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Estimating Regional Energy and Natural Resource Flows

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Estimates of direct and indirect material and energy usage for New York State are derived from existing input-output and natural resource and energy databases. The work provides both a generally applicable methodology and an empirical example for estimating energy and material flow impacts at the regional level.

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Abstract: Estimates of direct and indirect material and energy usage for New York State are derived from existing input-output and natural resource and energy databases. The work provides both a generally applicable methodology and an empirical example for estimating energy and material flow impacts at the regional level.

A substantial body of work utilizes energy and material flow approaches to address environmental impacts of economic activity. This work recognizes that material inputs and wastes are used and generated at all levels of the economic supply chain, and at final consumption. The insights of this work emphasize that economic activity at any level generates not only its own environmental impacts, but a range of upstream and downstream impacts as well. Empirical work has proceeded largely at the two extremes of national and international impacts of economic activity, and in work on life cycle impacts of specific industrial products and processes. The work reported here is positioned between these extremes, and provides both a generally applicable methodology and an empirical example for estimating energy and material flow impacts at the regional level.

Estimates of material and energy usage for New York State are derived, and natural resource impacts are given for five different categories of material flows: biodegradables, geologic process equivalents, active chemicals, wastes which received chemical processing, and heavy metals. In assigning impacts to a particular sector, the highest level sector to which the impact could be fully attributed was used. Thus carbon emissions from coal combustion were assigned to the utility sector, though the energy product (electricity) is in fact used throughout the economy. Less intuitively, emissions from refined oil products are assigned to petroleum and coal products rather that to service stations. While such fuels are sold by service stations, they also enter the economy through other channels (e.g. jet fuel for airplanes).

Economic activity is disaggregated to New York State impacts at the two digit SIC level. Physical impact estimates are attributed to sectors at this level of spatial and economic detail as needed. The result is a set of material and energy intensity estimates for the 67 two digit SIC sectors represented by IMPLAN, the economic database.

Background

There is a substantial body of work which utilizes materials flow approaches to address environmental impacts of economic activity. This work (e.g. Kneese, Ayres, D'Arge, 1970) recognizes that material inputs and wastes are used and generated at all levels of the economic supply chain, and at final consumption. The insights of this seminal work lead directly to the premise of industrial ecology, that industrial activity at any level generates not only its own environmental impacts, but a range of upstream and downstream impacts as well.

The insight that industrial activity in one sector results in activity in numerous additional sectors has led to a well developed economic methodology, input-output analysis. Making input-output analysis tractable are available databases which characterize the economic activity induced by and stemming from economic output by any given sector of the national or regional economy (e.g. Minnesota IMPLAN Group, Inc. 1999).

Input-output analysis has been applied to questions of materials flows at a much more spatially and sectorally disaggregated level than is available using existing material flows databases (Tracey et al., 2000). Specifically, total energy inputs (coal, oil, and natural gas) stemming from economic production in seven northeastern states were estimated separately for 15 industrial sectors. This work demonstrated

that an input-output database could be used to estimate both direct and indirect material flows resulting from economic activity.

Specific applications using this approach have been developed in life cycle analysis (LCA). Recognizing that perhaps the main challenge in LCA is identifying upstream indirect impacts, the use of input-output databases has been employed to capture these effects. An example of such work is provided by the online LCA calculator established by the Green Design Initiative.

Recent work at the level of national economies and broad economic sectors has led to creation of a publicly available database for expressing the material flows resulting industrial activity (Matthews et al., 2000). This working database covering the 1975-96 time period provides the empirical basis for understanding life cycle environmental impacts of national economic activity in general.

Methodological Approach

Estimates of material and energy usage in New York State are derived from existing input-output and natural resource and energy databases. Economic activity is disaggregated to New York State impacts at the 2 digit SIC level. Physical impact estimates are attributed to sectors at this level of spatial and economic detail as needed. The result is a set of material and energy intensity estimates for the 67 2 digit SIC sectors represented by the economic database.

First, direct material and energy impacts within New York State are estimated from the level of economic activity in each sector, multiplied by the estimated material or energy intensity in the sector. Second, the total impact of economic activity in any one sector is estimated from economic input-output relationships between sectors. For example, these relationships (described by a 67x67 set of multipliers)

provide an estimate of the impacts of an activity such as purchases from food stores (SIC 54). While the stores themselves "produce" few impacts, they purchase from many sectors which do: from agriculture, transportation, and energy for example. These indirect material and energy impacts are calculated using the multipliers together with estimates of energy intensity. Finally, many if not most purchased inputs are from outside of New York State, or even from outside the nation. These imports to the state also represent material and energy impacts which result from economic activity within the state, but which occur elsewhere. Estimates of the dollar value of imports to the state are used to estimate material and energy impacts in the rest of the nation, and in the rest of the world resulting from state economic activity.

Application of National Material Flow Estimates

The application of national physical impact estimates to develop regional estimates is presented here. While the specific application is to the national estimates available in a World Resources Institute (2000) database, the approach is applicable to any national, industry specific impact data. Let **R** be a matrix of national material flow estimates, where r_{kj} is the total impact for material flow k in the economic sector j. In practice we define economic sectors at the 2-digit SIC level, and consider both hidden and non-hidden material flows. Then the material flows $\boldsymbol{\rho}$ for New York State can be estimated as

$$\boldsymbol{\rho} = (\boldsymbol{\alpha}\, \mathbf{I})\, \mathbf{R}$$

where $\boldsymbol{\alpha}$ is the vector of New York State to national output ratios by economic sector, and **I** is the identity matrix.

Estimating Demand Driven Flows for New York State

A primary purpose of this work is to develop an understanding of the relationship between demand in differing economic sectors and the resulting material flows. First, the input-output database is used to estimate economic flows between sectors. This allows calculation of the economic inputs required to satisfy demand in any given sector. Second, the material flows by sector calculated in (1) are used to estimate the material requirements which result from the final demand.

Expanding on the approach described by Joshi (1999), let **F** be a diagonal matrix of final demands for individual economic sectors *j*. (To estimate the impact of $1 of spending in each sector, **F** is simply the identity matrix **I**; to estimate the impact of the existing level of output for final demand, the elements of **F** are those levels of output.) Then the matrix of required inputs **X** to meet demand in sector *j* is given by

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{F}$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is the Leontieff inverse calculated from the input-output database. Material flows θ arising from final demands in sector *j* are then given by

$$\theta = \rho \mathbf{X}$$

θ thus gives the material flows resulting from final demands in sector *j* by using the material flow database in conjunction with the input-output database to translate dollar flows to material flows.

Data

Estimates of direct national natural resource use intensity by economic sector are presented in Tables 1 and 2. In these estimates, the impact per million dollars of economic output in the selected 2-digit SIC economic sector is presented. Four databases of natural resource impact are utilized. These include the Toxic Release Inventory (Environmental Protection Agency, 2002a), commonly abbreviated as TRI, AirData emissions (Environmental Protection Agency, 2002b), energy usage estimates from the MECs database (Department of Energy) and World Resources Institute estimates "Resources and Materials Use."

Toxic Releases Inventory

Toxic release information covers a wide area of discharges, including air, land, and water. Toxic releases impact every industry and have extreme importance in this project, environmentally. All information relevant to this area came from the Toxic Release Inventory website, through the EPA. This information in available New York State specific, with reporting level at a two-digit SIC code. Since the information was available in database form, it was directly copied from its listed fashion, directly into the class database. This should prevent any recording errors. This information is available for a number of industries and sectors, all found within New York State. It is also broken down, into individual sectors that have each chemical separately listed. An example of both databases is show below. Since many different sectors are reported on, this allows for a wide range of information available. The reporting date, 1999, is recent and reliable.

Air Emissions Databases

Air emission data is an important factor in almost every industry studied because of the wide range of pollutants that are involved. The data that best represented the fields required came from the

AirData section in the Environmental Protection Agency website. This information is reported by states, and New York is listed with its own specific information. The SIC codes are listed to the four-digit level, since this is extremely specific to the point of practically reporting on individual industries, is reported in my database in the two-digit level. This is to make the information more applicable to the project as a whole. The data covered the emissions of sulfur dioxide (So2), nitrogen oxides (NOx), volatile organic compounds (VOC), particulates, and carbon monoxide (CO). This data is reported from the year 1999. Emission data from this website is all found to be extremely helpful because of the level of detail that the information is reported at.

Energy and Electricity Databases

The relevant information from this database came from the Department of Energy website, in their MECs Data. The information, geographically, does not cover specifically New York State. There are four total databases, covering a large amount of material. Two of the tables are regional information, and two of the tables are nationally reported. Regional information, in this specific case, is reported for the states f New York, Pennsylvania, and New Jersey, this information is recorded together and there is no way to divide up the information to obtain only New York's specifically. The information is given in two different ways as well. First in 4-digit NAICS coed, and also in 2-digit SIC code, with a wide range of industries represented. The NAICS can be valuable information because it can easily be transferred over into SIC standards. This data was available only in an html format, so it was all hand transferred over to Access. This could account for information that may not fit with the rest, or inaccuracies that cannot be explained. This information is listed from the year 1999.

Material Usage Databases

The World Resource Institute has created a database that covers the material usage for industry in the United States. The information is listed nationally, not New York State specifically. Estimates can be made for New York State by reviewing the data from other databases and indicators. This database is reported from the year 1999, and is reliable and extremely relevant to the final outcome of the project.

Indicators

Data collection in any project must have very specific information available for it to be applicable to the question asked in the project. To provide a detailed look of natural resources and energy by New York State industries, it must first be determined which indicators are gong to be specifically researched. Within the scope of the research project, it was determined that the following indicators played the heaviest into completing the final goal of the project. Each subsection of this project required certain environmental and economic information, and the list accumulated is as follows:

Electricity is applicable to all industries, and can be a strong factor in life cycle analyses. Electricity is measured in kilowatts/hour in almost all data obtained on it.

SO2, or Sulfur Dioxide, is emitted through the burning fossil fuels. This pollutant can have adverse effects on the environment through the creation of acid deposition, or more commonly known as acid rain.

CO, or Carbon Monoxide, is a deadly pollutant that is emitted through exhaust system of automobiles. It is a product of incomplete burning of hydrocarbon-based fuels; carbon monoxide consists of a carbon atom and an oxygen atom linked together.

NOx, or nitrogen oxides, are also prime pollutants in acid deposition. A quarter of the emissions of NOx come from electric power generation that relies on burning fossil fuels like coal.

Volatile organic compounds, more commonly cited as VOCs, are also a culprit in acid deposition. They are also widely known in the problem of ozone depletion, one of the suspected causes of global warming.

Other energy sources can be considered anything from natural gases to coal. These are all sources that are used in electricity and power production, and are incredibly important for life cycle analyses in any industry.

Toxic Releases. A list was composed to represent the releases that are harmful to the environment, these are the regulated pollutants, and what are considered toxic releases. This can be an extremely wide range of information, as almost anything can be considered a toxic release. The three areas this class is exceptionally concerned with are all air, land, and water releases.

Hidden economic flows are flows that are not outright seen in most analyses. The flows of materials that do not enter the monetary cycle are known as hidden flows (World Resources Institute 1997). These can be extremely important in completing life cycle analyses.

Results

New York State direct impacts are estimated from national materials intensity data simply by scaling to the level of economic activity in the state. To the extent that regional materials data is available, there is no need to consider national data. Table 3 shows estimates of direct usage and impacts on natural resources in selected industries.

To truly capture the natural resource impacts of regional economic activity, it is necessary to consider impacts indirectly occurring as a result of that activity. Specifically, the upstream inputs necessary for production in any given sector may be at least as significant in terms of natural resource impacts as the direct effects of in the final sector. In Tables 4 and 5 we present the final impact estimates,

treating economic output in each sector as final demand, and looking at both direct and indirect natural resource impacts.

Discussion

Study results show that for New York State there is little correlation between regionally large economic sales and total energy and resource impacts. The tendency to generate particular material flows is industry specific based upon the products and/or services produced within that industry. Not surprisingly, it was found that the leading industries in economic sales are not the leading industries causing the largest energy and resource impacts. Considering total (direct plus indirect) impacts, levels of energy and resource intensity (material impact per dollar of value added) vary by up to five orders of magnitude. Comparing industries at the 5 and 95 percentile ranking, total air emissions per unit of economic output vary by a factor of 500.

The study makes three primary contributions. First, a generally applicable methodology is developed for estimating regional energy and natural resource flows. Second, an empirical example is demonstrated, providing a comprehensive set of flow estimates for New York state. Third, the set of flow estimates can be used to generate a life-cycle impact estimate for output from a specific regional economic sector.

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This work as a whole is dedicated to the memory of a seminar participant Benjamin Klein, who passed away in the early weeks of the semester.

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Table 1. Material and energy intensity (direct) of selected manufacturing and related economic activities.

Description	National Industry Output (million $)	1- TRI total air emissions (lbs/million $)	2 - TRI total water emissions (lbs/million $)	3 - TRI total land emissions (lbs/million $)	4 - Total energy (billion BTU / million $)	6 - Selected CO emissions (tons/million $)	7 - Selected NOX emissions (tons/million $)	8 - Selected SO2 emissions (tons/million $)	9 - Selected VOC emissions (tons/million $)
10 - Metal mining	9,138	726.4	33.7	90,933	-	-	-	-	-
20 - Food and kindred products	488,217	11.6	173.4	2	2.3	-	-	-	-
21 - Tobacco products	45,321	6.1	-	-	0.6	-	-	-	-
22 - Textile mill products	75,939	124.9	0.1	-	4.1	-	-	-	-
23 - Apparel and other textile products	81,449	18.1	-	-	0.6	-	-	-	-
24 - Lumber and wood products	122,716	810.3	1,523.8	13	4.8	-	-	-	-
25 - Furniture and fixtures	70,963	177.9	-	-	1.1	-	-	-	-
26 - Paper and allied products	167,294	459.9	11.8	3	16.5	0.3	-	1.1	0.1
27 - Printing and publishing	218,672	0.0	0.0	-	0.8	-	-	-	0.1
28 - Chemicals and allied products	399,915	38.0	0.0	5	15.2	-	0.1	0.1	0.1
29 - Petroleum and coal products	167,693	6.5	-	-	-	-	-	-	-
30 - Rubber and misc plastic products	172,026	53.2	0.3	23	1.8	-	-	-	-
31 - Leather and leather products	8,832	3,253.8	162.8	7	1.0	-	-	-	-
32 - Stone, clay, and glass products	97,758	278.8	0.1	0	10.0	-	3.6	3.0	-
33 - Primary metal industries	178,943	55.2	0.5	0	-	3.4	0.4	0.6	-
34 - Fabricated metal products	245,863	42.3	212.2	0	1.7	-	-	-	-
35 - Industrial machinery and equipment	419,387	5.2	0.2	-	0.7	-	-	-	-
36 - Electronic and other electric equipment	378,986	267.4	35.5	0	0.7	0.7	-	-	-
37 - Transportation equipment	608,837	19.1	2.9	-	0.7	-	-	-	-
38 - Instruments and related products	162,191	-	-	-	0.7	0.1	0.5	-	0.7
39 - Miscellaneous mfg	52,926	-	-	-	0.9	-	-	-	0.2
49 - Electric, gas, and sanitary services	347,119	892.2	16.8	63	-	0.9	6.8	16.4	

Table 2. Natural resource intensity (direct) of selected manufacturing and related economic activities from World Resources Institute data.

	Economic Output		Direct natural resource intensity (thousand metric tons per million $ of output)				
Description	Regional Industry Output (million $)	National Industry Output (million $)	1 - biodegradable	2 - geologic	3 -processed materials	4 - chemically active	5 - hazardous
01 - Crops	4,457	161,722	4.30	15.92			
02 - Livestock	2,041	95,590	1.56				
10 - Metal mining	85	9,138		141.28		74.85	
12 - Coal mining	0	23,678		286.78	2.04	2.12	
13 - Oil and gas extraction	356	124,878					0.70
14 - Nonmetallic mineral except fuels mining	539	18,698		11.43	0.60	1.57	
15-17 - Construction	54,787	1,209,633		2.95			
20 - Food and kindred products	18,820	488,217	0.07				
24 - Lumber and wood products	2,146	122,716	1.66			0.21	
26 - Paper and allied products	7,376	167,294	0.28				
28 - Chemicals and allied products	22,521	399,915				0.10	0.10
29 - Petroleum and coal products	2,709	167,693			0.45	4.11	0.61
32 - Stone, clay, and glass products	5,007	97,758		9.34		11.92	
33 - Primary metal industries	5,317	178,943				0.26	
49 - Electric, gas, and sanitary services (Pub Uti	21,595	347,119				3.17	

Table 3. Direct material and energy impacts of selected manufacturing and related economic activities for New York State.

Description	Regional Industry Output (million $)	1-(thousand lbs)	2 -(thousand lbs)	3 -(thousand lbs)	4 - (trillion BTU / million $)	6 - Selected CO emissions (thousand tons)	7 - Selected NOX emissions (thousand tons)	8 - Selected SO2 emissions (thousand tons)	9 - Selected VOC emissions (thousand tons)
10 - Metal mining	85	62	3	7,764	-	-	-	-	-
20 - Food and kindred products	18,820	217	3,264	30	43	-	-	-	-
21 - Tobacco products	3,974	24	-	-	2	-	-	-	-
22 - Textile mill products	1,870	234	0	-	8	-	-	-	-
23 - Apparel and other textile products	9,454	171	-	-	5	-	-	-	-
24 - Lumber and wood products	2,146	1,739	3,271	28	10	-	-	-	-
25 - Furniture and fixtures	2,225	396	-	-	2	-	-	-	-
26 - Paper and allied products	7,376	3,393	87	19	122	2	-	8	1
27 - Printing and publishing	27,325	0	0	-	21	-	-	-	2
28 - Chemicals and allied products	22,521	857	1	108	343	-	2	3	3
29 - Petroleum and coal products	2,709	18	-	-	-	-	-	-	-
30 - Rubber and misc plastic products	5,860	312	2	132	11	-	-	-	-
31 - Leather and leather products	597	1,943	97	4	1	-	-	-	-
32 - Stone, clay, and glass products	5,007	1,396	0	0	50	-	18	15	-
33 - Primary metal industries	5,317	294	3	0	-	18	2	3	-
34 - Fabricated metal products	8,837	374	1,875	1	15	-	-	-	-
35 - Industrial machinery and equipment	20,752	109	5	-	14	-	-	-	-
36 - Electronic and other electric equipment	17,835	4,770	634	1	13	12	-	-	-
37 - Transportation equipment	8,581	164	25	-	6	-	-	-	-
38 - Instruments and related products	20,121	-	-	-	14	2	10	-	15
39 - Miscellaneous mfg	4,994	-	-	-	5	-	-	-	1
49 - Electric, gas, and sanitary services	21,595	19,266	364	1,362	-	19	147	355	2

Table 4. Direct plus indirect material and energy impacts by economic sector for New York State.

Description	Regional Industry Output (million $)	1- TRI total air emissions (lbs)	2 - TRI total water emissions (lbs)	3 - TRI total land emissions (lbs)	4 - Total energy (billion BTU)	6 - Selected CO emissions (tons)	7 - Selected NOX emissions (tons)	8 - Selected SO2 emissions (tons)	9 - Selected VOC emissions (tons)
01 - Crops	4,457	97,225	19,049	22,010	4,867	82	474	1,138	86
02 - Livestock	2,041	39,942	32,398	4,718	1,104	36	226	553	28
08 - Forestry (and hunting)	70	369	190	50	11	0	2	5	0
09 - Fishing (no hunting)	44	137	62	10	3	0	0	1	0
10 - Metal mining	85	69,806	3,293	8,379,089	29	3	20	49	1
12 - Coal mining	0	0	0	0	0	0	0	0	0
13 - Oil and gas extraction	356	4,454	290	548	62	5	32	73	1
14 - Nonmetallic mineral except fuels mining	539	17,750	808	1,784	133	19	123	298	6
15-17 - Construction	54,787	1,880,770	2,061,170	118,739	26,951	1,179	3,777	6,683	656
20 - Food and kindred products	18,820	670,913	3,488,792	66,321	56,874	350	1,777	4,599	316
21 - Tobacco products	3,974	74,968	4,819	4,399	4,217	39	129	369	44
22 - Textile mill products	1,870	306,020	3,082	21,420	13,083	42	318	742	61
23 - Apparel and other textile products	9,454	522,948	20,853	21,453	12,983	120	784	1,897	144
24 - Lumber and wood products	2,146	1,975,089	3,642,696	35,565	12,157	39	242	576	34
25 - Furniture and fixtures	2,225	511,086	115,009	7,221	4,102	42	182	448	38
26 - Paper and allied products	7,376	4,131,774	306,197	71,023	144,032	2,462	1,746	13,092	1,295
27 - Printing and publishing	27,325	1,046,710	84,727	51,692	56,386	710	1,779	6,025	2,575
28 - Chemicals and allied products	22,521	1,548,090	41,728	1,651,550	406,753	505	5,685	11,694	3,777
29 - Petroleum and coal products	2,709	128,707	3,707	14,914	666	107	818	1,966	28
30 - Rubber and misc plastic products	5,860	553,741	24,109	219,693	31,876	174	1,136	2,703	256
31 - Leather and leather products	597	2,032,506	103,364	6,776	1,131	9	62	149	8
32 - Stone, clay, and glass products	5,007	1,614,051	29,823	76,596	54,311	170	19,433	18,037	75
33 - Primary metal industries	5,317	532,626	28,234	4,041,842	1,839	18,332	3,385	6,289	98
34 - Fabricated metal products	8,837	536,038	1,899,152	104,756	17,491	320	955	2,296	111
35 - Industrial machinery and equipment	20,752	737,774	110,491	101,568	20,002	1,319	1,519	3,597	340
36 - Electronic and other electric equipment	17,835	5,538,615	737,846	175,277	20,127	13,663	1,171	2,637	256
37 - Transportation equipment	8,581	337,394	57,667	146,651	8,238	303	462	1,056	106
38 - Instruments and related products	20,121	929,366	128,316	148,518	26,960	3,782	11,810	3,936	15,623
39 - Miscellaneous mfg	4,994	104,936	41,437	18,526	7,902	109	267	683	1,084
40 - Railroads (and 4741)	1,802	10,897	4,640	1,280	169	12	43	101	7
41 - Local And Suburban Transit (incl IMPLAN 512)	6,990	336,897	55,969	25,463	2,086	408	1,799	4,294	131
42 - Trucking and warehousing (and part of 4789)	9,420	225,114	13,796	16,685	755	229	1,550	6,023	82

Table 4. Direct plus indirect material and energy impacts by economic sector for New York State (continued).

Description	Regional Industry Output (million $)	1- TRI total air emissions (lbs)	2 - TRI total water emissions (lbs)	3 - TRI total land emissions (lbs)	4 - Total energy (billion BTU)	6 - Selected CO emissions (tons)	7 - Selected NOX emissions (tons)	8 - Selected SO2 emissions (tons)	9 - Selected VOC emissions (tons)
43 - Post office	5,390	77,654	4,108	5,653	386	76	521	1,284	20
44 - Water transportation	1,950	13,833	2,008	1,256	205	16	68	165	10
45 - Transportation by air	8,462	22,962	3,702	2,457	309	25	113	275	16
46 - Pipelines except natural gas	40	264	48	18	1	0	2	4	0
47 - Transportation services (except 4740)	2,695	15,069	6,330	828	193	13	59	147	8
48 - Communications	35,985	403,479	79,220	21,075	3,030	706	1,024	2,440	126
49 - Electric, gas, and sanitary services (Pub Uti	21,595	19,914,246	413,706	1,415,190	1,440	19,635	151,662	366,220	2,105
50,51 - Wholesale trade	65,879	759,985	202,180	45,145	9,387	775	3,110	7,758	8,391
52 - Building materials and garden supplies	2,751	19,255	1,461	1,226	149	18	114	280	5
53 - General merchandise stores	5,059	51,978	3,944	3,311	402	50	308	756	14
54 - Food stores	8,569	34,577	2,623	2,202	268	33	205	503	10
55 - Automotive dealers and service stations	7,846	86,304	6,548	5,497	668	83	512	1,255	24
56 - Apparel and accessory stores	6,495	92,584	7,024	5,897	716	89	549	1,346	26
57 - Furniture and home finishing stores	3,407	29,533	2,241	1,881	229	28	175	429	8
58 - Eating and drinking stores	18,276	358,595	229,872	26,409	5,045	328	2,259	5,473	165
59 - Misc retail	14,907	132,942	10,086	8,468	1,029	127	789	1,933	37
60 - Depository institutions (banking)	84,567	547,292	46,451	35,023	5,544	549	3,047	7,587	247
61,67 - Non-depository and holding (exclude nonpro	13,466	19,495	2,497	1,201	309	20	86	216	13
62 - Security and commodity brokers	92,212	109,186	12,146	7,065	1,253	116	577	1,399	56
63 - Insurance carriers	23,093	27,435	3,861	1,759	394	29	127	314	17
64 - Insurance agents, brokers, service	7,739	35,719	4,726	2,309	504	38	167	416	21
65 - Real estate	129,584	1,232,963	431,499	88,185	9,160	1,088	8,890	16,042	321
70 - Hotels and lodging	7,622	168,655	11,296	12,001	765	162	1,162	2,784	36
72 - Personal services	6,506	113,321	7,948	8,042	884	109	675	1,642	41
73 - Business services	59,824	584,846	72,817	36,863	9,222	800	1,791	4,526	325
75 - Auto repair, services, and parking	7,052	65,507	7,519	5,766	661	79	343	803	38
76 - Miscellaneous repair services	2,662	72,188	9,357	4,696	632	109	189	443	33
78 - Motion pictures	8,681	68,794	14,018	4,251	651	85	322	779	46
79 - Amusement and recreation services	13,249	212,867	23,957	16,479	1,759	205	1,329	3,214	66
80 - Health services	63,333	721,739	84,517	170,777	38,449	679	3,949	8,844	893
81: Legal services	23,878	83,336	12,405	5,064	1,364	83	349	860	50
82 - Educational services	39,393	118,319	33,470	8,417	1,952	118	500	6,158	68
83 - Social services	16,268	280,780	76,552	19,021	3,371	258	1,515	3,698	129
84,86 Non-profit organizations (plus some 67 & 89)	13,826	290,691	59,410	19,230	2,459	262	1,669	3,950	99
87,89 - Professional services	34,157	278,417	34,516	20,829	4,755	383	974	2,376	151

Table 5. Direct plus indirect natural resource impacts by economic sector for New York State.

Description	New York Material and Energy indicators (thousand metric tons)			New York Material Flows treating output as final demand (thousand metric tons)		
	1	2	3-5	1	2	3-5
01 - Crops	19,165	70,960	0	19,652	72,970	424
02 - Livestock	3,183	0	0	3,851	2,238	152
08 - Forestry (and hunting)	0	0	0	15	54	1
09 - Fishing (no hunting)	0	0	0	0	5	2
10 - Metal mining	0	12,062	6,390	0	13,023	6,908
12 - Coal mining	0	3	0	0	3	0
13 - Oil and gas extraction	0	0	247	0	13	274
14 - Nonmetallic mineral except fuels mining	0	6,164	1,170	1	6,188	1,248
15-17 - Construction	0	161,447	0	2,635	168,242	7,707
20 - Food and kindred products	1,261	0	0	4,038	5,252	1,300
21 - Tobacco products	0	0	0	147	565	94
22 - Textile mill products	0	0	0	86	410	259
23 - Apparel and other textile products	0	0	0	63	451	503
24 - Lumber and wood products	3,572	0	443	3,990	139	684
25 - Furniture and fixtures	0	0	0	135	117	164
26 - Paper and allied products	2,038	0	0	2,502	570	1,101
27 - Printing and publishing	0	0	0	544	1,095	1,132
28 - Chemicals and allied products	0	0	4,458	147	3,610	8,598
29 - Petroleum and coal products	0	0	14,027	4	111	14,706
30 - Rubber and misc plastic products	0	0	0	56	572	1,005
31 - Leather and leather products	0	0	0	3	24	41
32 - Stone, clay, and glass products	0	46,783	59,670	49	48,005	61,436
33 - Primary metal industries	0	0	1,375	27	6,589	5,532
34 - Fabricated metal products	0	0	0	29	465	655
35 - Industrial machinery and equipment	0	0	0	81	996	1,046
36 - Electronic and other electric equipment	0	0	0	58	1,189	1,088
37 - Transportation equipment	0	0	0	25	537	467
38 - Instruments and related products	0	0	0	138	1,497	1,416
39 - Miscellaneous mfg	0	0	0	65	188	221
40 - Railroads (and 4741)	0	0	0	6	334	113
41 - Local And Suburban Transit (incl IMPLAN 512)	0	0	0	61	3,268	2,557
42 - Trucking and warehousing (and part of 4789)	0	0	0	17	313	1,250
43 - Post office	0	0	0	7	146	277
44 - Water transportation	0	0	0	3	37	75
45 - Transportation by air	0	0	0	5	63	329
46 - Pipelines except natural gas	0	0	0	0	3	1
47 - Transportation services (except 4740)	0	0	0	9	27	39
48 - Communications	0	0	0	94	3,312	676
49 - Electric, gas, and sanitary services (Pub Uti	0	0	68,464	52	2,605	71,038
50,51 - Wholesale trade	0	0	0	334	1,596	1,959
52 - Building materials and garden supplies	0	0	0	5	55	61
53 - General merchandise stores	0	0	0	13	148	165
54 - Food stores	0	0	0	8	98	110
55 - Automotive dealers and service stations	0	0	0	21	245	275
56 - Apparel and accessory stores	0	0	0	22	263	295
57 - Furniture and home finishing stores	0	0	0	7	84	94
58 - Eating and drinking stores	0	0	0	360	1,258	1,241

59 - Misc retail	0	0	0	32	377	423
60 - Depository institutions (banking)	0	0	0	125	1,241	1,620
61,67 - Non-depository and holding (exclude nonpro	0	0	0	7	73	52
62 - Security and commodity brokers	0	0	0	31	484	323
63 - Insurance carriers	0	0	0	9	119	75
64 - Insurance agents, brokers, service	0	0	0	11	134	99
65 - Real estate	0	0	0	1,753	37,358	4,575
70 - Hotels and lodging	0	0	0	43	596	633
72 - Personal services	0	0	0	19	251	356
73 - Business services	0	0	0	162	1,276	1,248
75 - Auto repair, services, and parking	0	0	0	10	187	290
76 - Miscellaneous repair services	0	0	0	8	107	134
78 - Motion pictures	0	0	0	24	259	181
79 - Amusement and recreation services	0	0	0	116	941	709
80 - Health services	0	0	0	255	2,723	2,732
81: Legal services	0	0	0	36	369	214
82 - Educational services	0	0	0	81	2,308	432
83 - Social services	0	0	0	145	1,070	873
84,86 Non-profit organizations (plus some 67 & 89)	0	0	0	181	4,091	961
87,89 - Professional services	0	0	0	74	768	667