



DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
STATISTICS DIVISION
UNITED NATIONS

ESA/STAT/AC.272
UNCEEA/8/7d

**International Conference “Global Implementation Programme for the SEEA” and the
Eighth Meeting of the UN Committee of Experts on
Environmental-Economic Accounting
New York, 17-21 June 2013
United Nations Secretariat Building – Conference Room S-2726 and S-2727**

SEEA Technical Notes: Water Accounting
(for discussion)

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1. Introduction

Water is essential for life. It is a key element in growing food, generating energy, producing many industrial products as well as in ensuring the integrity of ecosystems and the goods and services they provide. Increasing competition for freshwater between agriculture, urban and industrial use as well as population growth results in pressure on water resources, with many countries (or regions within countries) reaching conditions of water scarcity or facing limits to economic development. Moreover, water quality may deteriorate over time further limiting the availability of freshwater resources.

Because of the integral role that water plays in human life and economic activity, water accounting crosses a number of different types of accounts including physical flow accounts and asset accounts. The two core accounts for water concern the recording of flows of water through the economy in physical supply and use tables (PSUT) for water and the recording of stocks of water resources and changes in stocks in asset accounts for water.

This SEEA Technical Note introduces the key aspects of accounting for water within the SEEA framework. In Section 2 the general motivation for water accounting and the potential for derivation of aggregates and indicators from water accounts is described. In Section 3 the structures of the two core accounts are described and also the potential to compile combined presentations for water and thus organise information for the derivation of indicators.

In Section 4, possible extensions to the core accounts are described since each of the core accounts may be compiled at varying levels of detail (for example at different levels of industry or by river basin. Section 4 also introduces the potential to account for emissions to water and for water quality.

In Section 5, the basic steps required for the compilation of the core water accounts are outlined, together with a description of the key data sources. Significant material is available on the compilation of water accounts and this section provides a summary. In the final section, Section 6, links to relevant materials including to country examples are provided.

This technical note does not cover all potential areas of accounting interest in relation to water and its links to economic and other human activity. The additional areas include (i) accounting for water in marine environments (although abstraction of sea water is included); (ii) accounting for fish, other aquatic resources and sea-bed mineral resources; (iii) accounting for passive uses of water (such as for transportation and recreation); (iv) the valuation of water resources; and (v) accounting for water in the context of assessing ecosystems. Although these areas are not addressed directly in this technical note, the connections to accounting for these areas is summarised in Section 4.

2. Key aggregates and indicators

The integral role of water in development is widely recognized. It is not surprising that water is very high on the national and international development agenda, with several international agreements specifying targets on water supply and sanitation. The most notable is the inclusion of two indicators (proportion of population with sustainable access to an improved water source and proportion of population with access to improved sanitation) within a specific target in the Millennium Development Goals (MDGs), namely target 10 - to halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation.

It is because water is critical and intimately linked with socio-economic development that it is necessary for countries to move away from sectoral development and management of water resources and to adopt an integrated overall approach to water management (United Nations and the World Water Assessment Programme, 2006). The motivation for water accounting is that only by integrating information on the economy, hydrology, other natural resources and social aspects can integrated policies be designed in an informed and integrated manner.

The SEEA Central Framework defines three key aggregates that emerge from PSUT for water. They are gross water input, net domestic water use and final water use (also referred to as water consumption). These aggregates can be derived at an economy wide or industry level and provide a strong set of indicators covering the abstraction of water from various water sources, the use of water by economic units (including households) and a key indicator of environmental pressure, final water use, which reflects the quantity of water no longer available for use.

Information from the SEEA framework can also be used to derive analytical measures relating to efficiency of use and decoupling of water use from economic activity. SEEA based data can also inform on the allocation and distribution of water. Using data from the standard national accounts framework, it may also be useful to organise data relating to the pricing of water, the full costs of supplying and treating water, payments for water rights and the extent of investment in infrastructure for water supply and sanitation.

The SEEA framework provides a comprehensive framework for the assessment of water related issues as they concern human and economic activity. More detail on aggregates and indicators is provided in SEEA Water.

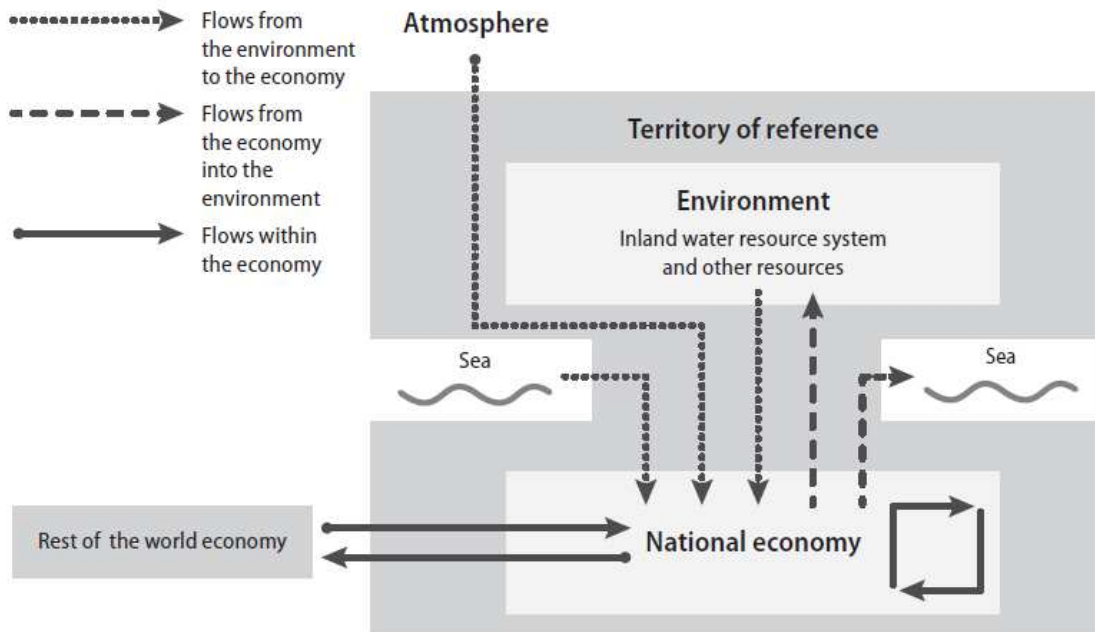
3. Core accounts for water

The hydrological system and flows of water between the environment and the economy

Water is in continuous movement through the processes of precipitation, evaporation, run-off, infiltration and flows to the sea. The natural cycle of water, the hydrological cycle, involves connections between the atmosphere, the oceans, and land surface and subsurface. The focus of the SEEA water accounts is the inland water system comprising surface water (rivers, lakes, artificial reservoirs, snow, ice and glaciers), groundwater and soil water within the territory of reference. Within this system water is abstracted, used and returned by humans as part of economic and other human activity. The PSUT for water and the asset account for water resources provide a structure for information on all of these flows and the related stocks of water resources.

The key flows between the environment and the economy are shown in Figure 1.

Figure 1 Flows in the physical supply and use tables



Physical supply and use tables for water

The PSUT for water records flows of water, in physical units, encompassing the initial abstraction of water resources from the environment into the economy, to the water flows within the economy in the form of supply and use by industries and households, and finally, flows of water back to the environment. Flows such as the evaporation of water from lakes and artificial reservoirs and flows between water bodies are considered flows within the environment and are recorded in the asset accounts. The SEEA Central Framework and SEEA Water provide an extensive description of the relevant accounting entries.

Physical supply and use tables can be compiled at various levels of detail, depending on the required policy and analytical focus and data availability. The core PSUT for is divided into five sections which organize information on (a) abstraction of water from the environment; (b) distribution and use of abstracted water across enterprises and households; (c) flows of wastewater and reused water (between households and enterprises); (d) return flows of water to the environment; and (e) evaporation, transpiration and water incorporated into products.

Table 1 shows the structure of the core PSUT for water. The structure reflects a basic set of industries and sources of water that should be part of a PSUT for water. Possible extensions to the core structure are described in Section 4.

Table 1 Physical supply and use table for water (cubic metres) of water)

Physical supply table for water	Abstraction of water; Production of water; Generation of return flows							Flows from the rest of the world	Flows from the environment	Total supply
	Generation of return flows									
	Agriculture, forestry and fishing	Mining & quarrying, Manufacturing and construction	Electricity, gas, steam and air conditioning	Water collection, treatment and supply	Sewerage	Other industries	Households			
(I) Sources of abstracted water										
Inland water resources										
Surface water								440.6	440.6	440.6
Groundwater								476.3	476.3	476.3
Soil water								50.0	50.0	50.0
Total								966.9	966.9	966.9
Other water sources										
Precipitation								101.0	101.0	101.0
Sea water								101.1	101.1	101.1
Total								202.1	202.1	202.1
Total supply abstracted water								1 169.0	1 169.0	1 169.0
(II) Abstracted water										
For distribution										
For own-use	108.4	114.6	404.2	378.2	61.2	100.1	2.3			378.2
(III) Wastewater and reused water										
Wastewater										
Wastewater to treatment	17.9	117.6	5.6	1.4			49.1			235.5
Own treatment										
Reused water produced										
For distribution										
For own use	10.0						42.7			42.7
(IV) Return flows of water										
To inland water resources										
Surface water			300.0				52.5	0.2	0.5	353.2
Ground water	65.0	23.5		47.3			175.0	0.5	4.1	315.4
Soil water										
Total	65.0	23.5	300.0	47.3			227.5	0.7	4.6	668.6
To other sources		5.9	100.0				256.3		0.2	362.4
Total Return flows	65.0	29.4	400.0	47.3			483.8	0.7	4.8	1 031.0
(V) Evaporation of abstracted water, transpiration and water incorporated into products										
Evaporation of abstracted water	76.2	43.2	2.5	1.8			0.7	3.6	10.0	138.0
Transpiration										
Water incorporated into products	267.5	314.8	812.3	489.9			627.3	55.7	250.3	3 986.8
Total supply										

Note: Dark grey cells are null by definition.

Table 1 (cont) Physical supply and use table for water (cubic metres) of water)

Physical use table for water	Abstraction of water, Intermediate consumption, Return flows							Accumulation	Flows to the rest of the world	Flows to the environment	Total use
	Agriculture, forestry and fishing	Mining & quarrying, Manufacturing and Construction	Electricity, gas, steam and air conditioning	Water collection, treatment and supply	Sewerage	Other industries	Households				
(I) Sources of abstracted water											
Inland water resources											
Surface water	55.3	79.7	301.0	4.5	0.1						440.6
Groundwater	3.1	34.8	3.2	432.9		2.3					476.3
Soil water	50.0										50.0
Total	108.4	114.5	304.2	437.4	0.1	2.3					966.9
Other water sources											
Precipitation				1.0	100.0						101.0
Sea water				1.1							101.1
Total	0.0	0.0	100.0	2.1	100.0	0.0					202.1
Total use abstracted water	108.4	114.5	404.2	439.5	100.1	2.3					1 169.0
(II) Abstracted water											
Distributed water	38.7	45.0	3.9			51.1	239.5				378.2
Own use	108.4	114.6	404.2	50.4	100.1	2.3	10.8				790.8
(III) Wastewater and reused water											
Wastewater											
Wastewater received from other units											
Own treatment	12.0	40.7		427.1							427.1
Reused water											
Distributed reuse											
Own use											
Total	12.0	40.7		427.1							479.8
(IV) Return flows of water											
Returns of water to the environment											
To inland water resources										668.6	668.6
To other sources										362.4	362.4
Total return flows										1 031.0	1 031.0
(V) Evaporation of abstracted water, transpiration and water incorporated into products											
Evaporation of abstracted water											
Transpiration											
Water incorporated into products											
Total use	267.5	314.8	812.3	489.9	627.3	55.7	250.3				3 986.8

Note: Dark grey cells are null by definition.

Asset accounts for water

Asset accounts for water resources focus on the inflows and outflows of water to and from the land surface and subsurface, and on the destination of these flows. The SEEA Central Framework and SEEA Water provide an extensive description of the relevant accounting entries.

The core asset accounts for water present information on the stock of water in the inland water system at the beginning and end of an accounting period, whether it is in artificial reservoirs, lakes or rivers, or stored as groundwater or soil water. The accounts then record the flows of water as it is abstracted, consumed, increased through precipitation, or changed through flows to and from other countries and returns to the sea.

The structure of the core asset account for water resources is shown in Table 2.

Table 2: Physical asset account for water resources (Cubic metres)

	Type of water resource					Total	
	Surface water				Groundwater		Soil water
	Artificial reservoirs	Lakes	Rivers and streams	Glaciers, snow and ice			
Opening stock of water resources	1 500	2 700	5 000		100 000	500	109 700
Additions to stock							
Returns	300		53		315		669
Precipitation	124	246	50			23 015	23 435
Inflows from other territories			17 650				17 650
Inflows from other inland water resources	1 054	339	2 487		437	0	4 317
Discoveries of water in aquifers							
<i>Total additions to stock</i>	1 478	585	20 240		752	23 015	46 071
Reductions in stock							
Abstraction	280	20	141		476	50	967
for hydro power generation							
for cooling water							
Evaporation & actual evapotranspiration	80	215	54			21 125	21 474
Outflows to other territories			9 430				9 430
Outflows to the sea			10 000				10 000
Outflows to other inland water resources	1 000	100	1 343		87	1 787	4 317
<i>Total reductions in stock</i>	1 360	335	20 968		563	22 962	46 188
Closing stock of water resources	1 618	2 950	4 272		100 189	553	109 583

Combined presentations for water

Within water accounting, the interest lies in linking the abstraction and use of water in physical terms with estimates of output and value added by industry and the total final consumption of households. The presentation of physical and monetary information in the same account allows for the derivation of consistent indicators for evaluating the impact on water resources of changes in the economy due, for example, to changes in economic structure. Using combined accounts in economic models permits the analysis of possible trade-offs between alternative water policies and economic strategies. (The potential links to economic models are described further in SEEA Applications and Extensions.)

The core combined presentation for water is presented in Table 3. For the monetary part of the combined supply table, two water-related products are identified: natural water and sewerage services. Depending on data availability, other products may be incorporated, for example those relating to irrigation water. The monetary part also includes estimates of total supply of products (i.e., including the output of non-water products) for each industry, thus providing an indication of the relative significance of the output of water-related products as part of total industry output.

The monetary part of the combined supply table records additional entries to illustrate the conversion of measures of output in basic prices to measures of output in purchasers' prices. This step enables an accounting balance to be maintained with the use table in monetary terms.

The physical flows in the combined supply table reflect volumes of water supplied between economic units, including volumes of wastewater to sewerage (shown along an of which row), as well as total returns to the environment. The bulk of the supply of water appears in the columns corresponding to the Water collection, treatment and supply industry and the Sewerage industry. Flows relating to hydropower are shown explicitly, reflecting the relative significance of these flows within the total physical flows of water.

The monetary part of the combined use table shows the intermediate consumption and final use of the two primary water-related products. Total intermediate consumption for each industry and total final consumption for households and government are also shown to provide an indication of the significance of the use of water as part of total consumption.

It is useful to incorporate in the monetary part of the combined use table, estimates of gross fixed capital formation (investment) for water supply and treatment operations. These entries are made for each relevant industry in additional rows in the table.

The physical part of the combined use table shows the volume of water abstracted from the environment, including amounts retained for own use, and amounts received by economic units.

Table 3 Combined presentation for water data

	Industries (by ISIC categories)									Rest of the world	Taxes less subsidies on products, trade and transport margins	Actual final consumption	Total	
	ISIC 1-3 41-43	ISIC 5-33 41-43	ISIC 35	ISIC 36	ISIC 37	ISIC 38, 39, 45-99	ISIC 7	ISIC 6005	ISIC 5022					ISIC 7123 543
1. Supply of water products (Currency units)														
Natural water	13	1	6 570	14	5 022	6 478 288	7	6 605	1	- 2			6 604	
Sewerage services								5 022	2	14			5 038	
2. Total supply of products	170 737	267 143	195 769	6 570	5 036	6 478 288	7 123 543							
3. Intermediate consumption and final use (Currency units)														
Natural water	406	643	88	1 004	100	1 229	3 470		4		3 074	60	6 608	
Sewerage services	3	229	1	13	1	1 406	1 653		3		3 316	66	5 038	
Other products	145 597	125 181	180 683	2 360	1 718	5 842 990	6 298 529				605 817	50 096	1 284 442	
4. Gross value added (Currency units)	24 731	141 090	14 997	3 193	3 217	632 663	819 891						819 891	
5. Employment	371	2 211	61	41	43	8 204	10 931						10 931	
6. Supply of water (Millions m3)														
Supply of water to other economic units				378									378	
Total returns	65	29	400	47	484	1	1 026				5		1 031	
7. Use of water (Millions m3)														
Total Abstraction	108	115	404	440	100	2	1 169						1 169	
of which: Abstraction for own use	108	115	404	50	100	2	780				11		791	
Use of water received from other economic units	39	45	4			51	139				240		378	
8. Gross fixed capital formation (Currency units)														
For water supply	582	16	819	2 872			4 289						4 289	
For water sanitation					2 874		2 874						2 874	
9. Closing Stocks of fixed assets for water supply (Currency units)	6 112	84	9 871	25 347		17	41 431						41 431	
10. Closing Stocks of fixed assets for water sanitation (Currency units)					37 457		37 457						37 457	
11. Water consumption (Millions m3)	76	43	3	2	1	4	128				10		138	

Note: Dark grey cells indicate zero entries by definition.

4. Extensions and links

Extensions to the core accounts

There are a number of ways in which the core accounts might be extended to provide additional avenues for analysis and additional indicators. The following paragraphs highlight some options that might be considered.

In relation to asset accounts for water resources one extension is the preparation of accounts for particular regions within a country, data by river basin or catchment being the most obvious example. It may well be the case that underlying data on physical stocks and flows of water resources are collected or organised by river basin and hence population of such extended accounts may be quite feasible. The primary reflection of the extension is the recording of flows between river basins within a country in addition to inflows and outflows from other countries.

The compilation of PSUT for water by river basin may be more difficult since this would require information on the use of water by industries and households classified by river basin and generally economic data of this type are not classified spatially. However, it may be relevant to expand only certain parts of the PSUT by river basin, for example those parts recording abstractions from the environment and returns to the environment.

Extensions to the PSUT may focus on additional detail concerning certain industries and on households. For example, it may be relevant to consider water use in agriculture by type of agricultural output/activity (e.g. water used in growing crops compared to raising livestock). Other examples could relate to examination of water use in electricity generation, or in specific manufacturing processes.

For households, the topic of access to water and sanitation is likely to be of interest and in this situation incorporating additional data on water use by type of household (for example by income decile, by family size, by location) may be considered.

In both these extensions the approach to be taken is to incorporate additional columns in the PSUT reflecting the additional activities or type of households and allocate the more aggregated data appropriately. Since the PSUT should remain balanced at the more aggregated levels it is possible to prepare these types of extensions only for part of the PSUT. Thus, for example, it is not necessary to allocate abstractions from the environment by household type in order to expand the view of use of water by household type.

Extensions are also possible to the combined accounts to add in additional socio-economic variables that may underpin the derivation of additional indicators. For example, distinction may be made between the final consumption expenditure by households and the actual final consumption of households. The difference reflects expenditure by Governments to provide goods and services (in this case, water supply) to households. Thus, although these goods and services are purchased by Governments, the consumption is in fact that of households. This distinction allows an improved comparison of consumption over time and across countries, as it is not dependent on the arrangements in place to manage and finance water supply.

Depending on the purpose of analysis, additional information, for example, concerning emissions to water by industry and household, or on prices paid for water supply by different users, can be included within the general combined supply and use table framework to

provide a single reference point for relevant information. Economic data relating to payments for water rights, expenditure on environmental protection and resource management related to water supply and water sewerage activities and other economic data may also be considered.

Additions such as these demonstrate the capacity of combined supply and use tables to incorporate additional information based on a core structure.

Other water accounts

Although not considered a core account, accounts for emissions to water are a recognised account in the SEEA Central Framework and the SEEA Water. Particularly where there are concerns about the quality of water in various water sources, accounting for emissions to water, such as nitrogen and phosphorous, heavy metals and other substances, may be useful. The compilation of water emission accounts is described in the SEEA Central Framework section 3.6.4 and in the SEEA Water, section IV.

Beyond water emissions accounts it is possible to compile water quality accounts for specific water bodies. This type of accounting is still developing as the definition of metrics for different qualities of water have not yet been standardised. The main metrics used relate to the existence of metals and pesticides and salinity levels. Water quality accounts are discussed in SEEA Water, section VII.

Links to other environmental-economic accounts

Because water is such an integral environmental asset and input an even broader picture of the role of water may be obtained through consideration of information on water other environmental-economic accounts. For example,

- Accounting for fish and other aquatic resources is included in asset accounts for aquatic resources (including aquaculture), and asset accounts for mineral and energy resources include known deposits of sea-bed mineral and energy resources. See SEEA Central Framework sections 5.5 and 5.9.
- Accounting for passive uses of water, such as for transportation and recreation, can be done in the context of assessments of land use, discussed in SEEA Central Framework, section 5.6.
- Accounting for water resources may also be an important component in the broader objective of accounting for ecosystem condition and ecosystem services as described in SEEA Experimental Ecosystem Accounting. Since the focus of water accounting in the SEEA Central Framework is on the inland water system there may be interest in considering water in marine environments as part of extended ecosystem assessment.

In addition, there are important considerations around the valuation of water resources which has not been resolved but which may be an important focus for accounting work.

5. Compilation of water accounts

Basic steps

This section outlines some basic steps that are relevant in the compilation of water accounts. Both the SEEA Water and the International Recommendations for Water Statistics (IRWS) provide more complete guidance on the organisation of basic data and the preparation of accounts. Links to these documents and other related material are provided in Section 6.

Following the decision to produce water accounts and the allocation of resources for this, a general process for the compilation of water accounts may be followed. This is described below in nine steps noting, however, the components are not strictly sequential and some may be completed concurrently and it may be necessary to revisit certain steps through the compilation process. The nine steps are:

1. Define the accounts of interest, the desired geographical scope, the frequency of reporting (e.g. 3 yearly, annual, quarterly), the temporal basis (e.g. financial year, calendar year, hydrological year) and the desired level of industry and household detail.
2. Identify potential data sources and assess their suitability for accounts relative to the design choices made in Step 1. In this step the metadata associated with the data sources should be closely examined. Potential sources of data for water accounts are listed below.
3. Secure access to data, including the data themselves, associated metadata and the rights to disseminate the accounts that are derived from that data.
4. Import data and prepare data for analysis noting that concordances may be required between the classifications used in the imported data (which should be articulated in the metadata associated with the important data) and the classifications to be used in the SEEA based accounts.
5. Analyse data, including data quality, to identify data gaps, coherence between data sources, etc.; and make required adjustments for scope, definition, timing, classification as appropriate.
6. Prepare and edit draft accounts and tables including undertaking an analysis of time series where possible and recognising the likely need for multiple iterations in this step.
7. Disseminate accounts, including material to assist interpretation such as indicators, methodological notes and statements of data quality.
8. Archive data and related methodological and other documentation.
9. Review accounts, data sources, methods and systems, including actively seeking user feedback.

Main data sources

The compilation of accounts necessarily requires the integration of data from a wide range of sources. Following is a list of the most common sources of information for water accounting but since the national statistical and information systems of all countries can vary considerably it should be recognised that there is no ideal data source for particular accounting components. The appropriateness of particular data sources should be determined on the basis of the degree of alignment between the scope, timing, and classification of the source data and the target concept as articulated in the SEEA.

The most common sources of information include:

- Survey data: Data from surveys of enterprises, households are likely to be important in determining patterns of use of water. Targeted surveys of some industries, for example, agriculture, may be relevant depending on output requirements. Often the supply and treatment of water will be managed by a limited number of enterprises and hence surveys (or complete enumeration) of these enterprises on their activities (including abstraction, distribution and treatment) may be important data sources.
- Administrative data: It may be that the operation of water supply and treatment generates various administrative data set, for example, on readings from water meters. With appropriate privacy considerations such administrative data sets may be considered.
- Hydrological / meteorological data: These data are likely to provide the main information for the measurement of stocks and changes in stocks of water resources. Through direct measurement or the use of scientific models data from these sources will provide measurement of, among other things, surface and groundwater levels, river flows, precipitation, evapotranspiration, and natural transfers between water bodies.
- Economic / national accounts data: Data from the national accounts and related economic surveys will provide the basis for generating combined presentations and for comparing physical flows of water (as recorded in the PSUT for water) with corresponding measures of economic activity. As well, the national accounts can provide information on transactions associated with the abstraction, distribution and treatment of water include payments for water rights, water prices, costs of production and levels of investment and capital stock.
- Social data: Relevant social data include employment and population data. These are commonly obtained through household surveys of the labour force, and through population censuses and associated demographic statistics.

Main measurement challenges

As with all accounting work there are a range of measurement challenges centred on aligning the available data with the conceptual definitions and scope required for coherent accounts. For water accounting some particular challenges include

- Aligning data spatially where physical stock and flow information may be available at a river basin or catchment level while economic data are only available at a national or administrative region level.
- Accounting for losses of water during abstraction and distribution and the flows of water lost through theft.
- The recording of household activity, particularly in countries where abstraction of water for own use is prevalent.

6. References and links

Conceptual materials and technical guidance

SEEA Central Framework

SEEA Water

SEEA Experimental Ecosystem Accounting

International Recommendations for Water Statistics

Glossary of Hydrology

Training materials and guides

Country examples (suggestions only)

Australia

Botswana

Canada

China

Denmark

France

Mexico

Namibia

Netherlands

South Africa

Sweden