Statistics NEW ZEALAND Te Tari Tatau

WATER

Monetary Stock Report

Partial monetary accounts plus review of background and valuation methods

Environmental Accounts Series

Prepared by Statistics New Zealand

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Acknowledgement

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1 Summary

This report contains partial monetary accounts for freshwater stocks. Indicative values have been obtained or calculated for some water uses but there is insufficient data to accurately determine all water values, particularly on a regional or annual basis. This report, in addition to showing partial monetary accounts, reviews background and valuation information that may be relevant to further development of the accounts.

The monetary accounts will add to the other natural resource accounts for freshwater, energy and minerals, fish and forests.[1] Natural resource accounts have potential use in their own right and may also play a role in the development of important socio-economic indicators such as environmentally-adjusted gross domestic product (ea-GDP) and national wealth.

Freshwater has value for domestic, commercial and industrial consumers and is essential for livestock, wildlife and plant-life. However, it is difficult to assign statistically-valid monetary figures to these uses. It is also difficult to assign values to non-consumptive uses of water, such as swimming, fishing, boating, skiing and aesthetics.

Economic values, according to concepts from the System of National Accounts (SNA)[2] and the United Nations handbook of Integrated Environmental and Economic Accounting (SEEA)[3], are best represented by market-based prices. "The SNA recommends that market prices be used wherever practicable to place a value on an asset."[4] However, market prices are generally not available in New Zealand and estimates or proxies of market prices are insufficiently developed to give comprehensive, nation-wide, annually-repeated coverage.

Some of the main points that emerge from this report are:

- Indicative values (totalling $1.4 billion) are shown for water supplied from local authority reticulation networks and water used for irrigation and hydroelectric generation. However, these values are for flows rather than stocks.
- Data for water accounting is limited because water is treated as a free good and is largely unmetered.
- Non-use or preservation values are not estimated for this report. Also excluded are values for privately-abstracted industrial, livestock and household water.
- Water does not have a single value or price. There is variation according to scarcity and productivity of use, which are related to location, time of use and purpose of use.
- Water scarcity, quality and protection of water bodies are issues that are bringing increasing pressure for changes in water management.
- Changes in water management, particularly relating to metering and pricing, may present opportunities in the future for further developing the water accounts.

Feedback on this report is welcome.

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1 Natural resource accounts are on the Statistics New Zealand website, http://www.stats.govt.nz/analytical-reports/natural-resource-accounts/default.htm [9 December 2004].
2 SNA – *System of National Accounts,* http://unstats.un.org/unsd/sna1993/introduction.asp [12 July 2004].
3 SEEA – United Nations handbook of *Integrated Environmental and Economic Accounting*.
4 SEEA 2003, paragraph 2.132, http://unstats.un.org/unsd/envAccounting/seea2003.pdf [8 July 2004].

2 Water account tables

2.1 Monetary stock accounts

Monetary stock accounts, the subject of this report, are a long-term development. If fully completed, they may be based on the physical stock accounts for water (see table 2 in section 2.2) but would be expressed in monetary values rather than physical quantities.

The accounts would ideally be calculated using market prices for water use and consistent estimation methodology for water non-use (preservation of water resources). However there is little or no market trading of water or water rights in New Zealand. Non-market valuation techniques are available for water use and non-use but are generally limited to one-off studies rather than ongoing annual or quarterly surveys. Values for water non-use may exceed values for water use but are more difficult to estimate.

In the absence of completed monetary stock accounts, some indicative values have been compiled and are shown in the following table. The values in this table are incomplete and, by necessity, were compiled using inconsistent valuation methods. Local authority water supply charges are based on supply costs and are therefore unlikely to represent the full value of water whereas the value-added figures for irrigation really measure economic productivity rather than water value.

Table 1 Freshwater Values

Region	Year ended June 2003							
	Local authority water supply (1)			Irrigation (2)	Hydro electric generation (3)	Other uses (4)	Non-use (5)	Sum of local authority, irrigation and hydroelectric generation values (6)
	rates	sales	total charges	value-added	resource rent			
	$(million) (7)							
Northland	7	10	16	29	0	..	..	45
Auckland	8	125	133	54	-	..	..	187
Waikato	18	13	31	56	22	..	..	109
Bay of Plenty	11	13	24	39	3	..	..	66
Gisborne	2	1	3	25	-	..	..	28
Hawke's Bay	6	2	8	99	2	..	..	109
Taranaki	4	5	9	6	1	..	..	16
Manawatu-Wanganui	15	5	20	21	1	..	..	42
Wellington	29	14	43	21	0	..	..	64
North Island	*101*	*187*	*288*	*350*	*28*	..	..	*666*
Tasman	2	1	3	47	1	..	..	51
Nelson	-	5	5	-	-	..	..	5
Marlborough	3	0	4	86	0	..	..	90
West Coast	2	1	3	-	0	..	..	3
Canterbury	22	7	29	335	33	..	..	397
Otago	14	5	18	87	17	..	..	122
Southland	5	1	6	13	20	..	..	38
South Island	*48*	*19*	*67*	*568*	*71*	..	..	*706*
Chatham Islands	*0*	-	*0*	-	-	..	..	*0*
New Zealand	150	206	355	920	99	..	..	1,374

Sources: Statistics New Zealand and the Ministry of Agriculture and Forestry (MAF).

(1) Values are mostly from the Local Authority Census 2002/2003 and are for water supplied to consumers (domestic, commercial, industrial and rural) on reticulation networks. Metrowater and United Water, although not local authorities, are included for completeness. Wholesale (bulk) water is excluded, to avoid double-counting where possible. Some water may be for irrigation and will overlap with the irrigation column and result in double-counting. Values are generally based on supply costs and are therefore unlikely to represent the full value of water.

(2) These values represent the economic activity attributable to irrigation and are from a MAF report available at: http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/irrigation/the-economic-value-of-irrigation/index.htm

(3) Based on the value of water used in hydroelectric power generation in the March 2001 year. Refer webpage: http://www.stats.govt.nz/NR/rdonlyres/0D3BD809-14F8-4691-BD8D-FECC245AF139/0/EnergyMonetaryStockAccount.pdf. The resource rental value was updated to approximately the March 2003 year using quarterly value-added data from the electricity industry and was assigned across regions on the basis of hydro power station energy generation.

(4) Includes livestock consumption and private abstraction for industrial or household use.

(5) Preservation value, comprising existence, option and/or bequest values. If available, the existence value may take account of wildlife and biodiversity but from a human perspective.

(6) The component values are not entirely comparable as they are a mix of supply charges, value-added figures and estimated resource rentals.

(7) Rounding may affect summations.

Symbols:

- nil or zero
.. not available

2.2 Physical stock accounts

Tables and reports for the physical stock accounts, published in July 2004, can be accessed from the Statistics New Zealand webpage:

http://www.stats.govt.nz/analytical-reports/natural-resource-accounts/water-natural-resource-accounts.htm#psa

Storage volumes, because of lack of information, are presented as annual changes. The physical stock account tables are thus more akin to flow tables, but without the industry supply and use detail.

Table 2 Physical Stock Accounts for Freshwater

New Zealand[1]	Year ended June						
	1995	1996	1997	1998	1999	2000	2001
	millions of cubic metres						
Inflows							
Precipitation	429,593	440,889	370,354	371,857	409,927	380,922	406,696
Total inflows	*429,593*	*440,889*	*370,354*	*371,857*	*409,927*	*380,922*	*406,696*
Outflows							
Evapotranspiration	163,099	174,949	168,049	167,432	161,174	166,600	184,609
Abstraction for hydroelectricity generation	222,579	225,950	196,020	195,256	200,170	183,310	192,772
Discharge from hydroelectricity generation[2]	222,579	225,950	196,020	195,256	200,170	183,310	192,772
Outflows to sea and net abstraction[3]	259,220	263,268	214,179	199,978	258,699	198,200	236,982
Total outflows	*422,319*	*438,217*	*382,228*	*367,410*	*419,873*	*364,800*	*421,591*
Change in storage[4]							
Soil moisture[5]	7,371	1,402	-1,958	-2,257	572	5,387	-10,519
Lakes and reservoirs[6]	-428	392	-2,222	2,322	-1,271	3,176	-4,382
Groundwater	4,220	-1,220	-2,480	-830	-1,810	820	290
Snow[7]	-6,819	3,098	-7,685	5,131	-5,998	7,778	-2,725
Ice[8]	2,930	-1,000	2,470	80	-1,440	-1,040	2,440
Total change in storage	*7,274*	*2,672*	*-11,874*	*4,447*	*-9,946*	*16,122*	*-14,895*

Source: based on data from National Institute of Water & Atmospheric Research Ltd (NIWA) and Institute of Geological and Nuclear Sciences Ltd (GNS).

(1) Sum of the 16 areas administered by regional councils and unitary authorities. The Chatham Islands and other outlying islands are excluded.

(2) Water used in hydroelectricity generation is returned to the hydrological system. Discharges match abstraction, meaning that 'net' abstraction is zero.

(3) This is a residual volume and is calculated as the inflow less other outflow and change in storage. It is the volume of water leaving the New Zealand water system, other than by evapotranspiration.

Net abstraction is the difference between abstraction and discharges. It is not specifically calculated because there is insufficient data on:

- abstraction of water for irrigation, livestock use, private domestic use, private industrial use, and geothermal electricity generation
- discharges of water back into the environment

(4) The change from the end of the previous June year to the end of the current June year.

(5) Changes in soil moisture average zero in the long-term, as represented by the average of the June years 1995 to 2001.

(6) These volumes include an estimate for unavailable data.

(7) These volumes are for water stored as seasonal snow at an altitude of 900m to 2,000m. Transient snow (below 900m) and perennial snow (above 2,000m) are excluded.

(8) These volumes are for water stored in glaciers. Snow above 2,000m will largely be included here.

2.3 Monetary flow accounts

There are no monetary flow accounts because there is insufficient information, particularly at an industry level, for annual, regional accounts.

If produced, the accounts would probably have the same structure as physical flow accounts but would be expressed in monetary values rather than quantities. Market prices would ideally be used but water is seldom explicitly priced.

2.4 Physical flow accounts

There is insufficient data or resources for producing regular physical flow accounts at a detailed industry level. Much water abstraction and usage in New Zealand is not metered and there is little compilation of the volumes that are measured. Extensive surveying or modelling would be required.

In theory, physical flow accounts would provide information on exchanges of water (abstractions and discharges) between the environment and the economy. Water abstracted from the environment would be presented in the form of supply and use tables by industry or sector in the economy. Water returned to the environment would be in the form of discharge tables by industry.

2.5 Sample flow account table

A sample table, which could be used for either physical or monetary flows, appears on the following page. The table is based on a SEEA example and is just one of many potential ways of expressing future flow information for freshwater. The development of such a flow table would depend on further developments with data supply and ideally would provide a finer level of detail for broad industries such as manufacturing.

Table 3 Sample Flow Table for Freshwater

Source and use of freshwater	Year ended June xxxx												
	Agriculture	Fisheries	Energy	Mining	Manufacturing	Distribution/irrigation water	Distribution/mains water	Sewerage	Government	Households	Rest of the world & sea	Environment	Total
	millions of cubic metres / millions of dollars												
From the environment													
total abstractions													
- from surfacewater													
- from groundwater													
- from other water													
- *for own use*													
- *for delivery*													
Within the economy													
total use of distributed water													
- water received by users													
of which recycled water													
- waste water collected by sewerage													
To the environment													
total residuals													
- to inland water													
returns from irrigation													
discharge wastewater after treatment													
discharge of untreated wastewater													
cooling water													
water used for hydroelectricity													
water lost in transport													
other returns of water													
- to the sea													
Consumption													
Total use													

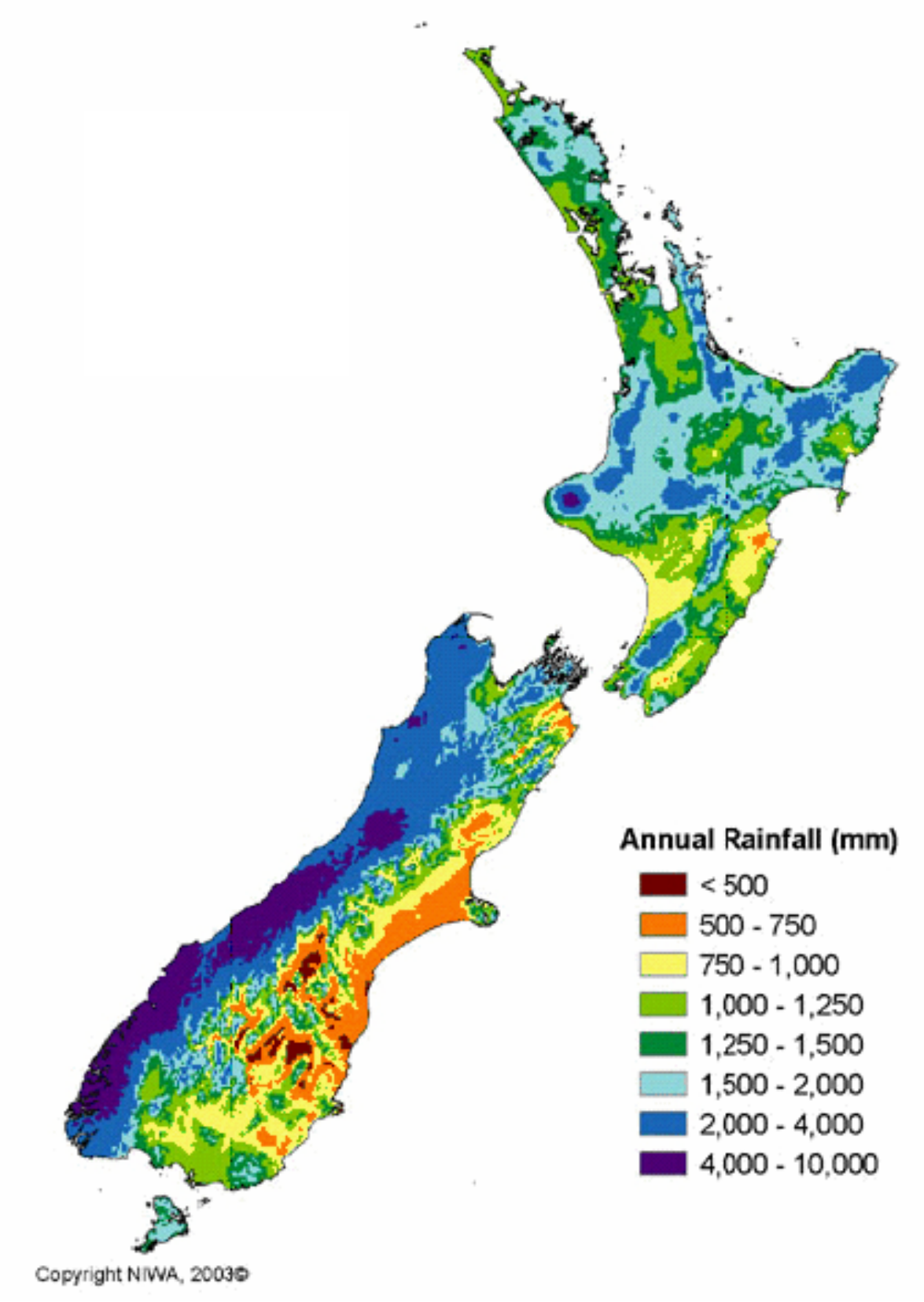
Source: Based on SEEA table 8.5 'Water use table'.

2.6 Precipitation

Water flows and replenishment of stocks depend primarily on precipitation. It is expected that fully developed water accounts, largely because of precipitation patterns, would show regional variation in water use and valuation. Market pricing of water or water rights, if it eventuates, would likely further influence water use and result in low prices in water-rich regions and higher prices in water-short regions. Prevailing westerly winds and mountainous terrain in the west mean that western regions generally receive more rainfall than eastern regions. This pattern is easily discernable in figure 1 on the following page.

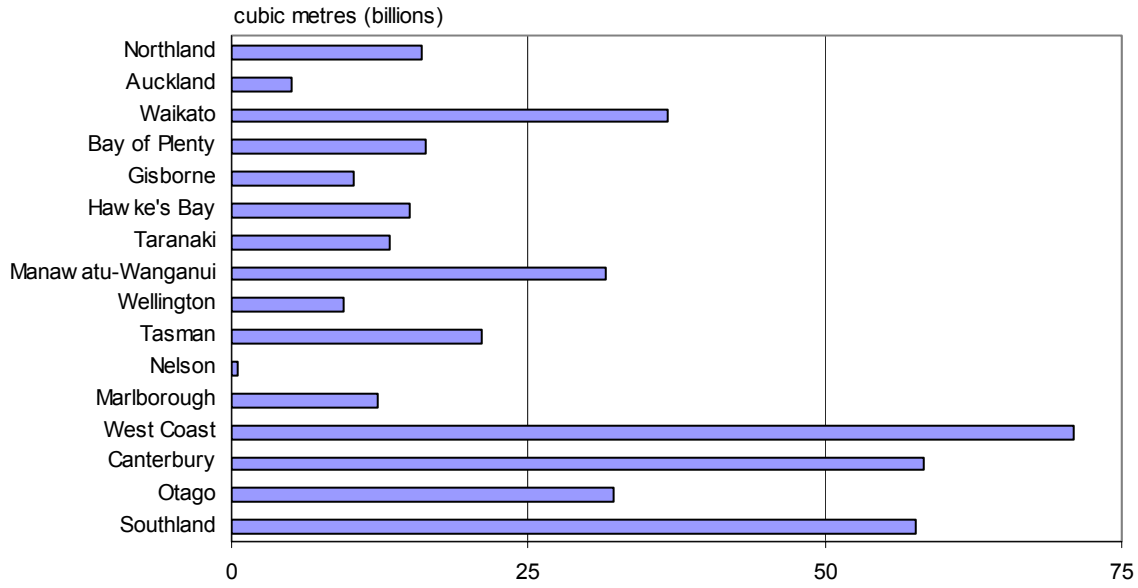
Storage, whether in aquifers or lakes, can partly smooth out fluctuations in the seasonal availability of water. Canterbury and Hawke's Bay, for example, receive relatively low precipitation but are able to draw water from aquifers to boost agricultural production above the levels possible with dryland farming.

Figure 1. Distribution of New Zealand's Rainfall
1971-2000



Source: NIWA: http://www.niwa.co.nz/edu/resources/climate/overview/climate_rainfall

Figure 2. Precipitation by Region for the Year Ended June 2001



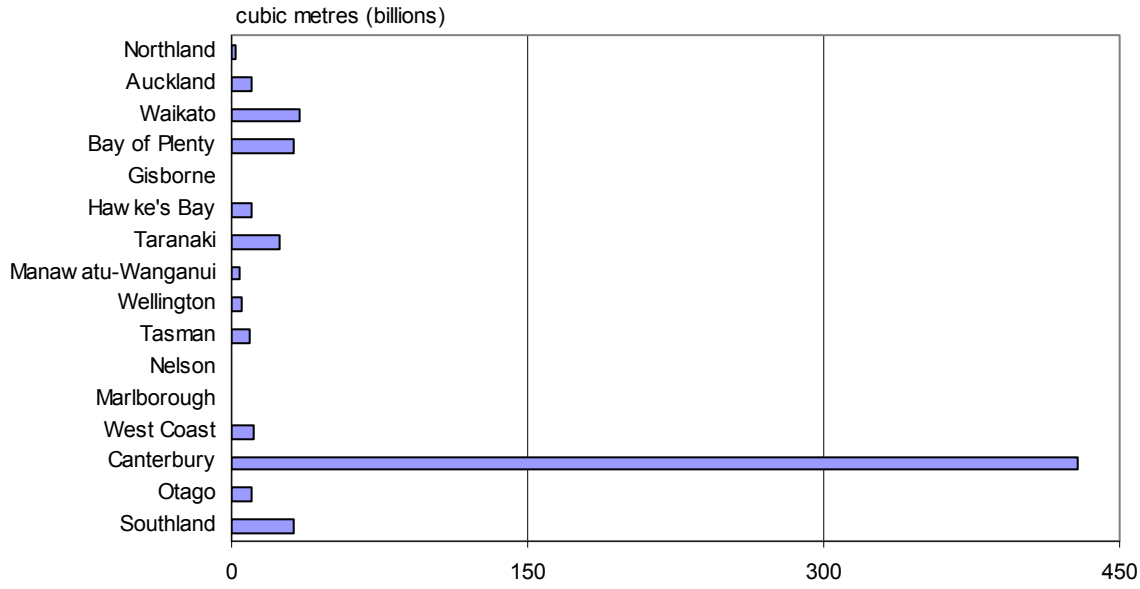
(1) Data supplied by NIWA.

(2) Precipitation includes rain, snow, hail, sleet and mist. Otago has the lowest precipitation per square kilometre.

(3) Volumes are from a table available at: http://www.stats.govt.nz/NR/rdonlyres/58CA8C3A-1482-47E3-865D-A76058BB4923/0/waterphysicalstockaccountsannualtables.xls

(4) Precipitation across the 16 regions totalled 407 billion cubic metres.

Figure 3. Groundwater Storage by Region at 30 June 2001



(1) Data supplied by GNS.

(2) All aquifer types (unconfined, semi-confined and confined) are included. Canterbury has 70 percent of the total groundwater volume, followed by Waikato at 6 percent then Bay of Plenty and Southland at 5 percent each.

(3) Volumes are from a GNS report available at: http://www.stats.govt.nz/NR/rdonlyres/25730D11-5D08-410A-BDCC-6A2EA570D756/0/groundwater.pdf

(4) Estimated groundwater volumes across the 16 regions totalled 613 billion cubic metres. This is 1.5 times the precipitation volume for the year ended June 2001.

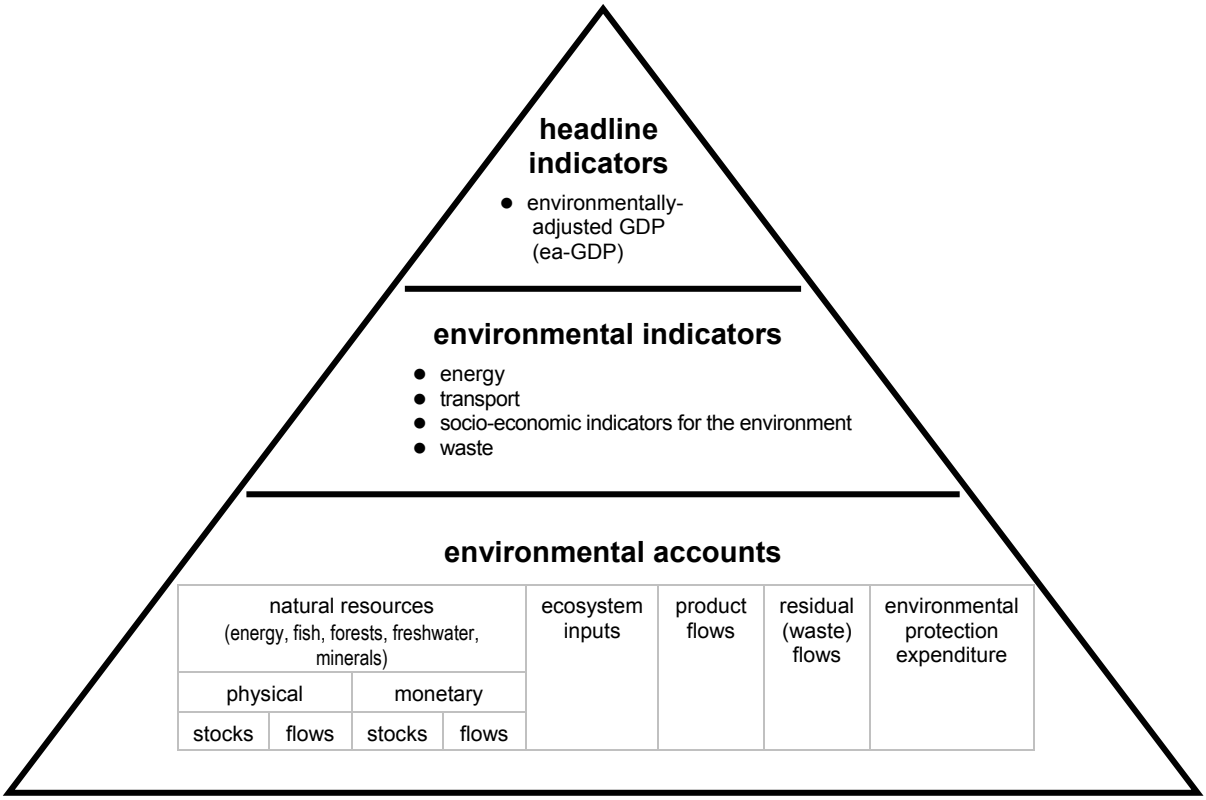
(5) Recharge rates and other considerations mean that sustainable maximum annual abstraction from aquifers is generally lower than the volumes stored.

3 Background

3.1 Environmental accounting

Statistics New Zealand is working with government and other agencies to produce a range of statistics about the natural environment and its interaction with the economy and society. Refer to figure 4 below. Environment statistics include accounts being developed for energy, fish, forests, freshwater and minerals. These accounts cover physical and monetary stocks and flows. Physical stock and flow accounts are referred to as 'natural resource accounts' and measure natural resource quantities in units such as tonnes and cubic metres. These stocks (assets) and flows, when valued in monetary terms, can be linked to economic statistics such as gross domestic product (GDP).

Figure 4. Statistics New Zealand's Environment Statistics Framework



Environmental accounting is being implemented in numerous countries and reflects a growing recognition that measures of economic activity need to account for environmental benefits and impacts. The environment has a finite capacity to supply materials and absorb waste and is under increasing pressure from population growth and economic development. Unadjusted economic measures, such as capital stocks or GDP, fail to incorporate the negative consequences of environmental degradation, pollution and unsustainable resource use.

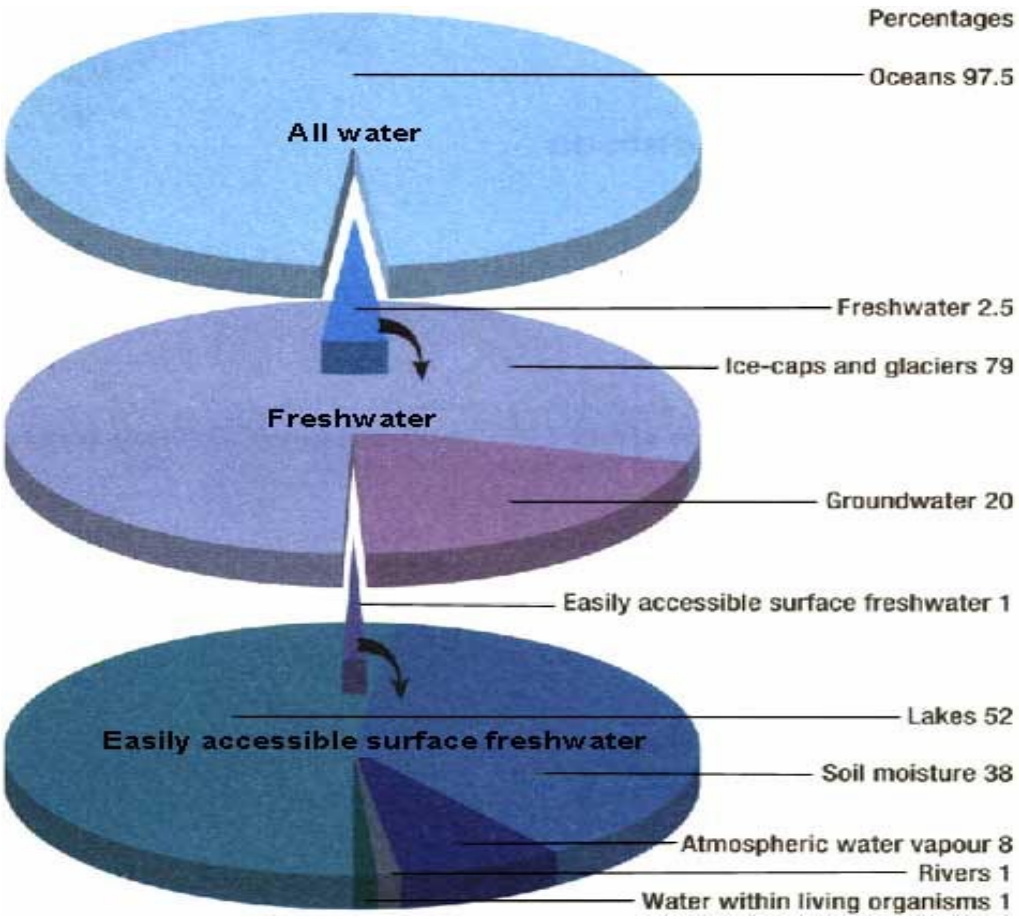
Further information on natural resource accounts and the environment statistics framework is available at the Statistics New Zealand web pages below.[5]

5 Natural resource accounts:
http://www.stats.govt.nz/analytical-reports/natural-resource-accounts/default.htm
Environment Statistics Strategy:
http://www.stats.govt.nz/domino/external/web/prod_serv.nsf/htmldocs/Environment+Statistics+Strategy
[4 November 2004].

3.2 Broad perspective

Most of the world's water is in the form of saltwater while most freshwater is in the form of ice in ice-caps and glaciers. "Only one-hundredth of 1 percent of the world's water is readily available [in lakes and rivers] for human use."[6]

Figure 5. Distribution of the World's Water



Source: Food and Agriculture Organization of the United Nations (1995).[6]

Historically, water has been treated as a free and often unlimited resource, but irrigation, industrialisation and population growth are leading to increased demand and competition. Allocation of water rights, pricing, pollution and conservation are becoming increasingly important and controversial issues in water-short areas of the world, including parts of New Zealand. For example, Canterbury has 70 percent of New Zealand's groundwater but is facing water shortages and increased competition for water as many groundwater zones approach or exceed their water allocation limits.

New Zealand has abundant freshwater but it is not always available in required quantities throughout each region and season. Demand for freshwater is growing, particularly from dairying, and there is increased awareness of its importance for maintaining the natural environment and biodiversity. Competition for water is not only for abstraction and

6 *Water: A Finite Resource,* Food and Agriculture Organization of the United Nations (FAO), http://www.fao.org/docrep/U8480E/U8480E0c.htm [9 July 2004].

consumptive usage but for its aesthetic and recreational attributes, as exemplified by the debate over taking water from the Waitaki River for hydroelectricity generation and irrigation.[7]

Water has multiple values for individual consumers and users, the economy and the environment. The problem is in determining these values when there is little market activity and many uses are for recreation and environmental protection. The aesthetic, cultural and psychological value of maintaining water in a pristine, natural state is also difficult to determine on an ongoing, nation-wide basis. Comprehensive valuation of water would also need to include snow and ice which have value as a store of water plus benefits for recreation, aesthetics and tourism. Soil moisture also has value, not only for farming but also for the environment and, less directly, for aesthetics, tourism and the broader economy.

In New Zealand, water is treated as a national resource and the right to manage it is vested in the Crown. Allocation of water is controlled via the Resource Management Act 1991 (RMA) which is administered by the Ministry for the Environment (MfE). Water rights are issued by regional councils and unitary authorities and rules of water use may vary from region to region. Water rights are required for any abstraction of water, other than for fire-fighting and reasonable domestic or animal use. Holders of water rights pay nothing for their water use, other than application, abstraction and infrastructure costs.

It has been estimated that irrigation accounts for 57 percent of New Zealand's consumptive water use, livestock 18 percent, industry 14 percent, and households 11 percent.[8]

The quality of water itself, whether for drinking, other uses, or discharge back into the environment, is of importance and would ideally be taken into account in any comprehensive system for measuring and compiling water values.

3.3 The value of water

According to the freshwater allocation conference held by the Ministry of Agriculture and Forestry (MAF) and MfE in 2002, water is valued by New Zealanders for many reasons:

- "economic – for irrigation and industry
- environmental – maintaining life in streams
- health – for water supply and safe swimming
- cultural – mahinga kai and mauri
- recreation – for fishing, boating and canoeing"[9]

"The world's national economies are based on the goods and services derived from ecosystems …" according to a report based on contributions by over 175 scientists.[10] Freshwater is a primary or vital part of most of these ecosystems and provides a variety of goods and services of benefit to the economy and humankind.

7 *Draft National Cost Benefit Analysis of Proposals to Take Water from the Waitaki River,* prepared by Sinclair Knight Merz Pty Ltd for the Ministry of Economic Development (May 2004), http://commcons.skm.com.au/waitakiriver/ [9 November 2004].

8 New Zealand Official Yearbook on the web 1999, http://www.stats.govt.nz/domino/external/pasfull/pasfull.nsf/web/Yearbook+16+Land+and+environment+1999+16+Land+and+environment?open#three [27 October 2004].

9 *Water: The Lifeblood of New Zealand - The Allocation of Freshwater,* national conference hosted by MAF and MfE on 23/24 July 2002 in Wellington, http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/water-efficiency/water-conference/ [22 November 2004].

10 *World Resources 2000-2001: People and Ecosystems: The Fraying Web of Life.* United Nations Development Programme, United Nations Environment Programme, World Bank and World Resources Institute (2000), http://water.wri.org/pubs_description.cfm?PubID=3027 [9 November 2004].

Figure 6. Primary Goods and Services Provided by Freshwater Ecosystems

Goods	Services
Drinking and irrigation water Fish Hydroelectricity Genetic resources	Buffer water flow (control timing and volume) Dilute and carry away wastes Cycle nutrients Maintain biodiversity Provide aquatic habitat Provide transportation corridor Provide employment Contribute aesthetic beauty and provide recreation

Source: United Nations Development Programme, et al. (2000).[11]

The Parliamentary Commissioner for the Environment stated in 2002 that "fresh water IS the most precious resource; the most valuable natural capital."[12]

3.3.1 Overall value

The asset value of New Zealand's freshwater is likely to be several tens of billions of dollars. The derived annual benefit is probably several billion dollars.

For comparison, the value of net capital stock (fixed assets including buildings, vehicles and machinery) was $290 billion for the March 1999 year. For the same year, monetary flow (supply/use) values are estimated at $10 billion for energy products and $6 billion for forestry products.

On a population basis, the derived annual benefit of New Zealand's freshwater is broadly in line with an estimated global value. The World Resources Institute reports that "although water in rivers, lakes, and wetlands contains only 0.01 percent of the world's water (including seawater) and occupies less than 1 percent of the Earth's surface, the global value of freshwater services is estimated in the trillions of U.S. dollars."[13]

As at 2002, there have been about 85 non-market valuation studies of freshwater undertaken in New Zealand.[14] Results of a number of studies vary markedly and are not produced by Statistics New Zealand, but show that freshwater has considerable value to the New Zealand economy and environment. However, there is no comprehensive, nationwide, SEEA-based, annually-repeated study suitable for ongoing use in monetary stock or flow accounts.

Some sampled studies are summarised in the following pages and placed for convenience into economic, irrigation and preservation categories. There is some crossover among these categories.

11 *World Resources 2000-2001: People and Ecosystems: The Fraying Web of Life. United Nations Development Programme, United Nations Environment Programme, World Bank and World Resources Institute (2000),* http://water.wri.org/pubs_content_text.cfm?ContentID=235 [9 November 2004].

12 *Natural Capital; The account we all continue to plunder,* Dr J Morgan Williams, Parliamentary Commissioner for the Environment, New Zealand. IWA Conference, Venice (November 2002), http://www.pce.govt.nz/news/speeches/speech_02_11_25.pdf [4 November 2004].

13 *Human modification of freshwater systems.* World Resources Institute, Washington (2002), http://www.wri.org/wr2000/freshwater_humanmod.html [13 July 2004].

14 *Valuation of Instream Issues,* Geoffrey N Kerr, Lincoln University (22 August 2002), http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/water-efficiency/water-conference/water-conference-09.htm [15 July 2004].

3.3.2 Economic value

According to a study in 2001, "the economic value of groundwater to abstractive users in the Waimea Plains, Nelson, is estimated to be approximately $250 million. … The economic value of New Zealand's total consumptive water allocation would be estimated at $24 billion to $25 billion if the unit economic value of Waimea Plain's groundwater could be applied to all of New Zealand's water allocation."[15] The estimated $24 billion to $25 billion for national freshwater assets is for consumptive use and excludes the economic value of water for waste disposal, freshwater fisheries, recreation, hydroelectric generation and gravel replenishment.

In 2002, the economic value of freshwater assets in the Manawatu-Wanganui Region alone was assessed at approximately $2.6 billion by GNS. This figure includes $146 million for non-consumptive uses (hunting, boating, fishing and recreation) and $137 million for existence value to householders.[16] The Manawatu-Wanganui Region has 8 percent of New Zealand's land area and 6 percent of its population, suggesting, by extrapolation, that the economic value of all freshwater assets across New Zealand could be about $30 billion to $45 billion.

The preceding extrapolation is consistent with a national benefit of about $2 billion *per annum* from freshwater assets, if a discount rate of 6 percent is assumed. CS First Boston New Zealand Limited, in a 1995 report commissioned for the New Zealand Business Roundtable, stated that the "the value of natural water for waste disposal, water supply, recreation and commercial fisheries (and excluding ecological and cultural values) has been estimated at around $1.5 billion per annum."[17]

3.3.3 Irrigation value

"The net contribution of irrigation to GDP at the farmgate is estimated to be in the order of $920 million in [the] 2002/03 [production season]" according to a MAF technical paper in April 2004.[18] This value is over and above GDP at the farmgate that would have been produced without irrigation. Excluding forestry, it is about 11 percent of farmgate GDP and is produced from 3.9 percent of farmed land. Refer section 4.1.4 for further discussion of irrigation and resource rent.

A side-effect of the first in, first served issuing of water rights and the non-pricing of water usage is that the scarcity value of water becomes factored into land prices. A PricewaterhouseCoopers report in 2004 mentions that "properties that have access to water have risen substantially in value. This is particularly in evidence in areas subject to viticulture and dairying development. One estimate puts the values of water availability on the Wairau Plains at $50-60,000 per hectare."[19]

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15 *Economic valuation of the Waimea Plains groundwater system,* White PA, Sharp BMH & Kerr GN (2001), Journal of Hydrology (NZ) 40(1) pp 59-76, http://www.hydrologynz.org.nz/jnl-abstracts-vol40.html [8 October 2004].

16 *Economic Valuation of Water Resources in the Manawatu-Wanganui Region,* GNS report by White PA & Sharp BMH (November 2002), http://www.horizons.govt.nz/default.asp?data_article=564 and http://www.horizons.govt.nz/default.asp?pageid=92&data_article=594 [20 October 2004].

17 *Reform of the Water Industry,* report prepared by CS First Boston New Zealand Limited for the New Zealand Business Roundtable (August 1995), http://www.nzbr.org.nz/documents/publications/new-publications/reform_of_water.pdf [20 October 2004].

18 MAF Media Release (Ministry of Agriculture and Forestry, 31 May 2004). The full report is at: http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/irrigation/the-economic-value-of-irrigation/index.htm [13 July 2004].

19 *Ministry of Economic Development Infrastructure Stocktake,* PricewaterhouseCoopers (January 2004), http://www.med.govt.nz/irdev/econ_dev/infrastructure/reports/pwc-audit/pwc-audit.pdf [27 October 2004].

3.3.4 Preservation value

Preservation of freshwater resources may be of considerable ecological value, as shown in the following estimates for the 10,320 hectare Whangamarino wetland in the North Island:

"Economic Value per year (converted to 2003 US$)

- non-use preservation 7,247,117
- recreation 2,022,720
- commercial fishing 10,518
- flood control 601,037
- total 9,881,392."[20]

The non-use preservation value in the above study is almost three-quarters of the wetland's total value. For rivers the same high proportion may apply. According to a study of Colorado rivers in 1984, "use values were found to only account for approximately 20 percent of the total willingness-to-pay for river preservation, with the remaining 80 percent attributed to non-use (preservation) values."[21]

Table 4 Values of Aquatic Ecosystem Water Services

Aquatic ecosystems have multiple roles which confer an economic value to water.

Ecosystem type	Total value per hectare (US$/year)	Total global flow value (US$billion/year)
Tidal marsh/mangroves	6,075	375
Swamps/floodplains	9,990	1,648
Lakes/rivers	19,580	3,231
Total		5,254

Source: United Nations Educational Scientific and Cultural Organization (UNESCO).[22]

Note: Global and per hectare values of ecosystems have been calculated based on the estimation of the indirect values of the aquatic ecosystems in flood control, groundwater recharge, shoreline stabilization and shore protection, nutrition cycling and retentions, water purification, preservation of biodiversity, and recreation and tourism.

Values for ecosystem services in the Waikato Region are shown in the following table, for the 1997 calendar year. Applying the relevant values per hectare to the estimated surface area of New Zealand's lakes, rivers and wetlands would give a value of about $15 billion per year. If ecosystem services from aquifers, glaciers and snow were added, the national value would likely reach several tens of billions of dollars per year.

20 *Living Waters – The Economic Values of the World's Wetlands,* WWF, Gland/Amsterdam (2004), http://www.panda.org/downloads/freshwater/wetlandsbrochurefinal.pdf [13 July 2004].

21 *Economic Impacts of Protecting Rivers, Trails, and Greenway Corridors, Chapter 9 Benefit Estimation,* National Park Service, U.S. Department of the Interior, http://www.nps.gov/pwro/rtca/benefit.htm#preservation [25 August 2004].

22 Extracted from the *World Water Development Report,* Costanza et al (1997), 'The nature of the world's ecosystem services and natural capital', Nature, Vol. 387, pp. 253-60, http://www.unesco.org/water/wwap/wwdr/pdf/chap13.pdf [14 July 2004].

Table 5 Values Derived from Ecosystem Services in the Waikato Region

Ecosystem type	Value per hectare/year ($)	Total value $(million)	% of total value
Lakes and Rivers	19,700	1,856	19.8
Forests	2,400	1,848	19.8
Agricultural/Horticultural	1,100	1,460	15.6
Freshwater Wetlands	39,800	1,211	12.9
Coastal Marine Area (CMA)	500	1,113	11.9
Near Coastal Zone	8,000	915	9.8
Estuarine	46,400	863	9.2
Other:			
Scrub/Shrub	500	55	0.6
Seagrass/Algal Beds	38,900	21	0.2
Cropland	140	9	0.1
Mangrove	19,000	3	0.1
Total		9,360	100

Source: Patterson M and Cole A (1998). [23]

Note: Ecosystem services of lakes and rivers include hydrological cycles, flow regulation and flood control, water supply, recreation and food. Ecosystem services of freshwater wetlands include storm protection, flood control, habitat, nutrient recycling and waste treatment.

3.4 SEEA basis

The monetary stock accounts for freshwater, if fully developed, would be based on the United Nations handbook of *Integrated Environmental and Economic Accounting* (commonly referred to as SEEA).[24] Water accounts, according to the SEEA, can be constructed from either a hydrological perspective or an economic perspective. The hydrological perspective traces flows of water through the environment and gives the impact of human intervention on water flows and storage, while the economic perspective deals solely with water that is used for economic purposes and discharged back into the environment.

The physical stock accounts for freshwater are based on the hydrological perspective, as in table 2 in section 2.2. The monetary version of these accounts, if fully developed, would ideally have the same table structure. There are difficulties, however, in assigning values for water that is not abstracted for economic purposes.

3.5 Scope of the accounts

Development of monetary stock accounts for freshwater is dependent on the availability of suitable data or estimation methods. The accounts, if and when fully developed, would not necessarily have the same scope as the physical stock accounts. They might exclude some

23 *The Economic Value of Ecosystem Services in the Waikato Region,* Patterson M and Cole A (1998), Report prepared for Environment Waikato. Massey University, Palmerston North, http://www.ew.govt.nz/enviroinfo/profile/economy/ecoservices.htm [21 October 2004].

24 The SEEA handbook can be downloaded from: http://unstats.un.org/unsd/envAccounting/seea.htm [13 July 2004].

components, such as precipitation and evapotranspiration, which are largely outside the economy and which pose severe valuation difficulties. Also, to fully incorporate non-consumptive values of water (such as water used for maintaining biological diversity in wetlands), the monetary stock accounts would ideally cover all stocks of water whereas the physical stock accounts, for practical reasons, deal only with annual changes when including storage volumes for water. Water quality is also an important determinant of value and would ideally be incorporated into any future monetary stock accounts.

3.6 Potential uses

Monetary stock accounts for freshwater, if they could be produced, would have potential uses in assessing:

- environmentally-adjusted gross domestic product (ea-GDP)
- national wealth (the stock of water resources is part of the wealth of a nation)
- cost variations associated with regional differences in supply and demand
- financial effects from El Niño–Southern Oscillation (ENSO) and Interdecadal Pacific Oscillation (IPO) climate cycles[25]
- comparative values of consumptive usage versus non-consumptive usage
- the value of environmental resources to the economy and society
- the cost of water pollution
- impacts of policy changes

3.7 Valuation of water quality

Pure water, for most uses, has higher value than polluted water.

Valuation of water quality would ideally use market prices or values but, in their absence, values can be measured using alternative methods. Contingent valuation, discussed in section 4.2.4, has been used in various studies in New Zealand.[26] Other methods include conjoint analysis and hedonic pricing. The cost of treatment is also a possible pricing differential between pure and polluted water.

The value that water users place on quality can be considerable, according to a contingent valuation survey in 2000. For Christchurch households, "the in-situ value of the groundwater resource (water quality aspects only) is estimated as $535 million …"[27]

Valuation of water quality on an accurate, ongoing basis across every region in New Zealand would involve extensive data collection and analysis and is outside the present scope of the monetary stock accounts.

25 For further information on climate cycles refer to http://www.niwa.cri.nz/edu/students/faq/enln and http://www.niwa.cri.nz/pubs/wa/09-4/world#panel [23 August 2004].

26 For example, *Instream Water Values: Canterbury's Rakaia and Waimakariri Rivers,* Kerr GN, Sharp BMH & Leathers KL (September 2004), p. 29, Research Report No. 272, Lincoln University.

27 *Valuation of in-situ groundwater resources in the Waimea Plains and Christchurch,* White PA, Kerr GN & Sharp BMH (2001), published in Just add water: conference programme and abstracts, p. 140-141, New Zealand Hydrological & New Zealand Limnological Society joint conference, 20-23 November 2001, Wellington, http://www.hydrologynz.org.nz/society-books.html [2 November 2004].

4 Valuation methods

The economic value of freshwater is not fixed but depends on location, time, circumstance and individual preference. Where market prices or values cannot be obtained, alternative valuation methods, such as travel cost or people's willingness to pay, can be used. Values may be either directly measured or else calculated by multiplying volumes and prices together.

Methods for valuing water use are generally not applicable for determining non-use values. Estimates of total water value typically combine several valuation methods. However, valuation of water non-use involves such notions as aesthetic beauty, cultural importance, recreational quality and maintenance of biodiversity and can be difficult and costly to accurately and unambiguously measure. According to a UNESCO-IHE paper, "the measurement of non-use values is by far more controversial than that of use values."[28]

4.1 Valuation of water use

Several methods for valuing water use are discussed below.

4.1.1 Market values

For valuing freshwater and other natural resources in the environmental accounts and ultimately the national accounts, the use of market values or prices is the preferred method. "The SNA recommends that market prices be used wherever practicable to place a value on an asset."[29]

Market values include rates and fees charged by water suppliers to users, even if there are no markets for trading water. Market values may also include traded values for rights to water, rather than water itself. In New Zealand, there is some trading of water rights but there are no formal water markets and therefore no market valuation information is readily available. The exception is water rates and fees charged by local authorities which, together with fees charged by irrigation scheme operators, are typically cost-based and are therefore unlikely to represent values that would occur in competitive markets. Market prices would likely exhibit regional differences and perhaps seasonal differences, depending on such factors as water quality, scarcity, time-span of rights, and cost of abstraction and supply.

Market prices, by their nature, are based on human use or exploitation potential and may be ideal for valuing the economic use of water but are unsuited for determining the non-use or preservation value of water. Because competitive market prices for water are not extensively available in many countries, SEEA discusses other valuation methods. These are summarised in paragraphs 4.1.2 to 4.1.5.

4.1.2 Cost of acquiring water rights

Where market values for water, such as irrigation water, are not available, one of the alternative valuation methods is to use the cost of acquiring water rights as a proxy for the value of the water itself.

Water rights in New Zealand are granted for various periods of time, such as 15 years, and specify maximum volumes that can be abstracted. The cost of acquiring a water right may

28 *The Economic Valuation of Water: Principles and methods,* J.I. Agudelo (August 2001), IHE Delft, The Netherlands, http://www.unesco-ihe.org/downloads/projects/value_of_water/05.pdf [22 October 2004].
29 United Nations handbook of *Integrated Environmental and Economic Accounting 2003* (SEEA), http://unstats.un.org/unsd/envAccounting/seea2003.pdf [8 July 2004].

include consultancy fees as well as an application fee. To calculate, for each time period, a cost per unit of quantity abstracted, the acquisition costs could be accrued, in real terms, over the time span for which the water right applies. However, this would be excessively time-consuming and would provide little indication of the economic price or value of water.

Water rights, when untraded, can be expected to provide little incentive to conserve supplies or make the best use of them. Competitive trading (as in water markets) may provide a financial incentive for holders to sell or lease their rights to others who have higher-value uses for the water and would also provide a means of obtaining prices for monetary accounts.

For environmental accounting purposes, water rights are difficult to quantify, value and statistically aggregate, particularly if water meters and monitoring are not a condition of their issuance. In the absence of a functioning market, the cost of acquiring water rights may bear little relationship to the value of water available or abstracted.

4.1.3 Cost of abstraction and distribution

This method assumes that the value of water is equal to the cost of abstraction and distribution. It is an unsatisfactory method because it sets the intrinsic value of water to zero. Price effects from water scarcity and changes in supply and demand are ignored.

The cost of abstraction and distribution, by itself, cannot realistically represent the value of water. A pricing measure for the water itself would need to be added. The resource rent, below, is such a measure.

4.1.4 Resource rent

Resource rent is the economic value of a resource and is attributable not to the users of the resource but to the limited supply of the resource. It is a measure of the scarcity value of a resource.

As water resources become fully allocated, the holders of water rights can make gains in property value and achieve higher economic returns than non-holders of water rights. For irrigation water, for example, a value for resource rent could in theory be calculated by comparing the operating surplus or profits for irrigated and unirrigated farms. The differential for farms that are otherwise well matched could be attributed to the resource rental value of irrigation water. However, in practice it is difficult to isolate the impact of irrigation water from other variables such as management, soil quality, capital assets and location.

Resource rent, according to the SEEA, can be used for balance sheet valuation of natural resources when market prices of natural assets are not available.

4.1.5 Economic activity

This method relates economic activity, such as value-added or gross profit, to the water used. It can be regarded as a productivity measure.

The value of economic activity, when expressed per unit of water used, gives an indication of the effectiveness of water usage. For agriculture, irrigation water can be a key input associated with production levels but in other industries water may be just one of many inputs. Care is required if making comparisons across industries that have little relationship between water usage and output. The economic activity method has its place in analysis and can guide allocation and investment decisions but can be expected to give imputed values that are much higher than would occur in water markets. The method is useful, however, for indicating the effect on the economy of water exploitation or re-allocation.

The Ministry of Agriculture and Forestry (MAF) periodically conducts a study on the 'at-farm gate' value of irritation water. Refer section 3.3.3. This study indicates the increase in GDP (value-added) that is attributable to irrigation. It is calculated on a per hectare basis rather than a per cubic metre basis.

4.2 Valuation of water non-use

Several methods can be used. *Revealed preference* pricing techniques use direct observations or actual prices and include travel cost, hedonic pricing and market valuation of economic losses. *Stated preference* or non-behavioural pricing techniques involve asking questions of people and include contingent valuation and conjoint analysis. The SEEA states that market prices are conceptually best but recognises that other pricing techniques are needed when markets are non-existent. Revealed preference pricing techniques are generally less susceptible to bias than stated preference pricing techniques.

4.2.1 Travel cost

Recreation and aesthetic values of lakes, river, wetlands and other water resources can be calculated in monetary terms by examining the travel cost to visit such sites. Travel costs have three components:

- direct transport costs (such as bus fares or fuel and vehicle wear)
- entrance fees (if applicable)
- time (the cost of opportunities forgone)

The relationship of costs to numbers of visits can show the average value per visit and enable calculation of the value of the site.

The method can be difficult to use because it includes opportunity costs and requires considerable data and analysis. Equating environmental value to the cost of human recreation and leisure is a superficial approximation and does not separate the value of the water resource from the value of the surrounding landscape or the facilities at the site. Values for wildlife and biodiversity are ignored. The method is limited in scope and would have little relevance to aquifers.

4.2.2 Hedonic pricing

Hedonic pricing is a statistical technique for assessing the contribution that each quality characteristic of a product makes towards the overall price of the product. The assessments are derived from analysis of similar products with differing quality characteristics. Proximity of a subdivision site to a scenic lake, for example, provides environmental amenity value that boosts land prices above those for comparable sites that are not close to such a lake.

Water in the environment is often associated with other characteristics, such as wildlife, vegetation, biodiversity, scenery and recreational qualities. Hedonic pricing can in theory be used to determine the contribution of each of these quality characteristics to overall changes in value. In practice there are unlikely to be sufficient market prices available for such analytical dissection. Furthermore, the values attributed to wildlife, vegetation and biodiversity can arguably all be assigned to the water on which they are dependent. Hedonic pricing requires a lot of high quality pricing data and is better suited to building price indexes of market commodities, such as computers and cars, than for determining the value of water in the environment.

4.2.3 Market valuation of economic losses

Measuring the economic effects of environmental damage to water resources can provide an indication of the economic worth of similar undamaged resources. Such measures, however, are limited to marketed assets and well-defined commodities and exclude intangible values for well-being and biodiversity.

4.2.4 Contingent valuation

This method involves asking people directly how much they would be willing to pay for specific environmental attributes (or alternatively how much they would be willing to accept for the loss of such attributes). It is called 'contingent' valuation because results are based on hypothetical scenarios.

Contingent valuation is a non-behavioural method which is subject to a number of possible sources of bias. It is a difficult method to apply correctly and may give results that are not necessarily a good proxy for actual behaviour.

4.2.5 Conjoint analysis

Conjoint analysis is similar to contingent valuation but is less direct. Instead of collecting values directly, the values are inferred (using discrete choice techniques) from the hypothetical choices, rankings or matches that survey respondents make. For example, a householder may be asked to state a preference between a nitrate-polluted water source at $5 per month and a cleaned-up water source that costs an extra $10 per month.

Conjoint analysis can be in the form of choice selections, contingent rankings or ratings, paired comparisons, and self-explication. It can be especially useful where there are policy decisions that would impact on several difficult-to-price attributes or environmental services such as the use of lake water for fishing, swimming and household supply.

4.2.6 Benefit transfer

This is not a pricing method in itself. It is a means of valuing an ecosystem, for example, by using unit values or information from studies done elsewhere. Benefit transfer can provide values when there is insufficient money or time to conduct new studies. The information or values used might be from overseas and require adjustment to New Zealand incomes and conditions. The studies used can be of any type but are better if rigorously conducted and matched as closely as possible to population sizes, income levels, site characteristics and market conditions.

4.3 Summary of valuation methods

For national accounting purposes, including environmental accounts, it is best to use *market prices* for valuing water supplies and usage. In New Zealand, however, water is generally not a market commodity and market prices are therefore mostly unavailable. The *cost of acquiring water rights* is an alternative but is largely an administrative charge rather than a market price and is not suited for representing water values in any environmentally-adjusted national accounts. The *cost of abstraction and distribution* is also unsuitable as it assumes that water has no intrinsic value. Assigning a value of zero to water would also set the value of lakes and other water resources to zero and would be totally unrealistic when valuing environmental depletion, for example. The *resource rent* method involves separating the value of water from the value of other variables and would be a difficult method to apply to all water usage. The

economic activity method indicates the economic effectiveness of water use but does not value water itself.

The non-use valuation methods are not ideal either. *Travel cost* and *hedonic pricing* methods are time consuming and neither is suitable for valuing the full range of water resources or environmental services. The *market valuation of economic losses* is limited to marketed assets and well-defined commodities. *Contingent valuation* and *conjoint analysis* are 'stated preference' valuation techniques based on hypothetical questions. They are complicated to operate, open to controversy, and better suited to local issues than to the full range of water resources at a national level. *Benefit transfer* is inherently biased towards the sites or countries where the studies were originally done.

In the absence of market prices, there is no single alternative method that appears suitable for efficient nationwide valuation of all types of water resource. Market prices, if they were available, would be the best means of determining the value of water used in the economy. For water that is not directly used in the economy, however, there would be no market prices, and alternative valuation methods would be unlikely to fully take future generations, biodiversity and ecosystem values into account.

4.4 Discounting

Discounting is not really a valuation method in itself but is a means of looking at future values from a current perspective. Values from different time periods may then be added to determine long-run costs, benefits or net present values of projects, investments or natural assets. When used for natural asset valuation it is supplementary to pure valuation methods, such as resource rent, and is typically used for compiling net present values (which are also known as present discounted values). Refer 'net present value' in the glossary.

Discounting accounts for the time value of money and is effectively the reverse of applying a compounding interest rate to an investment. For example, $1.00 today at an interest rate of six percent would be worth $1.06 in a year's time. Turning these figures around, the benefit from a resource next year may be discounted from $1.06 down to a value of $1.00 today, to allow for the cost (equivalent to interest or investment opportunities forgone) of having to wait a year for the benefit. Discounting, because of this 'investment-style' approach, puts a higher value on current benefits than future benefits. When applied to asset valuation of water resources, for example, it effectively treats the benefits that future generations may derive from the resource as being of lower importance than the benefits derived by current users.

Calculations of net present value are very sensitive to the discount rate selected. High discount rates, particularly over long or indefinite time scales, give relatively little value to future net benefits and may encourage rapid use of resources. However, low discount rates, if they are below industry norms or market investment returns, may impair the validity of economic comparisons and analysis.

5 Data for water accounts

The supply of data for water accounting is dependent on the type of water management regime in operation. Water metering and water pricing are crucial aspects of water management that can determine the type, coverage and quality of water accounts produced. Conversely, there is also potential for water accounts to affect water management decisions.

5.1 Current situation

There are limited opportunities for completion and further development of the water accounts, given the current water management regime and consequent paucity of data.

The present water management regime is largely based on:

- non-compulsory water metering in most regions
- treatment of water as a 'free' good (intrinsically free but with abstraction and supply costs and fees)
- 'first in, first served' issuing of water rights

The result for water accounting is that data is lacking for physical volumes and mostly unavailable for monetary values.

5.1.1 Physical volumes

The lack of measured, recorded and compiled data from water meters means that there is insufficient volumetric information to complete the standard range of natural resource accounts for water. Although physical stock accounts for water have been produced, they do not include abstraction volumes for irrigation or private industrial use. There is also insufficient data on industrial water use to compile physical flow accounts.

5.1.2 Monetary values

There is incomplete market or other valuation information suitable for use in monetary stock and flow accounts for water. The treatment of water as a free good means that values are mostly unavailable for water itself but local authority water rates and sales values are now available annually and application fees for water rights are potentially available if considered useful. There are some valuation difficulties and conceptual problems, including the following:

- Local authority water rates and excess charges apply to only a relatively small proportion of water use, are based on supply costs, and are largely unrelated to volumes supplied. They include domestic, commercial, industrial and rural usage.
- Private water abstraction is free, apart from the cost of obtaining water rights (if needed) and abstracting the water.
- Volumetric pricing for irrigation systems supplying multiple farms is a means of apportioning operating costs and such costs or prices are not readily available.
- Prices exist for bottled water but such water is only a tiny proportion of all abstracted water.

5.1.3 Pressure for change

Water scarcity and water quality are issues that are bringing increasing pressure for change to the current water management regime. Addressing these issues may present opportunities for improvement in data collection.

With water resources reaching or exceeding their sustainable abstraction limits, it can no longer be taken for granted that water rights will be available for new irrigation or industrial usage. Debate about water management is intensifying as burgeoning demand for water outstrips available supplies in many areas. The preamble to the water conference held by MAF and MfE in July 2002 states that "demand for water for all purposes is increasing. This in turn is leading to increasing public debate on the uses to which water is put, and how much is available for different purposes."[30] A November 2003 conference on freshwater, organised by the Royal Society of New Zealand, commented that "fresh water in New Zealand faces serious problems. Partly it is a matter of limited supply and growing demand. … Water quality is also a problem, and so is the way we manage water through law and government. There are issues of sustainability, risk and control."[31]

Demand in New Zealand is controlled under the RMA by a first in, first served system of allocating water rights for up to 35 years. However, with many rivers and aquifers becoming fully or over-allocated, as discussed in section 3.2, water is acquiring scarcity value in parts of New Zealand. Applications for water abstraction are sometimes turned down or put on hold yet there is little means of competing for scarce supplies or ensuring that supplies go to the highest-value uses. The current system of allocating water rights on a first in, first served basis "does seem to lead to possible unfairness and to potential inefficiency", according to the August 2004 Environment Court decision on the Rangitata River.[32]

5.1.4 Addressing the issues

In August 2002, *The Government's Approach to Sustainable Development* stated that "the sustainable management of fresh water is one of New Zealand's most significant environmental challenges …"[33]

The Government's 2003 *Sustainable Development for New Zealand: Programme of Action* has made water one of the four key issues. "Freshwater allocation and use, water quality issues, and water bodies of national importance are fundamental elements for New Zealand's sustainable development. There are a number of water-resource management issues that must be addressed for us to sustain our economic growth, natural environment and heritage, and the health and wellbeing of our people. … The programme of action seeks to achieve the following outcomes:

- freshwater is allocated and used in a sustainable, efficient and equitable way
- freshwater quality is maintained to meet all appropriate needs
- water bodies with nationally significant natural, social or cultural heritage values are protected."[34]

The Water Programme of Action includes projects to:

- "look at how to manage water allocation and factors affecting water quality and how to get the best balance
- determine what the national interest in water is and how to get the best results from this

30 Conference on *Water: The Lifeblood of New Zealand.* Ministry of Agriculture and Forestry (2002), http://www.maf.govt.nz/mafnet/publications/rmupdate/rm10/rm-update-june-2002-05.htm [12 July 2004].

31 *Fresh water New Zealand: problems, processes and priorities,* Proceedings of a conference organised by the Royal Society of New Zealand (November 2003), http://www.rsnz.org/topics/enviro/freshwater_conf/intropages.pdf [15 October 2004].

32 *Court decision saves river, say anglers and environmentalists,* Leanne Scott and John Keast, The Press, Christchurch, 10 August 2004.

33 *The Government's Approach to Sustainable Development,* Minister for the Environment, New Zealand, ISBN 0-478-26309-0 (2002), http://www.beehive.govt.nz/hobbs/med-sustainable-development-govt-approach.pdf [31 August 2004].

34 *Sustainable Development for New Zealand: Programme of Action*, Department of Prime Minister and Cabinet, New Zealand (2003), http://www.beehive.govt.nz/hobbs/30199-med-susined-developm.pdf [25 August 2004].

- identify the water bodies of national importance
- develop ways to get sustainable and fair results."[35]

5.2 Future situation

The outcome for New Zealand of addressing the water management issues of allocation, quality and protection is uncertain, but pointers to possible long-term change are the recurring themes emerging from the Australian experience, United Nations recommendations and other national and international debate. Some of these potential changes are of particular relevance to water accounting.

Australia, in 1994, developed a National Agenda for Water Reform. "Key features of this Agenda include:

- introduction of commercial principles to the water industry, including privatisation or corporatisation of utilities
- separation of water wholesale and retail supply organisations with performance monitoring at both levels
- separation from supply responsibilities of regulatory functions that protect the public interest in the way the resource is managed, allocated and priced
- consumption-based pricing (not property taxes) set to cover all costs of water supply
- establishment of water rights as a separate property right from the land
- markets for the free trading of water rights separately from land
- reduction of cross-subsidies in water provision
- specific water allocation to the environment
- natural resource management through integrated catchment management
- public consultation."[36]

The 1992 United Nations Conference on Environment and Development (UNCED, also known as the Earth Summit) agreed on principles for sustainable development and provided objectives for freshwater.[37] The objectives include:

- optimisation of water resources allocation under physical and socio-economic constraints
- implementation of allocation decisions through demand management, pricing mechanisms and regulatory measures
- promotion of schemes for rational water use through public awareness-raising, educational programmes and levying of water tariffs and other economic instruments
- integration of water (including surface and underground water resources) quantity and quality management
- promotion of water conservation through improved water-use efficiency and wastage minimisation schemes for all users, including the development of water-saving devices

According to the OECD, "There remains a need to allocate water resources efficiently and equitably, to operate water services cost-effectively, and to ensure proper financing of all water services. … [This includes charges] in line with the user pays and polluter pays principles".[38]

35 *The Water Programme of Action,* MfE (November 2003), http://www.mfe.govt.nz/publications/water/water-programme-nov03/water-programme-action-nov03.pdf [26 October 2004].
36 *Sea change for water policy,* Australian Academy of Technological Sciences and Engineering, http://www.atse.org.au/index.php?sectionid=213 [28 July 2004].
37 *Protection of the quality and supply of freshwater resources,* UNCED Agenda 21, Chapter 18 (2003), http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter18.htm [28 July 2004].
38 *Water: Performance and Challenges in OECD Countries,* OECD (2003), http://www.oecd.org/dataoecd/12/38/2498050.pdf [28 July 2004].

Nationally and internationally there is considerable discussion about the management of freshwater. Under-pricing or non-pricing of water, in much of this discussion, is linked to wastage, inefficient use, environmental damage and unbalanced supply and demand. The United Nations Conference on Trade and Development (UNCTAD), in a conceptual paper on environmental costs and resource values, mentions the international situation in which "governments tend to under-price water, both for irrigation and industry. This has encouraged excessive use both by agricultural producers and by mining and agro-processing plants that require water."[39] Similarly, the World Bank considers that "pricing water well below its economic value is prevalent throughout the world." … Pricing that induces efficient use of water is a key element of sound water resource management.[40]

The main impacts of water management reform on water accounting would be from water metering and pricing. Comprehensive volumetric and pricing information would enable the full range of physical and monetary water accounts to be completed. Environmental and economic performance could then be linked, providing a better measure of New Zealand's sustainable development. Analysis of the economic impact of subsequent water management changes could also be contemplated. Additional water management issues, such as ownership and efficiency of use, are related to metering and pricing and may indirectly affect, or be reflected in, water accounts. Pertinent aspects of water management are examined in the following sections.

5.3 Water metering

Compilation of water accounts depends on volumetric data obtained from metering of water usage. If future water management involves widespread use of water metering then the scope and accuracy of water accounting will benefit. The potential direct benefits for water accounting would include improved detail and accuracy of physical stock accounts and the opportunity to produce physical flow accounts. In addition, volumetric data would be a vital component in any monetary water accounts.

Demand for freshwater is increasing yet the supply is relatively fixed. This means that balancing supply and demand is essentially a matter of constraining the increasing demand. Whether this is done in future by allocation, rationing or pricing methods, it is increasingly likely to involve widespread metering.

At present, much water usage in New Zealand is not metered, monitored or recorded. This not only affects the compilation of water accounts but has implications for water management. The Parliamentary Commissioner for the Environment states that "current pricing and charging approaches for water and wastewater vary between different territorial authorities and different cities and towns. … With uniform annual charges and charges based on property rates there is no economic incentive for consumers to reduce their water consumption through efficiency measures. Where meters and flow based charges have been introduced, both in New Zealand and overseas, there has been a significant change in behaviour and a decrease in demand on a per capita basis."[41]

For compilation of water accounts, metered data is of maximum benefit when it is available for the largest categories of use. In New Zealand, metered data is often available for household and other municipal supply, which is a relatively minor use, and is lacking for irrigation which

39 *The Internalization of Environmental Costs and Resource Values,* (UNCTAD/COM/27, June 1994), http://www.iisd.org/trade/unctad/intern_a.rtf [9 July 2004].

40 *Water Resources – Management,* World Bank (1993), ISBN 0-8213-2636-8, http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/02/23/000178830_98101911251888/Rendered/INDEX/multi_page.txt [14 July 2004].

41 *Beyond ageing pipes. Urban water systems for the 21st century.* (Parliamentary Commissioner for the Environment (April 2001), http://www.pce.govt.nz/reports/allreports/0_908804_95_4.shtml [14 July 2004].

constitutes the bulk of consumptive use. Data is also lacking for livestock and private industrial abstraction, even though these volumes may each exceed national household use.

5.4 Water pricing

Further development and quality improvement of monetary water accounts may depend on the implementation of widespread volumetric water pricing.

Volumetric pricing and metering have large potential benefits for the compilation of water accounts, but these benefits would merely be by-products of water management reform being done for other reasons. Pricing and metering are primarily water management tools that can put a cost on wastage, encourage conservation, balance supply and demand and maximise economic benefit by improving efficiency of use. "Water pricing is becoming more widespread [internationally], with the dual aim of expanding supply and encouraging more responsible use. … Water-use charges, pollution charges, tradable permits for water withdrawals or release of specific pollutants, and fines are all market-based approaches that can contribute to making water more accessible, healthier and more sustainable over the long term. For this reason, OECD countries are working toward the goal of 'internalising' the full marginal costs (including environment costs) into decisions that affect water use and water quality."[42]

There are several existing or potential forms of water pricing, each with a different effect on possible data sources and suitability of data for water accounting. The main forms of water pricing are:

- costs and rates
- pay-for-use pricing
- market pricing
- levies

5.4.1 Costs and rates

Costs and rates are the present basis of water pricing in New Zealand. However, they are an indeterminate form of pricing as they are not directly related to volumes abstracted or used.

With costs and rates, the 'costs' are those associated with obtaining water rights (if applicable), abstracting water, and moving it to where it is used. Such costs are typically applicable to private abstraction. The 'rates' component applies to municipal supply where the cost of supplying water is included in local authority rates. The water component of local authority rates can be regarded as direct market prices but are included in this section as they are effectively a means of averaging and charging supply costs across municipal consumers.

Costs and rates reflect the historical treatment of water in New Zealand as being free, apart from abstraction and supply costs. Such treatment generally ignores the scarcity value of water and is not recommended in the SEEA for water accounting. According to paragraph 7.307 of SEEA, "the valuation technique of last resort, which is least satisfactory from a theoretical point of view but perhaps most common in practice, is to set the value of water equal to the cost of making it available. This is to confuse the price of the water with the cost of the means of delivery, as noted above, and is likely to prove increasingly unsatisfactory as pressure on water supplies increase."

42 *Pricing Water,* Tom Jones, OECD Environment Directorate (19 March 2003), OECD Observer, http://www.oecdobserver.org/news/fullstory.php/aid/939/Pricing_water.html [14 July 2004].

5.4.2 Pay-for-use pricing

Pay-for-use pricing reflects volumetric usage and often comprises an access tariff and a variable use tariff. This type of pricing is used for apportioning delivery costs among water users and generally does not include the scarcity value of water. Although obtained from economic transactions, pay-for-use prices typically represent only the cost of supply and not the value of water to the user or to the economy. The SEEA is ambiguous about pay-for-use prices. If water supply is privatised, they can apparently be regarded as 'direct market prices' but if treated as costs would be "the valuation technique of last resort".

Pay-for-use pricing is not widely-enough used in New Zealand to give comprehensive coverage. It includes municipal tariffs for excess water use and volumetric charging by irrigation systems supplying multiple farms. However, it is not applicable to private abstraction, which includes large proportions of irrigation, industrial, livestock and domestic rural use.

There was widespread introduction of pay-for-use pricing for urban water supply in Australia during the late 1990s, with mixed effects on consumption.[43] Significant effects of price changes on water demand were reported by the OECD.[44] [45] In theory, pay-for-use pricing should help balance supply and demand but in practice may have little effect if access tariffs are high and scarcity value is excluded.

5.4.3 Market pricing

Market prices, determined by supply and demand, would be ideal for environmental accounting. According to the SEEA, "the assumption is [that] the economic value is reflected precisely by market prices." However, in New Zealand, market prices for water are seldom available, unless the water component of local authority property rates and charges can be regarded as market prices. For irrigation and other non-domestic abstraction, water rights may be traded within catchment areas but there are few established markets and little trading occurs.

If market trading of water rights becomes widespread, the prospective new data source might facilitate valuation of water for the monetary stock accounts. However, there are many factors that would affect the availability and suitability of this data for environmental accounting. Transparency, coverage and frequency of trading would be important factors. Water rights, if expressed as peak seasonal flows, would be difficult to accurately convert into quarterly or annual volumes. Also, separation of abstraction volumes into consumptive versus non-consumptive usage (such as hydroelectric generation) might be required. Further factors would include the treatment of lump-sum market values for long-term water rights and the potential double-counting of re-sold water rights.

For various reasons (including practicality, overseas experience and issues of ownership), water markets would likely trade water rights rather than water itself. Whether such markets, if implemented in New Zealand, would be run by the private sector or by regional councils and unitary authorities, for example, could depend on how ownership or property rights of water resources are to be treated. If water markets are implemented, then it is expected that supply and demand would lead to low prices in water-abundant areas and high prices in water-short

43 *Charging for urban water supply and wastewater services,* Department of the Environment and Heritage, Australia, http://www.deh.gov.au/soe/2001/settlements/settlements02-6c.html [2 September 2004].

44 *Tourism, Water, Wastewater and Waste Services in Small Towns,* Research Project Funded by the Ministry of Economic Development and the Canterbury Development Corporation, Tourism Recreation Research and Education Centre (March 2004), http://www.lincoln.ac.nz/trrec/trrecpub/Report%2057f.pdf [8 September 2004].

45 *Exporting Water to the World,* Terry L Anderson and Clay J Landry, published by Universities Council on Water Resources, USA, Issue No. 118 (January 2001), http://www.ucowr.siu.edu/updates/pdf/V118_A8.pdf [8 September 2004].

areas. If market trading included pollution rights as well as abstraction rights, this would affect future environmental accounting of residuals (wastes).

For concepts related to markets and trading of rights, refer to 'cap and trade', 'Dutch auction' and 'grandfathering' in the glossary.

5.4.4 Levies

Levies on water (whether levied on rights, abstraction, use or discharge) would be of interest to water accounting in several respects. Comprehensive volumetric data would be a likely by-product of any administrative system set up for collecting water levies. Data on levy values would probably be another by-product. However, whether levy values could be used to represent water values in monetary accounts would depend on their treatment. If they were treated as commodity taxes they would not form part of the 'basic price' of water from a national accounting perspective and would therefore be excluded from the accounts. Levies, whether applied alongside or instead of market prices or other pricing, might provide useful volume data for water accounting without the levy values themselves being included in the accounts.

Levies that incorporate the external costs (refer 'externality' in the glossary) of water use and contamination could be regarded as 'user pays' and 'polluter pays' levies that would target costs at those who directly benefit from the water resource. If also responsive to changes in supply and demand, the levies could be used as a surrogate for market prices which are the recommended form of pricing for water accounting.

As with market or other forms of pricing, water levies have the potential to balance supply and demand, support efficiency of use and deal with allocation issues. However, unlike market prices, levies are conducive to incorporating seasonal variability to balance short-term supply and demand and might require quarterly water accounting to fully measure this variability. Any return of levy funds back to the environment would also be of interest for environmental accounting.

For further information on issues related to levies, refer to 'feebate system' and 'green tax shift' in the glossary.

5.5 Tradability of water rights

The development of markets for trading or leasing water rights may depend on their tradability, including the ease and certainty with which the rights can be transferred temporarily or permanently.

In New Zealand, water use is controlled by the Crown. Rights to use water, but not ownership of the water itself, are allocated in the form of resource consents. In water-short areas, water rights may acquire considerable scarcity value and inflate property prices.

Water rights are transferable if allowed in a regional plan or approved by the consent authority but in practice little selling, gifting or leasing of rights occurs and there is little indication of the market value of the water or water rights. According to a report prepared for MAF and MfE, "the government's Sustainable Development Programme of Action has identified problems with how water is allocated and used in New Zealand and it may be that these problems are related to the way in which property rights are held in water."[46] Factors that can affect the volume of trade in water rights include flexibility, divisibility, quality of title, exclusivity, duration

46 *Property Rights in Water: A Review of Stakeholders' Understanding and Behaviour,* Report Prepared for MAF Policy and Ministry for the Environment (November 2003), http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/water-efficiency/property-rights-in-water/property-rights-water-nov03.pdf [13 Sept 2004]

and transferability. The low cost of retaining unused or unneeded water rights may also inhibit trading.

Regular trading or leasing activity could determine market prices for water and provide valuation data for water accounts. Leasing of water rights, compared to outright ownership, may have further implications for the possible scope of environmental accounting if the revenue stream generated was directed back to the environment (for example, for maintenance of waterways, nitrate amelioration, or conservation of aquatic ecosystems).

Water rights are transferable (or rentable) in some countries, including Australia and Chile. In New Zealand the use of individual transferable quota for commercial fishing is an example of trading in rights to a natural resource.

Further information on water rights, and some conflicting views, can be obtained from the web-pages below.[47]

5.6 Summary

The key points of this chapter are:

- There is insufficient data to produce complete monetary stock accounts for water. (Table 1 is indicative only.)
- Future changes in water management may provide opportunities for obtaining data for the water accounts.
- Monetary stock accounts for water will be completed if and when suitable pricing data or estimation methodology becomes available.
- Physical and monetary flow accounts will also be produced if sufficient data and resources become available.

47 *Tradable Water Permits,* MAF, http://www.maf.govt.nz/mafnet/publications/rmupdate/rm9/rmupdate02.htm [17 Sept 2004]
Property Rights Framework, MfE, http://www.mfe.govt.nz/publications/water/property-rights-water-nov03/html/page4.html [6 Sept 2004]
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6 Glossary

Abstraction (of water): The taking of water from groundwater or surfacewater sources.

Aquifer: Permeable water-bearing geologic formation capable of yielding exploitable quantities of water.

Basic price: The producer's selling price before commodity tax or subsidy is applied.

Biodiversity: The range and variety of natural species of animals and plants.

Cap and trade: A system whereby a regulatory authority sets a limit to resource exploitation or pollution and issues tradable allowances that sum to this limit. See also 'grandfathering'.

Catchment: The area from which rainwater flows into a particular river or lake.

Conservation: The management of resources such as water so as to eliminate waste or maximise efficiency of use. See also 'sustainability'.

Dutch auction: An auction in which the seller accepts the highest price that will allow them to dispose of all offered stock. Those who bid above this price obtain the quantities they bid for but pay only this price. Those who bid exactly at the winning price might not obtain all the quantities they bid for. For such bids, quantities may be prorated down to match supply.

Ecological footprint: The land and water area required to indefinitely support a population's consumption and waste disposal, using prevailing technology. Modern city dwellers each need an estimated 12 acres (almost 5 hectares).

Economic efficiency: The allocation of goods to their highest relative economic value.

Ecosystem: A system, such as a wetland or forest, in which the interaction between different organisms and their environment generates a cyclic interchange of materials and energy.

Ecosystem services: The benefits of ecosystems for humankind. Benefits include provision of food, clean air and water, flood control, recreation, soil maintenance and removal of wastes.

Efficiency of use: For water, this term has many variants. It can mean the level of conservation or degree to which consumers use only as much water as needed. In economic terms, it can relate to the profit, added value or commodity value per unit of water used. For crop growing, it can be expressed as the yield per unit of evapotranspiration while for irrigation it can be the yield per unit of applied water or the percentage of water going to soil moisture.

El Niño–Southern Oscillation (ENSO): A 2–4 year major climate cycle with warm (El Niño) and cool (La Niña) fluctuations in sea surface temperatures in the central and eastern tropical Pacific and associated air pressure changes in the Pacific–Asia region (Southern Oscillation). See also 'Interdecadal Pacific Oscillation (IPO)'.

Environment: External conditions affecting organisms and social groups. It includes the natural environment (air, water, soil, plants, animals, fungi and micro-organisms), the built environment (buildings, roads, housing and recreation facilities) and social and cultural aspects of our surroundings.

Environmental accounts: Quantitative information linking environmental and economic performance.

- *natural resource accounts* provide information on usage and depletion of natural resources and complement economic measures such as GDP

- *ecosystem input accounts* show flows of substances absorbed from the environment for consumption and production processes, including oxygen for combustion and air, water and nutrients for biomass growth
- *product flow accounts* trace the movement of products or product groups (such as timber and packaging) through the economy
- *residual flow accounts* show volumes of waste (whether solid, liquid or gaseous) discharged from the economy into the environment
- *environmental protection expenditure* is the amount spent on maintaining or restoring the environment

Environmentally-adjusted GDP: This is also known as 'green GDP' or 'ea-GDP'. The original GDP figure, which measures economic activity, is adjusted to take into account the cost of natural resource depletion and environmental degradation.

Evapotranspiration: Transfer of water from the Earth's surface to the atmosphere by evaporation of liquid or solid water plus transpiration from plants and animals.

Existence value: The value that people place on the continued existence of a natural resource even if they never see or use it. See also 'preservation value'.

Externality: A side-effect of an economic activity that impacts society but for which no compensation is paid or received. Water contamination is a negative externality. Switching from border-dyke irrigation to more efficient spray irrigation is a positive externality.

Feebate system: A revenue-neutral strategy that puts fees on goods or activities that damage the environment and rebates these fees to cleaner alternatives. See also 'green tax shift'.

Freshwater: Naturally-occurring water having a low concentration of salts.

Grandfathering: A method that bases the initial allocation of resource rights, ownership rights or emission rights on historic use of the resources or emissions of pollutants. In the case of privatisation of publicly-owned resources, a grandfathering method of allocating property rights to a resource, such as fisheries, means that historic users are gifted the resource whereas new users must purchase their rights to it from historic owners. There is no return to the public with this type of privatisation. Alternatives to gifting the rights are leasing or auctioning them.

Green tax shift: A fiscal policy which lowers taxes on wages and profits, and raises taxes on consumption, particularly the unsustainable consumption of non-renewable resources.

Gross domestic product (GDP): This is a measure of economic activity. It is *gross* in that depreciation is not deducted and *domestic* in that it covers only national territory. There are no deductions for natural resource depletion and environmental degradation. The output-based version is the sum of the gross value-added of all resident producers at basic prices, plus all taxes (less subsidies) on imports.

Groundwater: Subsurface water occupying the saturated zone (in which all voids, large and small, are filled with water). Excludes soil moisture.

***In-situ* freshwater:** Freshwater that has not been removed from the lake, river, aquifer or other water body. *In situ* uses include recreation, tourism, hydroelectricity generation, fish farming and waste disposal.

Interdecadal Pacific Oscillation (IPO): A long timescale oscillation in the ocean–atmosphere system that shifts climate in the greater Pacific region every one to three decades. In the negative IPO phase, New Zealand generally experiences higher sea-levels, and more storm surges and floods in eastern areas. See also 'El Niño–Southern Oscillation (ENSO)'.

Irrigation: Artificial application of water to lands for agricultural purposes.

Limnology: The study of freshwater ecosystems.

National wealth: The sum of non-financial assets and net claims on the rest of the world.

Natural resources: Natural assets (raw materials) occurring in nature that can be used for economic production or consumption.

Net present value: The value of a future stream of net benefits (such as resource rent) discounted to the present by means of a discount rate (or deducted interest rate).

Operating surplus: The excess of operating income over operating costs. It is equivalent to producers' profits before financial adjustments. Gross operating surplus is before deduction of 'consumption of fixed capital' (which is similar to depreciation). See also 'value-added'.

Opportunity cost: The value of the best alternative to a given choice.

Orographic rainfall: Enhanced rainfall as a result of moist air cooling when it rises to cross a mountain range.

Polluter-pays principle: Where those responsible for pollution bear the cost of its abatement or remediation. See also 'user-pays principle'.

Precipitation: Water in any form (including rain, snow, hail, sleet and mist) that leaves the atmosphere and reaches the Earth's surface.

Preservation value: Also called 'non-use value', it includes existence, option and/or bequest values. (The option value relates to possible future use or enjoyment of the resource.)

Resource rent: The value of the resource to those exploiting it. It can also be defined as the supernormal profit derived from privileged access to natural resources. (Supernormal profit is that in excess of normal profit, which is the normal opportunity cost of labour and capital.)

Scarcity value: The value derived from scarcity or limited supply. With freshwater, prices that are too low to reflect its scarcity value can lead to over-use.

Soil moisture: Moisture contained in the portion of the soil that is above the water table. Includes water vapour, which is present in the soil pores.

Supply and use tables: Matrix tables showing commodity quantities (or values) categorised by supplier (domestic industries and imports) and by user (domestic industries, households and exports). Supply and use tables are collectively known as 'flow' tables or accounts.

Surfacewater: Water that flows over or is stored on the ground surface.

Sustainable: Activities are sustainable if they can be maintained over time without depleting the natural resource base. Sustainable activities do not reduce options or otherwise impoverish future generations.

Sustainable development: Improving the quality of life whilst living within the carrying capacity of the supporting ecosystem.

Sustainable Development Indicators (SDI): Statistical measures that show progress towards sustainable growth and development.

System of integrated Environmental and Economic Accounting (SEEA): SEEA measures the contribution of the environment to the economy and the impact of the economy on the environment and was developed by the United Nations Statistical Division as an extension to the world-wide System of National Accounts (SNA).

System of National Accounts (SNA): The international standard framework for compiling macro-economic accounts.

Tradable permit: A governmentally granted licence under which rights to discharge pollution or exploit resources can be bought and sold.

Triple bottom line: A framework for measuring corporate performance, taking account of social and environmental impacts in addition to economic values.

Unitary authority: A territorial authority (city or district council) which also has the responsibilities, powers and duties of a regional council.

User-pays principle: Where the user of a facility or public resource pays the market price for the service or good, plus a price for the associated externality costs. See also 'polluter-pays principle'.

Water cycle (hydrological cycle): The paths that water takes through its various states (liquid, vapour, solid) as it circulates among the ocean, atmosphere and land.

Water table: The top of the water surface in the saturated part of an aquifer.

Wetland: Semi-aquatic land that is either inundated or saturated by water for varying periods of time during each year, and that supports aquatic vegetation which is specifically adapted for saturated soil conditions.

Value-added: The value of goods produced less the cost of materials and supplies used in producing them. Gross value-added includes ‘consumption of fixed capital’ (which is similar to depreciation) while net value-added excludes it. Gross value-added is similar to gross profit.

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