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ANALYSIS

The human development index and sustainability — a constructive proposal

Eric Neumayer *

Department of Geography and Environment, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, UK

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Abstract

This paper proposes to qualify a country's human development as potentially unsustainable if the net depreciation of its manufactured and natural capital stock is bigger than its investment. Linking the Human Development Index with sustainability in this way would allow the United Nations Development Programme (UNDP) to check whether a country is 'mortgaging the choices of future generations'. An analysis for 155 countries leads to the conclusion that the indicated human development of 42 countries is potentially unsustainable. Most of these countries have a low HDI, which means that even this low achievement is not sustainable into the future. The results make a case for both a policy reform within these countries and for external assistance to help maintain at least this low level of human development. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

When the United Nations Development Programme (UNDP) launched the Human Development Index (HDI) for the first time in 1990 its major goal was to focus attention away from income towards a more comprehensive measure of human development. UNDP did not deny, of course, that per capita income is one of the main determinants of a country's level of human development. But it proposed to treat income as only one out of three factors — the other ones currently being life expectancy at birth as a proxy for health achievement and adult literacy together with educational enrolment as a proxy for educational attainment. What is more, income is not privileged as *primus inter pares*, i.e. it is not given a higher weight than the two other factors. Rather, all three variables are aggregated via a simple arithmetic average into the HDI and are thus treated equally.

From the beginning, publication of the HDI has aroused a lot of attention among policy mak-

* Tel.: +44-0207-955-7598; fax: +44-0207-955-7412.
E-mail address: e.neumayer@lse.ac.uk (E. Neumayer).

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ers and the wider public alike. Indeed, when the HDI is annually launched as part of the Human Development Report (HDR), this represents the one big opportunity for UNDP to bring its mission of 'putting people back at the center of development' (United Nations Development Programme, 1995, p. 11) into public awareness. Maybe surprisingly, given the importance that was attached to environmental aspects and to the concept of sustainable development at the beginning of the 1990s, there have not been many calls for a 'greening' of the HDI. Desai (1995) seems to be the only one who has developed an 'index of intensity of environmental exploitation' (Desai, 1995, p. 23). It ranks countries similar to the HDI methodology according to a composite index comprising greenhouse gas emissions per capita, water withdrawal as per cent of annual internal renewable water resources, and energy consumption per unit of GNP. Desai does not, however, attempt to integrate this index into the HDI itself and regards his whole enterprise as a tentative and exploratory exercise which 'may lead to other attempts in the future at improving the calculations or perhaps a prudent abandonment of the entire exercise' (Desai, 1995, p. 23).

This paper is concerned about natural resources and the environment as well. It agrees with Desai that resource exploitation and environmental degradation should be integrated into the HDI. This paper proposes, however, not to include these aspects into the HDI directly. Rather, they should be assigned the role of a fundamental qualification if a country's achieved level of human development appears to be unsustainable. Following this recommendation, it will be argued, will lead to a more comprehensive linking of the HDI with sustainability than a modification of the HDI itself could achieve.

Sagar and Najam (1998, p. 263) state 'that the HDI has neglected links to sustainability by failing to investigate the impact on the natural system of the activities that potentially contribute to national income — and hence to HDI'. They see a clear need for 'some mechanism for accounting over-exploitation of natural resources' in order for 'the HDI to capture the sustainability dimension of human development' (Sagar and Najam, 1998). It is the objective of this paper to make a constructive proposal for the establishment of such a mechanism.

The paper is structured as follows: Section 2 gives an overview on how the HDI is computed and presents its main critiques so far. Section 3 discusses whether and how the HDI should take resource exploitation and environmental pollution into account. It dismisses 'greening' the HDI itself, i.e. putting yet more variables into the index. Instead it is shown how conceptualising nature as natural capital, one of the determining factors of a country's sustainability, leads to a more comprehensive link with the HDI. Section 4 explains the methodology used to check whether a country's achieved level of human development is sustainable or not. Section 5 presents results for 1998 which is the latest year for which such computations were possible, indicates for which countries a qualification of their HDI would have been warranted and discusses policy implications. Section 6 concludes.

2. Critiques of the HDI

To understand the critiques that have been raised against the HDI, it is necessary to have a quick look at how it is computed. Without going into great detail, the HDI is currently calculated as follows (United Nations Development Programme, 2000, p. 269f.):[1] for two of the HDI's three components a transformed variable is derived from basic data. For the income component a log transformation is applied, in effect discounting higher incomes due to supposed diminishing marginal utility. For the educational component the transformed variable consists of two-thirds of the percentage rate of literate adults among all adults and one-third of the combined first-, second- and third-level educational gross enrolment ratio in per cent. The health/longevity component is directly measured by life expectancy

[1] To see how the HDI methodology has changed over time, refer to McGillivray and White (1993, pp. 183–185) and Hicks (1997, pp. 1284–1286). For a discussion of how the HDI relates to other measures, see Doessel and Gounder (1994).

at birth in years. For each variable a maximum and a minimum is defined. An index is then calculated as follows:

$$X \text{ index} = \frac{(\text{actual value} - \text{minimum value})}{(\text{maximum value} - \text{minimum value})},$$

$X = $ (Income, Longevity, Education).

This index is calculated for each variable. Until 1994 the minimum and maximum values were not absolutely fixed but derived from the minimally and maximally achieved values worldwide in each year. Then the methodology was changed and the minimum and maximum values became fixed in absolute terms. However, since the maximum values are chosen such that they are higher than or equal to the actual value a country can possibly achieve, every country's index for each variable lies between zero and one. A country's HDI is then simply the arithmetic average of its three indexes:

$$\text{HDI} = \frac{1}{3}(\text{Income index} + \text{Longevity index} + \text{Education index}).$$

It follows that the HDI as well lies between zero and one and countries are ranked according to how close their HDI is to one. Finally, note that although the table with the HDI is just one of many published in each year's Human Development Report, it is also UNDP's most important statistic and is used for grouping countries together and ranking them in all other tables.[2]

The HDI has been disputed in many respects. Desai (1991, p. 356), for example, has criticised that the three basic indices are added together to arrive at the HDI, thereby making income, health and education substitutes. Instead he proposes to use a log additive form which restricts substitutability. Similarly, and for the same reasons, Sagar and Najam (1998) propose that the basic indices must be multiplied to arrive at the HDI. Most critics, however, have objected to the way income above the threshold value is heavily discounted. Thus, for example, while in 1995 the difference between the United States with a real GDP per capita of 26 977 US$ and Uruguay with 6854$ is 20 123$, this difference melts down to 210$ after the transformation is undertaken (United Nations Development Programme, 1998, p. 128). Acharya and Wall (1994), Gormley (1995), Noorbakhsh (1998a), Noorbakhsh (1998b), and Sagar and Najam (1998) have therefore published modified HDIs that give more weight to high incomes. Kelley (1991) and McGillivray (1991) have even doubted the necessity of a composite index that pays attention to any other variable than income. In their view, the ranking according to the HDI is not so fundamentally different from a ranking according to income so that the additional information given by the HDI is rather negligible. For McGillivray (1991, p. 1467) the HDI is just 'yet another redundant composite intercountry development indicator'. Implicitly, a similar critique came from Dasgupta and Weale (1992) who looked in more detail at the determinants of well-being for poor countries.[3] Noorbakhsh (1998a) has maintained, however, that the individual components of the HDI are not highly correlated with each other, nor is the index itself highly correlated with any of its components, so that the HDI cannot be called redundant.

Still other critics have proposed to widen the coverage of aspects that comprise the HDI. Hicks (1997) has proposed to adjust *each* variable according to the inequality of its achievement within a country and to publish an Inequality-Adjusted Human Development Index (IAHDI) alongside the HDI. Indeed, UNDP has once already published an HDI for all countries that was adjusted for income inequality, but not for inequality in longevity and education (United Nations Development Programme, 1994). It also regularly publishes a gender-related development index which is basically the HDI adjusted for gender inequality in achieving income, longevity and education as well as regional HDIs and long-term time trends in national HDI for selected countries.

[2] Currently, there are three groupings: countries with high human development (HDI 0.800 and above), medium human development (HDI 0.500–0.799) and low human development (HDI below 0.500) (United Nations Development Programme, 2000, p. 249).

[3] These authors also criticised the cardinal treatment of what are essentially ordinal variables.

3. Greening the HDI?

As mentioned, there have not been many calls for a greening of the HDI. But should natural resource exploitation and environmental degradation be taken into account in computing the HDI? The answer must be yes if nature as a provider of resource input and of pollution assimilating capacity is taken seriously. More difficult is to say how it should be taken into account. An obvious suggestion might be to integrate one or more variables into the HDI. However, there are four major reasons why resource and environmental issues should not be integrated into the HDI itself:

First, there is no direct relationship between resource exploitation and environmental degradation on the one hand and the level of human development on the other hand. A country with a high HDI can have high resource exploitation like Canada or low exploitation like Switzerland. The same is true vice versa for a country with a low HDI. A look at the variables proposed by Desai (1995) makes this clear: whether a country withdraws 20 or 60% of its internal water resources each year depends a lot on a country's geophysical circumstances, but has virtually no direct impact upon human development. Equally, whether a country uses energy efficiently or not does not determine its level of human development. With environmental degradation the link seems to be stronger. But even there one would have to look at the impacts of emissions on human development rather than emissions as such. The ultimate impact would be on human health, however, which is reflected already by life expectancy as a proxy. One might object that life expectancy only reflects damage to human health after a considerable time lag. If so, then one should look for a better variable to replace longevity as a proxy for health achievement rather than include any environmental variable.

Second, while the variables included in the HDI so far are all clear on where improvement is to be gained — the longer people live, the better educated they are and the more income they have, the better — this is in general not the case for environmental variables. To reduce water withdrawal from internal renewable water resources to zero is just not a sensible goal. Neither is bringing pollution down to zero.

Third, the HDI already consists of variables that many regard as hardly commensurable. Entering a new variable would strengthen the case of those who claim that the HDI aggregates entities that should better be looked at separately. It would certainly strengthen Srinivasan's (1994, p. 241) critique that the HDI is 'conceptually weak' and that 'meaningful inferences about the process of development and performance as well as policy implications could hardly be drawn from variations in HDI.' While Atkinson et al. (1997, p. 151) are right in saying that 'given the unquestionable role of the HDI in raising the political profile of general health and educational policies, it seems fitting that there should be a similar statistical treatment of the environment', it is not necessary to enter environmental variables into the HDI directly. The next section will make this clear in proposing an alternative method.

Fourth, any structural change of the HDI will make comparability over time with former years impossible. This should be avoided as detecting a worsening or improving of a country's HDI over time is the second biggest objective of the whole HDI-exercise after ranking countries according to their level of human development. Indeed, in 1994 UNDP changed its methodology for computing the HDI to make comparability over time easier. In earlier reports a country's index could fall from one year to another even though its human development in every single variable had improved. Indices from different years were therefore not meaningfully comparable with each other. The reason was that, as mentioned above, the maximum and minimum values, which entered the indices, were not absolutely fixed but derived from the maximally and minimally achieved values worldwide in each year. Only the change in methodology in 1994 that fixed the maxima and minima in absolute terms ensured that a country's

index will now always improve if its human development improves in absolute terms.[4]

As an alternative to changing the structure of the HDI itself, a 'green HDI' could be computed alongside the traditional HDI. However, enough different HDIs have already been computed (modified HDI, reformed HDI, gender-related development index, inequality adjusted HDI, etc.). Yet another HDI would presumably generate little interest and will not find a lot of attention alongside the HDI proper.

If resource and environmental aspects should not be integrated into the HDI itself, how could they be taken into account then? To answer this question it is helpful to find out what information we really want to gain from taking nature into account. I propose that what we should really be interested in is not a ranking of countries according to some resource or environmental variables, but the following: is a country's level of human development bought at the expense of living off its natural capital stock, thereby impoverishing its own future? The 1998 *Human Development Report* demands that consumption must be 'sustainable' and translates this as not 'mortgaging the choices of future generations' (United Nations Development Programme, 1998, p. 1). This paper proposes to do just that: to check whether a given level of human development is sustainable or not. To find this out, it does not make any sense to include yet another variable into the HDI. Rather, we have to look for the fundament that allows the achievement of high incomes, healthy and well-educated people, and to ask whether this fundament can be maintained or not. Economists call this fundament 'capital', where capital is defined as a stock that provides current and future flows of services. In contrast to neo-classical economics, capital is to be understood in a broad sense here, however, encompassing not only manufactured capital, but natural capital as well.

[4] It can still happen, of course, that a country's human development improves and its HDI improves, but its ranking according to HDI in comparison to other countries worsens. This will be the case if the other countries are doing still better in improving their human development.

Before the method used in this article is explained in more detail in the next section, it is important to point out two things here: first, strictly speaking the proposed measure of sustainability is assessing the sustainability of the income component of the HDI only. At the moment there is no method available that could specifically address the sustainability of the other components. This is somewhat unfortunate because whilst income is the fundament on which private expenditures and public policies for health and education build upon, there is nevertheless no static link (see Ranis et al., 2000). At least theoretically it is possible to improve literacy and educational enrolment as well as life expectancy with an unsustainable income stream and indeed with falling income levels if only more and more of the income is spent on health and education. But in the long run this cannot be sustainable as it cannot be prolonged indefinitely. In this sense, while the proposed sustainability check is strictly speaking one of the income component only, sooner or later the achievements on the non-income components of the HDI become unsustainable as well if countries fail to pass the sustainability check proposed in this article.

Second, readers familiar with the debates on national income accounting and sustainability will have noticed that this section's discussion has its parallel in similar controversies on whether sustainability corrections of the national income accounting systems should take place in side (or satellite) accounts or in the accounting system itself. It would be beyond the scope of this paper to analyse these controversies here. Suffice it to say that most scholars seem to agree that, there as well, sustainability corrections are best left to the satellite accounts (see, Nordhaus and Kokkelenberg, 1999; United Nations, 2000). The reasons are not identical to the ones suggested in this article, of course, given the different points of reference. But, without going into any detail, it is probably fair to say that with respect to national income accounting as well the majority view is that more would be lost than gained if the sustainability corrections were undertaken in the accounts themselves since those accounts have their own proper role to play.

4. A proposed method for assessing the sustainability of the indicated human development

How do we know whether a country maintains its capital or not? One possibility is to look at whether 'genuine saving'[5] is positive, for which World Bank (2000) has provided a data set for 155 countries covering the period 1970–1998.[6] To understand the derivation of genuine saving, one needs to go in steps. One starts with a country's gross domestic investment. Then, World Bank (2000) subtracts net foreign borrowing and adds net official transfers to arrive at what it calls gross domestic saving:[7]

Gross domestic saving

= gross domestic investment − net foreign borrowing + official transfers.

Then one subtracts the net depreciation of the country's manufactured capital stock in order to arrive at net saving:

Net saving = gross saving − depreciation of manufactured capital.

Finally, net depreciation of a country's natural capital stock is subtracted to arrive at 'genuine saving':

Genuine saving = net saving − depreciation of natural capital.

The World Bank has estimated data on investment, depreciation of manufactured capital and rents from resource exploitation. Depreciation of natural capital in principle consists of two parts: valuation of pollution damage for pollution beyond the regenerative capacity of the environment and depreciation of the natural resource stock.

Ideally, one would want to include a value for pollutants that affect the domestic environment. Unfortunately, no comprehensive data set exists for such pollutants. The only pollutant included so far in the World Bank data set is carbon dioxide which is valued at 20 US$ per metric tonne of carbon. The value is taken from Fankhauser (1995) and is often regarded as a consensus estimate. The damage caused by carbon dioxide emissions is attributed to the emitting country. However, the accumulation of carbon dioxide in the atmosphere is the quintessential example of a public bad. The damage from carbon dioxide emissions inflicted upon the capital stock of a country depends not on the country's emissions, but on *all* countries emissions. And, of course, some countries will be more affected by global warming than others. I have therefore taken out the valuation of carbon dioxide emissions from the genuine saving computations. The reader should note that analysis of the data in World Bank (2000) shows that net depreciation of the natural capital stock due to resource exploitation dominates depreciation due to carbon dioxide emissions by orders of magnitude. The basic results reported in the next section will therefore not change much if the value of carbon dioxide emissions was included.

As concerns natural capital depreciation due to resource extraction, the following resources are included: oil, natural gas, hard coal, brown coal, bauxite, copper, iron, lead, nickel, zinc, phosphate, tin, gold, silver, and forests. As can be seen, the database is strong on non-renewable resources since for these marketed resources price and cost as well as extraction data are not too difficult to get hold of. The harvesting of forests is the only renewable resource taken into account so far.

How to measure depreciation of the natural resource stock? This is not easy to answer as there

[5] The term 'genuine' saving was introduced by Kirk Hamilton (1994) to distinguish it from traditional net saving measures which included only depreciation of manufactured capital. For formal demonstrations that genuine saving measures sustainability, see Hamilton (1994), Hamilton and Atkinson (1996) and Neumayer (1999).

[6] Countries missing are mainly small countries due to lack of data.

[7] Note that the Bank prefers to assess sustainability in terms of saving rather than investment, which is why it subtracts net foreign borrowing and adds net official transfers. This is somewhat unfortunate as what really matters for sustainability is investment, not saving, but we stick to the Bank's methodology here for lack of alternative data. Also, if we are really interested in productive investment in manufactured capital, ideally one might want to take out inventory investment. Current data availability does not allow doing so, however.

is no universally agreed method to do this. However, I have proposed elsewhere that the so-called 'El Serafy'-method is a good method to use (Neumayer, 2000). The formula for the 'El Serafy'-method is derived from the following reasoning (El Serafy, 1981, 1989, 1991): receipts from non-renewable resource extraction should not fully count as (sustainable)[8] income because resource extraction leads to a lowering of the resource stock and thus brings with it an element of depreciation of the resource capital stock. (The same reasoning applies to renewable resource stocks if harvesting exceeds natural regeneration.) While the receipts from the resource stock will end at some finite time, sustainable income by definition must last forever. Hence, sustainable income is that part of resource rents which if received infinitely would have a present value just equal to the present value of the finite stream of resource rents over the lifetime of the resource.

Let P be the resource price, AC average extraction cost, R the amount of resource extracted (or harvested beyond regeneration), r the discount rate and n the number of remaining years of the resource stock if extraction was the same in the future as in the base year, i.e. n is the reserves to extraction ratio. Let us define resource rents as $RR \equiv (P - AC)\,R$. Clearly, these resource rents will become zero in some finite period of time given that the resource is non-renewable (or, if renewable, the resource is harvested beyond regeneration). If extraction was the same in the future as in the present and the overall amount of reserves stayed the same, then n is the number of years after which the resource rents will disappear. The present value of RR is therefore equal to:[9]

$$\sum_{i=0}^{n} \frac{RR}{(1+r)^i} = \frac{RR\{1 - [1/(1+r)^{n+1}]\}}{1 - (1/1+r)}. \tag{1}$$

The reader should note that resource discoveries enter the formula via changing n for the next year. More generally, it is important to see that the formula is to be updated each year with the information available at the time. The 'El Serafy'-method is flexible and does *not* assume that resource extractors are locked into a particular, static extraction profile over the entire future of resource extraction.

Contrary to resource receipts, sustainable income (SI) by definition has to accrue forever. The present value of an infinite stream of SI is therefore[10]

$$\sum_{i=0}^{\infty} \frac{SI}{(1+r)^i} = \frac{SI(1+r)}{r} = \frac{SI}{1 - (1/1+r)}. \tag{2}$$

Next, if we set Eqs. (1) and (2) equal to each other, and rearrange the expression to have SI on the left-hand side of the equation, we can see which fraction of RR is truly sustainable in the sense that it represents the income that can be achieved infinitely, whereas the full amount of RR accrues only for a finite period of time:

$$SI = RR\left[1 - \frac{1}{(1+r)^{n+1}}\right]. \tag{3}$$

Hence the difference between resource rents RR and SI — that is, the fraction of RR that represents sustainable income — is the true depreciation of the resource stock. The correction term, representing this depreciation of the resource stock, would thus be

$$(RR - SI) = RR\left[\frac{1}{(1+r)^{n+1}}\right] = (P - AC)\,R\left[\frac{1}{(1+r)^{n+1}}\right]. \tag{4}$$

If $r > 0$ and $n > 0$, then depreciation is only a fraction of total resource rents $(P - AC)\,R$. The next section reports which countries' human development appears to be unsustainable if depreciation of the natural resource stock is computed

[8] Note that I have put the word sustainable in brackets here since in Hicks' (1946, p. 172) classical exposition income, by definition, must be sustainable or otherwise it does not count as income: "We ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning".

[9] By assumption, RR accrue at the beginning of the accounting period. If RR accrue at the end of the accounting period, then $n+1$ in Eq. (1) would be replaced by n.

[10] Note that n has been replaced with the sign for infinity in Eq. (2) to account for the fact that SI must accrue for an infinite time period.

with the 'El Serafy'-method. Before doing so, however, it has to be clarified to which country resource exploitation should be attributed. Poor developing countries with high resource exploitation could claim that these resources go to rich developed countries for their benefit and that therefore the rich countries should be blamed if resource exploitation is unsustainable. Indeed, the 1998 *Human Development Report* (United Nations Development Programme, 1998) stresses over and over again the unequal consumption pattern of natural resources. Nevertheless, resource exploitation should be attributed to the extracting country itself and not to the consuming country. This is because the purpose of resource accounting is to try to measure whether and by how much the natural capital stock of a country is changing. It simply does not matter who is 'responsible' for its growth or decline.[11] Of course, once it has been established that a country's natural capital stock is declining and that this might represent a problem for sustainability of its development, the question of who is 'responsible' for the resource extraction will come back on the agenda. But it is an entirely different question to which we will come back later.

Depreciation of the natural resource stock needs to be computed for all those countries which, according to World Bank (2000), have a positive net saving rate and resource rents that are big enough to potentially make their genuine saving rate negative:[12] Bolivia, Congo, Ethiopia, Gambia, Ghana, Iran, Kazakhstan, Kuwait, Mauritania, Nepal, Nigeria, Oman[13], Russia, Saudi Arabia, Syria, Togo, United Arab Emirates, Uzbekistan and Venezuela. To compute depreciation we have to find out which resources these countries mainly exploit. The answer is given in Table 1, which breaks down total resource rents into the percentage share attributable to individual resources.[14]

Unfortunately, forestry had to be excluded from the calculations due to the many difficulties in getting reliable data about forest stocks. For Ethiopia, Gambia, Nepal and partly for Ghana and Togo resource rents therefore counted fully towards natural capital depreciation, thus overstating depreciation in these countries. Note, however, that the World Bank (2000) data do take into account reforestation if it takes place. For the other resources, Appendix A explains where the extraction and reserves data came from. For the calculations a relatively low discount rate of 4% p.a. was applied following the rate which World Bank (1997) uses for wealth estimations.

5. Results and policy implications

The overall results are shown in Table 2 where countries are sorted according to their rank in the 1998 HDI. A whole range of countries marked with a '[a]' appear to be unsustainable because they exhibit negative net saving rates. For these countries it was not necessary to compute depreciation of the *natural* capital stock. These countries are unsustainable simply because they already eat up their stock of *manufactured* capital. The rest of the countries in Table 2 do not have negative net saving rates. But what happens to these countries after taking into account depreciation of natural capital as well? The following countries also become unsustainable: Ethiopia, Gambia, Ghana, Mauritania, Nepal, Nigeria, Oman, Syria and Togo. The HDI of all these countries together with those that exhibit negative net saving rates is therefore qualified as 'potentially unsustainable'.

A common feature for most of these countries that become unsustainable if depreciation of their natural capital stock is taken into account is that they have relatively low reserves to extraction ratios: for oil it is about 30 years for Nigeria, 16 years for Oman and 12 years for Syria. Togo has

[11] I am thankful to an anonymous referee who prompted me to clarify this point.

[12] In the following, saving rates are defined as saving divided by GNP.

[13] Due to lack of more recent data, data from 1994 had to be used in the case of Oman.

[14] Note that Table 1 gives the breakdown of resources as they are recorded in World Bank (2000). Minor extraction of other resources taking place in actual reality is likely to remain unrecorded.

Table 1
Breakdown of total resource rents into percentage share attributable to individual resources

	Oil	Gas	Bauxite	Copper	Forests	Gold	Hard coal	Iron	Phosphate	Silver	Tin	Zinc
Bolivia	13%	51%				15%		1%		10%	7%	3%
Congo	100%											
Ethiopia					100%							
Gambia					100%							
Ghana					88%	12%						
Iran	95%	4%						1%				
Kazakhstan	56%	13%					31%					
Kuwait	95%	5%										
Mauritania			100%					100%				
Nepal					100%							
Nigeria	90%				10%							
Oman	92%	8%		32.67%		25.68%						
Russia	36%	56%					4%					
Saudi Arabia	100%											
Syria	100%											
Togo					83%				17%			
UAE	76%	24%										
Uzbekistan	17%	83%										
Venezuela	97%						1%	2%				

(grey box) means that the share of this resource is either zero or negligible.

Source: own computations from World Bank (2000).

a reserves to extraction ratio for phosphate of only about 14 years. In contrast, countries with huge reserves to extraction ratios do not become unsustainable if depreciation of natural capital is taken into account. This was to be expected as a high reserves to extraction ratio means that only a small share of the total resource stock is used up by current resource extraction. Russia, for example, has a reserves to extraction ratio for natural gas of more than 80 years. Iran has a ratio for oil of 65 years, Kuwait and the United Arab Emirates more than 100 years, Saudi Arabia 80 years and Venezuela 60 years. Only Kazakhstan's ratio is somewhat intermediate at 37 years. Falling out of this picture is Mauritania, which has a very high reserves to extraction ratio for iron ore of over 60 years, but whose net saving is so low that its genuine saving rate becomes negative.

What is the lesson to be learnt for those countries with positive net saving rates but negative genuine saving rates? Most of these countries in the past did not adequately use the opportunities they were given through their natural resource endowment to build up and maintain manufactured capital in exchange for resource depletion. Nature endowed them with a free gift in the form of natural resource stocks. But instead of using this asset wisely and seizing the opportunity to achieve a level of human development that is sustainable into the future, too large a share of resource rents is wasted in unproductive expenditures and consumption instead of invested in

Table 2
Net savings rates and genuine savings rates according to the ‘El Serafy’-method

Rank in 1998 HDI	Country	Net savings rate (%)	Genuine savings rate (‘El Serafy’-method) (%)
High human development (*rank 1–46*)			
23	Israel[a]	−5.65	n.a.[c]
Medium human development (*rank 47–139*)			
50	Trinidad and Tobago[a]	−3.38	n.a.
64	Romania[a]	−0.02	n.a.
69	Macedonia[a]	−1.75	n.a.
70	Georgia[a]	−14.05	n.a.
82	Lebanon[a]	−23.05	n.a.
86	Oman[b]	12.19	−1.31
90	Azerbaijan[a]	−9.23	n.a.
92	Jordan[a]	−5.32	n.a.
93	Armenia[a]	−22.45	n.a.
94	Albania[a]	−15.35	n.a.
98	Kyrgyzstan[a]	−5.21	n.a.
102	Moldova[a]	−10.24	n.a.
104	El Salvador[a]	−5.32	n.a.
111	Syria[b]	15.09	−0.99
116	Nicaragua[a]	−6.46	n.a.
120	Guatemala[a]	−1.59	n.a.
127	Lesotho[a]	−50.12	n.a.
129	Ghana[b]	5.66	−0.81
136	Cambodia[a]	−1.54	n.a.
138	Kenya[a]	−0.75	n.a.
Low human development (*rank 140–174*)			
141	Madagascar[a]	−1.64	n.a.
144	Nepal[b]	6.08	−3.72
145	Togo[b]	0.16	−5.05
147	Mauritania[b]	0.51	−0.84
148	Yemen[a]	−4.65	n.a.
150	Haiti[a]	−8.82	n.a.
151	Nigeria[b]	4.49	−2.06
153	Zambia[a]	−2.02	n.a.
158	Uganda[a]	−1.57	n.a.
159	Eritrea[a]	−35.48	n.a.
161	Gambia[b]	0.11	−9.37
163	Malawi[a]	−6.06	n.a.
164	Rwanda[a]	−8.77	n.a.
166	Central African Republic[a]	−2.75	n.a.
167	Chad[a]	−4.27	n.a.
168	Mozambique[a]	−5.19	n.a.
169	Guinea-Bissau[a]	−15.46	n.a.
170	Burundi[a]	−8.81	n.a.
171	Ethiopia[b]	0.40	−11.00
173	Niger[a]	−3.37	n.a.
174	Sierra Leone[a]	−8.05	n.a.

Own computations from World Bank (2000) and sources indicated in Appendix A.
[a] ‘Potentially unsustainable’ because of negative net saving rates.
[b] ‘Potentially unsustainable’ because of negative genuine saving rates.
[c] n.a., not applicable.

manufactured capital. They should learn from their mistake for the future depletion of their remaining reserves.

But it is not just bad resource management that puts the human development of these countries at risk. Unsustainability is often the more general consequence of low saving rates. As World World Bank (1997, p. 35) puts it: “The depressed rates of genuine saving (…) represent an opportunity not seized. (…) [I]t is often the gross saving effort that is insufficient in these countries, which prompts the finger squarely at broader macroeconomic policies”. It is outside the scope of this paper to discuss in detail policies that can raise a country's gross saving rate. Suffice it to say here that increased public savings and a fully funded pensions scheme are likely to raise the saving rate in the long run (World Bank, 1999).

Note that it is not implied here that these countries should be left on their own in their struggle to become sustainable. This is for two reasons: first, often unsustainable resource extraction as well as wasteful military and other expenditures are encouraged by developed countries who want to import resources as cheaply as possible and to export military and other goods as much as possible.[15] Second, looking back at Table 2 shows that countries with low and lower medium human development are particularly likely to be unsustainable. Without help from the outside, it is most likely that not only will they be unable to improve their human development, but they also risk losing the little development they have since even this low level is unsustainable. In conclusion, while the results reported here make a clear case for macroeconomic policy and resource management reforms, they can also be interpreted as a call for assistance to countries with a low HDI and signs of unsustainability. This assistance needs to be designed such that policies move towards better resource management and higher saving rate, however. Merely granting countries better access to foreign financing can even reduce a nation's saving rate, if aid flows finance consumption instead of productive investments.

[15] For an early analysis of this phenomenon, see El Serafy (1981).

6. Conclusions

This paper made a constructive proposal on how to link the HDI with sustainability. It has argued that natural resources and the environment are best taken into account not in placing yet another variable into the HDI or calculating a ‘green HDI’ alongside the traditional index. Rather, the question of sustainability should be seen as a fundamental one and the achieved level of human development should be qualified as ‘potentially unsustainable’ where appropriate. Following this proposal would pay due regard to the role of natural capital as one of the enabling factors for human development. It would also allow continuing with the traditional index and would not inhibit comparisons with former years. As Trabold-Nübler (1991, p. 243) suggests, whenever possible ‘a change in the structure of the HDI should be avoided in order to assure comparability over time’.

What are the limitations of this constructive proposal to link the HDI with sustainability? First, the coverage of renewable resources needs to be extended if enough data of sufficient quality can be established. Forests are an important renewable resource, but not the only one.[16] If possible, resources like water, soil, fish and, more generally, biodiversity should be included.

Second, the current non-accounting for capital depreciation due to pollution is far from satisfactory. Ideally one would want to value the damage inflicted by pollutants like sulphur oxides, nitrogen oxides, fecal coliforms and particulate matter directly. That the more developed countries by and large do not become detected as potentially unsustainable is mostly to be explained by their usually quite high net saving rates. Nevertheless, these countries would no longer have such outstandingly good sustainability performance if more pollutants were taken into account. United Nations Development Programme (1998, p. 66) is correct in arguing that ‘it is the rich who pollute

[16] Even forests could not be adequately included in the computations above as the full amount of resource rents from forest harvesting was counted as depreciation, thus overstating the true amount of depreciation.

more (…) who generate more waste and put more stress on nature's sink'. Whether it will be possible in the near future to have reliable data on a broad range of pollutants and on the damage caused by their emission is far from clear, however.

Third, the coverage of countries in the World Bank database has to be extended and needs to be matched with the HDI database so as to include all countries that are covered by the HDI. It will only make sense to indicate potential unsustainability of the achieved human development if this exercise is undertaken for all countries.

Fourth, use of the 'El Serafy'-method necessitates the choice of a rate of discount, which is a contentious issue. Different conclusions on the sustainability of a country follow from using different discount rates — see Neumayer (2000) for more detail. Note, however, that various parameters have to be chosen for the construction of the HDI itself as well so that this problem is not exclusive to the proposal made here.

Fifth, for technical reasons that cannot be explained here, negative genuine saving rates in one year do not necessarily imply unsustainability (Asheim, 1994; Pezzey and Withagen, 1995). Only if these rates are 'persistently' negative can unsustainability be inferred. Also, given the sometimes shaky quality of the data, one must be precautious about making strong assertions. These are essentially the reasons why it was proposed to qualify the achieved human development of a country that exhibits negative genuine saving rates in one year with 'potentially unsustainable' rather than a definite 'unsustainable'.

Sixth, the concept of sustainability employed here is that of so-called weak sustainability which implicitly assumes substitutability between natural and other forms of capital (Neumayer, 1999). It can therefore not be taken into account that a natural resource might be 'critical' in the sense that the achieved level of human development is endangered if this resource is run down even though enough other forms of capital are built up in exchange to make genuine saving positive.

Seventh, the analysis here takes into account an important form of capital, namely natural capital. Of course, there exist other forms of capital such as human or social capital. Unfortunately, the change in these other forms of capital cannot at the moment be measured with sufficient precision, so that they were ignored here. It should be pointed out, however, that natural capital (contrary to, for example, human capital) is really under siege and in this respect more important for sustainability assessments.

All these limitations notwithstanding, it is important to take nature into account when one assesses human development. This paper has made the first step and proposed a method for linking the HDI with sustainability. Other steps should follow and a lot of work still needs to be done especially with regard to improving the database and the coverage of resources and pollutants.

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Appendix A. Sources of data for computing net depreciation of natural capital according to the 'El Serafy'-method

To compute user costs for resource extraction according to the 'El Serafy'-method, one needs to establish four different terms:

- $P-AC$, net resource price;
- R, resource extraction;
- r, the discount rate;
- n, the number of years reserves would last at current extraction rates (reserves to extraction ratio).

$(P-AC)$ as well as R were taken directly from World Bank (2000). The discount rate was assumed to be 4% p.a. This is the rate World Bank (1997) uses for wealth estimations (for a justification, see Kunte et al. (1998, p. 8f). The reserves to extraction ratios came from various data sources

depending on the particular resource. Note that for quite a few countries it proved to be sufficient to get reserve to extraction ratio data for their major resources (usually oil and natural gas), as it became already apparent that they would achieve positive genuine saving rates. There was therefore no need to search for reserve ratio data for their minor resources. Reserves to extraction ratios for oil and natural gas came from British Petroleum (2000), those for iron and phosphate from U.S. Bureau of Mines (2000). For Ghana, the 1998 ratio had to be computed indirectly as world reserves in 1998 times Ghana's 1994 share of 1994 world reserves divided by Ghana's 1998 extraction (all data from U.S. Bureau of Mines (2000), apart from Ghana's 1994 share which was provided by George J. Coackley, the U.S. Bureau of Mines' country expert for Ghana).

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