The need for 'convention' in environmental valuation

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ABSTRACT

The rate of growth or decline in Gross Domestic Product (GDP) is reported quarterly in New Zealand and regarded as the ultimate measure of the current wealth and well-being of the nation. However, the economy is much greater than the exchanges that take place in the marketplace (which is the source of GDP statistics) and in reality cannot be separated from the people who produce and consume goods or the environment from which the economy extracts resources and dumps wastes.

Systems to report GDP were first developed by the United Nations after World War II and are now hardwired into the decision-making and political process. As a result it is relatively easy to extract and count exchanges involving money. For the inputs provided by the environment, and many other unpaid services provided by households, no such mechanisms exist. The Genuine Progress Indicator (GPI) measures the contribution made by the environment and social fabric of society to the economy. GPIs have been constructed for a number of countries and they all show such contributions are considerable, but difficult to measure. No 'convention' has been established for the constructing of a GPI.

This paper looks specifically at the approaches taken to value natural capital and environmental services provided to the economy over the 1970 to 2005 period in New Zealand, and, whether or not such approaches could be used by other countries. It advocates the need for 'convention' in GPI reporting as occurs with the System of National Accounts from which GDP is extracted

"Everything should be made as simple as possible, but not simpler" (Albert Einstein)

1.1 Introduction

The need for a meaningful measure of well-being has led to a number of countries constructing indicators such as the Genuine Progress Indicator (GPI) or Index of Social and Economic Well-being (ISEW). These indicators take into account a broader range of factors than the traditionally used measure of Gross Domestic Product (GDP). This paper discusses issues associated with constructing a GPI for New Zealand.

GDP is at most a measure of the contribution of production to welfare but it is incorrectly used by many – either explicitly or implicitly – as a gauge of well-being. Growth in the economy expressed in terms of percentage increase in GDP is an aspiration of most governments. However, this growth must produce more "goods"

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than "bads" to improve the well-being of a nation. When GDP growth is reported in the media it is always on the basis of the 'bigger the better' with little if any diagnosis of which sectors contribute to the growth and whether additional income is from the degradation of natural assets that will not be available to produce benefits in the future, or whether it is from well-managed renewable sources.

GDP is a measure of output during a given period. As a result GDP may increase following major natural or man-made catastrophes in wealthy countries or poor countries that receive aid, because while production ceases rebuilding needs to take place. "Undoubtedly, major calamities destroy part of the economic wealth (buildings, houses, roads and infrastructure), but they do not, *per se*, constitute negative production and so do not directly contribute to a decline in GDP. Destruction can indirectly affect production in a negative or positive way. When a factory is destroyed it ceases production, but it also has to be rebuilt and this constitutes production. For this reason, paradoxically, it is possible for a natural catastrophe to have a positive impact (in the purely mathematical sense of the word "positive") on GDP" (Lequiller and Blades, 2006, 35). There are many examples that can be cited of situations that increase or decrease GDP but do not result in a similar directional change in the well-being of a nation. For instance a road accident may result in increased GDP due to greater activity of emergency services, and GDP will decrease if a man marries his housekeeper and she is no longer formally employed.

The goal for government should not be growth in GDP per se but an increase in the quality of life for people in their country. While GDP was never intended to be used as a measure of well-being for a nation it has assumed this role by default. Simon Kuznets the architect of GDP is reported as saying "The welfare of a nation can scarcely be inferred from a measurement of national income as defined [by GDP] …. Goals for 'more' growth should specify of what and for what" (Hamilton 2000, 65). The problems associated with using GDP as a measure of well-being for a nation are well recognised but finding an acceptable alternative is a challenge. Growth in GDP in itself needs to be evaluated from the premises of whether or not it produces a higher level of well-being and is sustainable in that it is not depleting the resource base from which future generations need to support themselves. It also needs to be evaluated from the perspective of whether or not it increases happiness. Research is increasingly showing a decoupling of material wealth from happiness and that economic growth and well-being are not the same thing (Hatfield-Dodds, 2005; The Economist, 2006)[2].

GDP does not represent 'the national wealth', which is gauged by the stock of a nation's assets. Rather GDP is a flow of output (Lequiller and Blades, 2006, 35). Indicators such as the GPI are more concerned with maintaining a nations sustainable income and therefore 'national wealth'. If GDP grew without increasing overseas debt, no loss of social capital, and with natural resources being consumed at a sustainable level then GPI and national wealth would grow with it Cobb et al. (1999). However, in most instances these liabilities are increasing along with GDP growth . The GPI aims to measure the extent to which well-being is affected by economic

[2] "Having grown at an annual rate of 3.2% per head since 2000, the world economy is over half way towards notching up its best decade ever… Market capitalism, the engine that runs most of the world economy, seems to be doing its job well. But is it? …. affluent countries have not got much happier as they have grown richer. From America to Japan, figures for well-being have hardly budged." (The Economist December 23rd 2006).

activity. It makes adjustments for negative or defensive spending undertaken to correct, for example, the effects of pollution or crime which impact negatively on welfare. It also makes adjustments for the depletion of natural capital which is not included in GDP. Depreciation of man-made capital is allowed for in GDP but there is no accounting mechanism to provide for the depletion of natural capital from which the man-made capital is derived.

The GPI is a more extensive accounting system than the System of National Accounts (SNA) used to calculate GDP because it captures the benefit of a particular activity as well as the cost of it. Hence when wetlands are converted to productive farmland, the benefits are revealed in terms of consumption expenditure (recorded as per GDP as income generated from the trading of agricultural products) and the cost of the lost wetlands are also accounted for (valued according to the net loss of ecosystems services provided by the converted wetland). If the benefit of converting wetlands to farmland exceeds the cost, this will have an overall positive influence on the GPI, and vice versa. GDP, on the other hand, counts the conversion and the agricultural output as a benefit only and so it never separates the benefits from the costs to allow the comparison to be made.

Cobb et al. (1995) argue that while the GPI may lack the precision of GDP in its estimation it is in fact a more accurate measure of well-being as it does not arbitrarily place a zero value on factors essential for long term sustainability. “To use the GDP as a measure of progress is to assume that families and communities and the natural habitat add nothing to economic well-being, so that the nation can safely ignore their contributions, and, in fact their destruction can be regarded as economic gain”(Cobb et al., 1999). GPI cannot accurately reflect everything of value in an economy or what is of value to every individual but it can highlight this important message: “the quality of economic development is at least as important as the quantity of economic activity measured by GDP” (Venetoulis and Cobb, 2004, 3).

New Zealand has recently constructed its first GPI for the 1970 to 2005 period. In total 23 adjustments were made to personal consumption to calculate the final GPI. This paper outlines the social and environmental factors whose inclusion was considered important in the New Zealand GPI and how they were calculated. It then looks specifically at the environmental categories and the issues associated with their calculation. The final section makes suggestions for how these problems could be managed not just for NZ but for other countries as well so that environmental adjustments might be made to GDP for loss of natural capital even if the full GPI was not calculated.

1.2 NZ GPI categories and how they are calculated

The New Zealand GPI endeavours to take into account important aspects of social and environmental impacts not included in GDP but regarded as having significance for the sustainable welfare of the nation.

The GPI starts from an estimate of total personal consumption in New Zealand and adjusts for social and environmental costs and benefits. For the New Zealand GPI, 13 social and economic categories and 10 environmental categories were included. The item, whether its impact is positive or negative, and the method of calculation/valuation are listed in Table 1.

Table 1 **Items and valuation methods used to calculate the New Zealand GPI**

Item	Welfare impact	Method of valuation
Personal consumption	+	Annualised time-series of private final consumption expenditure obtained from Statistics New Zealand (SNZ). Includes all household outlays on consumer goods and services along with expenditure on non-capital items by private non-profit organisations serving households.
Weighted personal consumption	+	Adjusts personal consumption for income inequality using an Income Distribution Index (IDI) based on Gini Coefficients. The year with the smallest recorded inequality (1973) was set as the base year with an index of 100. Derived by dividing Personal Consumption by the IDI, and then multiplying by 100.
Public consumption non-defensive	+	A time series of input-output tables was used to establish public consumption expenditure by category. Assumptions were made to estimate the non-defensive proportion in each category.
Value of household and community work	+	Calculated as non-leisure time spent on household and community work. Disaggregated by time spent on household and community work in 1999 by age-sex cohort. Adjusted through time for known changes in age-sex cohort demographics. Time-use estimates converted to dollars using median wage rate for housekeepers.
Cost of unemployment	-	Indirectly values the involuntary leisure time that unemployment brings. Calculated as total unemployed hours per week multiplied by a cost per hour and then annualised. The cost per hour is calculated as the minimum wage rate per hour less the weekly unemployment benefit divided by 40 hours. Allowances are made for both full and part-time employment.
Cost of underemployment	-	Indirectly values the involuntary leisure time that underemployment brings. Calculated as total part-time employees looking for full-time work multiplied by the average hours wanted to work per week (23.8 hours) and, then multiplied by the average hourly wage rate. Results are annualised.
Cost of overwork	-	Calculated as the loss of leisure time. Hours overworked per week (the difference between average hours worked and the average hours worked in 1991 which was the year with the lowest hours worked) multiplied by total employment and the average wage rate. Results are annualised.

Table 1 (Continued) Items and valuation methods used to calculate the New Zealand GPI

Item	Welfare impact	Method of valuation
Cost of private defensive expenditure on health and education	-	Calculated as the private defensive expenditure on health and education taken directly from SNZ time series data. Defensive proportion for health assumed to be 70% in the ’70s, 75% in the ’80s, and 80% from 1990 onwards. Defensive expenditure for education was 10 percent annually. Adjusted for price changes using the Consumer Price Index.
Services of public capital	-	The services rendered by government-owned capital stocks. Allowances are made for non-defensive (50%) and non-market services (80%). Estimated as the depreciation of capital stocks (adjusted for non-defensive and non-market services) plus the opportunity cost of government investment funds elsewhere in order to gain interest.
Cost of commuting to work	-	Incorporates both the direct (i.e. vehicle purchases, maintenance, bus and train fares etc) and time costs of commuting to work. Direct costs are calculated for both private and public components of commuting to work. Time costs are estimated as total employment multiplied by hours spent on commuting, multiplied by a cost per hour.
Cost of crime	-	Private sector property loss, property damage, and preventative expenditure including associated administration costs borne by insurance companies. Calculated as total offences multiplied by cost per offence. Requires scaling of recorded offences to derive an estimate of ‘actual’ offences; this is performed using ‘multipliers’ provided by Roper and Thompson (2004).
Net capital growth/decline	-,+	Calculated as the difference between two consecutive years’ net capital stock. An adjustment is also made for changes in the growth rate of the labour force.
Net foreign borrowing	-,+	Calculated as difference between foreign borrowing and lending as recorded in New Zealand’s International Investment Position. Indexed to GDP before 1992 due to lack of data..

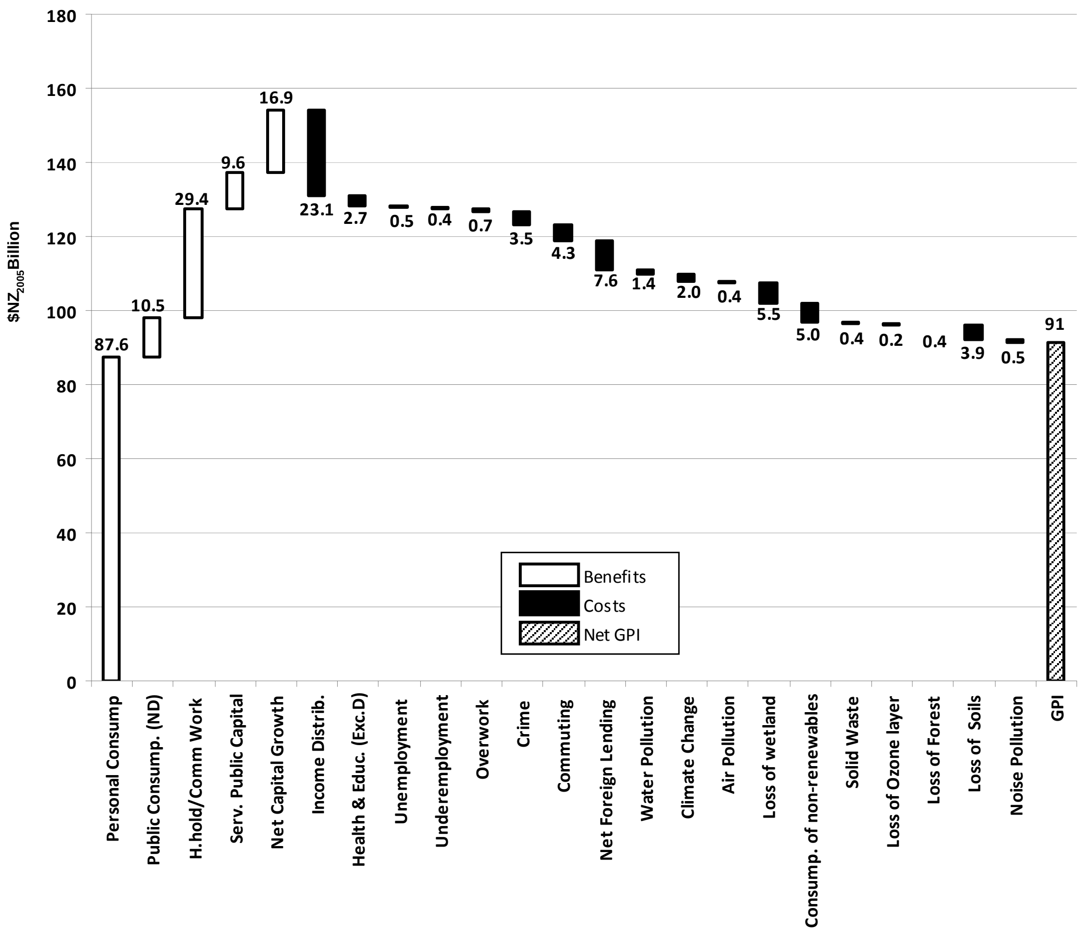
Table 1 (Continued) Items and valuation methods used to calculate the New Zealand GPI

Item	Welfare impact	Method of valuation
Loss and damage to terrestrial ecosystems	-	The main component of costs is damage caused by invasive pests, which has been identified as the single greatest threat to biodiversity on land, surpassing even habitat (Department of Conservation and Ministry for the Environment, 1998). To calculate loss and damage to terrestrial ecosystems, pest related annual expenditure by central government is used. Biodiversity loss from milling is valued on the basis of sawn timber extracted.
Loss of wetlands	-	Calculated by estimating the number of hectares of wetlands drained and their biodiversity value.
Loss of soils	-	Soil loss in New Zealand is mainly from erosion. There is a high natural background erosion rate as a result of geologically young landforms, tectonism, a steep topography and a maritime climate. Unsuitable agricultural activity accelerates erosion and has long-term effects. It is estimated erosion scars take 100 years to reach 80% of their former productivity (Parfitt, 2005). Erosion results in lost productivity and damage that requires defensive expenditure by other sectors of the economy to correct. The tonnes of soil lost annually have been estimated and a value put on this using a 1998 costing. Only erosion as a result of agricultural activity has a negative environmental impact for the GPI. Agricultural land lost to urban expansion has been valued on the basis of biodiversity loss and production loss.
Loss of air quality	-	Calculated by weighting the loss of life years and reduced activity days for 2004 by an air pollution index.
Solid waste contamination	-	The tonnes of waste going to landfills, multiplied by the ‘full accounting cost’ of disposal.
Climate change	-	This category is similar to that referred to in other studies as the ‘cost of long-term environmental damage’ and covers all greenhouse gas emissions from the country, not just energy related. New Zealand generates just under half (49.4% in 2004) of its greenhouse gas emissions from agriculture, which is production related. Climate change costs have been

		calculated from estimates of greenhouse gas emissions multiplied by the European Union ($NZ equivalent) December 2005 value of a carbon credit.
Loss of water quality	-	Pollution of New Zealand's freshwater resources is a major environmental concern (Ministry for the Environment, 1997; Parliamentary Commissioner for the Environment, 2005). Water quality has been valued using the cost of riparian planting lowland river margins and planned restoration work on eutrophic lakes. This valuation method is different from that used for water quality in other nation's GPIs, but is consistent with the 'Clean Streams Accord' approach used in New Zealand to prevent further loss of water quality.
Ozone depletion	-	New Zealand does not produce or consume high volumes of ozone-depleting substances, but as a nation its people are more exposed to the impact of damage to the ozone layer than most other countries. For this reason, instead of using volumes of CFCs produced or consumed, as is done for other GPIs, loss of life years from death from melanoma cancer has been used for valuation purposes.
Loss of non-renewable resources	-	Calculated by using the Stockhammer 'value-added' for mining, quarrying, and oil and gas extraction. To reflect scarcity, oil and gas have also been valued at the generation cost of a PJ of renewable replacement energy.
Noise pollution	-	The increase in the use of vehicles and the associated noise has been used to approximate the loss of amenity from the continual exposure to noise in the environment. This has been calculated from vehicle kilometres travelled and a 1995 study by the Ministry of Transport of environmental externalities associated with motor vehicle use.

For the 2005 financial year as can be seen in Figure 2 the major positive contributions to well-being captured by the GPI but not included in GDP is the unpaid work done by households for both their own needs and as voluntary work to help others in the community. The growth in man-made capital also makes a significant positive contribution. Income inequality and net foreign lending are the major negative social adjustments. When combined the total cost of the loss of environmental capital and services was $19.7 billion dollars. In 2005 the total GDP for the year was $148.9 billion whereas the GPI was $91 billion.

Figure 2 Component Contributions to the New Zealand Genuine Progress Indicator for the 2005 financial year (NZ_{2005}$ billion)



1.3 Problems associated with environmental measures

It is acknowledged that the methodology used to calculate environmental loss has a major impact on the dollar amount attributed to environmental costs. For the New Zealand GPI a conservative approach has been taken with the valuation.

As New Zealand is a small country with relatively advanced economic and social accounting systems, attempts have been made to value the inputs into the GPI using the most rigorous methods available. However, many attempts to do this proved futile as New Zealand is ‘information rich but system poor’ (Williams, 2007). As a result, available data especially for the environmental categories was either difficult to compare over time or not in an appropriate form to use for the GPI calculations. Traditionally, emphasis has been on economic and social data systems with few requirements for environmental accounting. This reflects the adage that 'we can only manage what we measure' and accordingly the New Zealand economy has been the focus of political and hence statistical processes.

The construction of a GPI for any country is very dependent on the underlying assumptions made within the methodological framework of the index – and New Zealand is no exception. This is especially pertinent for the environmental categories as, for example, an assumption regarding whether or not to accumulate costs over time, and if so the start point for accumulation, can have very significant impacts on the final GPI. The methodology used for New Zealand to value each environmental category is detailed in Table 1.

To calculate the actual dollar value of the change in natural capital stocks, it has been necessary to incorporate elements and use methodologies unique to New Zealand and to make specific assumptions. If there was an agreed on national system as per SNA this would make future calculations for the GPI more straight-forward and comparisons between countries easier. The following discussion looks at some of the specific problems encountered with the construction of the environmental section of the New Zealand GPI and how they could be addressed in a way that would enable other countries to make similar calculations. The problems looked are (i) what to include in the GPI, (ii) what measure can be used internationally, (iii) backcasting data, (iv) accumulation, and, (v) what are appropriate boundaries.

1.3.1 what to include in the GPI

From Table 2 it would seem certain environmental categories are essential to GPI (or similar indicators e.g. ISEW) calculations and therefore most important to include. General agreement on other categories has not yet been reached.

Table 2 Environmental Categories in selected GPI or ISEW

Category	Included by	
Loss and damage to terrestrial ecosystems	*Loss of forest cover /Loss of native-old growth* Lawn & Clarke, 2006; Hamilton, 1999 ; Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988,1995,1999,2002; Bleys, 2006; Forgie et al., 2007	8
Loss of wetlands	Hamilton, 1999; Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988,1995,1999,2002; Bleys, 2006; Forgie et al., 2007 *Natural areas* - Stockhammer et al. 1997	7 1
Loss of soils/agricultural land	Lawn & Clarke, 2006; Hamilton, 1999; Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988, 1995,1999,2002; Bleys, 2006; Forgie et al., 2007; Stockhammer et al. 1997	9
Loss of air quality	Lawn & Clarke, 2006; Hamilton, 1999; Jackson &	9

	Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988, 1995,1999,2002; Bleys, 2006; Forgie et al., 2007; Stockhammer et al. 1997	
Solid waste contamination	Forgie et al., 2007	1
Household pollution abatement	Redefining Progress, 1988, 1995,1999,2002; Jackson & Stymne, 1996,	3
Climate change /LT environ damage	Lawn & Clarke, 2006; Hamilton, 1999; Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988, 1995,1999,2002; Bleys, 2006; Forgie et al., 2007; Stockhammer et al. 1997	9
Loss of water quality/supply	*Urban Water pollution* Lawn & Clarke, 2006; Redefining Progress, 1988, 1995,1999,2002; Hamilton, 1999; Forgie et al., 2007; *Rural Water pollution* Forgie et al., 2007; *Irrigation* Lawn & Clarke, 2006; Hamilton, 1999 *Water pollution* Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988, 1995,1999,2002; Bleys, 2006; Stockhammer et al. 1997	5 1 2 6
Ozone depletion	Lawn & Clarke, 2006; Hamilton, 1999; Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988, 1995,1999,2002; Bleys, 2006; Forgie et al., 2007;	✓
Loss of renewable resources	Lawn & Clarke, 2006; Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988, 1995,1999,2002; Bleys, 2006; Forgie et al., 2007; Stockhammer et al. 1997 *Energy only:* Hamilton, 1999	8 1
Noise pollution	Hamilton, 1999; Jackson & Stymne, 1996, Guenno & Tiezzi, 1998; Redefining Progress, 1988, 1995,1999,2002; Bleys, 2006; Forgie et al., 2007; Stockhammer et al. 1997	8
Ecosystem health Index (EHI)	Lawn & Clarke, 2006	1
Cost of lost natural capital services (LNCS)	Lawn & Clarke, 2006	1

A comprehensive list of all GPIs and ISEWs was not constructed due to the large number in existence. Getting an agreed on standardised list of what to adjust is difficult as the natural environment varies from country to country. For example, loss of wetlands is significant for a temperate climate country like New Zealand but not costed in drier countries such as Australia because wetlands are not so numerous. It could be argued that wetlands because of their scarcity value are even more important in drier climates and their ability to slowly release water under dry conditions needs to be protected. All countries calculating the costs across a set criterion would enable a more standardised approach towards GPI and better reporting on the extent to which the environment contributes to annual GDP.

1.3.2 what measure can be used internationally

The GPI attempts to quantify the annual extent of environmental services consumed by an economy. Discussion on how best to measure environmental loss in this section is under three broad groupings: the loss of non-renewable resources, the loss of ecosystems and environmental damage.

Non-renewable resources
By definition a sustainable economy must live off the income or services produced by the environment without depleting the capital stock. Therefore, the value of non-renewable resources consumed in the process of economic production is a cost. The depletion of renewable resources is always a major item in the GPI and costs vary considerably depending on whether the replacement costs or resource rent method is used.

When estimating the depletion costs for non-renewable resources, a combination of approaches have been used by the different GPIs. If one accepts the premise of weak sustainability, in which there is no need to preserve natural capital intact for perpetuity and the marketplace will find appropriate substitutes when resources get scarce, what must be valued is the loss of natural capital as it is consumed each year. One way of doing this is to use the value-added contribution of the SNA as the 'resource rent' (as per Stockhammer et al., 1997). Another way is to cost the expenditure required if the item was replaced with a renewable resource, 'replacement cost'.

The advantage of using the value-added component to quantify the 'resource rent' of using non-renewable resources is the the systems are already in place with the SNA to determine this. The El Serafy (2002) refinement of the resource rent method leads to lower estimates of the depreciation of natural capital due to resource exploitation than Stockhammer (Neumayer, 2003, p164) but requires knowledge or assumptions to be made about the size of present stocks, future uses and the most appropriate discount rate. Given, the significant uncertainty associated with, for example, the future use of coal, which is a plentiful resource but may be left unused due to impacts on climate change, it seems prudent to avoid making such assumptions. As substantial quantities of resources are used outside the formal economy the Stockhammer approach is still likely to be conservative.

While it has been argued that natural assets as an input into the production process are substitutable and therefore, do not need to be preserved, a different view is sometimes voiced with respect to oil and natural gas reserves (Anielski and Rowe, 1999; Hamilton and Denniss, 2000). Therefore there is a case for treating non-renewable *energy*-producing resources differently because technology is dependent on energy. Oil and gas are the main sources of cheap energy and their depletion is potentially a significant cost to future generations. Past and present exploitation of oil and gas has allowed people on modest incomes to enjoy the lifestyle of the rich, but this is not sustainable and will have an impact in the future when supplies run out. The scarcity value of natural gas and crude oil extracted could be allowed for as a premium above the resource rent allowance. A standard way of doing this could be to cost the loss of each petajoule of energy consumed from natural gas and crude oil, at the cheapest replacement cost for a petajoule of renewable energy in the country concerned. This was the methods used for the New Zealand GPI.

Ecosystems
Ecosystems provide a range of services such as climate regulation, soil formation, waste treatment, biological control, recreation, cultural benefit, soil erosion control, water supply and watershed protection, nutrient cycling, gas regulation, pollination, habitat, disturbance regulation and genetic resources. If these services are lost then the cost of this loss needs to be allowed for. Categories in the New Zealand GPI included: loss of wetlands, loss of soil, and loss of indigenous forest.

Loss of wetland and loss of indigenous forest can be estimated by area lost and the valuation of lost ecosystem services associated with a typical measure of that area. Ideally each country should have its own ecosystem valuation per hectare, but in the absence of this global estimates can be used, such as those estimated by Constanza et al. (1997).

Loss of soil can be due to conversion of agricultural land to other uses, loss of fertility due to poor management, or erosion. Methods for how to value soil loss include estimating the loss in value-added from a typical hectare of land in a similar land use class, fertiliser requirement per hectare to boost fertility or estimating tonnes of soil lost from erosion and putting a value on lost production and the externalities such erosion causes.

Environmental damage
Environmental damage from wastes produced by the human economy that cannot be absorbed and assimilated by the environment is a cost. Categories in the New Zealand GPI included: ozone depletion, loss of water quality/supply, greenhouse gases, air pollution, and solid waste.

Ozone depletion can be estimated based on production of CFCs (as per USA see Cobb et al., 1995) or consumption (as per Jackson and Stymne, 1996) of ozone depleting substances. As the impacts from using CFCs are global, it is possible to determine an international price per tonne of CFC emitted. A decision as to whether the measure should be per tonne produced or consumed would be required. Given that many countries do not produce CFCs but do consume them and the premise that "consumption is the sole end and purpose of all production" (Adam Smith 1776, edited by Heilbroner, 1986) consumption may be the appropriate international standard to use.

The greenhouse gas inventory required by the United Nations Framework Convention on Climate Change, has demonstrated it is possible to devise international standards to measure environmental damage. Under the Kyoto protocol each country wanting to trade carbon on the international market is required to keep an inventory updated yearly. Agreement on a marginal social cost value to use per tonne of greenhouse gas emissions would provide an international mechanism for measuring this environmental impact. While the complexity of determining the marginal social cost is not to be underestimated, even using an accepted lower bound is more accurate than not taking the cost into account because it is too difficult to measure.

Solid waste to landfill statistics are included in the inventory so it is possible to estimate the tonnes of waste generated each year and dumped. A country could then use either an internationally set 'cost of waste' to quantify the cost of environmental damage from landfills or use an amount that more closely reflected the full accounting cost in the country concerned.

Air pollution and water pollution/water supply are both difficult environmental categories to value. A potential measure for air quality is the number of respiratory-related deaths linked to air pollution. Each country could then use either an internationally set ‘value of life’ to quantify the cost of environmental damage or use an amount that more closely reflected value of life in the country concerned.

Determining water values for the GPI is a major issue because climatic conditions impact on both supply and quality. Measuring change in water quality is difficult because this is related to temperature and flow, in addition natural sediment levels vary depending on the geology of the surrounding area. Water supply issues need to balance the needs of the environment and the demands of competing water users be it electricity generation, irrigation, business use or home use.

Methodologically sound ways for valuing changes in water quality are still being researched. Several different approaches were trialled for the New Zealand GPI and subsequently abandoned due to insufficient data or logic flaws. While there are data that indicate water quality especially in lakes and lowland rivers is declining (Vant and Smith, 2004; Gibbard et al., 2006; NIWA, 2006), quantifying the annual extent of the decline and placing a dollar value on this is very problematic.

1.3.3 backcasting data

Because it is the change in GPI rather than the absolute amount in dollars that is of interest, time-series must be calculated. Working back in time is very difficult due to the paucity of data. However if a ‘convention’ was agreed on for measuring environmental impacts then it would be possible to collect the required data so it would be available in the future.

1.3.4 accumulation

Another area of uncertainty when calculating environmental damage is how to allow for cumulative damage. It is accepted that the loss of ecosystem services increases as an ecosystem becomes more scarce and therefore losses need to be accumulated over time. When they calculated the US GPI, Anielski and Rowe (1999) included all wetland lost from the colonial period to 1995. This valuation amounted to $349.9 billion and is justified on the basis that the loss of ecosystem services when wetlands are converted to other uses is permanent and therefore the value needs to be in perpetuity. Initial wetlands conversion was valued at a lower marginal rate than later conversion as the value of the ecosystems loss increases with scarcity.

For the New Zealand GPI, soil loss and wetland loss have been accumulated from 1970 onwards. The rationale for this is that utility from personal consumption is measured for a given year and the starting point for the time-series is 1970 so we are looking at changes from this point onwards. Losses from flows of natural capital assets need to be compared over the same period of time. There would be some point in time when the marginal social cost of lost ecosystem services were greater than the marginal social benefit derived from any replacement activity but the actual point of cross-over is not known and therefore not surmised, other than it was pre 1970.

The approach of accumulating damage from 1970 onwards can be likened to the Kyoto Protocol forests where only forest planting from 1990 onwards qualify. A system of 'drawing a line in the sand' and working forward from there provides a point in time to measure from and comparability with other countries using the same point.

1.3.5 what are appropriate boundaries

The GPI boundaries are generally defined as 'nation' boundaries because the measure is for the well-being of a society. Unlike the Ecological Footprint (Wackernagel and Rees, 1996) the importation of natural capital and subsequent depletion of others nations' resources is not included in GPI calculations. However, often the impact of a nation's behaviour seriously impacts on the well-being of other nations, for example, the hole in the ozone layer leads to higher numbers of deaths from melanoma in fair-skinned people in New Zealand. Valuation on the basis of production of CFCs or consumption of ozone depletion substances within a country does not reflect this impact. The approach of valuing CFCs produced or consumed for ozone depletion introduces the issue of how responsible a country is for the impacts it has on another nation's well-being. Many countries have environmental impacts that extend beyond their national boundaries. Attempts to hold countries accountable for their CO_2 emissions have highlighted this fact.

1.4 The need for 'convention' in environmental valuation

If one looks at the SNA for reasons why particular accounting methods have been used, it often comes down to convention. While the approach taken may not be strictly accurate it has been adopted as the best method available to make the system work.

"As a result, the ***convention*** *adopted in national accounts has been to impute in the calculation of GDP the output of all goods going into households' own consumption, attributing to them the market price of an identical good" (Lequiller and Blades, 2006, p99).*

"Another important point is that expenditure by general government and non-profit institutions is classified by ***convention*** *as final, either as final consumption expenditure or as gross capital formation (GCF)" (Lequiller and Blades, 2006, p122).*

The first attempt to build a more robust and balanced indicator was Daly and Cobb's (1989) Index of Sustainable Economic Welfare (ISEW) which was calculated for the USA. Similar measures have been calculated for Australia, the UK, Canada, Chile, and a number of other European countries. Since 1989 methods have been modified and theoretical issues have been debated (Neumayer, 2000; Lawn, 2003; Neumayer, 2003). Criticisms made of the initial GPI have still not been resolved: lack of an exhaustive list of items; the overwhelming effects of dominant items; inadequate valuation methods; not a true measure of sustainable well-being; failure to reflect potential future impacts of present actions; the need for a more informative indicator; and data collecting framework (Lawn, 2005). Despite the short-comings of the GPI and ISEW, the large and growing number of countries and regions that have such measures of well-being reflect the acknowledged need for such a measure.

Bleys (2007) advances the concept of the Simplified Index of Sustainable Economic Welfare (SISEW) which omits items with low quantitative significance and encourages the monitoring of sustainable economic welfare using fewer data items than previously, but using more robust valuation methods. In this paper we advocate adopting 'convention' for calculating environmental losses so adjustments can readily be made to GDP to reflect the contribution made by the environment.

Building databases introduces problems of lack of consistency in definitions, concepts and classification systems and institutional feedback mechanism between data users and data collectors, particularly in reference to policy, social analysis, and public information (Friend and Rapport, 1991). The complexity of the integration problem between socio-economic and bio-physical data systems makes it easy to put valuing the environment in the too-hard basket. "Putting a price on ecological assets is symbolically a useful thing. But I don't think it will be economic reality in the next decades" (Schnellnhuber quoted by Doyle, 2006).

However, the need for the use of such pricing is becoming more urgent. Politicians have to make decisions that impact on voters now but will not benefit current voters but their children. There is no shortage of alternative economic and social indicators but there is a lack of support for their use and lack of institutional pressure to build robust systems. The IISD website alone lists more than 100 local, national and international indicator programs. "Instead, the current problem is one of consensus and acceptance. Government support is a major reason why the GDP was accepted, becoming the most widely used indicator. Only government can give an indicator program the recognition, the resources and the data base needed to make an indicator anything more than a semi-authoritative number designed to fit the needs – ideological, financial or otherwise – of its creator" (Haggart, 2000).

There is the *pars pro toto* risk that if we only monetize part of the environment the part will be regarded as whole. However, extension to include other categories is not ruled out by starting with a limited number. The proposed categories cover life-support ecosystem services, long-term environmental damage and non-renewable resource depletion. Environmental damage costs can be estimated and annual GDP adjusted accordingly[3].

The more complicated a system the more scope there is for disagreement and delay. Ways to report changes to the environment that people can relate to need to be found and put into practice quickly. Finding an accepted convention for calculating the dollar value of environmental damage and reducing GDP by this amount gives a readily understandable means of alerting politicians and the general population to the extent to which environmental degradation is occurring annually. While some argue that wedging environmental valuations into GDP means environmental concerns

[3] However, this adjustment cannot be integrated into input-output SNA for calculations on a sector-by-sector basis.

become subordinate to SNA and over-emphasis economic goals this may be required to achieve the paradigm shift necessary in the long-term. Having a convention accepted by government and ensuring that the assumptions behind the categories included for evaluation are visible and understood will enable international use and comparison.

1.5 Conclusion

This paper explores the potential for such convention based on research done from a New Zealand perspective.

There is a long history of developing 'management tools' for sustainable development. These range from natural resources accounts, Green GDP, GPI , and the human development index to more media-specific measures such as water indicators. "whatever information is collected and organised to support the relevant decision-making processes, the final outcome should always be judged in terms of its impacts on policy processes. Thus, we issue a warning against large-scale development of information systems, without due regard to the final utilisation of the output" (Alfsen and Greaker, 2006, p1).

A more accurate indicator of well-being is needed that does not arbitrarily place a zero value on ecological and social capital (Cobb et al., 1995). We should not continue with a system that counts the degradation of the environment as current income as is done under GDP. Such an approach allows countries to export natural capital and believe they have a current account surplus when in fact they have a serious deficit. We need a more accurate estimate of 'income' that does not confuse income with revenue and allows macroeconomic policy to address the right concerns.

The absence of data is an obstacle to rigorous environmental calculations but it must be remembered that the System of National Accounts from which GDP is extracted has developed over a 50-year plus period with accounting systems being improved along the way. The systems for collecting national accounts data are not completely comprehensive and a number of adjustments are made. It is not possible to estimate the accuracy of GDP because this statistic is calculated by "combining a complex mix of data from many sources, many of which require adjustment to put them into a national accounts database and which are further adjusted to improve coherence, often using non-scientific methods" (Lequiller and Blades, 2006).

National accounts data are approximations, but are accepted because the information is of value to business and policy makers. Adjusting GDP to reflect environmental damage in the ways suggested here is not an attempt to understate the complexity of the world or promise an easy solution but more a means of steering away from large-scale information systems that encourage inertia because of the difficulties associated with implementing and understanding such systems.

"Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted" (Albert Einstein)

References

Alfsen, K. H. and Greaker, M., 2006. From natural resources and environmental accounting to construction of indicators for sustainable development. *in*. Statistics Norway, Research Department. http://www.ssb.no/publikasjoner/DP/pdf/dp478.pdf.

Anielski, M. and Rowe, J., 1999. The genuine progress indicator – 1998 update. Redefining Progress, San Francisco, 61 p. www.rprogress.org.

Bleys, B., 2006. The index of sustainable economic welfare for Belgium. Report MOSI/27, Vrije Universiteit Brussel.

Bleys, B., 2007. A simplified index of sustainable economic welfare for the Netherlands, 1971-2004. *in*. Vrije Universiteit Brussel.

Cobb, C., Goodman, G. S., and Wackernagel, M., 1999. Why bigger isn't better: The genuine progress indicator - 1999 update. Redefining Progress, San Francisco, 44 p.

Cobb, C., Halstead, T., and Rowe, J., 1995. The genuine progress indicator: Summary of data and methodology. Redefining Progress, San Francisco.

Constanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Pareuelo, J., Raskin, R. G., Sutton, P., and Van den Belt, M., 1997. Nature, 387:253-260.

Daly, H. E. and Cobb, J., 1989. For the common good. Beacon Press, Boston.

Department of Conservation and Ministry for the Environment, 1998. Restoring the dawn chorus. Wellington, New Zealand.

Doyle, A., 2006. What price nature? Bogs $6,000, reefs $10,000. Reuters, May 15 2006. http://www.enn.com/today.html?id=10454.

El Serafy, S., 2002. The "El serafy" Method for estimating income from extraction and its importance for economic analysis. http://209.85.165.104/search?q=cache:FKk4zvnpf2sJ:www.ngps.nt.ca/Upload/Interveners/World%2520Wildlife%2520Fund%2520-%2520Canada/060228_WWF_No_3%2520-%2520El-Serafy%2520QuasiSust.pdf+The+%22El+Serafy%22+method+for+Estimating+Income+from+Extraction+and+its+importance+for+Economic+Analysis&hl=en&ct=clnk&cd=1&gl=nz.

Forgie, V., McDonald, G. Zhang, J., Hooker, L., 2007. A genuine progress indicator for New Zealand. Unpublished, New Zealand Centre for Ecological Economics, Palmerston North.

Friend, A. and Rapport, D., 1991. Evolution of macro-information systems for sustainable development. Ecological Economics, 3:59-76.

Gibbard, R., Roygard, J., Ausseil, O., and Fung, L., 2006. Water quality trends in the manawatu-wanganui region 1989-2004. Horizons Regional Council.

Guenno, G. and Tiezzi, S., 1998. The index of sustainable economic welfare (ISEW) for Italy. University of Siena, Department of Economics, Siena.

Haggart, B., 2000. The gross domestic product and alternative economic and social indicators. *in*. Economics Division, Government of Canada. http://dsp-psd.pwgsc.gc.ca/Collection-R/LoPBdP/BP/prb0022-e.htm#(13)txt (Accessed on 1 June 2007).

Hamilton, C., 1999. The genuine progress indicator methodological developments and results from Australia. Ecological Economics, 30:13–28.

Hamilton, C. and Denniss, R., 2000. Tracking well-being in Australia. The genuine progress indicator. Number 35, The Australia Institute.

Hatfield-Dodds, S., 2005. Decision support for highly contested choices: The role of monetised values and other metrics in the pursuit of sustainability. Presented at Australia New Zealand Society for Ecological Economics, Palmerston North, New Zealand.

Heilbroner, R. (Editor), 1986. The essential adam smith. Oxford University Press, Book IV, Chapter 8, "Conclusions of the Mercantile System" p284 p.

Jackson, T. and Stymne, S., 1996. Sustainable economic welfare in Sweden: A pilot index 1950-1996. Stockholm Environmental Institute, Stockholm.

Lawn, P. A., 2003. A theoretical foundation to support the index of sustainable economic welfare (ISEW), genuine progress indicator (GPI), and other related indexes. Ecological Economics, 44 (1):105–118.

Lawn, P. A., 2005. Workshop on genuine progress indicators. *in*. Australia New Zealand Society for Ecological Economics Conference "Ecological Economics in Action" Massey University, December 11-13, Palmerston North, New Zealand.

Lawn, P. A. and Clarke, M., 2006. Measuring genuine progress: An application of the genuine progress indicator. Unpublished.

Lequiller, F. and Blades, D., 2006. Understanding national accounts. Economica, France, 419 p.

Ministry for the Environment, 1997. The state of New Zealand's environment 1997. Ministry for the Environment, Wellington.

Neumayer, E., 2000. On the methodology of ISEW, GPI and related measures: Some constructive suggestions and some doubt on the 'threshold' hypothesis. Ecological Economics, 34 (3):347–361.

Neumayer, E., 2003. Weak versus strong sustainability (2nd ed.). Edward Elgar, Cheltenham.

NIWA, 2006. National river water quality network national monthly median data 1989–2004. [8 March 2006].

Parfitt, R., 2005. The 100-year manawatu flood event - one year on: A soils perspective. Soil Horizons, 11.

Parliamentary Commissioner for the Environment, 2005. Growing for good: Intensive farming, sustainability and New Zealand's environment, 2nd edition, Wellington, NZ, 238 p.

Stockhammer, E., Hochreiter, H., Obermayr, B., and Steiner, K., 1997. The index of sustainable economic welfare (ISEW) as an alternative to GDP in measuring economic welfare. The results of the Austrian (revised) ISEW calculation 1955-1992. Ecological Economics, 21 (1):19–34.

The Economist, 2006. Happiness (and how to measure it). The Economist (December 23).

Vant, B. and Smith, P., 2004. Trends in river water quality in the waikato region, 1997-2002. Environment Waikato Technical Report 2004/02, Hamilton, 40 p. http://www.ew.govt.nz/publications/technicalreports/documents/TR04-02.pdf [30.06.06].

Venetoulis, J. and Cobb, C., 2004. The genuine progress indicator 1950-2002 (2004 update). Sustainability Indicators Program, Redefining Progress, San Francisco, 22 p. www.RedefiningProgress.org.

Wackernagel, M. and Rees, W. E., 1996. Our ecological footprint: Reducing human impact on the earth. New Society Publishers, Philadelphia.

Williams, M., 2007. Pce20 parliamentary commissioner for the environment forum. *in*, Wellington.