creation of wholly new models for business and municipal activity. This is more likely to happen if EPA facilitates corporate and municipal transparency, accountability, and innovation. To be transformational, policy will need to act as a catalyst for change. For example, through multidisciplinary systems analysis, the EPA could identify market problems and leverage points where policy can help jump-start markets for revolutionary business models, products, and services that are environmentally sound. Through market mechanisms and incentives, sustainability policy could facilitate (not necessarily mandate) the creation of new financing models for purchase of green products, business mentoring for new business ideas, or industry standards for high environmental performance.

Sustainability policy solutions can only be accomplished by taking into account complex human and social dynamics in the environmental arena. On one hand, such policy would gain creative juices and public buy-in if it takes input from a variety of stakeholders including activist groups and their messages, research-based non-governmental organizations' (NGOs) insights, and the needs, behaviors, and preferences of various cultural and economic groups in our communities. Additionally, such policy would benefit from considering the power dynamics within government and the private sector to determine how best to achieve environmental results while navigating such power-houses.

EPA is in a unique position to develop sustainability policy in the context of these new realities. Other parties are not in a position to do so. Other governmental agencies do not have the environmental skills, values, and reputation. NGOs are not unified in mission and approach. Companies are operating in different countries and taking on varying levels of environmental protection, but they do not have incentive to scale up the solutions and look to the future. EPA can provide vision and systemic viewpoint to bring these various groups together and then coordinate ecosystem health and resource protection.

If EPA commits to taking this leadership role in sustainability policy, it must get its own house in order. Below are some recommended steps for organizational change within EPA.

1. Create a unifying vision for sustainability policy.

2. Set priority issues (e.g., greenhouse gases, water, ecosystem services).

3. Connect EPA employees who are currently working on sustainability via networks.

4. Benchmark the "competition" (i.e., innovative policies in other countries or other agencies).

5. Identify EPA's strengths and leverage them (e.g., EPA has science capabilities that could assess environmental impacts of a new technology or new materials and then make recommendations to the market).

6. Bring EPA leadership on board to support the change effort.

7. Find powerful leverage points both in government and outside of government. Understand their mental models and use them to navigate the system and accomplish goals.

8. Form partnerships to conduct activities that are outside of EPA purview.

9. Create incentive for internal innovation and experimentation with new programs or initiatives that address the new realities.

10. Maintain space for trial and error. The change process is iterative.

11. Build momentum through "small wins" to show what is possible (e.g., Energy Star, Gas Star, and Performance Track).

Once there is some understanding and some comfort, scale up and set ambitious goals for change (e.g., "EPA will help 50% of U.S. multinational corporations to create a sustainable product or service").

In spite of great barriers and challenges, EPA can institute true change towards more innovative and systemic policy. Even in times of political turmoil or transition, such a change can take place if individuals are committed to the change and coordinating their efforts. There is a clear opportunity for EPA to operate in this new space of sustainability policy, to join various stakeholders, and lead the U.S. environmental movement towards sustainability.

Panel 3: Policy Options
Panel 4: Policy Assessment

Richard B. Howarth
Dartmouth College, Hanover, NH

Under U.S. law, some types of environmental resources have long been recognized as the joint property of all citizens. This doctrine provides the legal foundation for statutes such as the Clean Air Act, the Clean Water Act, and the Endangered Species Act. Under this framework, future generations do not have special rights apart from those held by today's citizens. They do, however, have a right to share in the benefits provided by natural systems. In concrete terms, this *stewardship* or *sustainability* principle has been incorporated in federal practices:

- It has guided federal policies regarding timber, land, and fisheries management since the founding of the U.S. Forest Service in 1905.

- It is explicitly embraced by the National Environmental Protection Act (NEPA), which acknowledges the government's duty to "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations."

Based on this reasoning, the depletion or degradation of environmental resources raises core issues of intergenerational fairness. To fulfill its trusteeship duties under the sustainability principle, government agencies must fulfill at least one of two criteria:

1. Conserve and sustain the services provided by natural systems from generation to generation, and/or

2. Ensure that future generations are justly compensated for environmental degradation.

This approach acknowledges that the use and depletion of resource stocks may sometimes yield efficiency gains that would provide shared benefits to both present and future society. It suggests, however, that proposed policies and management regimes should be evaluated to ensure that they are specifically consistent with the rights and interests of future generations. It is not sufficient that an action provides positive present-value net benefits. Specific mechanisms must be implemented to ensure that future generations in fact benefit from a given action or receive just compensation, possibly through a financial mechanism **like** Norway's Oil Fund or the Alaska Permanent Fund.

Cost-benefit analysis can and should be used to evaluate the welfare implications of alternative policy options. Policy analyses, however, should also explicitly address other issues:

- The distribution of net benefits both between and within present and future generations.

- Moral values and policy objectives that are embodied in statutory language (such as NEPA's reference to the sustainability principle) or that are deeply held by key stakeholder groups.

In policy analysis, economic efficiency as measured through cost-benefit analysis should be viewed as one important goal that should be coordinated with the protection of rights, the achievement of equity, and other values that are articulated through the democratic process.

Cost-benefit analysis confronts unique theoretical and methodological challenges when applied to the analysis of long-term environmental policies. These challenges are rooted in at least three factors:

- Long-term environmental problems are often characterized by high degrees of scientific uncertainty, including the structural incompleteness of fundamental theories. Thus costs and benefits can be difficult to measure in clearly defined, objective terms.

- Since environmental systems involve non-linear dynamics, environmental degradation can lead to the permanent and irreversible loss of system functioning if system thresholds are exceeded. Such outcomes can have catastrophic effects if the system in question provides vital ecosystem services.

- The preferences of future generations are unknown and can be gauged only by extrapolation based on the preferences of today's citizens.

Cost-benefit analysis assumes that people's preferences are fixed and independent of social context. Yet psychologists, sociologists, and anthropologists view preferences as endogenously determined and strongly shaped by social factors, especially over generational time scales. Evidence from social surveys and experimental studies suggests that habit formation and relative consumption effects may significantly shape the relationship between income and well-being. If this suggestion reflects the broader reality, then standard monetary measures might overstate the welfare gains provided by private consumption and understate the social benefits of public goods such as environmental quality.

These challenges suggest the need to assess the completeness, adequacy, and quality of cost-benefit analyses when issues of sustainability and intergenerational fairness are at stake. Key uncertainties should be recognized and addressed with explicit attention to people's preferences regarding low-probability, catastrophic events. Abstracting away from uncertainty or focusing on expected (average or most likely) outcomes can be problematic in this context.

When the future costs of environmental degradation cannot be reliably assessed, the payment required to compensate future generations for environmental degradation cannot be determined. In such cases, the sustainability principle entails that resources must be conserved to protect the rights and interests of posterity, thereby satisfying the government's trusteeship duties.

Panel 4: Policy Assessment

John Gowdy
Rensselaer Polytechnic Institute, Troy, N.Y.

Is sustainability reflected in benefit-cost analysis (BCA)? If not, should BCA be modified, scrapped, or supplemented by other approaches?

The answer to this question, of course, depends on the definition of sustainability. The traditional economic view is expressed clearly in a review article by Arrow, et al., in the Summer 2004 *Journal of Economic Perspectives*. Sustainability means a non-declining per capita income, which in turn means maintaining the capital stock necessary to produce it (the Hartwick-Solow rule). In that framework, "sustainability" doesn't imply anything for policy analysis beyond the standard Walrasian welfare model. With all externalities taken into account (all human preferences correctly reflected in market prices), uncertainty reduced to risk, and so on, the proper policy is to maximize the discounted flow of future income.

The only reason to implement an environmentally friendly policy (e.g., climate change mitigation) would be if that policy increases the discounted flow of future consumption, and that should be done anyway, with or without the sustainability criterion. The question of what current generations should do, if anything, about the well-being of future generations is reduced to choosing the rate at which future income is discounted. In this framework, the goal of economic policy is to identify efficiency gains so that appropriate lump-sum transfers can be used to move the economy toward competitive equilibrium (based on the First and Second Fundamental Theorems of Welfare Economics).

Recent advances in economic theory and in empirical economics have called into question many of the underlying assumptions of the standard approach—including these:

1. Equating per capita income with social welfare, putting aside questions of distribution by invoking the notion of a potential Pareto improvement;

2. Implicitly assuming that money is a universal substitute for anything; and

3. Assuming that preferences are stable and self-regarding so that the costs and benefits to individuals are independent and additive.

Behavioral experiments, neurological studies, and game theoretic experiments have demonstrated that market consumption cannot be equated to well-being, that lexicographic preferences are prevalent, especially with regard to environmental features, and that preferences are other-regarding. How individuals value monetary payoffs depends on social context. These findings have important implications for the use of BCA. If monetary income is assumed to be a proxy for well-being, then the question of sustainability is reduced to "How much money should we leave future generations?" On the other hand, if we use a direct measure of well-being, the question becomes something like "What should we leave future generations to insure that their well-being is not reduced by current human activity?" If preferences are other-regarding, this implies that valuation techniques should be interactive and deliberative.

BCA was developed to evaluate specific projects, like building a particular bridge or levee system. Given the extremely strong and unrealistic assumptions about human preferences, well-being, and substitutability of natural for human made capital, it is inappropriate to expand the scope of BCA to evaluate the sustainability of entire economies.

Panel 4: Policy Assessment

William Pizer
Resources for the Future, Washington, D.C.

I view sustainability as an overused term, often applied interchangeably with "desirable" or "good" by policy proponents. Sustainability, in my mind, is related to three fundamental characteristics of a problem or policy: persistence, irreversibility, and a lack of substitutability. The extent to which a problem possesses these characteristics makes the problem, to me, more or less a sustainability issue.

Before briefly describing these three characteristics in more detail, I should note that the common usage of the word—an activity is unsustainable if you cannot continue doing it indefinitely because of associated harms—lends itself to a fairly generic application. The harms might arise, for example, from a sense of moral obligation, justice, or social welfare that the activity is simply a bad idea. I prefer to emphasize the *continuation* part of the definition; that is, we are looking at something where the period-to-period continuation of an action is aggravating a problem and making it progressively worse.

So why the three part definition? First, if a problem or policy has no persistent effect, there cannot be a sense in which continued activity is making the problem progressively worse. Instead, it is an issue that can be addressed independently, each period, by each generation or government. For example, transient air pollution, to the extent it is not persistent, is not a sustainability issue in my mind. Another way to look at this is whether a current action (or failure to act) leaves a future decision-maker in a different state, with different (presumably fewer and less desirable) options than current decision-makers.

This links to the second issue—irreversibility. If we leave future decision-makers in a different state, with different options, but this state can be undone, I view it as less of a sustainability issue. Like persistence, there is a question of degree. Endangered species or overexploited fisheries may eventually come back. Poorly managed finances—say in the context of social security—or a badly run government can be fixed. The duration of the persistence and the required effort to redress associated with a particular action or inaction can make it more or less of a sustainability question.

Now, here is what I might consider the prototypical sustainability issue: global climate change. Current accumulation of greenhouse gases is clearly a persistent effect and is not something that can be easily undone, if at all. Other environmental degradation that permanently harms the environment I would similarly identify as a sustainability issue.

What differentiates the legacy for future generations of more greenhouse gases from that of less wealth to fund social security is a lack of substitutability. In my mind, the real sustainability issues are problems for which there are not easy, if any, compensating adjustments or substitutions. We only have one atmosphere and climate system—there are no substitutes (though one might argue that we can make compensating adjustments in behavior, such as adaptation). But there are easy substitutes for government funded retirement benefits, namely private savings. As another example, some might argue that our use of fossil fuels, simply by virtue of depleting the resource, is a sustainability issue. I would argue that this is true only to the extent that alternative energy sources do not develop in a timely way as the resource is exhausted.

In laying out these characteristics, my goal has been to push us to think about why, exactly, something ought to be a sustainability issue. Perhaps more importantly, among sustainability problems, how do we differentiate? Sustainability is not the only metric for measuring the seriousness of a problem—and in some cases, it is a trivial metric. Disaster relief is an immediate need; but of course if not addressed, it can lead to persistent, irreversible, and non-substitutable consequences. But as we address the most obvious and recognizable problems, a focus on sustainability and particularly on its underlying characteristics can help us prioritize and address less obvious, but perhaps no less important, longer-term problems.

Panel 4: Policy Assessment

Mike Toman
Johns Hopkins University, Washington, D.C.

Overarching Questions: Does the adoption of sustainability as a major policy objective suggest the need for changes in the assessment process for EPA? In particular does it affect the choice of assessment methodologies? The choice of analytical techniques? Or the scope of the assessment?

Under current Executive Branch practice, cost benefit analysis (CBA) is an important part of regulatory policy assessment -- even when statutes limit the scope for making tradeoffs. Cost-benefit analysis retains an important role as well even when sustainability considerations—as reflected in irreversibility and scale—seem to loom larger than normal in a situation under consideration. However, maximizing net present value is not automatically going to generate weak sustainability (overall net welfare rising over time), or strong sustainability (maintenance of at least minimum flows of certain "key" values whose substitutability with other inputs or benefits may be limited).

Much of the concern with the usefulness of CBA in this context concerns the effect of intertemporal discounting on the assessment of costs and benefits experienced in the longer term (in particular, by future generations). A lot of good work from various disciplinary perspectives (including other panelists in this session) suggests that there are reasons to look at lower discount rates and perhaps hyperbolic rates for long-term analysis. What is not so satisfying, however, is the use of a lower "social discount rate" just to analytically stand in for a more explicit incorporation in the analysis of greater concern for the longer-term future.

Everything done to deal with sustainability is necessarily ad hoc at this stage, since there is not a sharp definition or empirical test of sustainability or unsustainability (even the theoretical tests of sustainability in terms of per capita income trends are difficult to implement absent counterfactual sustainability prices, and they can demonstrate unsustainability but not sustainability). Nevertheless, valuable steps in a sustainability analysis in addition to conventional CBA could include addressing the following questions:

1. Assessing the time profiles of potential benefits and costs over time: who is paying and who is benefiting?

2. Do these patterns seem to comport with some kind of intuition about equity or fairness? What if anything do we know about those sentiments empirically?

3. How sensitive are the key findings to not just the rate of time preference but also to the scale of key impacts, the possibility of unlikely but severe shocks, etc.?

4. Does analysis of physical impacts complementary to the economic analysis indicate any cause for concern in terms of the feasibility of sustainability?

In the context of this broader approach, it is possible to separate the assessment of costs and benefits. One can look at policy-induced opportunity costs with an appropriate opportunity cost of capital (recognizing that there is still a lot of uncertainty about just how this should be done), and to look at benefit streams from the perspective of intergenerational allocation as well as present value.

Beyond the technical aspects, another important part of the policy assessment process concerns the identification of values themselves. These may be endogenous, not just poorly understood by analysts. One might respond to this in principle through an iterative process:

1. Communal discussion (depending on how "community" is defined), so that analysts can have a better idea what pathways and impacts are important to the public;

2. Technical analysis reflecting that public feedback as well as other information;

3. Presentation to the public of findings, including information on impacts and incidence as well as net values; and

4. Possibly a return to stage (2) for more analysis if the process has led to a reconsideration by the public of its priorities and values.

Obviously this conceptual model would be very unwieldy and costly if implemented routinely. Agencies have to be pragmatic with limited analytical resources for CBA and sustainability assessment. In principle partial approaches always are less satisfactory, but informed judgments must be made about what scales of impacts should invoke broader sustainability analysis. Larger-scale impacts presumably require broader scale in analysis for desirable results. But if some aspects can be brought forward in regulatory assessment, the result may be more reliable and better grounded regulatory analysis. It is not clear that the current interagency review process for regulations does so well at picking up on these kinds of considerations.