Discounting the Children's Future?

Does the Non-symmetrical Depreciation of Natural and Human-made Capital Invalidate the Assumption of Substitutability in "Weak" Sustainability Analysis?

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HUMAN-MADE capital provides diminishing utility as it depreciates over time. Natural capital, which includes the planet itself, all minerals, all species, water, soil and air, does not depreciate over time, and theoretically may provide positive utility over time periods that tend towards infinity. From a utilitarian standpoint, therefore, it is unlikely that, when analysed over the long run, the substitution of non-renewable natural capital for human-made capital will ever be rational.

For this reason, argue the authors, discussion of substitutability between human capital and the resources of nature should be omitted from sustainability analysis. The key concept that renders sustainable development different from any other development or social model is that of intergenerational equity. Sustainable development has at its heart the idea that every generation should leave behind sufficient resources so as not to prevent future peoples from achieving their needs. This principle is undermined by the values that underpin the techniques of discounting the flow of future income, which reinforce the idea that it is legitimate to destroy natural capital.

In fact, argue McIntosh and Edwards-Jones, the "weak" form of sustainable development legitimises destruction which, in the long run, would short-change future generations.

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THE TERM "sustainable development" first came to prominence in the *World Conservation Strategy* of the International Union for the Conservation of Nature in 1980. The 1987 Brundtland Report, *Our Common Future*, defined it as development that meets the needs of the present generation, "without compromising the ability of future generations to meet their own needs". In 1992 the principle was endorsed by those national governments, including the British government, which became signatories to the *Rio Declaration on Environment and Development* (Reid 1995).

One of the problems with this concept, is determining how many of the existing resources we should use now, and how many we should leave for future generations. In an attempt to aid this decision Pearce *et al.* (1989) classified all existing resources into one of three classes of capital: natural capital, human-made capital and human capital. Here, natural capital includes the planet itself, all minerals, all species, water, soil and air. Human-made capital covers all material items which are non-natural such as roads, cars and buildings, while human capital is concerned with the knowledge, experience and culture which exist largely in the human mind. Possible variations in the stock of capital in these classes over time then leads to the recognition of two forms of sustainability: so called "weak" and "strong" sustainability.

According to the idea of "weak" sustainability the relative proportions of each of the classes of capital that we leave for the next generation do not matter. Rather we need to ensure that we leave a total stock of capital to the next generation that is at least as big as the one we inherited from our ancestors (i.e. a non-declining stock of capital). Thus "weak" sustainability entertains substitutability between the different classes of capitals, and within this definition it is considered acceptable to deplete natural capital so long as other forms of capital are correspondingly increased.

Turner and Pearce (1993) are quite explicit about the consequences of accepting the substitution of capital. They state: "It would for example, be justified on this rule to run down the environment provided the proceeds of environmental degradation were reinvested in other forms of capital." Thus, if adopted, the assumption of "substitutability" would justify the conversion of non-renewable resources into objects of consumption, while remaining within a rubric of "sustainable development". In contrast, "strong" sustainability requires the total stock of capital to be constant (or increasing) between generations, and further it recognises that certain items of "critical natural capital" must be preserved intact. This would be analogous to humankind living off "natural revenue" without causing material reduction of the natural capital base.

Economists have developed techniques which enable financial values to be placed on non-market goods e.g. contingent valuation methodologies have been developed that purport to quantify qualitative considerations by using, for example, bidding games to value non-market goods and thereby place a financial value on natural capital (see Edwards-Jones *et al.* 2000, Mitchell & Carson 1989, discussion in Shogren & Nowell 1992), and in this way natural capital can be valued. However, these valuation techniques have the effect of eliminating the distinction between monetary and non-monetary considerations. In philosophical terms, they commit the "naturalistic fallacy", which is to say, they confound quantity with quality (Frankena 1939). The acceptability of so doing is a matter for intense philosophical debate that goes beyond the scope of this article. Suffice to say that whether we like it or not, "weak" sustainability's common assumption of the financial quantifiability of the natural world is often forced upon us. As El Serafy (1996) of the World Bank asserts:

> Defining genuine income is of fundamental importance to economists, and it is the proper measurement of that income that will satisfy the "weak sustainability" criterion. This is a technical or value-free requirement that has little to do with the environment. As such, "weak sustainability" is indispensable for accurately assessing economic performance. "Strong sustainability", by contrast, is a normative concept, and relates to the immensely complex stock of environmental assets and properties. Many of these are not easy (in the famous Pigouvian phrase) "to bring into a relationship with the measuring rod of money".

Differences in depreciation rates over time between natural and human-made capital

WHILE THE APPLICATION of the "weak" sustainability is concept appears simple when considered within a static framework, and it may be perfectly rational to trade natural capital of a given value for human-made capital of equal or greater value. However, the analysis becomes more complex when considered within a dynamic framework – that is to say, one that models economic systems dynamically through time. One of the reasons for this increased complexity is that many items of human-made capital depreciate over time, and as they depreciate, so the utility derived from them declines. It remains unclear, however, if the utility derived from natural capital declines over time, and even if it does, it may not do so at the same rate as human-made capital. Accordingly, it may be the case that direct comparison between natural and human-made capital is invalid, or must be qualified, because the respective rates at which each depreciates are not symmetrical.

It is apparent from a consideration of almost any development project (e.g. roads, houses, industrial complexes, dams and irrigation schemes) or consumer goods (*e.g.* domestic appliances, clothes, leisure equipment) that human-made capital does depreciate over time is apparent from a consideration of almost any development project (*e.g.* roads, houses, industrial complexes, dams and irrigation schemes) or consumer good (*e.g.* domestic appliances, clothes, leisure equipment). All such items suffer from wear and tear. In the absence of repair, this causes a decline in their functionality and a concomitant decline in the utility derived from them.

It is not so apparent, though, whether or not natural capital depreciates over time, nor whether any future changes in the form of natural capital will lead to a decrease in utility. A mountain, for instance, does not depreciate. In accounting terminology it might be likened to "a going concern", and be treated as such in terms of "going concern" accounting conventions of valuation which do not necessarily imply depreciation. Inasmuch as the mountain erodes over geological time, such "depreciation" is arguably compensated for by related geomorphological processes such as soil formation, sedimentary rock formation and fresh tectonic uplift. These changes can be viewed, from the perspective of our current geological era, as little more than the self-compensating ups and downs of planetary middle age. Consequently, when considering any utility derived from mountains the analytical time span ought to be nothing short of geological.

In contrast to geological systems, changes in ecological systems may occur quite naturally over relatively short time spans. For example, during secondary succession, communities of annual plants are typically replaced by woody perennials in less than a century (Southwood, Brown and Reader 1979). Despite the fact that the biotic components of any ecological community on any given area of land may vary with time, it is probable that some form of ecological community will always exist in any one place. Thus, although the abundance of individual plant and animal species does vary with time, and despite the fact that ecological processes are characterised by local extinctions, it is unlikely that there is any natural state which is entirely devoid of life. If life is presumed to have intrinsic value, it is therefore unlikely that a natural ecosystem can ever be accorded zero value as might be assigned, say, to the residue of human-made capital that has been consigned to a landfill site.

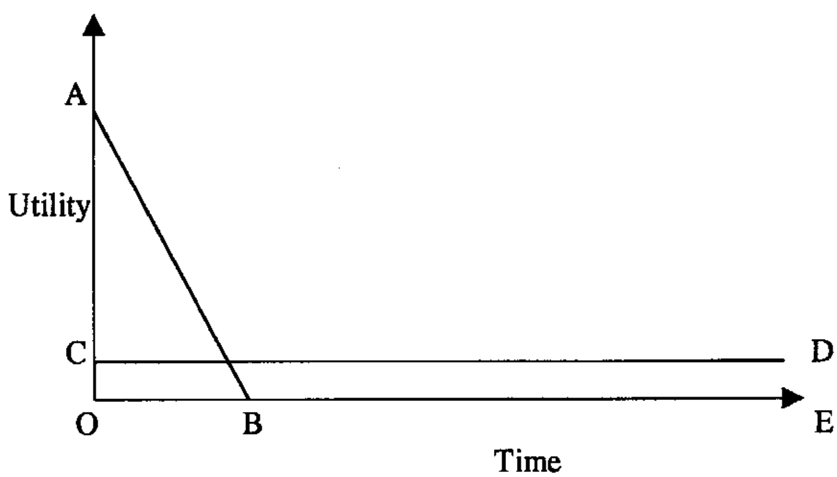
In addition to ecological change, other examples of natural capital dynamics abound. For example in the 1960s fresh terrestrial natural capital was created when the volcanic island of Surtsey emerged from the sea near Iceland. The rise in biodiversity and processes of soil formation were carefully monitored. Assuming these changes provide satisfaction to humans or had intrinsic biodiversity value in their own right, then this item of natural capital would seem to have "appreciated" in "worth" in a matter of decades.

Thus, at the gross level, there is no evidence to suggest that natural capital depreciates with time. The "value" to humankind of any one unit of "natural capital" may vary with time according to changes in the magnitude of time specific use and non-use values, (*e.g.* as a provider of genetic material for biotechnology, as a refuge for wildlife, or as an element in the landscape), but as long as humans derive some satisfaction from the existence of natural capital, then whether it be biotic or geological, the utility derived from such natural capital will never reach zero. Accordingly, the natural depreciation rate of natural capital tends towards zero, and in some situations, such as where an evolutionary dynamic is taking place, it may arguably be negative (*i.e.* utility will increase over time).

These points are illustrated in Figure 1. The long-term utility function for natural capital is represented by C-D. That for human-made capital represented by the line A-B, which makes the simplifying but often realistic assumption of straight-line (and therefore, finite) depreciation. Total utility for natural and human-made capital is therefore, respectively, the area within the rectangle OCDE and within the triangle, OAB. In order for the substitution of natural capital for human capital to be rationally consistent with the principles of "weak" sustainability analysis, the total

Figure 1: Trends in the utility derived from hypothetical items of human-made and natural capital over time.

For simplicity, a linear rate of decline in utility is assumed for human-made capital, while for natural capital a zero rate of decline is assumed. In reality many functional forms are possible for both of these rates, but regardless of form, that for human-made capital will usually be of negative gradient, while in the long run, that for natural capital will tend towards zero.



utility derived from the human-made capital must be equal to or greater than that foregone from using up the natural capital. That is, only substitute if OAB > OCDE.

Given that it is unlikely that either geological or ecological capital naturally depreciate over the short to medium term (*i.e.* in time spans of less than millions of years, which effectively tends towards infinity) then as long as natural capital maintains a positive utility value it would seem likely that the total utility derived would outweigh that derived from human-made capital, which will depreciate to negligible value over short time periods (i.e. often less than 100 years). That is, OCDE is probably usually greater than OAB.

Analytic variations due to the form of the natural capital

CLEARLY THOUGH, the exact outcome of any such analysis will depend upon the characteristics of the items of natural capital under consideration. Compare for example the characteristics of mineral oil and the entire species of Blue Whale. Oil and other minerals probably provide little utility in their natural state, i.e., they have extremely low non-use values, whereas the Blue Whale does provide significant amounts of positive utility through its existence as an extant species (Semples, Gowen and Dixon 1986). Conversely, oil may provide a large amount of utility through it use-values, whereas the use-values provided by Blue Whales, in terms of food stuffs, ecotourism or other products, may be lower. Thus it would be more acceptable to substitute oil for human-made capital than Blue Whales.

While this example is clearly a little simplistic and contrived, a more complex and realistic problem is provided by considering a project such as the proposed and opposed development of the Lafarge Redland Aggregates super-quarry on the Isle of Harris in the Outer Hebrides of Scotland (McIntosh 1994-95). Here it is proposed to quarry some ten million tonnes of aggregate per annum over 60 years from a mountain in order to build new roads throughout Europe. While these roads will provide utility to many people, they will inevitably degrade over time. The rock used in them will reach a point, through the effects of pounding by traffic, where it provides very little or no utility and has to be replaced in the course of routine roads maintenance. In other words, the aggregate will depreciate – typically over a period of 10 to 30 years. In the case of Britain, most used aggregate is not recycled. It is land-filled into quarry sites from which fresh product has been extracted, therefore it could be said to have a residual value that is nil or even negative.

The proposed super-quarry will require the substantial destruction of the mountain in order to permit the removal of geological natural capital from the site. It would be 50 times larger than a conventional (200,000 tonne per annum) large British quarry. It would leave an opencast scar six times the height of the White Cliffs of Dover and require 36 tonnes of explosive per week once geared up to full production (1998 draft Scottish Office Public Inquiry Report). Over the life of the project this would represent the equivalent of dropping six Hiroshima-sized (13 kilotonne) atomic bombs on Harris.

Such a development will inevitably destroy some of the ecological communities which currently inhabit the mountain. Golden Eagles have an eyrie just 400 metres from the quarry boundary, Golden Plover nest there and otters have their holts down by the shore. The reporter in the draft Public Inquiry report stated (*ibid.* 1999 amended version, 14:295-303):

> I find that the proposed quarry will completely change the landscape characteristics of Lingerbay by changing the scale and character of the coastline and its hinterland. Furthermore ... the inevitable scale and characteristics in terms of industrialisation of the superquarry will be so significant that the underlying objectives of the NSA (National Scenic Area) in terms of scenic beauty and the landscape characteristics will be materially affected by virtue of the change from a small scale landscape of detailed variety to a large scale industrial area ... I find that the impact cannot be described as minimal – on the contrary, it would be locally severe ... The present remote, peaceful, and traditional ensemble of a semi-natural and crofting agriculture environment would be disrupted by the intrusion of a man made excavation and associated quarry and harbour installations on an enormous scale ... Altogether, I find that this would have a very disruptive effect on the character of the area affecting local residents ... It would ... introduce a form of industrial activity incompatible with an area of scenic beauty.

The utility currently derived by humans from the site to be quarried may only be small, but it is positive. Summing up in the 1994-95 public inquiry – the longest ever to run in Scotland – John MacAulay, representing the local community, said (*West Highland Free Press*, 9-6-95, 5):

> It provides peat for fuel from the lower slopes; clean fresh water from the upper streams for public water supplies; grazing for sheep; salmon and trout from the surrounding lochs; the very best of shellfish from round its coastline. It is of excellent educational and recreational value, both from the geological and historical significance of the area. It quietly dominates the crofting townships of Strond, Borosdale, Rodel, Lingerabay and Finsbay, as well as the main southerly village of Leverburgh. It is not a "holy mountain", but is certainly worthy of reverence for its place in Creation.

Provided that both *Homo Sapiens* and the mountain with its biodiversity could both be viewed, in accordance with standard accounting conventions, as "going concerns", it is possible that such utility could continue to be positive over geological time periods. The mountain is already 2.8 billion years old (Piper 1992). The sun is not expected to go into supernova for another 4 billion years. Yes, there will be ice-ages and other upheavals, but the rocks by and large endure, and who are we to presume that this mountain will not therefore have some sort of value "for as long as the Earth endures"?

Set against this ongoing low-level trickle of utility, if the mountain (or a disfiguring chunk of it) is taken away, then the public inquiry report considers that it will provide Harris people with 33 direct jobs and 10 indirect jobs, with a further 70 or so direct jobs filled by people from surrounding islands and the mainland. Total annual income from these jobs, at full production, which would be for only 50 years of the 60-year project life, would be £1.3 million. In addition, there would be other benefits to stakeholders, like shareholder dividends, which are not quantified in the report. The bottom line consideration, however, is that a mountain that would otherwise yield utility over a very long period of time (OCDE in Figure 1) would be turned into roadstone, which would depreciate over a relatively short period of time (OAB in Figure 1).

In July 2000 Sarah Boyack, Environment Minister in the Scottish Parliament, announced that a decision as to whether or not the superquarry would go ahead was to be further delayed, pending scientific advice being taken as to whether the mountain merited European status as a Special Area of Conservation. If this goes ahead, the area will be safeguarded, hopefully in perpetuity, on grounds of intrinsic value. However, let us suppose that the decision was being made on purely economic criteria. How, then, might the considerations outlined above be assessed?

Discounting and utility over the long run

THE STANDARD ECONOMIC approach to such a question would be to apply discounted cash flow (DCF) methodology (see, for example, Bromwich 1976). This would quantify and then discount the future stream of benefits from both options respectively, and reduce them to a "net present value" (NPV) by which a comparison of the options can be made. DCF accordingly degrades or "discounts" the value of future returns by treating a given return in, say, 10 years time as being less valuable than the same sum received tomorrow. For example, if a discount rate of 5% is assumed, a £1 million return in 14 years" time would be counted as being worth only about £500,000 in today's terms, and after 100 years the same return would discount down to a mere £7,600 or thereabouts. (put another way, £7,600 invested today at a 5% real rate of compound interest would yield £1 million after 100 years).

This discounting presumption, "the time-value of money", is an inevitable consequence of money having acquired time-value in its own right, instead of being merely a medium of exchange. It is intrinsic to any economy that allows money to be loaned at interest. Interestingly, Islamic economics and certain other theocratic systems explicitly try to prevent this, perhaps partly because of its intrinsic discounting implications (Visser & McIntosh 1998).

Applying any positive discount rate to any future return assumes that at some time in the future an item will cease to provide material positive utility (Dixon *et al.* 1988). This is a well-known economic phenomenon, and while not necessarily problematical when used within a project analysis framework, this property of discounting causes problems when applied to environmental goods (Hanley and Spash 1993). In the case of natural capital, it remains undeniable that environmental goods which exist over spans of time greater than a few decades will supply positive utility which will not be adequately captured within typical calculations of net present value. As Norgaard and Howarth (1995: 150) surmise, "A fundamental contradiction exists: all [such DCF-based] techniques to measure benefits are developed in the context of current generations, whereas sustainability is concerned with the future... Questions of inter-temporal resource use have been addressed only ... as if the present generation had all the rights to resources". Harris (in Harris & Goowin, 1992: 102) says of this position:

> This point is of extraordinary importance, for it means that hidden in the apparently "neutral" principle of inter-period efficiency is a normative judgement that gives absolute primacy to short-term, present-generation interests over future interests in the resource and environmental area. The only justification for this would be the assumption that future citizens are fully compensated for resource loss and environmental degradation by the accumulation of human-made capital. But since most of this capital itself has a lifetime of only 20 to 50 years, and since the substitutability of human-made and natural capital is a serious question, this clearly short-changes the future.

In other words, discounting future flows of natural revenue arguably steals the children's future and predicates decisions made for the short-term. It is to this mindset that we might look to discern some of the economic roots of the "throw-away society".

Given the above analysis, it is suggested that the total utility derived from non-renewable natural capital (over the long term) will almost always be greater than that derived from any form of human-made capital for which it could be substituted. The permanent destruction of significant parts of the natural world can only be rationally justified if a values basis is assumed, which contrary to El Serafy's assumption is not a "value-free" one that presumes discounting. From a utilitarian standpoint, then, it is probably impossible to maintain a constant stock of capital, as any loss of natural capital may result in utility foregone. This holds true for all items of natural capital that would provide any positive utility over a span of time which, in human terms, tends toward infinity.

However, the same does not hold true for items which might be considered as "natural revenue", such as an individual plant or animal. Thus, while it may be rational to substitute between an individual tree and some timber products, it may not be rational to substitute an entire forest for some produce. This is because the forest, as an ecosystem, has capital attributes prerequisite to producing a continuous flow of natural revenue, *i.e.*, utility. The idea that the individual members of a set may be substitutable, but that a species, community, habitat or ecosystem is not, supports the idea of minimum impact selective harvesting, which is a concept central to achieving the sustainable utilisation of the environment. It implies that it is acceptable to take part of what nature provides, but not to exhaust the whole lot.

Living for the short-term cannot be classed as rational behaviour

ALTHOUGH THIS DISCUSSION is purely qualitative, several conclusions may be drawn. Firstly, if items of natural capital provide positive utility and have the ability to exist over long time spans, then despite fluctuations in the actual level of utility they provide, it is unlikely that its would ever be rational to substitute these for items of human-made capital that depreciate. That does not mean that in practice we should do not do it: it simply means that living for the short-term cannot be classed as rational behaviour for a species that might like to think of itself as a "going concern".

Secondly, as most of the utility provided by the items of natural capital will be related to their non-use values, it may be possible to establish a ranking of items of natural capital in terms of the utility foregone if they are destroyed. It is suggested that little utility is foregone from losing pockets of minerals as elements of natural capital, but greater amounts of utility may be foregone if items such as whole mountains, species or forest ecosystems are lost.

Thirdly, the concept of "weak" sustainability is presented in many texts as the easiest form of sustainable development that may be achieved (Pearce 1993, Pearce and Turner 1990). However our analysis suggests that when a dynamic element is introduced into the analysis, it becomes apparent that even meeting the criterion of "weak" sustainability places severe constraints on any future development requiring the destruction of natural capital. In fact, when taken to its limit, it may be argued that so few substitutions between "human-made" and "natural" capital will ever be rational, in terms of utility foregone, that the whole concept of the substitution of capital should be omitted from future discussions of "sustainable development".

Where does such an assiduous, if not to say, ascetic conclusion leave us in practical terms? It suggests that a far more honest approach for planning future developments than that of applying DCF to nature is to recognise that, in addition to any other ethical considerations, any irreversible loss of natural capital will result in a loss of utility to humankind. Therefore all such losses should be minimised. Adherence to the idea of the subsititutability of capital simply provides a mechanism for justifying developments that are environmentally damaging. If such developments are to continue, then their proponents should be aware of the full consequences of their actions, rather than hiding behind the idea of maintaining a constant stock of capital.

There are no easy answers to the conundrums of sustainable development. Probably as much as can be said was summed up by Aldo Leopold in a famous dictum in his *Land Ethic*: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise".

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