Selection X.5. Sustainable Development: Ecology and Economic Progress*

Introduction

While "sustainable development" is the acknowledged subject of much recent development thinking (see e.g. World Commission on Environment and Development, 1987; Repetto, 1986; Redclift, 1987; Turner, 1988; Stockholm Group, 1988), little headway appears to have been made in terms of a rigorous definition of the concept. Therefore, not surprisingly, efforts to "operationalize" sustainable development and to show how it can be integrated into practical decision-making have been few and generally unpersuasive. The use of the term "development," rather than "economic growth," implies acceptance of the limitations of the use of measures such as gross national product (GNP) to measure the well-being of nations. Instead development embraces wider concerns of the quality of life—educational attainment, nutritional status, access to basic freedoms and spiritual welfare. The emphasis on sustainability suggests that what is needed is a policy effort aimed at making these developmental achievements last well into the future. By implication, some at least of past development efforts have achieved only short-lived gains.

In this chapter we suggest a simple *definition* of sustainable development, and elaborate a set of *minimum* conditions for development to be sustainable, the conditions being based on the requirement that the *natural capital stock* should not decrease over time. Natural capital stock, in this context, is the stock of all environmental and natural resource assets, from oil in the ground to the quality of soil and groundwater, from the stock of fish in the oceans to the capacity of the globe to recycle and absorb carbon. We keep the definition of natural capital stock deliberately vague in order to capture the more general picture, and in the belief that a more detailed investigation will not raise insuperable problems. The meaning of a *constant* natural capital stock is more problematic, however, and we therefore devote a little time to alternative meanings.

The idea that the natural capital stock should be held constant or improved, broadly reduces to an embodiment of the idea that resource and environmental degradation has gone "too far." This basic feeling is what we detect as the undertone to much recent environmental campaigning and discussion. In the language of economics, as degradation increases so the economic value of the next unit of environment at risk from destruction, whether tropical forest or wetland or whatever, is seen to be higher than the unit that has just disappeared or been degraded. Of itself, this idea of a rising "marginal" economic value of natural environments the less there is of them will not justify maintaining what there is at any given moment of time. As we shall see, economists would typically argue that environmental degradation *should* take place so long as the gains from the activities causing the degradation (e.g. agricultural clearance of forests, development of wetlands) are greater than the benefits of preserving the areas in their original form. The idea that there is some "optimum" stock of natural assets based on this comparison of costs and benefits needs to be addressed directly in order to see why the conservation of the existing stock should be elevated to be a goal of sustainable development. The rest of this chapter investigates this question.

Defining Sustainable Development

Since "development" is a value word, implying change that is *desirable,* there is no consensus as to its meaning. What constitutes development depends on what social goals are being advocated by the development agency, government, analyst or adviser. We take development to be a *vector* of desirable social objectives; that is, it is a list of attributes which society seeks to achieve or maximize. The elements of this vector might include:

- increases in real income per capita;
- improvements in health and nutritional status;
- educational achievement;
- access to resources;
- a "fairer" distribution of income;
- increases in basic freedoms.

Correlation between these elements, or an agreed system of weights to be applied to them, might permit development to be represented by a single "proxy" indicator, but this is not an issue pursued here.

Sustainable development is then a situation in which the development vector D does not decrease over time. However, such a simple definition is not

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problem-free. For example, use of the term implies the adoption of an infinite time horizon—i.e. that the aim is to achieve everlasting development—whereas practical decision-making requires adoption of some finite horizon. Nor does it tell us if the rate of change of D with respect to time t must be positive for each and every time period (which we might term *strong sustainability*), or whether only the trend of dD/dt must be positive (*weak sustainability*). One variant of the weak sustainability measure is that the *present value* of development benefits should be positive. A present value is a way of expressing a stream of benefits (or costs) that occur over time as a value perceived from the standpoint of the present. To do this future benefits and costs are *discounted*—i.e. given a lower weight relative to a similar benefit or cost in the present. Chapter 2 investigates the discounting issue in detail. For the moment, however, it is sufficient to note that present value maximization is consistent with the extinction of resources. How far those extinctions result in the development objectives themselves becoming unsustainable is open to question. But they lend some support to the idea that present value maximization is not a sufficient criterion for sustainable development. Sustainable development is better interpreted in its weak form—i.e. as saying that the rate of change of development over time is *generally* positive over some selected time horizon.

Subject to the above caveats, we suggest that sustainability be defined as the general requirement that a vector of development characteristics be non-decreasing over time, where the elements to be included in the vector are open to ethical debate and where the relevant time horizon for *practical* decision-making is similarly indeterminate outside of agreement on intergenerational objectives. This level of generality may seem unsatisfactory, but the essential point is that *what* constitutes development, and the *time horizon* to be adopted, are both ethically and practically determined. Such an ethical debate can be illuminated by discussion of the alternative views on both issues, but it cannot be resolved other than by ethical consensus.

The Conditions for Sustainable Development: Constant Capital Stock

Much of the sustainable development literature has confused *definitions* of sustainable development with the *conditions* for achieving sustainability. The preceding discussion suggests that the definition, the meaning, of sustainable development, is evident from the phrase itself. We now consider a key necessary condition for achieving sustainable development. These conditions, elaborated below, are not sufficient, however. A sufficient set of conditions is likely to include, for example, institutional requirements for implementing sustainable development policy, and it may even require systematic changes in social values.

We summarize the key necessary condition as "constancy of the natural capital stock." More strictly, the requirement is for non-negative change in the stock of natural resources and environmental quality. In basic terms, the environment should not be degraded further but improvements would be welcome.

The presumption that sustainability has something to do with non-depreciation of the natural capital stock is explicit in the Brundtland Report. Thus, "If needs are to be met on a sustainable basis the Earth's natural resource base must be conserved and enhanced" (World Commission on Environment and Development, 1987, p. 57). It is somewhat more vaguely embraced in the World Conservation Strategy in terms of maintaining "essential ecological processes and life support systems," "preserving genetic diversity" and ensuring "sustainable utilization of species and ecosystems" (IUCN, 1980, I). Both sources offer rationales for conserving natural capital in terms of moral obligation and the alleged mutual interdependency of development and natural capital conservation. A similar definition is advanced by economist Robert Repetto:

> sustainable development [is] a development strategy that manages all assets, natural resources, and human resources, as well as financial and physical assets, for increasing long-term wealth and well-being. Sustainable development, as a goal *rejects policies and practices that support current living standards by depleting the productive base, including natural resources,* and that leaves future generations with poorer prospects and greater risks than our own. (Repetto, 1986, p. 15)

Existing and Optimal Capital Stock

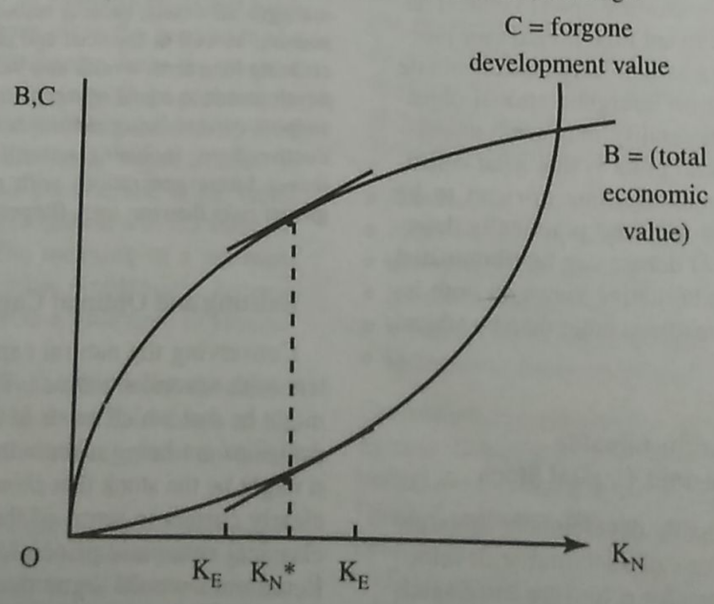
Conserving the natural capital stock is consistent with several situations. The stock in question might be that which exists at the point of time that decisions are being taken—the *existing* stock—or it might be the stock that *should exist*. The latter is clearly correct in terms of the application of neoclassical economic principles to resource issues. Economics would argue that there are costs and benefits of changing the natural capital stock. If it is reduced, it will be for some purpose; for example, much tropical forest clearance takes place for agricultural purposes. Similarly, wetlands are drained to gain the fertile soil for crop growing; natural habitats are reduced for housing development, and so on. Thus each destructive act has benefits in terms of the gains from the use to which the land is put. In the same way, using the atmosphere or the oceans as "waste sinks" has benefits, in that alternative means of disposal are often more expensive. Thus the environment as a waste sink reduces production and consumption costs compared to what they would have been. Environmental destruction also has costs since a great many people use natural environments (for wildlife observation, recreation, scientific study, hunting, etc.). These "use benefits" are lost (i.e. there are costs of destruction) if the land is converted for some other purpose. Similarly, one of the benefits of keeping the atmosphere unpolluted is that we avoid the damage that is done by pollution—e.g. better health and, globally, the avoidance of impacts such as global warming through trace gas emissions. Natural environments do not just have "use values." Many people like to think of environments being preserved for their own sake, an "existence value." These "non-use" values need to be added to the use values to get the *total economic value* of the conserved resource or environment.

Figure 1 depicts the cost-benefit comparison. The stock of natural assets is shown on the horizontal axis and costs and benefits are shown on the vertical axis. The cost curve shows that as the stock of natural capital (K_N) increases, there are increasing costs in the form of forgone benefits from *not* conserving the environment. The benefit curve captures the benefits to users and non-users of natural environments. Economic analysis would identify K_N^* as the optimal stock of the environment. If the existing stock is to the right of K_N^*, then it will be beneficial in net terms to reduce the stock—i.e. to engage in environmental degradation and destruction. If the existing stock is to the left of K_N^*, then improvements in environmental quality are called for.

If our overview of the meaning of sustainable development is correct, it appears to be inconsistent with the idea of maintaining optimal stocks of natural assets or, at least, it will only be consistent if we are to the left of the optimum depicted in Figure 1 (since sustainability is consistent with increasing environmental assets) or coincident with it. We therefore need to investigate further the rationale for maintaining and improving existing levels of environmental assets.

Several observations are in order. First, existing stocks would generally be regarded as being below optimal stocks in many developing countries. For some Sahelian countries they are significantly below the optimum, in that desertification and deforestation actually threaten livelihoods (Falloux and Mukendi, 1988). Nor is there evidence that the further reduction of soil quality, tree cover or water

Figure 1. The costs and benefits of environmental change.



K_N is the natural capital stock; B shows the benefits from increasing it, benefits that accrue as use and non-use values; and *C* is the cost of increasing the natural capital stock, and these costs are the forgone benefits from using the natural assets for some other purpose. K_N^* is the optimal stock.

supplies will result in some form of surplus which can be reinvested in other man-made capital assets. Therefore, to some extent, deliberations about what precisely constitutes an optimum are redundant in the contexts of these countries.

The second observation relates to the identification of the "optimum" in Figure 1. To say that capital stocks "should" be optimal is tautologous. The interesting feature of optimality is how the benefits of augmenting natural capital are calculated. The critical factor here is that the *multifunctionality* of natural resources needs to be recognized, including their role as integrated life support systems. Thus a cost-benefit analysis that compares the "value" of, say, afforestation with the opportunity cost of land in terms of forgone development values needs more careful execution than might otherwise appear to be the case. How far life support functions, such as contributions to geochemical cycles, can be captured by cost-benefit is open to question. In the face of uncertainty and irreversibility, conserving what there is could be a sound risk-averse strategy. Put another way, even in countries where it might appear that we can *afford* to reduce natural capital stocks further, there are risks from so doing because of (a) our imperfect understanding of the life support functions of natural environments, (b) our lack of capability to substitute for those functions, even if their loss is reversible in theory, and (c) the fact that losses are often irreversible. There is therefore a rationale in terms of *uncertainty* and *irreversibility* for conserving the existing stock, at least until we have a clearer understanding of what the optimal stock is and how it might be identified. . . .

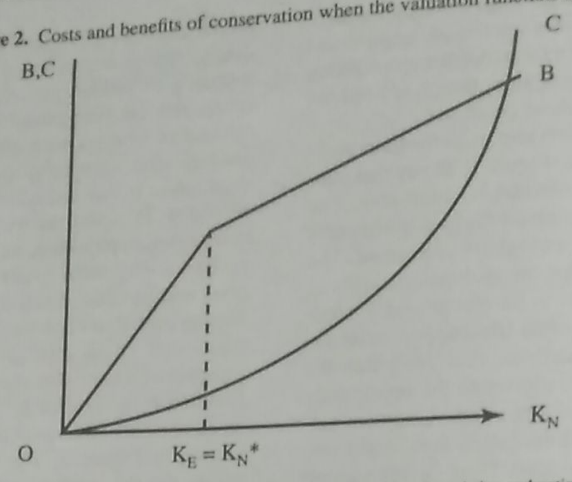
A fourth reason for supposing that existing stocks are important arises from recent research on the use of willingness-to-pay and willingness-to-accept measures of benefit. A simple conceptual basis for estimating a benefit is to find out what people are willing to pay to secure it. Thus, if we have an environmental asset and there is the possibility of increasing its size, a measure of the economic value of the increase in size will be the sums that people are willing to pay to ensure that the necessary land or other asset is obtained. Whether there is an actual market in the asset or not is not of great relevance. We can still find out what people would pay if only there were a market. In the same way, if there is to be reduction in the size of the asset, we can ask what people are willing to accept to give it up. Economic theory predicts that the difference between the willingness to pay and willingness to accept measures (the "equivalent and compensating variation" measures of welfare gain) will not differ significantly. That is, a measure of willingness to pay for a small gain will be approximately equal to the requirement for compensation to give up a small amount of an asset. Empirical work suggests otherwise, with very large discrepancies between willingness to pay and willingness to accept being recorded. Prospect theory offers a rationale for compensation requirements being very much larger. Essentially, what exists is seen as a reference point and attitudes to surrendering some of what is already owned or experienced are quite different to those that come into play when there is the prospect of a gain. Put another way, the valuation function B in Figure 1 is "kinked" at the existing stock of assets. The result of modifying Figure 1 is shown in Figure 2. The existence of the kink means that the optimal level of K_N is likely to be at the point of the kink: existing and optimal natural capital stocks coincide. In terms of the "constant capital" idea in sustainable development, it implies that a high valuation should be placed on reductions in the existing capital stock, thus supporting the view that conservation of existing stocks itself has a high priority.

Overall, while there is a powerful case in analytical economics for thinking in terms of maintaining optimal rather than existing natural capital stocks as the basic condition for sustainability, there are also sound reasons for conserving at least the existing capital stock. For poor countries dependent upon the natural resource base, optimal stocks will in any event be above the existing stock. In other cases, there is a rationale in terms of incomplete information about the benefits of conservation (the failure to appreciate and measure multifunctionality), uncertainty and irreversibility for conserving the existing stock. Additionally, resource conservation serves non-efficiency objectives, whereas optimality tends to be defined only in terms of efficiency. Finally, even in terms of efficiency, the existence of a valuation function which is kinked at the existing endowment of natural resources adds emphasis to the conservation of existing stocks.

The Meaning of Constant Capital Stock

Constancy of the natural capital stock can take on several different meanings. A common interpretation is in terms of constant *physical* capital stock. This is appealing for renewable resources, but, clearly, has little relevance to exhaustible resources since any positive rate of use reduces the stock. An alternative interpretation is in terms of a

Figure 2. Costs and benefits of conservation when the valuation function is kinked.



The benefit function of Figure 1 is now kinked at the existing stock of natural capital, making the existing and optimal stocks probably coincident.

constant *economic value* of the stock. This allows for a declining physical stock with a rising real price over time, maintaining a constant economic value. The problem here is that the "price" variable needs to be interpreted with considerable care to reflect all the economic values deriving from multifunctional resources. Valuation problems, especially with functions such as contributions to reducing future catastrophes, are formidable. An additional complication lies with the presence of discontinuities in the valuation function—i.e. threshold effects such that stocks below a minimum critical level result in major costs.

A variant of the constant economic value concept is the view that a constant capital stock can be interpreted as one where the *price* of the stock remains constant over time. The motivation behind this idea is that scarcity can often be effectively measured in terms of the price of a natural resource, higher prices reflecting scarcity and lower prices reflecting abundance. This has some appeal in terms of exhaustible resources with uncertain reserves, where scarcity results in increased exploration effort or technological substitution. But for renewable resources, current prices are less likely to reflect future scarcity. As an example, fuelwood prices may remain constant in real terms, despite stock reductions, because the *flow* of harvest is not significantly affected. Price may then rise only as the last units of the resource are extracted.

A broader version of the constant value rule would require that the total value of *all* capital stocks be held constant, man-made and natural. Here the basic idea is that future generations would inherit a combined capital stock no smaller than the one in the previous generation. In this way, a depleted resource, say oil, would be compensated for by other investments generating the same income. This argument is considered in more detail shortly; but if it is to be advanced, it is clearly important that natural capital stocks be correctly valued, and that threshold effects be allowed for.

In general, there is no easy interpretation to the idea of a constant capital stock. Some combination of an equal value rule with indicators of physical stocks to allow for critical minimum stocks (which, in turn, might qualify as 'sustainability indicators") appears appropriate, but the issues have yet to be resolved.

References

Falloux, F. and Mukendi, A. (eds) (1988), *Desertification Control and Renewable Resource Management in the Sahelian and Sudanian Zones of West Africa*, World Bank Technical Paper No. 70, World Bank, Washington DC.

International Union for the Conservation of Nature (IUCN) (1980), *World Conservation Strategy*, Gland, Switzerland: IUCN.

Redclift, M. (1987), *Sustainable Development: Exploring the Contradictions*, London: Methuen.

Repetto, R. (1986), *World Enough and Time*, New Haven, Conn.: Yale University Press.

Stockholm Group for Studies on Natural Resource Management (1988), *Perspectives of Sustainable Development*, Stockholm Group, Stockholm.