

Chapter 4

Sustainability and the Currency of Intergenerational Obligations: Norton, Solow, Rawls, Mill, and Sen on Problems of Intergenerational Allocation

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Abstract Concepts of sustainability guide policy and environmental management decisions. But when goals are articulated badly, they provide poor decision guides, and may lead to serious mistakes. This paper reviews and critically evaluates a series of popular conceptions of 'sustainability,' with special focus on a conception advocated by Bryan Norton. While no conception of sustainability (not even Norton's) is problem-free, we gain by understanding the limitations of each. Adaptive management, as I understand it here, is not a *conception* of sustainability, but a view about how conceptions of sustainability might be used in practical reasoning about policy or management.

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Resource management

4.1 Sustainability: Shifting Standards, Shifting Problems

In 1934 an American forester named Nelson Courtland Brown evaluated the state of forest harvest in the United States. Brown was concerned about the communities supported by the lumber industry, and the ability of that industry to maintain thriving permanent towns and settlements. He was disappointed to find that much U.S. forestry was, in effect, following a "slash and burn" model. The virgin timber was so valuable that logging camps would follow the stands of old-growth trees as they gave way before a steadily receding frontier. Brown looked forward to a time

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in the future when forestry would provide a more stable and organized way of life for those who pursued it. But before that could happen, he argued, the virgin timber needed to be removed from the land so that a sustainable and stable second-growth timber industry could develop.

The nomadic character of the [timber] industry has resulted in the rapid building of camps and forest communities, the concentration of labor in temporary quarters, and the subsequent abandonment of woods settlements and sawmill towns. Until the virgin forests are removed, the stabilization of forest communities as found throughout Europe is not to be expected. With the increasing importance of second-growth forests, however, stable forest communities will gradually develop and continue. (Brown 1934 pp. 54–55)

Brown's views on these issues are not simple productionism—the view that the rate of production is the only standard we should use to measure success. He was concerned about the economic and social sustainability of the communities that developed around the business of logging production. His words embody a principle of environmental management that led him to recommend the cultivation of what he believed would be a more effectively productive and sustainable ecosystem—an ecosystem of second-growth lumber—that would, he hoped, be capable of sustaining the economic and social needs of the communities of people who depended on the logging industry for their livelihoods. But, recommended Brown, before we can have sustainable logging communities, we first need to cut down all the old growth timber.

In retrospect we see the flaw in Brown's theory of sustainability: the careless logging of old-growth U.S. and Canadian forests constitutes one of the worst environmental disasters of the last two centuries. For decades, the forests of North America had seemed so vast that some thought we could never deplete them. But deplete we did. The indigenous forest ecosystem of North America was almost entirely *removed*. Was it worth it? Defenders note that logging made possible economic development and settlement, as European immigrants and their children moved across the continent, changing it forever. To recognize the logging era as an environmental disaster is not to overlook the benefits that have resulted from economic and industrial development, or to deny those aspects of our present well-being that essentially depend on that development. Perhaps it is unreasonable to expect that we might have done differently, perhaps the development and settlement of the western United States was inevitable, perhaps our present well-being depends, in part, on processes that involved removal of the old-growth timber. But to think that present economic prosperity depended on the wholesale destruction of North American old-growth forests is just a mistake.

Often times the ancient trees were cut for trivial purposes: on the campus of the University of California at Santa Cruz, there are ruined furnaces where old-growth trees were burned to fire-harden clay bricks. The bricks can be seen in the older buildings of downtown Santa Cruz, but they are crumbling away after a century. In retrospect, it seems clear that removing valuable ancient trees to make 100-year bricks made us poorer, not richer. Taking down these trees was a serious mistake, and this mistake resulted, in part, from a flawed view of forest management.

It is worthwhile to count the environmental and human cost of deforestation and to think about different management decisions that might have been made. By coming to an understanding of the values and objectives that informed the decisions of Brown and others whose vision shaped the nation, we might hope to learn how to make better decisions in the future.

Environmental ethicists have often focused on problems of *value*, and on which objects and/or processes may have it. Such issues are important. But we cannot settle questions about environmental decision-making simply by showing that ecosystems or trees have (or do not have) intrinsic value. The foresters of Santa Cruz valued the bricks, and to them the value of the bricks seemed greater than the value—intrinsic or no—of the trees they burned. In a world where values clash, we often face trade-offs among values we regard as intrinsically, or non-instrumentally valuable. Perhaps the most productive way to proceed in environmental ethics would be to examine the process of environmental decision making and the various values and goals that inform that process.

The environmental philosopher who has most consistently focused on environmental decision-making is Bryan Norton, whose work is honored in the present volume. Norton has developed an articulate theory of adaptive environmental management, a flexible decision-making process that requires collection of data and vigilant responsiveness to changing circumstances (esp. Norton 2005, 2015). He has also emphasized, in his work, the different, plural objectives we have when we make management decisions, and the difficulties involved when we must make trade-offs among competing aims. This paper will evaluate one important element of Norton's account of environmental decision-making. While it is in one sense unfair to extract an element of Norton's complex view and subject it to independent analysis and criticism, the aim of this paper is constructive: by extracting an articulate statement of Norton's criterion of sustainability and critically comparing it with relevant alternatives, we may hope to expand and improve Norton's project. This process also, I believe, helps to draw out implications of that project for development theory, for economics, and for public policy.

4.2 Adaptive Management and Obligations to Future Generations

Environmental management involves present decisions that will shape the opportunities and even the circumstances of life for later generations. Our present choices may preserve or create opportunities for future generations, as they do when we take steps to conserve our accessible resources so that they will still be available for use in the future, or when we develop new technologies that enable future people to accomplish what would have been impossible or difficult otherwise. But our choices may also impose constraints: we can significantly alter, use up, or destroy resources that could have been used by future generations, and our present choices

may, in a wide variety of different ways, impose limits on what they can do with their own lives. Norton's account of sustainability is designed in response to our power to constrain or enable people in the future: "A set of behaviors is... understood as sustainable" writes Norton, "if and only if its practice in generation m will not reduce the ratio of opportunities to constraints that will be encountered by individuals in generations n, o, p ." (Norton 2009, p. 41).

Unfortunately, the process of environmental management involves daunting challenges: environmental systems are complex, and the effects of our interventions are often unpredictable. For this reason, among others, Norton recommends that we adopt a process of *adaptive management* for making environmental decisions. Adaptive managers adopt an experimental process, taking actions that are reversible (when possible) and studying outcomes of prior decisions to inform the process of subsequent decision-making. Adaptive managers model environmental problems as multi-scalar systems, and must be cognizant of the way management decisions influence environmental systems at different scales. Finally, adaptive management requires sensitivity to *place*. Management decisions involve interaction between human communities and the environmental systems in which those communities exist. Just as human communities are substantially unique, environmental systems are unique to the region and the place where they exist. The requirement that management must be sensitive to local human communities means that management decisions should have a democratic component. And the requirement that they be sensitive to local natural systems means that management decisions must be informed by the unique peculiarities of the locale where they are implemented.

As Norton argues, the problem of environmental management is inherently value-laden. We bring values to the process in a variety of different ways: some values are built into the analytic tools we use to evaluate policies and actions, as they are, for example, when it is assumed that goods are fungible, or that human well-being can accurately be measured by the rate at which people consume market goods. Values also drive our interest in the more purely scientific aspects of environmental management: while our effort to understand environmental systems may sometimes reflect our interest in finding undiscovered truths, our interest in these systems reflects a wide range of underlying attitudes that are linked to human interests and human concerns. The very scientific concepts we employ are inextricably entangled with underlying values in a way that makes it impossible to draw a sharp boundary between facts, as the realm of science, and values as a realm of human interests. For this reason, argues Norton, it is a mistake to think that physical or social scientists can engage management or policy problems by resolving the objective facts, and that they can then depart to leave the final choice to the political process. Ideally, adaptive management will constitute a kind of 'mission oriented science,' a process of information gathering that leads managers and communities to alter their objectives as they gain information and improve their understanding.

One important way that management is value-laden is that it is forward-looking, since present decisions may decisively shape future circumstances. At the inter-generational scale, management choices made in the present may shape the circumstances and the lives of people who don't yet exist. The concept of

sustainability embodies a conception of our obligations to these future people: an obligation not to constrain the circumstances of their lives as compared with our own. It will be illuminating to compare this conception of sustainability with relevant alternatives from economics, from development theory, and from political philosophy.

4.3 Sustainability as a Ratio of Opportunities and Constraints

Recall Norton's criterion of 'sustainability' (Norton 2009, p. 41), stated in a slightly expanded version below:

Norton's sustainability criterion: A set of behaviors (an institution, a policy, or a management practice) is sustainable if and only if its practice in generation m will not reduce the ratio of opportunities to constraints that will be encountered by individuals in generations n, o, p ...

To take this principle out of context, one might define it as a *goal*, and shape environmental practices around the instrumental achievement of this goal. One could, for example, define a way to *optimize* the ratio of opportunities and constraints left as a bequest for future generations, subject to constraints imposed by budget, resource availability, and protections for later generations. To do so, however, would be at odds with the spirit and form of Norton's project. Norton *contrasts* his view with others that recommend optimization, and recommends that we should instead adopt an *adaptationist* model that takes goals (like the criterion above) and constraints to be provisional (Norton 2015). Adaptive management involves incremental decision-making and continued revision of goals in light of new information that becomes available. Even within an adaptationist model, however, decision-making will involve prioritization of plural goals, and consideration of value trade-offs. Such tools, however, will be used in the context of a decision structure that involves continued openness to information, and reconsideration and reformulation of decision frames.

Norton applies this criterion to 'sets of behaviors,' but here it has been extended to institutions, policies, and management practices. I believe this to be in the spirit of Norton's proposal, and it is a relevant extension in any case, since we need to evaluate sustainability in each of these domains. As Norton defines it, this criterion applies only to a few subsequent generations n, o , and p , but one might assume ellipses (...) after those three listed generations to extend the criterion into the indefinite future. It would seem that we have good reason to effect such an extension, even though our ability to apply such a criterion will be limited by our understanding of the way present actions and institutions will influence the lives of people who are increasingly distant from us in time. It is sometimes assumed (wrongly, I think) that our knowledge and ability to predict will decrease in a regular geometric sequence as events are projected further and further into the

future. Sometimes this assumption is used to justify the practice of *discounting* future events. But even if our confidence about the future diminished in this way, it would not imply that we should regard institutions or practices that impoverish the opportunities of people in the more distant future to be *sustainable*. Rather it would mean that our ability to ensure the long-term sustainability of these practices will be limited by constraints in our knowledge and understanding of their predicament.

Norton's sustainability criterion is *anthropocentric*, since it focuses our attention exclusively on human beings (future human beings). But to say that Norton's criterion is anthropocentric is not a criticism of the criterion, but a comment about it. Norton advocates a weakly anthropocentric view that recognizes valuation as a human activity, but does not assume that it is irrational or inappropriate for people to place non-instrumental value on environmental preservation. By contrast, we could articulate a non-anthropocentric conception of sustainability that does not assume that nature (or natural objects or natural systems) has *intrinsic* value. For example, consider the following criterion:

Non-Anthropocentric Sustainability: Institutions, policies, or management practices are sustainable if and only if their operation leaves environmental systems no more damaged in subsequent generations than they were in earlier generations.

This principle is non-anthropocentric because it focuses not on preservation of some good for people, but on environmental preservation as such. But a person's reasons for advocating non-anthropocentric sustainability as a value (as some do) might themselves be anthropocentric reasons. It is possible to read human interests into the concept of 'damage' to environmental systems, though there may be ways to avoid this. Some advocates find non-anthropocentric sustainability appealing because they regard environmental systems to have intrinsic or non-instrumental value. Others might favor the same ideal for an anthropocentric reason: because they believe that we have an obligation to preserve environmental systems for future generations.

Norton's criterion defines sustainability in terms of the opportunities and constraints afforded to later generations. It is satisfied if the *ratio* of opportunities to constraints is not reduced for later generations as compared with earlier ones. Constraints might be thought to include restrictions, burdens, and deprivations. If the existence of thriving ocean fisheries constitutes an opportunity (or more likely, a large set of varied opportunities), then the destruction of ocean fisheries will constitute a constraint, since those opportunities can no longer be exercised if the fishery is destroyed. The oil reserves in the North Sea, similarly, constitute an *opportunity*, but if we use that oil we may impose different kinds of constraints, since the oil won't be there for later generations to use, and since our present use of oil will create pollution and release CO₂.

In applying Norton's criterion we may need a way to model opportunities and constraints as quantities that can be represented in a ratio. Since the criterion is satisfied if that ratio is nondecreasing over time, we can represent the value of that ratio as a constant S , representing the present ratio between opportunities and

constraints faced by the extant generation. Then Norton's criterion for sustainability can be represented as a simple equation:

$$\frac{\text{Opportunities}}{\text{Constraints}} = S$$

Several questions might be posed about this equation: Note that the ratio S can stay constant even if opportunities decline, as long as constraints decline proportionally. If there is some minimum level of opportunity that is necessary if people are to live reasonable lives, then we might reasonably be concerned not simply to keep the ratio stable, but to ensure that the numerator, expressing the quantity or value of opportunities available in subsequent generations, should not fall below a certain level. Perhaps this problem will not arise, if we assume that opportunities and constraints are causally related (as they sometimes are) so that whenever opportunities diminish, constraints increase. Once again, however, this will importantly depend on how opportunities and constraints are defined and represented, and how the values representing them are determined. In what follows, I will identify Norton's account with the view that sustainability requires maintenance of nondecreasing opportunity for later generations. It should be understood, by this, that I mean to refer to the nondecreasing ratio of opportunities to constraints, as Norton more specifically requires.

The idea that sustainability might be represented as a ratio of opportunities and constraints is intuitively plausible, if what we hope to sustain is a set of life circumstances that will leave future persons as well-off as present persons, in the specified respect. Even so, operationalizing a model that incorporates such a value is a more daunting task than it might seem. To effect such a formalization, we would need a method to quantify the values involved. For example, we might try to apply Norton's criterion by simply counting opportunities (and constraints) and listing the numbers in the numerator and denominator of this ratio. Norton does not recommend such a method, and there are good reasons to avoid such simple enumeration. First, as Norton certainly recognizes, opportunities are not all created equal. To quantify by counting would be to give equal significance to life-changing excellent opportunities, mediocre opportunities, and decidedly bad opportunities. But second, the sheer *number* of opportunities we face, at any given moment, may be infinite. At this moment, I have the opportunity to hold my arm straight, to hold my arm at a 90° right angle, or to hold my arm at any of the infinite number of angles that lie between these two alternatives. But these opportunities are insignificant. The fact that I have an infinite number of opportunities available to me, in this sense, does not mean that I am very well-off. Similar difficulties apply, *mutatis mutandis*, to the quantification of constraints. Infinite values in the numerator and denominator of the ratio would render Norton's criterion mathematically useless. So we will need a method for setting such values that avoids infinite lists of opportunities, and which appropriately evaluates opportunities of different kinds and assigns them appropriate quantificational weight. This may be very difficult to do.

Norton's response to this problem is to specify the meaning of "opportunity" in a way that is specifically designed to incorporate natural values in human decision-making processes. He distinguishes an 'option,' which he identifies as "a natural resource available for human use," from an 'opportunity,' which is "a situation in which all the conditions are right to allow the choice to use that resource at that time," including "the power to act to use the resource at a particular time" (Norton 1999, p. 135). In an early discussion of this distinction, Norton writes

For a resource option to truly present an opportunity, the resource must continue to exist in a non-degraded and usable form at the time the person faces the choice, and the person must have the power, both physical and political, to gain access to that option. (Norton 1999, p. 135)

Even with this explanation, however, Norton's sustainability criterion will be difficult to apply in practice. There are myriad conditions necessary for a person to have physical and political power to access and use an option, but specifying them all may be impossible. And to specify these conditions for future people and future times and future conditions of the world is sure to be impossible. Application difficulties like these, however, are in no way a "knock down argument" against Norton's account of sustainability. First, the fact that a technical problem is difficult does not mean that it is impossible. In fact, as I will argue later in this paper, the development of capabilities theory by Amartya Sen and others might be interpreted as an attempt to provide a way to operationalize and quantify the key elements of a conception of sustainability like Norton's. Second, Norton's criterion might be the right one, in the sense that it captures what *matters* when we discuss sustainability, even if it were *impossible* to operationalize because of limitations in our knowledge or modeling abilities. It would be disappointing to discover that other human limitations prevent us from effectively pursuing what we care about, but if that were the case the problem would be with our knowledge, not with the criterion. But finally, and importantly, in order to use a criterion like Norton's as a guide for environmental decision making, it will not always be necessary to provide a strictly formal interpretation or to specify the impossible range of powers and conditions needed by each future person. Even for large-scale decisions, adaptive managers can guide decisions by considering the opportunities and constraints that might be implied by alternative courses of action, even if they cannot specifically quantify all of the opportunities and constraints.

It is worth noting that similar problems arise for other suggested sustainability criteria, and arguably for most practical decision-making criteria we might use. As we will see, Norton's criterion is not worse than relevant alternatives, and is better in several important ways. And there is good reason to think that we need a criterion like this one, to gauge the weight and content of our obligations to future generations, and to evaluate the effects of present actions on future persons. If the best criterion we have turns out to be a criterion that is difficult to apply, this will be a reason to work to make it more articulate and applicable. If the effects of our present choices on future persons *matter*, then we can't just throw up our hands and give up.

Difficulties associated with formal quantification of Norton's criterion do not render it useless. In some cases, we might be fairly confident in evaluations based on such an intuitive projection of future constraints and opportunities. For example, consider the case mentioned earlier, concerning the decision to cut down the ancient redwood forest around Santa Cruz California in order to make cheap bricks with a 100 year lifespan, or the decision to cut old-growth trees to make hot-tub decking. The present value of living old-growth trees is enormous, even if we restrict our estimate of that value to their economic existence-value: the amount people are presently willing to pay just to preserve them. Of course, that value is partly contingent on scarcity, which resulted from decisions to develop, like the decision under consideration here. If old-growth trees are to be cut and "developed," there are many more value-preserving ways to develop them than burning them for fuel or cutting them into deck boards. And these environmentally destructive alternatives must be evaluated against the option not to develop such a resource at all, but to leave the trees standing. In this case, as in many environmental management decisions, there are clearly-better (and clearly-worse) development paths available and we can be reasonably confident that the path selected by the brick makers of Santa Cruz reflects a net loss of opportunity. In contexts where such a comparison is difficult and judgment is uncertain, at least Norton's criterion (or its close relatives) point us in the right direction, directing our attention to the effects that our choices might have to diminish the opportunity or freedom of later generations. In a world in which processes are underway that threaten resources that might provide options and opportunities for future generations, it is not difficult to predict that our present actions—the status quo—are compromising opportunities that might otherwise have been enjoyed by future persons.

Is it a concern that Norton's criterion represents the value of environmental resources in terms of their ability to provide opportunities for human beings? In some contexts of environmental choice, this might be a serious concern: Nelson Courtland Brown and Gifford Pinchot famously saw environmental systems as *resources*, and often they judged that the best way to realize the value of these resources was to harvest and destroy. In the context of present-day environmental decision-making, the concern is more minimal. We live in an era of swift environmental change and, in many instances, destruction that threatens the most serious imposition of constraints, and deprivation of opportunities for later generations. While anthropocentric and biocentric theories of value might have had important implications for environmental policy in an earlier age, we now live in an age where advocates of different value theories are likely to converge in their judgments about most of the pressing environmental policy and environmental management decisions we presently face. This *convergence hypothesis* is another important claim that has been associated with Norton's work. If the convergence hypothesis is true, then we don't need to resolve underlying theories of environmental value before we can figure out what to do.

Norton's sustainability criterion is a principle of intergenerational distribution. In fact, it is an egalitarian principle that identifies sustainability as intergenerational equality. As such, it can be usefully compared with other views of intergenerational

allocation, some of which are expressly identified as principles of intergenerational justice. Alternative conceptions of intergenerational allocation differ on at least two dimensions: they differ in the *currency* that is to be allocated among members of different generations, and they differ in the shape of the function that allocates whatever currency is chosen. The question of currency has been an important one in other areas of political theory and policy. If equality is valuable, what is it that should be equal? Candidate theories have proposed to equalize welfare, opportunities, resources, primary goods, capabilities, and freedoms, among other candidates.

Conceptions of intergenerational equity (and sustainability) differ on another important dimension as well: While some (Norton, Solow, Hartwick, Barry, Dasgupta) identify sustainability with non-decreasing availability of some good thing (opportunity, welfare, capital, productive opportunities, renewable resources), others (Mill, Brundtland, and Rawls) identify key sustainability concepts with need satisfaction, or with the provision of a sufficient minimum. Still others (Sen) urge that we should measure sustainability in a currency of freedom or capability. In what follows, I will compare Norton's criterion with some of these relevant alternatives.

4.4 Sustainability as Intergenerational Equality

The model of sustainability as intergenerational equality has become standard in most economic theory and social science literature. This model is often associated with the work of Robert Solow (1974, 1993a, b), who argues that we should equalize the *capacity to achieve welfare* across generations. According to Solow, sustainability implies "an obligation to conduct ourselves so that we leave to the future the option or the capacity to be as well-off as we are" (Solow 1993b, p. 181).

Sustainable Welfare (Solow Sustainability-1): Institutions, policies, or management practices are sustainable if and only if their operation in the present generation leaves later generations the capacity to be as well off as (no worse off than) earlier generations.

Note that Solow's view is one-step removed from the view that we should equalize intergenerational welfare. It is not welfare itself, but the *capacity* for welfare that is to be equalized. If we were to interpret 'capacity' as 'opportunity,' then we might be tempted to see Solow's view as a version of Norton's, and to interpret both as recommending a principle of *equal opportunity for welfare*. Since the principle of equal opportunity for welfare has articulate contemporary philosophical defenders (Arneson 1989), this interpretation would be interesting and potentially promising.

There are several reasons why this promising interpretation must be ruled out: First, Solow makes it clear that his model equates welfare with consumption—a view that might reasonably be rejected, since there are many things that contribute to make good lives good. And as Solow explains the principle that we should

equalize 'the capacity for welfare' it soon becomes clear that what he has in mind is equalization of 'access to consumable resources.' So from the view that we should equalize intergenerational welfare, he much too quickly moves to the view that our obligation to future generations is to ensure that the available stock of consumable goods will not decrease from one generation to the next. This takes Solow one step from the view that sustainability requires equalization of intergenerational *consumption*, but advocates of that view (Heap et al. 2000) can and do see Solow as their inspiration.

Sustainable Consumption (Solow Sustainability-2): Institutions, policies, or management practices are sustainable if and only if their operation in the present generation leaves later generations with consumption opportunities that are no worse than the consumption opportunities available to earlier generations.

These views are problematical. But if we were to try to follow Solow's criterion, what would we do? Even if we assume, with Solow, that the welfare of future generations depends only on their consumption opportunities, we don't know what future people will want to consume. In response to this concern, Solow argues that we cannot save *everything*. It is impossible for us to leave the world just as we found it, and Solow insists that we cannot be responsible to do what is impossible. In response to this impossibility, Solow flies to the opposite extreme: Since we cannot reasonably be required to save *everything*, Solow argues that we therefore (therefore?) have no obligation to save anything in particular. Instead, we should use resources that are at our disposal, but should set aside a pot of fungible resources that future generations can use in place of the resources we use up. Norton calls this peculiar move the "Grand Simplification," since Solow simplifies the saving problem by reducing 'saving' to 'capital.' Following Solow's earlier (1974) work on this problem, John Hartwick (1977) famously worked out the rate of investment necessary of offset declining resource stocks, so that consumption will not fall from present to future generations. The rule that we should invest at an appropriate rate so that we precisely offset the value of declining nonrenewable resources as we use them up is often called "Hartwick's Rule."

Non-Depletionary Use (Hartwick/Solow Sustainability): Institutions, policies, or management practices are sustainable if and only if their operation leaves later generations *capital resources* that are value-equivalent to the capital resources available to earlier generations.

The most common interpretation of Solow's suggestion is that we should set aside a portion of the funds generated from the use of irreplaceable resources to generate a growing investment that will be at the disposal of later generations. A more accurate account of the Solow/Hartwick view would note that they recommend investment in durable or renewable capital resources, including intellectual property and infrastructure that will that have long-term value for future generations. Hartwick proposed that we invest in "reproducible capital." He intended that we should gradually replace our reliance on natural resources with reliance on "machines" (Hartwick 1977, p. 972). The goal, however, was to

guarantee nondecreasing intergenerational "consumption" under the assumption that population size remains constant from one generation to the next.

While he is at pains to distinguish his view from Solow's, Norton's suggestion that we equalize intergenerational opportunity is similar to the Solow/Hartwick view: while Solow and Hartwick focus on the preservation of a non-decreasing stock of capital resources, others (Heap and Kent 2000) focus on intergenerationally equitable *consumption*. By contrast, Norton requires nondecreasing opportunities, so that the actions of the present generation will not unduly constrain later generations. In his critique of Solow, Norton has focused on what he calls "the grand simplification": the claim that goods are fungible, so that we need not save anything in particular since we cannot save everything. Norton urges, among other things, that environmental resources are heterogeneous on a variety of different dimensions. He argues that our choices should not be measured not merely in terms of the welfare costs our resource-use might impose. We need to consider, in addition, the extent to which the environmental damage we cause is *reversible*, and the magnitude of environmental impact as independent decision factors. I will not emphasize these issues here not because I regard them to be unimportant, but because I find Norton's arguments for these claims to be conclusive. As Norton insists, treating environmental systems and resources as an undifferentiated and fungible mass of goods is a fatal error that will lead (and has led) to disastrous decisions (Norton 1995).

Aside from the "grand simplification," the main difference at play between Norton and the economists he addresses is one of *currency*: While Solow and Hartwick focus on welfare and resource availability as the value to be maintained at a nondecreasing level from generation to generation, Norton measures sustainability as nondecreasing *opportunity*. As others have noted, there are definite advantages to the focus on opportunity instead of focusing on goods or welfare (Dworkin 1981a, b). Ideals that focus on opportunity recognize future persons as *agents*, not as mere recipients of what we pass on to them. To urge that we should protect future opportunities instead of goods or welfare is to recognize that future people must be substantially responsible for their own lives.

A more serious problem arises for these conceptions when we add the possibility of changes in population size. Solow and Hartwick both expressly assume that population will remain the same from one generation to the next, but this assumption is counterfactual, and severely limits the applicability of their account. It is easy to see why they impose this condition as a modeling requirement: a sustainability criterion that requires a nondecreasing supply of consumable resources or nondecreasing aggregate welfare will imply increasing want and deprivation, or decreasing per-capita well-being from one generation to the next; if population size is increasing rapidly from one generation to the next, paradoxically, these criteria are fully satisfied, so under plausible population predictions, increasing deprivation or decreasing per capita welfare is to be expected on the optimal development path if these measures are used. This would seem sufficient reason to reject them both. The most obvious adjustment to make would be to move

to per capita provision, or average welfare measures. But these adjustments bring their own characteristic problems (Parfit 1981; Wolf 1996, 1997a, b, 2004, 2009a).

Norton's criterion of intergenerationally nondecreasing opportunity may also be ambiguous when applied to contexts where population is changing. Norton's account of options and opportunities would seem to imply that we must not only save resources to equalize access across generations, but we must also ensure that future persons enjoy conditions that facilitate the just (permissible) use of those resources. This seems right, but less specific than one might wish. And Norton does not specify how opportunities and constraints are to be evaluated in circumstances of changing population size. Perhaps Norton's criterion should be read to require that no future person should lack adequate opportunities. This interpretation would bring Norton's view in line with the sufficientarian views to be discussed in the next section. But such a view might require *more* than merely preservation of intergenerationally equal opportunity. Since there are people in the current generation who lack adequate opportunities, such a criterion would require more than simply maintaining the status quo. Perhaps this is a reason to think that such an interpretation diverges from Norton's intent.

I have argued that criteria like those recommended by Solow and Hartwick, and even the criterion recommended by Norton will not adequately account for what we owe to future generations, this does not mean that they are entirely off-track. When we use renewable resources, it is crucial to understand how much and at what rate these resources can be used without *depleting* them. Solow's sustainability criteria have an important role to play in such calculations, since they are, in essence, principles that forbid us from using resources at depletionary rates. For an account of intergenerational justice or intergenerational obligations, however, we need to look further.

4.5 Sustainability as Sufficiency

Egalitarian conceptions of 'sustainability' like those of Solow and Norton focus on the maintenance of an intergenerationally equal, or at least nondecreasing stock of some good thing that must be preserved for the future. Such conceptions can be contrasted with another conception that has roots in the work of John Stuart Mill.

Mill's most famous discussion of sustainability appears in his *Principles of Political Economy*. Book IV, Chapter VI, "The Stationary State" (Mill 1879, p. 452). In that brief but brilliant chapter, Mill describes economic circumstances that are 'stationary' in the sense that there is no further growth, but human needs are satisfied and people are free to pursue whatever projects or whatever way of life seems best to them. Mill's 'stationary state' embodies a conception of what we would call 'sustainability,' but one that is focused on sufficiency, not on stable non-decreasing availability of resources or opportunities or any other good. This ideal also finds expression in Mill's *Principles*. Discussing the decision whether to

accept a system of collectively held property and liberty, or an alternate system of private property and liberty, Mill writes:

If a conjecture may be hazarded, the decision will probably depend mainly on one consideration, viz. which of the two systems is consistent with the greatest amount of human liberty and spontaneity. After the means of subsistence are assured, the next in strength of the personal wants of human beings is liberty; and (unlike the physical wants, which as civilization advances become more moderate and more amenable to control) it increases instead of diminishing in intensity, as the intelligence and the moral faculties are more developed. The perfection both of social arrangements and of practical morality would be, to secure to all persons complete independence and freedom of action, subject to no restriction but that of not doing injury to others. (Mill 1879, p. 129)

Mill regarded need satisfaction—universal access to the “means of subsistence”—to be an urgent social priority. This makes Mill a ‘sufficientarian’ in an important sense: according to Mill, satisfaction of fundamental needs (subsistence needs) is necessary so that people will be able to enjoy the benefits of “liberty and spontaneity.” Once subsistence needs have been met, Mill argued, then after that point public institutions can then address other most important requirements, which are, in Mill’s view, to keep people from harming one another, and to avoid interfering with their liberty of choice and freedom of action. Mill’s statement here is not expressly intergenerational, but his later discussion of stationary-state economics makes it clear that he has the same goal over time and across generations. Like most utilitarians, Mill advocated intertemporal neutrality: it doesn’t matter when or where needs and unhappiness exist, our obligation is to address them if it is in our power to do so. Extrapolating Mill’s commitments, we might formulate this into a sustainability criterion of its own, though we might be cautious about attributing the result too directly to Mill:

Sufficientarian Sustainability: Institutions are sustainable just in case they minimize unmet needs, regardless of the time or generation in which the needy persons exist.

Mill is not usually interpreted to be a sufficientarian, and one might wonder whether sufficientarianism is consistent with Mill’s utilitarianism. If we read Mill to be a sufficientarian, his still turns out to be ‘utilitarian’ in an important sense, since he regards it as paramount to alleviate deprivation and suffering and to promote well-being. But Mill’s view differs dramatically from most contemporary utilitarian ethical theories, which focus on maximizing happiness not on minimizing unmet needs or misery. Mill’s view differs even more sharply from the utilitarianism of most contemporary economic theory, which does not usually distinguish between deprivation with respect to needs, and deprivation with respect to non-need-wants. The fundamentals of economic utility theory *prevent* one from making such a distinction. This has in turn led many economists to deny its relevance. But if Mill’s empirical claim is true—the claim that people require only liberty once their subsistence needs are met—then institutions built on modern utility theory will not lead toward truly ‘utilitarian’ policy recommendations. For an economist using von Neumann-Morgenstern utility theory, it may be difficult to decide whether it is better to provide food for people who are hungry or to provide theater tickets to

people who are bored. The choice involves interpersonal comparisons, which cannot be made using standard economic tools. But the choice was easy for Mill, and should be easy for us: hungry people must have their subsistence needs met first. Bored people should have liberty to pursue other amusements, but they do not have unmet needs that constitute a public priority, and boredom does not give bored people a claim to public assistance.

What reasons favor a sufficientarian conception? Mill’s sufficientarianism is in part based on or constituted by an empirical claim about the relationship between sufficiency and happiness. According to Mill, beyond a certain point, material goods are no longer necessary or even particularly relevant to happiness. Interestingly this thought has been confirmed by contemporary work in economics and psychology. In 2010, Kahneman and Deaton (2010) found that people who earned more than ~\$75,000 per year were as well-off, in terms of their emotional well-being, as people who earned much more. Their finding supports Mill’s view that subsistence needs should be met, but once they are met, we don’t increase utility by increasing income or goods beyond that point. “After the means of subsistence are assured,” writes Mill, “the next in strength of the personal wants of human beings is liberty” (Mill 1879, p. 129).

Other considerations are commonly cited in support of sufficientarianism, at least as a high-priority principle among others. Needs are a high-priority category, often distinguished from mere ‘wants,’ or from other goods that are less urgently required. A sufficientarian conception recognizes this priority of needs in the strongest terms. Needs do not always provide a justificatory foundation for rights—the fact that a person needs something is not always recognized as sufficient reason to think that she has a right to it. But on a plausible theory of rights (Hohfeld 1917; Feinberg 1992; Rainbolt 2006), a person has a right to something if she has an undefeated *prima facie* claim to it. Needs constitute a strong *prima facie* reason in favor of a person’s claim. Unless that reason is in conflict with the prior or stronger claim of someone else, that reason will support a right in this minimal sense. Accounts of sustainability (and of justice) that recognize such rights will have good reason to favor sufficientarianism.

If the function of a theory of sustainability is to promote long-term human interests, sufficientarian views may do better than conceptions of sustainability that instead require non-depletory use of resources. In the context of increasing population size, sufficientarian principles direct attention to the needs of those who require resources, not to the resources themselves. If the value of managed resources *as resources* is their ability to contribute to the lives of those who have the opportunity to use them, then it is better to adopt a theory that addresses the human need for resources first, and which treats the resources themselves as instrumentally valuable.

Mill’s sufficientarian account of public priorities is naturally allied with a popular contemporary conception of sustainability, one that is usually associated with the “Brundtland Report”—the World Commission report titled “Our Common Future” (WCED 1987). While the Brundtland Report specifically offered an account of ‘sustainable development,’ the expression of the Brundtland criterion

given below has been adapted for comparison with the other views described above:

Brundtland Sustainability: Institutions, policies, and management practices are sustainable if and only if they "meet the needs of the present generation without compromising the ability of future generations to meet their needs." (Adapted from WCED 1987, p. 43)

Note that in a wide range of possible cases, this conception of sustainability, focused as it is on minimizing unmet needs, has quite different implications from the conceptions offered by Solow and Hartwick. Note, for example, that the Brundtland condition can be satisfied where there is no saving for the future at all, as long as there will be no future people to be deprived. But the Brundtland criterion does not tell us what to do in cases of tragic choice, when the two identified goals conflict with each other: What if we find ourselves in circumstances in which it is impossible to meet the needs of the present generation without compromising the needs of future people? Brundtland's criterion gives no unambiguous guidance, but can be read as giving nominal priority to the needs of the present generation—they are listed first. Otherwise, without this implied priority, the Brundtland criterion will be equivalent to Mill's more general and generation-neutral directive to "Minimize deprivation," or "Minimize unmet needs."

Where population size is increasing, sufficientarian conceptions of sustainability will sharply diverge from intergenerational egalitarian conceptions like those of Solow and Norton. For this reason, it would also be a mistake to think that Brundtland sustainability, or sufficientarian conceptions in general, are either weaker or stronger than intergenerational egalitarian conceptions. Where population size is increasing, and future needs will be greater than present needs, it will not be enough simply to preserve non-decreasing stocks of resources or goods or to preserve an equal set of opportunities over constraints, to be distributed among members of the increasingly larger group. Sufficientarianism requires more than preservation of nondecreasing resources or opportunities in such circumstances. But where needs are met and populations size is decreasing, sufficientarianism may require less: as long as depleted future resource stocks don't cause deprivation, sufficientarianism does not require that they be preserved. Sufficientarian principles also have direct implications for fertility decisions: sufficientarianism recommends against bringing children into the world if their needs cannot be met.

Sufficientarian conceptions of sustainability might seem to mesh well with the social priorities of justice. John Rawls recommends liberal principles of justice among members of a given generation, but recommends a mixed sufficientarian principle in his discussion of justice between generations. Like Solow and Hartwick, Rawls frames this principle as an obligation to save for future generations:

The purpose of a just (real) saving principle is to establish (reasonably) just basic institutions for a free constitutional democratic society (or any well-ordered society) and to secure a social world that makes possible a worthwhile life for all its citizens. Accordingly, savings may stop once just (or decent) basic institutions have been established. At this point real saving (that is, net additions to real capital of all kinds) may fall to zero; and existing stock

only needs to be maintained, or replaced, and nonrenewable resources carefully husbanded for future use as appropriate. (Rawls 1999, p. 107)

Rawls's account here describes a two-stage process: In the first stage, before just institutions have been established, the purpose of saving is to ensure that later generations will have it better than earlier ones. Earlier generations save so that just institutions can be put in place, where the required institutions must meet needs and protect fundamental rights and liberties. As Rawls recognizes, this requires stable access to resources, but resources are not an end in themselves. Rawls does not specify exactly what should be saved, but he is usually assumed to have meant investment in long-lived capital resources. Rawls assumes without argument that population will cease to grow in the second stage, since his view will otherwise be subject to increasing scarcities.

4.6 Sustainability as Opportunity, Capability, and Freedom

Norton urges that we should pass on an undiminished ratio of opportunities to constraints. But how should we understand 'opportunity'? Norton conceives of an opportunity as a certain kind of access to a material resource, and recommends that we should pass on a bequest of undiminished opportunities to constraints. Interestingly, this makes Norton's account surprisingly similar to Solow's intergenerational resource egalitarianism. It is not identical to Solow's criterion, since Norton denies that resources are fungible, insisting that we should leave a complex and structured resource bequest to later generations. On Norton's view, we should take careful account of the extent to which our present management decisions put at risk resources that are irreplaceable, and the effects on ecosystems are not local but ecosystem-wide (Norton 2005, p. 353). In spite of these important differences, Norton's association of 'opportunities' and 'options' with specific resources that can be used, and his insistence that his conception of sustainability is based on "stuff" not "welfare" make his view quite similar to Solow's notion of sustainability as non-depletionary use (Norton 2005, p. 306).

But we might instead read Norton's criterion in a sufficientarian mode. Note that this is not the obvious reading, and may not be what Norton has in mind. But a sufficientarian reading might be better for several reasons. A moderate sufficientarian reading would recommend that present actions should not reduce the average opportunity range available to people at present. A somewhat stronger sufficientarian reading would hold that people who lack an adequate range of opportunities are relevantly deprived, and would urge that we ensure that later generations should at least be no more deprived than the current generation with respect to the opportunity/constraint ratio we face. A fully sufficientarian reading would hold that we should minimize deprivation with respect to opportunity, between and across generations.

On Norton's view, a resource option does not constitute a proper opportunity unless it is available for use. This restriction makes his view both more complicated and more plausible than many relevant alternatives. Note that subsequent generations will have the same obligation to preserve opportunities for later generations that we in the present generation have to preserve opportunities for them. So *deplimentary* use of resources would seem to be off the table: if a resource can be used only by violating one's obligations to future generations, then the conditions of one's life are not such as to make that resource "available for use" in Norton's sense. Norton insists that opportunities include resource options, combined with social and economic circumstances that render it permissible for people to *use* those options. This, in turn, means that a full account of the view will require that we specify those circumstances more fully. One way to do this would be to link the project to the development economics of Amartya Sen.

Instead of focusing on 'opportunity,' Sen argues that appropriate sustainable development involves preservation and promotion of substantive freedoms and capabilities, where capabilities provide people with the ability to do or be what they choose, with minimal constraints. Of course Sen recognizes that the freedoms of different people need to coincide, so we cannot increase the freedom of some people in ways that inappropriately encroach on the freedom of others. Sen insists that social circumstances that enable the exercise of freedom include protections for political liberties, economic facilities, and social opportunities. Sen de-emphasizes goods and resources in his discussion of substantive liberties. Although he does identify poverty as "capability deprivation" (Sen 1999, p. 87), his primary focus is on capabilities, not on the substantive resources people need to survive. In his more recent work, Sen expressly urges that sustainability is "*the preservation, and when possible expansion, of the substantive freedoms and capabilities of people today without compromising the capability of future generations to have similar - or more - freedom*" (Sen 2009, pp. 251–2). This enables us to articulate a version of Sen's view that can be compared with others we have considered above:

Sustainable Freedom and Capability (Sen): Institutions, policies, or management practices are sustainable if and only if their present operation preserves or expands the substantive freedoms and capabilities of people in the present generation without compromising the ability of later generations to have similar or greater freedom.

Sen's criterion is obviously designed to mirror the structure of the Brundtland criterion. But Sen's version is ambiguous, and departs from the Brundtland approach in important ways. The requirement to "preserve substantive freedoms" and to avoid "compromising the ability of later generations to have similar or greater freedom" appears to be an injunction to maintain intergenerational equality of substantive freedoms. The objective to "Satisfy needs" is satiable—once people's needs are satisfied, the objective is completely fulfilled. But Sen's substantive freedoms do not work that way: unlike needs, freedoms are not satiable. A person can always expand one's capability set—there is no endpoint, on Sen's view, where one is maximally free. Further, while sufficientarian proposals keep us focused on those who are worst off, and recommend that we satisfy the needs of those who are

badly off as a first priority, Sen's criterion is ambiguous about tradeoffs between the freedoms of those who are better off, and the freedom of those who are worse off. Sen's long career, focusing on issues of poverty and need, might lead one to think that he would favor an interpretation that would give priority to those who are worse off. But unlike the sufficientarian principles considered in the previous section, his criterion does not express this priority.

Sen's criterion also diverges from sufficientarian formulations in its implications for development paths that involve changes in population size. But when the same level of freedom is preserved for later generations, we can once again ask whether the capabilities associated with later freedoms are more widely dispersed in cases of population increase. This may seem an odd interpretation of Sen's dictum, but Sen's text makes it clear that he sees his account as a descendant of Solow, and only indirectly a descendant of Brundtland. In fact, Sen appears not to notice the importantly different implications of Brundtland's and Solow's very different accounts—he presents Solow's view as a refinement and an 'elegant extension' of the Brundtland conception. (Sen 2009, p. 250) and apparently regards his own proposal as an extension of the Brundtland-Solow view. It should be evident that the views of Brundtland and Solow—intertemporal sufficientarianism and intertemporal egalitarianism—have very different implications in a variety of different circumstances. Sen's account of sustainability, as presently expressed, does not resolve these differences. In fact, it incorporates them both. In this, it introduces serious and perhaps unmanageable ambiguities.

4.7 A Return to Adaptive Management: Paradox or Reconciliation?

All of the authors discussed in this paper—all including Nelson Courtland Brown—agree that we owe *something* to future generations. All are concerned to find a precise way to specify the value of sustainability so that we can use it to make practical decisions about environmental policy and management. Brown's example shows that the way we articulate our values can have important practical implications. The cost can be high if we get things wrong. I have raised objections to each of the formulations discussed, and none of them would seem to define an unambiguously pursuit-worthy goal. As should be clear from my remarks above, and for reasons I have explained elsewhere, in cases concerning our obligations to future generations I favor sufficientarian principles (Wolf 1995, 1996, 1997a, b, 2004, 2009a, b, 2010, 2012, 2013). Sufficientarianism focuses our attention on prevention of misery and deprivation. Equalizing opportunities between generations won't be enough to provide sufficient opportunities for everyone in contexts where population is increasing, and might not be necessary for the achievement of that goal if population levels were to decrease. But 'sustainability' is a broad concept, and it should be equally clear that we should not always use the same sustainability

criterion in different practical contexts. Different sustainability criteria will be appropriate in different circumstances, for managers and policymakers who face different concrete problems.

For example, effective environmental management often means that managers will compare damage/consumption and growth rates, and will use Solow's formula to figure out what management options will avoid depletion. It is Solow's conception of sustainability that is implicit in the annual calculation of "Earth Overshoot Day" (www.overshootday.org), the day when the human population of the earth has used more resources than can be produced in the course of a year. But that conception is not, I have argued, the one that should be primary in our determination of what we owe to future generations. When we use these different criteria to guide our choices, it will be crucial to keep in mind their limitations, and to be aware of objections like those discussed above. But the 'upshot' of a paper like this one should not be to select a single winner. There is no single criterion for sustainability that can fill all the various functions we need that concept to fill.

This brings us back to consideration of the concrete circumstances of environmental decision making and policy choice, and to Bryan Norton's advocacy of adaptive management. Norton often writes as if optimization reasoning were an alternative to adaptive management. In his recent book *Sustainable Values, Sustainable Change* (2015) the two are expressly presented as alternative modes of thinking. But perhaps it is better to treat optimization reasoning as a procedure that will often take place within the context of adaptive management. Pragmatists will recognize that optimization exercises may sometimes be useful, but will recognize that such analyses are always exercises in partial reasoning, limited by the conceptual frame in which they take place. Because of these limitations, the results of an optimization exercise is never a full exercise of pragmatic reasoning.

The discussion above considers alternative criteria of sustainability—alternative ways to *analyze* the concept of sustainability. But adaptive management is not a criterion of sustainability, nor is it a conception of sustainability. It is, instead, an approach to sustainable decision-making that will *use* conceptions like those discussed above as tools, but will not do so in a way that is rigid or insensitive to new data, or to the changing context of choice. As I hope the discussion above shows, it matters how we specify the content of our obligation, and will be important to find unambiguous ways to express our objectives. But there is no single simple sustainability criterion that will be appropriate for use in all circumstances. Several of the principles identified above have appropriate domains where they capture important intergenerational values. The best management strategy may, as Norton suggests, involve careful and ongoing re-evaluation not only of the effects of prior management decisions, but of the way objectives and goals have been articulated and re-articulated over the course of time. Environmental management problems are complex, and the constraints of our reasoning make it impossible adequately to account for all variables and uncertainties. We cannot simply settle on a strategy as optimal, and then pursue it to the grim conclusion, we need to stop and take stock as we go. This is one of the most important lessons of Norton's pragmatist theory of management.

What happens when this simple, intelligent, pragmatist advice is ignored? If we allow our free capacity to reason about policy and management to be coopted by a simplistic maximization exercise, then we, like Nelson Courtland Brown, may find ourselves overlooking important costs as we make the decisions and evaluate the tradeoffs involved in environmental management. The values Brown failed to recognize are, in fact, values Norton has articulated with great clarity: the old-growth forests were irreplaceable, and the effects of deforestation were ecosystem-wide. Appropriate environmental management would require care to ensure that these resources would be protected and valued appropriately. Norton recommends the limited use of a precautionary approach, or of safe minimum standard principles, in contexts where management decisions have irreversible and ecosystem wide implications. Would Brown have done better if he had selected a different objective? Recall that Brown hoped to describe a system of forest management that would encourage the rise of thriving sustainable human communities. Brown envisioned communities that would exist in harmony with forest ecosystems, with workers harvesting forest resources at nondepletionary rates. It is a good vision, one that is shared by many contemporary advocates of sustainable forestry and sustainable agriculture. But it is also a seriously flawed and incomplete vision. It led to serious mismanagement of irreplaceable resources. Perhaps if Brown had reflected on the receding lines of old-growth forests, he would have realized their irreplaceable value. Perhaps if he had reflected on the continent-wide implications of deforestation, he would have come to a richer understanding of what was being lost as the great ancient trees came down.

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