SUSTAINABILITY IS AN OBJECTIVE CONCEPT

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Published in Ecological Economics, 27(2), 139-47, 1998.

Abstract

Sustainability is defined as the use of the vital functions (possible uses) of our biophysical surroundings in such a way that they remain indefinitely available. This situation can be established scientifically. Consequently, sustainability is an objective concept to the extent that natural science is objective. The objective description of sustainable use of functions and the subjective preferences for such a use - the question whether or not we want to achieve such use - should be sharply distinguished.

Keywords: Sustainability; Environmental function

1. Introduction

The notion of sustainability has a long intellectual history, going back to the concept of a 'stationary' or 'steady state' economy employed by nineteenth-century economists. This concept denotes a state of equilibrium between production and natural resources. J.S. Mill (1876) wrote that he sincerely hoped that people would be content to be stationary, for the sake of posterity, long before necessity compels them to it. This pronouncement can be interpreted as being based on considerations of intergenerational equity. In the twentieth century the notion of sustainability has been extended to encompass other aspects of the environmental issue, such as the relation with the living world (nature) and pollution. (Daly, 1973; IUCN, 1980; Goodland, 1995).

In the process, the principle of preferences for intergenerational equity has always remained a core element of the concept. This implied a state of equilibrium with the available natural resources and with the living world, and abatement of pollution, to the

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extent of its significance for future generations. Uncompensated exportation of anthropogenic environmental risks to future generations was rejected as inadmissible. To establish an appropriate maximum environmental burden to meet these preferences was seen as a task for natural scientists. In other words, sustainability was taken to mean that the environmental capital - defined as the possible uses, or functions, of the environment and natural resources - provided by nature and capable of being scientifically established, should remain intact (Daly, 1973; Hueting, 1974a; Goodland, 1995).

Using Boulding's (1991) terminology, this implies a dynamic equilibrium, in which (ceteris paribus) the functions of environment and natural resources remain available. Measures taken to allow for the permanent availability of functions should be derived from scientifically based presuppositions. Whether these measures are sufficient can be evaluated "after the fact", in the terminology of Costanza and Patten (1995), again using natural science. So in this view sustainability is an objective concept to the extent that natural science is objective.

In the report Our Common Future (Brundtland et al., 1987), also known as the Brundtland report, the concept of sustainability was clearly linked to the issue of intergenerational equity. In Our Common Future this was phrased as follows: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Many countries have by now subscribed to sustainable development as defined in the Brundtland report.

2. Is sustainability subjective?

Increasingly, studies are being published that abandon the idea that sustainability requires there to be a state of equilibrium between production, on the one hand, and natural resources and nature, on the other, with exportation of uncompensated anthropogenic environmental risks to future generations deemed unacceptable. A good example thereof is Expanding the Capital Stock by Serageldin and Steer (1994). They argue that 'sustainability has several levels - weak, sensible, strong and absurdly strong- depending on how strictly one elects to hew the concept of maintenance or non-declining capital'. Other examples are given by Goodland (1995).

The abandonment of the notion that sustainability means that the functions of natural capital should remain intact increasingly spills over in studies pertinent to national sustainability policies. Two recent studies published in the Netherlands illustrate this.

The first study is by the governmental Central Planning Office (CPB, 1996), the second by the Institute of Environmental Studies of the Free University of Amsterdam (Verbruggen et al, 1996).

The mental leap made in these studies already has a certain tradition in the Netherlands, having already been made by the Scientific Council for Government Policy in its report Sustainable risks, a permanent fact (WRR, 1994). In essence, the Council's stand is that sustainability is a social construct determined by the present generation. From this viewpoint, it is impossible to establish objectively what sustainability is, it being above all a question of determining what constitute acceptable risks to the present and future generations.

In the Central Planning Office study, Economy and environment: in search of sustainability (CPB, 1996) sustainability is referred to as a subjective notion. According to the study, it is "a reflection of how the current and future quality of the environment is subjectively valued by an individual or group". The study then goes on to focus on the short-term environmental targets set by the Dutch government in its Second National Environmental Policy Plan.

In the study by the Institute of Environmental Studies, Sustainable economic development scenarios (the so-called DEOS study; Verbruggen et al, 1996), several different definitions of sustainability are employed, including 'weak', 'strong' and 'balanced' sustainability. The distinction in weak, strong and balanced sustainability is inconsistent with the original meaning of the concept, since the possible uses, or functions, of our physical surroundings (the environment), on which all human life depends, either remain available or they do not, whereby it should be borne in mind that these functions have come into being largely via processes proceeding at a geological or evolutionary pace. In contrast to what is presumed in the ideas underpinning the notion of 'weak' sustainability, it is moreover unfeasible for our planet's life support systems[1] ever to be completely replaced by technology (Goodland, 1995). It is thanks to these life support systems or processes, which are under threat of disruption, that indispensable environmental functions remain available. Even the strong variant of sustainability mentioned by Verbruggen et al. (1996) does not lead to a state of equilibrium between natural resources and production and implies the exportation of uncompensated risks.

According to Verbruggen et al, 1996,, it is only on political grounds that a choice can be made from among the different forms of sustainability. The study then goes on to state: "On the one hand, this involves the question of how material components of welfare are to be weighed up against immaterial, viz. environmental quality. On the other, the choice is determined by the estimated vulnerability or stability of the environment, and also involves the question of the material sacrifice people are prepared to make in order to insure against future disappointments with respect to that vulnerability and stability" (Verbruggen et al, 1996, p.iv). The study thus continues, explicitly and fully, the tradition of the aforementioned report by the Scientific Council for Government Policy, Sustainable risks, a permanent fact (WRR, 1994).

In our opinion, in the last quote the concepts (im)material and welfare are used improperly, from both the economic and scientific viewpoint. In the first place, from the economic angle it makes no difference whether a good is material or immaterial: all that matters is whether or not it is scarce (because free goods have no economic value, no matter how valuable they are for humans). Secondly, the satisfaction of wants, or welfare, is a subjective notion. It is a personal experience, not directly observable 'from outside', not in itself measurable in cardinal units and therefore immaterial (Hennipman, 1995; Robbins, 1952). Thirdly, it is hardly tenable that a tree (environment) is immaterial, while the chair that is made from it (production) is material, as implied by the statement cited from the DEOS study. It is obviously an important question whether the economic subjects are prepared to sacrifice some fraction of the scarce produced goods to reacquire scarce environmental functions. However, the question has nothing to do with the question of whether or not sustainability is a state of affairs that can be established scientifically.

The Central Planning Office study and the DEOS study are both unacceptably far removed from the core element of the notion of sustainability, intergenerational equity, as employed in Our Common Future (Brundtland et al, 1987) and previously (Daly, 1973; Hueting, 1974; Reijnders, 1984).

The issue of the environmental problem has its roots in human society and is in that sense obviously of a social nature. In our dealings with the environment, however, it is important that it is a relationship that on the environmental side is of a physical nature, and that is able to be described in scientific terms. The environment (defined in terms of natural resources, living beings and degree of pollution) is in a certain state and, as a result of the actions of mankind, undergoes changes that are not social constructs. Striking examples thereof can be derived from recent collapses of major fisheries (Birkeland, 1992; Ludwig et al, 1993; Brown ,1995). Though often fishery policies were in place, that were said to lead to 'sustainable yields', this has not prevented the actual collapse of a number of fish stocks. There is obviously a level, defined as a number of individuals of a species, below which this species is threatened by extinction; arriving below that level is unsustainable, remaining above that level is sustainable.

To cite another example: in contrast to the situation prior to human intervention, the rate at which natural species are becoming extinct is today at least a factor 10,000 higher than the rate at which new species are evolving, regardless of the fact that humanity has not even named many of these species and political agencies and the community at large have only a limited knowledge thereof (Raup, 1986). Likewise, it makes no difference for actual, contemporary climate change due to carbon dioxide and other emissions of greenhouse gases whether societies or governments believe in it or not.

Although historians of future generations may most certainly be interested in the social constructs we devised with respect to physical reality, the generations in question will be confronted primarily with reality and not with the contemporary social construct we made of it. There is thus every reason to reject the idea that sustainability is a subjective concept or a contemporary social construct.

Here, a comparison can be drawn with prevailing views on other scientific phenomena that are rooted in human behaviour. If the mental leap of the Dutch Central Planning Office (CPB, 1996), the Dutch Scientific Council for Government Policy (WRR, 1994) and Verbruggen et al (1996) were to be generalized, one would also have to maintain that scientists, such as medical specialists, cannot reasonably be expected to establish whether or not a person has AIDS and what behaviour might lead to the elimination of AIDS, but that this is an issue for the parliament and government of the day.

3. Maintenance of the functions of natural capital

If the essence of sustainability is that the objective conditions for intergenerational equity are realized (assuming preferences for this), and it is assumed that there are still very many generations to come, then the obvious course is to continue to define sustainability in the way it was defined before the Scientific Council for Government Policy put the term up for discussion in the Netherlands (WRR, 1994). Sustainability then means that the environmental capital provided by nature - defined as the possible uses, or the functions, of our physical surroundings - should be preserved.

As a fundamental objection to this stand, Pelle (1996), following the Dutch Central Planning Office (CPB, 1996), argues that this definition is difficult to apply in practice: because of natural processes, environmental capital is subject to continual change; for example, of all the plant species that have ever grown on earth, 99.9% are now extinct.

This objection is unjustified. It is true that environmental capital is, by nature, not constant. Some elements of natural capital tend naturally to grow. To this category belong natural resources that are formed in prolonged geological processes, such as petroleum and copper ore. It is also true that species are continually becoming extinct, but new species also come into existence all the time. In the course of evolution, the creation of new species has usually outpaced the extinction of existing species, resulting in a marked increase in biodiversity. It is assumed that conditions during the past several thousand years have been such that, ignoring drastic human intervention for the moment, the number of new species must certainly have at least equalled the number of extinct species (Raup, 1986; Hawksworth, 1995). Without drastic human intervention, the quantity and quality of renewable natural resources such as groundwater or biomass (including wood) show a substantial degree of constancy. In the absence of human intervention, environmental capital is thus characterized by a substantial degree of constancy or even increase. Moreover, the concept of sustainability does not extend to humanity having an obligation to compensate for losses of environmental capital due to quirks of nature.

The reason brought forward by the Dutch Central Planning Office and Pelle therefore gives no grounds for abandoning a definition of sustainability that aims to maintain the functions of environmental capital provided by nature.

As rightly pointed out by Goodland this definition of sustainability goes beyond 'sustainable yield', a notion that is current in fishery and forestry circles. Sustainability applies to aggregate natural capital, not just to a few species of fish or timber trees (Goodland,1995). In the case of forestry, for instance, it includes biodiversity, ecosystem integrity, water source and water moderation values and the contributions to geochemical cycles (including the Carbon cycle) and climate (Goodland, 1995). Apart from this, a level can be established above which a (plant or animal) species can be harvested sustainably (see Section 2); together with the condition that harvesting this species should not disrupt the ecosystem of which it forms part (see Odum, 1972), this yields the sustainability standard for the species.

4. The concept of environmental function and its sustainable use

The concept of environmental function was introduced by Hueting (1970, 1974a and 1974b). Briefly and incompletely, the concept comes down to the following. Environmental functions or, in short, functions, are defined as possible uses of humanity's biophysical surroundings: water, air, soil, natural resources, plants and animals. Uses can be either passive or direct and practical. The 'services' of environmental functions are defined as their possibilities or their potential to be used by humans for whatever end. Some functions can be conceived as consumption goods, other as capital goods. Because we depend on our physical surroundings for all our activities, we stand literally empty handed if we lose vital functions, unless we find substitutes. As soon as the use of a function is at the expense of another (or the same) function, or threatens to be so in the future, there is competition of functions. Competing functions are economic goods, because they fully meet the definition of scarcity. In the process of production growth, most functions have been changed from free goods with an economic value zero into scarce goods with an ever higher positive value. This increase in value (per function) is basically an increase in scarcity (costs).

A distinction is made between three kinds of competition of functions: spatial, quantitative and qualitative. When spatial and quantitative competition occurs, the amount of space and the amount of matter respectively are deficient in respect to the existing or future needs for them. In qualitative competition, overburdening the function 'waste dumping medium' by chemical, physical or biological agents has caused partial or total loss of other possible uses of the environment, such as the function 'drinking water' or 'air for breathing'.

The estimate of Sustainable National Income as described by Hueting et al. (1992) is based on the concept of environmental function. Sustainability is defined as the use of vital environmental functions in such a way that they remain available indefinitely, and sustainable income as the level of production and consumption that can be sustained indefinitely with available technology while maintaining the availability of vital functions. The availability of functions and the sustainability standards are reflected in all kinds of physical variables (see Figure 1); state variables are related to pressure variables via environment models; measures to restore and preserve functions by eliminating the pressure include development of substitutes for functions that are in danger of being lost.

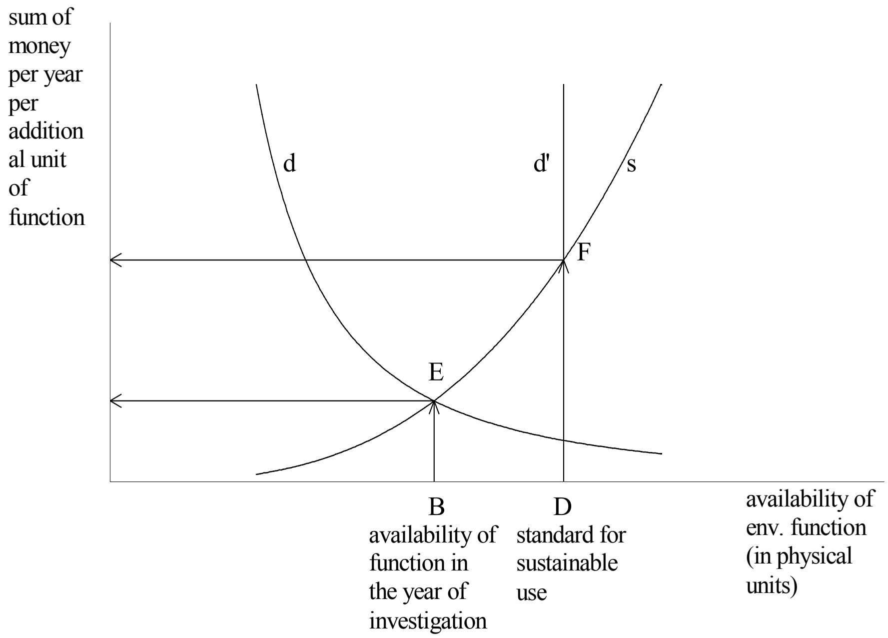

Figure 1. *Translation of costs in physical units into costs in monetary units: s=supply curve or marginal elimination cost curve; d=incomplete demand curve or marginal benefit curve based on individual preferences (revealed from expenditures on compensation of functions, and so on; d'='demand curve' based on assumed preferences for sustainability; BD=distance that must be bridged in order to arrive at sustainable use of environmental functions; area BEFD=total costs of the loss functions, expressed in money; the arrows indicate the way via which the loss of environmental functions recorded in physical units is translated into monetary units. The availability of the function (B) does not need to coincide with the level following from intersection point (E).*

When using the concept of function, the only thing that matters in the context of sustainability is that vital functions remain available. What does the conservation of vital functions mean for the distinction between renewable and non-renewable and for the distinction between strong and weak sustainability ?

As for renewable resources, functions remain available as long as their regenerative capacity remains intact. Regeneration in relation to current use of 'non-renewable' resources such as crude oil and copper, that are formed by slow geological processes, is close to zero. Regeneration then takes the form of developing substitutes. The possibilities for this are hopeful (Brown et al., 1998; Reijnders, 1996). So, economically speaking, there seems to be no essential difference between the two.

Weak sustainability takes the line that the elements of the environment are substitutional in the short term, so that restoration of lost elements can be postponed, awaiting cheaper solutions provided by future technologies. Meanwhile income level can be sustained by reserving a sufficient part of the revenues of a resource for investment in the consumption goods industries. However, the life support systems [1] of our planet, on which a number of vital functions depend, are not substitutional (Lovelock, 1979; Roberts, 1988; Reijnders, 1996). The same applies to most functions of natural ecosystems [1], especially in the long term. Consequently, weak sustainability is impossible for the functions of these systems.

Strong sustainability takes the line that substitution of all elements of the environment is not possible. This implies that the stocks of non-renewable resources should remain in tact integrally. This is impossible. Consequently, strong sustainability for non-renewables seems to be impossible. In Hueting et al.(1992) suggestions are made on how to tackle the problem in practical research. In Hueting et al. (1995) a numerical solution is given - albeit not a perfect one - with regard to the rate of substituting non-renewables in order to meet the sustainability standard. It boils down to permanently compensating the reduction of the stock of a resource, e.g. crude oil, by a new source which can provide an equivalent use of the functions of the resource, e.g. 'provider of energy'. In this way the functions of the resource are assumed to remain available, completely and indefinitely.

In conclusion, there seems to be only one kind of sustainability, by which it is sometimes possible to substitute elements of the environment (resources) by other elements in order to guarantee the availability of functions, and sometimes it is not.

The question is often asked whether sustainability standards should be applied locally or globally. The answer depends on the scale upon which functions should be substituted. For instance, preservation of the function 'soil for raising crops' requires local application of the standard for erosion (the rate of erosion may not exceed the rate of soil formation, see Section 5), because exceeding the standard cannot be compensated by remaining under the standard elsewhere. Crude oil, on the other hand, is a global resource, so application of the standard for its functions by increasing efficiency and developing substitutes should be applied worldwide.

5. Establishment of sustainable environmental burdens

The 'admissible' environmental burden that goes with the definition of sustainability in terms of conservation of the functions of environmental capital can, in principle, be established scientifically (Hueting et al 1992; Reijnders, 1996). Operationalisations thereof can for instance be found in Goodland (1995) and Reijnders (1996). For example, it can be established that the rate of erosion of topsoil may not exceed the rate of formation of such soil due to weathering. Similar consumption standards can be set for other natural resources. With respect to how sustainability relates to species, then, the standard holds that the man-made rate of extinction should not exceed the rate at which new species come into existence. With regard to pollution, too, criteria can be established. Acid precipitation, for example, should not exceed the neutralizing capacity of the soil. Likewise, there should be no exportation of risks to future generations through pollution of groundwater that is to serve as a source of drinking water for those generations. In many cases, the accompanying environmental burden can be determined with great accuracy. There is a wealth of data on the rate at which new fertile soil is naturally formed and on the neutralizing capacity of natural soils, and these data enable a precise indication to be given of the admissible environmental burden due to erosion and acid rain (Reijnders, 1996). In other cases we have insufficient knowledge to make firm pronouncements. For example, at present we can do no more than give a rough indication of the conditions under which plant and animal species are able to survive (Hawksworth, 1995; Den Boer, 1979). On the basis of the best available global circulation models it can be calculated that worldwide emissions of carbon dioxide must be reduced drastically to achieve stabilization of the global warming process, but an exact percentage cannot be given (De Boer, 1996). Similarly, shortcomings in our toxicological knowledge mean that we cannot fully analyse the risks associated with polluted groundwater. However, this does not detract from the fact that improvement of scientific knowledge can lead to a more precise establishment of standards for sustainability.

All in all, it is feasible to establish scientifically the environmental burden that is 'admissible' on the basis of the objective of sustainability.

6. Political choice

One problem that then arises is that the admissible environmental burden established will not be to everybody's liking. Given current technology, to maintain environmental functions for future generations requires a sacrifice, which necessarily consists mainly of giving up some fraction of current consumption. This can either be done via technical measures, which implies a shift of production factors from production of consumer goods to pollution abatement, or it can take the form of adopting a consumption pattern that was not our preferred choice (more beans and less meat, for example, or more cycling and less motoring), or it may result from investments in research on application of renewable, but currently still more expensive, substitutes for non-renewable resources. Another essential step to relieve some of the environmental burden is to reduce population numbers (Tinbergen & Hueting, 1991). Whether people will be prepared to make the consumption sacrifice is something that cannot be established scientifically (Hueting, 1974a,b, 1992); the same holds for the opposite.

If only for this reason, it is necessary that a political choice be made. Here we agree with the Dutch Central Planning Office (CPB,1996) and Verbruggen et al (1996). In making such a choice, however, we should not be ignoring factual information on the conditions under which our generation behaves fairly towards future generations. In addition, calculations will be have to be made of the costs of the measures required to arrive at the appropriate level of production and consumption (Sustainable National Income) (Hueting et al, 1992). Armed with such calculations, policy-makers will be able to obtain at least some idea of what must be done in the fields of environmental technology, substitutes, consumption patterns and population policies to achieve the goal of sustainability.

Note

[1] 'Life support systems' are understood to mean the processes that maintain the conditions necessary for life on earth. This comes down to maintaining equilibria within narrow margins. The processes may be of a biological or physico-chemical nature, or a combination thereof. Examples of biological processes include the carbon and nutrient cycles, involving the extraction of such substances as carbon dioxide, water and minerals from the abiotic environment during creation of biomass, and the return of these substances to the abiotic environment during decomposition of the biomass. Examples of physico-chemical processes include the water cycle and regulation of the thickness of the stratospheric ozone layer. These examples show that there is interaction between the processes, whereby equilibrium may be disturbed. The water cycle, for example, may be disturbed by large-scale deforestation.

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