The Economy and Environment- an Integrated Approach for Canada

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(Revised draft)

The economy and environment- An integrated approach for Canada

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Abstract

This paper presents a hybrid framework integrating the national accounts data with environmental statistics. It shows economic accounts in monetary units and the environment accounts in physical units. It presents environment indicators that are consistent with national accounts aggregates. The framework also identifies the SNA monetary transactions related to environment like environment taxes, property income, environmental protection expenditure, (current and capital) and expenditure on natural resources.

This framework can serve as an analytical tool that would relate the impact of production and consumption activities on environmental variables that are of great concern to the public and policy makers.

Introduction

The System of National Accounts (SNA) measures income net of consumption of fixed capital covering only the produced fixed assets. This concept of income suffers from two important shortcomings. First, it overstates income by making no allowance for the depletion of natural resources due to the production process. The depletion is recorded in the SNA's other changes in volume of assets account rather than in the flow account. This is a major failing of the system because it cannot properly inform public debate about the full cost of economic policy options.

The 2008 SNA states that "another way of looking at the process of incorporating the use of environmental inputs into the system is to relocate some of the other changes in asset items into the accounts portraying transactions…, An alternative measure of income allowing for the consumption of natural capital as well as consumption of fixed capital may be considered to take account of the depletion of natural resources" (Para 29.118, SNA 2008). This measure is important for portraying the sustainability of the economy.

The second important shortcoming of the income concept is not taking account of the degradation of the environment that results from economic activity. Production and consumption processes produce harmful residuals (that pollute the air and water) which affect the well being of the population. Like the first shortcoming noted above, this renders the system incapable of showing the full costs of economic choices made collectively by governments or individually by persons and firms.

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A statement in Para 2 of the UN handbook on *Integrated Environmental and Economic Accounting* summarizes the main issue "By not accounting for the private and social costs of the use of natural resources and the degradation of the environment, conventional accounts may send wrong signals of progress to decision makers who may then set society on a non-sustainable development path".

Both the 2008 SNA (Para 29.102) and the Special Conference of the International Association for Research in income and Wealth[2] support use of the System of National Accounts as the basic framework for environmental accounting.

This paper presents a framework where environment indicators can be integrated with the production and consumption flows in the national accounts. This framework closely follows the framework that Mark and Keuning (1996) employ for extending the national accounts to include environment indicators. They call this framework "National Accounting Matrix including Environmental Accounts (NAMEA)". This is preferred to the traditional T-account[3] for institutional sectors because it allows more flexibility in selecting relevant classification and valuation principles. National Accounting Matrix with social indicators is also known as a Social Accounting Matrix (SAM).

Statistics Canada is in the process of developing an environmental accounting framework aimed at measuring and monitoring environmental quality. In developing such a framework "One could envision ecosystems in the proposed environmental statistics framework as the equivalent of the economic production in the SNA".[4]

The proposed framework

The present framework (Social accounting matrix including environment accounts) is a hybrid in that economic accounts are shown in monetary units while environment accounts are shown in physical units. It consists of 11 national economic accounts in monetary units and three environment accounts in physical units. The national economic accounts consist of the following 11 sub-accounts: goods and services, consumption of households, production, generation of income, allocation of income, redistribution of income, use of income, capital, tax account and the rest of the world current and capital accounts.

The environment accounts include a substance account plus two accounts for environmental indicators: global and national. Global indicators are greenhouse gas and ozone depletion indicators and national indicators cover acidification, other air pollution, waste production and natural resource depletion.

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[2] "A number of commonalities did emerge from the different case studies and theoretical contributions. They included a consensus on using the national accounts system as the basic framework for environmental accounting, the use of certain valuation, notably net-pricing of natural resources and maintenance costing of environmental degradation and need to examine more systematically the analytical and policy uses of the accounting results" (Environmental Accounting in theory and practice,1998)

[3] "In a T account only one set of descriptive headings is shown in the middle of the table with values representing resources in columns to the right and values representing uses in columns to the left… Data for individual sector accounts are not shown but the total economy as well as for the rest of the world and the total of both these are shown" (Para 16.4, 2008 SNA)

[4] Statistics Canada "A framework for developing environmental statistics" October 28, 2009

Data sources for constructing an aggregate SAM including environmental accounts

The data to construct the economic accounts are entirely obtained from the Canadian supply and use tables, income and expenditure accounts, financial accounts and the balance of payments. For the environment accounts, the relevant data are obtained from the Environment Division of Statistics Canada.

Structure of the aggregate Social Accounting Matrix (SAM)

In a SAM, rows record receipts (incomings) by origin, and columns record outlays (outgoings) by destination. Total receipts (row sums) equal total outlays (column sums). Accordingly, each account in SAM is represented by a row and column pair, identically numbered.

Table 1 presents the aggregate Social Accounting Matrix including the environmental accounts, for Canada for the reference year 2002. The aggregate SAM provides coherent economic aggregates without sector or institutional detail. Each entry is in fact the grand total of a sub-matrix. For example, the entry described as "output" in the third row, first column of Table 1, is the sum total of all goods and services domestically produced in Canada for reference year 2002 and contained in the production matrix of the Canadian Supply and USE tables (SUTs). In that matrix, domestic production is articulated for 727 goods and services produced by 300 industries. Similarly, the entry described as Intermediate Consumption (first row, third column) represents the sum total of the intermediate consumption matrix of the SUTs. The entry denoted gross domestic product represents primary inputs, cross-classified by industry.

Imports of goods and services are shown on the 11^{th} row, 1^{st} column. In the SUTs, imports are potentially classified by 727 commodities.

The first row and column shows the goods and services account. The row shows the use of goods and services at purchaser's prices at $2,608 billion. This figure is broken down into consumption of households (1, 2) intermediate consumption (1, 3), government consumption (1, 7), capital formation (1, 8), and exports (1, 11). The column shows how the supply of these goods and services is made up of domestic production (3, 1), imports (11, 1), and taxes on products (10,1). Each of these items is split between environmental and other goods and services.

The classification scheme of environment goods and services was taken from the OECD publication "The environment goods and services industry, manual for data collection and analysis" (1999). The OECD divides the environmental goods and services into three main groups: the pollution management group covering goods and services that have significant impact in reducing polluting emissions; cleaner technologies and products group which reduce or eliminate negative environmental impacts and the resource management group which include goods and services associated with environmental protection but their main purpose is not environmental protection like indoor pollution control.

Statistics Canada collects data on revenue from sales of environmental goods and services (See Catalogue 16F008XIE). The total revenue for 2002 was 15.8 billion which compares well to 19.1 billion independently calculated as the sum of intermediate and final use. The latter includes trade margins. These figures were also compared with the environmental protection expenditure published by Statistics Canada. This is further discussed below under "environmental protection expenditure by government and industry".

The second account relates to consumption of households. Household consumption is shown at (2, 7). Households produce pollutants which are displayed in the extended table (2, 13). Household consumption is classified by purpose and pollutants can be related to the types of goods and services consumed. Presently, data do not permit the identification of consumer' expenditure on environmental goods and services.

The third account records in row the output of industries (3, 1), while the column shows the breakdown of production into intermediate consumption (1, 3), gross value added at factor cost (4, 3), and other taxes on production (10, 3).The accounts represented by rows and columns 1 to 3 are aggregates version of supply and use tables of the Canadian System of National Accounts which are linked with other accounts of the system.

The 2008 SNA distinguishes rent (economic rent) on natural resources included in gross value added. The resource rent on oil and gas is shown separately.

The third row is extended to include pollutants produced by industries (3, 13). The pollutants produced by government are also included here, while the column is extended to include absorption of natural resources and amounts of waste recycled (3, 13). Natural resources are limited to gas and oil due to absence of adequate data.

The fourth account is the generation of income account. Row 4 records different components of GDP at factor cost. It shows the resource rent separately. The corresponding column shows how the income flows are allocated to institutional sectors; consumption of fixed capital is recorded in the capital account.

The fifth account is the allocation of primary income account. Row 5 records how primary incomes are allocated to institutional sectors: net domestic generated income (5, 4), property income received from other sectors (5, 5), taxes less subsidies on production (5, 10), and property income received from the rest of the world (5, 11).Column 5 shows property income paid to other sectors and to the rest of the world. The balancing item of this account (6, 5) is national income.

The next account (Account 6) shows the relationship between the national income and disposable income. Row 6 records the national income, as well as, inter-sectoral transfers including current transfers to and from the rest of the world. Note that inter-sectoral property income changes only the distribution of incomes. It does not alter the total national income. The balancing item (7, 6) that equates the column and row totals is disposable income.

The row and column 7 describes the use of disposable income. The row shows net disposable income (7, 6). Column 7 shows the spending of disposable income on final government consumption expenditure (1, 7), final consumption expenditure of households and non-profit institutions serving households (2, 7) and net national saving (8, 7). This saving is carried forward into the capital account.

The capital account (Account 8) in row 8 shows the availability of funds coming from net saving (8, 7), consumption of fixed capital (8, 4) and capital transfers from the rest of the world (8, 12). Column 8 records the allocation of these funds, namely, capital formation (1, 8), net lending (9, 8), and capital transfers to the rest of the world (12, 8).

The row of the capital account is expanded to include addition to proven reserves (8, 13) and the column is extended to include environmental indicators (14, 8) and (15, 8). Row 9 is **t**he balancing item: net lending of the economy equals net lending to the rest of the world with an opposite sign.

Account 10 represents a tax account which shows different types of taxes. The row shows taxes on product (10, 1), other taxes on production (10, 3), taxes on income and wealth (10, 6), and taxes received from the rest of the world (10, 11). The column shows taxes on production (5, 10) taxes on income and wealth as well as taxes paid to the rest of the world (11, 10). The environment tax is presented separately.

The 2008 SNA defines environment tax as follows: "An environment tax is one whose tax base is a physical unit (or proxy of it) that has proven specific negative impact on the environment" (Para 29.111). The SNA treats energy taxes, transport taxes, pollution taxes and resource taxes as environmental taxes. The taxes on products (10, 1) cover gasoline, aviation and diesel taxes levied at the federal and provincial level and tax on electricity levied at the local level as well air transport tax. Canada does not have yet a carbon trading tax. Other taxes on production (10, 3) include natural resource tax and resource licenses.

The accounts 11 and 12 present current and capital transactions with the rest of the world. The rest of the world current account shows trans-boundary flows (exports and imports) of pollution. No data is presently available on these flows.

Column 13 shows the origin of pollutants, namely producers (3, 13), consumers (2, 13) and trans-boundary pollution from the rest of the world (11.13). Thus three sources of emissions are production, consumption and international imports. The export of emissions appears in (13, 11)

The row 13 shows use of natural resources, namely gas (13m), oil (13n) and absorption of waste into economic processes (recycling) (13L). The row also shows grouping of emissions and the rest of the waste under environmental indicators (13, 14) and (13, 15). The negative value of oil and gas in (13, 15d) represents loss of natural resources in the sense that uses of these resources are higher than their addition to reserves.

The quantity of waste recycled is shown in row/column (13L, 3). The residual wastes meant for landfill appear under column 13L. In the UN System of Environmental and Economic accounts the waste meant for landfill is shown under capital account.

The total quantity of waste shown in the table does not account for waste recycled or waste managed on-site by a company or household or transported by the generator directly to a secondary processor such as a pulp and paper mill. Hazardous waste flows are also not reflected here.

Of the total waste of 30723 thousand tons in 2002, 6642 thousand tons was recycled (3,13L) leaving 24081 tons in the (indicator 15c). The proportion of recycled waste rose from 21% in 2002 to 24% in 2004.

Accounts 14 and 15 refer to global and national environmental indicators respectively. The global indicators are greenhouse gases and ozone depletion while acidification, other air pollution, waste production and natural resource depletion (loss of natural resources) fall under national environmental indicators.

Table 1 Aggregated Social Accounting Matrix Including Environmental Accounts for Canada 2002
(Accounts 1-12 in Millions dollars; Accounts 13-15 in physical units)

Account (Classification)		Goods and Services (Products Groups)		Consumptions Of Households (Purposes)		Production (Branches of Industries)		Generation of income account (Primary Input categories)	Allocation of primary of (Institutional Sec	Redistribution of income account (institutional Sectors)	Use of income account (Institutional sectors)	Capital	Tax Account (categories of taxes and subsidies) Environmental taxes		Rest of World ROW (Currrent)
		Environment	Other Purpos	Environment	Other Purpos	Environment	Other Purpose							Other taxes	
		1a	1b	2a	2b	3a	3b	4	5	6	7	8	10a	10b	11
Goods and services (Product Groups)				Consumption of Households		Intermediate Consumption					Government Consumption	Gross captial formation			Export of goods and Services
Environmental	1a			---		3832					8109	4690			4663
Other goods and services	1b			655721		1023163					216319	217173			474528
Consumption of Household (Purpose)											Consumption of household				
Environmental	2a										---				
Other pupose	2b										655721				
Production Branch of industries		Output basic prices													
Environmental	3a	19193													
Other pupose	3b	2064098													
Generation of income Account (Primary input categories)	4					Gross Domestic Product factor cost									
						9600	1005249								
Allocation of primary (Institutional sectors)	5							Net National Generated income Factor cost	Property income				Taxes less subsidies on production		Property income from ROW
								859282	244020				12992	125064	23462
Redistribution of (Institutional sectors)	6								Net National income,	Unrequitted current transfer n.e.c.			Taxes on income and wealth and social contributions		Current transfer from ROW
									968470	122348				244960	2505
Use of income account (Instituional sectors)	7									Net Disposable National Income					
										968453					
Capital	8							Consumption of Fixed capital			Net National Saving				
								155567			88304				
Financial Balance	9											Net Lending of the total economy			
												26944			
Tax Account (Categories of taxe and subsidies)		Taxes less subsidies on products				Other taxes less suubsidies on production				Taxes on income and wealth					Taxes received from the rest of the world
Environmental Taxes	10a	12310				682									
Other taxes	10b	84299				40765				240579					4381
Rest of World (current)	11	Import of goods and services (cif)							Property income to ROW	transfer to ROW			Taxes paid to the rest of the world		
Environmental		2101													
Other pupose		426197							52330	6903					
Rest of World (Capital)	12											Unrequitted captial transfer to ROW			Balance of payment of he rest of the world
												696			-22008
Substances						Absorption of substance in production									Trans boundary pollution to the rest of world
CO2	13a														
NO2	13b														
CH4	13c														
CFCs	13d														
HFCs	13e														
Nox	13f														N/A
SOX	13g														N/A
NH3	13h														N/A
PM 2.5	13i														N/A
VOC	13j														N/A
CO	13k														N/A
WASTE (000 Tons)	13l					6642									
Gas (million M3)	13m					176076									
Oil (million M3)	13n					83									
Global environmental Indicators												Environmental indicators			
Greenhouse(GWP)	14a											690249			
Ozone Depletion(ODP)	14b											69			
National environmental Indicators															
Acidification	15a											9558			
Other air pollution	15b											N/A			
Waste production (KG)	15c											24081			
Loss of Natural resource	15d											-18295			
Total		Supply purchasers' prices		Consumption of households		Input Basic prices		generated income	Destination of primary income	Destination of secondary income	Current expenditure	Capital expenditure	Taxes less subsidies		Current receipts from the rest of the world
		2608198		655721		2083291		1014849	1264820	1338283	968453	249503		383016	487531

Account (Classification)		Rest of World														Global Environmental Indicator		National Environmental indicator				Total
		ROW (Capital)	CO2	N20	CH4	CFC	HFC	Nox	SOX	NH3	PM 2.5	VOC	CO	Waste 000 tonnes	Gas million m^3	Oil million m^3		in 000 Tons				1 2 3
			000 tonnes			tonnes		000 tonnes		000 tonnes												
																Green house effect	Ozone Layer depletio	Acidifcation	Other Air Pollutants	Waste	Loss of Natural Resource	4 5 6
		12	13a	13b	13c	13d	13e	13f	13g	13h	14i	13j	13k	13l	13m	13n	14a	14b	15a	15b	15c	15d	
Goods and services (Product Groups)																						Use purchasers prices
Environmental	1a																					2608198
Other goods and services	1b																					
Consumption of Household (Purpose)			Emission of pollultant from houseolds																			Final consumption of houseolds
Environmental	2a		104527	10	7	0	0	259	21	19	130	508	4789	12237								
Other pupose	2b																					655721
Production			Emissinof pollutant from industries																			Output
Branch of industries			467421	136	3524	1	991	2333	2248	556	1216	2395	9366	18486								basic prices
Environmental	3a																					
Other pupose	3b																					2083291
Generation of income Account (Primary input categories)	4																					Generated income
																						1014849
Allocation of primary (Institutional sectors)	5																					Primary income
																						1264820
Redistribution of (Institutional sectors)	6																					Secondary income
																						1338283
Use of income account (Instituional sectors)	7																					Disposable income
																						968453
Capital	8	Capital transfer from ROW	Other changes in natural resources																			Capital income
															157820	44						
		5632																				249503
Financial Balance	9	Net lending of the rest of the world																				
		-26944																				0
Tax Account (Categories of taxe and subsidies)																						Taxes less subsidies
Environmental Taxes	10a																					
Other taxes	10b																					383016
Rest of World (current)	11		Trans boundary pollution from the rest of the world					N/A	N/A	N/A	N/A	N/A	N/A									Current payment to the rest of the world
Environmental																						
Other pupose																						487531
Rest of World (Capital)	12																					Capital flow to the rest of the world
																						-21312
Substances																	Allocation to Global environmental themes		Allocation to national environmental themes (Emission of substances)				Destination of Substance
CO2	13a																571948						571948
NO2	13b																146						146
CH4	13c																3531						3531
CFCs	13d																	1					1
HFCs	13e																	991					991
Nox	13f																		2592				2592
SOX	13g																		2269				2269
NH_3	13h																		575				575
PM 2.5	13i																			1346			1346
VOC	13j																			2903			2903
CO	13k																			14155			14155
WASTE (000 Tons)	13l																				24081		30723
Gas (million M^3)	13m																					-18256	157820
Oil (million M^3)	13n																					-39	44
Global environmental Indicators																							
Greenhouse(GWP)	14a																						690249
Ozone Depletion(ODP)	14b																						69
National environmental Indicators																							
Acidification	15a																						9558
Other air pollution	15b																						N/A
Waste production (KG)	15c																						24081
Loss of Natural resource	15d																						-18295
Total		Capital flows From the rest of the world	Origin of substances														GWP	ODP	EP	Other			
		-21312	571948	146	3531	1	991	2592	2269	575	1346	2903	14155	30723	157820	44	690249	69	9558	N/A	24081	-18295	

Indicators of environmental degradation

Columns 14 and 15 provide summary environmental indicators: the greenhouse gases, ozone depletion, air pollution, waste and loss of oil and gas resources. The substance indicators are obtained from a weighted aggregation procedure.

The greenhouse effect and ozone layer depletion are labeled as global environment indicators (account 14a and 14b) because they show how much Canada contributes to the global environmental picture. Account 15 is labeled as national environmental indicators because the environmental impact is limited to Canada. However there are some cross-border flows of these substances but the relevant data are not available.

The greenhouse effect indicator (**Account 14a**)

Six gases were recognized in the Kyoto Protocol as climate-changing (See Statistics Canada Catalogue-16-251, p.25): Carbon dioxide ($CO_{2)}$, Methane (CH_4), Nitrous oxide (N_2O),Sulphur hexafluoride (SF_6), Hydro fluorocarbon (HFCs[5]).and Per fluorocarbons (PFCs). However Statistics Canada's green house gas indicators incorporates three greenhouse gases: carbon dioxide ($CO_{2)}$, Methane (CH_4), and Nitrous oxide (N_2O)
The relative contribution of each gas to the so-called greenhouse effect or global warming potential is expressed in CO_2 equivalents by multiplying the estimated emission of each gas by a weighting factor called global warming potentials (GWP) as follows:

Text Table 2 Conversion of Canada gas emissions into GWP, 2002

Emission in 000 tonnes		Global warming potential	Emission in GWP
CO_2	571,948	1	571,948
N_2O	146	310	45,151
CH_4	3531	21	74,151
Total (Account 14a)			691250

The GWP in 2005 was 709 million tonnes representing an increase of 2.6% over 2002. (See table 3 in the Appendix)

Ozone depletion potential (**Account14b**)

Nearly 90% of the Earth's ozone is in the stratosphere and is referred to as the ozone layer. The depletion of the ozone layer leads to higher exposure to UV radiation which

[5]"**CO_2** emission results from fossil fuel combustion, deforestation and industrial processes. **CH_4** results from livestock, leakage from pipeline, coal mining, and decay of organic waste in landfills. **N_2O** is released by cultivating soil, using nitrogen-based fertilizer, producing nylon and burning fossil fuels and wood. **SF_6** is emitted when the electric power industry installs, services and disposes equipment such as circuit breakers, gas installed substations and switchgears **HFC**s and **PFCs** are produced in refrigeration equipment , fire extinguishers and air conditioners".(Page 25, Statistics Canada cat.16-251)

affects human health and the ecosystem[6]. These substances include CFCs, halons, Carbon tetrachloride, and methyl chloroform. Hydrochloro fluorocarbons, hydrobromoflurocarbons, methyl bromide, bromochloromethane

Text table 3 presents the quantity of CFCs and HFCs produced along with the ozone depletion potential (ODP). The ODP refers to the amount of ozone depletion caused by a substance.

Text Table 3 Conversion of ozone depleting substances to ODP, 2002

Emission in tonness		Conversion factor to ODP	ODP in tonnes
CFCs	1*	1	1
HFCs	992	.07	69
Total	(14b)		70

* Rounded to 1

In 2005, the value of ODP declined by about 4% over 2002. In 2002, about 75% of ODP is contributed by two industries: Petrochemical manufacturing (10%) and Polystyrene, urethane, and other foam product manufacturing (65%). (See table 4 in the Appendix)

Airborne Acidification (Account 15a)

At the national level, important substances contributing to acidification are: nitrogen oxides (NOx), sulphur dioxide (SO_2) and ammonia (NH_3). The Equivalence potential is taken from the technical report[7] by Judith Bates et al.

Text Table 4 Conversion of acidification contributing substances to EP, 2002

Emission in 000 tonnes		Conversion factor to EP	EP in 000 tonnes
NOx	2592	1	2592
SOx	2269	1.76	3993
NH3	575	5.17	2973
Total	(15a)		9558

The level of acidification declined in 2005 over 2002. The value of EP was 9.5 million tons in 2002 while the EP in 2005 was about 9 million tones. (See Table 5 in the Appendix)

[6] The substances that deplete ozone layer are covered under the Montreal Protocol.The Montreal Protocol is an international treaty (adopted on 22 March 1985, last revised in 1999) designed to protect the ozone layer by phasing out the production of a number of substances which are responsible for ozone depletion.

[7] Technical Report P6-015/TR2 Environmental *Burden Measures for Air: Global Warming, Stratospheric Ozone Depletion, Photochemical Ozone Creation and Airborne Acidification*. By Judith Bates et al., 2003

Other air pollutants

The other pollutants include Total Particulate Matter (TPM), Volatile Organic Compounds (VOC) and Carbon Monoxide (CO). We were not able to find a common denominator for these substances.

Waste

The waste indicator shows the total amount of non-hazard waste originating from residential and non-residential sources; that is net addition to waste in 2002. In 2004, the net addition to waste was 25,291 thousand tons representing an increase of 5%.

Loss of Natural resources

For this indicator, we have included only two resources: Gas and oil. This indicator represents the net change in these natural resources. The net change in natural resources is equal to addition to proven reserve less the quantity absorbed in production. A negative quantity signifies a net loss of natural resources to the economy.

Contribution of industries and households to environmental indicators

Text table 5 presents the relationship between the change in economic and environmental indicators. It displays the amount of pollution produced by industries and households in question directly. The pollution produced by the materials used by the industry is not presented here. The latter is an indirect effect that can be calculated with a model specification.

The following table presents volume changes (2002-2005) of environment and economic indicators for industries and households.

Text Table 5

Volume Change for Some Economic and Environmental Indicators 2002 and 2005							
	Economic Indicators			Environmental Indicators			
Industry	% Change in Volume Measure of GDP	% Change in Employment	% Change in Personal Expenditure	% Change in Global Warming Potential	% Change in ODP	% Change in EP	% Change in Waste
Crop & animal production	35	-2		6		9	
Forestry & logging	4	-2		23		2	
Fishing, hunting and trapping	-2	1		-9		-26	
Support activities for agriculture	5	-3		40		10	
Mining and oil & gas extraction	4	18		4		30	
Utilities	6	17		-3		-16	
Contruction	14	19		31		1	
Manufacturing	2	-1		4	-4	-10	
Food, beverage and tabacco manufacturing	1	1		8		0	
Wood product manufacturing	9	-4		-7		-61	
Paper manufacturing	-1	7		-17		-18	
Petroleum and coal product manufacturing	-4	46		1		-11	
Chemical manufacturing	4	15		11	11	7	
Plastic manufacturing	3	6		9	2	0	
Non-metallic mineral manufacturing	12	5		8		-2	
Primary metal manufacturing	5	-7		2		-11	
Other manufacturing	1	-3		20	-44	21	
Wholesale Trade	16	4		-15		-36	
Retail Trade	10	5		-17		22	
Transportation and warehousing	7	5		12		-3	
Government sector	6	7		5		4	
Other services	9	6		1		-20	
Household consumption expenditure							
Household transport				3			
Home heating/lighting				-3			
Total	**8**	**6**		**3**	**-4**	**-6**	**5**
Business	9	5		3	-4	-6	6
Government	6	7		5		4	
Households			11	1		-20	4

Note: The number of vehicles registered by households was 16,888 in 2002 and 17,373 thousands in 2005 representing an increase of about three percent.

For the whole economy, between during 2002-2005, the environmental indicators increased less than the economic indicators. The GDP increased by 8% and employment increased by 6%. We can compare this with the environmental indicators. Pollutants which damage the ozone layer decreased by 3% and those contributing to acidification decreased by 6%. And the global warming pollutants and waste increased by 3% and 5% respectively. This indicates that business produced less waste than their contribution to the GDP. While the volume of household expenditure increased by 11 percent, the global warming potential increased by one percent, and acidification decreased by 20%, a dramatic change. Households also registered a phenomenal decrease in growth of waste. It is interesting to find that the global warming emissions by households matched the growth in car ownership- both grew by 5%.

Environmental protection expenditure by government and industries

In this section we discuss the compliance of business and government, whether mandatory or voluntary, in protecting the environment. Statistics Canada through surveys collects data on environmental protection expenditure for selected industries. "Environmental protection expenditure are defined as all capital and operating expenditures incurred by businesses in order to comply with or to anticipate Canadian and international regulations, conventions or voluntary agreement" (See the Environmental protection expenditures in the business sector, Statistics Canada Catalogue 16F0006X)

Text Table 6 below present environmental protection expenditure for government and industries for the years 2002 and 2004.These data are not available for 2005. The data for households are also not available. The text Table 1 displays the same data at the aggregate level. For example the aggregate intermediate consumption of industries for 2002 is 3832 millions. (See cell 1a, 3a)

Text Table 6

Environmental Protection Expenditure by Government and Industries 2002 and 2004 ($ millions)								
	2002			2004			2002	2004
	Current Expenditure	Capital Expenditure	Total	Current Expenditure	Capital Expenditure	Total	Current Expenditure as % of intermediate	
Government	**8109**	**3263**	**11372**	**N/A**	**N/A**	**11903**		
Industries	**3832**	**1427**	**5259**	**3836**	**2918**	**6754**	**0.8**	**0.7**
Logging	136	1	137	200	2	202	0.4	0.5
Oil and gas extraction	540	244	784	600	561	1161	2.7	2.4
Mining	278	31	309	292	171	463	2.5	2.3
Electric power incl. Transmission and distribution	326	228	554	225	282	507	3.5	2.3
Natural gas distribution	10		10	27	14	41	1.4	2.5
Food	212	46	258	167	81	248	0.4	0.3
Beverage and tabacco products	19	6	25	14	11	25	0.4	0.3
Wood products	126	29	155	147	80	227	0.6	0.6
Pulp, paper and paperboard mill	422	153	575	409	163	572	1.9	1.8
Petroleum and coal products	244	500	744	247	984	1181	0.7	0.6
Chemicals	302		302	333	85	418	1.0	0.9
Non-metallic mineral products	77	24	101	74	104	178	1.4	1.3
Primary metals	522	31	553	573	169	742	1.9	1.7
Fabricated metal products	84		84	51	34	85	0.4	0.2
Transport equipment	202	27	229	139	88	227	0.2	0.1
Other manufacturing	274		274	265	85	350	19.1	18.6
Pipeliner transportation	58	32	90	73	54	127	0.1	0.1
	11,941	4,690	16,631	3,836	2,918	18,657		

For government, the split of expenditure between and current is not available for 2004. So the combined expenditure represents an increase of 5% for 2004. For business, the table presents environmental protection expenditure (current) as a percentage of their intermediate consumption. The ratio of protection expenditure for total business in 2004 declined by one percentage point from 2002. This contrasts with GDP growth of 9.0 percent between 2002 and 2005. Only the natural gas distribution industry showed an increase in the share of protection expenditure to total intermediate expenditure rising from 1.4% in 2002 to 2.5% in 2004.

Concluding Remarks

The framework presented here, displays environmental data along with some summary environmental indicators which are fully consistent with the data in National Accounts. These summary indicators can be extended as new data come on stream in the future. This framework is an effective analytical tool for relating the impacts of production and consumption activities on environmental variables that are of great concern to the public and to policy makers. As our simple analysis demonstrated, the integration presented in this paper offered permits clear and powerful conclusions to be drawn for some of the most commonly debated relationships between economic and environmental variables.

Appendices:

Appendices

Table 1 Volume Measure of GDP Canada, 2002 and 2005 ($ millions)				
Industries	**2002**	**2005**	**Volume Change**	**Change %**
Crop and Animal Production	13,557	18,338	4,781	35
Forestry and Logging	5,619	5,860	241	4
Fishing, Hunting and Trapping	1,085	1,063	-22	-2
Support Activities for Agriculture	1,100	1,159	59	5
Mining and Oil and Gas Extraction	52,493	54,784	2,291	4
Utilities	25,843	27,329	1,486	6
Construction	55,015	62,725	7,710	14
Food, Beverage and Tobacco	22,710	22,992	282	1
Wood Products	11,867	12,970	1,103	9
Paper Manufacturing	11,440	11,369	-71	-1
Petroleum and Coal Production	3,374	3,254	-120	-4
Chemical Manufacturing	14,808	15,375	567	4
Plastics Manufacturing	9,793	10,095	302	3
Non-metallic Mineral Product	4,964	5,580	616	12
Primary Metal Manufacturing	10,750	11,295	545	5
Other Manufacturing	89,278	90,413	1,135	1
Wholesale Trade	53,106	61,445	8,339	16
Retail Trade	55,717	61,500	5,783	10
Transportation and Warehousing	45,764	49,070	3,306	7
Government Sector	154,410	164,190	9,779	6
Other Services	372,156	407,510	35,353	9
Total	**1,014,849**	**1,098,314**	**83,465**	**8**

Table 2 Employment in Canada, 2002 and 2005 ($ millions)				
Industries	**2002**	**2005**	**Change in Employment**	**Change %**
Crop and Animal Production	319,087	311,179	-7,908	-2
Forestry and Logging	63,556	62,280	-1,276	-2
Fishing, Hunting and Trapping	12,950	13,084	134	1
Support Activities for Agriculture	34,138	33,205	-932	-3
Mining and Oil and Gas Extraction	153,845	182,118	28,272	18
Utilities	108,811	126,779	17,968	17
Construction	913,988	1,087,000	173,012	19
Manufacturingt	2,252,815	2,240,459	-12,359	-1
Food, Beverage and Tobacco	249,356	251,641	2,285	1
Wood Products	134,983	129,627	-5,356	-4
Paper Manufacturing	106,251	114,190	7,939	7
Petroleum and Coal Production	15,387	22,466	7,078	46
Chemical Manufacturing	94,836	108,896	14,059	15
Plastics Manufacturing	127,076	134,654	7,577	6
Non-metallic Mineral Product	58,275	61,012	2,737	5
Primary Metal Manufacturing	93,538	87,294	-6,244	-7
Other Manufacturing	1,373,113	1,330,679	-42,434	-3
Wholesale Trade	856,613	888,888	32,275	4
Retail Trade	1,849,163	1,942,202	93,038	5
Transportation and Warehousing	759,429	795,076	35,646	5
Government Sector	2,182,394	2,324,511	142,117	7
Other Services	6,079,604	6,447,883	368,279	6
Total	**15,586,394**	**16,454,663**	**868,269**	**6**

Table 3 Global Warming Potential Canada, 2002, 2005 (000 tonnes)										
	2002				2005				Volume Change in GWP	Change %
Industries	CO2	CH4	N2O	GWP2002	CO2	CH4	N2O	GWP2005		
Crop and Animal Production	9,280	1,271	104	68,336	8,909	1,345	113	72,162	3,826	6
Forestry and Logging	2,433	1	1	2,696	2,988	1	1	3,318	622	23
Fishing, Hunting and Trapping	1,062	0	0	1,142	956	0	0	1,034	-108	-9
Support Activities for Agriculture	771	0	0	850	1,075	0	0	1,189	338	40
Mining and Oil and Gas Extraction	81,825	1,800	3	120,557	86,169	1,785	4	124,858	4,301	4
Utilities	123,764	166	2	127,994	120,149	174	2	124,524	-3,470	-3
Construction	8,223	3	2	8,919	10,705	3	3	11,685	2,766	31
Manufacturing	107,524	2	10	109,562	109,498	2	14	113,968	4,406	4
Food, Beverage and Tobacco Manufacturing	4,203	0	0	4,245	4,520	0	0	4,570	325	8
Wood Product Manufacturing	2,430	0	0	2,467	2,269	0	0	2,306	-161	-7
Paper Manufacturing	9,813	0	0	9,880	8,187	0	0	8,247	-1,633	-17
Petroleum and coal product Manufacturing	24,942	0	1	25,079	25,223	0	0	25,363	284	1
Chemical Manufacturing	20,160	0	8	22,730	21,289	0	13	25,250	2,520	11
Plastic Manufacturing	924	0	0	932	1,002	0	0	1,012	80	9
Non-metallic Mineral Product Manufacturing	15,693	0	0	15,739	17,016	0	0	17,068	1,329	8
Primary Metal Manufacturing	22,886	0	0	22,957	23,411	0	0	23,487	530	2
Other Manufacturing	6,473	0	0	5,533	6,581	0	0	6,665	1,132	20
Wholesale Trade	13,931	1	1	14,302	11,885	0	1	12,169	-2,133	-15
Retail Trade	9,630	0	1	9,858	8,065	0	0	8,224	-1,634	-17
Transportation and Warehousing	55,736	277	8	63,955	63,442	274	8	71,804	7,849	12
Governemnt Sector	15,369	1	1	15,634	16,098	1	1	16,357	723	5
Other Services	37,872	2	2	38,647	38,381	2	2	39,102	455	1
Household Consumption Expenditure										
Household Transport	64,139	6	9	67,193	66,623	5	8	69,185	1,992	3
Home heating/light	40,388	1	1	40,604	38,984	1	1	39,203	-1,401	-3
Total	571,948	3,531	146	691,250	583,929	3,594	159	708,781	17,531	3
Business	452,052	3,523	135	567,819	462,223	3,587	149	584,036	16,217	3
Government	15,369	1	1	15,634	16,098	1	1	16,357	723	5
Households	104,527	7	10	107,797	105,607	6	9	108,388	591	1
Total	**571,948**	**3,531**	**146**	**691,250**	**583,929**	**3,594**	**159**	**708781**	**17,531**	**3**

Table 4 ODP Canada, 2002 and 2005								
	2002			2005				
Industries	CFC	HFC	ODP	CFC	HFC	ODP	Volume Change in ODP	Change %
Petroleum	0	0	0	0	6	0	0	0
Chemical Manufacturing	1	128	9	0	146	10	1	11
Plastic and Rubber	0	735	51	0	754	52	1	2
non-metallic mineral							0	0
Primary metal							0	0
Other Manufacturing	0	128	9	0	74	5	-4	-44
							0	0
Total	1	991	70	0	980	67	-3	-4

Table 5 Acidification Canada, 2002 and 2005										
	SOX	NOX	NH3	EP2002	SOX	NOX	NH3	EP2005	Volume Change	Change %
Crop & animal production	5	122	310	1734	4	96	345	1885	151	9
Forestry & logging	2	44	0	47	2	44	0	48	0	1
Fishing, hunting and trapping	1	16	0	17	0	12	0	13	-4	-26
Support activities for agriculture	1	14	0	15	1	15	0	16	2	10
Mining and oil & gas extraction	131	160	2	402	176	198	3	522	119	30
Utilities	622	293	2	1398	520	258	0	1176	-222	-16
Construction	5	136	0	145	5	137	0	147	2	1
Manufacturing										
Food, beverage and tabacco manufacturing	0	0	0	1	0	1	0	1	0	0
Wood pruduct manufacturing	3	16	5	45	2	12	0	18	-28	-61
Paper manufacturing	71	54	4	202	62	45	2	165	-37	-18
Petroleum and coal pruduct manufacturing	385	464	6	1174	302	494	3	1041	-133	-11
Chemical manufacturing	17	35	10	115	25	28	10	124	8	7
Plastic manufacturing	0	0	0	1	0	0	0	1	0	0
Non-metallic mineral product manufacturing	48	43	0	130	45	46	0	128	-2	-2
Primary metal manufacturing	858	26	1	1541	763	18	1	1364	-177	-11
Other manufacturing	28	62	4	132	48	67	1	160	28	21
Wholesale Trade	1	17	1	23	0	11	1	15	-9	-36
Retail Trade	21	45	2	92	37	40	1	112	20	22
Transportation and warehousing	47	635	2	729	48	611	3	709	-20	-3
Government sector	2	76	5	105	1	80	5	109	4	4
Other services	3	75	200	1114	3	22	168	894	-221	-20
Household consumption expenditure	21	259	19	396	14	209	16	316	-80	-20
Total	2270	2592	575	9558	2058	2444	560	8960	-598	-6
Business	2247	2257	551	9058	2043	2155	539	8535	-522	-6
Government	2	76	5	105	1	80	5	109	4	4
Household	21	259	19	396	14	209	16	316	-80	-20
Total	**2270**	**2592**	**575**	**9558**	**2058**	**2444**	**1334**	**8960**	**-598**	**-6**

Table 6 Other Air Pollutants in Canada, 2002 and 2005										
	2002					2005				
Industries	**TPM**	**PM10**	**PM2.5**	**VOC**	**CO**	**TPM**	**PM10**	**PM2.5**	**VOC**	**CO**
Crop and Animal Production	1786	922	62	358	689	2123	1090	66	378	683
Forestry and Logging	5	5	5	21	160	5	5	4	22	182
Fishing, Hunting and Trapping	2	2	2	21	173	1	1	1	15	137
Support Activities for Agriculture	1	1	1	6	48	2	2	1	6	54
Mining and Oil and Gas Extraction	216	67	36	117	400	202	42	22	110	487
Utilities	78	31	14	9	88	35	17	9	8	83
Construction	2263	750	135	126	1021	3253	986	209	126	1113
Food, Beverage and Tobacco Manufacturing	0	0	0	6	7	0	0	0	7	12
Wood Product Manufacturing	137	77	36	58	550	75	45	19	48	283
Paper Manufacturing	40	28	21	25	132	29	21	15	22	95
Petroleum and Coal Product Manufacturing	49	19	14	553	500	66	22	15	510	466
Chemical Manufacturing	5	4	2	15	21	4	3	2	12	19
Plastic Manufacturing	0	0	0	5	4	0	0	0	3	3
Non-metallic Mineral Product Manufacturing	37	14	6	1	25	53	18	9	1	29
Primary Metal Manufacturing	48	32	23	20	428	36	25	19	5	511
Other Manufacturing	83	65	46	124	57	63	38	25	110	57
Wholesale Trade	1	1	0	19	301	0	0	0	11	176
Retail Trade	5	5	4	357	192	5	4	3	345	116
Transportation and Warehousing	83	34	20	61	650	60	30	20	58	582
Government Sector	10835	3181	667	265	2079	11419	3352	698	292	2184
Other Services	187	152	122	227	1842	15	7	2	35	335
Household	140	133	130	508	4789	129	122	119	408	3798
Total	**16001**	**5523**	**1346**	**2903**	**14155**	17573	**5830**	**1260**	**2531**	**11404**

Table 7 Volume Measure of Economic and Environmental Indicators 2002					
Industry	**Volume Measure of GDP**	**Employment**	**Global Warming Potential**	**ODP**	**EP2002**
Crop and Animal Production	13,557	319,087	68,336		1,734
Forestry and Logging	5,619	63,556	2,696		47
Fishing, Hunting and Trapping	1,085	12,950	1,142		17
Support Activities for Agriculture	1,100	34,138	850		15
Mining and Oil and Gas Extraction	52,493	153,845	120,557		402
Utilities	25,843	108,811	127,994		1,398
Construction	55,015	913,988	8,919		145
Manufacturing	**178,984**	**2,252,815**	**109,562**	**70**	**3,341**
Food, Beverage and Tobacco Manufacturing	22,710	249,356	4,245		1
Wood Product Manufacturing	11,867	134,983	2,467		45
Paper Manufacturing	11,440	106,251	9,880		202
Petroleum and Coal Product Manufacturing	3,374	15,387	25,079	0	1,174
Chemical Manufacturing	14,808	94,836	22,730	9	115
Plastic Manufacturing	9,793	127,076	932	51	1
Non-metallic Mineral Product Manufacturing	4,964	58,275	15,739		130
Primary Metal Manufacturing	10,750	93,538	22,957		1,541
Other Manufacturing	89,278	1,373,113	5,533	9	132
Wholesale Trade	53,106	856,613	14,302		23
Retail Trade	55,717	1,849,163	9,858		92
Transportation and Warehousing	45,764	759,429	63,955		729
Government Sector	154,410	2,182,394	15,634		105
Other Services	372,156	6,079,604	38,647		1,114
Household Consumption Expenditure					396
Household Transport			67,193		
Home heating/lighting			40,604		
Total	**1,014,849**	**15,586,393**	**690,249**	**70**	**9,558**
Business	860,439	13,403,999	566,818	70	9,057
Governmnent	154,410	2,182,394	15,634	0	105
Households	0	0	107,797	0	396
Total	**1,014,849**	**1,586,393**	**690,249**	**70**	**9,558**

Table 8 Volume Measure of Economic and Environmental Indicators 2005					
Industry	Volume Measure of GDP	Employment	Global Warming Potential	ODP	EP2005
Crop and Animal Production	18,338	311,179	72,162		1,885
Forestry and Logging	5,860	62,280	3,318		48
Fishing, Hunting and Trapping	1,063	13,084	1,034		13
Support Activities for Agriculture	1,159	33,205	1,189		16
Mining and Oil and Gas Extraction	54,784	182,118	124,858		522
Utilities	27,329	126,779	124,524		1,176
Construction	62,725	1,087,000	11,685		147
Manufacturing	**183,343**	**2,240,459**	**113,968**	**67**	**3,002**
Food, Beverage and Tobacco Manufacturing	22,992	251,641	4,570		1
Wood Product Manufacturing	12,970	129,627	2,306		18
Paper Manufacturing	11,369	114,190	8,247		165
Petroleum and Coal Product Manufacturing	3,254	22,466	25,363	0	1,041
Chemical Manufacturing	15,375	108,896	25,250	10	124
Plastic Manufacturing	10,095	134,654	1,012	52	1
Non-metallic Mineral Product Manufacturing	5,580	61,012	17,068		128
Primary Metal Manufacturing	11,295	87,294	23,487		1,364
Other Manufacturing	90,413	1,330,679	6,665		160
Wholesale Trade	61,445	888,888	12,169		15
Retail Trade	61,500	1,942,202	8,224		112
Transportation and Warehousing	49,070	795,076	71,804		709
Government Sector	164,190	2,324,511	16,357		109
Other Services	407,510	6,447,883	39,102		894
Household Consumption Expenditure			108,388		316
Household Transport			69,185		
Home heating/lighting			39,203		
Total	**1,098,316**	**16,454,664**	**708,782**		**8,964**
Business	934,126	14,130,153	584,037	67	8,539
Governmnent	164,190	2,324,511	16,357	67	109
Households			108,388		316
Total	**1,098,316**	**16,454,664**	**708,782**	**67**	**8,964**

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