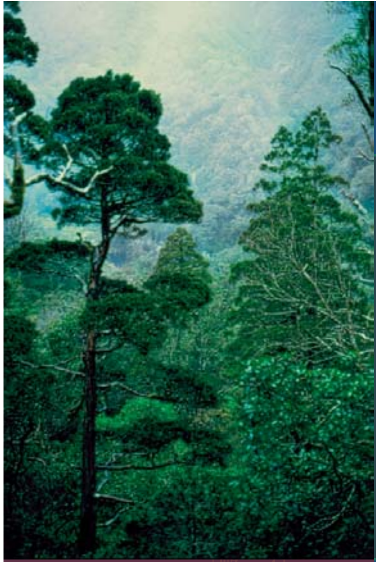

How Clean and Green is New Zealand Tourism?

Lifecycle and Future Environmental Impacts

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Landcare Research Science Series No. 24

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SI units used in this report

ha	hectares (land area)
kg	kilograms (weight)
kt	kilotonnes (weight)
m^3	cubic metres (volume)
MJ	megajoules (10^6) (energy)
PJ	petajoules (10^{15}) (energy)
TJ	terajoules (10^{12}) (energy)
t	tonne(s) (weight = 1000 kg)

Summary

Focus of the study

The central argument of this report is that a broader assessment of the environmental impacts is required in order to fully evaluate the environmental performance of the tourism sector. To date, New Zealand research has focused on on-site and local-area environmental impacts of tourism activity. The overall aim of our study was to assess the *indirect* and *future* environmental effects, as well as the previously researched *direct* effects. This was achieved by constructing input-output economic-environmental accounts of the tourism sector. These accounts not only provide a platform for lifecycle assessment (indirect effects) and scenario analysis (future effects), but also allow environmental data to be integrated with data about the economic performance of the tourism sector.

Integrated economic-environmental accounts of the tourism sector

Statistics New Zealand (1999) for the first time constructed tourism satellite accounts, which described the economic operation of the tourism sector in 1997/98. In our study these economic satellite accounts were extended to cover the use of natural resources (land, energy, water) and the production of pollutants (water discharges, nitrate, biological oxygen demand (BOD), phosphorus and carbon dioxide (CO_2)) by the tourism sector[1].

The reason for constructing these integrated economic-environmental accounts was to obtain an improved understanding of the economy–environment links of the tourism sector. It is argued that such a framework is critical to understanding the ecological sustainability of the tourism sector. In this study, the framework also provided a direct platform for application of a number of analytical methods, which ensured further insights into the tourism sector economy–environment interconnections:

(1) Lifecycle assessment of the tourism sector, using input-output methods pioneered in the early 1970s by analysts such as Hite & Laurent (1971) and Wright (1975).

(2) Eco-efficiency analysis that relates environmental "costs" to the economic "benefits" of the tourism sector. This can include simple ratios of direct benefits to direct costs for the tourism sector, or impact analysis that involves indirect benefits and indirect costs as well.

(3) Comparative analysis of the environmental performance of the tourism sector with other sectors in the economy, especially using "pressure indicators" such as BOD or CO_2 loading on the environment.

(4) Projecting future levels of resource use and pollution in the tourism sector, as determined by the key drivers of visitor arrivals, economic growth, price effects, technical change and other such factors.

Lifecycle assessment of the tourism sector

Lifecycle assessment, using input-output analysis, was used to assess the indirect environmental impacts of the tourism sector in New Zealand. A new methodology was developed to quantify and depict these indirect environmental impacts by way of using lifecycle assessment diagrams. For example, a lifecycle assessment diagram could be generated that depicted direct and indirect CO_2 emissions by the tourism sector (Figure S1). When international air transport (return) by overseas tourists was included, the direct CO_2 emissions of the tourism sector were very considerable at 4 999 975 tonnes (t). Most of these CO_2 emissions were from international aircraft (3 561 591 t), domestic aircraft (661 104 t), and other tourism activities such as accommodation and retailing (777 280 t). The total CO_2 emissions from tourism within New Zealand amounted to 1 438 384 tonnes.

As can be ascertained from Figure S1, the indirect CO_2 emissions by the tourism sector are also significant, totalling 1 794 807 t CO_2. The largest indirect category of CO_2 emissions for the tourism sector relates to the infrastructure and services required to support international air travel, for example, air terminal buildings, runways, booking services and so forth. This was estimated to amount to 544 369 t CO_2, but unfortunately this aggregate figure cannot be broken down any further. Next in the ranking was transport sector inputs into the tourism sector at 419 272 t CO_2. Most of these were transport services purchased by the tourism sector from non-tourism operators. The purchase of food and beverages was also significant in terms of indirect CO_2 emissions, with direct purchases by the tourism sector accounting for 125 207 t CO_2, and another 14 224 t CO_2 embodied in the purchase of food and beverages through the wholesale and retail trade sector.

[1] The base year for this analysis was the financial year from 1 April 1997 to 31 March 1998. All figures reported in this Summary are for this 1997/98 financial year, if not otherwise specified.

Similar lifecycle assessment diagrams were generated for *resources* (land, energy, water) and *other pollutants* (nitrate, phosphorus, BOD, water discharges). All highlighted the importance of indirect inputs of natural *resources* into the tourism sector, as well as the *indirect releases of pollutants* embodied in purchases by the tourism sector. The indirect inputs of land were the highest (92.5%), followed by water takes (91.5%), water discharges (69.8%), nitrate (52.1%), phosphorus (42.3%), BOD (42.9%), CO_2 (26.4%) and energy (25.9%), when international air travel was included. Caution has to be displayed in interpreting these results, however, as: (1) use of reticulated water was considered to be an indirect use, as it is purchased from another sector in the economy; (2) the disposal of tourism-sector effluent was also considered to be an indirect release in the input-output framework, as this effluent is treated and released by another sector (community, social services and personal) in the economy; (3) "net effects" were not considered, i.e. the fact that domestic tourists generate waste and water discharge during their holiday in similar quantities to that in their home environment. Under this assumption the net effect would be zero. In fact, the only real footprint from domestic tourism is probably in ''additional" travel and associated greenhouse gas emissions.

Total environmental impact of the tourism sector

For any resource or pollutant, the "total environmental impact" of the tourism sector can be assessed, that is the *direct plus indirect* environmental effects of tourism activity can be quantified. This total environmental impact of the tourism sector can then be compared with other sectors in the economy. On this basis, the performance of the tourism sector was generally poor, ranging from the fourth largest impact on the environment to the 12th largest impact (out of 25 sectors), depending on which of the eight indicator variables was used.

For the water pollutant indicators (BOD, nitrate, phosphorus) the total amount of pollutants released to the environment, directly and indirectly, was high. Only the food, beverages and tobacco, community, social and personal services (which includes sewage treatment), and agriculture sectors generally had higher levels of water pollution.

The tourism sector ranked fifth largest for the total amount of energy used and CO_2 emissions released within New Zealand, when internal energy use was considered. If return overseas travel by inbound tourists was included, the tourism sector then became the second highest user of energy and the highest CO_2 emitter out of the 25 sectors considered. On this latter basis, the total energy used was 107 124 TJ (oil equivalents), which was equivalent to 21.7% of New Zealand's annual energy consumption in 1997/98. Similarly, if overseas travel was included, the tourism sector accounted for 6 794 783 t CO_2 emissions, which was equivalent to 24.3% of New Zealand's CO_2 emissions.

The total amount of land directly and indirectly occupied by the tourism sector was estimated to be 873 525 ha, ranking sixth largest out of the 25 sectors. This ranking would increase to second largest if national parks, forest parks and other reserves were attributed to the tourism sector. This allocation, of course, is debatable.

In terms of water inputs (water takes) and water outputs (discharges) the tourism sector ranked 12th largest. Directly and indirectly, the sector was estimated to have water inputs amounting to 101 131 000 m^3 and water outputs of 172 599 000 m^3.

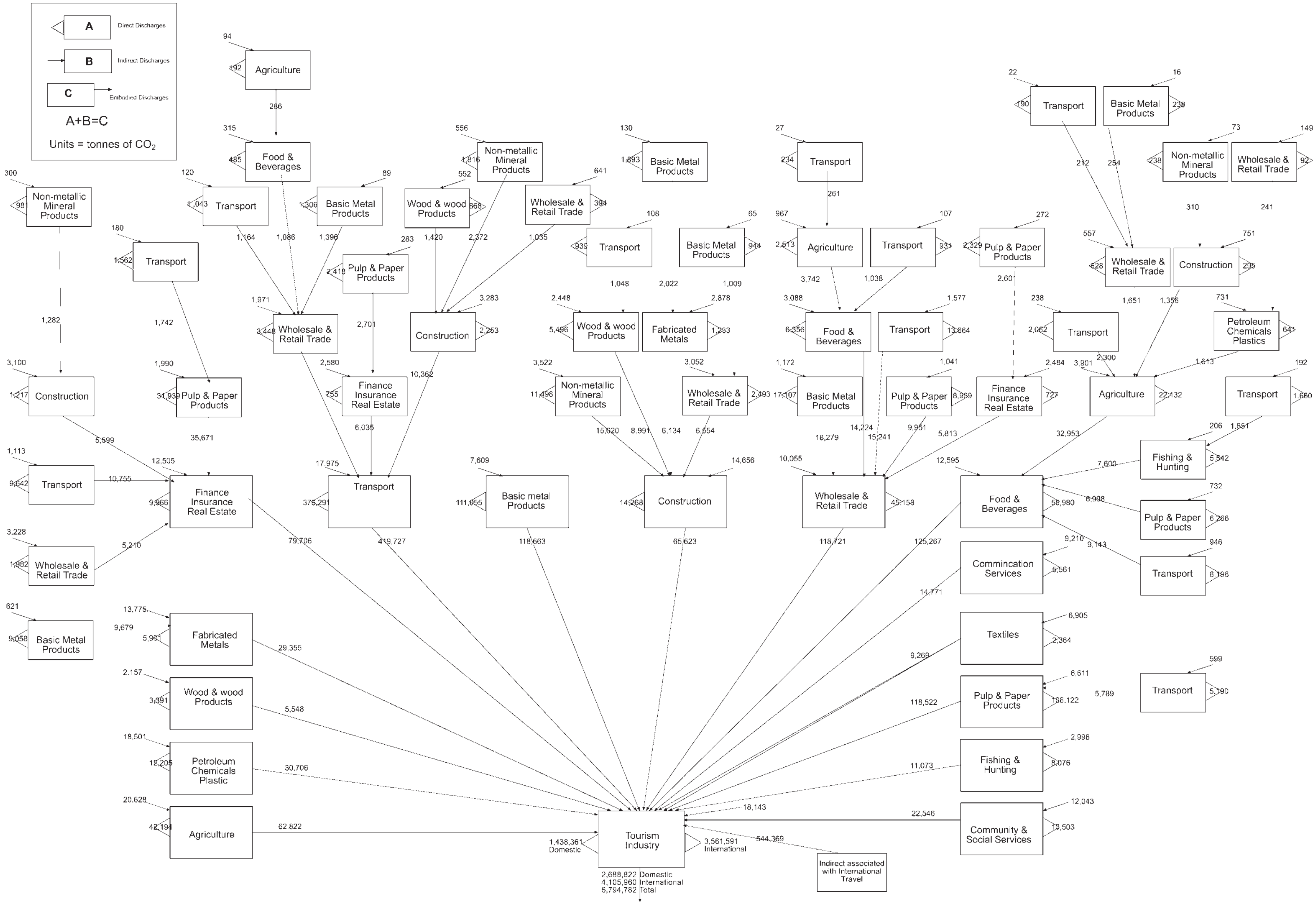

Figure S1. Direct and indirect CO_2 outputs from the tourism sector, 1997, 98.

Eco-efficiency of the tourism sector

The World Business Council for Sustainable Development introduced the concept of eco-efficiency as one of its responses to the Rio Conference. The ecological multipliers generated in the lifecycle analysis arguably provide an operational measure of the eco-efficiency concept, that is they measure economic performance (production of goods and services, $\$_{output}$) in relation to environmental costs (environmental impacts across the lifecycle). Using input-output analysis, the ecological multipliers for the *domestic* tourism sector for 1997/98 were mathematically determined to be:

4.50 TJ	energy (oil equivalents) / $million output
9799 m^3	water / $million output
174.22 kg	BOD / $million output
5.10 kg	nitrate / $million output
33.55 kg	phosphorus / $million output
16 723 m^3	water discharges / $million output
84.64 ha	land / $million output
260.52 t	CO_2 / $million output

If *international* travel was included in these multipliers, the energy multiplier increased to 10.38 TJ energy (oil equivalents) / $million output and the CO_2 multiplier increased to 658.35 t CO_2 / $million output. With the inclusion of international travel the other multipliers would also increase, but there are insufficient data available to make reliable estimates of these multipliers. Nevertheless, it is likely that the direct and indirect multipliers associated with international travel for land inputs, water inputs and water pollutants would be very small.

The ecological multiplier for tourism can be compared with other sectors in the economy in 1997/98. On this basis, the eco-efficiency of the tourism sector was generally poor – for seven out of the eight of the indicator variables, the eco-efficiency performance of the tourism sector was below average (ranging from 13th to 24th position, out of 25 sectors).

The worst performance was for the water pollutants indicators (BOD, nitrate, phosphorus): BOD (174.22 kg BOD/$million) was ranked in 21st position, nitrate (5.10 kg/$million) in 24th position and phosphorus (33.55 kg/$million) in 21st position. Only the food and beverages sector ranks worse than the tourism sector across all of these indicator variables. The agriculture, water distribution, and community, social and personal services (which includes sewage treatment) sectors all ranked worse than the tourism sector for BOD and phosphorus, but not nitrate.

The eco-efficiency performance of the tourism sector as measured by the energy and CO_2 multipliers was also relatively poor, both ranking 17th position out of 25 sectors, when the within-New Zealand multiplier effects were taken into account. However, the performance deteriorated even further when overseas travel (return trips by inbound tourists) was taken into account. The energy multiplier then increased to 10.38 TJ (oil equivalents / $million), with only the basic metals sector having a higher energy multiplier. Perhaps surprisingly, the energy multiplier for the tourism sector was higher than all of the industrial sectors (pulp and paper; petroleum and chemicals, fabricated metal products and so forth) and the transport sector, all of which are seen as energy-intensive sectors. The CO_2 multiplier also increased to 658.58 t/$million when overseas travel was included, which put the tourism sector as the fifth to worst sector in terms of this indicator of eco-efficiency.

The land multiplier also indicated a relatively poor performance in terms of land use (18th position out of 25 sectors). The direct land use was low at only 7.51% of the total, but the tourism sector's poor performance was essentially brought about by significant indirect land use through the purchases of food and beverages and agriculture sector inputs.

The tourism sector's best result in terms of eco-efficiency performance was for water inputs and water outputs, ranking 11th and 13th positions respectively out of 25 sectors. The tourism sector was slightly worse than most of the other service sectors, using slightly more water per dollar of product, but significantly better than most of the industrial sectors.

For water outputs (water discharges) the tourism sector was ranked 13th, which was much better than the ranking of 21st and 24th for the water pollutants. This implies that although the volume of water discharges (m^3) was about average for the tourism sector, the water was relatively "polluted" in the sense there were comparatively high levels of pollutants per cubic metre of discharge.

Projections of future environmental impacts of the tourism sector

Forecasts of visitor numbers (1997–2007) from McDermott Fairgray Group (2001a,c) were used as a starting point for these projections. These forecasts were combined with the environmental data collected in the previous section of the report in order to produce projections of future resource use and pollution by the tourism sector. These projections ran from the base year of 1997 to 2007.

For each of the eight indicator variables, three projections were produced (Projection A: No technical change, Projection B: Mid-range technical charge, and C: Continuation of historical technical charge). These projections were disaggregated, according to direct, indirect and total impacts, as well as across the domestic and international visitor markets.

Energy use. Total energy use (direct and indirect) is expected under the mid-range projection to increase from 107.1 PJ in 1997 to 150.0 PJ in 2007. These figures include the return travel by international visitors. This is a 38.8% increase over the 10-year period. With greater than expected improvements in the technical efficiency of energy use, the increase could be as low as 130.6 PJ for 2007. However, even under this optimistic scenario, total energy use in the tourism sector still increases by 21.8%. Most of this projected energy use is due to increased direct energy use by international long-haul flights to and from New Zealand by overseas tourists. The projected increases in the number of international tourists (increasing energy use) is the primary driving force behind this increase, which cannot be compensated for by even the most optimistic assumptions concerning improvements in energy efficiency.

Water use. Overall, total water use by the tourism sector is expected to marginally decline from 101 119 000 m^3 to 100 003 000 m^3 over the period 1997–2007, under the mid-range projection. This represents a 1.10% decrease. For the d*omestic tourism* market, water usage is projected to drop significantly over the same period, due essentially to a decrease in tourist numbers. When the numbers are projected to increase again in 2002 and 2003 (due to a cyclical trend), the water demand consequently increases. The overall effect is a flattening off of total water demand by the domestic tourism sector from 2004 to 2006, with a slight increase in 2007. For the i*nternational tourism* market, under the mid-range projection, water demand is projected to increase steadily from 26 619 000 m^3 to 39 681 000 m^3 over the 1997–2007 period. Notably, under the mid-range projection, the aggregate-level water demand by the international tourism market at the end of the period (2007), despite increasing, is still less than that for the domestic tourism sector.

Land use. Overall, it is expected that total commercial land use by the tourism sector will increase from 873 535 to 1 010 591 ha from 1997 to 2007 under the mid-range projection. This represents a 15.7% increase in land use. The international tourism sector's total land use is expected to increase by 170 554 ha, whereas the domestic sector is expected to decrease by 35 385 ha. The net effect is a 137 169-ha increase.

There is projected to be a much lesser impact from technical efficiency gains than for other resources and pollutants. This applies to both direct land use, where productivity gains are limited, and indirect land use (e.g. agricultural farm use), where marginal gains from the improvement in agriculture are small due to gains already made over many decades in that sector.

Water discharges. Over the 1997–2007 period, it is projected that water discharges from the tourism sector will increase from 172 578 000 m^3 to 199 303 000 m^3 under the mid-range projection. This is estimated to be about 6.0% of the water discharges in the New Zealand economy. Again there are important structural effects that explain these changes. Water discharges in the d*omestic tourism market* will decline, under the mid-range projection, by 6 927 000 m^3 over the same period. Water discharges in the i*nternational tourism market,* however, will steadily increase, resulting in an extra 33 653 000 m^3 by 2007. The net result is a 26 725 000-m^3 increase estimated under the mid-range projection for 1997–2007.

Nitrate discharges. It is difficult to project precisely the future level of total nitrate discharges by the tourism sector, due to uncertainty over the level of technological improvement. Hence, there is a reasonably large divergence between the three projections. If current trends observed in the *Eco*Link database continue, then the total nitrate discharges could reduce quite dramatically over the forecasting period as indicated by Projection C. Under this projection, over the 1997–2007 period, the total discharge of nitrate from the tourism sector drops from 52 631 kg to 30 698 kg ("41.7%). Under Projection B, which assumes the mid-range level of technical change, which is more likely, the total discharge of nitrate from the tourism sector decreases to 47 342 kg ("10.1%).

Phosphorus discharges. Overall it is expected under the mid-range projection that total phosphorus discharges from the tourism sector will increase from 346 265 kg in 1997 to 353 648 kg in 2007. This is a slight increase of 2.13% over the forecasting period. Assuming more optimistic assumptions concerning technological improvement and better practice under Projection C, the total discharges of phosphorus by the tourism sector could reduce to 286 320 kg in 2007. This represents a 17.3% decrease from 1997 to 2007.

BOD discharges. Overall, total (direct and indirect) discharges of BOD by the tourism sector are projected under the mid-range projection to slightly decrease from 1 797 922 kg BOD to 1 789 405 kg BOD ("0.5%) by 2007. For the period 1997–2001, there is expected to be a significant drop in the level of BOD discharges, primarily due to fewer domestic tourists. However, with the forecasted upturn of the domestic tourism market, there is expected to be a steady increase in the total level of BOD discharges for every year except 2005, when a very slight decline is projected.

CO_2 emissions. Under the mid-range projection, total emissions for international tourists are expected to increase from 4 822 416 t in 1997 to 7 796 833 t in 2007 (61.9% increase). This increase is particularly strong from 1999 to 2001 (6–10% increase) tapering off between 2002 and 2007 (3–5% increase). In contrast, for the domestic tourist market, total CO_2 emissions are projected to decrease from 1 980 762 t in 1997 to 1 807 311 t in 2007 under the mid-range projection. Other than an increase in CO_2 emissions in 2002 and 2003 due to the forecast upturn in domestic tourist numbers, a steady downward trend in CO_2 emissions is projected because of improvements in technology and energy management practice.

Research conclusions and their policy implications

This study represents the first comprehensive assessment of the environmental impacts of the tourism sector, from a national perspective. Generalising from 1997/98 it is clearly demonstrated that the tourism sector's environmental performance is poor. For *eco-efficiency*, on average the tourism sector ranks about 19th out of the 25 sectors. For *total pressures* (resources used and pollutants produced) exerted on the environment, on average the tourism sector ranks about 20th. In general terms, the only sectors that perform worse than the tourism sector include: agriculture, food and beverages, community, social and personal services (which includes sewage treatment), and pulp and paper, as well as the basic metal sector (with respect to energy and CO_2 only). Notably, the tourism sector seems to have an overall environmental performance below some of the industrial sectors and certainly worse than all but one of the other service sectors.

Energy use and associated CO_2 emissions are the two most problematical impacts revealed by this study. Firstly, the tourism sector in the base year directly and indirectly accounts for energy use and CO_2 emissions equivalent to about 22–25% of New Zealand's totals (including International air travel). For most other resources and pollutants, even when taking account of indirect effects, the tourism sector is only responsible for about 5–6% of the total impact related to that resource/pollutant. Secondly, there is good evidence that energy use and CO_2 emissions are not only comparatively large but that the tourism sector's totals for energy and CO_2 are rapidly increasing. It is projected, under the mid-range projection, that both energy use (38.9%) and CO_2 (41.2%) will increase over the 1997–2007 period, at a rate much faster than other resources/pollutants.

It may seem that adding international travel to this analysis is a somewhat unfair treatment of tourism compared with other export-oriented sectors such as agriculture. However, there is ongoing discussion about the possible inclusion of international travel in the Kyoto Protocol's second commitment period, and for this reason it is posited that New Zealand's position as a long-haul destination will be one of the major problems the sector has to face More attention should be paid to how emissions from international air travel could be allocated to the countries involved. For example, there is debate as to whether the benefits of travel accrue to the tourists (based in countries of origin) or to destinations (economic growth) and which countries should include the associated emissions in their national greenhouse gas accounts. It is recommended that international travel should be accounted for, but treated as a separate policy issue.

For the other resources (land and water) and pollutants (water discharges, BOD, nitrate, phosphorus), the spatial distribution of their environmental impacts can be more critical than the actual total quantities of resource use/pollutants. For example, if water demand increases, local supply issues are more likely to be problematic than concerns about the total levels of water use. For instance, ensuring adequate water supply could create problems in localities where there is poor natural supply, lack of existing infrastructure and/or inability to pay for such infrastructure. Spatial pressure points are exacerbated by seasonal peak demands, which may in fact become a significantly limiting factor in the further development of the sector and its sustainability.

These research results do challenge the idea that New Zealand's tourism is "sustainable" and "clean and green". This naturally leads to a number of possible policy and strategic responses from both the industry and government:

(1) The implications for the Kyoto Protocol and energy policy are critical. Conventional analysis and policy responses tend to ignore the "tourism sector" as it is not considered to be a sector. For climate change policy, this is an unfortunate oversight as this sector is the second largest energy user and the largest producer of CO_2 emissions. This coupled with the fact that tourism is the fastest growing sector in the economy, means that serious policy attention needs to be given to energy use and CO_2 emissions by the sector in initiatives such as the Energy Efficiency and Conservation Authority's *(2001b) National Energy Efficiency and Conservation Strategy* and the New Zealand Government's preferred policy package on climate change (Ministry for the Environment 2002).

(2) Marketing and branding of New Zealand tourism needs to be carefully re-examined in light of these research findings. The Ministry for the Environment's 2001 report *Our Clean Green Image: What's it Worth?* highlights the sensitivity of overseas purchasers to this image. The income loss to the tourist industry could be considerable if environmentally aware tourists decide not to travel to New Zealand because they perceive the country not to be "clean and green".

(3) More attention needs to be given to environmental performance, auditing and certification in the New Zealand tourism industry. Compliance with environmental standards, self-monitoring and demonstrable good practice could go a long way to allaying the fears of overseas tourists. The projections in fact show that the environmental performance of the industry could be significantly improved by better pollution abatement technology and management practices, in spite of the existence of more intractable structural issues to do with the need for international travel to get to New Zealand.

(4) The challenge for the tourism sector is how to balance out the additional costs of environmental compliance with the potential damage to market image if it does not respond positively to improving its environmental performance. This is particularly the case with costs stemming from the ratification of the Kyoto Protocol.

In the long term, industry and government policy makers may need to scrutinise the possibility of more drastic changes to the tourism industry. For example, in terms of the seemingly intractable problem of overseas travel to New Zealand, the strategy may be to promote fewer but longer-duration stays, thus reducing energy use and CO_2 emissions. The purchase of carbon credits and mechanisms for the industry and government to share these costs, and other such responses to climate change and environmental outcomes, may need to be considered in the long term.

1. Introduction

1.1 Scope of the report

The overall aim of this report is to undertake a comprehensive assessment of the environmental impacts of the New Zealand tourism sector, from a national perspective. Using environmental accounting techniques, these data on tourism's environmental impacts will also be integrated with data on economic impacts, in order to provide a more complete assessment of the performance of the tourism sector. An underlying research question that will be addressed is: how sustainable is the tourism sector, particularly in relation to other sectors in the New Zealand economy?

The specific objectives of the report are as follows:

1. To construct environmental accounts of the tourism sector for the base year of 1997/98. These environmental accounts, which are consistent with the United Nations (1993) SEEA methodology, will integrate and link economic data with environmental data. This integrated database provides the platform for further analysis of the performance of the tourism sector, including lifecycle assessment, eco-efficiency analysis and the forecasting of future economic and environmental impacts.
2. To undertake a lifecycle assessment of the New Zealand tourism sector using input-output analysis techniques. This will provide a basis for assessing the "hidden" indirect environmental impacts of the tourism sector, which are significant but rarely addressed in the literature.
3. To evaluate the eco-efficiency of the tourism sector based on the definition used by the World Business Council for Sustainable Development – namely, "the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing *environmental impact and resource intensity through the lifecycle"* (emphasis added).
4. To develop scenarios to describe the environmental implications of national tourism forecasts. These scenarios/projections will emphasise the role of the drivers of tourism growth and link these to environmental pressures and impacts.
5. To discuss the policy and strategic implications of the research results, particularly highlighting issues such as New Zealand's overseas image as a "clean green" destination, certification of environmental performance in the tourism industry, and the Kyoto Protocol.

The emphasis of the study is to assess the *national-level environmental impacts of the tourism sector*, as a context and complement to the analysis of tourism impacts at regional and local scale being undertaken by the Lincoln University – Landcare Research collaborative research team (Ward et al. 2000; Cullen et al. 2001; Johnson et al. 2001).

1.2 Why assess the environmental impact of the tourism sector?

The advent of tourism in New Zealand is not a recent phenomenon. Tourists visited New Zealand in the nineteenth century, visiting such destinations as the famous "pink and white terraces" and other natural features. The government became involved in promoting tourism with the 1901 establishment of the Department of Tourist and Health Resorts, which developed a number of resorts including Rotorua, Hanmer and Mount Cook. The earliest recorded number of tourists to New Zealand was 5233 in 1903 (Statistics New Zealand 2000b). The growth of tourism for the best part of 50 years was slow and there were even sustained periods of negative growth (Figure 1). It was not until the early 1960s that significant growth was experienced and this accelerated in a dramatic fashion through the 1970s to 1990s, following an exponential growth curve. The advent of low-cost and long-haul aircraft, as well as increased disposal incomes, made travel to New Zealand both feasible and affordable to an increasing range of potential visitors. Tourism was no longer just a privilege of the "leisured" upper classes. Over this period there was a dramatic increase from 100 000 international tourists in 1963 to 1 560 000 in 1999 (Statistics New Zealand 2000b), and over 2 million visitors in 2003.

Mass tourism brought with it obvious economic benefits to New Zealand, which have been widely studied and are now well understood. The *Tourism Satellite Accounts* recently developed by Statistics New Zealand indicate that tourism is a $4.8 billion industry (4.6% of GDP) and generates significant export earnings (16% of exports). In the year 2000, it accounted for 94 024 full-time equivalent jobs directly and about an equivalent number indirectly. International visitor numbers continued to grow at an average rate of 5.4% in the 1990s and New Zealand set a target of 1.9 million visitors for 2000/01 (McDermott Fairgray Group 2001a). Economic impact studies have also demonstrated that tourism has a strong multiplier effect in local economies. For example, Lim's (1991) analysis found that in addition to direct income generated by tourism the indirect and

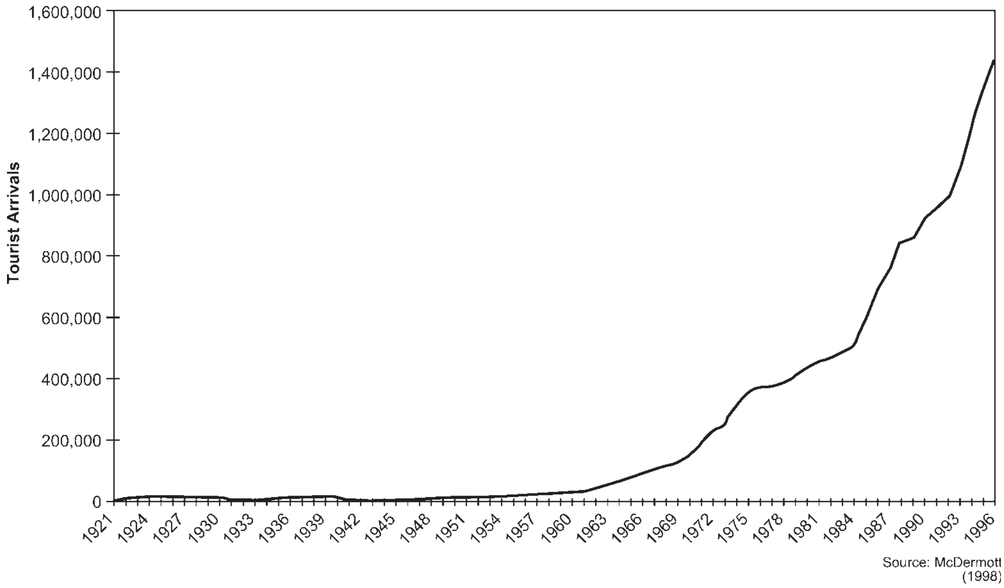

Figure 1. International tourist arrivals to New Zealand, 1921–1997.

induced income effects in the Auckland, Canterbury and Bay of Plenty regions are also considerable, at 76%, 79% and 55% of the direct income respectively. More recent studies by Statistics New Zealand (1998b, 1999, 2000a, 2001a,b) have also quantified the direct and indirect income/employment benefits of tourism at the national level.

Tourism growth, however, brought with it not only economic benefits but environmental costs which are becoming an increasing part of government and industry thinking on tourism. In New Zealand, such concerns about the environmental impacts of tourism led to an investigation by the Parliamentary Commissioner for the Environment (Office of the Parliamentary Commissioner for the Environment 1997). This investigation although initially focused on the "concerns of tourism on the conservation estate" was broadened to cover the wider impacts of the tourism sector on the biophysical environment in New Zealand. The Parliamentary Commissioner for the Environment's report had only one principal recommendation, which was to "facilitate and resource the development of a strategy for sustainable tourism in New Zealand". In response, the Tourism Industry Association of New Zealand (TIANZ) released its draft strategy in 1999. This was followed by the government announcing, at the New Zealand Tourism 2000 Conference, the formation of the Tourism Strategy Group to develop a strategy by March 2001 that focuses on the sustainable development of the tourism industry. The strategy includes economic, environmental, cultural and social perspectives (Tourism Strategy Group 2001).

The government (Tourism New Zealand and the Ministry of Tourism) and the industry (e.g. through its Tourism Industry Association New Zealand (TIANZ)) collaborate in two initiatives aimed at developing sustainable and high-quality tourism. The first is developing quality tourism standards in conjunction with "Qualmark" focusing on safety, compliance with regulatory requirements, service delivery, environmental management, cultural management and business skills and practices. The second is supporting the introduction of the Green Globe 21 environmental standard programme.

It is now widely acknowledged that the environmental impacts of tourism are important to the industry and have been the focus of academic and public concern. The reasons for this emphasis on environmental impacts and the call to improve understanding of these impacts are several-fold.

Firstly, from a pragmatic point of view the concept of sustainable tourism is important to the marketing of New Zealand tourism. As stated in the *New Zealand Yearbook 2000,* "New Zealand is internationally renowned for its vast expanse of natural assets and natural beauty. Traditionally, international tourists have been drawn to New Zealand to experience the unpolluted air and water, the open spaces and unique plant and animal life". Indeed, in 1999, this environmental emphasis in the marketing of New Zealand was further emphasised by the "100% Pure New Zealand" branding campaign by

Tourism New Zealand. If this branding is to have credibility and substance there must be good evidence that New Zealand tourism is indeed “clean and green” and sustainable. This can only be achieved by having good information and understanding of the environmental effects of tourism, so that management practices and industry standards can be put in place to achieve the goal of sustainability.

Secondly, and related to the first point, if the environmental performance of the New Zealand tourism industry is to improve (and be seen to be improved), there is a need for better benchmarking and measurement of its environmental effects. A wide array of tourism eco-labelling and certification schemes have now been established to promote the goal of sustainability in tourism. Font & Buckley (2001) outline and critically review 70 such schemes. Perhaps the most widely known is Green Globe 21, which is based on 10 key performance areas: reduction in greenhouse gas emissions; energy-efficiency, conservation and management; reduction in the consumption of fresh water resources; ecosystem conservation and management; support for local community development; improved management of social and cultural issues; improved land use planning and management; improved air quality and noise reduction; improved waste water management; waste minimisation, reuse and recycling. If eco-labelling and certification is to be successful there is a fundamental need to have data on the environmental impact of the tourism industry particularly for benchmarking purposes.

Thirdly, from a public policy and planning perspective at both national and regional level, the need to understand the environmental impacts (as well as the economic and social impacts) of tourism is becoming increasingly important[2]. This is particularly the case in New Zealand, not only because of the marketing focus on the natural environment but also because of the statutory requirements of the Resource Management Act 1991, which emphasises the “environmental effects” of “activities” such as tourism. This latter point is discussed in some depth by Page & Thorn (1997), who go further suggesting a national policy or strategy is required in addition to the Resource Management Act 1991, if sustainable tourism in New Zealand is to be achieved.

The recent reassertion of the sustainable development concept in New Zealand (which argues for the integration of economic, social and environmental factors in public policy and planning) is also important here. It is increasingly being recognised that an “optimal” public policy mix will require the integration of environmental factors with economic and social considerations. In tourism sector planning this is clearly the case, with some quite stark choices between the economic benefits and the environmental costs of tourism often confronting decision makers. Before a relevant and informed choice can be made between these economic and environmental trade-offs, good information about the benefits and costs are needed, with the most pressing need being for environmental data, which are currently lacking.

1.3 Rationale for this study

There is now a burgeoning literature on sustainable tourism and on the environmental impacts of tourism activity (Coccossis & Nijkamp 1995; Hall & Lew 1998; Swarbrooke 1999). There have been a number of studies covering the full range of environmental impacts of the tourism industry, including impacts on biodiversity (Buckley 1999), vegetation and soil impacts (Sun & Walsh 1998), water use (Gössling 2001), alpine vegetation impacts (Whinam & Chilcott 1999) and climate change and energy use (Gössling 2000). Similarly in New Zealand there is now a wide-ranging literature on the environmental effects of tourism, which is usefully summarised in a report by the Office of the Parliamentary Commissioner for the Environment (1997). Environmental impacts identified include air pollution, water pollution, soil and geological aspects, wildlife disruption, loss of habitat, vegetation damage, crowding, noise, amenity effects, climate change and energy use (Table 1).

The purpose of this study is not to replicate or summarise these environmental impact studies in New Zealand, which tend to be site-specific, but to broaden the scope of the assessment to cover indirect and future environmental impacts of the tourism sector. Techniques such as lifecycle assessment and input-output analysis show that the *indirect effects* are usually more significant than the direct effects. For example, data summarised in the *Eco*Link Database (McDonald & Patterson 1999a,b,c,d) demonstrate that the energy embodied in inputs to various industries in New Zealand is much higher than the direct energy use. The same applies to other resources as well as pollutants – namely, the cumulative indirect effects are usually more important than the direct effects. In the tourism sector, indirect pressures exerted on the

[2] The social and cultural impacts of tourism are also important in most public policy and planning decisions. A good summary of the social impacts of tourism in New Zealand is provided by Lawson et al. (1996) and the Office of the Parliamentary Commissioner of the Environment (1997).

Table 1. Previous research into the environmental impacts of tourism in New Zealand

Environmental impact	**Specific impacts identified in the literature**	**References**
Air pollution	Emissions mainly from vehicles, both private and commercial	Cessford & Dingwall 1996; Ward & Beanland 1996
Water pollution	Spread of waterweed	Cessford & Dingwall 1996; Ward & Beanland 1996
Water pollution due to human waste and disease pathogens	Health risk (e.g. giardia)	Cessford & Dingwall 1996
Soil (effect on composition and structure)	Due to physical contact and wastes, including chemicals	Booth & Cullen 1995; Devlin et al. 1995
Soil erosion	Due to trampling, construction and extreme weather	Department of Lands and Survey 1986
Geological aspects	Effects of facility construction including instability and erosion	Department of Lands and Survey 1986
Wildlife disruption	Disruption by visitors of breeding, feeding, and normal behaviour of wildlife	Gordon et al. 1992; Robertson 1995; Higham 1994; Kearsley & Higham 1997
Loss of habitat	Habitat loss and displacement of wildlife	Butler 1991; Clearwater 1993
Vegetation damage	Due to trampling and introduced species. Changes in species composition and age structure	Booth & Cullen 1995; Cessford & Dingwall 1996
Crowding	Negative perception of numbers of people, leading to stress and displacement	Kearsley & O'Neill 1994
Displacement and reduced satisfaction	Tourists and locals move to other locations to avoid tourists	Higham & Kearsley 1994; Kearsley 1997
Scenic amenity	Due to facilities such as skifields, roads, tramping huts and accommodation	Boffa Miskell 1997
Climate change and energy	Energy use, CO_2 emissions	Becken 2001 Becken et al. 2001

Source: Updated and adapted from the Office of the Parliamentary Commissioner for the Environment's (1997) report *Management of the Environmental Effects Associated with the Tourism Sector.*

environment are likely to be even more significant due to the extensive backward linkages required to supply inputs of food, accommodation, roading, business services and so forth. In spite of this, there has been virtually no analysis of the indirect effects or lifecycle assessments of the tourism industry, except for the occasional mention of such effects by some authors, e.g. Font & Buckley (2001) who argue that lifecycle assessment is a necessary component of the "very strong" form of eco-labelling.

Another key emphasis of the current study and a point of departure from previous studies is to project *future environmental impacts* of tourism activity. Current studies have tended to either be for a single point in time or adopt a retrospective time horizon. These retrospective studies are important in establishing historical trends and benchmarks. However, if decisions are to be made about the future sustainability of tourism and how to manage future environmental effects, it is useful to project future levels of environmental impacts and pressures. If future levels of impacts are known (even with some uncertainty) this provides industry, government and other stakeholders with an ability to anticipate environmental issues and problems before they happen. The *Resource Futures* research by CSIRO is a good example of this type of proactive research (Foran et al. 1998).

1.4 Related previous research

The current study relates to and attempts to build on a number of other areas of previous tourism research in New Zealand, apart from that into environmental impacts as discussed in section 1.3 and summarised in Table 1.

Economic impact assessment, using multiplier analysis, has been a dominant tourism research topic in New Zealand. At the national level, various studies have attempted to quantify the total (direct and indirect) income generated by the tourism sector. Lim (1991) found that for 1988/89 the direct GDP generated by tourism was 5.2%, with a further 3% as the indirect effect and 4.4% as the induced effect. More recently Statistics New Zealand (2001b), in constructing the *Tourism Satellite Accounts*, estimated that during 1999/2000 tourism contributed 4.9% directly to GDP, and 9.7% once indirect effects were taken into account. Multiplier analysis was also used to calculate the total employment of the tourism sector by Lim (1991) and Statistics New Zealand (1999, 2001a,b). In addition, Duncan et al. (1992) extended the analysis to measure the economic flow-on effects of tourism in 13 regional economies.

Economic multiplier analysis has also been widely used at the local level, often to justify public sector investment in tourism attractions. Butcher et al. (1998), for example, measured the flow-on effects of tourism ventures in Kaikoura, in terms of employment, output, value added and household income multipliers. Kerr et al. (1986) also used multiplier analysis, to estimate the flow-on regional economic benefits of activity in Mt Cook National Park.

This report extends multiplier analysis to cover environmental variables. That is, the direct and indirect resources (energy, land, water) required to sustain the New Zealand tourism sector are calculated by using multiplier analysis. In addition, the direct and indirect pollutants (CO_2, water discharges, BOD, phosphorus, nitrate) produced by the New Zealand tourism sector are calculated. By incorporating environmental variables into the multiplier analysis, a more complete picture is provided of the direct and indirect environmental costs of tourism activities, which can be put alongside the economic benefits in a more holistic analysis.

Related to the calculation of economic multipliers is the need to construct input-output economic accounts of the tourism sector. Although Lim (1991) and Duncan et al. (1992) had sought to do this as part of their multiplier analysis, the construction of the *Tourism Satellite Accounts* by Statistics New Zealand (1997) is the most definitive research in this area. Statistics New Zealand developed New Zealand's first official tourism satellite accounts for the year ended March 1997. These were compiled using the World Tourism Organisation's (WTO 1999, 2000) methodology, which is consistent with the United Nations (1993) system of national accounts. Since 1996/97, tourism satellite accounts have been updated for the years 1997/98, 1998/99 and 1999/2000. The research reported here extends the tourism satellite accounts to cover selected natural resources and pollutants, thus creating a set of integrated economic-environmental accounts for the New Zealand tourism sector. This is seen as a first step only towards the better integration of national economic and environmental data for the sector.

Forecasting tourism activity (visitor nights, number of tourists, length of stay etc.) has also been a dominant strength of the empirically orientated tourism research in New Zealand. McDermott & Jackson (1985) provided the earliest economic forecast of arrivals to New Zealand, using income, airfares and prices as the determinants.

This research was updated and refined in the 1980s to the mid-1990s in studies in McDermott Miller (1988, 1989) and Patterson (1995). In 1999, the Foundation for Research, Science and Technology sponsored comprehensive forecasting studies of arrivals to New Zealand across origin countries by types of tourists (refer to Chapter 4 for further details). This study, by Goh & Fairgray (1999a), extended the range of predictor variables used in the econometric forecasts to include income, own price, substitute price, exchange rate, and relative price index as well as including lagged effects. The Goh & Fairgray (1999a) report was updated and expanded by McDermott Fairgray Group (2001a) to include details on the regional spread of arrivals as well as extending the scope of several other aspects of the forecasts.

These econometric-based forecasts of arrivals to New Zealand have underestimated arrivals in the order of 2–3%, in overall terms. There have been greater variances when individual markets are examined and, of course, the forecasts have not predicted the effect of one-off events such as the Asian Financial Crisis in 1997 or the flow-on effects of the Twin Towers disaster in September 2001. Our current analysis will attempt to extend these econometric forecasts to include an environmental dimension. Future levels of resource use (land, energy, water) and pollution (CO_2 emissions, BOD, nitrate, phosphorus, water discharges) will be projected, using the econometric forecasts as the starting point. A key feature of these environmental forecasts will be to take account of decoupling effects brought about by technical change.

1.5 Definitions

For the purposes of this study, a number of standard definitions need to be adopted in order to avoid ambiguities and potential confusion in the interpretation of the results.

1.5.1 Tourist

The definition of what constitutes a “tourist” is not as straightforward as it first appears. Various definitions have been put forward by a number of authors (Hunziker 1951; Jafari 1977; Leiper 1990). Probably the most widely accepted definition and certainly the one used in official studies in New Zealand is the one used by the World Tourism Organisation (WTO 1999, 2000), which is accordingly adopted in this study:

> *A tourist is any person travelling to a place other than that of his/her usual environment for less than twelve months and whose main purpose of trip is other than the exercise of an activity remunerated within the place visited.*

What is crucial in this definition is the concept of “usual environment”. The concept of “usual environment” is difficult to define because it depends on the nature of the country in question. Statistics New Zealand (2001a) have used the following criteria to define *travel outside the usual environment* in the New Zealand case:

- travel by a scheduled flight or inter-island ferry service;
- travel more than 40 km from their residence (one way) and
  travel outside the area they commute to work in or visit daily;
- travel by an international tourist.

Tourists are further split in this study (as they were in other New Zealand studies) into three broad categories:

- *Holiday*: A tourist whose main purpose of travel is for a holiday or vacation.
- *Visiting Friends or Relatives (VFR)*: A tourist whose main purpose of travel is to visit friends or relatives.
- *Business*: A tourist whose main purpose of travel is the carrying out of some business activity.

The inclusion of business travellers is of course a broader definition of “a tourist” than would be widely accepted by the general public.

1.5.2 Tourism sector and tourism ratios

The tourism sector is unlike other sectors in the economy in that it is not defined by the goods and services it produces. Rather it is defined by the distinctive set of goods and services *consumed* by tourists, that is, it is defined on the basis of consumption rather than production.

The tourism sector therefore consumes a proportion of the gross output of other sectors in the economy, e.g. it consumes 47% of the output of the “accommodation, restaurants and cafes” sector. This is called the *tourism ratio*.

1.6 Systems boundaries

The general aim in this study is to take a lifecycle assessment approach to the analysis. In this approach, all of the indirect upstream inputs into the tourism sector need to be tracked and quantified. The approach taken here does not take into account social and cultural costs of tourism, which could add substantially to the tourism sector's footprint.

Usually, in the *process method* approach to lifecycle assessment, there is some cut-off point as to how far up the production chain you track inputs. For example, some percentage (say 1% of the mass of the final output of the product) can be set as the cut-off point. This approach is not necessary in the input-output approach used here, as the input-output method implicitly calculates the n^{th}-round inputs into the product or activity (Wright 1975).

Other boundary issues do arise, however, the first being whether or not to include indirect environmental pressures (resources and pollutants) from imported products used by the tourism sector or otherwise expand the boundary of the study to include overseas tourist-related activity. The approach used in this study was not to include natural resources or pollutant impacts associated with the production of overseas goods imported for use by the New Zealand tourism sector, e.g. the resources and pollutants resulting from manufacturing a tour bus overseas[2]. The main reason for excluding such imported items was due to the lack of data, although it could be argued that on pragmatic grounds such imports are not relevant to New Zealand, as we cannot control the level of resources and pollutants in these imported goods.

However, the CO_2 emissions and energy use associated with international tourists into New Zealand were included from the time the tourist left home until they returned. This systems boundary was used because international travel was seen to be an *integral part* of the tourist's trip to New Zealand that just could not be excluded for analytical convenience. This is a somewhat unfair treatment of tourism compared with other export-oriented sectors such as agriculture. However, it is possible that international travel will be included in the Kyoto Protocol's second commitment period. This will pose pressure on New Zealand's tourism industry, and it is critical to discuss how emissions from international air travel could be allocated to the different countries involved. For example, there is debate as to whether the benefits of travel accrue to the tourists (based in countries of origin) or to destinations (economic growth) and as to who should include the associated emissions in their national greenhouse gas accounts (this could also include stop-over destinations).

A second issue that needed to be considered was whether to include the resources and pollutants embodied in capital items used by the tourism sector. The approach taken in this study was not to include these due to a combination of methodological and data problems required to reliably calculate such resources and pollutants. Capital items are produced in one time period and they need to be analytically depreciated (maybe over 30–50 years), which makes the calculation of annual amounts of embodied resources and pollutants associated with capital inputs very problematical. It should be noted that tourism development occurred within a relatively short time span (see Figure 1) and for this reason infrastructure may have added to the environmental impact on New Zealand during its construction time.

[3] This implies that the average resource intensity of imports to New Zealand is similar to that for exports.

2. Integrated Economic-Environmental Accounts of the Tourism Sector

2.1 Rationale

The drivers of change in the tourism sector are essentially *economic* and *social* in nature, that is, they relate to human behaviour. On a global level, over the last 30 years, particularly as the cost of air travel ($/passenger-kilometre) and the forces of globalisation have taken hold, the level and extent of international tourism has increased dramatically. This, coupled with more leisure time and the greater disposable income of developed and developing countries, has meant that tourism has become available to the middle classes and is a pursuit not confined to the "leisured classes" as it once was (McDermott 1998).

Econometric evidence from New Zealand of the importance of these economic drivers is compelling, clearly demonstrating that income, airfare and price are strong determinants of the level of inbound international tourism into New Zealand (Table 2). For example, typically these three variables alone explain about 95% of the changes (variance) across a number of markets for New Zealand tourism (McDermott & Jackson 1985; Patterson 1995; Goh & Fairgray 1999; McDermott Fairgray Group 2001). These data show that inbound tourists into New Zealand are income rather than price responsive, since the income elasticities mostly exceed unity, with the notable exception of Australia.

These economic drivers are of course a reflection of people's preferences, values and behaviours, so inevitably there is also a psychological and sociological dimension to tourism behaviour. There is, for example, a great deal of market research literature in tourism that elaborates on the underlying demand for tourism products (which ultimately influences price). The motivation to travel to a tourist destination, according to Collier (1997), can be tracked back to physical, cultural, interpersonal status and prestige motivators and no doubt there are other behavioural and cognitive factors that come into play.

Table 2. Income, air fare and price elasticities for international tourists to New Zealand, 1985–1994

Origin Markets	Income Elasticities		Air Fares Elasticities		Price Elasticities	
	1967-84	1979-94	1967-84	1979-94	1967-84	1979-94
Australia, Holiday	0.76	n.s.[3]	-0.50	n.s.[3]	-0.50	n.s.[3]
United States, Holiday	0.99	1.16	-0.15	n.s.[3]	-0.91	n.s.[3]
Japan, Leisure	2.07	9.15	-0.71	n.s.[3]	-0.51	-0.68
United Kingdom, Holiday	2.32	2.36	-6.63	n.s.[3]	-0.71	-0.65
West Germany, Holiday	3.61	6.98	-0.39	n.s.[3]	n.s.[3]	-1.01
Canada, Holiday	1.11	1.34	-0.40	n.s.[3]	n.s.[3]	n.s.[3]

Notes:
1. Adapted from McDermott (1998), based on data from McDermott & Jackson (1985) and Patterson (1995)
2. The elasticities measure the percentage change in "tourist arrivals" in response to a 1% increase in either income (GDP), airfare or price
3. n.s. = no statistically significant elasticity at the $2P < 0.05$ level

Although the drivers of change in the tourism sector are often economic and social in nature, the impacts are often biophysical. The purpose of the integrated economic-environmental accounts framework (Figure 2) used in this study is therefore to understand better the relationship between human behaviour (economic and social) and its environmental impact in the tourism sector. From an ecological perspective the tourism sector (and any other economic sector) has two classes of interactions with the biophysical environment, both of which are important in terms of ensuring the sustainability of the sector[4]:

[4] Common (1995) identifies four functions of the environment: (1) resource base; (2) waste sink; (3) amenity base; (4) life support function. In this study, we classify both "amenity base" and "life support function" as "ecosystem services inputs" into the economy. The idea of an "amenity base" function of the environment is particularly relevant to the tourism sector and therefore it could be argued that it is justifiable to consider it as a separate category of inputs.
Furthermore, Common (1995) argues that amenity flows are fundamentally different to resource inputs as they do not involve direct physical flows – namely, he contends: "the biosphere provides humans with recreational facilities and other sources of pleasure and stimulation. Swimming from an ocean beach does not require productive activity to transform an environmental resource into a source of human satisfaction, for example".

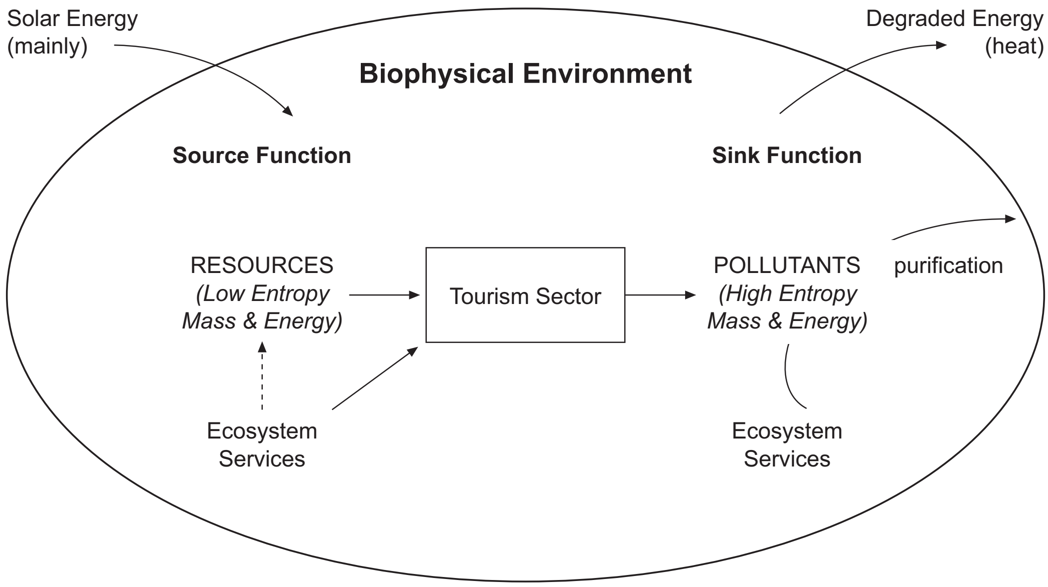

Figure 2. Ecological framework for analysing interactions between the biophysical environment and the tourism sector.

1. The biophysical environment is a *source* of resources for the tourism sector. The tourism sector depends on the biophysical environment for land (accommodation, roads), water, energy inputs, minerals, biodiversity and a whole host of ecosystem services such as climate regulation, refugia, gas regulation, soil formation and so forth, which provide direct inputs into the tourism sector as well as maintaining the life-supporting capacity of ecosystems that are critical to the sustainability of the tourism sector. Clearly, if these resources or ecosystems services are depleted or degraded over time, the ecological sustainability of the tourism sector is threatened. For example, if there is a lack of water in an arid locality that hosts tourism activity, this presents a physical resource constraint that could affect the sustainability of excessive tourism growth in that locality[5] (Gossling 2001). Or, there are often well-known physical-carrying-capacity limits to many natural assets such as national parks, which can lead to problems in sustaining ever-increasing numbers of visitors (Whinam & Chilcott 1999).
2. The biophysical environment assimilates, breaks down, and purifies waste products produced by the tourism sector. This is often termed a *sink function.* A tourism activity can become unsustainable if the amount of pollutants produced exceeds the biophysical capacity to assimilate them. For example, if sewage waste produced by a tourism activity is in excess of the ability of the environment to break it down, that activity could become unsustainable in that environment. Ecosystem services are important in providing this sink function of the biophysical environment. In Costanza et al.'s (1997) taxonomy for eaxample, these functions include "nutrient cycling" and "waste treatment".

The reason for constructing these integrated economic-environmental accounts is therefore to obtain an improved understanding of the economy–environment links of the tourism sector. It is argued that such a framework is critical to understanding the ecological sustainability of the tourism sector. The framework also provides a platform for applying a number of analytical methods that can provide further insights into the economy–environment interconnections within the tourism sector (Patterson & McDonald 1996). These applications include:

[5] In terms of addressing sustainability problems, it is difficult to address the tourism sector's resource use in isolation to the usage by other sectors; for example, it is unlikely that the tourism sector will be the sole user of water in the example given above. This is one reason, for addressing ecological sustainability problems in terms of the integrated economic-environmental accounts framework as it takes account of all sectors and their interrelations with each other.

1. Lifecycle assessment of the tourism sector, using input-output methods pioneered by analysts such as Hite & Laurent (1971) and Wright (1975).
2. Eco-efficiency analysis, which relates environmental "costs" to the economic "benefits" of the tourism sector. This can include simple ratios of direct benefits to direct costs for the tourism sector, or impact analysis that involves indirect benefits and indirect costs as well.
3. Ecological footprint calculations can be made from the accounts, using input-output methods developed by Bicknell et al. (1998), Ferng (2001), and McDonald & Patterson (2003).
4. Comparative analysis of the environmental performance of the tourism sector with other sectors in the economy, especially using "pressure indicators" such as BOD or CO_2 loading on the environment.
5. Forecasting future levels of resource use and pollution in the tourism sector, as determined by visitor growth, economic growth, technical change factors and other such drivers. The integrated economic-environmental accounts (as operationalised by the input-output matrices) provide an excellent basis for projecting economic changes and associated environmental changes in one modelling framework. Such forecasts track not only direct linkages, but also indirect impacts that the tourism sector has on the environment.
6. Modelling integrated economic and environmental scenarios for the tourism sector is possible using the accounts. This can enable the analyst to better understand the trade-offs between economic and environmental values in the tourism sector, as well as providing an ability to anticipate future problems and issues in the tourism sector.

In this report, the integrated economic-environmental accounts are used to undertake a lifecycle assessment of the tourism sector (Chapter 3), an eco-efficiency analysis of the tourism sector (Chapter 3), a comparative analysis of the environmental performance of the tourism sector (Chapters 2 and 3) and environmental forecasts of the tourism sector (Chapter 4). It is hoped that in the future the Foundation for Research, Science and Technology will support the systems dynamic modelling of scenarios for the tourism sector, which could be based on the integrated economic-environmental accounts developed in this study.

2.2 Methodology

2.2.1 Framework and classification systems

The standard framework for developing integrated economic-environmental accounts is the United Nations (1993) SEEA. The SEEA (System of Integrated Economic-Environmental Accounts) is seen as a "satellite" account of the United Nations System of National Accounts (SNA), which is the internationally accepted way of compiling national economic accounts. The origin of the SEEA can be traced back to the 1970s when a number of countries (e.g. Norway, France) established systems to integrate economic and environmental accounts (Wright 1989, 1990). It became increasingly evident through the 1970s and 1980s that an internationally standardised system for integrating economic and environmental accounts was required. There were several initiatives in the 1980s through organisations such as the United Nations and World Bank to achieve this. Eventually in 1989, a joint workshop of the United Nations Environmental Programme and the World Bank recommended "that an economic and environmental accounting system to take account of the national economy and environment" be established. From that point onwards the United Nations moved quickly to establish the SEEA framework, which was released on an interim basis in 1993 (United Nations 1993). Such moves to establish formalised environmental accounting systems were featured strongly in *Agenda 21* (especially, paragraphs 8.41–8.54), which was promoted by the United Nations Conference on the Environment and Development in Rio de Janeiro.

The sector classification and other aspects of the economic accounts constructed in this study are fully consistent with SEEA. However, it is not possible, and arguably not appropriate, to strictly follow SEEA in this study. Furthermore, as the economic accounts were based on modifying the New Zealand input-output matrix, this study uses the same framework as in the *Inter-Industry Study of the New Zealand Economy 1987* as published by the Department of Statistics (1991). Therefore, the economic accounts in this study are fully consistent with Statistics New Zealand's input-output framework. In addition, they are also consistent with Statistics New Zealand's *Tourism Satellite Accounts*.

The classification of natural resources and pollutants utilise the definitions used in the *Eco*Link database constructed by McDonald & Patterson (1999a,b,c,d). These *Eco*Link definitions have some compatibility with definitions used in official

New Zealand databases (e.g. Energy Efficiency and Conservation Authority's (EECA) Energy Use Database, Quotable Value New Zealand Database), as well as being consistent with definitions adopted by the Ministry for the Environment's Performance Indicator programme. Further work would be required, however, to formulate the coverage of resources and pollutants in terms of the SEEA framework.

Sectors covered

In this study the 24 economic sectors covered by the New Zealand Standard Industrial Classification are:

Sector [6]	**NZSIC classification**
Agriculture	11111 to 11259
Fishing and Hunting	11310 to 11320, 13114 to 13300
Forestry	12101 to 12300
Mining and Quarrying	21000 to 29100
Food, Beverages and Tobacco	31114 to 31400
Textiles, Clothing and Footwear	32111 to 32400
Wood and Wood Products	33111 to 33209
Pulp and Paper Products, Printing and Publishing	34110 to 34209, 83401 to 83402
Petroleum, Chemical, Plastics and Rubber Products	35110 to 35600
Non-metallic Mineral Products	36100 to 36997
Basic Metal Products	37101 to 37202
Fabricated Metal Products, Machinery and Equipment	38120 to 38520
Other Manufacturing	39010 to 39098
Electricity, Gas	41010 to 41020
Water Distribution	41030 to 42000
Construction	51010 to 53199
Wholesale and Retail	61111 to 63290
Transport and Storage[7]	71110 to 71939
Communication	72002 to 72003
Finance, Insurance, Real Estate and Business Services	81110 to 83121, 83123 to 83300
Ownership of Owner Occupied Dwellings	83122
Community, Social and Personal Services	92011 to 95999
Central Government	91011 to 91017
Local Government	91020
Tourism	Not covered

Primary inputs covered

The following primary inputs are used in this study: compensation of employees, operating surplus, commodity indirect taxes, non-commodity indirect taxes, commodity subsidies, consumption of fixed capital, second-hand assets and imports. These categories of primary inputs are fully defined by the Department of Statistics (1991).

Final demand categories covered

The five categories of final demand used in this study are household consumption, consumption of central government services, consumption of local government services, exports, capital formation and net increase in stocks. These categories of final demand are fully defined by the Department of Statistics (1991).

[6] In this study, the "tourism" proportion of each sector is deducted from the activity of the sector and put into the tourism sector. The tourism ratios supplied by P. Cresswell (Statistics New Zealand pers. comm. 2002) are used to do this.

[7] This includes "transport and storage" sector activities within New Zealand (NZSIC Classification). It does not include energy use in international travel by inbound and outbound tourists.

Resources and pollutants covered

The resources covered in this study include energy (total oil equivalents and heat equivalents), total water takes (m^3), and land (ha). The pollutants covered include biological oxygen demand of water discharges (BOD_5 – kg); nitrate content of water discharges (nitrate – kg); phosphorus content of water discharges (total phosphorus – kg); total volume of water discharges (m^3); and carbon dioxide emissions (t CO_2). A full definition of these variables is contained in McDonald & Patterson's (1999d) description of the *Eco*Link database. It is important to note that the water discharge variables *only cover point-source pollutants*. Non-point-source pollutants are not covered in the analysis because they are not included in the *Eco*Link database. The inclusion of non-point source pollutants will mainly affect the estimates for the agriculture sector. However, this may to some extent affect the estimates of water pollutants for the tourism sector, as the tourism sector both directly and indirectly purchases significant inputs from the agriculture sector.

2.2.2 Analytical steps

Economic accounts

Construction of the economic accounts used in this study involved the following analytical steps (summarised in Figure 3):

Step 1: *Construction of a 1997/98 New Zealand Input-Output Matrix (48 sectors, 23 sectors).* The 1994/95 New Zealand input-output matrix was obtained from Statistics New Zealand (1998a). This matrix was updated to 1997/98 to take account of labour productivity changes, price changes, output growth of sectors and changes in exports. Full details of this updating methodology are outlined by McDonald & Patterson (1999c).

Step 2: *Construction of a 1997/98 New Zealand Input-Output Matrix (24 sectors).* Sector 14 "electricity, gas and water distribution" in the 23-sector matrix was disaggregated into "electricity and gas" and "water distribution", using data from the 48-sector input-output matrix. The rationale for this disaggregation was twofold: (1) to allow for the separate measurement of the indirect reticulated water distribution in the multiplier analysis, and (2) to allow electricity and gas to be separated out in the multiplier analysis, so as to avoid delivered electricity and gas being double-counted.

Step 3: *Selection of the Quadrant 1 and Quadrant 3 Primary Inputs to Intermediate Demand Sectors Data.* These data were abstracted from the 1997/98 24-sector model for further analysis.

Step 4: *Quantification of Purchases by the Tourism Sector.* A column of data quantifying the purchases (from the 24 other sectors) in the economy was compiled. This involved multiplying each of the columns in the 1997/98 24-sector input-output matrix by the tourism ratio obtained from Statistics New Zealand's (2002) satellite accounts, and then aggregating these columns into a total[8].

Step 5: *Quantification of Sales by the Tourism Sector.* A row of data quantifying the sales (to the other 24 sectors) in the economy was compiled. Unfortunately Statistics New Zealand satellite accounts do not contain any data on the sales of the tourism sector output to the intermediate demand sectors. However, the total "business sector" intermediate demand is known from the 1997 tourism satellite accounts, and this was pro-rated to each intermediate demand sector on the basis of the size of the sector's contribution to GDP[9].

Step 6: *Insertion of a Tourism Sector Row and Column into the Intermediate Demand Matrix.* The column (from Step 4) and the row (from Step 5) were inserted into the intermediate demand matrix. This resulted in an intermediate demand matrix for 1997/98 of 25 sectors.

Step 7: *Selection of Quadrant 4 Data for Further Analysis, from the 1997/98 25-Sector Model.* These are data on primary inputs into final demand, which were obtained for inclusion in the final 25-sector model. This was a fairly sparse matrix with few entries.

[8] This assumes that the tourism share of each of the 23 sectors has the same mix of inputs as the sector's average mix of inputs. This may not necessarily be the case, as tourists may have a propensity to purchase commodities from a sector of a different input mix to that of the sector's average. However, it is reasonable to assume that the NZSIC system tends to classify similar products, with similar input mixes, into a given sector, which therefore reduces the possibility of significant error in the analysis.

[9] This assumes that business-related tourism travel is directly proportional to the GDP of the sector. This is probably a reasonable assumption. In any case, the coefficients in this row are relatively small, and sensitivity tests show that shifts in the order of 50% in these coefficients have little effect on the multiplier analysis, due to their relatively small size.

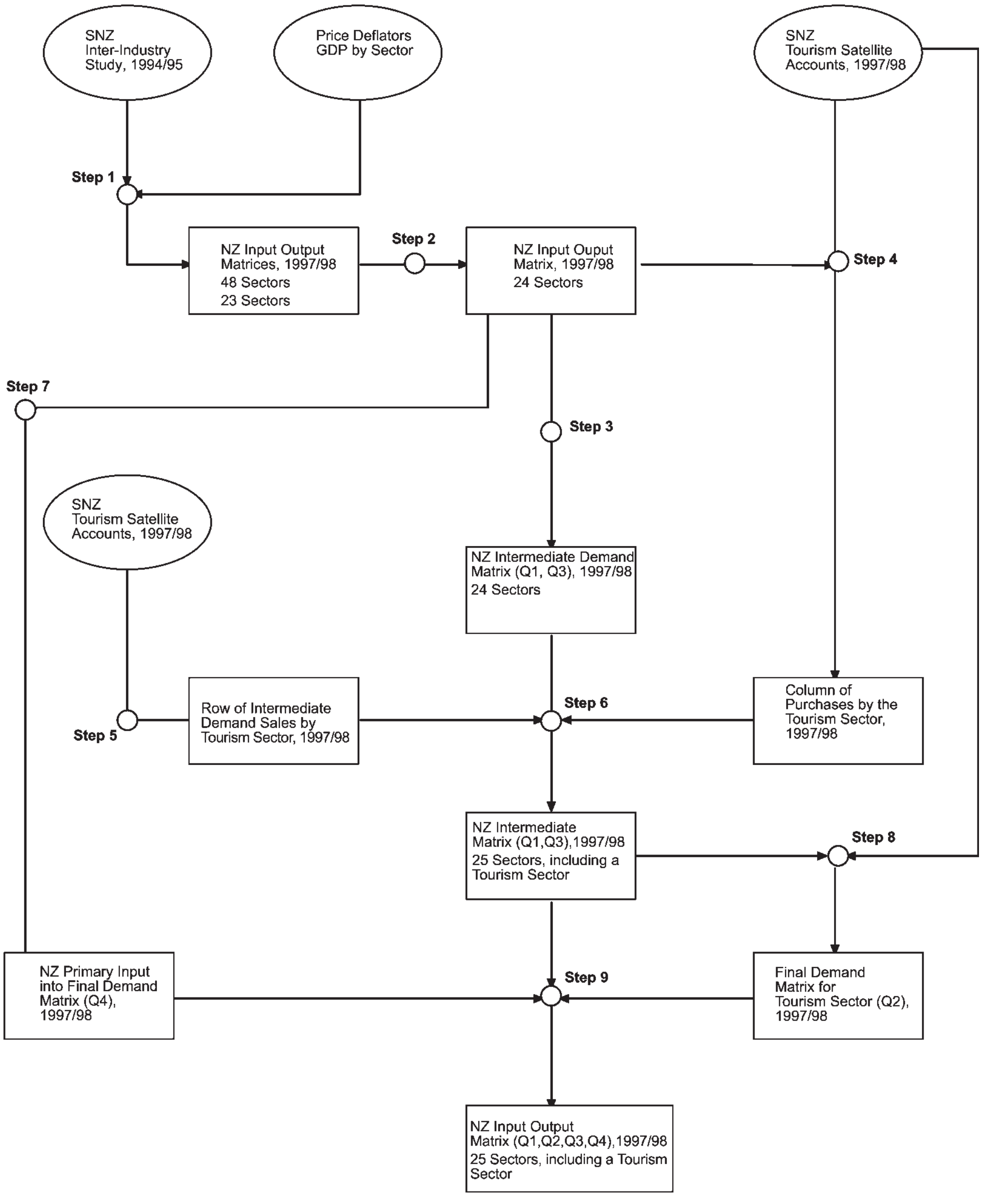

Figure 3. Methodological process for constructing the economic accounts of the New Zealand tourism sector.

Step 8: Determination of the Final Demand Matrix for Inclusion in the 25-Sector Model. With the determination of the intermediate demand matrix in Step 6 the columns and rows in the final demand matrix did not add up. This meant that most of the internal coefficients in the final demand matrix had to be re-estimated, except for the coefficients that represented "household consumption of tourism output" and "exports of tourism outputs" (which were both known from the tourism satellite accounts). The row totals and column totals, however, were known. This analytical problem was solved by using the RAS optimisation procedure; this is an iterative numerical method that adjusts the internal coefficients so that they sum to the correct row and column totals (Henry 1974). In this case, the original coefficients (before the inclusion of the tourism rows and columns) were used as the starting point to the RAS optimisation, and it was found that the RAS solution differed only slightly from the original coefficients.

Step 9: Construction of 25-Sector Input-Output Matrix for New Zealand, Including a Tourism Sector. A full input-output matrix for New Zealand including a tourism sector is constructed by combining the matrices estimated in Steps 6, 7 and 8. This matrix complied with the standard accounting identities used in input-output analysis, which requires various balances of inputs and outputs across the economy.

Environmental accounts

Construction of the environmental accounts used in this study involved the following analytical steps (summarised in Figure 4):

Step 10: Regional Data for Selected Resources and Pollutants Abstracted from EcoLink. Regional data for biological oxygen demand of water discharges (BOD_5 – kg), nitrate content of water discharges (NO_3 – kg), phosphorus content of water discharges (total phosphorus – kg) and total water discharges (m^3) and water takes (m^3) were uplifted from the EcoLink database (McDonald & Patterson 1999c,d) for the year 1997/98 for the Northland, Auckland and Waikato regions. This quantified the inputs (resources) and outputs (pollutants) across the 24 sectors for each region.

Step 11: Scaling up Regional Pollutant Data for New Zealand, 1997/98. The regional data obtained in Step 10 was scaled up to obtain a national estimate. The scalar used was:

$$\frac{\text{National GDP contribution of a given sector}}{\text{(Northland + Auckland + Waikato) GDP contribution of a given sector.}}$$

The combined economies of Northland, Auckland and Waikato made up 45.06% of the New Zealand economy, so on average this sectoral scalar was 2.12 (1/0.4500)[10].

Step 12: New Zealand Data for Land Inputs into 24 Sectors, 1997/98. Estimates of the land inputs into each of the 24 sectors were based on data gathered from Quotable Value New Zealand (1998), Statistics New Zealand (1998b,c), Ministry of Agriculture and Forestry (1999), and Works Consultancy Services (1996). These estimates exclude national parks, inland water bodies (lakes and rivers) and marine land.

Step 13: New Zealand Data for Delivered Energy Inputs and End Uses of 24 Sectors, 1994/95. These data were obtained from the Energy Efficiency Conservation Authority (1998) energy database for 38 sectors and then aggregated to the 24 sectors used in this study.

Step 14: Updating the New Zealand Energy Data to 1997/98. The data obtained in Step 13 were updated by using data on delivered energy inputs available from the Ministry of Commerce (1998) and GDP data from Statistics New Zealand (2000). It was assumed that the mix of end uses of energy for each sector remained constant between 1994/95 and 1997/98.

Step 15: Calculation of CO_2, NO_x and CH_4 Emissions for 1997/98. These emissions were calculated using the delivered energy data for the 24 sectors obtained in Step 14. These emission factors were the same emission factors used in the EECA database, cross-checked against emission factors obtained from Turbott et al. (1991) and Baines (1993).

[10] On average, this means that the data here were a sample of 45.06% of the population for these resources and pollutants. There is some "sampling error" involved in this scaling up procedure, which could be quantified by analysing the consents records used as the base data into *Eco*Link. Further, there could be some "regional bias" in these data, e.g. water usage by agriculture (m^3/\$GDP) could be different in the regional sample compared with the national average.

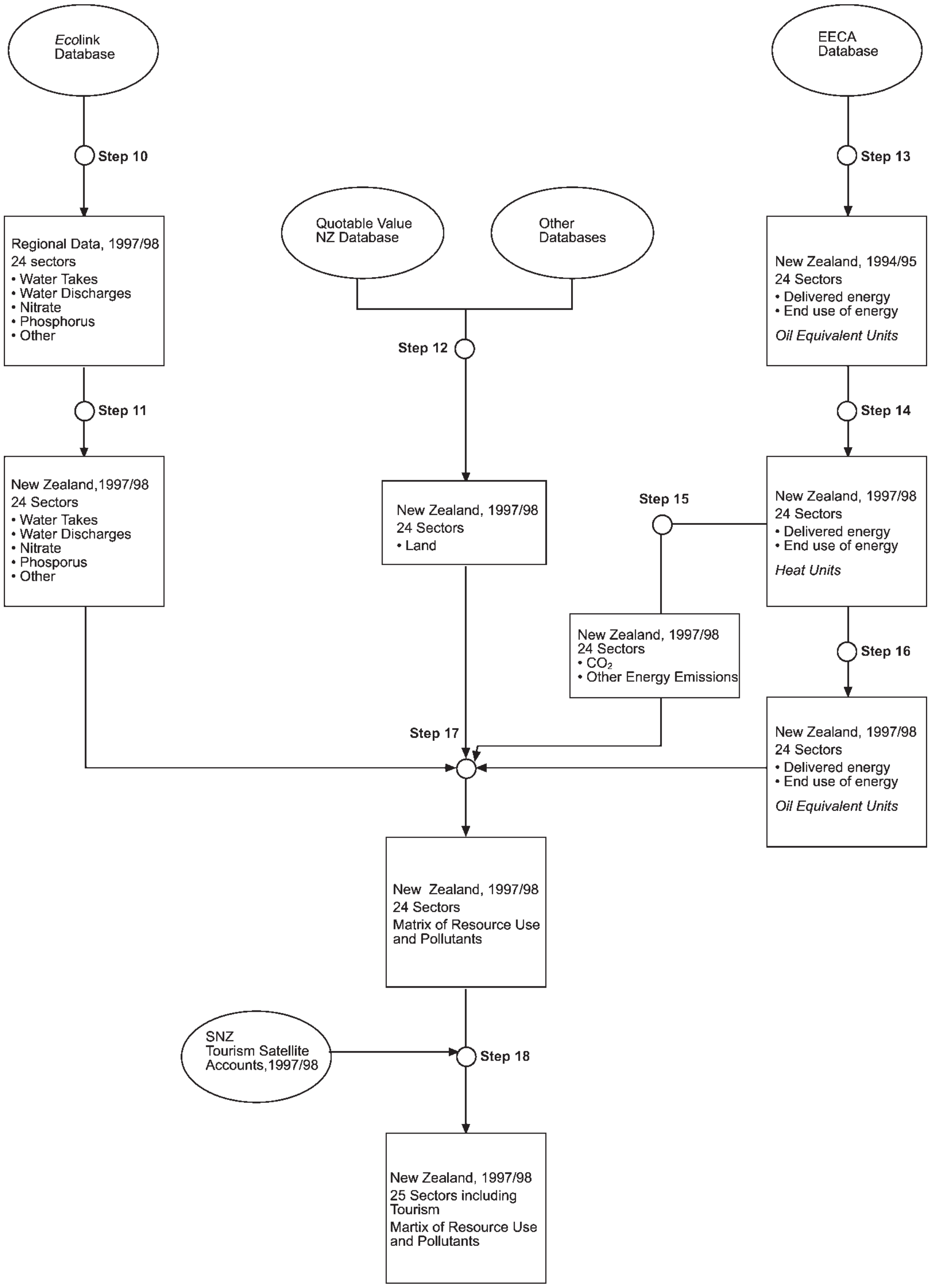

Figure 4. Methodological process for constructing the environmental accounts of the New Zealand tourism sector.

Step 16: Calculation of Delivered Energy Inputs and End Use Energy Outputs, in Terms of Oil Equivalents, 24 sectors for New Zealand, 1997/98. The energy data in Steps 13 and 14 are measured in heat equivalents. This takes no account of the energy quality (usefulness) of the different forms of energy. The energy data (in heat equivalent terms) were converted to energy data (oil equivalent terms) by using quality coefficients. Once the energy data are measured in oil equivalent terms, different forms of energy can be validly "added up" as they are expressed in common units of energy quality[11].

Step 17: Integration of the Resources and Pollutants Data to Construct a National Set of Environmental Accounts for 24 Sectors, 1997/98. Data from Steps 11 (water inputs and outputs, water-related pollutants), 12 (land) and 16 (energy) were combined to construct a national set of environmental accounts across the 24 sectors in the economy for 1997/98.

Step 18: National Set of Environmental Accounts for 25 Sectors (including a Tourism Sector), 1997/98. Tourism ratios from Statistics New Zealand's (2002) *Tourism Satellite Accounts 1997/98* were used to construct these accounts. This required a proportion from each of the 24 sectors to be attributed to the tourism column in the new input-output matrix.

Integrated economic-environmental accounts

Step 19: Integration of the Economic and Environmental Data Matrices. The matrix from Step 9 (New Zealand input-output matrix of the economy, 25 sectors including a tourism sector, 1997/98) was combined with the matrix from Step 18 (matrix of resource use and pollutants, 25 sectors including a tourism sector, 1997/98). This provided an input-output model that quantifies the relationships between the economy and the environment, which can be used for a variety of purposes, including multiplier analysis (Patterson & McDonald 1996).

2.3 Economic accounts of the tourism sector

A full set of economic accounts for the New Zealand tourism sector was developed for the financial year 1997/98. Essentially, this was achieved by integrating data from Statistics New Zealand's (1999, 2001a, b) *Tourism Satellite Accounts* with data on the structure of the rest of the economy derived from Statistics New Zealand's (1998a) inter-industry study. Accordingly, an input-output matrix of the economy with an embedded tourism sector was developed. This input-output matrix details how the tourism sector interacts with other sectors (purchases and sales) and contains data on final demand and the primary input characteristics of the tourism sector. From these input-output data, indicators of economic performance can be derived for the tourism sector, e.g. GDP generated, operating surplus and so forth. To aid the reader, discussion in the text rounds figures presented more exactly in the accompanying tables.

2.3.1 Input-output model including the tourism sector

A full input-output matrix of the New Zealand economy (1997/98) including the tourism sector, as well as the 24 other sectors in the economy, is reproduced in Appendix A. A 49-sector model was also constructed but is not reproduced here due to its size.

2.3.2 Tourism sector inputs and outputs

The inputs (purchases) and outputs (sales) of the tourism sector can be abstracted from the modified input-output matrix (Section 2.3.1).

Tourism sector inputs (purchases)

The total purchases of intermediate demand inputs by the New Zealand tourism sector amounted to $4,777 million for 1997 (Table 3). The largest inputs were from the finance, insurance, real estate and business services sector at $1,035 million, followed by transport and storage at $732 million and the wholesale and retail trade at $596 million. Collectively, these three largest input categories accounted for nearly half (48%) of the intermediate demand purchases by the tourism sector.

[11] A discussion of the determination of quality coefficients can be obtained from: Patterson (1993), Patterson (1998) and Collins & Odum (2001). The particular quality coefficients used in this study were: 1.00 for Aviation Fuel, 0.64 for Black Liquor, 0.52 for Coal, 1.00 for Diesel, 2.00 for Electricity, 1.00 for Fuel Oil, 0.42 for Geothermal, 1.00 for LPG, 0.80 for Natural Gas and 0.20 for Wood. These quality coefficients were obtained from Jollands et al. (1998), and are expressed in terms of oil equivalents.
Caution needs to be exercised when comparing the results of this study with studies that did not use the approach of energy qualities.

The primary inputs into the New Zealand tourism sector are summarised in Table 4. Salaries paid to employees amounted to $2,518 million for 1997/98, being the largest input (purchase) of any sector across both primary inputs and intermediate demand inputs. This high figure for wages and salaries inputs reflects the labour-intensive nature of the tourism sector. Operating surplus (profit) was the next largest primary input at $1,395 million, followed by imports, consumption of fixed capital, indirect commodity taxes and second-hand assets. There were $39 million of grant subsidies received by the tourism sector 1997/98, which are counted as a negative entry in the input-output methodology.

Tourism sector outputs (sales)

The "tourism sector output" is in actuality a composite of a number of outputs defined by a common consumption activity (tourism). In this sense tourism, as McDermott (1998) argues, is quite distinct from traditional industries that are defined in terms either of a common product (e.g. meat) or common production technology (e.g. moulding).

The outputs that make up this "composite" in the New Zealand tourism sector for 1997/98 are summarised in Table 5. These outputs (sales to tourists) were dominated by two product categories: transport and storage at $4,014 million (38.9% of total sales) and wholesale and retail trade at $3,719 million (36.0% of total sales). This is not surprising given the very nature of tourism as a travel activity (covered by "transport and storage") and its associated activities such as the purchase of food, entertainment and souvenirs (covered by "wholesale and retail trade"). Both these output categories are widely recognised as the core components of tourism (McDermott 1998). All other outputs produced by the tourism sector are relatively insignificant, collectively accounting for 25% of total sales ($2,587 million) across all the other output categories.

Table 3. Purchase of intermediate demand inputs by the tourism sector, 1997/98

Intermediate demand inputs	Inputs ($/000's)	Inputs (%)
Finance, Insurance, Real Estate and Business Services	1,034,855	21.67%
Transport and Storage	732,407	15.33%
Wholesale and Retail Trade	596,032	12.48%
Food, Beverages and Tobacco	388,373	8.13%
Construction	352,515	7.38%
Agriculture	268,955	5.63%
Communication	262,359	5.49%
Community, Social and Personal Services	236,781	4.96%
Petroleum, Chemical, Plastics and Rubber Products	208,571	4.37%
Fabricated Metal Products, Machinery and Equipment	184,899	3.87%
Pulp and Paper Products, Printing and Publishing	150,378	3.15%
Basic Metal Products	77,874	1.63%
Electricity, Gas	76,595	1.60%
Tourism	66,825	1.40%
Textiles, Clothing and Footwear	47,508	0.99%
Wood and Wood Products	18,970	0.40%
Fishing and Hunting	15,520	0.32%
Mining and Quarrying	11,761	0.25%
Water Distribution	11,295	0.24%
Local Government	10,469	0.22%
Non-metallic Mineral Products	8,821	0.18%
Forestry	7,583	0.16%
Central Government	5,268	0.11%
Other Manufacturing	1,980	0.04%
Ownership of Owner-Occupied Dwellings	0	0.00%
Total	4,776,594	100.00

Table 4. Purchase of primary inputs by the tourism sector, 1997/98

Primary inputs	Inputs ($/000's)
Compensation of Employees	2,518,385
Operating Surplus	1,394,657
Imports	856,980,000
Consumption of Fixed Capital	553,677
Non-Commodity Indirect Taxes	157,268
Commodity Indirect Taxes	135,404
Second Hand Assets	33,868
Commodity Subsidies	-9
Non-Commodity Subsidies	-39,027
Total	5,611,203

The tourism ratio for each output category is also recorded in Table 5. This measures the total production of each product attributed to the tourism sector. As can be ascertained (Table 5) the tourism ratio for transport and storage is 0.3472, meaning that 34.72% of the transport and storage output in New Zealand was consumed by tourists. A more detailed breakdown of this figure reveals that the tourism ratio for air transport is 0.8174, with road and rail transport only 0.0565. Although demand for air transport appears to be driven by tourist demand, it needs to be remembered that a tourist is defined as "any person travelling to a place other than that of his/her usual environment for less than 12 months and whose purpose of trip is other than exercise of an activity renumerated from within the place visited" – this covers businesspeople making overnight stays, which might not be considered to be "true" tourism (especially as regards domestic tourism).

2.3.3 intermediate final demand for tourism output

The intermediate final demand for tourism output is directly obtained from row 24 of the input-output matrix (Appendix A) and is summarised in Table 6. "Household consumption", which is expenditure by New Zealand households on travel both within New Zealand and overseas, accounted for $6,256 million (60.2%)(Table 6).

"Exports", which is expenditure by overseas tourists in New Zealand, accounted for $2,728 million (26.3%)(Table 6). It is important to note, however, that this "exports" figure is understated, because the Statistics New Zealand's (2001a,b) data, on which it is based, combine within-New Zealand travel by overseas tourists with household expenditure for air transport, for confidentiality reasons. Conversely, this also means that the "household consumption" figure is overstated for the same reason.

The intermediate demand by non-government sectors in the economy was estimated (based on pro-rating the total "business demand" by the GDP share of each sector) to amount to $1,403 million (13.5%); that consumed by central and local government was estimated to be $171 million (1.65%) – this figure is reasonably precise in comparison as it is based on a 1997 survey figure by Statistics New Zealand (2001).

2.3.4 Macro-economic indicators of the tourism sector performance

A number of macro-economic indicators of performance of the tourism sector can be directly obtained from the input-output-based economic accounts constructed in this study: export earnings, employment generation, operating surplus (profit), and GDP contribution. These indicators can be readily used to compare the tourism sector's economic performance against other sectors in the economy.

Export earnings

The input-output accounts compiled in this analysis indicate that the export earnings of the tourism sector were $2,728 million for 1997/98. This represents 8.85% of the total export earnings of New Zealand for that year (Table 7).

It is often asserted that tourism is New Zealand's biggest export earner. Whether this is or is not the case depends on how

Table 5. Tourism sector outputs, 1997/98

Outputs	Total Output ($/000's)	Total Output (%)	Tourism Ratio
Transport and Storage	4,013,906	38.89	0.3472
Wholesale and Retail Trade	3,719,280	36.04	0.1252
Community, Social and Personal Services	757,342	7.34	0.0399
Food, Beverages and Tobacco	503,641	4.88	0.0261
Finance, Insurance, Real Estate and Business Services	289,023	2.80	0.0109
Textiles, Clothing and Footwear	264,671	2.56	0.0643
Fabricated Metal Products, Machinery and Equipment	217,654	2.11	0.0185
Ownership of Owner-Occupied Dwellings	192,213	1.86	0.0223
Petroleum, Chemical, Plastics and Rubber Products	152,541	1.48	0.0192
Pulp and Paper Products, Printing and Publishing	78,264	0.76	0.0132
Communication	56,527	0.55	0.0099
Agriculture	31,082	0.30	0.0026
Local Government	20,556	0.20	0.0177
Other Manufacturing	12,039	0.12	0.0267
Non-metallic Mineral Products	5,717	0.06	0.0032
Wood and Wood Products	2,770	0.03	0.0007
Central Government	1,569	0.02	0.0003
Basic Metal Products	802	0.01	0.0004
Construction	560	0.01	0.0000
Fishing and Hunting	471	0.00	0.0006
Forestry	315	0.00	0.0001
Mining and Quarrying	27	0.00	0.0000
Total	10,320,971	100.00	

Note: This table does not include internals transactions within the Tourism Sector

you classify other economic activities and commodities[12]. If you use the 24-sector classification system used in this study, then tourism is the fourth largest export earner, behind food, beverages and tobacco, the wholesale and retail trade, and transport and storage.

It is arguably more meaningful to assess the export performance of sectors in terms of net exports generated. On this basis, the tourism sector had a net export earning of $1,871 million ($2,728 million exports minus $857 million imports). Here, the tourism sector is again the fourth largest earner behind food, beverages and tobacco, the wholesale and retail trade, and transport and storage.

Employment generation

Although the input-output economic accounts contain no data about employment by the tourism and other sectors in the economy, they do contain data on the wages and salaries ("compensation of employees") earned by employees in the various sectors in the economy (Table 8). This "compensation of employees" variable could be used as a surrogate for employment.

[12] Statistics New Zealand's (1999) *Tourism Satellite Accounts 1997,* for example, compare the tourism sector's export performance based on a commodity-based classification of exports. On this basis, tourism is ranked as the largest exporter. One of the features of this classification (used by Statistics New Zealand) is disaggregating "food, beverages and tobacco" into its component products such as "dairy products", "meat and meat products" and "seafood". This disaggregation alone removes "food and beverages" from the top ranking and promotes "tourism" to first place.

Table 6. Intermediate final demand for tourism sector output, 1997/98

Demand from these sectors	Output ($/000's)	Output (%)
Household Consumption	6,255,844	60.22
Exports (Overseas Visitors)	2,728,391	26.27
Finance, Insurance, Real Estate and Business Services	206,262	1.99
Wholesale and Retail Trade	178,880	1.72
Community, Social and Personal Services	167,193	1.61
Central Government	143,714	1.38
Ownership of Owner-Occupied Dwellings	102,795	0.99
Agriculture	74,795	0.72
Tourism	66,825	0.64
Communication	57,626	0.55
Food, Beverages and Tobacco	57,549	0.55
Construction	52,544	0.51
Fabricated Metal Products, Machinery and Equipment	51,113	0.49
Transport and Storage	45,977	0.44
Pulp and Paper Products, Printing and Publishing	31,032	0.30
Electricity, Gas	30,543	0.29
Petroleum, Chemical, Plastics and Rubber Products	30,007	0.29
Local Government	27,319	0.26
Forestry	18,912	0.18
Wood and Wood Products	17,510	0.17
Textiles, Clothing and Footwear	9,558	0.09
Mining and Quarrying	9,104	0.09
Non-metallic Mineral Products	8,540	0.08
Basic Metal Products	8,184	0.08
Fishing and Hunting	3,865	0.04
Other Manufacturing	1,989	0.02
Water Distribution	1,723	0.02
Total	10,387,796	100.00

Note: Intermediate Demand Categories (row 3 to row 27) crudely estimated by pro-rating 'Business Demand' using GDP of each sector

Tourism employees were paid $2,518 million of wages and salaries in 1997/98. This rates fifth behind the labour-intensive sectors of community, social and personal services, the wholesale and retail trade, finance, insurance and business services, and central government. The wages and salaries paid to tourism employees represented 5.8% of the total wages and salaries paid in New Zealand in 1997/98.

Employment numbers for the tourism sector, although not part of the input-output accounts generated in this analysis, are available from the tourism satellite accounts produced by Statistics New Zealand (2001a,b). For example, for the year ending 1997, Statistics New Zealand (2001a) estimated direct employment in tourism to be 85 771 full-time equivalent employees and multiplier analysis indicated another 63 000 indirectly employed by the tourism sector. This direct employment represents 5.6% of the New Zealand labour force, which compares with broadly similar figures for Australia (6.0%), Canada (3.7%), United States of America (3.4–4.1%) and Norway (6.7%) for the years 1997 and 1998 (Statistics New Zealand 2001a,b).

Table 7. Exports from tourism and other sectors in the New Zealand economy, 1997/98

Sector and Primary Input Categories	Exports ($/000's)	Exports (%)
Food, Beverages and Tobacco	8,346,130	27.06
Wholesale and Retail Trade	4,391,796	14.24
Transport and Storage	3,174,565	10.29
Tourism	2,728,391	8.85
Fabricated Metal Products, Machinery and Equipment	1,912,800	6.20
Textiles, Clothing and Footwear	1,830,686	5.94
Agriculture	1,536,531	4.98
Petroleum, Chemical, Plastics and Rubber Products	1,161,184	3.76
Wood and Wood Products	969,244	3.14
Pulp and Paper Products, Printing and Publishing	835,125	2.71
Basic Metal Products	669,779	2.17
Forestry	645,277	2.09
Finance, Insurance, Real Estate and Business Services	457,147	1.48
Commodity Indirect Taxes	415,639	1.35
Community, Social and Personal Services	351,724	1.14
Mining and Quarrying	340,362	1.10
Communication	306,507	0.99
Other Manufacturing	242,438	0.79
Fishing and Hunting	204,817	0.66
Second Hand Assets	148,412	0.48
Non-metallic Mineral Products	85,468	0.28
Central Government	48,074	0.16
Construction	32,671	0.11
Electricity, Gas	5,808	0.02
Local Government	1,458	0.00
Water Distribution	60	0.00
Ownership of Owner-Occupied Dwellings	0	0.00
Total	30,842,094,000	100.00

Operating surplus (profit)

The operating surplus (profit) earned by the tourism sector and other sectors in the New Zealand economy for 1997/98 is summarised in Table 9[13]. As can be ascertained (Table 9) the tourism sector generated $1,395 million in 1997/98 (4.4% of all profits earned in New Zealand), ranking seventh out of 23 sectors in terms of the amount of profit generated.

GDP contribution

The contribution of the tourism sector to New Zealand gross domestic product (GDP) is arguably the most important indicator of its economic performance. This is because GDP measures the total value of goods and services (once purchases have been deducted) produced by the sector, that is, the total value added by the sector. In the input-output matrix, for the

[13] In strict terms, "operating surplus" is a balancing item in the input-output matrix. The Department of Statistics (1991) defined it as "the gross output at producers' values less the sum of intermediate consumption, compensation of employees, consumption of fixed capital and indirect taxes net of subsidies. In the column of the inter-industry transactions table this is equivalent to total input at approximate basic values less the sum of the first quadrant, compensation of employees, Indirect taxes (including import duty) less subsidies, consumption of fixed capital, second-hand assets and imports". Although it is a balancing item, it broadly equates to the term "profit".

Table 8. Wages and salaries paid to tourism and other sector employees, 1997/98

Sector	Wages and Salaries ($/000's)	Wages and Salaries (%)
Community, Social and Personal Services	9,260,706	21.18
Wholesale and Retail Trade	6,989,191	15.99
Finance, Insurance, Real Estate and Bus. Srvcs	5,499,763	12.58
Central Government	2,716,165	6.21
Tourism	2,518,385	5.76
Food, Beverages and Tobacco	2,421,077	5.54
Construction	2,262,827	5.18
Fabricated Metal Products, Machinery and Equip.	2,058,395	4.71
Transport and Storage	1,632,291	3.73
Communication	1,562,850	3.57
Pulp and Paper Products, Printing and Publishing	1,239,269	2.83
Agriculture	1,203,035	2.75
Petroleum, Chemical, Plastics and Rubber Prod.	926,773	2.12
Wood and Wood Products	794,118	1.82
Local Government	537,811	1.23
Textiles, Clothing and Footwear	476,314	1.09
Electricity, Gas	452,894	1.04
Basic Metal Products	328,893	0.75
Non-metallic Mineral Products	297,119	0.68
Forestry	188,174	0.43
Mining and Quarrying	169,610	0.39
Other Manufacturing	74,841	0.17
Fishing and Hunting	57,986	0.13
Water Distribution	52,511	0.12
Ownership of Owner-Occupied Dwellings	0	0.00
Total	43,721,000	100.00

entire economy, GDP is the sum of row totals for the following primary inputs: compensation of employees, operating surplus, commodity indirect taxes, commodity subsidies, non-commodity subsidies, consumption of fixed capital, and second-hand assets. The same items are summed, but only for the tourism column, in order to determine the tourism sector's contribution to GDP.

The tourism sector contributed $4,754 million to New Zealand GDP in 1997/98. This represented 4.8% of the total GDP. Tourism ranked seventh, behind finance, insurance, real estate and business services, the wholesale and retail trade, community, social and personal services, ownership of owner-occupied dwellings, household consumption, and agriculture (Table 10).

According to Statistics New Zealand (2001a) the tourism sector in Australia (1997) generated 4.5% of that country's GDP, in Canada 2.5%, in the United States of America 2.1–2.4%, and Norway 3.9%. New Zealand's tourism sector generates a higher percentage of GDP (4.8%) than any of these countries, being approximately double that for Canada and the United States.

Table 9. Operating surplus (profit) generated by tourism and other sectors in the New Zealand economy, 1997/98

	Operating Surplus ($/000's)	Operating Surplus (%)
Finance, Insurance, Real Estate and Business Services	6,198,738	19.63
Ownership of Owner Occupied Dwellings	5,450,848	17.26
Wholesale and Retail Trade	3,898,061	12.35
Agriculture	2,865,396	9.08
Community, Social and Personal Services	1,891,469	5.99
Communication	1,530,923	4.85
Tourism	1,394,657	4.42
Electricity, Gas	1,316,493	4.17
Fabricated Metal Products, Machinery and Equipment	1,093,470	3.46
Forestry	1,073,535	3.40
Transport and Storage	880,086	2.79
Food, Beverages and Tobacco	764,543	2.42
Construction	747,742,	2.37
Petroleum, Chemical, Plastics and Rubber Products	707,53	2.24
Pulp and Paper Products, Printing and Publishing	549,573	1.74
Mining and Quarrying	269,854	0.85
Wood and Wood Products	267,011	0.85
Non-metallic Mineral Products	198,323	0.63
Fishing and Hunting	145,331	0.46
Textiles, Clothing and Footwear	138,405	0.44
Basic Metal Products	85,579	0.27
Other Manufacturing	52,743	0.17
Water Distribution	52,678	0.17
Total	31,573,000	100.00

2.4 Environmental accounts of the tourism sector

2.4.1 Energy accounts

Analysis of data primarily abstracted from the EECA (1998) energy database enabled reasonably accurate energy use data to be compiled for the: (1) entire tourism sector, (2) international travel sub-sector, (3) motels, hotels and guest houses sub-sector, and (4) domestic transport sub-sector. The base year for the accounts is 1997/98.

The focus of the approach was not only to quantify the delivered energy inputs (electricity, natural gas, coal, etc.), which is usually the case in energy accounting exercises, but also to extend the accounts to include effective energy end-uses (lighting, heating, transport, etc.).

Overall tourism accounts

The tourism sector was calculated to use 75.62 PJ (heat units) of energy in 1997/98, when international air travel by overseas visitors was included. The components of this total are shown in Table 11.

The tourism energy accounts were also calculated taking account of energy quality differences in the delivered energy inputs (Table 12). On this basis, by far the largest energy input was aviation fuel (at 61 466 TJ, oil equivalents), representing 77.4% of the tourism-sector energy use. This was followed by electricity (at 9236 TJ, oil equivalents), representing 11.6% of the total. All of the other delivered energy inputs accounted for only 10.9% of the total energy used by the tourism sector – most important of them being diesel (3.6%) and petrol (3.7%), both used for transport within New Zealand.

Table 10. Operating surplus (profit) generated by tourism and other sectors in the New Zealand economy, 1997/98

Sector and Final Demand Categories	GDP Contribution ($/000's)	GDP Contribution (%)
Finance, Insurance, Real Estate and Business Services	14,674,297	0.01%
Wholesale and Retail Trade	12,726,261	0.01%
Community, Social and Personal Services	11,894,784	0.01%
Ownership of Owner Occupied Dwellings	7,313,270	0.01%
Household Consumption	7,223,358	0.01%
Agriculture	5,321,216	0.01%
Tourism	**4,754,224**	0.00%
Communication	4,099,721	0.00%
Food, Beverages and Tobacco	4,094,288	0.00%
Construction	3,738,183	0.00%
Fabricated Metal Products, Machinery and Equipment	3,636,395	0.00%
Transport and Storage	3,270,984	0.00%
Central Government	2,979,980	0.00%
Pulp and Paper Products, Printing and Publishing	2,207,747	0.00%
Electricity, Gas	2,172,979	0.00%
Petroleum, Chemical, Plastics and Rubber Products	2,134,853	0.00%
Forestry	1,345,473	0.00%
Wood and Wood Products	1,245,730	0.00%
Textiles, Clothing and Footwear	679,984	0.00%
Mining and Quarrying	647,730	0.00%
Non-metallic Mineral Products	607,584	0.00%
Basic Metal Products	582,221	0.00%
Local Government	566,472	0.00%
Exports	564,051	0.00%
Fishing and Hunting	275,001	0.00%
Other Manufacturing	141,541	0.00%
Water Distribution	122,586	0.00%
Net Increases in Stocks	46,274	0.00%
Total	99,067,187	100.00

A further breakdown shows that aviation fuel was the dominant delivered energy input to international travel (51 843 TJ, oil equivalents), with a much smaller amount (9623 TJ, oil equivalents) used for domestic travel by tourists within New Zealand.

Overall, the delivered energy inputs to the tourism sector (79 376 TJ, oil equivalents) can be compared with the total for the New Zealand economy (440 640 TJ, oil equivalents), which indicates the tourism sector directly used 17.0% of the total energy used in the New Zealand economy. If the international travel component (51 843 TJ, oil equivalents) is subtracted from the calculation, this figure reduces to 23 774 TJ (oil equivalents), which means the tourism sector only used 5.35% of the total delivered energy used in New Zealand in 1997/98.

Domestic sub-sector breakdown

A more detailed breakdown of the overall accounts on a sub-sector basis is presented in terms of delivered energy inputs (Table 13) and end uses of energy (Table 14).

In terms of delivered energy inputs, the transport and storage sub-sector accounted for the largest energy usage (53.5%), followed by the wholesale and retail trade (36.0%), and food and beverages (3.6%). All other sub-sectors accounted for the remaining 6.9% of energy use.

Table 11. Direct energy use (heat units) by the tourism sector, 1997/98

Delivered Energy Inputs	Tourism Sector TJ (Heat Units)	New Zealand Economy TJ (Heat Units)
Aviation Fuel	61 466	13 431
Black Liquor	0	15 371
Coal	647	45 576
Diesel	2869	69 850
Electricity	4618	116 064
Fuel Oil	599	8046
Geothermal	217	6247
LPG	297	6341
Natural Gas	1900	42 993
Petrol	2951	106 422
Wood	53	14 298
Total	75 617	444 640

Note: For aviation fuel, the tourism sector total exceeds the New Zealand total because it includes aviation fuel used outside New Zealand by international tourists travelling to and from New Zealand.

Table 12. Direct energy use (oil equivalents) by the tourism sector, 1997/98

Delivered energy inputs	TJ (Oil equivalents)	Total (%)
Aviation Fuel	61 466	77.44
Black Liquor	0	0.00
Coal	336	0.42
Diesel	2 869	3.61
Electricity	9 236	11.64
Fuel Oil	599	0.75
Geothermal	91	0.11
LPG	297	0.37
Natural Gas	1 520	1.91
Petrol	2 951	3.72
Wood	11	0.01
Total	79 376	100.00

In terms of end-uses of energy, transport end-uses collectively accounted for more than half the total: air transport (26.3%), land transport (25.6%), sea transport (5.3%) and rail (1.3%)(Table 14). The end uses of energy associated with buildings and accommodation were also significant: space heating (8.1%), water heating (6.8%), refrigeration (8.55%) and cooking (4.3%).

International travel

It was estimated that the total amount of energy directly used by foreign tourists in travelling to and from New Zealand in 1997/98 was 51 843 TJ. This was based on calculating the weighted mean distance travelled from data from Goh & Fairgray (1999a) and multiplying this by Lenzen's (1999) energy intensity of 1.77 TJ/passenger-km.

This figure of 51 843 TJ assumed a return flight. By way of comparison, Becken (2001) calculated a figure of 27 800 TJ for 1999 on the basis of a one-way flight. If the Becken (2001) figure is doubled to account for a return flight, the comparable

Table 13. Delivered energy inputs (oil equivalents) into tourism sub-sectors within New Zealand, 1997/98

Tourism Sub-Sectors	Aviation fuel (TJ)	Coal (TJ)	Diesel (TJ)	Electricity (TJ)	Fuel oil (TJ)	Geo-thermal (TJ)	LPG (TJ)	Natural gas (TJ)	Petrol (TJ)	Wood (TJ)	Total (TJ)	Total (%)
Agriculture	0	0	33	19	0	0	0	0	20	0	73	0.27
Fishing and Hunting	0	0	3	0	1	0	0	0	0	0	4	0.01
Forestry	0	0	0	0	0	0	0	0	0	0	0	0.00
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0.00
Food, Beverages and Tobacco	0	170	44	451	16	0	10	258	53	0	1001	3.64
Textiles, Clothing and Footwear	0	19	15	79	7	0	1	72	5	0	198	0.72
Wood and Wood Products	0	0	0	3	0	0	0	1	0	0	4	0.02
Pulp and Paper Products, Printing and Publishing	0	7	1	242	9	34	1	58	0	9	361	1.31
Petro., Chemical, Plastics and Rubber Products	0	4	22	135	4	0	1	44	1	0	212	0.77
Non-metallic Mineral Products	0	9	1	6	0	0	1	4	0	0	20	0.07
Basic Metal Products	0	4	0	18	0	0	0	1	0	0	24	0.09
Fabricated Metal Products, Machinery and Equip.	0	1	37	48	2	0	3	27	5	0	124	0.45
Other Manufacturing	0	0	0	14	0	0	0	1	2	0	17	0.06
Electricity, Gas and Water Distribution	0	.	0	0	0	0	0	0	0	0	0	0.00
Construction	0	0	0	0	0	0	0	0	0	0	0	0.00
Wholesale and Retail Trade	0	40	157	7016	187	57	103	929	1 429	2	9921	36.03
Transport and Storage	9622	3	2541	618	365	0	178	46	1 359	0	14 733	53.51
Communication	0	0	4	18	0	0	0	0	8	0	31	0.11
Finance, Insurance, Real Estate and Bus. Services	0	0	0	76	3	0	0	9	0	0	88	0.32
Ownership of Owner-Occupied Dwellings	0	0	0	0	0	0	0	0	0	0	0	0.00
Community, Social and Personal Services	0	79	10	475	4	0	0	69	68	0	703	2.55
Central Government	0	0	0	0	0	0	0	0	0	0	1	0.00
Local Government	0	0	0	18	0	0	0	0	0	0	18	0.07
Household	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	9 623	336	2869	9236	599	91	297	1520	2951	11	27 533	100.00
% of Total Delivered Energy Input	34.95	1.22	10.42	33.55	2.17	0.33	1.08	5.52	10.72	0.04	100.00	

Notes: 1. The delivered energy inputs are measured in oil equivalent units, to take account of energy quality differences. Refer to Footnote 9 for further explanation.
2. The delivered energy inputs can also be measured in heat equivalents units, for the tourism sub-sectors (refer to Appendix B for the equivalent table expressed in heat equivalent units).
3. This only includes energy use within New Zealand's borders, which doesn't include energy used in overseas travel by international visitors to New Zealand.

Table 14. End-Uses of Energy (Oil Equivalents) by Tourism Sub-Sectors Within New Zealand, 1997/98

Tourism sub-sectors	Space Cooling	Electronics and Other Electrical Uses	High Temp. Heat (>300°C), Process Req.	Intermed. Heat (100-300°C), Cooking	Intermed. Heat (100-300°C), Process Heat	Lighting	Low Temp Heat (<100°C) Process Heat	Low Temp Heat (<100°C) Space Heating	Low Temp Heat (<100°C) Water Heating	Motive Power, Mobile	Motive Power, Stationary	Pumping	Refrigeration	Transport, Air	Transport, Land	Transport, Rail	Transport, Sea	Other	Total	Total
	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(%)
Agriculture	0	0	1	0	1	1	1	0	4	17	2	9	2	0	46	0	0	0	83	0.29
Fishing & Hunting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	5	0.02
Forestry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Mining & Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Food, Beverages & Tobacco	0	6	0	0	704	22	4	0	150	19	99	142	241	0	95	0	0	0	1 481	5.06
Textiles, Clothing & Footwear	0	2	0	0	156	5	24	0	0	1	54	0	0	0	9	0	0	0	250	0.85
Wood & Wood Products	0	0	0	0	2	0	1	0	0	0	2	0	0	0	0	0	0	0	6	0.02
Pulp & Paper Products, Printing & Publishing	0	1	17	0	259	3	7	7	0	1	215	26	0	0	0	0	0	0	537	1.84
Petroleum, Chemical, Plastics & Rubber Prod.	0	3	111	0	38	11	0	0	0	0	49	30	0	0	33	0	0	0	276	0.94
Non-metallic Mineral Products	0	0	21	0	1	0	0	0	0	0	5	0	0	0	0	0	0	0	28	0.09
Basic Metal Products	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	18	23	0.08
Fabricated Metal Products, Machinery & Equip	0	1	55	0	0	3	0	0	0	1	35	0	0	0	65	0	0	0	160	0.55
Other Manufacturing	0	0	2	0	0	1	0	0	0	0	12	0	0	0	3	0	0	0	19	0.06
Electricity, Gas & Water Distribution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Wholesale & Retail Trade	304	88	0	1255	0	355	0	2066	1726	0	33	0	2255	0	2369	0	0	0	10450	35.70
Transport & Storage	0	127	0	0	0	202	0	0	0	0	235	0	0	7699	4747	386	1534	0	14930	51.00
Communication	3	6	0	0	0	2	0	6	0	0	1	0	0	0	20	0	0	0	37	0.13
Finance, Insurance, Real Estate & Bus. Services	13	20	0	0	0	30	0	24	3	0	7	0	0	0	0	0	0	0	98	0.33
Ownership of Owner-Occupied Dwellings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Community, Social & Personal Services	61	64	0	0	34	146	0	271	98	0	61	13	5	0	116	0	0	0	869	2.97
Central Government	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.00
Local Government	1	1	0	0	0	15	0	2	0	0	1	0	0	0	0	0	0	0	19	0.06
Household	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	382	318	211	1255	1196	796	37	2377	1979	39	813	221	2503	7700	7503	386	1539	18	29272	100.00
% of Total Energy End-Use	1.31	1.09	0.72	4.29	4.08	2.72	0.13	8.12	6.76	0.13	2.78	0.76	8.55	26.30	25.63	1.32	5.26	0.06	100.00	

Notes:1. This only includes energy use within New Zealand's borders, which doesn't include overseas travel for international visitors to New Zealand.
2. Energy end-uses by the tourism sub-sectors in heat equivalent terms, refer to Appendix B.

figure is 55 600 TJ. Given the 7.6% increase in tourism numbers over the 1997/98 to 1999 period reported by McDermott & Fairgray Group (2001a), our estimate is very similar to Becken's (2001)[14].

Motels, hotels and guest houses sub-sector

Manipulating data from the EECA (1998) database enabled a more detailed picture of energy use in the motels, hotels and guest houses sub-sector to be obtained.

Delivered energy inputs amounted to 6481 TJ oil equivalents[15], with the largest input being electricity at 4845 TJ oil equivalents (74.8%). Other delivered energy inputs are shown in Table 15.

End-use energy outputs amounted to 6714 TJ oil equivalents. Three end-uses predominated (69% of the total): space heating, refrigeration, and water heating (Table 16). These were followed by land transport and cooking, with other end uses only amounting to 8.2% of the total energy used in the motels, hotels and guest houses sector.

2.4.2 Carbon dioxide accounts

The data compiled in Section 2.4.1 were used to calculate the CO_2 emissions for various activities and sub-sectors in the tourism sector. Delivered energy input data were multiplied by CO_2 emission factors, remembering that the CO_2 emission factor for electricity is the weighted mean of all forms of electricity generation: hydro (zero emissions), coal, natural gas, geothermal and oil.

Table 15. Delivered energy inputs into motels, hotels and guest houses, 1997/98

Delivered energy input	Heat equivalents (TJ)	Oil equivalents (TJ)	Oil equivalents (%)
Coal	18	9	0.14
Diesel	85	85	1.32
Electricity	2,422	4,845	74.76
Fuel Oil	174	174	2.69
Geothermal	128	54	0.83
LPG	90	90	1.39
Natural Gas	921	736	11.36
Petrol	487	487	7.51
Total	4,325	6,481	100.00

Notes: 1. The "motels, hotels and guest houses sector" is NZSIC Major Group 632.
2. In strict terms it is methodologically incorrect to add up the column "heat equivalents".

[14] Our 1997/98 figure of 51 843 TJ can be multiplied by 1.0758 to account for growth in international tourists from 1997/98 to 1999. The resultant figure is 55 770 TJ. This assumes that the weighted mean travel distance remains constant, which will not be the case if there is a shift in the mix of origin countries of international tourists over this period. Nevertheless, the 55,770 TJ figure is very close to Becken's (2001) figure of 55 600 TJ (27 400 TJ × 2, assuming a round trip).

[15] This figure is converted to 4325 TJ (heat units). It is higher than previously published figures for the "accommodation" sector and "hotels", which are broadly comparable to the NZSIC "motels, hotels and guest houses" sector – EECA (1996, 2000) arrived at a figure of 2.21 PJ; Baines & Brander (1991 in EECA 2000) 3.42 PJ; and Becken et al. (2001) 1.74 PJ. The first reason for the lower estimates reported in the literature is that these studies tend to focus on building energy-uses and do not include "off-site" energy uses, such as land transport, which can be significant. The NZSIC classification, which is used in the EECA database, is inclusive of all energy end-uses in the sector, not just building-related end-uses. In this vein, if the land transport figure (487 TJ) is subtracted from our total figure, we arrive at 3753 TJ for 1997/98, which is reasonably consistent with Baines & Brander's figure for 1990 of 3420 TJ. The second reason for these lower estimates in the literature is that they do not always cover the entire NZSIC "motels, hotels and guest houses" sub-sector, e.g. the EECA (1996, 2000) studies only covered hotels, not motels and guest houses and other establishments in the NZSIC sub-sector.

Table 16. Energy end uses in the motels, hotels and guest houses Sector, 1997/98

Energy End-Use	Heat equivalents (TJ)	Oil equivalents (TJ)	Oil equivalents (%)
Electronics and Other Electrical Uses	29	66	0.98
Intermediate Heat (100-300 C), Cooking	154	694	10.34
Lighting	13	210	3.13
Low Temperature Heat (<100 C), Space Heating	1,111	1,827	27.20
Low Temperature Heat (<100 C), Water Heating	651	1,347	20.06
Refrigeration	788	1,440	21.45
Space Cooling	259	273	4.07
Transport, Land	82	857	12.77
Total	3,088	6,715	100.00

Notes: 1. The "motels, hotels and guest houses sector" is NZSIC Major Group 632.
2. In strict terms it is methodologically incorrect to add up the column "heat equivalents"

Overall tourism accounts

The tourism sector was calculated to produce nearly 5 million tonnes of CO_2 in the year 1997/98 (Table 17). This compares with an estimated 28 million tonnes for the entire New Zealand economy. On this basis, therefore, the tourism sector produced CO_2 emissions equivalent to 17.8% of that produced by the entire New Zealand economy.

Aviation fuel accounted for by far the largest component of the CO_2 emissions with a total of 4 million tonnes (85.45%). This was followed by diesel, petrol, electricity, and natural gas. All other sources accounted for less than 52 000 t (2.6%)(Table 17).

International travel

The CO_2 emissions resulting from international tourists travelling to and from New Zealand were by far the largest source of tourism-sector CO_2 emissions. These emissions in total amounted to an estimated 3 561 614 t in 1997/98, which represented 71.2% of the tourism-sector CO_2 emissions. This figure is consistent with Becken's (2001) estimate for one-way trips of 1 900 00 t for 1999 (remembering this present analysis calculates return trips).

Table 17. CO_2 emissions from delivered energy use in the tourism sector, 1997/98

Delivered energy	CO_2 emissions (t)	Total (%)
Aviation Fuel	4,222,695	84.45
Coal	59,272	1.19
Diesel	197,086	3.94
Electricity	152,355	3.05
Fuel Oil	44,110	0.88
Geothermal	2,412	0.05
LPG	17,966	0.36
Natural Gas	100,497	2.01
Petrol	196,522	3.93
Wood	7,060	0.14
Total	4,999,975	100.00

Becken (2001) provides a useful breakdown of the quantities of CO_2 produced by tourists from the main origin countries (Table 18). The leading five countries in terms of CO_2 for one-way trips to New Zealand in 1999 were the United Kingdom (400 kt), United States (230 kt), Australia (210 kt), Japan (180 kt) and Germany (110 kt). These countries collectively accounted for 59.5% of the total CO_2 emissions for one-way trips by international tourists to New Zealand.

Domestic sub-sectors

Further analysis of the accounts revealed the major sources of CO_2 emission in the tourism sector at sub-sector level (Table 19).

Transport and storage accounted for 68% (977 571 t) of all CO_2 emissions excluding international travel. Most of these emissions arose from aviation activities (661 031 t), but diesel (174 567 t) and petrol (90 509 t), which are used almost entirely in land transport, were also significant sources of CO_2.

Table 18. CO_2 emissions from international travel for various overseas origins, 1999 (Source: Becken 2001)

Country of origin	Total air arrivals	One-way distance (km)	CO_2 per visitor (t)	CO_2 per country (kt)
Australia	521 912	3 446	0.42	210
United States	173 182	11 146	1.4	230
United Kingdom	167 202	19 955	2.4	400
Japan	146 953	9 931	1.2	180
Germany	45 603	20 701	2.5	110
Korea	43 386	10 684	1.3	56
Taiwan	40 186	9 579	1.2	46
Singapore	33 873	8 514	1	35
Canada	32 864	15 172	1.8	60
Hong Kong	29 665	9 808	1.2	35
Thailand	23	10 257	1.2	29
China	22 978	13 874	1.7	39
Netherlands	19 394	19 077	2.3	45
Malaysia	17 161	8 755	1.1	18
South Africa	14 832	17 001	2.1	30
Fiji	14 151	2 218	0.27	4
Samoa	12 837	2 928	0.35	5
Switzerland	12 061	18 721	2.3	28
Other Countries	220 177	13 208	1.6	350
Total	1 591 650			1 900

The wholesale and retail sub-sector, which includes accommodation, restaurants and the retail trade activities of the tourism sector, accounted for 312 849 t CO_2 emitted (21.75% of the domestic CO_2 emissions of the tourism sector). This sub-sector is a heavy user of electricity (which resulted in 115 732 t CO_2 emitted) with the use of petrol for transport also being significant (95 200 t CO_2 emitted). All of the other domestic sub-sectors were relatively small emitters of CO_2, collectively accounting for 10.3% (147 941 t).

2.4.3 Water accounts

Water indicators

Analysis of data from the *Eco*Link database enabled estimates of various water indicators for the tourism sector:

1. *Water takes (m^3).* This is water *directly* abstracted by the tourism industry from a lake, river, stream or other natural water source. It does not include reticulated water (which is purchased from the "water distribution" sector), which is technically an *indirect* water supply because it passes through an intervening sector.

Table 19. CO_2 from energy use (t) in tourism sub-sectors within New Zealand, 1997/98

Tourism sub-sectors	Aviation fuel (t)	Coal (t)	Diesel (t)	Electricity (t)	Fuel oil (t)	Geo-thermal (t)	LPG (t)	Natural gas (t)	Petrol (t)	Wood (t)	Total (t)	Total (%)
Agriculture	25	0	2266	318	8	0	0	6	1345	0	3967	0.28
Fishing & Hunting	0	0	192	1	53	0	0	0	0	0	246	0.02
Forestry	0	0	7	0	0	0	0	0	3	0	11	0.00
Mining & Quarrying	0	2	2	1	1	0	0	0	0	0	6	0.00
Food, Beverages & Tobacco	0	29866	3011	7441	1209	0	584	17048	3521	0	62679	4.36
Textiles, Clothing & Footwear	0	3320	1056	1301	520	0	42	4774	316	0	11330	0.79
Wood & Wood Products	0	25	4	43	12	0	1	47	0	291	423	0.03
Pulp & Paper Prod., Printing & Pub.	0	1254	64	3996	654	894	50	3862	5	5731	16509	1.15
Petro., Chem., Plast. & Rubb. Prod.	0	620	1525	2234	287	0	65	2907	98	0	7735	0.54
Non-metallic Mineral Products	0	1630	47	97	8	0	37	258	0	0	2077	0.14
Basic Metal Products	0	669	3	304	27	0	3	72	0	0	1078	0.07
Fabric. Metal Prod., Mach. & Equip.	0	262	2540	794	159	0	186	1798	336	0	6074	0.42
Other Manufacturing	0	0	17	226	1	0	5	56	131	0	436	0.03
Electricity, Gas & Water Distrib.	0	0	0	0	0	0	0	0	0	0	0	0.00
Construction	0	0	12	1	0	0	0	0	4	0	18	0.00
Wholesale & Retail Trade	0	7123	10794	115732	13775	1518	6 238	61431	95200	1038	312849	21.75
Transport & Storage	661031	550	174567	10194	26901	0	10 751	3068	90509	0	977571	67.96
Communication	0	0	293	295	0	0	4	28	538	0	1158	0.08
Fin., Insur., Real Est. & Bus. Srvcs	0	75	0	1 254	216	0	0	591	0	0	2136	0.15
Ownership of Owner Occ. Dwell.	0	0	0	0	0	0	0	0	0	0	0	0.00
Community, Social & Pers. Srvcs	0	13840	670	7830	261	0	0	4530	4508	0	31640	2.20
Central Government	24	6	17	4	12	0	0	4	7	0	74	0.01
Local Government	0	32	0	289	6	0	0	18	0	0	345	0.02
Household	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	661081	59272	197086	152355	44110	2412	17966	100497	196522	7060	1438361	100.00
Total (%)	45.96	4.12	13.70	10.59	3.07	0.17	1.25	6.99	13.66	0.49	100.00	

Note: The emission factors used in these calculations are: aviation fuel 68.7 t/TJ, black liquor 133 t/TJ, coal 91.6 t/TJ, diesel 68.7 t/TJ, electricity 32.99 t/TJ, fuel oil 73.7 t/TJ, LPG 60.4 t/TJ, natural gas 52.9 t/TJ, petrol 66.6 t/TJ and 133.0 wood t/TJ.

2. *Water discharges (m³).* This is water directly discharged into the biophysical environment, by the tourism industry.
3. *Biological oxygen demand (BOD-kg).* This is the amount of biological oxygen demand in the water discharged into the biophysical environment. It is a measure of the potential for wastes in water to cause low dissolved levels of oxygen in waterways, measured at 20°C over 5 days.
4. *Nitrate (NO_3-kg).* This is the amount of nitrate in the water discharged into the biophysical environment. Nitrogen can be a limiting factor in natural ecosystems that receive these nitrate discharges. Excessive amounts of nitrate can therefore lead to undesirable biological growth, ranging from algal growth to that of larger plants.
5. *Total phosphorus (TP-kg).* This is the total amount of phosphorus in the water discharges into the biophysical environment. Phosphorus can be a limiting factor in natural ecosystems that receive such discharges. Excessive amounts of phosphorus can therefore lead to undesirable biological growth, ranging from algal growth to that of large plants.

The water indicators (1) to (5) only relate to discharges *directly* into the biophysical environment by the tourism sector. Discharges from the sewage and urban drainage sector (NZSIC 92012) (Part of the community, social and personal services sector) are noot included, as these are *indirect* discharges.

Overall tourism accounts

The data calculated for *Eco*Link allowed reasonably accurate accounts to be constructed for the tourism sector. However, it was not possible to reliably disaggregate the tourism water accounts into: (1) various tourism activities (accommodation, retail trade, travel); (2) various end-uses (e.g. for laundry, cleaning, restaurants, irrigation, swimming pools) – as it is for example for the energy accounts; or (3) various types of tourist (e.g. international versus domestic, or backpacker versus business traveller versus package tour tourist).

Caution also needs to be displayed in interpreting these accounts, as they relate only to direct water takes and discharges. Most of the water used by the tourism sector in cleaning, laundry, bathroom and other "direct uses" is reticulated water from the water distribution sector (20 534 724 m³) with direct takes being much smaller (8 637 460 m³). Technically, reticulated water is an "indirect" use because it is sold to the tourism sector through the water distribution sector. To a much lesser extent the same issue arises with water discharges, with 13 430 537 m³ being indirectly released to the environment through the community, social and personal services sector.

The estimated total amount of water takes (m³) and water discharges (m³; BOD, nitrate, phosphorus) produced by the tourism sector are summarised in Table 20 and its footnotes. The accounts indicate that in total there were 29 172 204 m³ of water inputs into the tourism sector (direct water takes and reticulated water), and 65 566 159 m³ of water outputs (direct water discharges and treated effluent). These figures are apparently inconsistent with the mass balance principle, where the inputs and outputs of water should be equal. Regional councils tend to monitor outputs into the environment more closely because of their environmental effects; whereas there is considerable under-monitoring and under-reporting of water inputs – this has resulted in discrepancy in data obtained from the *Eco*Link database, which was used as the source of base data in this analysis.

Overall, the level of direct water takes and water discharges are very small compared with the total loading in the environment by the entire New Zealand economy – tourism water takes (m³) account for only 0.4% of the New Zealand total, water discharges only 1.6%, BOD only 3.4%, nitrate 2.7% and phosphorus (3.1%) (Table 20). However, the analysis pursued in Section 3 of this report clearly demonstrates that the indirect pressures placed on the environment by the tourism sector by water discharges are usually of at least equal significance to the direct pressures.

The direct intensities (physical unit/$000 GDP) indicated even more markedly that direct impacts of the tourism sector relative to GDP output were less than the economy-wide average for New Zealand (Table 21). There was little difference in nutrient levels (BOD, nitrate and phosphorus) between tourism sector and New Zealand figures, in the sense they are both small and of the same order of magnitude. However, for *water takes* (tourism sector 1.82 m³/$000; New Zealand 20.49 m³/$000) and *water discharges* (tourism sector 10.97 m³/$000; New Zealand 32.53 m³/$000) the differences were significant indeed. These differences remained significant even with reticulated water added to the water takes intensity and waste effluent discharged through the community, social and personal services sector added to the water discharges intensity.

It is difficult to compare these water take and discharge figures with literature values. Gössling (2001) investigated water usage in 28 hotels and guest houses in Zanzibar and found a weighted mean figure of 685 litres/day/visitor, with a range

Table 20. Water accounts for the New Zealand economy and tourism sector, 1997/98

Water variable	New Zealand (000's)	Tourism sector (000's)	Tourism sector (% of NZ)
Direct Water Takes (m^3)	2,012,737	8,637	0.43
Direct Discharges (m^3)	3,195,147	52,136	1.63
BOD_5 (kg) in Direct Water Discharges	29,867	1,027	3.44
Nitrate (kg) in Direct Water Discharges	939	25	2.69
Phosphorus (kg) in Direct Water Discharges	5,848	179	3.06

Notes: 1. In addition to direct water takes, there is an estimated 20 534 724 m^3 of reticulated water inputs to the tourism sector. "Direct water takes" is water directly taken from a natural water source (e.g. river) by the tourism sector.
2. In addition to direct discharges, there is an estimated 13 430 537 m^3 of treated effluent from the tourism sector, which is disposed of by sewerage treatment works in the community, social and personal services sector.

from 100 to 2000 litres/day/visitor. APEC (1996) quote a figure of 378.5 litres/visitor-day for water and sewer uses in intensive accommodation ("intensive" accommodation probably equates with Western-style hotel developments). The comparable figure derived from Table 20 data is 373 litres/visitor-day for the New Zealand tourism sector (water takes plus water reticulated to the tourism sector from the water distribution sector). This is close to the APEC (1996) figure but only half the Gössling (2001) figure[16]. However, it must be remembered that in Gössling's (2001) Zanzibar study, 50% of the water was used to irrigate hotel gardens, which is unlikely to be the case in the New Zealand tourism sector.

2.4.4 Land accounts

Analysis of data derived from Quotable Value New Zealand and other sources enabled us to obtain accurate measurements of the land directly used by the New Zealand tourism sector and its sub-sectors.

Overall tourism accounts

The tourism sector was calculated to directly use 65 564 ha of land (i.e. land directly occupied by tourism businesses (Table 22). This represents only 0.4% of land occupied by the entire New Zealand economy.

Arguably, however, the "tourism sector" occupies a far larger amount of land than is indicated by the input-output accounts, if one takes into account national parks, forest parks, land reserves and marine reserves, which fall outside the input-output accounts. National parks cover 2 914 988 ha, forest parks 3 020 000 ha, land reserves 614 500 ha and marine reserves 756 003 ha (Patterson & Cole 1999). Collectively this amounts to 7 307 491 ha. It could be reasonably argued that a large proportion of this land could be allocated to the "tourism sector", as most of the visitors to these parks and reserves are

Table 21. Direct water account intensities: tourism sector versus entire economy, 1997/98

Direct intensities	Tourism sector	New Zealand
Total Water Takes (m^3/\$000 GDP)	1.8168	20.4865
Total Discharges (m^3/\$000 GDP)	10.9662	32.5216
Biochemical Oxygen Demand (BOD_5 - kg/\$000 GDP)	0.2161	0.3040
Nitrate (NO_3 - kg/\$000 GDP)	0.0053	0.0096
Total Phosphorus (TP - kg/\$000 GDP)	0.0377	0.0595

[16] The Ministry for the Environment (1997) report the water usage (litres/person) across a number of cities and districts: Auckland (380), Taupo (610), Gisborne (180), Opotiki (500), Kapiti Coast (670), Wellington (550), Nelson (190), Renwick (760), Greymouth – metered (400), Greymouth – unmetered (600), Christchurch (450), Dunedin (500) and Invercargill (360). The figure of 373 litres per tourist seems to be broadly consistent with the above data.

"tourists" under the World Tourism Organisation's (1999, 2000) definition. The authors accept that the allocation of national park land to tourism is arbitrary and future research would need to define an appropriate breakdown of conservation land into different categories or uses (including opportunity cost of biodiversity).

Domestic sub-sector accounts

Although the agriculture sub-sector of tourism contributed only 0.3% of the GDP output of tourism, it covered 59.4% (38 964 ha) of land (Table 22). The agricultural component of tourism covers such activities as farm stays, farm visits and eco-tourism ventures on farmland.

The second largest sub-sector was community, social and personal services occupying 14 164 ha (21.6%). This sector includes schools, hospitals, camping grounds, municipal parks and so forth.

The transport sub-sector, occupied the third largest amount of land at 8586 ha (13.0%). This mainly includes the roads allocated to the tourism sector according to its proportional usage of roads.

The wholesale and retail trade sub-sector, which includes hotels, motels, other accommodation, restaurants, cafes and the shops used by tourists, surprisingly only covered 1535 ha (2.3%) and was the fourth largest sub-sector. Although this sub-sector produced 38.3% of the GDP produced by the tourism sector, it covered a comparatively small area as the hotels and shops catering for tourists tend to be multi-storeyed.

Table 22. Direct land use by the tourism sector, 1997/98

Tourism sector sub-sectors	Land (ha)	Land (%)	GDP (%)
Agriculture	38 964	59.43	0.29
Fishing and Hunting	4	0.01	0.00
Forestry	186	0.28	0.00
Mining and Quarrying	1	0.00	0.00
Food, Beverages and Tobacco	443	0.68	2.30
Textiles, Clothing and Footwear	66	0.10	0.98
Wood and Wood Products	3	0.00	0.02
Pulp and Paper Products, Printing and Publishing	21	0.03	0.62
Petroleum, Chemical, Plastics and Rubber Products	49	0.07	0.88
Non-metallic Mineral Products	9	0.01	0.04
Basic Metal Products	0	0.00	0.01
Fabricated Metal Products, Machinery and Equipment	67	0.10	1.44
Other Manufacturing	7	0.01	0.08
Electricity, Gas	0	0.00	0.00
Water Distribution	0	0.00	0.00
Construction	0	0.00	0.00
Wholesale and Retail Trade	1 535	2.34	38.31
Transport and Storage	8 586	13.10	36.59
Communication	17	0.03	0.86
Finance, Insurance, Real Estate and Business Services	14	0.02	3.42
Ownership of Owner Occupied Dwellings	0	0.00	3.51
Community, Social and Personal Services	14 164	21.60	10.41
Central Government	28	0.04	0.02
Local Government	1 399	2.13	0.21
Total	65 564	100.00	100.00

Note: This does not include land in national parks, forest parks and other statutory land reserves.

2.5 Overall environmental accounts of the tourism sector

2.5.1 Direct environmental pressures of the tourism sector

The environmental pressures (pollutants, resource use and depletion) exerted by the tourism sector can be summarised by collating the data presented in Section 2.3 (Table 23). The tourism sector's environmental performance can then be compared against other sectors in the New Zealand economy.

Resource use

In terms of domestic energy consumption (i.e. that consumed within New Zealand borders), the tourism sector ranked seventh out of 25 sectors, with 25 533 TJ (oil equivalents). Those sectors with higher energy use were basic metals transport and storage, wholesale and retail trade, food, beverage and tobacco, pulp and paper products, and agriculture (range 28 086–54 231 TJ; Table 23).

When international travel was included, the figure increased to 79 376 TJ (oil equivalents), which then ranked the tourism sector as the largest energy consumer of any sector in the New Zealand economy. This ranking is arguably debatable, however, as other sectors could also have an "overseas" energy component, e.g. the food, beverages and tobacco sector could also include the energy it takes to export products overseas, which would be considerable. If these other sectors had an "overseas" energy component included, their total energy consumption would increase and, therefore, tourism might no longer be ranked first.

In terms of water consumption (i.e. direct water takes only; Table 23), the tourism sector ranked ninth (worst) of 25 sectors, at 8 637 480 m^3, behind water distribution; mining and quarrying; electricity and gas; agriculture; food, beverages and tobacco; pulp and paper products; community, social and personal services; and basic metals products. Six of these sectors had direct water takes greater than 199 million cubic metres, which are orders of magnitude greater than the tourism sector. In addition the tourism sector "indirectly" consumed more than 20 million cubic metres of reticulated water (refer to Section 2.4.3).

In terms of land use, the tourism sector ranked seventh at 65 564 ha, behind agriculture, forestry, community, social and personal services, central government, water distribution, and local government (Table 23). As previously mentioned if national parks, forest parks, land reserves and marine reserves were completely included as part of the tourism sector (which they are not in the above figures), the tourism sector would rank second behind the agriculture sector in terms of land use (this is a maximum figure for tourism's land use).

Pollutants and emissions

In terms of water discharges, the tourism sector ranked eighth highest out of 25 sectors, with 52 135 622 m^3. Those sectors with higher discharges of water were mining and quarrying; community, social and personal services; food, beverages and tobacco; petroleum, chemical, plastics and rubber products; electricity and gas; and agriculture (Table 23). It must be recognised that the 52 135 622 m^3 included only *direct* discharges of water into the environment by the tourism sector, most of which came from the food and beverages sub-sector. An additional 13 million cubic metres of tourism-sector effluent was discharged indirectly through the community, social and personal services sector (refer to Section 2.4.3).

In terms of BOD, nitrate and phosphorus in water discharges, the tourism industry ranked third highest (Table 23). The sectors that ranked higher than tourism were food, beverages and tobacco and community, social and personal services (which include sewerage treatment plants). The reason the tourism sector ranked so highly is that there was a significant tourism ratio of 0.0261 for the food, beverages and tobacco sector, which had very high levels of pollutants in its water discharge.

In terms of CO_2 emissions, the tourism sector ranked seventh highest at 1 438 361 t. Those sectors with higher CO_2 emissions included transport and storage; pulp and paper products; basic metal products; food, beverages and tobacco; wholesale and retail trade; and agriculture (Table 23). With international travel included, the tourism-sector CO_2 figure would increase to 4 999 925 t, which would then rank the tourism sector the highest emitter of CO_2 of all the sectors in the New Zealand economy. However, as mentioned above, an "overseas" CO_2 component could be included in other sectors (particularly the food, beverage and tobacco sector) also, which might relegate tourism from the highest ranking.

Overall

In terms of direct environmental pressures the tourism sector ranked between seventh and ninth highest for the resource use indicators (energy, water, land) and from third to eighth for the pollutants and emissions indicators (water discharge,

Table 23. Environmental accounts for the tourism and other sectors in the New Zealand economy, 1997/98

Sector	Energy use (TJ - oil equivalents)	Water takes (m^3)	Land use (ha)	Water discharges (m^3)	Nitrate in water discharges (kg)	Phosphorus in water discharges (kg)	BOD in water discharges (kg)	CO_2 emissions (t)
Agriculture	28,086	240,970,117	15,068,073	85,203,670	8,018	1,335,687	3,783,927	1,534,151
Fishing & Hunting	5,595	2,872,631	5,494	1,235,198	0	0	0	384,960
Forestry	1,422	576,843	1,704,479	208,542	0	0	0	96,800
Mining & Quarrying	5,764	416,436,992	60,281	1,357,380,864	0	403	2,380	311,536
Food, Beverages & Tobacco	37,417	199,044,082	16,543	196,659,418	838,088	168,067	840,626	2,342,381
Textiles, Clothing and Footwear	2,879	3,565,571	966	491,407	0	0	0	164,897
Wood & Wood Products	6,257	2,666,258	4,362	3,996,498	0	139	855	640,473
Pulp & Paper Prod., Printing & Publishing	36,629	45,692,075	1,582	138,927,048	0	0	0	3,248,788
Petrol., Chemical, Plastics & Rubber Products	10,794	1,972,334	2,480	194,373,874	0	0	0	394,648
Non-metallic Mineral Products	6,458	5,230,862	2,817	2,553,651	0	0	0	655,902
Basic Metal Products	54,231	26,553,651	495	37,596,847	0	41	265	2,459,735
Fabricated Metal Products,Machinery & Equip.	6,586	373,113	3,541	6,791	0	0	0	322,531
Other Manufacturing	615	72,631	247	0	0	0	0	15,896
Electricity, Gas	0	285,070,228	27,167	131,956,691	0	59	296	0
Water Distribution	1,139	540,174,075	102,545	13,818,857	535	32,529	189,129	18,791
Construction	8,491	0	2,850	0	0	0	0	539,811
Wholesale & Retail Trade	40,180	4,086,209	10,726	2,524,995	0	292	1,633	1,849,491
Transport & Storage	43,626	44,282	16,146	141,412	15	552	3,223	3,396,631
Communication	3,083	0	1,750	0	0	0	0	116,154
Finance, Insurance, Real Estate & Bus. Services	7,981	0	1,298	0	0	0	0	193,010
Ownership of Owner-Occupied Dwellings	0	0	0	0	0	0	0	0
Community, Social & Personal Services	16,891	27,264,365	340,427	972,430,815	66,813	4,105,675	23,869,952	760,453
Central Government	3,253	805,024	102,848	1,574,704	95	6,753	39,320	276,639
Local Government	1,002	31,602	77,636	287	0	0	0	19,150
Tourism[1]	[2]25,533 (7th)	8,637,480 (9th)	65,564 (7th)	52,135,622 (8th)	25,234 (3rd)	179,112 (3rd)	1,027,387 (3rd)	[3]1,438,361 (7th)
Household Consumption	134,214	1,734,329	156,070	1,421,354	76	5,942	34,671	6,011,065
Total	490,125	1,813,874,754	17,776,388	3,194,638,547	938,874	5,835,250	29,793,663	27,192,253

Notes:[1] In brackets is tourism's ranking in terms of environmental impact. 1 = highest impact, 25= lowest impact. Households are not included in this ranking.
[2] If international travel is included this figure increases to 79 376 TJ (oil equivalents) and the tourism sector is ranked first.
[3] If international travel is included this figure increases to 4 999 975 tonnes (CO_2) and the tourism sector is ranked first.

Table 24. Resource use and pollutants per unit of GDP, for the tourism sector and other sectors in the New Zealand economy, 1997/98

Sector	Energy (TJ - oil equiv / $ mil)	Total water takes (m³ / $ mil)	Land (ha / $ mil)	Water discharges (m³ / $ mil)	Nitrate (kg / $ mil)	Phosphorus (kg / $ mil)	BOD_5 (kg / $ mil)	CO_2 (t / $ mil)
Agriculture	5.28	45 285	2 831.70	16 012	1.51	251.01	711.10	288.31
Fishing and Hunting	20.35	10 446	19.98	4 492	0.00	0.00	0.00	1,399.85
Forestry	1.06	429	1 266.83	155	0.00	0.00	0.00	71.94
Mining and Quarrying	8.90	642 918	93.07	2095 598	0.00	0.62	3.67	480.97
Food, Beverages and Tobacco	9.14	48 615	4.04	48 033	204.70	41.05	205.32	572.11
Textiles, Clothing and Footwear	4.23	5 244	1.42	723	0.00	0.00	0.00	242.50
Wood and Wood Products	5.02	2 140	3.50	3,208	0.00	0.11	0.69	514.13
Pulp and Paper Products, Printing and Publishing	16.59	20 696	0.72	62 927	0.00	0.00	0.00	1,471.54
Petroleum, Chemical, Plastics and Rubber Products	5.06	924	1.16	91 048	0.00	0.00	0.00	184.86
Non-metallic Mineral Products	10.63	8 609	4.64	4 203	0.00	0.00	0.00	1,079.52
Basic Metal Products	93.15	45 607	0.85	64 575	0.00	0.07	0.46	4,224.74
Fabricated Metal Products, Machinery and Equipment	1.81	103	0.97	2	0.00	0.00	0.00	88.70
Other Manufacturing	4.34	513	1.75	0	0.00	0.00	0.00	112.31
Electricity, Gas	0.00	131 189	12.50	60 726	0.00	0.03	0.14	0.00
Water Distribution	9.29	4 406 485	836.52	112 728	4.36	265.36	1 542.82	153.29
Construction	2.27	0	0.76	0	0.00	0.00	0.00	144.40
Wholesale and Retail Trade	3.16	321	0.84	198	0.00	0.02	0.13	145.33
Transport and Storage	13.34	14	4.94	43	0.00	0.17	0.99	1,038.41
Communication	0.75	0	0.43	0	0.00	0.00	0.00	28.33
Finance, Insurance, Real Estate and Business Services	0.54	0	0.09	0	0.00	0.00	0.00	13.15
Ownership of Owner-Occupied Dwellings	0.00	0	0.00	0	0.00	0.00	0.00	0.00
Community, Social and Personal Services	1.42	2 292	28.62	81 753	5.62	345.17	2 006.76	63.93
Central Government	1.09	270	34.51	528	0.03	2.27	13.19	92.83
Local Government	1.77	56	137.05	1	0.00	0.00	0.00	33.80
Tourism	5.79	1 817	13.79	10 966	5.31	37.67	216.10	302.54
Household Consumption	18.58	240	21.61	197	0.01	0.82	4.80	832.17
Weighted Mean	4.98	18 423	180.55	32 447	9.54	59.27	302.61	276.18

BOD, nitrate, phosphorus, CO_2). Given that there are 25 sectors in the New Zealand economy, in terms of direct environmental pressures the tourism sector was always ranked in the top half (i.e. greater than or equal to 12th) and for three indicators ranked third highest.

2.5.2 Direct environmental pressures per unit of GDP

Although quantifying the direct pressures exerted on the environment by the tourism sector is useful (refer to Section 2.5.1), such data need to be assessed alongside data on the economic benefits of tourism. One way of doing this is to develop ratios that compare the environmental costs (resource depletion; pollution) with the economic benefits as measured by GDP for tourism and other sectors in the economy (Table 24).

Resource use

For energy, the tourism sector ranked ninth highest out of 25 sectors, at 5.79 TJ (oil equivalents)/ $million GDP. This was slightly higher than the economy average of 4.90 TJ (oil equivalents)/ $million GDP (Table 24).

For total water takes the tourism sector ranked 13th, at 1816 m^3/$million GDP. This was considerably lower than the economy average of 18 423 m^3/$million GDP (Table 4).

For land use, the tourism sector ranked ninth, at 13.79 ha/$million GDP. This was considerably lower than the economy average of 180.55 ha/$million GDP (Table 24).

Pollutants and emissions

For total water discharges the tourism sector ranked 10th, at 10 966 m^3/$million GDP. This was only about one-third of the economy average of 32 447 m^3/$million GDP (Table 24).

For nitrate, BOD, and phosphorus in water discharges, the tourism sector ranked third, fourth and fifth respectively in terms of pollutants/$million GDP. However, in all cases the pollutants/$million GDP ratio was below the economy-wide average, due to the very high values of those sectors that ranked ahead of tourism.

or CO_2 emissions, at 302.5 t/$million GDP, the tourism sector ranked ninth. This was less than half the total for household consumption (832 t/ $million GDP) but more than the economy-wide average of 276 t/$million GDP (Table 24).

Overall

In comparing the direct environmental pressures in relation to sector GDP, the tourism sector's performance was seen in a slightly more favourable light (i.e. compared with data presented in Section 2.5.2 that only focused on the environmental pressures of each sector). However, for all but one indicator (water takes)[17] it still ranked in the bottom half of sectors in terms of environmental pressures per $million GDP. For energy (17th position out of 25 sectors), land use (17th position), water discharges (18th position) the tourism sector's performance was worse than average and for nitrate, BOD, and phosphorus (21st, 22nd and 23rd positions) performance was even poorer, being in the bottom quartile.

2.5.3 Direct environmental pressures per tourist trip

The direct environmental pressures on a per trip basis, exerted by international and domestic tourists and all tourists together, are summarised in Tables 25 and 26.

International tourists, although being fewer in number, had significantly more impact per trip than domestic tourists. For example, the water takes for international tourists were 1518 litres/trip compared with domestic tourists at 403 litres/trip. The main reason for this difference is that international tourists had longer trips (19.6 days per trip, according to McDermott Fairgray Group) compared with domestic tourists (3.29 days per trip).

The most significant difference between international tourists and domestic tourists, however, was for energy consumption and CO_2 emissions. For CO_2 emissions international tourists on average had 2637 kg of direct emissions per trip, compared with only 67 kg per domestic trip. The reason for this difference was the large amount of CO_2 produced (and energy used) in travelling to and from New Zealand by international tourists.

[17] The reason for this apparently good performance of the tourism sector for water takes is that this indicator does not include reticulated water, which is considerable.

Table 25. Direct land use by the tourism sector, 1997/98

Indicator	Units per trip	Direct pressures
Energy (Within New Zealand)	MJ (oil equvalients) / trip	4 840.00
Energy (Outside New Zealand)	MJ (oil equvalients) / trip	34 700.00
Energy (Total)	MJ (oil equvalients) / trip	39 540.00
Total Water Takes[1]	litres/trip	1 518.00
BOD_5 (Point Source Only)[2]	grams/trip	180.62
Nitrate (Point Source Only)[2]	grams/trip	4.44
Total Phosphorus (Point Source Only)[2]	grams/trip	31.49
Total Water Discharges[2]	litres/trip	9 166.00
Land	m^2/trip	115.00
Carbon Dioxide (Within New Zealand)	kg/trip	253.00
Carbon Dioxide (Outside New Zealand)	kg/trip	2 384.00
Carbon Dioxide (Total)	kg/trip	2 637.00

Notes: [1] This only includes direct water takes from natural water bodies. It doesn't include reticulated water inputs into the tourism sector.
[2] This only includes direct discharges into the environment. It doesn't include tourism-sector effluent treated by sewerage treatment plants and then disposed of into the environment.

Table 26. Direct environmental pressures, per trip, for domestic tourists, 1997/98

Indicator	Units per trip	Direct pressures
Energy (Within New Zealand)	MJ (oil equvalients) / trip	1 283.00
Energy (Outside New Zealand)	MJ (oil equvalients) / trip	0.00
Energy (Total)	MJ (oil equvalients) / trip	1 283.00
Total Water Takes[1]	litres/trip	403.00
BOD_5 (Point Source Only)[2]	grams/trip	47.89
Nitrate (Point Source Only)[2]	grams/trip	1.18
Total Phosphorus (Point Source Only)[2]	grams/trip	8.35
Total Water Discharges[2]	litres/trip	2 430.00
Land	m^2/trip	31.00
Carbon Dioxide (Within New Zealand)	kg/trip	67.00
Carbon Dioxide (Outside New Zealand)	kg/trip	0.00
Carbon Dioxide (Total)	kg/trip	67.00

Notes: Refer to Table 25

3. Lifecycle Assessment Of The Environmental Impacts Of New Zealand Tourism

3.1 Rationale for the assessment of indirect impacts

The assessment of environmental impacts tends to focus on direct and local area effects. This is certainly the case for environmental impact research in the New Zealand tourism sector as summarised by Table 1. Most, if not all, of the research cited in Table 1 examines the direct on-site effects of tourism activity, whether it be noise or impacts on biodiversity. The same can be said of the international research on the environmental impacts of tourism activity. On one level, the reason for this focus on direct impacts is justified given the fact that the tourist operator or management agency is seeking to protect the integrity and sustainability of their tourism attraction. Indeed several tools and approaches to environmental impact assessment in tourism have been specifically designed with this end-objective in mind, e.g. the Limits to Acceptable Change (LAC) approach defined by Hall & Lew (1998) as "a planning procedure designed to identify preferred resource and social conditions in a given recreation area… and to achieve and protect these conditions". The emphasis on carrying capacity in tourism research also ultimately seeks to protect or preserve the natural tourism asset or host environment. What happens "off-site" seems to be of little relevance.

In the environmental impact assessment literature there has been a movement towards the consideration of cumulative effects starting with early work of researchers such as Clark (1986). Cumulative effects assessment adopts a more "complex systems perspective" on environmental impact assessment recognising that there are many non-linear and synergistic flow-on effects across both space and time resulting from the initial impact. Cumulative effects may be individually minor, but collectively significant. There is now a considerable overseas literature on the assessment of cumulative effects (Contant & Wiggins 1991; Spaling 1994; Carter 1999), along with some New Zealand research (Cocklin 1989; Dixon & Montz 1995).

The infiltration of cumulative effects assessment into the tourism research literature seems to have been slow, with only the occasional mention in sustainable tourism texts (e.g. Hall & Lew 1998). Few authors seem to appreciate the importance of cumulative effects, and particularly off-site impacts. Gössling (2000) is one of the very few who highlights such effects in relation to the effects of tourism air travel on global warming. Font & Buckley (2001) implicitly recognise the importance of indirect effects in their advocacy of lifecycle assessment (LCA) as a method for eco-labelling of tourism products. Hoyer (2000) also recognises the importance of "off-site" impacts by including transport considerations in his analysis of sustainable tourism, while he criticises the WTO for excluding such impacts from the core indicators of sustainable tourism.

A key focus of our current study is to broaden the emphasis of the assessment of environmental impacts of New Zealand tourism, to include *indirect effects* and *future effects*[18]. In the tourism sector there are many indirect (flow-on) effects, e.g. if a tourist purchases a hamburger, the hamburger bun and its contents need to be supplied by food manufacturers, and the raw materials required by food manufacturers will then be supplied by farmers, market gardeners and so forth. Right along this production chain will be environmental impacts and pressures such as CO_2 emissions. Similarly, there are all sorts of indirect pressures resulting from tourism transport if all of the inputs into transport are tracked. Lifecycle assessment is one popular tool for assessing the indirect effects through the lifecycle of a product. Lifecycle assessment procedures have been formalised by the Society of Environmental Chemistry and Toxicology (1993). Accordingly, the four formal steps of lifecycle assessment are: (1) *Goal and scope definition;* (2) *Inventory analysis,* to quantify the resource inputs and pollutants outputs at each step in the lifecycle; (3) *Impact assessment* (this step aims at quantifying the impacts, often using CO_2 equivalents, acidification equivalents or some other such equivalents to summarise the data); and (4) *Interpretation* of results and recommendations to reduce the environmental impact of the product.

Input-output analysis is one way of operationalising a lifecycle assessment. Input-output analysis has the key advantage of directly using data on production chains in the economy that are routinely collected by statistical agencies. The use of such data drastically reduces the need to collect base data for the lifecycle assessment. Input-output analysis involves calculating "ecological multipliers" from input-output matrices. The ecological multiplier measures the total embodied resource it requires to produce a commodity. For example, the total energy it takes to produce $1 worth of dairy products can be calculated from an input-output matrix. This includes the total energy in the *whole production chain,* tracing flows back to the dairy farm or, for example if packaging is required, the raw resources required to make the packaging. In other words, the total energy inputs across the whole lifecycle are mathematically determined by input-output analysis. This analysis can be repeated for any resource (e.g. land, water, minerals, biomass) or for that matter any pollutant (e.g. CO_2, BOD, sulphates, nitrates)[19].

[18] It is acknowledged that there are cumulative effects other than the indirect and future impacts being quantified in our current study, such as, for example, the ecological effects due to loss of habitat. Understanding and tracking such effects form an important part of a future research agenda for assessming the environmental impacts of tourism activity.

[19] The ecological footprint method developed and popularised by Wackernagel & Rees (1996), is also a useful way of measuring the indirect offsite environmental impacts of tourism (or any other activity). Bicknell *et al*. (1998) have demonstrated how the ecological footprint of economic sectors (like tourism) can be calculated, using input-output analysis, similar to that used in this report. The ecological footprint involves calculating the direct and indirect land requirements of a sector.

3.2 Methodology

The analytical method focuses on calculating "ecological multipliers" for the tourism sector. An ecological multiplier is calculated for each resource (water, land, energy) and for each pollutant (CO_2, BOD, nitrates and so forth). The ecological multiplier measures the total amount of "embodied resource" or "embodied pollutants" per unit of sector output ($). The embodied "resource or pollutant" is the sum of the direct and indirect resource inputs or emissions.

There are various mathematical methods for calculating these ecological multipliers from input-output matrices. All of these methods closely resemble each other and use matrix algebra (Hite & Laurent 1971; Wright 1975; Carter et al. 1981; Costanza & Neill 1981).

3.2.1 Mathematics of the calculation of ecological multipliers

The method used in this report essentially follows that of Costanza & Neill (1981). It involves constructing input-output matrices, or "use" and "make" matrices. This approach has the advantage of allowing for multiple outputs per sector, which is not possible in the Hite & Laurent (1971), Wright (1975) and Carter et al. (1981) methods.

Construction of the inputs and outputs matrix

The first step is to set up the inputs **V** and outputs **U** matrices. The outputs matrix **U** describes the commodity outputs ($) of each sector in the economy:

$$\mathbf{U} = \begin{bmatrix} u_{11} & u_{12} & u_{13} & . & . & . & u_{1n} \\ u_{21} & u_{22} & u_{23} & . & . & . & u_{2n} \\ . & & & & & & . \\ . & & & & & & . \\ . & & & & & & . \\ . & & & & & & . \\ u_{m1} & u_{m2} & u_{m3} & . & . & . & u_{mn} \end{bmatrix}$$

where: m = number of commodities
n = number of sectors.

Usually (e.g. in the standard Leontief formulation) there is one characteristic commodity per sector, hence, the diagonal elements of the matrix **U** are positive numbers and the non-diagonal elements of **U** are zeros.

The inputs matrix **V** is defined as:

$$\mathbf{V} = \begin{bmatrix} v_{11} & v_{12} & v_{13} & . & . & . & v_{1n} \\ v_{21} & v_{22} & v_{23} & . & . & . & v_{2n} \\ . & & & & & & . \\ . & & & & & & . \\ . & & & & & & . \\ . & & & & & & . \\ v_{m1} & v_{m2} & v_{m3} & . & . & . & v_{mn} \end{bmatrix}$$

where: m = number of commodities
n = number of sectors.

This is usually a dense matrix with few, if any, zero elements. That is, each sector has m number of commodity inputs.

Usually the number of commodities equals the number of sector (i.e. $m = n$). Hence, the matrix is square, which facilitates standard matrix algebra calculations. If the matrix is rectangular (i.e. $m \neq n$), the subsequent analysis can be undertaken using generalised or pseudo matrices.

Construction of an exogenous resource inputs/pollutant output vector

A row vector $\boldsymbol{\beta}$ measures the input of a resource (or output of a pollutant) across n sectors in the economy

$$\boldsymbol{\beta} = [\beta_1 \quad \beta_2 \quad \beta_3 \quad \dots \quad \beta_n]$$

That is, for each resource or pollutant under consideration it is necessary to construct a row vector $\boldsymbol{\beta}$.

An alternative approach is not to construct separate row vectors for each resource or pollutant, but combine them into a matrix $\boldsymbol{\beta}$:

$$\boldsymbol{\alpha} = \left[\begin{array}{cccc} \beta_{11} & \beta_{12} & \dots & \beta_{1n} \\ \beta_{21} & \beta_{22} & \dots & \beta_{2n} \\ \vdots & & & \vdots \\ \beta_{p1} & \beta_{p2} & \dots & \beta_{pn} \\ \hdashline \beta_{11} & \beta_{12} & \dots & \beta_{1n} \\ \beta_{21} & \beta_{22} & \dots & \beta_{2n} \\ \vdots & & & \vdots \\ \beta_{q1} & \beta_{q2} & \dots & \beta_{qn} \end{array}\right] \begin{array}{l} \longleftarrow \text{resource 1} \\ \\ \\ \longleftarrow \text{resource p} \\ \longleftarrow \text{pollutant 1} \\ \\ \\ \longleftarrow \text{pollutant q} \end{array}$$

In general terms, if using $\boldsymbol{\alpha}$, the matrix algebra that needs to be followed is analogous to the use of the row vector $\boldsymbol{\beta}$. However, using $\boldsymbol{\alpha}$ is more conceptually difficult to follow. Hence, the explanation used in this report uses $\boldsymbol{\beta}$.

Construction of the net matrix U – V

A net matrix is defined as **U – V**. Schematically this can be represented as follows (**–** represents negative elements, + represents a positive element):

U – V =

$$\begin{array}{l} \\ \text{Commodity 1} \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ \text{Commodity } m \end{array} \begin{array}{c} \text{Sector 1} \;\dots\dots\dots\dots\; \text{Sector } n \\ \left[\begin{array}{cccccccccc} + & - & - & - & - & - & - & - & - & - \\ - & - & + & - & - & - & - & - & - & - \\ - & - & - & - & + & - & - & - & - & - \\ - & - & - & - & - & + & - & - & - & - \\ - & - & - & - & - & - & - & + & - & - \\ - & - & - & - & - & - & - & - & - & + \end{array}\right] \end{array}$$

The inputs and outputs of commodities into a sector can be read down the column. If you utilise a Leontief input-output matrix as the source of base data, there will be only one output per column (sector).

The term "net" matrix is used, as the elements in the matrix represent net inputs and net outputs, as opposed to gross inputs in **V** and gross outputs in **U**.

Calculation of the ecological multiplier

In order to calculate the ecological multiplier, an exogenous vector $\boldsymbol{\beta}$ (say, for energy inputs into each sector) is defined as:

$$\boldsymbol{\beta} = \boldsymbol{\varepsilon}\,(\mathbf{U} - \mathbf{V}) \qquad (1)$$

where: $\boldsymbol{\beta}$ **=** Exogenous vector (*1 × n*) of resource inputs or pollutant outputs into sectors, physical units
U – V = net matrix (*m × n*) of commodity inputs and outputs, into and from each of the sectors, $
$\boldsymbol{\varepsilon}$ **=** vector (*1 × m*) embodied resource inputs or pollutant outputs for each of *m* commodities, physical units / $

To solve for $\boldsymbol{\varepsilon}$, equation (1) needs to be rearranged:

$$\boldsymbol{\beta}\,(\mathbf{U} - \mathbf{V})^{-1} = \boldsymbol{\varepsilon} \qquad (2)$$

In this calculation, the inverse matrix $(\mathbf{U} - \mathbf{V})^{-1}$ is retained irrespective of which particular resource or pollutant is represented by vector $\boldsymbol{\beta}$.

The solution vector $\boldsymbol{\varepsilon}$ represents the total (direct and indirect) resource or pollutant per $1 of net output of a given commodity. This is called the "ecological multiplier". In this analysis we are only interested in the ecological multiplier of the tourism sector (commodity), although incidentally the ecological multipliers for the other sectors are calculated and are represented in the vector $\boldsymbol{\varepsilon}$.

Calculation of first-round, second- to n^{th}-round effects

The vector $\boldsymbol{\varepsilon}$ quantifies the total (direct and indirect) resources or pollutants per dollar of output. The vector ε needs to be decomposed into first-round, second-round and n^{th}-round impacts (refer to Appendix C for a numerical example) – as it stands, it only measures the total impact (i.e. the aggregation of first-round, second-round… n^{th}-round impacts).

First- round impact. The first-round impact can be calculated by:

$$\hat{\boldsymbol{\varepsilon}}\,(\mathbf{U} - \mathbf{V})^{-1} = \mathbf{W} \qquad (3)$$

where: $\hat{\boldsymbol{\varepsilon}}$ = $\boldsymbol{\varepsilon}$ diagonalised matrix (*m × m*), physical units / $
W = evaluated matrix (*m × n*) of the first-round impacts of *n* sectors, physical units.

The first-round impacts for sector 1 are the first column in the evaluated matrix **W**. The first-round impacts for sector 2 are the second column in the evaluated matrix **W**, and so forth.

Second-round impacts (using Sector 1 as an example). If we are to trace the second- round impact, we need to select a nominated sector (column) from the evaluated matrix **W** for further analysis[20]. Once we have selected a nominated column (Sector 1 column in this example), we then need to calculate the second-round impacts of each of the elements in the nominated column. For example, if we want to calculate the second-round impact *stemming from the first-round input of commodity 2 into sector 1*, it is calculated by:

$$\mathbf{w}_1\,\boldsymbol{\delta}_{2,2,1} = \mathbf{x}_{2,2,1} \qquad (4)$$

where: $\mathbf{w}_1$ = column vector (*m × 1*) of the first column (sector 1) of the evaluated matrix **W**

$\mathbf{x}_{2,2,1}$ = vector (*m × 1*) of the second-round impact (first subscript); stemming from the first-round input of commodity 2 (second subscript) into sector 1 (third subscript)

$\boldsymbol{\delta}_{2,2,1}$ = scalar (*1 × 1*). This is the ratio of: "commodity 2 input into sector 1" from **W;** *divided* by the "net output of sector 2" from **W**. The same subscripting system is used for $\boldsymbol{\delta}_{2,2,1}$ as for $\mathbf{x}_{2,2,1}$

[20] The nominated sector is represented by a column in the evaluated matrix **W**. This nominated column tells us the total embodied resource/pollutant (a positive element) and the indirect embodied resource/pollutants (negative elements). To complete the analysis, an additional row for the direct resource/pollutants must be included in **W**.

If we want to track the second-round impact *stemming from the first-round input to commodity 4 into sector 1*, it is calculated by:

$$\mathbf{w}_1 \, \boldsymbol{\delta}_{2,4,1} = \mathbf{x}_{2,4,1.} \qquad (5)$$

The same procedure is used to calculate the second-round impacts of other commodity inputs in sector 1. Then, an analogous process is used to calculate subsequent-round impacts. The so-called "infinite regress" situation arises, as the individual indirect contributions that are represented in elements of **x** get progressively smaller and smaller with each subsequent round. The number of branches in the lifecycle assessment diagram increases exponentially with each subsequent round in the lifecycle assessment diagram (Figure 5). The number of branches "q" in any given round "y" is given by:

$$q = (n - 1)^y \qquad (6)$$

where: n = number of sectors
y = round number.

The total number of branches across all rounds "y_j" is given by:

$$\sum_{i=j}^{i=0} q_j = \sum_{i=j}^{i=0} \left[(n-1)^{y_j} \right] \qquad (7)$$

where: i = rounds 0 … j.

A large number of branches can therefore be generated even with relatively few sectors and rounds, e.g. in this study with 25 sectors and 6 rounds, 199 411 801 potential branches would be generated. This means certain selection criteria need to be applied, so that only the main embodied flows are represented in the lifecycle assessment diagram[21].

3.2.2 Analytical steps

Figure 6 describes the analytical steps involved in calculating the lifecycle multipliers and constructing the associated lifecycle assessment diagrams:

Step 20: *Construction of the Net Matrix (U – V) 25 Sectors Including Tourism, 1997/98.* This net matrix is constructed from the Leontief matrix (**Ax** = **y**) obtained from Step 9 (see 2.2.2). The **U** matrix is the **x** vector diagonalised and the **V** matrix is the **Ax** matrix.

Step 21: *Invert (**U** - **V**) to Derive (**U** - **V**)$^{-1}$.* This is a standard matrix inversion, if the matrix is square. If the matrix is rectangular, a generalised inverse matrix can be used, although some caution then needs to be applied in subsequent steps.

Step 22: *Determination of Lifecycle Multipliers.* As explained in Section 3.2.1 (equation (2)), this is achieved by multiplying $\boldsymbol{\beta}$ by $(\boldsymbol{U} - \boldsymbol{V})^{-1}$ to obtain a solution vector $\boldsymbol{\varepsilon}$. The elements in $\boldsymbol{\varepsilon}$ are the lifecycle multipliers for each sector in the economy.

Step 23: *Determination of the First-Round Impacts for the Tourism Sector.* The first-round impacts (resource and pollutants) are determined by multiplying $\hat{\boldsymbol{\varepsilon}}$ by the inverse matrix $(\mathbf{U} - \mathbf{V})^{-1}$ to obtain the matrix **W** (refer to equation (3)). The first-round impact (indirect inputs, embodied outputs) is the tourism-sector column in **W**.

Step 24: *Determination of Second- to n^{th}-Round Impacts for the Tourism Sector.* These impacts can be calculated by using the procedure outlined in Section 3.2.2 (equations (6) and (7)).

Step 25: *Lifecycle Assessment (LCA) Diagrams.* These diagrams are constructed using the data from Steps 23 and 24. The LCA diagrams are constructed to show the "conservative" nature of direct and indirect flows, i.e. for a process, direct inputs + indirect inputs = embodied output. As there are numerous indirect inputs that arise after second- or third- impact rounds, specific criteria need to apply to only the more significant flows, e.g. in the energy diagram only the following flows were considered: first round (>150 TJ), second round (>100 TJ), third round (>20 TJ),

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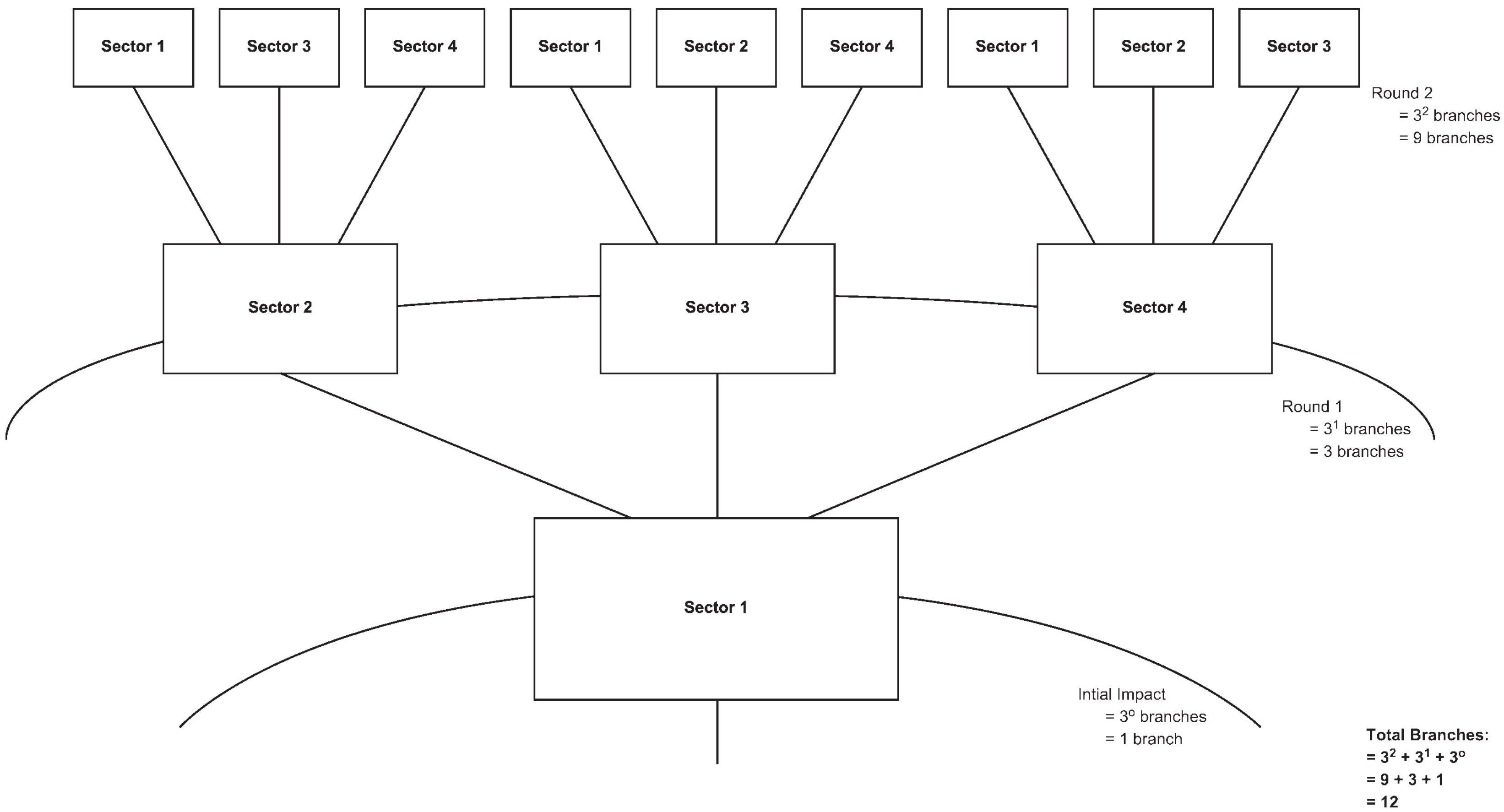
[21] For example, for BOD (kg) only the following were considered: first round (>6000 kg); second round (>2000 kg); third round (>300 kg), fourth round (>150 kg), fifth round (>75 kg) and sixth round (>30 kg).

Figure 5. Schematic representation of the number of branches in a 3-sector x 2-rounds lifecycle assessment diagram.



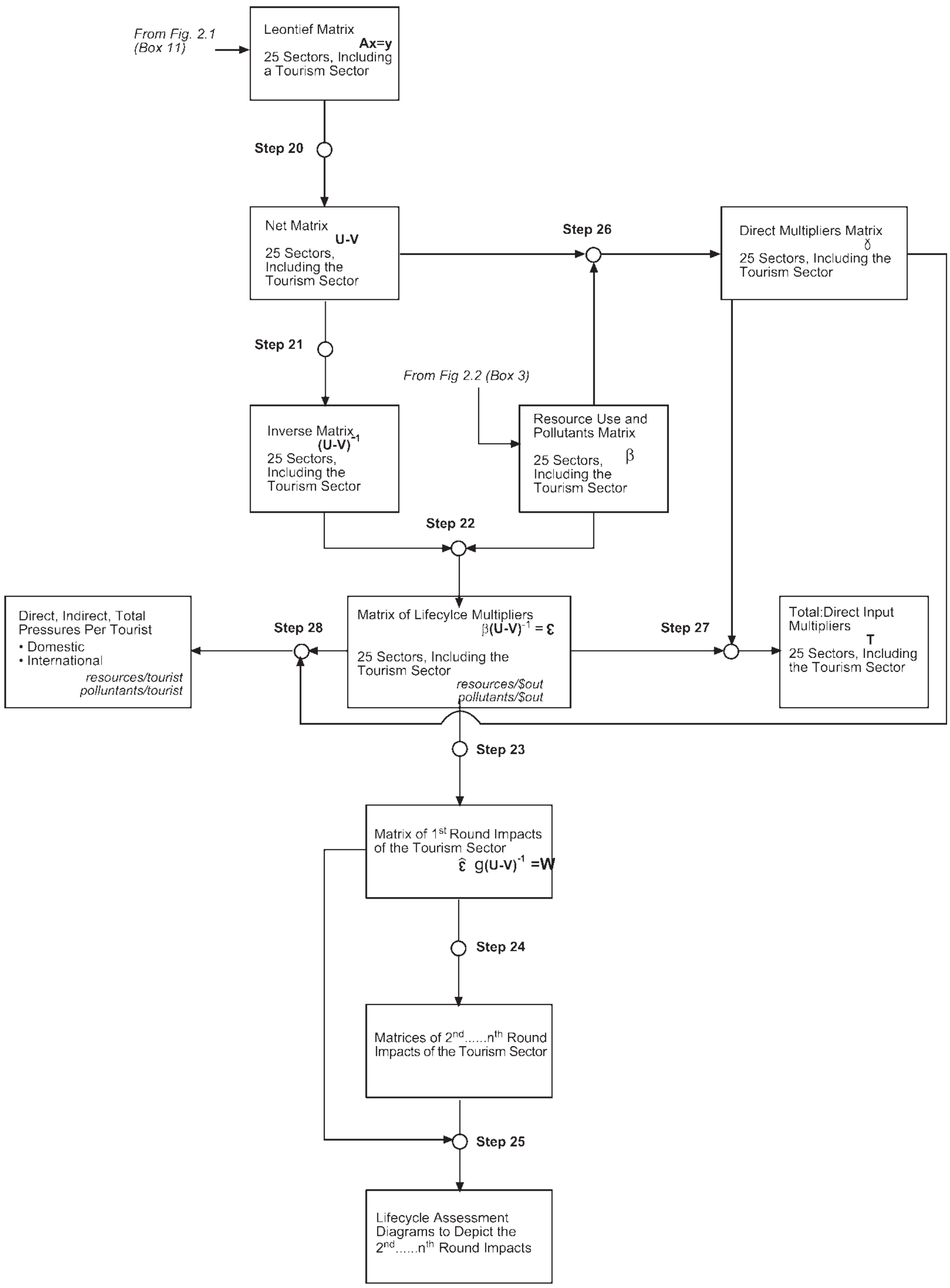


Figure 6. Methodological process for calculating lifecycle assessment multipliers and diagrams.

fourth round (>4 TJ) and fifth round (>1 TJ). Generally, after four rounds, inputs become small enough to be excluded due to the "infinite regress".

Step 26: *Determination of the Direct Multipliers Matrix (δ).* The direct multipliers are determined by dividing the physical amount of resource/pollutant (elements in $\boldsymbol{\beta}$) by the net output for each sector (elements on the diagonal of $\mathbf{U}$). The resultant numbers are represented by the matrix $\boldsymbol{\gamma}$ (physical units/$ net output).

Step 27: *Compare Total Multipliers with Direct Multipliers.* This is an element wise division of matrix $\boldsymbol{\varepsilon}$ by matrix ($\boldsymbol{\delta}$), with the resultant being matrix $\mathbf{T}$. Matrix $\mathbf{T}$ measures the total impact (direct + indirect) *relative to the direct impact* of the first round, which is an indicator variable often used in multiplier analyses.

Step 28: *Lifecycle Assessment Multipliers Per Tourist Trip*. Instead of expressing the lifecycle multiplier in terms of $ net output, the data are converted to per tourist trip.

3.3 Ecological multipliers for the tourism sector

3.3.1 Ecological multipliers as an operational measure of eco-efficiency

The World Business Council for Sustainable Development introduced the concept of eco-efficiency as one of its responses to the Rio Conference (de Simonne & Popof 2000). The concept of eco-efficiency is now beginning to have a significant impact not only in the business world but also in the public policy area (Hinterberger & Stiller 1998). Eco-efficiency was defined by the World Business Council for Sustainable Development as:

> *the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing environmental impacts and resource intensity throughout the lifecycle, to a level at least in line with the earth's carrying capacity.*

Eco-efficiency indicators based on this concept attempt to link *economic performance* (producing competitively priced goods and services) to *environmental costs* (environmental impacts and resource intensity).

Ecological multipliers, as derived using the methodology outlined in Section 3.2, arguably provide an operational measurement of the eco-efficiency concept. That is, ecological multipliers measure the direct and indirect resources (or pollutants) across the *lifecycle* it takes to produce one dollar's worth of output, for a given commodity or sector.

3.3.2 Resource and pollutant multipliers for the tourism sector

Per economic output ($)

The ecological multipliers for the domestic tourism sector for 1997/98 could be mathematically determined as:

4.50 TJ	energy (oil equivalents) / $million output
9799 m^3	water / $million output
174.22 kg	BOD / $million output
5.10 kg	nitrate / $million output
33.55 kg	phosphorus / $million output
16 723 m^3	water discharges / $million output
84.64 ha	(land) / $million output
260.52 t	CO_2 / $million output

When international air travel was included in these multipliers, the energy multiplier increased from 4.50 to 10.38 TJ energy (oil equivalents) / $million output and the CO_2 multiplier from 260.52 to 658.35 t CO_2 / $million output. With the inclusion of international travel the other multipliers would also increase, but there were insufficient data to make reliable estimates of these multipliers. Nevertheless, it is likely that the direct and indirect multipliers associated with international travel for land inputs, water inputs and water pollutants would be very small.

For the *domestic economy*, the above multipliers could be disaggregated into their direct and indirect components (Figure 7). Land had a relatively small direct component at only 7.5% of the total multiplier of 84.64 ha/$million. This is because

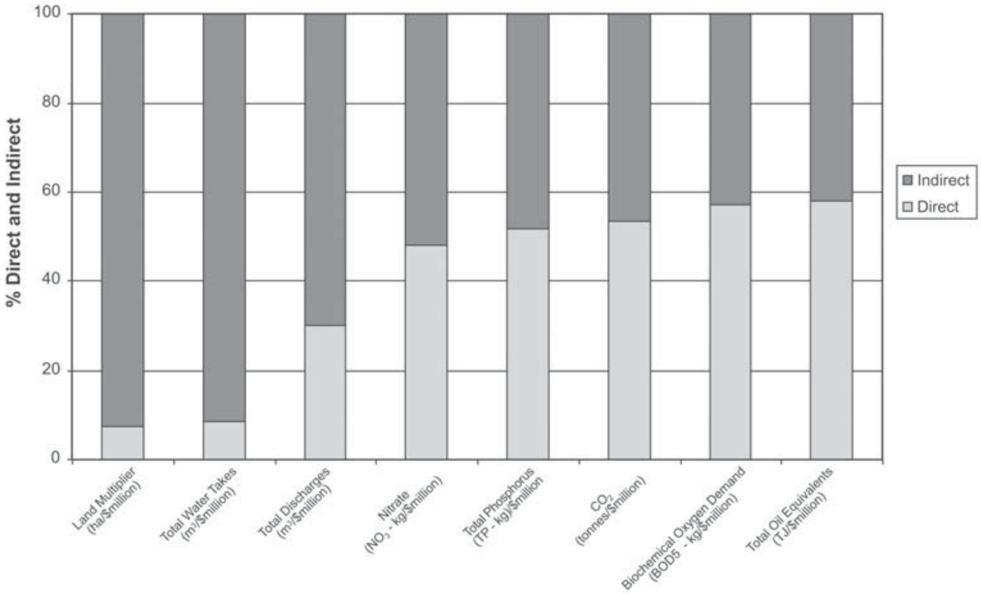


Figure 7. Direct and indirect components of the tourism sector ecological multipliers.

of a particularly high embodied land content associated with the food, beverages and agricultural inputs into tourism, far exceeding the direct use of land by the tourism sector. Water inputs also had a small direct component at only 8.5% of the total multiplier of 9799m^3 water/$million – this is water abstracted directly from natural sources (groundwater, rivers, lakes) by tourist industry. Not surprisingly, the reticulated component (supplied to the tourism industry via the water distribution industry) was 20.1% of the total multiplier. However, there is also a large embodied-water content in many of the inputs (food and beverages, electricity and gas, retail goods) supplied to the tourism sector.

The direct component for the water pollutant multipliers was generally higher: water discharges (30.2%), nitrate (47.9%), phosphorus (51.7%) and BOD (57.1%). For all these multipliers the pollutants embodied in the supply of food and beverages

Table 27. Direct and total environmental pressures, per trip for international tourists, 1997/98

Indicator	Units Per Trip	Direct Pressures	Total Pressures
Energy (Within New Zealand)	MJ (oil equvalients) / trip	4 840.00	8 326.00
Energy (Outside New Zealand)	MJ (oil equvalients) / trip	34 700.00	40 004.00
Energy (Total)	MJ (oil equvalients) / trip	39 540.00	48 329.00
Total Water Takes [1]	litres/trip	1 518.00	17 779.00
BOD_5 (Point Source Only)[2]	grams/trip	180.62	316.12
Nitrate (Point Source Only)[2]	grams/trip	4.44	9.25
Total Phosphorus (Point Source Only)[2]	grams/trip	31.49	60.88
Total Water Discharges[2]	litres/trip	9 166.00	30 343.00
Land	m^2/trip	115.00	1 536.00
Carbon Dioxide (Within New Zealand)	kg/trip	253.00	473.00
Carbon Dioxide (Outside New Zealand)	kg/trip	2 384.00	2 748.00
Carbon Dioxide (Total)	kg/trip	2 637.00	3 221.00

Notes: 1. For the direct pressures, this only includes direct water takes from natural water bodies. It does not include reticulated water inputs into the tourism sector

2. For the direct pressures, this only includes direct discharges into the environment. It does not include tourism sector effluent treated by sewerage treatment plants and then disposed of into the environment.

Table 28. Direct and total environmental pressures, per trip for dometic tourists, 1997/98

Indicator	Units Per trip	Direct Pressures	Total Pressures
Energy (Within New Zealand)	MJ (oil equvalients) / trip	1 283.00	2 208.00
Energy (Outside New Zealand)	MJ (oil equvalients) / trip	0.00	0.00
Energy (Total)	MJ (oil equvalients) / trip	1 283.00	2 208.00
Total Water Takes [1]	litres/trip	403.00	4 714.00
BOD_5 (Point Source Only)[2]	grams/trip	47.89	83.82
Nitrate (Point Source Only)[2]	grams/trip	1.18	2.45
Total Phosphorus (Point Source Only)[2]	grams/trip	8.35	16.14
Total Water Discharges[2]	litres/trip	2 430.00	8 046.00
Land	m^2/trip	31.00	299.00
Carbon Dioxide (Within New Zealand)	kg/trip	67.00	125.00
Carbon Dioxide (Outside New Zealand)	kg/trip	0.00	0.00
Carbon Dioxide (Total)	kg/trip	67.00	125.00

Notes: 1. For the direct pressures, this only includes direct water takes from natural water bodies. It does not include reticulated water inputs into the tourism sector
2. For the direct pressures, this only includes direct discharges into the environment. It does not include tourism sector effluent treated by sewerage treatment plants and then disposed of into the environment.

products are high. For BOD, phosphorus and water-discharges multipliers, the "indirect" component contributed by sewage treatment services supplied by the community, social and personal services sector was also relatively high.

Per tourist trip

It is perhaps more meaningful to present the ecological multiplier data in terms of direct and indirect inputs *per tourist trip* (Tables 27 and 28). The pressures exerted directly and indirectly on the environment during a trip were considerable. For example, an average return trip to New Zealand by an international tourist generated 3221 kg of CO_2 and consumed 48 329 MJ (oil equivalents) of energy. The CO_2 emissions generated by just one trip to New Zealand by an international tourist were about double those generated by a New Zealander's annual personal and household energy use. Considering that an international tourist only visits New Zealand for an average of 20 days, this is a disturbingly large amount of CO_2 emissions.

3.3.3 Comparison of tourism ecological multipliers with other sectors

Multiplier comparison

The ecological multiplier for tourism can be compared against other sectors in the economy (Table 29). This provides a mechanism for comparing the eco-efficiency of the tourism sector against other sectors. On this basis, the eco-efficiency of the tourism sector was generally poor – for seven out of eight of the indicator variables the sector's performance was below average (ranging from 13th to 24th position, out of 25 sectors).

The worst performance was for the water pollutant indicators: BOD (174 kg/$million) was ranked 21st, nitrate (5 kg/$million) 24th and phosphorus (33.5 kg/$million) 21st (Table 29). Only the food and beverages sector ranked worse than the tourism sector across all of these indicator variables. The agriculture, water distribution, and community, social and personal services (which includes sewage treatment) sectors all ranked more poorly than the tourism sector for BOD and phosphorus, but not for nitrate.

The eco-efficiency performance of the tourism sector as measured by the energy and CO_2 multipliers was also relatively poor, both ranking 17th out of 25 sectors, when the within-New Zealand multiplier effects were taken into account. However, the performance deteriorated even further when overseas travel (return trips by inbound tourists) was taken into account. The energy multiplier then increased to 10.38 TJ (oil equivalents)/$million, with only the basic metals sector having a higher energy multiplier. Perhaps surprisingly, the energy multiplier for the tourism sector was higher than for all of the industrial sectors (pulp and paper; petroleum and chemicals, fabricated metal products and so forth) and the transport sector, all of

Table 29. Ecological multipliers of the tourism and other sectors in the New Zealand economy, 1997/98

Sector	Energy (TJ - oil equiv / $ mil)	Total water takes (m^3 / mil)	Land (ha / $ mil)	Water discharges (m^3 / $ mil)	BOD_5 (kg / $ mil)	Nitrate (kg / $ mil)	Phosphorus (kg / $ mil)	CO_2 (t / $ mil)
Agriculture	4.12	30 381	1 561.30	23 054	458.81	1.98	149.65	233.58
Fishing and Hunting	10.21	7 010	27.79	6,763	33.45	0.91	6.56	713.48
Forestry	1.81	3,748	943.68	8,339	31.70	0.65	6.68	121.84
Mining and Quarrying	5.97	327 692	60.75	1 060 091	40.38	0.65	7.39	341.30
Food, Beverages and Tobacco	5.19	37 652	582.12	30 345	251.16	52.81	70.71	322.54
Textiles, Clothing and Footwear	3.31	20 538	463.52	16 099	167.49	4.14	49.68	195.09
Wood and Wood Products	3.47	7,319	194.31	11,515	37.11	0.86	7.41	292.46
Pulp and Paper Products, Printing and Publishing	9.24	24 145	64.69	40 310	42.02	0.67	7.80	788.16
Petroleum, Chemical, Plastics and Rubber Products	3.03	22 561	28.87	84 718	37.22	1.14	7.43	147.22
Non-metallic Mineral Products	6.10	50 535	27.24	113 000	42.75	0.79	7.95	539.09
Basic Metal Products	33.08	56 386	22.75	111,408	37.51	0.91	7.09	1 523.80
Fabricated Metal Products, Machinery and Equipment	2.96	7,770	21.85	11 724	36.64	0.91	7.00	158.76
Other Manufacturing	4.01	24 117	31.57	69 762	44.87	1.28	8.77	186.67
Electricity, Gas	1.05	123 123	22.67	107 179	29.31	0.40	5.32	64.73
Water Distribution	5.23	1 818 165	372.65	67 905	761.27	2.76	131.48	149.47
Construction	2.79	9 972	36.89	20 602	48.63	0.97	9.11	186.16
Wholesale and Retail Trade	3.70	9 207	68.27	11 833	60.06	4.25	13.27	199.19
Transport and Storage	7.61	5 930	25.58	9 430	69.87	1.27	12.88	573.08
Communication	1.13	5 065	13.70	5 718	42.52	0.38	7.82	56.30
Finance, Insurance, Real Estate and Business Services	1.34	3 212	13.15	6 275	52.72	0.47	9.46	77.02
Ownership of Owner-Occupied Dwellings	0.37	14 813	9.80	2,501	13.91	0.23	2.62	21.85
Community, Social and Personal Services	1.77	7 644	39.29	62 520	1 409.27	4.50	243.11	95.22
Central Government	1.64	5,146	35.86	10 677	127.68	0.89	22.54	115.04
Local Government	1.99	12 716	97.15	9,349	61.00	0.90	11.12	79.01
Tourism (not including international travel)	4.59 (17th)	9 799 (11th)	84.64 (18th)	16 723 (13th)	174.22 (21st)	5.10 (24th)	33.55 (21st)	260.52 (17th)
Tourism (including international travel)	10.38 (24th)	-	-	-	-	-	-	658.58 (22nd)

Note: Best (i.e. lowest) ecological multiplier is ranked 1st ; worst (i.e. highest) ecological multiplier is ranked 25th.

which are seen as energy intensive. The CO_2 multiplier also increased (to 658.58 t/$million) when overseas travel was included, which again put the tourism sector as the second worst sector next to the basic metal sector in terms of this indicator of eco-efficiency.

The land multiplier also indicated a relatively poor performance in terms of land use (18^{th} out of 25 sectors). Direct land use was low at only 7.5% of the total, there being significant indirect land use through the purchase of food and beverages and agricultural sector inputs.

The tourism sector's eco-efficiency performance fared better for water inputs and outputs, ranking 11^{th} and 13^{th} respectively out of 25 sectors. For water usage (water inputs), the tourism sector was slightly worse than most of the other service sectors, using slightly more water per dollar of product, but significantly better than most of the industrial sectors.

For water outputs (water discharges) the tourism sector ranked 13^{th}, much better than the ranking of 21^{st} and 24^{th} for the water pollutants. This implies that although in terms of volume (m^3) discharged tourism ranked about the middle of the sectors, the water was relatively "polluted" in the sense there was a relatively high level of pollutants per unit volume of discharge.

Total impact comparison

The total (both direct and indirect) pressure exerted on the environment by the tourism and other sectors in the economy could be calculated (Table 30). On this basis, the performance of the tourism sector was again poor, ranking from 14^{th} to 22^{nd} (out of 25 sectors) across the eight indicator variables. In these rankings, the sector with the lowest impact is ranked first and the sector with highest impact is ranked 25^{th}.

For the water pollutant indicators (point source BOD, nitrate, phosphorus) the total amount of pollutants released to the environment, directly and indirectly, was high. Only the food, beverages and tobacco; community, social and personal services (which includes sewage treatment) and agriculture sectors generally had higher levels of water pollution[22].

The tourism sector ranked 21^{st} for total (direct and indirect) energy use and CO_2 emissions released within New Zealand. When overseas travel was included the sector became the highest user of energy and highest CO_2 emitter out of the 25 sectors considered. On this basis, total energy used was 107,124 TJ (oil equivalents), equivalent to 21.7% of New Zealand's annual energy consumption in 1997/98. Similarly, when overseas travel by inbound tourists was included, the tourism sector released 6.8 kt $CO_{2,}$ which is equivalent to 24.3% of New Zealand's CO_2 emissions for 1997/98.

The total amount of land directly and indirectly occupied by the tourism sector was estimated to be 873 525 ha (ranking 14^{th} lowest out of 25 sectors). The ranking of the tourism sector would have increased to 24^{th} if national parks, forest parks and other reserves were attributed to the sector.

In terms of water inputs (water takes) and water outputs (discharges), the tourism sector ranked 14^{th} (with 25^{th} being highest). Directly and indirectly the sector was estimated to have used 101.1 million cubic metres of water and discharged 172.6 million cubic metres of water in 1997/98 (Table 30).

Conclusion

Some preliminary conclusions can be made about the environmental performance of the tourism sector (Table 31). Firstly, the sector's "eco-efficiency" performance can be evaluated. On this basis, the mean eco-efficiency performance of the tourism sector was 18^{th} out of 25 sectors, where 25^{th} is the worst sector. When overseas travel was included, this performance dropped to 19^{th} position. Secondly, the tourism sector's environmental performance can be evaluated in terms of "total pressures" exerted on the environment (resources used, pollutants produced). On this basis, the mean performance of the tourism sector was 19.5^{th}, where 25^{th} is the worst sector. When overseas travel was included, the performance of the tourism sector in terms of this criterion dropped even further to 20.25^{th} position.

In general terms, the only sectors that performed worse than the tourism sector were agriculture; food and beverages; community, social and personal services (which includes sewage treatment); and pulp and paper; as well as the basic metals (with respect to energy and CO_2 only). Notably, the tourism sector seemed to have an overall environmental performance below some of the industrial sectors and certainly worse than all but one of the other service sectors.

[22] The only exception to this generalisation is that the agriculture sector did not have a higher level of point-source nitrate pollution than the tourism sector.

Table 30. Total (direct and indirect) resources/pollutants of sectors in the New Zealand economy, 1997/98

Sector	Energy (TJ - oil equiv)	Total water takes (m^3)	Land (ha)	Water discharges (m^3)	BOD_5 (kg)	Nitrate (kg)	Phosphorus (kg)	CO_2 (t)
Agriculture	40 325	297 100 650	15 267 966	225 444 395	4 486 740	19 337	1 463 437	2 284 165
Fishing and Hunting	7 552	5 186 055	20 558	5 003 767	24 745	675	4 851	527 855
Forestry	3 367	6 982 778	1 758 128	15 535 850	59 056	1 205	12 441	227 000
Mining and Quarrying	7 699	422 787 903	78 386	1 36 7 726 428	52 095	840	9 537	440 344
Food, Beverages and Tobacco	84 289	611 878 650	9 459 959	493 128 527	4 081 477	858 237	1 149 142	5 241 588
Textiles, Clothing and Footwear	10 985	68 061 069	1 536 084	53 350 975	555 046	13 726	164 645	646 537
Wood and Wood Products	12 449	26 222 846	696 201	41 256 538	132 966	3 097	26 566	1 047 849
Pulp and Paper Products, Printing and Publishing	42 533	111 155 983	297 797	185 569 636	193 443	3 105	35 894	3 628 388
Petroleum, Chemical, Plastics and Rubber Products	20 458	152 152 233	194 717	571 336 934	251 038	7 718	50 110	992 856
Non-metallic Mineral Products	9 695	80 317 047	43 295	179 594 203	67 941	1 260	12 632	856 795
Basic Metal Products	57 060	97 255 362	39 247	192 157 929	64 701	1 564	12 224	2 628 256
Fabricated Metal Products, Machinery and Equipment	29 955	78 524 777	220 796	118 490 614	370 267	9 195	70 752	1 604 578
Other Manufacturing	1 748	10 505 692	13 750	30 389 632	19 547	556	3 820	81 319
Electricity, Gas	3 198	374 993 887	69 058	326 432 664	89 282	1 210	16 209	197 153
Water Distribution	1 568	545 010 945	111 705	20 355 130	228 198	827	39 411	44 804
Construction	37 234	132 986 752	492 051	274 754 930	648 532	12 933	121 517	2 482 694
Wholesale and Retail Trade	90 284	224 739 940	1 666 545	288 855 098	1 466 221	103 665	324 010	4 862 297
Transport and Storage	50 294	39 203 856	169 086	62 341 692	461 945	8 388	85 151	3 788 711
Communication	6 195	27 754 599	75 088	31 332 725	233 034	2 055	42 845	308 531
Finance, Insurance, Real Estate and Business Services	26 768	64 375 168	263 561	125 751 175	1 056 542	9 508	189 584	1 543 608
Ownership of Owner Occupied Dwellings	3 128	126 180 685	83 489	21 307 345	118 451	1 965	22 336	186 102
Community, Social and Personal Services	30 390	131 040 005	673 592	1 071 820 437	24 160 214	77 069	4 167 740	1 632 420
Central Government	9 849	30 870 004	215 130	64 054 447	765 990	5 314	135 236	690 139
Local Government	1 973	12 634 489	96 534	9 289 698	60 608	899	11 046	78 504
Tourism (not including international travel)	47 358 (21st)	101 131 237 (14th)	873 525 (20th)	172 598 772 (14th)	1 798 143 (22nd)	52 637 (22nd)	346 308 (22nd)	2 688 823 (21st)
Tourism (including international travel)	107,124 (25th)	-	-	-	-	-	-	6 794 783 (25th)

Note: Best (i.e. lowest) ecological multiplier is ranked 1st ; worst (i.e. highest) ecological multiplier is ranked 25th.

Table 31. Environmental performance ranking of the tourism sector compared with other sectors in the economy, 1997/98

Indicators	"Eco-Efficiency" Criterion Ranking[1] (total resource or total pollutant per $)		"Total Pressure" Criterion Ranking[1] (total resources or total pollutants)	
	Not including overseas travel	Including overesas travel[2]	Not including overseas travel	Including overesas travel[2]
Energy (TJ - oil equivalents)	17th	24th	21st	25th
Total Water Takes (m^3)	11th	-	14th	-
BOD_5 (kg)	21st	-	22nd	-
Nitrate (kg)	24th	-	22nd	-
Total Phosphorus (kg)	21st	-	22nd	-
Total Discharges (m^3)	13th	-	14th	-
Land (ha)	18th	-	20th	-
CO_2 (tonnes)	17th	22nd	21st	25th
Mean Overall Performance[3]	17.75th	19.25th	19.5th	20.25th

Notes: 1. Best (i.e. lowest total pressure and lowest eco-efficiency ratio) is ranked 1st; worst (i.e. highest total pressure and highest eco-efficiency ratio) is ranked 25th.
2. These rankings include energy use and CO_2 emissions associated with overseas travel of international tourists to New Zealand.
3. This is the arithmetic mean of the above indicators. Various weighting schemes can be applied to these indicators, which lead to very similar results.
4. "Eco-efficiency" rankings are obtained from Table 29 and "total pressures" from Table 30.

3.3 Lifecycle assessment diagrams

Typically, in ecological multiplier analysis only one value is reported (e.g. 10 MJ/$), with no disaggregation into the direct and indirect components that make up this value. However, by using the methodology described in Section 3.2.1, the first-, second-, third- and n^{th}-round inputs that make up the multiplier can be eliminated. The so-called "infinite regress" becomes evident in this diagram as the individual inputs progressively decrease in magnitude as the number of rounds increases. The "conservative" nature of the flows of inputs and outputs is also evident, e.g. for each process in Figure 8, direct inputs + indirect inputs = embodied output.

3.4.1 Energy inputs

Direct energy inputs

Direct energy inputs into the tourism sector in 1997/98 were greater than the indirect energy inputs, amounting to 79 376 TJ (oil equivalents), or 74.1% of the total energy inputs (Figure 8). Of this amount domestic energy inputs made up 27 533 TJ (oil equivalents) (cf. 51 843 TJ for international travel). Most of this direct energy was aviation fuel (77.4%), but significant amounts of diesel (3.6%), petrol (3.7%), natural gas (1.9%) and electricity (11.6%) were also used in the domestic sector of the tourism industry.

Indirect energy inputs

Indirect energy inputs into the tourism sector accounted for only 25.9% of the total energy inputs for 1997/98. Many of the *first-round* embodied energy inputs were associated with supplying consumer products and other inputs required by the sector, e.g. food, beverages, souvenirs and other consumer items as well as paper products (e.g. disposable cups). These inputs were supplied by the following sectors: wholesale and retail trade (2204.4 TJ oil equivalents), food and beverages (2014.4 TJ), and pulp and paper products (1389.3 TJ). The most significant single first-round input was transport services (5571.1 TJ oil equivalents). The purchase of construction materials was also significant, as reflected in the purchases of basic metal (2576.2 TJ oil equivalents) and fabricated metal (548.0 TJ) products.

Finance, insurance and real estate also had a high first-round input at 1382.2 TJ oil equivalents. Of this, a significant amount (418 TJ) was for the supply of paper and related products to the finance, insurance and real estate industry.

Similarly, a significant proportion of the first-round inputs from the wholesale and retail trade can also be traced back to paper products. The lifecycle assessment diagram (Figure 8) reveals that many of the first-round inputs can be tracked back ultimately to energy-intensive inputs from the transport, basic metals, and pulp and paper sectors.

It is also noted on Figure 8 that there was 7924 TJ oil equivalents of indirect energy embodied in international travel, most of which was indirect inputs of energy from overseas economies. This aggregate figure unfortunately cannot be broken down any further because of a lack of overseas data.

3.4.2 Water inputs

Direct inputs of water into the tourism sector accounted for over 8 million cubic metres in 1997/98 (Figure 9), or only 8.5% of the total water input into the sector. However, direct water inputs are direct water takes from a natural water body (river, stream, lake, underground water) and do not include reticulated water, which is considered to be an "indirect" water source as it is supplied through the water distribution sector. Direct water takes by the tourism sector mainly consisted of water use by rural and agricultural-based tourism ventures, as well as direct water takes for swimming pools and garden irrigation purposes. Most of the potable water for the tourism sector comes from reticulated water supply.

Indirect water inputs

Indirect water inputs into the tourism sector were substantial and amounted to over 92 million cubic metres (Figure 9) or 91.5% of the total water inputs into the sector. The largest "indirect" water input was reticulated water supplied by the water distribution sector (20 354 724 m^3). This could be considered a "direct" input as it is *directly used* by the tourism industry, rather than being strictly embodied in the supply of goods and services to the sector.

Much water was embodied in the direct supply of food and beverages to the tourism sector (14 756 893 m^3). This included nearly 5 million cubic metres directly used by the food and beverages industry and, up the production chain, nearly 4 million cubic metres directly used by the agriculture sector (Figure 9). Food and beverages, sold through the wholesale and retail sector to the tourism industry, had an additional embodied water content of over one and a half million cubic metres.

The supply of electricity also had a high embodied water content and accounted for most of the first-round input of electricity and gas (9 430 599 m^3). This was mainly water used for cooling and other purposes by thermal power stations, and did not include water used by hydroelectric stations to generate power[23].

Other significant first-round indirect water inputs into the tourism industry (accounting for between 3 and 8 million cubic metres; Figure 9) were agriculture; the wholesale and retail trade; petroleum, chemicals and plastics; basic metal products; transport; mining and quarrying; pulp and paper products; construction; and finance, insurance and real estate.

Ultimately, most of the first-round inputs into the tourism sector that have a high embodied water content can be tracked back up the production chain to a few water-intensive industries (mining and quarrying, electricity and gas, agriculture and water distribution).

3.4.3 Land inputs

Direct land inputs

Direct land inputs into the tourism sector amounted to 65 564 ha, or only 7.5% of total land inputs into the sector (Figure 10). This is the land directly occupied by hotels, motels, camping grounds, restaurants and other tourist retail activities, as well as the tourism share of the transport network. When national parks, forest parks, land reserves and marine reserves were included as tourism sector land, the direct land use by tourism increased to over 7 million hectares.

Indirect land inputs

Although in financial terms agricultural sector inputs into the tourism sector were relatively small (2.6% of all inputs), these inputs were very land intensive (ha/$). This is the reason for the high input (419 919 ha) of embodied land from the agriculture sector.

[23] Based on data from McDonald & Patterson (1999), if the water used by hydroelectric dams were included it would probably account for more than 90% of the water usage in New Zealand.

Figure 8. Direct and indirect energy inputs into the tourism sector, 1997/98.

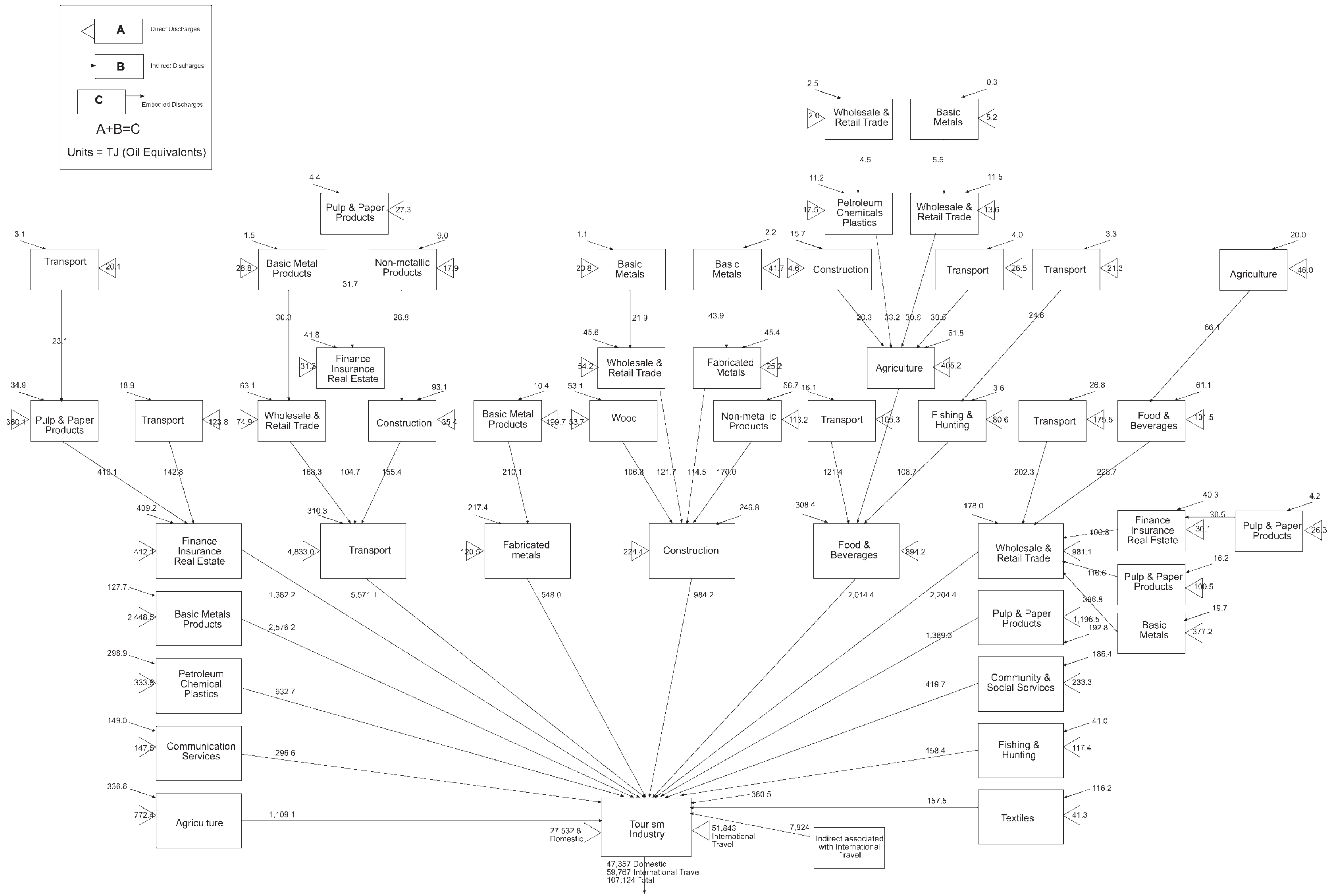


Figure 9. Direct and indirect water inputs into the tourism sector, 1997/98.

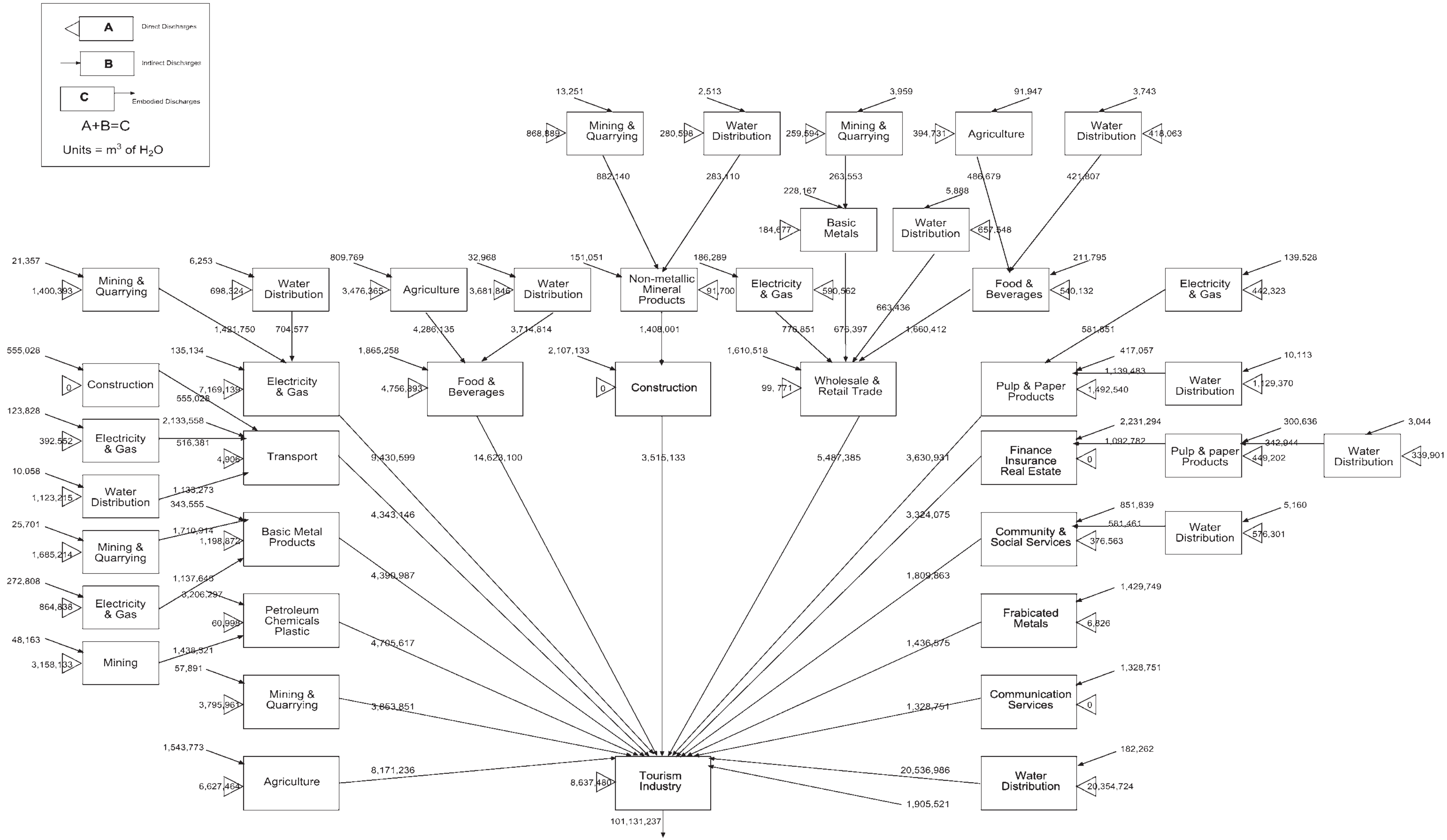
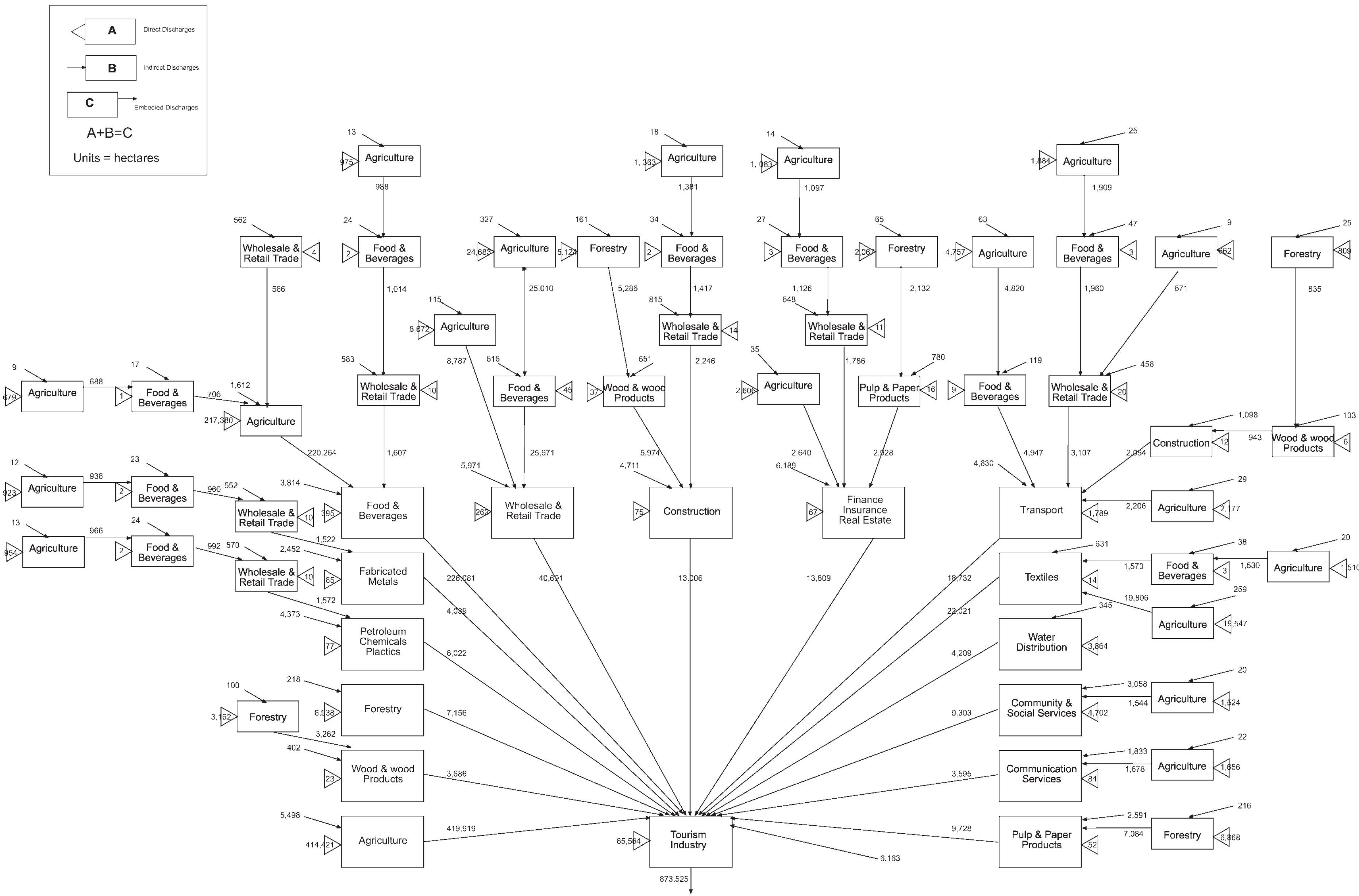


Figure 10. Direct and indirect land inputs into the tourism sector, 1997/98.



There was also significant indirect land embodied in the direct supply of food and beverage products to the tourism sector (226 081 ha). An additional 25 671 ha of land was embodied in food and beverage products indirectly supplied to the sector via the wholesale and retail sector.

After accounting for agricultural and food and beverage inputs into the tourism sector, there was then a very considerable drop to the next sectors, in terms of embodied land inputs. Textile sector inputs accounted for 22 021 ha, transport for 18 732 ha, finance, insurance and real estate for 13 609 ha, and construction for 13 006 ha.

Ultimately, when the production chains for various inputs into the tourism sector were tracked back, they ended up at significant inputs of *agricultural land* and to a lesser extent *forestry land*. For example, the construction sector input of 13 006 ha of embodied land was tracked back to 5974 ha embodied in wood and wood products and then back one step further to 5124 of forestry sector land. For this reason, the "Forestry" and "Agriculture" sector boxes tend to be at the outer edges of the lifecycle assessment diagram (Figure 10).

3.4.4 Water outputs

Direct water discharges

Water discharged directly from the tourism sector was found to be about 52 million cubic metres (Figure 11), representing 30.2% of the total water discharged by the sector. Most of this was not from the "traditional" tourism activities (e.g. accommodation complexes, restaurants) but from agricultural and food and beverage activities attributed to the tourism sector in the tourism satellite accounts. These activities use large amounts of water, which are ultimately discharged back into the environment.

Indirect water discharges

Indirect water discharges by the tourism sector amounted to over 120 million cubic metres, representing 69.8% of the sector's total discharges (Figure 11). The largest single indirect discharge was attributed to petroleum, chemicals, and plastics with a first-round indirect input of close to 18 million cubic metres, which can be tracked back one step in the production chain to over 10 million cubic metres of discharges embodied in the supply of mining and quarrying inputs into that sector. Community and social services was the second largest first-round indirect discharge (14 803 481 m^3), this mostly consisting of treated sewage wastes.

Significant amounts of water discharges were embodied in the supply of mining and quarrying (12 467 278 m^3) and food and beverage (11 785 127 m^3) inputs into the tourism sector. For mining and quarrying, there were considerable direct discharges and few embodied discharges. The situation was more complicated for food and beverages, with a complex array of upstream inputs into the sector that involve significant discharges of water (Figure 11). One such input was agriculture (3 252 383 m^3) but there were also significant second-, third-, or fourth-round inputs from the mining and quarrying and petroleum, chemicals, plastics sectors.

Other significant amounts of water discharges are embodied in the supply of basic metal products, electricity and gas, construction, transport, finance, insurance and real estate, agriculture, and pulp and paper products (all between 6 and 9 million cubic metres) (Figure 11).

3.4.5 Nitrate outputs

Direct nitrate discharges

The direct discharge of nitrate was just under half (47.9 %) the total nitrate discharged by the tourism sector. Most of the 25 234.5 kg (Figure 12) was from agricultural, and food and beverage activities attributed to the tourism sector in the tourism satellite accounts.

Indirect water discharges

Nitrate discharges embodied in the supply of food and beverages were very large (20 510.7 kg) and far higher than from any of the other sectors. This food industry waste-water directly discharged into the environment has a high nitrate content, compared with waste-water from other industries.

There was also significant nitrate embodied in the supply of wholesale and retail trade inputs to tourism, particularly

Figure 11. Direct and indirect water outputs from the tourism sector, 1997/98.

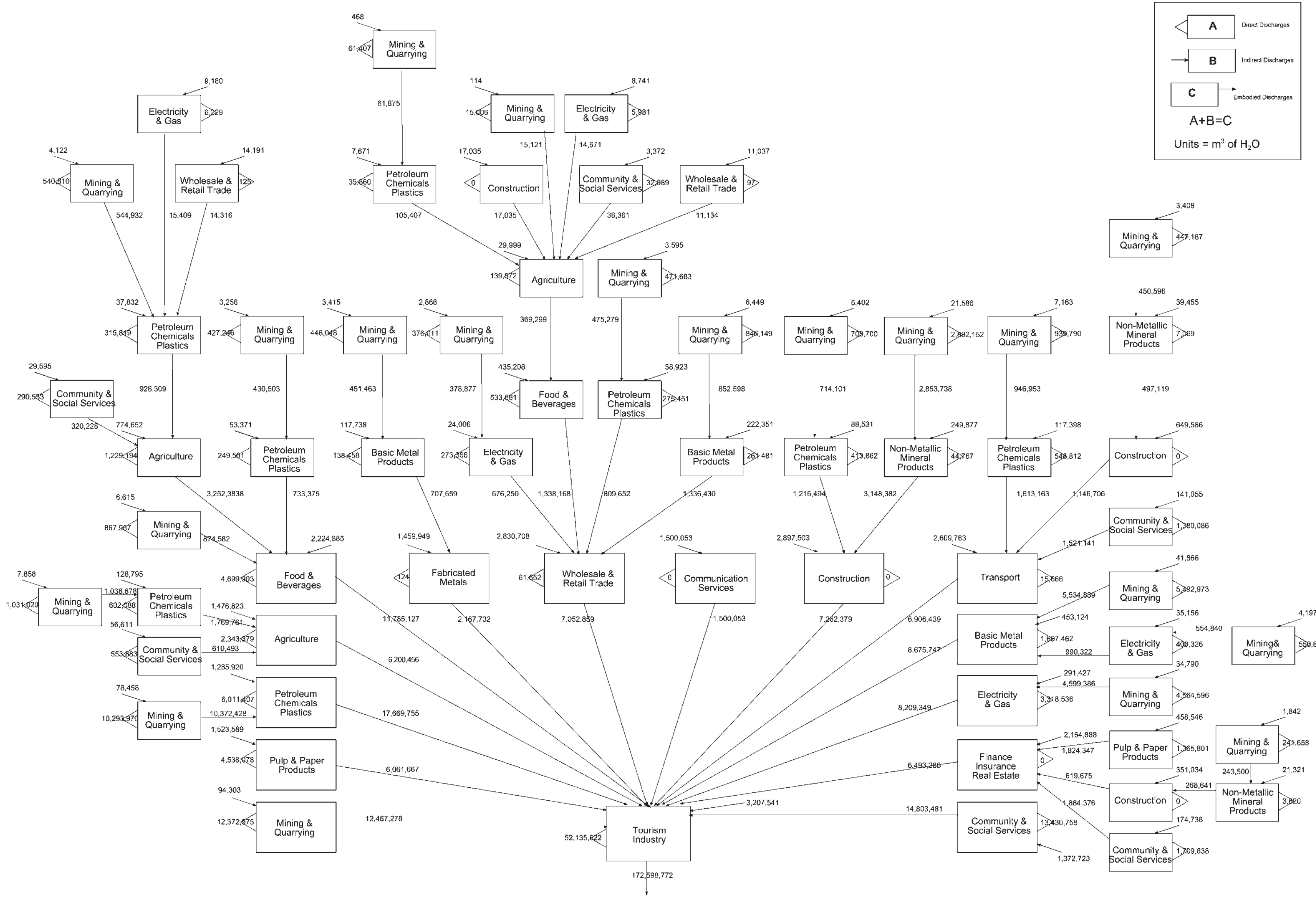
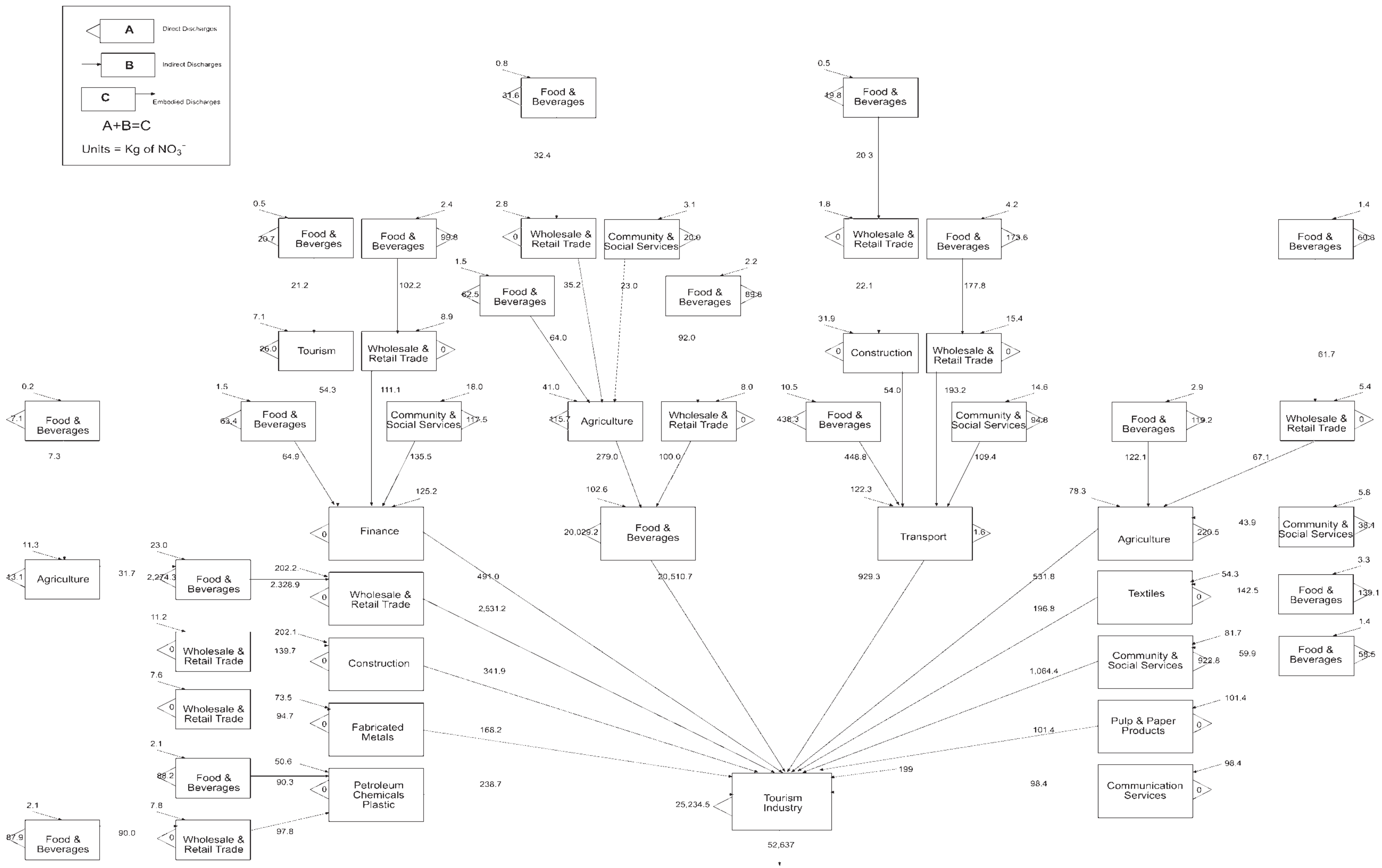


Figure 12. Direct and indirect nitrate outputs from the tourism sector, 1997/98



through the sale of food products (2 531.2 kg). Next ranked inputs from the community and social services sector (1064.4 kg), which is mainly the nitrate contained in "tourism" effluent being released by sewage treatment plants.

All other first-round input categories were below 1000 kg of nitrate (Figure 12).

Ultimately, many of the indirect inputs of nitrate track back to second-, third-, or fourth-round inputs from the food and beverages sector, with some tracking back to community and social services (sewage treatment) and agriculture. This is due to the relatively high nitrate discharges from these sectors.

3.4.6 Phosphorus outputs

Direct discharges

Just over half (51.7%) the phosphorus discharged by the tourism industry was discharged directly (179 111.6 kg), mostly from agricultural and food and beverage activities attributed to the tourism sector in the tourism satellite accounts (Figure 13).

Indirect discharges

Indirect discharges of phosphorus from the tourism industry amounted to 167 196.4 kg. The largest component of these was from the community and social services sector (57 562.9 kg). Almost all of the phosphorus was contained in treated sewage effluent originating from the tourism sector.

Next highest was phosphorus embodied in Agriculture inputs used by the tourism sector (40 249.3 kg), mostly from on-farm discharges, with very little indirect phosphorus flows embodied in inputs into farms.

Food and beverages inputs into the sector also had much embodied phosphorus. Firstly, food directly purchased from the food and beverages sector contained 27 463 kg of phosphorus – a complex array of indirect inputs flowing into food production have a high embodied phosphorus content (Figure 13). Secondly, food and beverages supplied through the wholesale and retail trade sector also contained significant embodied phosphorus (3118.3 kg).

Other first-round inputs that had a significant embodied phosphorus content included finance, insurance and real estate; transport; the wholesale and retail trade; construction; textiles; and communication services (Figure 13).

Ultimately, many of these indirect effects can be again tracked back to the third or fourth rounds where just a few, key sectors (agriculture and community and social services) record relatively high levels of phosphorus outputs, e.g. in the sewage of service sector employees, treated by sewerage plants – part of the community and social services sector (Figure 13).

3.4.7 Biological oxygen demand

Direct BOD

The BOD from direct discharges from the tourism sector was about a million kilograms, or 57.1% of BOD from both direct and indirect discharges (Figure 14). Most of this was not from the "traditional" tourism activities (e.g. accommodation complexes, restaurants) but from agricultural and food and beverages activities attributed to the tourism sector in the tourism satellite accounts.

Indirect BOD

The largest indirect BOD content (329 681 kg) was embodied in the inputs purchased from the community and social services sector. This was tourism sector effluent treated and disposed of by sewage plants. The amount of sewage produced by large hotel and motel complexes represented a considerable proportion of this.

Next in the ranking, in terms of embodied BOD content, were agriculture and food and beverages inputs into the tourism sector. Agriculture inputs had an embodied BOD content of 123 400 kg, mainly consisting of direct BOD pollution on farms. Food and beverages directly purchased by the tourism sector had a BOD content of 97 542 kg and those indirectly purchased through the wholesale and retail trade sector accounted for another 11 076 kg. The backward linkages for food and beverages are quite complex and involved considerable discharges of BOD at the agricultural production stage.

Somewhat surprisingly, transport was a significant indirect input of BOD (51 176 kg), mainly because of the quantity of sewage (34 288 kg) produced by the transport industry that needs to be treated and disposed of.

Figure 13. Direct and indirect phosphorus outputs from the tourism sector, 1997/98.

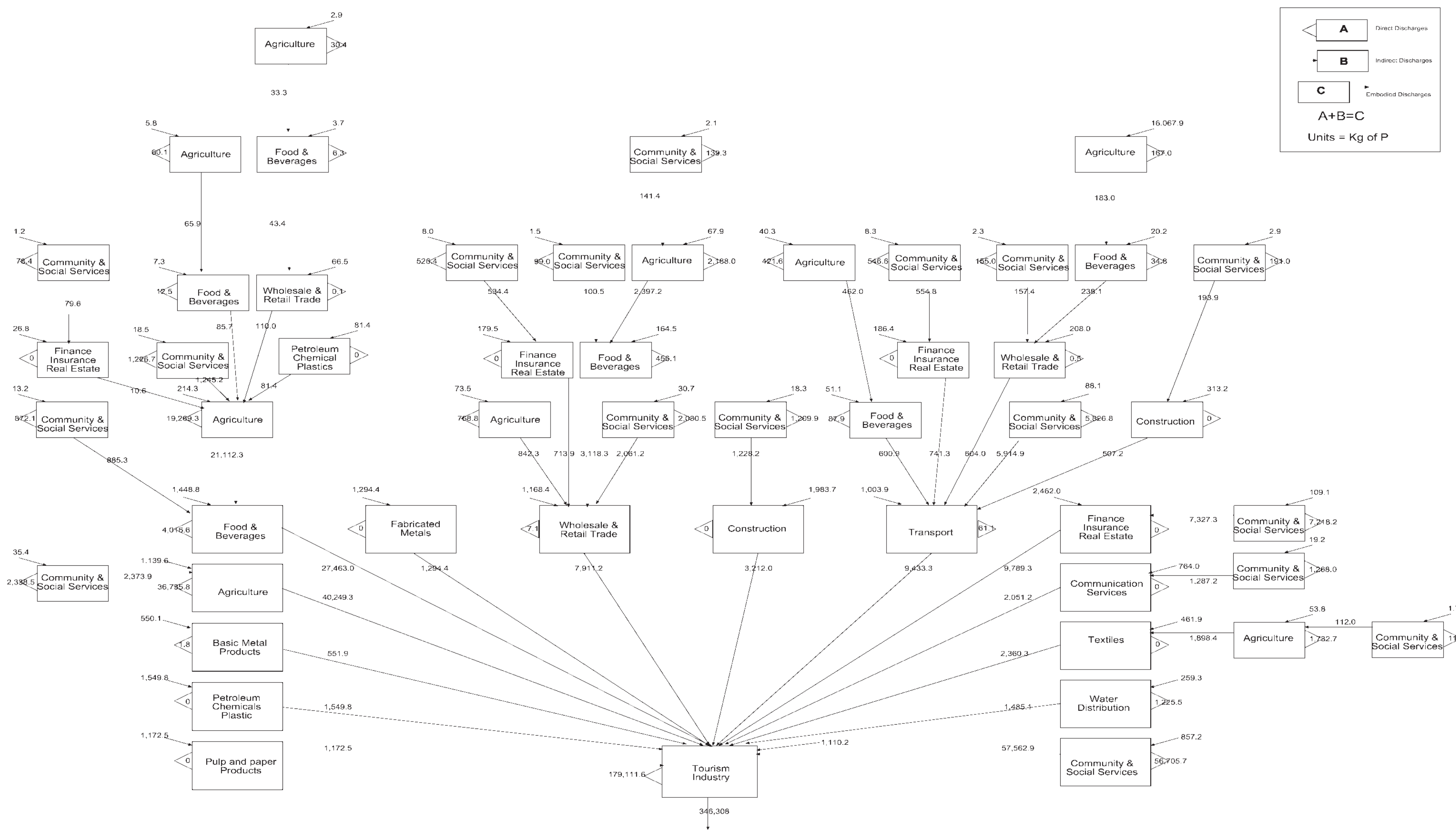
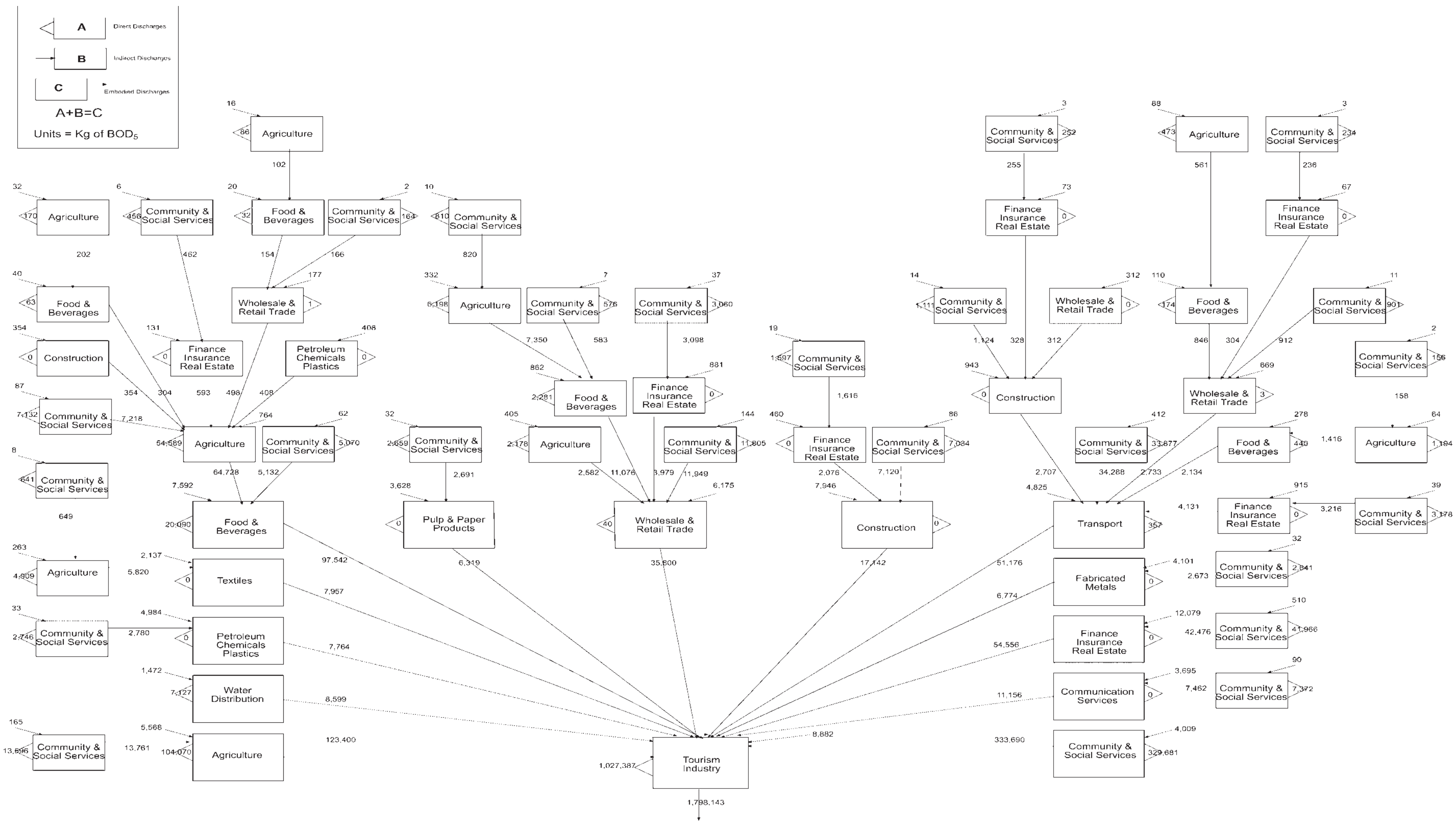


Figure 14. Direct and indirect BOD_5 outputs from the tourism sector, 1997/98.



Similarly, the disposal of tourism sector effluent by the community and social services sector explains much of the embodied BOD content of the service sector inputs into the tourism sector. For example, the finance, insurance and real estate sector input an embodied BOD content of 54 556 kg into the tourism sector, of which 41 966 kg was from sewage effluent (Figure 14).

3.4.8 Carbon dioxide emissions

Direct emissions

Direct CO_2 emissions from the tourism sector were very considerable, with over 4 million tonnes produced from aircraft operation alone (Figure 15). The total (internal and international flights) was equivalent to 24.3% of the total CO_2 emissions across the entire New Zealand economy. International air travel by overseas tourists accounted for most of the aircraft CO_2 emissions (3 561 591 t), with domestic air travel accounting for 1 438 361 t.

There were direct CO_2 emissions from other activities that make up the domestic tourism industry, e.g. accommodation complexes and retail trade, but these were relatively minor, collectively amounting to 777 280 t.

Overall, the direct CO_2 emissions by the tourism sector amounted to almost 5 million tonnes in 1997/98. This represents 73.6% of the total CO_2 emissions by the tourism sector in that year.

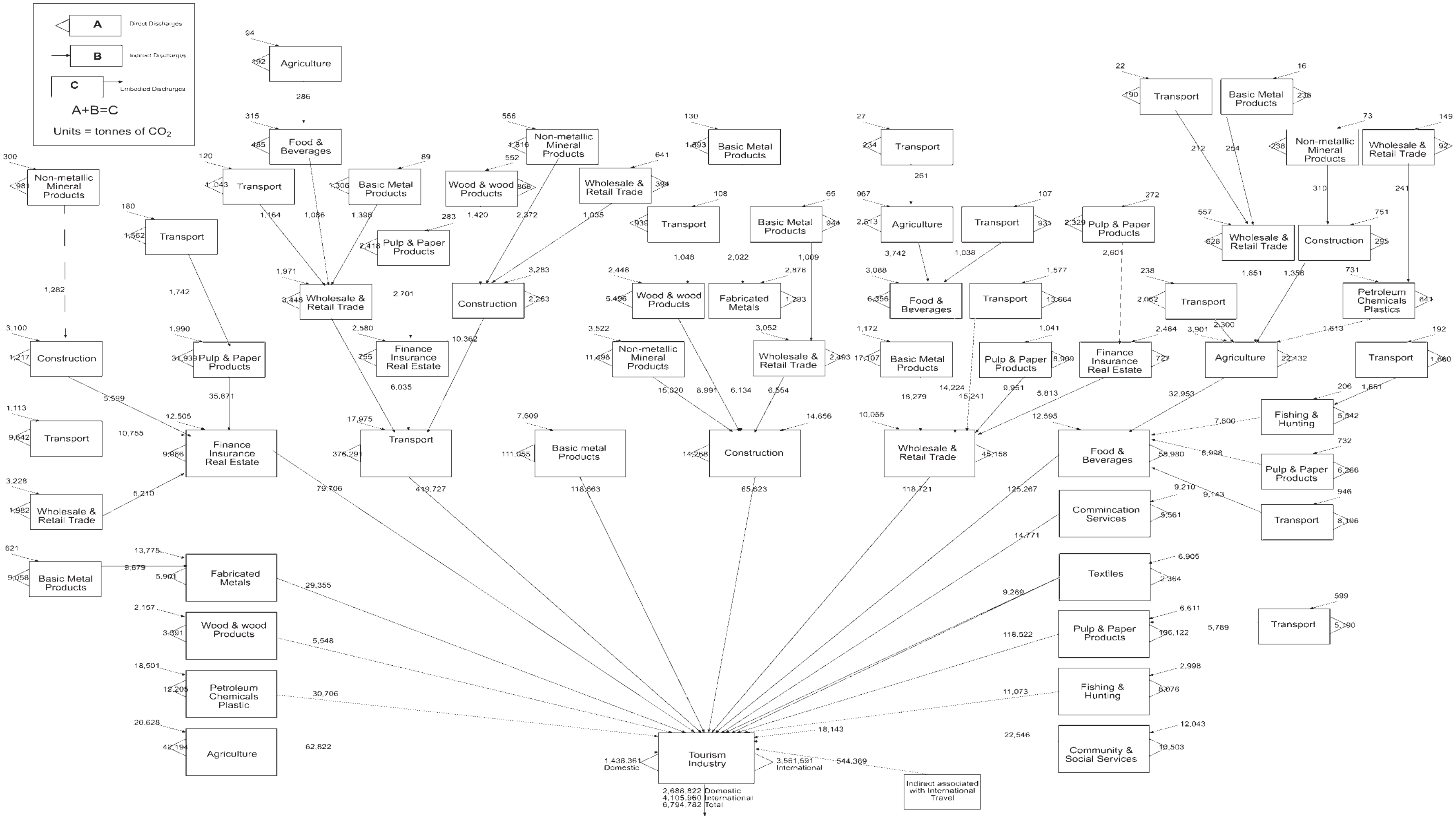
Indirect emissions

The largest category of indirect CO_2 emissions related to infrastructure and services required to support international air travel (e.g. runways, air terminal buildings, booking services). This was estimated at 544 369 t CO_2, but unfortunately this aggregate figure cannot be further broken down.

Next ranked were transport sector inputs into the tourism sector (419 727 t CO_2). Most of these were transport services purchased from non-tourism operators. The purchase of food and beverages was also significant in terms of indirect CO_2 emissions. Purchases directly by the tourism sector accounted for 125 207 t CO_2, with another 14 224 t CO_2 embodied in purchases of food and beverages through the wholesale and retail trade.

The purchase of pulp and paper products was also important, accounting for 118 522 t of embodied CO_2. This included such products as paper cups, towels, office paper and other disposable items. A very similar quantity (118 721 t CO_2) was associated with wholesale and retail inputs into tourism. Surprisingly, CO_2 emissions embodied in finance, insurance and real estate inputs were considerable (79 706 t CO_2), most significantly explained by the 35 671 t CO_2 embodied in paper products used. Construction materials also had significant amounts of embodied CO_2, most notably, in basic metal products (118 663 t CO_2) (Figure 15).

Figure 15. Direct and indirect CO_2 outputs from the tourism sector, 1997/98.



4. Projections of Future Environmental Impacts of the Tourism Sector

4.1 Rationale and conceptual framework

There is a history of "forecasting" tourist arrivals in New Zealand, dating back to the work of Hunn (1985) and McDermott and Jackson (1985). McDermott and Jackson (1985) undertook a study for the New Zealand Tourist Industry Federation that used econometric (regression) equations to predict arrivals into New Zealand and Australia. Their analysis, to some extent, differentiated between various types of tourists (holiday makers, visiting friends and family). The main determinants of arrivals were found to be income, airfares and prices, with elasticities calculated for each of these variables. Similar studies were repeated by McDermott Miller (1988, 1989) for the New Zealand Tourist and Publicity Department.

Patterson (1995) built on this earlier experience to use regression equations (linear and log-linear) to forecast arrivals from 20 countries across three tourist types (holiday, friends and relatives, business). Patterson's (1995) study, which was more comprehensive that its predecessors, confirmed the importance of GDP in the origin country (as a measurement of income), it being the most powerful explanatory variable in all markets, with typically CPI, exchange rates, and cost of airfares having a lesser effect.

Goh and Fairgray's (1999a) analysis covered a similar number of international markets to Patterson's (1995) study, but extended the regression analysis to cover a wider range of independent variables (income, own price, substitute price, exchange rate, relative price index), as well as incorporating lagged effects. Goh and Fairgray (1999b) also derived regression-based forecasts for the domestic market (i.e. New Zealand tourists within New Zealand).

McDermott Fairgray Group (2001a) essentially replicated the Goh and Fairgray (1999a,b) studies, with increased detail on the regional spread of arrivals, as well as covering, for the first time, predictions of outbound New Zealand tourists to overseas destinations. They also forecasted the length of stay and expenditure of overseas tourists. (McDermott Fairgray Group 2001a,b,c,d). Parallel academic research in New Zealand has focused more on methodological and model development issues (rather than reporting actual forecasts) – e.g. Turner et al. (1995, 1997).

The emphasis so far in New Zealand tourism research has been to *forecast arrivals*, which can be linked with data from satellite accounts to measure the future economic impacts of tourism. These forecasting exercises not only attempt to predict future arrivals but, as McDermott and Jackson (1985) point out, are useful in quantitatively understanding the relationship between the "economic drivers" (income, price, exchange rate) and resultant tourism activity.

The purpose of this section is to extend these economic forecasts to cover also environmental aspects. It is important that tourism planners, the tourism industry, and other stakeholders in the industry not only understand the economic implications of future tourism growth, but also understand the environmental impacts. The analytical framework for doing this is outlined in Figure 16.

Tourism Activity (Box 1) forecasts are obtained from regression-based forecasts abstracted from McDermott Fairgray Group (2001a,b) for both the international and domestic tourist markets. The determinants of future international tourist numbers (visitor nights, arrivals) are: income of the visitor (GDP proxy), own price, substitute price, exchange rate, long-term departures and arrivals, relative price index, New Zealand GDP, and dummy variables for extraordinary events. There are fewer determinants for the domestic forecasts: GDP, private travel cost index, and domestic visitor nights from the previous year.

Intensity of Tourism Activity (Box 4). These forecasts are essentially measured in terms of the "ecological footprint per visitor night". That is, the amount of direct and indirect resources (land, energy, water) consumed per visitor night; and the direct and indirect pollutants (CO_2, BOD, nitrate, phosphorus, water discharges) produced per visitor night. These footprints change each year, as technology and management practices either improve or deteriorate – this is taken account of by measuring shifts in the technical change coefficients for each category of resource use and pollutant production. For example, the energy use may decrease each year due to improvements in the efficiency of the aircrafts that tourists use.

The data on tourism activity (Box 4) are multiplied by the data on intensity of tourism activity (Box 1) to obtain the *Environmental Pressures* (Box 5) exerted by the tourism industry. That is, the e*nvironmental pressures* (resources used, pollutants produced) are calculated by:

$$P = A \times I$$

where: P = *Environmental pressures* (e.g. tonnes of CO_2 per year)
A = *Tourism activity* (e.g. number of visitors per night for a given market)
I = *Intensity of tourism activity* (e.g. tonnes of CO_2 per visitor night).

(The equation "P = A × I" is reminiscent of the famous Ehrlich/Commoner equation used in the early 1970s to understand the relationships between population (≈A), affluence (≈I) and environmental impact (≈P).)

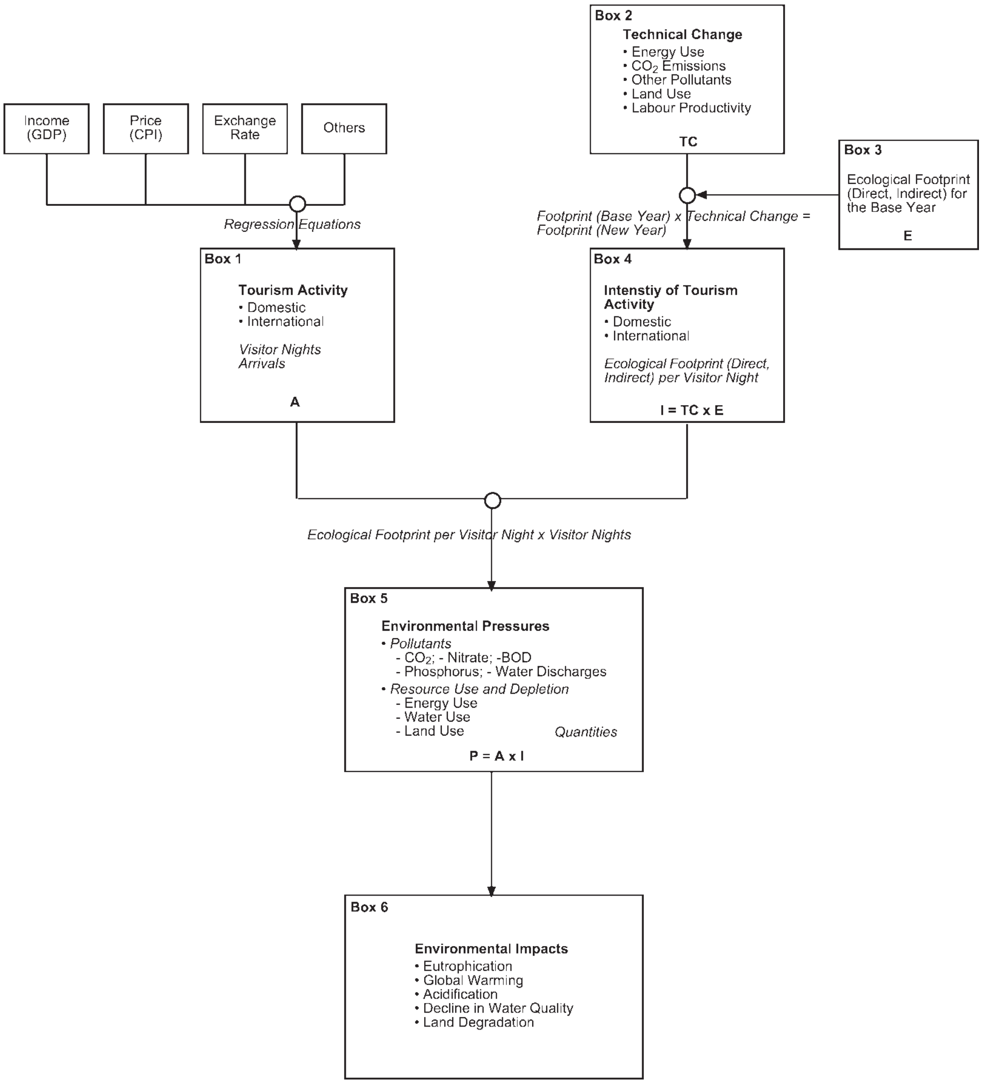


Figure 16. Analytical framework for the projection of future environmental impacts of the tourism sector.

Although not attempted in this study, the last step in the analysis could be to convert the "environmental resources" (Box 5) to actual *Environmental Impacts* (Box 6) such as eutrophication, global warming and acidification. This could be readily achieved applying Adrianese's (1993, 1996) eutrophication equivalents, global warming equivalents and acidification equivalents to the environmental pressures data that we measured in this study. These are standard equivalents, which, for example, measure the eutrophication effect of a tonne of phosphorus, given certain assumptions.

4.2 Methodology

4.2.1 Forecasting philosophy

The purpose of the analysis presented here in Section 4 is to estimate future levels of resource use and pollution in the tourism sector. There is a healthy debate in the literature over the philosophical basis and validity of such methods.

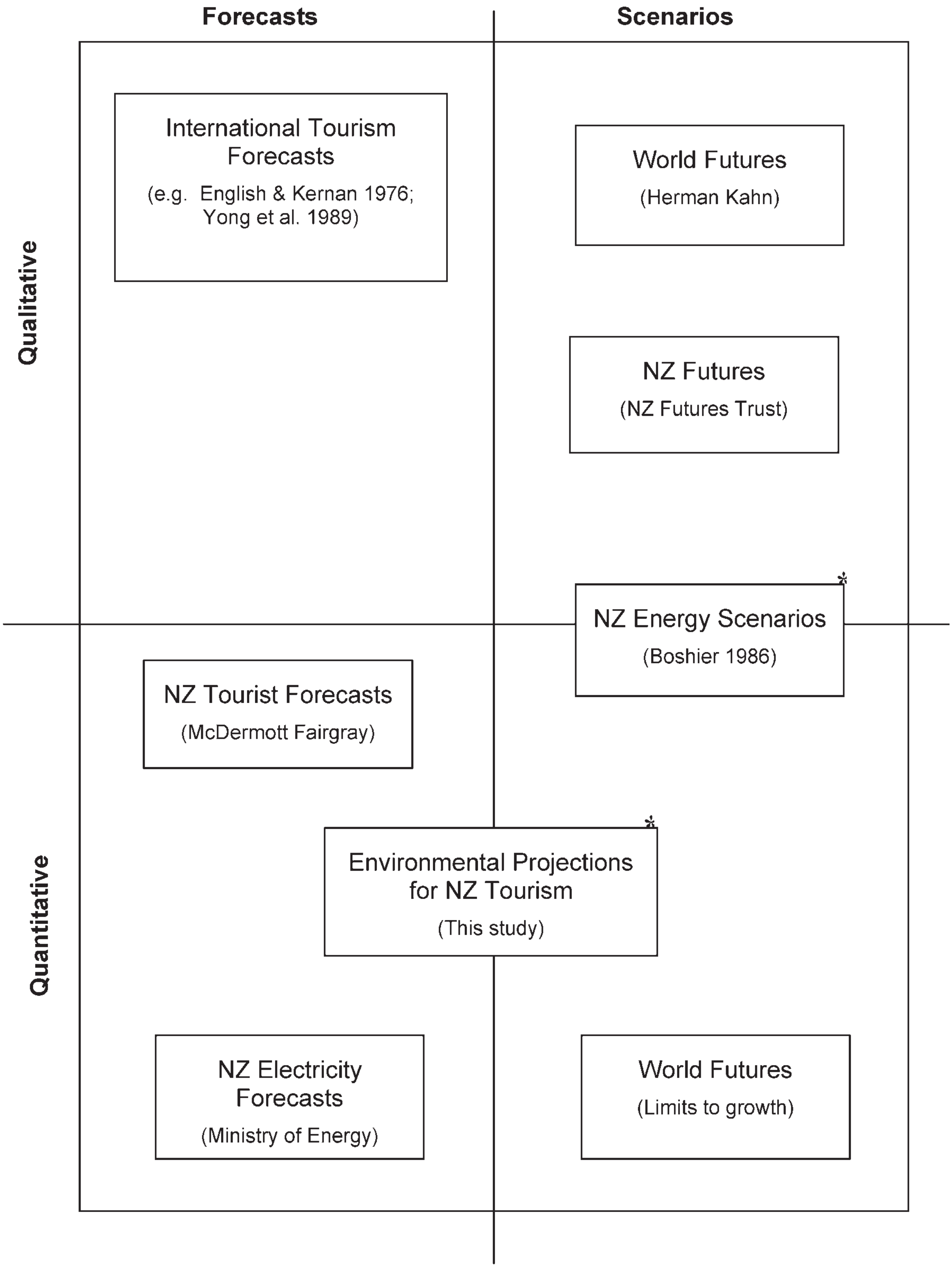


Figure 17. Different forecasting/scenario approaches for projecting future impacts.

* These studies demonstrate characteristics of more than one Quadrant in this schematic diagram

It is possible to classify different future projection methods according to the 2 × 2 typology outlined in Figure 17. On one dimension of the typology it is possible to draw a distinction between "forecasting" and "scenario" methods. Forecasting methods attempt to *predict* the future with respect to a few key variables – in this case resource use and pollution in the tourism sector. There has been much debate about the validity of such methods, with many arguing that complex economic, social and environmental variables are too difficult to predict into the future due to inherent complexities and uncertainties (Schwartz 1991). Another line of criticism of forecasting is that the method *perpetuates the status quo*, not allowing for the possibility of other alternative futures that decision makers should consider apart from the one predicted.

Such criticisms have led to the development of the "scenario" method (Schnaars 1987). The scenario method is not about predicting the future, as this is argued to be both infeasible and undesirable. Instead, it is about presenting decision makers with alternative (plausible) scenarios of future developments, so that they can weigh up and consider the implications of each.

Forecasts can be both "qualitative" and "quantitative". Typically, in tourism forecasting, the methods employed are quantitative, as these are seen to be more rigorous and scientific (Crouch 1994; Smeral & Weber 2000). Regression-based models are typically used to produce forecasts of future tourism activity, based on quantitatively analysing and statistically verifying historical data for trends and structural relationships. Certainly, the history of tourism forecasting in New Zealand has been dominated by such approaches, e.g. Hunn (1985), McDermott & Jackson (1985), Patterson (1995), Turner et al. (1995), Goh & Fairgray (1995) and McDermott Fairgray Group (2000 a,b,c,d). However, qualitative forecasting methods have been used by overseas researchers, e.g. particularly the Delphi method, where experts anonymously predict future developments in tourism demand. Such methods have been used since the 1970s in projecting future levels of tourism activity (English & Kearnon 1976; Yong et al. 1989).

Scenario methods can also both be "qualitative" and "quantitative", as well as some being a mixture of both approaches. The strongest proponent of the qualitative approach to scenarios has been Kahn (1979), who developed scenarios for the future of the United States and the world based on narratives. Perhaps the best example of quantitative scenarios is the "Limit to Growth" study, which used a computer model to explore various scenarios for world development in the light of resource depletion and other environmental constraints (Meadows et al. 1972).

The approach used in this study is to produce three scenarios that highlight the difference between three different levels of technological improvement:

Projection A: No technical change over the period 1997–2007

Projection B: Mid-range technical change over 1997–2007 – based on the idea there will be some slowdown in historical rates of technical change

Projection C: Continuation of historical levels of technical change over 1997–2007

All three projections (scenarios) are leveraged off "forecasts" of tourism arrivals by McDermott Fairgray Group (2001 a).

The projections used in this study are considered to be scenarios not forecasts. Whether it is meaningful to "forecast" or "predict" tourism-related variables is indeed debatable. Fundamentally, it is assumed that the relationships observed in past trends are persistent, which may be a reasonable assumption up to say five years in a stable operating environment. However, unpredictable events, such as the 11 September disaster alone, make forecasts very prone to error[24]. Furthermore, the inclusion of environmental (resources and pollutants) variables in the current study adds to the uncertainty, which makes predictive forecasting very difficult and problematical. Hence, our more cautious approach of using "projections" (scenarios) rather than forecasts.

[24] In energy planning in New Zealand, forecasts have been widely criticised for being misleading. For example, Boshier (1986) cites examples of how econometric (regression)-based forecasts overpredicted electricity demand increases in the 1970s and led to an overinvestment in hydro-capacity; as well as how international forecasts of oil prices have also been notoriously unreliable. Generally, forecasts of tourism arrivals in New Zealand have been more successful due to the persistence of existing trends – only one-off events such as the Asian financial crisis and 11 September 2001 disaster have caused major departures from forecasted values.

4.2.2 Analytical steps

Figure 18 outlines the analytical process used to project future environmental pressures and impacts for the New Zealand tourism sector. This involved the following steps:

Step 29: *"Projection A" Based on No Technical Change.* These projections were undertaken for international tourists and domestic tourists separately, as well as disaggregating the resource use and pollutants levels on the basis of direct and indirect effects. On this basis, projections of resource use and pollutants were calculated by multiplying "visitor nights" by the "resources/pollutants per visitor night". These projections were made for 1997–2007, and assumed no technical change. Actual (1997–2000) and forecasted (2001–2007) "visitor nights" used in these calculations were obtained from McDermott Fairgray Group (2000a).

Step 30: *Projected Technical Change for Energy and CO_2 Intensities.* Tourism ratios were used to disaggregate the tourism sector into a number of sub-sectors for analysis: hotels, commercial buildings, air transport, bus transport, rail transport and the rest of the economy. The historical trends in the energy (and CO_2) intensities for these sub-sectors were determined by using time series regression models, and these models were then used to project future energy (and CO_2) intensities for each sub-sector. These sub-sector analyses were then combined in an index (based on GDP weights) for the tourism sector. The data for this analysis were obtained from EECA (1996, 2000, 2001) and Baines & Brander (1991, quoted in EECA 2000).

Step 31: *Forecasted Technical Change for Water Use, Water Pollutants and Land Intensities.* The historical change in water use and water pollutants (m^3, nitrate, phosphorus, BOD) intensities were calculated using partial data from the *Eco*Link database. From the *Eco*Link database changes in the intensities can be measured from 1994/95 to 1997/98 for the Northland, Auckland and Waikato regions, on a 48-sector basis. Ideally, more than two points in time and a greater number of regions are needed to establish clear trends. The land intensity data in *Eco*Link are only obtainable for 1997/98 so no trends can be firmly established for land. Nevertheless, data obtained from McDonald & Patterson (2003) indicate a rate of change in land intensity (ha/$) of about 1% per year reduction, and this figure was used in this analysis. The average rate of change in these intensities estimated from the historical data series (for land and water) was used to project future rates of change for 1997–2007.

Step 32: *Projected Technical Change for Labour Productivity*. There is a significant history of labour productivity research in New Zealand (Orr 1988; Philpott 1996) that was drawn upon to calculate an average rate of labour productivity change over the 1978–1999 period, which was used to project forecasts for 1999–2007.

Step 33: *Projected Technical Change Matrix for the Tourism Sector.* The projected intensities: for energy and CO_2 (Step 30); water use, water pollutants and land use (Step 31) and labour intensity (Step 32), were all normalised at unity for the base year of 1997. If the technical change coefficient for a particular resource decreases below unity, this means that relative to the base year the intensity (resource/$; pollutants/$) has decreased and, therefore, there has been an improvement in eco-efficiency.

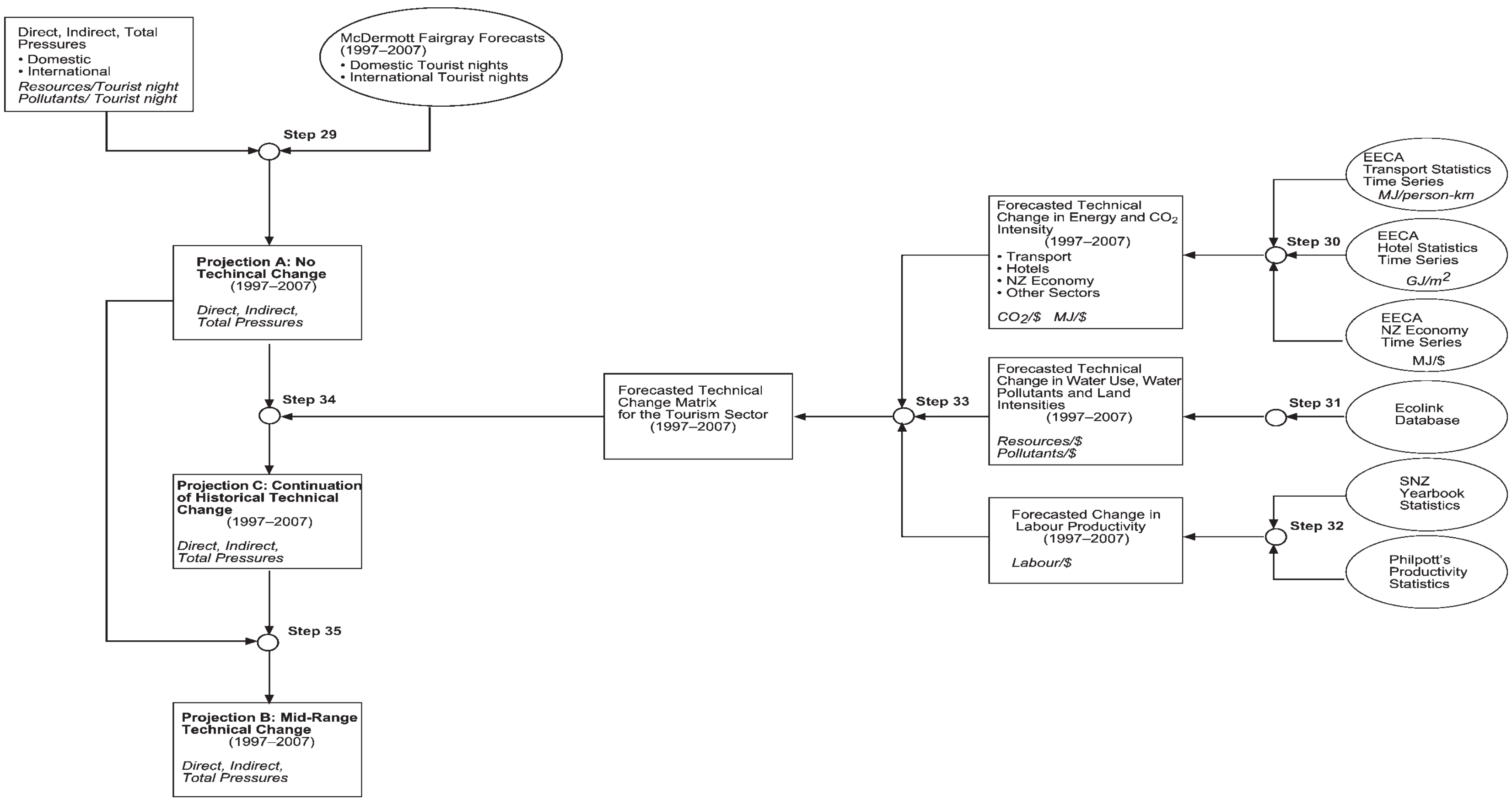
Step 34: *"Projection C" Based on a Continuation of Technical Change.* The matrices of data produced in Step 29 (Projection A) are multiplied by the appropriate rows in the technical change matrix. This results in a forecast based on a continuation of technical change improvements, which were generally observed over the last two or three decades. These resultant forecasts are disaggregated according to tourist type (international, domestic) as well as distinguishing between direct and indirect effects for resource use and pollutants.

Step 35: *"Projection B" for Mid-Range Technical Change.* A mid-range projection was produced, which lies midpoint between the estimates obtained for Projections A and C. This is termed Projection B. The reason for producing Projection B is that it seems to be overly optimistic that the rate of technical change observed over the last two or three decades will continue. There is good evidence that there will be a slowdown in technical change ratios for at least some resources, particularly those relating to energy use and CO_2 emissions, e.g. Penner et al. (1999) present data that demonstrate a slowdown in the technical efficiency of aircraft operation. On this basis, "Projection B" could be considered to be the most realistic and most likely to represent future levels of resource use and pollution in the tourism industry.

4.3 Projected tourism activity (1997–2007)

Data on projected (and actual) levels of tourism activity were obtained from McDermott Fairgray Group (2001a) for international tourists to New Zealand; and from McDermott Fairgray Group (2001c) for domestic tourism.

Figure 18. Methodological process for projecting future environmental impacts of the New Zealand tourism sector.



4.3.1 International tourism activity and its determinants

Tourist activity 1997–2000

Reliable data on actual tourism arrivals into New Zealand over the 1997–2000 period are available from McDermott Fairgray Group (2001a). These data on tourism activity can also be disaggregated by country of origin (27 countries) and type of visitor (Tables 32, 33 and 34). For comprehensive details of this historically disaggregated data, readers are advised to refer to the McDermott Fairgray Group (2001a) publication.

Table 32. Actual and forecasted visitor arrivals to New Zealand, 1980–2007

Year	Holiday (000's)	VFR (000's)	Business (000's)	Other (000's)	Total (000's)
1980	249.8	101.2	50.8	63.3	465.2
1981	254.1	108.0	54.3	61.7	478.0
1982	253.1	113.6	57.9	57.2	481.7
1983	276.9	116.3	59.3	55.9	508.5
1984	319.3	124.2	67.2	56.9	567.6
1985	392.0	137.6	73.9	66.1	669.6
1986	426.3	151.6	75.8	79.8	733.4
1987	463.0	182.2	82.3	116.7	844.3
1988	441.3	206.9	99.7	117.0	864.9
1989	449.6	220.3	105.0	126.2	901.1
1990	489.7	234.8	110.4	141.1	976.0
1991	498.0	236.6	99.6	129.3	963.5
1992	559.7	261.9	112.4	121.8	1055.7
1993	661.1	259.5	120.1	116.2	1157.0
1994	765.2	280.0	135.7	141.7	1322.6
1995	799.7	306.7	151.3	151.1	1408.8
1996	848.6	346.7	163.8	169.7	1528.7
1997	806.0	350.5	170.2	170.5	1497.2
1998	741.7	386.4	179.6	176.9	1484.5
1999	820.0	412.0	191.6	183.7	1607.2
2000	929.2	476.4	200.6	180.5	1786.8
2001 (f)	1014.9	509.7	212.1	198.7	1935.4
2002 (f)	1078.4	548.3	226.9	209.3	2062.9
2003 (f)	1150.7	574.0	239.5	219.2	2183.4
2004 (f)	1220.0	611.4	253.9	229.3	2314.6
2005 (f)	1298.0	646.1	269.4	240.6	2454.1
2006 (f)	1379.9	687.2	288.5	251.7	2601.3
2007 (f)	1415.2	723.3	306.8	262.3	2743.7

Note: (f) denotes a forecast.

Table 33. Percentage increases in actual and forecasted visitor arrivals to New Zealand, 1983–2007

Period	Holiday (%)	VFR (%)	Business (%)	Other (%)	Total (%)
1983–87	10.8	9.4	6.8	15.8	10.7
1988–92	4.9	4.8	2.4	0.8	4.1
1993–97	4.0	6.2	7.2	8.0	5.3
1998–02 (f)	7.8	7.2	4.8	3.4	6.8
2003–07 (f)	4.8	4.7	5.1	3.7	4.7

Note: (f) denotes a forecast.

Table 34. Forecasts of visitor arrivals to New Zealand, by country of origin, 2001–2007

Major markets	Actual (000's)					Forecasts (000's)				Annual average (%)
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2000-2007*
Australia	523.4	573.9	615.5	647.5	673.6	706	750.5	797.3	839	5.6
United States	180.9	195.8	200	205.9	213.7	221.3	228.9	235.7	242.9	3.1
Canada	33.3	33	35.3	36.9	38	39	40	40.6	41.3	3.3
South America (4)	9.8	11.3	12.1	13.1	13.9	14.7	15.7	16.6	17.7	6.7
Japan	147.3	151.4	163.8	175.4	187.5	198.8	210.1	222.8	233.9	6.4
Taiwan	40.2	40.8	41.4	43.2	46.7	49.6	51.5	54.4	56.9	4.9
Hong Kong	29.7	29.9	31.1	32.2	33.3	35	36.8	38.3	39.7	4.1
South Korea	43.2	66.6	80.6	93.9	105.8	114.3	121.9	128.8	135.2	10.6
China	23.3	33.5	44.7	52.2	59.6	67.8	76.2	85.4	96.6	16.3
Singapore	33.9	35.7	37.7	39.6	41.4	43.3	45.1	47	49	4.6
Malaysia	17.2	20.5	21.9	23.3	25.1	27.8	30.5	32.6	34.7	7.8
Thailand	23.2	26.7	26.9	29.4	32	34.8	37.5	40.7	44.1	7.4
Indonesia	6.2	9	9.6	10.3	11	11.9	12.8	13.5	14.2	6.7
India	6.6	8.3	11	12.6	14.2	16.3	18.6	20.9	23.4	15.9
United Kingdom	168.3	200.3	220.7	243.1	262.2	286.1	308.2	336	365.1	9
Northern Europe	22.3	24.6	25.4	26.6	27.9	28.9	30.2	31.3	32.3	3.9
Ireland	7	9.6	10.5	11.4	12.3	13.1	14	15	16.2	7.8
Germany	46.2	51.5	54.9	57.7	60.2	64.3	67.5	69.5	71.1	4.7
Netherlands	19.6	23.9	26.2	28.5	30.5	32.3	34.4	36.8	38.9	7.2
Switzerland	12.1	13.4	14.5	16	17.5	18.7	19.5	20.3	20.9	6.5
Euro 7	28.3	32.5	32.8	35.6	38.6	41.5	44.1	46.6	48.9	6
South Africa	14.9	16.2	17.4	18.8	20.3	21.8	23.3	24.7	26.5	7.3
Other markets	170.3	178.4	201.4	209.5	217.9	227.3	236.9	246.5	255.2	5.2
Total	1607.2	1786.8	1935.4	2062.9	2183.4	2314.6	2454.1	2601.3	2743.7	6.3

Tourist activity 2001–2007

McDermott Fairgray Group (2001a) “forecast” total international arrivals by visitor type (Tables 32 and 33) and by origin countries (Table 34), for the years 2001–2007.

These “forecasts” were derived from a series of regression equations (origin countries × visitor types), which were then added up to derive the totals presented in Tables 32 and 33. The regression equations were determined by examining time series data (1985–2000) for each origin country by visitor type. These equations were found to be very good predictors (R^2 H” 0.90) of the historical time series data.

The explanatory variables used in the regression equations were:

1. *Income of the Visitor.* This was measured by the real GDP of the origin country by McDermott Fairgay Group (2001a). This is widely recognised as the most important driver of tourism numbers (McDermott 1998). Quite simply the more money people have to spend, the more they are likely to spend at least some proportion on tourism activities. Typically GDP alone may explain 80–90% of the variance in tourism numbers (Patterson 1995). GDP forecasts for the countries in the study were obtained from organisations such as the Economist Intelligence Unit, World Bank, OECD and IMF.
2. *Own Price*. The price of the tourism trip is considered to be the second-most important determinant of international tourism activity (McDermott Fairgay Group 2001a). In the McDermott Fairgray Group (2001a) study the consumer price index (CPI) is used as a surrogate for own price, in the absence of reliable cross-country data on the specific price of tourism products. There is a negative relationship between consumer price and tourist demand, as revealed by the regression equation, i.e. the higher the price for tourism, the lower the amount of tourism.
3. *Substitute Price.* This is the price of tourism to New Zealand, relative to other competitive destinations. The CPI of the country of origin is used as a proxy for substitute price in the McDermott Fairgray (2001a) study.
4. *Exchange Rate.* Exchange rate affects the purchasing power of tourists and, therefore, could either encourage or deter tourists. It has consistently been found to be a significant determinant of international tourism arrivals in New Zealand (McDermott & Jackson 1985; Patterson 1995; Goh & Fairgray 1999; McDermott Fairgray 2001a), although some overseas studies (Witt & Witt 1992; Frechtling 1996) question its use.
5. *Long-Term Departures and Arrivals.* Former New Zealand residents return to visit friends and family, which adds to international tourism arrivals in New Zealand. Similarly, New Zealand residents (e.g. from Taiwan) attract international visitors to New Zealand.
6. *Relative Price Index.* The relative price index combines the “own price” and “cross price” effects into a single composite variable.
7. *New Zealand GDP.* The rationale for including this variable is that the higher the New Zealand GDP, the more likely business travellers will be attracted to New Zealand. This variable accordingly was only utilised by McDermott Fairgray Group (2001a) for regression equations of business arrivals.
8. *Dummy Variables.* Dummy variables are used to take account of extraordinary “one-off” events that are not fully captured by the above variables, e.g. Auckland Commonwealth Games in 1990 or the Asian Financial Crisis in 1997. Such “extraordinary events” can be very important determinants of tourism arrivals.

4.3.2 Domestic tourism activity and its determinants

Tourist activity 1997–2000

Reliable data on visitor nights by domestic tourists (i.e. New Zealanders) for 1997–2000 are available from McDermott Fairgray Group (2001b) (Table 35). These data can be used to measure the A (activity) variable in the equation “$P = A \times I$”. Useful data are also available on numbers of domestic trips and mean length of stay for 1982–2000 (Table 36).

Whereas the international tourist market has experienced a steady and sometimes spectacular growth since the early 1980s with a slight dip for the Asian Financial Crisis in 1997, the domestic market has not increased and seems to be prone to cyclical trends. There has also been a strong trend to shorter and more frequent trips in the domestic market over the last decade.

Tourist activity 2001–2007

McDermott Fairgray Group (2001c) “forecast” domestic visitor nights (Table 35), domestic visitor trips (Table 36) and domestic trip length (Table 36).

Table 35. Actual and forecasted (f) domestic tourists: visitor nights, 1982–2007

Year	Visitor nights (000's)	Annual change (000's)	Annual change (000's)
1982	54 502	n/a	n/a
1983	52 175	–2327	–4.3
1984	51 710	–465	–0.9
1985	51 038	–672	–1.3
1986	49 642	–1396	–2.7
1987	48 981	–661	–1.3
1988	48 349	–632	–1.3
1989	49 748	1399	2.9
1990	51 035	1287	2.6
1991	51 497	461	0.9
1992	49 245	–2252	–4.4
1993	48 168	–1077	–2.2
1994	49 486	1318	2.7
1995	50 418	932	1.9
1996	51 274	856	1.7
1997	53 252	1978	3.9
1998	53 449	197	0.4
1999	52 940	–509	–1.0
2000	49 890	–3050	–5.8
2001 (f)	49 251	–639	–1.3
2002 (f)	51 561	2310	4.7
2003 (f)	53 118	1557	3.0
2004 (f)	53 246	129	0.2
2005 (f)	52 748	–498	–0.9
2006 (f)	52 630	–118	–0.2
2007 (f)	53 006	376	0.7

A single regression equation (as opposed to many for the various markets for international tourists) was derived to forecast domestic tourist nights:

$$\ln(\text{Nights})_t = \beta_1 + \beta_2 \ln(\text{GDP})_{(t-1)} + \beta_3 \ln(\text{TCI})_t + \beta_4 \ln(\text{DOM})_{(t-1)} + \beta_5 \ln(\text{DOM})_{(t-2)} + \varepsilon_t$$

where	$\text{GDP}_{(t-1)}$	New Zealand gross domestic product in year t–1
	TCI_t	Private travel cost index in year t
	$\text{DOM}_{(t-1)}$	Domestic visitor nights in year t–1
	ε_t	Stochastic error term in year t

The solved coefficients were:

β_2 (Last year's GDP)	0.23 (t = 3.13, 2P < 0.01)
β_3 (Private travel cost)	–0.44 (t = –2.81, 2P < 0.02)
β_4 (Last year's domestic visitors nights)	0.52 (t = 2.01, 2P < 0.09)
β_5 (Year before's domestic visitor nights)	–0.48 (t = –2.18, 2P < 0.08)

The model had an R^2 of 0.79, indicating that 79% of the variance in domestic nights can be explained by the explanatory variables. A useful property of these log-linear models is that the co-efficient can be interpreted as elasticities, i.e. for an

Table 36. Actual and forecasted (f) domestic tourists: number of trips and mean length of stay, 1982–2007

Year	Domestic trips		Mean length of stay	
	Total (000's)	Yearly change (%)	Total (Nights)	Yearly change (%)
1982	13 390	n/a	4.1	n/a
1983	12 730	–4.9	4.1	0.7
1984	12 670	–0.5	4.1	–0.5
1985	12 540	–1.0	4.1	–0.2
1986	12 170	–3.0	4.1	0.2
1987	12 030	–1.2	4.1	–0.2
1988	11 760	–2.2	4.1	1.0
1989	11 840	0.7	4.2	2.2
1990	12 300	3.9	4.2	–1.2
1991	12 810	4.1	4.0	–3.1
1992	12 570	–1.2	3.9	–2.6
1993	12 630	0.5	3.8	–2.7
1994	13 340	5.6	3.7	–2.7
1995	13 990	4.9	3.6	–2.8
1996	14 650	4.7	3.5	–2.9
1997	15 680	7.0	3.4	–3.0
1998	16 230	3.5	3.3	–3.1
1999	16 600	2.3	3.2	–3.2
2000	16 370	–1.4	3.0	–4.4
2001 (f)	16 470	0.6	3.0	–1.9
2002 (f)	17 540	6.5	2.9	–1.7
2003 (f)	18 350	4.6	2.9	–1.5
2004 (f)	18 640	1.6	2.9	–1.3
2005 (f)	18 670	0.2	2.8	–1.1
2006 (f)	18 790	0.6	2.8	–0.9
2007 (f)	19 060	1.4	2.8	–0.7

Note: (f) denotes a forecast.

elasticity of 0.23, a 1% increase in last year's GDP will lead to a 0.23 increase in domestic tourist nights.

In summary, an analysis of the time series data (1982–2000) indicated that "private cost of travel" was the strongest determinant of the number of domestic tourist nights, with lagged effects for "GDP" and the "previous two years' domestic visitor nights". Based on these data derived from McDermott Fairgray Group (2001c), the forecasts for 2000–2007 were generated (Table 35). They indicate an increase in domestic tourist nights from 2001 to 2004, followed by two years of slight decline in 2005 and 2006.

4.4 Projected technical change (1997–2007)

The technical change ratio measures how much resource is used or pollutants produced per tourist night, relative to the base year. For example, a technical change ratio of 0.63 for direct water use in 2007, means that only 63% of the water used per visitor night in 1997 is being used in 2007. That is, forecasted water use per tourist is projected to decline by 37% due to improvements in technology, behaviour, management procedures and so forth.

In this study, the technical change ratios were derived by projecting historical trends into the future using a linear extrapolation.

In some cases, the constancy of historical linear trends can be tested by regression analysis, but in other cases there are insufficient data to subject it to regression analysis (refer to Section 4.4.2).

4.4.1 Technical change ratios for the tourism sector (1997–2007)[25]

Using the methodology described in Section 4.4.2, technical change ratios were forecasted for direct resource use and pollution by the Tourism sector for the 1997–2007 period (Table 37). For most variables the data were based on forecasted technical change ratios, but in some instances actual technical change ratios were available for 1998. Due to the lack of data that distinguished between international tourists and domestic tourists, the technical change ratio projections were considered to be the same for both groups.

The water pollutants (phosphorus, BOD, nitrate) had the highest rate of technical change with ratios of 0.48, 0.64 and 0.68 respectively, over the 1997–2007 period (Figure 19). This means, for example, that for nitrate (technical change ratio = 0.48) that the amount of direct nitrate emission per tourist was forecasted to drop by 52% or 4.28% per annum. The relatively high rate of reduction of phosphorus/tourist, BOD/tourist, and nitrate/tourist could be explained by the early (and relatively easy) gains that are to be expected in an area of new initiative; unlike energy for example, which has been the subject of attention for 30 years, only in relatively recent times with the Resource Management Act 1991 have these pollutants been subject to close scrutiny[26].

The technical change ratios for land, energy (domestic), CO_2 and employment are less spectacular, however, and probably reflect the fact that over the historical period (1975–1998) gains have slowed as the limits to improvement in these areas have been approached.

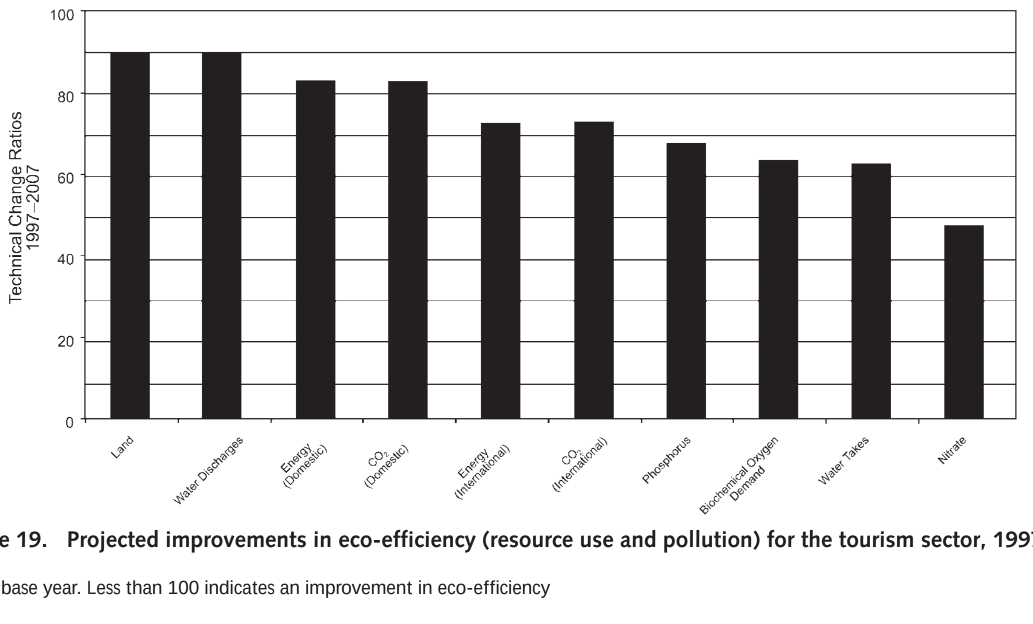


Figure 19. Projected improvements in eco-efficiency (resource use and pollution) for the tourism sector, 1997–2007.

100 = base year. Less than 100 indicates an improvement in eco-efficiency

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[25] Technical change ratios, for the "rest of economy" were also derived from historical data and incorporated into the indirect resource inputs and pollutant flows. These were derived from the same sources of data as for the direct tourism sector data, except for indirect energy inputs and CO_2 emissions for the international data, which were derived from technical change data collected by the International Energy Agency (1997).

[26] The technical change ratios for the water pollutants are linear extrapolations of *Eco*Link data for Northland, Auckland and Waikato for the 1994/95 to 1997/98 period, so these comments about the technical change ratios really relate to behaviour and attitudes over this period rather than the forecasting period 1997–2007. Whether these technical coefficient changes for Northland, Auckland and Waikato will persist into the future at this high rate is debatable and this is partly the reason behind estimating the mid-range projections.

Table 37. Projected technical change ratios: for direct resource use intensities and direct pollutant intensities for the tourism sector, 1997–2007

Year	Resources				Pollutants					
	Energy (Domestic travel)	Energy (International travel)	Water takes	Land	Biochemical oxygen demand	Nitrate	Phosphorus	Water discharges	CO_2 (Domestic travel)	CO_2 (International travel)
1997	1.000(A)	1.000(A)	1.000(A)	1.000(A)	1.000(A)	1.000(A)	1.000(A)	1.000(A)	1.000(A)	1.000(A)
1998	0.9776(A)	0.9857(A)	0.9408	0.9900	0.9424	0.9160	0.9485	0.9755	0.9776(A)	0.9857(A)
1999	0.9980	0.9716	0.8852	0.9801	0.8881	0.8391	0.8997	0.9515	0.9980	0.9716
2000	0.9715	0.9488	0.8413	0.9703	0.8455	0.7765	0.8622	0.9377	0.9715	0.9488
2001	0.9411	0.9177	0.7996	0.9606	0.8049	0.7185	0.8261	0.9240	0.9411	0.9177
2002	0.9228	0.8867	0.7679	0.9510	0.7742	0.6717	0.7998	0.9199	0.9228	0.8867
2003	0.9045	0.8557	0.7373	0.9415	0.7447	0.6280	0.7743	0.9159	0.9045	0.8557
2004	0.8882	0.8246	0.7080	0.9321	0.7163	0.5871	0.7496	0.9118	0.8882	0.8246
2005	0.8699	0.7935	0.6799	0.9227	0.6889	0.5489	0.7257	0.9078	0.8699	0.7935
2006	0.8516	0.7625	0.6529	0.9135	0.6626	0.5132	0.7025	0.9038	0.8516	0.7625
2007	0.8333	0.7315	0.6269	0.9044	0.6373	0.4798	0.6801	0.8998	0.8333	0.7315

Note: (A) denotes an actual value. All other values are forecasts.

The superior gains in energy (international) and CO_2 (international) are due to the continued projected improvements in airline operations. The gains in airline improvements are only partially reflected in the domestic figure, as air transport is only part of the domestic energy and CO_2 figures, but makes up all of the international figures (1997–2007).

Historical data (1994/95 – 1997/98), which are projected into the future (1997–2007) for water discharges, have relatively low technical change ratios, compared with the data for pollutants contained within this water. This is because although there have been improvements in removing nitrate, phosphorus and BOD from the water discharges, the total volume of water discharged has not been reduced to the same extent, although it is "cleaner".

4.4.2 How the technical change ratios (1997–2007) were calculated

The technical change ratios for the tourism sector were calculated using historical data derived from a variety of sources[27]. Trends in these historical data were then used to forecast future changes in the technical change ratios.

Domestic use energy and CO_2 emissions

Time series regressions were undertaken of the tourism sub-sectors (or sectors that could be used as proxies for various tourism sub-sectors) (Table 38). These equations, usually based on 24 years of data (1975–1998), were used to project future technical change ratios for tourism sector energy use and CO_2 emissions. For full details of how the calculations were undertaken refer to Step 30 of the methodology section.

Analysis of the historical trends in energy use intensities for the tourism sub-sector exhibited good times-series (linear) trends for air transport (coefficient = "0.08, R^2 = 0.79), hotels (coefficient = "0.05, R^2 = 0.94), commercial buildings (coefficient = "20.02, R^2 = 0.75) and the New Zealand economy (coefficient = "0.09, R^2 = 0.85)(Table 38). For all of these sub-sectors, there was a consistent downward trend, as reflected in the negative coefficients and relatively high R^2 value. There was, however, no discernible trends for both rail and bus transport, i.e. the technological efficiency remained unchanged over the 1975–1998 period.

This is a valid assumption if it can be presumed that the mix of energy inputs remains constant over the forecasting period – under these circumstances any change in the technical change ratio for energy use will lead to the same change in the technical change ratio for CO_2. If, however, there is a change in the energy input mix over the forecasting period, the two technical change ratios (for energy and CO_2) may not change coincidentally.

Details of the time series regression analysis, and the subsequent forecasts of the variables, are presented in Table 38 and can be found in Appendix D.

Table 38. Time series analysis of direct energy and CO_2 intensities for the tourism sub-sectors, 1975–2000

Tourism sub-sectors	Indicator	Time series covered	Constant	Coefficient	R^2
Air transport	MJ/person-km	1975–1998	158.93	–0.08	0.79
Rail transport	MJ/person-km	1975–1998	–6.53	0.00	0.03
Road transport (Buses)	MJ/person-km	1975–1998	–0.67	0.02	0.06
Hotels	GJ/m^2	1991–1995	96.93	–0.05	0.94
Commercial	GJ/$million	1990–2000	40 859.00	–20.02	0.75
NZ economy	TJ/$million	1980–2000	180.67	–0.09	0.85

[27] Technical change ratios were also calculated for indirect resource inputs and outputs, based on the assumption that they generally reflect changes in the New Zealand economy's technical change ratio. For the international situation, indirect energy inputs data from the International Energy Agency (1997) were used to calculate a technical change ratio of "1.14% per annum (which was the average rate of change over the 1970–1993 period).

Table 39. Direct water pollutant intensities and technical change ratios for the combined northern regions, 1994/95–1997/98

Indicator	1994/95	1997/98	1994/95–1997/98	Mean change per year
Water Takes (m/$)	19.0704	15.4108	0.8081	0.9314
Water Discharges (m^3/$)	28.8734	26.0046	0.9006	0.9657
BOD_5 (kg/$)	0.3489	0.2833	0.8121	0.9330
Nitrate (kg/$)	0.0101	0.0075	0.7458	0.9069
Phosphorus (kg/$)	0.0645	0.0534	0.8281	0.9391

Notes: 1. Direct intensities were obtained from the *Eco*Link database (McDonald & Patterson 1999c,d).
2. Technical change ratio is the 1997/98 direct intensity divided by the 1994/95 direct intensity.
3. "Mean change per year" is calculated on a compounded basis.
4. The "northern regions" include Northland, Auckland and Waikato regional council areas.

Water use and water discharges

The only known New Zealand data that measure the eco-efficiency ratios of water use and discharge (water in/ $out; pollutants out/ $out) can be obtained from the *Eco*Link database compiled by McDonald & Patterson (1999a,b,c,d). Unfortunately, this only covers two reporting years (1994/95) and (1997/98) and three regions. These are insufficient data for regression analysis, as there are only two time periods (df = 0). Nevertheless, an average rate of change from 1994/95 to 1997/98 in the eco-efficiencies across these three regions can be determined, and then used as a basis for a linear projection of the technical change ratios from 1997 to 2007.

Table 39 outlines the changes in the direct intensities of water use and pollutants for Northland, Auckland and Waikato and calculates an average ratio of change in these indicators. These eco-efficiency ratios have quite high per annum technical change ratios, indicating reduction in resource use/pollution per dollar of output, in the order of 3–9% per annum. This compares with a reduction of about 2% per annum for energy use and CO_2 emissions. One reason for this difference is that energy efficiency and CO_2 reduction have been a target of Government attention for the last two decades and the easy returns that can be achieved have been readily exploited; whereas water-related pollutants have only really received a planning focus since the Resource Management Act in 1991, which has meant that the performance improvement for these pollutants could have been relatively large and might hit diminishing returns like energy and CO_2 in later years.

Land use

There are no data on the changes in land use intensity (ha/$). *Eco*Link does have data for 1997/98 but not for 1994/95. Crude estimates on data provided by McDonald & Patterson (2003) indicate that the changes are likely to be very small, probably about 1% decrease per year.

Labour productivity

Labour productivity data from Statistics New Zealand (2000a) and Philphott (1996) enabled an average labour productivity rate over the period 1978–1999 to be calculated. The mean labour productivity rate increase over this period was found to be 1.85%.

International energy use and CO_2 emissions

There are no available time series data for changes in the energy intensity of international airline travel. Therefore, the technical change ratios for domestic airline travel were used as a proxy for international travel.

4.5 Projections of resource use and pollution by the tourism sector

4.5.1 Characteristics of the projections

Direct and indirect effects

Both *direct and indirect* levels of future resource use and pollution are quantified in these projections. Due to the tourism sector being essentially a service sector activity there are significant linkages in the economy back through the manufacturing and primary sectors. This leads to relatively high indirect effects measured by the tourism sector's ecological multipliers.

Three projections rather than one forecast

For each resource and pollutant there are three projections that assume different levels of technical change:

Projection A: This assumes *no technical change* over the period 1997–2007. That is, the ratio of "resource use/pollutant per tourist night" remains constant at the 1997 level.

Projection B: This is a mid-range projection, which assumes a *rate of technical change at a mid-point* between Projection A and Projection C. This projection in most cases is considered to be the "most realistic", as it has a built-in assumption that the rate of technical change will decline, as diminishing marginal returns and biophysical limits to change are being reached.

Projection C: This assumes *the rate of technical change as observed historically* over the last 20 years continues at the same rate over the period 1997–2007. This could be considered to be an optimistic projection.

The differences between these projections can be as instructive as the projections themselves. For example, the differences between Projection A and C tell us what impact technological, behavioural and management improvements could have on resource use and pollution in the tourism sector. These differences also give us broad guidance concerning the levels of uncertainty in making these projections, as relatively small changes in one variable (technical change) can have a relatively large impact on the resultant forecasts/projections.

4.5.2 Energy use

Direct energy use

Direct energy use is dominated by energy used by *international tourists* to New Zealand, mostly in their long-haul flights to and from New Zealand. Under the mid-range projection, it is estimated that energy use by international tourists will increase by 59.8% over the period 1997–2007, which assumes an improvement of energy efficiency in international air travel of 23.5% (1.4% p.a.). This is a very significant increase in projected energy use from 59.2 PJ/yr in 1997 to 94.6 PJ/yr in 2007, which is fundamentally driven by steady increases in the number of international tourists. The McDermott Fairgray Group forecasts show some tapering off in these numbers from 2001 onwards, but nevertheless the increase in numbers is still very strong at about 5–6% annually.

Direct energy use by *domestic tourists* will remain relatively small compared with energy use by international tourists over the 1997–2007 period (Figure 20)[1]. The mid-range projection shows a decline from 20.3PJ to 18.5PJ, which represents an 8.8% decline over the 10-year period. This is on the basis that there will be a very light decline in domestic tourist nights ("0.5% over the 10-year period), but significant gains in the energy efficiency of the domestic tourism sector, based on a continuation of current trends in the hotel, accommodation and domestic airline sub-sectors. There is a dip in the direct energy use projected for the years 1999 and 2000 due mainly to a cyclical downturn resulting in fewer domestic tourists.

Overall, direct energy use, combining the international and domestic tourists, shows an increase from 79.5 PJ in 1997 to 113.1 PJ for 2007 for the mid-range projection. This is an increase of 42.3% in direct energy use by the tourism sector, over a period where international tourists are expected to increase by 83.6% and domestic tourist numbers remain about static.

Total energy use

Indirect energy use by the tourism sector can be added to the direct energy use accounted for above (Figure 21). For the base year of 1997, direct energy use accounts for 79.5 PJ and indirect energy use for another 27.7 PJ, amounting to 107.1 PJ overall.

The total energy use (direct and indirect) is expected under the mid-range projection to increase from 107.1 PJ in 1997 to 150.0 PJ in 2007. This is a 38.8% increase over the 10-year period. This is less the 42.3% for direct energy use, because the growing and larger international tourist market has a lower ecological multiplier than the static and smaller domestic market, which weights the percentage increase down.

With greater than expected improvements in the technical efficiency of energy use, the increase could be as low as 130.6 PJ for 2007. However, even under this optimistic scenario, total energy use by the tourism sector still increases by 21.8%. Most of this projected energy use consists of increased direct energy use by international long-haul flights to and from New Zealand by overseas tourists. The projected increases in the number of international tourists is the primary driving force behind this increase, which cannot be compensated for by even the most optimistic assumptions concerning improvements in energy efficiency.

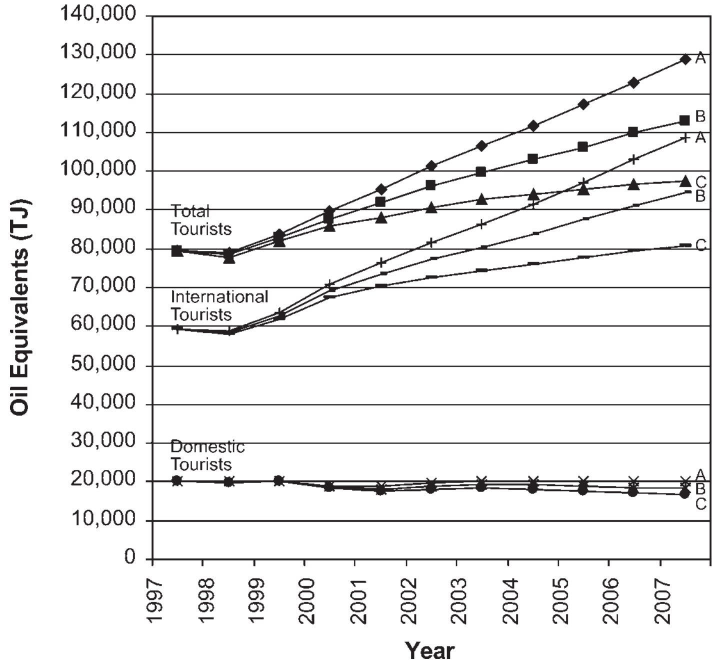

Figure 20. Projections of direct energy use by the tourism sector, 1997–2007.

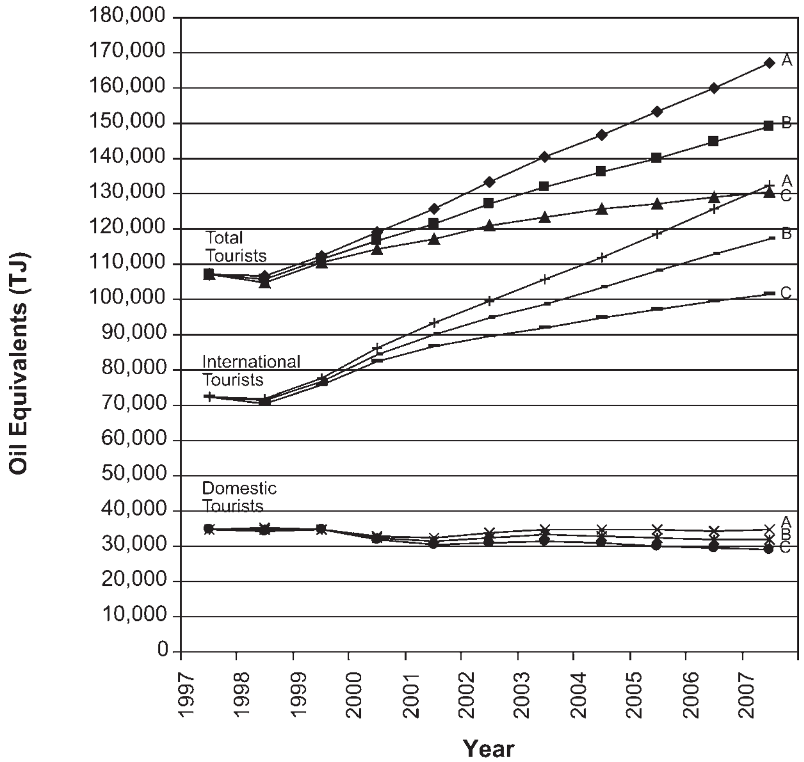

Figure 21. Projections of direct and indirect energy use by the tourism sector, 1997–2007.

Implications

The mid-range projection is for 150.1PJ of direct and indirect energy use by the New Zealand tourism sector for 2007. This represents an increase of 41PJ from 1997. By 2007 this will make the tourism sector easily the largest and fastest-growing sector for energy use in the New Zealand economy, far exceeding the energy use by the pulp and paper, basic metals, transport and other industries traditionally thought of as our big energy-users. However, Little attention has been specifically given to energy conservation and efficiency in the tourism sector, partly because of the non-recognition of the tourism sector in conventional forecasts and energy-monitoring regimes. This is an unfortunate oversight that needs to be addressed in future energy-forecasting exercises and also in energy-efficiency strategies of agencies such as the Energy Efficiency and Conservation Authority (EECA).

The implications of this rapid projected growth of energy use in the tourism sector need to be taken heed of, particularly in terms of the Kyoto Protocol and national energy-efficiency strategies. The implications for the Kyoto Protocol are discussed in Section 4.5.9.

The tourism industry and Government need to work through the marketing implications of the rapidly increasing energy use by the tourism sector. In part, the high energy-use by the tourism sector is an intractable structural problem to do with energy-intensive long-haul flights being a necessity if we are to continue to attract international tourists to New Zealand. The options for reducing such energy use seem to be limited. However, in the long term, the tourism industry may wish to consider encouraging fewer trips to New Zealand (hence reducing energy use) and, as an alternative strategy, promoting longer stays in New Zealand. The tourism industry could also focus more on "destination stays" within New Zealand, rather than promoting "tours" that cover large distances and hence are heavy energy-consumers.

4.5.2 Water use

Direct water use

Direct water use is projected to decrease from 8 636 417 m^3 to 8 541 106 m^3 per annum over the 1997–2007 period, under the mid-range projection (Figure 22). This slight decrease (1.1% over the period) is the result of two contrary trends: water use by domestic tourists decreasing (by 1 210 900 m^3) and that by international tourists increasing (by 1 115 589 m^3)(Figure 22).

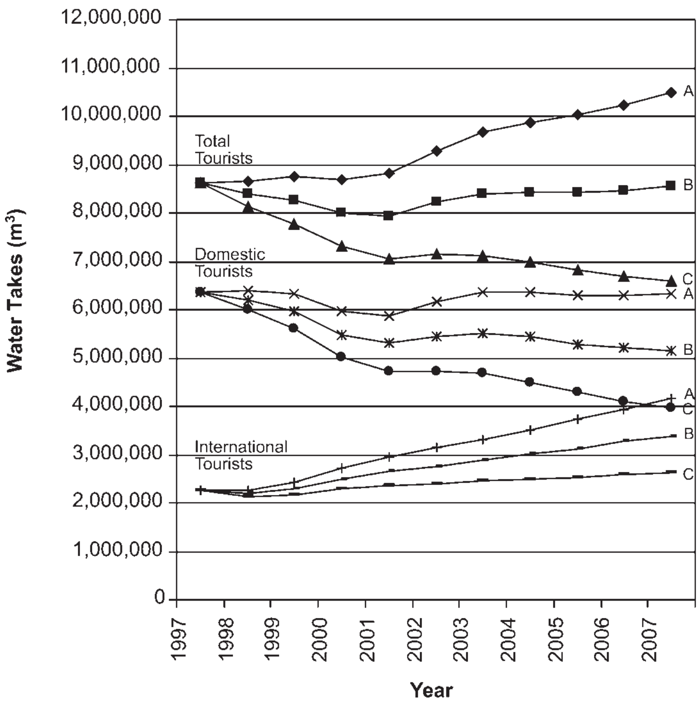

Figure 22. Projections of direct water use by the tourism sector, 1997–2007.

Direct water use by *domestic tourists* is estimated in the mid-range projection to decrease by 19.03% over the 1997–2007 period. This is almost entirely because of projected improvements in the technical efficiency of water use (i.e. m^3 water/tourist). There is virtually no change in forecasted domestic tourists, which may have otherwise pushed up water demand. In fact, on this static domestic market, if historical patterns of technical improvement in direct water use continue, the decline in direct water use by domestic tourists could drop even further than Projection C.

Direct water use by *international tourists,* on the other hand, is anticipated to increase in all three projections, as increasing numbers of international tourists push up the demand for water. Overall, under the mid-range projection, direct water use by international tourists is expected to increase by 49.1% over the 1997–2007 period.

Total water use

Indirect water use is far greater than direct water use by the tourism sector. In the base year, the indirect water use accounted for 91.5% of the total water use. Reticulated water (20 354 724 m^3 in 1997) is included in the "indirect" water use, although arguably it could be considered to be direct water use – this reticulated water is 2.4 times the direct water use.

Overall, under the mid-range projection, total water use by the tourism sector is expected to marginally decline (from 101 118 785 m^3 to 100 002 845 m^3) over the 1997–2007 period (Figure 23). This represents a 1.1% decrease. There is projected to be a significant drop in water usage over the 1997–2001 period, due essentially to a decrease in domestic tourists. When the numbers of domestic tourists are projected to increase in 2002 and 2003 (due to a cyclical trend), the water demand consequently increases. The overall effect is then a flattening off of total water demand by the tourism sector from 2004 to 2006, with a slight increase in 2007.

The increase in international tourists and the static domestic tourist market over the 1997–2007 period is an important structural effect. This increase in international tourists will push the water demand up quite markedly over the 1997–2007 period. Under the mid-range projection, there is an extra 13 061 787 m^3 of water used due to more international tourists. If there are slower technical efficiency gains in the use of water, this extra demand by international tourists could be as high as 22 161 696 m^3 as estimated under Projection A.

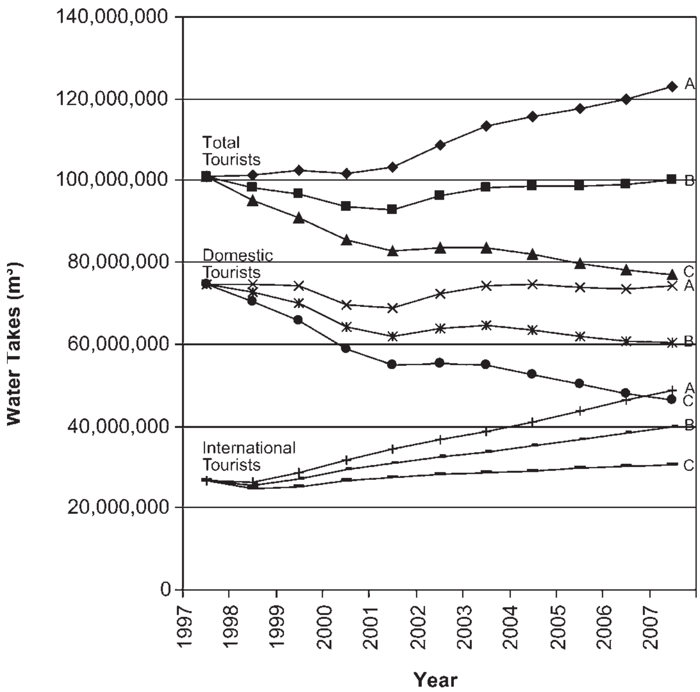

Figure 23. Projections of direct and indirect water use by the tourism sector, 1997–2007.

The potential role of technical change is significant as reflected in the quite divergent projections. Under no technical change (Projection A) total water usage increases by 21.6% (to 122 936 323), under the mid-range technical change it decreases by 1.1% (to 100 002 845 m^3), and under the maximum level of technical change it decreases by 23.8% (to 77 069 703 m^3).

Implications

Overall, the direct and indirect water use of the tourism sector is estimated to be 5.0% of total water use in New Zealand in 1997. This is a relatively moderate use of water, given the size of the tourism sector compared with other sectors. It is expected that this percentage share of water use will remain about the same over the 1997–2007 period. Even if poorer than expected efficiency gains in water usage by the tourism sector eventuate, the tourism water use is not expected to increase to more than a 6% share of the national total.

With respect to water use, what is more important than these total figures, is the spatial distribution of water demand increases, i.e. local supply issues are more likely to be problematic than concern about total levels of water use by the tourism sector. For example, ensuring an adequate water supply could create problems in localities where there is a poor natural supply, a lack of existing infrastructure, and/or an inability to pay for such infrastructure due to a low population or rating base.

Temporal and seasonal issues can be just as important as total levels of projected water demand. That is, it is not only the total quantity of water that is important, but also the seasonal demand for water, especially in localities that are drought prone and do not have the infrastructure or contingency plans to deal with this situation. In destinations such as Kaikoura, water may in fact become a limiting factor in the further development of the sector.

4.5.3 Land use

Direct use

Direct land use (i.e. land covered by accommodation complexes, camping grounds, roads, retail outlets, farms and other activities) by the tourism sector is only 7.5% of the total land use by the sector. As previously mentioned, direct land use by the tourism sector could arguably include hectares in national parks, forest parks and other reserves. The demand for this land is not dependent on tourist numbers, i.e. it is demand inelastic, as obviously if tourist numbers were to increase by say 50%, this land in the conservation estate would not increase accordingly.

Overall, direct land use in the tourism sector is expected to increase by 15% (from 65 564 to 75 300 ha) according to the mid-range projection (Figure 24). The driving force behind this 9820-ha increase is the forecasted increase in international tourists, which will push up the demand for more accommodation complexes and so forth, all of which require land.

It is assumed for the domestic sector that land inputs are downwardly inelastic, at least in the short run. That is, it is unlikely that the drop in domestic tourism numbers for 1999, 2000 and 2001, although quite significant, would lead to an immediate decrease in direct land use by the domestic tourism sector. It is more likely that operators in the sector would just have lower occupancy rates.

Total land use

There is considerable land embodied in the goods and services purchased by the tourism sector, particularly from the food and beverages and agricultural sectors. In total, in 1997, the tourism sector directly and indirectly required 873 525 ha of land, which represents 4.9% of the commercial land use in New Zealand.

There is projected to be a 174 305-ha increase in indirect land use by the tourism sector over the 1997–2007 period, under the mid-range projection (Figure 25). Most of this indirect land is agricultural land required to provide food to the tourism sector. The demand for indirect land is more elastic, than that for direct land, as it really reflects the year-on-year variability of commodities purchased by the industry, which very much depends on tourism activity (numbers). Quite simply, if there are fewer tourists, less food will be purchased by restaurants serving tourists.

For land, there is projected to be a smaller impact from technical efficiency gains than for other resources and pollutants. This applies to both direct land use where productivity gains are limited and also for indirect land use (e.g. agricultural farm use) where marginal gains from the improvement in agriculture are small due to gains already made over many decades. Consequently, there is less divergence in the three projections for land in comparison with other resources and pollutants.

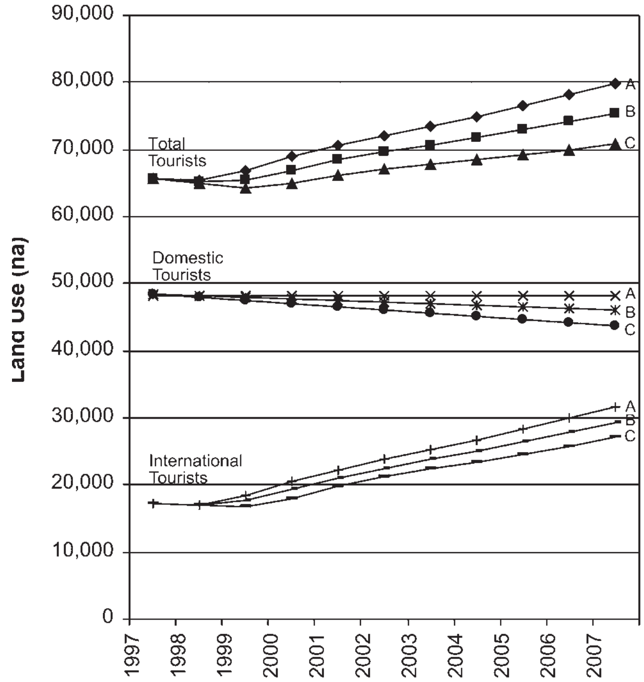

Figure 24. Projections of direct land use by the tourism sector, 1997–2007.

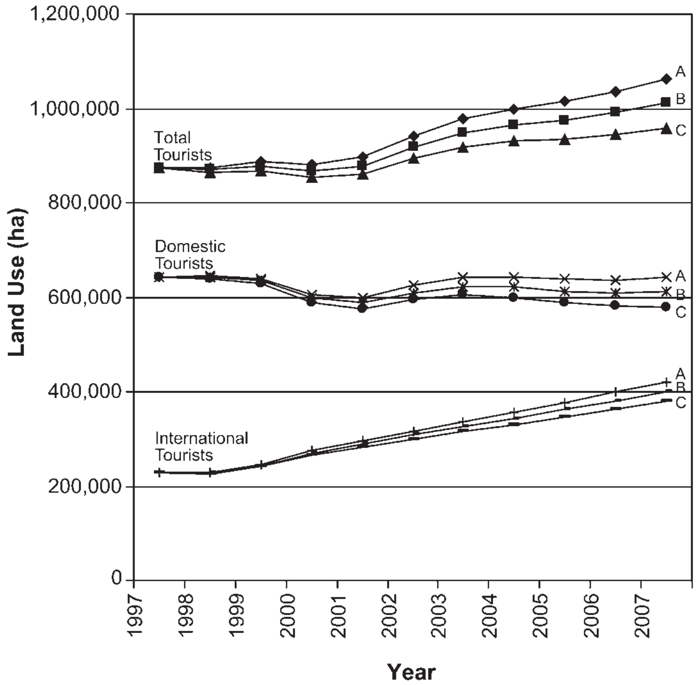

Figure 25. Projections of direct and indirect land use by the tourism sector, 1997–2007.

Overall, it is expected that total commercial land use by the tourism sector will increase by 15.7% (from 873 535 to 1 010 591 ha) over the 1997–2007 period under the mid-range projection. The domestic tourism sector's total land use is expected to decline by 170 554 ha, whereas that of the international sector is expected to increase by 35 385 ha. The net effect is a 137 169-ha increase.

Implications

Commercial land use by the tourism sector will remain about 5% of the New Zealand total, even after allowing for the projected 15.7% increase over the 1997–2007 decade. This in itself is not likely to present problems, but the increased land-use requirements of the tourism sector in particular localities will be an issue, as the sector competes with other sectors for scarce land resources. This is particularly pertinent in urban areas experiencing growth or in environmentally sensitive areas where increasing land pressures can be a serious problem.

Finally, although the tourism sector only appears to directly and indirectly occupy a small area of New Zealand, as do many other sectors, it is the cumulative effect across many sectors that adds to New Zealand's ever-increasing ecological footprint. Furthermore, it could be argued that the tourism sector appropriates large areas (7 373 053 ha) of national parks, forest parks, land reserves and marine reserves, as tourists are the main direct users of these parks and reserves. If such "non-commercial" land use were counted as tourism land use, then the ecological footprint of the tourism sector would increase very substantially. The exact allocation of conservation land to different sectors is debatable.

4.5.4 Water discharges

Direct discharges

Overall, it is projected under the mid-range projection that direct water discharges will increase from 52 129 202 m^3 to 60 201 965 m^3 over the 1997–2007 period (Figure 26). This 8 072 762 m^3 represents an increase of 15.5%. Most of these "direct" water discharges are from non-traditional tourism activities (e.g. agriculture) that are attributed to the tourism sector in the satellite accounts. The mid-range projection shows a slight decline in water discharges over the 1997–2000 period, and thereafter a steadily increasing trend from 2001 to 2007.

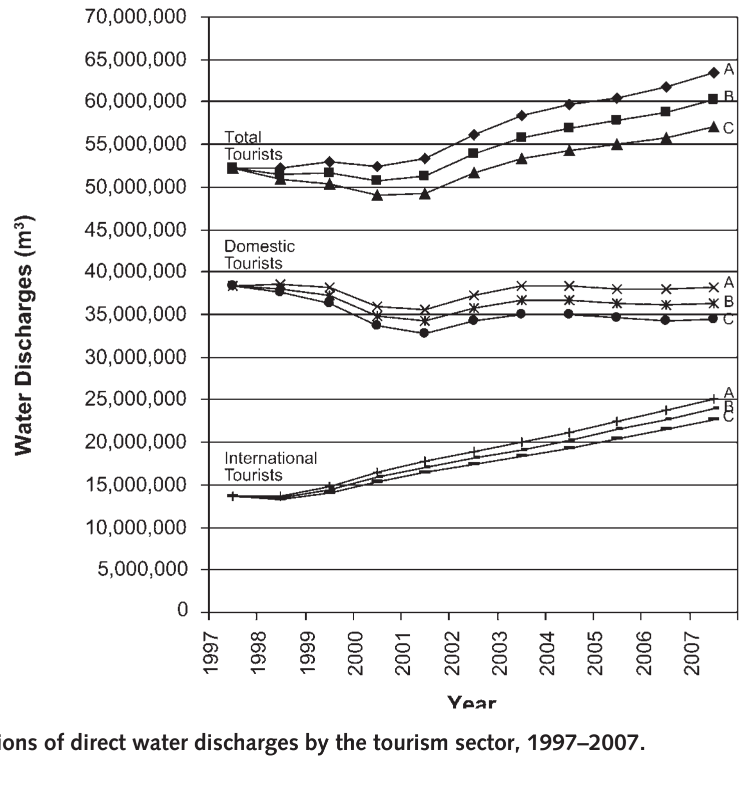

Figure 26. Projections of direct water discharges by the tourism sector, 1997–2007.

Direct water discharges from the *domestic tourism sector* are expected to decline by 5.5% (2 094 420 m^3) from 1997 to 2007 according to the mid-range projection. This decline is largely attributable to lower projected water discharges per visitor night, and to a much lesser extent to slightly fewer domestic tourists. Under optimistic assumptions concerning improved water treatment technologies and practices, it is possible that water discharges may decline by 10.4% as indicated by Projection C.

In the *international tourism sector*, a steady increase in water discharges is predicted in all three projections, as the result of the continued dramatic rise in international tourists coming to New Zealand. Under the mid-range projection, it is expected that direct water discharges will increase by 74.1% (from 13 722 706 m^3 to 23 887 889 m^3). Improvements in technology and management practices will not compensate for the pressures brought about by much greater numbers of international tourists.

Total discharges

Indirect water discharges represent 69.8% of the total water discharged by the tourism sector. Many of the inputs into the tourism sector have embodied water discharges that are collectively very significant. Most important is sewage from the tourism sector, which is counted as an "indirect" discharge because its treatment involves purchases from the community and social services sector.

Over the 1997–2007 period, it is projected that water discharges from the tourism sector will increase from 172 577 520 m^3 to 199 302 907 m^3 under the mid-range projection (Figure 27). This is estimated to be about 6% of the water discharges in the New Zealand economy. Again there are important structural effects that explain these changes. Water discharges in the *domestic tourism* market will decline under the mid-range projection (by 6 927 110 m^3) from 1997 to 2007. Water discharges in the *international tourism* market, however, will steadily increase resulting in an extra 33 652 577 m^3 by the end of the forecasting period. The net result is a 26 725 467-m^3 increase estimated under the mid-range projection for 1997–2007.

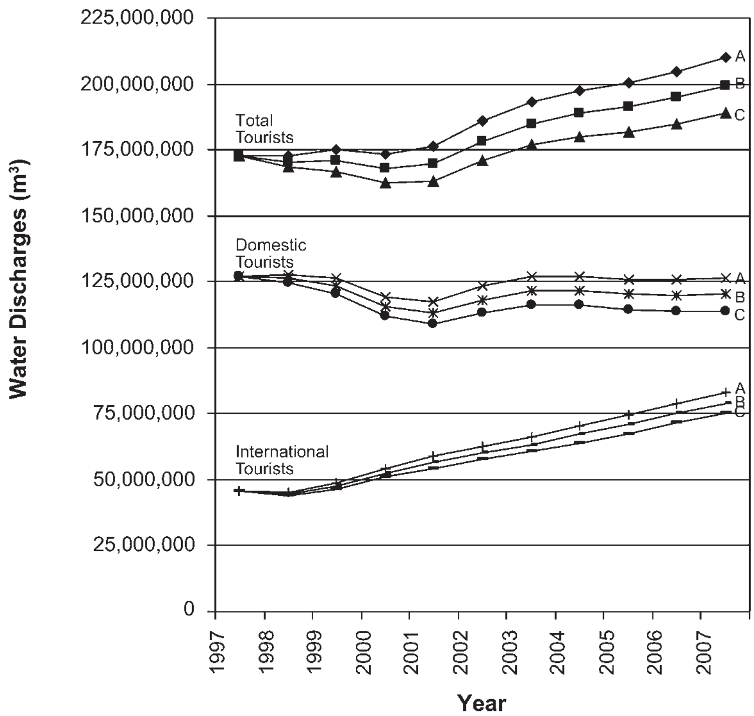

Figure 27. Projections of direct and indirect water discharges by the tourism sector, 1997–2007.

Water discharges from domestic tourism will very much reflect year-on-year shifts in the numbers of tourists. It is therefore projected that there will be a significant drop in water discharges over the 1997–2000 period as there are fewer domestic tourists forecasted by McDermott Fairgray Group (2000c). From 2001, this trend will reverse as a cyclical upturn in domestic tourism numbers will in turn lead to higher levels of water discharges.

Overall, there is a clear pattern of slightly declining levels of water discharges in the tourism sector from 1997 to 2001. However, when the domestic tourism market picks up in 2002 as forecasted, combined with the ever-present growth trend in the international visitors market, there will be steady increase in the level of water discharges from the tourism sector.

Implications

The steadily increasing level of water discharges (Figure 27) in the tourism sector, particularly from 2002 onwards, is a cause for concern. Although tourism's share of total discharges is only 5.4% of the New Zealand total, it is projected to steadily increase from 2002. Again, it is likely that such increased pressures will be more problematic in smaller tourist centres experiencing rapid growth, rather than in larger cities or towns.

It is evident (Figure 28) that water discharges from international tourists will overtake the levels from domestic tourists in the foreseeable future. This high level of water discharges from the international tourists is likely to be concentrated in iconic tourist centres, which have more of an international tourism focus.

There is an unknown "net effect" of domestic tourism that could be particularly relevant for water discharge parameters (including the pollutants further described below). It is fair to assume that domestic tourists generate waste and use water in their household at similar levels as they do during their holiday. The net effect would be zero under such an assumption. Too little information is available, however, to compare tourism footprints with household footprints to allow a deduction of a net effect.

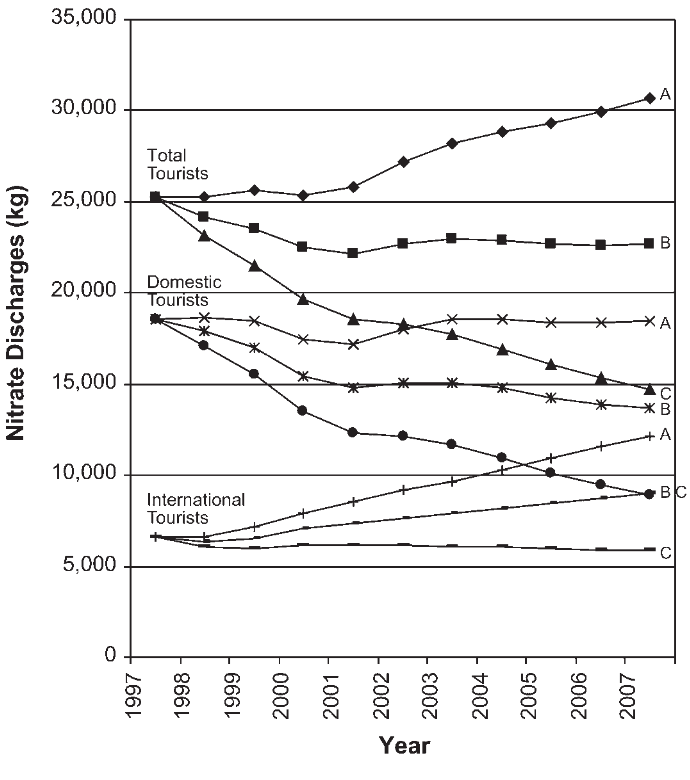

Figure 28. Projections of direct nitrate discharges by the tourism sector, 1997–2007.

4.5.6 Nitrate discharges

Direct discharges

The mid-range projections indicate that direct nitrate discharges from the tourism sector will decrease by–10.1% (from 25 231 kg to 22 696 kg) over the 1997–2000 period (Figure 28). Most of these "direct" nitrate discharges are from non-traditional tourism industries (e.g. agriculture and food manufacturing) attributed to the tourism sector in the satellite accounts.

Direct nitrate discharges in the domestic sector are expected to decrease steadily over the 1997–2007 period due to technical improvements. It is projected that there will be decreased nitrate loading into the environment from the *domestic tourism sector* of –26.4% (–4899 kg NO_3). The opposite trend is projected for the *international tourism sector*, with the increase in forecasted numbers, being the driving force behind increased direct nitrate discharges. That is, even though improved technology and management practices will decrease the "direct nitrate discharge/visitor night" ratio, this is not sufficient to compensate for the increased number of tourists.

The net effect of these two opposing trends is a decrease in direct nitrate loadings of –10.1% over the 1997–2007 period, indicated by the mid-range projection. The drop in direct nitrate discharges is marked till 2001, as a result of a downturn in domestic tourist numbers, and then the projection tends to flatten out for the rest of the forecasting period (Figure 28).

Total discharges

It is difficult to project precisely the future level of total nitrate discharges by the tourism sector, due to uncertainty over the level of technological improvement – hence, the reasonable large divergence between the three projections (Figure 29). If current trends observed in the *Eco*Link database continue, then total nitrate discharges could reduce quite dramatically over the forecasting period as indicated by Projection C. Under this projection, over the 1997–2007 period, the total discharge of nitrate from the tourism sector drops from 52 631 kg to 30 698 kg (–41.7%). Under Projection B, which assumes the mid-range level of technical change, which is more likely, the total discharge of nitrate from the tourism sector decreases to 47 342 kg (–10.1%).

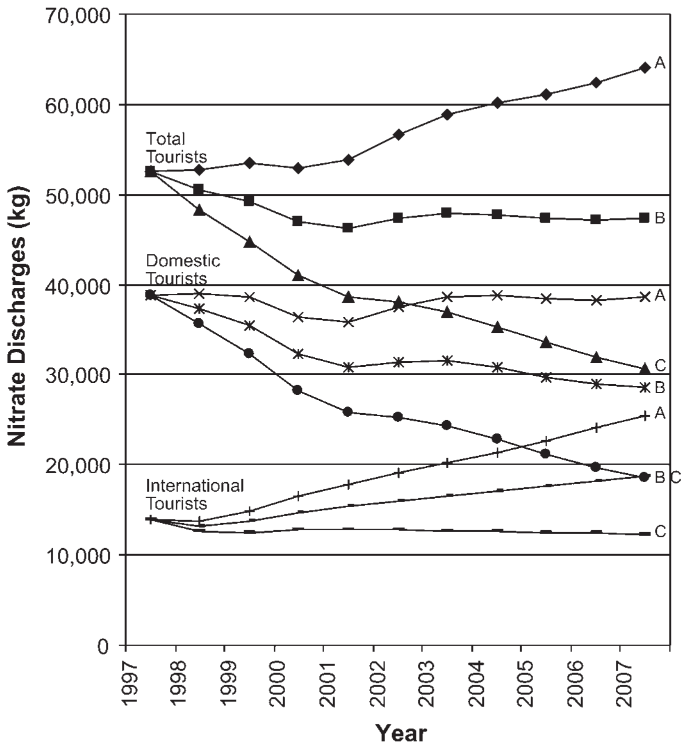

Figure 29. Projections of direct nitrate discharges by the tourism sector, 1997–2007.

The nitrate discharges embodied in the purchase of food by the tourism sector is a very important indirect effect, accounting for 20 510.7 kg in the base year. It is expected with the cyclical downturn in the domestic tourism numbers over the 1998–2001 period that there will be fewer food purchases by the domestic tourism sector and, therefore, a lower level of indirect nitrate discharges.

Under the mid-range projection, it is expected that total nitrate discharges will decrease for each of the years in the 1997–2001 period. This is because the decline in domestic tourism numbers will push down the direct and indirect nitrate discharges, outweighing the effect of international tourism pushing the nitrate discharges upwards. There is then expected to be an overall increase in nitrate discharges for the years 2002, 2003 and 2004, as the domestic tourism industry recovers. For the remaining years up to 2007 the trend tends to flatten out – the downward domestic trend (due to technical improvements) and the upwards international trend (due to increased number of tourists) tend to counterbalance each other.

Implications

These projections highlight the role that technology can have on "decoupling" environmental impacts (in this case environmental impacts due to nitrate pollution) from economic growth in the tourism sector. Specifically, both Projections B and C show that technology can "decouple" income growth (through increased tourists) from nitrate pollution. Although this is an encouraging result, more research on the rate of technological improvement in reducing nitrate pollutants is required before these projections can be confirmed.

These projections also highlight the importance of indirect effects. In the case of the tourism industry, the indirect nitrate embodied in food supplied to the tourism industry is very significant indeed. The nitrate discharges resulting from manufacturing food for the tourism industry are, for example, much greater than the nitrate in sewage from the tourism industry, which is disposed of into the environment.

With nitrate, it is important to understand the spatial distribution of both direct and indirect nitrate discharges. For example, nitrate discharges are important in the Lake Taupo region because of their effect on the water quality of the lake. In this case, there may not be any direct discharges of nitrate into Lake Taupo by the tourism industry, but there may, however, be "indirect" discharges in the production of the products that the tourism industry requires.

The temporal dimension of these nitrate discharges can also be important. The level of nitrate discharges can vary quite markedly during the year, increasing to a peak at the height of the tourism season in particular localities. This can be problematical in these localities, particularly if there is poor infrastructure and/or there are nitrogen-sensitive environments.

4.5.7 Phosphorus discharges

Direct discharges

The mid-range projection indicates that direct phosphorus discharges will increase slightly (2.1%) from 179 090 kg to 182 908 kg over the 1997–2007 period (Figure 30). Most of this "direct" phosphorus discharge is from non-traditional tourism industries (e.g. agriculture and manufacturing) attributed to the tourism sector in the satellite accounts.

The direct discharges of phosphorus in the mid-range projection demonstrate a distinct dip from 1997 (182 908 kg) to 2001 (167 069 kg) on the back of declining domestic tourist numbers. Thereafter, there is a steady increase in the direct phosphorus discharge for the tourism sector from 2000 (167 069 kg) through to 2007 (102 408 kg).

The overall pattern is one of declining amounts of phosphorus loading from the d*omestic tourist* market as opposed to an increasing amount from the *international tourist* market. Under the mid-range projection, for the domestic sector there is estimated to be a "16.2% decline (from 131 945 kg to 110 331 kg) in phosphorus for direct discharges, whereas, for the international sector the direct phosphorus discharges increase by 54.0% (from 47 144 kg to 58 760 kg) over the 1997–2007 period.

Total discharges

The most important "indirect" discharge is 56 706 kg of phosphorus in the treated sewage from the tourism sector. There are, however, several other "indirect" discharges of phosphorus embodied in the purchase of goods and services by the tourism sector, all of which could have significant environmental effects in a given regional economy.

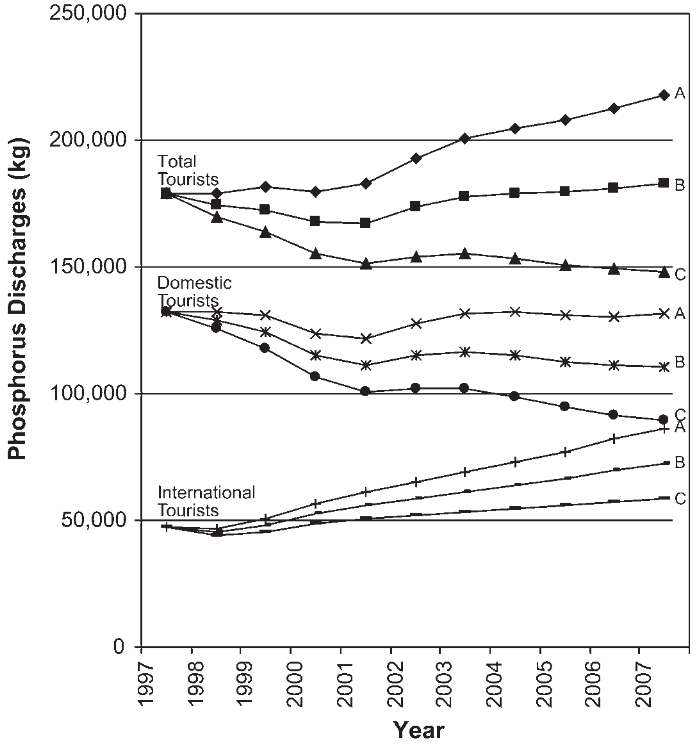

Figure 30. Projections of direct phosphorus discharges by the tourism sector, 1997–2007.

Overall it is expected under the mid-range projection that total phosphorus discharges from the tourism sector will increase from 346 265 kg in 1997 to 353 648 kg in 2007 (Figure 31). This is a slight increase of 2.1% over the forecasting period. Assuming more optimistic assumptions concerning technological improvement and best practice, the total discharges of phosphorus by the tourism sector could reduce to 286 320 kg in 2007, under Projection C. This represents a –17.3% decrease over the 1997–2007 period.

Although improvements in technology and practice are expected to reduce the phosphorus discharges in Projections B and C, these will not be sufficient to decrease phosphorus discharges from the international tourism market in the face of the strong increases in international tourist numbers forecasted by McDermott Fairgray Group (2001a).

Implications

The total discharge of phosphorus from the tourism industry sector is about 6% of the total phosphorus discharges across the entire New Zealand economy. Although this appears to be a low percentage, it is bigger than many other sectors, and in spite of technical improvements it is likely to increase over the forecasting period.

Again the spatial distribution of this level of discharge is important. Flow-on effects within a regional economy can be quite problematical, particularly in small towns or localities where, for example, there is poor existing infrastructure to deal with extra sewage. Increases in phosphorus discharges can also cause problems in areas where there are sensitive ecosystems and environments, e.g. lakeside tourism communities.

The temporal dimension of these phosphorus discharges can also be important. The level of phosphorus discharges can vary quite markedly during the year, increasing to a peak at the height of the tourism season in particular localities. This can be problematical in these localities, particularly if there is poor infrastructure and/or there are phosphorus-sensitive environments.

The evidence from the projections is that technical improvement and better practice could have an important role to play in reducing potential phosphorus loading from the tourism sector, particularly in the face of ever-increasing tourist numbers.

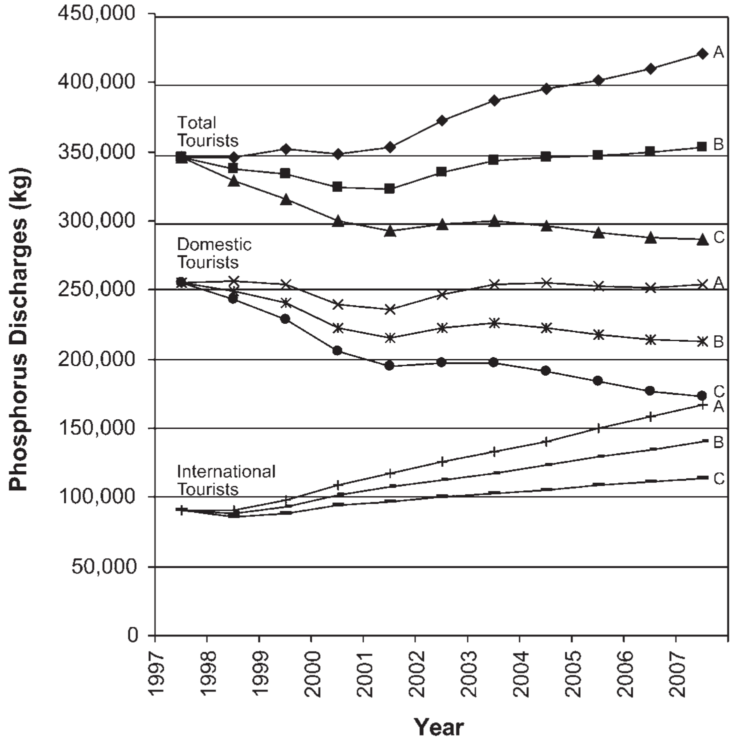

Figure 31. Projections of direct and indirect phosphorus discharges by the tourism sector, 1997–2007.

4.5.8 Biological oxygen demand

Direct discharges

The mid-range projection indicates that the direct BOD discharges from the tourism sector will remain virtually unchanged, reducing by only –0.5%. Most of these direct BOD discharges are from the non-traditional tourism industries (e.g. agriculture and food manufacturing) attributed to the tourism sector in the satellite accounts.

For the d*omestic tourist* market, the mid-range projection indicates a decrease from 756 840 kg BOD in 1997 to 616 740 kg BOD in 2007, due almost entirely to improved technology and better practice reducing the BOD per visitor night (Figure 32). This, coupled with domestic visitor nights remaining about static, results in a decrease in BOD of 140 100 kg (–18.5%) under the mid-range projection.

The *international tourist* market exhibits the opposite trend, with a 50.0% increase (from 270 420 kg BOD to 405 700 kg BOD) over the 1997–2007 period for the mid-range forecast. This 135 280-kg increase in BOD almost counterbalances the domestic market decrease, resulting in very little net effect.

Total discharges

The largest "indirect" BOD discharge is sewage effluent from the tourism sector, amounting to 333 690 kg BOD in 1997. As pointed out earlier, this arguably could be considered to be a direct discharge.

Overall, the direct and indirect discharges of BOD by the tourism sector are projected under the mid-range forecast to slightly decrease (from 1 797 922 kg to 1 789 405 kg BOD; "0.47%)(Figure 33). For the period 1997–2001 there is expected to be a significant drop in the level of BOD discharges, primarily due to fewer domestic tourists. However, with the forecasted upturn of the domestic tourism market, there is expected to be a steady increase in the total level of BOD discharges for every year except 2005 when a very slight decline is projected.

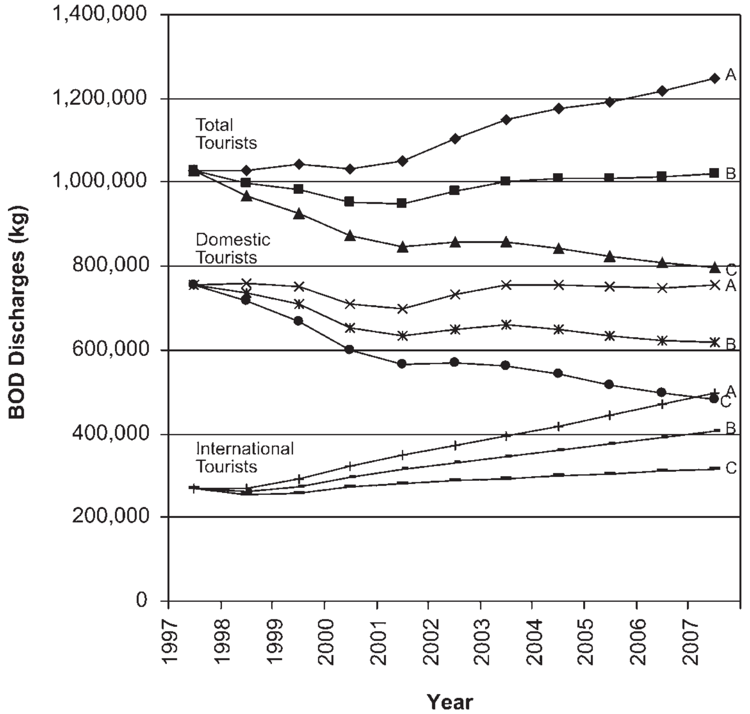

Figure 32. Projections of direct BOD discharges by the tourism sector, 1997–2007.

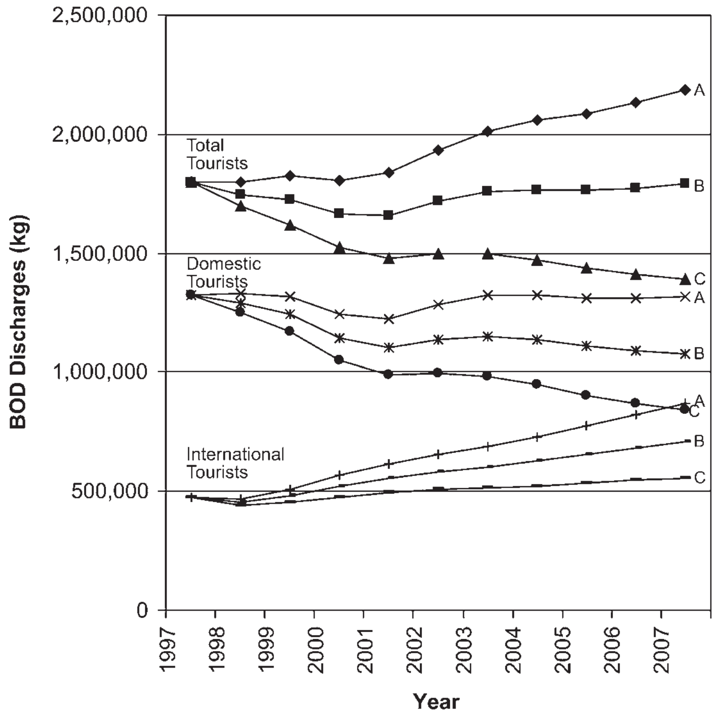

Figure 33. Projections of direct and indirect BOD discharges by the tourism sector, 1997–2007.

There is quite some divergence in the projections (A, B, C) due to different levels of technical change, which are quite uncertain. Under the mid-range Projection (B), BOD discharge drops "0.5%, but this moves to "22.5% over the 1997–2007 period when more optimistic assumptions about technological change are made in Projection C. Projection C assumes the same level of rapid technical change improvement as observed in the *Eco*Link database between 1994/95 and 1997/98, which is not expected to continue into the future. Further research is required to ascertain more precisely the level of technical change with respect to the ecological multiplier for BOD for the tourism and related sectors.

Implications

Biological oxygen demand of direct and indirect water discharges from the tourism sector in 1997 was 6.0% of BOD discharges across the entire New Zealand economy. This percentage, which should remain unchanged over the forecasting period, is the highest of all the pollutants covered in these forecasts except CO_2.

As for the other water-based pollutants, the spatial distribution of BOD discharges and the extent of indirect BOD discharges in regional economies are important. In particular, the BOD content of sewage discharges from the tourism sector is relatively large and a cause of concern particularly if there is strong tourism growth in a given locality.

The temporal dimension of the BOD can also be important. The level of BOD discharges can vary quite markedly during the year, increasing to a peak at the height of the tourism season in particular localities. This can be problematical in these localities, particularly if there is poor infrastructure and/or there are BOD-sensitive environments.

4.5.9 Carbon dioxide emissions

Direct emissions

International tourists are by far the largest source of direct CO_2 emissions with 3 947 954 t for 1997. Most of the emissions are from travel to and from New Zealand by international tourists (90.4% in 1997), but there are also significant amounts of CO_2 emissions associated with domestic travel and other activities by international tourists within New Zealand (9.6% in 1997).

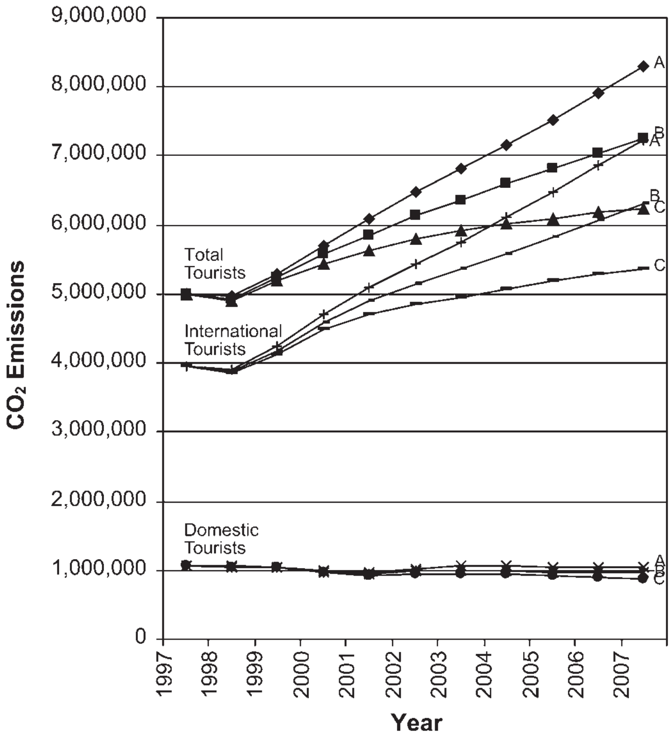

Figure 34. Projections of direct CO_2 emissions by the tourism sector, 1997–2007.

The mid-range projection indicates that the direct CO_2 emissions by international tourists to New Zealand will increase dramatically over the 1997–2007 period from 3 947 754 to 6 298 503 t (59.6% increase) (Figure 34). If the expected technological improvements under the mid-range forecast do not eventuate, this could increase as far as 7 234 472 t (83.3% increase).

Domestic tourists produce a relatively small amount of direct CO_2 emissions, at 1 059 590 t for 1997, furthermore, it is not expected that this amount will increase over the 1997–2007 period. In fact, the mid-range projection indicates that the direct CO_2 emissions from domestic tourists will decrease by 8.72% over the 1997–2007 period. Even if there are no technological improvements in energy efficiency over this period, (as in Projection A) it is still expected that direct CO_2 emissions from domestic tourists will decrease slightly by –0.46%.

Total emissions

Most of the indirect CO_2 emissions are associated with the flat domestic tourism market. That is, in 1997/98 there were 544 369 t of indirect CO_2 emissions associated with international air travel compared with 1 797 831 t of indirect CO_2 emissions associated with tourism activities within New Zealand. The backward linkages from accommodation, restaurants and other such services are more extensive than those for international air travel, hence the greater magnitude of the multiplier.

Under the mid-range projection, total emissions for international tourists are expected to increase by 61.9% (from 4 822 416 t to 7 796 833 t) between 1997 and 2007 (Figure 35). The increase in total CO_2 emissions by *international tourists* is particularly strong from 1999 to 2001 (6–10% increase) tapering off in 2002–2007 (3–5% increase); whereas, for the *domestic tourist* market, the total CO_2 emissions are projected to decrease from 1 980 762 t in 1997 to 1 807 311 t in 2007 under the mid-range projection. Other than an increase in CO_2 emissions in 2002 and 2003 due to the forecasted upturn in domestic tourist numbers, there is an otherwise steady downward trend in CO_2 emissions projected because of improvements in technology and energy management practice.

The three Projections (A, B, C) for total CO_2 emissions are quite divergent, ranging from 10 808 950 t CO_2 for Projection A in 2007 to 8 399 438 t CO_2 for Projection C. This difference, which is very significant, is purely due to different assumptions

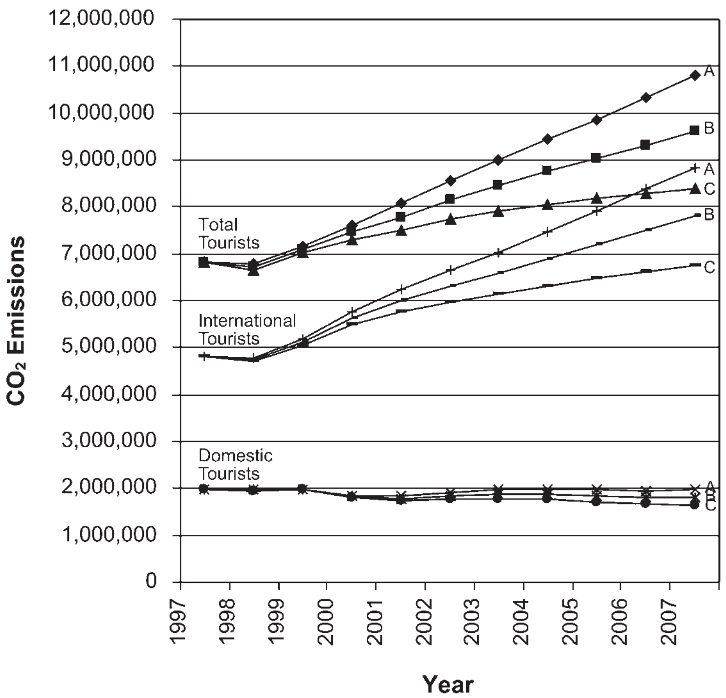

Figure 35. Projections of direct and indirect CO_2 emissions by the tourism sector, 1997–2007.

about improvements in energy efficiency (mainly to do with air travel). Projection C assumes the continuation of the trends in energy efficiency experienced over the 1970–2000 period in New Zealand aviation, which may not be appropriate. Further research is required into this matter, given the importance of potential reductions in CO_2 emissions due to technological advancement.

Implications

Carbon dioxide emissions are arguably the most serious "environmental" issue facing the tourism sector. If the New Zealand Government ratifies the Kyoto Protocol, then reducing the CO_2 emissions in the tourism sector will be a particularly challenging task, although it has to be pointed out that emissions from international air travel are not part of the Kyoto Protocol at this stage. Even under the most optimistic projection, it is projected that total CO_2 emissions from the tourism sector will increase by 23.5% (from 6 803 178 to 8 399 438 t CO_2).

A key issue is whether international travel should, or should not, be included in Kyoto CO_2 budgets for New Zealand. In the current round of the Kyoto Protocol, CO_2 emissions associated with international travel are not included, but this may change in future rounds. It seems unlikely that technical improvements in energy efficiency will be sufficient to reduce CO_2 emissions to target levels, if international travel is included in the Kyoto Protocol. The industry therefore needs to develop alternative long-term strategies for dealing with this issue: (1) promoting fewer (but longer-stay) visits to New Zealand should be encouraged, instead of the current pattern of large volumes of relatively short stay trips; (2) promoting domestic tourism and increasing promotion efforts in countries that are geographically close to New Zealand; (3) focus more on "destination stays" within New Zealand, rather than promoting "tours" that cover large distances and produce large amounts of CO_2 emissions; (4) exploring the option of "buying" carbon credits to offset emission increases.

The marketing implications of all of the strategies need to be carefully investigated. If the New Zealand tourism industry is not seen to be making efforts to reduce its CO_2 emissions, this could have an adverse effect on promoting New Zealand as a "100% Pure NZ" clean and green destination. The Ministry for Environment's (2001) report *Our Clean Green Image: What is it Worth?* highlights the sensitivity of overseas consumers to this image. It could be argued that being proactive about CO_2 emissions (and other environmental impacts) may be an unavoidable "cost" that the industry needs to face up to if it wants to maintain overseas market share.

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Appendices

Appendix A: Input-output model of the New Zealand economy including a tourism sector

Table A.1 outlines a 24-sector input-output model of the New Zealand economy for 1997/98, which includes a tourism sector. A 48-sector input-output model was also constructed but is not produced here because of its size.

It is important to bear in mind that in deriving tourism sectors and rows in the IO matrices, approximate methods had to be used. This can introduce errors. Moreover the determination of ecological multipliers assumes linearity, which in real economies is probably not the case. For this reason, *one should not rely on too many significant figures when interpreting the results*.

Appendix A: Input Output Matrix of the New Zealand Economy including a Tourism Sector ($ 000), 1997-98

	Agriculture	Fishing & Hunting	Forestry	Mining & Quarrying	Food, Beverages & Tobacco	Textiles, Clothing & Footwear
Agriculture	2,315,479	1,360	22,252	248	5,903,136	884,908
Fishing & Hunting	28,212	148	13	31	445,687	3,549
Forestry	7,383	15	1,040,357	103	5,195	145
Mining & Quarrying	8,707	32	5,627	168,828	34,521	1,809
Food, Beverages & Tobacco	84,030	4,520	9,172	2,236	2,628,367	188,154
Textiles, Clothing & Footwear	17,491	4,236	282	321	20,033	547,661
Wood & Wood Products	28,964	192	2,104	1,447	23,883	5,810
Pulp & Paper Products, Printing & Publishing	71,797	1,405	2,554	4,700	371,504	36,517
Petroleum, Chemical, Plastics and Rubber Products	759,545	5,675	47,602	20,309	362,222	108,929
Non-metallic Mineral Products	9,285	82	206	1,253	94,617	537
Basic Metal Products	439	88	29	361	809	826
Fabricated Metal Products, Machinery & Equipment	132,136	16,293	19,650	43,590	214,298	21,573
Other Manufacturing	522	22	53	59	1,819	6,128
Electricity, Gas	83,565	394	1,431	18,077	154,733	26,438
Water Distribution	111	6	21	77	85,493	9,564
Construction	504,779	2,429	9,265	86,260	117,040	50,041
Wholesale & Retail Trade	574,397	15,326	44,773	50,175	985,104	307,759
Transport & Storage	278,188	224,390	143,706	115,672	667,544	90,310
Communication	80,938	1,985	6,880	12,950	158,793	55,011
Finance, Insurance, Real Estate and Business Services	779,442	27,132	93,416	191,471	1,092,425	319,119
Ownership of Owner-Occupied Dwellings	0	0	0	0	0	0
Community, Social and Personal Services	355,043	1,745	15,449	12,865	152,377	27,230
Central Government	2,256	45	147	493	1,723	806
Local Government	6,300	98	600	74	2,461	1,167
Tourism	74,795	3,865	18,912	9,104	57,549	9,558
Compensation of Employees	1,203,035	57,986	188,174	169,610	2,421,077	476,314
Operating Surplus	2,865,396	145,331	1,073,535	269,854	764,543	138,405
Commodity Indirect Taxes	139,609	6,201	25,102	20,162	117,779	5,280
Non-Commodity Indirect Taxes	348,484	18,338	20,034	18,630	103,082	11,825
Commodity Subsidies	-1,960	0	0	0	0	0
Non-Commodity Subsidies	-15,841	-4,025	-4,112	0	-9,363	-4,998
Consumption of Fixed Capital	773,053	45,801	39,613	153,164	636,809	49,806
Second Hand Assets	9,441	5,369	3,127	16,309	60,361	3,352
Imports	569,468	153,493	73,442	70,593	1,203,548	478,096
Total	12,094,485	739,978	2,903,415	1,459,025	18,879,167	3,861,631

Appendix A: Input Output Matrix of the New Zealand Economy including a Tourism Sector ($ 000), 1997-98

	Wood & Wood Products	Pulp & Paper Products, Printing & Publishing	Petroleum, Chemical, Plastics & Rubber Products	Non-metallic Mineral Products	Basic Metal Products
Agriculture	9,045	5,141	28,206	1,280	403
Fishing & Hunting	31	68	1,254	28	12
Forestry	652,761	229,824	433	61	46
Mining & Quarrying	678	820	316,373	153,559	115,641
Food, Beverages and Tobacco	7,777	7,724	55,313	2,390	1,723
Textiles, Clothing and Footwear	26,726	3,394	11,779	958	774
Wood & Wood Products	628,104	57,326	15,837	14,183	3,931
Pulp & Paper Products, Printing & Publishing	55,230	1,265,517	103,110	26,738	3,737
Petroleum, Chemical, Plastics & Rubber Products	98,416	127,523	1,074,219	27,708	30,519
Non-metallic Mineral Products	19,577	605	10,356	224,380	2,568
Basic Metal Products	3,357	2,098	8,460	4,137	112,752
Fabricated Metal Products, Machinery & Equipment	123,485	64,116	90,406	47,308	55,416
Other Manufacturing	316	3,020	680	201	41
Electricity, Gas	45,637	144,673	88,486	26,723	204,653
Water Distribution	1,331	19,186	8,817	8,882	1,442
Construction	85,155	26,177	119,144	85,283	59,262
Wholesale and Retail Trade	268,887	251,979	744,620	120,374	217,972
Transport and Storage	213,043	309,232	183,296	78,361	48,912
Communication	49,517	103,652	65,090	18,096	10,163
Finance, Insurance, Real Estate and Business Services	260,786	425,024	563,445	149,380	121,941
Ownership of Owner-Occupied Dwellings	0	0	0	0	0
Community, Social and Personal Services	23,270	58,457	63,779	15,068	14,642
Central Government	652	933	983	277	164
Local Government	262	3,404	648	155	94
Tourism	17,510	31,032	30,007	8,540	8,184
Compensation of Employees	794,118	1,239,269	926,773	297,119	328,893
Operating Surplus	267,011	549,573	707,539	198,323	85,579
Commodity Indirect Taxes	24,591	26,920	70,722	8,592	4,687
Non-Commodity Indirect Taxes	20,158	32,841	35,949	18,947	10,321
Commodity Subsidies	0	0	0	0	0
Non-Commodity Subsidies	0	-1,759	0	0	0
Consumption of Fixed Capital	130,719	306,512	368,866	80,215	151,003
Second Hand Assets	9,133	54,391	25,004	4,387	1,737
Imports	373,685	520,455	2,098,588	192,054	240,345
Total	4,210,967	5,869,129	7,818,182	1,813,709	1,837,562

Appendix A: Input Output Matrix of the New Zealand Economy including a Tourism Sector ($ 000), 1997-98

	Fabricated Metal Products, Machinery & Equipment	Other Manufacturing	Electricity, Gas	Water Distribution	Construction
Agriculture	9,651	935	734	221	3,484
Fishing & Hunting	142	1,772	21	23	352
Forestry	534	23	68	68	560
Mining & Quarrying	3,104	22,975	172,521	35	18,790
Food, Beverages & Tobacco	24,958	3,433	1,418	826	24,597
Textiles, Clothing & Footwear	14,104	1,985	458	119	28,284
Wood & Wood Products	175,245	3,633	7,720	280	1,163,071
Pulp & Paper Products, Printing & Publishing	115,379	9,670	14,109	3,237	157,754
Petroleum, Chemical, Plastics & Rubber Products	238,434	27,553	11,703	2,109	543,250
Non-metallic Mineral Products	56,439	1,107	11,163	8,779	1,054,085
Basic Metal Products	347,204	9,840	553	551	48,962
Fabricated Metal Products, Machinery & Equipment	1,502,545	8,807	63,787	7,019	1,461,616
Other Manufacturing	1,194	4,821	114	30	2,270
Electricity, Gas	73,142	2,055	2,502,998	24,958	43,969
Water Distribution	8,544	15	15,409	146,532	3,072
Construction	90,152	7,597	80,350	9,601	3,818,191
Wholesale & Retail Trade	1,218,782	47,964	76,643	10,150	1,244,879
Transport & Storage	267,812	15,228	84,805	5,261	137,482
Communication	168,628	6,466	68,200	1,662	215,132
Finance, Insurance, Real Estate and Business Services	1,022,420	47,584	101,901	16,049	1,489,894
Ownership of Owner-Occupied Dwellings	0	0	0	0	0
Community, Social & Personal Services	103,687	5,036	25,256	22,457	191,139
Central Government	1,784	111	206	82	5,128
Local Government	1,069	36	28,094	45,987	160,586
Tourism	51,113	1,989	30,543	1,723	52,544
Compensation of Employees	2,058,395	74,841	452,894	52,511	2,262,827
Operating Surplus	1,093,470	52,743	1,316,493	52,678	747,742
Commodity Indirect Taxes	30,260	1,136	29,129	894	80,206
Non-Commodity Indirect Taxes	51,407	2,106	17,901	458	85,072
Commodity Subsidies	0	0	0	0	-1
Non-Commodity Subsidies	-11,356	0	0	0	-8,342
Consumption of Fixed Capital	278,302	9,904	351,065	15,553	386,803
Second Hand Assets	135,918	810	5,496	493	183,876
Imports	2,476,842	68,267	76,927	15,945	1,547,474
Total	11,609,307	440,443	5,548,679	446,291	17,154,746

Appendix A: Input Output Matrix of the New Zealand Economy including a Tourism Sector ($ 000), 1997-98

	Wholesale & Retail Trade	Transport & Storage	Communication	Finance, Insurance, Real Estate & Business Services	Ownership of owner-occupied dwellings
Agriculture	230,512	12,755	22,448	32,749	0
Fishing & Hunting	14,935	1,865	47	489	3
Forestry	22,824	323	245	1,182	19
Mining & Quarrying	15,250	1,355	3,590	1,721	109
Food, Beverages & Tobacco	1,806,093	76,709	1,932	23,810	1,963
Textiles, Clothing & Footwear	34,181	3,081	1,118	12,537	35,856
Wood & Wood Products	58,847	2,502	1,464	22,684	43,618
Pulp and Paper Products, Printing & Publishing	517,065	37,710	16,531	876,490	14,448
Petroleum, Chemical, Plastics & Rubber Products	391,414	171,880	36,804	110,762	16,730
Non-metallic Mineral Products	19,379	759	463	16,570	20,389
Basic Metal Products	491,297	671	80	601	195
Fabricated Metal Products, Machinery & Equipment	291,221	168,004	29,443	160,632	70,622
Other Manufacturing	4,002	432	160	7,153	76
Electricity, Gas	258,412	37,858	72,862	58,643	55
Water Distribution	14,944	5,626	5,500	2,544	64,407
Construction	289,317	502,429	27,273	582,519	279,147
Wholesale and Retail Trade	1,756,513	410,765	132,675	506,524	108,144
Transport & Storage	1,089,216	982,817	94,170	363,442	1,362
Communication	832,075	187,561	249,749	851,108	87
Finance, Insurance, Real Estate & Business Services	3,090,863	707,327	573,175	6,279,487	236,112
Ownership of Owner-Occupied Dwellings	0	0	0	0	0
Community, Social & Personal Services	347,248	219,623	110,596	583,712	4,299
Central Government	6,316	7,268	2,387	7,345	78
Local Government	4,449	7,288	995	18,127	55
Tourism	178,880	45,977	57,626	206,262	102,795
Compensation of Employees	6,989,191	1,632,291	1,562,850	5,499,763	0
Operating Surplus	3,898,061	880,086	1,530,923	6,198,738	5,450,848
Commodity Indirect Taxes	295,567	133,395	44,726	519,734	226,889
Non-Commodity Indirect Taxes	470,200	72,763	28,196	672,642	1,005,138
Commodity Subsidies	-11	0	0	-1	0
Non-Commodity Subsidies	-29,653	-53,606	0	-6,909	0
Consumption of Fixed Capital	1,035,205	576,850	927,404	1,689,100	629,462
Second Hand Assets	67,701	29,204	5,622	101,229	933
Imports	1,675,939	730,393	188,773	919,453	204,588
Total	26,167,452	7,593,961	5,729,828	26,320,840	8,518,427

Appendix A: Input Output Matrix of the New Zealand Economy including a Tourism Sector ($ 000), 1997-98

	Community, Social and Personal Services	Central Government	Local Government	Tourism	Household Consumption	Consumption of Central Government Services
Agriculture	71,590	10,901	1,339	268,955	493,593	0
Fishing & Hunting	1,391	3,343	355	15,520	3,181	0
Forestry	7,490	3,903	171	7,583	30,125	0
Mining & Quarrying	6,370	3,324	1,403	11,761	24,714	0
Food, Beverages & Tobacco	82,111	13,383	6,245	388,373	5,651,248	0
Textiles, Clothing & Footwear	28,182	6,189	184	47,508	1,363,000	0
Wood & Wood Products	44,689	7,440	175	18,970	566,912	0
Pulp & Paper Products, Printing & Publishing	282,107	87,356	10,100	150,378	770,873	0
Petroleum, Chemical, Plastics & Rubber Products	278,745	68,904	12,787	208,571	1,882,828	0
Non-metallic Mineral Products	7,991	2,797	49	8,821	121,752	0
Basic Metal Products	1,089	1,151	13	77,874	13,743	0
Fabricated Metal Products, Machinery & Equipment	261,440	166,052	12,826	184,899	1,320,789	0
Other Manufacturing	9,940	304	53	1,980	134,668	0
Electricity, Gas	154,432	19,271	10,417	76,595	1,368,296	0
Water Distribution	23,155	4,010	4,446	11,295	4	0
Construction	406,686	331,534	48,488	352,515	1,136,580	0
Wholesale & Retail Trade	584,310	153,813	29,538	596,032	12,448,647	0
Transport & Storage	243,136	94,157	10,290	732,407	1,216,118	0
Communication	405,141	162,514	20,349	262,359	1,279,287	0
Finance, Insurance, Real Estate & Business Services	1,000,955	716,742	148,802	1,034,855	4,000,630	0
Ownership of Owner Occupied Dwellings	0	0	0	0	8,607,845	0
Community, Social & Personal Services	1,225,867	424,829	24,764	236,781	6,185,546	7,361,388
Central Government	5,049	5,054	217	5,268	79,932	5,625,840
Local Government	56,584	2,237	174,386	10,469	79,195	0
Tourism	167,193	143,714	27,319	66,825	6,255,844	0
Compensation of Employees	9,260,706	2,716,165	537,811	2,518,385	0	0
Operating Surplus	1,891,469	0	0	1,394,657	0	0
Commodity Indirect Taxes	103,038	20,045	12,056	135,404	6,647,158	0
Non-Commodity Indirect Taxes	327,015	187,229	11,472	157,268	0	0
Commodity Subsidies	-52	0	0	-9	0	0
Non-Commodity Subsidies	-127,977	0	0	-39,027	0	0
Consumption of Fixed Capital	401,115	0	0	553,677	0	0
Second Hand Assets	39,470	56,541	5,133	33,868	576,200	0
Imports	1,119,181	591,389	56,815	856,980	7,188,173	0
Total	18,369,609	6,004,292	1,168,004	10,387,796	69,446,882	12,987,228

Appendix A: Input Output Matrix of the New Zealand Economy including a Tourism Sector ($ 000), 1997-98

	Consumption of Local Government Services	Interregional Exports	International Exports	Net Increases in Stocks	Capital Formation	Total
Agriculture	0	0	1,536,531	130,130	52,786	12,050,772
Fishing and Hunting	0	0	204,817	9,130	164	736,583
Forestry	0	0	645,277	224,173	3,927	2,884,819
Mining and Quarrying	0	0	340,362	3,525	12,443	1,449,948
Food, Beverages and Tobacco	0	0	8,346,130	-145,756	26,379	19,325,259
Textiles, Clothing and Footwear	0	0	1,830,686	67,034	8,582	4,116,744
Wood and Wood Products	0	0	969,244	28,167	299,786	4,196,228
Pulp and Paper Products, Printing and Publishing	0	0	835,125	39,564	35,656	5,916,361
Petroleum, Chemical, Plastics and Rubber Products	0	0	1,161,184	76,588	37,806	7,940,716
Non-metallic Mineral Products	0	0	85,468	9,114	22,296	1,810,886
Basic Metal Products	0	0	669,779	-1,050	34,273	1,830,180
Fabricated Metal Products, Machinery and Equipment	0	0	1,912,800	135,649	3,189,426	11,775,847
Other Manufacturing	0	0	242,438	20,511	7,484	450,492
Electricity, Gas	0	0	5,808	-1	13,556	5,518,135
Water Distribution	0	0	60	1	71	444,568
Construction	0	0	32,671	509	7,962,365	17,102,762
Wholesale and Retail Trade	0	0	4,391,796	-5,973	2,415,285	29,707,852
Transport and Storage	662,942	0	3,174,565	578	33,452	11,561,891
Communication	0	0	306,507	0	148,830	5,728,730
Finance, Insurance, Real Estate and Business Services	0	0	457,147	37	1,456,040	26,403,601
Ownership of Owner Occupied Dwellings	0	0	0	0	0	8,607,845
Community, Social and Personal Services	723,288	0	351,724	715	71,876	18,959,757
Central Government	0	0	48,074	118	53,412	5,862,147
Local Government	554,542	0	1,458	12	408	1,161,242
Tourism	0	0	2,728,391	0	0	10,387,796
Compensation of Employees	0	0	0	0	0	43,721,000
Operating Surplus	0	0	0	0	0	31,573,000
Commodity Indirect Taxes	0	0	415,639	15,945	674,570	9,835,436
Non-Commodity Indirect Taxes	0	0	0	0	119,090	3,846,564
Commodity Subsidies	0	0	0	0	0	-2,034
Non-Commodity Subsidies	0	0	0	0	0	-316,966
Consumption of Fixed Capital	0	0	0	0	0	9,590,000
Second Hand Assets	0	0	148,412	30,329	-1,613,847	0
Imports	0	0	0	240,950	4,464,880	28,396,736
Total	1,940,772	0	30,842,094	880,000	19,530,996	342,574,896

Appendix B: Energy use by the tourism sector

Table B.1 describes the delivered energy inputs into each of the tourism sub-sectors for 1997/98, expressed in heat-equivalent terms. Table 13 presents the same set of data expressed in oil-equivalent terms, so that energy quality is taken into account.

Table B.2 describes the energy end-uses for each of the tourism sub-sectors for 1997/98, expressed in heat-equivalent terms. Table 14 presents the same set of data expressed in oil-equivalent terms.

Table B.1. Delivered energy inputs (heat equivalents) into the tourism sub-sectors within New Zealand, 1997/98

Tourism sub-sectors	Aviation fuel (TJ)	Coal (TJ)	Diesel (TJ)	Electricity (TJ)	Fuel oil (TJ)	Geo-thermal (TJ)	LPG (TJ)	Natural gas (TJ)	Petrol (TJ)	Wood (TJ)
Agriculture	0	0	33	10	0	0	0	0	20	0
Fishing and Hunting	0	0	3	0	1	0	0	0	0	0
Forestry	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	326	44	226	16	0	10	322	53	0
Textiles, Clothing and Footwear	0	36	15	39	7	0	1	90	5	0
Wood and Wood Products	0	0	0	1	0	0	0	1	0	2
Pulp and Paper Products, Printing and Publishing	0	14	1	121	9	81	1	73	0	43
Petroleum, Chemical, Plastics and Rubber Prod.	0	7	22	68	4	0	1	55	1	0
Non-metallic Mineral Products	0	18	1	3	0	0	1	5	0	0
Basic Metal Products	0	7	0	9	0	0	0	1	0	0
Fabricated Metal Products, Machinery and Equip.	0	3	37	24	2	0	3	34	5	0
Other Manufacturing	0	0	0	7	0	0	0	1	2	0
Electricity, Gas and Water Distribution	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0
Wholesale and Retail Trade	0	78	157	3,508	187	137	103	1,161	1,429	8
Transport and Storage	9,622	6	2,541	309	365	0	178	58	1,359	0
Communication	0	0	4	9	0	0	0	1	8	0
Finance, Insurance, Real Estate and Bus. Srvcs	0	1	0	38	3	0	0	11	0	0
Ownership of Owner Occupied Dwellings	0	0	0	0	0	0	0	0	0	0
Community, Social and Personal Services	0	151	10	237	4	0	0	86	68	0
Central Government	0	0	0	0	0	0	0	0	0	0
Local Government	0	0	0	9	0	0	0	0	0	0
Household	0	0	0	0	0	0	0	0	0	0
Total	9,623	647	2,869	4,618	599	217	297	1,900	2,951	53

Notes: 1. This only includes energy use within New Zealand's borders, which doesn't include overseas travel for international visitors to New Zealand.
2. It is methodologically incorrect to "add-up" row totals. The energy inputs need to be converted to common energy quality units before valid aggregation can take place (refer to Table 13).

Table B.2. **Delivered energy inputs (heat equivalents) into the tourism sub-sectors within New Zealand, 1997/98**

Tourism sub-sectors	Aviation fuel (TJ)	Coal (TJ)	Diesel (TJ)	Electricity (TJ)	Fuel oil (TJ)	Geo-thermal (TJ)	LPG (TJ)	Natural gas (TJ)	Petrol (TJ)	Wood (TJ)
Agriculture	0	0	33	10	0	0	0	0	20	0
Fishing and Hunting	0	0	3	0	1	0	0	0	0	0
Forestry	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	326	44	226	16	0	10	322	53	0
Textiles, Clothing and Footwear	0	36	15	39	7	0	1	90	5	0
Wood and Wood Products	0	0	0	1	0	0	0	1	0	2
Pulp and Paper Products, Printing and Publishing	0	14	1	121	9	81	1	73	0	43
Petroleum, Chemical, Plastics and Rubber Prod.	0	7	22	68	4	0	1	55	1	0
Non-metallic Mineral Products	0	18	1	3	0	0	1	5	0	0
Basic Metal Products	0	7	0	9	0	0	0	1	0	0
Fabricated Metal Products, Machinery and Equip.	0	3	37	24	2	0	3	34	5	0
Other Manufacturing	0	0	0	7	0	0	0	1	2	0
Electricity, Gas and Water Distribution	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0
Wholesale and Retail Trade	0	78	157	3,508	187	137	103	1,161	1,429	8
Transport and Storage	9,622	6	2,541	309	365	0	178	58	1,359	0
Communication	0	0	4	9	0	0	0	1	8	0
Finance, Insurance, Real Estate and Bus. Srvcs	0	1	0	38	3	0	0	11	0	0
Ownership of Owner Occupied Dwellings	0	0	0	0	0	0	0	0	0	0
Community, Social and Personal Services	0	151	10	237	4	0	0	86	68	0
Central Government	0	0	0	0	0	0	0	0	0	0
Local Government	0	0	0	9	0	0	0	0	0	0
Household	0	0	0	0	0	0	0	0	0	0
Total	9,623	647	2,869	4,618	599	217	297	1,900	2,951	53

Notes: 1. This only includes energy use within New Zealand's borders, which doesn't include overseas travel for international visitors to New Zealand.
2. It is methodologically incorrect to "add-up" row totals. The energy inputs need to be converted to common energy quality units before valid aggregation can take place (refer to Table 13).

Appendix C: Numerical example of the calculation of the ecological multiplier and its component parts

Take the example of a simple economy of three sectors and three commodities, with one exogenous resource input (water).

The outputs matrix **U** is:

	Sector 1	Sector 2	Sector 3
Commodity 1	380	0	0
Commodity 2	0	770	0
Commodity 3	0	0	360

These values are measured in $million.

The inputs matrix **V** is:

	Sector 1	Sector 2	Sector 3
Commodity 1	30	300	10
Commodity 2	100	20	100
Commodity 3	50	50	360

These values are measured in $million.

The net matrix **(U – V)** is the inputs matrix **V** subtracted from the outputs matrix **U**:

	Sector 1	Sector 2	Sector 3
Commodity 1	350	–300	–10
Commodity 2	–100	750	–100
Commodity 3	–50	–50	310

The inputs and the output of each sector are read down the respective column. Outputs are positive elements. Inputs are negative elements.

The inverse matrix $\mathbf{(U - V)^{-1}}$ is:

	Sector 1	Sector 2	Sector 3
Commodity 1	0.0033	0.0014	0.0015
Commodity 2	0.0005	0.0016	0.0005
Commodity 3	0.0006	0.0015	0.0034

The exogenous input vector $\boldsymbol{\beta}$ representing water inputs (kilotonnes) into each sector is:

	Sector 1	Sector 2	Sector 3
Water	500	100	2

This solution vector **ε** representing the water multipliers (kilotonnes / $million) is:

	Sector 1	Sector 2	Sector 3
Water	1.72	0.84	0.33

The solution vector **ε** is determined by multiplying β by $(\mathbf{U} - \mathbf{V})^{-1}$.

		Sector 1	Sector 2	Sector 3
Matrix **W**	Commodity 1	600.91	–515.07	–17.17
	Commodity 2	–84.25	631.74	–84.23
	Commodity 3	–16.68	–16.68	103.40
Vector **β**	Direct Water	–500.00	–100.00	–2.00

The evaluated matrix **W** is calculated by multiplying $\hat{\boldsymbol{\varepsilon}}$ by $(\mathbf{U} - \mathbf{V})^{-1}$. The embodied flows in this matrix **W** are measured in kilotonnes of water. The vector **β** can be put alongside the matrix **W** in order to gain a more complete picture of direct and indirect water flows (kilotonnes) into each sector.

The positive elements on the diagonal represent the embodied water output (kilotonnes) of each sector. Reading down the column, the negative elements represent the direct and indirect inputs of water into each sector. The sum of the direct inputs and indirect inputs *equals* the embodied water output for each sector – namely, the sum of each column sums to zero.

The data from **W** can be used to generate lifecycle assessment diagrams. The first-round indirect inputs into Sector 1 are the negative elements of the first column of **W.** The first-round direct input into Sector 1 is the first element of **β**. The second-, third- and fourth-round inputs of embodied water are calculated according to the equations outlined in Section 3.2.1, and the results can be summarised in a lifecycle assessment flow diagram.

Appendix D: Actual and forecasted direct energy intensities for various sectors of the New Zealand economy

Actual and forecasted direct energy intensities for the transport sector (Table D.1), hotel sector (Table D.2), commercial sector (Table D.3) and the New Zealand economy (Table D.4) are presented in Appendix D. The forecasted values were estimated using linear regression time series analysis. These forecasts were used to calculate the technical change ratios presented in Section 4.4.1 of the main body of the report.

Table D.1 **Actual and Forecasted, Direct Energy Intensities, for the Passenger Transport Sector of the New Zealand Economy**

Year	Cars		Buses		Rail		Air	
	(MJ / person km)	(Annual % change)	(MJ / person km)	(Annual % change)	(MJ / person km)	(Annual % change)	(MJ / person km)	(Annual % change)
1975	2.30		0.75		1.72		4.49	
1976	2.48	7.83	0.77	2.67	1.26	–26.74	4.58	2.00
1977	2.31	–6.85	0.77	0.00	1.32	4.76	4.56	–0.44
1978	2.45	6.06	0.78	1.30	1.22	–7.58	4.43	–2.85
1979	2.30	–6.12	0.79	1.28	1.23	0.82	4.25	–4.06
1980	2.40	4.35	0.77	–2.53	1.32	7.32	3.72	–12.47
1981	2.28	–5.00	0.76	–1.30	1.42	7.58	3.30	–11.29
1982	2.20	–3.51	0.75	–1.32	1.37	–3.52	3.22	–2.42
1983	2.19	–0.45	0.73	–2.67	1.41	2.92	3.22	0.00
1984	2.15	–1.83	0.73	0.00	1.21	–14.18	3.49	8.39
1985	2.10	–2.33	0.73	0.00	1.07	–11.57	3.26	–6.59
1986	2.15	2.38	0.74	1.37	1.10	2.80	3.35	2.76
1987	2.19	1.86	0.74	0.00	1.17	6.36	3.32	–0.90
1988	2.05	–6.39	0.75	1.35	1.23	5.13	2.94	–11.45
1989	2.05	0.00	0.77	2.67	1.25	1.63	2.93	–0.34
1990	2.05	0.00	0.78	1.30	1.33	6.40	2.93	0.00
1991	2.03	–0.98	0.79	1.28	1.19	–10.53	2.93	0.00
1992	2.00	–1.48	0.80	1.27	1.28	7.56	2.92	–0.34
1993	1.98	–1.00	0.79	–1.25	1.31	2.34	2.92	0.00
1994	1.95	–1.52	0.78	–1.27	1.52	16.03	2.91	–0.34
1995	1.93	–1.03	0.77	–1.28	1.58	3.95	2.87	–1.37
1996	1.91	–1.04	0.77	0.00	1.54	–2.53	2.83	–1.39
1997	1.91	0.00	0.76	–1.30	1.45	–5.84	2.79	–1.41
1998	1.90	–0.52	0.75	–1.32	1.44	–0.69	2.75	–1.43
1999(f)	1.84	–3.18	0.63	–15.50	1.38	–4.15	2.39	–13.00
2000(f)	1.82	–1.29	0.63	0.10	1.38	0.29	2.31	–3.27
2001(f)	1.79	–1.31	0.64	0.10	1.39	0.29	2.24	–3.38
2002(f)	1.77	–1.32	0.64	0.10	1.39	0.29	2.16	–3.50
2003(f)	1.74	–1.34	0.64	0.10	1.40	0.28	2.08	–3.63
2004(f)	1.72	–1.36	0.64	0.10	1.40	0.28	2.00	–3.77
2005(f)	1.70	–1.38	0.64	0.10	1.40	0.28	1.92	–3.91
2006(f)	1.67	–1.40	0.64	0.10	1.41	0.28	1.84	–4.07
2007(f)	1.65	–1.42	0.64	0.10	1.41	0.28	1.77	–4.25

Notes: 1. (f) denotes forecast based on a linear regression time series.
2. These forecasts were used to project the technical change ratios for the "Transport" sub-sector.
3. The 1975–1998 data were obtained from EECA (1999).

Table D.2 Actual and Forecasted, Direct Energy Intensities, for the Hotel Sector of the New Zealand Economy

Year	Direct energy intensity	
	(GJ/m²)	(Annual % change)
1991	1.34	
1992	1.32	–1.49
1993	1.29	–2.27
1994	1.20	–6.98
1995	1.16	–3.33
1996(f)	1.12	–3.62
1997(f)	1.07	–4.29
1998(f)	1.02	–4.49
1999(f)	0.97	–4.70
2000(f)	0.93	–4.93
2001(f)	0.88	–5.18
2002(f)	0.83	–5.47
2003(f)	0.78	–5.78
2004(f)	0.73	–6.14
2005(f)	0.69	–6.54
2006(f)	0.64	–7.00
2007(f)	0.59	–8.47

Notes: 1. (f) denotes forecast based on a linear regression time series.
2. These forecasts were used to project the technical change ratios for the "Hotels" sub-sector of the tourism sector.
3. The 1991–1995 data were obtained from EECA (2000).

Table D.3 Actual and Forecasted, Direct Energy Intensities, for the Commercial Sector of the New Zealand Economy

Year	Direct energy intensity	
	(GJ/m²)	(Annual % change)
1991	1006.00	
1992	930.00	–7.55
1993	969.00	4.19
1994	930.00	–4.02
1995	969.00	4.19
1996	928.00	–4.23
1997	913.00	–1.62
1998	856.00	–6.24
1999	867.00	1.29
2000	761.00	–12.23
2001(f)	802.80	5.49
2002(f)	782.78	–2.49
2003(f)	762.76	–2.56
2004(f)	742.75	–2.62
2005(f)	722.73	–2.70
2006(f)	702.71	–2.77
2007(f)	682.69	–2.85

Notes: 1. (f) denotes forecast based on a linear regression time series.
2. These forecasts were used to project the technical change ratios for the "Commercial" sub-sector of the tourism sector.
3. The 1991–2000 data were obtained from EECA (2000).

Table D.4 Actual and Forecasted, Direct Energy Intensities, for the the Entire New Zealand Economy

Year	Direct energy intensity	
	(GJ/m²)	(Annual % change)
1980	4.89	
1981	5.06	3.5
1982	5.07	0.2
1983	5.00	–1.4
1984	4.99	–0.2
1985	4.76	–4.6
1986	4.59	–3.6
1987	4.75	3.5
1988	5.03	5.9
1989	4.93	–2.0
1990	5.06	2.6
1991	5.30	4.7
1992	5.33	0.6
1993	5.46	2.4
1994	5.27	–3.5
1995	5.06	–4.0
1996	5.00	–1.2
1997	4.92	–1.6
1998	4.81	–2.2
1999	4.91	2.1
2000	4.78	–2.6
2001(f)	4.63	–3.1
2002(f)	4.54	–1.9
2003(f)	4.45	–1.9
2004(f)	4.37	–2.0
2005(f)	4.28	–2.0
2006(f)	4.19	–2.1
2007(f)	4.10	–2.1

Notes: 1. (f) denotes forecast based on a linear regression time series.
2. The 1980–2000 data were obtained from EECA (2001).

Appendix E: Projections of resource use, pollutants and employment generated by the New Zealand tourism sector, 1997–2007

Projections of future levels of resource use and production of pollution are graphically depicted by Figures 20 to 35 in the main body of the report. Tables E.1 to E.16 presented in Appendix E contain the data used in these graphical depictions of the forecasts. Also contained in Appendix E is the future projection for direct employment (Table E.19) and total employment (Table E.18) in the New Zealand tourism sector.

Table E.1 Projections of direct energy use (terajoules, oil equivalents) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (TJ – Oil Equiv)	Projection B (TJ – Oil Equiv)	Projection C (TJ – Oil Equiv)	Projection A (TJ – Oil Equiv)	Projection B (TJ – Oil Equiv)	Projection C (TJ – Oil Equiv)	Projection A (TJ – Oil Equiv)	Projection B (TJ – Oil Equiv)	Projection C (TJ – Oil Equiv)
1997	79 482	79 482	79 482	20 282	20 282	20 282	59 200	59 200	59 200
1998	79 055	78 379	77 703	20 358	20 130	19 902	58 698	58 249	57 800
1999	83 713	82 893	82 072	20 164	20 143	20 123	63 549	62 750	61 950
2000	89 653	87 671	85 690	19 002	18 732	18 461	70 651	68 940	67 228
2001	95 285	91 694	88 103	18 759	18 206	17 653	76 526	73 488	70 450
2002	101 206	96 008	90 810	19 638	18 880	18 122	81 568	77 128	72 688
2003	106 564	99 626	92 688	20 231	19 265	18 299	86 332	80 361	74 389
2004	111 800	102 998	94 196	20 280	19 147	18 013	91 520	83 851	76 183
2005	117 126	106 256	95 386	20 091	18 784	17 477	97 036	87 473	77 909
2006	122 902	109 762	96 623	20 046	18 558	17 071	102 856	91 204	79 551
2007	128 676	113 104	97 533	20 189	18 506	16 824	108 487	94 598	80 709

Table E.2 Projections of Direct and Indirect Energy Use (Terajoules, TOE) by the New Zealand Tourism Sector, 1997-2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (TJ – Oil Equiv)	Projection B (TJ – Oil Equiv)	Projection C (TJ – Oil Equiv)	Projection A (TJ – Oil Equiv)	Projection B (TJ – Oil Equiv)	Projection C (TJ – Oil Equiv)	Projection A (TJ – Oil Equiv)	Projection B (TJ – Oil Equiv)	Projection C (TJ – Oil Equiv)
1997	107 245	107 245	107 245	34 887	34 887	34 887	72 359	72 359	72 359
1998	106 761	105 818	104 875	35 016	34 624	34 233	71 745	71 193	70 642
1999	112 357	111 420	110 482	34 682	34 647	34 612	77 675	76 773	75 871
2000	119 039	116 614	114 189	32 684	32 219	31 754	86 355	84 395	82 434
2001	125 802	121 384	116 966	32 266	31 315	30 364	93 537	90 069	86 602
2002	133 478	127 150	120 823	33 779	32 475	31 170	99 699	94 676	89 653
2003	140 321	131 939	123 556	34 799	33 137	31 475	105 522	98 802	92 081
2004	146 746	136 202	125 659	34 883	32 933	30 983	111 863	103 269	94 676
2005	153 162	140 223	127 285	34 557	32 309	30 061	118 605	107 914	97 223
2006	160 198	144 638	129 078	34 479	31 921	29 363	125 719	112 717	99 714
2007	167 327	148 958	130 589	34 726	31832	28 938	132 601	117 126	101 651

Table E.3 Projections of direct water use (m^3) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)
1997	8 636 417	8 636 417	8 636 417	6 362 931	6 362 931	6 362 931	2 273 486	2 273 486	2 273 486
1998	8 640 671	8 385 122	8 129 573	6 386 470	6 197 589	6 008 708	2 254 201	2 187 533	2 120 865
1999	8 766 171	8 262 985	7 759 798	6 325 651	5 962 553	5 599 455	2 440 520	2 300 432	2 160 344
2000	8 674 456	7 986 298	7 298 139	5 961 215	5 488 302	5 015 389	2 713 241	2 497 995	2 282 750
2001	8 823 752	7 939 827	7 055 902	5 884 863	5 295 343	4 705 823	2 938 889	2 644 484	2 350 079
2002	9 293 375	8 214 700	7 136 026	6 160 878	5 445 790	4 730 702	3 132 497	2 768 911	2 405 324
2003	9 662 395	8 393 423	7 124 452	6 346 920	5 513 373	4 679 826	3 315 475	2 880 051	2 444 626
2004	9 876 915	8 435 024	6 993 132	6 362 214	5 433 420	4 504 625	3 514 701	3 001 604	2 488 507
2005	10 029 240	8 423 975	6 818 709	6 302 709	5 293 907	4 285 104	3 726 531	3 130 068	2 533 605
2006	10 238 663	8 461 521	6 684 379	6 288 610	5 197 085	4 105 561	3 950 053	3 264 436	2 578 818
2007	10 499 823	8 541 106	6 582 389	6 333 537	5 152 031	3 970 524	4 166 286	3 389 075	2 611 864

Table E.4 Projections of direct and indirect water use (m^3) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)
1997	101 118 785	101 118 785	101 118 785	74 499 858	74 499 858	74 499,858	26 618 926	26 618 926	26 618 926
1998	101 168 594	98 176 518	95 184 442	74 775 463	72 563 967	70 352,472	26 393 131	25 612 551	24 831 970
1999	102 638 000	96 746 485	90 854 970	74 063 369	69 812 064	65 560,759	28 574 632	26 934 422	25 294 212
2000	101 564 166	93 506 918	85 449 670	69 796 401	64 259 340	58 722,280	31 767 765	29 247 577	26 727 389
2001	103 312 181	92 962 818	82 613 455	68 902 436	62 000 091	55 097,746	34 409 745	30 962 727	27 515 709
2002	108 810 724	96 181 153	83 551 581	72 134 140	63 761 589	55 389,039	36 676 585	32 419 564	28 162 543
2003	113 131 363	98 273 715	83 416 066	74 312 392	64 552 875	54 793,359	38 818 971	33 720 839	28 622 707
2004	115 643 058	98 760 788	81 878 518	74 491 464	63 616 752	52 742,039	41 151 594	35 144 036	29 136 479
2005	117 426 543	98 631 421	79 836 299	73 794 759	61 983 277	50 171,795	43 631 784	36 648 144	29 664 504
2006	119 878 550	99 071 029	78 263 509	73 629 677	60 849 650	48 069,624	46 248 873	38 221 379	30 193 884
2007	122 936 325	100 002 845	77 069 364	74 155 703	60 322 132	46 488,561	48 780 622	39 680 713	30 580 803

Table E.5 Projections of direct BOD discharges (kg) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)
1997	1 027 260	1 027 260	1 027 260	756 840	756 840	756 840	270 420	270 420	270 420
1998	1 027 766	998 169	968 571	759 640	737 764	715 888	268 126	260 405	252 683
1999	1 042 694	984 368	926 043	752 406	710 318	668 231	290 288	274 050	257 812
2000	1 031 785	952 087	872 388	709 058	654 288	599 518	322 727	297 799	272 870
2001	1 049 543	947 184	844 826	699 976	631 710	563 443	349 567	315 475	281 383
2002	1 105 402	980 617	855 831	732 807	650 082	567 358	372 595	330 534	288 473
2003	1 149 295	1 002 575	855 855	754 936	658 560	562 184	394 360	344 015	293 671
2004	1 174 812	1 008 139	841 467	756 755	649 393	542 031	418 057	358 746	299 436
2005	1 192 930	1 007 382	821 835	749 677	633 073	516 468	443 253	374 310	305 366
2006	1 217 840	1 012 408	806 976	748 000	621 823	495 646	469 840	390 585	311 329
2007	1 248 903	1 022 440	795 976	753 344	616 740	480 136	495 560	405 700	315 840

Table E.6 Projections of direct and indirect BOD discharges (kg) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)
1997	1 797 922	1 797 922	1 797 922	1 324 629	1 324 629	1 324 629	473 292	473 292	473 292
1998	1 798 807	1 747 005	1 695 203	1 329 530	1 291 242	1 252 954	469 278	455 763	442 249
1999	1 824 934	1 722 852	1 620 770	1 316 868	1 243 206	1 169 545	508 065	479 646	451 226
2000	1 805 841	1 666 352	1 526 863	1 241 000	1 145 142	1 049 283	564 840	521 210	477 580
2001	1 836 921	1 657 772	1 478 623	1 225 106	1 105 625	986 144	611 815	552 147	492 479
2002	1 934 687	1 716 286	1 497 884	1 282 566	1 137 781	992 996	652 120	578 504	504 889
2003	2 011 509	1 754 717	1 497 926	1 321 296	1 152 618	983 940	690 213	602 099	513 986
2004	2 056 167	1 764 456	1 472 745	1 324 480	1 136 574	948 668	731 687	627 882	524 076
2005	2 087 878	1 763 131	1 438 384	1 312 092	1 108 011	903 929	775 786	655 121	534 455
2006	2 131 476	1 771 927	1 412 377	1 309 157	1 088 321	867 485	822 319	683 605	544 892
2007	2 185 844	1 789 485	1 393 125	1 318 510	1 079 425	840 339	867 334	710 060	552 786

Table E.7 Projections of direct nitrate discharges (kg) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)
1997	25 231	25 231	25 231	18 589	18 589	18 589	6 642	6 642	6 642
1998	25 244	24 184	23 124	18 658	17 875	17 091	6 586	6 309	6 033
1999	25 610	23 550	21 489	18 480	16 994	15 507	7 130	6 556	5 983
2000	25 343	22 510	19 677	17 416	15 469	13 523	7 927	7 041	6 155
2001	25 779	22 150	18 522	17 193	14 773	12 353	8 586	7 378	6 169
2002	27 151	22 694	18 238	17 999	15 045	12 090	9 152	7 649	6 147
2003	28 229	22 978	17 728	18 543	15 094	11 645	9 686	7 885	6 083
2004	28 856	22 898	16 941	18 587	14 750	10 913	10 268	8 148	6 029
2005	29 301	22 692	16 083	18 413	14 260	10 107	10 887	8 431	5 976
2006	29 912	22 631	15 350	18 372	13 900	9 428	11 540	8 731	5 922
2007	30 675	22 696	14 717	18 503	13 690	8 877	12 172	9 006	5 840

Table E.8 Projections of direct and indirect nitrate discharges (kg) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)
1997	52 631	52 631	52 631	38 776	38 776	38 776	13 855	13 855	13 855
1998	52 657	50 445	48 234	38 919	37 285	35 651	13 737	13 160	12 583
1999	53 421	49 123	44 825	38 549	35 447	32 346	14 873	13 676	12 479
2000	52 863	46 954	41 045	36 328	32 267	28 207	16 535	14 686	12 838
2001	53 772	46 204	38 635	35 863	30 815	25 767	17 910	15 389	12 868
2002	56 634	47 338	38 043	37 545	31 382	25 220	19 090	15 956	12 823
2003	58 883	47 931	36 978	38 678	31 484	24 290	20 205	16 447	12 688
2004	60 190	47 765	35 339	38 772	30 768	22 763	21 419	16 997	12 575
2005	61 119	47 333	33 548	38 409	29 746	21 082	22 710	17 587	12 465
2006	62 395	47 207	32 019	38 323	28 994	19 666	24 072	18 212	12 353
2007	63 986	47 342	30 698	38 597	28 557	18 517	25 390	18 785	12 181

Table E.9 Projections of direct phosphorus discharges (kg) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)
1997	179 090	179 090	179 090	131 945	131 945	131 945	47 144	47 144	47 144
1998	179 178	174 568	169 959	132 433	129 026	125 620	46 744	45 542	44 339
1999	181 780	172 668	163 556	131 172	124 597	118 021	50 608	48 071	45 534
2000	179 878	167 481	155 084	123 615	115 096	106 576	56 263	52 386	48 508
2001	182 974	167 069	151 163	122 032	111 424	100 816	60 942	55 645	50 347
2002	192 713	173 422	154 131	127 755	114 967	102 178	64 957	58 455	51 953
2003	200 365	177 752	155 140	131 613	116 760	101 907	68 752	60 993	53 234
2004	204 813	179 170	153 527	131 930	115 412	98 894	72 883	63 758	54 632
2005	207 972	179 447	150 922	130 697	112 771	94 845	77 275	66 677	56 078
2006	212 315	180 737	149 160	130 404	111 009	91 614	81 911	69 728	57 545
2007	217 730	182 908	148 086	131 336	110 331	89 326	86 394	72 577	58 760

Table E.10 Projections of direct and indirect phosphorus discharges (kg) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)	Projection A (kg)	Projection B (kg)	Projection C (kg)
1997	346 265	346 265	346 265	255 113	255 113	255 113	91 152	91 152	91 152
1998	346 436	337 524	328 611	256 057	249 470	242 882	90 379	88 054	85 729
1999	351 468	333 849	316 231	253 618	240 905	228 192	97 849	92 944	88 039
2000	347 790	323 821	299 851	239 007	222 534	206 062	108 784	101 286	93 789
2001	353 776	323 023	292 271	235 946	215 435	194 925	117 831	107 588	97 345
2002	372 605	335 307	298 008	247 012	222 286	197 559	125 593	113 021	100 449
2003	387 401	343 680	299 960	254 471	225 752	197 034	132 929	117 928	102 926
2004	396 001	346 421	296 840	255 084	223 147	191 209	140 917	123 274	105 631
2005	402 109	346 957	291 805	252 699	218 039	183 380	149 410	128 917	108 425
2006	410 505	349 451	288 397	252 133	214 634	177 134	158 372	134 817	111 263
2007	420 976	353 648	286 320	253 935	213 322	172 710	167 042	140 326	113 611

Table E.11 Projections of direct water discharges (m^3) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)
1997	52 129 202	52 129 202	52 129 202	38 406 496	38 406 496	38 406 496	13 722 706	13 722 706	13 722 706
1998	52 154 880	51 515 287	50 875 694	38 548 577	38 075 843	37 603 108	13 606 304	13 439 445	13 272 586
1999	52 912 395	51 630 545	50 348 695	38 181 475	37 256 494	36 331 514	14 730 920	14 374 051	14 017 181
2000	52 358 807	50 727 344	49 095 881	35 981 749	34 860 583	33 739 417	16 377 058	15 866 761	15 356 463
2001	53 259 952	51 236 519	49 213 086	35 520 888	34 171 391	32 821 895	17 739 064	17 065 127	16 391 191
2002	56 094 585	53 849 071	51 603 556	37 186 910	35 698 286	34 209 662	18 907 675	18 150 785	17 393 894
2003	58 321 980	55 868 894	53 415 808	38 309 852	36 698 498	35 087 144	20 012 127	19 170 396	18 328 664
2004	59 616 820	56 988 771	54 360 721	38 402 169	36 709 311	35 016 453	21 214 652	20 279 460	19 344 268
2005	60 536 250	57 745 851	54 955 451	38 043 000	36 289 420	34 535 840	22 493 250	21 456 431	20 419 611
2006	61 800 320	58 827 839	55 855 358	37 957 896	36 132 192	34 306 487	23 842 423	22 695 647	21 548 871
2007	63 376 677	60 201 965	57 027 252	38 229 076	36 314 076	34 399 076	25 147 602	23 887 889	22 628 176

Table E.12 Projections of direct and indirect water discharges (m^3) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)	Projection A (m^3)	Projection B (m^3)	Projection C (m^3)
1997	172 577 520	172 577 520	172 577 520	127 147 501	127 147 501	127 147 501	45 430 019	45 430 019	45 430 019
1998	172 662 528	170 545 109	168 427 691	127 617 870	126 052 849	124 487 828	45 044 659	44 492 261	43 939 863
1999	175 170 336	170 926 678	166 683 020	126 402 552	123 340 337	120 278 122	48 767 784	47 586 341	46 404 897
2000	173 337 643	167 936 566	162 535 488	119 120 199	115 408 498	111 696 798	54 217 444	52 528 067	50 838 690
2001	176 320 948	169 622 226	162 923 504	117 594 486	113 126 879	108 659 271	58 726 462	56 495 347	54 264 232
2002	185 705 209	178 271 269	170 837 329	123 109 974	118 181 775	113 253 576	62 595 235	60 089 494	57 583 752
2003	193 079 160	184 958 041	176 836 922	126 827 555	121 493 051	116 158 546	66 251 605	63 464 990	60 678 376
2004	197 365 824	188 665 475	179 965 126	127 133 175	121 528 847	115 924 518	70 232 649	67 136 629	64 040 608
2005	200 409 664	191 171 843	181 934 022	125 944 122	120 138 767	114 333 412	74 465 542	71 033 076	67 600 610
2006	204 594 457	194 753 843	184 913 229	125 662 379	119 618 251	113 574 124	78 932 078	75 135 592	71 339 105
2007	209 813 105	199 302 987	188 792 870	126 560 138	120 220 391	113 880 644	83 252 967	79 082 596	74 912225

Table E.13 Projections of direct land use (ha) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (ha)	Projection B (ha)	Projection C (ha)	Projection A (ha)	Projection B (ha)	Projection C (ha)	Projection A (ha)	Projection B (ha)	Projection C (ha)
1997	65 556	65 560	65 564	48 299	48 321	48 343	17 257	17 239	17 221
1998	65 409	65 177	64 944	48 299	48 079	47 860	17 111	17 098	17 085
1999	66 824	65 488	64 151	48 299	47 840	47 381	18 525	17 648	16 770
2000	68 894	66 888	64 882	48 299	47 603	46 907	20 595	19 285	17 975
2001	70 607	68 414	66 222	48 299	47 368	46 438	22 308	21 046	19 784
2002	72 076	69 632	67 189	48 299	47 136	45 974	23 778	22 496	21 215
2003	73 465	70 683	67 900	48 299	46 906	45 514	25 166	23 776	22 386
2004	74 977	71 747	68 516	48 299	46 679	45 059	26 679	25 068	23 457
2005	76 585	72 906	69 226	48 299	46 453	44 608	28 287	26 452	24 618
2006	78 282	74 142	70 003	48 299	46 230	44 162	29 983	27 912	25 840
2007	79 923	75 380	70 837	48 299	46 010	43 721	31 625	29 371	27 116

Table E.14 Projections of direct and indirect land use (ha) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (ha)	Projection B (ha)	Projection C (ha)	Projection A (ha)	Projection B (ha)	Projection C (ha)	Projection A (ha)	Projection B (ha)	Projection C (ha)
1997	873 417	873 421	873 425	643 495	643 518	643 540	229 922	229 904	229 885
1998	873 669	869 395	865 121	645 697	642 491	639 284	227 972	226 904	225 837
1999	886 822	877 327	867 832	640 008	633 662	627 316	246 814	243 666	240 517
2000	880 313	866 258	852 202	605 918	596 942	587 965	274 395	269 316	264 237
2001	895 991	877 537	859 083	598 776	587 000	575 225	297 215	290 537	283 859
2002	941 390	917 644	893 898	624 595	609 310	594 026	316 795	308 333	299 872
2003	977 298	948 069	918 841	641 997	623 234	604 470	335 300	324 836	314 371
2004	998 876	964 263	929 650	643 428	621 593	599 759	355 448	342 670	329 892
2005	1 014 733	974 815	934 897	637 862	613 243	588 625	376 871	361 572	346 272
2006	1 036 019	990 466	944 912	636 543	609 038	581 534	399 476	381 427	363 379
2007	1 062 090	1 010 591	959 091	640 746	610 132	579 519	421 344	400 458	379 572

Table E.15 Projections of direct CO_2 emissions (tonnes) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (tonnes)	Projection B (tonnes)	Projection C (tonnes)	Projection A (tonnes)	Projection B (tonnes)	Projection C (tonnes)	Projection A (tonnes)	Projection B (tonnes)	Projection C (tonnes)
1997	5 007 344	5 007 344	5 007 344	1 059 590	1 059 590	1 059 590	3 947 754	3 947 754	3 947 754
1998	4 977 777	4 936 389	4 895 001	1 063 510	1 051 621	1 039 733	3 914 267	3 884 767	3 855 268
1999	5 291 179	5 235 299	5 179 418	1 053 382	1 052 312	1 051 241	4 237 797	4 182 987	4 128 177
2000	5 704 053	5 574 397	5 444 740	992 694	978 571	964 447	4 711 359	4 595 826	4 480 293
2001	6 083 161	5 850 107	5 617 053	979 980	951 098	922 217	5 103 181	4 899 009	4 694 836
2002	6 465 311	6 127 024	5 788 737	1 025 943	986 324	946 704	5 439 367	5 140 700	4 842 033
2003	6 814 021	6 361 605	5 909 189	1 056 924	1 006 441	955 958	5 757 097	5 355 164	4 953 231
2004	7 162 510	6 586 754	6 010 997	1 059 471	1 000 253	941 034	6 103 039	5 586 501	5 069 963
2005	7 520 429	6 807 880	6 095 332	1 049 562	981 298	913 034	6 470 867	5 826 583	5 182 298
2006	7 906 212	7 043 372	6 180 533	1 047 214	969 524	891 835	6 858 998	6 073 848	5 288 698
2007	8 289 168	7 265 308	6 241 448	1 054 696	966 804	878 913	7 234 472	6 298 503	5 362 535

Table E.16 Projections of direct and indirect CO_2 emissions (tonnes) by the New Zealand tourism sector, 1997–2007

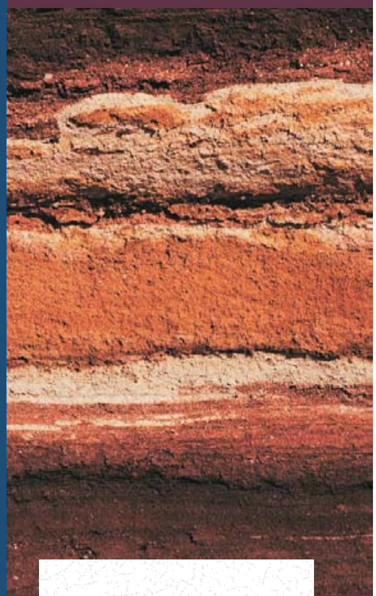
Year	Total tourists			Domestic tourists			International tourists		
	Projection A (tonnes)	Projection B (tonnes)	Projection C (tonnes)	Projection A (tonnes)	Projection B (tonnes)	Projection C (tonnes)	Projection A (tonnes)	Projection B (tonnes)	Projection C (tonnes)
1997	6 803 178	6 803 178	6 803 178	1 980 762	1 980 762	1 980 762	4 822 416	4 822 416	4 822 416
1998	6 769 599	6 711 140	6 652 680	1 988 090	1 965 865	1 943 640	4 781 510	4 745 275	4 709 039
1999	7 145 878	7 082 060	7 018 242	1 969 157	1 967 156	1 965 154	5 176 721	5 114 904	5 053 088
2000	7 610 914	7 452 368	7 293 822	1 855 709	1 829 307	1 802 904	5 755 205	5 623 061	5 490 917
2001	8 065 780	7 779 250	7 492 720	1 831 941	1 777 951	1 723 960	6 233 839	6 001 299	5 768 759
2002	8 562 374	8 151 161	7 739 947	1 917 863	1 843 800	1 769 736	6 644 511	6 307 361	5 970 212
2003	9 008 414	8 462 701	7 916 989	1 975 778	1 881 406	1 787 035	7 032 636	6 581 295	6 129 954
2004	9 435 764	8 747 518	8 059 271	1 980 539	1 869 838	1 759 137	7 455 226	6 877 680	6 300 134
2005	9 866 564	9 020 340	8 174 115	1 962 015	1 834 404	1 706 794	7 904 549	7 185 935	6 467 322
2006	10 336 300	9 316 966	8 297 632	1 957 626	1 812 396	1 667 165	8 378 674	7 504 570	6 630 467
2007	10 808 950	9 604 194	8 399 438	1 971 612	1 807 311	1 643 010	8 837 338	7 796 883	6 756 428

Table E.17 Projections of direct employment (FTE) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (FTEs)	Projection B (FTEs)	Projection C (FTEs)	Projection A (FTEs)	Projection B (FTEs)	Projection C (FTEs)	Projection A (FTEs)	Projection B (FTEs)	Projection C (FTEs)
1997	80 994	80 994	80 994	59 673	59 673	59 673	21 321	21 321	21 321
1998	81 034	80 284	79 534	59 894	59 339	58 785	21 140	20 945	20 749
1999	82 211	80 703	79 195	59 323	58 235	57 147	22 888	22 468	22 048
2000	81 351	79 133	76 916	55 905	54 382	52 858	25 445	24 752	24 058
2001	82 751	79 771	76 792	55 189	53 202	51 215	27 561	26 569	25 577
2002	87 155	83 268	79 382	57 778	55 201	52 625	29 377	28 067	26 757
2003	90 616	85 811	81 006	59 523	56 366	53 210	31 093	29 444	27 796
2004	92 628	86 950	81 272	59 666	56 009	52 351	32 962	30 941	28 920
2005	94 056	87 527	80 997	59 108	55 005	50 901	34 948	32 522	30 096
2006	96 020	88 589	81 158	58 976	54 412	49 847	37 044	34 177	31 311
2007	98 469	90 078	81 687	59 397	54 336	49 274	39 072	35 743	32 413

Table E.18 Projections of direct and indirect employment (FTE) by the New Zealand tourism sector, 1997–2007

Year	Total tourists			Domestic tourists			International tourists		
	Projection A (FTEs)	Projection B (FTEs)	Projection C (FTEs)	Projection A (FTEs)	Projection B (FTEs)	Projection C (FTEs)	Projection A (FTEs)	Projection B (FTEs)	Projection C (FTEs)
1997	155 509	155 509	155 509	114 572	114 572	114 572	40 937	40 937	40 937
1998	155 585	154 145	152 705	114 996	113 931	112 867	40 589	40 214	39 838
1999	157 845	154 950	152 055	113 901	111 812	109 723	43 944	43 138	42 332
2000	156 193	151 936	147 679	107 338	104 413	101 487	48 855	47 523	46 192
2001	158 882	153 161	147 440	105 964	102 148	98 333	52 918	51 013	49 107
2002	167 338	159 875	152 413	110 934	105 986	101 039	56 404	53 889	51 373
2003	173 982	164 757	155 531	114 284	108 224	102 164	59 699	56 533	53 368
2004	177 845	166 943	156 041	114 559	107 536	100 514	63 286	59 407	55 527
2005	180 588	168 051	155 515	113 487	105 609	97 731	67 100	62 442	57 784
2006	184 359	170 091	155 823	113 234	104 470	95 707	71 125	65 621	60 116
2007	189 061	172 951	156 840	114 043	104 324	94 606	75 019	68 626	62 233



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