Water Asset Account in Physical Terms

Regional Training Workshop on the System of Environmental-Economic Accounting with a Focus on Water Accounting

September 26-30, 2016
Putrajaya, Malaysia

François Soulard Ph.D.

Environment, Energy and Transportation Statistics Division

Statistics Canada

Outline

1. What are asset accounts
2. Asset classification
3. The water cycle
4. Water asset accounting

What do asset accounts measure?

Asset accounts describe in physical units

- The stocks of water resources
- The changes in stocks that occur during the accounting period (natural and anthropogenic changes)

They link information on abstraction and returns with information on the stocks of water resources

- Provide information on supply and demand
- Identify socio-economic uses, that can then be integrated in ecosystemic requirements

Why produce an asset account?

- Helps assess the state of the water resources over time
  - Changing climate, land cover, hydrology…
- Helps understand the relationship between the water environment and the economy
  - E.g. decoupling water use from economic production
- Support planning and policy making
  - Competing demands, limited resources
- Provide information to the ecosystem accounts
- …

Water resources

- 6.12. Water resource assets are defined as
  - “water found in freshwater, brackish surface water and groundwater bodies within the national territory that provide direct use benefits, currently or in the future (option benefits), through the provision of raw material, and may be subject to quantitative depletion through human use.”

Asset classification

- EA.13 Water resources
  - EA.131 Surface water
    - EA.1311 Artificial reservoirs
    - EA.1312 Lakes
    - EA.1313 Rivers and streams
    - EA 1314 Glaciers, snow and ice
  - EA 132 Groundwater
  - EA.133 Soil water

Water resources: Surface water

Surface water: water which flows over, or is stored on the ground surface. Includes:

- Artificial reservoirs, which are constructed reservoirs used for the storage, regulation and control of water resources
- Lakes, which are generally large bodies of standing water occupying depressions in the Earth's surface;
- Rivers and streams, which are bodies of water flowing continuously or periodically in channels;
- Snow and ice, which include seasonal layers of these forms of frozen water on the ground surface;
- Glaciers, which are defined as an accumulation of ice of atmospheric origin, generally moving slowly on land over a long period. Snow, ice and glaciers are measured in water equivalents.

Water resources: Groundwater

- **Groundwater**: water which collects in porous layers of underground formations known as aquifers. An aquifer can be:
  - Unconfined: have a water table and an unsaturated zone
  - Confined between two layers of impervious or almost impervious formations.

- Depending on the recharge rate of the aquifer, groundwater can be:
  - Renewable in the sense that water is replenished by nature during the human lifespan
  - Non-renewable (fossil water)

Water resources: Soil water

- **Soil water**: water suspended in the uppermost belt of soil, or in the zone of aeration near the ground surface, that can be discharged in to the atmosphere by evapotranspiration, or migrate downwards towards aquifers.

  - Also known as “soil moisture”

Fresh and non-fresh water resources

6.20. Water resources comprise all inland water bodies regardless of their salinity level—they include both fresh and brackish inland water.

- Freshwater is naturally occurring water having a low concentration of salt.
- Brackish water has a salt concentration between that of fresh and marine water.
  - Brackish water can be used with or without treatment for some industrial uses or for irrigation purposes for some specific crops
  - Distinguishing between fresh and brackish water enables a more detailed analysis of the stocks of water and their uses according to salinity level.
  - Chapter VII presents quality accounts for water, which can be based on salinity levels.

Water in oceans, seas and atmosphere

Are not recorded in terms of stocks but only in terms of flows.

For example, abstraction from the seas, collection of precipitation, outflows to the seas, evaporation/evapotranspiration etc.

Produced versus non-produced assets

All water resource assets described in the previous slides are considered as non-produced assets

- “non-financial assets that come into existence other than through processes of production”.
- What about water in reservoirs?
  - It could be argued that water contained in artificial reservoirs comes into existence through a production process

Other disaggregations

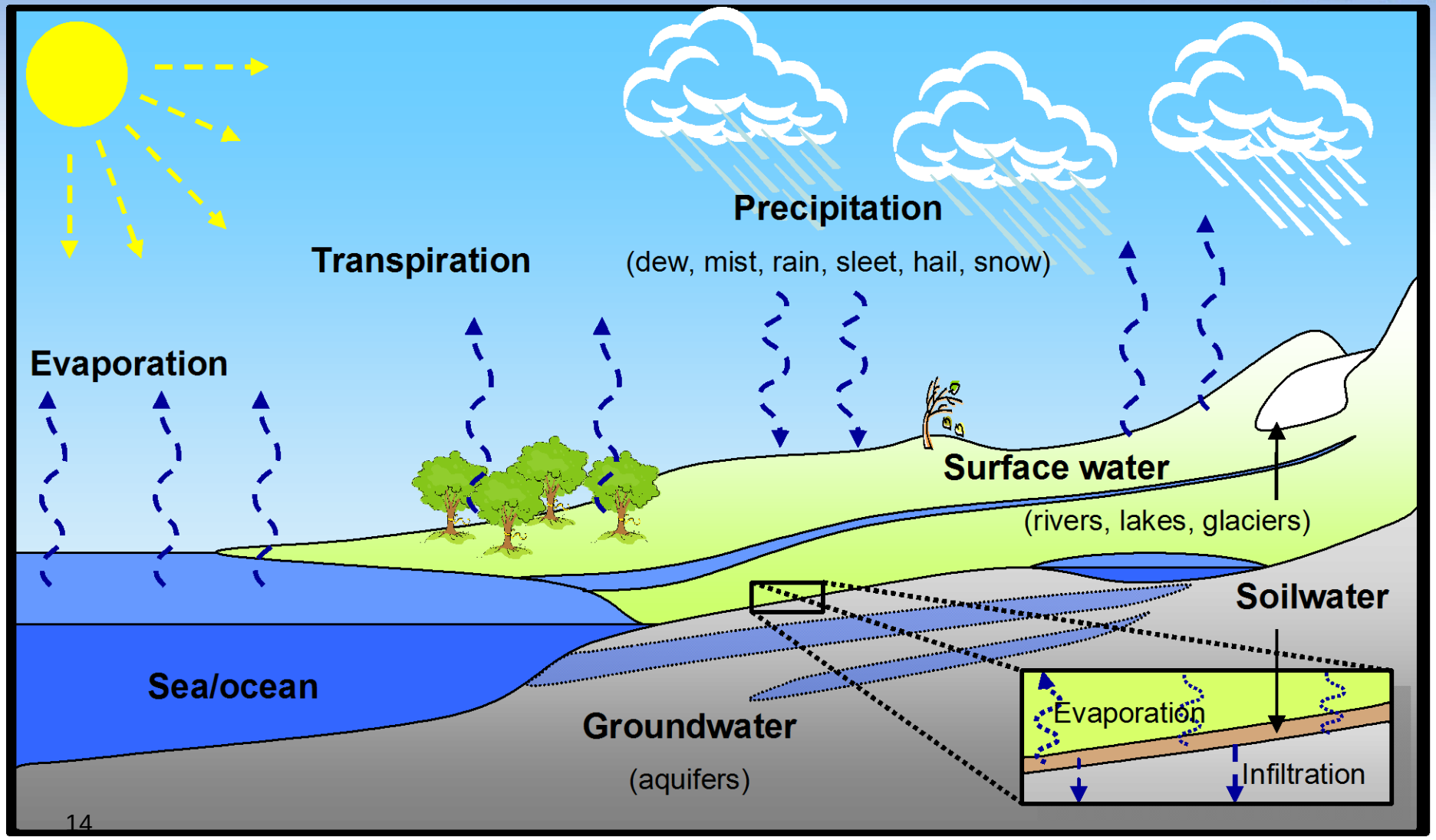
The asset classification can be adapted to specific situations depending on data availability and country priorities.

- Classify artificial reservoirs according to the type of use, such as for human, agricultural, hydroelectric power generation or mixed use.
- Rivers can be further classified on the basis of the regularity of the run-off: as perennial rivers, where water flows continuously throughout the year, or ephemeral rivers, where water flows only as a result of precipitation or the flow of an intermittent spring.

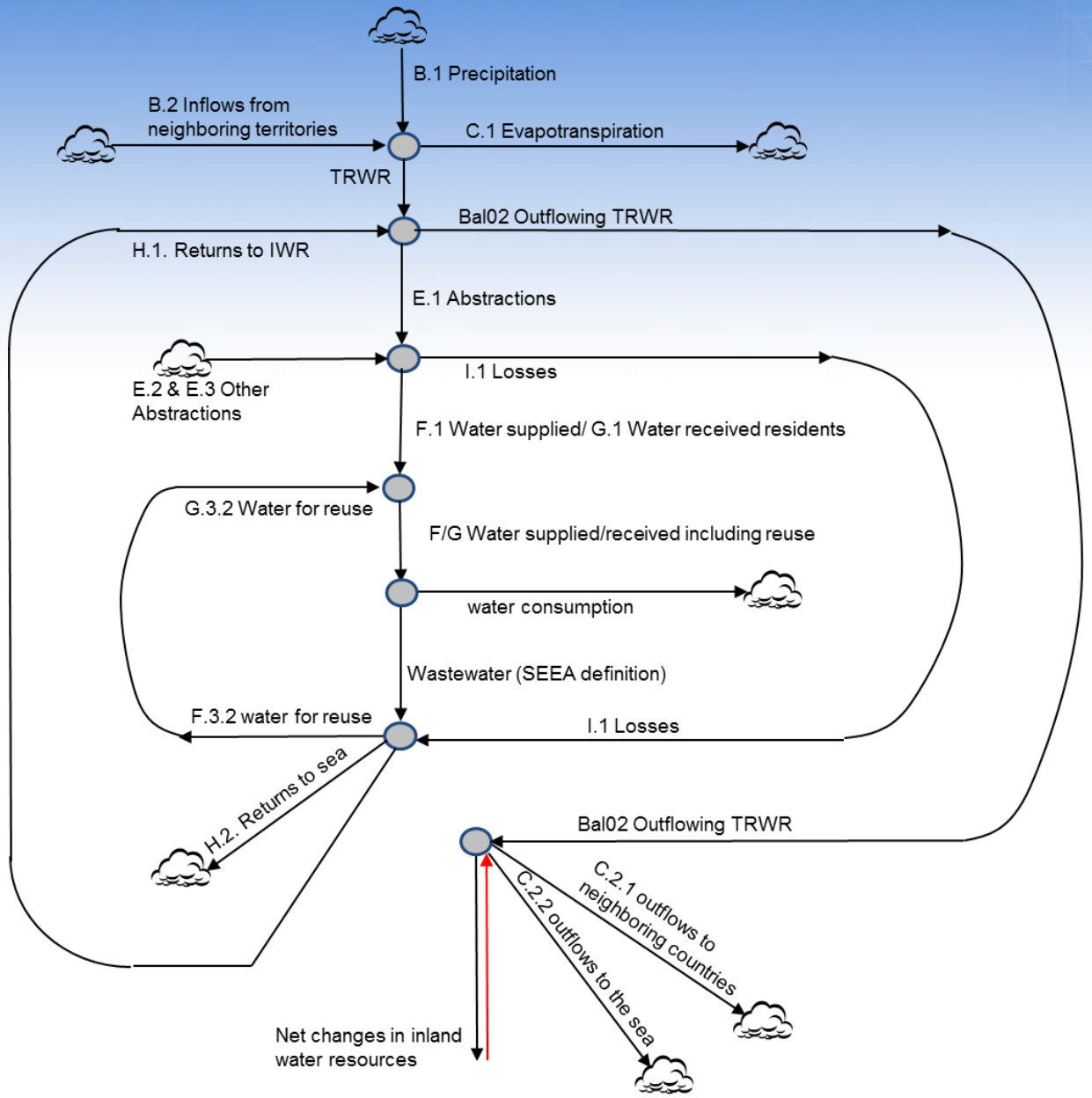
Boundaries between the different categories in the asset classification, such as between lakes and artificial reservoirs and rivers and lakes/reservoirs, may not always be precise.

- However, this is mostly a hydrological problem; it does not affect the accounts

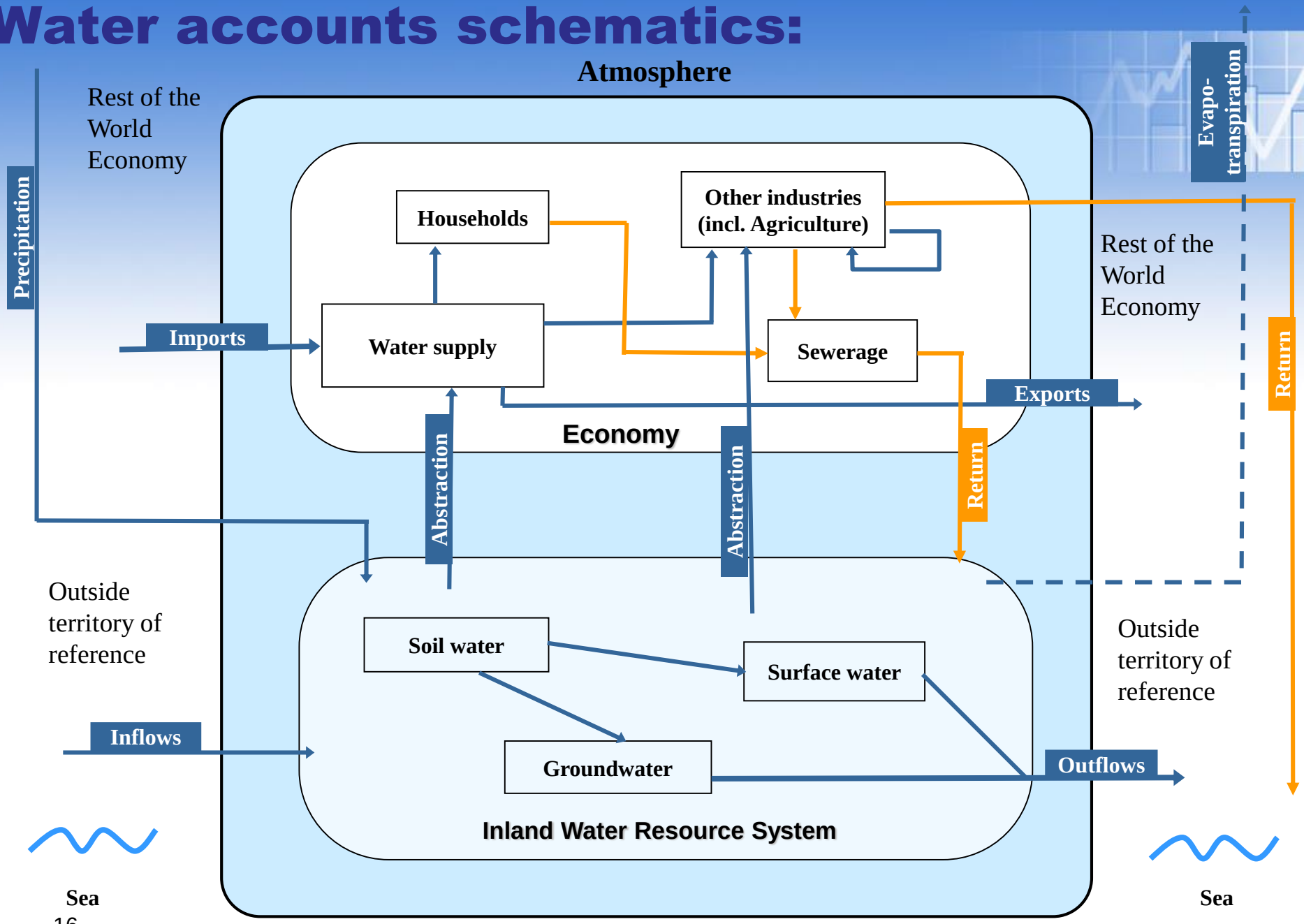
The hydrological cycle



Water accounts schematics:

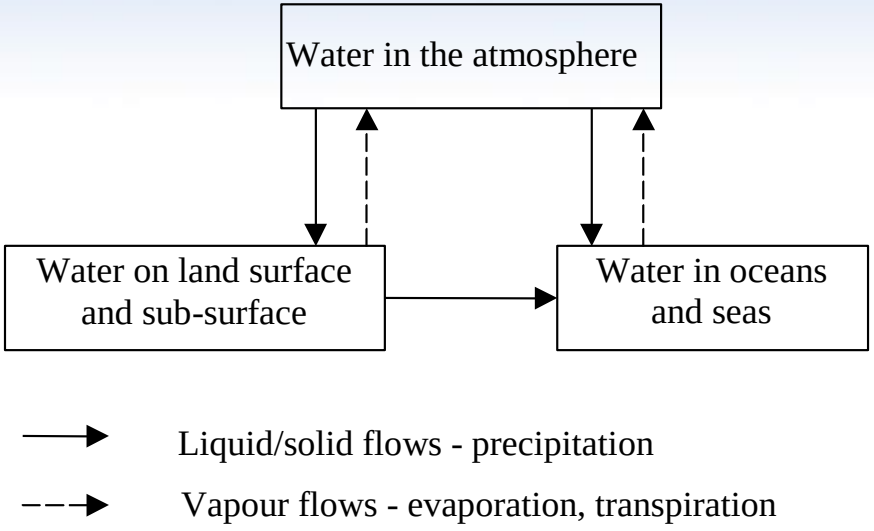


Water accounts schematics:



16

Hydrological cycle and water balance



Precipitation = Evapotranspiration + runoff +/- changes in storage

National accounts' Basin-based water balance equation

$$R = CWB + SWB + EWB$$

R = Run off to lakes, rivers, reservoirs, groundwater (recharge)

CWB = precipitation - evapotranspiration

SWB = surface (inflow - outflow)

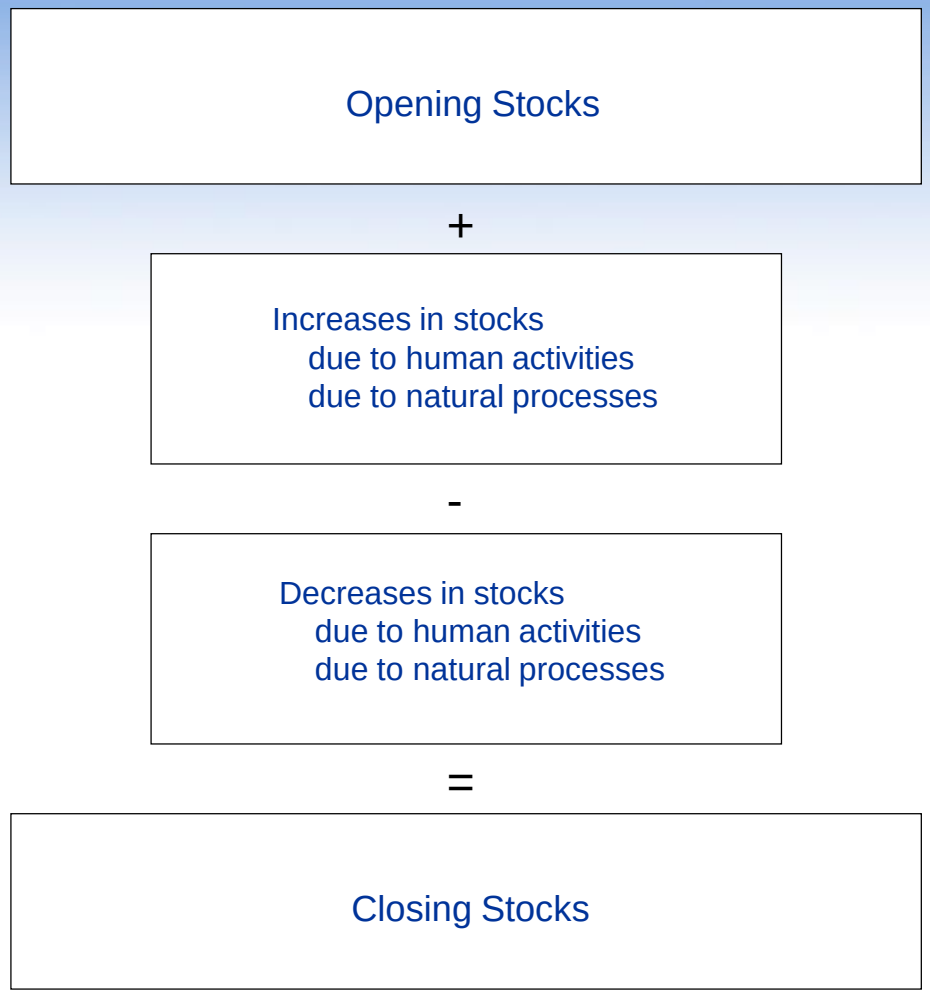
EWB = economic consumption (intake - discharge)

CWB: Climatic water balance

SWB: Surface water balance

EWB: Economic water balance (Municipal, I.C.I.)

Schematic of an asset account



The important identity of the physical asset accounts

The asset account “explains” the development of the stock from the beginning to the end of the period. The “explanation” is given by the basic identity that the closing stock is always equal to the opening stock plus changes during the period.

Identity of the asset accounts:

Opening stock

\+ Additions to stocs

\- Reductions in stocks

= Closing stock

Causes of change in stocks of groundwater resources

Opening stock

+ **Additions to stock**
  - Discoveries
  - Upwards reappraisals
  - Reclassifications

Three items for additions/increases

- **Reductions in stock**
  - Extractions
  - Catastrophic losses
  - Downwards reappraisals
  - Reclassifications

Four items for reductions/decreases

= Closing stock

Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

6.26. Returns represent the total volume of water that is returned from the economy into surface and groundwater during the accounting period. Returns can be disaggregated by type of water returned, for example, irrigation water, treated and untreated wastewater. In this case, the breakdown should mirror that used to disaggregate the returns in the physical supply and use tables in chapter III.

Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

6.27. Precipitation consists of the volume of atmospheric wet precipitation (rain, snow, hail, etc.) on the territory of reference during the accounting period before evapotranspiration takes place. Most of the precipitation would fall on the soil and would thus be recorded in the column under soil water in the asset accounts. Some precipitation would also fall into other water resources, such as surface water

Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

6.28. Inflows represent the amount of water that flows into water resources during the accounting period. The inflows are disaggregated according to their origin, that is, (*a*) inflows from other territories/countries; and (*b*) from other water resources within the territory.
Inflows from other territories occur in the case of shared water resources. Inflows from other resources include transfers, both natural and artificial, among the resources within the territory. They include, for example, flows of infiltration and seepage, as well as channels built for water diversion.[25]

Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

6.29. Abstraction represents the amount of water removed from any resource, either permanently or temporarily during the accounting period, for final consumption and production activities. Water used for hydroelectric power generation is considered part of water abstraction. Abstraction also includes the use of precipitation for rain-fed agriculture as this is considered removal of water from the soil as a result of a human activity, such as agriculture. Water used in rain-fed agriculture is thus recorded as abstraction from soil water.

Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

6.30. Evaporation/actual evapotranspiration is the amount of evaporation and actual evapotranspiration that occurs in the territory of reference during the accounting period. Evaporation refers to the amount of water evaporated from bodies of water. Evapotranspiration refers to the amount of water that is transferred from the soil to the atmosphere by evaporation and plant transpiration.

Asset accounts

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

6.31. Outflows represent the amount of water that flows out of water resources during the accounting period. Outflows are disaggregated according to the destination of the flow, namely: (*a*) to other territories/countries, (*b*) to the sea/ocean and (*c*) to other water resources within the territory. Outflows to other water resources within the territory represent water exchanges between water resources within the territory.

Asset accounts : Table VI.1

Millions cubic metres

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.131 3 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns from the economy							
3. Precipitation							
4. Inflows							
4.a. from upstream territories							
4.b. from other resources in							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual							
7. Outflows							
7.a to downstream territories							
7.b to the sea							
7.c to other resources in the							
8. Other changes in volume							
9. Closing Stocks							

6.32. Other changes in volume include all the changes in the stocks of water that are not classified elsewhere in the table. This item may include, for example, the amount of water in aquifers discovered during the accounting period, and the disappearance or appearance of water due to natural disasters, etc. Other changes in volume can be calculated directly or as a residual.

Sustainable water abstraction

1. Broadly defined as the level of abstraction that meets the needs of the current generations without compromising the ability of future generations to meet their own needs
   - Can be specified for each water resource.
2. This variable is exogenous to the accounts; it is often estimated by the agencies in charge of water management and planning in a country.
   - In Canada: Water Yield
3. Its estimation takes into account economic, social and environmental considerations.

Stocks for rivers, lakes, glaciers

- The stock of a river and lake should be measured as the volume of the active riverbed determined on the basis of the geographic profile of the riverbed and the water level, at any give point in time.
- This quantity in rivers is usually very small compared to the total stocks of water resources and the annual flows of rivers.
- Stocks in snow and glaciers are estimated using modelling and remote-sensing

Matrix of transfers within the environment

Destination: ⇨ gin ⇩	EA.131 Surface water				EA.132 Groundwater	EA.133 Soil water	Outflows to other resources in the territory
	EA.1311 Reservoirs	EA.1312 Lakes	EA.1313 Rivers	EA.1314 Snow, Ice and Glaciers			
1311 Reservoirs							
1312 Lakes							
1313 Rivers							
1314 Snow, Ice and ciers							
132 Groundwater							
133 Soil water							
ows from other urces in the territory							

Water Asset Account in Physical Term

Regional Training Workshop on the System of Environmental-Economic Accounting with a Focus on Water Accounting

Thank you for your attention

September 26-30, 2016
Putrajaya, Malaysia

François Soulard Ph.D.

Environment, Energy and Transportation Statistics Division

Statistics Canada