Background Paper:

CREATING OUR FUTURE
Sustainable Development for New Zealand

Sustainability Indicators

Office of the
PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT
Te Kaitiaki Taiao a Te Whare Pāremata

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1. The evolution of indicators

Since the establishment and adoption of Systems of National Accounts (SNA)[1] in many countries over 50 years ago, calculation of Gross Domestic Product (GDP)[2] and Gross National Product (GNP)[3] have become the common means of measuring economic growth. The emergence of these and other economic signals in the aftermath of World War II, when there was a population explosion and growing technical capacity, reflects the material growth-dominated perspective of the day. As Sen (2000) points out, in the 1940s when there was such a strong focus on economic growth the world was very different. The tolerance of insecurity and of poverty (and, arguably, of environmental impacts) was much greater in the post-depression and post-war era.

Since the end of the Second World War, monetary valuation has generally become the accepted measure of a society's prosperity. While there are benefits to be gained from the quantitative valuation of goods and services, material output alone is not sufficient to measure quality of life, well-being, or any other way of expressing the social, economic and environmental goals of a society.

Economists, politicians and commentators use GDP figures to justify or criticise our well-being as a nation. Criticisms are usually made when the GDP is not growing fast enough, whereas rapid growth in GDP is widely regarded as a positive indication. Essentially GDP adds up the total quantity of goods and services produced in the economy, regardless of whether these come from economic activities that contribute to well-being or detract from the quality of life. More crime, prisons, road accidents, pollution and landfill costs increase GDP along with new schools, exports and tourism earnings. All negative impacts on our well-being are therefore included as a positive contribution to GDP and act to distort our perception of how well or poorly our society is developing with respect to its resources and other assets.

The Commissioner's report on New Zealand's urban environment (PCE, 1998) drew attention to the fact that New Zealand's energy use and waste generation closely correlates with its economic growth. Figure 1 shows that up until the 1990s energy use rose as real GDP per capita increased. Similarly, Auckland regional waste disposal data show that the faster the growth in per capita GDP, the more waste Aucklanders generate (see figure 2).

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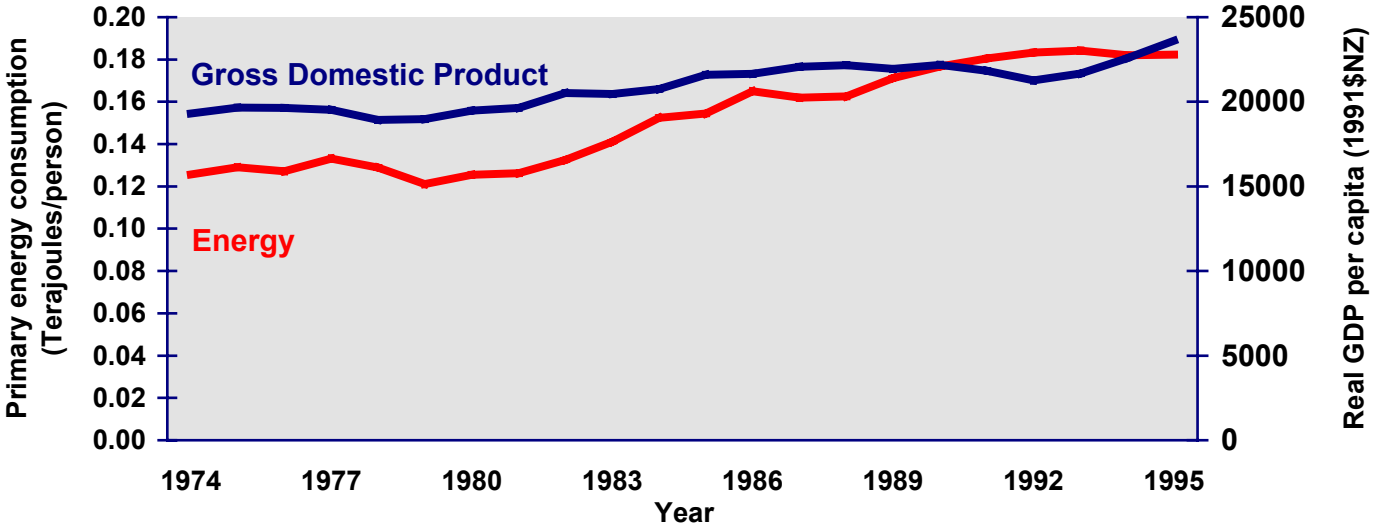
[1] The System of National Accounts (SNA) consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules. It provides a comprehensive accounting framework within which economic data can be compiled and presented in a format that is designed for the purposes of economic analysis, decision-taking and policy-making. It also serves as a point of reference in establishing standards for related statistics (United Nations definition in http://esa.un.org/unsd/sna1993/introduction.asp).

[2] GDP is a measure of the total flow of goods and services produced by the economy over a specified time period, normally a year or a quarter. It is obtained by valuing outputs of goods and services at market prices, and then aggregating. Only goods used for final consumption or investment goods or changes in stocks are included (Bannock, *et al.*, 1992).

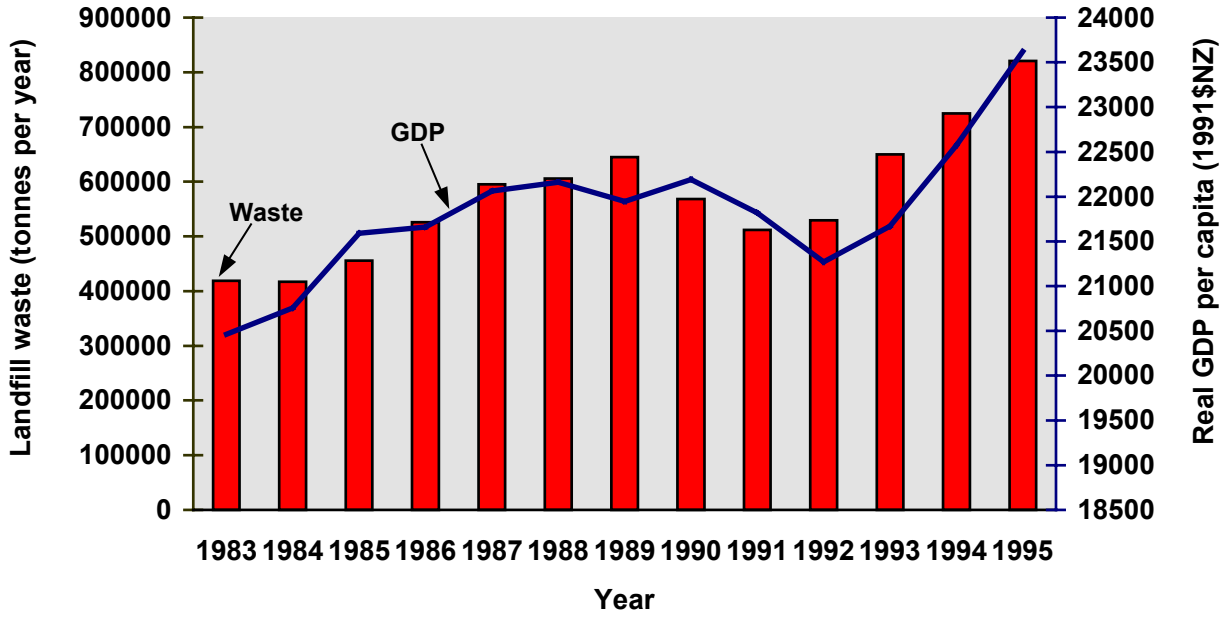
[3] GNP is the GDP plus the income accruing to domestic residents arising from investment abroad less income earned in the domestic market accruing to foreigners abroad (Bannock, *et al.*, 1992). The main outputs from New Zealand's National Accounts are GDP and 'Real Gross National Disposable Income', which is the net income of NZ residents from both domestic and overseas sources after taking into account income redistribution by way of international transfers, or Gross National Income plus net international transfers (http://www.stats.govt.nz/).

Figure 1: Energy Use and Economic Growth in New Zealand 1974-95



Source: Ministry for the Environment; Statistics New Zealand; Ministry of Commerce

Figure 2: Economic Growth and Waste Disposal at Auckland Landfills



Source: Ministry for the Environment

In the 1960s, social indicators emerged along with a strong focus on quality of life studies. By the late 1960s and 1970s the environmental movement started to gain momentum. In the 1970s and 1980s the World Health Organisation was promoting the concept of 'healthy communities'. Later the Brundtland Commission introduced the idea of sustainable development in response to a growing sense that a new approach to development was needed. This was one which took into account many externalities that had been excluded in the immediate post-World War II era and which included, among other things, consideration of matters such as inter-generational equity.

By the late 1980s ecological economics was emerging and displacing the previous narrow view about material growth being the primary means of measuring society's wealth, health and happiness (Hodge *et al.*, 1999).

The 1990s saw a growing international awareness of sustainable development, spurred on by the Earth Summit in Rio de Janeiro in 1992. Agenda 21, the outcome of the Earth Summit, which contains a list of principles, programmes and actions, also identified a range of information that needed to be gathered to evaluate the success of the programmes. This was the catalyst for the development of indicators of sustainability.

Patterson (2002) mentions attempts in the 1990s to design a modified GDP indicator to take account of its environmental and social shortcomings, and the construction of the Index of Sustainable Economic Welfare (ISEW) by Daly and Cobb (cited in Patterson, 2002). The ISEW adjusted GDP to take account of environmental factors and was dubbed a 'green' GDP. In 1995 the ISEW was reformulated and renamed the Genuine Progress Indicator.

Paehlke (2002) points out that one way of understanding sustainability indicators is to see them as a way of indicating society's progress in terms broader than just monetary valuation. Sustainability indicators are the means to measure and communicate fundamental qualities of human societies and the effects on the natural environment of the full range of their activities. Together, sustainability indicators must capture and convey a set of realities as important to society as are the vital signs (pulse, temperature, breathing rhythm) as indicators of human health.

2. Ecological footprint

The ecological footprint has been defined as "the area of productive land and water ecosystems required to produce the resources that a population consumes, and assimilate the wastes that the population produces, wherever on Earth that land and water may be located" (Rees, 2000 cited in McDonald and Patterson, 2001). It can be used to make visible the hidden ecological cost of an activity or population. As a sustainability indicator, the ecological footprint:

- measures the total ecological cost (in land area) of supplying all of the goods and services to a human population
- identifies 'carrying capacity', which in ecology is the maximum population a given land area can support indefinitely (McDonald and Patterson, 2001).

The ecological footprints of most developed nations are unsustainable because they exceed the total biologically productive land available to a specified population (bio-capacity). Globally, the ecological footprint for humanity exceeds bio-capacity by 34 percent (Loh, 2000 cited in McDonald and Patterson, 2001). New Zealand is one of the few developed countries whose ecological footprint (so far) is smaller than its actual land area (Bicknell *et al.,* 1998 cited in McDonald and Patterson, 2001). But this does not necessarily mean that New Zealand has succeeded in becoming sustainable. The ecological footprint is a useful measure of ecological impacts, but as a measure of sustainability it lacks consideration of social and economic factors that also need to be taken into account.

3. Well-being assessment

Prescott-Allen (2001) describes an approach to measuring sustainability in terms of human and ecosystem well-being[4] and how they both affect each other. This is referred to as well-being assessment. It consist of four indices that have been developed to enable societies to learn what combinations of human and ecosystem well-being are sustainable, and make their own decisions about how to achieve them. It is based on an assessment that poses three questions:

- How well are people?
- How well is the ecosystem?
- How are people and the ecosystem affecting each other?

The indices used are:

- the Human Well-being Index (HWI) and Ecological Well-being Index (EWI), which are measures of quality of life and the environment
- the Well-being Index (WI), which juxtaposes the HWI and EWI to enable comparisons to be made between countries
- the Well-being/Stress Index (WSI), which shows how much human well-being each nation obtains for the amount of ecosystem stress it causes.

When ecosystem stress is higher than human well-being, this is regarded as a clear sign that efforts to improve quality of life for people are inefficient and overexploit the environment.

The well-being assessment method and the four indices cover both people and the ecosystem, give them equal weight, and have been developed to provide:

- a clearly stated goal
- a way of measuring progress towards the goal
- an analytical tool for deciding priority actions
- a process to keep the goal in mind and help people learn how to reach it.

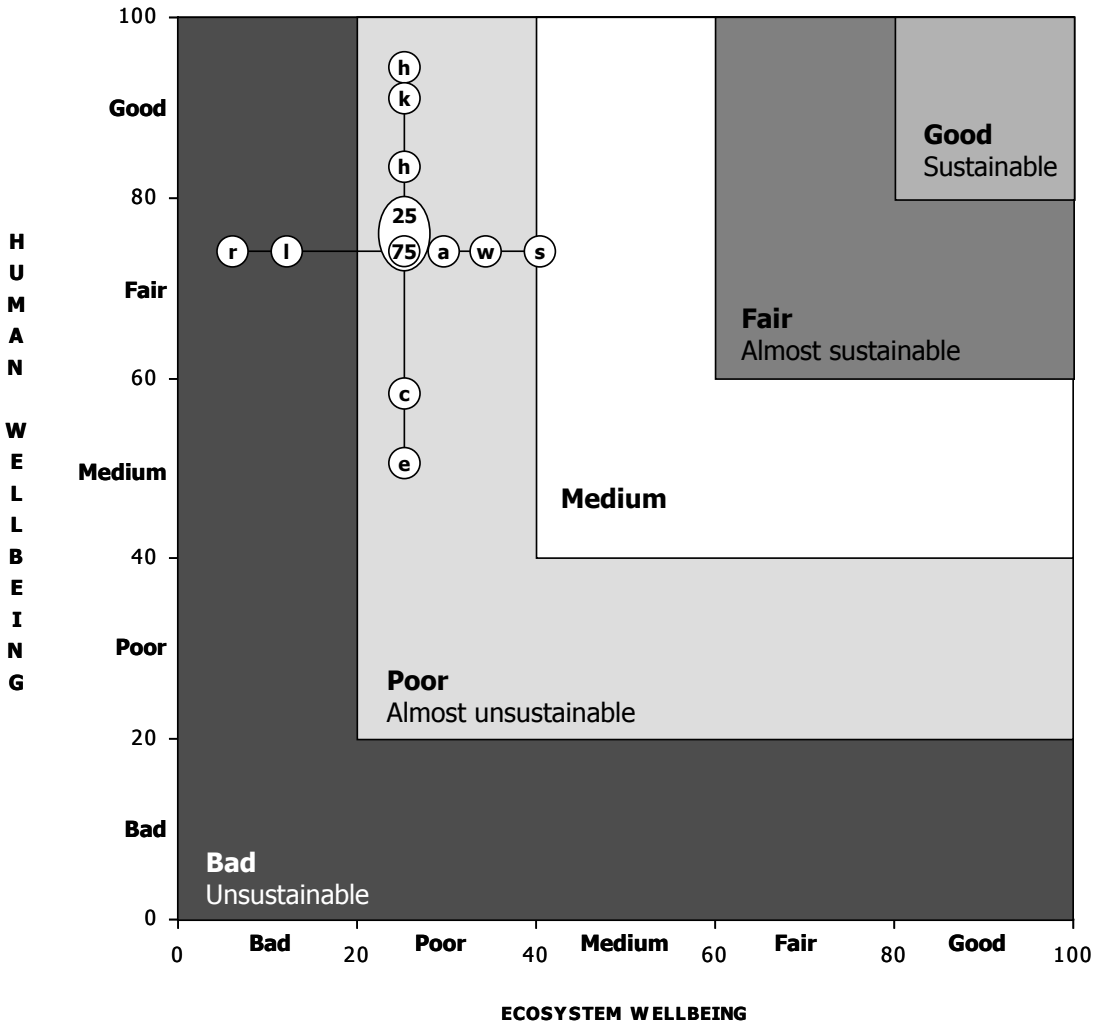
It has been designed to cover more than, for example, the ecological footprint (see section 2 above) and the environmental sustainability index (World Economic Forum, 2001), both of which focus mainly on ecosystem well-being, and the human development index (UNDP, 2001), which excludes consideration of ecosystem well-being. The human development index (HDI) provides a standard of achievement that is a blend of social and economic factors, where otherwise in the public eye economic success might stand as a measure of all things. But, in the absence of environmental data, HDI is not in itself sufficient to the tasks of sustainability analysis (Paehlke, 2002).

[4] Human well-being is defined as a condition in which all members of society are able to determine and meet their needs and have a large range of choices to meet their potential. Ecosystem well-being is defined as a condition in which the ecosystem maintains its diversity and quality – and its potential to adapt to change and provide a wide range of choices and opportunities for the future. (Prescott-Allen, 2001, p.5)

3.1 Barometer of Sustainability

Well-being assessment uses the barometer of sustainability to illustrate the levels of both human and ecosystem well-being, and combines them into an index of sustainability without trading one off against the other (see figure 3).

Figure 3 Barometer of Sustainability



Source: Prescott-Allen (2001)

The above diagram illustrates the Well-being Index of a hypothetical country. The number 75 within a circle represents the human well-being index, while the ecosystem well-being index is represented by the number 25 within the oval shape. The well-being index is where the human and ecosystem well-being indexes intersect. Letters in circles along the vertical axis show the points on the scale of the human dimensions: h = health and population, k = knowledge, w = wealth, c = community, and e = equity. Letters in circles along the horizontal axis show the points of the ecosystem dimensions: r = resource use, l = land, a = air, w = water, and s = species.

The barometer of sustainability is one of a number of ways of portraying the extent to which a country is (or is not) functioning in a sustainable way, by comparing human conditions with the state of the environment. According to Prescott-Allen (2001), who has examined and compared 180 countries using this method, "no country is sustainable or even close" (pp.1-2). Nations with a high standard of living impose excessive pressure on the global environment, and nations with low demands on the ecosystem are desperately poor.

Prescott-Allen (2001) compares the well-being of New Zealand and Australia. Both countries enjoy northern European levels of human well-being, but New Zealand's health and population and knowledge scores are below Australia's. New Zealand's better ecosystem well-being index reflects differences in water (inland water quality) and air (global atmosphere) – poor in New Zealand, worse in Australia. Phosphorus levels in most of New Zealand's rivers are high probably because of inefficient use of fertilisers. While both countries have dramatically cut their use of ozone-depleting substances, they emit increasing amounts of CO_2: New Zealand's 2,258 kg of carbon per person compared to Australia's figure of 4,709 kg of carbon per person. These are, respectively, almost three and six times the maximum level defined as fair. Fossil fuel consumption is excessive, with solid fuels the main culprit in Australia, and liquid fuels in New Zealand, indicating that better management of transport and industry to curb fossil fuel use is required.

Scores for land, species and genes are close. Although New Zealand has converted more of its land to buildings and cultivation (25% versus Australia's 8%), it also protects more (20% versus 8%). Very high percentages of wild species are threatened: 19% of plants and 15% of birds and mammals in Australia; 7% of plants and 61% of birds and mammals in New Zealand. Prescott-Allen (2001) considers that better management of land outside protected areas is needed to conserve wild species, increase agricultural diversity, and restore water quality.

Designing Analytical Frameworks to Integrate Environmental and Economic Systems: A Scientific Approach

Researchers at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) have developed a series of analytical frameworks to explore sustainability issues in Australia. Their objective has been to design and test models that integrate physical (ecological) and economic systems. By bringing these systems together, the researchers are exploring the ways in which sustainability goals could be achieved through planning and policy approaches and how economic decisions may impact on ecological sustainability (Foran & Poldy, 2001).

CSIRO believes that analytical models represent an important tool to examine the long-term consequences of public policies. Researchers have highlighted the need to base these policies on sound scientific advice. They also recognise the importance of understanding changing social and institutional structures. Models therefore need to deal with the complex ways in which social, economic and environmental factors are inter-linked.

One of the models that CSIRO has developed is the Australian Stocks and Flows Framework (ASFF). This forms part of a wider project to explore the links between population, development and the environment to identify future scenarios for the use and management of Australia's natural resources. These scenarios focus on regional and national scales and vary according to different time frames. An important aspect of this model is its reference to the *physical economy*. This term represents the vast array

of physical (ecological) factors that underpin a monetary economy. Associated with this, the framework has been designed to keep track of significant 'stocks' and 'flows' in the Australian socio-economic system. Stocks include people, livestock, trees, buildings, vehicles, capital machinery, infrastructure, and land, air, water, energy and mineral resources. Flows represent the rates of change of stocks and influence the ways in which a system may develop.

The ASFF model simulates interactions between factors in the areas of demography, consumption, buildings, transport, construction, manufacturing, energy supply, agriculture, forestry, fishing, mining, international trade, and land, water and air resources. A key component of the framework is that an analyst can alter the variables in the model to examine their impact on future scenarios. This feature can be used to account for the influence of different social goals and values. An analyst is also restricted, however, from changing the way the model makes its calculations. This is to ensure that scenarios are based on physical laws relating to materials, energy and ecological processes.

Another analytical framework that CSIRO has developed, linked with the project on the ASFF, is the OzEcco Embodied Energy model. This was designed to integrate forces relating to population, lifestyles, organisation and technology and to explore their potential impacts on the Australian environment. The core concept of this model is that access to energy (usually sourced from stocks of fossil fuels) and its transformation provide the key determinants of physical growth in modern industrial economies. Thus, all goods and services are seen in terms of their embodied energy content. The model therefore integrates the structure of the Australian economy with energy accounts. This enables all economic transactions to be represented by the physical factors that underpin them.

The ASFF and OzEcco models are currently being used by CSIRO to examine long-term population policies, land and water futures, fisheries management and the decarbonisation of transport fuels. By taking an integrated approach, researchers at CSIRO have noted the ways in which "the concept of sustainability, linkages between energy use and greenhouse politics, population policy and lifestyle options are all linked to environmental quality in the long term. That is not to say that larger populations live in a less sustainable manner than smaller populations. Nor does it assume that technology will find a way to overcome all environmental challenges or constraints to resource use" (Foran & Poldy, 2001, p 194). By identifying some of the consequences associated with alternative scenarios, these researchers are helping to highlight the range of options available for societies to meet their long-term planning needs.

CSIRO researchers have acknowledged the difficulties in dealing with the complexities of these models. Nonetheless, they argue that the frameworks are *not* designed to provide accurate predictions of the future. Rather, they are intended to provide a general picture of future directions and to highlight the broad set of implications associated with any policy decisions. By basing these frameworks on scientific evidence, the implications for sustainability can also be examined with greater accuracy.

See http://www.cse.csiro.au

4. Environmental Sustainability Index

A task force of the World Economic Forum (World Economic Forum, 2001) developed the Environmental Sustainability Index (ESI) as a measure of overall progress towards environmental sustainability for 122 countries. ESI scores are based upon a set of 22 core indicators, each of which combines two to six variables for a total of 67 underlying variables.

The ESI was developed to permit cross-national comparisons of environmental progress in a systematic and quantitative fashion. It enables:

- identification of issues where national environmental results are above or below expectations
- policy tracking to identify areas of success or failure
- benchmarking of environmental performance
- identification of best practices
- investigation into interactions between environmental and economic performance.

The ESI was deliberately developed to focus on environmental sustainability. This was based on the reasoning that efforts to measure sustainability often fail because they seek to fold too many disparate phenomena under the same conceptual umbrella, and the environment often gets overshadowed in analyses such as 'triple bottom line' reporting.

The components of environmental sustainability developed by the World Economic Forum Task Force are outlined in Table 1.

Table 1 Components of Environmental Sustainability

Component	Logic
Environmental systems	A country is environmentally sustainable to the extent that its vital environmental systems are maintained at healthy levels, and to the extent to which levels are improving rather than deteriorating.
Reducing environmental stress	A country is environmentally sustainable if the levels of anthropogenic stress are low enough to engender no demonstrable harm to its environmental systems.
Reducing human vulnerability	A country is environmentally sustainable to the extent that people and social systems are not vulnerable (in the way of basic needs such as health and nutrition) to environmental disturbances. Becoming less vulnerable is a sign that a society is on a track to greater sustainability.
Social and institutional capacity	A country is environmentally sustainable to the extent that it has in place institutions and underlying social patterns of skills, attitudes and networks that foster effective responses to environmental challenges.

Source: World Economic Forum, 2001, p.9

5. Genuine Progress Indicator (GPI)

The Genuine Progress Indicator (GPI)[5] is based on the fundamental understanding that social, economic and environmental realities are inextricably linked. The GPI recognises that true long-term prosperity and well-being are not measured by material gain alone, but are dependent on the protection and strengthening of our social and environmental assets. If these deteriorate, we are not living sustainably. GPI also recognises that any indicator of progress is value-based and must address the question 'progress towards what?' It makes use of, and integrates, indicators from a range of sources.

The GPI starts with personal consumption expenditure (taken from the national accounts) and adjusts this figure for income distribution. It then adds several benefits that national accounts omit or do not count as benefits, such as the value of household work, parenting and volunteer work. It makes a number of other adjustments and then subtracts a series of social and environmental costs including crime, pollution, depletion of non-renewable energy resources, and loss of productive and conservation land (Prescott-Allen, 2001).

During the course of this investigation, we learned of a Public Good Science Fund application to undertake research to develop the GPI in New Zealand. The proposition is that GPI tells us more than our current reliance on GDP and its focus on economic growth. GDP assumes that 'more' is always better (e.g. more prosperity), whereas with GPI 'less' may sometimes be better (e.g. less pollution). GPI distinguishes between 'goods' and 'bads' and acknowledges that society's views on these can change over time, leading to appropriate changes in the indicators used.

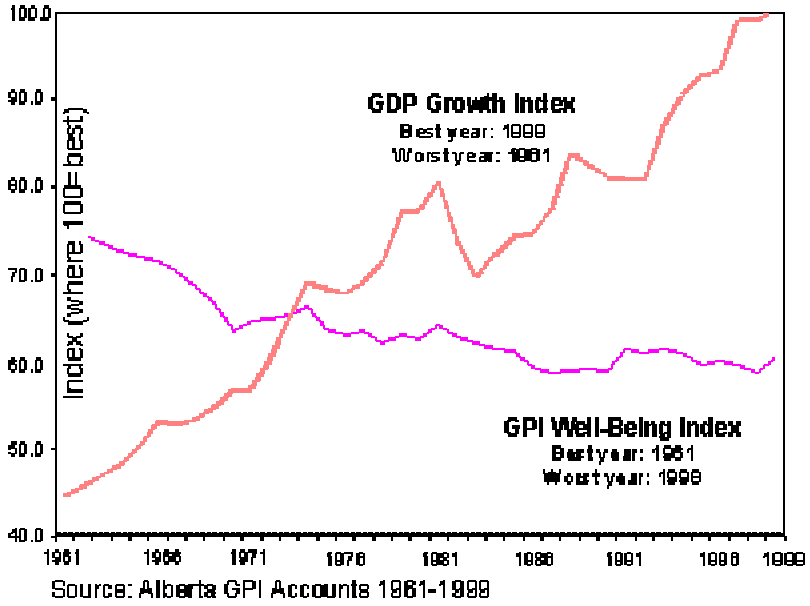
5.1 Example of the use of GPI

The following example of the use of the GPI, and its contrast with GDP, is taken from a report on the application of the indicator to Alberta (Canada) showing trends over the period 1961 to 1999 (Anielski, *et al.*, 2001).

As shown in figure 4, although Alberta's GDP (in 1998 dollars) grew over 400%, or 4.4% per year, from 1961 to 1999, the GPI sustainability well-being index – a composite index of 51 genuine progress indicators – was highest in the 1960s then fell slowly by 0.5% per year, reaching a low in 1998. In the 1990s, the GPI well-being index remained relatively unchanged even though GDP continued to rise.

[5] For further information see Patterson (2002) or http://www.gpiatlantic and http://pembina.piad.ab.ca/.

Figure 4

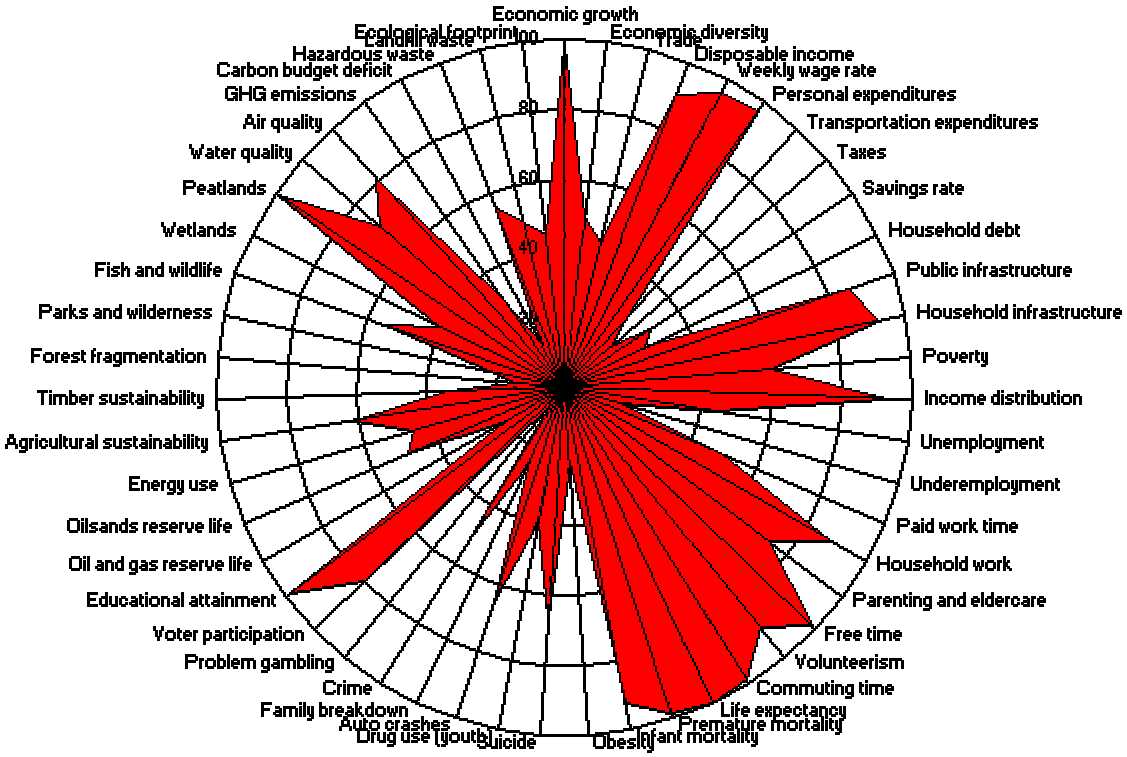


The analysis of economic indicators shows that while GDP rose steadily after the 1982 recession, average real disposable income and real weekly wages (adjusted for inflation) have remained virtually unchanged in Alberta in almost 20 years.

When it comes to the environment, the report on Alberta GPI accounts suggests that growing economic prosperity has come with some ecological costs. For example, Albertans' ecological footprint (the amount of land and resources per person required to meet their consumptive lifestyle) has increased steadily; Alberta has the fourth highest footprint in the world consuming roughly 5.8 times the Earth's carrying capacity.

Like the barometer of sustainability mentioned in section 3, the GPI can be portrayed in a diagram that clearly shows the extent to which sustainability is being achieved (see Figure 5).

Figure 5 Example of the GPI Sustainable Well-being Circle Index



Source: Anielski, *et al.*, 2001

The above illustration is an integrated portrait of sustainability and well-being, showing the best condition of each of 51 genuine progress indicators during the time period for the study (1961-1999). It is a good example of how useful such a visual representation can be for decision makers and the public to see those areas where progress has been made (ie closer to the outside edge of the circle, towards the higher end of the scale from 0 to 100), and those where some progress still needs to be made in the management of the economy, society and the environment.

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