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WATER RESOURCE ACCOUNTS

Paper submitted by the United Nations Statistics Division[1]

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A Water resources

1 Introduction

7.1 Water is a literally vital resource since it is fundamental to any form of life. Chapter 18 of Agenda 21 reads in part:

> "Water is needed in all aspects of life. The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting to human activities within the capacity limits of nature and combating vectors of water-related diseases… The multi-sectoral nature of water resources development in the context of socio-economic development must be recognized, as well as the multi-interest utilization of water resources for water supply and sanitation, agriculture, industry, urban development, hydropower generation, inland fisheries, transportation, recreation, low and flat lands management and other activities".

7.2 As a starting point one could easily be led to treat water in a manner similar to other natural resources. However water has two particular characteristics. In the first place, water travels under the influence of solar radiation and gravity and it is in continuous movement and transformation partially escaping the control of humans. This elusive nature of water influences its potential economic and environmental usage. Secondly, water resources represent both an input into production and a "sink" for liquid discharges. To take account of these characteristics, water accounts have developed differently from accounts for other resources. Information on flows are often more easily available than for stocks but stocks and flows are both crucial for monitoring the quality and quantity of water resources and for the management of water resources.

7.3 Several case studies have been undertaken at the national and/or regional level. Examples include France, Spain, Finland, Netherlands, Denmark, Chile, Moldova, Australia, Namibia, Korea, Canada, and Philippines. Despite limited experience in water accounting and some formal differences that exist in the presentation of the accounts, important similarities can be noted. These similarities result from the use of a systematic way of organizing data on water resources, water supply and water use in a manner consistent with the concepts, definitions, and classifications of the System of National Accounts (SNA) while respecting the fundamental concepts of hydrology.

7.4 Water resources accounts comprise stock and flow accounts in physical and in monetary terms and quality accounts. Because of the nature of water, a set of physical flows accounts, discussed in detail in Chapter III, is often the starting point in the compilation of water accounts. Stock accounts are also very important for groundwater, lakes and reservoirs. Accounts are calculated for a given geographical territory, which can be a country, a region or a river basin (catchment area) or any relevant area of interest. Here the focus is on water accounts at the national level in line with the other parts of this handbook.

7.5 One advantage of compiling and using water accounts versus water statistics is that the indicators that can be derived from the accounts result from an accounting system in which economic and environmental information are presented side by side using common classifications and definitions. Thus users can link physical and monetary data in a consistent framework to study the impact on the environment of different sectors of the economy and the resource requirements by the economy as a result of structural changes. The accounts offer an integrated view of water supply and uses by industry and by purpose. They include measures of water pollution, protection and management and describe water quality in physical and monetary terms. The accounts help to understand the interaction between human activity and the environment. They help to identify water availability for various uses, stresses on water, and qualitative and quantitative water scarcity. They provide an information system which facilitates the formulation and evaluation of policies and strategies of sustainable development.

7.6 In Section 2 the basic concepts of hydrology are introduced and the interaction between the hydrological system and the economy described. Section 3 discusses in detail the asset classification of water resources. Section 4 discusses physical flow accounts by presenting supply and use tables for water flows and accounts for water stocks. Practical examples are included as well as a more theoretical framework. Water asset accounts are presented in Section 5 together with a discussion on sustainability and other issues pertaining to water accounts. Monetary accounts and environmental protection expenditures are presented in Sections 6. Quality accounts in physical terms are discussed in Section 7. For the definitions of the terms used throughout this section, we refer to the glossary at the end.

2 The hydrological system

7.7 When compiling water accounts, it is important to understand the hydrological cycle and to describe what the hydrological system means within a territory of reference. The hydrological or water cycle is the

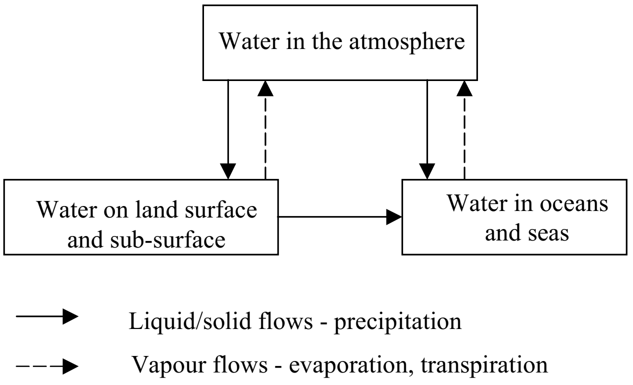
> "succession of stages which water passes from the atmosphere to the earth and back to the atmosphere: evaporation from the land or sea or inland water, condensation from clouds, precipitation, accumulation in the soil or in bodies of water, and re-evaporation" (International Glossary of Hydrology, 1992).

The hydrological system is a system of repositories of water in the territory of reference which describes the transfers among these repositories. The simplest description of the hydrological system uses three repositories: water in the atmosphere, water in the oceans and seas, and water on land surface and subsurface. Figure 7.1 shows the main components of the hydrological system and the transfers between them. The transfers to the atmosphere are represented by evaporation and transpiration, and the transfers from the atmosphere are by precipitation.

7.8 Here we focus only on the part of the global hydrological system which deals with water on land surface and sub-surface in the territory of reference: the inland water system. This sub-system can be further disaggregated into various components such as lakes, reservoirs, groundwater, rivers, snow, ice, and water in soil.

7.9 At the global level, the natural input of water to the inland water system is precipitation. Part of this precipitation evaporates back into the atmosphere immediately; part drains into surface water (lakes, rivers, reservoirs) to ultimately end up in the sea; part infiltrates soil and becomes soil moisture and then groundwater. A portion of the groundwater gradually works its way back into surface water (and becomes the main source of dependable river flow) and or to the sea. Plants and vegetation absorb part of the soil moisture through their roots, and release most of it into the atmosphere in the process of transpiration. Snow and ice formation represent a large store of water in its solid form. They contribute to the flow of water in surface and subsurface water during snowmelt seasons. In addition to these movements of water, there are also natural flows into and out of the territory of reference and the sea through rivers and groundwater. This natural system is modified through human activities such as activities of direct abstraction, returns of water, and induced evapo-transpiration.

Figure 7.1 **Elements of the global hydrological system.** Source: UNESCO (1989).



3 *Asset Classification*

7.10 The asset classification of water resources in the SEEA reflects those components of the hydrological system that are available for water abstraction and provide direct inputs into production process. The stock classification can be described as follows:

- EA.13 Water Resources (cubic metres)
  - EA.131 Surface water
    - EA.1311 Reservoirs
    - EA.1312 Lakes
    - EA.1313 Rivers
  - EA.132 Groundwater

7.11 ***Surface water*** comprises all water which flows over or is stored on the ground surface (International Glossary of Hydrology, 1992). Depending on data availability and country priorities, the classification could be further disaggregated. Reservoirs can be classified according to the type of use, for example, for human, agricultural, electric power generation and mixed use. Rivers can be classified on the basis of the regularity of the runoff as perennial, where water flows continuously throughout the year, or ephemeral, when water flows only in direct response to precipitation or to the flow of an intermittent spring. Namibia (Lange 1997), Moldova (Tafi and Weber 2000) and France (Margat 1986) have used such a breakdown.

7.12 ***Groundwater*** comprises all water which collects in porous layers of underground formation known as aquifers. Aquifers may be unconfined, that is they have a water table and an unsaturated zone or may be confined when they are between two layers of impervious or almost impervious formations. Unconfined aquifers are recharged during the water cycle by the percolation of rain or melted snow and thus hold renewable groundwater. The water in confined aquifers has accumulated over a geological time span and, because of its location, cannot be recharged at all or only over a long time span. Such water resources are non-renewable or fossil water. (Most water in lakes is also non-renewable since the replenishment rate is a small proportion of the total volume of water.)

7.13 The other components of the hydrological system such as soil water, glaciers, snow, ice, and marine water are not part of the classification of stocks either because water cannot be abstracted (soil water) or because water abstraction does not have an effect on the size of the stocks (glaciers, marine water, etc.). However, it is important to understand the role of these components in the hydrological cycle and to account for them when compiling the accounts. If data on stocks of soil water, snow and ice are available, they can be included in a special column in the asset accounts. Several countries including France, Moldova, Spain, and Chile have compiled accounts for soil water, snow and ice. This information can be particularly relevant in the case of seasonal accounts, when water stored in soil and snow at one period is an essential resource for the following one.

7.14 The 1993 SNA includes only a small portion of the total water resources. “Aquifers and other groundwater resources to the extent that their scarcity leads to the enforcement of ownership and/or use of rights, market valuation and some measure of economic control” are within the SNA asset boundary.

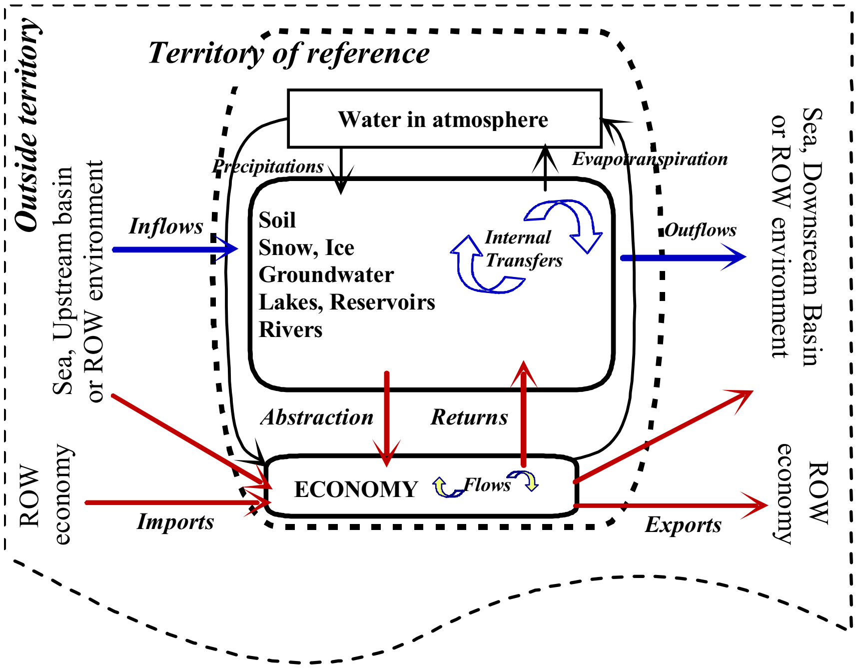
7.15 SEEA extends the boundary to include all water resources that provide both direct use and non-use benefits. This implies that the category “Water Resources “, EA.13, includes all the water resources which can be extracted in the current period (direct use benefits) or might be of use in the future (option benefits). In practice data are more likely to be available in case of scarcity and the services to production and consumption provided by the water bodies are threatened or actually diminished.

7.16 The SEEA also considers water resources in terms of the area covered by surface water. The area of surface water is included in the EA.2 category of the asset classification, namely “Land and surface water”. Moreover water ecosystems are included in the category EA.3 “Ecosystem” of the classification. Measurement relating to surface water is included under land cover in the section on land accounts.

4 Physical accounts for water

7.17 Figure 7.2 shows the interaction between the hydrological system and the economy. The exchanges of water between the environment and the economy include direct abstraction from and returns of water to ground, surface water and other water such as sea and brackish water. In-situ uses of water by the economy, which do not involve direct abstraction, such as water recreation or means of transport, are not considered here. In addition, precipitation onto agricultural land or precipitation collected by the sewage system is also considered as an input into the economy, although not a result of human activity. The storage and release of water in dams is not considered to create products within the economy, but remain part of the hydrological system. This is because it is difficult to make a distinction between the direct economic use of the water and what is required for regulating the discharge of the rivers, say for flood prevention or support to the runoff in summer period.

Figure 7.2 Schematic representation of the interaction between the hydrological system and the economy.



Source: based on Tafi and Weber (2000)

7.18 The economy returns water to the hydrological system through various flows such as returns of wastewater to aquifers and rivers, returns from irrigation activities, losses in transportation (supply and sewerage pipes etc.). These return flows are an input to the hydrological system and become a resource (even if often of lower quality) for subsequent uses. Discharges of water can also be made directly to the sea in which case they are no longer available for immediate use. Imports/exports of water to and from the economy are considered as direct inflows/outflows of water through pipes from and to the economies of other territories. That is they are regarded as flows of products and not of natural resources.

Water accounts: physical flows

7.19 Physical water accounts describe the whole system of flows of water in physical terms between the environment and the economy and within the economy. In describing these flows, it is important to recall the difference between ecosystem inputs, natural resources, products and residuals. *Ecosystem inputs* are inputs from the environment into the economy. Although they are not a result of human activity, they lead to biomass growth. Hence precipitation on agricultural land is treated as *ecosystem input*. *Natural resources* refer to the raw materials that are withdrawn from the environment. Hence all water abstracted from the environment is considered a *natural resource*. Part of abstracted water is then supplied to a third party. In this case, it becomes a *product* as it enters into the economy. *Residuals* are the unwanted and undesired outputs from production and consumption processes within the economy which return to the environment. Hence when water is discharged back into the environment, it is considered to be a *residual*.

7.20 The boundary between what should be considered a natural resource and what should be considered a product are not well delimited. Water abstracted for motive power, for cooling, or which is simply displaced from one location to another (e.g. in mines or as a result of flooding) is a *natural resource*. Water abstracted for own use, other then the ones mentioned above, could be considered either a *natural resource* or a *product*. In the first case, it is recorded in the use table as a use of a natural resource by the extracting industry and, in the supply table, a return into the environment after use. In the second case, it is also recorded as a supply of water (as a product) by the extracting industry to itself and as a use by the same industry. Large amounts of water are abstracted for own use (including but not confined to irrigation water) and there is increasing concern about the amounts of such usages. Moreover the establishment of water rights, which regulate the access to the resource through fees, has become increasingly a common practice. This has lead some countries to argue that water abstracted for own use should be considered as product. Other countries object to this position as treating water as product would lead to the imputation in the monetary supply and use tables the value of water that is not transacted in the market. A compromise solution is to record water used by industry and identify the water for which access rights were paid and water which was directly abstracted from the environment free of charge. In the tables presented in this paper, all water abstracted for own use is considered a natural resource.

7.21 The treatment of wastewater, which is delivered to a treatment plant, is also controversial. Some argue that it is a residual as it is an unwanted result of production which has a "negative price"[2]. This approach is however not consistent with the coverage of the "Central Product Classification" which includes all products that can be object of domestic or international transactions or that can be entered into stocks. We therefore suggest to treat all wastewater delivered to a treatment plant as a product and all wastewater released to the environment (treated and untreated) as a residual. From the definition above, it follows that wastewater which is supplied from one industry to another (different from ISIC 90 "Sewage and refuse disposal, sanitation and similar activities") should be considered as product. Figure 7.3 gives a diagrammatic view of water flows from the abstraction to the use within the economy and to the returns to the environment

7.22 Flows of water from the environment to the economy, within the economy, and from the economy back to the environment can be described in a supply and use table. Supply and use tables are constructed such that the basic identity "supply equals use" is satisfied for each water categories, ecosystem input, natural resource, product and residual, separately. In the case of water as a *natural resource*, the environment supplies all the water that is directly abstracted by the economy. Within the economy, the total water supplied through mains is equal to the total use of water received through mains. As for *residuals*, the environment is considered to use all the water discharged (hence supplied) by the economy. Also in this case, the total supply equals the total use.

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[2] CPC is currently under revision and the inclusion of wastewater in the CPC waste categories has been suggested and is currently under discussion by the technical sub-group on International classifications

Figure 7.3 Schematic water flows

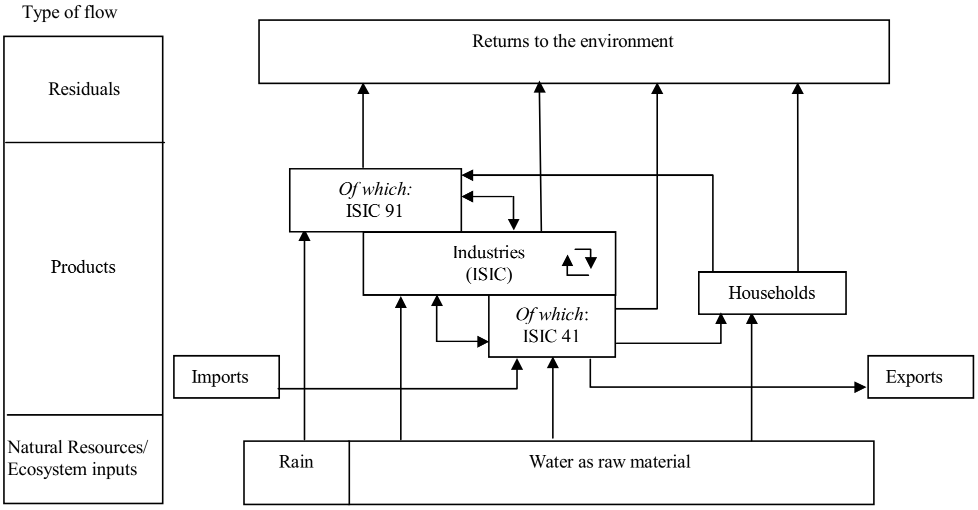

Figure 7.4 Description of the main agents which supply and treat water

ISIC 41 "Collection, purification and distribution of water"

- Includes activities that produce water as the principal product of interest
- Includes desalting of sea water to produce water as the principal product of interest
- Excludes irrigation system operation which is included in ISIC 1.40 and treatment of wastewate in order to prevent pollution which is included in ISIC 90.

ISIC 1.40 "Agriculture and animal husbandry service activities, except veterinary activities"

- Includes operation of irrigation system for agricultural purposes.

The operation of irrigation system is a specific service providing water to farmers, especially through network of open-air canals. It should be noted that irrigation water could also be provided by ISIC 41 through normal pipes (as drinking or non-drinking water).

ISIC 90 "Sewage and refuse disposal, sanitation and similar activities"

- Includes activities of sewage and refusal disposal and other processes of sewage disposal an maintenance of sewers and drains.

Supply table

7.23 Table 7.1 shows the supply of water by industries, final consumers, rest of the world and the environment. Shaded cells in this and future tables in this section indicate where entries are possible.

7.24 All abstraction of water is shown as coming from the environment to the economy. It can and should be disaggregated between whether it is ground, surface or other water (e.g. sea or brackish water) and for some countries further detail may be useful.

7.25 Figure 7.4 shows which are the main industries supplying water as a product. In addition some industries may supply water which is already been used in the production process to other industries needing lower quality water in their production process. When data are available, the supply can therefore be further disaggregated depending on the type of water, water as reused, treated water, etc. The supply of water as a product is net of the leakages during transportation. These losses are considered as returns from the industry supplying water.

7.26 The entries under residuals cover the returns of water to the environment and include all the flows of water from the economy to the environment: they are supplied by the industries and used by the environment. Residuals flowing to the environment come from different industries in different ways. The returns of water from agriculture include the runoff of that part of water used for irrigation, which is not absorbed by plants and returns to surface, ground or other water. Water used for cooling or hydroelectricity generation is returned to the environment directly after use. Discharges of wastewater are disaggregated into treated and untreated wastewater discharges.

7.27 The supply of water as product in the column "rest of the world" indicates imports of water from other countries.

Table 7.1 Schematic water supply table

(million m^3)

		ISIC				Final Consumer	Rest of the World	Environment	Total
		ISIC 01	ISIC 02	ISIC 03	…				
Ecosystem Inputs	S1- Rain							▨	▨
Natural Resources	S2- Total water abstracted							▨	▨
	Water abstracted for own use							▨	▨
	of which: for irrigation							▨	▨
	Water abstracted for delivery							▨	▨
Products	S3- Water supplied to other sectors	▨	▨	▨	▨	▨	▨		▨
	of which: Wastewater	▨	▨	▨	▨	▨	▨		▨
Residuals	S4- Water returned (water discharged)	▨	▨	▨	▨	▨	▨		▨
	Irrigation water	▨	▨	▨	▨	▨	▨		▨
	Cooling water	▨	▨	▨	▨	▨	▨		▨
	Wastewater treated	▨	▨	▨	▨	▨	▨		▨
	Wastewater untreated	▨	▨	▨	▨	▨	▨		▨
	Losses/leakages	▨	▨	▨	▨	▨	▨		▨
	Other returns	▨	▨	▨	▨	▨	▨		▨
S- **Total Supply** (S3+S4)		▨	▨	▨	▨	▨	▨		▨

7.28 All tables are illustrated using fictitious but realistic data. Table 7.2 shows the data for the supply table.

Table 7.2 Numerical water supply table

(million m^3)

		Agriculture	Fisheries	Energy	Mining	Manufacturing	Distribution of irrigation water	Collection & Distribution of water	Sewerage	Households	Rest of the World	Environment	Total
Ecosystem Inputs	S1- Rain											750	750
Natural Resources	S2- Total water abstracted											3198	3198
	Water abstracted for own use											1791	1791
	of which: for irrigation											100	100
	Water abstracted for delivery*											1407	1407
Products	S3- Water supplied to other sectors*	34				135	530	725		480	5		1909
	of which: Wastewater	30				130				480			640
Residuals	S4- Water returned (water discharged)	319	46	1377	4	29	80	75	1340	197	0		3467
	Irrigation water	319											319
	Cooling water			1377									1377
	Wastewater treated		16						1340				1356
	Wastewater untreated		30							197			227
	Losses/leakages					29	80	75					184
	Other returns				4								4
S- **Total Supply** (S3+S4)		353	46	1377	4	164	610	800	1340	677	5		5376

* Entries net of leakages

Water flows within the economy

7.29 In order to see who is supplying water to whom, a matrix of flows of water (as product) within the economy can be compiled as shown in Table 7.3. The numerical example is given in Table 7.4. In this particular case, the main redistribution is of irrigation water to agriculture and of drinking water to households. The row totals in both tables show the total supply of water as a product and are thus equal to the row for total supply of product in Table 7.1 and Table 7.2

Table 7.3 Schematic matrix of flows within the economy

(m^3)

	ISIC 01	ISIC 02	ISIC 03	…..	Final Consumer	Rest of the World	Total
ISIC 01							
ISIC 02							
ISIC 03							
…..							
Final Consumer							
Rest of the World							
Total							

Table 7.4 Numerical matrix of flows within the economy

(million m^3)

	Agriculture	Fisheries	Energy	Mining	Manufacturing	Distribution of irrigation	Collection & Distribution of water	Sewerage	Households	Rest of the World	Total
Agriculture	4							30			34
Fisheries											
Energy											
Mining											
Manufacturing					5			130			135
Distribution of irrigation water	530										530
Collection & Distribution of water			10		115				570	30	725
Sewage											
Households								480			480
Rest of the World							5				5
Total	534		10		120		5	640	570	30	1909

7.30 Only the flows within the economy are recorded in Table 7.3. The diagonal elements of the table indicate the supply of water of one industry to itself according to the level of aggregation of ISIC. For example, in the case of Manufacturing in Table 7.4, 5 represents water used by one manufacturing industry, e.g. manufacture of beverages, may be reused by another manufacturing industry, e.g. manufacture of basic chemicals, or by itself. If abstractions *for own use* are considered as a product (see paragraph 7.20), then these quantities will appear in the main diagonal of Table 7.3.

Use table

7.31 Table 7.5 is the counterpart to Table 7.1 and shows the use of water. In this table the abstractors of water as a natural resource are shown by industry and sector. Usually the largest abstractors will include agriculture and electricity generation, who abstract for own use, as well as the water supply industries that abstract in order to supply third parties. As before disaggregation between ground, surface and other water is desirable. Table 7.5 shows the use of precipitation by industry. The main users of precipitation are ISIC 01 “Agriculture” and ISIC 90 “ Sewage and refuse disposal”. For agriculture it is particularly important to record this quantity to determine the efficiency of rainfed agriculture as compared to irrigated agriculture.

7.32 It may be helpful to analyse these total uses by purpose. The use of water could be disaggregated by purpose according to data availability and specific country needs. In Denmark, for example, five types of uses are identified; tap water production, cooling, directly for production processes and other uses. This decomposition may not be relevant to all the industries, and consequently a number of more informative satellite tables could be constructed to the extent data have been available (Bie and Simonsen 1999). For example, the use of water by agriculture could be classified as water for irrigation, for animal husbandry, sanitary purposes and other purposes (Bie and Simonsen 1999). The Australian Bureau of Statistics (2000) distinguishes the use of water according to whether the water is reused in the production process, after having been treated to some extent, or whether it is directly supplied through mains. Namibia and Botswana classify the water used according to whether it is provided by bulk systems or rural systems.

7.33 Analogously in the use table, the use of water as product in the column “rest of the world” represents the exports of water to other countries.

Table 7.5 Schematic use table for water

(m^3)

		ISIC				Final Consumer	Rest of the World	Environment	Total
		ISIC 01	ISIC 02	ISIC 03	….				
Ecosystem Inputs	U1- Rain								▨
Natural Resources	U2- Total water abstracted	▨	▨	▨	▨	▨	▨		▨
	Water abstracted for own use	▨	▨	▨	▨	▨	▨		▨
	of which: for irrigation	▨	▨	▨	▨	▨	▨		▨
	Water abstracted for delivery	▨	▨	▨	▨	▨	▨		▨
Products	U3- Water delivered through mains	▨	▨	▨	▨	▨	▨		▨
	of which: Wastewater	▨	▨	▨	▨	▨	▨		▨
Residuals	U4- Water returned (water discharged)							▨	▨
	Irrigation water							▨	▨
	Cooling water							▨	▨
	Wastewater treated							▨	▨
	Wastewater untreated							▨	▨
	Losses/leakages in distribution							▨	▨
	Other returns							▨	▨
U- **Total Water Use** (U1+U2+U3)		▨	▨	▨	▨	▨	▨		▨
CONSUMPTION (U-S)		▨	▨	▨	▨	▨	▨		▨

7.34 From the Supply and Use Table the total water consumption can be calculated. Water consumption is defined as the part of abstracted water which is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, consumed by man or livestock, or otherwise removed from freshwater resources. Water consumption is calculated for each sector as the difference between water use and water supply.

7.35 Table 7.6 shows a numerical example of a use table. The table shows that about 56 per cent of abstractions are for own use and only about 44 per cent for delivery. Almost 80 per cent of water abstracted for own use is used in the generation of electricity and about 10 per cent for irrigation. Of all distributed water, more than 50 per cent is for irrigation and households. The amount of water going for treatment is about two third of the total redistributed.

Table 7.6 Numeric use table for water

(million m^3)

		Agriculture	Fisheries	Energy	Mining	Manufacturing	Distribution of irrigation water	Collection & Distribution of water	Sewerage	Households	Rest of the World	Environment	Total
Ecosystem Inputs	U1- Rain	50							700				750
Natural Resources	U2- Total water abstracted	147	46	1400	5	54	610	800		136			3198
	Water abstracted for own use	144	46	1400	5	50	10			136			1791
	of which: for irrigation	100											100
	Water abstracted for delivery*	3				4	600	800					1407
Products	U3- Water delivered through mains*	534	0	10	0	120	0	5	640	570	30		1909
	of which: Wastewater								640				640
Residuals	U4- Water returned (water discharged)											3467	3467
	Irrigation water											319	319
	Cooling water											1377	1377
	Wastewater treated											1356	1356
	Wastewater untreated											227	227
	Losses/leakages											184	184
	Other returns											4	4
U- **Total Water Use** (U1+U2+U3)		731	46	1410	5	174	610	805	1340	706	30		5857
CONSUMPTION (U-S)		378	0	33	1	10	0	5	0	29	25		481

* Entries net of leakages

5 Asset accounts for water

7.36 Asset accounts for water describe how the stocks of water at the beginning of the accounting period are affected by transfers of water between the environment and the economy and transfers of water internal to the hydrological system to reach the stocks of water at the end of the accounting period.

7.37 Before embarking on the compilation of asset accounts for water, the definition of water stock has to be clarified. For groundwater, reservoirs and lakes it is conceptually simple to measure stocks. For rivers, the stock of water is not well defined due to the "flowing" nature of the resource. Here to maintain consistency with the other water resources, the stock of water in a river is measured as the volume of the riverbed. This is the definition that has been used by Spain, France, Chile and Moldova. However the volume of a riverbed is not a quantity of interest in itself and is not a good measure of water stocks for ephemeral rivers in particular. An alternative measure is annual runoff (AR) into the river or the mean annual runoff (MAR) in a country subject to very large annual variation.

7.38 AR is the total volume of water that flows during a year, usually referring to the outflow of a drainage area or river basin. For perennial rivers, runoff is measured at the lowest (downstream, sometimes close to the estuary) point. Hence it includes all the flows which have happened upstream in the river basin. For rivers crossing national borders, the runoff may take place entirely or mainly outside the country being considered in which case it is the runoff at the point of entry which is of interest.

7.39 MAR is defined as the average annual flow under natural conditions. The definition is dependent on the runoff regime for each river basin. Where flow increases downstream, the flow is greatest at the mouth of the river basin, MAR is defined at the river basin. Where flow in the rivers decreases downstream, often with little or no outflow from the river basin, MAR is defined as the combined MAR of each of the major catchments in the river basin, calculated at the point where the flow is greatest and excluding runoff from upstream basins. (ABS 2000, and AWRC 1987)

7.40 The use of AR or MAR as a measure of stock presents problems in the asset accounts as some of the flows in the table may be already included, depending on where the river flow is measured. In such a case the flows in the asset account should be modified accordingly to avoid double counting.

7.41 Table 7.7 represents the asset accounts for surface water and groundwater resources. As explained above, the classification of water assets does not include water in soil and vegetation, snow and ice. In this case the asset accounts will measure the precipitation which falls directly on rivers, lakes and reservoirs, and the part of the precipitation which reaches surface and ground water. The runoff to surface water and infiltration to groundwater are therefore net of evapo-transpiration.

7.42 Table 7.8 includes a category "Other" so as to allow countries to expand the accounts as they see fit. For example, France, Spain, Chile and Moldova have compiled accounts also for permanent snow and ice and water in soil. If a column for "soil" is introduced, water asset accounts allow for measuring real precipitation and real natural evapo-transpiration. The presentation of these accounts in terms of gross precipitation allows, among other things, the assessment of the relative importance of natural versus artificial evapo-transpiration.

7.43 The opening and closing stocks represent the quantity of water, in cubic metres, at the beginning and end of the accounting period. The changes in stocks during the accounting period can be caused by human activities (abstraction and return of water to the environment) and by natural process (precipitation, evapo-transpiration, natural inflows and outflows to other rivers, etc.). The detailed description of the table entries is as follows:

> ***Abstraction*** (row A1) this is the total volume of water abstracted in a year (these data can be obtained from Table 7.5 by rearranging the data. A distinction is made between the sustainable level of abstraction and what constitutes depletion of the resource. The sustainable levels are determined based on environmental, socio-economic considerations. For a detailed discussion see the next section.
>
> ***Residuals*** (row A2) represent the total volume of water in the accounting period returned to the environment. The total return of water, A2, has to be equal to the part of the supply S5 in Table 7.1 which returns to surface and groundwater. When data are available, the returns of water could be disaggregated by type of water returned.
>
> ***Precipitation*** (row A3) is composed by all wet precipitation. When the category "water in soil" is not included in the table, the figures for precipitations are net of evapo-transpiration, namely they represents the part of the total annual precipitation that reaches the lakes (directly), rivers (via runoff), reservoirs (directly), and groundwater (infiltration).
>
> ***Inflows*** (row A4) represent the total volume of water in the accounting period that enters the territory of reference. For a river that enters the territory of reference, the inflow is the total quantity at its entry point. If a river borders two territories without finally entering either of them, both territories could, depending on conventions or treaties, claim 50% of the flow to be attributed to their territory. In situation in which rivers cross borders several times it is necessary to take account of outflows at exit as well as inflows on entry.
>
> ***Net natural transfers*** (row A5) for a water resource is defined as the difference between the inflows to one type of water resource from all the others and the outflows from the same water resource to all the others. This quantity represents a measure of the natural exchanges of water is computed from the natural transfer matrix in Table 5.
>
> ***Evapo-transpiration*** (row A6) is the loss (in cubic metres) during the accounting period of the water resources due to the process of evapo-transpiration.
>
> ***Outflows*** (row A7) represent the volume of water that leaves the territory of reference during the accounting period. This flow could be disaggregated depending whether the flow is to other territories or to the sea.
>
> ***Other changes in volume*** (row A8) include all the changes in the stocks of water that are not specified elsewhere in the table. This is item can either be estimated or calculated directly. It is usually calculated as a difference between the closing and opening stocks and the entries in the table, that is it is a balancing item.

Table 7.7 Schematic asset account for water

(m^3)

			EA.131 Surface water			EA.132 Groundwater	Other	Total
			EA.1311 Reservoirs	EA.1312 Lakes	EA.1313 Rivers			
Opening Stocks								
A1	Abstraction	Sustainable use						
		Depletion						
A2	Residuals	Irrigation						
		Wastewater						
		….						
A3	Precipitation (+)							
A4	Inflows (+)							
A5	Net natural transfers (+/-)							
A6	Evapotranspiration (-)							
A7	Outflows (-)	To other regions						
		To the sea						
A8	Other Volume changes	Due to natural disaster						
		Discovery (+)						
		Others						
Closing Stocks								

Indicators						
Total natural renewable resources						
Total actual renewable resources						
Dependable water						
Total non-renewable water						

7.44 Some countries may not have information on each flow separately. Some of the flows can be combined according to data availability. Table 7.7 can be augmented with information on important indicators such as total renewable water resources, total actual renewable water resources, total non-renewable water, and dependable water.

Total natural renewable water resources water resource is the sum of the average annual flow of rivers and recharge of ground water generated from endogenous precipitation and the natural flow originating outside the country (FAO, 2000).

Total actual renewable water resources is the sum of the internal renewable water resources and natural incoming flow originating outside the country, taking in to account the quantity of flow reserved to upstream and downstream countries through formal or informal agreements (FAO, 2000).

Dependable water is defined as the portion of the surface water resource that can be depended upon for annual water development during a period of time. The period of time varies according to countries situation, and it is usually defined as 19 out of 20 consecutive years.

Total non-renewable water is the volume of water which is not renewable by endogenous processes during the hydrological cycle. It includes fossil groundwater generated in geological times as well as a large part of water in lakes, whose replenishment rate is very small.

Table 7.8 Numerical example of an asset account for water

(million m^3)

			EA.131 Surface water			EA.132 Groundwater	Total
			EA.1311 Reservoirs	EA.1312 Lakes	EA.1313 Rivers		
Opening Stocks				2700	500	150000	153200
A1	Abstraction	Sustainable use			2500	698	3198
		Depletion					
A2	Residuals	Irrigation					319
		Wastewater					1583
		….					1565
A3	Precipitation (+)			210	2725	265	3200
A4	Inflows (+)				9000	1100	10100
A5	Net natural transfers (+/-)				45	-45	0
A6	Evapotranspiration (-)			420	320		740
A7	Outflows (-)	To other regions			8900	1400	10300
		To the sea					
A8	Other Volume changes						
Closing Stocks				2490	550	149222	155729

7.45 Table 7.9 shows the matrix of transfers between water resources. These are natural flows and are determined by processes of infiltration from surface water to groundwater, processes of groundwater discharge to surface water, etc.

Table 7.9 Matrix of transfers between water resources

(m^3)

		EA.131 Surface water			EA.132 Groundwater	Other	Total Outflows
		EA.1311 Reservoirs	EA.1312 Lakes	EA.1313 Rivers			
EA.131 Surface Water	Reservoirs						
	Lakes						
	Rivers						
EA.132 Groundwater							
Other							
Total Inflows							
Net Natural transfer (inflows-outflows)							

7.46 Table 7.10 gives a rather simplistic numeric example of transfers between water resources.

Table 7.10 Numerical example of transfers between water resources

(m^3)

		EA.131 Surface water			EA.132 Groundwater	Total Outflows
		EA.1311 Reservoirs	EA.1312 Lakes	EA.1313 Rivers		
EA.131 Surface Water	Reservoirs					
	Lakes					
	Rivers				20	20
EA.132 Groundwater				65		65
Total				65	20	
Net Natural transfer (inflows-outflows)				45	-45	

Sustainability

7.47 In the case of water, sustainability refers to the amount of water that can be abstracted without impairing the ability of the ecosystem to regenerate itself. This interpretation of sustainability is related to environmental and socio-economic considerations. The first consideration is whether there are physical constraints to water abstraction; water may be stored in soil or glaciers and cannot be abstracted for a certain time period of the year. In addition, water may also be lost underground, that is it filters through the soil but the corresponding aquifer is not identified. There are also environmental issues that should be taken into account when looking at the exploitation of water resources.

7.48 For an aquifer, abstraction should not exceed its future replenishment nor impair its functions. On an annual basis, sustainable abstraction may be defined as equal to the aquifers' replenishment, resulting from infiltration from precipitation and inflows, less a minimal outflow to other components of the hydrological system, such as springs and baseflow. When calculating sustainable abstraction one has to take into consideration the long-term rainfall and other condition that may affect the water table. Often the level of the water table may provide an indication on the level of abstraction. If the level of the water table falls, that might indicate that the use is non-sustainable but not give a quantifiable measure of how much use is non-sustainable. Common sense and experience must be used not to raise concerns over non-sustainable use of water when there are realistic expectations that the decline in stocks of water is a temporary one due to seasonal rainfall patterns.

7.49 For water in lakes, reservoirs and dams, abstraction must not threaten the maintenance of the economic, ecological or recreational "in situ" functions or uses of water such as those which support biodiversity, water recreation, outflows to other components of the inland water system and so on. Sustainable water abstraction may be defined as equal to the lake's natural replenishment, resulting from runoff, inflows from rivers, springs. A temporary decrease in the stock, in particular when the reservoir is part of the surface water regulation system, may be sustainable.

7.50 For water in rivers, abstraction must not threaten the maintenance of the economic, ecological or recreational "in situ" or downstream functions or uses of water as with lakes and other such water bodies. These functions may only be provided if a minimal flow is maintained in the watercourse.

7.51 Abstraction is also limited by the current level of technology, the costs of abstraction, purification, and distribution as compared to revenues to be gained from making the water available and by legal constraints on water use including but not confined to quality delivered and minimal treatment of wastewater.

7.52 This implies that exploitable water is relative to a set of conditions and depends upon its uses. Valuation of exploitable water is often the responsibility of the institution in charge of the water management and planning in a country. It requires consideration of many issues and constraints and it is therefore often the result of modelling.

Seasonal and geographical issues

7.53 One of the issues that has to be taken into account when compiling water accounts is the seasonal aspect. Water availability may change significantly over the seasons of the year with water being abundant during certain periods of the years and scarce in others. This variability is usually not reflected in yearly accounts. Depending on data availability and the length of the water cycle, it may be useful to compile water accounts quarterly as to reflect water availability and water demands in different seasons.

7.54 Some countries suffer long-term rain cycle, in which several years may go by without significant rainfall. In such cases, indicators which are useful for water-abundant areas may be of limited application.

7.55 Similar reservations apply in the context of the spatial dimension of water. Water may be widely available in certain locations, but absent in others. In Botswana, for example, there is only one river in the extreme north west of the country (the Okavango delta). While this represents a huge amount of fresh water, all of which comes from catchment areas outside the country, it is not available for commercial exploitation and the country as a whole is seriously water stressed, much of it being desert. For such a country, the indicators shown under Table 7.7 would be seriously misleading for Botswana as a whole. As with many indicators, therefore, care in their use has to be taken when there are particular characteristics of a country which invalidate the usefulness of the indicators.

7.56 Water accounts compiled at the national level do not show regional variability. In order to identify this variability, it would be useful to link water data to regional economic accounts. However, if as is sometimes the case, water data is available by watershed these do not fit tidily into administrative regions where rivers may often mark the border between one region and another. Attempting regional disaggregation the data may increase the amount of data to be presented to the extent that the database becomes unwieldy (Vaze 1997).

6 Monetary Accounts

7.57 This section covers monetary valuation of flows, environmental expenditure and resource management accounts, and issues on valuation of water resources taking into account the particular nature of water.

Monetary valuation of flows

7.58 The physical supply and use tables presented in Table 7.1 and Table 7.5 relating to the supply and use of products have monetary counterparts. Water supply in monetary units records the major economic output of industries related to water and imports. In particular it includes output of production of drinking water, non-drinking water, irrigation water, production of sewage removal, and treatment services. The water use table in monetary units records the use of water by different economic agents.

Environmental protection and management activities

7.59 As described in Chapter V, environmental protection and management activities are considered under four main categories:

Environmental protection expenditures;

Management expenditure for regular and ancillary activities;

Environmentally beneficial activities;

Minimisation of natural hazard.

Environmental protection expenditure

7.60 Protection expenditures related to water involve activities of “waste water management” and of “protection and remediation of soil, groundwater and surface water” in CEPA 2000. Wastewater management is mainly undertaken as part of the ISIC 90 “Sewage and refusal disposal, sanitation and similar activities” as well as treatment of wastewater as an ancillary activity.. For soil and groundwater they include activities of prevention of pollutant infiltration (which aim at the reduction or elimination of polluting substances that may be applied to soil and percolate into groundwater), decontamination of soil, activities of monitoring and control soil pollution.

Management expenditures

7.61 Management expenditures accounts cover both primary, secondary and ancillary activities related to water management.

7.62 Management expenditure accounts for primary water activities include the production and generation of income accounts for ISIC 01, “Operation of irrigation systems”, ISIC 41 “Collection, purification and distribution of water” and part of ISIC 75 “Public administration of services”. These accounts may contain supplementary information about fixed capital and labour inputs.

7.63 Management expenditure accounts can be compiled for ancillary water related activities, that is those activities carried out either by industries different from ISIC 01, 41 and 75, for example these activities include direct abstraction of water from a river by manufacturing industry of basic metals for cooling purposes, or by final consumers for own use. These accounts cover expenditures related to activities of abstraction of water and purification of abstracted water. They include information on current expenditure such as intermediate consumption, compensation of employees, taxes and subsidies related to water, on capital expenditure, and, when possible, information on consumption of fixed capital, stock of fixed assets, and labour inputs.

Environmental beneficial activities

7.64 Environmental beneficial activities are those activities which may be primarily undertaken for economic reasons but yield substantial environmental benefits even though the primary purpose is not environmental protection. Environmental beneficial activities related to water include those activities aimed at saving water, whether for final consumers, industrial, service or agricultural uses. They may take the form of investment (irrigation systems, facilities and appliances to reduce water consumption, recycle water, etc.) or the use of products adapted for lower water consumption, such as specially adapted washing machines. (SERIEE 1994).

Minimisation of natural hazard

7.65 Expenditure to minimise natural hazards related to water includes expenditures to prevent flooding, such as the construction of dams to slow down water flow, management of retention areas, measures to avoid droughts and so on. These accounts may provide an indication of the effects of alteration of landscapes and water system or global warming.

Issues on valuation of water resources

7.66 Until the present, water has often been made available free as a public service or for a flat charge because it has been seen to be freely available and not subject to scarcity. The costs, therefore, have tended to be related to the cost of transporting water by pipe to designated outlets rather than to the volume of water consumed. There are indications that this is changing in many parts of the world and this change may accelerate as demand for water increases with increasing populations and increasing prosperity.

7.67 Water valuation is crucial for water management decisions in particular related to allocation of water to different uses in presence of increasing demands for freshwater and limited supply. Decision makers in many nations face many questions such as: How much water should be allocated to agriculture, for irrigated food production? How much should go to cities for final consumers and industries? How much is needed for hydropower generation and in-stream uses? How much groundwater should be pumped now and how much should be saved for future needs? How much groundwater should be extracted versus how much surface water? How much should the beneficiaries of water pay for water supply?

7.68 There are two main ways in which water can be valued. The first and uncontroversial measure is that of the direct market price. As noted, the privatisation of formerly public utilities has led to more direct charging. Sometimes this is still on the basis of a flat fee per dwelling, more often there is a move to charge by volume consumed. Even when charges are levied per litre consumed the rates charged may vary considerably from one kind of user to another. For example, one form of subsidising agriculture may be to offer bulk water supplies at very advantageous rates. This may lead to excessive overuse with consequent shortages for other consumers. For the purposes of sound management of the resource, monetary accounts should be drawn up to show the different classes of consumer linked to the different rates charged.

7.69 Another form of pricing of growing application is the issuing of water rights. These may offer a short term rental of a water source or perpetual water rights. Short term rentals grant rights for a limited period of time, say for one irrigation cycle or a season. The prices observed in this situation are short run and may often reflect other factors in addition to the marginal value of water. The prices paid for the rights can be taken as the value of the water available in the period covered by the rights and a value for the total stock of water estimated using net present value techniques applied to future rights issues. Prices paid for perpetual water rights represent an immediate estimate of the stock of water to which the rights give access without the need for net present value calculations. There is however an element of speculation involved in determining these prices and with an underdeveloped market in such rights, care should be used in using these prices.

7.70 In principle, it would be possible to calculate a resource rent for water used for irrigation by looking at the rent for similar unirrigated land and attributing the increase for the irrigated land to the water used. In practice, however, it is unlikely that the same crop will be grown extensively on near-identical land with and without irrigation so this is not likely to be a very practical means of valuation.

7.71 The valuation techniques of last resort, least satisfactory from a theoretical point of view but perhaps most common in practice, is to set the value of water equal to the cost of making it available. This is to confuse the price of the water with the cost of the means of delivery, as noted above, and likely to prove increasingly unsatisfactory and pressure on water supplies increase.

7 Water quality accounts

7.72 The use to which water can be put depends crucially on the quality of the water. For example, water used for hydropower generation, industrial purposes, and transportation does not require high standards of purity, meanwhile other uses, such as drinking, fishing, habitat for aquatic organisms, rely on higher levels of water quality. Once quality classes are defined, water quality accounts can be constructed following the same general structure as asset accounts in physical terms with quality as another dimension. The accounts show the opening and closing stocks together with the changes in stocks during the accounting period for each quality class. Table 7.11 shows the general structure for quality accounts.

Table 7.11 Quality accounts.

	Quality classes				
	Q1	Q2	Q3	Q4	Q5
Opening stocks					
Changes in stocks					
Closing stocks					

7.73 Quality classes can be defined in various ways depending on the particular interest of the country or region concerned. In Australia, for example, groundwater assets are divided into four water quality categories which indicate the potential use of the resource. The quality classes are based on the total dissolved solids which are measured in milligram per litre (mg/L). Good quality water for human use has a salinity of less than 500 mg/L, with an upper limit of 1,500 mg/L, which is also the limit for crop irrigation. Water for livestock is preferably in the lower ranges, but some salt tolerant livestock can tolerate water up to 15,000 mg/L. For coarse industrial process, such as ore processing, the upper limit may be much higher. By comparison sea water has a concentration of about 35,000 mg/L.

7.74 Quality classes of surface waters can be defined according to of the level of pollution with organic matter such as BOD (biochemical oxygen demand), COD (Chemical Oxygen Demand) or other indicators such as ammonium (ion NH_4^+). Usually, for surface waters, a number of quality classes are defined at the national level. Table 12 shows the accounting structure for the accounts of the quality of rivers in France for the years 1992 and 1994. The quality classes are referred as 1A, 1B, 2, 3 and NC (not classified), with 1A being the highest and 3 the lowest quality class.

The quality of watercourses (organic matter indicator), France, by size class of watercourses.

Thousand kilometres of standard river (kmsr)

Group of water-courses	**1992 state**					**Differences by quality class**					**1994 state**				
	1A	**1B**	**2**	**3**	**NC**	**1A**	**1B**	**2**	**3**	**NC**	**1A**	**1B**	**2**	**3**	**NC**
Class A rivers	5	1253	891	510	177	3	*336*	*9*	*- 183*	*- 165*	8	1583	893	358	12
Class B rivers	309	1228	1194	336	50	*16*	464	- 275	- 182	- 22	325	1691	919	154	28
Class C rivers	260	615	451	128	47	*44*	*130*	- 129	- 17	- 28	306	749	322	110	18
Streams	860	1464	690	243	95	*- 44*	*- 176*	*228*	*15*	- 23	810	1295	917	258	72

7.75 The general structure of quality accounts is simple conceptually, however it presents numerous problems of measurement. Temporal and spatial dimension of water play an important role on its quality and should be taken into account when compiling quality accounts, especially if the accounts are used for water management. The quality of a river, for example, might increase enormously during particular weather conditions, and decrease rapidly when the conditions change. Periodical variations, such as time of the day, season, year, are complemented by sporadic changes in quality due for example to a sudden catastrophe, such as a chemical spill. In addition, a long river may contain water of different quality, with quality often being high at the source of the river and low at the mouth.

7.76 Another issue relates to the measurement of stocks of water of a certain quality. Water quality is measured at a single point and it is difficult to aggregate such measurements to represent large regions such as big lakes, rivers and even drainage regions. This problem is particularly difficult for rivers due to the running nature of the water. One measure that has been proposed by the French environment institute (IFEN) and used by several countries is the Kilometre of Standard River (kmsr) which is a standardised unit of account representing a river stretch of one kilometre with a water flow of one cubic metre of water per second. This measure entails multiplying each stretch of a river containing a certain quality of water by its flow. The river is thus divided in different sections with different quality classes, whose water flow can be aggregated without double counting.

7.77 Although the major changes in stocks of water are due to abstractions and returns, unless very detailed information on the quality of abstractions and returns is available, it will not be practicable to relate changed in water quality to these additions and subtractions from stock levels. In fact, linking the quality of the river asset (expressed in standard river kilometres weighted by indexes of quality) to the flows of residuals and the flows of water which have generated this quality requires using analytical hydrological models. These models exist but they are data demanding and are more for local than national use.

7.78 On the basis of the quality accounts, global indices of water quality have been calculated by France and Chile.

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Glossary

Abstraction: Removal of water from any source, either permanently or temporarily. (International glossary of hydrology, 1992)

Annual Runoff: Total volume of water that flows during a year, usually referring to the outflow of a drainage area or river basin. (International glossary of hydrology, 1992)

Aquifer: Permeable water-bearing formation capable of yielding exploitable quantities of water. (International glossary of hydrology, 1992)

Confined Aquifer: Aquifer overlain and underlain by an impervious or almost impervious formation. (International glossary of hydrology, 1992)

Consumption: water abstracted which is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, consumed by man or livestock, or otherwise removed from freshwater resources. Water losses during transport of water between the point or points of abstraction and the point or points of use are excluded. (EUROSTAT)

Dam: Barrier constructed across a valley for impounding water or creating a reservoir. (International glossary of hydrology, 1992)

Evapo-transpiration: Quantity of water transferred from the soil to the atmosphere by evaporation and plan transpiration. (International Glossary of Hydrology, 1992)

Fossil Water: Water infiltrated into an aquifer during an ancient geological period under climatic and morphological conditions different from the present and stored since that time. (International Glossary of Hydrology, 1992)

Groundwater: Subsurface water occupying the saturated zone. (International Glossary of Hydrology, 1992)

Hydrological cycle: Succession of stages which water passes from the atmosphere to the earth and returns to the atmosphere: evaporation from the land or sea or inland water, condensation from clouds, precipitation, accumulation in the soil or in bodies of water, and re-evaporation. (International Glossary of Hydrology, 1992)

Irrigation: Artificial application of water to lands for agricultural purposes. (International Glossary of Hydrology, 1992)

Lake: Inland body of water of considerable size. (International Glossary of Hydrology, 1992)

Mean Annual Runoff (MAR): MAR is defined as the average annual flow under natural conditions. The definition is dependent on the runoff regime for each river basin. Where flow increases downstream, the flow is greatest at the mouth of the river basin, MAR is defined at the river basin. Where flow in the rivers decreases downstream, often with little or no outflow from the river basin, MAR is defined as the combined MAR of each of the major catchments in the river basin, calculated at the point where the flow is greatest and excluding runoff from upstream basins. (ABS 2000, and AWRC 1987)

Percolation: Flow of liquid through an unsaturated porous medium, e.g. of water in soil, under the action of gravity. (International Glossary of Hydrology, 1992)

Precipitation: (1) Liquid or solid products of the condensation of water vapour falling from clouds or deposited from air on the ground. (2) Amount of precipitation (as defined under (1)) on a unit of horizontal surface per unit time. (International glossary of hydrology, 1992)

Reservoir: Body of water, either natural or man-made, used for storage, regulation and control of water resources. (International Glossary of Hydrology, 1992)

Return flow: Any flow, which returns to a stream channel or to the groundwater.

River: Large stream which serves as the natural drainage channel for a drainage basin. (International Glossary of Hydrology, 1992)

Runoff: The part of precipitation that appears as stream flow. (International Glossary of Hydrology, 1992)

Soil water: Water suspended in the uppermost belt of soil, or in the zone of aeration near the ground surface, that can be discharged into the atmosphere by evapotranspiration. (International Glossary of Hydrology, 1992)

Unconfined Aquifer: Aquifer containing unconfined groundwater that is having a water table and an unsaturated zone. (International Glossary of Hydrology, 1992)

Wastewater: Water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. (Eurostat/OECD Questionnaire 2000)

Water cycle: see *Hydrological cycle*

Water loss during transport: Volume of water lost during transport between a point of abstraction and a point of use, or between points of use and reuse. (OECD questionnaire, 2000)