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Chapter 3

Sustainable National Income, A Prerequisite for Sustainability

Roefie Hueting

Introduction

The World Conservation Strategy of 1980 (IUCN *et al.* 1980), with the subtitle "Living Resource Conservation for Sustainable Development," introduced the concept of sustainability in the international discussion. This notion of sustainability was used in a way that was in line with a longer tradition of advocacy for a steady-state economy (Daly 1973), conceived as an equilibrium relation between human activities and the physical environment. This boils down to safeguarding the vital functions (possible uses) of the non-human-made biotic and abiotic physical surroundings, of which the biodiversity of natural ecosystems forms part. Humans are completely dependent on these surroundings, since they include humanity's life-support systems[1] (Hueting 1969, 1980, 1992). Safeguarding these environmental functions yields a production level that can be sustained 'for ever' without threatening the living conditions of future generations. This production level is called the sustainable national income (SNI) (Hueting and de Boer 2001; Verbruggen *et al.* 2001).

More precisely, SNI is defined as the maximum attainable production level at which vital environmental functions remain available, based on the technology available at the time. Thus, SNI provides information about the distance between the current and a sustainable situation. The length of the period to bridge this distance, that is, the transition period towards a sustainable situation, is limited only by the condition that vital environmental functions must not be damaged irreversibly. In combination with the standard national income (NI), the sustainable national income (SNI) indicates whether or not the part of the production that is not based on sustainable use of the environment, is becoming smaller or greater. Because the precautionary principle lies at the heart of the concept of sustainability, future technological progress is not anticipated in the calculation of SNI. The reason is self-evident: if the anticipated technological progress is not realised, future generations are confronted with the detrimental consequences of an unsustainable production level. In the calculation of SNI, anticipating is considered as gambling, while putting at risk generations to come. Furthermore, the main purpose of SNI research is to calculate the development of the distance between SNI and standard NI over the course of time, expressed through a time series of SNI and NI; this distance

[1] Life-support systems are understood to mean the processes that maintain the conditions necessary for life on earth. This implies maintaining equilibria within narrow margins. The processes may be of a biological or physico-chemical nature (or a combination thereof).

cannot be measured if technological progress is anticipated, since technological progress is one of the main factors influencing the distance. Not anticipating is, of course, not the same as not assuming future technological progress.

In this chapter, first the theory behind SNI is described. Then it is expounded why it is unlikely that a policy focussed on ongoing growth of the production and consumption as measured in standard NI will lead to a sustainable production level. Subsequently, some recent developments in the field of environment and production are discussed, such as the introduction of the 'factor four' concept, the notion of 'broad sustainability', and the 'genuine savings' approach – as well as the implications of their use. Finally, some concluding remarks are made.

The Theory of SNI*

The theory of sustainable national income (SNI) and the statistics needed for it have been worked on since the mid-sixties. A first rough estimate of SNI for the world in 1991 by Tinbergen and Hueting (1991) arrives at fifty percent of the global production level (the world income). Recent estimates by the Institute of Environmental Studies for the Netherlands also arrived at fifty percent of its production level or national income (Verbruggen *et al.* 2001). This corresponds approximately with the Dutch production level in the early seventies. It should be noted that in view of the smaller size of the Dutch population, the consumption per capita was by that time substantially higher than fifty percent of the current level. Roughly the same holds true for the world.

In the theoretical basis for the calculation of SNI, the environment is defined as the non-human-made physical surroundings, or elements thereof, on which humanity is entirely dependent whether producing, consuming, breathing or recreating. It is true that our observable surroundings are largely human-built. However, houses, roads, machines and farm crops are the result of two complementary factors: labour, that is, technology, and elements of the physical surroundings as here intended. Producing is defined, in accordance with standard economic theory, as the adding of value. This value is added to the physical elements of our environment.

In our physical surroundings, a great number of possible uses can be distinguished, which are essential for production, consumption, breathing, et cetera, and thus for human existence. These are called environmental functions, or in short: functions. As long as the use of a function does not hamper the use of another or the same function, so as long as environmental functions are not scarce, an insufficiency of labour, that is intellect or technology, is the sole factor limiting production growth, as measured in standard NI. As soon as one use is at the expense of another, though, or threatens to be so in the future, a second limiting factor is introduced. The emergence of competition between functions marks a juncture at which functions start to fall short of meeting existing wants. Competing functions are by definition scarce and consequently these functions are economic goods. In a situation of severe competition between functions, such as is the case today, labour is not only reducing scarcity, and thus causing a positive

* This section is vital for understanding (1) the concept of SNI and (2) the relationship between growth of production as measured in standard NI and safeguarding the functions of our physical environment. In case the reader considers this section too technical, it may be skipped without the understanding of the succeeding sections being hampered.

effect on our satisfaction of wants, or welfare – but it is also increasing scarcity, thus causing a negative effect on welfare. The same holds for consumption.

The availability of functions, or, in terms of the System of National Accounts, their volume, decreases from 'infinite' (abundant with respect to existing wants) to finite, that is, falling short. As a result, the shadow price[2] of environmental functions and with it their value, defined as price times quantity, rises from zero to an ever-higher positive value. *This rise in value reflects a rise in costs*. To determine the extent of the loss of function, we must know the value of the function. Since environmental functions are collective goods that are not traded on the market, supply and demand curves have to be constructed. Without data on both preferences and opportunity costs, determination of value is impossible.

The estimated costs of measures necessary to restore functions, which rise progressively per unit of function restored, can be seen as a supply curve. This is called the cost-effectiveness curve or the elimination-cost curve, because it refers to measures that eliminate the pressure on the environment. Except in the case of irreparable damage, this curve can always be constructed. Preferences for environmental functions, on the contrary, can only partially be determined, since these can only partially be expressed via the market.[3] Their expression via the market and budget mechanism is blocked by so-called blockages or barriers (Hueting and de Boer 2001). Therefore, it is not possible to construct a complete demand curve. Expenditure to compensate loss of function and to restore physical damage resulting from loss of function, however, constitute revealed preferences for the availability of functions, so that some impression of these preferences can be obtained. Examples are the additional measures for the production of drinking water as a result of the loss of the function 'drinking water' because of pollution, or the restoration of damage caused by flooding due to forests losing their 'hydrological regulation' function.

According to key authors such as Tinbergen, Kuznets and Hicks, who pioneered and developed the practical implementation of the concept of NI in the nineteen-thirties, changes in the level of NI are explicitly intended as *one* of the indicators for the development of welfare, alongside other indicators such as employment, labour conditions and income distribution. This is the way changes in the level of production are still understood by part of the public, the media and governments. This is understandable, because all economic action is aimed at the satisfaction of wants, so at the increase of welfare. In the nineteen-thirties, however, when Tinbergen and others were developing the concept of NI, the environment did not play a role in economics; therefore they did not yet take environmental functions into account as basic economic goods. This is different today. Safeguarding the vital functions of our physical surroundings, which include humanity's life-support systems, has become the most important economic issue confronting mankind. Scarce environmental functions are the most fundamental

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[2] Shadow prices are prices that are constructed with the aid of data derived from market behaviour or other behaviour that can be translated into market terms, when market prices are not correctly reflecting the scarcity ratio's or not at all available.

[3] Willingness to pay techniques can provide some information about effects that directly affect the living conditions *hinc et nunc*, such as noise nuisance, but cannot yield reliable data for precisely the vital functions on which future generations are dependent (Hueting and de Boer 2001).

economic goods at mankind's disposal, because we are entirely dependent on them. Nevertheless, their loss is not recorded in the standard NI. As a result of this omission we now have to deal with the situation in which a process that is accompanied by the destruction of the most fundamental economic goods is called economic growth and is identified with economic success. Continuation of this process receives the highest priority in the policy of all countries in the world. Therefore, publication of 'green' NIs, that is NIs corrected for environmental losses, alongside the standard NIs, is urgent. It provides essential information for society and policy-making. This was the firm conviction of Tinbergen, that is documented in his papers (e.g., Tinbergen and Hueting 1991), while it is implied in the work of Kuznets and Hicks.

Because individual preferences can be measured only partially, shadow prices for environmental functions, which are indispensable for the correction for loss of these functions and which are determined by the intersection of the first derivatives of the constructed curves for demand and supply, cannot be calculated. Consequently, these shadow prices remain unknown. This means that the *correct prices for the human-made goods* that are produced and consumed at the expense of environmental functions are *equally unknowable*. However, to provide the necessary information, assumptions can be made about the relative preferences for environmental functions and produced goods. This means that there are as many shadow prices for environmental functions and produced goods as reasonable assumptions can be made – and consequently as many green NIs. Each of these assumptions is associated with the 'optimal path' of the economy that follows from it. That is, the 'path' on which the annually available package of economic goods (including both human-made goods and environmental functions) perfectly reflects the assumed preferences. *One* of the possible assumptions is that the economic agents, individuals and institutions, have a dominant preference for an environmentally sustainable development; this is the path denoted by the subscript *s* in Figure 3.1. This assumption is legitimate since governments and institutions all over the world have stated support for sustainable development. A second possible assumption is that the economy is currently on an optimal path that is characterised by the changes in the standard NI: the path labelled *b* in Figure 3.1. A third possibility is that path *b* is attained because expression of preferences for sustainability is blocked (see above). So *both the SNI and the standard NI are fictitious* in the context of what is at issue in economic theory and statistics, namely to provide indicators of the effect of our actions on our welfare (Hueting 1980).

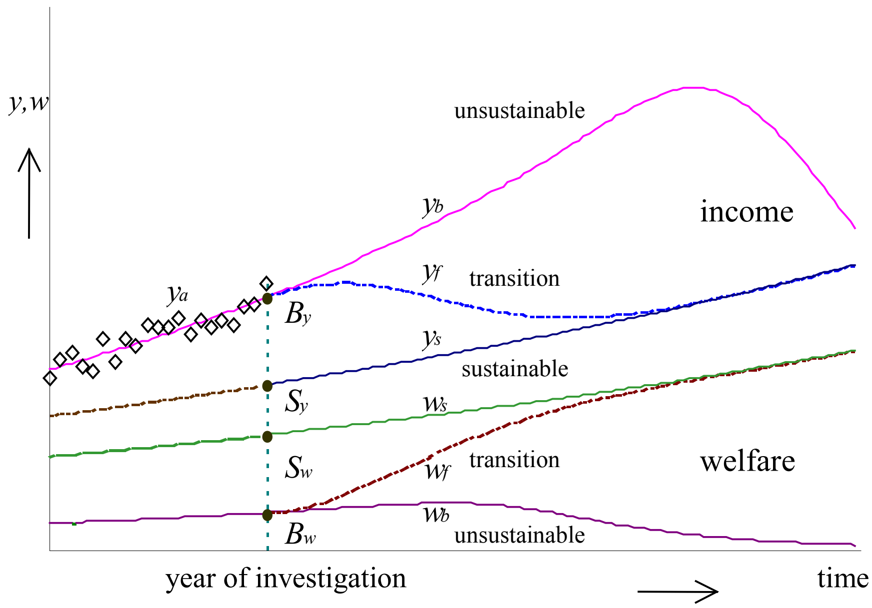

Figure 3.1. Actual standard national income observations (y_a, fictitious example) compared with the net national income (y) and a welfare indicator (w) on three optimal paths, calculated with a dynamic environmental economic model. The business-as-usual path (index b) approximates the actual path (index a) by assuming incomplete expression of preferences for the environment. These preferences are assumed to be completely expressed on the unfeasible sustainable path (index s) and the feasible transition path (index f). The points B_y and B_w indicate the levels of national income y and the welfare measure w on the business-as-usual path b in the year of investigation; S_y and S_w are the corresponding points on the unfeasible sustainable path s.

When assuming absolute preferences for sustainability, the unknown demand curves must be replaced by *physical* standards for sustainable use of the environment. The standards are scientifically estimated using environmental models and are in this sense objective (Hueting and Reijnders 1998). They must, of course, be distinguished clearly from the subjective preferences for whether or not they should be attained. From an economic perspective, sustainability standards approximate demand curves that are vertical in the relevant area of a diagram that has the availability of functions measured in physical units on the *x*-axis and the demand for functions and their opportunity costs on the *y*-axis. The shadow price for environmental functions based upon the assumed preferences for sustainability then follows from the intersection of the vertical line and the marginal cost-effectiveness curve. In this manner the distance to sustainability, denoted in physical units on the *x*-axis, is translated into monetary units, see Figure 3.2 (Hueting 1980). In principle, this monetary distance is equal to the distance between the national income figures belonging to the current path *b* and the sustainable path *s* in Figure 3.1. This is the distance to sustainability the country in question has to bridge in terms of the required opportunity costs. For a correct approximation, such calculations have been done with the aid of a general equilibrium model, which also generates the shadow prices for produced goods in a sustainable economy. From this, the level of sustainable national income follows.

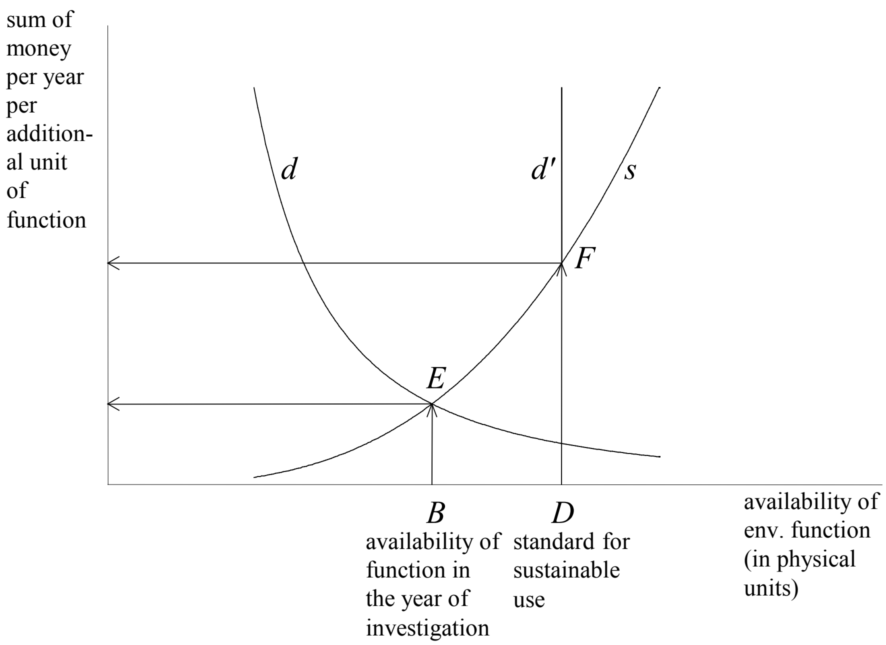

Figure 3.2. Translation of costs in physical units into costs in monetary units: *s* = supply curve or marginal elimination cost curve; *d* = incomplete demand curve or marginal benefit curve based on individual preferences (revealed from expenditures on compensation of functions, and so on); *d′* = 'demand curve' based on assumed preferences for sustainability; *BD* = distance that must be bridged in order to arrive at sustainble 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*).

The actual economic development path *a* displayed in Figure 3.1 is calculated in the System of National Accounts over a series of years. It can be approximated by path *b* using the models just mentioned. Far extrapolation may indicate a collapse of production and therefore income and welfare, because the environmental functions which are vital for production are depleted. This collapse is the characteristic of an unsustainable development.

Sustainable economic development paths have in common that environmental functions do not decline in the future due to the limitation in their use for production and consumption.

The Improbability of Sustainable Continuation of Production Growth

The official policy of all countries in the world is that standard NI, that is, the production, must increase in order to create scope for financing environmental conservation and thus attain a sustainable situation. Of course, the future cannot be predicted. But the *plausibility* of whether (a) the actual production level (as measured in standard NI) and closely related elements such as industrial capital and consumption and (b) sustainability (the safeguarding of vital environmental functions leading to a sustainable production level) will develop in the same direction *can be examined*. This is a minimum prerequisite for assuming a causal relation. On the grounds of the data discussed below such development is extremely unlikely, however. We feel the opposite is more plausible for the following six reasons.

(1) Theoretically, the possibility that growth of production and consumption can be combined with restoration and maintenance of environmental quality cannot be excluded. However, such combination is highly uncertain and scarcely plausible. It would require technologies that are (i) sufficiently clean, (ii) do not deplete renewable natural resources, (iii) find substitutes for non-renewable resources (iv) leave the soil intact, (v) leave sufficient space for the survival of plant and animal species and (vi) are cheaper in real terms than *current* available technologies, because if they are more expensive in real terms growth will be checked. Meeting all these six conditions is hardly conceivable for the whole spectrum of human activities. Especially simultaneously realising both (i) through (v) and (vi), which is a prerequisite for combining production growth and conservation of the environment, is difficult. To give one example: as a rule, renewable energy is currently much more expensive than energy generated using fossil fuels. In the case of photovoltaic power, the ultimate price may even be far higher than for electricity from a current coal-fired plant (Johansson *et al.* 1993). The costs of implementing renewable energy throughout society are very high, and this substantially checks production growth. Anyhow, technologies necessary for the combination of production growth and full conservation of the functions of the environment are not yet available. Anticipating on their future availability is in conflict with the precautionary principle and consequently with sustainability. As explained above, in this application of the precautionary principle no future technological progress is anticipated.

(2) An analysis of the basic source material of the Dutch national accounts shows that roughly one third of the activities making up standard NI (measured as labour volume) does not contribute to its growth. These activities include governing, the administration of justice and most cultural activities. One third contributes moderately to the growth of NI, while the remaining one third contributes by far the largest part to the growth of production. Unfortunately, this latter part consists of activities associated with production and consumption that cause the greatest damage to the environment in terms of loss of nature and biodiversity (by use and fragmentation of space), pollution and depletion of resources. These activities include the oil and petrochemical industries, agriculture, public utilities, road construction and mining. These results are almost certainly valid for other industrialised countries and probably valid for developing countries (Hueting 1981; Hueting *et al.* 1992).

(3) The burden on the environment as represented in standard NI equals the product of the number of people and the volume of the activities per person. From this fact and point (2) above it follows that environmentally beneficial measures, such as decrease in population by family planning and shifts in production and consumption patterns into environmentally benign directions, check growth or lead to a lower production level.

(4) A price rise resulting from internalising the costs of the measures which restore the environment means, like any price rise in real terms, a check on production growth. Depending on the situation, this decreases the production level. For a given technology, product costs will rise progressively as the yield (or effect) of environmental measures is increased. Of course, technological progress leads to higher yields. As production increases further, however, so must the yield of the measures increase in order to maintain the same state of the environment, while the fact of progressively rising costs with rising yields remains unaltered.

(5) An unknown part of the costs of restoration of physical environmental damage caused by production and consumption is entered in standard NI as value added, so as a contribution to its volume (Hueting 1980).

(6) A sustainable production level with available technology is about fifty percent lower than the current level, both for the world (Tinbergen and Hueting 1991) and for the Netherlands (Verbruggen *et al.* 2001).

The Risk of Factor Four

If, with the above-mentioned statistical facts in mind, we look at the study *Factor Four: Doubling Wealth, Halving Resource Use* by Ernst von Weizsäcker, former president of the Wuppertal Institute, and co-authors (von Weizsäcker *et al.* 1998) the following remarks can be made.

(i) To bring about an increase by a factor two in the vast bulk of national income (NI), average labour productivity must be doubled. For, with a given labour volume, increase in labour productivity is by definition the only factor that can bring about an increase in the volume of NI. To achieve this average increase, however, the labour productivity of the one third of productive activity that generates the bulk of growth and has the greatest negative impact on environment and biodiversity must far more than double, as follows from point (2) in the previous section. For this reason, the reduction of the environmental burden of this one third of productive activity must be far greater than a factor four. How much greater depends on a number of circumstances.

(ii) To achieve a doubling of national income, moreover, the cost of applying the as yet non-operational technology must be much lower than in the current situation, as follows from point (1) in the previous section.

(iii) The factor-four prognostication takes no account of human's ongoing encroachment upon physical space, the principal cause of species extinction, nor of the fact that ongoing growth requires ever greater efficiency to achieve the desired environmental result. The latter means that with new technologies, too, one ends up in the progressively rising portion of the elimination-costs curve, so with ever rising costs which severely check growth, as follows from point (4) in the previous section.

While sharing von Weizsäcker's optimism regarding technological progress, these kind of 'factor four' or even 'factor ten' recommendations and forecasts combined with doubling the production volume are extremely risky for nature and environment. Authors who make this kind of recommendations probably overlook the statistical fact that in accordance with the (sensible) rules of the System of National Accounts the expansion of a sector of production is something entirely different from the contribution of this sector to the growth of production as measured in national income. This is because (an increase in) value added is not the same as (an increase in) volume; growth of national income is a growth in volume.

To give one example: the cultural sector does hardly damage environment and biodiversity. However, expansion of the cultural sector, that is increase of the value added of this sector, does not contribute to growth of national income, as follows from the research mentioned under point (2) in the previous section. Instead it means a check on production growth because of the transfer of workers in sectors with high or moderate productivity increase to a sector with no productivity increase. *Mutatis mutandis* the same holds true for a transfer of workers from sectors with high productivity increase and great negative impact on environment and biodiversity to sectors with moderate increase in productivity and less negative impact on biodiversity.

The Risk of Concealing Choices by Broadening Sustainability

With the publication of the Brundtland report *Our Common Future* (WCED, 1987) sustainability became the focus of a major world-wide discussion. Taking a cue from *Our Common Future*, there has been the tendency to broaden the original concept of sustainability, as described in the introduction. In the run-up to the Johannesburg World Summit on Sustainable Development, the UN Secretary-General wrote: *'Sustainable development rests on three pillars: economic growth, social progress and protection of the environment and natural resources'* (Annan 2002).

A similar broadening may be noted at the country level. In the German context, the 'three-pillar' approach to sustainability has been advocated, focussing equally on the environmental, social and economic dimensions (Jänicke *et al.* 2001). In the United Kingdom, the government has defined sustainable development by including the themes: social progress which recognises the needs of everyone; effective protection of the environment; prudent use of resources; and maintenance of high and stable levels of economic growth and employment (Turner and Fairbrass 2001). In its national sustainability strategy, the Dutch government includes economic, socio-cultural and ecological aspects (de Jongh 2001). O'Conner (1995), de Kruijf and van Vuuren (1998), RIVM (2002) and Zoeteman (2003) have proposed the construction of sustainability indicators for countries that cover both environmental, social and economic aspects of human activities. Social progress, production and consumption are evidently important for human welfare (satisfaction of wants). However, for the following two reasons, criticism may be levelled against the construction of sustainability indicators that cover both environmental, social and economic aspects.

The *first* problem of the indicators discussed above concerns the relation between the proposed constitutive elements of the indicators and sustainability, understood as a sustainable production level. The lack of a causal relationship between sustainability (a sustainable production level) and the actual production level, as measured in standard national income (NI), has been discussed two sections above. The problematic relation between what is socially attractive in the short term and what should be done for attaining a sustainable production level is discussed in the following section.

The *second* problem is that indicators that cover both environmental, social and economic aspects have an additive character. Such a character is problematic because there may be tensions between different human goals. A case in point is the tension between (a) the wishes regarding production (as measured in standard NI) in the short run and (b) the wishes for safeguarding vital environmental functions in the long run in order to attain a sustainable production level that does not jeopardise the living conditions of future generations.

Discussions about production levels are concerned with changes from year to year. The aim is always to increase the production level. Maintaining a certain production level is labelled as a highly undesirable stagnation of progress and decrease is labelled as disastrous. The basis of our existence, our physical environment has been formed over a period of hundreds of millions of years. Sustainability, defined as passing vital environmental functions undamaged from generation to generation, is also a long-term matter. There is undeniably a serious conflict between the wishes regarding production in the short term and the wishes not to jeopardise the living conditions of future generations.

By adding elements reflecting these conflicting goals together in a sustainability indicator, the danger arises that inevitable choices are concealed. This hampers an open decision-making process in the course of which the inevitable sacrifice of either less sustainability or less production in the short run is not hidden.

Consequences of Unsustainability

There are several regions in developing countries today where wishes for production in the short term over production that can be sustained in the long term already have led to production levels that are most probably much lower than sustainable levels. Thus deforestation has contributed to flooding, causing loss of harvests, houses and infrastructure, and to erosion leading to loss of soil (UNEP 2002). Restoration of the damage constitutes costs and consequently a decrease in production. Deforestation has also caused reductions in local rainfall, thus contributing to drought (Silveira and Sternberg 2001). Overgrazing and salination have led to decreases in the yield of agriculture (UNEP 2002). Excessive fishing and destruction of the coral reefs by using dynamite have led to lower catches (UNEP 2002). These developments have partly been caused by companies from the rich countries.

However, the consequences of evading difficult choices are also exemplified by fisheries policies in North Western Europe that in fact go back to the sixteenth century for national waters and to the nineteenth century for international waters (Symes 1997). Fisheries have been important in creating man-made capital. Some of the important cities in the area such as Amsterdam have even been said ‘to be built on fish’. Fisheries policies have, however, always been uneasy compromises between what is profitable and socially attractive in the short term, and what is preferable on ecological grounds in the long term (sustainability). The effects of such compromises on fish stocks have been dramatic. For instance, in Dutch coastal and inland waters during the last two thousand years the following fish species have become extinct: dogfish, smooth hound, common skate, thorn back ray, sting ray, sturgeon, allis shad, houting, salmon, 15-spined stickleback and deep-mouthed pipefish (Wolff 2001). Consequently, their price is far above the price that would have resulted from timely transition to sustainable catches.

To the extent that members of fish species are still present, catches are often well below the levels that would have been realised, had fishing activities remained on a sustainable footing. The North Sea cod fishery is currently on the brink of collapse, and the current catch of cod is less than 20% of what would have been possible, had fishing remained sustainable (Nakken *et al.* 1996; Parsons and Lear 2001).

Thus, considerations aimed at short-term improvement of living conditions and income in fishing communities, which would have contributed positively to broad sustainability criticised above, have led in the long term to a collapse of most of the Dutch fishing industry. Consumer prices for quite a few fish species are today well above a level linked to sustainable fishing. Similar results may be noted elsewhere. The 40,000 people who lost their jobs in the early 1990s due to the collapse of the once great Newfoundland and Labrador cod fisheries is a case in point (Longhurst 1998).

The Risk of Genuine Savings as an Indicator for Sustainability

In addition to the 'factor-four' concept and the broadened concept of sustainability, also the 'genuine savings' approach (GS) constitutes a risk, because, as the other approaches, it hampers obtaining a clear sight on the inevitable choice between focussing on production growth in the short run and securing production in the long run by safeguarding the functions of our physical environment. The GS approach is actively promoted by officials of the World Bank. Analogous to the definition of gross national product (GNP) as the sum of consumption and savings, Pearce *et al.* (2001) have defined "a measure of . . . 'green' net national product income (NNP)" as the sum of consumption and the 'genuine savings' rate, which includes adjustments of gross savings consisting of depreciation of human-made capital, over-extraction of resources and social damage caused by emissions.

We agree with Pearce *et al.* that the genuine savings approach can provide some kind of (weak) signal *vis-à-vis* sustainability. The SNI and the GS approach could supplement one another, but only under additional conditions. These conditions are currently not met by far, as is shown below.

As Pearce *et al.* rightly assert, welfare depends on total stocks of produced, natural and human assets. Produced capital, however, is a combination of labour (technology) and elements from our physical surroundings (the environment). In the final count, we are dependent on only two factors: human and environmental assets (Hueting and de Boer 2001). The *sine qua non* of *environmentally* sustainable development is a production level that guarantees preservation of vital environmental functions with available technology (Hueting and de Boer 2001). From this, three conditions follow for calculation of the 'genuine savings' indicator.

(1) Any increases in human assets must be used exclusively for environmental protection and/or for growth of production that does not (further) damage the environment. This condition is hard to satisfy, because (a) being intermediate deliveries, expenditures on environmental protection check production growth (Hueting 1980; Hueting and de Boer 2001) and (b) it is precisely the most environmentally damaging sectors of the economy that account for the bulk of production growth (Hueting l981; Hueting *et al.* 1992). In implementing this first condition, due heed must be paid to the essential difference between (i) an increase in the size of a sector (expansion) in terms of added value and (ii) that sector's contribution to an increase in production volume, as measured in standard NI. Ignoring this essential difference leads to wrong prognoses on

the combination of production growth and maintenance of environmental quality, as extensively explained in Hueting (1981) and Hueting *et al.* (1992), and furthermore in Hueting (1980: 170, footnote 2).

(2) Likewise, increases in stocks of produced assets must be exclusively for the purpose of environmental protection or 'clean' growth. Again, it is a condition that is not easy to satisfy, for the reasons just given under (1) (a) and (1) (b). According to Pearce *et al.* investments in infrastructure contribute positively to genuine savings. From the perspective of sustainability, however, their contribution is negative. The fragmentation of the landscape caused by roads and other infrastructure and the consequent loss of habitat and isolation of gene pools are substantially accelerating the rate at which plant and animal species are becoming extinct, which in turn negatively affects life support systems (Hueting and de Boer 2001). Certainly in the industrialised countries and in tropical rainforests, infrastructure should be demolished rather than constructed if the goal of sustainability is to be realised.

(3) Resource revenues must be invested in environmental protection or 'clean' growth; see (1) and (2).

The consumption part of the green NNP, as defined by Pearce *et al.*, is most probably taken from standard NI statistics. So the consumption part contains most probably some asymmetric entries (Hueting 1980; Hueting and de Boer 2001), which leads to the next condition.

(4) Expenditures on elimination of and compensation for loss of environmental functions must be deducted from the consumption, to the extent that these are financed by government or private households, as the theory presented by the authors suggests.

Further:

(5) The genuine savings rate must be positive over a long time series in order to warrant (weak) sustainability, so it must not just be positive for a single year or single accounting period, as in the formula presented by Pearce *et al.*

(6) Only in the case of non-renewable resources may technology be substituted for nature, as argued in Hueting and Reijnders (1998) and Hueting and de Boer (2001).

As long as these six conditions remain unsatisfied, the genuine savings method certainly cannot serve as an indicator for environmentally sustainable development.

Conclusion

We would like to conclude with the following brief remarks.

First, production and consumption of the same amount of goods requires more labour with conservation of nature and environment than without. Therefore, under logical conditions, environmental measures increase employment. The conditions are: (i) income has to be reduced in proportion to the costs of the environmental measures and (ii) these measures have to be taken simultaneously by all firms involved, in all countries. Internalisation of the costs of the measures raise the prices of the products and consequently checks production growth. The conflict is between conservation and growth, not between conservation and employment (Hueting 2001).

Second, it is not true that we cannot afford conservation of nature and environment, for a bicycle and public transport are cheaper than a car, beans are cheaper than meat, raising two children is cheaper than raising ten, et cetera. Of course, mostly a sacrifice is involved in one way or another, otherwise there would not be an environmental problem (Hueting 2001).

Third, we recommend that SNI research is also set up in other countries, including developing countries. The Foundation SNI Research is working to secure financial support for this purpose. Calculation of an SNI for only the Netherlands will not have sufficient impact to make policy makers and citizens wonder whether they might adhere to a wrong belief in a wrongly defined growth that threatens our planet.

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