

TOWARDS A GENUINE PROGRESS INDICATOR FOR NEW ZEALAND

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ABSTRACT: The concept of the Genuine Progress Indicator (GPI) has been developed internationally to provide a measure of national well-being that can be used to complement economic indicators. In the absence of an alternative, Gross Domestic Product (GDP) is currently used as a proxy measure of well-being, but this has many serious short-comings such as, not taking into account unpaid contributions made to well-being, or providing a means for monitoring the extent to which natural capital is being drawn down or maintained. Calculation of the GPI starts with the personal consumption component of GDP and adjusts this figure up or down for a range of additional social and economic factors. In this chapter, we describe the GPI calculation process that has been developed for New Zealand for the period 1970 to 2006. Social factors include income inequality, non-defensive public consumption, unemployment, underemployment, overwork, the services from public capital, household and community work, commuting, private defensive expenditure on health, and crime. Environmental factors considered include loss and damage to terrestrial ecosystems, loss of wetlands, soils and air quality, land degradation, climate change, reduced water quality, ozone depletion, loss of renewable resources, and noise pollution. Each of these factors constitutes a consumption or replenishment of non-financial forms of capital critical to the nation's well-being. At the broadest level, we found that GDP and the GPI were similar for the period preceding the reforms of the 1980s. Subsequently, the two measures diverged substantially. Whereas GDP doubled, the GPI increased by less than 50%. In both cases, most of this increase occurred from the early 1990s onwards. The data reveal areas where well-being is under pressure, and opportunities for redirecting policy in order to maximise well-being. Although refinements are needed before the measure can feature routinely in the country's national accounting, the GPI provides new insights into the country's development, and the calculation framework can be used to drive data improvement efforts.

Key words: Genuine Progress, Genuine Progress Indicator, GPI, Gross Domestic Product, GDP, human well-being.

INTRODUCTION

New indicators and performance measures are required to manage the affairs of nations and guide decision-making to meet the challenges of the 21st century. These need to reflect the focus on national well-being in its broadest sense, and provide a means for tracking the effects of the important pressures of modern life, including the growing impact on the natural environment of a larger and more affluent population. Increasingly, it has become apparent that Gross Domestic Product, or GDP, hitherto the most widely used means for tracking national progress, at least from an economic perspective, is inadequate for the wider task. The search for more robust measures is international and considerable effort has been devoted to the challenge of developing alternatives to GDP (Daly and Cobb 1989; Hamilton and Denniss 2000; Lawn 2003, 2008; Stiglitz et al, 2009).

Fundamentally, society aims to maximise human happiness in the long run. Well-being is the degree to which the nation is 'living and faring well', and "flourishing" (Walsh 2005). As a prerequisite for human happiness and what a good life achieves, well-being provides a yardstick for genuine progress. Consequently, attention has shifted to the challenge of measuring well-being. One measure that has become increasingly popular is the Genuine Progress Indicator (GPI) see for example, Jackson and Stymne 1996; Stockhammer et al. 1997; Guenno and Tiezzi 1998; Anielski and Rowe 1999; Hamilton and Denniss 2000; Venetoulis and Cobb 2004; Lawn and Clarke 2006; Talberth et al. 2007. The GPI, like its forerunner, the Index of Sustainable Economic Welfare (ISEW), has been promoted on the grounds that it attempts to measure not only the increased production of goods and services, as measured by GDP, but also many other relevant contributions to welfare (Daly and Cobb 1989; Hamilton and Denniss 2000; Lawn 2003). For this reason GPIs and ISEWs have been constructed for many countries and regions.

Any new measure needs to be clear and appealing (like GDP),

but also much more inclusive, incorporating social and environmental as well as economic factors. They also must be defensible, and provide a means for directing the attention of policymakers to the areas where new and improved policies will provide the greatest dividends in terms of national well-being.

Despite the considerable efforts by a number of countries to date, there is as yet no agreed standard for calculating a nation's GPI. Accordingly, we present the results of efforts so far to develop procedures that will be useful for New Zealand, and especially provide an advance over the use of GDP as a proxy for well-being. We start by reviewing the shortcomings of GDP as a measure of national well-being, and then move on to describe procedures we have developed to calculate a GPI for New Zealand. The procedures have been applied for 1970 to 2006, a period during which New Zealand's economy, society, and environment have undergone considerable change, as a result of internal and external pressures. We discuss how these changes have affected the GPI, consider the issues surrounding creation of a robust new indicator, and then conclude with some general observations and recommendations for further work.

LIMITATIONS TO GDP AS A MEASURE OF WELL-BEING

In the absence of alternatives, gross domestic product (GDP), the foremost measure of economic activity, universally recognised and widely accepted, is used as a proxy to measure progress. Since the release of the 1953 System of National Accounts (SNA) by the United Nations, substantial attention has been devoted to GDP as a measure of economic welfare and precise regulations have been developed for reporting GDP. The importance given to this measure cannot be overlooked, as GDP 'is the standard measure of economic success accepted by economists, politicians, financiers, humanitarians, and the general public' (Daly and Cobb 1989, p. 4). As a result, growth in GDP (the sum of monetary transactions for all final goods and services bought and

sold within an economy in a given period) is the aspiration of most governments and, hence, when GDP statistics are reported they are always interpreted on the basis of ‘the bigger, the better’, with little, if any, diagnosis of how this growth has been achieved or the wider welfare implications¹. As the inventor of GDP noted, ‘Goals for more growth should specify more growth of what and for what.’ (Kuznets 1962, p. 29). In other words, growth must produce more ‘goods’ than ‘bads’² to improve the welfare of a nation (Daly 2005).

Many examples can be cited of situations that increase GDP without an equivalent directional change in the welfare of a nation. For instance, output from heavy industry increases GDP but reduces air quality and impacts on the health and well-being of citizens; a road accident results in increased GDP due to the greater activity of emergency services and the vehicle repairs required; marriage breakdown results in increasing demand as two households need to be supported instead of one; while buying bottled water because the public water supply is not of sufficiently high quality to drink safely increases GDP but not welfare. Neither does GDP reflect distributional change. Growth in GDP does not report on whether or not the benefits accrue to a small or large number of individuals. As such, GDP privileges the world of the market without taking into account the social and environmental costs of producing the goods and services that are bought and sold in the marketplace.

The shortcomings of using GDP to measure the well-being of a nation are well documented (Kuznets 1962; Kennedy 1968; Daly and Cobb 1989; Cobb et al. 1995; Galbraith 1999; Anielski 2001; Lawn 2003, 2006; European Commission et al. 2007; Stiglitz et al. 2009). Research over a similar period has distinguished material wealth from happiness, and showed that economic growth and well-being is not the same thing (Easterlin 2003; Hatfield-Dodds 2005). As a result there is increasing demand for indicators that take into account a broader range of factors than just aggregated national income (The European Commission et al. 2007; Stiglitz et al. 2009). The scope, ability and freedom for individuals to live a life they value is recognised as just as important as the bundle of goods and services they consume (Sen 1999).

Another issue of concern with use of GDP as a measure of well-being for a nation is that as we move to a ‘full’ world (i.e. a world where the human niche becomes large relative to the natural environment), the sustainability limits imposed by the laws of thermodynamics on economic growth become more pervasive. In a full world, there is an increased risk that GDP growth will no longer contribute positively to our well-being. The concept of uneconomic growth has to be incorporated into our economic thinking if it is to express what is really happening to our well-being and our ability to sustain it in the long run (Daly 2005). Developing and implementing the best possible indicator makes sense for several reasons, not least economic, as, if the true contribution of the environment and social systems to the current economy are misrepresented, there is a risk that economic development will not deliver the best outcomes in the long-term course.

CALCULATING A GPI FOR NEW ZEALAND

The construction of a GPI for New Zealand (Figure 1) is seen as the start of a process to establish and maintain procedures for ongoing data collection. This will eventually lead to a comprehensive GPI for New Zealand that can be used with a degree of confidence. The GPI starts with the personal consumption element of GDP, rather than GDP itself, on the assumption that

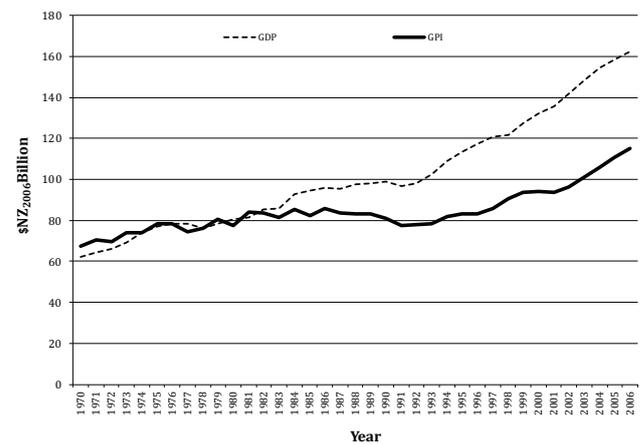


FIGURE 1 New Zealand Genuine Progress Indicator versus Gross Domestic Product.

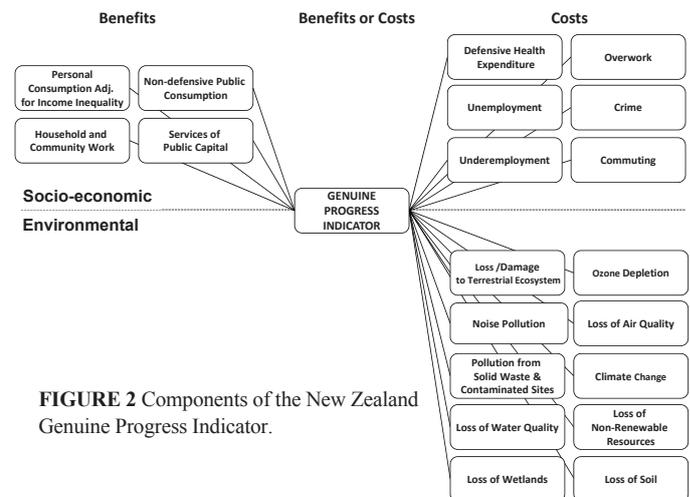


FIGURE 2 Components of the New Zealand Genuine Progress Indicator.

while consumption contributes to well-being, not all components of GDP do. Adjustments (additions and subtractions) are made to personal consumption to incorporate social costs and allow for the depletion of natural capital when this conversion represents a transfer from a capital asset to current income. Calculations for the GPI take a long-term ‘balance sheet’ approach concerned with maintaining and managing the asset base that produces revenue. In contrast, GDP is a measure that provides an ‘income statement’ for a given period and does not account for human and natural capital consumed in the production process.

The items, both benefits and costs, that have been summed to obtain the final annual figures for the New Zealand GPI are shown in Figure 2. The GPI aggregates data into a single monetary-based index expressed in constant $\$NZ_{2006}$. In our study 10 socio-economic and 10 environmental components of ‘genuine progress’ were assessed. Each of these components is discussed below. For exposition purposes each component of the GPI is followed by a letter and sign in parentheses. The letter corresponds directly to the column labels in Table 1, while the sign indicates whether the component represents an addition (+) or subtraction (–) in deriving the GPI.

Personal consumption adjusted for income inequality [A, +]

Fundamental to concepts such as well-being, economic prosperity and standard of living is the ability of individuals in a society to access those goods and services that improve their quality of life. Personal consumption is therefore used as the starting point for calculating the GPI on the premise that, other aspects of life notwithstanding, a higher level of expenditure indicates a higher level of well-being.

TABLE 1 The New Zealand Genuine Progress Indicator, 1970–2006

Year	Personal Consumption adjusted for Income Inequality [A,+]	Non-Defensive Public Consumption [B,+]	Cost of Unemployment [C,-]	Cost of Under-employment [D,-]	Cost of Overwork [E,-]	Services of Public Capital [F,+]	Value of Household and Community Work [G,+]	Private Defensive Expenditure on Health [H,-]	Cost of Commuting [I,-]
	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)
1970	44,104	8,616	40	108	1,602	5,968	18,440	148	1,360
1971	44,224	9,419	53	120	1,662	6,897	20,305	150	1,356
1972	44,675	9,433	74	127	1,704	6,830	19,744	153	1,389
1973	47,932	9,908	64	131	1,780	7,039	20,456	160	1,444
1974	46,221	10,486	60	144	1,907	8,018	21,695	165	1,492
1975	46,002	12,161	72	144	1,984	9,644	23,642	163	1,732
1976	43,951	12,807	65	132	2,018	10,317	24,609	160	1,649
1977	43,071	11,813	54	129	2,019	10,065	23,318	160	1,600
1978	43,692	12,796	57	130	1,964	10,520	22,954	160	1,549
1979	44,359	14,220	46	128	2,022	11,184	24,593	158	1,477
1980	40,893	14,409	86	122	2,074	11,506	25,474	158	1,439
1981	43,124	15,684	143	132	2,096	11,878	28,221	162	1,514
1982	43,387	16,374	170	135	2,199	11,629	27,731	163	1,556
1983	46,060	15,999	319	133	2,213	11,053	24,706	174	1,719
1984	50,315	16,370	291	129	2,396	11,588	24,055	186	1,761
1985	48,985	16,626	245	129	2,441	11,449	22,699	190	1,735
1986	50,026	17,117	110	144	2,252	11,417	24,876	197	1,889
1987	49,274	17,186	204	161	2,205	10,843	23,774	197	1,893
1988	50,140	17,439	291	203	2,256	10,011	23,757	194	2,008
1989	51,365	17,876	490	246	2,303	9,540	23,532	189	2,066
1990	48,935	18,619	643	334	2,321	9,116	23,937	192	2,101
1991	45,881	18,241	847	501	2,330	8,724	25,455	206	2,149
1992	46,993	18,450	842	588	2,473	8,531	25,585	226	2,182
1993	47,982	18,627	675	528	2,663	8,318	25,384	217	2,049
1994	51,299	18,795	505	529	3,011	8,447	25,765	218	2,198
1995	52,203	19,666	359	454	3,051	8,489	25,954	213	2,549
1996	53,274	19,532	363	476	3,342	8,404	26,231	234	2,751
1997	53,830	20,888	519	528	3,345	8,568	26,968	241	2,850
1998	57,840	20,811	622	619	3,410	8,820	27,995	249	2,991
1999	59,539	22,222	511	647	3,715	9,220	28,478	260	3,462
2000	59,558	21,692	369	550	3,730	9,449	29,230	264	3,653
2001	59,752	22,557	416	517	3,705	9,755	28,347	269	3,761
2002	61,933	22,886	493	508	3,783	10,235	28,570	279	4,100
2003	64,624	23,603	331	437	3,880	10,766	29,971	291	4,504
2004	67,740	24,874	349	475	3,916	11,183	30,024	305	4,798
2005	70,398	25,923	324	353	3,895	11,955	30,516	316	4,835
2006	71,836	27,128	325	412	3,798	12,682	31,736	322	4,821

Year	Cost of Crime [J,-]	Loss and damage to terrestrial ecosystems [K,-]	Loss of Wetlands [L,-]	Loss of Soils [M,-]	Loss of Air Quality [N,-]	Land degradation [O,-]	Climate change [P,-]	Loss of Water Quality [Q,-]	Ozone Depletion [R,-]
	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)
1970	1,416	502	183	122	348	336	2239	1088	0.001
1971	1,524	511	326	245	366	339	2332	1064	0.001
1972	1,613	519	468	369	383	343	2550	1104	0.001
1973	1,646	526	608	496	401	348	2714	1055	0.001
1974	1,779	534	746	623	419	296	2969	1060	0.000
1975	1,935	541	883	750	488	301	3078	1058	0.002
1976	2,011	549	1017	877	418	304	3082	1046	0.003

1977	2,103	556	1149	1004	432	305	2931	1045	0.002
1978	2,231	561	1278	1132	427	305	2858	1039	0.002
1979	2,343	566	1405	1260	413	301	2581	1039	0.002
1980	2,605	570	1529	1389	415	302	2668	1079	0.002
1981	2,670	575	1651	1518	404	303	2570	1085	0.002
1982	2,814	579	1769	1647	393	305	2516	1091	0.003
1983	3,053	584	1884	1776	390	319	2298	1114	0.002
1984	3,156	589	1995	1903	398	333	2183	1109	0.004
1985	3,368	594	2103	2030	371	348	2157	1078	0.003
1986	3,420	599	2208	2157	404	362	2215	1113	0.003
1987	3,349	604	2308	2283	412	376	2102	1032	0.003
1988	3,434	609	2404	2409	415	390	2073	1036	0.003
1989	3,496	612	2495	2534	438	402	2097	1072	0.003
1990	3,722	615	2582	2658	471	413	2140	1079	0.003
1991	4,055	618	2664	2784	465	422	2231	1085	0.003
1992	4,220	610	2741	2908	506	424	2403	1110	0.003
1993	4,201	637	2813	3035	499	426	2441	1217	0.003
1994	4,065	637	2879	3160	537	428	2483	1285	0.003
1995	4,224	645	2939	3284	571	432	2463	1368	0.003
1996	4,338	636	2993	3406	573	426	2532	1381	0.003
1997	4,301	660	3041	3530	585	420	2559	1358	0.003
1998	4,193	704	3082	3655	515	414	2400	1396	0.004
1999	3,979	722	3116	3782	555	408	2447	1437	0.004
2000	3,880	726	3142	3904	441	403	2500	1521	0.004
2001	3,908	747	3161	4021	540	400	2619	1680	0.004
2002	4,012	773	3173	4133	406	397	2614	1855	0.004
2003	3,966	828	3176	4241	434	407	2645	1932	0.004
2004	3,734	814	3176	4349	430	418	2582	1967	0.004
2005	3,735	835	3176	4457	400	416	2632	1989	0.004
2006	3,874	809	3176	4565	364	414	2749	1897	0.004

Year	Loss of Non-renewable Resources [S,-]	Noise pollution [T,-]	GPI	GDP	Population	GPI per Capita	GDP per Capita	Proportion of GDP
	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ mil)	(\$ ₂₀₀₆ bil)	(\$ ₂₀₀₆ bil)		(2006 \$)	(2006 \$)	
1970	0	99	68	62	2,875,992	23,483	21,603	109%
1971	0	109	71	64	2,921,484	24,196	22,056	110%
1972	0	119	70	66	2,973,912	23,459	22,219	106%
1973	0	130	74	69	3,036,642	24,314	22,721	107%
1974	0	140	74	74	3,102,636	23,879	23,833	100%
1975	0	151	78	77	3,162,102	24,720	24,331	102%
1976	12	161	78	78	3,194,436	24,475	24,489	100%
1977	31	171	75	78	3,205,452	23,266	24,423	95%
1978	20	182	76	76	3,206,370	23,725	23,746	100%
1979	6	203	80	78	3,200,556	25,123	24,496	103%
1980	6	202	78	80	3,206,880	24,209	25,072	97%
1981	19	208	84	81	3,219,834	26,045	25,240	103%
1982	81	223	83	85	3,244,416	25,730	26,279	98%
1983	77	230	82	86	3,286,134	24,812	26,112	95%
1984	130	247	86	93	3,317,856	25,776	27,998	92%
1985	211	250	83	95	3,336,930	24,726	28,363	87%
1986	206	260	86	96	3,342,540	25,699	28,636	90%
1987	159	275	84	95	3,369,672	24,785	28,259	88%
1988	171	286	83	98	3,383,340	24,582	28,871	85%
1989	181	300	83	98	3,396,804	24,550	28,904	85%

1990	199	312	81	99	3,429,750	23,566	28,800	82%
1991	249	310	77	97	3,495,800	22,137	27,724	80%
1992	265	313	78	98	3,533,000	22,006	27,697	79%
1993	282	329	78	102	3,573,600	21,910	28,659	76%
1994	241	343	82	109	3,621,600	22,583	30,045	75%
1995	222	358	83	114	3,675,800	22,630	30,887	73%
1996	280	372	83	117	3,733,900	22,319	31,394	71%
1997	350	383	86	121	3,782,600	22,626	31,943	71%
1998	273	396	91	122	3,815,800	23,729	31,906	74%
1999	286	412	94	127	3,837,300	24,423	33,209	74%
2000	338	419	94	132	3,860,100	24,375	34,288	71%
2001	406	427	94	136	3,887,000	24,140	34,885	69%
2002	340	440	96	142	3,951,200	24,377	35,930	68%
2003	290	449	101	148	4,027,700	25,114	36,789	68%
2004	252	464	106	154	4,088,700	25,874	37,740	69%
2005	298	471	111	159	4,136,000	26,755	38,352	70%
2006	359	469	115	162	4,186,900	26,839	38,743	71%

Estimates of personal consumption were derived from annualised time series of private final consumption, and expenditure of private non-profit organisations serving households (e.g. private schools, religious bodies and cultural and recreational groups), as obtained from Statistics NZ³). This included all household and non-profit-organisation outlays on consumer goods and services.

Whereas the well-being of a society can in part be expressed by personal consumption, this does not take into account the diminishing marginal utility of that consumption, i.e. the benefit received from an extra dollar of consumption is likely to be more for a poor family than for an affluent family. It is, therefore, necessary to consider how income, and thus spending power, is distributed throughout society. If, for example, the income and spending power of the nation is in the hands of only a small percentage of the total population, then the well-being of the majority is likely to be lower than if the distribution had been more broadly based and equitable. This reflects that as income distributions widen, there is a tendency for the poor to become poorer as they are less able to maintain their living standards in the face of rising costs (Kerr et al. 2004). There is an additional 'dis-utility' as society's poor not only become financially worse off, but also feel disadvantaged in terms of their social standing (Brekke and Howarth 2002; Kerr et al. 2004). In this study we assume that the more equally incomes are distributed, the better⁴.

Various methods exist for adjusting personal consumption to account for income inequality. In alignment with previous studies (Easton 1996; Statistics NZ 1999b) we apply the Gini coefficient⁵. This measures the difference between a straight line representing income equality and a Lorenz curve that describes the distribution of income among, typically, deciles or quintiles of the population⁶. A Gini coefficient ranges between 0 and 1, where a coefficient of 0 means all income is equally spread, and a coefficient of 1 means all income is held by a single decile or quintile. Incorporating income inequality into the GPI is achieved by adjusting personal consumption by the percentage change in the Gini coefficient from a 1969 base year⁷.

Non-defensive public consumption [B, +]

As with the treatment of personal consumption, public consumption (i.e. government expenditure) is treated as a positive

contribution to the GPI. We, however, include only the non-defensive portion of public consumption. Several commentators have critiqued the use of defensive expenditures (Maler 1991; Hamilton 1994, 1996; Neumayer 2000) and noted that it is often difficult to draw a clear line as to what does, and does not, constitute such expenditure. Neumayer (2000, pp. 7–8) states, 'if health expenditures are defensives against illness, why should food and drinking expenditure not count as defensive expenditures against hunger and thirst?' Thus, to some extent, determining the value of non-defensive public consumption requires subjective judgements on behalf of the evaluators.

TABLE 2 Percentage of non-defensive public expenditure

Expenditure category	Description	Non-defensive percentage
Services to land transport	Expenditure by local authorities on maintenance of roads: preserve existing levels of service	100%
Public administration	Comprises the administration, order and defence functions of central government, and the administrative functions of local government including civil defence, firefighting, traffic control and health inspection	95%
Sanitary and similar services	Comprises refuse collection, sewage disposal, drainage and pest control by local authorities or their designated subcontractors. Maintains sanitary conditions in the face of waste produced by socio-economic activities	0%
Education services	All establishments engaged in teaching or providing education. Considered to be entirely non-defensive	100%
Health services	Encapsulates all activities concerned with providing medical, dental and nursing services, and a variety of paramedical and ancillary services	90%
Social and community services	Comprises payments made to scientific research institutions and businesses, professional and labour associations, and other establishments engaged in providing social and community services	90%
Recreation and cultural services	Expenditure on recreation and cultural services	100%

Estimates of expenditure on public consumption were, as per personal consumption, extracted from Statistics NZ's National Accounts⁸. In order to differentiate between the defensive and non-defensive portions of public consumption, expenditure was grouped into seven categories according to purpose: services to land transport, public administration, sanitary and similar services, education services, health services, social and community services, and recreation and cultural services.

A judgment was required as to the defensive portion of each category's expenditure on the basis of its underlying spending purpose and the extent to which it represented an addition to the national well-being. It was further assumed that the selected non-defensive percentages remained constant over the study period (Table 2).

Public consumption by category of expenditure was determined by multiplying the total public consumption by the expenditure category percentages. Multiplying these results by the non-defensive-portion percentages in Table 2, and, in turn, summing the results provided an estimate of non-defensive public consumption.

Cost of unemployment [C, -]

A society where there are people who want to work, but are unable to do so, is one that is not fulfilling its potential. The far-reaching impacts of unemployment on society mean that its measurement, in GPI terms, straddles several factors, including loss of economic output, deterioration of human capital (reducing productivity), loss of public sector income (lower tax revenue and public consumption), and increased health, crime and psychological costs (Möller 1990; Davidmann 1996; Hamilton and Denniss 2000). With the exception of psychological costs these components are valued elsewhere in the GPI.

Unemployment can induce, or exacerbate, a range of psychological problems (e.g. mental illness, stress) and family problems (e.g. breakdown, homelessness), in turn leading to a reduction in the well-being of society as a whole, not just those directly affected (Junankar and Kapuscinski 1992; Davidmann 1996). It is these costs that are measured in this component of the GPI.

It is difficult to value the psychological effects of unemployment as the causality between unemployment and, say, stress and trauma are not well understood and the data upon which to base such an analysis are not readily available. Consequently, an indirect valuation method has been adopted in this study, based on valuing the involuntary leisure time that unemployment brings.

The formula for estimating the psychological costs of unemployment per annum is:

$$TC = UH \times C \times 52.14,$$

where TC is the total cost of unemployment, UH represents total unemployed hours per week and C is the cost (\$) per hour. The 52.14 constant approximates the number of weeks per year and is used to convert hours per week to annual estimates. The total unemployed hours per week, UH , is calculated as:

$$UH = UHF + UHP,$$

where UHF is the unemployed hours per week for people seeking full-time work, and UHP is the unemployed hours per week for people seeking part-time work. The UHF term, in turn, is calculated as:

$$UHF = U \times UF \times 37.5,$$

where U is total unemployment⁹, UF is the proportion of unemployed people seeking full-time work, and the 37.5 constant represents involuntary leisure hours per week per unemployed person seeking full-time work. The term UHP is derived in a similar manner to UHF , except UF is replaced with UP representing the proportion of unemployed people seeking part-time work and a multiplier of 20 rather than 37.5 is applied. Total unemployment, U , is defined as:

$$U = CU + HU,$$

where CU is costly unemployment and HU represents hidden unemployment¹⁰. In turn, CU is calculated as:

$$CU = (OUR - FUR) \times LF,$$

where OUR and FUR respectively represent the official unemployment¹¹ and frictional unemployment rates¹², and LF is the total labour force. Finally, C , the cost per hour, is determined as:

$$C = M - B/37.5$$

where M is the minimum wage rate per hour¹³ and B is unemployment benefits per week¹⁴. All figures were deflated to constant 2006 dollars.

Cost of underemployment [D, -]

Underemployment refers to workers who, though employed, would like to increase their working hours. As with the calculation of unemployment costs, we have used the value of involuntary leisure hours resulting from underemployment as a proxy for estimating the value of the psychological costs arising out of underemployment. The total cost of underemployment, TC , is calculated as:

$$TC = U \times H \times C \times 52.14,$$

where U is total part-time employees looking for full-time work, H is hours sought per week per part-time employee, and C is the cost (\$) per hour.

Underemployment statistics for the period 1986–2006 covered part-time employees who preferred to work more hours¹⁵ and part-time employees looking for full-time work¹⁶. In calculating the cost of underemployment, only the statistics for part-time employees looking for full-time work were assessed as no reliable data exist for estimating the number of hours desired by part-time workers who wish to work additional hours, but not full-time¹⁷.

To estimate the number of part-time employees looking for full-time work during the period 1970–1985, the 1986 proportion of this group relative to total part-time employment between 1986 and 2006 was applied to the total part-time employment for each year between 1970 and 1985. For the years 1987–2005 the number of hours worked per week by part-time workers was extracted from Statistics NZ's HLFSS and converted to a percentage profile (Table 3). Using this profile and the associated hours required to reach full-time status (i.e. 37.5 hours minus the hours currently worked), a weighted average of hours required across all part-time workers was calculated. Between 1986 and 2006 part-time workers looking for work full-time, on average, sought an additional 21.25 hours per week. This figure was used to calculate the total working hours sought by part-time workers looking for full-time work for the period 1970–1985.

TABLE 3 Percentage of the people working part-time hours in New Zealand 1987–2005

	Part-time hours worked 1–9 hours [5] ¹	Part-time hours worked 10–19 hours [15] ¹	Part-time hours worked 20–29 hours [25] ¹
Average % profile 1987–20052	27	36	37
Additional hours required to reach full-time work	32.5	22.5	12.5

¹ Figures in brackets are the mean hours worked.

² The average percentage profile for each year was used in the calculation of underemployment.

To value the total additional hours of work sought for each year, the number of underemployed was multiplied by the average hours sought (21.25 hours) and the average hourly wage rate for each year. The results for each year were then converted to constant 2006 dollars.

Cost of overwork [E, -]

Overwork may have detrimental effects on individuals and on the economy at large, including symptoms such as poor physical and mental health and increased stress on family life (Career Services 2006). Although many of the costs arising from overwork are captured in other components, the loss of leisure associated with overwork is not included elsewhere. This is the focus of this component, which we calculate as:

$$CO = OH \times C \times 52.14,$$

where *CO* is the cost of overwork, *OH* is the number of over-time hours worked per week, and *C* is the cost (\$) per hour. These calculations were performed in two steps:

Step 1: The cost of overwork 1986–2006. Several possibilities exist for determining the point at which overwork occurs. The number of working hours is generally negotiated on an employee-by-employee basis; however, an employer may not unilaterally impose more than 40 hours of work per week exclusive of overtime¹⁸. The Ministry of Social Development (2006), Department of Labour (2008) and Paul Callister, social policy expert, advocate that overwork occurs beyond the 50-hour mark. We assume this also to be the case in our study.

For those who worked 50 hours and over, the average number of hours worked per person is estimated by dividing total hours worked¹⁹ by number of people²⁰. On average, this equated to 60 hours per week for the period 1986–2006. In any given year, the overwork hours per week per person are then multiplied by the number of persons working 50 hours and over to derive the total overwork hours. Multiplying this, in turn, by the average hourly wage rate for all occupations²¹ for the given year derives the total cost of overwork. This was performed for all years 1986–2006. Finally, the values of overwork were deflated to constant 2006 dollars.

Step 2: The cost of overwork 1970–1985. Data constraints prohibited the approach above being used for the period 1970–1985. Unfortunately, trends in working hours established for the years in which data are available also do not constitute a satisfactory basis for estimating missing data. This is because working conditions have changed significantly over the last 35 years with improved technologies (e.g. the wide use of computers) and changes in the labour force structure (e.g. changing female

participation rates). It is worth noting, however, that wages and salaries (which include overwork contributions), by definition, are a key contributing component of GDP. In order to estimate the cost of overwork for the period 1970–1985 the trend in GDP for the period 1970–1985 is applied. This requires the calculation of the ratio of real cost of overwork to real GDP of the years 1986–2006; 2.6% of GDP on average. This ratio is then multiplied by each year's real GDP to backcast the cost of overwork prior to 1986.

Services of public capital [F, +]

This component values the economic benefits from services gained from the use of public capital stocks. There are two types of stocks providing goods and services: (1) stocks owned by trading enterprises (e.g. electricity and gas supply infrastructure) whose services are charged to consumers directly; and (2) stocks owned by the government, which generate both market and non-market goods and services. Only non-market goods and services, such as amenity and recreational services provided by national parks, are unaccounted for and as such are valued in this component. Furthermore, it is also only the non-defensive services of public capital stocks that are of interest.

The value of non-defensive non-market services rendered by government-owned stocks is calculated as the depreciation of capital stocks and the opportunity cost of the government investing its funds elsewhere. The formula used to estimate the value of these services, *S*, is as follows:

$$S = CS \times NM \times (DR + RI),$$

where *CS* is capital stocks owned by general government²², *NM* is the proportion of these stocks used to produce non-market goods and services (set to 80%, based on Officer, Statistics NZ, pers. comm.), *DR* is the depreciation rate associated with these stocks²³, and *RI* is the real interest rate²⁴. Comprehensive datasets were available to apply this formula to produce results for all years of the study.

Value of household and community work [G, +]

Some of the most essential work undertaken in a society to facilitate national well-being is performed without monetary compensation. Unpaid household work (caring for children, home decoration, preparation of meals, and so on) makes a large contribution to human welfare, providing a source of utility to members of each household. Additionally, there is a significant amount of work undertaken for under-serviced communities, schools, churches, and neighbourhoods. This volunteer community work may be formal, such as volunteering for private non-profit institutions like New Zealand Red Cross, or informal, such as childcare for other households. Anielski and Rowe (1999, p. 8) refer to this work as the 'nation's informal safety net' or the 'invisible social matrix' upon which a healthy market economy depends. Despite the importance of unpaid household and community work to national well-being, these activities, because they do not involve monetary transfers, are thus not accounted for in GDP. The value of household and community work was calculated as follows:

Step 1: Determine resident population by age and sex. For the years 1991–2006 resident population by age–sex cohort was obtained from the INFOS database²⁵. These data were then grouped into the following cohorts by sex: 0–24 years, 25–34 years, 35–44 years, 45–54 years, 55–64 years, and 65 years and over. Prior to 1991, population data with the same resident

TABLE 4 Time use in minutes by sex–age cohorts, 1999

	Male						Female					
	12–24	25–34	35–44	45–54	55–64	65+	12–24	25–34	35–44	45–54	55–64	65+
Household work												
Food preparation	11	23	27	31	42	59	26	58	69	70	85	92
Indoor cleaning	8	13	16	18	24	27	28	60	71	72	87	78
Grounds (gardening)	6	15	19	21	28	44	8	18	21	22	26	28
Home maintenance	8	16	20	22	30	28	3	4	5	5	6	5
Household administration	2	3	3	3	5	6	3	5	6	6	7	6
Production of goods	0	0	0	0	1	1	1	2	3	3	3	3
Gathering food	1	1	2	2	3	3	0	0	1	1	1	1
Travel	1	2	3	3	4	5	1	2	2	2	2	2
Other	1	3	3	3	5	6	2	4	5	5	6	6
Total	38	76	93	103	142	179	72	153	183	186	223	221
Caregiving for household members												
Physical care	2	10	13	4	3	2	14	52	43	10	5	2
Being available	0	2	2	1	1	0	1	5	4	1	0	0
Playing	1	6	9	3	2	1	4	15	12	3	1	1
Teaching	0	0	0	0	0	0	0	1	1	0	0	0
Educational help	0	1	2	1	0	0	1	4	4	1	0	0
Travel	1	6	7	2	2	1	5	18	14	3	2	1
Other	0	1	2	1	0	0	1	5	4	1	0	0
Total	4	26	35	12	8	4	26	100	82	19	8	4
Purchasing goods and services												
Purchasing	13	16	18	17	19	24	24	29	30	31	29	28
Travel	8	10	12	11	12	15	13	15	16	16	15	15
Total	21	26	30	28	31	39	37	44	46	47	44	43
Unpaid work outside the home												
Formal	6	10	12	13	19	19	6	13	15	19	28	17
Informal	8	13	16	17	24	24	9	18	21	26	39	23
Total	14	23	28	30	43	43	15	31	36	45	67	40

definition were not available; we instead relied on: (1) census-night population counts by age–sex cohorts for the years 1971 and 1976²⁶, and (2) de facto resident population estimates by age–sex cohort for 1981 and 1986²⁷. The ratio of de facto resident population to total population for each age–sex category in 1981 was then used to convert the 1971 and 1976 total population data to proxy de facto estimates. Next, the de facto resident population estimates for 1971, 1976, 1981 and 1986 were converted to resident population estimates so as to be consistent with the 1991–2006 data²⁸. These resident population estimates were also adjusted to a December year-end. Finally, resident population estimates for the remaining years were derived using Statistics NZ’s total resident population estimates for each year by an appropriate census-year profile (those for 1970 and 1972–1975 were, for example, based on the 1971 profile, while 1977–1980 was based on a 1976 profile, 1982–1985 on a 1981 profile, and 1987–1990 on a 1986 profile).

Step 2: Determine time spent on household and community work in 1999 base year. Between 1 July 1998 and 30 June 1999, Statistics NZ (2001b) conducted New Zealand’s first major time use survey. The survey involved a sample of more than 8500 residents aged 12 years and over and required each participant to fill out a 48-hour time diary. The work was commissioned by the Ministry of Woman’s Affairs, primarily to identify the annual volume of unpaid work undertaken by New Zealanders (Statistics NZ 2001a). The survey provided the basis for estimating time

spent on household and community work in this study (Table 4). Resident population by age–sex cohort for 1999 was used to scale-up the average time-use figures from the survey to produce national totals for household and community work by age–sex cohort in hours.

Step 3: Valuing household and community work for 1999. Several approaches exist for assigning monetary value to household and community work, including opportunity- and replacement-cost methods. In this study, the housekeeper replacement cost method was used. This required multiplication of the annual amount of time spent on household and community work as derived in Step 2, excluding any leisure component, by a housekeeper wage rate representing the value of an hour of work in each year²⁹.

To exclude leisure the following assumptions were made: indoor cleaning and home administration (10% leisure), gardening activities and playing with other household members (entirely leisure), other household work (approximately 50% leisure³⁰), and informal community work (50% leisure). These assumptions are consistent with the Australian GPI (Hamilton and Dennis 2000).

A single general housekeeper wage rate of \$9.60 per hour was used to value household and community activities. This figure was extracted from the 1999 median wage of occupation 512 ‘Housekeeping and Restaurant Services Workers’ in the New Zealand Income Survey (Statistics NZ 2006).

Step 4: *Valuing household and community work for all other years.* For the remaining years, in the absence of any time-use estimates, we applied the 1999 time-use estimates, but made adjustments for known changes in the age–sex cohorts of the New Zealand population. The average time spent on activities by individuals in each age–sex cohort is assumed to remain the same as for the 1999 year. We also adjusted the housekeeper wage rate by trends in the median wage rate for the Housekeeper and Restaurant Service Workers for the years 1997–2005 as obtained from Statistics NZ’s Annual Income Survey. For all other years, average wage rate changes were indexed to Statistics NZ’s Labour Cost Index. Finally, all values were converted to constant 2006 dollars.

Private defensive expenditure on health [H, –]

Under the public consumption component defensive expenditure that does not contribute to an improvement in well-being has already been excluded. However, under personal consumption defensive expenditure on health is included and for consistency purposes must be removed.

Statistics NZ’s National Accounts were used to derive resident households’ private expenditure³¹ and private non-profit organisations expenditure (PNPOs)³² on health for the years 1988–1996. To determine the remaining years (1970–1987 and 1997–2006) the average ratio of the combined households’ private and PNPO expenditure on health to total personal and PNPO consumption was multiplied by total personal and PNPO consumption. It was also assumed that 10% of private expenditure on health was defensive. Finally, all values were converted to constant 2006 dollars.

Cost of commuting [I, –]

As countries become increasingly urbanised and cities larger it is inevitable that people will spend more time and money getting to, and from, work; a result of greater distances travelled and increased traffic congestion. In the calculation of GDP, the direct costs made by commuters in the pursuit of getting to work (e.g. vehicle purchases, petrol, maintenance, bus and train fares) are counted as a positive contribution. This expenditure, along with the time spent commuting, are, however, a drain on well-being, reducing personal consumption and the time available for productive work and leisure³³. For these reasons both are treated as negative contributions in the GPI.

The direct cost of commuting for each year, CC , is calculated as follows:

$$CC = 0.23 \times (PR - 0.10 \times PR) + 0.10 \times PU,$$

where PR represents expenditure on private transportation, the first 0.10 constant adjusts private transportation expenditure for capital (i.e. vehicle purchase) costs, PU represents expenditure on public transportation, and 0.23 and the second 0.10 constants respectively represent the share of expenditure on private and public transportation for commuting to work. These shares are derived from the average distance travelled by a person for work purposes relative to total distance travelled³⁴. Expenditures on private, PR , and public, PU , transportation were determined by multiplying total household expenditure, as obtained from Statistics NZ’s Household Economic Survey (Statistics NZ 2004a), by the percentage of household expenditure spent on private and public transportation as calculated by Dravitzki and Lester (2006).

The time costs of commuting, TC , were calculated as follows:

$$TC = E \times CH \times C,$$

where E is total employment³⁵, CH are the hours spent on commuting annually per employee³⁶, and C is the cost per commuting hour estimated at \$7 per hour in 1998³⁷. The total cost of commuting is the total of each year’s direct, CC , and time costs, TC . Finally, all values were converted to constant 2006 dollars.

Cost of crime [J, –]

Despite the suffering caused by crime and the negative impacts it creates on quality of life it is generally counted as a positive contribution to GDP due to the expenditures on policing, security, replacing property and the like. By contrast, in the calculation of the GPI, these expenses are regarded as monies that could have been invested in more productive and welfare-enhancing activities.

The public sector costs of crime (policing, justice systems, prisons and so on) along with the costs of violent and sexual crimes³⁸ are already captured elsewhere in the GPI, thus only the following private property costs³⁹ associated with crime are considered in this component. Specifically, these cover property loss (i.e. as resulting from robbery, burglary and theft), property damage, and preventative expenditures (i.e. insurance premiums, alarms and security monitoring). The cost of crime is measured by multiplying the total number of property offences occurring each year by the estimated cost per offence.

As the methods used to record crimes have changed over time, it is very difficult to compile consistent time series of recorded property crimes for the study period⁴⁰. To account for changes in police reporting, the annual number of property offences committed was assumed to be approximately 70% of the total recorded offences (after Roper and Thompson 2006), for each year.

The New Zealand Police provided counts of the total recorded offences in two data series: (1) for the period 1970–2000 based on December year-end, and (2) after 2000 based on a June year-end. The latter series was rebased to a December year-end. These figures were then scaled using a multiplier of 4.3 to account for unrecorded property crime (after Roper and Thompson 2006).

The average cost per property offence for the year 2004 was derived by dividing the estimated total cost of those offences on the private sector for that year, by the estimated number of property offences as reported by Roper and Thompson (2006)⁴¹. Finally, the estimated 2004 value of \$2,896 was inflated to \$3,021 in constant 2006 dollars. This average cost per offence is assumed to be the same, in real terms, for all remaining years in the study.

Loss and damage to terrestrial ecosystems [K, –]

Terrestrial ecosystem loss in New Zealand is from two main sources: (1) of old-growth forest and (2) pests and weeds.

When forests are cut, the value of the products produced from the tree and the services and labour used in the process contribute to GDP. These dollar amounts reflect the exchange value of timber in the marketplace and are determined by supply and demand for timber products. This is the ‘use’ value of the timber only and does not take into account the other non-use services that forests provide. Such services include open access to non-priced recreation, landscape amenity, prevention of soil erosion, sediment control, maintenance of biodiversity, providing a habitat for wildlife, carbon sequestration, pollution absorption, protecting watersheds, and tourism promotion.

Approximately 23% of New Zealand is still covered by indigenous forest (MfE 1997). The greatest threat to native forests in New Zealand now is not milling for timber or land clearance but the destruction of palatable trees, understorey shrubs and regeneration (seedlings) by introduced pests such as possums, goats and deer (MfE 1997, p. 8.5). Demand for recreational access is also putting pressure on forest ecosystems (Statistics NZ 2000b).

To estimate loss of old-growth forest the total number of hectares of indigenous forest lost or damaged has been calculated using statistics for roundwood removal. Roundwood removal declined significantly from 1970 to 2006. As the loss of old-growth forest is not just in the year of harvest but over the length of time it takes for a replacement tree to mature the loss is treated as cumulative. Roundwood removal statistics were converted to hectares using data for beech forest, as two-thirds of New Zealand's 6.4 million hectares of indigenous forest are dominated by beech species (Ministry of Forestry 1998, p. 39). Sawlog volumes in unmanaged beech forests range from 70 to 200 cubic metres per hectare (Ministry of Forestry 1998, p. 48) so the mid-point of 135 cubic metres per hectare was used for the conversion rate to estimate old-growth forest lost between 1970 and 2006.

Patterson and Cole (1999) calculate the direct, indirect, and passive values of New Zealand forest ecosystems in 1994. For this GPI study, when indigenous forest is milled it is assumed to revert to forest scrub. Forest scrub provides similar levels of direct and indirect ecosystem services as forest ecosystems so the net difference is loss of passive value. Passive value is made up of existence, bequeath, and option value, and estimates the long-term loss of biodiversity and the intrinsic value established old-growth forest has for New Zealanders.

The value of \$NZ871 (1994) or \$NZ1,100 per hectare (2006) was used to estimate the loss from each hectare of indigenous forest milled.

GPIs constructed for other countries do not include the environmental cost of pests and weeds. This category has been included for New Zealand as introduced invasive plant and animal pests have been identified as the single greatest threat to New Zealand's indigenous land-based biodiversity, surpassing even habitat loss (DOC & MfE 1998). The annual cost of pest control in New Zealand will continue to rise, even if no new organisms are introduced, because some pests already established have not yet become invasive (Hackwell and Bertram 1999). In the report 'Pests and Weeds – A Blueprint for Action', Hackwell and Bertram (1999) estimated that defensive and production loss in New Zealand from plant and animal pests cost NZ\$840 million per annum, or approximately 1% of GDP.

To put an estimate on the cost of weeds and pests the following resources were used: Hackwell and Bertram (1999) tables that estimate defensive expenditures by central and regional governments on pest control between 1991 and 1999. From 2000 onwards, expenditure by the Department of Conservation on species and habitat protection (Annual Reports, Vote Conservation and Vote Biosecurity) and MAF on border control and quarantine statistics (Annual Reports, Vote Biosecurity) was used. Regional council spending has been estimated based on the Waikato Regional Pest Management Strategy – Operative 2002–2007 (Environment Waikato 2002). To extrapolate an expenditure trend before 1991, government expenditure on subsidies to agriculture that cover pest control, noxious plant control, eradication of bovine tuberculosis etc. was used (Statistics NZ various).

Loss of wetlands [L, –]

Wetlands provide a variety of ecosystem services, including regulation of water flows and volumes, purification of water, regulation of gas, a habitat for birds and fish, and flood protection. When a wetland is drained and converted to an alternative use, such as agriculture, the increased output from the farm contributes to GDP, but no account is taken of the loss of ecosystem services that occur. Such services are provided in perpetuity if the wetland remains intact. In addition, society needs to counteract the loss of wetlands through investment in expensive waste treatment and water purification plants, and through the development of man-made constructions to control erosion and flooding.

Only wetlands lost since 1970 have been valued for the New Zealand GPI, therefore the valuation is very conservative. We have assumed that in 1970 (the study start point) levels were reasonably sustainable – from the viewpoint that flood protection, habitat, recreation, water retention, etc., services were adequately provided by remaining wetlands.

Only three data sources (1972, 1983 and 2002) were found for wetland cover in New Zealand. The figure for 1972 (350 055 ha) was from a Landcare Research study of wetlands based on vegetation type, undertaken in the early 1970s. The 1983 (311 300 ha) estimate was from the New Zealand Land Resource Inventory, also based on vegetation type. The 2002 figure (249 565 ha) came from an analysis in 2008 that used soil type (AG Ausseil, unpublished data). A smooth curve was fitted to the three figures to estimate the loss between 1970 and 2006. The conversion rate for wetlands declined from an estimated 6800 hectares annually in the early 1970s to levelling off in 2003.

To value wetlands, the New Zealand study by Patterson and Cole (1999) draws on values from Costanza et al. (1997), which are primarily from the United States. The total value of New Zealand wetlands in 1994 is estimated at \$35,053 per hectare per annum, and the total ecosystem value for agricultural land is estimated at \$1,583 per hectare per annum. Therefore, the net loss from converting wetland to agricultural land is estimated at \$33,470 (1994) or \$42,184 (2006) per hectare per annum. To reflect the increase in the marginal value of wetlands as their scarcity increases, the dollar value per hectare (expressed in constant 2006 dollars) increases by 2% per annum from 1970 onwards.

Loss of soils [M, –]

New Zealand's naturally fertile soils provide the foundation for the country's agricultural economy. Agricultural and forestry products earn more than half of New Zealand's export income (Statistics NZ 2002a). Soils are 'natural capital' and an asset to be maintained and protected so they can continue to support a variety of future renewable production alternatives. Loss of soil in the GPI is treated as a loss of capital as soil formation takes place over thousands of years and is not easily renewed when lost.

The New Zealand GPI calculation for loss of soils is limited to: (1) the loss of fertile farmland soil due to expansion of the built environment, and (2) erosion from agricultural land. From 1970 onwards the loss has been measured as cumulative.

Land lost to urban expansion was measured as follows: the 1970 urban area for New Zealand (162 492 ha) came from MacIntyre (1970); satellite image mapping was used for the other data points (of 217 741 ha) for 1996/1997 (LCDB1 2000) and (220 462 ha) for 2001/2002 (LCDB2 2004). A trend line ($R^2 = 0.9884$) was fitted through the three data points to estimate the hectares lost for the remaining years.

A study to quantify the economic value of ecosystem services associated with highly modified arable landscapes in Canterbury, New Zealand, estimated the total economic value in 2005 to be between \$1,792 and \$20,254 per hectare per annum for conventional farmland (Sandhu et al. 2007). The 2005 non-market values of ecosystem services were estimated at between \$70 and \$1,750 per hectare per annum. The ecosystem services values measured comprised biological control of pests, soil formation, mineralisation of plant nutrients; pollination, services provided by shelter belts and hedges; hydrological flows, aesthetics; carbon accumulation; nitrogen fixation; soil fertility; food and raw materials (Sandhu et al. 2007). For the GPI, the value of the loss of the natural capital soil to the built environment has been based on the median economic value (direct and indirect), from Sandhu et al. (2007), of \$11,023 (2005) or \$11,291 (2006) per hectare per annum, and applied to hectares of 'arable' land converted.

Erosion causes permanent long-term loss of productive capacity as well as external effects not captured by market values, such as impacts on landscape quality, siltation of dams and rivers, reduced biodiversity, and reduced water quality. Erosion costs have been calculated based on the number of tonnes of sediment lost from land in agricultural use as estimated by the soil erosion model developed in 2007 by Landcare Research (Dymond et al. 2010). Figures for the hectares of agricultural land in 'grassland, lucerne and tussock' between 1970 and 2002 are from the Ministry of Agriculture and Forestry (2005) and were extended to 2006 with data on change in the planted forest estate (MfE 2008). The model covers sedimentation of waterways and soil transfer to the marine environment. Soil loss from forestry is included, but no account is taken of the extra soil loss in conversion from forestry to pasture. The model does not take into account wind erosion, but this is small by volume, compared to water erosion (J. Dymond, Landcare Research, pers. comm. 2007).

The estimated annual economic cost of erosion and sedimentation in New Zealand in 1998 was calculated to be \$126.7 million (Krausse et al. 2001, p. 38). The impacts cover the permanent loss to future agricultural output, the downstream costs imposed on other sectors, and the cost of defensive expenditure undertaken to prevent further erosion. The estimate covers the 'total impact regardless of erosion cause or type' (Krausse et al. 2001, p. 14). As this erosion cost is the result of tectonic activity and agricultural land use, the \$126.7 million amount has to be reduced accordingly. It is estimated that the total annual input of river-suspended sediment to the New Zealand coast is approximately 209 million tonnes (Hicks and Shankar 2003). Much of this comes from areas that are not farmed. From the modelled data, in 1998 agricultural-land-use-related erosion accounted for 75 million tonnes, which is 36% of the 209 million tonnes total. Therefore costs needing to be split between agriculture and tectonic activity have been apportioned using 36%.

The erosion impacts from agricultural land use in 1998 were estimated as \$86.41 million. When this dollar amount is divided by the estimated 75 million tonnes of soil lost in 1998 this is equivalent to \$1.15 per tonne. These dollar values were converted to 2006 dollars and then multiplied by the modelled tonnes of soil lost to determine the total cost of erosion as a result of agricultural activity each year.

The dollar values used for erosion are conservative, given that the Krausse et al. (2001) value excludes a number of other costs that could be included if there were sufficient data. Soil, especially soil with high organic matter content, provides ecosystem services that include improved water storage and release,

biodiversity protection, as well as the ability to filter and degrade wastes. Erosion as a result of agricultural production also causes a loss of visual amenity due to the scarred landscape, damage to aquatic life, loss of traditional food sources and recreational use, the need for research into erosion prevention, and flood prevention.

Loss of air quality [N, -]

Calculating the change in New Zealand's air quality from 1970 to 2006 is difficult, as the measures used to determine air quality standards have changed over time, and air quality monitoring has not been extensive. Data limitations have required broad assumptions to estimate costs. In the 1970s, attention was paid to total suspended particulates (TSP), which measures large particles in the air. While TSP is visible in the atmosphere, it is generally filtered out by the nasal passage, and inflicts less damage to health than microscopic fine particulate matter (PM₁₀ or PM_{2.5}), which is now monitored. Studies show a correlation between levels of fine particles in the air – even though they are not readily detectable by the senses – and the number of people who die each year (Hales et al. 1999).

The GPI study puts a monetary value on air pollution by costing reduced activity days and annual premature death from air pollution in New Zealand. Neither cost includes loss of work income, as this is allowed for in other items that make up the GPI (e.g. lower personal consumption). Adjustment for defensive expenditure on health, which includes the direct health costs of all sources of air pollution, is also made elsewhere in the GPI calculations. The cost of air pollution is therefore estimated in terms of 'intangible' losses in well-being, such as life years lost and reduced quality of life. Air pollution levels in New Zealand are not regarded as intense enough for measurable impacts on building maintenance, and the effects on animals and ecosystems are not included as they are considered insignificant (G.W. Fisher, pers. comm. 2006).

Air quality monitoring and emission inventory studies have only been carried out in New Zealand for a short time. Due to the lack of national data, air quality statistics from Auckland and Christchurch have been used to estimate New Zealand air quality trends, as records have been kept on these centres for the longest period of time. The study uses PM₁₀ data for Christchurch and Auckland, weighted by population, to construct an index for air quality change between 1996 and 2006. PM₁₀ are particles less than 10 microns in diameter that are invisible to the human eye but are suspended in the air and can carry carcinogenic material into the lungs (Auckland Regional Council 2006, p. 4). Experts agree that particulate matter, especially PM₁₀, is a good surrogate for the health impacts from air pollution (Fisher et al. 2002; Auckland Regional Council 2006). To avoid double counting, it is assumed the impacts of nitrous oxides, sulphur dioxide, and carbon monoxide are subsumed in the effects of PM₁₀, although there is growing evidence that separate and independent effects are associated with nitrous oxide exposure, especially affecting children (Fisher et al. 2007).

Fisher et al. (2007) calculated the annual cost of air pollution, excluding background effects, in New Zealand in 2001 at \$1,139.2 million. This health impact assessment study covered 67 urban areas included because of size, local activities, and/or monitoring data that showed high levels of air pollution. The estimated effects are for 2.73 million people (as of the 2001 census), or 73% of the population of New Zealand (Fisher et al. 2007, S2). Health impact estimates are based on exposures derived from

modelling, and then validated against monitoring and published dose–response relationships. Mortality rates are based on the Künzli et al. (2000) dose–response⁴² study, which extrapolated an increase in mortality of 4.3% for every additional 10 µg in annual average PM₁₀ concentration. Although this study was not New Zealand specific, the results are regarded as applicable (though likely to be conservative) to New Zealand (Fisher et al. 2007).

As the group most generally affected by air pollution tends to be the older age group, Fisher et al. (2007) assumed a loss of 5 years of life would be typical for air pollution. The working value used for the Fisher et al. (2007) study was \$2.725 million per statistical life over a 44-year lifespan. Using a 6% discount rate, the value for loss of 5 years of life of \$750,000 per person was arrived at for death from air pollution. The GPI study has not applied discounting to years of life so the value per loss of life is \$308,000 per person (Fisher et al. 2007, Table 10-4).

In line with Fisher et al. (2007), the GPI calculation for chronic bronchitis is 10% of the value attributed to mortality. For respiratory/cardiac hospital admissions, a cost of \$150 per day for a 7-day period was used, which does not cover health treatment costs, just the inconvenience of hospitalisation. The cost of restricted-activity days has been reduced to remove ‘work loss’, as this cost is already reflected in reduced GDP. These adjustments gave an annual cost of \$487.3m (2001) or \$540m (2006) for loss of air quality.

The cost of air pollution per head of population was calculated for 2001 as this was the year for which data were available. To calculate the loss of well-being from air pollution it has been assumed that the same percentage (i.e. 73%) of the population have been exposed to air pollution each year since 1970. This amount was adjusted by the air quality index for the period 1996–2006 and the ratio of annual change in fossil fuel consumption from 1970 to 1995.

Land degradation [O, –]

There are no comprehensive records on the extent of land contamination in New Zealand or when it occurred. The GPI has, therefore, used as proxies (1) waste to landfill and (2) cost of remedial action to rectify contaminated sites. An estimate of the health costs associated with pollution from contaminated sites was calculated but not included in the GPI as the data on which it was based are too spurious. Land degradation costs exclude greenhouse gas (GHG) emissions from the waste sector, as these are accounted for in the climate change calculations, and water degradation, which is covered in the water quality section.

Economic activity in New Zealand has left a legacy of an estimated 1500 seriously contaminated sites (service stations, sawmills, timber treatment plants, railway yards, engine works, metal industries, and chemical manufacturers), and thousands more with some level of contamination (Worley Consultants 1992). In addition, closed landfills have left numerous contaminated sites as, until the 1980s, most New Zealand landfills were no more than tip/dump sites, often poorly sited, designed and managed (MfE 2001, p. 1).

Contaminated sites impact on the well-being of New Zealanders in various ways: toxic chemicals and leachate (liquid from a landfill) draining from the sites can have undetected health effects; the sites cannot be used for other purposes; property values in the vicinity are reduced; land can be unstable; and, the cost of remediation is often paid for by the taxpayer, which diverts government expenditure from other more beneficial uses.

For 1970–1981, an estimate for total solid waste in 1982 (638

kg per person) was used to derive a statistic for the kilograms of waste per head of population. This was multiplied by the population numbers to get costs for 1970–1981. The difference in waste generation between 1982 and 1990 (where data were available) was averaged to obtain an annual estimate of waste produced between 1983 and 1989. The trend was consistent with Auckland Regional Council statistics on waste to landfills for the same time frame (Envision New Zealand 2003, p. 10).

Estimates for the cost of disposal of waste to landfill use full cost accounting (FCA) rather than the actual amount charged. FCA includes costs to cover management, administration and organisational overheads, pollution control, planning and resource consents, land costs, development costs, operational costs, as well as closure and aftercare costs (MfE 2004). FCA encourages both waste reduction initiatives and the minimisation of environmental effects by ensuring full environmental costs are, as far as practicable, reflected in the charges applied (MfE 2004, p. 3). This GPI study used the cost of disposing of a tonne of waste at the Kate Valley regional landfill in North Canterbury (\$125 per tonne) because the FCA guide was used extensively to check costs when the landfill was proposed (Centre for Advanced Engineering 2005).

A study by Worley Consultants (1992) identified 7800 locations in New Zealand that could be potentially contaminated. The estimated cost (in 1992 dollars) of remediating these sites was given as \$1,644 million. The order of accuracy of the estimate is given as ±50% (Worley Consultants 1992, p. 6.8) so the valuation used in the GPI is indicative only.

The GPI attributes the cost of polluting to the period of economic output, so the temporal pattern of pollution cost at five major contaminated sites (Tui mine at Te Aroha, timber treatment plant at Hanmer Springs, Waiwhetu Stream, Waipa Mill, and Fruitgrowers Chemical Company at Mapua) has been used to spread the \$1,644 million on an annual basis.

It has been assumed the tighter requirements of the Resource Management Act 1991 and recycling have reduced the more recent annual cost of contamination. This has been estimated at \$10 million per annum since 2000 to cover accidental spills and low-level effects from industry.

Climate change [P, –]

Increased fossil fuel use, cement manufacturing, deforestation, and farming have led to a global rise in carbon dioxide in the atmosphere. As a result of the greater concentration of greenhouse gases in the atmosphere, the Earth has begun to warm up and its climate is changing. Climate change will impact on the well-being of New Zealanders in the future: the anticipated effects include increased flooding and storm events, inundation of low-lying land due to sea-level rises, drought in eastern parts of the country, increases in pests and disease due to warmer temperatures, and social disruption as refugees from other parts of the world affected by climate change seek new homes.

While accounting for only 0.2% of the world’s total greenhouse gas emissions, New Zealand ranks 11th in the world on a per capita basis (MfE 2007). The GPI includes costs for New Zealand’s greenhouse gas emissions between 1970 and 2006 as greenhouse gases remain in the atmosphere for a long time and as a country we need to take responsibility for our contribution to climate change. The burden imposed on future generations should rightfully be accounted for when the contribution to personal consumption generating the negative impacts takes place. The exact future impacts of climate change are unknown. For the GPI

period, New Zealand's greenhouse gas emissions to the atmosphere have been estimated for each year and the environmental cost priced. Greenhouse gas emissions and emission factors for 1990–2006 are from the New Zealand Greenhouse Gas Inventory 1990–2006 (MfE 2008). The spreadsheets from New Zealand's Greenhouse Gas Inventory were used where possible with the relevant emissions factors to calculate emissions from 1970 to 1989. Stock numbers came from the Ministry of Agriculture (MAF 2005, p. 61), energy use from the Energy Data File (MED 2007), fertiliser use from O'Hara et al. (2003), and sequestration rates from Scion (Maclaren and Wakelin 1992). For waste, solvents and industrial processes (WSIP) a percentage of total energy emissions was used as a proxy.

The 2006 value of \$NZ50 per tonne of carbon dioxide was used based on the Stern Review estimate of \$US30 per tonne in 2000 for a 450ppm CO₂-e stabilisation goal (Stern 2006, p. 304). There are numerous prices for carbon that could be applied, as tradable instruments have different risks and volume volatility and operate in a range of global markets. An international price per tonne of carbon is used, as climate change is an externality of global proportions and the marginal damage from an extra tonne of greenhouse gas is the same regardless of where it comes from.

The valuation of environmental damage from CO₂ emissions is calculated using the marginal social cost per tonne of CO₂-e emitted into the atmosphere – referred to as the social cost of carbon (SCC). This is a measure of the full global cost today of an incremental unit of carbon dioxide (or equivalent amount of other greenhouse gases) emitted now, summing the full global cost of the damage it imposes over the whole of its time in the atmosphere (Price et al. 2007). The SCC reflects 'the total (discounted) value of all future damage arising from that tonne of emissions' (Neumayer 2000, p. 354). Greenhouse gas emissions costs are therefore not accumulated over time.

Although the SCC is relatively straightforward in principle, in practice it is difficult to ascertain an appropriate value for the SCC because the amount of damage done (both now and in the future) by each incremental unit of carbon in the atmosphere will depend on the outcome of complex system interactions that will vary according to current and future concentrations of greenhouse gases in the atmosphere.

Loss of water quality [Q, –]

While water is probably the most monitored feature of the New Zealand environment (MfE 1997), extrapolating trend data is not easy. Both temperature and flow rate vary annually due to changing weather patterns and these factors affect the assimilation capacity of water (Salinger and Mullan 1999; Larned et al. 2005). Furthermore, there are no established water standards from which to estimate environmental degradation.

The inclusion of changing water quality in the New Zealand GPI is essential, as the availability of clean water is fundamental to every aspect of life and linked closely with important cultural values. The quality of water is of prime importance to anyone intending to drink water, swim, eat fish, provide water for livestock and food processing, or base their business on tourism. Water degradation can be caused by pollutants affecting water quality or damage from siltation. The costs of siltation are covered in the New Zealand GPI as costs relating to erosion. Therefore, this section is specifically looking at the costs of damage to water quality by pollutants.

For the GPI, separate valuations have been conducted for river water (Step 1) and lake water (Step 2) and then summed.

Step 1: River water quality. In the 1970s and '80s both non-point and point sources of pollution contributed to poor river water quality. Present-day water quality decline in lowland rivers is attributed more to non-point pollution. As it is not possible to calculate with any precision the extent that water quality deviated annually from acceptable standards between 1970 and 2006 – and nor is it possible to accurately place a dollar value on this loss, the more holistic approach of estimating the cost of establishing riparian margins has been used. This method is currently implemented by the Clean Streams Dairy Accord to improve river water quality.

To measure changes in water quality from non-point sources it was assumed that the total river length in pastoral farming alongside low-elevation waterways in New Zealand is riparian planted. Low-elevation waterways are approximately 195 200 km long. Adjacent land use is classified by the River Environment Classification (REC) as 73% pastoral, 19% natural, 6% exotic forest, and 2% urban. The total bank length of rivers requiring planting is therefore 284 992 km.

This study has applied a riparian management strategy involving the construction of a single-wire electric fence and the planting of a 15-m-wide strip of native vegetation. Auckland Regional Council regards the optimal buffer width as 15–20 m, which is sufficient to develop a self-sustaining buffer of native vegetation (Auckland Regional Council 2001). Cost estimates for riparian planting were obtained from the Farm Environment Award Trust worksheet for working out the cost of managing waterways on your farm (Farm Environment Award Trust 2004).

The annual loss of productive land is calculated by multiplying 83% of the riparian area by the value-added estimate in 2003 for sheep and beef farming (\$1,100 per hectare), and 17% of the land area by the value-added estimate for dairy farming (\$6,600 per hectare).

To allow for variation between 1970 and 2006, the total cost of riparian planting was apportioned over this period on the basis of annual nitrate leaching and runoff estimates calculated by Parfitt et al. (2006) and nitrogen fertiliser application estimates (O'Hara et al. 2003). The split used was calculated from the OVERSEER model and attributed 80% to stock effects and 20% to fertiliser impacts (R. Parfitt, pers. comm. 2008).

The cost of damage to waterways from point sources has been extrapolated from riparian planting costs. Point sources were 10.2% of agricultural non-point sources for nitrogen loading to surface waters in 1992 (MfE 1997, p. 7.38). This percentage was used to get the total monetary value of loss of water quality between 1970 and 2006 from point-source pollution (assumed for 2006 to be 10.2% of \$41,887m, i.e. \$4,272m). To measure changes in water quality over time, mean BOD₅ (biological oxygen demand, i.e. dissolved oxygen consumed in 5 days by biological processes breaking down organic matter) data for New Zealand rivers from 1988 to 2002 (Scarsbrook and McBride 2003) were used. The trend gives pollution damage from non-point sources declining over time but damage still occurring, for example, from elevated phosphorus levels in wastewater discharges to waterways.

The riparian method does not allow for the disturbance caused by invasive weeds, such as didymo (a freshwater alga discovered in New Zealand in 2004 and thought to have been introduced by overseas anglers fishing in New Zealand). So, while economic activities such as tourism and didymo clean-up efforts positively contribute to GDP, the negative impact on waterways is not taken into account.

Step 2: Lake water quality. Lakes act as sinks for sediment and

nutrients and, as water is resident in lake basins for long periods, it is more vulnerable to the effects of human activities and developments in the lakes' catchments than rivers, which are constantly renewed by flows upstream (Spigel and Viner 1992). Of New Zealand's 700 or so shallow lakes, between 10% and 40% are eutrophic (MfE 1997). In these lakes the nutrient concentration is so high that dissolved oxygen levels are significantly reduced, and many fish and aquatic organisms cannot survive.

The publication 'Inventory of New Zealand lakes' (Livingston et al. 1986) classified lakes in New Zealand according to their trophic state. Although the study was not exhaustive, it captured most major lakes and many smaller lakes. Comparisons of data from the Livingston et al. (1986) study with data collated by Hamill (2006) indicate that lake water quality overall is in decline, especially in lakes in lowland areas. Lakes where water quality improved were mostly the near pristine Canterbury high-country lakes (Hamill 2006, p. 6).

For Lake Taupo clean-up costs in 2003 have been estimated at \$72 million over a 10-year period, funded by rates in the Waikato Region, and a further \$83 million over a 15-year period from central government (Environment Waikato 2003). An estimated \$144.2 million is needed to clean up the four worst affected Rotorua lakes – Rotoiti, Rotorua, Rotoehu, and Okareka (Environment Bay of Plenty 2005). The total surface area of these lakes is 125 km² so the cost per square kilometre is approximately \$1.16 million.

Besides Lake Taupo and the Rotorua Lakes the total area of lakes in New Zealand requiring treatment has been estimated by summing the surface areas of the lakes classified as eutrophic or worse in Livingston et al. (1986). This gives a total surface area for lakes of 439 km². Multiplying this total surface area by the average cost per square kilometre gives 439.075 km² × \$1.16m = \$507.21m. The total estimated cost of improving lake water quality is therefore: \$144.2m + \$155m + \$507.21m = \$806.41m.

The total cost of \$806.41 million for lake water pollution was apportioned over the 1970 and 2006 period as per rivers.

Ozone depletion [R, -]

New Zealand emits small quantities of CFCs and is responsible for very little of the damage to the ozone layer. In 1986, before restrictions were introduced under the 'Montreal Protocol' New Zealand's total emissions of ozone-depleting gases (mostly CFCs) was 2100 tonnes, approximately 0.002% of global emissions (McCulloch et al. 1994). The Ozone Layer Protection Act 1996 introduced measures to reduce the use of ozone-depleting substances. The importation of CFCs is prohibited except for recycled CFCs and use relating to human health and safety. Hydrochlorofluorocarbons (a less damaging substitute for CFCs) are subject to controlled importation and will be phased out by 2015. However, there is still use of methyl bromide, which has ozone-depleting properties. This is controversial both for this effect and for the impact it has on human health.

The total cost of ozone depletion generated by economic activity in New Zealand is measured by the number of deaths from melanoma, proportioned by New Zealand's contribution to global ozone depletion.

To calculate the cost of ozone depletion the average number of deaths for each 5-year age cohort was calculated for 1954–1969, and this was treated as the base number of expected deaths. The number of years of life lost from melanoma death over and above this figure was attributed to ozone depletion. The 2002 average life expectancy figures (Statistics NZ 2004c) were used to calculate

the difference between expected and actual life years. As data on death by 5-year age cohort were only available to 2005, the 2006 figure was estimated as an average of the previous 5 years.

Putting a value on an individual's life is subjective, but regularly done. Land Transport New Zealand uses a value of statistical life of \$2.725 million (June 2004) on the basis of a Ministry of Transport study (1996). If this value is for a citizen of an average age of 35 with a life expectancy of a further 44 years, this gives an annual value of life of \$61,932 per annum in 2004.

While it is known that ozone depletion has an impact on the well-being of New Zealanders (death from melanoma cancer alone is valued here at more than \$200m in 2006), the causes are mostly generated offshore and the GPI only measures the impact of economic activity within a country. For the GPI, the cost of ozone depletion is measured by emissions generated by the New Zealand economy, which has been taken to be 0.002% of annual death from melanoma cancer costs.

Loss of non-renewable resources [S, -]

The theoretical underpinning of the GPI is the need to maintain the asset base from which to generate a sustainable economic income. Natural resource depletion represents the consumption of income-generating capital and results in running down capital to boost current income. If a country depletes natural capital by extracting resources (or depletes renewable resources at a rate exceeding their natural regenerative capacity) and fails to reinvest enough of the proceeds to generate a long-term income stream, it cannot expect to sustain the same level of consumption in the future (Lawn 2007). As the global population grows, and societies become more materialistic, natural capital, rather than man-made capital, is rapidly becoming the scarce resource. Such depletion is encouraged by accounting systems that count the liquidation of natural capital wealth as income (Daly 1996).

The revenue from the sale of any asset should not be counted as income if the sale reduces the ability to generate income in the future. As stated by El Serafy (2002, p. 3): 'False levels of estimated income and inflated consumption cannot obviously be sustained since the very source of revenue diminishes with extraction.' Therefore, an adjustment needs to be made in the GPI to allow for the annual flow of depleted non-renewable assets.

Estimations of the value of non-renewable resources vary significantly, depending on whether a 'weak sustainability' or 'strong sustainability' approach is taken. The 'weak sustainability' approach assumes that investment in other forms of income-generating capital is an adequate substitute for the depletion of natural resources. Therefore, to sustain a given level of well-being and national income, an economy needs only ensure the total net investment rate in all forms of capital (man-made, human, non-renewable natural and renewable natural) is positive.

Advocates of 'strong sustainability' require 'the preservation of the physical stock of those forms of natural capital that are regarded as non-substitutable (so-called critical natural capital)' (Neumayer 2003, p. 25). Much of the debate over the valuation of non-renewable resources concerns what constitutes a permanent loss, that is, what is substitutable and what is non-substitutable. Some argue non-renewable energy resources are not readily substitutable (Anielski and Rowe 1999; Hamilton and Denniss 2000) and as technology runs on energy, with fossil fuels providing the main source of cheap energy, depletion is a significant cost to future generations.

Another viewpoint is that non-renewable resources are not 'resources' until a use is derived by technology, and as such they

should be treated as substitutable (Ray 1984 cited in Neumayer 2003). Resource extraction increases the well-being of a country, and if the income generated is used wisely and includes investment in future replacement income-generating capital sources, this is positive. Non-renewable resources represent a long-term asset; however, if they are never extracted, they represent an unrealised asset, and do not contribute to well-being.

In New Zealand there are large remaining reserves of non-metallic minerals, so for the GPI calculations it is assumed present consumption levels will not significantly impact on future resource requirements. Only four non-renewable resources – gold, silver, oil and gas – are extracted at such a rate that known reserves will be depleted at some point. For these four resources, revenues generated contain a large component of depreciation of the natural resource stock, which needs to be accounted for in the GPI. This has been done using the El Serafy (2002) economic ‘user cost’ method, the most widely recognised method for valuing non-renewable resources. An interest rate of 2% was used, as a low interest rate approximates the anticipated regeneration rate of the renewable resource to be cultivated to replace the depleted non-renewable resource (Lawn 2006). This satisfies the strong sustainability condition, namely constant natural capital. The proportion of revenue from extraction that needs to be put aside to generate a permanent income stream once the resource is depleted was calculated for each year for the four resources, then summed and adjusted for inflation.

This method adjusts for depreciation of the natural capital stock but does not make an allowance for environmental damage from extraction.

Noise pollution [T, –]

Noise pollution refers to unwanted or offensive sounds coming from a variety of sources: industry, activities such as lawn mowing, recreational events, people communicating, animals, etc. It is both a health and an environmental issue. While the extent of sustained loud noise is controlled in New Zealand with district or city planning controls, increased urban living has resulted in an increase in the area and length of time people are exposed to noise on a daily basis. One of the main sources of noise that unreasonably intrudes into our daily activities is traffic noise, especially from heavy vehicles (Hamilton and Denniss 2000).

A survey on the quality of life in New Zealand’s 12 largest cities found 26% stated that noise was an issue. While property values can be affected if noise levels are extreme, for most people noise is an uncompensated cost. In New Zealand noise is present even in small urban settlements, where ribbon development is common, with road and rail networks in close proximity to houses.

As no data are available to calculate absolute noise levels or change in intensity, vehicle kilometres travelled (VKT) in New Zealand has been used as a proxy. Given that most people in New Zealand live in urban areas and that car ownership levels are high, a significant proportion of the population experience noise associated with traffic. In large urban areas, high-density development and urban spread (which increases car dependency) mean people live close to traffic noise (Statistics NZ 1999d). The largest contributor to increased kilometres travelled by vehicles is the car; however, kilometres travelled by light and heavy commercial vehicles have also increased (Statistics NZ 2002b). While engine and road noise from motor vehicles would have decreased with improved technology between 1970 and 2005, the number of cars

on the road has risen significantly. Vehicles may have become quieter but more densely populated urban areas expose more people to noise over longer periods.

To calculate the GPI for New Zealand, this study used VKT and noise cost dollar estimates from the Land Transport Pricing Study (Ministry of Transport 1996, p. 31). That study researched environmental externalities associated with motor vehicle use, estimating the total annual social cost of noise pollution from vehicles in 1995 at between \$230 million and \$2,650 million with the best estimate being \$290 million per annum (Ministry of Transport 1996, p. 38). The total social cost is defined as private costs plus externalities. According to the research, the \$290 million for 1995 was derived from a pilot study of road traffic exposure in an Auckland suburb with a range of road networks. A marginal damage function for noise was estimated and then combined with residential property values to generate estimates of the total social cost ranging from \$1,480 million to \$17,000 million, with a best estimate of \$1,850 million. This cost was then annualised using a discount rate of 6.4%. The distribution of traffic noise costs was calculated over 15 urban centres, with a strong weighting (65%) given to Wellington, Christchurch and Auckland (Ministry of Transport 1996, p. 25–39).

For the New Zealand GPI, the 1995 best estimate figure of \$290 million has been used to calculate a cost of noise pollution from vehicles per kilometre travelled of 1.2 cents/km. Variation in the volume of noise each year has been allowed for by multiplying the cost of noise per kilometre travelled in 2006 dollars by the estimated number of kilometres travelled annually.

RESULTS

Socio-economic measures

The time frame for our analysis (1970–2006) was a period during which the New Zealand socio-economic system underwent huge economic reform and experienced significant structural changes. Any interpretation of socio-economic performance must therefore be understood against this historical backdrop. To this end, throughout this analysis we refer to three distinct periods. First is the *pre-reform* period of 1970–1984. These years were characterised by strong protection of local industries, tight monetary controls (i.e. wage/price freeze), government investment in ‘Think Big’ projects and closer economic relations (CER) with Australia. A group of interrelated economic crises also marked this period, comprising two serious energy supply shocks (the oil crises), rising inflation, reductions in commodity trade with the UK and increasing unemployment. Second is the *reform* period (1984–1994), commencing with the election of the fourth Labour Government and followed by a decade of dramatic reform. Very broadly, the reforms were aimed at opening the way for the elaboration of ‘market forces’ and a retreat of the state from the supportive and regulatory role that had been characteristic of preceding years (Briton et al. 1992). These reforms carried on into the mid-1990s, and included such changes as the restructuring and sale of State Owned Enterprises, deregulation of financial markets, curbing of government expenditure and the introduction of more open international trade conditions. Third is the *post-reform* period of 1995–2006. In this period New Zealand’s economic performance became highly connected with performance in other nations, with increasing globalisation being the norm. Major events included the Asian crises of 1998 and the 2001 US terrorist attacks.

The weighted personal consumption category is the starting point for calculating the GPI and is the logical place to begin this

results summary. Income inequality was lowest during the *pre-reform* period, weighted personal consumption was relatively static. A small peak in both total (\$47.9 billion) and per capita (\$15,800) and weighted personal consumption occurred in 1973 that, at least in per capita terms, was not reached again throughout the *pre-reform* period. Total weighted personal consumption remained relatively stable during the first part of the *reform* period also, fluctuating around \$49.0 billion. Coinciding with the highest levels of unemployment, weighted personal consumption then slumped to a low in 1991 of \$45.9 billion, or \$13,100 per capita. During the *reform* period income inequality increased substantially with, for example, the proportion of household income going to the top quintile of households increasing from 40% in 1984 to 44% by 1994 (OECD 2008). This highlights the uneven impacts on society of the economic reforms and structural changes throughout this period. While steady losses of jobs in manufacturing, and to a lesser extent in primary sectors, meant a marked deterioration in the labour market position for many of the lower skilled 'working class', the movement towards a more 'service economy' also led to some better opportunities for persons working in corporate, financial and producer services. During the *post-reform* period, the level of personal consumption grew faster than in previous years, influenced generally by declining levels of unemployment, strong business confidence both at home and abroad, and an increasing import trade in consumer goods – particularly low cost apparel and footwear from China (Ministry of Commerce and Ministry of Foreign Affairs and Trade 2004). Even when adjusted for greater income inequality, per capita consumption is calculated to have increased from around \$14,200 in 1994 to \$17,000 in 2005.

A number of distinct trends are evident in the public sector components of the GPI. For the majority of the *pre-reform* period, public expenditure increased at a significantly higher rate than both population and GDP growth, such that by the early 1980s, public expenditure for non-defensive purposes alone is estimated to have equated to 8.4% of GDP. Non-market services from public capital are estimated to have grown at an annual average rate of 4.9%, from about \$6.0 billion in 1970 to \$11.6 billion in 1984. Attempts to curb growth in public expenditure became evident by the end of the period, with, for example, government departments ordered to prune 3% from their annual budgets in 1982 (Statistics New Zealand (NZ) 1988). Then, during the *reform* period, numerous measures were put in place to further curb government expenditure (e.g. increasing tertiary student fees and prescription charges, restructuring of public housing and health funding). Although non-defensive public expenditure continued to rise, it was at a significantly lower rate of 1.4% per annum. Non-market services from public capital, however, fell drastically during the *reform* period, by around \$3.1 billion or 27% in total over the 10 years. From the mid-1990s onwards, a more buoyant economy entailing greater public revenues enabled the rate of growth in non-defensive public consumption to accelerate, reaching around 3% per annum. Among the most noticeable increases in funding occurred with regards to the education sector (Ministry of Education 2007) and the provision of cultural services (Statistics NZ 2000a).

During our study period the labour market components of the GPI (i.e. cost of unemployment, cost of underemployment and cost of overwork) exhibited some of the most significant changes of all the socio-economic components considered. For the majority of the *pre-reform* period, the number of unemployed and, by corollary, the costs of unemployment remained very

low. Over this period the costs of underemployment and overwork also remained consistently low, both in absolute and per capita terms. However, by the end of the *pre-reform* period, the deepening economic crises had become evident, and the costs of unemployment are estimated to have increased more than three-fold over the years 1980–1984. To some extent this also reflected changes in cultural arrangements and significant increases in the number of women seeking employment (Chapple 1986). The number of unemployed continued to rise sharply during the *reform* period and reached a peak in 1992, when the official number of unemployed was recorded as over 176 000 (Statistics NZ 2004b). There is little doubt that in the years immediately following there was a substantial recovery by the New Zealand economy and unemployment levels dropped. Assisted by the structural reforms, financial assets were reallocated into industries with greater competitive advantage. This, in turn, provided New Zealand with a more liberalised and competitive economy from a global perspective. Although two 'spikes' in unemployment numbers occurred in association with the 1998 Asian economic crises and the 2001 terrorist attacks, unemployment numbers continued a general decline in the *post-reform* period. By 2003 the official unemployment rate had fallen to below 5% – similar to that achieved in the *pre-reform* period.

Interestingly, the trends observed for the costs-of-overwork component are quite different from those observed for unemployment and underemployment. While the costs of the latter fell sharply in later years of the *reform* period, the estimated costs of overwork accelerated, and then remained consistently high throughout the *post-reform* period. This trend occurred in the context of strong growth in part-time employment positions, declining working conditions and rates of pay in depressed sectors, and a rise in multiple job holders. Additionally, the introduction of Sunday trading produced more available working hours in a week. At the same time there was strong growth in service sector employment, with associated skill shortages in areas such as information technology, telecommunications and finance. Some commentators also attribute the trend in increasing working hours to the flow-on effect of a cultural change towards increasing materialism and consumerism (e.g. Hamilton and Denniss 2000).

It is not surprising to find that the costs-of-crime component of the GPI shows a strong correlation with the costs of unemployment, thus reinforcing that crime is a symptom of turbulent social and economic conditions. Also of no surprise, the GPI components for household and community work, private defensive expenditure on health, and costs of commuting show a general pattern of increase over the entire study period, largely reflecting the overall growth in the population and economy. Of these components the value of household and community work is the most erratic, which largely reflects some quite big fluctuations in the real wage rate, and thus the value assigned to these activities.

With respect to the costs of commuting, it is noteworthy that during the latter years of the *reform* period the estimated indirect costs (i.e. time spent commuting) overtook the estimated direct costs. In 1994, for example, it is estimated costs attributed to loss of time made up 53% of the total estimated costs for that year, compared with a 47% share in 1985. Particularly important influences were the privatisation of public transport, dismantling of the import licensing regime for motor vehicles, and tariff reductions (NZIER 1998). As a result the real price of motor vehicles fell significantly over the study period, coupled with dramatic increases in the number of imported motor vehicles, particularly

second-hand vehicles – effectively putting more cars on the roads and increasing congestion.

Environmental measures

This section provides a conservative monetary estimate of the cost of environmental damage and depreciation over our study period. New Zealand experienced significant population, income and material growth between 1970 and 2006, as outlined above for the socio-economic sector. As a result drawdown of the nation's natural capital has occurred to deliver the goods and services we consume and to assimilate the waste we generate with our modern-day life styles.

The foundation for the calculations in the environmental categories is the concept of 'sustainability' (though the GPI is not a measure of sustainability; GPI data show the extent to which national well-being is sustained from year to year, not whether it can be sustained in the long term). From a GPI perspective the economy is a subsystem of the natural environment, therefore the *scale* at which the economy operates is important. Ethical considerations come into play in terms of the rights of future generations and present society (*distribution*) as well as providing for the survival of other species that inhabit the earth. All sources of capital, be it man-made, natural, human or social, are subject to depreciation. The GPI treats natural capital as an asset and advocates we should live off the interest or service rendered by the asset without depleting the capital. Therefore, the consumption of capital needs to be *allocated* with care and compensated for by new investment to ensure a continued flow of services into the future.

The environmental categories covered for New Zealand are those considered most significant when constructing a GPI (Jackson and Stymne 1996; Stockhammer et al. 1997; Guenno and Tiezzi 1998; Anielski and Rowe 1999; Hamilton and Denniss 2000; Venetoulis and Cobb 2004; Lawn and Clarke 2006; Talberth et al. 2007). At the outset it should be pointed out there are well-founded arguments against the monetisation of natural capital. These include, among others: (1) monetisation promotes the trading of ecosystems goods and services in the marketplace, which is not appropriate as they are too important to be privatised and allocated to the highest bidder; (2) monetary values cannot anticipate the point at which natural capital crosses an irreversible threshold into an altered state whereby it is no longer able to maintain the same provision of goods and services; (3) human and other species are totally reliant for survival on natural capital, therefore it is priceless. The GPI promotes an alternative viewpoint that ball-park dollar amounts can give an appreciation of the scale of the contribution made by natural capital in a language that can be readily understood. Such information is necessary as 'Ecosystem management decisions inevitably involve trade-offs across services and between time periods, and weighing those trade-offs requires valuation of some form' (Farber et al. 2006, p. 118). Global population growth and greater individual material demand mean the environment is under increasingly greater pressure and therefore we need a way to include natural capital in the decision criteria. We cannot avoid the valuation issue because when we are forced to make choices, we are doing valuation (Costanza and Folke 1997, p. 50). When making decisions people need to be well informed about relevant ecological and human well-being factors; estimated monetary values can contribute to the knowledge base. Kahneman et al. (2008) have shown in their research the 'endowment effect': people put more importance on retaining what they currently have than potential future

gains. Without some understanding of the level of contribution the natural environment makes to their welfare, people have no basis for making decisions to avoid loss.

To estimate the extent to which natural capital as an asset has been depleted over our 1970–2006 study period differing quantification techniques have been used. To assign a monetary value to damage and restoration costs for non-market environmental goods and ecosystem services the concepts of both 'defensive expenditure outlay' and 'required but not spent defensive expenditure outlay' have been used. Restoration costs for fixing a mess or preventing further deterioration is classified as 'defensive expenditure' as it does not directly improve net well-being. The definition the GPI study used for defensive expenditure is: 'involuntary expenditure undertaken by the government and individual citizens to eliminate, mitigate and neutralise, unwanted damages and deterioration'⁴³. Such expenditure is to compensate for unwanted side effects of production rather than natural phenomena (Daly and Cobb 1989).

'Preventative expenditure' – which is money spent to eliminate, mitigate or reduce environmental externalities – is not considered to be defensive expenditure. Rather, preventative expenditure is considered to internalise the true cost of economic production. For example, money spent on dairy-shed effluent ponds and sewage treatment plants to stop water degradation is 'preventative' in nature not 'defensive'. Likewise, employing ecologists and landscape planners to identify landscape and ecological values to ensure environmental effects are avoided with a new development is preventative. When such measures are inadequate, defensive expenditure (money spent involuntarily by the government or citizens to overcome an unwanted side effect of production) is then required to rectify environmental damage (such as work to improve water quality in eutrophic lakes).

In our study 10 environmental components of 'genuine progress' were assessed. For each of the environmental categories the changes in flow of goods and services from the environment to the economy are estimated and monetised. The general trends for each category are as follows:

Loss and damage to terrestrial ecosystems shows an increase over time, with pest and weed damage the biggest contributor. For pests and weeds no data were available for 1970–1990, so costs were assumed constant as per the 1991 value after this period costs have increased. The rate of indigenous forest loss decreased over the study period due to the Forest Act 1949, which prohibited clear-cutting areas larger than half a hectare, the New Zealand Forest Accord of 1991 and the indigenous forestry provisions of the Forests Act in 1993, which shifted the focus to sustainable resource use and management. Annual losses are small, but as they are cumulative the total environmental cost increases over time

Loss of wetlands is high in 1970 (at an estimated 6800 ha p.a.) and decreases annually to level off in 2004. After 2004, wetland reinstatement is assumed to balance drainage. The vast majority of New Zealand wetlands have been drained or modified for coastal land reclamation, farmland, flood control, road construction and the creation of hydro-electricity reservoirs. Most of the loss of wetlands occurred between 1920 and 1980, but loss was still occurring up to 1997 (MfE 1997 p.7.37). Wetland conversion was encouraged by the government with the Rural Banking and Finance Corporation funding Improvement Loans, Livestock Incentive Schemes and Land Encouragement Loans (National Water and Soil Conservation Organisation, 1983). The end of government subsidies for flood control and drainage schemes

in the mid-1980s stopped wholesale drainage and infilling. However, even during the 1990s, conversions were taking place that were associated with dairying and urbanisation. As the loss of ecosystem services from wetlands is permanent once they have been drained, the hectares lost are treated as cumulative over time. Over our study period a total of 120 800 hectares of wetland were lost.

Loss of soils is an important category for New Zealand as the ecosystem services provided by soils are the basis of the country's economy. The cost of losing farmland to urban land use increased exponentially between 1970 (\$22m) and 2006 (\$824m). As cities in New Zealand have expanded they have taken a disproportionate amount of the elite soils (Ward et al, 1996). Between 1978 and 1985, Supplementary Minimum Prices and land clearance subsidies paid to farmers encouraged the clearance of marginal hill-country land for agricultural production. Much of this land has subsequently been subject to severe erosion. The cost of erosion, which is the biggest component of soil loss, increased from \$100 million in 1970 to \$3,700 million in 2006 as loss is treated as cumulative.

Air pollution costs fluctuated up and down over the study period, around the \$300 million per annum mark. Values were highest in early 1990 when the PM₁₀ readings were the highest. It should be noted that data availability and measurement consistency are issues for this category.

Land degradation costs, using landfill and contaminated sites as a proxy, fluctuated (between \$300m and \$420m per annum) over the study period. The annual cost of contaminated sites reduced as tighter regulations were imposed under the RMA (1991). Landfill costs peaked in the 1990s when volumes were high. Since then higher charges have resulted in a levelling off and more recycling.

Climate change costs were highest in the mid-1970s due to the lack of sequestration benefits in this period from land-use, land use change and forestry. New forest plantings increased during the 1970s when a combination of tax breaks and export incentives encouraged plantings. However, at the same time removals were large due to increases in rough-sawn timber and demand from the pulp and paper industry as a result of government incentives such as the Export Manufacturing Investment Allowance. During the 1980s sequestration increased and energy emissions were relatively low. From 1988 onwards emissions have increased due to population and economic growth.

Loss of water quality is a serious issue for New Zealand. Again lack of data has been a problem and a more rigorous method of estimation needs to be found. Water quality loss increased over time, in the main due to the method of apportioning costs based on nitrogen leaching and fertiliser use, both of these increased from the 1990s as a result of agricultural intensification.

Ozone depletion costs for New Zealand in the GPI are lower than actual due to boundary definition requirements. Data relate to the impact of domestic economic activity on well-being rather than global impacts. Ozone depletion costs are small but they increase from the 1970s onwards to reflect the trend of increased death from melanoma.

Loss of non-renewable resources starts at 1976, as data were not available before this. The trend is upwards over time but fluctuates with international prices, which impact on extraction profitability and, therefore, the 'user cost' component.

Noise pollution costs have been calculated using data for vehicle kilometres travelled, which have increased linearly from 1970 onward for the reasons outlined in the socio-economic

results section.

DISCUSSION

The following discussion gives a brief overview of some of the theoretical, methodological and empirical issues that impact on the construction of a GPI for New Zealand.

Selection of components for inclusion

Unlike in the calculation of, say, GDP, there are currently no international standards specifying the method by which a GPI is to be calculated. This means that the types of socio-economic/environmental benefits or costs included in any particular GPI calculation are to a large degree left to the discretion of the persons undertaking the study. This somewhat arbitrary nature of the GPI is perhaps its most fundamental theoretical issue. For example, studies in other countries have included additional socio-economic components, such as the cost of gambling. The GPI could also include issues such as the cost of alcoholism, drug abuse, child abuse, money laundering and fraud, etc., as separate categories from the cost of crime. It can be noted further that the comparison of GPIs between countries is complicated by variances in social problems experienced, and also variances over time. For example, Internet crime was unheard of before the 1990s. Further debate about appropriate components to include in the New Zealand GPI will be beneficial. Moreover, a key focus of this debate should be on what New Zealanders conceive are key determinants of their welfare.

Definition of system boundaries

System boundaries create further complications in the calculation of a GPI, as some issues (e.g. Internet crime and fraud) may be experienced by a victim in New Zealand, yet be committed by a person based overseas. The system boundary issue is perhaps the most problematic for the calculation of the environmental components of the GPI. For example, New Zealand does not produce or consume a high volume of ozone-depleting substances, but as a nation we are more exposed to the impact of damage to the ozone layer than most other countries. Similar arguments can be made concerning the potential consequences of climate change, where the impacts of burning fossil fuels in other nations may have a profound impact on our climate.

Definition of defensive expenditures

Another factor that could have an important impact on the New Zealand GPI valuation is the definition given to 'defensive expenditures'. Commentators, such as Hamilton and Denniss (2000), note that the definition of what constitutes a defensive expenditure, or the degree to which an activity is considered defensive, is largely an arbitrary decision. Often, for example, only anecdotal or ad hoc information exists for setting the degree to which a component is defensive. Moreover, in those cases where anecdotal or ad hoc information does not exist, the analyst implementing the component is left to make a judgement or assumption.

Monetary valuation of non-market externalities

Assigning a monetary value to many social and environmental goods and services is often problematic. Frequently, as is the case in this study, value is dependent on implied or imputed benefits/costs. The benefits derived from ecosystem services such as climate regulation, for example, cannot be adequately captured in economic markets due to the intangible nature of the

services provided. In this case, economists typically rely on non-market valuation techniques such as willingness-to-pay, hedonic pricing, and travel cost methods. Unfortunately, there are many well-known limitations associated with the application of these methods (e.g. see Khan (1995) for further details). It is also worth noting many commentators argue that it is inappropriate to place economic values on social and environmental goods and services that are 'invaluable'. It is, however, the opinion of the authors that without valuations many of the components included in this study would remain unaccounted for, or at least undervalued, in New Zealand.

Selection of an appropriate base year

The selection of an appropriate base year from which to conduct the valuation is critical in determining the quantum of several GPI components. The valuation of components such as the loss and damage to terrestrial ecosystems and loss of soils rely on accurately determining the point in time when the marginal benefits gained from depleting (or drawing down) an environmental good/service become less than the marginal costs incurred as a result of the loss of that resource. This is a task fraught with difficulties such as lag effects, cumulative effects, and compounding data paucity.

Partial or incomplete valuation of components

Assumptions made in estimating the GPI are open to debate (Neumayer 2000; Lawn 2003). The cost of unemployment and underemployment, for example, is determined using an average wage rate per hour. This is likely to be an overestimate as a vast majority of the unemployed, and underemployed, are unskilled. Incomplete valuation, such as the omission of the psychological costs associated with unemployment, means components are only partially, rather than fully, accounted for. While full cost accounting of all sub-components of a component is not possible, it is important that all major sub-components are evaluated. The key barriers to full cost accounting are difficulties associated with measurement and insufficient data (see below).

Lack of standardised valuation methodologies

The comparability of different GPI studies is often limited because, as described above, no international standardised valuation method currently exists. This means that in calculating a GPI, the researcher must decide both which items will be incorporated in the index and which valuation methods are best to employ. These decisions are typically made on the basis of data availability. It should, however, be noted that effort are currently underway to standardise core components of the GPI across nations – refer, for example, to Lawn and Clarke (2008).

Paucity of data

The paucity of data is a significant obstacle to rigorous GPI calculations. It is recommended that a database of information sources pertaining to each socio-economic and environmental component be created. This database would record not only bottom-up primary data for improving the construction of the GPI, but, importantly, also information on the causal mechanisms responsible for change in components. This of course would take time, like the System of National Accounts from which the GDP indicator is extracted developed over a period of 70+ years, with definitions and accounting procedures evolving along the way. Under ideal circumstances, information for development of component accounts would be based on regularly collected

data. Furthermore, the development of regional GPIs would be a nationwide exercise supported by statistical data sources from Statistics NZ.

Data accuracy and certainty

To help interpret the accuracy of the findings, standard statistical errors could be added where possible to component valuations, with a sensitivity analysis undertaken to allow for feasible ranges of values. Alternatively, a Monte Carlo analysis could be undertaken to provide certainty bounds for component valuations and for the overall aggregate indicator.

CONCLUDING REMARKS

While putting dollar values on socio-economic and environmental contributions to well-being is problematic, and deciding what should be included or excluded is subjective, a measure such as the GPI brings us closer to providing a realistic picture of how we are progressing than using GDP as a proxy.

No handbook, as exists for the SNA, has been established for constructing a GPI and there are still theoretical, methodological and empirical issues to be resolved. Despite these limitations it is argued that while GPI-type measures may lack the precision of GDP in that extensive statistical systems and conventions have not been established, it is a more reliable measure as it does not arbitrarily place a zero value on factors essential for long-term well-being. The GPI, despite its shortcomings, is preferred because 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. 1995, p. 8).

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REFERENCES

- Anielski, M., 2001. The Alberta GPI Blueprint. The Genuine Progress Indicator (GPI). Sustainable Well-Being Accounting System, in: Institute, T.P. (Ed.). The Pembina Institute, Edmonton, p. 126.
- Anielski M, Rowe J 1999. The Genuine Progress Indicator – 1998 update. San Francisco, Redefining Progress. 61 p. http://rprogress.org/publications/1999/gpi1998_data.pdf
- Auckland Regional Council 2001. Riparian zone management (ISSN 1175 205X). Auckland, Auckland Regional Council.
- Auckland Regional Council 2006. Auckland air emissions inventory 2004. Auckland, Auckland Regional Council.
- Black J 2002. A dictionary of economics, 2nd revised edn. Oxford Paperback Reference.
- Brekke K, Howarth R 2002. Status, growth, and the environment: goods as symbols in applied welfare economics. Cheltenham, UK, Edward Elgar.
- Briton S, Le Heron R and Pawson E eds 1992. Changing places in New Zealand: A geography of restructuring. Christchurch, New Zealand Geographical Society.
- Career Services 2006. Overworked New Zealand – a matter of choice? Career Edge, the Magazine for the Careers Industry, 15 (February): 6–8.
- Centre for Advanced Engineering 2005. Landfill full cost accounting guide for New Zealand. Information Bulletin 34: 8.
- Chapple S 1986. Full employment: Whence it came and where it went. Research Monograph 66. Wellington, NZIER.
- Chapple S 1997. Do minimum wages have an adverse impact on employment?

- Evidence from New Zealand. *Labour Market Bulletin* 2: 25–50.
- Cobb et al. 1995. Cobb, C., Halstead, T., Rowe, J., 1995. The genuine progress indicator: summary of data and methodology. *Redefining Progress*, San Francisco.
- Costanza R, Folke C 1997. Valuing ecosystem services with efficiency, fairness, and sustainability as goals. In Daily G ed. *Nature's services. societal dependence on natural ecosystems*. Washington, DC, Island Press.
- Costanza R, d'Arge R, deGroot R, Farber S, Grasso M, Hannon B, van den Belt M 1997. The value of the world's ecosystem services and natural capital. *Nature* 387(6630): 253–260.
- Daly H 2005. Economics in a Full World. *Scientific American* 293, 100–107.
- Daly H, Cobb J 1989. *For the common good: redirecting the economy toward community, the environment and a sustainable future*. Boston, Beacon Press.
- Daly HE 1996. *Beyond growth*. Boston, Beacon Press.
- Davidmann M 1996. *Exporting and importing of employment and unemployment*. Oakland, CA, Community Economics.
- Department of Labour 2008. *Working long hours in New Zealand: a profile of long hours workers using data from the 2006 Census*. Wellington, Department of Labour.
- DOC & MfE 1998. *Restoring the dawn chorus*. Wellington, Department of Conservation and Ministry for the Environment.
- Dodds C, Colman R 2001. *Income distribution in Nova Scotia, Executive Summary*. Canada, Genuine Progress Index for Atlantic Canada.
- Dravitzki V, Lester T 2006. Economics drove our first sustainable urban transport system and the unsustainable one that followed. Lower Hutt, Opus International Consultants.
- Dymond J, Betts H, Schierlitz CS 2010. An erosion model for evaluating land-use scenarios in New Zealand. *Environmental Modelling and Software* 25: 289–298.
- Easterlin 2003. Explaining happiness. *Proceedings of the National Academy of Sciences* 100, 11176–11183.
- Easton B 1996. *Income distribution. A study of economic reform: The case of New Zealand*. North Holland Books. Pp. 101–138. <http://www.eastonbh.ac.nz>.
- El Serafy S 2002. The 'El Serafy' method for estimating income from extraction and its importance for economic analysis. A Synoptic Paper. Retrieved from http://www.ngps.nt.ca/registryDetail_e.asp?CategoryID=169
- Environment Bay of Plenty 2005. Govt help needed to fund \$170m Rotorua lakes costs. <http://www.scoop.co.nz/stories/PO0506/S00226/govt-help-needed-to-fund-170m-rotorua-lakes-costs.htm> (accessed 22 May 2007). Environment Bay of Plenty media release, June 2005.
- Environment Waikato 2002. *Regional Pest Management Strategy 2002–2007*. Hamilton, Environment Waikato. <http://www.ew.govt.nz/policyandplans/rpmsintro/rpms2002/index.asp>
- Environment Waikato 2003. *Protecting Lake Taupo - A long term strategic partnership*. Hamilton. <http://www.ew.govt.nz/policyandplans/taupo/documents/index3.pdf>
- Envision New Zealand 2003. *Resourceful communities. a guide to resource recovery centres in New Zealand. A report funded by the Ministry for Economic Development*. <http://www.zerowaste.co.nz/assets/Reports/ResourcefulCommunities-lowres.pdf>
- European Commission et al. 2007. *The European Commission, European Parliament, Club of Rome, OECD, WWF, 2007. Beyond GDP: measuring progress, true wealth and the well-being of nations*.
- Farber S, Costanza R, Childers DL, Erickson J, Gross K, Grove M, Wilson M 2006. Linking ecology and economics for ecosystem management. *BioScience* 56: 117–129.
- Farm Environment Award Trust 2004. *Work out the cost of managing waterways on your farm*. <http://www.ew.govt.nz/enviroinfo/water/documents/feal.pdf>
- Fisher G, Kjellstrom T, Kingham S, Hales S, Shrestha R, Sturman A, Durand M 2007. *Health and air pollution in New Zealand*. Wellington, Health Research Council of New Zealand, Ministry for the Environment, Ministry of Transport.
- Fisher GW, Rolfe KA, Kjellstrom T, Woodward A, Hales S, Sturman AP, King D 2002. *Health effects due to motor vehicle air pollution in New Zealand. Report to Ministry of Transport*.
- Galbraith JK 1999. Frank M. Engle Lecture in Economic Security, American College, Bryn Mawr, May, 1999. Reviewed in *IMF Survey*, 2 August 1999.
- Guenno G, Tiezzi S 1998. *The Index of Sustainable Economic Welfare (ISEW) for Italy*. Siena, University of Siena, Department of Economics.
- Hackwell K, Bertram G 1999. *Pests and weeds: a blueprint for Action*. Wellington, New Zealand Conservation Authority.
- Hales S, Town G, Kejjellstrom T, Woodward A 1999. *Daily mortality in relation to weather and air pollution in Christchurch, New Zealand*. *Australian and New Zealand Journal of Public Health* 24(1).
- Hamill K 2006. *Snapshot of lake water quality in New Zealand (ME 776)*. Wellington, Opus International Consultants report for the Ministry for the Environment.
- Hamilton C, Denniss R 2000. *Tracking well-being in Australia. The Genuine Progress Indicator (No. 35)*. The Australia Institute.
- Hamilton K 1994. *Green adjustments to GDP*. *Resources Policy* 20: 158–168.
- Hamilton K 1996. *Pollution and pollution abatement in the national accounts. Review of Income and Wealth* 42: 291–304.
- Hatfield-Dodds, S., 2005. *Decision support for highly contested choices: The role of monetised values and other metrics in the pursuit of sustainability*, Australia New Zealand Society for Ecological Economics. Massey University, Palmerston North, New Zealand.
- Hicks DM, Shankar U (Cartographer) 2003. *Sediment from New Zealand rivers. NIWA Chart miscellaneous series*. Wellington, National Institute for Water and Atmospheric Research. 79 p.
- Hirsch ED, Kett JF, Trefil J 2002. *The new dictionary of cultural literacy*, 3rd edn. Boston, USA, Houghton Mifflin.
- Jackson T, Stymne S 1996. *Sustainable economic welfare in Sweden: a pilot index 1950-1996*. Stockholm, Stockholm Environmental Institute.
- Junankar PN, Kapuscinski CA 1992. *The costs of unemployment in Australia*. EPAC Background Paper No. 24, AGPS, Canberra, Australia.
- Kahn JR 1995. *The economic approach to environmental and natural resources*. Harcourt Brace, Orlando, FL.
- Kahneman D, Knetsch J, Thaler R 2008. *The endowment effect: evidence of losses valued more than gains*. In: Plott CR, Smith VL eds *Handbook of experimental economics results Vol. 1*. Amsterdam, North-Holland. Pp. 939–948.
- Kennedy R 1968. *Speech at the University of Kansas, Lawrence, Kansas, 18 March 1968, p. 4*. <http://images2.americanprogress.org/campus/email/RobertFKennedyUniversityofKansas.pdf>
- Kerr T, Constanza R, Erickson J, Fligger K, Adams A, Adams C, Altschuler B, Balter S, Fisher B, Hike J, Kelly J, McCauley M, Montone K, Rauch M, Schmiedeskamp K, Saxton D, Sparacino L, Tusinski W, Williams L 2004. *Estimates of the Genuine Progress Indicator (GPI) for Vermont, Chittenden County and Burlington, from 1950 to 2000*. *Ecological Economics* 51: 139–155.
- Krause M, Eastwood C, Alexander RR 2001. *Muddied waters: Estimating the national economic cost of soil erosion and sedimentation in New Zealand*. Lincoln, Landcare Research.
- Künzli N, Kaiser R, Medina S, Studnicka M, Chanel O, Filliger P, Sommer H 2000. *Public-health impact of outdoor and traffic-related air pollution: a European assessment*. *The Lancet* 356(September): 795–801.
- Kuznets S 1962. *How to judge quality*. *The New Republic*, 29–32.
- Larned S, Scarsbrook M, Snelder T, Norton N 2005. *Nationwide and regional state and trends in river water quality 1996–2002 (ME 590)*. Wellington, Ministry for the Environment.
- Lawn PA 2003. *A theoretical foundation to support the index of sustainable economic welfare (ISEW), genuine progress indicator (GPI), and other related indexes*. *Ecological Economics* 44: 105–118.
- Lawn P 2004. *An assessment of the valuation method used to calculate the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and Sustainable Net Benefit Index (SNBI)*. *Environment, Development and Sustainability* 7: 185–208.
- Lawn P 2006. *Sustainable development: concept and indicators*. In: Lawn P ed. *Sustainable development indicators in ecological economics*. Cheltenham, UK, Edward Elgar.
- Lawn P 2007. *A stock-take of green national accounting initiatives*. *Social Indicators Research* 80: 427–460.
- Lawn P, Clarke M 2006. *Measuring genuine progress: an application of the Genuine Progress Indicator*. New York, Nova Science.
- Lawn P, Clarke M 2008. *Sustainable welfare in the Asia-Pacific: studies using the Genuine Progress Indicator*. Cheltenham, UK, Edward Elgar. Pp. 126–152.
- LCDB1 2000. *New Zealand Land Cover Database Version 1 released in 2000*. LCDB1 was derived from SPOT satellite imagery acquired over the summer in 1996/97. Wellington, Ministry for the Environment.
- LCDB2 2004. *Land Cover Database Version 2 released in 2004*. NZ Land Cover Database Version 2 (LCDB2) used Landsat 7 ETM+ satellite imagery acquired over the summer of 2001/02. Wellington, Ministry for the Environment.
- Leipert C 1989. *Social costs of the economic process and national accounts: The example of defensive expenditures*. *Journal of Interdisciplinary Economics* 3: 27–46.
- Livingston ME, Biggs BJ, Gifford JS 1986. *Inventory of New Zealand lakes: Part I North Island and Part II South Island*. Water and Soil Miscellaneous Publication 81. Wellington, Ministry of Works, Water and Soil Directorate.
- MacIntyre D 1970. *Utilisation of New Zealand's land resources*. In: Bockemuehl HW ed. *New Zealand's wealth. Studies in Resource*

- Development and Utilisation. Palmerston North, Manawatu Branch, New Zealand Geographical Society (Inc.).
- Maclaren J, Wakelin S 1992. Carbon sequestration by New Zealand's plantation forests - the long term view. Rotorua, Forest Research Institute.
- MAF 2005. Situation and outlook for New Zealand agriculture and forestry: 2005 (ISBN 0-478-29805-6). Ministry of Agriculture and Forestry. <http://www.maf.govt.nz/mafnet/rural-nz/statistics-and-forecasts/sonzaf/>
- Maler K 1991. National accounts and environmental resources. *Environmental and Resource Economics* 1: 1–15.
- Mankiw N 1999. *Macroeconomics*, 4th edn. New York, Worth.
- Mazin I 2006. Correlation between the Gini Index and the Observed Prosperity. 2006 APS March Meeting, Baltimore, MD. <http://meetings.aps.org/link/BAPS.2006.MAR.A33.7>.
- McConnell C, Brue S 2004. *Microeconomics: principles, problems and policies*. Part 5: Microeconomic issues and policies. Chapter 21: Income inequality and poverty. New York & London, McGraw-Hill Professional.
- McCulloch A, Midgley PM, Fisher DA 1994. Distribution of emissions of chlorofluorocarbons (CFCs) 11, 12, 113, 114 and 115) among reporting and non-reporting countries in 1986. *Atmospheric Environment* 28(16): 2567–2582.
- MED 2007. New Zealand energy data file June 2007. Wellington, Ministry of Economic Development. www.med.govt.nz/energy/info/
- MfE 1997. The state of New Zealand's environment. Wellington, Ministry for the Environment.
- MfE 2001. A guide for the management of closing and closed landfills in New Zealand. Wellington, Ministry for the Environment.
- MfE 2004. Landfill full cost accounting guide for New Zealand. Wellington, Ministry for the Environment.
- MfE 2007. New Zealand and climate change. Wellington, Ministry for the Environment. <http://www.mfe.govt.nz/issues/climate/work-programmes/nz-climate-change.html> (accessed 21 May 2007).
- MfE 2008. New Zealand's Greenhouse Gas Inventory 1990–2006: An overview. Wellington, Ministry for the Environment. www.mfe.govt.nz
- Ministry of Commerce (China) and Ministry of Foreign Affairs and Trade (New Zealand) 2004. The joint study report on a free trade agreement between China and New Zealand. Wellington, Ministry of Foreign Affairs and Trade.
- Ministry of Education 2007. Total investment in education. Wellington, Ministry of Education. www.educationcounts.edcentre.govt.nz
- Ministry of Forestry 1998. Indigenous forestry. sustainable management. Wellington, Ministry of Forestry.
- Ministry of Social Development 2006. Work, family, and parenting study: research findings. Wellington, Ministry of Social Development.
- Ministry of Transport 1996. Land transport pricing study: Environmental externalities (Discussion Paper). Wellington, Ministry of Transport.
- Ministry of Transport 2003–2006. New Zealand Household Travel Survey, Wellington, Ministry of Transport.
- Möller J 1990. Unemployment and deterioration of human capital: a labour market model with hysteresis implications. *Empirical Economics* 15: 199–215.
- National Water and Soil Conservation Organisation, 1983. Wetlands: A diminishing resource (A report for the Environmental Council), in: Water and Soil Division, M.o.W.a.D. (Ed.), *Water and Soil Miscellaneous Publications* No. 58, 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: 347–361.
- Neumayer E 2003. *Weak versus strong sustainability*, 2nd edn Cheltenham, UK, Edward Elgar.
- New Zealand Herald 2008. Government chips in to clean up polluted lakes, New Zealand Herald 26 March, 2008. <http://www.nzherald.co.nz/news/print.cfm?objectid=10500108>
- New Zealand Parliament 2007. Employment Relations (Flexible Working Hours) Amendment Bill – Second Reading. Order Paper, Debates (Hansard), Questions, Daily Progress, Journals 641: 11624.
- New Zealand Road Safety Trust 1999. New Zealand Travel Survey Report. Wellington, New Zealand Road Safety Trust.
- NZIER 1998. Parallel importing: a theoretical and empirical investigation. Report to Ministry of Commerce. Wellington, NZIER.
- O'Dea D 2000. The changes in New Zealand's income distribution. The Treasury Working Papers 00/13. Wellington, New Zealand Treasury.
- OECD 2008. Growing unequal? Income distribution and poverty in OECD countries. Paris, OECD.
- O'Hara P, Freney J, Ulyatt M 2003. Abatement of agricultural non-carbon dioxide greenhouse gas emissions: a study of research requirements. 177 p.
- Parfitt RL, Schipper LA, Baisden WT, Elliot AH 2006. Nitrogen inputs and outputs for New Zealand in 2001 at national and regional scales. *Biogeochemistry* 80: 71–88.
- Patterson MG, Cole AO 1999. Assessing the value of New Zealand's biodiversity (Occasional Paper No. 1). Palmerston North, School of Resource and Environmental Planning, Massey University.
- Price R, Thornton S, Nelson S 2007. The Social Cost of Carbon and the Shadow Price of Carbon: What are they, and how to use them in economic appraisal in the UK. The Department of Environment, Food and Rural Affairs, London, UK.
- Reid, MG 1934. *Economics of household production*. New York, J. Wiley and Sons.
- RMA 1991. The Resource Management Act 1991. Parliament of New Zealand.
- Roper T, Thompson A 2006. Estimating the costs of crime in New Zealand in 2003/04. New Zealand Treasury Working Paper 06/04. Wellington, New Zealand Treasury.
- Salinger MJ, Mullan AB 1999. New Zealand climate: temperature and precipitation variations and their links with atmospheric circulation. *International Journal of Climatology* 19: 1049–1071.
- Sandhu HS, Wratten SD, Cullen R, Case B 2007. The future of farming: the value of ecosystem services in conventional and organic arable land. An experimental approach. *Ecological Economics*: doi:10.1016/j.ecolecon.2007.05.007.
- Scarsbrook MR, McBride, GB 2003. The evolving roles of long-term monitoring programmes in water resource management: A New Zealand case study. Paper presented at the Monitoring Tailor-Made (MTM) IV, St. Michielsgestel, The Netherlands. http://www.mtm-conference.nl/mtm4/docs/Sh_Scarsbrook.pdf
- Sen 1999. *Development as Freedom*. Anchor Books, London.
- Spigel RH, Viner AB 1992. Lakes. In: Mosley MP ed. *Waters of New Zealand* Wellington, New Zealand Hydrological Society Inc. Pp. 305–334.
- Statistics New Zealand (NZ) 1988. *New Zealand Official Yearbook 1988/89*. Wellington, Statistics New Zealand.
- Statistics NZ 1999a. Time use survey. Wellington, Statistics New Zealand.
- Statistics NZ 1999b. Incomes: income distribution in New Zealand. Wellington, Statistics New Zealand.
- Statistics NZ 1999c. Effects of changing from de facto population estimates to resident population estimate. Wellington, Statistics New Zealand.
- Statistics NZ 1999d. A regional profile Auckland. Wellington, Statistics New Zealand.
- Statistics NZ 2000a. Government spending on culture 1990–1999. Wellington, Statistics New Zealand.
- Statistics NZ 2000b. *New Zealand Official Yearbook 2000*. Wellington, Statistics New Zealand.
- Statistics NZ 2001a. Measuring unpaid work in New Zealand 1999. Wellington, Statistics New Zealand.
- Statistics NZ 2001b. New Zealand time use survey 1999. Wellington, Statistics New Zealand.
- Statistics NZ 2001c. Crime in New Zealand. Wellington, Statistics New Zealand.
- Statistics NZ 2002a. Agriculture in New Zealand. Wellington, Statistics New Zealand. <http://www.stats.govt.nz/analytical-reports/agriculture-in-nz/default.htm>
- Statistics NZ 2002b. Monitoring progress towards a sustainable New Zealand. Wellington, Statistics New Zealand.
- Statistics NZ 2004a. Household economic survey, 1985–1998, 2001, 2004. Wellington, Statistics New Zealand.
- Statistics NZ 2004b. New Zealand Long Term Data Series (LTDS): Labour market, unemployment and unemployment rate. Wellington, Statistics New Zealand.
- Statistics NZ 2004c. New Zealand Life Tables, 2000_2002. Wellington, Statistics New Zealand.
- Statistics NZ 2006. New Zealand income survey. Wellington, Statistics New Zealand.
- Statistics NZ (various). *New Zealand Official Yearbook*. Auckland, David Bateman.
- Stern N 2006. Stern Review: The economics of climate change. HM Treasury. http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm
- Stiglitz JE, Sen A, Fitoussi JP 2009. Report by the Commission on the Measurement of Economic Performance and Social Progress. Commission on the Measurement of Economic Performance and Social Progress, Paris.
- Stockhammer E, Hochreiter H, Obermayr B, 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.
- Talberth J, Cobb S, Slattery N 2006. *The Genuine Progress Indicator 2006 – A tool for sustainable development*. San Francisco, CA, Redefining Progress.
- Talberth J, Cobb S, Slattery N 2007. *The Genuine Progress Indicator 2006: A tool for sustainable development*. Oakland, CA, Redefining Progress. 31 p. <http://rprogress.org/publications/2007/GPI%202006.pdf>

- Transfund NZ 1997. Project Evaluation Manual. Wellington, New Zealand.
- UNEP 1987. Montreal Protocol on Substances that Deplete the Ozone Layer.
- Venetoulis J, Cobb C 2004. The Genuine Progress Indicator 1950-2002 (2004 Update) (Sustainability Indicators Program). San Francisco, CA, Redefining Progress. 22 p. http://rprogress.org/publications/2004/gpi_march2004update.pdf
- Walsh 2005. The Oxford Companion to Philosophy. Oxford University Press, Oxford, UK.
- Ward, C., Cairns, I., Anderson, D., 1996. Land use change – are current policies adequate? Ministry of Agriculture and Forestry.
- Worley Consultants Limited 1992. Potentially contaminated sites in New Zealand: A broad scale assessment. Wellington, Ministry for the Environment.

ENDNOTES

- 1 Governments also have other policy objectives, such as stable prices, a healthy trade balance, low unemployment, and for some but not all, a fair distribution of income, but growth in GDP is generally the foremost goal.
- 2 'Goods' are products that contribute to well-being and utility. 'Bads' are the unwanted side effects of growth, such as pollution, that have disutility and require sacrifices bigger than the worth of the good produced (Daly 2005).
- 3 Statistics NZ's INFOS database series SNA, SNB, and SNC. Rebasing was required to ensure consistency between the series.
- 4 This assumption is not without contention as noted by O'Dea (2000), Dodds and Colman (2001), Neumayer (2003), Lawn (2004), McConnell and Brue (2004), and Talberth et al. (2006).
- 5 The Gini Coefficient is sometimes referred to as the Gini Index.
- 6 The Gini coefficient, G , is calculated as

$$G = (\sum (2i-n-1) X_i) / (n \sum X_i)$$
 where n is the number of income groups, i is the rank value in ascending order, and X_i is the average annual income in each income interval.
- 7 The Gini coefficient ranged between 0.30 (1970) and 0.40 (2004) for the period 1972–2006. Mazin (2006) asserts that a healthy and dynamic economy typically exhibits a Gini coefficient of between 0.22 and 0.36.
- 8 Series SNA, SNB, and SNC. Rebasing was required to ensure consistency between the series.
- 9 Obtained from Statistics NZ's Household Labour Force Survey (HLFS) Long Term Data Series Labour Market Table B2.2 for 1970–1985, and from the INFOS database (series HLFA.SAB3AZD) for 1986–2006. Rebasing of the data was necessary to ensure the same year end.
- 10 Hidden unemployment refers to those people who are unemployed or underemployed, but are not recorded in official unemployment statistics. It includes people who have given up looking for a job (i.e. the discouraged), those who are working less than they would like, and those who work in jobs in which their skills are underutilised (Hirsch et al. 2002). In this component only the psychological costs of discouraged workers are assessed. Data on hidden unemployment were drawn from series HLFA.SXR3TBD, HLFA.SXR3TCD and HLFA.SXR3TDD. It was assumed that hidden unemployment only imposed a cost if the official unemployment rate exceeded the frictional unemployment rate.
- 11 Obtained from the HLFS Long Term Data Series Labour Market Table B2.3 for 1970–1985, and from the INFOS database (series HLFA.SAF3AZD) for 1986–2006. Rebasing of the data was necessary to ensure the same year end.
- 12 Frictional unemployment, which covers short-term unemployment resulting typically from job transition (Mankiw 1999; Hamilton and Denniss 2000), was estimated to be 0.25% per annum of total unemployment for the period 1970–1978, and 1.3% per annum thereafter.
- 13 As obtained from New Zealand's *Official Year Books* and Chapple (1997).
- 14 Calculated using the annual unemployment benefit distributed (series SOWA.SM2C and SOWA.SJ2C) and the number of people receiving the benefit (series SOWA.SM1C and SOWA.SJ1C).
- 15 Series HLFA.SNH3JAD.
- 16 Series HLFA.SNH3JBD.
- 17 Synonymous to the approach used in the Australian (Hamilton and Denniss 2000) and US (Anielski and Rowe 1999) GPIs.
- 18 Most European countries have a 40-hour week, the United States has a 40-hour week for wage earners, and in Australia the standard working week is 38 hours without payment of overtime (New Zealand Parliament 2007).
- 19 Series HLFA.SMA3IAJD.
- 20 Series HLFQ.SHB.
- 21 As obtained directly from Statistics NZ.
- 22 Series SNCA.S5NK90T2 and SNCA.S5NK90T3.
- 23 Series SNCA.S3NK10T2 and SNCA.S3NK10T3.
- 24 As obtained directly from Statistics NZ.
- 25 Series DAEA.SPA012-DAEA.SPA014, DAEA.SPAG04-DAEA.SPAG18 and DAEA.SPAG90.
- 26 Series POPC.S4V112-POPC.S4V191, POPC.S4V19A, POPC.S4V212-POPC.S4V2289 and POPC.S4V29A.
- 27 Series POPC.S4C112-POPC.S4C189, POPC.S4C19A, POPC.S4C212-POPC.S4C289 and POPC.S4C29A.
- 28 Specifically, the de facto resident population estimates were inflated by 2% in all years to produce a resident population equivalent. This percentage was based on the work of Statistics NZ (1999c).
- 29 We adopted Margaret Reid's 1934 definition of household work to include activities that 'might be replaced by market goods and services, if circumstances such as income, market conditions and personal inclinations permit the services being delegated to someone outside the household group'. Preparation of meals and household shopping is therefore considered work, while consumption of meals and window-shopping is not.
- 30 Some minor variations exist by age–sex cohorts reflecting differing lifestyles and time-use patterns.
- 31 Series SNCA.S2NP30EAE.
- 32 On average household expenditure accounted for 98% of the combined household and PNPO expenditure.
- 33 There are other less tangible costs associated with commuting such as the stress and frustration caused by sitting in traffic which could arguably be included in the GPI.
- 34 New Zealand Travel Survey Report (New Zealand Road Safety Trust 1999; Ministry of Transport 2003–2006).
- 35 As obtained directly from Statistics NZ.
- 36 The Time Use Survey (Statistics NZ 1999a) provides the average minutes spent per day on commuting by mode.
- 37 This is based on the hourly value for car and motorcycle drivers undertaking non-work travel as derived from the 1997 Project Evaluation Manual (Transfund New Zealand 1997). This figure was adjusted by the Consumer's Price Index for transportation to account for price changes in all remaining years.
- 38 The trauma experienced by the victims of crime in terms of psychological distress, heightened anxiety, and feelings of insecurity can seriously curtail individuals' ability to conduct a normal lifestyle. These hidden aspects of the effects of crime are difficult to quantify and have not been included in the GPI.
- 39 It could be argued, in strict economic terms, that theft does not result in any loss of well-being as it represents a property transfer from the owner to the thief; nevertheless a thief acquires goods by dishonest means to the detriment of society as a whole. It is important to note that the personal time lost as a result of crime (filing police reports, obtaining insurance quotes and so on) is not included in our calculations.
- 40 To complicate matters further, the definition of an offence has changed many times during the years of the study. The consumption of alcohol by 18- and 19-year-olds, for example, ceased to be an offence when the drinking age was lowered to 18 in December 1999 (Statistics NZ 2001c). In this study property crime includes serious traffic offences causing damage.
- 41 This cost also includes the private expenditure on insurance premiums, alarms and the like.
- 42 The dose–response relationship is the relationship between the dose (or quantity of exposure) and the proportion of individuals in an exposed group that develop a specific effect due to exposure (Yassi et al. 2001 cited in Fisher et al. 2007).
- 43 Defensive expenditure is defined by Leipert (1989, p. 28) as 'expenditure ... made to eliminate, mitigate, neutralise, or anticipate and avoid damages and deterioration that industrial society's process of growth has caused to living, working and environmental conditions'.