Natural resource accounting
– an overview from a New Zealand perspective
with special reference to the Norwegian experience

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Preface

Early in 1989, the New Zealand Ministry for the Environment commissioned a small research project in order to set directions for work on natural resource accounting in this country. Three recommendations were made in the resulting report (Wright, 1989).

Firstly, there is a great deal of natural resource and environmental data in New Zealand and thus there is a good basis for building some natural resource accounts. Indeed, what some may call natural resource accounts already exist - the energy input-output tables and the Land Resource Inventory, for instance. Consequently, it was recommended that existing data be examined to see what natural resource accounts could be readily assembled.

Secondly, a watching brief on overseas developments was recommended. There is much international activity in this area and debate is intense.

Thirdly, for a number of reasons, it was recommended that New Zealand could save a lot of time and effort by learning, in particular, from the Norwegian experience of resource accounting.

I have acted on these recommendations in preparing this report and, accordingly, it is presented in three major parts. Each part corresponds to one of the recommendations, although the order differs.

Part A (Sections 1 through 10) comprises an international overview. It has been difficult to keep this under control since new material has arrived on my desk virtually every week. This part of the report is somewhat similar to the initial scoping report with definition(s) of "natural resource accounting" followed by categorisation and descriptions of various methodologies. Some material is reproduced where relevant. However, the survey of methodologies in this report goes into more detail and an emphasis is put on applications.

The Norwegian experience in environmental accounting is examined in Part B (Sections 11 through 14). I was fortunate in being able to visit Norway and found discussions with various "resource accountants" immensely valuable. The Norwegians have been working on natural resource accounts for 15 years and their experience goes well beyond the academic. As with the international overview, I have included a large number of actual resource accounts.

In Part C (Sections 15 through 18), I have not been able to act fully on the first recommendation. To do so would require a commitment to a particular resource accounting approach and the establishment of a team to do the job.

Thus the report reflects a kind of odyssey - a voyage of discovery - that begins with the broad picture of an international overview, moves to the detail of one particularly useful experience, and finishes by drawing together material and insights relevant to the New Zealand situation.

In my earlier report, I discussed the confusion caused by the use of the two terms "natural resource accounting" and "environmental accounting". It seems to me that the latter is a more general term and, therefore, a better choice when considering the overall problem of tracing links between the economy and the environment. Terms like "environmental capital" can be used to refer to stocks of sources like fish or coal, and stocks of sinks like clean air. Environmental accountants try to record the depletion of both.

However, in the Norwegian system that is the subject of the second part of this report, "natural resource accounting" is used as the "umbrella" term and so, to avoid confusion, I have continued to use "natural resource accounting" in this way.

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A International overview

1 What is natural resource accounting?

1.1 The reason for natural resource accounting

> "*Natural Resource Accounting combines concepts of national income and product accounting with the analysis of natural resource and environmental issues*" (Cabe & Johnson, 1989).

Several years ago there was great enthusiasm for natural resource accounting; it was hailed by some as the answer for pinning down that elusive concept, sustainable development. This enthusiasm has been replaced by rather more pragmatic expectations. Natural resource accounting is now more modestly seen as the presentation of linked environmental and economic data which should be useful in the gargantuan task of trying to monitor sustainable development.

Economic systems are human artifacts that lie within the physical environment. There are flows in both directions across the economy-environment interface. Many of these flows are invisible or blurred. For instance, air pollutants flow invisibly (in an economic sense) from the economy to the environment because clean air is free. Oil flows from the environment to the economy in a partly visible flow; prices reflect the costs of extracting and marketing the oil but are unlikely to capture fully the cost of depletion.

Hence, the costs of environmental degradation and natural resource depletion are distorted in standard macroeconomic accounting. The interest in natural resource accounting is a response to the growing concern about the misleading treatment of environmental capital in national accounting.

1.2 Stocks and flows

An accountant is concerned with stocks and flows of money; an environmental or natural resource accountant is concerned with stocks and flows of environmental goods and services. The basic concept that underlies natural resource accounting, as with financial accounting, is the notion of a balance. The stock at the beginning of a time period, plus the input flows, minus the output flows, must equal the stock at the end of the time period.

Thus, the objective of resource accounting is to:

> "*(i) prepare a balance sheet giving a profile of what stocks of the resource are available at a given point in time,*
> *(ii) prepare an account of what uses are made of these stocks, what sources they are derived from and how they are added to or transformed over time, and,*
> *(iii) ensure that the stock accounts and the flow accounts are consistent, so that the balance sheet in any year can be derived from the balance sheet of the previous year plus the flow accounts of that year*" (Pearce *et al.*, 1989, p.93).

Such balances can be expressed formally in equations like the following (for a renewable resource):

$$S_0 + I + N = C + E + M + S_1$$

where:
S_0 = stock at beginning of year (e.g. tonnes of fish)
I = imports (e.g. fish immigrating into a particular fishery)
N = natural gain (e.g. growth, natality)
C = consumption (e.g. catch)
E = exports (e.g. fish emigrating to another fishery)
M = natural loss (e.g. mortality)
S_1 = stock at end of year (e.g. tonnes of fish)

(Adapted from Gilbert, 1987, p.6).

However, physical balances alone do not reveal how our picture of the economy's production function is distorted by the absence of environmental inputs and outputs. David James provides a succinct definition of resource accounting that stresses the need to go beyond physical balances.

> "*... the starting point should be a data base linking physical environmental indicators and natural resource stocks and flows to specific sectors of the economy*" (James, 1988, p.7).

Once these environment-economy links have been identified and quantified, the ground is prepared for modelling activities such as simulation and forecasting.

1.3 The two paths of natural resource accounting

The development of resource accounting is generally perceived as having gone along two different paths; these are characterised as "physical" accounts and "monetary" accounts. This categorisation reflects the two different origins of resource accounting.

The "physical" approach is based on the laws of conservation of matter and of energy. Tracing flows of materials through the economy was proposed by Kneese, Ayres and D'Arge in 1970 (Kneese *et al.*, 1970). In the seventies also, energy analysts like Slesser and Peet began to trace flows of energy through economic systems.

The "monetary" approach has its base in the pioneering work of Nordhaus and Tobin who set out to modify the system of national accounting (SNA) in order to better reflect economic welfare (Nordhaus & Tobin, 1973).

However, a rigid classification into "physical" and "monetary" systems is somewhat misleading. For instance, the Norwegian resource accounts are frequently described as being at one end of the spectrum, since they are in physical units. But Norwegian resource accountants have not been able to escape problems of valuation. In seeking to quantify stocks of mineral resources *in situ*, they used current prices and technology in assessing stocks of reserves (see Section 12.3). Further, the natural resource accounting team in Norway makes great efforts to bring the information from their "physical" accounts into standard macroeconomic models. Thus, it is more accurate to denote the Norwegian system as "mixed".

It is more useful to distinguish between methodologies in which the aim is direct modification of the system of national accounts (SNA) and methodologies with broader goals. The first group is focused on the use of resource accounting in measuring welfare; the second group is focused on resource accounts as useful sets of information (Peskin, 1990, p.23).

Thus, the international overview, which forms the first third of this report, is in two major parts. Firstly, the set of methodologies in which the aim is to modify the SNA and obtain better measures of social and economic welfare are examined. Secondly, methodologies, in which such direct modification is not the primary aim, are described. Generally, "non-SNA" resource accountants conceive of resource accounts as a subset of a much wider activity - the establishment of environmental information systems that are useful for policy analysis and decision making. Thus, resource accounts in this context are frequently linked with state of the environment reporting and environmental statistics.

Various attempts are being made to find a way through the maze of resource accounting methodologies by classifying and evaluating different approaches. To a large extent, my intent of expanding on my initial overview of international developments (Wright, 1989) has been preempted. A number of key overviews have appeared in the last year.

A good introduction is Chapter 4 in the British *Blueprint for a green economy* by Pearce, Markandya and Barbier. The World Bank collection of papers edited by Ahmad, El Serafy and Lutz summarises much of the international discussion that has taken place in a series of workshops run by UNEP and the World Bank. A new report by Henry Peskin titled *Environmental accounting for sustainable development*, is the most systematic and comprehensive overview to date.

Most work on resource accounting has tended to focus on the first set of approaches described above - the SNA modifications. I will argue that the second set are of more interest to New Zealand and, moreover, are a necessary precursor to the modification of the SNA system.

Resource/environmental accounting is an umbrella term that encompasses many different approaches and concerns. The reader should not regard this paper as some kind of search for the "correct" methodology. Generally, the approach chosen reflects the interests and concerns of the researchers themselves, their institutions, and the sources of their funds.

2 Modifications of the System of National Accounts

2.1 The evolution of the System of National Accounts

National accounting dates back to 1758 when Francois Quesnay attempted to capture the workings of the French economy in a matrix. However, the real incentive to understand flows of money in a national economy came during the Depression, with the notion that understanding the relationship between macroeconomic variables was the key to controlling economic events. National accounting gained a new status in western countries during the Second World War with direct government control of economies.

After the war, with a desire for international comparability, the United Nations issued standard guidelines for the preparation of national accounts. These are known as the UNSNA guidelines. There is considerable variation in the adherence of different countries to these guidelines; New Zealand is relatively conformist (Payne, pers. comm., 1989).

It is important to keep in mind that the UNSNA framework grew out of Keynesian analysis. The environment was not an issue when Keynes developed his framework.

> "*Keynes and his contemporaries were preoccupied with the Great Depression and the business cycle; specifically, with explaining how an economy could remain for long periods of time at less than full employment. The least of their worries was a scarcity of natural resources*" (Repetto *et al.*, 1989).

From its inception, the SNA framework has been criticised and modified. One major set of modifications was proposed by Nordhaus and Tobin in 1973. They suggested that Gross Domestic Product (GDP) be replaced by a new indicator of economic welfare known as NEW. The modifications discussed in this section follow from their approach.

At times in this report, it may appear that I have used Gross Domestic Product (GDP) and Gross National Product (GNP) interchangeably. In New Zealand, GDP (the value of domestic production) is used as the major indicator of economic growth, but in many other countries, GNP (the total net income earned by an economy) is used for this purpose. Where citing studies that refer to GNP, I use GNP, but otherwise, I use GDP.

2.2 The concept of sustainable income

The basis of the various attempts to "green" the SNA is the concept of **sustainable income.** This concept provided the unifying theme for the World Bank publication that summarised developments in environmental accounting (Ahmad *et al.*, 1989).

A number of writers have pointed out that sustainable income is simply a return to the concept of income stated by Sir John Hicks in 1946, that is:

> "... *the maximum value that a person can consume during a time period and still expect to be as well off at the end of the period as at the beginning...*" (El Serafy & Lutz, 1989, p.2).

There is nothing revolutionary about this; Daly comments that sustainable income ought to be considered a redundancy, that is, sustainability is intrinsic to the definition of income (Daly, 1989a, p.8). Under this concept, money gained from the liquidation of assets is not to be regarded as true income. However, when national income is assessed, revenue from the liquidation of "environmental assets" is taken automatically as income.

Normally, we do not speak of environmental issues in accounting language; this is unfortunate since the imagery of the ledger is surprisingly powerful. What environmental assets are we liquidating in New Zealand and consequently, what proportion of our national income is unsustainable? The Chatham Rise orange roughy fishery, South Island beech forests, the Taranaki gas fields, and the rivers that assimilate our wastes are all environmental assets. How much of the income we receive from their liquidation is spurious? How much of our economic growth is illusory?

2.3 Revisions of the System of National Accounts

The United Nations System of National Accounting (UNSNA) has undergone periodic revision although, for the most part, changes have been minor. The latest revision is due to be completed in 1991 and a major effort has been directed at improving the inadequate treatment of natural resource depletion and environmental degradation.

This effort has been focused in a series of five workshops followed by three expert group meetings run by UNEP and the World Bank from 1983 to 1988 (Ahmad *et al.*, 1989). No clear consensus on the details of SNA modifications has emerged in this process and debate continues.

Consequently, the United Nations Statistical Office (UNSO) has decided that the central UNSNA framework will remain unmodified in the 1991 guidelines with regard to the environment, but that individual countries will be encouraged to experiment with environmental modifications in what are termed "satellite accounts". Current UNSO effort is being directed towards the production of a handbook that will contain options and guidelines for environmental satellite accounts. A framework for these guidelines has been prepared (Bartelmus *et al.*, 1989).

A series of case studies is planned for 1990. These will involve the collection of basic data and the testing of the draft handbook for a number of countries. It is hoped that practical application will reveal which methods are workable, expose data inadequacies and pave the way toward a degree of consensus (Lutz, pers. comm., 1989). The countries selected for case studies by the World Bank are Malaysia, the Ivory Coast, Ecuador and Tunisia (Warford, 1989). The United Nations Statistical Office is planning a case study on Mexico.

2.4 Two emphases and two groups of modifications

There are a number of researchers around the world working on environmental modifications of the SNA. In what follows I look at some of the corrections that have been proposed. My purpose is to be illustrative rather than exhaustive. Generally, I have selected methods that have been applied so that actual examples can be given.

There are two broad classes of "green" corrections proposed for the SNA - one concerned with resource depletion and the other with environmental degradation. The examples that follow in Sections 3 and 4 are grouped into these two categories.

Not surprisingly, highly industrialised countries are more interested in correcting the SNA for environmental degradation whereas countries with economies based on the exploitation of natural resources are interested in depletion corrections (El Serafy & Lutz, 1989, p.3). It is no accident that, for example, Roefie Hueting who lives in the Netherlands focuses on pollution or that the World Bank, which is concerned with developing countries, focuses on resource depletion.

3 Modifying the System of National Accounts for resource depletion

3.1 Two approaches to resource depletion corrections

Resource depletion modifications of the SNA will be most significant for countries that rely heavily on non-renewable resources like petroleum, bauxite and phosphate.

In this section, I describe two approaches to dealing with resource depletion - the depreciation approach and the user cost approach. Both proponents have the same aim - the measurement of national "Hicksian" income - but one tries to make net product equivalent to sustainable income whereas the other modifies gross product. One analyst has applied both approaches to the same situation. This is described at the end of this section; the difference in the results suggests that considerably more work is needed in this area.

3.2 The depreciation approach

The main exponent of what is known as the depreciation approach is Robert Repetto of the World Resources Institute in Washington D.C. Repetto's starting point is the "*dangerous asymmetry*" in the treatment of natural capital as opposed to man-made capital in the SNA.

As man-made assets - buildings and equipment - age, they become worth less and money is set aside for their replacement in order that the income flowing from their use be sustainable. Gross domestic product (GDP) is adjusted for such depreciation to give net domestic product (NDP). But the value of natural assets also falls if they are depleted.

> "*Thus, in the same sense that a machine depreciates, soils depreciate as their fertility is diminished, since they can only produce at higher costs or lower yields*" (Repetto, 1988, p.4).

Repetto and his colleagues treat natural resource depletion as asset depreciation in order to put man-made capital and environmental capital on the same footing. Thus, in this methodology, GDP remains unchanged but NDP is changed.

Repetto calculates the change in the value of an environmental asset, that is, depreciation, using the net price method of Landefeld & Hines (1985, pp.14-15). The economic value of reserves is taken as the product of the net price per unit of the resource and the physical quantity of proven reserves. (Net price is the average price per unit of the resource minus the costs of extraction, development and exploration.) The modified NDP thus produced can be taken as a better measure of sustainable income than the standard economic indicators.

GDP - depreciation of man-made capital = standard NDP

Standard NDP - depreciation of environmental capital = modified NDP

Repetto has applied his method to petroleum, timber and soil in Indonesia and the result is shown in Table 3.1. The method is currently being applied to selected natural resources in China, Costa Rica and the Philippines (Repetto, pers. comm., 1989).

Theoretically, NDP is a better indicator of income than GDP even when the difference between the two is due only to the depreciation of man-made capital. But because NDP generally tracks GDP closely (and because depreciation is a sum of imputations), NDP is largely ignored. However, Repetto's Indonesian analysis shows GDP and "NDP" not moving together; GDP grew at an average rate of 7% per year from 1971 to 1984 whereas "NDP" grew at an average rate of only 4% per year.

Table 3.1 Comparison of GDP and "NDP" (corrected for resource depletion) in Indonesia. (Units are billions of 1973 Rupiah.)

		Net change in natural resource sectors				
Year	GDP	Petroleum	Forestry	Soil	Net change	NDP
1971	5,545	1,527	-312	-89	1,126	6,671
1972	6,067	337	-354	-83	-100	5,967
1973	6,753	407	-591	-95	-279	6,474
1974	7,296	3,228	-533	-90	2,605	9,901
1975	7,631	-787	-249	-85	-1,121	6,510
1976	8,156	-187	-423	-74	-684	7,472
1977	8,882	-1,225	-405	-81	-1,711	7,171
1978	9,567	-1,117	-401	-89	-1,607	7,960
1979	10,165	-1,200	-946	-73	-2,219	7,946
1980	11,169	-1,633	-965	-65	-2,663	8,506
1981	12,055	-1,552	-595	-68	-2,215	9,840
1982	12,325	-1,158	-551	-55	-1,764	10,561
1983	12,842	-1,825	-974	-71	-2,870	9,972
1984	13,520	-1,765	-493	-76	-2,334	11,186

Notes:
1. In 1971 and 1973 "NDP" is shown as larger than GDP. Repetto explains: "... the value of additions to petroleum reserves in these years were considerably larger than all categories of depletion combined, leading to 'negative' depreciation" (Repetto et al., 1989, p.25).
2. Repetto appears to have modified GDP rather than NDP. (Presumably, NDP is not calculated in Indonesia.)

Source: Repetto et al., 1989, p.6.

Repetto's approach has attracted some strong criticism. Clarke and Dragun (1989) attempted to use it in a case study of land use in the East Gippsland region of Victoria in Australia. On the practical level they simply could not find the data required, although one would expect this to be the case for information on recreation. On a theoretical level, they found the method unacceptable. In particular:

> "*There seems to be no clearcut procedure for determining the extent to which given natural resources are being depleted to add only to current consumption, or are being replaced by more 'valuable' community assets such as agricultural land. Depletion in itself is not equivalent to depreciation*" (Clarke & Dragun, 1989, p.2).

This criticism that Repetto is "overcorrecting" because physical depletion and depreciation are not the same is one shared by El Serafy whose approach is described next.

3.3 The user cost approach

Salah El Serafy, an economist at the World Bank, is an advocate of a user cost approach to accounting for the depletion of natural resources (El Serafy, 1981 & 1989).

El Serafy partitions the annual receipts from the sale of a depletable resource into two components - an income component and a capital component - and argues that only the first component is real (sustainable) income. The second component is based on the liquidation of assets and is, therefore, illusory income. It should not be consumed but reinvested to generate interest to compensate for the lost asset. Thus, El Serafy revises GDP downward by subtracting out the capital component or user cost. Daly has suggested that the user cost should be reinvested in a substitute renewable resource (Daly, 1989b, pp.29-30) but this seems rather too restrictive.

El Serafy argues that GDP already has some user costs subtracted out since private companies may make provision for the loss of natural assets especially where a taxation advantage exists. Thus, he sees the problem as most acute where resources are publicly owned (El Serafy & Lutz, 1989, p.3; El Serafy, 1989, p.10).

To identify the user cost, El Serafy has proposed a formula for partitioning receipts into sustainable income and user cost based on the life expectancy of the resource and the discount rate.

$$X/R = 1 - 1/(1+r)^{n+1}$$

X = true income
R = total receipts (net of extraction cost)
r = discount rate
n = years over which the resource is to be liquidated
R - X is the user cost (El Serafy, 1989, p.13).

El Serafy has applied his method to several petroleum producing countries and calculated time series of GDPs modified for petroleum depletion. These are not yet available for publication. It is clear, however, from the mathematics of the formula above, that countries with petroleum reserves which are small in relation to extraction rates should regard a relatively small proportion of their oil income as sustainable (El Serafy, 1981, p.86). The dependence of the capital content of a depletable resource on the discount rate and depletion period is shown in Table 3.2.

Table 3.2 Capital content (or user cost) of mineral sales (1-X/R) as a percentage of total receipts.

Depletion period	Discount rate										
	0	1	2	3	4	5	6	7	8	9	10
1	100	98	96	94	92	91	89	87	86	84	83
2	100	97	94	92	89	86	84	82	79	77	75
3	100	96	92	89	85	82	79	76	73	71	68
4	100	95	91	86	82	78	75	71	68	65	62
5	100	94	89	84	79	75	70	67	63	60	56
6	100	93	87	81	76	71	67	62	58	55	51
7	100	92	85	79	73	68	63	58	54	50	47
8	100	91	84	77	70	64	59	54	50	46	42
9	100	90	82	74	68	61	56	51	46	42	39
10	100	90	80	72	65	58	53	48	43	39	35
15	100	85	73	62	53	46	42	34	29	25	22
20	100	81	66	54	44	36	29	24	20	16	14
25	100	78	60	46	36	28	22	17	14	11	8
30	100	73	54	40	30	22	16	12	9	7	5
35	100	70	49	34	25	17	12	9	6	4	3
40	100	66	43	30	20	14	9	6	4	3	2
50	100	60	36	28	14	8	5	3	2	1	1
60	100	54	30	16	9	5	3	2	1	1	0
80	100	45	20	9	4	2	1	0	0	0	0
100	100	37	14	5	2	1	0	0	0	0	0

Note: Figures are rounded to the nearest digit.

Source: El Serafy, 1989, p.15.

Like Repetto, El Serafy has his critics. For instance, Peskin is concerned about the stability of an adjustment to GDP that is dependent on volatile market prices (Peskin, pers. comm., 1989).

3.4 An application of both approaches

It seems premature to select any one method for correcting the SNA for resource depletion. Even if it were simply a choice between the two methods presented above, there is no clear "winner". As an example of the ongoing debate, consider the application of the depreciation approach to a renewable resource such as forests. On the one hand, El Serafy has no difficulty with a depreciation approach to renewable resources; it is in the treatment of non-renewable resources that disagreement occurs (El Serafy, pers. comm., 1989). On the other hand, Clarke & Dragun (1989) believe Repetto's approach is not appropriately applied to renewable resources.

One analyst has taken the interesting step of applying the depreciation and user cost approaches to the same set of data. George Foy adjusted the gross state product (GSP) of Louisiana for oil and gas depletion.

> "*Over the 1963-86 period, the average annual gross state product was 3.3 and 13.8 percent lower when adjusted for oil and gas depletion using the depreciation and user cost methods respectively*" (Foy, 1989, p.2).

In Foy's analysis, the depreciation-adjusted GSP is far more volatile than both the unmodified GSP and the user cost-adjusted GSP. El Serafy's approach yields a more stable time series, a point that Foy considers to be in its favour.

That the two methods give such different results indicates that selection of one or the other, or indeed any other resource depletion correction, is premature. However, a repetition of Foy's experiment would be a useful learning exercise. The correction of New Zealand's GDP for oil and gas depletion would at least highlight that all is not well with GDP as an indicator of welfare and growth and would generate debate on the sustainability of our national income.

4 Modifying the System of National Accounts for environmental degradation

4.1 The treatment of the "environment" in the System of National Accounts

Although the "environment" is not completely invisible in national accounting, its treatment produces some curious results. It is often better, economically speaking, to cause environmental damage and then to repair it than to avoid causing the damage in the first place; this is hardly an efficient form of economic growth.

There have been a number of attempts to rectify this. At one extreme, environmental accounting involves simply identifying environmental expenditures but leaving GNP unaltered (Peskin, 1990, p.9). Others have suggested removing expenditures on pollution abatement from final demand (thus reducing GNP) and reclassifying such expenditures as intermediate (Peskin, 1990, p.9). More radical suggestions are aimed at making GNP into a better welfare indicator by properly reflecting losses and gains in environmental quality.

In this last category, I now describe in some detail two sets of proposed modifications to the SNA. These two - defensive expenditures and monetarisation of residual pollution damage - deal with different aspects of the problem and are complementary, not exclusive.

4.2 Defensive expenditures

When money is spent to **maintain** environmental quality, welfare does not rise; the purpose is simply to defend existing environmental welfare. It has been argued that such defensive expenditures ought to be subtracted from, rather than added to, GDP. For example, when a homeowner invests in double-glazing in order to negate an **increase** in traffic noise, this is a defensive expenditure since welfare is not increased but merely maintained (Pearce *et al.*, p.105). When a government puts money into cleaning up the aftermath of a cyclone, this too is a defence against environmental degradation, albeit only partly of human origin.

However, not all environmental defensive expenditures show up as increases in GDP. Usually investments by businesses (in contrast to household and government expenditures) are classed as intermediate expenditures and, therefore, do not feature in GDP, which is a summation of final production.

Interest in the identification of, and subtraction from, GDP of expenditure on environmental defence is greatest in Europe. There are two major advocates -

Roefie Hueting of the Central Bureau of Statistics in the Netherlands and Christian Leipert of the International Institute for Environment and Society in Berlin.

Leipert and Simonis have summed the investment and operating expenses for waste disposal, water and air pollution control, and noise abatement to arrive at total environmental defensive expenditures for West Germany of at least DM 24.1 billion in 1984 (Leipert & Simonis, 1987, p.46) (see Table 4.1).

Table 4.1 Expenditures for environmental protection, Federal Republic of Germany. (Units are millions of DM in current prices.)

Year	Industry	Government	Industry & Government
1975	5,680	7,740	13,420
1976	6,000	8,850	14,550
1977	6,180	8,410	14,590
1978	6,390	9,780	16,170
1979	6,740	11,350	18,090
1980	7,810	12,750	20,560
1981	8,860	12,510	21,370
1982	10,110	11,890	22,060
1983	10,620	11,640	22,260
1984	10,890	11,830	22,720

Note: This does not include expenditure on environmental protection by other economic sectors such as agriculture, forestry, trade, transport, communication, and other services estimated at 1.4 billion DM in 1984.
Source: Adapted from Leipert & Simonis, 1987, p.49.

The notion of defensive expenditures has come in for a great deal of criticism. Repetto terms the concept "*elusive*" and echoes Jaszi's comment that practically anything can be considered a defensive expenditure since "*spending on food can be considered a defence against hunger*" and so on (Repetto *et al.*, 1989, p.17, Peskin, 1990, pp. 10-11). Certainly, there are many other expenditures, such as the repair, medical and policing costs associated with road crashes, which increase GDP while reducing welfare. Leipert has accepted the challenge of broadening the application of defensive expenditures beyond pollution and classifies environmental expenditures as only one of five categories of defensive expenditures (see, for instance, Leipert, 1986, and Leipert, 1989).

Another difficulty is that investments frequently have more than one purpose. When a householder invests in double-glazing, as in the above example, two outcomes are usually sought - reducing noise and keeping warm. There is a danger of double-counting.

4.3 Residual pollution damage

We do not defend ourselves against all environmental damage. A decline in environmental quality or "residual pollution damage" is another loss of welfare and, therefore, another candidate for monetarisation and subtraction from GDP.

There are two approaches to quantifying and valuing residual pollution damage. The first involves the setting of environmental quality standards and the estimation of the expenditure that would be required to meet these standards. The second approach sets no exogenous environmental targets, but instead estimates the amount of money people are willing to pay for better environmental quality. There seems to be a cultural component operating in the choice between these two approaches. The first approach is more "European" and, as we shall see, "Japanese" where there is a tradition of accepting socially agreed goals; the second is more "American" since it is based on the preferences of individuals.

Hueting and Leipert are advocates of the first approach. Hueting has, for example, worked on the costs of eliminating and compensating for what he terms "*losses of environmental function*" due to air and water pollution such as biodegradable organic matter in water and salination of the Rhine (Hueting, 1980).

Leipert and Simonis cite "*extremely cautious*" estimates of the annual environmental damage (air, water, soil and noise) in West Germany that amounts to roughly 6% of GNP - about four times as much as is spent on environmental protection (Leipert & Simonis, 1987, pp. 50-51). This is shown in Table 4.2.

One country took an initiative some time ago to correct its national income for pollution damage. In 1973, Japan initiated several corrections to its national income by producing a measure of Net National Welfare based on the Nordhaus and Tobin proposal (Pearce *et al.*, 1989, pp. 109-110). Two environmental adjustments were made. The first was the costs of complying with standards of water contamination, air pollution and waste disposal. The second was an estimate of the costs of urbanization. The extent of the adjustments can be seen in Table 4.3.

Henry Peskin is an advocate of the second approach where monetarisation of loss of environmental quality is based on "willingness to pay"; the neoclassical principle of consumer sovereignty lies at the base of his framework (Peskin, 1990). In practice of course, estimating "willingness to pay" is very difficult and various indirect methods are used. Peskin has applied his method to air and water pollution in the United States. His calculations suggest that taking account of the environmental damage due to air and water pollution would involve lowering GNP by about 2.5% in 1972 and by 1.5% in 1978 (Peskin, 1990, p.17).

Table 4.2 Environmental damage in the Federal Republic of Germany. ("Measurable damage" in units of billions of DM per year.)

Environmental sectors	Environmental damage
Air pollution	c. 48.0
Health hazards	between 2.3 - 5.8
Material damage	more than 2.3
Degradation of vegetation	more than 1.0
Forest blight	between 5.5 - 8.8
Water pollution	far more than 17.6
Damage to rivers and lakes	more than 14.3
Damage to the North Sea and Baltic Sea	far more than 0.3
Contamination of ground water	more than 3.0
Soil degradation	far more than 5.2
Costs of Chernobyl disaster	more than 2.4
Rehabilitation of "yesterday's waste"	more than 1.7
Costs of preserving biotopes and species	more than 1.0
Other soil contamination	far more than 0.1
Noise	more than 32.7
Degradation of residential amenities	more than 29.3
Productivity losses	more than 3.0
"Noise rents"	more than 0.4
Grand total of damage	far more than 103.5

Source: Leipert & Simonis, 1987, p.51 taken from Wicke, L. et al., 1986, "The ecological billions", Munich.

Table 4.3 Adjustments to GNP in Japan to obtain net national welfare. (Units are billions of yen, 1970 prices).

Fiscal year	1955	1960	1965	1970	1975	1980	1985
NNW government expenditure	1,199	1,374	2,254	2,988	3,865	4,283	4,887
NNW personal consumption	10,427	14,706	22,168	32,097	43,003	54,009	61,700
Government capital service	62	99	169	317	559	756	1,103
Personal durable goods service	91	195	755	2,342	4,187	5,270	6,813
Leisure time	4,871	6,098	7,325	10,509	16,759	18,961	20,816
Extra-market activities	1,876	2,388	4,068	7,213	12,707	12,571	13,079
Environmental pollution	-38	-1,037	-3,735	-6,805	-5,729	-3,932	-3,103
Loss due to urbanization	-452	-695	-889	-1,113	-1,119	-1,272	-1,514
NNW	18,036	23,128	32,116	47,548	74,231	90,646	103,781
GNP	17,268	26,183	41,591	72,144	93,260	118,105	143,387

Source: Pearce et al., 1989, p.110 taken from Uno, K. 1988, "Economic growth and environmental change in Japan - net national welfare and beyond", Institute of Socioeconomic Planning, University of Tsukuba, Japan.

There are clearly conceptual and data problems associated with both approaches. In the first approach, the arbitrary (politically determined) nature of the environmental benchmarks has attracted criticism.

> "*By choosing a low enough standard the costs can be made negligible and by choosing a high enough one they can be made astronomic*" (Pearce *et al.*, 1989, p.109).

According to Peskin (1981, p.515), Japan took 1955 pollution levels as a benchmark.

The second approach where valuation is based on "willingness to pay" is also problematic. Hueting is one of many critics of the approach and after listing 11 criticisms concludes:

> "*... a correction based on this method will lead to meaningless figures and most probably to a serious underestimation of environmental decline*" (Hueting, 1988, pp.7-10).

5 Other approaches to resource accounting

5.1 The information approach

Some researchers have devised approaches to resource accounting that do not involve direct SNA modifications. Some of these researchers could be characterised as pragmatists who want to get on with the job and produce information that can be used to improve the quality of decision making. Richard Norgaard expresses this attitude well.

> "*... less effort should be spent on debating and more on experimenting, learning through doing, and sharing experiences*" (Norgaard, 1989, p.57).

Norgaard is perhaps the most articulate of those who argue against modification of the SNA, seeing such modification as a force fitting of the environment into the dominant macroeconomic model.

> "*Logic ... indicates that multiple methodologies - conceptual pluralism - provide the key to a safer and more pragmatic strategy for linking environmental and economic accounting. Sustainability is too important, too multidimensional, and too poorly understood for societies to rely on one methodology*" (Norgaard, 1989, p.57).

"Non-SNA" methodologies vary greatly and it is difficult to decide in some instances whether some of them can properly be called resource or environmental accounting. The framework discussed next provides one way of deciding which information systems might be reasonably called environmental or natural resource accounts.

In the non-SNA approaches that follow this section, not all the "resource accountants" are opposed to modification of the SNA. Many would be happy to more accurately reflect environmental changes in the SNA, but see it as a culmination of various stages rather than a target that can be achieved directly. Others see attempts to modify the SNA as rather pointless since they cannot see how better management decisions would follow such modification.

5.2 The Gilbert framework

A comprehensive framework for natural resource accounting has been proposed by Alison Gilbert (Gilbert & James, 1987, Gilbert, 1987). She distinguishes between three classes of information. These three classes appear in three sets of accounts representing respectively, the environment, the environment-economy interface and the economy.

A. The environment is represented in "*stock accounts*". These give quantity and quality in physical units.

B. The environment-economy interface is represented in "*resource user accounts*". These accounts form a bridge between the environment and the economy, and record the use of stocks in a mixture of units.

C. The economy is broadened into society and represented by "*socioeconomic accounts*". These comprise the standard national accounts along with demographic elements, social indicators and government policies such as the setting of quota or environmental standards.

It seems that those who would modify the SNA are trying to collapse all three sets of accounts into one. If this is not the goal, then Gilbert's framework is a good one for deciding whether a given information system can be denoted natural resource or environmental accounting. Environmental and natural resource data bases that lack explicit formalised links with economic data should perhaps not be described as accounting systems. Set B, the "*resource user accounts*" which form the environment-economy bridge, should be present.

5.3 Examples of other approaches

In the following four sections, I describe four examples of non-SNA systems. These four have been chosen because their proponents (with one exception) have progressed beyond a conceptual framework and produced environmental accounts of one form or another. A fifth example - the Norwegian system - is described in detail in Part B of this report.

The first example is Gilbert's application of her framework described above to drylands management in Botswana and as part of a large study on renewable resources in Europe. The second example is the French natural patrimony accounts. The third example is the GIS-based system being developed in Australia. The fourth example is the energy version of the New Zealand inter-industry tables.

6 Applications of the Gilbert framework

6.1 Drylands management in Botswana

Alison Gilbert has experimented with her framework as part of a larger study on a sustainable development strategy for Botswana.

The stock accounts are set up in four groups:

Land suitability: climate, water availability, vegetation, soils
Water quantity: groundwater, surface water
Ecosystems: quantity, quality
Species: livestock, wildlife, crops, wood and thatch

Table 6.1 A stock account - surface water subaccounts for Botswana. (Units are millions of cubic metres.)

Stocks		
Storage capacity		319
Gaborone Dam		144
Mopipi Dam		90
Shashe Dam		85
Imports:	114	
Limpopo		113.5
Runoff:	55,000	
Okavango R		44,000
Chobe R		11,000
Consumption:*	207,500	
Livestock		124,600
Irrigation		122,900
Urban		40,600
Mining		44,100
Villages		17,900
Export:**	501	

* Figure excludes livestock and villages which rely heavily on boreholes.
** Excludes Okavango.

Source: Gilbert, 1987, p.23. The data is based on Arntzen, J.W. & Veenendaal, E.M., 1986, "A profile of environment and development in Botswana", Institute of Environmental Studies, Free University, Amsterdam & University of Botswana, Gabarone.

Table 6.1 is an example of a stock account for surface water. This account is incomplete since it does not balance; consumption and exports exceed stocks. Gilbert notes that such a "national" account is of limited use since:

> "*Water problems in Botswana are characterised by the spatial separation of demand and supply. Regional balances are necessary, as is vertical disaggregation into groups of regions with similarities in water demand and supply*" (Gilbert, 1987, p.22).

The resource user accounts also fall into four groups.

Livestock:	landuse/suitability, herd composition and management, production
Crops:	production, management
Wildlife:	enhancement, hunting
Settlements:	

Table 6.2 is an example of a resource user account.

The socioeconomic accounts fall into three groups.

Economic:	modified version of SNA
Social:	demography
Policy:	current environmental and resource policy

In Gilbert's framework, the modifications proposed for the SNA such as those in Sections 3 and 4 would form economic subaccounts.

Table 6.2 A resource user account - crop subaccount for Botswana.

Character	Sn	SE	Kw	Kg	Cl	NE	Nd	Ch	Gh	Kl	Botswana
Stock											
Area Ploughed											
('000 ha)	152	23	138	52	325	58	41	3	9	14	816
(% of district)	5.7	15.5	3.6	6.9	2.2	11.0	0.4	0.1	0.1	0.1	1.4
(% national cultiv.)	18.7	2.8	16.9	6.4	39.9	7.2	5.0	0.4	1.0	1.7	100
Effort											
Rural population ('000)	120	30	117	44	323	37	68	8	19	24	791
Arable practices (%)											
broadcasting											82
weeding											72
crop rotation											31
thinning											56
row planting											21
winter ploughing											40
contour ploughing											8
fencing											40
Ownership of implements (%)											
single plough											79
double plough											20
Irrigation ('000 m^3/day)											100
Expenditure: (Pula/ha)											8.0
Government policy											
National Food Strategy											x
Arable Land Development Programme											
Financial Assistance Policy											
Accelerated Rainfall Arable Programme											
Soil Conservation (Pula)											50000
Production of main cereals											
(kg/rural person)	150	250	45	55	55	55	15	10	0	0	
Income											
Current Prices (Pula)											139
Constant Prices (Pula)											101
Environmental impact											
Erosion	xx		xx								
Productivity loss (%)	12		7								

Note: Sn etc. denote codes for Botswana's administrative regions. This is a preliminary summary table.

Source: Gilbert, 1987, p.30. Based on Arntzen & Veenendaal (1986). See source for Table 6.1.

6.2 Renewable resources in Europe

An earlier version of Gilbert's framework can be seen in work done on a system devised to assist policy development in the management of renewable natural resources in Europe. Natural resource accounts were envisaged as one component of this system (Gilbert & Hafkamp, 1986; Gilbert & James, 1987).

In this earlier version, the stock accounts are termed ecological accounts. Table 6.3 is an example of an ecological quality account. The quality issue in this account is the accumulation and biological magnification of harmful substances through food chains.

Table 6.3 An ecological quality account. Concentrations of heavy metals and polychlorinated biphenyls in fish caught in the North Sea in 1982. (Units are mg/kg fresh weight.)

	Hg	Cd	Pb	Cr	Cu	Zn	PCBs
Mussel*							
Borkum	0.50	0.18	0.41	1.00	18	0.46	0.019
Oosterschelde-Hammen	0.50	0.19	0.42	1.12	15	0.26	0.220
Westerschelde-Vlissingen	0.40	0.53	0.66	1.04	20	0.87	0.031
Meetpost Noordwijk	0.50	0.37	0.67	1.15	22	0.32	0.056
Shrimp**							
Meetpost Noordwijk	0.13	0.02	0.04	0.43	13	0.01	0.010
Maasvlakte	0.10	0.01	0.04	3.60	13	<0.01	0.008
Breskens	0.10	0.01	0.05	4.20	12	0.01	0.006
Flounder***							
Ijmuiden	0.04	0.04	0.10	0.04	7	18.00	0.410
North of Goeree	0.12	0.15	0.11	0.01	17	32.00	0.780
Breskens	0.08	0.11	0.12	0.02	17	34.00	0.480
Cod***							
North of Terschelling	0.08	0.01	<0.03	-	7	13.00	1.770

* average of April and October measurements

** October measurements

*** August measurements

Source: Gilbert & Hafkamp, 1986, p.29. Taken from Rijksinstituut voor Zuivering van Afvalwater, 1983, "De waterkwaliteit van de Noordzee".

7 The French system

7.1 A framework for environmental information

The French have worked on natural resource and environmental accounts within a general framework of environmental data stratified into six levels (Theys, 1984, pp.4-5). The framework is very intricate and it is difficult to assess whether it has been of much practical use. It is an ambitious system, perhaps over-ambitious. In one review concern was expressed about "... *the fragmentation of the data within a complex set of overlapping categories*" (Friend, 1983, p.11).

Level I is environmental data that have been collected for various purposes but that have not been organised into a comprehensive framework.

Level II is all the environmental data bases that are generally byproducts of various agencies - information on water, land, wildlife, and so on.

In Level III, information from various sectors is brought together producing outcomes like state of the environment reports.

"Accounts" appear on Level IV. On the one hand, there are natural resource accounts, known as the "natural patrimony accounts", which are primarily in physical units (see Section 7.2). On the other, there are environmental satellite accounts in monetary units, in which environmental expenditures are separated out from the SNA (see Section 7.3).

Two models appear on Level V - one for forecasting the economic impacts of environmental policies and the other for forecasting the environmental effects of economic policies.

On Level VI, the aim is to supplement GNP with other indicators of national welfare.

7.2 The natural patrimony accounts

The term, "*natural patrimony accounts*" suggests a heritage to be held in trust for French citizens in the future. The most complete natural patrimony accounts are those on water. Table 7.1 is a quantity account for water whereas Table 7.2 is a quality account.

Table 7.1. A natural patrimony account - central account of water in France. (Units are billions of cubic metres.)

		A	B	C	D	E	F	G	H	I	J	K	L	Final
1,844	Initial	130	600	709	200	30	8	165	-	-	-	2		
181	A										30		1	150
717	B					5		106	6			10	5	585
885	C							140					22	723
202	D								2					200
58	E							10	2	4		2	10	30
16	F							6	1	1				8
622	G		5	150		10	8		10	4		20	282	133
286	H		10	20	2			10		244				-
534	I	50	90						265		116			13
152	J			5				140					7	-
34	K		7			3		14		2	6			2
327	L	1	5	1		10		31		279				
	Total	181	717	885	202	58	16	622	286	534	152	34	327	1,844

Water classes:

A	Snow and glaciers	G	Watercourses
B	Ground aquifers	H	Infiltrated groundwaters
C	Alluvial aquifers	I	Water vapour
D	Confined aquifers	J	Run-off waters
E	Lakes and ponds	K	Human activities
F	Dams	L	External

Source: Cornière, 1986, p.54.

Table 7.2. A natural patrimony account - a water pollution account in France. (Units are converted into population-equivalents for traditional types of pollution and into equitox terms for chemical pollution.)

Production -consumption	Emissions			Treatment capacity			Net pollution	
	OM	SS	Tox.	OM	SS	Tox.	Ordinary	Toxic
General public	31	30.8		11	8.1		42.7	
Industry	30	69.2	15	15	34.2	5	49.2	10
Agriculture			5			1		4
Total	61	100.0	20	26	42.3	6	91.9	14

Notes: OM = Organic material
SS = Suspended solids
Tox. = Toxic wastes

Source: Cornière, 1986, p.60.

7.3 The environmental satellite accounts

In an environmental satellite account expenditure on improving or maintaining environmental quality is separated out from the SNA. The intent is to establish links between the natural patrimony accounts and environmental satellite accounts such as that in Table 7.3.

Table 7.3 An environmental satellite account - expenditures on water treatment in France in 1975. (Units are millions of 1981 Francs.)

Consolidated expenditure	Total	Consolidated income	Total
Operating expenditure	17,161	Sales of goods & services	21,477
Current outward transfers	1,343	Financing from	3,151
Gross savings transfers	13,500	Current inward	7,311
	--------		--------
Total current expenditure	32,004	Total current income	32,004
	--------		--------
Investment	13,893	Limited savings	13,500
Net flow of financial assets	807	Net flow of financial liabilities	1,700
	--------		--------
Total capital expenditure	14,700	Total capital income	14,700

	National expenditure by function		
	Investment	Operation	Total
Treatment, non-connected industries	765	1,500	2,265
Drainage and treatment, local communities	6,230	6,000	12,230
Supply of drinking water	4,987	8,850	13,837
Agricultural water	1,390	350	1,740
Water control	513	300	813
	-------	-------	-------
	13,885	17,000	30,885

Source: Cornière, 1986, p.61.

8 The geographical information system approach in Australia

8.1 A policy-relevant system

One major attempt at preparing resource accounts is taking place at the Division of Wildlife & Ecology at the CSIRO in Canberra. Here work is being done on a "megatool" for natural resource management - a huge resource assessment data base that is being designed to be directly useful for policy analysis (Young, pers. comm., 1989).

The task is being tackled from both ends with some researchers collecting data and others designing the framework that will enable the data to have "*maximum policy relevance*". Natural resource accounts would be one form in which information could be extracted from this data base. Similarly, the production of a state of the environment report would be "*almost automatic*".

8.2 The geographic information system base

The system is "GIS-based". In a geographical information system (GIS) data are spatially disaggregated. (The New Zealand Land Resource Inventory is a GIS.) In the Australian system, the country is divided into "cells" that are roughly homogeneous in terms of land use and ecological conditions. Time series of various production and land use parameters are recorded for each cell. The map-based systems software SPANS is used for data storage.

In practice, all production data available at a local government area level are reallocated back out to source locations. Reallocation is achieved by taking full account of the known distributions of land use intensity across soil types, land use categories, and so on. Rates of soil loss etc. are then estimated and valued using a variety of process and economic modelling techniques.

Mike Young and his colleagues at CSIRO have no interest in leading the theoretical debate, but rather want to produce information about the links between the environment and the economy in a useful form. They are concerned that government programmes and policies often work at cross-purposes when links are not evident because of the boundaries of different analyses. For instance, tree-clearing and irrigation projects often have downstream effects that do not appear in cost-benefit analyses of the upstream projects.

The CSIRO approach is based to some extent on the work of Richard Cabe at the Center for Agricultural and Rural Development at Iowa State University. The U.S. Soil and Water Resource Conservation Act (1977) requires "*periodic data collection, analysis and reporting that amounts to natural resource accounting for the agriculture sector*" (Cabe & Johnson, 1989, p.2).

The current focus of the CSIRO work is on agricultural land and includes estimates of soil loss, salinisation, etc. An extension to include the forestry sector is envisaged but is not part of the present programme. The system is to be tested by looking at the effects of past policies. Its potential will be realised when environmental and economic impacts can be mapped for different policy options. When completed it is anticipated that it will be possible to identify quickly, for example, how a change in a tax programme would affect erosion and salinity problems, how it would change production, and which people would gain and which lose from the programme.

Young and his colleagues plan to build a set of soil and water resource accounts for agriculture in the Darling Basin in New South Wales for the years 1981-1989. Inclusion of the forestry sector is anticipated in the second phase. Expansion to cover the whole Murray-Darling Basin is anticipated in the third phase. If the approach proves successful, expansion to cover all of Australia is intended. The framework for these accounts is shown in Table 8.1.

Unlike all the other tables in this report, Table 8.1 is hypothetical. However, this work is included here because, although it is in an early stage, it has significant potential relevance to New Zealand. Table 8.1 shows the corrections that can be made to conventionally measured agricultural income when environmental degradation and the economic effects of government interventions are taken into account.

Table 8.1 Draft framework for natural resource accounts that describe soil, water and related agricultural resources in the Murray Darling Basin. (The numbers are for a hypothetical GIS cell.)

Conventional accounts			
Farm cash receipts	100		
Less: Intermediate goods & services purchased		70	
Net agricultural operating surplus			30
Plus: change in farm inventory, including land (?)		10	
Less: depreciation of farm building and equipment		4	6
Conventional net agricultural income			36
Natural resource modifications			
A. Less degradation associated with land use within cell			
Water erosion		1	
Wind erosion		1	
Salinity		8	
Soil fertility		3	
Soil acidity		0	
Soil structure decline & compaction		0	
Waterlogging		1	
Shrub invasion		0	14
Net agricultural income corrected for degradation			22
B. Correct to reveal the cause of degradation			
Less: Net off-site effects (transfers back from other cells)			
Irrigation salinity			
Agriculture	9		
Other sectors	3	12	
Dryland salinity			
Agriculture	2		
Other sectors	1	3	
Soil erosion			
Agriculture	-1		
Other sectors	2	1	
Other		2	18
			4
Add back degradation induced by other farms and sectors			
Other cells			
Agriculture		10	
Other sectors		3	
This cell but other sectors		1	14
Net agricultural income corrected to show cause & effect			18
C. Add effects of government agricultural programs and policies			
Plus: indirect farm taxes		20	
Less: farm subsidies			
Water delivery	3		
Water infra-structure	20		
Other	5	28	-8
Real net agricultural product			10
D. Add net change in other resource values caused by agriculture in this cell			
Agriculture		0	
Non-agricultural assets			
Timber production		3	
Conservation (?)		-1	-2
Real net social product from agric. sector within cell			8

Source: Young, pers. comm., 1989.

9 Energy input-output analysis in New Zealand

9.1 Input-output analysis

All resource accounting systems are based on input-output analysis since the intent of natural resource accounting is to make obscured and invisible environmental inputs and outputs visible. However, in this section, input-output analysis is taken to mean its conventional macroeconomic form.

Allied to their systems of national accounts, many countries present economic information in an input-output accounting framework. In New Zealand, this information appears every five years and is known as the Inter-Industry Study. The inter-industry tables are presented as matrices and show how goods and services move from one economic sector to another, thus revealing the structure of the economy.

The inventor of input-output analysis, Wassily Leontief, suggested in 1970 that environmental externalities could be incorporated into conventional economic input-output tables.

> "*Frequently unnoticed and too often disregarded, undesirable by-products (as well as certain valuable, but unpaid-for natural inputs) are linked directly to the network of physical relationships that govern the day-to-day operations of our economic systems*" (Leontief, 1970, p.262).

Leontief proposed one environmental input-output model; several others have also been devised (see Victor, 1972, pp. 25-52).

The main limitations of environmental input-output models are the extensive data requirements and the assumption of linear relationships when many environmental effects are non-linear; that is, damage is not necessarily proportional to stress (Cocklin, 1989, p.41).

9.2 The New Zealand energy tables

One interesting modification of the inter-industry tables has been done in New Zealand. "Energy versions" of the 1971-72, 1976-77 and 1981-82 tables have been produced at the University of Canterbury by John Peet, James Baines and others (see Hendtlass *et al.*, 1988).

In this type of energy analysis, the joule is regarded as a more robust numeraire than the dollar since energy is the one resource that is an input to all activity. Another form of energy-based resource accounting has been developed in Britain (Slesser & King, 1988).

The 1981-82 New Zealand energy input-output table is shown as Table 9.1. It can be seen that different economic sectors use different amounts of primary energy to produce a dollar's worth of economic output. Table 9.1 is to be interpreted as follows. The sector "Chemicals, rubber and plastics" has an oil intensity of 2.65 MJ/$ in 1981-82. Thus, if $100,000 of these products are required annually in the operation of a particular process, this represents an annual oil flow for that input of 265 GJ.

This work has been extended to an employment analysis of the economy where the entries in the matrix are measured in person-years employment/million $ output (Baines & Peet, 1981). An obvious extension is to energy-sourced pollutants such as carbon dioxide to assess pollutant intensities of various economic sectors.

Table 9.1. Energy intensities of output for 29 economic sectors in New Zealand in 1981-82. Units are MJ/$ except for the five energy sectors (at the top of the table) where the units are MJ/MJ.

Industry	Coal	Natu. gas	Oil	Elec.	Manu. gas	Total*
Coal mining	1.03	0.00	0.00	0.00	0.00	1.03
Crude petroleum & nat gas prod	0.00	1.14	0.00	0.00	0.00	1.14
Petroleum & coal products	0.00	0.14	1.05	0.00	0.00	1.08
Electric light & power	0.06	0.39	0.01	1.14	0.02	1.49
Gas manufacture & distribution	0.08	1.13	0.02	0.00	1.10	1.23
Agriculture	0.38	1.06	3.08	1.00	0.29	5.05
Fishing & hunting	0.16	2.68	17.50	0.37	0.13	18.61
Forestry & logging	0.34	1.60	8.65	0.62	0.19	10.12
Mining & quarrying	2.75	2.36	4.89	4.35	0.29	13.33
Food, beverages & tobacco	2.48	2.25	4.12	1.77	1.08	9.95
Textiles, apparel & leather	0.86	1.54	2.26	1.03	0.87	5.31
Wood & wood products	0.59	2.14	3.09	2.46	0.89	7.66
Paper & paper prods, printing	1.75	4.12	3.81	4.90	1.97	13.62
Chemicals, rubber, plastics	1.03	2.01	2.65	1.26	1.20	6.50
Non-metallic minerals	12.13	3.39	3.57	2.21	2.12	20.62
Basic metal industries	5.15	6.84	2.36	15.82	1.42	28.26
Fabricated metal products	0.68	1.38	1.42	1.75	0.60	4.87
Other manufacturing industries	0.79	1.45	1.86	2.24	0.46	5.89
Construction	1.40	1.28	2.31	1.29	0.53	5.89
Trade, restaurants, hotels	0.38	1.11	2.19	1.24	0.39	4.53
Transport, storage	0.32	2.15	11.74	0.89	0.23	13.62
Communication	0.15	0.50	1.34	0.48	0.15	2.27
Financing, insurance, etc	0.25	0.74	1.11	0.95	0.27	2.81
Ownership of owner-occ. dwgs	0.54	0.57	0.78	0.61	0.26	2.34
Community, social & pers. services	0.73	1.60	2.78	1.80	0.61	6.39
Central government services	1.47	0.75	1.14	0.71	0.35	3.86
Local government services	0.61	1.61	3.24	1.55	0.64	6.46
PNP services to households	0.38	1.56	2.21	1.64	0.71	5.36
Domestic services of households	0.29	0.63	1.05	0.75	0.24	2.52

* Sum of primary inputs.
Source: Baines & Peet, 1989, p.15.

10 Resource accounting activity in other countries

10.1 Modifications of the System of National Accounts

At the beginning of this report, I asserted that keeping up with international developments in this area was a major task. The examples of environmental accounting presented thus far are just that - examples, not a complete set. There is a great deal more activity underway throughout the world.

The case studies funded by the World Bank and the UN Statistical Office (UNSO) are scheduled for 1990 (Warford,1989). Other countries may join in this exercise. For instance, in a consultant's report for Environment Canada, the recommendation was made that Canada should undertake its own case study concurrently with those in the Warford proposal (Potvin, 1989).

Some countries appear to be committing themselves to the production of environmental satellite accounts even before the UNSO framework has been tested and published as a manual (Lutz & El Serafy, 1989, p.90). The Federal Statistics Office in West Germany has announced a major environmental statistics project aimed at producing a "Green GNP" by the mid-1990s (Herald Tribune, 1989). Sweden's Finance Ministry has announced that it intends to evaluate "*in hard cash the depletion of natural resources to complement the official GDP account*" (Christchurch Press, 1990).

10.2 Other approaches

There is also a great deal of environmental accounting activity that is not focused as much on SNA modifications.

The OECD pilot resource accounts on water (led by France) and forestry (led by Norway) are underway (OECD, 1988a & 1988b).

In Australia, as well as the CSIRO work, the Resource Assessment Commission is developing a forestry information system that will involve some resource accounting (Peskin, pers. comm., 1990).

The Canadians are working on environmental accounting closely linking it with their Stress-Response environmental statistical system (Friend & Rapport, 1989). A new institute is being set up for research into environment-economy interaction at the

University of Ottawa and resource accounting will be a main focus (Friend, pers. comm., 1989).

The National Institute for Environmental Studies in Japan is establishing a new Global Environment Research Center that will set up a number of global environmental data bases. The notion of establishing a common resource accounting system among Pacific Basin countries has been discussed (Whitham, pers. comm., 1990).

It is important to emphasise again that, to a very large extent, the different approaches taken to environmental accounting depend on the concerns of the "environmental accountants". Europeans tend to be primarily interested in pollution; countries with economies heavily dependent on natural resources are concerned about resource depletion. Some see modification of the SNA as an ideal; others see it as essential. The range of disagreement is perhaps not as great as it might appear; different people are working on different parts of the puzzle. But clearly, blind application of any methodology would be inappropriate for New Zealand; experiments in this area should be at least partly homegrown.

Keypoints from Part A

* The costs of natural resource depletion and environmental degradation are distorted in standard macroeconomic accounting. Attempts to remedy this are known as natural resource accounting and/or environmental accounting.

* In resource accounts both stocks and flows of resources (and pollutants) are recorded.

* The "monetary" approach to resource accounting aims at modification or supplementation of the SNA. Modification involves changing the core accounts while supplementation involves the preparation of satellite accounts.

* Proposals for direct modification of the SNA fall into two classes - corrections for resource depletion and corrections for environmental degradation.

* Corrections proposed for resource depletion include the depreciation approach of Repetto and the user cost approach of El Serafy.

* Corrections proposed for environmental degradation include the defensive expenditures approach of Hueting and Leipert for measuring the costs of maintaining environmental quality and the various methods for valuing losses in environmental quality. Examples of the latter include Uno's Net National Welfare for Japan and Peskin's downward revision of the United States GNP due to damage from air and water pollution.

* The "mixed" or "physical" or "information" approach to resource accounting involves the collection and structuring of environmental information in systems that can be linked with economic information systems.

* "Mixed" resource accounting methodologies vary greatly and include the well-developed Norwegian system, the French natural patrimony accounts, Gilbert's work on drylands management in Botswana, the GIS-based system being developed in Australia and the New Zealand energy input-output tables.

* The World Bank, the UNSO and the OECD are all coordinating research and case studies on resource accounting.

B Natural resource accounting in Norway

11 An introduction to the Norwegian experience

11.1 Why is the Norwegian experience relevant to New Zealand?

In my earlier Information Paper, I suggested that learning about the Norwegian experience of natural resource accounting would be particularly useful for New Zealand and supported my assertion with the following arguments.

Norway and New Zealand are similar countries in at least some relevant aspects. Both countries are small (Norway has four million people), with economies largely dependent on renewable natural resources like fish and forests, and on tourism. This last is important because the image of a clean environment has economic value.

Norway has put more effort into a system of resource accounting than any other country and some hardheaded evaluations of its usefulness have been and are being made. It makes sense for New Zealand to "jump up" Norway's learning curve. Further, Norway is already providing leadership to western countries in this field as the pilot country in the OECD forestry accounting study (OECD, 1988b).

It is important for New Zealand to take cues from other western countries with complex economies. Some resource accounting approaches have been developed with the policy needs of Third World countries in mind. This is encouraging since the environment has little protection where economic choices are restricted. But Third World models may not be appropriate for New Zealand.

The Norwegian resource accounting system is in physical units, but monetarisation is not precluded nor is integration into the national accounts since the Norwegian System of Resource Accounts (SRA) and System of National Accounts (SNA) are compatible.

On first taking up the recommendation to study the Norwegian system, I began to wonder if it had been such a good idea. The *Ressursregnskap* comprised a great number of tables and some figures with little structural uniformity apparent (Central Bureau of Statistics, 1981). However, after reading more recent reports and talking with some Norwegian resource accountants, I became once again impressed with the effort and with the adaptations that had occurred. Although the Norwegian system was conceived as a complete description of environmental resources, it has moved from being "data-driven" to being "issue-driven". This explains the variation in the accounts. Work that failed to yield useful information has been abandoned; the effort has become more "*partial and pragmatic*" (Friend, 1983, p.5).

Another appealing feature of the Norwegian approach is the rigorous evaluation of the accounts. They are not trying to sell a methodology but to assemble information that is genuinely useful. For instance, in his evaluation of the Norwegian experience, Øyvind Lone states:

> "*The results of natural resource accounting and managing so far are not very impressive; perhaps 'mixed but still promising' would be a fair, if optimistic, conclusion*" (Lone, 1988, p.19).

11.2 Natural resources and the Norwegian economy

Before looking at the Norwegian experience of resource accounting, it is useful to understand something of the recent history of resource management in Norway.

The Norwegian economy is very distorted; 7 to 8% of government expenditure is used for direct subsidies (Bye, pers. comm., 1989). This has been made possible by the discovery of North Sea oil. Oil income has been used to keep government expenditure high and delayed restructuring of the economy. Norwegians refer to the oil crisis of 1986, when each Norwegian "lost" 500,000 kroner in expectations.

The exploitation of natural resources in Norway has been fed by subsidies. Electricity generation is a state monopoly and certain industries that enjoy cheap power (such as aluminium smelting) are subsidised. The traditional economic activities of agriculture, forestry, and fishing are all heavily subsidised and there seems to be a cultural imperative driving this, that is, that these activities are fundamental to the Norwegian national identity. This "cultural" justification of subsidies is closely connected with "regional development" and "employment" justifications.

Like New Zealand, the "clean green" image of Norway is rather shaky. Issues such as the pollution of fjords by paper mills and the increasing eutrophification and toxicity of the North Sea have resulted in the rapid growth of green politics. In the eyes of a significant number of her citizens, Prime Minister Brundtland was not green enough.

However, the international prominence of the Brundtland Report has "*made it difficult for any government ministry to be hostile towards environmental issues*". The environment is now second on the parliamentary agenda; when the Ministry of the

Environment's follow-up to the Brundtland Report was presented to Parliament (Ministry of Environment, 1989), the carbon dioxide targets adopted by Parliament were more stringent that those recommended by the Ministry (Lorentsen, pers. comm., 1989).

11.3 The history of resource accounting in Norway

As it has already been noted, resource accounting in Norway now is very different from the original conception 16 years ago. The evolution has occurred in response to the changing perception of "the problem" and to feedbacks from practical experience. Other major factors have been a new economic environment and some political instabilities, such as frequent changes in environment ministers.

In his report to the OECD on the Norwegian experience of resource accounting, Øyvind Lone describes the development of resource accounting and the accompanying political and bureaucratic difficulties (Lone, 1988). More information is contained in the report by Alfsen *et al.* (1987). The work on resource accounts has been done jointly by the Ministry of Environment (MoE) and the Central Bureau of Statistics (CBS).

The system began officially in 1974, when a Department of Natural Resources was set up within the newly established Ministry of Environment. This department was to develop a system for natural resource accounting and budgeting.

The name given to the system reveals the perception of "the problem" and the anticipated use of the accounts in the early seventies. Firstly, the term "resource accounting" shows that the emphasis was put on resource scarcity; now the emphasis has shifted to pollution. Secondly, it was envisaged that the accounts would be used to produce resource budgets. Some resource budgets do exist - for example, total allowable catches for fish - but the term "resource budgets" went out of favour during the mid-eighties as being rather too socialist. As in New Zealand, there has been a move away from central planning toward a greater reliance on market mechanisms (Lone, 1988, p.21).

In 1978, the responsibility for resource accounting was given to the Central Bureau of Statistics, which is attached to the Ministry of Finance. A special unit with a staff of seven was set up and accounts were published for energy, fish, land use, forestry and some minerals. Later the unit expanded to some 30 staff, took over responsibility for environmental and energy statistics as well and was named the Section for Resource and Environmental Analysis (Lone, 1988).

The Ministry of Environment continued to oversee work on resource accounting and to work on mapping (land accounts) and water accounts. Its role in resource accounting seems to have virtually ceased with the presentation of the chapter on resource accounts and budgets in the government's Long Term Programme to Parliament in 1985 (Royal Norwegian Ministry of Finance, 1985; Ministry of Environment, 1985).

One of the most difficult aspects of the resource accounting work seems to have been the relationships of the Central Bureau of Statistics and the Ministry of Environment with the "line ministries" - the Ministries of Energy, Fisheries, Agriculture & Forestry, and so on. Clearly the line ministries have not been enthusiastic supporters of resource accounting. Lone gives a number of reasons for this reluctance, but notes that the major reason has been the existence of real conflicts.

> "*Linked economic/physical forecasts, which were quite feasible and might have been very useful, were therefore actively resisted by the line ministries of agriculture as well as fisheries (both very sensitive on the subject of subsidies)*" (Lone, 1988, p.18).

However, one result of Norway's follow-up to the Brundtland report has been a new policy of "environmental accountability". In their annual budgets each ministry is now required to discuss the environmental impacts of their policies, the environmental situation in their sector, and the ameliorating measures they are taking (Lone, pers. comm., 1989). Consequently, line ministries are being forced to do their own resource accounting.

Both the Central Bureau of Statistics and the Ministry of Environment continue to collect environmental data, but resource accounting defined as the formal linking of economy and environment is done by the Central Bureau of Statistics since its focus is on information that can be linked to macroeconomic models. The Research Department of the Central Bureau of Statistics contains a Resource Accounting Unit and an Environmental Statistics Unit that work closely together.

12 The structure of the Norwegian resource accounting system

12.1 Classification of natural resources

For the purposes of resource accounting and management, a distinction has been made between two main categories of natural resources - *material resources* and *environmental resources*. Material resources are distinguished from environmental resources in that they are **consumed** by the production process (the quantity changes), whereas environmental resources are **changed** by the production process (the quality changes). Material resources are further divided into three types according to the degree of renewability as shown in the following table.

Table 12.1 Classification of natural resources in Norway.

Economic classification	Physical classification	Physical properties
Material resources	Mineral resources: - minerals - hydrocarbons -stone, gravel, sand	Non-renewable
	Biological resources - in the air - in the water - on land and in the ground	Conditionally renewable
	Inflowing resources - solar radiation - the hydrological cycle - wind - ocean currents and waves	Renewable
Environmental resources	Status resources - air - water - soil - space	Conditionally renewable

Source: Longva, 1981, p.8.

12.2 Structure of accounts

There are four conceptual categories of natural resource accounts in the Norwegian system:
- material stock accounts;
- material flow accounts;
- environmental stock accounts;
- environmental flow accounts.

Material stock accounts comprise biological and mineral reserve accounts. The definition of "reserves" is problematic and explained below.

Material flow accounts trace the flow of energy and materials from their natural state to different sectors of the economy. They are thus modified input-output tables (see Section 9). Monetarising the material flow accounts would allow their incorporation into national accounts.

Environmental stock accounts are known as "state accounts". Assessment is made of the state of the environment at different points in time.

Environmental flow accounts are known as "emission accounts" and deal with the emission of waste products into air, water and soil.

In practice, stock and flow information is presented in various combinations in the forms most appropriate for the particular resource. The tables in Section 14 show this. However, in spite of the very different appearance of accounts for different resources, the principle of establishing an accounting balance remains.

12.3 Defining "reserves" of material resources

The Norwegian system is frequently described (and, sometimes, criticised) for being expressed entirely in physical units. But Norwegian resource accountants are well aware that the physical cannot be considered in isolation from the economic. This is very clear in the assessment of stock sizes, particularly for mineral reserves.

The existence of physical quantities of a resource that are not likely to be extracted in the foreseeable future is of little interest to a resource accountant. The value of a resource stock is determined by many economic factors such as extraction cost, transport cost, concentration cost (ore grade), world price as well as by physical size.

The Norwegians have focused on a subset of the resource base termed reserves. Reserves are "*supposed to be economically exploitable, measured as net numbers and given as unbiased numbers*" (Longva, 1981, p.11).

In physical terms, the sizes of stocks of mineral resources are constant, but the sizes of reserves are constantly changing. This is demonstrated by the classification system developed in Canada known as McKelvey's box.

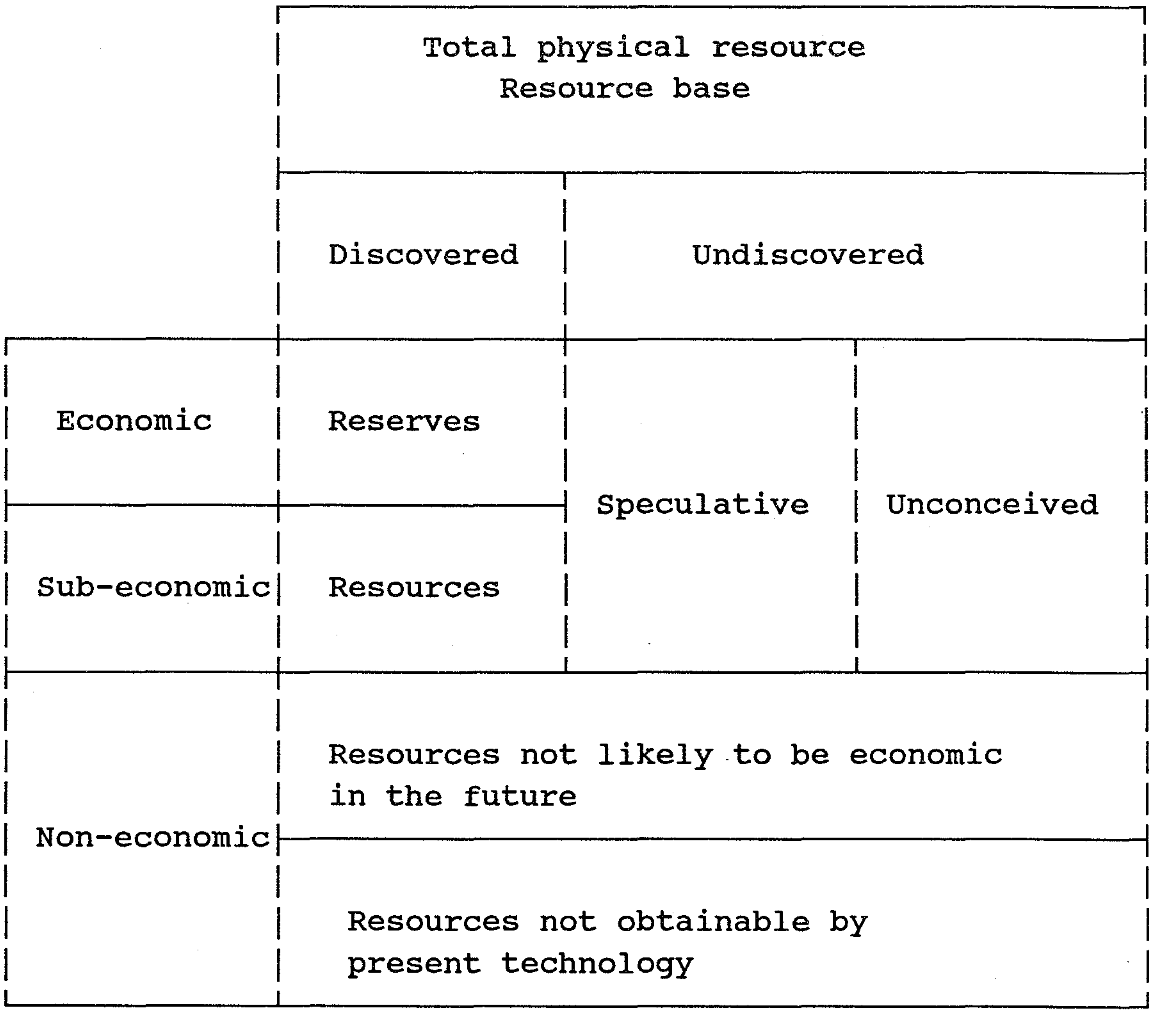

Figure 12.1 McKelvey's box. From top to bottom, economic viability decreases and from left to right, geologic certainty decreases.

Source: Alfsen, *et al.*, 1987, p.12.

12.4 Compatibility with the System of National Accounts

In Norway, there does not appear to have ever been any great enthusiasm for direct environmental modification of the SNA. For instance, Øyvind Lone considers that modifications of GDP are mostly of pedagogical value in revealing the environmental inadequacies of the SNA (Lone, pers. comm., 1989). More surprising is the attitude toward SNA modifications from the staff of the Central Bureau of Statistics since they are mostly macroeconomists who work alongside the SNA accountants. This seems to be largely the result of experience, in particular, of valuing reserves of metals and oil, and then seeing these valuations fluctuating greatly with volatile world prices (Bye, pers. comm., 1989).

The concept of national wealth (including natural capital) is at the centre of the sustainability debate in Norway and defining it has proved very problematic (Lorentsen, pers. comm., 1989). Attempts have been made to value North Sea oil and gas, but there are so many ways to do this that scepticism has been the result. When the price of oil fell in 1986 and the wealth attributable to North Sea oil fell by billions of kroner, this was a loss that had nothing to do with physical depletion.

> "*In Norway in the early 80's, many were eager to say that GDP should be lower because of the oil income but this is no longer so*" (Aaheim, pers. comm., 1989).

There is now, however, a recognition that an oil-fed GDP may be unsustainable. Government revenue from oil and gas is to be siphoned off into a special fund and invested abroad (National Business Review, 1990). This is reminiscent of El Serafy's argument (Section 3.3) for not consuming the capital component of income from resources like oil.

Norwegian scepticism about SNA modifications is not confined to the resource depletion corrections. For instance, defensive expenditure corrections (see Section 4.2) are criticised on the grounds that expenditure on the environment does not reflect environmental welfare and, therefore, subtracting defensive expenditures from GDP does not improve GDP as an indicator of national welfare (Aaheim, pers. comm., 1989).

Although the Norwegians have not integrated their NRA system with the SNA, they have designed the NRA system to be **compatible** with the SNA system because:

> "*If we are to have any kind of an environmental or natural resource policy, we must forecast and this means nothing unless it is tied in with macroeconomic models*" (Bye, pers. comm., 1989).

Table 12.2 depicts the structure of material resource accounts. The Reserve Accounts (Part I) are not related to the SNA but in the others (Parts II and III), the definitions of commodities and sectors are those used in the SNA. The linking of the NRA to the SNA is the most complete with the energy accounts, since all production sectors of the economy use energy. In contrast, the fish accounts have few links with the SNA; the detail in the fish accounts occurs in Part I (Alfsen *et al.*, 1987, p.12).

Environmental flow accounts can also be linked to the SNA. For instance, estimation of the quantities of various pollutants produced by different sectors of the economy can form the basis of modelling the economic effects of pollution policies (and the pollution effects of economic policies).

Table 12.2 Structure of material resource accounts.

I Reserve accounts	
Beginning of period:	Resource base Reserves (Developed, Non-developed)
	Total gross extraction during period
	Adjustments of resource base (New discoveries, reappraisal of old discoveries)
	Adjustments of reserves (New technology, cost of extraction, transport etc., price of resource)
End of period:	Resource base Reserves (Developed, Non-developed)
II Extraction, conversion & trade accounts	
	Gross extraction (by sector) - Use of resource in extraction sectors = Net extraction (by sector)
	Import (by sector) - Export (by sector) = Net import (by sector)
	Changes in stocks
For domestic use:	Net extraction + net import +/- changes in stock
III Consumption accounts:	
	Domestic use (final use category, commodity)

Source: Alfsen, et al., 1987, p.13.

13 The benefits of the Norwegian accounts

13.1 The envisaged use - resource budgets

The use envisaged for resource accounting was the preparation of resource budgets, that is, the establishment of depletion rates for mineral resources, harvesting quota for biological resources, and so on. A resource budget for an environmental resource would comprise environmental quality targets such as maximum emissions of air pollutants. In practice, the term has been interpreted more broadly.

> "*The purpose of natural resource budgeting is to use the natural resource accounting, analysis and forecasting framework in order to better integrate the management of natural resources and the environment, such as (i) better integration of environmental and economic planning, (ii) better integration of the plans and policies of various bodies and agencies managing (parts of) the same resource as well as resources whose management involves major implications for other resources, and (iii) better integration of national and regional management policies*" (Lone, 1988, p.14).

Because resource budgeting is virtually synonymous with planning, it is clear that the political emphasis on resource budgeting has changed as planning has become "unfashionable" (Alfsen *et al.*, 1987, p.33). Originally it was envisaged that Natural Resource Budgets would be presented to Parliament at regular intervals. Every four years in Norway, the incoming Government prepares a Long-Term Programme (LTP) which describes its economic and social aims and political directions. The Ministry of Environment planned to present Natural Resource Budgets to Parliament as separate reports at the same time as the LTP. The decision to include Natural Resource Budgets as only a chapter (and appendix) in the 1985 LTP, and not as separate reports, was clearly a great disappointment (Royal Norwegian Ministry of Finance, 1985, Ministry of Environment, 1985).

> "*The only non-historical numbers given in the chapter were key figures concerning land utilization in 1990, key figures concerning water supplies in 1990 and 2000, emission prognoses in connection with energy consumption for 1990 and 2000 and key figures concerning ocean fisheries and fish farming in 1989. None of these short overviews were budgets in the sense of planned or optimal use, and only the emission prognoses had any connection to the economic and energy scenarios presented elsewhere in the programme... If the 10-15 years of preceding work should be judged by the results*

appearing in the LTP the conclusion would be easy: The mountain had given birth to a mouse" (Alfsen *et al.*, 1987, pp.33-34).

However, this is not the whole story and although Natural Resource Budgets have not been fully integrated into the LTPs, they have been presented in other forms with some effect. For instance, the forecasting of electricity in Norway is now done by using the information in the energy accounts in the major long term macroeconomic model (Lone, 1988, p.25). The outcome of this - the curbing of over-investment in hydropower - is acknowledged as one of the major achievements of resource accounting in Norway.

Simple natural resource budgets for land and water appear as Tables 14.4 and 14.12 in this report.

Norway's response to the Brundtland Report contains a number of environmental goals that might well be termed environmental budgets, for instance, "*to reduce the* NO_x *emissions by 30 per cent by 1998, with 1986 as the base year*" (Ministry of Environment, 1988, p.9). Further, because of the systematic nature of the information contained in their environmental statistics and resource accounts, the Norwegians can identify measures that will enable such goals to be achieved.

13.2 Responding to issues - providing "relevant" benefits

In Section 11.1, Norway's system of resource accounting was described as having moved from being data-driven to being issue-driven. Another way of putting this would be to say that conceptual purity and completeness have been abandoned in response to the urgent demands generated by current issues. The desire to provide "relevant" benefits has been a major factor in the evolution of the system.

One major shift already mentioned has been the change in emphasis from resource scarcity to the externalities imposed by resource use. For example, attention has shifted from energy depletion to air pollution caused by energy consumption.

As in New Zealand, sustainable development has been the focus of much debate in Norway. In New Zealand, attention has focused on whether sustainable development should be the overriding objective of the proposed Resource Management Act. In Norway, the prominent international role played by the last Prime Minister has presumably increased interest in the concept. The Resource Accounting Unit in the Central Bureau of Statistics is working on the notion of supplementing GDP with "indicators of sustainability" (see Section 18).

The free flow of information is basic to the concept of democracy. The resource accounts and environmental statistics published in Norway have in themselves engendered a great deal of interest in, and debate on, environmental issues. *Miljøstatistikk 1988* (*Environmental Statistics 1988*) was a best seller. Energy provides a good example of the interest generated by information. It is a heavily subsidised and polluting resource and, in Norway, the manufacturing sector has tried to make energy a non-issue. The existence of energy and air pollution accounts and statistics has kept energy alive as an issue (Bye, pers. comm., 1989).

With sustainable development as a goal or otherwise, numerical information on the state of the environment, (defining environment in the broadest sense including natural resources), is essential for good policy and management. Resource accountants in Norway spoke of the benefits of keeping "tabs" on the environment through a systems overview. For instance, if the demand for electricity has grown, energy accounts will tell us where this growth has occurred. With such information, forecasting of the effects of environmental policies using macroeconomic models is possible. One cannot make good decisions without being able to predict the effects of various options.

Another example of the adaptability of the resource accountants with particular relevance to New Zealand has occurred in the level of resource accounts. It is relatively meaningless to put "localized" resources like land and water into national level resource accounts (Lone, 1988, p.34). An excess of water in Northland is no use to Central Otago.

Attempts were made in the late seventies and early eighties to establish regional level resource accounts. One major obstacle has been that natural resources are managed either at the national or local level, with virtually no power at the regional level and, consequently "... *regional forestry accounts found no real users/managers*" (Lone, 1988, p.18).

Another case where national level resource accounts made little sense is for sand and gravel. Sand and gravel are scarce in some regions and transport costs are high. A national **register** of sand and gravel, which provides information on regional reserves in terms of standardised assessment procedures, has apparently been useful for resource managers. But national **totals** of sand and gravel are of little practical use (Lone, pers. comm., 1989).

13.3 Unanticipated benefits

Resource accounting in Norway has clearly generated many incidental benefits. Although accounts for some resources have been abandoned, this does not mean that the exercise of preparing them was valueless.

> "*... the only realistic view of the process of developing and introducing such an innovation ... is as a learning process*" (Lone, 1988, p.20).

One example of education and discovery occurred with metals. When Asbgørn Aaheim began work on metal accounts by travelling to nine mines he found that most of the geologists had a "*strange view of resource estimates*" (Aaheim, pers. comm., 1989). Very few were familiar with statistics and uncertainty and found his request for ranges in estimates odd. However, most were willing to cooperate and happy to be educated into providing minimum, expected and maximum estimates of resource stocks using Monte Carlo simulation. Another education process involved understanding and accepting the McKelvey box definition of reserves (see Section 12.3) and "*each year expected reserves dropped as geologists became more willing to accept that price mattered*".

The presentation of data in various forms seems to have led to some unexpected insights into policy advice. The collection of data is not a passive exercise and there is a strong feeling in CBS that the presentation of numbers is only the beginning; there is an obligation to say how the numbers should be used.

Aluminium smelting is one example where implications for policy have flowed directly from data. Aluminum smelters pay as little as 8 øre per kWh for electricity - a third to a seventh of the residential price (Aaheim, pers. comm., 1989). When attempts are made to renegotiate electricity contracts, the response is that the smelters would be forced to close down because output would fall if they had to pay more for electricity and that would create regional unemployment. But data collected by the CBS shows that output could remain constant if the electricity price rose and the labour force was reduced. The implication is clear. The subsidy on the price of electricity is "justified" on the grounds of employment and regional development. The fiscal instrument is misdirected; it should be directed toward labour not electricity, and then labour-intensive industry, not energy-intensive industry, could be encouraged in the regions (Bye, pers. comm., 1989).

Finally, it should be understood that the benefits of resource accounting are very dependent on the resource accountants. Those given the job of preparing resource accounts (or environmental statistics) should build on their skills while recognizing that they may not be capturing the full picture.

14 Resource accounts for various sectors in Norway

14.1 Energy

Norway is an energy-rich country. As well as the enormous bonus of North Sea oil and gas, Norway shares with New Zealand the advantage of a vast resource of hydroelectricity. Electricity production in Norway totals about 100 TWh per year (virtually all hydro) in contrast with New Zealand's 29 TWh per year (about 75% hydro). Norway's four million people would seem to be comparatively profligate in their electricity use but, as well as having a much colder climate to cope with, they export excess electricity directly and indirectly (embodied in energy-intensive products like aluminium).

The energy accounts are unquestionably the most successful of all the resource accounts. They are widely used by various planners and generate considerable comment from the public. As well as energy accounts, energy statistics are also published both as a special report (Central Bureau of Statistics, 1988c) and as a chapter in the environmental statistics report (Central Bureau of Statistics, 1988b). There are many reasons for the relative success of energy accounts and energy statistics, ranging from the continuity of the effort and the resulting competence (Alfsen *et al.*, 1987, pp.48-49) to patterns of resource ownership and consumption, and the extent of public management (Lone, 1988, pp.15-16).

The energy accounting effort has had effects on electricity policies but not on oil policies. Although Norwegian depletion rates of North Sea oil have peaked later than Britain's, this has apparently not been influenced by the energy accounts (Lone, pers. comm., 1989). However, energy accounts for oil and gas are still seen as important. For instance, the continued publication of estimates of oil and gas reserves is seen as being in the public interest, because these reserves are so large and so vulnerable to changes in world price (Aaheim, pers. comm., 1989).

The major achievement of the electricity accounts is seen as the most significant outcome of the whole resource accounting effort to date, that is, the much improved forecasting of electricity demand which has led to the curbing of over-investment in hydropower. Up until 1978, forecasting of demand was done by the supplier, that is, the Norwegian Water and Electricity Board, and was based on "*crude energy/GNP per capita calculations*" (Lone, 1988, p.12). The energy accounts and associated statistics (for example, energy elasticities) have enabled much more sophisticated forecasting of energy demand using the CBS's major long-term macroeconomic model, the Multi-Sectoral Growth (MSG) model.

As a consequence, the building of hydro dams slowed right down in 1980. However, the pressure is on again with the "hydro lobby" using the greenhouse effect to argue for more hydroelectricity to substitute for fossil fuels; this is an argument that we can increasingly expect to hear in New Zealand. The "energy accountants" are trying to divert the pressure for more hydroelectricity into pressure for energy conservation (Bye, pers. comm., 1989).

A Type I (see Table 12.2) energy account showing reserves of hydropower in Norway is shown as Table 14.1.

Table 14.1 Reserves of hydropower in Norway. Mean annual production (GWh) and economy class of concession granted, concession applied for and prior noticed watercourses at 1 January, 1987.

Watercourse	Average annual production	Economy-class
Developed at 1 Jan. 1987	102,716	
Concession granted	4,447	
Jostedalen	879	3
Kobbelv	711	3
Alta	625	1
Others*	2,241	
Concession applied for	12,217	
Holandsfjord	1,980	3
Glitra	830	1
Skåre	825	5
Stavem	768	2
Oyberget	507	1
Others*	7,307	
Prior noticed	6,559	
Grong	538	3
Trofors	1,203	4
Others*	4,818	

* Projects with mean annual production of less than 500 GWh.
Source: Central Bureau of Statistics, 1988b, p.63.

The Norwegian experience in encouraging energy conservation (or energy management) is particularly pertinent to New Zealand. In the response to the Brundtland report, there seems to be a new commitment to energy conservation which is informed by the failures of the earlier efforts (Ministry of Environment, 1989). Energy conservation has been on the agenda for some time but some hard lessons have been learned about the folly of, for instance, "soft" loans for insulation. This time the push for energy conservation is motivated by the desire to reduce air pollution rather than by the desire to slow resource depletion.

"Conservation of energy can make an effective contribution to the reduction of emissions, including CO_2, NO_x and SO_2. Grants for energy conservation measures over the national budget make up 217 million kroner in 1989. In recent years, use of these funds has been reorganized, so that they are directed to a larger extent towards measures which have major effects" (Ministry of Environment, 1989, p.34).

Energy accountants in Norway are now somewhat sceptical of a microeconomic approach to assessing the potential for energy conservation because of the partial nature of analyses (Bye, pers. comm., 1989). For instance, Government has, in the past, loaned money cheaply to reasonably wealthy householders for double-glazing. Net energy savings are by no means certain; savings in home heating energy will translate into more disposable income, which may well be spent on energy-intensive leisure. It is only through macroeconomic interventions such as removal of energy subsidies and addition of energy taxes (to account for externalities like the greenhouse effect) that a less energy-intensive economy can develop.

The information contained in energy accounts is essential for a macroeconomic approach to energy conservation. With additional parameters such as energy elasticities, the impact of such interventions can be forecasted. A Type II and III energy account (see Table 12.2) is shown in Table 14.2. This table shows how energy consumption can be linked explicitly to economic sectors. Consumption can be further disaggregated to some 150 economic sectors.

Table 14.2 Extraction, conversion and use* of energy in Norway in 1986. (PJ)

	Total	Coal	Coke	Bio-mass	Crude oil	Nat-ural gas	Refin-nery prod.	Elec tri-city
Extraction of energy	3142	12	-	-	1754	982	43	351
Energy use in extraction sectors	-49	-	-	-	-	-40	-3	-6
Imports & purchase abroad	443	22	30	0	86	-	290	15
Exports & foreign purchase in Norway	-2597	-3	-6	0	-1496	-934	-150	-8
Stocks (+ decrease, - increase)	-12	-1	-2		-6		-3	
Primary supply	927	29	22	0	338	8	177	353
Petroleum refineries	-17	-	5	-	-312	-	291	-1
Other energy sectors, other supply	33	-12	9	32	-	-	3	1
Registered losses, statistical errors	-82	-1	3	-	-26	-8	-21	-29
Use outside energy sectors	861	16	39	32	-	-	450	324
Ocean transport	122	-	-	-	-	-	122	-
Inland use	739	16	39	32	-	-	328	324
Agriculture & fishing	30	0	-	-	-	-	27	3
Energy intensive manufacturing	189	8	31	0	-	-	47	103
Other manufacturing & mining	116	8	7	14	-	-	36	52
Other industries	198	-	-	-	-	-	140	58
Private households	206	0	1	18	-	-	78	109

* Includes energy used as raw materials.
Source: Central Bureau of Statistics, 1988b, p.68.

14.2 Fish

A great deal of effort has gone into fish accounts but they are considered to have had very little impact. Some fish stocks have been monitored for 50 years and it has been obvious that some were declining, but sustainable yield has never been taken seriously (Bye, pers. comm., 1989). The preparation of fish accounts has made little difference to this situation.

The fishing lobby is extremely strong in Norway. It is one of the traditional economic activities where subsidies are justified on grounds of employment and regional development. Subsidies were related to catch weight but recently have been related to investment in new boats and technology and so are less obvious since they come through the Ministry of Industry not through the Ministry of Fisheries (Glømsrod, pers. comm., 1989).

Not surprisingly, the fish accounts have not been popular with the fishing industry nor with the Ministry of Fisheries. Easily available official fish data have been mostly catch information, that is, one set of flows. Even catch data present difficulties due to the large amount of fish consumed but not sold; domestic consumption is about 30% higher than domestic sales (Lone, 1988, p.27). Through the fish accounts, information has become more publicly accessible.

North East Arctic cod is the commercial species that once comprised half the value of all the saltwater fisheries. Figure 14.1 shows a resource account for cod that conveys a great deal of information graphically, for instance, the purpose of TAC's. However, the stock assessments in the figure should be viewed sceptically. The optimism suggested by the rising stock has apparently been misplaced; the latest stock assessments have led to a recommendation to reduce the cod quota to less than half (Glømsrod, pers. comm., 1989). Table 14.3 shows how much stock estimates for this species varied over a short period. For instance, the stock of cod in 1975 was assessed at 3.6 million tonnes in the following year but, by 1981, with the benefit of greater hindsight, the stock in 1975 was believed to have been only 2.76 million tonnes.

Since a major purpose of resource accounting is to provide information for forecasting, some work on fish supply and demand models has been done. One area of work has involved forecasting the impacts of various harvesting strategies and quota on future fish stocks; presumably, the uncertainty in stock estimates discussed above has made this difficult. In addition, considerable work has been done on a fish export model and on a model of the fish processing industry. Neither of these has been a success (Lone, 1988, p.13).

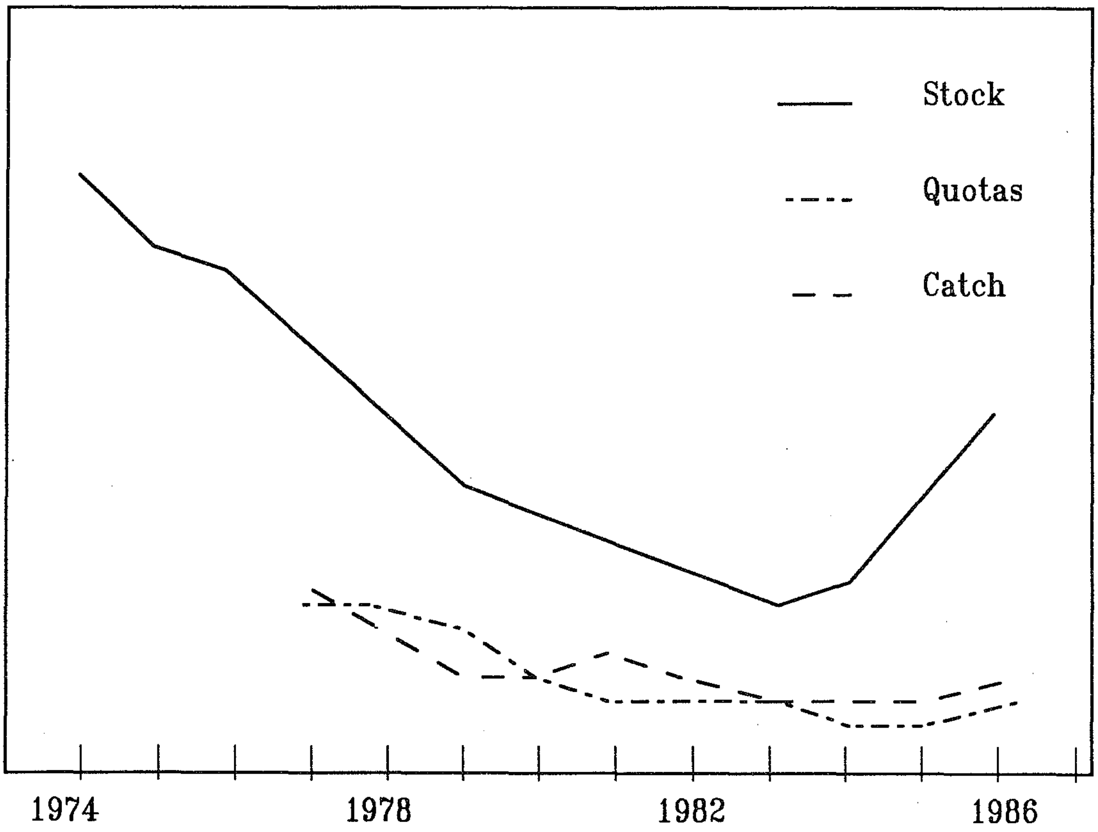

Figure 14.1. Stock, quota and catch of North East Arctic cod in Norway, 1977-86. (1000 tonnes.)

Table 14.3 Stock estimates for North East Arctic cod (over 2 yrs old). (1000 tonnes)

	Year of evaluation					
	1976	1977	1978	1979	1980	1981
1964			1970	1970	1970	1970
1965			2190	2190	2190	2190
1966	3430		3070	3030	3030	3030
1967	3860	3850	3860	3860	3860	3860
1968	3980	3970	3970	3980	3980	3980
1969	3420	3410	3410	3430	3420	3420
1970	2440	2410	2420	2440	2430	2430
1971	1900	1870	1860	1880	1870	1870
1972	2180	2140	2040	2080	2060	2050
1973	3230	3270	2930	3030	2990	2980
1974	3540	3590	3030	3160	3100	3090
1975	3600	3620	2750	2870	2780	2760
1976		4110	2750	2720	2600	2550
1977			2500	2350	2290	2200
1978				1920	1980	1970
1979					1690	1720
1980					1500	1660
1981						1560

Source: Central Bureau of Statistics, 1982, p.22.

14.3 Land

The land accounts presented in the 1981 *Ressursregnskap* form the second biggest section after energy (Central Bureau of Statistics, 1981). Some 22 tables and 8 figures are presented. It appears that regular updating of this enormous amount of data has not occurred and the land accounts seem to illustrate the shift from a data emphasis to an issues emphasis. In the 1987 and 1988 *Naturressurser og miljø* (Central Bureau of Statistics, 1988a & 1989), the land chapters are much shorter and entirely concerned with agriculture.

The work on land accounts began with three major projects that were to establish:
- a survey of the major land use / land cover / land potential categories;
- a survey of urban land use and land use changes; and
- a system for "planned use" accounts, that is, a register of present and planned land use on the municipal level that would be regularly updated (Lone, 1988, p.11).

The first two of these projects turned out to be expensive exercises and although they provided useful data bases, regular updating of all the information does not seem to have occurred, presumably, because it was not cost-effective. These land data bases have provided valuable information for agriculture and policy on the in-filling of urban land with buildings. Norway has a national policy of 50% self-sufficiency in food production and a major task has been the development of a "Self-sufficiency model" to provide information necessary to implement this policy.

Table 14.4 is a land account and a land budget since the column on the right is a target for the future. However, it is not a satisfactory account since it does not balance; one cannot tell, for instance, which type of land is to become protected. Lone states that the "*major problem in land use accounting is the lack and/or unreliability of regular, preferably annual data on land use changes*" (Lone, 1988, p.33), a problem that is shared by New Zealand's Land Resource Inventory.

Table 14.4 A land account and budget. Key figures concerning land utilization in Norway. (km^2)

Land class	1972	1982	1990
Mainland, total land area	323,900	323,900	323,900
Built-up area	3,700	4,000	4,250
Agricultural area under cultivation	9,500	9,500	9,700
Productive forest area	66,950	66,450	66,370
Protected area	3,400	12,100	16,500
Arable land	8,900	8,400	8,100
Svalbard	62,700	62,700	62,700
Protected area	0	34,900	34,900

Source: Ministry of Environment, 1989, p.5.

14.4 Forestry

Forestry accounting has been only a minor part of the resource accounting effort and does not appear to have been successful in influencing management or policy decisions. The purpose of forestry accounts has clearly caused some soul-searching.

For instance, the national stock of spruce shown in Table 14.5 is really of no practical use. There is no scarcity of production trees in Norway; there are many subsidised forests that will not be harvested since timber grown on flat, accessible land in Sweden and Finland will always be cheaper. Regional stock accounts may be of more direct use.

Table 14.5 Forest balance in Norway, 1985. Millions of m^3 (over bark).

	In all	Spruce	Pine	Broadleaves
Stock 1 Jan. 1985	616.93	282.06	197.32	137.55
Annual increment	20.59	9.54	5.44	5.61
Natural losses	1.65	0.76	0.44	0.45
Gross removals	11.63	7.82	2.18	1.62
(Net removals	10.97	7.38	2.06	1.53)
Stock 31 Dec. 1985	624.25	283.01	200.14	141.09

Source: OECD, 1988b, p.5.

However, the forestry accounts have produced some interesting monitoring information. For instance, a mass balance for wood raw materials, which includes by-products, waste and emissions, has shown the following.

> "*Over the period 1975-1985, the forestry accounts show a considerable increase in the utilization of wood-based waste for energy production and in the total utilization rate (up from some sixty to some eighty percent) and a major reduction (ninety-five percent) in pollution of water from wood pulp production, mainly as a result of higher energy prices and stricter pollution control measures*" (Lone, 1988, p.29).

The mass balance for 1983 is shown in Table 14.6.

Table 14.6 Timber industry mass balance, Norway, 1983. (1000 tonnes dry weight.)

	Saw-logs	Pulp-wood	Fuel sold	Resi-dues	C/M pulp	Main prod.	Fuel used	By-prod.	Emis-sion	Loss error
Sawing and planing										
input (-)	2143	2				153				
output	7	38	31	884		1074	148		48	68
Particle board prod.										
input (-)	6	116		143		17				
output						209	21			52
Fibre board prod.										
input (-)	1	38		89						
output						99	3		8	18
Mechanical pulp prod.										
input (-)		972		101						
output						907	49		67	50
Chemical pulp prod.										
input (-)		832		537		70				
output			1			646	494	130	96	72
Paper & board prod.										
input (-)					1129	76				
output						1158			22	25

Source: OECD, 1988b, p.7.

Trees serve functions other than timber production and continuing work on forestry is seen as vital because of the links with energy and water pollution as above, but also because of the links with land use (including protected areas), with wildlife, with the greenhouse effect and with acid rain. An effort to link forestry stocks with land use data has been successful following the merger of the National Forest survey with the Institute of Land Registry (Lone, 1988, p.28). The more environmental links will be harder to formalise.

Work on forest inventories has now gone beyond the purely physical (as in Table 14.5) into the economic, by classifying forest stocks into cost classes according to harvesting and transport costs. Work on demand analysis for forest products (see Table 14.7), intended to lead to better forecasting of demand, has not been successful mainly due to poor data (Aaheim, pers. comm., 1989).

Norway is currently leading an OECD pilot study on forestry resource accounts (OECD, 1988b). New Zealand has been invited to take part in this study along with Canada, Italy, Finland, France and Sweden. Tables 14.5, 14.6, and 14.7 provide models for the three types of accounts planned.

Table 14.7 Sector/commodity balance - extraction, conversion and use of forest products in Norway. 1985.

	Saw-logs	Pulp-wood	Fuel sold	Rsi-dues	Sawn wood	Part board	Fibre board	Mech pulp	Chem pulp	Paper board
	1000 m^3					1000 tonnes				
Removals	5202	4455	1308							
Imports	148	989	118	614	652	50	8	13	100	294
Exports (-)	220	327	2	176	314	29	29	242	370	1338
Inventories	-35	520		3	-3	-1	-2	-1	17	-16
Primary supply	5095	5637	1424	441	335	20	-23	-230	-253	-1060
Sawing and planing										
input (-)	5112	6		1	431					
output	28	94	82	2485	2465					
Particle board prod.										
input (-)		256		328	1	22	1			3
output						275	3			
Fibre board prod.										
input (-)	2	83		105			1	2		1
output				18			102			
Mechanical pulp prod.										
input (-)		2903		456				6		
output			8	17				1278		
Chemical pulp prod.										
input (-)		3040		853						
output			4						716	
Paper & board prod.										
input (-)								1041	477	109
output									5	1649
Other supply	42		920	171	161	6				177
Losses, stat. error	715	566	-188	-1029	252	14	26	4	13	7
End use sectors:	766	9	2250	360	2781	293	106	3	4	660
Agriculture & fisheries	363			49						
Prefab. dwellings	95				174	30	10			3
Building materials	249	1		3	660	19	6			
Furniture, fixtures	1	8			126	57	4			
Paper goods/packaging								3	3	296
Printing										171
Newspaper/publishing										160
Other manufacturing	32		70	193	58	17	6		1	30
Building/construction	26			85	1531	170	80			
Commerce, transport					4					
Public administration					72					
Private households				2180	30					
Unspecified/packaging						156				

Source: OECD, 1988b, p.6.

14.5 Minerals

In the Norwegian resource accounting classification, minerals are put into three groups - fossil fuels, metals, and other. The fossil fuel accounts are included in the energy accounts, so the minerals accounts comprise metals accounts and accounts for sand, gravel, rock, quartz, limestone, etc.

Although Lone states that no real successes can be claimed for the modest efforts with mineral accounting, there have been spinoff benefits such as the spreading acceptance of the McKelvey box approach discussed earlier. Before the metal accounts, estimates of metal reserves were usually not connected to economic valuations. In Table 14.8, which shows reserve accounts for iron, copper and zinc, depletions are minor compared with some of the changes due to re-evaluation. From the beginning of 1980 to the end of 1986, the size of iron reserves fell from 157.3 million tonnes to 25.25 million tonnes; 13% of the change was due to extraction and 87% to re-evaluation.

Table 14.8 Reserve accounts for iron, copper and zinc in Norway, 1980-86. (1000 tonnes pure metal.)

Year	Reserves 1st Jan.	Extraction	Re-evaluation 31st Dec.	Reserves 31st Dec.
Iron				
1980	157,300	-2,500	-3,200	151,600
1981	151,600	-2,667	-70,933	78,000
1982	78,000	-2,125	-873	75,000
1983	75,000	-2,299	-1	72,700
1984	72,700	-2,497	-35,577	34,700
1985	34,700	-2,246	-4,494	27,960
1986	27,960	-2,385	-325	25,250
Copper				
1980	502	-29	-83	390
1981	390	-28	-82	280
1982	280	-28	-2	250
1983	250	-23	-2	225
1984	225	-25	-22	178
1985	178	-24	-20	134
1986	134	-22	10	122
Zinc				
1980	535	-27	-63	445
1981	445	-30	-85	330
1982	330	-32	2	300
1983	300	-32	2	270
1984	270	-29	-91	150
1985	150	-27	21	144
1986	144	-27	71	188

Source: Central Bureau of Statistics, 1988b, p.54.

The second "educational" result of minerals accounts was the requirement to supply a range of stock estimates rather than just one number (see Table 14.9).

Table 14.9 Estimates of Norwegian metal resources, 1st January, 1987. (1000 tonnes pure metal.)

Metal	Category	Low	Expected	High
	Proven	23,495	25,253	27,140
Iron	Probable	11,865	13,870	16,302
	Possible	58,783	63,824	69,713
	Proven	104	122	145
Copper	Probable	15	17	23
	Possible	45	60	220
	Proven	165	189	215
Zinc	Probable	15	18	23
	Possible	157	231	483
Pyrite	Proven	2,862	3,427	4,114

Source: Central Bureau of Statistics, 1988b, p.53.

Resource accounts have been prepared for sand and gravel by extending registers to include extraction and use. As noted earlier, such accounts make little sense nationally since management is necessarily local and regional because of high transport costs and land use implications (Lone, 1988, p.26).

A recent report on industrial minerals has recommended a change in focus to "*minerals such as limestone, dolomites and quartz, which are produced by several producers, and where a large part of the production is consumed or processed nationally*" (Lone, 1988, p.26). Again this is consistent with an issues approach. For instance, a mass balance for quartz has shown how silica dust once emitted to the atmosphere in the production of ferrosilisium is now recovered and sold as a reinforcing cement additive (Lone, 1988, p.26).

Within the CBS, the primary concern with the extraction of "traditional" metals seems to be with subsidies. Estimates of the total resource rents paid for metals extraction are negative and have grown from 212 million kroner in 1975 to 695 million kroner in 1986, that is, an increasingly large social subsidy has been paid for the extraction of these metals (Central Bureau of Statistics, 1988b, p.55).

14.6 Air

The major effort in environmental accounting in Norway has been directed at air pollution. The environmental accounts for air contain data obtained from direct monitoring of air quality (30 urban stations and 6-8 rural stations) and data deduced from energy use and industrial statistics (Alfsen *et al.*, 1987, p.29).

The general aim of the work has been to identify the links between economic activity and the production of various pollutants. When these links are identified, it is possible to model the impacts of various measures to reduce air pollution. Thus, accounts showing emissions of sulphur dioxide, nitrogen oxides, and carbon monoxide from the activity in various economic sectors have been prepared using historical data back to 1976 (see Table 14.10). More recently, accounts showing emissions of volatile organic compounds, particulates, carbon dioxide and lead by sector have been prepared. In 1982 and 1984, regional surveys also assessed emissions of ammonium, hydrocarbons, cadmium and mercury (Alfsen *et al.*, 1987, p.29). Inventories of methane and nitrous oxide have been developed for the year 1987. Emission input-output tables have also been generated (Lorentsen, pers. comm., 1990).

Table 14.10 Emissions of SO_2, NO_x and CO by sectors[1] in Norway, 1976, 1980 and 1985. (1000 tonnes.)

	SO_2			NO_x			CO		
	1976	1980	1985	1976	1980	1985	1976	1980	1985
	155	150	105	191	194	223	589	608	590
Agriculture	3	2	1	4	5	6	14	14	15
Fishing, sealing, whaling	3	3	3	31	26	30	6	6	6
Manufacturing, mining, quarrying	114	109	71	33	24	26	49	48	44
Pulp & paper	33	26	8			1			0
Energy intensive manufacturing[2]	45	54	53			19			38
Other manufacturing & mining	36	29	10			6			6
Oil extraction & oil well drilling	1	2	1	6	13	17	1	1	2
Construction	2	2	1	4	5	7	3	4	4
Trade, services	9	7	5	16	17	19	101	83	74
Transport	17	20	20	74	80	86	50	49	42
Ocean transport	7	9	8	18	18	20	2	2	2
Aviation	0	0	0	2	3	3	7	8	9
Coastal water transport	8	9	9	41	41	42	4	4	4
Road transport	2	2	3	13	18	21	37	35	27
Households	7	6	4	24	24	31	365	402	403
Unspecified									

1. Included oil extraction and oil well-drilling, ocean transport and aviation.
2. Included refining of petroleum products.

Source: Central Bureau of Statistics, 1988b, p.163.

Beside providing a data base for forecasting, such environmental accounts provide useful overviews, especially when available as time series. For instance, Table 14.10 shows that sulphur dioxide emissions have fallen significantly and coupled with sectoral production data the effectiveness of measures against sulphur dioxide can be assessed.

In predicting the impacts of various air pollution measures, Alfsen *et al.* warn against partial analyses.

> "*For instance taxes on SO_2 emissions from manufacturing industries not only augment costs and prices in the affected sectors. Higher costs are passed on to other producers via increased input prices, inter alia inflation is increased, competitiveness reduced, capital markets affected, sector composition changed, and the amount of emissions of other pollutants affected. These indirect effects can be significant, but are not picked up by partial analyses of the problem*" (Alfsen *et al.*, 1987, p.59).

One major attempt to link air pollution and economic production in an analysis aimed at picking up indirect as well as direct effects is a recently completed SIMEN report (Bye *et al.*, 1989). (SIMEN is the abbreviation for a major research project, "Studies of industry, environment and energy up to the year 2000", initiated as part of Norway's response to the Brundtland Report (Ministry of Environment, 1989, p.73-74).

In this analysis, various scenarios for attaining national air pollution targets were explored. The stabilization or reduction of CO_2 emissions was seen as the greatest challenge because of the necessary reduction in fossil fuel combustion but would give the bonus of reductions in NO_x and SO_2. The scenario with the greatest promise was the "Tax scenario" which achieved the CO_2 and SO_2 targets, but not the NO_x targets, with only moderate cost to economic growth by an increase in the real price of oil products of 75-80% (see Table 14.11 below). Under the Tax scenario, the total tax take is not increased; an indirect environmental tax of 10-12 billion kroner on oil substitutes for a similar reduction in income tax. Clearly, the impacts of such a radical measure would be uneven, but the proposal breaks new ground and is well worth scrutiny.

For the purposes of this discussion, the conclusion of this SIMEN report is a side issue. The important point here is that time series of major air pollutants by economic sector, that is, environmental air pollution accounts, provide the basis for such modelling exercises.

Table 14.11 Emissions to air[1,2] of CO_2, SO_2 and NO_x under the Reference scenario and Tax scenario. Modelling results of a SIMEN Report. CO_2 in million of tonnes per year; SO_2 and NO_x in thousands of tonnes per year.

	Level 1986	Level 1987	2000 Reference scenario	2000 Tax scenario	Percent deviation
Total					
CO_2	35	36	43	36	-16.3
SO_2	99	88[3]	104	82	-21.1
NO_x	244	245	258	223	-13.6
Processes					
CO_2	5	5	7	7	-0.0
SO_2	45	34	40	39	-2.5
NO_x	11	11	14	14	-0.0
Stationary combustion					
CO_2	14	15	17	13	-23.5
SO_2	29	28	32	16	-50.0
NO_x	24	26	30	24	-20.0
Mobile sources					
CO_2	15	16	19	16	-15.8
SO_2	27	25	31	27	-22.9
NO_x	209	208	214	186	-13.1

1. Emissions from international shipping in Norwegian waters and petroleum activities excluded.
2. Possible emissions from gas power production excluded.
3. Shut-down of the copper smelter in Sulitjelma included from 1986.

Source: Bye et al., 1989, p.88.

14.7 Water and other environmental resources

It is odd that the two areas most developed in the French natural patrimony accounts are the least developed in Norway, that is, water and flora and fauna.

No national water resource accounts have yet been prepared in Norway. Water is a complex resource since in Norwegian terminology it is both a material resource (quantity matters, locally at least) and an environmental resource (quality matters). A rationale for water emissions accounts has been provided by the follow-up to the Brundtland Report where targets have been set for marine pollution following the 1987 London Declaration on Pollution of the North Sea, (Ministry of Environment, 1989, p.49).

Lone has outlined some suggestions for the structure of water accounts (Lone, 1988, pp. 34-36). For water accounts to be useful, they should be disaggregated to catchment level.

A major challenge with water pollution policies in Norway is the "crossing" of water policies with other policies. The government targets of decentralisation of population and regional income equity have resulted in the subsidy of agriculture and energy-intensive regional industry and hence subsidised nutrient and toxic pollution (Alfsen *et al.*, 1987, p.59).

A water account and budget are shown in Table 14.12.

Table 14.12 Water supply in Norway - a quantity and quality budget.

	1974	1983	1984	1990	2000
Water supply (litre/person-day):					
Total withdrawn	600	600	600	575	550
Estimated leakage	300	300	300	275	250
Percentage of population with non-acceptable water quality	20	15-20	15-20	12-18	10-15

Source: Alfsen, et al., 1987, p.35.

With regard to flora and fauna, a report was produced recommending that "*regular (stock/population) accounts be established particularly for threatened species and game species*" but this recommendation has not been taken up (Lone, 1988, p.31).

It should have become clear by now that resource accounts in Norway have become integrated into the broader field of environmental statistics. Not all environmental statistics can be linked directly with the economy. "Environmental Statistics 1988" contains chapters on noise, waste, radioactivity and acidification that do not contain any resource accounts (Central Bureau of Statistics, 1988b).

Keypoints from Part B

* The Norwegian system of resource accounting is particularly useful to New Zealand because of the similarities between the two countries and the length and pragmatism of the Norwegian experience.

* The Norwegian system is in physical units but is compatible with the SNA. It has undergone considerable re-evaluation and change; in particular, it has shifted from being data-driven to being issue-driven.

* Resource accounting in Norway began in the Ministry of Environment; now it is largely done in the Central Bureau of Statistics in conjunction with work on environmental statistics.

* The Norwegians have classified natural resources into material resources and environmental resources. Over time the emphasis has shifted from material accounts to environmental accounts (with the exception of energy).

* Material resource accounts are of three kinds - reserve accounts; extraction, conversion and trade accounts; and consumption accounts. Environmental resource accounts comprise state accounts and emission accounts.

* The main use envisaged for resource accounts was the preparation of resource budgets. This has only happened to a limited extent as planning has become politically unfashionable. Some budgets exist in other guises such as air pollution targets.

* The resource accounts have provided a variety of benefits - some unanticipated. In particular, the overview they give is considered very valuable. Accounts for some resources have not been continued - either because annual updating was unproductive or because the information provided was not being used.

* The energy accounts are unquestionably the most successful of the material accounts. Their use was instrumental in curbing over-investment in hydropower in Norway. They are currently used in a macroeconomic approach to energy conservation.

* The linking of pollution data with economic data is currently being used to forecast the economic impacts of environmental policies and *vice versa*. This is seen as essential in planning for sustainable development.

C A New Zealand perspective

15 A "green" Gross Domestic Product for New Zealand?

15.1 Arguments for and against a "green" Gross Domestic Product

In this, the third part of the report, the focus moves to New Zealand. In this section I return to what is generally meant by natural resource accounting, that is, environmental modifications to the SNA. The intent is to consider whether a move in this direction is appropriate for New Zealand at this time. For instance, should New Zealand join in the United Nations experiment and try to prepare environmental satellite accounts? Before answering this, it is important to review the arguments for and against such modifications.

The proponents of SNA modifications argue that the costs of resource depletion and environmental degradation must be brought into the mainstream of macroeconomic analysis before they will be taken seriously. It is no accident that the focus of attempts to modify the SNA is at the World Bank since it is in the Third World that the impacts of unsustainable growth are most obvious. When the World Bank makes investment decisions, GDP per capita is an important parameter that is taken into account. The Bank is concerned with improving this indicator, particularly now that the Brundtland Report has put sustainable development on their agenda.

In spite of the huge difficulties, proponents of environmental modifications to the SNA believe that disagreements about methods and the inaccessibility of much of the data must not be allowed to stop the search for better measures of economic welfare.

Opposition to modification of SNA comes from both ends of a spectrum. For national accounting conservatives, opposition to environmental modifications is part of a larger debate on imputations. There is also a reluctance to make normative judgements as Derek Blades explains with reference to Hueting-Leipert defensive expenditure corrections.

> *"The SNA reviewers have answered no partly because of their natural reluctance to add any further imputations to the national accounts. A more important reason perhaps, is that they do not accept the implicit argument of the environmentalists that the national accounts should provide normative measures. Since the high polluting country has voluntarily accepted low environmental standards, why should that*

country's statisticians feel obliged to draw up national accounts that pretend that the country has adopted higher standards? However they may personally feel about pollution, the job of national accountants is to measure the world as it actually is and not what it might be like under different management" (Blades, 1989, p.214).

At the other end of the spectrum, the SNA is seen as so flawed an indicator of economic welfare, that downgrading its status is preferable to tinkering with it.

"*Are we trying to fine-tune a system that is getting more and more grossly out of focus?*" (Kneese *et al.*, 1970, p.119).

The fundamental issue is whether SNA statistics such as GDP per capita, should be improved as measures of economic welfare or left as measures of a subset of economic activity. It is not generally known that most economists recognise GDP as performing only the latter task. Economists frequently express concern about the misinterpretation of the SNA. For instance:

"*At first it may seem counterintuitive that the degradation of permanent resources leads to an increase in GDP. This reflects the common lack of awareness that the 'gross' in GDP means 'before allowance has been made for consumption of capital'*" (Harrison, 1989, p.22).

15.2 The compromise - satellite accounts

The preparation of environmental satellite accounts, that is, "green" accounts that can be put alongside the core of the SNA, has been put forward as a compromise by the United Nations Statistical Office (UNSO). It is a compromise that has not satisfied many of the proponents of modification since the very word "satellite" suggests that the new information will not be absorbed into mainstream decision making, but will be doomed to circle on the periphery. (For this reason, the Norwegians prefer to use the term, "linked accounts".)

A more positive attitude is that satellite accounts be viewed as a vehicle for international experimentation and that, when some consensus emerges as to which approaches are the most conceptually sound and workable, there will be a much stronger case for modifying the core of the SNA.

A proposed framework for environmental satellite accounts (Bartelmus *et al.*, 1989) has been discussed at an international level. This framework is to form the basis for a "*Handbook on Environmental Accounting*" to be published by the UNSO in 1991. The revised flow accounts culminate in two new indicators - Sustainable Gross Domestic Product (SGDP) and Sustainable Net Domestic Product (SNDP). The flow accounts are complemented by a balance sheet showing stock assets of tangible wealth including environmental resources. The framework is shown in Table 15.1.

15.3 Options for New Zealand

At a minimum, national accountants in New Zealand should monitor international developments in environmental modifications of the SNA; already some staff time in the Department of Statistics has been assigned to this. If the potential for more involvement exists, then it would be useful for New Zealand to join in the UNSO experiment by preparing satellite accounts. It is not yet clear how many countries will participate in this exercise; West Germany and Sweden are two that have indicated their intentions.

Some case studies testing the practicalities of various modification methodologies would be excellent learning experiences; Maui gas would be an obvious choice for testing the depletion approaches described in Section 3.

It has probably become clear that my personal preference is the same as Drechsler's.

> "*It seems to me better to leave the content of the national accounting aggregates broadly as they are now, and let us supplement the national accounting information by a series of physical, chemical, biological etc. indicators of the state of the environment*" (Drechsler, 1976, p.251).

Fortunately, there is no need at this stage to make a choice between a monetary or a physical approach to resource accounting; it is possible to proceed with the task of preparing resource accounts in physical units and defer decisions on valuation and modification of the SNA. Physical data are prerequsites for monetary data. The trick is to collect the physical data that would need to be monetarised for SNA modification. The Norwegians have not ruled out integration of their natural resource accounting (NRA) system with their system of national accounts (SNA) by designing the former to be compatible with the latter.

Table 15.1 The SNA framework for environmental accounting that will form the basis of the UNSO guidelines.

Supply	Economic activities	Im-ports		Opening Balance Sheet Economic Activities Reproducible & renew. assets	Opening Balance Sheet Economic Activities Non-renew. assets	Environ-ment
Goods & services	517,372	74,527		1,074,355	1,679,001	

+ (plus)

Use/Value added	Economic activities	Ex-ports	Final consumption Households & Government	Tangible wealth accumulation Economic activities Reproducible & renew. assets	Tangible wealth accumulation Economic activities Non-renew. assets	Environment Envir. assets used by ec. activities (-)	Environment Assets of ec. activiti destroyed (+)
Goods & services	224,035	73,797	217,437	76,630			
GDP	293,337						
Envir.protect.serv. services incl. in final demand ...	19,023		(19,023)				
GDP Environm. adj.	274,314						
Environmental cost	51,839			(25,322)	30,098	(95,193)	38,5
Sustainable gross domestic product	222,476						
Consumption of fixed capital	26,366			(26,366)			
Sustainable net domestic product	196,110						
Total	517,372	73,797	198,414	24,942	30,098	(95,193)	38,5

+ (plus)

Revaluation Economic activities Reproducible & renew. assets	Revaluation Economic activities Non-renew. assets	Environ-ment
150,718	380,469	

= (equals)

Closing Balance Sheet Economic activities Reproducible & renew. assets	Closing Balance Sheet Economic activities Non-renew. assets	Environ-ment
1,250,015	2,089,568	

Note: The numbers in the table are the product of a desk study which was based partly on the actual national accounting figures of a country.

Source: Bartelmus, Stahmer & van Tongeren, 1989, p.7.

16 The potential for physical resource accounts in New Zealand

16.1 Introduction

In this section I look at some natural resource and environmental data in New Zealand with the intent of assessing how easily Norwegian-style resource accounts could be prepared, and evaluating to some extent whether they would be useful. The treatment is uneven due to time constraints; I am aware that a great deal more information exists, especially in the private sector and in state-owned corporations. Thus, this section is intended to be indicative rather than comprehensive. I have echoed Section 14 - resource accounts for various sectors in Norway - by dealing with energy, fish, land, forestry, minerals and air pollution in that order. Of course, data bases on other resources like water and wildlife, and on environmental problems like water pollution and solid waste exist, but the Norwegian resource accountants have not been active in these areas.

It is probably true to say that most of the information does exist but has not been organized and presented according to the concepts of natural resource accounting. There are some New Zealand equivalents to Norwegian resource accounts; the difference is that the Norwegians have tried to gain a coherent overview by treating resources consistently. It is this overview that we lack in New Zealand, and will need, in aiming at a national objective of sustainable development.

16.2 Energy

The oil shock of 1973-74 sparked an enormous amount of interest in energy in New Zealand as in other countries. Energy was a "hot" topic in the media and it seemed that nearly everyone was debating the merits of energy projects like the Clyde dam, the Motonui synthetic petrol plant and the Marsden oil refinery expansion. Under a high-ranking Minister of Energy, a great deal of energy research was funded and, as part of this activity, various data bases were established. The New Zealand Energy & Research Development Committee (NZERDC) and the Liquid Fuels Trust Board (LFTB) were the two main conduits for research funds.

During the eighties energy ceased to be the "fashionable resource" as it became increasingly clear that the large energy projects had been bad investments. Energy became viewed more as a commodity to be traded and less as a strategic resource in need of special public policies and management. The large, powerful Ministry of Energy was broken up, with most of the trading functions becoming the responsibility of profit-oriented state-owned enterprises. A much reduced Ministry of Energy was finally absorbed into the Ministry of Commerce in 1989.

Currently, a new public concern is emerging about energy, motivated less by scarcity and more by the environmental impacts of energy production and use. It seems short-sighted to have let information and research about energy wax and wane with the vagaries of fashion. New Zealand is not alone in this. In Australia also, energy is no longer "fashionable"; forestry has taken its place, but many anticipate a large upwelling of concern about energy in about five years time and, once again, there will be a demand for energy information (James, pers. comm., 1989). In Norway, "*the manufacturing sector tries to make energy a non-issue*", but the analytical and data work done by the Central Bureau of Statistics and the Ministry of Environment keep energy alive as an issue, chiefly through revealing the extent of indirect subsidisation and pollution (Bye, pers. comm., 1989).

What has happened to public energy information in New Zealand during this period of low interest? In particular, do we have the information to prepare Norwegian-style energy accounts? If we do have this information, would it be more usefully presented in a resource accounting format? These questions cannot be answered fully without actually attempting the task and that is beyond the scope of this report. However, I suspect that at least some Norwegian-style energy accounts could be prepared using existing data.

Obviously, energy data are collected and analysed for their own purposes by private energy suppliers, the state-owned energy corporations, electricity supply authorities, and so on. Information on the use of fuels in different economic sectors is collected by the Department of Statistics in their economy-wide census.

The most easily accessible energy information now (in the absence of the Energy Plan) is the *Energy Data File* now prepared by the Ministry of Commerce (Dang & Ling, 1990). Most of these data record flows of various energy types - extraction, production, sales, and so on, by month and by year. Stocks, that is, estimates of energy reserves like those in Table 14.1, are not present in this document. However, the document contains an overview of flows in the form of a matrix of energy supply and demand. The preparation of such an energy matrix was recommended by a Review Committee on Energy and Mining Statistics in 1983 (Dept of Statistics, 1983) and was published every quarter from 1983 to 1986 under the title of *New Zealand energy balance* (Dept of Statistics, 1986). The version produced in the Energy Data File is shown in Table 16.1. It should be noted that demand is broken down into only four categories although the original design of the matrix recommended an end-use classification based on the standard economic sectors (Dept of Statistics, 1983, 3.2.3).

Table 16.1 Energy matrix - energy supply and demand in New Zealand. Year ending March 1989. (The table has been broken into two parts. Entries in the lower right hand column "TOTAL" are the sums of rows from both sections.) Units are Terajoules (delivered).

	Solid fuels				Gas			Water & Steam		
	Bitum Coal	Lignite	Other Solids	Total Solids	Natural Gas	Manuf Gas	Total Gas	Hydro	Geoth	Elec
Supply										
Indig prodn +	53947	4282	20500	78729	171610		171610	81695	56550	
Imports +				0			0			
Exports -	11100			11100			0			
Stock change -	2539	-40		2499	240		240			
Intern transp -										
Primary energy	40308	4322	20500	65130	171370	0	171370	81695	56550	
Transformation										
Elec generation	6178			6178	50225		50225	81695	44550	
Petrol prod'n				0	55969		55969			
Gas manuf.	200			200	772		772			
Solid fuel				0			0			
Losses / own use	2539		3690	6229	3043	0	3043		6000	9644
Non-energy use				0	18000		18000			
Secondary prodn				0		-110	-110			-106045
Cons. en (calc)	31391	4322	16810	52523	43361	110	43471		6000	-115689
Error	-448	39	-90	-499	-1144	6	-1138		0	-211787
Cons. en (obs)	31839	4283	16900	53022	44505	104	44609		6000	96098
Demand										
Industrial	27908	2577	10500	40985	30389	52	30441		5800	42178
Commercial	1742	675		2417	5600	23	5623		130	19515
Domestic	2105	1031	6400	9536	4572	29	4601		70	34225
Transport	84			84	3944		3944			180

			Liquid fuels						TOTAL
	Crudes	LPG & NGL	Motor Gas	Diesel	Fuel Oil	Av fuel Kero	Other Liquids	Total Liquids	
Supply									
Indig prodn +	73760	6030			79790		468374		
Imports +	115150		12020	230	500	1180	2400	131480	131480
Exports -	13140		12430	10900	620	6030		43120	54220
Stock change -	-1080		-50	-2500	-170	1800	-30	-2030	709
Intern transp -			0	4840	4810	14250	190	24090	24090
Primary energy	176850	6030	-360	-13010	-4760	-20900	2240	146090	520835
Transformation									
Elec generation			123	94	430	2		649	183297
Petrol prod'n	176850							176850	232819
Gas manuf.			1					1	973
Solid fuel			190	120				310	310
Losses / own use		610				130		740	25656
Non-energy use				24		102	7530	7656	25656
Secondary prodn			-85220	-58650	-13150	-32280	-5610	-194910	-301065
Cons. en (calc)		5420	84546	45402	7960	11146	320	154794	141099
Error		-180	-461	-583	-136	443	185	-732	-214156
Cons. en (obs)		5600	85007	45985	8096	10703	135	155526	355255
Demand									
Industrial		2000	555	12670	4336	230	27	19818	139222
Commercial			254	5945	575	230	60	7064	34749
Domestic		700		100		10	5	815	49247
Transport		2900	84198	27270	3185	10233	43	127829	132037

Source: Dang & Ling, 1990, p.57.

The energy matrix appears to provide some of the "extraction and conversion" data necessary for a Norwegian Type II material resource account (see Table 12.2). Much more detail, particularly on end-use, is required to develop accounts that are compatible with the SNA.

Such consumption detail can, of course, be found in the energy input-output tables of Section 9 and these could presumably provide data for Norwegian Type III material resource consumption accounts (see Table 12.2). It is fortunate that this data base has been continued, but there are no guarantees since even the standard $/$ inter-industry tables on which the energy MJ/$ tables are based may cease to be prepared in a user pays policy climate.

It should be noted that most of the energy consumption data are still "supply-side", that is, data on consumption of various fuels and not data on the actual end uses of the energy - water heating, process steam, freight transport, and so on. End use data are useful for assessing the scope for improved efficiency of use, interfuel substitution and emission reduction.

The major omission in readily available New Zealand energy data appears to be in the Type I accounts - the reserve accounts. Some of this information was regularly published in the Energy Plan by the Ministry of Energy up to 1985. But I do not know of any New Zealand versions of Table 14.1 (hydro reserves in Norway) freely available now. Estimates of coal and lignite resources have been published but with the emphasis placed on the resource technically recoverable rather than on reserves economically recoverable (Anckorn *et al.*, 1988).

Debates over future supply and demand of energy will continue to occur in New Zealand, if for no other reason than the requirement for Electricorp to reapply for all its water rights by 2003. Official forecasters have been wrong before (electricity from Clyde was supposed to be needed by 1985), and public interest will continue in supply and demand projections.

In short, the problem with energy information in New Zealand is probably not that most of it does not exist, but that it is poorly presented and inaccessible.

16.3 Fish

Sufficient New Zealand data do exist to construct Norwegian-style fish resource accounts (Robertson, pers. comm., 1989). The chief purpose of constructing fish accounts would be educative. As with energy, flow data are much more accessible than stock data.

Information on reported catches and total allowable catches (TACs) is readily available in, for instance, the report on the "Quota Monitoring System" published by the Ministry of Agriculture & Fisheries (MAFFish) every month. Such information would provide the "flow" part of a graph such as Figure 14.1. (Of course, actual catch can be considerably higher than reported catch.)

Stock assessments are not published in one document but can be found in the Fisheries Assessment Research Documents and their predecessors, the Stock Assessment Reports. These reports do not just present numerical assessments, but discuss in detail the scientific basis for the assessments and the implications for management. For instance, the 1988-89 report on the Chatham Rise orange roughy fishery concludes that the present allocated catch is not sustainable.

> "*If the present allocated catch of 34,000 tonnes (plus a 30% over-run) is continued, the fishery is likely to collapse within 5 years (i.e. recruited biomass will be less than the catch)*" Robertson, 1989, p.15).

Not surprisingly, MAFFish has experienced the same large uncertainty in assessment of fish stocks as has its counterpart in Norway (see Table 14.3). Table 16.2 shows reduction in stocks and the variation in estimates for one commercial species in one fishery.

Table 16.2 Trawl survey estimates of total biomass, with upper and lower bounds (95% confidence limits) and coefficients of variation (CVs) for the south Chatham Rise orange roughy fishery.

Year	1986	1987	1988
Lower bound	11,026	5,553	1,553
Biomass	29,192	11,028	5,786
Upper bound	47,358	16,863	10,019
CV%	31	25	37

Source: Robertson, 1989, p.9.

16.4 Land

New Zealand has a major land data base known as the Land Resource Inventory (LRI), which was developed by the Water & Soil Directorate of the Ministry of Works and is now held and operated by the DSIR at Aokautere. In the LRI, the country is divided into some 90,000 units that vary in area, but are reasonably physically homogeneous. Each unit is described by a number of physical parameters - rock type, soil type, slope, erosion, vegetation, rainfall, and so on. The LRI is primarily used for land use planning. A particular use has been for the identification of land on high country runs especially vulnerable to erosion in order to retire it from grazing. The LRI is essentially static, since updating is limited and irregular.

The only set of information, which the Norwegian land accounts contain, that could not be obtained from the LRI seems to be data on land use in cities. However, there is little reason for putting such information into a national data base.

In New Zealand, as elsewhere, there is currently great interest in geographic information systems (GIS). This is why this report contains the plan for the Australian GIS resource accounting system, although it is only in an early stage (see Section 8).

New Zealand could perhaps learn from the Norwegian experience of land accounts and environmental statistics in the publication of data of environmental significance in time series. For instance, in *Environmental Statistics 1988*, one graph shows how the total area in national parks in Norway has risen over the last 24 years, another shows the yields per unit area of grains and grass for five-year periods from 1930 to 1985, and a third shows the areas of cultivated land "developed" annually from 1965 to 1986 (Central Bureau of Statistics, 1988b, p.159, p.152, p.155). In New Zealand, information presented in such time series would help rank our own priority environmental land issues such as soil erosion or nitrates in groundwater; the gaps in the series would help identify monitoring requirements.

Such information will carry more weight where it is possible to attach monetary values. One attempt at a monetary resource accounting approach to soil erosion has been made for Java (Magrath & Arens, 1989). The researchers concluded that soil erosion costs the Javanese economy between U.S. $340 and $406 million annually - a little less than 0.5% of GDP. Over 95% of these costs were on-site, that is, loss of soil productivity. Off-site costs were estimated for irrigation system siltation, siltation of harbours and major waterways, and reservoir sedimentation.

16.5 Forestry

The three main types of Norwegian forestry accounts have been reproduced in this report as Tables 14.5, 14.6 and 14.7. Do we have the information to compile such forestry accounts in New Zealand and would they be useful?

There is a major difference between forestry in New Zealand and forestry in Norway that limits the relevance of the Norwegian experience of forestry accounts. In Norway, the production species are indigenous. In New Zealand, production forests comprise almost entirely one exotic species, pinus radiata and, consequently, there are very different issues associated with exotic forests and indigenous forests.

We have a great deal of numerical information about our exotic production forests. Both the Ministry of Forestry and the Department of Statistics hold data bases on stocks and flows of pine. *A national exotic forest description* is published annually by the Forestry Council (e.g. Turland and Novis, 1990). Most of the data in this document are exotic forest areas broken down by region and age class. However, the summary table contains information that can be used to prepare a forest balance like that in Table 14.5.

Table 16.3 An exotic forest balance for New Zealand. (Units are 1000's m^3.)

Growing stock (TSVIB) 1 April, 1988	220,925
Annual increment (TSVIB)	25,166
Natural losses	?
Estimated roundwood removal	10,255
Growing stock (TSVIB) 1 April, 1989	235,840

Note: TSVIB = total stem volume inside bark.

Source: Derived from Turland and Novis, 1990, p.1.

The other two types of Norwegian forestry accounts are the mass balance and the sector/commodity balance. Production statistics on a quarterly basis for the production of sawn timber, pulp, paper, paperboard, fibreboard, plywood, veneer, particleboard etc., and for imports and exports are published by the Statistics Section of the Ministry of Forestry. Presumably, at least some of the data required for the two balances of Tables 14.6 and 14.7 are available. This could be tested by taking up the invitation to join in the OECD pilot forestry accounts study being led by Norway (OECD, 1988b, Lone, pers. comm., 1989).

Data on indigenous forests are not as easily obtained. The statistical release on roundwood removals published quarterly by the Ministry of Forestry contains information on indigenous as well as exotic removals. For instance, in 1988, 593,000 cubic metres of indigenous timber were harvested, of which 400,000 cubic metres were exported as chips (Ministry of Forestry, 1989). Once again, flows are easier to find than stocks.

The forestry accounts in Norway have not been especially useful although experimentation continues. One new area of ongoing work, which might be relevant to New Zealand, is the classification of forest stocks into cost classes according to harvesting and transport costs.

If the value of resource accounts is judged by their usefulness in policy formation and management decisions, then identification of the issues in New Zealand forestry is fundamental. What are we trying to sustain? A distinction must be made between timber plantations and indigenous forests. With timber plantations (exotic or indigenous), the aim is to sustain a supply of timber. With indigenous forests, the sustainability issue is the protection of ecosystems. Thus, totally different forms of resource accounting and/or environmental statistics may be required for plantations and for indigenous forests.

As with land, environmental information relevant to plantation forestry should be presented as time series. In trying to sustain timber supply, it may be useful to gather information on the effects on productivity of monocultures, on soil acidification, and so on. For indigenous forests, time series of areas of different forest types would be fundamental. Such information has been assembled in the past, but usually in response to a particular "crisis" and, therefore, on an *ad hoc* basis.

There is one small, but significant, lesson that we can easily learn from Norway, which is simply a question of terminology. Our management of resources like fish and forests may become oriented more toward sustainability if we stop referring to these resources as "renewable" and begin calling them "conditionally renewable".

16.6 Minerals

Readily available information on minerals in New Zealand comprises mainly records of production, that is, flows. Stock assessments must exist; the assessments for coal are publicly available but as mentioned in Section 16.1, the criterion for classification as a "resource quantity" is technical recoverability, not economic recoverability (Anckorn *et al.*, 1988).

Mineral production statistics have been published annually by the Ministry of Energy's Market Information and Analysis Division; presumably, this will be continued by the Ministry of Commerce. As in Norway, a three-way split is made between fuels (coal), metals (gold, silver, iron ore, ironsand concentrate, tungsten ore) and non-metals (clay, limestone, rock, sand, gravel, etc.) (Ministry of Energy, 1989). The publication of production quantities only is of no use in monitoring a management objective of sustainable development. There is no indication of, for instance, whether some regions will soon face a shortage of gravel.

16.7 Air pollution

Air pollution data come from two sources. Direct monitoring of air quality will provide concentrations of various pollutants at monitoring stations, for example, lead in the air of major cities in $\mu g/m^3$. Emissions of pollutants can be calculated from data on energy consumption and industrial processes. (The same dual monitoring/calculation approach applies to water pollution.)

In New Zealand, direct monitoring of some air pollutants has been done by the Department of Health. Calculated pollution data have been produced on a much more *ad hoc* basis by a variety of researchers. This is not always efficient. For instance, the Department of Health has not been interested in carbon dioxide since it does not threaten human health directly. However, carbon dioxide emissions are of great relevance in the major issue of global climate change and various researchers have been estimating carbon dioxide emissions, largely independently from each other with considerable overlap.

Norwegian-style environmental accounts for air pollutants comprise a state account (concentration of pollutant in time series) and an emissions account (tonnes of pollutant emitted per year by economic sector). Would such accounts be useful in New Zealand?

Monitoring information produced by the Department of Health could be readily cast into state accounts as a presentation of trends in air quality. For example, the number of days each year in which air pollution exceeded WHO levels in Christchurch is used as an indicator of trends in local air quality. But establishing emission accounts for a city like Christchurch does not seem particularly useful. The effort involved in estimating the emission of each pollutant by economic sector would be excessive; the current approach of studying pollutants by source - households, vehicles, industry - seems to be adequate for local pollution problems.

There is more of a role for natural resource accounting in national air pollution problems, which are, of course, also global pollution problems. With these pollutants - carbon dioxide, methane, chlorofluorocarbons, etc. - emissions accounts have the potential to provide basic data for analysis of policy options. With emissions of carbon dioxide broken down by economic sector and other information such as demand elasticities, the economic impacts of, for instance, a "polluter pays" fuel tax can be modelled (see Section 14.6).

17 The wider context of environmental statistics

17.1 Introduction

Given that much of the information required for Norwegian resource accounts appears to be available, is there a case for preparing such accounts in this country? I believe there is, with the proviso that work on natural resource accounts should be done in the wider context of work on environmental statistics. This has indeed happened in Norway, where some of the tables in *Environmental statistics* (Central Bureau of Statistics, 1988b) are resource accounts, but most are not.

The same situation applies to reporting on the state of the environment. Table 14.10, for instance, may be an environmental account, but it is also a report on emission rates of three major air pollutants. Both natural resource accounting and state of the environment reporting are heavily dependent on a sound environmental data base. The problem of quantification should be tackled at a fundamental level by designing an environmental and natural resource data base, which can then be used to produce natural resource accounts and state of the environment reports, but will also serve wider purposes.

In short, the production of a coherent and comprehensive system of environmental statistics is overdue in this country. At present environmental statistics exist, but are incomplete and fragmented.

17.2 Problems with existing environmental information

From observation and discussion, I believe there are three (related) problems with existing environmental statistics in New Zealand that a comprehensive well-designed system would alleviate. These three problems are "institutional" in nature.

The first problem is redundancy and consequently, inefficiency. Although some environmental data bases have been assembled in a systematic fashion, much useful information is collected on an *ad hoc* basis. Such information is often left to gather dust on bookshelves and later investigators repeat the same process.

The case of carbon dioxide emissions provides a good example of this. Concern about the greenhouse effect has led to a number of studies with considerable data overlap. The Ministry for the Environment is currently formulating a greenhouse policy and has been assembling estimates of carbon dioxide emissions for that purpose. Studies on the agricultural implications of the greenhouse effect are being undertaken by the Ministry of Agriculture. The Coal Research Association has quantified carbon dioxide emissions from coal and lignite. The Forest Research Institute are studying how net emissions of carbon dioxide can be reduced by increasing biological uptake. The Centre for Resource Management has been looking at the magnitude of carbon dioxide emissions associated with different electricity generation options. The Maruia Society has been working on a "carbon budget".

It is not clear how representative this example of redundancy is. Certainly, many environmental/natural resource research reports are used more often for the tables of data they contain, rather than for the conclusions they reach.

The second problem is inaccessibility. There are various aspects to this. There is no central "clearing house" for environmental information; it is my experience that access to, and indeed knowledge of the existence of, environmental data too often depends on personal contacts. There is, for instance, no longer an Energy Plan; for all its shortcomings, the Energy Plan was a readily available source of basic information. Corporatisation of natural resource development has compounded the problem although, to be fair, commercial sensitivity is not always the culprit. Cost recovery policies in government agencies have not helped.

Information is sometimes held in surprising places. For example, one researcher charged with assessing the potential for cogeneration could not find the necessary information from the conventional energy sources; the breakthrough came when a colleague suggested the Department of Health might have information on boilers because of air pollution concerns (Williamson, pers. comm., 1990).

Another aspect of accessibility is "user-friendliness". The fish stock assessment reports published by MAFFISH are scientifically sound, but not user-friendly. In contrast, the graphical fish accounts published in Norway communicate a great deal of information. In looking at Figure 14.1, one immediately sees the purpose of TACs, that catches have sometimes exceeded TACs and that stocks (or rather stock assessments) vary greatly. Of course, one problem with clear presentation is the risk of simplistic interpretation, which is why the Norwegian environmental statisticians are adamant that "*... the presentation of numbers is just the first part; it is vital to say how those numbers should be used*" (Aaheim, pers. comm., 1989).

The third problem is that environmental information tends to be supplier-driven, rather than user-driven. A recent survey of public agencies involved in environmental quality monitoring revealed that the users and the suppliers of specific information sets generally coincide (Steven, 1990).

17.3 Resource accounting concepts in an environmental statistics system

In designing a framework for an environmental statistics system, an initial task would be the identification of principles. These principles should depend on the envisaged uses of the statistical system. I believe that the design of such a system should be based where possible on the concepts of resource accounting.

The fundamental concept of resource accounting is the identification and quantification of links between the economy and the environment. Thus, collecting environmental data by economic sector would be essential, if the economic effects of environmental policy options and *vice versa* are to be modelled. Environmental forecasting is much more powerful when it is linked with economic forecasting. Thus, environmental statistics should be developed alongside economic statistics.

It would be far too ambitious to try to link all environmental statistics to economic statistics. One of the conclusions reached by David Pearce and his colleagues on natural resource accounting is that:

> "*... some of the objectives of such an accounting system can be achieved by expanding the existing environmental database, and developing the linkages between the environmental data and the economic demands on a piecemeal basis*" (Pearce *et al.*, 1989, p.117).

More generally, an accounting framework for recording numerical information (whether in dollars or not) has enormous strengths (Theys, 1984, p.10). Both stocks and flows must appear. Data can be aggregated in various ways and information gaps become obvious.

17.4 Some advice in hindsight from Norway

Lone concludes his report on the Norwegian experience of natural resource accounting by listing six preconditions for (greater) success. I have reproduced them here (some in a shortened form), because the underlying principles seem to apply equally well to environmental statistics, and certainly to an environmental statistical system design influenced by the concepts of resource accounting. (NRAB is the abbreviation for natural resource accounting and budgeting.)

"IDENTIFY important resource and environment problems, and the major decision-making institutions as users of NRAB...;

CONCENTRATE on a few of the most important of these problems, where it is possible to reach some results in the relatively near future, and where managers are (or may become willing) and able to use NRAB in their planning and management;

INVOLVE managers/users and political institutions as early and as closely as possible ...;

DEVELOP the necessary integrated economic/ecologic expertise ...;

EXPLOIT to the utmost existing data collection routines, management concepts and management tools ...; and

AVOID ambitious theoretical system-building and resist the temptation to engage in large, indiscriminate data collection that very easily may emerge as an end in itself..."

(Lone, 1988, pp.22-23).

18 Indicators of sustainability

18.1 Introduction

The concept of sustainable development lies behind the various attempts to develop natural resource accounting systems. Thus, a major purpose of natural resource accounting could be said, in broad terms, to be the monitoring of sustainable development. However, difficulty in describing its objectives more precisely has dogged the development of resource accounting.

> "*A major impediment to progress is a lack of clarity about what the purpose of 'natural resource accounting' is*" (Common, 1989, p.1).

One approach to the challenge of monitoring sustainable development, the notion of "indicators of sustainability", has evolved alongside natural resource accounting.

Natural resource accounting has followed two paths, on the one hand, the direct modification of the SNA and, on the other, formalising the connections between the environment and the economy without necessarily altering GDP or other standard economic indicators. In the first approach, the connection with sustainable development is made by trying to find a measure of sustainable national income. In the second approach, one explicit connection with sustainable development that is attracting interest is the selection of environmental indicators that can be used to assess progress toward (or away from) sustainability. Such indicators would, of course, require a base of environmental data as has been discussed in Section 17.

An impetus to develop such indicators is developing simultaneously around the world. In New Zealand, the proposed Resource Management Act should create some urgency since the purpose of that Act is "*to promote the sustainable management of natural and physical resources*" (Resource Management Bill, 1990, p.17). Such a purpose begs two questions, namely, "what is sustainable management?" and "how can it be measured?" I suspect that attempts to answer the second question may help answer the first.

18.2 Some thoughts on sustainability

Much effort has been expended in the last few years in New Zealand and elsewhere on attempts to define sustainability. I do not propose to put forward any definition here, but follow Herman Daly in urging that a distinction be made between sustainable development and sustainable growth; one is concerned with quality and the other with quantity (Daly, 1989c). The failure to make such a distinction has caused a great deal of confusion.

The elusiveness of the concept of sustainability has brought its validity into question for some. But there are many words that are used in public policy goals that can never be defined precisely - for example, "equity" and "efficiency".

It is not the aim of this report to produce yet another definition of sustainability. However, I believe that, in the context of this report, it may be more helpful to think about unsustainability rather than sustainability. We strive to make society more equitable by removing specific inequities; we strive to make the economy more efficient by removing specific inefficiencies. Can we strive to make our national development more sustainable by eliminating unsustainable practices?

One common misconception is to conceive of sustainability as absolute rather than relative. There is no one sustainable utopia waiting for us. Rather, we move toward more sustainable or less sustainable situations. To know in which direction we are moving, to measure sustainable development, we need indicators of sustainability.

18.3 Some thoughts on indicators

The report "*Indicators for the state of the environment*" (Vos *et al.*, 1984) forms an excellent starting point for developing environmental indicators of various kinds. Vos *et al.* note that an indicator is selected for the reliability of its measurement and the validity of its representation of a theoretical concept. An indicator is not simply a statistic.

> "... *it is evident that indicators contain more information than statistics. The latter form a collection of observed data to be used for all sorts of applications. The former are thriftily selected data assumed to have a causal relation with a theoretical concept*" (Vos *et al.*, 1984, p.6).

Because the major social function of indicators is simplification, indicators are necessarily compromises between scientific description and "*the social demand for concise information*" (Vos *et al.*, 1984, p.6).

A set of indicators of sustainability and a set of indicators of environmental quality may overlap, but will not be identical. For instance, a set of indicators of sustainability may include economic and social as well as physical indicators, whereas indicators of environmental quality will measure physical phenomena (although the selection of such indicators will be based on social perceptions).

When a set of indicators are weighted together in some fashion, an "index" is formed. A single (national) index of sustainability does not seem to be a possibility. Rather, I conceive of indicators of sustainability as analogous to the indicators of economic performance already widely used and accepted. Economic indicators such as real GDP, price indices, terms of trade and numbers of unemployed are published regularly. They cannot be weighted together into a grand economic index, but together build up a picture, albeit a different picture in different minds. Similarly, the interpretation of a set of (a dozen?) indicators of sustainability will not be straightforward. The indicators themselves will, like the economic indicators, be flawed and always in need of improvement.

18.4 International interest in indicators of sustainability

There seems to have been a simultaneous recognition around the world in the last two years that, in order to make the concept of sustainable development operational, some means of measuring progress must be devised.

One approach, as mentioned above, is to devise some kind of fundamental index of sustainability. At least two writers have suggested basing such an index on the ratio of plant material harvested annually for human use to the total net primary production (NPP) of plant material through photosynthesis (Daly, 1989b, pp.10-11, Shearer, 1989). Currently, this ratio is about 0.4 for terrestrial ecosystems and about 0.25 for terrestrial and aquatic ecosystems (Vitousek *et al.*, 1986).

> "*An advantage of using the NPP from photosynthesis is that environmental degradation such as soil erosion and fertility depletion, the effects of pollution including acid rain, and diminishing water resources are automatically factored into the result because they directly influence biological production, albeit with some delay*" (Shearer, 1989).

This approach reflects Daly's assertion that the increasing throughput of energy and materials is the fundamental problem.

> "*The humanly directed flows of matter and energy through the economy rival in magnitude the flow rates of many natural cycles and fluxes*" (Daly, 1989c, p.4).

Because this approach is an attempt to measure global sustainability, it could be seen as less relevant from a national perspective (and even less relevant from a regional perspective). However, it is not clear to me where the distinction between global and national sustainability lies. National sustainability seems to suggest self-sufficiency, and a policy of national self-sufficiency in energy in the early eighties in New Zealand resulted in development that was neither environmentally nor economically impressive.

In a rather more conventional economic context, Anne Harrison proposes the adoption of "sustainability factors" as a link between satellite environmental accounts and the main SNA (Harrison, 1989, p.24). She adopts Hicks' definition of income - "*what you can consume in the period and be as well off at the end as at the beginning*" - as the basis, defining sustainability factors as ratios of capital stocks at the end of a period to capital stocks at the beginning (adjusted for price changes).

> "*A value less than one implies that too much capital has been consumed and that the consumption level is not sustainable indefinitely*" (Harrison, 1989, p.24).

Harrison suggests that such factors could be calculated for man-made capital (disaggregated by asset and industry), for environmental resources such as land, water and air (at the project level) and for human capital (for example, the number of trained doctors).

A team of researchers at the University of Wisconsin have developed eight criteria for guiding the selection of global sustainability indicators - sensitivity to change in time, sensitivity to change across space or within groups, predictive ability, availability of reference or threshold values, ability to measure reversibility or controllability, appropriate data transformation, integrative ability, relative ease of collection and use (Liverman *et al.*, 1988). These criteria are used to evaluate two categories of indicators and some specific indicators. In an evaluation of three energy indicators - commercial energy consumption, imports as a percentage of consumption, and energy imports as a percentage of mercantile exports - the third satisfied the eight criteria best.

The Wisconsin analysis has been incorporated into a paper by Opschoor on sustainable development and macro indicators (Opschoor, 1989). He envisages at least five indicators related to five classes of environmental capital - pollution, renewable resources, non-renewable resources, semi-renewable resources and biological diversity. Opschoor's view on natural resource accounting seems to concur with the conclusions reached in this report. Towards the end of his paper, he writes:

"A notion of 'sustainable income' could be defined and perhaps even quantified, if appropriate estimates could be developed not only of so called 'defensive expenditure', but also of two much nastier environmental cost categories: environmental stock depreciation (on a replacement basis) and the value of remaining environmental degradation. It is with the latter two categories of damage that difficulties in placing monetary values on them must be expected. Given this situation, but also due to a need to explicitly know the quality of the environmental foundations on which our economies are built, it is believed that there will always be a need for indicators expressing the development over time of environmental quality, in physical terms" (Opschoor, 1989, p.14).

Keypoints from Part C

* It is probably premature for New Zealand to produce a "green" GDP because there is no international consensus on whether this is desirable or on how to do it. New Zealand could engage in some limited experimentation and should certainly monitor international developments.

* There is good reason for New Zealand to do some work on physical resource accounts within the wider area of environmental statistics - not least because physical data are prerequisites for monetary data.

* The preparation of Norwegian-style energy accounts would be very valuable. It would give an overview of the role of energy in the economy and form a basis for policy evaluation tasks like forecasting the economic impacts of a carbon tax or estimating the potential for energy conservation.

* The merits of other Norwegian-style material accounts are less clear. Fish accounts would perhaps form a valuable communication function. New Zealand is already well-endowed with land data bases. Before forestry accounts are prepared, a clear identification of forestry issues should be made. Non-energy minerals accounts would seem to have little value on a national basis.

* Some Norwegian-style environmental accounts might prove very useful and could form a subset of state of the environment reporting. Air pollution accounts of some kind would be essential if New Zealand is to address national emissions targets seriously.

* The production of a coherent and comprehensive system of environmental statistics is long overdue in New Zealand. Problems with current environmental statistics include redundancy of effort and other problems of lack of coordination, inaccessibility, and the supplier-driven nature of much of the information.

* The fundamental concept of resource accounting, that of establishing formal links between the environment and the economy, should be a guiding concept in the development of environmental statistics. Even piecemeal links are better than what we have now.

* Resource accounting was hailed as the answer to monitoring that elusive concept, sustainable development. It may be that this problem could be tackled more directly via the concept of "indicators of sustainability". Issues-driven physical resource accounts could help make this concept operational.

Recommendations

I conclude with a list of recommendations for further work in resource accounting and related areas in New Zealand. These recommendations should be discussed widely. I have been conscious of the large amounts of money (from a New Zealand perspective) that have been soaked up by resource accounting efforts in some countries and have, therefore, made some relatively low cost suggestions. I have not linked particular tasks to particular institutions. Before reading the list the reader should return to page 81 and re-read Lone's pre-conditions for (greater) success.

* **With regard to environmental modification of the SNA:**

  absorb and debate the research coordinated by the World Bank, in particular, Ahmad *et al.* (1989) and Peskin (1990);

  follow the World Bank case studies;

  consider the applicability to New Zealand of the UNSO framework for environmental satellite accounts noting reaction to it from the international environmental economics community;

  follow and participate in the ongoing international debate.

* **With regard to "mixed" accounts:**

  prepare pilot Norwegian-style energy accounts;

  follow and possibly participate in the OECD pilot project on forestry accounting;

  consider whether fish accounts would be useful in making quota imposition and changes publicly acceptable and politically feasible;

  follow the progress of the GIS system in Australia and consider its applicability to land use management here;

  consider how energy input-output tables might be used in planning a strategy for achieving the greenhouse carbon dioxide target;

  prepare emissions accounts for selected pollutants, both for setting targets and for planning strategies to meet targets (as above).

* **With regard to environmental statistics:**

develop a framework;

identify sources of data;

prepare pilot information sets and disseminate them for comment;

take a pragmatic issues-driven approach and continually question the usefulness of the data;

seek to establish explicit economy and environment links even if they are only piecemeal;

view physical resource and environmental accounts as a subset of environmental statistics.

* **With regard to the broader objective of monitoring sustainable development:**

postulate some indicators of sustainability in energy, agriculture and forestry;

circulate these widely and create discussion on their appropriateness and usefulness.

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