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Income and Expenditure Accounts Technical Series

The Natural Resources Satellite Account – Sources and methods

by Marco Provenzano and Conrad Barber-Duec



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- . not available for any reference period
- .. not available for a specific reference period
- ... not applicable
- 0 true zero or a value rounded to zero
- 0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
- ^P preliminary
- ^r revised
- X suppressed to meet the confidentiality requirements of the *Statistics Act*
- ^E use with caution
- F too unreliable to be published
- * significantly different from reference category ($p < 0.05$)

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The Natural Resources Satellite Account – Sources and methods

by Marco Provenzano and Conrad Barber-Dueck

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1 Overview

The natural resources sector is an important part of the Canadian economic landscape. It plays a significant role in Canada's economic growth, employment and investment. The development of new mines, energy sources, oil and gas reserves, as well as forest products, have led to the sector's increasingly important role in Canada's overall economic development. The sector is often an important driver of economic growth and is a key influence on regional economic performance. Given the importance of this sector, policymakers, researchers, businesses and households require comprehensive and timely statistics in order to assess the evolution, structure, role and contribution of this sector to the Canadian economy.

The Natural Resources Satellite Account (NRSA) is an expandable framework that can be used to present Statistics Canada's existing data holdings for the natural resource sector as well as provide increased detail for data users. This paper examines the data sources and methodology used in creating the NRSA.

Sections 2 and 3 provide overviews of both the Canadian System of National Accounts (CSNA) and Satellite Accounting. Section 4 defines natural resources in the context of the NRSA. Sections 5 and 6 present the annual and quarterly methodologies respectively.

2 The Canadian System of National Accounts

The foundation of the NRSA is the data contained within the CSNA. The CSNA is based on the 2008 System of National Accounts (2008 SNA), an internationally recognized framework used to measure economic activity within a country or region. The framework is used by countries throughout the world to record their production, incomes, investment, consumption, financial transactions and stocks of assets and liabilities. The data are organized into a sequence of accounts that articulate the change in wealth from one period to another by tracking the activities of economic agents (households, governments, corporations). The SNA provides a set of concepts, classifications and accounting rules for compiling and integrating data to give a comprehensive picture of the economy and how it works. Key measures that emerge from this framework include gross domestic product (GDP) at both basic and market prices, household disposable income, investment, capital stock, productivity, the balance of international payments and government debt.

The annual supply and use tables (SUT), formerly known as the input-output tables (IOT), produced by Statistics Canada, are the main source of information used to derive the annual NRSA estimates. These tables balance the total supply of all products in the economy with their uses. By definition, total supply must equal total demand for each product. The supply of a product can originate from domestic production or imports and is expressed in market prices (the price paid by the final consumer of the good); including margins for transport, trade, sales tax and tariffs. The various uses of a product include the utilization by businesses for the production of other goods or services (intermediate consumption), along with final consumption by households, government or non-profit institutions. Further, the product could be purchased as an asset for ongoing use in the production of other products (investment or gross fixed capital formation) or it can be exported.

At Statistics Canada, industries are defined by the North American Industry Classification System (NAICS); similarly, all products are catalogued by the North American Product Classification System (NAPCS). These classification systems are the building blocks for constructing the SUT, which in turn combines and modifies some of these industries and products. These are then called the Input Output Industry Classification (IOIC) and the Supply Use Product Classification (SUPC), formerly the Input Output Commodity Classification (IOCC).

Estimates of GDP can be calculated in three separate ways using the SUT: by production, by incomes and by final expenditures. These different calculations of GDP fit into the SNA sequence of accounts that begin with total output (production) and continue to articulate primary incomes generated in productive activity and final expenditures.

H Y dfcXi Wjcb a Yh cX expresses who produces the natural resource products and how they are produced. Estimates are calculated using the total output of the natural resource economy less its intermediate inputs. Output is the production of goods and services by the sector. Intermediate consumption refers to the goods and services the sector uses as material inputs into the production process. Other inputs include labour and capital.

H Y jbwca Y a Yh cX considers the generation of income. It sums all income originating from natural resource production, including both the return to capital (operating surplus) and labour (compensation of employees). In the case of unincorporated businesses, the return to capital and labour cannot be separated and therefore their income is referred to as mixed income. Taxes less subsidies on products and production are also included in this method, as they are part of the valuation of production at market prices.

H Y Yi dYbXjh fY a Yh cX sums all final expenditure on natural resources in the economy. These expenditures include final consumption of households, government and non-profit institutions. They also include investment in capital (gross fixed capital formation) and the change in inventory levels. Exports of natural resources minus any imports of inputs into the production process complete the calculation.

In the SUT, these GDP estimates, along with other data, are calculated in nominal terms. The effect of prices can also be removed so that the volume of economic activity can be observed.

3 Satellite accounts

One of the strengths of the CSNA lies within its flexibility. While the system lays out the concepts, accounts and accounting rigour required to produce a set of integrated and internally consistent set of accounts, it does afford the compiler the flexibility to vary and, in a sense, expand the framework to address a specific need. At the limit, this expansion is referred to as satellite accounting. There are essentially two types of satellite accounts that can be produced. One type of satellite account involves a rearrangement of the classifications or data (e.g., more detailed alternative aggregations) and possible addition of complementary information of the existing core accounts. These satellite accounts do not change the underlying concepts of the core CSNA but provide an expanded perspective on a particular sector, group of products or activity.¹ The second type of satellite account seeks to expand or supplement the underlying concepts of the core CSNA to study a topic of social interest. This could involve, for example, expanding the concept of production (e.g., including volunteer activities as production), consumption or capital formation. The NRSA falls into the first category, where concepts are consistent with the core CSNA, but additional detail and presentational changes are used to better identify and articulate the natural resource sector.

The development of the NRSA involves extracting detail related to natural resource activities from the core set of published CSNA data. The account follows the main principles, classifications and definitions of the core CSNA, ensuring it is directly comparable with the rest of the CSNA. From this account, therefore, it is possible to calculate a GDP for the natural resource sector comparable to total GDP—providing a measure of the sector's contribution to total economic activity. By using the same principles as those in the CSNA, the satellite account leverages an internationally accepted statistical framework and infrastructure. Examples of other macroeconomic aggregates directly comparable to the core framework include international exports and imports, gross fixed capital formation (investment), domestic demand and employment.

In addition to comparability and efficiency, the use of the CSNA infrastructure also provides a number of other advantages. A large array of data is already available at Statistics Canada to construct standard macroeconomic accounts and can be used as the starting point in the construction of the NRSA. The data has already gone through data quality validation and have been further integrated, reconciled and balanced in the process of producing the CSNA. This ensures that the data underlying the satellite account is equivalent in quality to Canada's core macroeconomic accounts.

The NRSA also provides a clear organizing framework for analysis of the natural resource sector. It clearly defines the sector and thereby presents a consistent set of numbers rather than a variety of estimates based on inconsistent concepts. The account goes beyond an industry perspective of the natural resource sector, rather using natural resource activities as its main organizing structure. As a result, the NRSA will eliminate industry production unrelated to natural resources and add in natural resource production that takes place in industries that aren't traditionally defined as natural resources (such as the production of refined precious metals in the miscellaneous manufacturing industry and the production of fuel wood in the agricultural crop industry).

4 Defining natural resources

The first step in creating the NRSA is to clearly define natural resource activity and to develop the corresponding classification systems. In doing so, two important factors to consider are:

- Does the definition align with international standards?
- Does the account serve the needs of users for policy or business decisions?

4.1 International definitions

It is important that the NRSA follows international standards to ensure data are not only comparable with the Canadian accounts but also internationally, as much as possible. Two key international definitions of natural resources come from the Organization for Economic Cooperation and Development (OECD) and The System of Environmental-Economic Accounting 2012—Central Framework (SEEA), the internationally accepted economic-environment accounting framework.

The OECD defines natural resources as: “Naturally occurring assets that provide benefits through the provision of raw materials and energy used in economic activity (or that may provide such benefits one day) and that are subject primarily to quantitative depletion through human use.”²

The SEEA defines natural resources as including “... all natural biological resources (including timber and aquatic resources), mineral and energy resources, soil resources and water resources. All cultivated biological resources and land are excluded from scope.”³

Moreover, the definition of energy is taken from Statistics Canada's Energy Statistics Framework that is based on the International Recommendations for Energy Statistics (IRES) established by the United Nations Statistical Division⁴. These frameworks follow the definitions above while more precisely defining the energy sub-sector, for example, treating all products produced within petroleum refineries to be energy, this includes such products as petrochemicals and asphalt.

4.2 Natural resources satellite account definition

With these definitions in mind, the NRSA defines natural resource activities as those which result in goods and services originating from naturally-occurring assets used in economic activity. These assets comprise mineral and energy resources, water, as well as natural timber, aquatic, and other natural biological resources, and may be renewable or non-renewable. As per international standards, they do not include intensively cultivated biological resources such as agricultural crops.⁵ To provide a more complete measure of the economic importance of the natural resource products, the services required in the extraction as well as the initial processing of natural resource inputs will be included. The activities related to the production of natural resource products constitute the scope of production for the NRSA.

In essence, the preceding definition splits the scope of natural resource activity into three processes: the extraction of the natural resource inputs, the services required to undertake this extraction (such as transportation, distribution and scientific services), and the initial processing of the resulting natural resource products.

The NRSA further breaks the sector down into 4 sub-sectors, namely:

- energy sub-sector;
- forest sub-sector;
- mineral and mining sub-sector and;
- hunting, fishing and water sub-sector.

4.3 Natural resource products

Using the above definition, the economic activities defined as being natural resource-related can be mapped out. This can be done from both a product and industry perspective. For products, the starting point is the SUT product classification, as these tables contain all the goods and services produced in the Canadian economy. The product classification structure is based on NAPCS.

4.3.1 Extractive natural resource products

From a product perspective, given the criteria to exclude intensely-cultivated biological resources, agricultural products such as crop or livestock production would not be included in the account, nor would aquaculture products (fish farms), fur farming or tree farms⁶. Commercial fishing from the ocean or inland lakes would be included, as would products from hunting and trapping, as well as goods produced from forestry and mining. The extraction of energy from natural resources (such as water, wind, solar, crude oil, and gas) would also be included. These products would constitute the natural inputs (extraction) portion of the account (see table 1).

4.3.2 Natural resource service products

As part of the process of extracting natural resource inputs, some service products are required that would not be produced in the economy without the extraction activity. As a result, they are included in the sector to provide a more complete picture of the size of the natural resource activity in the economy. Services related to the extraction or discovery and development of natural resources are included in this category, as well as any transportation of the natural resource product to the location of processing. As such, mineral exploration as well as pipeline transportation would be included as service products in this category. The transportation services provided in the forest and mining sub-sectors for the delivery of goods to the initial processing location (e.g., trucking and rail) should also be included as natural resource activities, but data for this service is not separately available at this time (see table 1). As data becomes available, this category will be included.⁷ Services related to research and development as well as legal, scientific and technical services are included, as are all other services that are required to create the product. Housing and accommodation services are excluded as they would exist regardless of the existence of the sector.

4.3.3 Initial processing products (primary manufacturing)

Similar to the case of natural resource service products, the initial processing of natural resource inputs, for the most part, would not be found in the economy without their initial extraction.⁸ As a result, the initial processing of natural resources is a clear extension of the extraction industry and is therefore included within the natural resource sector. These products are often classified as manufactured goods within the SUT framework since the processes physically transform inputs. As a practical implementation rule, manufacturing activity will only be included in the natural resource sector if over 50% of the material inputs into the production process are natural resource inputs (4.3.1).⁹

Initially, natural resources inputs such as logs and crude oil are identified. Secondly, each industry within the SUT framework is examined to determine if it meets the 50% criteria in its production process; these could be thought of as the “main” natural resource industries, although natural resource activity could also take place in other industries. As a final step, all products processed primarily in these industries are deemed to be natural resource products. The NRSA captures the production of these products regardless of whether they take place in the main natural resource industries or outside of them (see table 3 for a list of specific natural resource industries)¹⁰.

This definition results in the inclusion of manufacturing activities such as sawmill activity and the refining of ores and oil in the NRSA. Further downstream processes using the refined products, for example, wood furniture and manufactured metal products, are not in scope for the core NRSA, but are presented in a supplementary “downstream” table (see table 1 and 2).

With advances in technology, new natural resource products are being developed and new uses are being found for traditional by-products or waste products from natural resource product manufacturing. For example, lignin was once considered a by-product of producing pulp and is now being used as an important building block for bio-products. Unfortunately, data on lignin and other new natural resource products are not easily accessible at this time. It is not known where in the NAICS or NAPCS they have been included; although included in the scope of the NRSA, they have not been included in the estimates as reliable data currently does not exist within Statistics Canada. Going forward, attempts will be made to fully capture these activities as new data sources become available. The Cleantech Satellite Account (CTSA), which is currently under development, will likely be used to fill in some of these gaps. Once estimates are available, they will be incorporated into the NRSA.

4.3.4 Downstream activities (secondary and tertiary production)

Although not part of the core account, natural resources have important downstream effects on other sectors. These products fall outside of the definition of the natural resources sector but are nonetheless important in understanding the role of natural resources in the Canadian economy. They include such items as iron pipes, copper and aluminium tubing, cutlery, wood and kitchen cabinets. Measurements have been made for these activities which are presented in a downstream supplement to the NRSA account. In general, secondary production uses a large portion of primary manufactured products as inputs. These secondary products are then used in the production processes of tertiary products. The economic contribution of these products are calculated at the request of Natural Resources Canada. These products, however, are not part of Statistics Canada's main natural resources calculations.

4.4 Natural resource industries

Within the industry classifications of the SUT, there is no single industry that comprises all natural resource activities, rather, the economic activity attributable to natural resources is found in many industries. For the purposes of the satellite account, natural resource industries can be defined as those in which more than half of the total output originates from the production of primary natural resource inputs as described in section 4.3.1. It also includes industries in which at least half of the material inputs in the production process are natural resource inputs. For example, the logging industry chiefly produces SUPC commodity MPG113001 – Logs, a natural resource commodity and therefore is a natural resources industry. The main products derived from these industries are then considered natural resource products (4.3). Downstream industries are those in which 50% of material inputs are either primary or secondary manufactured products.

It is important to note that only the activity within an industry that is attributable to natural resource product production is included in the NRSA. Therefore, if the forest industry produces both logs and provides housing for its employees, only the natural resource activity (production of logs) will be included.

Further, some non-natural resource industries may produce natural resource products. This economic activity is also included in the account. For example, an agriculture chemical manufacturer may produce some electricity internally as part of their primary production process. Although the manufacturer's total output would not be included in the energy sub-sector, its production of electricity would. Another example concerns the production of refined precious metals in the "other miscellaneous manufacturing" industry; this production would be included in the mineral and mining sub-sector. Other outputs from the miscellaneous manufacturing industry, such as sporting and athletic goods, will be excluded. An example of this, using electricity GDP, is presented in table 4.

In this way, the NRSA goes beyond a simple industry perspective of natural resources and seeks to accurately identify natural resource activities within the Canadian economy.

4.5 Natural resource sub-sectors

The natural resource sector will be split into four distinct sub-sectors: forest, energy, minerals and mining, as well as hunting, fishing and water. SNA and NRSA concepts will be applied consistently across the four sub-sectors, with the aggregation forming the total natural resources sector. The sub-sectors are each a cross-section of products and industries (see table 1).

For example, the forest sub-sector includes the natural inputs, services and processing products related to forestry, this activity occurs across several IOIC industries.

One complication of the sector presentation is that in some cases products and industries may be classified to more than one sub-sector. The three chief examples in the NRSA are coal and uranium mining that are included in the energy and mining sub-sectors, as well as the extraction of fuel wood, in both the energy and forest sub-sectors. Under Statistics Canada's SUT classification systems, fuel wood is considered an energy product, which is primarily produced within the forest-related industries. Similarly, coal and uranium are considered energy products produced in mining industries. For the purposes of aggregation, each of these products will be assigned to sub-sectors based on their industry classification. That is to say, fuel wood will primarily be considered part of the Forest sub-sector and coal and uranium will be primarily considered part of the mineral and mining sub-sector. In order to accommodate the cross-cutting nature of these activities, the tables in the NRSA present the energy sub-sector both with and without these specific products.

5 Creating the annual estimates

The NRSA provides both quarterly and annual estimates of economic activity attributable to natural resources in Canada. Annual estimates, which are presented in this section, are created first. Section 6 reviews the quarterly methodology and how those estimates link to their annual counterparts. In creating annual data, extended use is made of Statistics Canada's SUT.

5.1 The Canadian system of national accounts and the supply-use tables

The NRSA estimates rely heavily on the SUT of the CSNA. These tables provide the most comprehensive and detailed economic data by product and by industry in the CSNA for benchmarked years¹¹. Their compilation involves the integration and the reconciliation of economic information from a wide array of survey and administrative data sources.¹²

The SUT present three main tables, namely the Output, Input and Final Demand tables (see figure 1). Taken together, these tables show the production of goods and services, the generation of income from the production process, and the flows of goods and services through the economic system between producers and consumers.

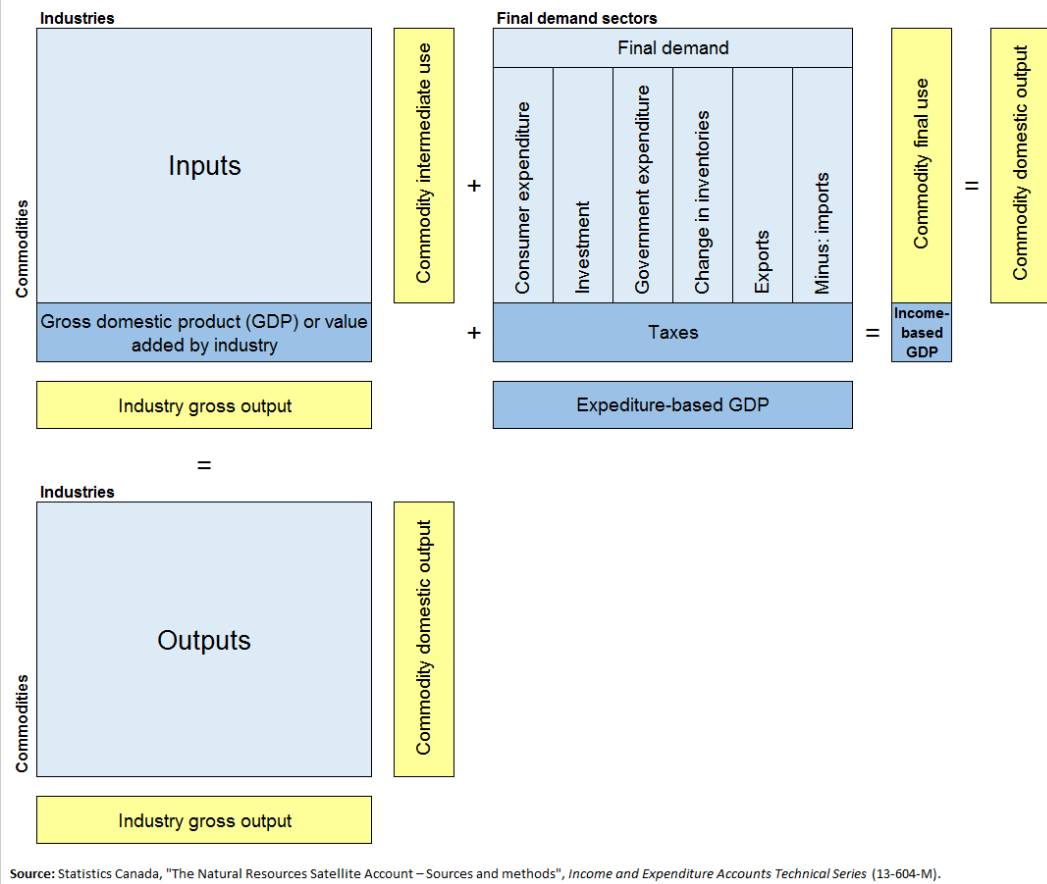
H Y Ci hdi h HVY is where the values of production of goods and services are recorded for each industry in the economy. In most cases, domestic production or output of an industry is simply its sales or shipments measured at producer prices. Estimates of the supply of natural resource products in the NRSA would come from this table.

H Y bdi h HVY is where the purchases of various product inputs into production are presented for each industry in the economy. This table also shows the costs of "primary inputs" to production, including labour income, income of unincorporated businesses, other operating surplus and net indirect taxes. The estimates of GDP due to natural resources are based on the data reported in this table.

Lastly, **H Y: jbu' 8 Ya UbX' HVY** shows expenditures on goods and services that are for final use (i.e., consumed, used as capital investment or exported). While all purchases by households (persons) and government are considered final consumption in the SNA, businesses make purchases both as intermediate and as final expenditure.

Two broad classifications are used in the SUT to specify both products and industries.¹³ At the most detailed level 473 products and over 235 industries are specified.

Figure 1 The structure of the supply-use tables



Box 1 Balancing industry and product accounts in the SUT

One of the most important accounting identities (or constraints) found in the SUT is that supply must equal demand for each product (each good or service). In other words, the sum of the expenditures on a particular product must equal the revenues generated from sales (taking into account exports and imports). Similarly, there is an additional constraint that each industry's total output (revenues) must equal its total inputs (costs).

In practice, due to limitations of the statistical system, these identities are not always satisfied. For instance, data obtained from surveys or administrative sources provide different estimates for the same phenomenon, have different levels of quality, may contain reporting errors and may not provide complete coverage, and so on. Ensuring that the data jointly satisfy both of these accounting identities through an iterative process referred to as the balancing of industry and product accounts is an integral part of compiling the SUTs.

Certain rules of consistency are followed during this process. For example, in the balancing of the industry account, the ratios of GDP, surplus, mixed and labour income, indirect taxes and material, energy and service inputs to gross output are all checked for consistency for each industry. Balancing the product account entails a similar set of consistency checks. The balancing process overall is a rigorous test for coherency across all the data that goes into the SUT. With each iteration, data inconsistencies are revealed, the reasons for them are identified and corrective steps are taken to reconcile the data. Balanced supply-use estimates are produced three years after the reference period.

5.2 Annual NRSA benchmarks

As a first step in creating the NRSA, benchmark annual data is compiled. The main source of data for these benchmarks are the detailed SUT presented in the previous section. From these SUT, a production and generation of income account, as well as an expenditure account and the associated GDP estimates, can be created for benchmarked years.

5.2.1 Production and generation of income accounts

The first accounts in the sequence of national accounts are the production and the generation of income accounts. The balancing entries of both these accounts will provide an estimate of GDP for the natural resource sector. The structures of the accounts are shown in table 5 and table 6.

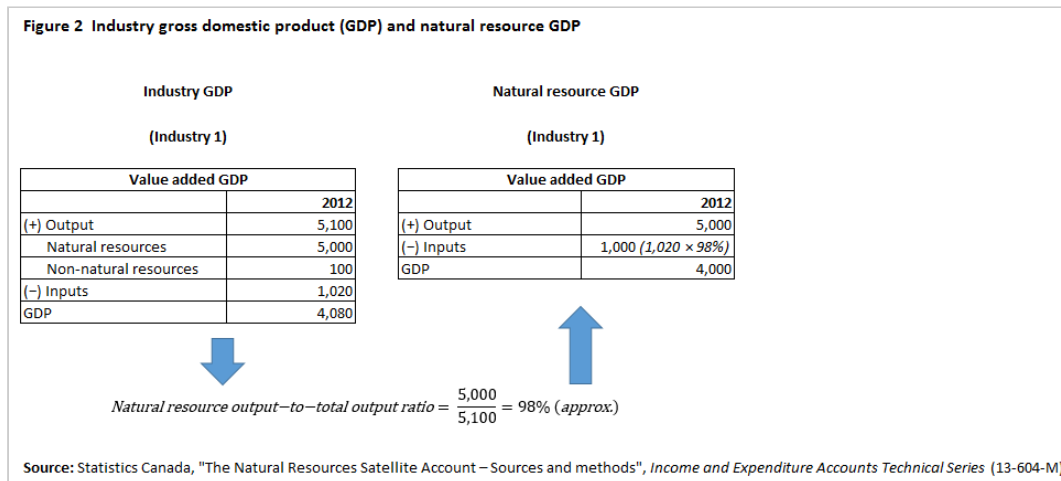
5.2.2 Natural resource GDP vs. industry GDP

As shown in table 5, there is certain output produced by natural resource industries that wouldn't be considered natural resource products. An example of this would be a forestry and logging company that manufactures its own saws. The production of logs by this company would be included in natural resource GDP while the production of saws would be included in the industry's GDP but not in the industry's natural resource GDP.

The opposite of this case would be non-natural resource industries, such as the automotive and textile manufacturing industries, that produce some natural resource output as part of their normal production processes (for example, by producing their own electricity). This output would also be included in the NRSA.

In order to calculate natural resource GDP, we must assume that the production function of the industry is the same for each product. In other words, we assume that both natural resource and non-natural resource products have the same inputs and they are used in the same proportions. This assumption is necessary because more detailed data is not available. Fortunately, the assumption has little impact on the estimates since, in most cases, natural resource products comprise over 95% of the total industry.

With this assumption in place, a natural resource output-to-total output ratio can be applied to both intermediate inputs and primary inputs. This, in turn, allows for the measurement of GDP for natural resource activity to be separated from non-natural resource activity for each industry in the Canadian economy.



This process of calculating both a production and income-based GDP is carried out for each industry and then aggregated up. By doing so, a calculation can be made for the production and income account along with a GDP estimate of each of the natural resource sub-sectors and for the economy-wide impact of natural resources (see table 7).

5.2.3 Expenditure-based GDP

When the SUT are presented on a product basis, an expenditure account can be created. This will yield a third estimate of GDP, namely expenditure-based GDP. Table 8 shows the structure of the expenditure account.

$$\textit{Expenditure – based GDP} = \textit{Final demand} + \textit{Inventory} + \textit{Exports} – \textit{Imports}$$

5.2.4 Expenditure adjustments

In theory, GDP derived from all three approaches should be identical. In practice, some adjustments must be made to the data to ensure this identity.

5.2.4.1 Final demand adjustment

The production of natural resource products are used as inputs into the production process of many non-natural resource final outputs, such as cars and other manufactured final products. In order to get a full measure of expenditure on natural resource products, part of the expenditure on these other commodities must be included. In practice, this is done by treating the intermediate inputs to non-natural resource industries as flows leaving the sector, which is similar to final demand or exports (see table 9).

5.2.4.2 Input adjustment

The production process for natural resources includes inputs that come from outside of the sector. For example, the process of extracting resources from the ground requires various machines and different types of gases and chemicals. These inputs, since they originate from outside of the natural resource “economy”, are treated similarly to imports in the production process. As a result, they are removed from the expenditure based GDP calculation. This is the exact opposite of the final demand adjustment.

5.2.4.3 Net adjustment

The net of these two adjustments are added to the expenditure GDP calculation to arrive at a natural resource GDP number consistent with the production and income approaches to calculating GDP.

$$\textit{Net expenditure embedded in non-natural resource products} = \textit{Expenditure adjustment} - \textit{Input adjustment}$$

This adjustment represents the net expenditure on non-natural resources products that are imbedded in natural resource GDP.

5.2.4.4 Margins

The production and income-based GDP approaches measure economic activity at basic prices, while expenditure-based GDP is measured at market prices. In order to get all three GDP figures on the same basis, margins must either be removed from expenditures or added to production and income.

Box 2 Basic prices versus market prices

6 U_gW dfJW_g. The amount actually received by the producer from the purchaser for each unit of the good or service produced as output, before any taxes levied on products have been added and before any subsidies received on products have been subtracted. It also excludes any transportation or other margins that are invoiced separately by the producer.

A U_f_Y_h dfJW_g: # Di fW U_gYfgD dfJW_g. The actual costs incurred by users of the product. Purchasers' prices are measured after any taxes paid on products have been added and after any subsidies on products have been deducted. They include any transportation or other margins paid separately by the purchaser to take delivery of the product.

Note: for further detail, see User Guide: Canadian System of Macroeconomic Accounts, Chapter 4 Supply and Use Accounts.

5.2.4.5 Applying the adjustments

In order to ensure the identity that all three GDP measures must be equal, the adjustments presented previously are applied to expenditure-based GDP. Firstly, the "net expenditure on natural resource products embedded in non-natural resource products" is added to expenditures. The addition of this adjustment will yield an expenditure GDP at market prices consistent with the production and income approaches. Secondly, in order to get expenditure GDP on the same basis as production and income GDP, it is converted from market prices to basic prices. This is done by removing margins from the estimate (see table 10).

5.2.5.6 Employment

Employment numbers are derived from the national accounts labour productivity data¹⁴. This dataset contains the number of jobs (both part time and full time) by detailed IOIC industry. In order to derive a natural resource employment number, the number of jobs in each industry is multiplied by the natural resource output ratio, which was previously derived.

$$\text{Natural resource employment}_x = \text{Number of jobs}_x \times \text{Natural resource output ratio}_x$$

$$\text{Total natural resource employment} = \sum_{x=1}^x (\text{Natural resource employment}_x)$$

where $x = \{\text{IOIC}\}$

5.3 Current year estimates

The benchmark estimates, once created, are pushed forward to the most current year. This is done using a variety of data sources at a detailed commodity and industry level. Some of the main sources are presented in section 5.3.1 and 5.3.4. Balancing adjustments, as presented in box 1, are also applied at this stage.

5.3.1 Production account

In the production account, current year estimates need to be created for production, intermediate consumption and gross value added GDP.

Production estimates are derived from a variety of sources both internal and external to Statistics Canada. Energy data is derived mainly from supply-disposition tables for various commodities, pipeline statistics, and energy production statistics¹⁵ along with relevant price indices (such as the IPI, CPI and RMPI).¹⁶ Mining data mainly comes from Natural Resources

Canada products and surveys,¹⁷ while forestry data comes from various lumber and forestry surveys.¹⁸ These estimates are confronted and reconciled with internal work done in the production of quarterly and annual GDP estimates.

GDP is derived from internal estimates of current year GDP growth rates by industry and commodity, as well as with monthly and annual industry GDP, while intermediate consumption is taken as a residual in order to balance the production account.

5.3.2 Generation of income account

The generation of income account variables are carried forward using estimates from national accounts labour productivity data¹⁹, surplus estimates from the national economic accounts as well as internal estimates. This data is then benchmarked to the GDP estimates derived in the production account.

5.3.3 Expenditure

Lastly, expenditure estimates are carried forward to current years. This is done at a detailed level for exports, imports, final demand, intermediate consumption and inventories. Trade data is derived from HS level customs data and from merchandise trade estimates published by Statistics Canada²⁰. Final demand, intermediate consumption, inventories and margins are derived from internal estimates used in the production of quarterly and annual GDP.

5.3.4 Employment

Employment data is derived from labour productivity data²¹. Where data is missing from this source, it is supplemented using the survey of employment, payrolls and hours (SEPH)²².

5.4 Adjusting the expenditure estimates for price

Including the expenditure-based GDP estimates comes with one very important feature, namely the ability to calculate constant dollar GDP estimates for each of the natural resource sub-sectors. This measure removes the effect of price changes (either inflation or deflation) from the estimates and leaves the volume of the product produced. For example, an oil producer may have earned \$200 of revenue in consecutive years. This is a current (nominal) dollar estimate. However, the producer may have generated one hundred barrels of oil one year and two hundred the next. So, although the revenue stayed the same over the two years, the volume of their production would have doubled. GDP in constant dollars measures this second case and is a volume measure. Both calculations provide important economic information.

GDP values from the expenditure account are deflated using two main sources. Firstly, price indices (either CPI, RMPI or IPI)²³ are used to deflate the GDP estimates for each sub-sector and commodity detail. Secondly, where possible, these estimate are compared to real GDP values by industry from the monthly GDP program²⁴.

6 Creating the quarterly estimates

Once the annual NRSA is complete, the quarterly series are created using the annual as a benchmark. This is done in two separate phases: firstly, the back periods are distributed on a quarterly basis and, secondly, the quarterly series for the back periods are pushed forward to the most recent quarter (published 90 days after the reference period). The quarterly data is not as detailed as the annual due to data limitations. The variables produced for this program are: production, GDP (nominal); exports, imports and employment.

6.1 Distribution of the annual data by quarter

The first step requires that the annual benchmarked data be distributed quarterly. In doing this, distributor series (on a quarterly basis) are obtained from various sources both internal and external to Statistics Canada (See table 12).

Once the series are obtained, they are benchmarked to the annual totals. This is done using a variation of the proportional Denton method as described in the IMF manual on national accounting²⁵. This will ensure that the quarterly series will have growth rates that match the indicator series as closely as possible while maintaining the constraint that the sum of the quarterly data for each year is equal to the annual benchmark totals. The formulation of the method is shown below (extra detail can also be found in the IMF SNA benchmarking guidelines). In practice, the benchmarking is done using in-house software²⁶

$$\min_{(x_1 \dots x_T)} \sum_{t=2}^T \left[\frac{x_t}{I_t} - \frac{x_{t-1}}{I_{t-1}} \right]^2 \quad t \in \{1, \dots, 4T\}$$

$$\text{subject to: } \sum_{t \in y} x_t = A_y \quad \{y = 1, \dots, T\}$$

where t = Time (4y = Q4 of year y and 4y - 3 = Q1 of year y),

x_t = Quarterly benchmarked series,

I_t = Indicator series,

A_y = Annual total for year y,

T = Last year of annual data

6.2 Current quarter estimates

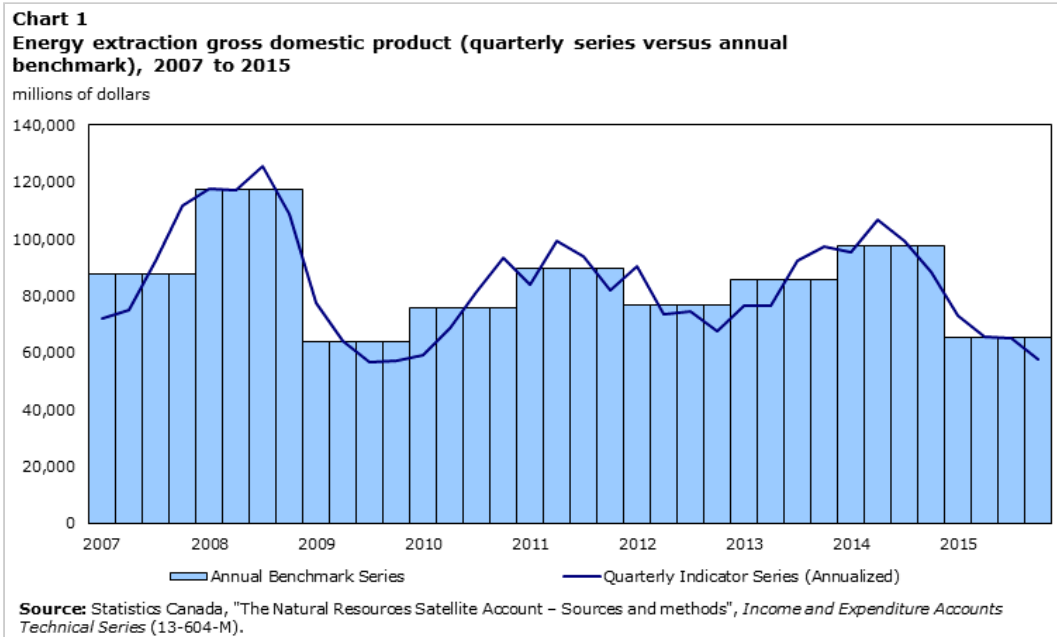
The second step is to extend the quarterly data to the most recent periods using the same indicators from table 12. This is done using explicit forecasts based on the indicator series and will yield quarterly data that is available 90 days after the reference period.

$$x_t^{\text{unbenchmarked}} = x_{t-1} \times \left[1 + \frac{I_t}{I_{t-1}} \right]$$

where t = Time (quarterly),

X_t = Quarterly series,

I_t = Indicator series



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Notes

1 Examples of this type of satellite account include the Tourism Satellite Account and the Culture Satellite Account, both produced by Statistics Canada.

2 OECD Glossary of Environment Statistics.

3 SEEA p27, 2.101

4 A Statistical Framework for Energy in Canada.

- 5 However, it should be noted that globally, timber is often intensively cultivated, and the use of high-yield or genetically enhanced plantations growing in key forest product exporting countries such as the United States, New Zealand, and Brazil. Plantations have yet to take hold economically in Canada, but the relationship between the forest sector and what is considered natural resource products may need to be revisited in the future should circumstances change.
- 6 See footnote 5.
- 7 One possible solution would be to use the transportation margins associated with each product as a proxy for the transportation industry.
- 8 A natural resource could be imported and processed domestically. However, this does not seem to be the case for the majority of products in Canada. One notable exception is bauxite, which is used in aluminium production.
- 9 For the energy industry, use is made of Statistics Canada's energy statistics framework, which is based on IRES.
- 10 This process will occasionally be repeated to ensure proper coverage, however, in-scope products and industries are not expected to change from year to year.
- 11 Final SUTs are produced three years after the reference period in November of that year.
- 12 See box 1 for an explanation of the IO benchmarking process.
- 13 The industry classification used in the SUT is a special aggregation of the North American Industry Classification System (NAICS), while the product classification is a special aggregation based on the North American Product Classification (NAPCS).
- 14 CANSIM table 383-0008 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3830008).
- 15 CANSIM tables 135-0001 (www.statcan.gc.ca/cansim/a05?lang=eng&id=1350001) , 135-0002 (www.statcan.gc.ca/cansim/a05?lang=eng&id=1350002) , 129-0002 (www.statcan.gc.ca/cansim/a05?lang=eng&id=1290002) , 133-0002 (www.statcan.gc.ca/cansim/a05?lang=eng&id=1330002) , 129-0003 (www.statcan.gc.ca/cansim/a05?lang=eng&id=1290003) , 134-0004 (www.statcan.gc.ca/cansim/a05?lang=eng&id=1340004) .
- 16 IPPI = Industrial Product Prices Index (CANSIM table 329-0075 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3290075)), CPI = Consumer Price Index (CANSIM table 326-0020 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3260020)), RMPI = Raw Materials Price Index (CANSIM table 380-0008 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3800008)).
- 17 NRCan mining data (<http://www.nrcan.gc.ca/mining-materials/statistics/8850>).
- 18 CANSIM tables 303-0064 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3030064) , 303-0065 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3030065) .
- 19 CANSIM table 383-0008 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3830008) .
- 20 CANSIM table 228-0059 (www.statcan.gc.ca/cansim/a05?lang=eng&id=2280059) .
- 21 CANSIM table 383-0008 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3830008) .
- 22 CANSIM table 281-0047 (www.statcan.gc.ca/cansim/a05?lang=eng&id=2810047) .

23 IPPI = Industrial Product Prices Index (CANSIM table 329-0075 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3290075)), CPI = Consumer Price Index (CANSIM table 326-0020 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3260020)), RMPI = Raw Materials Price Index (CANSIM table 380-0008 (www.statcan.gc.ca/cansim/a05?lang=eng&id=3800008)).

24 CANSIM table 379-0031 (www.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3790031&&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=) .

25 International Monetary Fund (IMF). (2001). "Quarterly National Accounts Manual: Chapter 6, Benchmarking". Washington

26 Fortier, S. and B. Quenneville (2007). "Theory and Application of Benchmarking in Business Surveys", ICES III proceedings, Introductory Overview Lecture at the International Conference on Establishment Surveys III, June 2007.

Table 1

In-scope products

Category	Products
Energy sub-sector	
Extraction	
Crude oil	<ul style="list-style-type: none"> • Conventional and synthetic crude oil • Crude and diluted bitumen
Natural gas	<ul style="list-style-type: none"> • Natural gas • Natural gas liquids and related products
Other	<ul style="list-style-type: none"> • Fuel wood • Coal • Radioactive ores and concentrates
Services	<ul style="list-style-type: none"> • Support services • Exploration • Natural gas distribution • Transportation via pipeline • Other services (legal, accounting, etc.)¹
Primary manufacturing	
Utilities	<ul style="list-style-type: none"> • Electricity (including distribution) • Steam and heated or cooled air supply services
Refined petroleum products	
Fuels and lubricants	<ul style="list-style-type: none"> • Gasoline • Diesel • Light fuel • Jet fuel • Heavy fuel • Lubricants and other refinery products
Petrochemicals	<ul style="list-style-type: none"> • Petrochemicals
Other primary manufacturing ²	<ul style="list-style-type: none"> • Asphalt and asphalt products • Coke and coke oven products • Other petroleum and coal products (non-refinery)
Biofuels	<ul style="list-style-type: none"> • Biofuels
Forest sub-sector	
Extraction	<ul style="list-style-type: none"> • Logs • Pulpwood • Fuel wood • Rough untreated poles, posts and piling
Services	<ul style="list-style-type: none"> • Support services for forestry • Custom work, agriculture • Other services (legal, accounting, etc.)¹
Primary manufacturing	
Primary sawmill and wood products	<ul style="list-style-type: none"> • Hardwood lumber • Softwood lumber • Wood chips • Other sawmill and treated wood products • Veneer and plywood • Engineered wood members and trusses • Reconstituted wood products • Waste and scrap of wood, wood by-products

Primary pulp and paper products	<ul style="list-style-type: none"> • Wood pulp • Paper (except newsprint) • Newsprint • Paperboard
Bio-products	<ul style="list-style-type: none"> • Bio-products
Mineral and mining sub-sector	
Extraction	
Metallic minerals	<ul style="list-style-type: none"> • Iron ores and concentrates • Gold and silver ores and concentrates • Copper ores and concentrates • Nickel ores and concentrates • Lead and zinc ores and concentrates
Non-metallic minerals	<ul style="list-style-type: none"> • Stone • Sand, gravel, clay, and refractory minerals • Uncut diamonds • Potash • Non-metallic minerals (except diamonds)
Coal	<ul style="list-style-type: none"> • Coal
Services	<ul style="list-style-type: none"> • Support services for mining and quarrying • Mineral exploration • Other services* (legal, accounting, etc.)
Primary manufacturing	
Primary metallic minerals products	<ul style="list-style-type: none"> • Iron and steel basic shapes and ferro-alloy products • Bauxite and aluminum oxide • Aluminum and aluminum-alloy ingots and billets • Aluminum and aluminum-alloy semi-finished products • Basic non-ferrous metal products (except aluminum) • Waste and scrap of non-ferrous metals • Refined copper and copper alloys • Refined nickel and nickel alloys • Refined precious metals and precious metals alloys • Other refined non-ferrous metals and non-ferrous metal alloys
Primary non-metallic minerals products	<ul style="list-style-type: none"> • Clay products and refractories • Glass and glass products • Waste and scrap of glass • Cement • Ready-mixed concrete • Concrete products • Lime and gypsum products • Non-metallic mineral products, not elsewhere classified
Hunting, fishing and water sub-sector	
Extraction	<ul style="list-style-type: none"> • Raw furskins, and animal products n.e.c. • Fish, crustaceans, shellfish and other fishery products
Services	<ul style="list-style-type: none"> • Water delivered by water works and irrigation systems • Sewage and dirty water disposal and cleaning services
Primary manufacturing	<ul style="list-style-type: none"> • Bottled water, soft drinks and ice (water and ice only)
<p>1 Other services includes such commodities as MPS541600 – Management, scientific and technical consulting services and MPS541100 – Legal Services which take place within each specific sub-sector. It also includes the own consumption of software design and research and development services. This excludes services that would be produced in the economy without the presence of each sector (for example housing and accommodation services).</p> <p>2 As per the IRES and the Energy Statistics Framework, all products primarily produced in petroleum refineries are considered energy.</p> <p>Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).</p>	

Table 2

Downstream (secondary and tertiary) products

Category	Products
Downstream forest sub-sector	
Secondary wood products and furniture	<ul style="list-style-type: none"> • Wood windows and doors • Prefabricated wood buildings, components and other miscellaneous wood products • Wood containers and pallets • Other wood millwork products • Wood kitchen cabinets and counter tops • Household furniture (wood) • Office furniture (wood)
Secondary paper products	<ul style="list-style-type: none"> • Paperboard containers • Paper stationery products • Disposable diapers and feminine hygiene products • Sanitary paper products • Other converted paper products • Waste and scrap of paper and paperboard
Services and custom work	<ul style="list-style-type: none"> • Custom work, other manufacturing production services (wood)
Secondary bio-products	<ul style="list-style-type: none"> • Secondary bio-products
Downstream mineral and mining sub-sector	
Secondary metal products	<ul style="list-style-type: none"> • Iron and steel pipes and tubes (except castings) • Rolled and drawn steel products including wire • Foundry products
Tertiary metal products	<ul style="list-style-type: none"> • Forged and stamped products • Cutlery and hand tools • Architectural and structural metal products • Boiler, tank and shipping containers • Hardware • Spring and wire products • Machine shop products • Other Fabricated Products
Other metal products	<ul style="list-style-type: none"> • Communication and energy wire and cable • Motor vehicle metal stamping and brakes
Services	<ul style="list-style-type: none"> • Coating, engraving, heat treating and similar metal processing services • Custom work, other manufacturing production services (metal)
Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).	

Table 3

Natural resource and downstream industries

	Input Output Industry Classification industry code
Natural resource industries	
Energy industries	
Conventional oil and gas extraction	BS211113
Non-conventional oil extraction	BS211114
Coal mining	BS212100
Other metal ore mining	BS212290
Support activities for oil and gas extraction	BS21311A
Electric power generation, transmission and distribution	BS221100
Natural gas distribution	BS221200
Petroleum refineries	BS324110
Crude oil and other pipeline transportation	BS486A00
Pipeline transportation of natural gas	BS486200
Mineral and mining industries	
Iron ore mining	BS212210
Gold and silver ore mining	BS212220
Copper, nickel, lead and zinc ore mining	BS212230
Stone mining and quarrying	BS212310
Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying	BS212320
Diamond mining	BS212392
Other non-metallic mineral mining and quarrying (except diamond and potash)	BS21239A
Potash mining	BS212396
Support activities for mining	BS21311B
Non-metallic mineral product manufacturing (except cement and concrete products)	BS327A00
Cement and concrete product manufacturing	BS327300
Alumina and aluminum production and processing	BS331300
Non-ferrous metal (except aluminum) production and processing	BS331400
Forest industries	
Forestry and logging	BS113000
Support activities for forestry	BS115300
Sawmills and wood preservation	BS321100
Veneer, plywood and engineered wood product manufacturing	BS321200
Pulp, paper and paperboard mills	BS322100
Hunting, fishing and water industries	
Fishing, hunting and trapping	BS114000

Water, sewage and other systems	BS221300
Downstream industries	
Downstream mining industries	
Iron and steel mills and ferro-alloy manufacturing	BS331100
Steel product manufacturing from purchased steel	BS331200
Foundries	BS331500
Forging and stamping	BS332100
Cutlery, hand tools and other fabricated metal product manufacturing	BS332A00
Architectural and structural metals manufacturing	BS332300
Boiler, tank and shipping container manufacturing	BS332400
Hardware manufacturing	BS332500
Spring and wire product manufacturing	BS332600
Machine shops, turned product, and screw, nut and bolt manufacturing	BS332700
Coating, engraving, heat treating and allied activities	BS332800
Downstream forest industries	
Other wood product manufacturing	BS321900
Converted paper product manufacturing	BS322200
Household and institutional furniture and kitchen cabinet manufacturing	BS337100
Office furniture (including fixtures) manufacturing	BS337200
Other furniture-related product manufacturing	BS337900
Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).	

Table 4

Electricity gross domestic product by industry , 2012

	Electricity GDP
	millions of dollars
Total natural resources sector	28,405,116
Energy industries	28,096,218
Mineral and mining industries	93,687
Forest industries	59,829
Other natural resource industries	100,440
Downstream mining and forest industries	5,811
Non-natural resource industries	49,130

Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).

Table 5

Production account

	Industry 1	Industry 2	Industry 3	Industry n	Total
Output					
Natural resource product 1					
Natural resource product 2					
Natural resource product 3					
Natural resource product n					
Non-natural resource products					
Inputs					
Gross value added					

Note: Industries 1, 2, 3, up to n are fictitious examples for illustrative purposes only.
 Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).

Table 6

Generation of income account

	Industry 1	Industry 2	Industry 3	Industry n	Total
(-) Taxes less subsidies					
(+) Compensation of employees					
(+) Gross mixed income					
(+) Gross operating surplus					
Gross value added					

Notes: This table is a template showing the general structure of the account.
 Industries 1, 2, 3, up to n are fictitious examples for illustrative purposes only.
 Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).

Table 7

Production and income accounts for the Natural Resources Sector , 2012

	Industry 1	Industry 2	Industry 3	Industry n	Total
	millions of dollars				
Total natural resources account					
Production account					
(+) Output	5,000	100,000	25,000	10,000	481,445
(-) Inputs	1,000	50,000	5,000	2,000	264,089
Gross value added / gross domestic product	4,000	50,000	20,000	8,000	217,356
Generation of income account					
Taxes less subsidies	50	2,000	750	100	6,702
Compensation of employees	500	14,000	7,750	1,000	67,348
Mixed income	200	300	250	400	1,370
Surplus	2,800	24,700	8,000	5,600	141,936
Gross value added	4,000	50,000	20,000	8,000	217,356

Note: Industries 1, 2, 3, up to n are fictitious examples for illustrative purposes only. The total corresponds to the actual Natural Resources Satellite Account values.
Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).

Table 8

Expenditure account and gross domestic product

	Forestry products	Mining products	Energy products	Fishing, hunting and water products	Natural resources
Expenditure GDP in current dollars ¹					
Final demand					
(+) Inventories					
(+) Exports					
(-) Imports					
GDP at market prices					
(-) Margin adjustment					
GDP at basic prices					

1 Expenditure GDP = Final demand + Inventory + Exports - Imports

Note: This table is a template showing the general structure of the account.

Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).

Table 9
Final demand adjustment ¹ for logs, 2012

	Use of logs
	millions of dollars
Input	
Sawmills and wood preservation	4,623
Pulp, paper and paperboard mills	716
Other non-forestry industries	1,331
Final demand	
Final demand	0
Inventory	113
International exports	633
<p>1 Final demand adjustment = Input into non-forestry industries = 1,331</p> <p>Notes: According to the Supply-Use table for logs, there is no "final demand". All logs are either exported, held in inventories or used in the production process of another industry. To avoid double counting, inputs into other industries are excluded when calculating GDP. However, because the NRSA is only considering the Forest sector, inputs into Non-forest industries should in fact be considered as "final demand" for this industry and not "intermediate inputs". To do this, the inputs of logs into Non-forest industries are added to GDP. This accounts for the forest portion of non-forest products (In practice, this is added as a "net adjustment" (see Section 5.2.4.3)).</p> <p>Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).</p>	

Table 10

Calculating expenditure-based GDP for the natural resources sector , 2012

	2012
	millions of dollars
Expenditure GDP	
Final demand	92,186
Inventories	2,004
(+) Exports	205,588
(-) Imports	103,995
Net expenditure embedded in non-natural resources products	93,827
Expenditure GDP (market prices)	289,611
(-) Margins	72,255
Expenditure GDP (basic prices) ¹	217,356
Value added GDP	217,356
Income GDP	217,356
<p>1 Expenditure GDP at basic prices = value added GDP = Income GDP = \$217,356 million in 2012.</p> <p>Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).</p>	

Table 11

Expenditure-based gross domestic product for natural resources, 2009 to 2012

	2009	2010	2011	2012
	millions of dollars			
Gross domestic product (GDP) at basic prices	170,035	199,832	230,415	217,356
Implicit GDP deflator (in percent)	92	101	113	107
Real GDP at basic prices	184,453	196,905	204,335	202,912

Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).

Table 12

Quarterly indicator series

Quarterly variable	Indicator
Production	<ul style="list-style-type: none"> • StatCan supply-disposition tables for energy commodities • NRCan mining data • Price indices (RMPI, IPPI) • Monthly manufacturing surveys
GDP	<ul style="list-style-type: none"> • Monthly industry GDP • Various production measures
Export and imports	<ul style="list-style-type: none"> • Quarterly international merchandise trade data • HS trade data
Employment	<ul style="list-style-type: none"> • SEPH • LFS
Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).	

Table 13

Quarterly versus annual data, 2015

	Energy extraction GDP
	millions of dollars
First quarter 2015	18,319
Second quarter 2015	16,451
Third quarter 2015	16,311
Fourth quarter 2015	14,454
Sum of quarters (2015)	65,535
Annual benchmark (2015)	65,535
First quarter 2016	12,184
Second quarter 2016	14,093

Source: Statistics Canada, "The Natural Resources Satellite Account – Sources and methods", Income and Expenditure Accounts Technical Series (13-604-M).