“Conventional economic aggregates generated through national accounting, such as GDP, do not reflect the extent to which production and consumption activities may be using up environmental assets and limiting the capacity for these assets to generate ecosystem services in the future.”


OECD: indicators and reports: Green Growth and Material Flows and Resource Productivity

World Bank: Wealth Accounting and the Valuation of Ecosystem Services (WAVES)
Monitoring and management of natural wealth

- What is the contribution of natural assets to national wealth?
- Are we maintaining total wealth (produced and natural) over time, both in total and per capita?
- To what extent are we substituting produced assets for natural assets?
- Is resource rent recovered successfully by governments?
## Linking natural assets to the SNA

### Table 378-0121

National Balance Sheet Accounts  
quarterly (dollars x 1,000,000)

<table>
<thead>
<tr>
<th>Categories</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Total assets</td>
<td>30,812,653</td>
<td>30,828,353</td>
<td>31,588,251</td>
</tr>
<tr>
<td>Non-financial assets</td>
<td>8,570,455</td>
<td>8,625,366</td>
<td>9,024,332</td>
</tr>
<tr>
<td>Non-produced non-financial assets</td>
<td>3,742,683</td>
<td>3,760,809</td>
<td>4,070,867</td>
</tr>
<tr>
<td>Land</td>
<td>2,968,103</td>
<td>3,053,233</td>
<td>3,100,706</td>
</tr>
<tr>
<td>Natural resources</td>
<td>754,580</td>
<td>707,576</td>
<td>970,161</td>
</tr>
</tbody>
</table>
Corporate sector net worth

- Non-financial assets excluding natural resources
- Non-financial assets including natural resources
SEEA view

Sectors
- Industrial output of goods and services
- Industrial intermediate demand
- Resource production by industries
- Waste consumption by industries
- Financial and produced assets, opening balance

Commodities
- Environmental protection expenditures
- Resource use by industries
- Waste output by industries
- Environmental protection expenditures
- Natural resource assets, opening balance

Final demand
- Final demand
- Resource production by households/gov’t
- Resource use by households/gov’t
- Waste consumption by households/gov’t
- Capital expenditures for environmental protection

Assets
- Gross fixed capital formation
- Other changes in volume & holding gains/losses on financial & produced assets
- Changes in holding gains/losses on natural resource assets
- Natural resource assets, opening balance
- Financial and produced assets, closing balance
- Natural resource assets, closing balance

Wastes
- Waste output by industries
- Changes in and holding gains/losses on natural resource assets
- Natural resource assets, closing balance

Statistics Canada
**Structure**: conforms with a balance sheet structure - opening stocks, closing stocks and annual variations

## Physical stock accounts: an example for crude bitumen

### Table 153-0122

Selected natural resource reserves
annual (data in thousands)

The data below is a part of CANSIM table 153-0122. Use the **Add/Remove data** tab to customize your table.

<table>
<thead>
<tr>
<th>Stock</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening stock</td>
<td>1,660,000</td>
<td>1,620,000</td>
<td>3,340,000</td>
</tr>
<tr>
<td>Additions</td>
<td>17,258</td>
<td>1,785,707</td>
<td>237,000</td>
</tr>
<tr>
<td>Depletion</td>
<td>57,258</td>
<td>65,707</td>
<td>77,000</td>
</tr>
<tr>
<td>Closing stock</td>
<td>1,620,000</td>
<td>3,340,000</td>
<td>3,500,000</td>
</tr>
</tbody>
</table>
Table 153-0121\textsuperscript{1, 2}
Value of selected natural resource reserves
annual (dollars x 1,000,000)

<table>
<thead>
<tr>
<th>Stock</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconciliation account opening stock\textsuperscript{3}</td>
<td>191,145.4</td>
<td>476,744.1</td>
<td>182,194.4</td>
<td>336,498.2</td>
</tr>
<tr>
<td>Reconciliation account additions\textsuperscript{3}</td>
<td>97,122.8</td>
<td>103.7</td>
<td>611.1</td>
<td>3,244.6</td>
</tr>
<tr>
<td>Reconciliation account depletion\textsuperscript{3}</td>
<td>8,426.2</td>
<td>3,733.8</td>
<td>7,618.1</td>
<td>10,571.1</td>
</tr>
<tr>
<td>Reconciliation account revaluation\textsuperscript{3}</td>
<td>196,902.1</td>
<td>-290,919.7</td>
<td>161,310.8</td>
<td>95,764.8</td>
</tr>
<tr>
<td>Reconciliation account closing stock\textsuperscript{3}</td>
<td>476,744.1</td>
<td>182,194.4</td>
<td>336,498.2</td>
<td>424,936.5</td>
</tr>
</tbody>
</table>
Sample results – Canada’s natural resource wealth

Net Present Value

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy</th>
<th>Minerals</th>
<th>Timber</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td></td>
<td></td>
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<td>2006</td>
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<td>2007</td>
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<td>2008</td>
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<td>2011</td>
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<td>2012</td>
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<td>2013</td>
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<td></td>
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<tr>
<td>2014</td>
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<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Axis Title

million dollars
Links to the SNA

- The monetary accounts are integrated with the National Wealth Account of the CSNA
  - The addition of the monetary values of key natural resource assets (energy, minerals, timber and land) recognizes that these resources, although provided by nature, contribute significantly to Canada’s national wealth
Natural resource assets and national wealth

Natural wealth and produced wealth

- Produced non-financial assets
- Non-produced non-financial assets
Accounting structure

- Is wealth really going up like this all the time?
  - Not really, since the stock is valued in current prices and includes inflation.
Why value assets in current prices?

- The assumptions on resource rent, stocks, extraction, etc. are all based on current prices.
Natural Resource Stock Accounts: Applications

- Physical indicators that relate to the management of natural resource stocks and their use in the economy
  - Are resource stocks growing / declining over time?
    - Stocks of mineral and energy assets
    - Remaining reserve life of energy and mineral assets
    - Annual depletion of mineral and energy reserves
    - Total natural resource base

- Monetary indicators that tell us if our resource base (natural wealth) is being maintained or at least replaced by adequate produced capital.
Physical stocks of selected minerals

Natural Resource Reserves

- Proven and probable copper reserves (x 1,000)
- Proven and probable lead reserves (x 1,000)
- Proven and probable nickel reserves (x 1,000)
- Proven and probable zinc reserves (x 1,000)
Reserve life for selected resources (Closing stock)/(extraction)
How can we have 10 years of crude oil for the last 17 years?

- Extraction is balanced by discoveries and other additions to stock.
In order to be included within the balance sheet accounts, natural resource assets must fit into the asset boundary of the SNA – i.e. they must be economic assets

“Economic assets are entities over which ownership rights are enforced by institutional units, individually or collectively, and from which economic benefits may be derived by their owners by holding them, or using them, over a period of time”

They also must be recoverable under current technological and economic conditions

• E.g., for oil sands (crude bitumen) we only value “known deposits under active development”
Physical stock accounts: an example for crude bitumen

**Table 153-0012**

Established crude bitumen reserves
annual (cubic metres x 1,000)

<table>
<thead>
<tr>
<th>Stock</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening stock, established crude bitumen reserves</td>
<td>1,660,000</td>
<td>1,620,000</td>
<td>3,340,000</td>
<td>3,500,000</td>
<td>4,300,000</td>
<td>4,216,000</td>
<td>4,130,000</td>
</tr>
<tr>
<td>Additions, established crude bitumen reserves</td>
<td>17,258</td>
<td>1,785,707</td>
<td>237,000</td>
<td>876,000</td>
<td>2,000</td>
<td>1,332</td>
<td>31,000†</td>
</tr>
<tr>
<td>Depletion, established crude bitumen reserves</td>
<td>57,258</td>
<td>65,707</td>
<td>77,000</td>
<td>76,000</td>
<td>86,000</td>
<td>87,332</td>
<td>101,000†</td>
</tr>
<tr>
<td>Closing stock, established crude bitumen reserves</td>
<td>1,620,000</td>
<td>3,340,000</td>
<td>3,500,000</td>
<td>4,300,000</td>
<td>4,216,000</td>
<td>4,130,000</td>
<td>4,060,000</td>
</tr>
</tbody>
</table>

**Symbol legend:**
- † Revised

**Footnotes:**
1. Alberta Energy Regulator.

**Source:** Statistics Canada. Table 153-0012 - Established crude bitumen reserves, annual (cubic metres), CANSIM (database). (accessed: 2014-06-06)
Question: what factors could lead to the large jump in stocks in 2006?

- Prices increase making existing deposits profitable to extract.
- New technology making extraction more profitable or opening formerly unrecoverable stocks to exploitation.
### Table 153-0005¹,²

Value of established crude bitumen reserves  
annual (dollars x 1,000,000)

<table>
<thead>
<tr>
<th>Value</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconciliation account, established crude bitumen reserves, opening stock³</td>
<td>107,560.2</td>
<td>111,305.7</td>
<td>197,972.4</td>
<td>167,541.6</td>
<td>437,070.6</td>
<td>143,720.4</td>
<td>301,647.0</td>
</tr>
<tr>
<td>Reconciliation account, established crude bitumen reserves, additions³</td>
<td>1,185.8</td>
<td>105,844.5</td>
<td>11,345.0</td>
<td>89,040.4</td>
<td>68.2</td>
<td>97.3</td>
<td>2,872.7</td>
</tr>
<tr>
<td>Reconciliation account, established crude bitumen reserves, depletion³</td>
<td>3,934.1</td>
<td>3,894.6</td>
<td>3,685.9</td>
<td>7,725.0</td>
<td>2,931.7</td>
<td>6,378.5</td>
<td>9,359.3</td>
</tr>
<tr>
<td>Reconciliation account, established crude bitumen reserves, revaluation²</td>
<td>6,493.8</td>
<td>-15,283.1</td>
<td>-38,089.8</td>
<td>188,213.5</td>
<td>-290,486.7</td>
<td>164,207.0</td>
<td>81,064.9</td>
</tr>
<tr>
<td>Reconciliation account, established crude bitumen reserves, closing stock²</td>
<td>111,305.7</td>
<td>197,972.4</td>
<td>167,541.6</td>
<td>437,070.6</td>
<td>143,720.4</td>
<td>301,647.0</td>
<td>376,225.2</td>
</tr>
</tbody>
</table>

**Footnotes:**

2. For concepts, sources and methods, see "Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts", catalogue number 16-505-GPE.
3. The reconciliation account entries are calculated using the present value methodology.
4. Negative values for net price I, net price II and present value are set to zero.

**Source:** Statistics Canada. Table 153-0005 - Value of established crude bitumen reserves, annual (dollars), CANSIM (database). (accessed: 2014-06-06)
Accounting structure

- **Question:** what factors could lead to the large revaluation in 2009?
  - The economic crisis leading to a drop in prices.
Valuation of energy and mineral stocks

- Valuation: indirect estimation of market values of natural assets
  - Valuation of natural resource asset stocks would ideally be based on observed market value for transactions in these assets
  - Such values are not available for most resource assets however, since there are few transactions in resource assets in their “natural” state
  - Estimates of market value must be derived indirectly (economic or resource rent)
  - The total value, or wealth, associated with the stock is calculated as the present value of all future annual rent that the stock is expected to yield
Resource rent is the part of the revenue from the sale of the resource which remains after having deducted all costs associated with extraction – including fuel, labour and capital costs.
Calculation of resource rent

\[ RR_I = TR - C - (r_c K + \delta) \]

where:
- \( RR = \) resource rent (annual)
- \( TR = \) total annual revenue
- \( C = \) annual non-capital extraction cost (excluding taxes)
- \( \delta = \) annual depreciation
- \( r_c K = \) return to produced capital
Net present value (NPV) is the discounted value of future economic benefits from a given asset.

*Follows conventions adopted in the System of National Accounts to value capital assets*

\[
NPV = \sum_{t=1}^{T} \frac{RR_t}{(1 + r_i)^t}
\]

*where:*

- \(RR\) = resource rent
- \(T\) = reserve life, i.e. Closing stock ÷ extraction
- \(r_i\) = discount rate
Generally, the data in monetary terms come from Statistics Canada. Those data include (but not exclusively):

- Value and quantity of production
- Capital expenditures
- Operating costs (materials and supplies, fuel and electricity, and wages and salaries)
- Value of the produced capital stock and the value of the annual depreciation of that stock
Generally, the data in physical terms (mainly reserve estimates) come from Federal and Provincial natural resource departments. Data suppliers include:

- **Natural Resources Canada**
- **Canadian Association of Petroleum Producers**
- **Alberta Energy Regulator**
- **British Columbia Ministry of Energy, Mines and Petroleum Resources**
- **Manitoba Energy and Mines, Petroleum and Energy Branch**
- **Saskatchewan Department of Energy and Mines**
The Land Accounts provide information on the cover and the use of Canada’s land

Respond to questions like:

- What is the distribution and quality of the land?
- How is land used and what are the trends in this use?
- How quickly is rural land being converted to urban land?
- What share of urban land is occupying prime agricultural land?

At the moment, only agricultural and built-up land are valued and included in the country’s National Wealth Account

- In future we hope to develop methods and estimates for other land types, such as parkland and recreational land
Land use change

Note(s): The settled area boundary inside the greenbelt is derived from a special tabulation of data from the 1971 Census of Population. The greenbelt boundary is defined by the Government of Ontario's Greenbelt Act, 2005.

Land characteristics

MEGS, Soil landscape 350255 data integration sources

Streams from CANVEC buffered to 5m

Water bodies from CANVEC

2011 census blocks and associated data (population and dwellings)

Wetlands from CANVEC

Settlements from STC

Road network from STC buffered by type

Reclassed DEM

- plain: 0 - 100
- lowland: > 100 - 200
- hill: > 200 - 500
- upland: > 500 - 1000
- mountain: > 1000

Lowlands
Hills

Land cover from CCRS MODIS 250 metre

- Evergreen forest high
- Deciduous forest high
- Mixedwood high
- Shrubland
- Wetland shrub - herb
- Cultivated and managed areas - high
- Settlements
- Water bodies
Water stocks

Map 1.1
Renewable freshwater resources by country, and water yield by drainage region within Canada

Note(s): Data for Canada were derived from discharge values contained in Environment Canada, 2010. Water Survey of Canada, Archived Hydrologic Data [WSDAT] (www.wsc.ec.gc.ca/hydro/has/index_e.cfm?name=main_e.cfm).


Questions?

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