

Linking the Canadian Tourism Satellite Account and the Canadian System of Environmental and Resource Accounts to measure the environmental impact of tourism in Canada: An exploratory study for two pilot industries

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1. Introduction

The need to manage tourism development in a way that is socially and environmentally responsible and sustainable has become more pressing in recent years. The tourism sector already sees its impact on the environment as playing a key role in the marketing of Canada as a tourism destination.¹ More and more, sector leaders and government officials face questions like: Is tourism a strain on Canada's environmental resources? How much does it contribute to greenhouse gas emissions? And how much in comparison to other industries?

The environmental impact of tourism need not be seen as only negative. Tourism also requires the creation and maintenance of parks and managing the effects associated with their use, as well as the conservation and protection of natural habitats and wildlife. Tourists also pay fishing and hunting license fees, and park and camp ground admissions, that can be used to offset any adverse effects of their activities. Whether they are negative or positive, the environmental impacts need to be included in any complete analysis of tourism. Only then can one begin to answer the broader question is tourism a net contributor to sustainable development? Currently, however, a policy and strategic information gap exists on the subject of the relationship between tourism and the environment at the macro level.

The need to provide measures on the environmental effects of tourism has consequently become more pressing. Such measures would help industry leaders and policy makers in developing strategies for the tourism sector. This need is recognized in the 2008 International Recommendations for Tourism Statistics, approved earlier this year by the United Nations Statistical Commission, where linking tourism and environment through the Tourism Satellite Account and environmental accounts is considered a priority.²

This paper presents the results of a pilot study that links two Canadian satellite accounts, the tourism and the environment accounts, to provide a first set of estimates of energy use and greenhouse gas emissions for two tourism industries, air transportation and food and beverage services.³ This would be the first step in a statistical assessment of the environmental impact of tourism in Canada and a step as well towards answering the questions above and filling the information gap on the relationship between tourism and the environment.

The organization of the paper reflects the exploratory nature of this pilot study. The first section, gives some background and introduces some of the research that provides statistical

¹ The Report on Canada's Tourism Competitiveness, the Tourism Industry Association of Canada, June 2008.

² 2008 International Recommendations for Tourism Statistics, background document for 39th session of the UN Statistical Commission, 26 – 29 February 2008, Chapter 8, Section D.

³ These two industries were selected because one, air transportation, has a high degree of dependency on tourism while the other, food and beverage services, has a low degree of dependency.

measures of the environmental impact of tourism. The second part describes the two main data sources, the Canadian Tourism Satellite Account and the Canadian System of Environmental and Resource Accounts. Next, the method used to link the two accounts is discussed. Preliminary results are presented in the following section for the air transportation industry and the food and beverage services industry. The limitations of these results are outlined next. Last, the conclusion includes a discussion on potential avenues for future work either to incorporate different indicators, extend the work to other tourism industries or create timely indicators of the environmental impact of tourism in Canada.

2. Background

In 2003, the United Nations World Tourism Organisation (UNWTO) convened the First International Conference on Climate Change and Tourism, in Djerba, which led to the recognition that climate change is a concern for tourism. At the Second International Conference on Climate Change and Tourism, in Davos (2007), participants concluded that the tourism sector must rapidly respond to climate change. In a report sponsored by the UNWTO following the Davos meeting, it was noted that tourism was not only affected by climate change but was also a “non-negligible contributor to climate changes through greenhouse gas emissions derived especially from the transportation and accommodation of tourists”.⁴ The report also indicates that about 4.9% of worldwide CO₂ emissions in 2005 were related to domestic and international tourism. Of these emissions, 75% were due to transport, with 40% coming from air transportation alone. The UNWTO report emphasizes the fact that the air transportation share of CO₂ emissions far exceeds the share of tourism trips taken by plane.

The literature on “sustainable tourism” has grown rapidly⁵ over the last two decades, while measurements of the environmental impact of tourism have taken various directions.⁶ A number of studies on subjects like “eco-tourism” and “geo-tourism” have focussed mainly on best case studies of experiences in developing, marketing and managing tourism products and destinations in ways that are sensitive to environmental impacts. Another body of work takes a “bottom-up” approach to assess the “GHG footprint” or the environmental impact of tourism activities at the micro-level. Kelly and Williams (2007) provide a Canadian example of this type of work for the Whistler community near Vancouver that will be co-hosting the 2010 Winter Olympic Games.

⁴ World Tourism Organization and United Nations Environment Programme. *Climate Change and Tourism – Responding to Global Challenges*. Madrid, Paris 2008. p. 27.

⁵ Scott, D. et al. (2005a), *Climate, Tourism and Recreation: A Bibliography – 1936 to 2005*, University of Waterloo, Waterloo, Ontario.

⁶ Schianetz, Kavanagh, Lockington (2007) provide a comprehensive review.

However, little has been done to provide macro level information, which is national and international, on the environmental aspects of tourism. Even less has been done in the area of linking environmental and tourism satellite accounts. Patterson and McDonald (2004) used the lifecycle assessment approach to obtain measures of energy use and GHG emissions for New Zealand tourism. They combine TSA estimates with preliminary work on environment accounts to measure the direct and indirect impact of tourism activities in New Zealand. Jones and Munday (2007) combined the Wales TSA estimates to pilot environment satellite account estimates to produce direct, indirect and induced waste and GHG emissions due to tourism demand. They used an Input-Output impact model to derive their estimates. Studies like these, including this pilot study, essentially take a “top-down” approach to measure the environmental impact of tourism.

3. Data sources

Any assessment of tourism’s “sustainability” requires comparing the economic benefits of tourism to its environmental impacts. Fortunately, Canada has good measures on both sides of the equation. Tourism’s economic impact is well measured by the Canadian Tourism Satellite Account (CTSA), while the environmental impacts of economic activity are detailed in another satellite account, the Canadian System of Environmental and Resource Accounts (CSERA). Both of these statistical products are compiled in the System of National Accounts Branch of Statistics Canada, Canada’s national statistical office.

3.1 The Canadian Tourism Satellite Account: an economic assessment of tourism

In Canada, the economic assessment of tourism is well established. Since 1994, the Canadian Tourism Satellite Account (CTSA) has provided detailed economic information on tourism. The CTSA closely follows the international standard presented in *Tourism Satellite Account: Recommended Methodological Framework* (TSA:RMF).^{7,8} In particular, tourism is defined in the CTSA as “the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes.”⁹ It is worth emphasizing that the concept of tourism here is quite broad, covering more than just “leisure travel”; it includes travel for business, leisure and other personal reasons, such as visiting friends and relatives, religious purposes and medical treatment.

⁷ See *Tourism Satellite Account – Recommended Methodological Framework*. Organisation for Economic Co-operation and Development, Statistical Office of the European Communities, the United Nations and World Tourism Organisation, 2001.

⁸ For a detailed comparison of the CTSA and the TSA:RMF, see Kemp and Nijhowne (2004).

⁹ *Canadian Tourism Satellite Account Handbook*, Catalogue 13-604, no. 57, Statistics Canada, p. 74.

The Tourism Satellite Account is an extension to the System of National Accounts (SNA). As such, it highlights the economic transactions that are recorded (explicitly or implicitly) in the SNA, but which are related specifically to tourism. The CTSA brings together information from the travel surveys, which provide a measure of tourism demand, with information from the surveys of suppliers of tourism commodities. These two sets of information are integrated and reconciled within the CTSA framework.

The CTSA plays a crucial role in defining the “tourism industries” in Canada. These industries are not identified as such in the industrial classifications used in the statistical system because what is “tourism” is not dependent on the characteristics of any particular production process or similarity of the economic activity undertaken (the criteria normally used to define industries). On the contrary, what is tourism is dependent on the consumer’s purchases as a visitor or tourist. Thus a commodity (passenger air transportation, hotel accommodation, restaurant meals, etc.) is a “tourism commodity” if a significant portion of its demand comes directly from visitors, and an industry (air transportation, accommodation, food and beverage services) is a “tourism industry” if tourism commodities make up a significant part of its output.

Because visitors purchase goods and services from many different tourism and non-tourism industries, the CTSA must identify and separate out the tourism components from each of them. As an example, in the CTSA, only the passenger air transportation service that is used by visitors is considered as a tourism output of the air transportation industry. The sum across all industries (tourism and non-tourism) of their tourism outputs (i.e., goods and services consumed directly by visitors) gives the total direct impact of tourism on the economy. Indirect effects of tourism are not included in the CTSA. In other words, the production of commodities that are used as inputs to the goods and services consumed directly by visitors (e.g., the catering of meals for airlines) and the related employment are not counted in the CTSA measures of tourism’s direct economic impact.

The CTSA measures the spending on various domestically-produced goods and services by resident and non-resident visitors in Canada. Estimates of tourism (direct) gross value added and tourism (direct) employment by industry are also provided. The CTSA also supports several extensions that provide more detailed information on tourism in Canada. The National Tourism Indicators (NTI) provide timely, quarterly estimates of tourism spending, tourism gross value added and employment attributable to tourism benchmarked to the CTSA. The Government Revenues Attributable to Tourism (GRAT) module of the CTSA links tax information with the CTSA and NTI to provide annual estimates of the tax revenues that can be directly attributed to tourism in Canada. Similarly, the Tourism Human Resource Module (HRM) links information from the Census, the Productivity Accounts and the Labour Force Survey to the CTSA and NTI to provide detailed information on the jobs and wages due directly to tourism.

The CTSA, and its extensions, paint a comprehensive economic portrait of tourism in Canada. In 2002, there were 229.8 million person-trips in Canada for one or more days. About 80% of these trips stemmed from Canadians visiting places in Canada (Table 1). Non-residents, mainly Americans, made up the remaining 20%, but accounted for 32% of the tourism spending in

Canada (Table 2). Including both Canadian and non-resident visitors, tourism injected more than 56 billion dollars into the Canadian economy in 2002. This translated into \$23.3 billion of gross value added (at basic prices) or 2.1% of the entire economy (Table 3), more than the contribution of agriculture, forestry and fishing. Tourism also generated revenues for the various levels of government. Overall, tourism directly generated \$16.3 billion or 4% of all government revenues in 2002. Tourism was also an important provider of jobs; as 611 thousand jobs representing 3.9% of all jobs in Canada depended directly on tourism. What is currently missing from this picture however is some macro-level indicators of tourism's environmental impacts. This is where linkages to the environmental accounts need to be drawn.

Table 1 Number of trips by Canadian and non-resident visitors in Canada, 2002

	Same-day	Tourists ¹	Total
	visitors		visitors
Thousands of person-trips			
All origins	117,607	112,179	229,786
Canadian residents	92,675	92,215	184,890
Non-residents	24,932	19,964	44,896
From United States	24,710	16,168	40,878
Other than United States	222	3,796	4,018

1. Tourists are defined as overnight visitors.

Sources: - *International Travel*, Catalogue no. 66-201, Statistics Canada.

- *Canadian Travel Survey: Domestic Travel*, Catalogue no. 87-212, Statistics Canada.

Table 2 Tourism expenditures, by commodity, Canada 2002

Commodity	Domestic	International	Total	Total
	demand	demand	demand	domestic
millions of dollars				
		(exports)		supply
Transportation	14,729	4,824	19,553	52,287
of which: Passenger air	7,964	2,797	10,761	11,290
Accommodation	4,674	4,324	8,998	9,802
Food and beverage services	5,544	3,006	8,550	42,364
Other tourism commodities	7,016	2,418	9,434	23,020
Non-tourism commodities	6,481	3,544	10,025	2,094,031
Total tourism expenditures	38,444	18,116	56,560	2,221,504

Source: *Canadian Tourism Satellite Account 2002*, 13-604 no. 58, Statistics Canada.

Table 3 Gross value added, employment and government revenues attributable to tourism, Canada 2002

Industry	Gross value	Government	Number
	added (GVA) at	revenue	
	basic prices	attributable	of jobs
millions of dollars			
		to tourism	thousands
Transportation	5,526		78
of which: Air transportation	3,088		51
Accommodation	5,708		161
Food and beverage services	2,898		145
Total tourism activities	23,319	16,305	611
Total non-tourism activities	1,045,445	391,021	14,972
Total economy	1,068,764	407,326	15,583

Sources: - *Government Revenues Attributable to Tourism, 2000-2006*, Catalogue 13-604 no. 57, Statistics Canada.

- *Canadian Tourism Satellite Account Handbook*, Catalogue 13-604 no. 52, Statistics Canada.

- *Human Resource Module of the Tourism Satellite Account*, Catalogue 13-604 no. 59, Statistics Canada.

3.2 The Canadian System of Environmental and Resource Accounts: an environmental assessment of the Canadian economy

The *Canadian System of Environmental and Resource Accounts* (CSERA) represents a comprehensive framework for linking the economy and the environment. Its three main components are introduced below.

The *Natural Resource Stock Accounts* measure Canada's natural resource stocks in physical and monetary terms as well as the annual changes in these stocks due to natural and human processes. The *Environmental Protection Expenditure Accounts* identify current and capital expenditures by business, government and households for the purpose of protecting the environment.

Last, and most important for the purposes of this study, the *Material and Energy Flow Accounts* record, in physical terms, the flows of materials and energy in the form of natural resources and wastes between the economy and the environment.

3.2.1 The Material and Energy Flow Account

Flows of produced goods and services are already well articulated in monetary terms in the national accounts. The Input-Output Accounts provide annual estimates of the production and consumption of 719 commodities by 303 industries and 167 categories of final demand. The Material and Energy Flow Accounts (MEFA) build on this detail by incorporating physical estimates of greenhouse gas emissions and energy and water use.¹⁰

By linking these physical measures in the MEFA with data from the Input-Output Accounts, detailed estimates of the resource and waste intensity of the economic activities of businesses, government and households are obtained. These intensities measure the physical quantities of resources (or wastes) used (or produced) per unit of economic activity. For example, tonnes of carbon dioxide emitted per thousand dollars of electricity production. Both direct and indirect measures are calculated in the MEFA. Direct energy use is that associated with an industry's own production (e.g., electricity to heat hotels), whereas the indirect energy use is that associated with the "up-stream" production of goods and services that are used as inputs by the industry (e.g., electricity used in textile mills to make linen used in hotels). Similarly, direct GHG emissions are related to an industry's own activities, while its indirect GHG emissions are related to the activities of its suppliers. Such measures provide indicators of the strain placed on the environment by economic activities. They have been used successfully over the past decade to inform public environmental policies and industry decision-making within other traditional industries in Canada's business sector.

¹⁰ It should be pointed out that tourism has other environmental impacts that are not included in MEFA. For instance, recreational fishing may be depleting wild fish stocks and tourism development can lead to destruction of natural habitats in certain localities.

Table 4 presents energy use and greenhouse gas emissions in Canada for the air transportation and food and beverage services industries as estimated in the MEFA. In 2002, the air transportation industry, which accounted for 0.6% of Canadian gross output, directly used 2.4% of the energy combusted in the production of goods and services by both the business and non-business sectors.¹¹ Its contribution to direct GHG emissions was in the same order of magnitude. From 1990 to 2002, the intensity of energy use and of GHG emissions by the air transportation industry increased.

For its part, the food and beverage services industry is less energy intensive, as its share of gross output is much larger than its share of energy directly used up in production. Compared to 1990, the intensity of energy use in food and beverage services in 2002 was almost the same, while there was a small reduction in GHG emissions intensity.

Table 4 Gross output, energy use and greenhouse gas emission in Canada, 2002

Industry / sector	Gross output ¹ (1) (\$ millions)	Energy use ² (2) (terajoules)	Greenhouse gas emissions ³ (3) (Kt of CO ₂ -e)	Proportion of output (4) (%)	Proportion of energy use (5) (%)	Proportion of GHG emissions (6) (%)	Direct and	Direct and indirect
							indirect energy intensity by industry ^{4,6} (7) (1990=100)	GHG emissions intensity by industry ^{5,6} (8) (1990=100)
Air transportation	13,025	192,508	13,457	0.6%	2.4%	2.3%	113.54	107.05
Accommodation and food services	51,822	72,549	2,263	2.3%	0.9%	0.4%	99.03	96.54
Accommodation services	13,854	31,937	1,047	0.6%	0.4%	0.2%	n/a	n/a
Food and beverage services	37,968	40,612	1,217	1.7%	0.5%	0.2%	n/a	n/a
Business sector	1,937,364	7,552,989	555,275	87.2%	94.3%	96.9%	n/a	n/a
Non-Business sector	284,140	457,912	17,665	12.8%	5.7%	3.1%	n/a	n/a
Total excluding households	2,221,504	8,010,901	572,940	100.0%	100.0%	100.0%	n/a	n/a
Household sector		2,256,077	110,006					
Total all sectors		10,266,979	682,946					

1. *The Input-Output Structure of the Canadian Economy*, Catalogue no. 15-201, Statistics Canada and special tabulations.

2. *Material and Energy Flows Account*. Special tabulation and CANSIM table 153-0032. Statistics Canada.

3. *Material and Energy Flows Account*. Special tabulation and CANSIM table 153-0034. Statistics Canada.

4. *Material and Energy Flows Account*. CANSIM table 153-0031. Statistics Canada.

5. *Material and Energy Flows Account*. CANSIM table 153-0033. Statistics Canada.

6. Separate estimates for Accommodation and Food and beverage services and the various aggregation are not provided in the MEFA.

The remainder of this section elaborates on the two environmental measures used in the pilot study – energy use and greenhouse gas emissions.

Energy use by industry

The MEFA record in quantitative units (joules)¹² the annual consumption of energy commodities by industries, persons and governments. Eleven energy commodities are represented in the accounts: coal, crude oil, natural gas, liquid petroleum gases, electricity, coke, motor gasoline, diesel fuel, aviation fuel, light fuel oil and heavy fuel oil. In the case of the

¹¹ It might be noted that the output of the air transportation industry, as defined in the MEFA, includes the provision of passenger and cargo transportation services on all domestic flights and international flights to/from Canada by Canadian carriers. The industry emissions relate to the combustion of all fuels on these flights irrespective of whether the fuel was supplied in Canadian or foreign airports.

¹² See Table 4, column 2. A joule is the International System of Units (SI) unit of energy. 1 joule corresponds to the work done to produce power of one watt continuously for one second. A Megajoule is one million joules, a Gigajoule is one billion joules and a Terajoule is one trillion joules.

air transportation industry, the consumption of fuel and oil are derived from the *Canadian Civil Aviation - Annual Report*.¹³ The data are reported in litres and are transformed into Joules using conversion factors from the *Report on Energy Supply – Demand in Canada*.¹⁴

For some industries (including some in tourism) and sectors, only the monetary values of energy consumed are reported in surveys, but not the quantities. In these cases, the MEFA rely on an indirect measurement approach using an aggregate (or economy-wide) energy supply-disposition model maintained by Statistics Canada. When known quantities of energy consumed are removed from the known total supply, a “residual quantity of energy used” remains. This amount is allocated across sectors and industries (where quantities consumed are unknown) in proportion to their known expenditures on energy, on the assumption that each one pays the same unit price for energy. Table 5 gives a simple numerical example.

Table 5 Allocation of an energy commodity – an hypothetical example

Sector	Quantity consumed in the economy (units)	Quantity consumed from available data by industry (units)	Quantity consumed with residual estimates (units)	Value of purchases (\$)	Implicit unit price ¹ (\$/unit)	Quantity entered in MEFA energy use account ² (units)
Mining industries		30	30	185	6.17	30.0
Manufacturing		40	40	230	5.75	40.0
Other industries		n/a	30 { n/a n/a n/a	180 { 60 70 50	6.00	10.0
Households		n/a			6.00	11.7
Governments		n/a			6.00	8.3
Total	100	70	100	595	5.95	100.0

1. The implicit unit price is estimated by dividing the "Value of purchases" with "Quantity consumed with residual estimates".
2. For each sector for which no direct quantity of energy use is available, a quantity is estimated by dividing the value of energy consumption with the implicit unit price.

Greenhouse gas emissions by industry

The MEFA record the production of three main greenhouse gases in Canada: carbon dioxide, methane and nitrous oxide. In all cases, the MEFA measure the quantitative production of these gases (in tons) that occurs when energy is used. But greenhouse gases differ in their ability to absorb heat in the atmosphere based on their chemical properties and lifetime in the atmosphere. For example, over a period of 100 years, methane is 21 times as powerful as carbon dioxide in terms of its potential to trap heat in the atmosphere, so it is considered to have a “global warming potential” of 21. Therefore, all greenhouse gas emissions are reported

¹³ See Statistics Canada, Catalogue no. 51-004-XIB.

¹⁴ See Statistics Canada, Catalogue no. 57-003-X.

in terms of “carbon dioxide equivalents”. The following calculation is performed for all industries, including air transportation and food and beverage services.

$$\text{Emissions} = \text{quantity of fuel combusted} \times \text{emission factor per physical unit of fuel}$$

The fuel- and technology-specific emission factors and the conversion factors to carbon dioxide equivalents can be found in Annex 13 of the National Inventory Report.¹⁵ These factors are based upon the physical quantity of fuel combusted and are subdivided by the type of fuel used.

4. Methodology: Linkage of the two satellite accounts

There is no specific "tourism industry" or "tourism commodity" within the SNA or, for that matter, in the CSERA. Rather, as mentioned earlier, tourism is dispersed among the various industries and commodities of the system. However, tourism's share of each industry in the economy is calculated in the CTSA, and because the environment account follows the same industry classification, a link can be made between the two accounts.

The tourism shares of industries provide the crucial ratios to estimate the portion of energy use and greenhouse gas emissions due to tourism. These shares are calculated using the tourism gross value added (GVA) for each industry from the CTSA divided by the total GVA (at basic prices) of an industry from the I-O tables. This ratio is then applied to the energy use and greenhouse gas emissions by industry, to obtain the portion attributable to tourism.¹⁶ These calculations are done at the most detailed level of the I-O tables. For publication, the results are aggregated so as not to reveal any confidential data.

To give an example, if an industry uses 20 terajoules of energy and the CTSA shows 10% of its total output is to serve visitors directly, the energy use attributed to tourism is 2 terajoules (20 terajoules X 10%). This method assumes that the tourism energy use and greenhouse gas emissions share is equal to the tourism industry share. Equivalently, this assumes that the energy use and GHG emissions from an industry per dollar of demand for its outputs, are the same whether the purchaser is a visitor (same-day or tourist) or non-visitor (e.g., local consumer).

By undertaking the calculations described above for each industry, it would be possible to provide a new aggregate measure that would indicate the overall environmental impact of tourism demand in Canada. At present, using the MEFA, one can only sum the environmental

¹⁵ Environment Canada. *National Inventory Report, 1990–2005: Greenhouse Gas Sources and Sinks in Canada*. Ottawa, 2007.

¹⁶ This method is essentially the one used in the module on Government Revenues Attributable to Tourism and the Tourism Human Resource Module to determine the revenues, on the one hand, and the employment, on the other, that are directly attributable to tourism.

impacts of tourism industries resulting from both their tourism activities (serving visitors) and non-tourism activities (serving non-visitors).

5. Preliminary results

Table 6 shows the results from combining the Canadian Tourism Satellite Account and the Canadian System of Environmental and Resource Accounts for the year 2002. On the left-hand side of the table, the economic measures for the air transportation and the food and beverage services industries are shown. Column 1 shows the tourism GVA while column 2 shows the “tourism shares of industries” as calculated in the CTSA. In 2002, 79% of the output of the air transportation industry was directly attributable to tourism while 17% of that of the food and beverage services industry was due directly to tourism.

Table 6 Economic and environmental measures of selected tourism industries - Canada 2002

Industry	Economic measures of tourism		Environmental measures of tourism	
	CTSA tourism GVA ¹ (\$ millions) (1)	Tourism ² shares of industries (%) (2)	Energy Use ³ (terajoules) (3)	GHG emissions ⁴ (Kt of CO ₂ -e) (4)
Air transportation	3,088	78.7%	151,572	10,595
Food and beverage services	2,898	17.3%	7,019	210

1. Gross Value Added (GVA) is known as Gross Domestic Product in the Canadian System of National Accounts. GDP at basic prices is GDP at market prices minus taxes less subsidies on products. *Canadian Tourism Satellite Account Handbook*, Catalogue no. 13-604 no. 52, Statistics Canada.
2. Also known as the Tourism GVA ratio, it is calculated by taking tourism GVA and comparing it to the total GVA of the industry (i.e. Tourism GVA + Non-tourism GVA). It measures how much of the production of a certain industry is attributable to tourism. *Canadian Tourism Satellite Account Handbook*, Catalogue no. 13-604 no. 52, Statistics Canada.
3. Energy use to satisfy TSA tourism demand. Calculated as energy use from the MEFA multiplied by the tourism shares of industries.
4. Greenhouse gas emitted while satisfying TSA tourism demand. Calculated as GHG from the MEFA multiplied by the tourism shares of industries.

In the second part of Table 6 (columns 3 and 4), the quantitative impact on the environment of the tourism activity in the two industries is reported. In 2002, air transportation combusted 151,572 terajoules and emitted 10,595 KT of CO₂-equivalents as a direct result of the transportation of visitors. If this exercise were repeated for each industry, one could sum the amount of energy used and the related GHG emissions needed to directly serve tourists and same-day visitors. This could be used to examine the tourism share of the energy consumption and GHG emissions of each industry as well as the aggregate for the sum of all industries providing services to visitors.

Improvements or deteriorations in the economic/environmental performance of an industry can be tracked as well. Measures of the energy or GHG emissions intensity of an industry over time could be used in modelling or simulation exercises to assess sustainability under various

scenarios. In this case, the denominator of the indicator would need to be in real terms (e.g., the value of output adjusted for inflation). This would provide a statistical basis for assessing the effectiveness of new or existing government policies and industry strategies as well as targeting possible mitigating actions.

Table 7 combines the economic measures and the environmental measures of Table 6, in the same way as in the MEFA, to obtain measures of the “intensity” of energy use and GHG emissions¹⁷ for the two industries. As can be seen, air transportation directly used 14.8 gigajoules of energy (Column 1), producing 1.03 tons of GHG emissions (Column 2), for every \$1,000 of tourism output (in nominal terms) in 2002. Air transportation is clearly more energy and GHG emissions intensive than food and beverage services, which used only one-fourteenth as much energy, producing almost 33 times fewer GHG emissions, for every \$1,000 of output.¹⁸

Table 7 Intensity measures for selected tourism industries - Canada 2002

Industry	Direct energy intensity by industry ¹	Direct GHG emissions intensity ²	Direct and indirect energy intensity by industry ^{3,5}	Direct and indirect GHG emissions intensity ^{4,5}
	(GJ/\$ '000)	(tonnes of CO ₂ -e / \$ '000)	(GJ/ \$ '000)	(tonnes of CO ₂ -e / \$ '000)
	(1)	(2)	(3)	(4)
Air Transportation	14.8	1.03	22.7	1.62
Food and beverage services	1.1	0.03	nd	nd

1. Direct energy intensity by industry is a measure of direct use of energy per \$1,000 of tourism output.
2. Direct greenhouse gas emissions intensity is a measure of direct GHG emissions per \$1,000 of tourism output.
3. *Material and Energy Flows Account* . CANSIM table 153-0031 and special tabulations, Statistics Canada.
4. *Material and Energy Flows Account* . CANSIM table 153-0033 and special tabulations. Statistics Canada.
5. The *Material and Energy Flows Account* does not publish measures of combined direct and indirect intensity for the food and beverage services industry. A figure for the "Accommodation and food services" industry is available, but not shown

These measures are intuitively appealing because, in addition to serving as measures of the stress or strain put on the environment resulting from different types of economic activity, they also relate directly to the kinds of decision-making taking place at the micro-level. For example, an airline company considering replacing its aging fleet with more energy efficient aircraft will aim (among other goals) to lower its energy use and GHG emissions per dollar of output (i.e., reduce its energy and GHG emissions intensity). More importantly, these measures can be aggregated across industries to arrive at the direct energy use and GHG emissions intensity of tourism, which can then be compared to that of other activities, the rest of the economy or the economy overall. Different variants could be relevant for certain uses and purposes. For instance, a measure of energy use per 1,000 full-time equivalent jobs could be relevant for

¹⁷ These are also called measures of “eco-efficiency”. See for example, Dachraoui, et. al. The sources of growth of the Canadian business sector’s CO₂ emissions, 1990-1996. Catalogue no. 11F0027, No. 15, Statistics Canada, 2003.

¹⁸ A comparison of both direct and indirect effects could be important in this case, because the food and beverage services industry relies heavily on inputs from agriculture which is a high emissions industry.

assessing the impact of creating tourism jobs, whereas a measure of energy use per 1,000 visitors could be more useful for assessing the impact of attracting visitors from abroad, and a measure of energy use per 1,000 passenger-kilometers could be more useful in the realm of transportation policy.

The last two columns of Table 7 provide even broader measures showing the combined direct and indirect energy and GHG emissions intensities for the two industries. For example, air transportation directly and indirectly used 22.7 gigajoules of energy for every \$1,000 of output in nominal terms in 2002, comprising 14.8 gigajoules of direct energy use (to fly planes) and 7.9 gigajoules of indirect energy use in the production by other industries of the intermediate inputs to air transport (e.g., refining of aviation fuel, preparation of catered meals, etc.). Estimates like these for all tourism would facilitate comparisons with studies like those of Patterson and McDonald (2004) and Jones and Munday (2007). For example, the Jones and Munday paper presents an indicator in tonnes of CO₂ per £1m of gross spending on tourism within Wales. Of course, for meaningful international comparisons, the denominator would need to be standardized using purchasing power parities (PPP).

6. Limitations of the results

The exploratory results in this paper provide a preliminary macroeconomic assessment of the environmental impact of tourism for two tourism industries in Canada. One of the main assumptions of this approach is to use the same energy and GHG emissions intensity measure for both the tourism and non-tourism activities of a given industry. In the absence of more detailed information, this seems like a reasonable assumption. In some cases, the non-tourism activities of an industry can be more energy or emissions intensive (e.g., “caterers” services, a non-tourism activity of the food and beverage services industry, may be more energy intensive than other tourism activities in the industry owing to the need to deliver the service to a location). In other cases, the opposite may hold.

One complication with the macroeconomic approach not considered in this study lies in taking account of the energy use and the GHG emissions directly resulting from consumption activities of households. The non-market production of transportation services through own-vehicle use is a case in point. Since this portion of tourism activities in Canada is far from negligible, it will be important to develop a solid method for this sector. One obvious approach in this case would be to use the tourism commodity share for vehicle fuel in a manner similar to the industry shares described earlier. In other cases, such as the measurement of emissions resulting from non-market production of accommodation services for visiting friends and relatives, the approach to take is less obvious.

Another limitation¹⁹ relates to the measurement of aviation GHG emissions. In particular, on top of the standard GHG emissions, the air transportation industry has an additional warming effect because GHGs are emitted at high altitudes.²⁰ For this reason, the UNWTO (2008) and Peeters (2007) have used “radiative forcing”²¹ as the measurement tool in the case of air transportation. This method is also used by the Intergovernmental Panel on Climate Change (IPCC)²² to measure the role of aviation in climate change.

Also, the economic and environmental data from the CTSA and the CSERA on air transportation follow the SNA “production boundary”.²³ This means that the estimates here relate only to domestically produced air transportation (produced by Canadian carriers). As a consequence, the estimates of energy use and GHG emissions relate to the flights of domestic carriers regardless of the destination or point of origin. On the other hand, emissions produced by a non-Canadian carrier flying to or from Canada would not be included in either the economic or environmental estimates pertaining to tourism in Canada. The measurement of emissions in Canadian air space, a somewhat different concept, would need in addition to take into account both the exports and imports of emissions related to international air travel.

7. Conclusions and potential avenues

This exploratory study for two industries of the tourism sector for 2002 indicates that the linking of Statistics Canada’s tourism and environment accounts is possible. The same method could be used for other industries not included here. Further work is needed to link the environment accounts and the CTSA for the household own production of tourism services (mainly car use) and MEFA household sector energy use and gas emissions.

¹⁹ Peeters, P. et al. (2007a), ‘Air Transport Greenhouse Gas Emissions’, in P. Peeters (ed.), *Tourism and Climate Change Mitigation – Methods, Greenhouse Gas Reductions and Policies* (pp. 29–50), NHTV Academics Studies, No. 6, NHTV, Breda University, Breda.

²⁰ World Tourism Organization and United Nations Environment Programme. *Climate Change and Tourism – Responding to Global Challenges*. Madrid, Paris 2008. p. 126.

²¹ Radiative forcing is the change in the balance between radiation coming into the atmosphere and radiation going out. A positive radiative forcing tends on average to warm the surface of the Earth, and negative forcing tends on average to cool the surface.

²² The Intergovernmental Panel on Climate Change (IPCC) is a scientific body tasked to evaluate the risk of climate change caused by human activity. The panel was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), two organizations of the United Nations. IPCC (2007a), *The Physical Science Basis – Summary for Policymakers*.

²³ The “production boundary” is a System of National Accounts concept which defines what is, measured (and what is not measured) as economic production in the national accounts. See SNA 1993, paragraphs 6.17-6.18.

The proposed methodology could be extended to provide a breakdown of the environmental impact of domestic and international tourism in Canada. This will be possible shortly as a method to create distinct industry ratios for the domestic and export portions of tourism demand is currently being developed for the GRAT module of the CTSA.

Before moving to the development of annual measures of energy use and GHG emissions due directly to tourism, the possibility of extending the approach to water use should be assessed. This would maximize the use of the environment accounts and help in the development of an expertise that could well become the next “hot” environmental subject.

Annual measures of the environmental impact of tourism would facilitate monitoring and tracking the progress of the tourism sector. Initially, a method could be developed to produce estimates up to the most recent reference year of the I-O tables (which are available with a lag of three years). Taking November 2008 as an example, this would mean that indicators would be available up to 2005. In a subsequent stage, a method could be devised to estimate the indicators on a more timely basis, using information from the National Tourism indicators and other sources of data.

In Canada, one important research direction would be in estimating tourism’s environmental impacts at the provincial/territorial level. While Statistics Canada has developed in the past a Provincial/Territorial Tourism Satellite Account, no work has been done on compiling the MEFA on a regional basis. Considerable work would thus be required to move on this front both in terms of developing requisite data and a sound methodology. If the work were carried out however, it would fill a strategic information gap for provincial governments and tourism offices, help in tracking tourism’s environmental performance over time, and help to inform decision-making.

The macroeconomic approach is certainly not the only way to assess the “sustainability” of tourism. Work could be done, not necessarily by Statistics Canada, on a micro-measurement of tourism’s impact in general and the environmental impact of passenger air transportation in particular using a method similar to the one described in a recent report from the World Tourism Organization and United Nations Environment Programme.²⁴ This combination of bottom-up and top-down approaches was successfully employed by Becken and Patterson (2006) using New Zealand data. Not only did both methods yield similar results of the degree to which tourism contributes to national carbon dioxide emissions, but each method had its advantages in terms of informing strategies to reduce emissions and assessing the efficiency of public policy. Hence, the development of bottom-up measures of the impact of tourism on the environment would help to complement and validate the “macro-economic” approach.

Overall, this preliminary, exploratory study demonstrates that it is possible to link the Tourism Satellite Account with Environment Satellite Account. Such work, if carried further, could help

²⁴ *Climate Change and Tourism – Responding to Global Challenges*. Madrid, Paris 2008, Appendix 2.

overcome the current strategic information gap regarding tourism's relationship with the environment at the macro-level. Additional work along these lines could eventually lead to specific measures and estimates of the current environmental impacts of tourism that in turn could help assess the effectiveness of various mitigating policies and strategies.

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