The Unu-Water Exercise

A Step-by-Step
Introduction to
Environmental –Economic Accounts
for Water
(SEEA-Water)

Solution Booklet

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Rev 35
(translation was done with version 26)

Water in Unu

Module I: Basic understanding of the water cycle in the economy

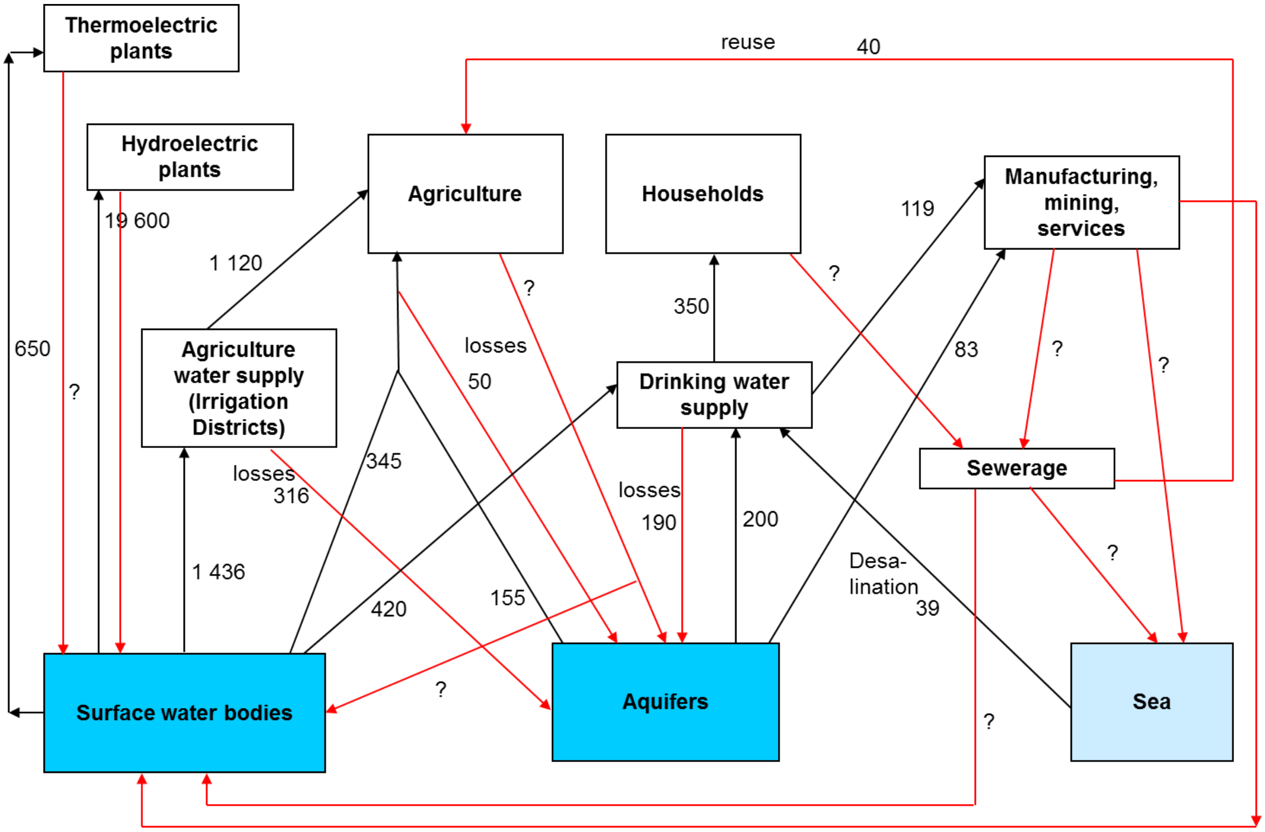
1. Review the following standard concepts from the System of Environmental Accounts Central Framework (SEEA-CF): Abstraction, Final Water Use, and Return.

The following are the standard definitions provided in the System of Environmental-Economic Accounting, Central Framework (SEEA-CF). The specific paragraphs in the SEEA-CF, where the definitions can be found, are provided in parenthesis:

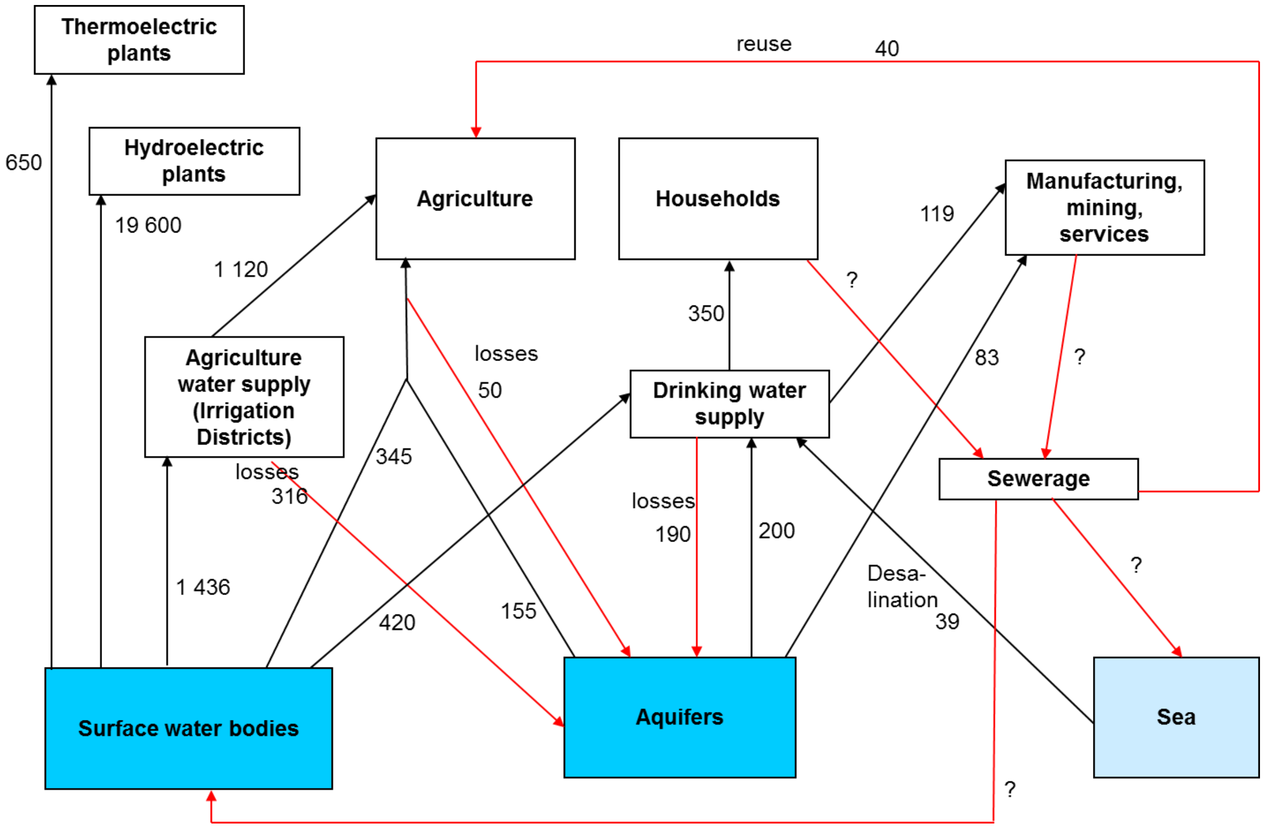
Abstraction	Abstraction is defined as the amount of water that is removed from any source, either permanently or temporarily, in a given period of time. Water used for hydroelectric power generation, is considered as abstraction and is recorded as a use of water by the abstractor. Water abstracted but not used in production, such as water flows in mine de-watering, are recorded as natural resource residuals. Water abstraction is disaggregated by source and by industry. (SEEA-CF 3.195)
Final Water Use	Final Water Use is equal to evaporation, transpiration and water incorporated into products. (Also referred to in the SEEA-Water as "water consumption") (SEEA-CF 3.222)
Return Flows of Water	Return flows of water comprise water that is returned to the environment. (SEEA 3.210)

2. Make a diagram of all the interconnected flows of water with the information provided. Use the template provided.

The diagram below shows all or most of the “flows” of water. The second diagram below shows a simplification, removing some of the “flows” of water in order to simplify the diagram.



In the second diagram, below, some “flows” of water have been removed in order to simplify the diagram.



3. Identify the data items provided according to the data item codes of the IRWS (Annex I).

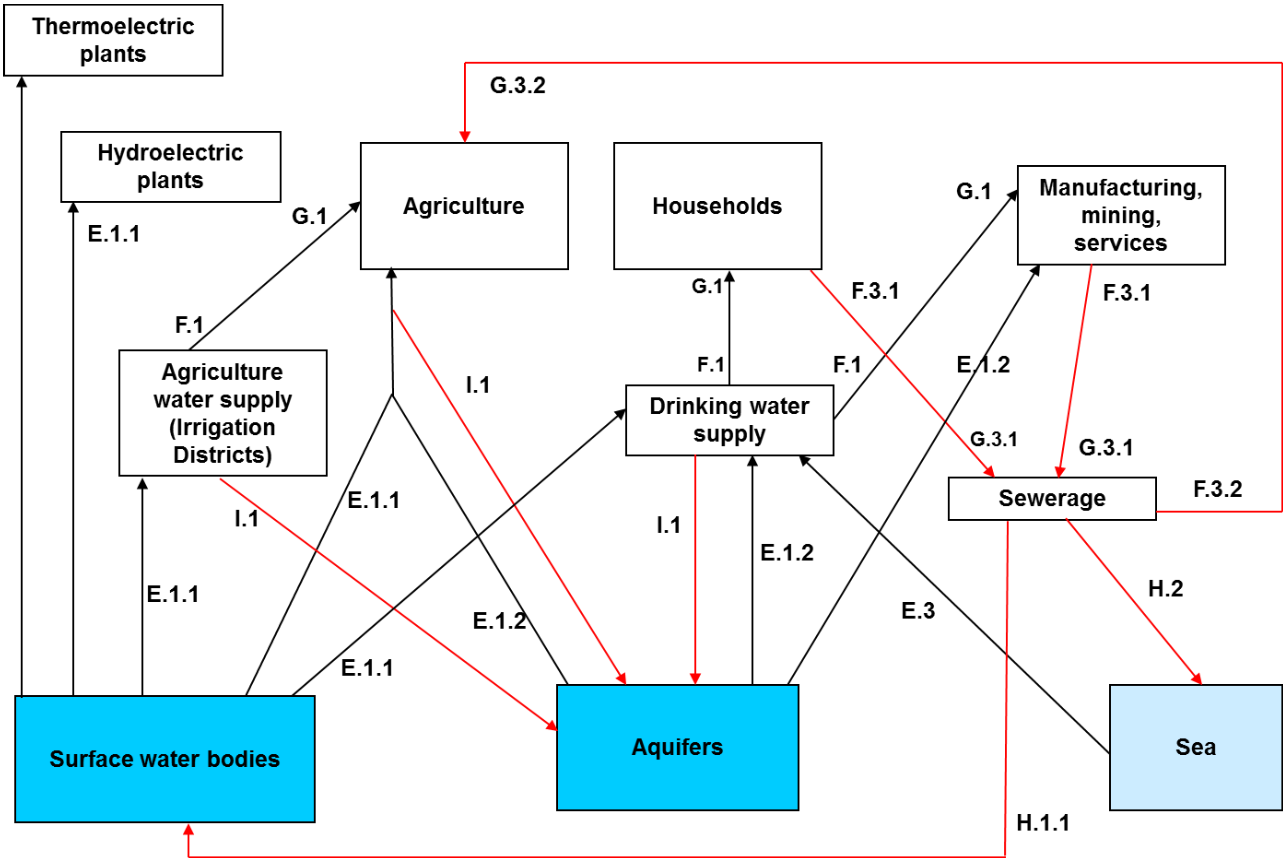
The full list of data items can be found in Annex I of the IRWS. The data items provided in this exercise are the following:

IRWS code	**Data item**
E.1.1	Abstraction of water from surface water
E.1.2	Abstraction of water from groundwater
E.3	Abstraction of water from the sea.
F.	Water supplied to economic units
F.1	Water supplied by resident economic units to resident economic units
F.3.1	Wastewater supplied for treatment or disposal
F.3.2	Wastewater supplied for further use
G.1	Water received by economic units
G.3.1	Wastewater received for treatment or disposal
G.3.2	Wastewater received for further use
H.1	Returns to inland water resources. (This can be further disaggregated into H.1.1. Returns to surface water, and H.1.2. Returns to groundwater.)
H.2	Returns to the sea

I.1 Losses of water

Note that some data items are recorded twice, from the supplier side and from the user side. Therefore, water supplied (F.1) is recorded from the supplier side, and water received (G.1) is recorded from the user side. The same occurs with F.3.1 and G.3.1, and F.3.2 and G.3.2.

The diagram below shows the flows with the corresponding IRWS codes.



4. Identify the industrial activities according to the ISIC standard revision 4.

In order to simplify the example, some activities were lumped together in one group. The following list shows the activities separated.

Activity	ISIC code
Agriculture, forestry and fishing	01 to 03
Mining and quarrying	05 to 09
Manufacturing	10 to 39
Construction	41 to 43
Wholesale and retail trade	45 to 47
Generation, transmission and distribution of electricity	3510
Water supply	36

Sewerage	37

5. Can you provide quantitative estimates of the information that is not provided and that is necessary to quantify all the flows of water, such as, water discharged to the sewers and returns to inland water resources? You can use coefficients to estimate the final water use (also known as water consumption).

The following assumptions will be made:

The final water use or “water consumption,” can be estimated using coefficients determined specifically for each case. If the coefficients are not available locally, coefficients from other countries in the region may be used in a first stage, and then adjusted based on data from the country. For the purpose of this exercise, some arbitrary coefficients, based on international data, will be used, as described below

- Hydroelectricity: it will be assumed that all the water turbinated is returned to inland water resources after leaving the power plant.
- Thermoelectricity: it will be assumed that 95% of the water abstracted for cooling is returned to inland water resources. The rest, 5%, is evaporated.
- Households: it will be assumed that 80% of the water received goes to the sewers, the rest is evaporated.
- Agriculture: it will be assumed 40% of the water used (received from the irrigation districts and abstracted by agriculture) is returned to inland water resources.
- It will be assumed that the different industries and services, other than agriculture, discard 70% of the water received.

Regarding the destination of wastewater, some assumptions can be made based on the different discharges identified and/or the general known facts of the country or region. The following assumptions will be made for this exercise:

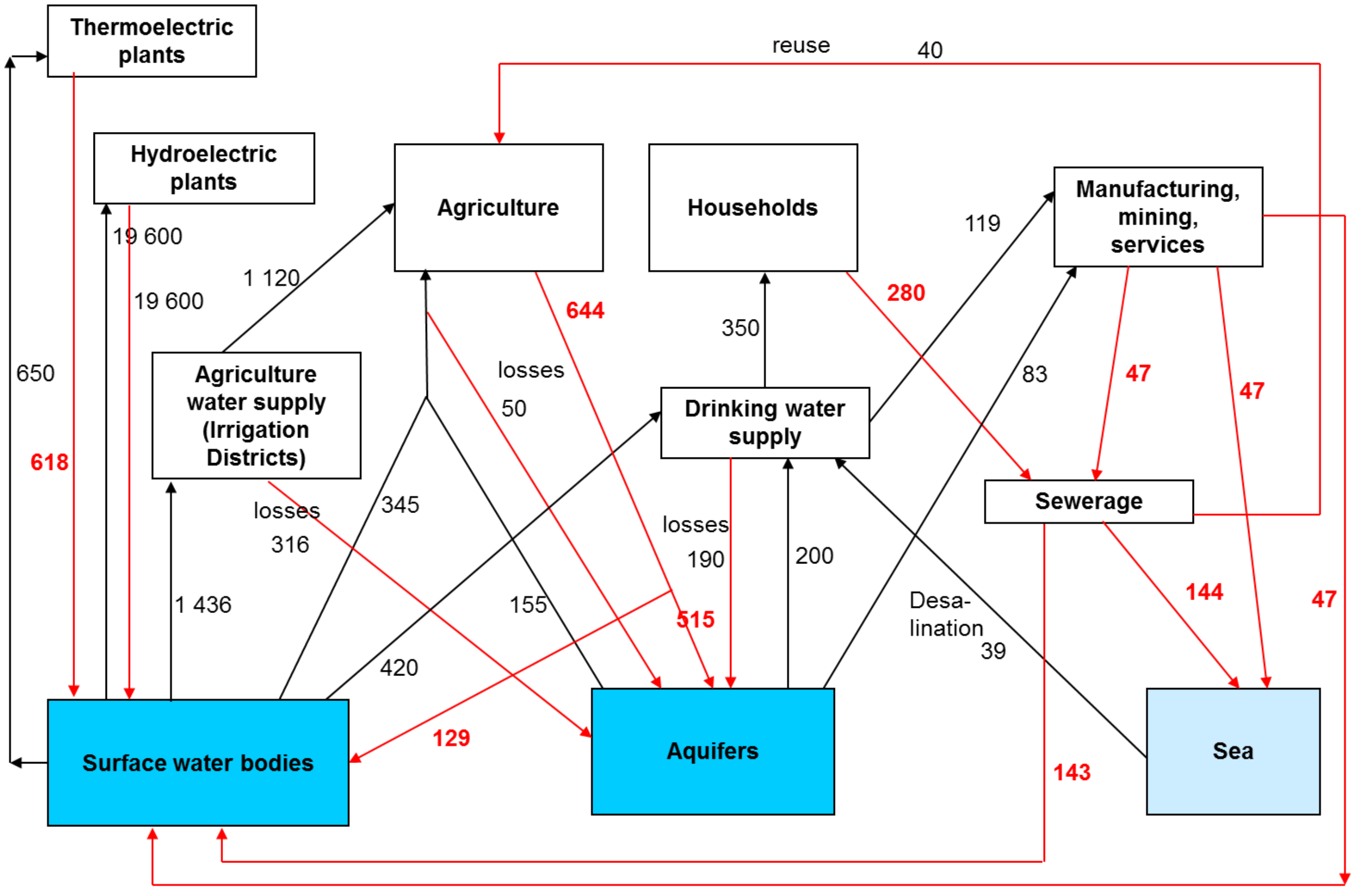
- The water discarded by industries and services is sent to the sewers, to the sea, and to surface water in equal proportions.
- 40 million cubic meters per year of the water discarded through the sewers is sent to agriculture for reuse (information provided in the statement of the problem). From the amount not sent to reuse half is sent to surface water bodies and half to the sea.
- 80% of the water discarded by agriculture goes to groundwater and 20% to surface water.

With these assumptions, the following estimates are made (all the numbers are in million cubic meters of water per year):

- Returns to surface waters (H.1.1) from hydroelectric plants = 19 600.
- Returns to surface waters (H.1.1) from thermoelectric plants = 618.
- Returns to surface waters (H.1.1) from agriculture = 20% (40%)(1 600) = 515.
- Returns to groundwater (H.1.2) from agriculture = 80% (40%)(1 600) = 129.
- Wastewater from households to sewers (F.3.1) = 80% (350) = 280.
- Wastewater from industries and services to sewers (F.3.1) = 1/3 (70%)(202) = 47
- Returns from industries and services to surface waters (H.1.1) = 1/3(70%)(202) = 47
- Returns from industries and services to the sea (H.2) = 1/3(70%)(202) = 47

- Flows from sewerage to the sea = 50%(287) = 143.5. This will be rounded as 144.
- Flows from sewerage to surface water bodies = 50%(287) = 143.5. This will be rounded as 143.

The following diagram shows the estimated values in red.

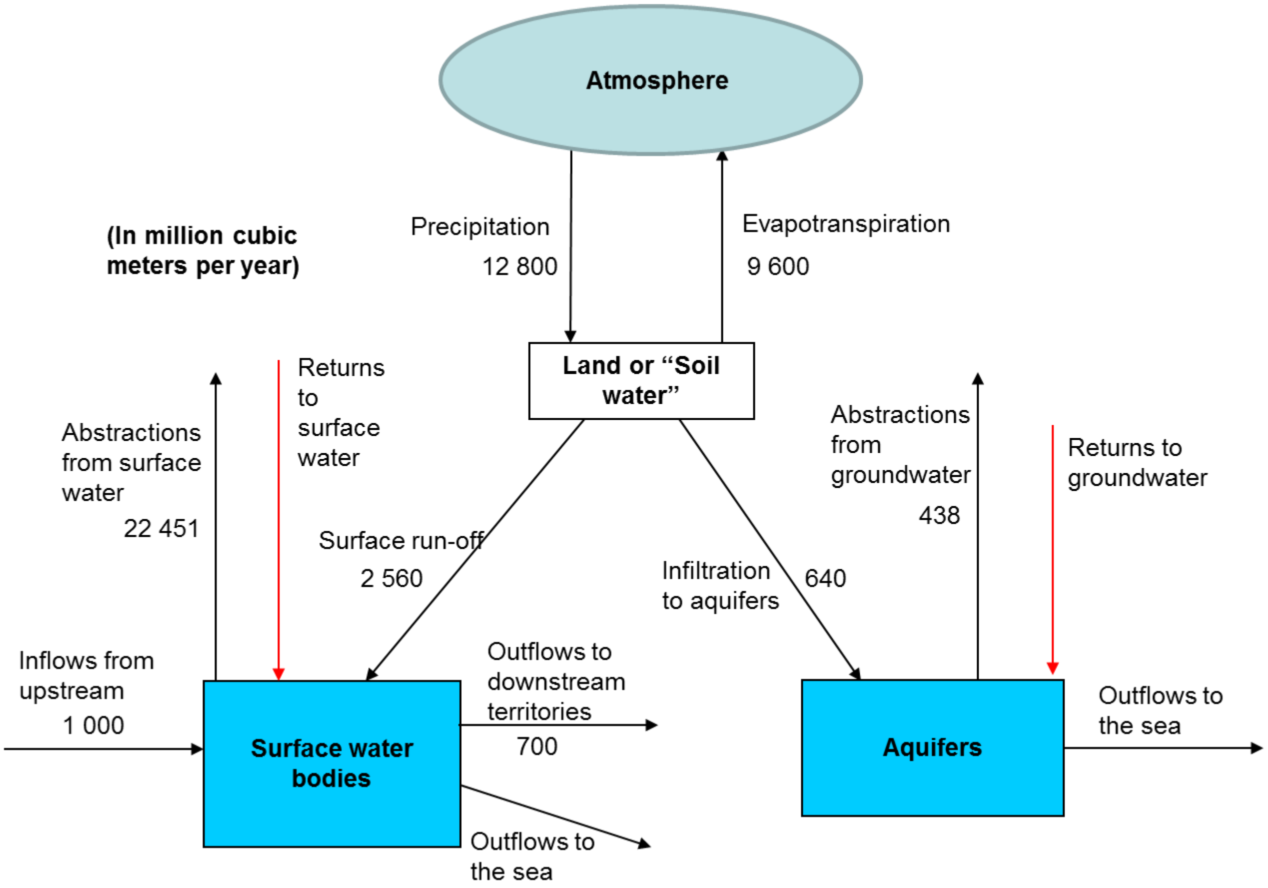


Module II: Basic understanding of the natural water cycle

1. Make a diagram that shows all the interconnected flows of water entering and leaving Unu, with the information provided. Use the template provided.

The following diagram shows a simplification of some of the main elements of the water cycle. For simplicity, all the precipitation is assumed to fall on the soil, and from there it becomes surface runoff or infiltrates to the aquifers. It is also assumed that all the evapotranspiration comes from the soil.

In reality the flows are much more complicated. Precipitation infiltrates and later becomes surface water. Surface water can also feed the aquifers during a season or part of a season. All these details can be incorporated in the diagram as more data become available, but it is useful to start with a very simple diagram, such as the one shown below.

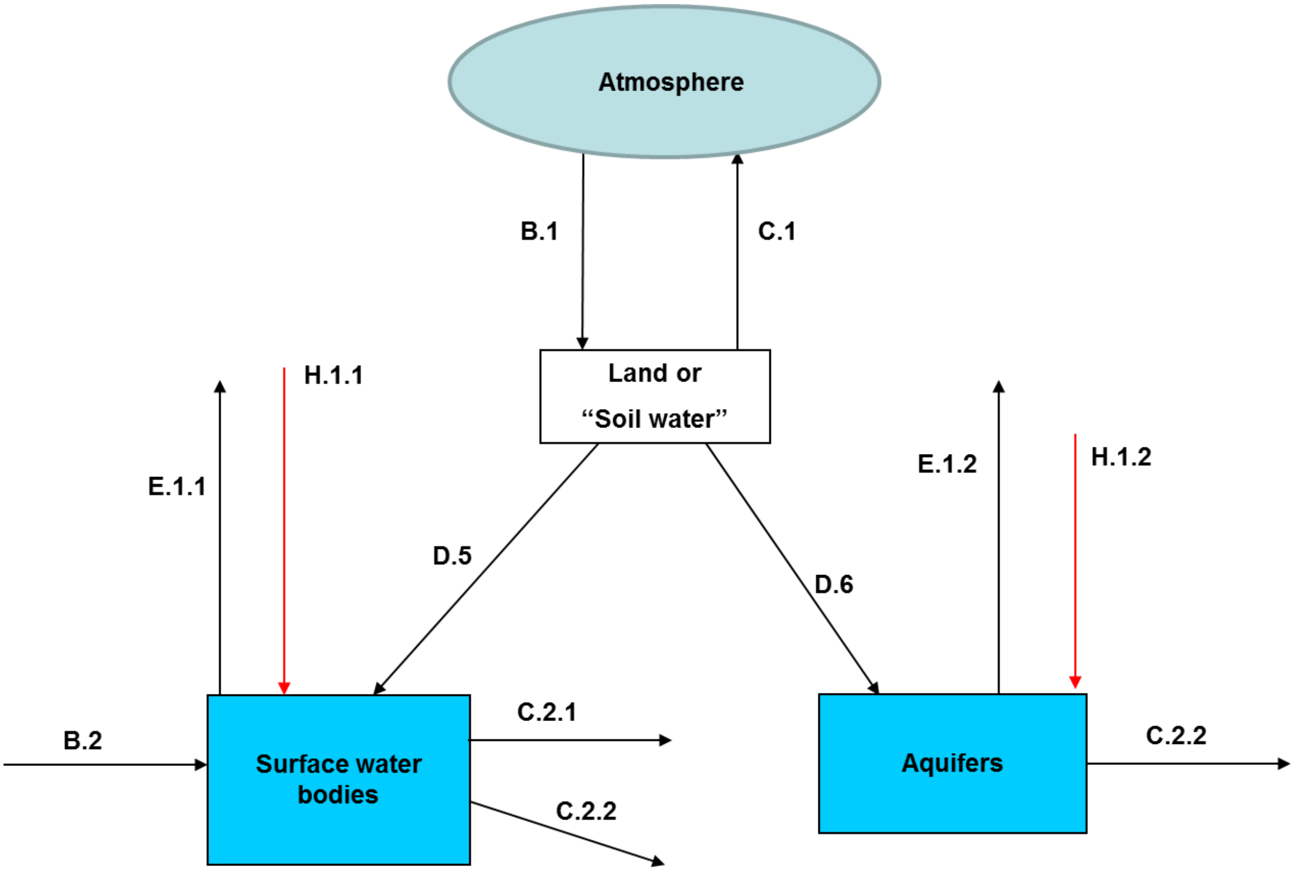


2. Identify the data items provided according to the data item codes of the IRWS (annex I).

The data items provided in this exercise are the following:

IRWS code	Data item
B.1	Precipitation.
B.2	Inflow of water from neighboring territories.
C.1	Evapotranspiration from inland water resources.
C.2.1	Outflow of water to neighboring territories.
C.2.2	Outflow of water to the sea.
D.5	Natural transfer of water from soil water to surface water.
D.6	Natural transfer of water from soil water to groundwater.

The following diagram shows the codes for the different flows.



Module III: Monetary supply and use tables

1. Review the following standard concepts from the System of National Accounts (SNA): Output, Intermediate Consumption, and Gross Value Added.

The following are the standard definitions provided in the System of National Accounts (SNA 2008). The specific paragraphs are provided in parenthesis:

Value Added (Gross)	Gross value added is the value of output less the value of intermediate consumption. (SNA 6.8). Value added is the balancing item in the production account (SNA 6.8).
Intermediate consumption	Consists of the value of the goods and services consumed as inputs by a process of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital. (SNA 6.213)
Output	Output is defined as the goods and services produced by an establishment, excluding the value of any goods and services used in an activity for which the establishment does not assume the risk of using the products in production, and excluding the value of goods and services consumed by the same establishment except for goods and services used for capital formation (fixed capital or changes in inventories) or own final consumption. (SNA 6.89)

2. Construct a monetary supply table.

SUPPLY TABLE (basic prices)

↓	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Electricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Sewerage, ISIC 37	**Total production (basic prices)**	Imports	**Total supply (basic prices)**
Agricultural products, CPC 01-04	25					**25**	5	30
Industrial and service products CPC 11-99, excl 18, 6911 and 94110		99				**99**	21	120
Electricity, CPC 6911	4	2	18			**24**	0	24
Water ("drinking"), CPC 18				7		**7**	0	7
Sewerage, CPC 94110					6	**6**	0	6
	29	**101**	**18**	**7**	**6**	**161**	**26**	187

The supply table is constructed by arranging the industrial groups in columns and the product groups in rows, then writing the values of the products produced by each industrial group in the corresponding cell.

3. Construct a monetary use table.

The use table is constructed by arranging the industrial groups in columns and the product groups in rows, then writing the values of products consumed or used by each industrial group in the corresponding cell.

USE TABLE (basic prices)

	Intermediate Consumption						Final Use			
	Agriculture	Industry and services	Electricity	Water Supply (drinking water)	Sewerage	**Intermediate consumption (basic prices)**	Final consumption	Gross Capital Formation	Exports	**Total use (basic prices)**
Agricultural products	3	6				**9**	14	1	6	30
Industrial and service products	6	22	7	1	1	**37**	37	32	14	120
Electricity	2	12		2	1	**17**	7			24
Water ("drinking")		2				**2**	5			7
Sewerage		3				**3**	3			6
	11	**45**	**7**	**3**	**2**	**68**	**66**	**33**	**20**	**187**

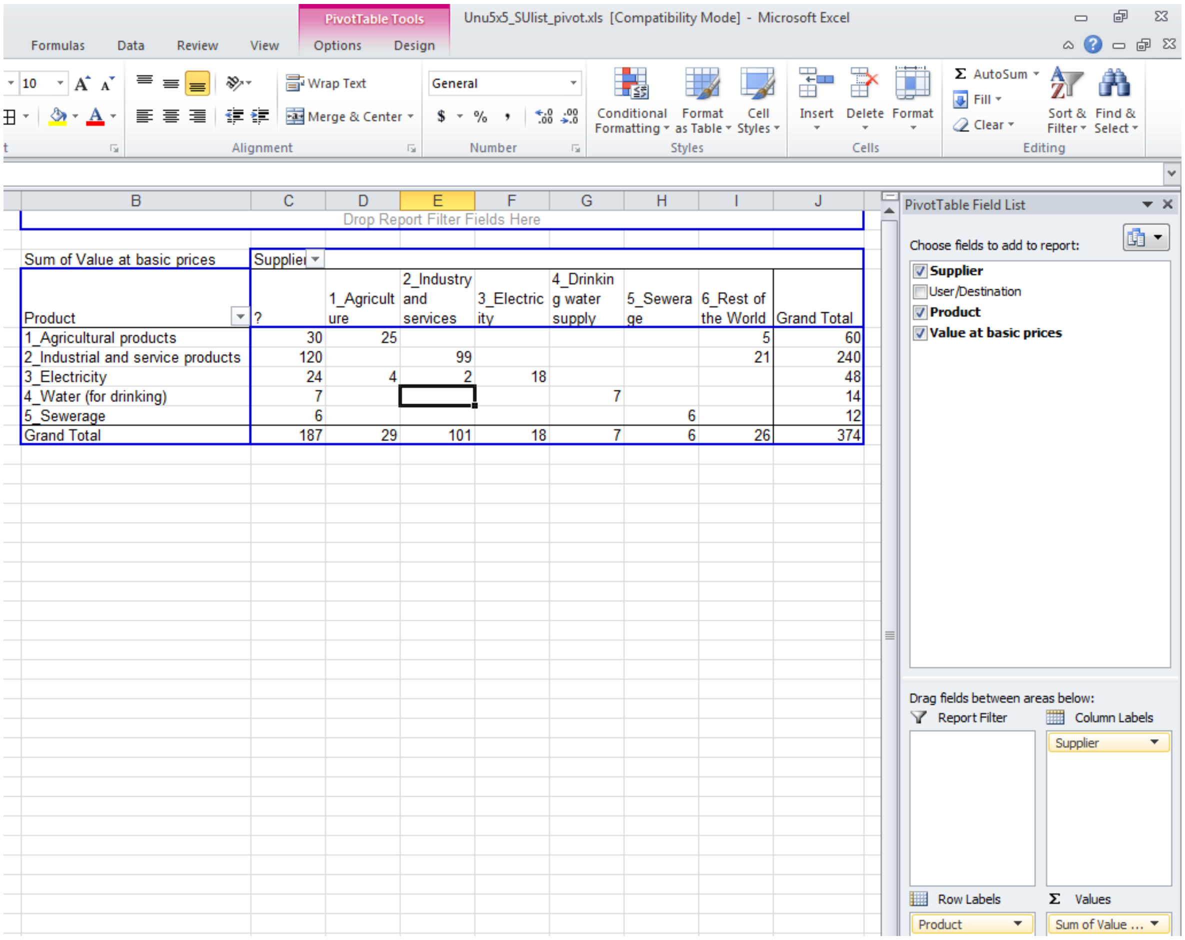
4. Compare the tables and find the relationships between supply and use. Is the information consistent?

The tables show that supply is equal to use. It can be seen that the totals for each row, shown in the last column of the supply and use tables, are equal for the corresponding rows in the supply and use tables. The amount of product supplied (produced domestically or imported) is the same as the amount of product used (for intermediate consumption in the domestic production process, or for final use).

Since the sums of the corresponding rows are equal, the information is consistent.

Note that for didactic purposes the supply and use tables have been aggregated to only five groups of activities and five groups of products. Usually, the supply and use tables have many more columns and rows. They can have hundreds of rows and columns.

5. If the data presented above are provided as a spreadsheet list, such as the one below, can you quickly assemble the supply and the use tables using the Excel Pivot option? What advantages do you see in the tabular approach over the list of data? What are the properties of the supply and use tables? How can consistency be checked?



Sum of Value at basic prices	Supplier							
Product	?	1_Agriculture	2_Industry and services	3_Electricity	4_Drinking water supply	5_Sewerage	6_Rest of the World	Grand Total
1_Agricultural products	30	25					5	60
2_Industrial and service products	120		99				21	240
3_Electricity	24	4	2	18				48
4_Water (for drinking)	7				7			14
5_Sewerage	6					6		12
Grand Total	187	29	101	18	7	6	26	374

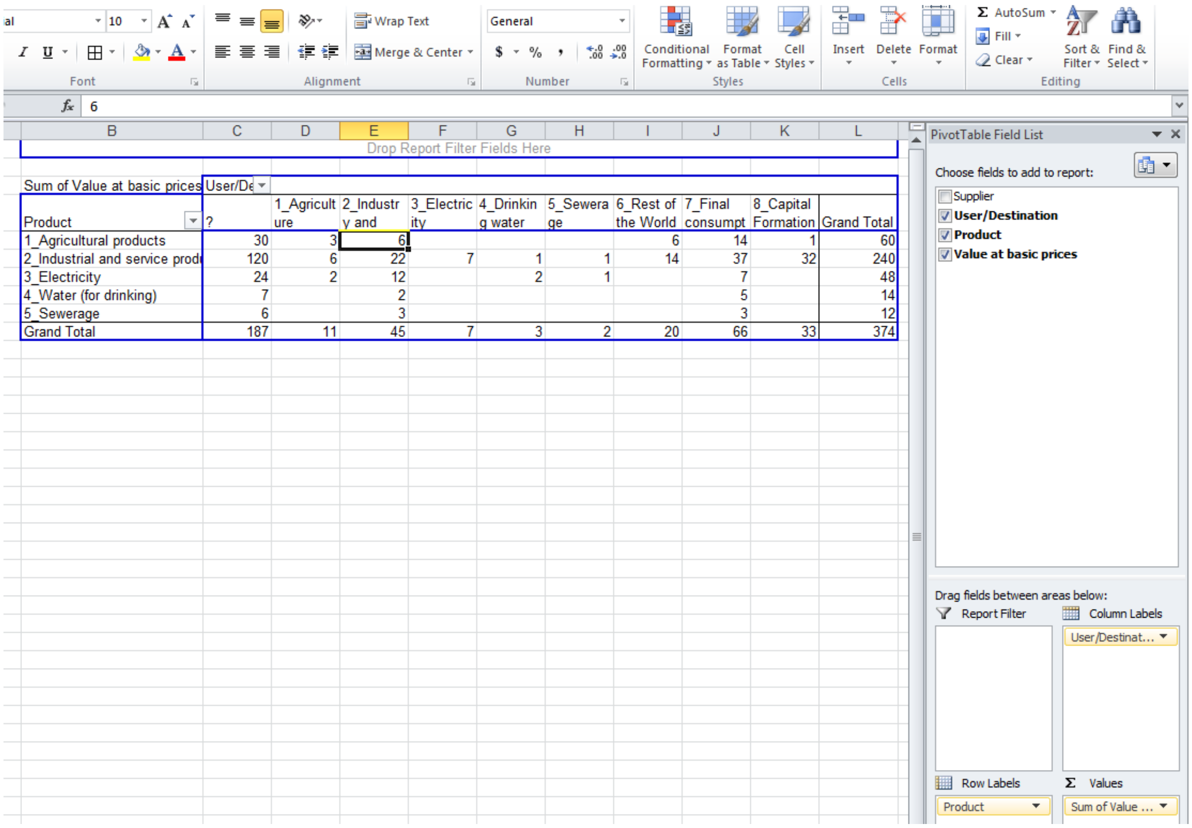
Choose fields to add to report:

☑ Supplier
☐ User/Destination
☑ Product
☑ Value at basic prices

Column Labels: Supplier
Row Labels: Product
Values: Sum of Value ...

The Excel screen above shows the conversion of the list into a supply table by using the Excel option: "Insert ->Pivot Table," The headers of the list appear on the field list on the right of the pivot table. The table is constructed by dragging the header "Producer" to the box of Column Labels, the header "Product" to the box of Row Labels, and the header "Value at basic price" to the box of Values. In the Box of Values it is important to specify that the values will be added ("Sum option").

The use table is constructed by dragging the header "Producer" out of the box of Column Labels and replacing it with the header "User," as shown below.



fx 6

Sum of Value at basic prices	User/De									
Product	?	1_Agriculture	2_Industry and	3_Electricity	4_Drinking water	5_Sewerage	6_Rest of the World	7_Final consumpt	8_Capital Formation	Grand Total
1_Agricultural products	30	3	6				6	14	1	60
2_Industrial and service prod	120	6	22	7	1	1	14	37	32	240
3_Electricity	24	2	12		2	1		7		48
4_Water (for drinking)	7		2					5		14
5_Sewerage	6		3					3		12
Grand Total	187	11	45	7	3	2	20	66	33	374

Choose fields to add to report:

☐ Supplier
☑ **User/Destination**
☑ **Product**
☑ **Value at basic prices**

Column Labels: User/Destinat...
Row Labels: Product
Values: Sum of Value ...

6. How could Value Added be calculated? What additional information is required in order to calculate Value Added?

As mentioned above, gross value added is the difference between output and intermediate consumption. This is simply the difference between the totals in the columns of the supply table and the use tables.

The problem is that all the values in this exercise are at basic prices. Gross value added at basic prices is the difference between output, valued at basic prices, and intermediate consumption, valued at purchasers' prices. On the other hand, gross value added at producers' prices is the difference between output at producers' prices and intermediate consumption at purchasers' prices. In both cases values at purchasers' prices are needed. Therefore, the values at purchasers' prices need to be known in order to determine gross value added.

7. What happens if some of the data in the list are randomly changed? Will the information remain consistent?

If the numbers are randomly changed, most likely the supply and use will not balance. The supply and use tables are useful for checking the consistency of the data collected through surveys. The totals of each row in the supply and use tables have to be equal in order to guarantee that the data is consistent.

Module IV: Including taxes and trade margins

1. Review the following standard concepts from the SNA: Basic Prices, Purchasers' Prices, and Gross Value Added at Basic Prices.

Value Added (Gross), basic prices	Gross value added at basic prices is defined as output valued at basic prices less intermediate consumption valued at purchasers' prices (SNA 6.77). "…from the producer's point of view these are the prices actually paid and received.
Price (basic)	Basic price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable, and plus any subsidy receivable, by the producer as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer. (SNA 2008 6.51a)
Price (purchasers')	The purchaser's price is the amount paid by the purchaser, excluding any VAT or similar tax deductible by the purchaser, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The purchaser's price of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place. (SNA 6.64) **Purchasers' price = basic price + taxes on products (excl VAT) – subsidies + VAT (not deductible) + transport + margins to wholesalers and retailers.**

2. With this new information calculate the Value Added for each industrial activity.

The gross value added at basic prices is calculated as the difference between the totals in each column of the supply table, showing values at basic prices, and the totals in each column of the use table, showing values at purchasers' prices.

The results are shown in the following table:

	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Electricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Sewerage, ISIC 37	**All industries**
Gross Value Added (GVA) at basic prices	18	62	11	4	4	99

3. Using the supply table at basic prices, the valuation table, and the use table at purchasers' prices, check that supply equals use.

By adding import taxes, trade and transportation margins, taxes less subsidies on products, and non deductible Value Added Tax (VAT), in the valuation table provided, the total supply of each group of products is obtained at purchasers' prices.**Table to convert Supply Table to purchasers' prices:**

SUPPLY TABLE

	Output												
	Agriculture	Industry and services	Electricity	Water Supply (drinking water)	Sewerage	**Total production (basic prices)**	Imports	**Total supply (basic prices)**	Import taxes	Trade and transport ma	Taxes less subsidies on products	Non deductible VAT	**Total supply (purchasers' prices)**
Agricultural products	25					**25**	5	**30**		3			**33**
Industrial and service products		99				**99**	21	**120**	5	-3		2	**124**
Electricity	4	2	18			**24**	0	**24**					**24**
Water ("drinking")				7		**7**	0	**7**			-1		**6**
Sewerage					6	**6**	0	**6**					**6**
	29	**101**	**18**	**7**	**6**	**161**	**26**	**187**	**5**	**0**	**-1**	**2**	**193**

The total supply, now valued at purchasers' prices, can be compared with the use table at purchasers' prices provided. It can be seen that the totals of each row are equal. This means that supply equals use.

USE TABLE (purchasers' prices)

	Intermediate Consumption						Final Use			
	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Electricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Sewerage, ISIC 37	**Intermediate consumption (purchasers' prices)**	Final consumption	Gross Capital Formation	Exports	**Total use (purchasers' prices)**
Agricultural products, CPC 01-04	3	6				**9**	17	1	6	33
Industrial and service products CPC 11-99, excl 18, 6911 and 94110	6	16	7	1	1	**31**	42	33	18	124
Electricity, CPC 6911	2	12		2	1	**17**	7			24
Water ("drinking"), CPC 18		2				**2**	4			6
Sewerage, CPC 94110		3				**3**	3			6
	11	**39**	**7**	**3**	**2**	**62**	**73**	**34**	**24**	**193**

4. Based on the results of the previous exercises find the Gross Domestic Product (GDP).

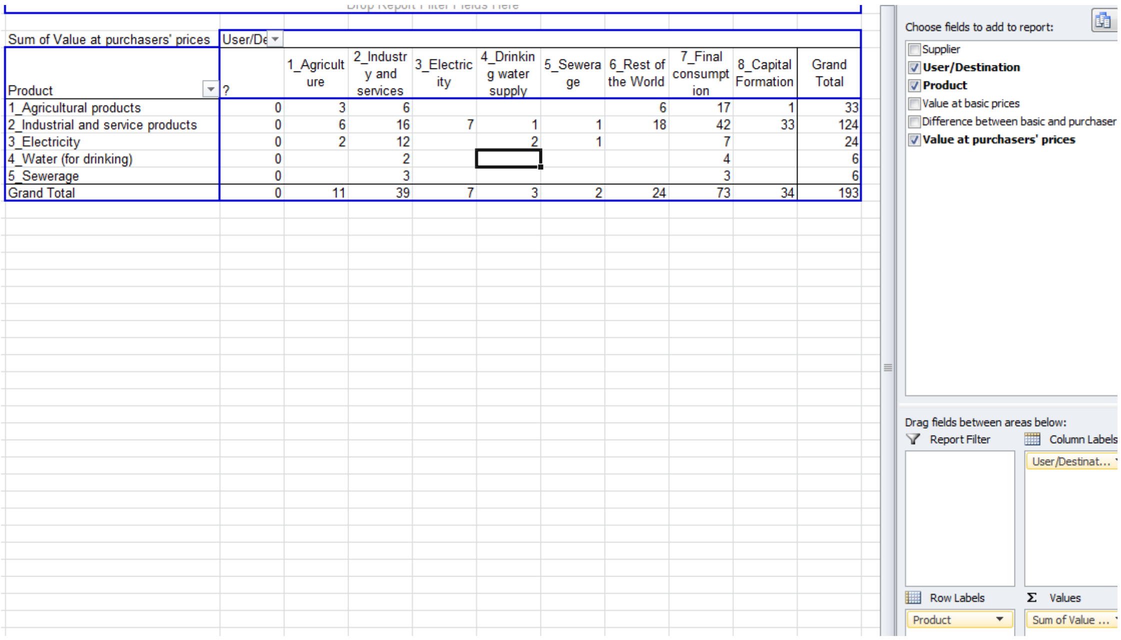
GDP can be calculated by adding the gross value added (GVA) at basic prices and adding all the taxes less subsidies on products.

GVA at basic prices was calculated in question 2. GVAbp = 99 bk.
From the valuation table provided, taxes less subsidies on products are = import taxes + taxes less subsidies on products + non deductible VAT = 5 -1 +2 = 6 bk.

Therefore GDP = 99 + 6 = 105 bk.

5. The spreadsheet list presented below presents a more realistic aggregation of survey data. The basic prices are known from the producers' side, but not from the users' side. On the contrary purchasers' prices are known from the users' side but not from the producers' side. Can you quickly assemble the supply and the use tables using the Excel Pivot option?

See answer for exercise 5 in module III. The difference is that value at purchasers' prices has to be chosen when building the use table using the pivot table option in Excel.



Sum of Value at purchasers' prices	User/De									
Product	?	1_Agriculture	2_Industry and services	3_Electricity	4_Drinking water supply	5_Sewerage	6_Rest of the World	7_Final consumption	8_Capital Formation	Grand Total
1_Agricultural products	0	3	6				6	17	1	33
2_Industrial and service products	0	6	16	7	1	1	18	42	33	124
3_Electricity	0	2	12		2	1		7		24
4_Water (for drinking)	0		2					4		6
5_Sewerage	0		3					3		6
Grand Total	0	11	39	7	3	2	24	73	34	193

Choose fields to add to report:
☐ Supplier
☑ User/Destination
☑ Product
☐ Value at basic prices
☐ Difference between basic and purchaser
☑ Value at purchasers' prices

Column Labels: User/Destinat...
Row Labels: Product
Values: Sum of Value ...

6. The supply and use tables shown below show more resolution that the tables presented above. They show 10 groups of economic activities and 10 groups of products. Can you see how lower resolution tables can be generated from higher resolution ones?

In order to reduce the resolution of the supply and use tables, the following activities will be grouped into one single activity: mining, manufacturing, water supply for irrigation, construction, wholesale and retail trade, and other services. Therefore the numbers in the intersections of the second, third, fifth, eight, ninth, and tenth columns with the second, third, fifth, eight, ninth, and tenth rows will be added to create a single new row and column.

The second column and second row of the simplified supply table will be the sum of 10+34+3+18+13+18+3 = 99. Similarly, the second column and second row of the simplified use table will be the sum of 1+2+1+3+1+1+1+4+2 = 16.

The other rows will remain the same, except for the second column, which will be the sum of the contents of the second, third, fifth, eight, ninth, and tenth columns.

Module V: Monetary information related to water supply and sewerage

1. Review the following standard concepts from the SNA: Consumption of Fixed Capital, Compensation of Employees, and Property Income.

Compensation of employees	Compensation of employees is defined as the total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the latter during the accounting period. (SNA 7.5) Classification of transactions: D1 Compensation of employees D11 Wages and salaries D12 Employers’ social contributions (SNA Annex 1).
Consumption of fixed capital	Consumption of fixed capital is the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage. (SNA 6.240).
Property income	Is the income that accrues by lending or renting financial or natural resources, including land, to other units for use in production (SNA 7.2). Property income is the sum of investment income and rent. (SNA 7.107). Classification of transactions: D4 Property income Investment income D41 Interest D42 Distributed income of corporations D43 Reinvested earnings on foreign …………………………………………direct investments D44 Investment income disbursements (SNA Annex 1).

2. Determine if the water supply and sewerage rates or “tariffs” are enough to keep the system running.

Water supply industry

For the case of the drinking water supply industries, as was shown in the previous module, the output is 7.0 bk at basic prices. Note that there is a subsidy of 1.0 bk on products, so the output at purchasers’ prices is 6.0 bk. This means that the users of water only pay 6.0 bk, but the water supply industry receives 7.0 bk.

Intermediate consumption includes all the expenditures on the products that are needed to supply the service. In this case, as mentioned in module III of the exercise, 2.0 bk are spent on electricity and 1.0 bk in different industrial products and services, such as chlorine to treat the water, maintenance service to the equipment, etc. The total intermediate consumption is 3.0 bk at purchasers’ prices.

The difference between output and intermediate consumption is gross value added = 7.0 – 3.0 = 4.0. This is gross value added at basic prices since output is valued at basic prices and intermediate consumption at purchasers’ prices.

From value added compensation of employees is paid. Compensation of employees, which includes wages, salaries, and employers’ social contributions is 2.0 bk. The industry receives 0.9 bk as subsidy from the government. Therefore, the gross operating surplus is 4.0-2.0+0.9 = 2.9 bk.

From the gross operating surplus property income has to be paid. In the case of the water supply industry 0.4 bk are paid as “royalties” to the government of Unu for the abstraction of water. This payment is considered a rent for the use of the resource. The full definition of rent can be found in the SNA 2008 paragraph 7.109.

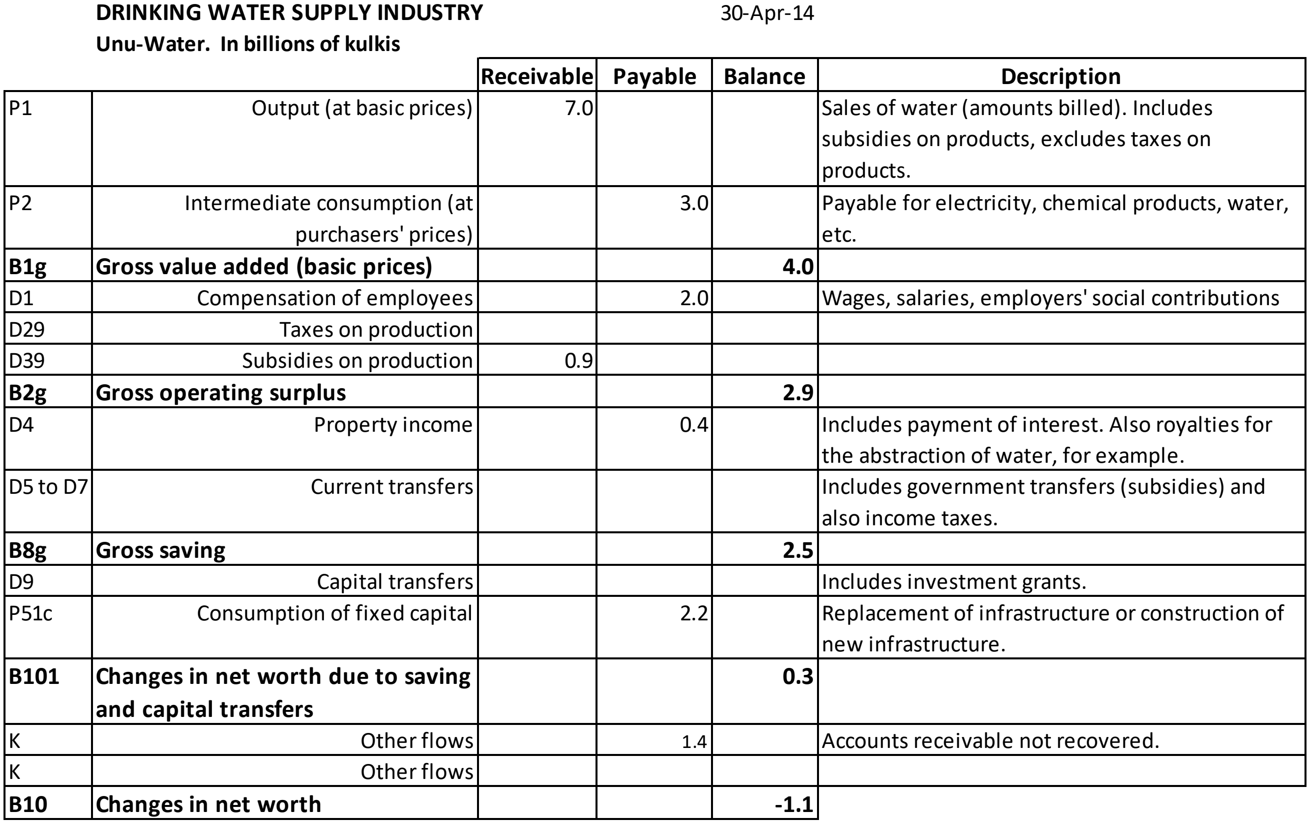
Current transfers are then added or subtracted. In this case there are no current transfers, so gross saving is 2.5 bk.

There are no capital transfers, such as investment grants, so the investments in infrastructure (gross fixed capital formation) are paid from gross saving. The amount left 2.5-2.1= 0.4 is the net lending amount, which can be used to purchase financial assets or to reduce debts, for example.

Since there is positive net lending, we can say that the expenses can be covered with the rates or “tariffs” and the corresponding subsidies (subsidy on products, and subsidy on production).

However, it is important to consider that, with time, the infrastructure will have to be replaced due to its normal wear and tear. This is accounted for as consumption of fixed capital. Still gross saving is larger than the consumption of fixed capital, therefore, the infrastructure can be replaced when needed by using the gross saving, which every year may be transformed to financial assets for later application to fixed capital formation.

The following table summarizes the calculations described above:



DRINKING WATER SUPPLY INDUSTRY 30-Apr-14

Unu-Water. In billions of kulkis

		Receivable	Payable	Balance	Description
P1	Output (at basic prices)	7.0			Sales of water (amounts billed). Includes subsidies on products, excludes taxes on products.
P2	Intermediate consumption (at purchasers' prices)		3.0		Payable for electricity, chemical products, water, etc.
B1g	**Gross value added (basic prices)**			**4.0**	
D1	Compensation of employees		2.0		Wages, salaries, employers' social contributions
D29	Taxes on production				
D39	Subsidies on production	0.9			
B2g	**Gross operating surplus**			**2.9**	
D4	Property income		0.4		Includes payment of interest. Also royalties for the abstraction of water, for example.
D5 to D7	Current transfers				Includes government transfers (subsidies) and also income taxes.
B8g	**Gross saving**			**2.5**	
D9	Capital transfers				Includes investment grants.
P51c	Consumption of fixed capital		2.2		Replacement of infrastructure or construction of new infrastructure.
B101	**Changes in net worth due to saving and capital transfers**			**0.3**	
K	Other flows		1.4		Accounts receivable not recovered.
K	Other flows				
B10	**Changes in net worth**			**-1.1**	

Sewerage industry

The case of the sewerage industry is very similar to the case of the water supply industry. The calculations are summarized in the table below. One difference is that the property income includes the payment of “royalties” for the use of the water bodies to discharge wastewater, 0.2 bk, and also the payment of interest on a loan, 0.1 bk, total = 0.2+0.1 = 0.3 bk.

As in the case of water supply, since there is positive net lending, we can say that the expenses can be covered with the “tariffs” and the corresponding subsidies (subsidy on products, and subsidy on production).

As in the case of water supply, it is important to consider that, with time, the infrastructure will have to be replaced due to its normal wear and tear. This is accounted for as consumption of fixed capital. Still gross saving is larger than the consumption of fixed capital, as shown in the table below, therefore, the infrastructure can be replaced when needed by using the gross saving, which every year may be transformed to financial assets for later application to fixed capital formation.

SEWERAGE INDUSTRY 30-Apr-14

Unu-Water. In billions of kulkis

		Receivable	Payable	Balance	Description
P1	Output (at basic prices)	6.0			Sales of sewerage services (amounts billed). Includes subsidies on products, excludes taxes on products.
P2	Intermediate consumption (at purchasers' prices)		2.0		Payable for electricity, chemical products, water, etc.
B1g	**Gross value added (basic prices)**			**4.0**	
D1	Compensation of employees		1.5		Wages, salaries, employers' social contributions
D29	Taxes on production		0.0		
D39	Subsidies on production				
B2g	**Gross operating surplus**			**2.5**	
D4	Property income		0.3		Includes payment of interest. Also royalties for the abstraction of water, for example.
D5 to D7	Current transfers				Includes government transfers (subsidies) and also income taxes.
B8g	**Gross saving**			**2.2**	
D9	Capital transfers				Includes investment grants.
P51c	Consumption of fixed capital		1.3		Replacement of infrastructure or construction of new infrastructure.
B101	**Changes in net worth due to saving and capital transfers**			**0.9**	
K	Other flows		1.2		Accounts receivable not recovered.
K	Other flows				
B10	**Changes in net worth**			**-0.3**	

3. Answer the question above, considering that the amounts billed to the users are not paid in full. Consider that every year about 20% of the amount billed becomes accounts receivable, and that the accounts receivable are never actually paid.

In order to consider the fact that the “tariffs” are not paid in full, it is necessary to take into account the fact that in the previous calculations net lending included accounts receivable (which is a financial asset). Accounts receivable can be accumulated through the years as financial assets; however, after some years they may be simply written off because they may be considered not recoverable. This is recorded as changes in financial assets. It is considered that the accounts receivable are 20% of total sales = 0.2 * 7.0 = 1.4 bk.

The following table shows the calculations for the water supply industry.

		Increases	Decreases	Balance	
K	Other flows		1.4		Accounts receivable not recovered.
B102	**Changes in net worth due to other changes in volume of assets**			**-1.4**	

Therefore, since in the previous table we had that the changes in net worth (balance B101) was 0.4, less 1.4 due to the write off of the accounts receivable, the total changes in net worth are -1.0. This means that every year the net worth of the assets of the water supply industry are reduced in 1 billion kulkis. Therefore the financial flows are not sustainable. The “tariffs” need to be raised, subsidies need to be increased, or the efficiency in the collection of accounts receivable has to be increased.

B101	Changes in net worth due to saving and capital transfers	0.3
B102	Changes in net worth due to other changes in volume of assets	-1.4
B103	Changes in net worth due to nominal holding gains/losses	0.0
B10	**Changes in net worth**	**-1.1**

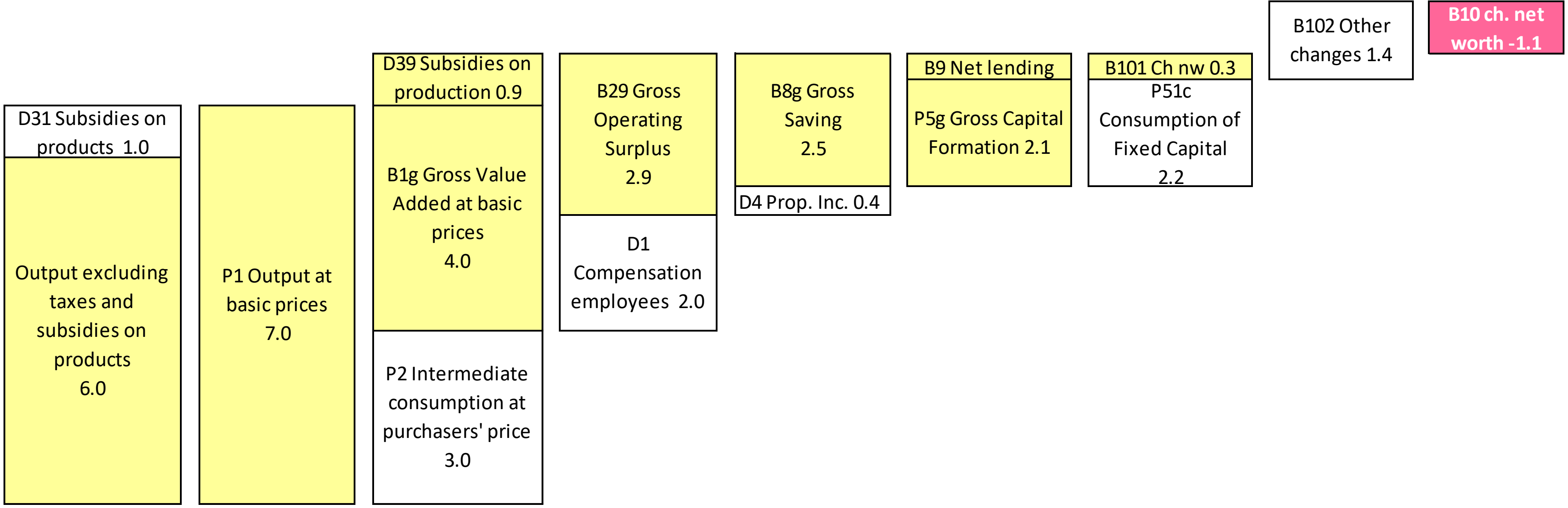
The case of the sewerage industry is similar. In this case accounts receivable are 20% of the sales = 0.2*6.0 = 1.2 bk.

		Increases	**Decreases**	**Balance**	
K	Other flows		1.2		Accounts receivable not recovered.
B102	**Changes in net worth due to other changes in volume of assets**			**-1.2**	

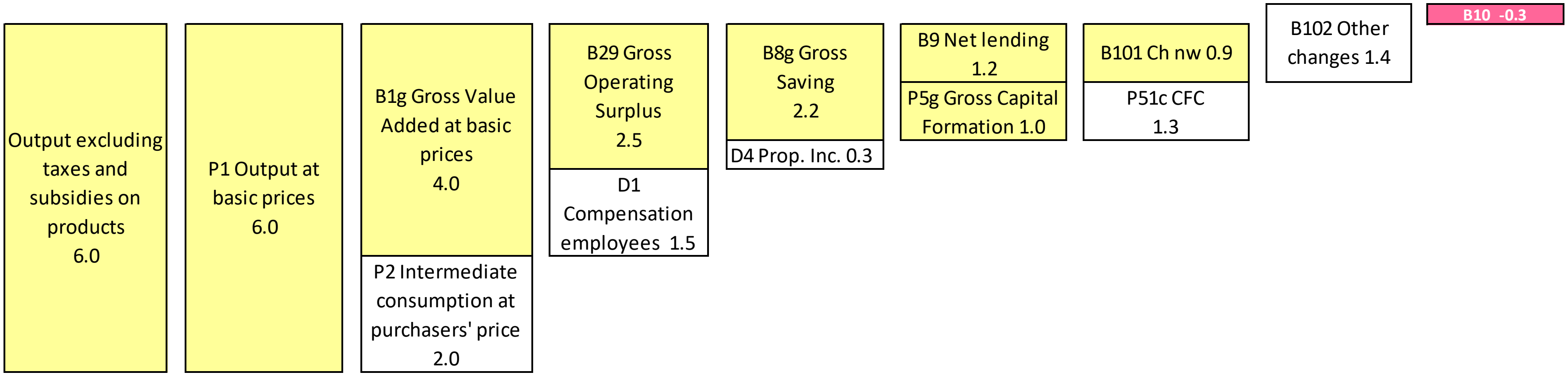
The table below shows the summary. As in the case of the water supply industry, in the case of the sewerage industry the net worth of the assets of the sewerage industry is reduced by 0.3 billion kulkis every year.

B101	Changes in net worth due to saving and capital transfers	0.9
B102	Changes in net worth due to other changes in volume of assets	-1.2
B103	Changes in net worth due to nominal holding gains/losses	0.0
B10	**Changes in net worth**	**-0.3**

Water supply industry



Sewerage industry



Module VI: Physical supply, use, and asset tables

1. Construct the supply and use tables using the information provided in module I.

The diagrams constructed in module I can be written in a tabular form. A tabular representation of the diagrams is easier to process in a computer. The diagrams are useful when dealing with a small number of elements, but as the number of elements in the diagrams increases, the tables become a much more efficient way of recording and sharing information.

The physical supply table is shown below:

PHYSICAL SUPPLY TABLE

	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Hydroelectricity, ISIC 3510	Thermoelectricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Water Supply (irrigation water), ISIC 36-B	Sewerage, ISIC 37	Households	Environment	**Total**
Water ("drinking"), CPC 18-A					469					**469**
Water ("irrigation"), CPC 18-B						1 120				**1 120**
Reuse water							40			**40**
Surface water									22 451	**22 451**
Groundwater									438	**438**
Seawater									39	**39**
Losses	50				190	316				**556**
Wastewater	644	141	19 600	618			287	280		**21 570**
Evaporation, transpiration, inclusion in products	966	61	0	32				70		**1 129**
	1 660	**202**	**19 600**	**650**	**659**	**1 436**	**327**	**350**	**22 928**	**47 812**

Note that the final row in the above physical supply table "Evaporation, transpiration, inclusion in products" is equivalent to Water Consumption, or Final Water Use.

The physical use table is shown below:

PHYSICAL USE TABLE

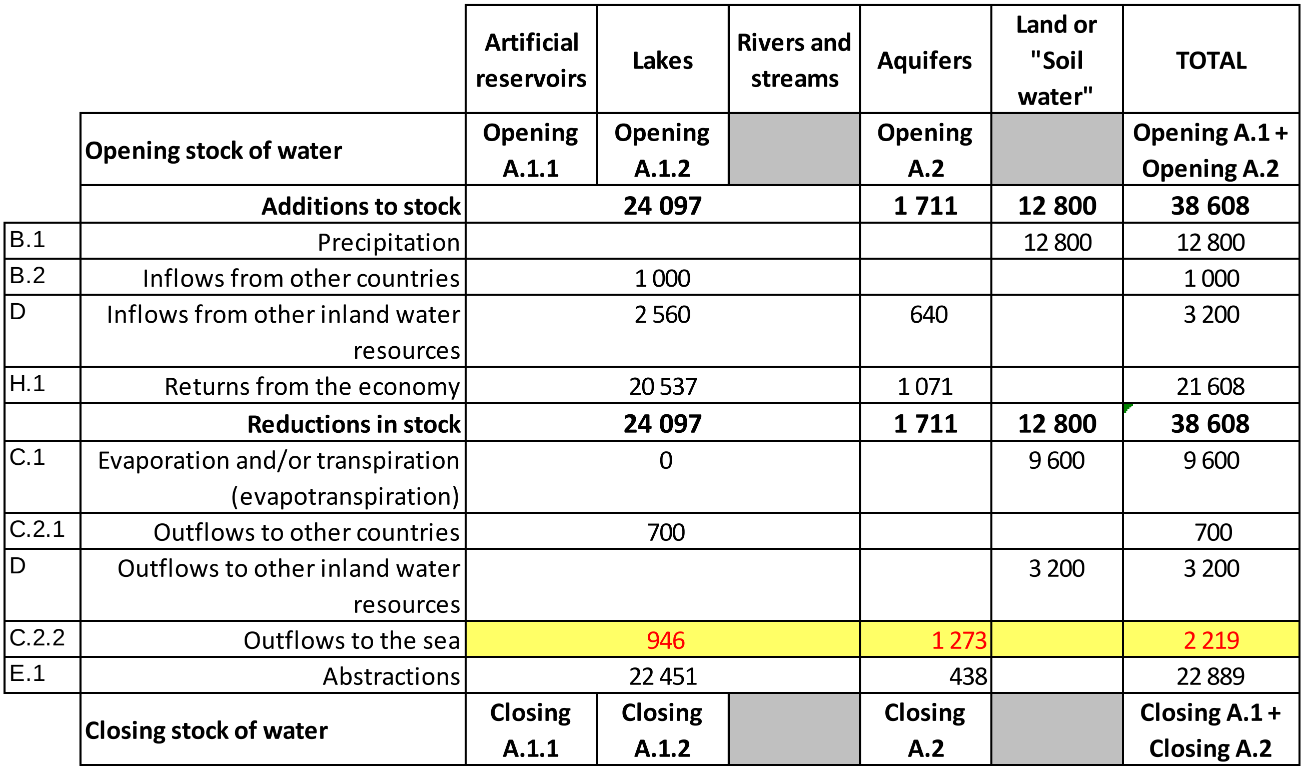
	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Hydroelectricity, ISIC 3510	Thermoelectricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Water Supply (irrigation water), ISIC 36-B	Sewerage, ISIC 37	Households	Environment	**Total**
Water ("drinking"), CPC 18-A		119						350		**469**
Water ("irrigation"), CPC 18-B	1 120									**1 120**
Reuse water	40									**40**
Surface water	345		19 600	650	420	1 436				**22 451**
Groundwater	155	83			200					**438**
Seawater					39					**39**
Losses									556	**556**
Wastewater							327		21 243	**21 570**
Evaporation, transpiration, inclusion in products									1 129	**1 129**
	1 660	**202**	**19 600**	**650**	**659**	**1 436**	**327**	**350**	**22 928**	**47 812**

2. Construct the asset accounts table using the information provided in modules I and II.

Based on the information processed in modules I and II the following asset accounts table was compiled. The numbers in red are not provided. They were calculated assuming that there are no changes in the stocks of inland water resources.

The outflow of surface water to the sea can be checked against measurements with stream gauges near the mouth of rivers and streams. However, typically a large amount of surface runoff flows unmeasured to the sea.

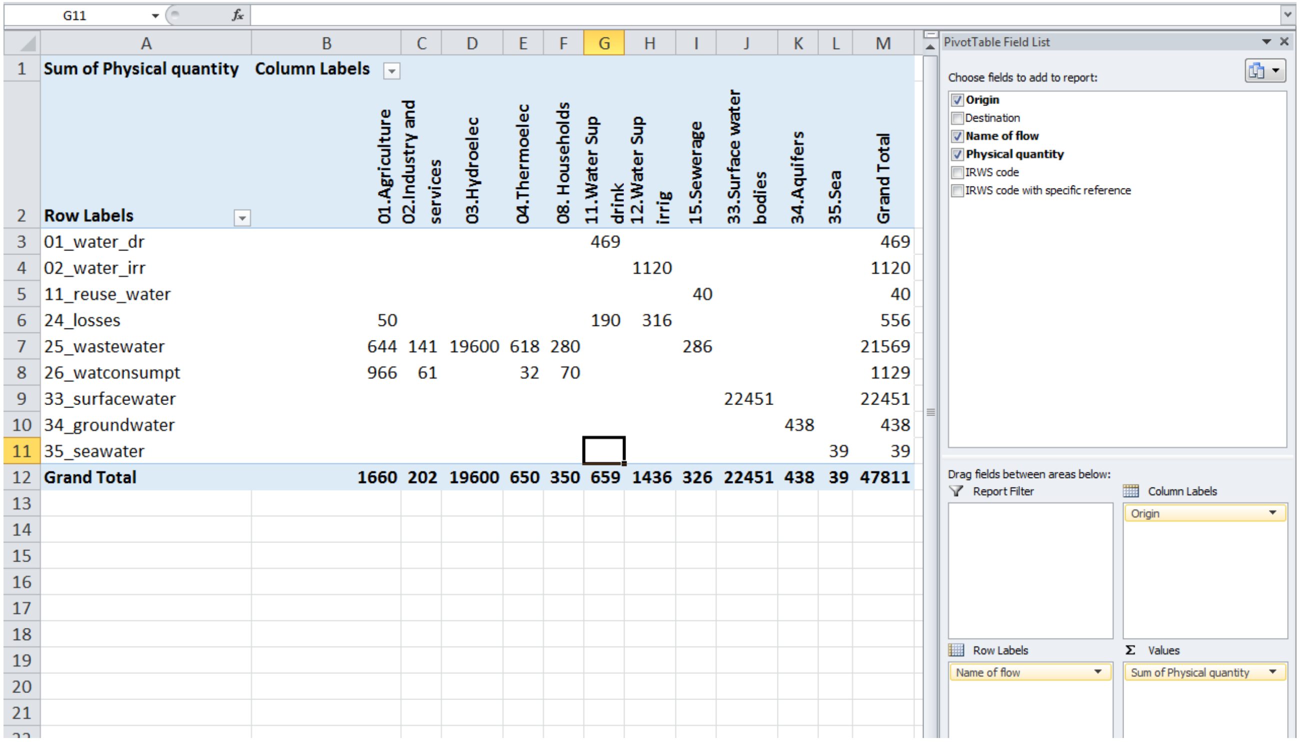
The differences of surface water stocks can be calculated based on the measurements of the water levels in artificial reservoirs and lakes. However, it is difficult to have good annual estimates of evapotranspiration and surface runoff.



		Artificial reservoirs	Lakes	Rivers and streams	Aquifers	Land or "Soil water"	TOTAL
	Opening stock of water	**Opening A.1.1**	**Opening A.1.2**		**Opening A.2**		**Opening A.1 + Opening A.2**
	Additions to stock	**24 097**			**1 711**	**12 800**	**38 608**
B.1	Precipitation					12 800	12 800
B.2	Inflows from other countries	1 000					1 000
D	Inflows from other inland water resources	2 560			640		3 200
H.1	Returns from the economy	20 537			1 071		21 608
	Reductions in stock	**24 097**			**1 711**	**12 800**	**38 608**
C.1	Evaporation and/or transpiration (evapotranspiration)	0				9 600	9 600
C.2.1	Outflows to other countries	700					700
D	Outflows to other inland water resources					3 200	3 200
C.2.2	Outflows to the sea	946			1 273		2 219
E.1	Abstractions	22 451			438		22 889
	Closing stock of water	**Closing A.1.1**	**Closing A.1.2**		**Closing A.2**		**Closing A.1 + Closing A.2**

3. The spreadsheet presented below is similar to the spreadsheet of module III, except that now everything is expressed in terms of water quantities instead of monetary values. Besides, thanks to the assumptions made, there are no unknown quantities. Can you quickly construct the physical supply and use tables using the pivot option of Excel? Can you check the consistency of the data?

The screens below show the pivot tables generated in Excel. The first pivot table is the supply table.



G11

Row Labels	01.Agriculture	02.Industry and services	03.Hydroelec	04.Thermoelec	08. Households	11.Water Sup drink	12.Water Sup irrig	15.Sewerage	33.Surface water bodies	34.Aquifers	35.Sea	Grand Total
01_water_dr						469						469
02_water_irr							1120					1120
11_reuse_water								40				40
24_losses	50					190	316					556
25_wastewater	644	141	19600	618	280			286				21569
26_watconsumpt	966	61		32	70							1129
33_surfacewater									22451			22451
34_groundwater										438		438
35_seawater											39	39
Grand Total	**1660**	**202**	**19600**	**650**	**350**	**659**	**1436**	**326**	**22451**	**438**	**39**	**47811**

Sum of Physical quantity — Column Labels

PivotTable Field List

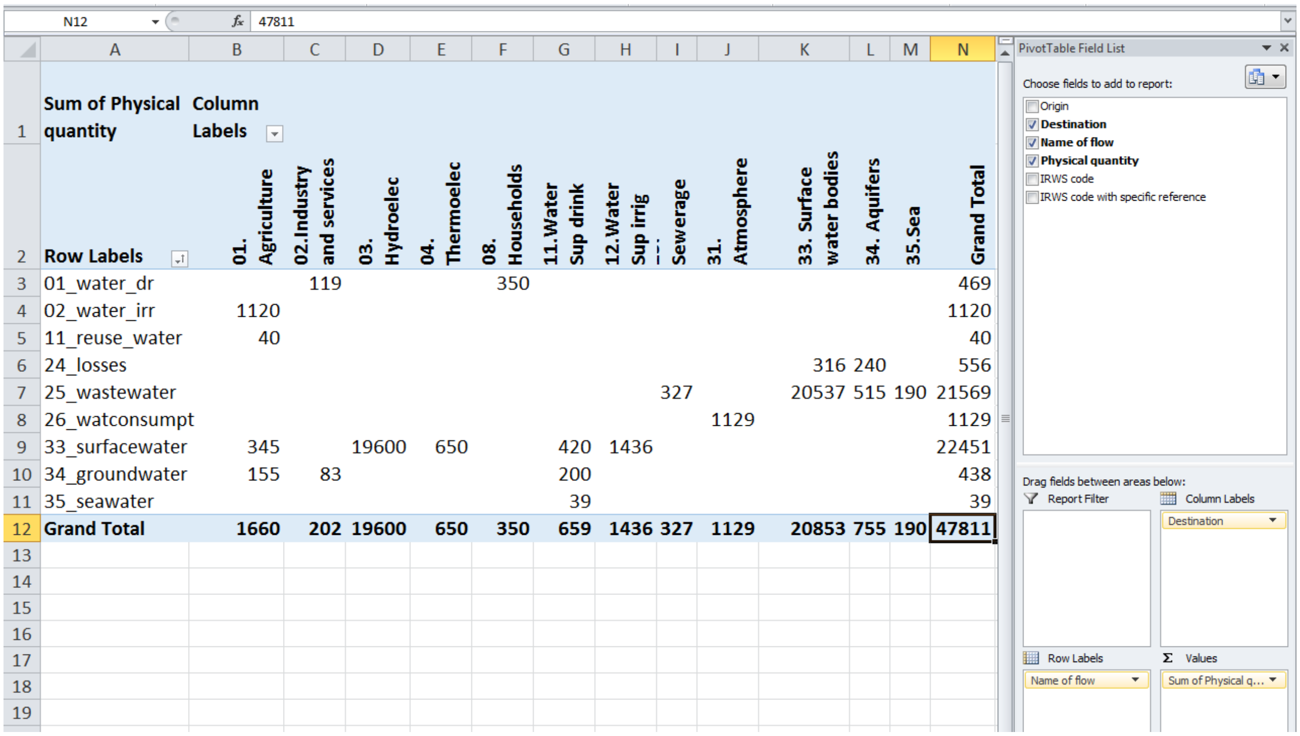
Choose fields to add to report:

☑ Origin
☐ Destination
☑ Name of flow
☑ Physical quantity
☐ IRWS code
☐ IRWS code with specific reference

Drag fields between areas below:

Report Filter:
Column Labels: Origin
Row Labels: Name of flow
Values: Sum of Physical quantity

The second pivot table is the use table.



N12 — 47811

Row Labels	01. Agriculture	02.Industry and services	03. Hydroelec	04. Thermoelec	08. Households	11.Water Sup drink	12.Water Sup irrig	Sewerage	31. Atmosphere	33. Surface water bodies	34. Aquifers	35.Sea	Grand Total
01_water_dr		119			350								469
02_water_irr	1120												1120
11_reuse_water	40												40
24_losses										316	240		556
25_wastewater								327		20537	515	190	21569
26_watconsumpt									1129				1129
33_surfacewater	345		19600	650		420	1436						22451
34_groundwater	155	83				200							438
35_seawater						39							39
Grand Total	**1660**	**202**	**19600**	**650**	**350**	**659**	**1436**	**327**	**1129**	**20853**	**755**	**190**	**47811**

Sum of Physical quantity — Column Labels

PivotTable Field List

Choose fields to add to report:

☐ Origin
☑ Destination
☑ Name of flow
☑ Physical quantity
☐ IRWS code
☐ IRWS code with specific reference

Drag fields between areas below:

Report Filter:
Column Labels: Destination
Row Labels: Name of flow
Values: Sum of Physical q...

4. Summarize all the physical information as a sequence of accounts, similar to the one in module V for water and sewerage. Use the template provided.

Based on the information compiled in the physical supply and use tables, the sequence can be computed as follows.

1	**Renewable water**	**Resources**	**Uses**	**Balance**
B.1	Precipitation	12 800		
B.2	Inflows from other countries or territories (OECD-Eurostat q. 4)	1 000		
C.1	Evapotranspiration		9 600	
Bal01	**Total Renewable Water Resources (TRWR)**			**4 200**

2	**Ouflowing TRWR & returns**	**Resources**	**Uses**	**Balance**
	Total Renewable Water Resources (TRWR)	4 200		
H.1	Returns of water to inland water resources	21 608		
E.1 (offstream)	Abstractions from inland water resources (offstream)		3 289	
E.1 (instream)	Abstractions from inland water resources (instream)		19 600	
Bal02	**Outflowing TRWR & returns**			**2 919**

3	**Water supplied and received**	**Resources**	**Uses**	**Balance**
E.1 (offstream)	Abstractions from inland water resources (offstream)	3 289		
E.1 (instream)	Abstractions from inland water resources (instream)	19 600		
E.2 & E.3	Abstractions from other sources (sea & precipitation)	39		
G.2	Imported water	0		
F.3.2/G.3.2	Reused water	40		
I.1	Losses in transportation and distribution		556	
F.2	Exported water		0	
Bal 03	**Water supplied or self supplied to resident users**			**22 412**

4	**Wastewater generated**	**Resources**	**Uses**	**Balance**
Bal 03	Water supplied/received by resident users	22 412		
	"Water consumption"		1 129	
Bal04	**Wastewater (as defined in SEEA, regardles of quality)**			**21 283**

5	**Final balance of wastewater**	**Resources**	**Uses**	**Balance**
Bal04	"Wastewater" (as defined in SEEA, regardless of quality)	21 283		
I.1	Losses in transportation and distribution	556		
H.2	Returns to the sea		191	
F.3.2/G.3.2	Water for reuse		40	
H.1	**Returns of water to inland water resources**			**21 608**

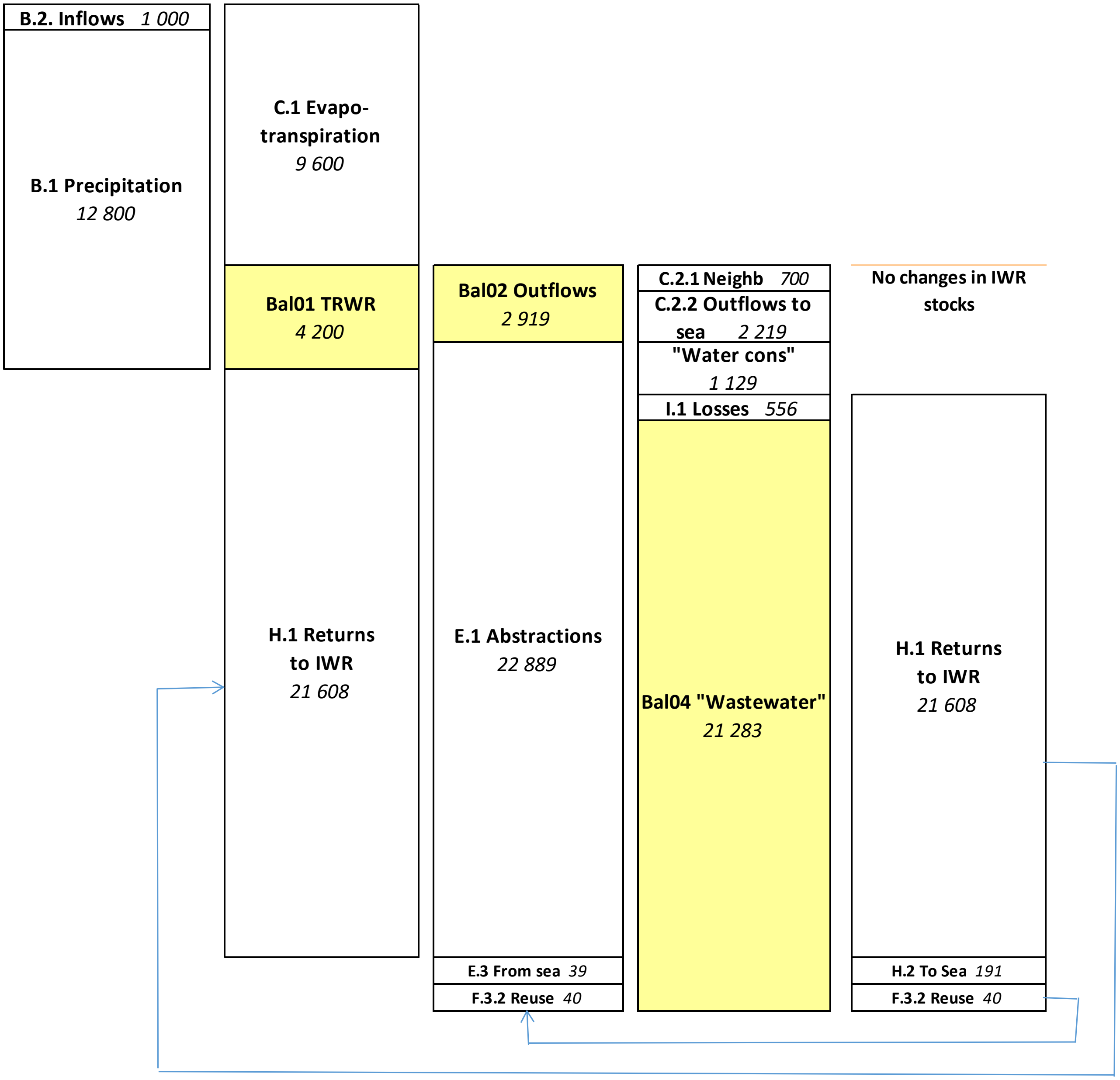
6	Final balance of discharges	Resources	Uses	Balance
Bal02	Outflowing TRWR & returns	2 919		
C.2.1	Outflows to neighboring countries or territories		700	
C.2.2	Outflows to the sea		2 219	
Bal05	**Net changes in Inland Water Resources**			**0**

7	Balance Sheet	Opening	Changes	Balance
A.	Inland water resources	3 000	0	3 000

Note that some of the answers above may sometimes vary by one digit as a result of rounding. Item C.2.2 has been calculated as a balance assuming the opening and closing stock of water remains the same.

The different balances are useful for the calculation of the different indicators (see module VIII).

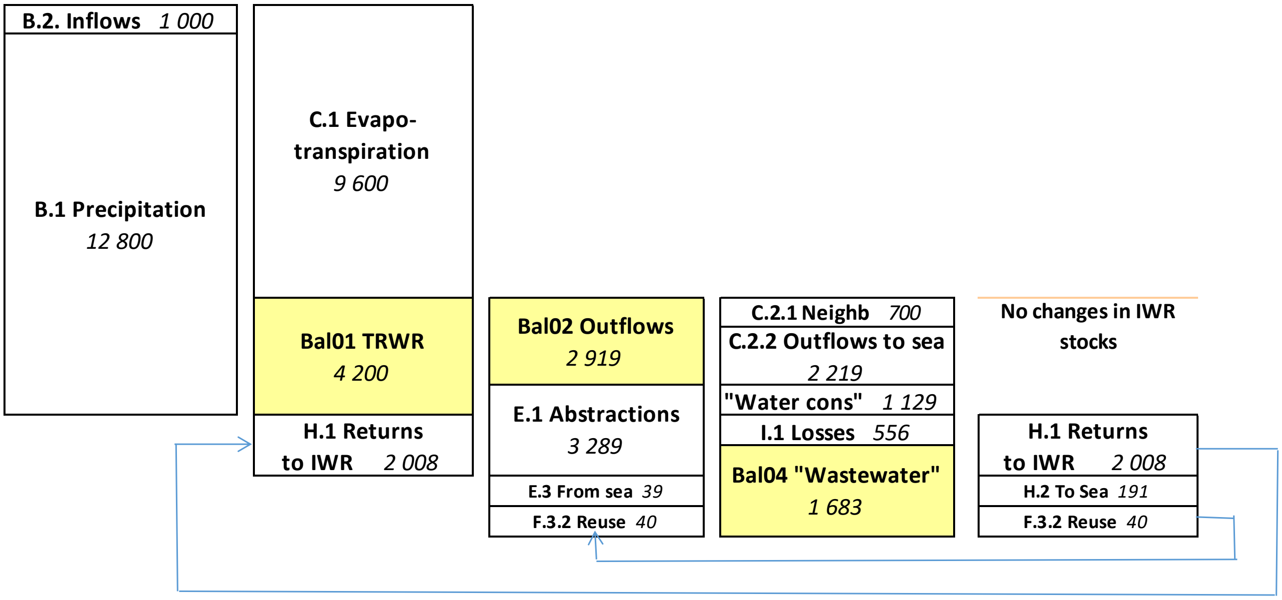
The following figure shows the sequence of accounts in a graphical format (not to scale).



Wastewater = Discarded water that is no longer required by owner or user. Includes returns from hydroelectric plants.

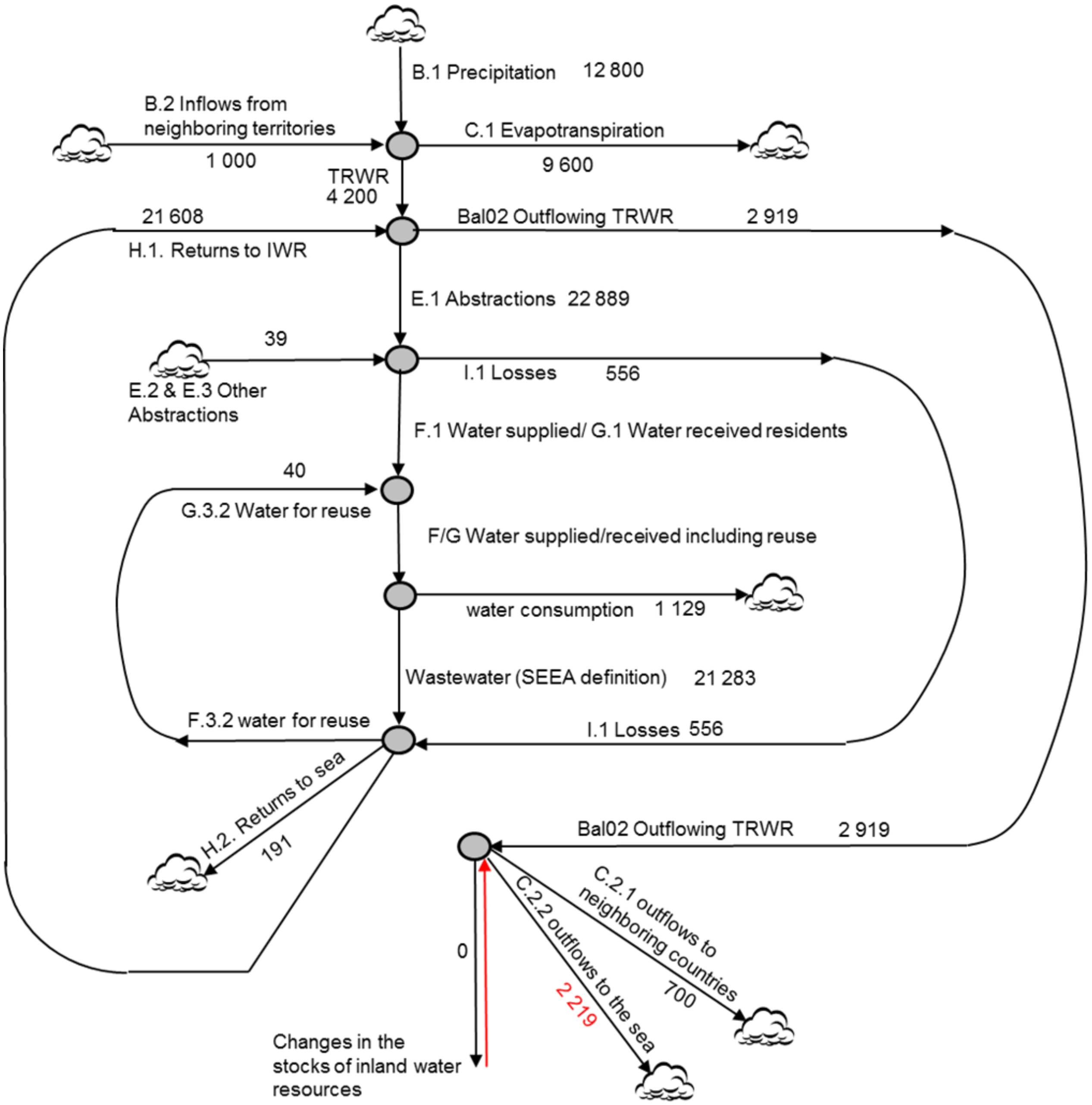
Hydroelectricity considerably increases the size of the bars and is not an offstream abstraction (or consumptive use abstraction). The diagram below shows the sequence excluding hydroelectricity (not to scale).

Unu-water (excluding hydroelectricity)



Wastewater = Discarded water that is no longer required by owner or user.

Still an additional way of viewing the physical sequence of water accounts is using a diagram of flows, such as the ones below. The information is exactly the same, but presented in different ways, which may facilitate the development of common understanding by a wide variety of actors from, often with different professional backgrounds.


B.1 Precipitation
12 800
B.2 Inflows from neighboring territories
1 000
C.1 Evapotranspiration
9 600
TRWR
4 200
21 608
H.1. Returns to IWR
Bal02 Outflowing TRWR
2 919
E.1 Abstractions
22 889
39
E.2 & E.3 Other Abstractions
I.1 Losses
556
F.1 Water supplied/ G.1 Water received residents
40
G.3.2 Water for reuse
F/G Water supplied/received including reuse
water consumption
1 129
Wastewater (SEEA definition)
21 283
F.3.2 water for reuse
I.1 Losses
556
H.2. Returns to sea
191
Bal02 Outflowing TRWR
2 919
C.2.1 outflows to neighboring countries
700
C.2.2 outflows to the sea
2 219
0
Changes in the stocks of inland water resources

Module VII: Waterborne pollution

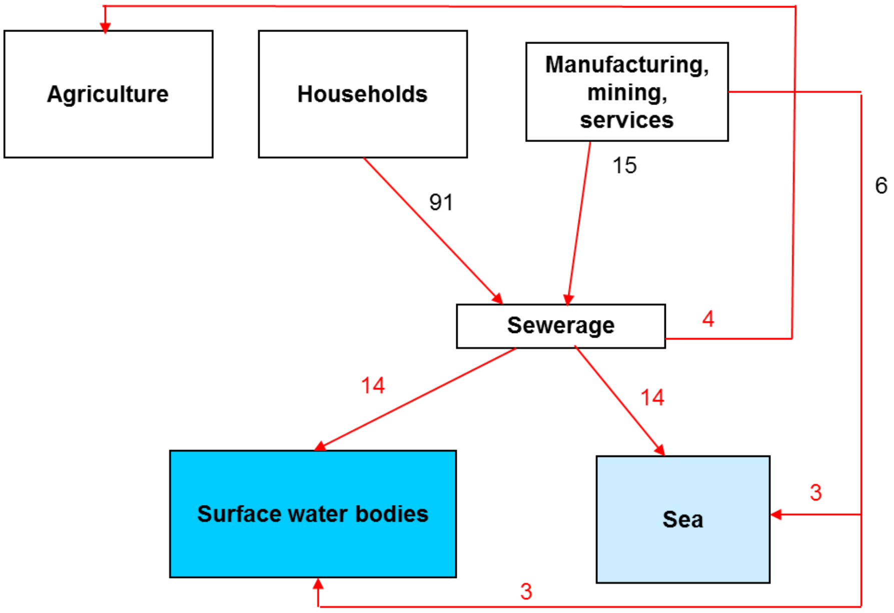
1. Review the standard concepts from the SEEA-CF of Emissions and Releases.

The following are the standard definitions provided in the System of Environmental-Economic Accounting, Central Framework (SEEA-CF). The specific paragraphs are provided in parenthesis:

Emissions to water	Emissions to water are substances released to water resources by establishments and households as a result of production, consumption and accumulation processes. For any individual establishment or household, emissions to water are measured in terms of the additional substances that the establishment or household has added to water rather than the total quantity of substances in the water discharged by the establishment or household. In this way, substances that were already in the water received by the establishment or household are not attributed to that unit. (SEEA 3.92)
Releases	Substances added by economic activities and households that are released to other economic units (mainly sewers). "…releases to economic units (largely, sewerage facilities)" (SEEA 3.94).

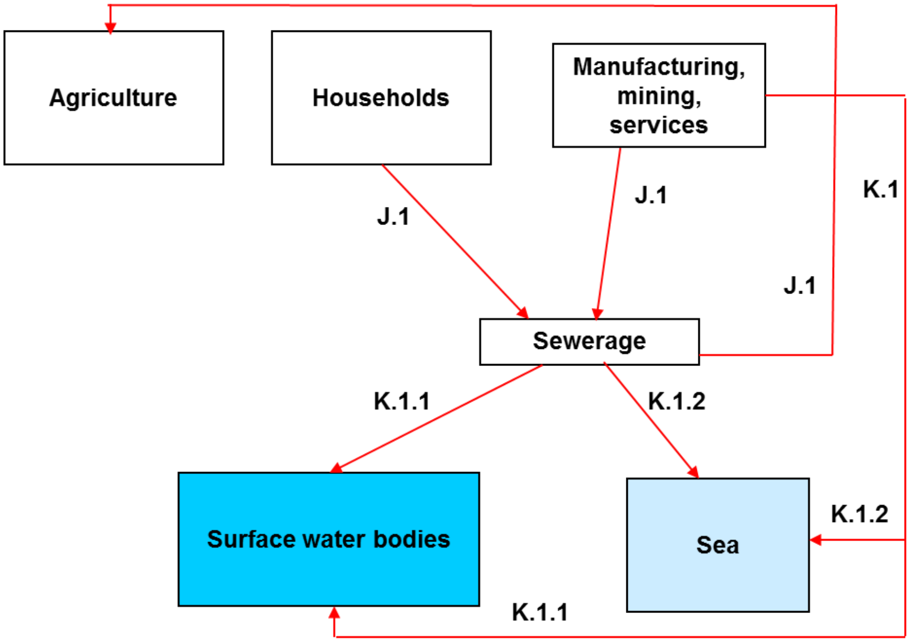
2. Make a simplified diagram showing the flows of pollution. (For the purpose of the exercise only point sources of pollution are included)

Flows in thousands t/year in terms of BOD_5



The diagram above shows the flows of pollution within the economy and from the economy to inland water resources. The numbers in black are provided. The numbers in red are based on assumptions made in order to complete the picture.

The diagram below shows the IRWS codes that correspond to each of the pollution flows.



3. Compile the water emission account.

POLLUTION SUPPLY TABLE

	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Hydroelectricity, ISIC 3510	Thermoelectricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Water Supply (irrigation water), ISIC 36-B	Sewerage, ISIC 37	Households	Environment	**Total**
Emissions by test or parameter										
BOD_5		6					28			**34**
Releases within the economy										
BOD_5		15					4	91		**110**
	0	**21**	**0**	**0**	**0**	**0**	**32**	**91**	**0**	**144**

In thousands of metric tons per year

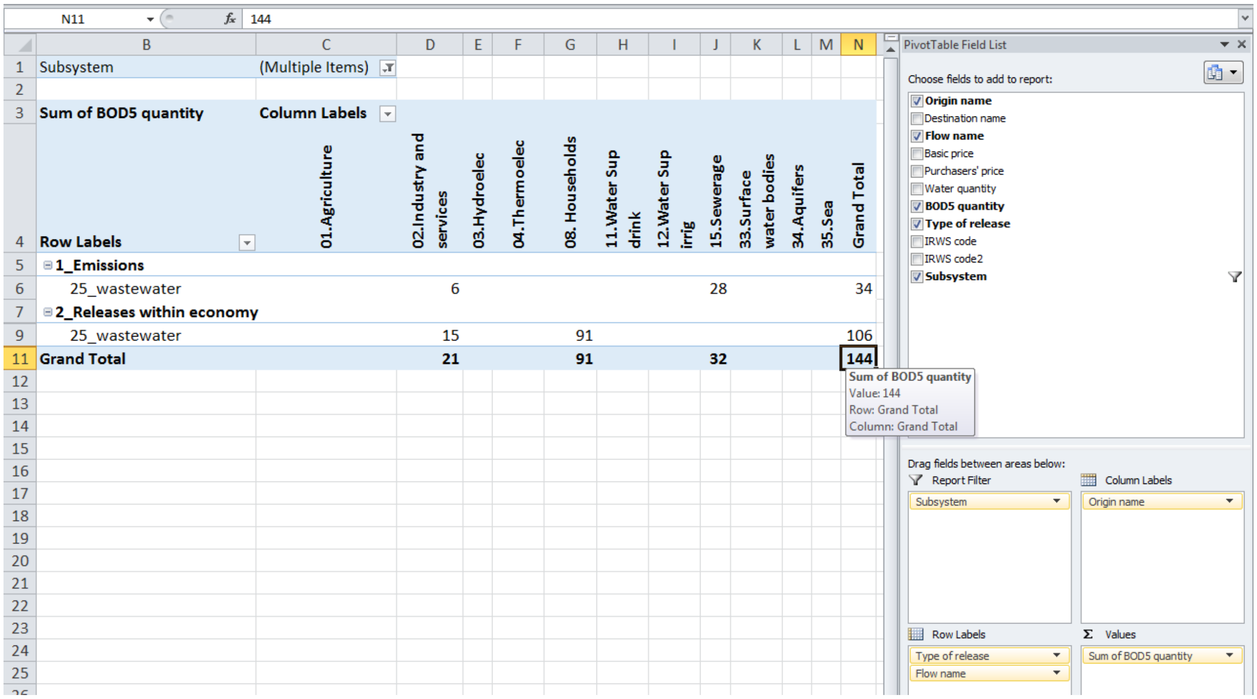
POLLUTION USE TABLE

	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Hydroelectricity, ISIC 3510	Thermoelectricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Water Supply (irrigation water), ISIC 36-B	Sewerage, ISIC 37	Households	Environment	**Total**
Emissions by test or parameter										
BOD_5									34	**34**
Releases within the economy										
BOD_5	4						106			**110**
	4	**0**	**0**	**0**	**0**	**0**	**106**	**0**	**34**	**144**

In thousands of metric tons per year.

4. If the data presented above are provided as a spreadsheet list, such as the one below, can you quickly assemble the emission accounts using the Excel Pivot option? What advantages do you see in the tabular approach over the list of data? How can consistency be checked?

The Excel screens are shown below. First for the pivot table to generate the pollution supply table.



Subsystem (Multiple Items)

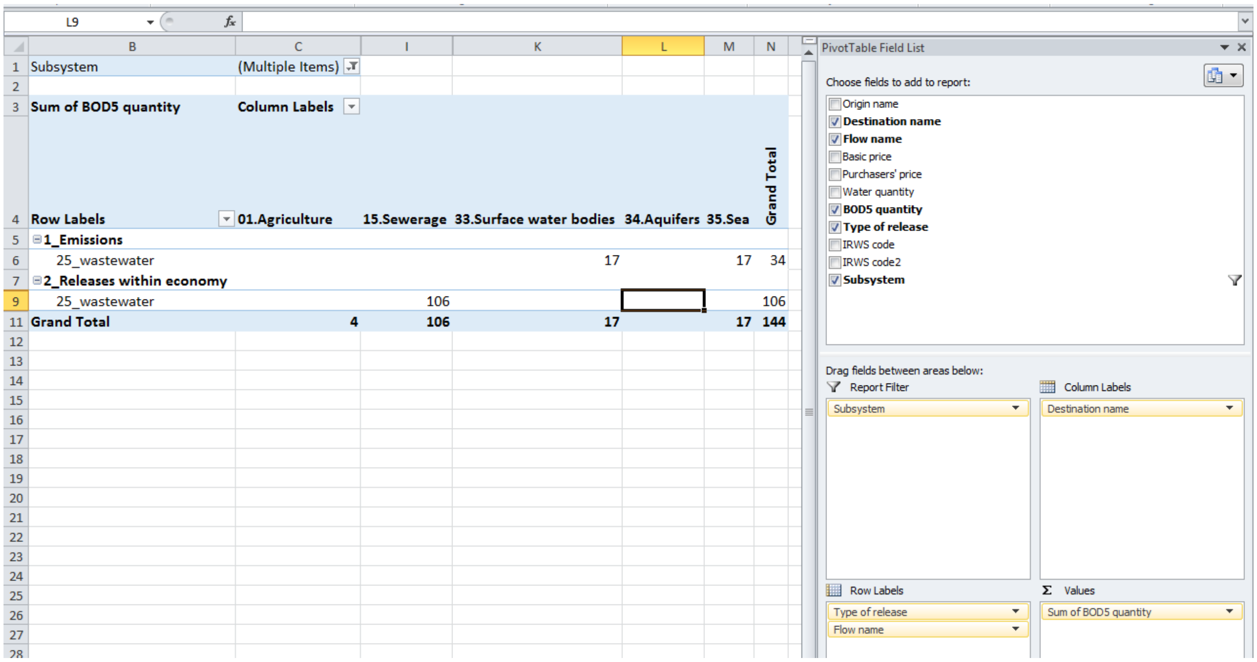
Sum of BOD5 quantity	Column Labels											
Row Labels	01.Agriculture	02.Industry and services	03.Hydroelec	04.Thermoelec	08. Households	11.Water Sup drink	12.Water Sup irrig	15.Sewerage	33.Surface water bodies	34.Aquifers	35.Sea	Grand Total
1_Emissions												
25_wastewater		6						28				34
2_Releases within economy												
25_wastewater		15			91							106
Grand Total		**21**			**91**			**32**				**144**

Sum of BOD5 quantity
Value: 144
Row: Grand Total
Column: Grand Total

- ☑ Origin name
- ☐ Destination name
- ☑ Flow name
- ☐ Basic price
- ☐ Purchasers' price
- ☐ Water quantity
- ☑ BOD5 quantity
- ☑ Type of release
- ☐ IRWS code
- ☐ IRWS code2
- ☑ Subsystem

Report Filter: Subsystem
Column Labels: Origin name
Row Labels: Type of release, Flow name
Values: Sum of BOD5 quantity

Then the Excel screen for the pivot table to generate the pollution use table.



Subsystem (Multiple Items)

Sum of BOD5 quantity Column Labels

Row Labels	01.Agriculture	15.Sewerage	33.Surface water bodies	34.Aquifers	35.Sea	Grand Total
1_Emissions						
25_wastewater			17		17	34
2_Releases within economy						
25_wastewater		106				106
Grand Total	**4**	**106**	**17**		**17**	**144**

PivotTable Field List

Choose fields to add to report:

☐ Origin name
☑ **Destination name**
☑ **Flow name**
☐ Basic price
☐ Purchasers' price
☐ Water quantity
☑ **BOD5 quantity**
☑ **Type of release**
☐ IRWS code
☐ IRWS code2
☑ **Subsystem**

Drag fields between areas below:

Report Filter: Subsystem
Column Labels: Destination name
Row Labels: Type of release, Flow name
Values: Sum of BOD5 quantity

In this case the subtotals for the types of flows have been deactivated, since the results of the different pollution tests cannot be added.

Module VIII: Basic Indicators

1. Calculate the following physical indicators:
    - off-stream abstractions as proportion of renewable inland water resources (MDG indicators 7.5),
    - sectorial proportions of off-stream abstractions, and
    - losses as proportion of abstractions in agriculture and drinking water supply.

From the information compiled in module VI we have that:

Off-stream abstraction (E.1off) = 3 289 million cubic meters per year (hm^3/year).
Total Renewable Water Resources (TRWR) = 4 200 hm^3/year
E.1off/TRWR = 78%

Abstractions by agriculture = E.1agr = 1936 hm3/year. E.1agr/E.1off = 59%
Abstractions by industry = E.1ind = 83 hm^3/year. E.1ind/E.1off = 3%
Abstractions by thermoelectric plants = E.1thermo = 650 hm^3/year E.1thermo/E.1off = 20%
Abstractions by drinking water suppliers = E.1drink = 620 hm^3/year E.1drink/E.1off = 19%

Losses in agriculture = I.1 = 366 hm3/year. I.1/E.1agr = 19%
Losses in drinking water supply = I.1 = 190 hm3/year. I.1/E.1drink = 31%

2. Calculate the following monetary indicators:
    - Value Added generated by the water and sanitation sector as a proportion of GDP,
    - investments in water and sanitation as a proportion of GDP.
    - changes in net worth of drinking water supply and sewerage infrastructure.

From module III:
GVA in water supply and sanitation = GVA in water supply + GVA in sewerage = 4 bk +4 bk = 8 bk
GDP = 105 bk/year
GVAwater&sanitation/GDP= 8/105*100% = 7.6%

From module V:
GFCFwater&sanitation = GFCF in water supply + GFCF in sewewage = 2.1 bk + 1.0 bk = 3.1 bk/year
GFCFwater&sanitation/GDP = 3.1/105*100% = 3%

From module V:
Changes in net worth of drinking water supply assets = -1.1
Changes in net worth of sewerage assets = -0.3

3. Calculate the following pollution indicators:
    - emissions of organic pollution to inland water resources and/or the sea
    - proportion of organic pollution releases that are removed by wastewater treatment plants,

Emissions of organic pollution measured as BOD_5 = 10 thousand ton/year

Wastewater treatment plants remove 74 thousand ton/year of BOD_5
Releases = 91 + 15 = 106 thousand ton/year BOD_5
Proportion removed = 74/106 = 70%

4. Calculate the following indicators that combine monetary and physical information:
    - water productivity by economic activity in terms of value added and off-stream water abstractions,
    - ratio of value added to emissions of organic pollution by economic activity,
    - Ratio of GDP to off-stream water abstraction,

We can construct a combined table using the information in the supply and use tables constructed in the previous modules as follows:

	Agriculture, ISIC 01-03	Industry and services ISIC 05-99, except 3510, 36, and 37	Hydroelectricity, ISIC 3510	Thermoelectricity, ISIC 3510	Water Supply (drinking water), ISIC 36-A	Sewerage, ISIC 36	Households
Gross Value Added (GVA) at basic prices (bk/year)	18	62	11		4	4	
Water Used (hm^3/year)	1 660	202	19 600	650	659		350
Releases (thousands of tons BOD_5/year)		15					91

GVA/water used (kulkis/m^3)	11	307			6		
GVA/organic pollution releases (kulkis/kg BOD_5/year)		4 133					

We observe that the productivity of water in industries and services (value added per cubic meter of water used) is 307 kulkis/m^3 of water. In terms of pollution (value added per kilogram of organic pollution released) is 4 133 kulkis/kg BOD_5. These indicators are useful when compared through time or with other countries or regions. It is also useful to disaggregate the column of industry and services in order to better understand which industries generate more value added per cubic meter of water used.

In the case of electricity, it is necessary to separate the portion of the value added that corresponds to hydroelectricity and the portion that corresponds to thermoelectricity. If we only consider off-stream or consumptive use of water, then the ratio is 11 billion kulkis/650 million m^3 = 17 kulkis/m^3.

GDP = 105 bk/year
Off stream water abstractions = E.1off = 3 289 hm^3/year
GDP/E.1off = 32 kulkis/m^3

5. Provide preliminary interpretations of the indicators and their relevance to water policies in Unu.

By themselves, the basic indicators do not provide a clear policy relevant message. They are relevant when comparisons in time and space are done. It is therefore very important that the indicators are calculated for several years in order to identify trends. It is also important to compare the indicators with other countries, or even calculate them for different areas of the country.

More detail is needed in order to understand the productivity of each industry. In this simplified example, several industries are lumped together under the generic name of industries and services.

Nevertheless, from the indicators above we can conclude that there is a high pressure on inland water resources. The off-stream abstractions represent 78% of the total renewable water resources. Policies to avoid prevent the increase of this ratio may be needed in Unu.

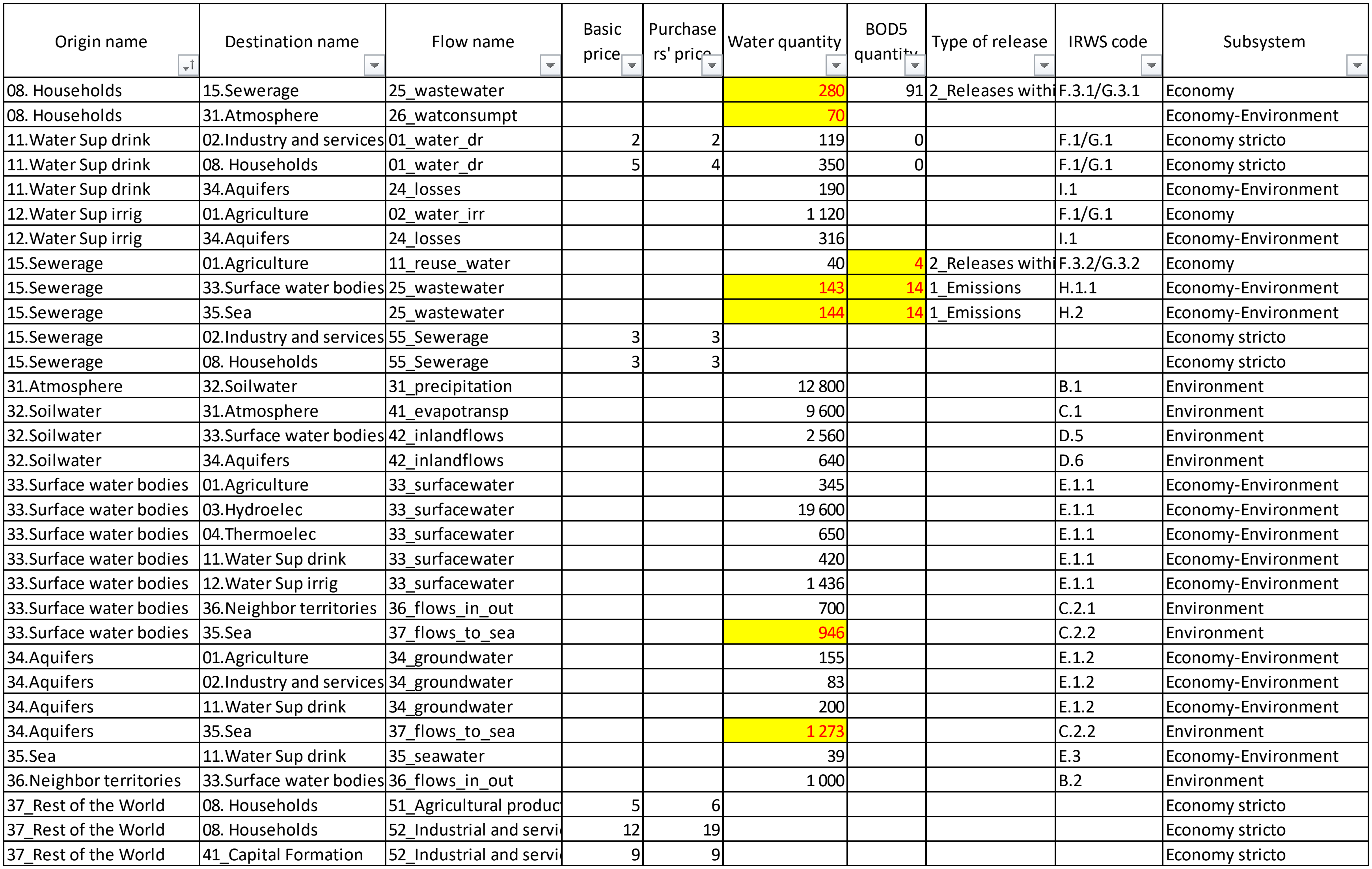
The removal of organic pollution is 70% of the total organic pollution released by point sources. It may be of interest to the government of Unu to track this ratio and implement policies to increase it, in order to reduce the pollution of inland water resources, which further decreases available water resources. This is especially relevant for the Eastern watershed, where pollution problems are more acute.

The changes in net worth of the assets of drinking water supply and sewerage are decreasing. This means that the investments in drinking water supply and sewerage are insufficient to keep the system running. The government of Unu wants to provide universal access to water and sanitation, which means that the investments in this sector have to be substantially increased in order to, not only maintain the infrastructure, but expand it.

6. Can you combine all the spreadsheets mentioned in the previous modules and create one single spreadsheet from which all the different tables can be quickly generated using the Excel Pivot option?

The following spreadsheet combines all the information presented in the different modules. From this list all the different tables can be generated using the Pivot tool of Excel.

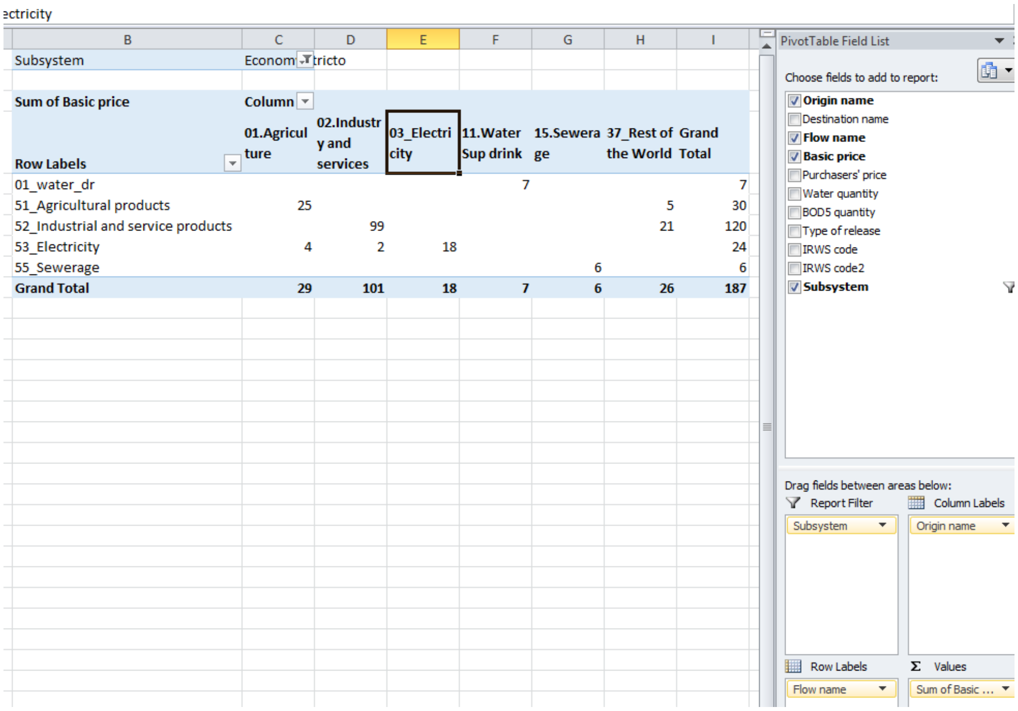
Origin name	Destination name	Flow name	Basic price	Purchasers' price	Water quantity	BOD5 quantity	Type of release	IRWS code	Subsystem
01.Agriculture	34.Aquifers	24_losses			50			I.1	Economy-Environment
01.Agriculture	33.Surface water bodies	25_wastewater			129			H.1.1	Economy-Environment
01.Agriculture	34.Aquifers	25_wastewater			515			H.1.2	Economy-Environment
01.Agriculture	31.Atmosphere	26_watconsumpt			966				Economy-Environment
01.Agriculture	01.Agriculture	51_Agricultural produc	3	3					Economy stricto
01.Agriculture	02.Industry and services	51_Agricultural produc	6	6					Economy stricto
01.Agriculture	03_Electricity	51_Agricultural produc	1	1					Economy stricto
01.Agriculture	08. Households	51_Agricultural produc	9	11					Economy stricto
01.Agriculture	37_Rest of the World	51_Agricultural produc	6	6					Economy stricto
01.Agriculture	01.Agriculture	53_Electricity	2	2					Economy stricto
01.Agriculture	02.Industry and services	53_Electricity	2	2					Economy stricto
02.Industry and services	15.Sewerage	25_wastewater			47	15	2_Releases withi	F.3.1/G.3.1	Economy
02.Industry and services	33.Surface water bodies	25_wastewater			47	3	1_Emissions	H.1.1	Economy-Environment
02.Industry and services	35.Sea	25_wastewater			47	3	1_Emissions	H.2	Economy-Environment
02.Industry and services	31.Atmosphere	26_watconsumpt			61				Economy-Environment
02.Industry and services	01.Agriculture	52_Industrial and servi	6	6					Economy stricto
02.Industry and services	02.Industry and services	52_Industrial and servi	22	16					Economy stricto
02.Industry and services	03_Electricity	52_Industrial and servi	7	7					Economy stricto
02.Industry and services	08. Households	52_Industrial and servi	25	23					Economy stricto
02.Industry and services	11.Water Sup drink	52_Industrial and servi	1	1					Economy stricto
02.Industry and services	15.Sewerage	52_Industrial and servi	1	1					Economy stricto
02.Industry and services	37_Rest of the World	52_Industrial and servi	14	18					Economy stricto
02.Industry and services	8_Capital Formation	52_Industrial and servi	23	24					Economy stricto
02.Industry and services	02.Industry and services	53_Electricity	2	2					Economy stricto
03.Hydroelec	33.Surface water bodies	25_wastewater			19 600			H.1.1	Economy-Environment
03_Electricity	02.Industry and services	53_Electricity	8	8					Economy stricto
03_Electricity	08. Households	53_Electricity	7	7					Economy stricto
03_Electricity	11.Water Sup drink	53_Electricity	2	2					Economy stricto
03_Electricity	15.Sewerage	53_Electricity	1	1					Economy stricto
04.Thermoelec	33.Surface water bodies	25_wastewater			618			H.1.1	Economy-Environment
04.Thermoelec	31.Atmosphere	26_watconsumpt			32				Economy-Environment



Origin name	Destination name	Flow name	Basic price	Purchase rs' pric	Water quantity	BOD5 quantit	Type of release	IRWS code	Subsystem
08. Households	15.Sewerage	25_wastewater			280	91	2_Releases withi	F.3.1/G.3.1	Economy
08. Households	31.Atmosphere	26_watconsumpt			70				Economy-Environment
11.Water Sup drink	02.Industry and services	01_water_dr	2	2	119	0		F.1/G.1	Economy stricto
11.Water Sup drink	08. Households	01_water_dr	5	4	350	0		F.1/G.1	Economy stricto
11.Water Sup drink	34.Aquifers	24_losses			190			I.1	Economy-Environment
12.Water Sup irrig	01.Agriculture	02_water_irr			1 120			F.1/G.1	Economy
12.Water Sup irrig	34.Aquifers	24_losses			316			I.1	Economy-Environment
15.Sewerage	01.Agriculture	11_reuse_water			40	4	2_Releases withi	F.3.2/G.3.2	Economy
15.Sewerage	33.Surface water bodies	25_wastewater			143	14	1_Emissions	H.1.1	Economy-Environment
15.Sewerage	35.Sea	25_wastewater			144	14	1_Emissions	H.2	Economy-Environment
15.Sewerage	02.Industry and services	55_Sewerage	3	3					Economy stricto
15.Sewerage	08. Households	55_Sewerage	3	3					Economy stricto
31.Atmosphere	32.Soilwater	31_precipitation			12 800			B.1	Environment
32.Soilwater	31.Atmosphere	41_evapotransp			9 600			C.1	Environment
32.Soilwater	33.Surface water bodies	42_inlandflows			2 560			D.5	Environment
32.Soilwater	34.Aquifers	42_inlandflows			640			D.6	Environment
33.Surface water bodies	01.Agriculture	33_surfacewater			345			E.1.1	Economy-Environment
33.Surface water bodies	03.Hydroelec	33_surfacewater			19 600			E.1.1	Economy-Environment
33.Surface water bodies	04.Thermoelec	33_surfacewater			650			E.1.1	Economy-Environment
33.Surface water bodies	11.Water Sup drink	33_surfacewater			420			E.1.1	Economy-Environment
33.Surface water bodies	12.Water Sup irrig	33_surfacewater			1 436			E.1.1	Economy-Environment
33.Surface water bodies	36.Neighbor territories	36_flows_in_out			700			C.2.1	Environment
33.Surface water bodies	35.Sea	37_flows_to_sea			946			C.2.2	Environment
34.Aquifers	01.Agriculture	34_groundwater			155			E.1.2	Economy-Environment
34.Aquifers	02.Industry and services	34_groundwater			83			E.1.2	Economy-Environment
34.Aquifers	11.Water Sup drink	34_groundwater			200			E.1.2	Economy-Environment
34.Aquifers	35.Sea	37_flows_to_sea			1 273			C.2.2	Environment
35.Sea	11.Water Sup drink	35_seawater			39			E.3	Economy-Environment
36.Neighbor territories	33.Surface water bodies	36_flows_in_out			1 000			B.2	Environment
37_Rest of the World	08. Households	51_Agricultural produc	5	6					Economy stricto
37_Rest of the World	08. Households	52_Industrial and servi	12	19					Economy stricto
37_Rest of the World	41_Capital Formation	52_Industrial and servi	9	9					Economy stricto

The following screens show some examples of the different tables that can be generated using the Pivot tool of Excel.

Monetary supply table:


ectricity

Subsystem	Econom tricto						
Sum of Basic price	**Column**						
Row Labels	**01.Agriculture**	**02.Industry and services**	**03_Electricity**	**11.Water Sup drink**	**15.Sewerage**	**37_Rest of the World**	**Grand Total**
01_water_dr				7			7
51_Agricultural products	25					5	30
52_Industrial and service products		99				21	120
53_Electricity	4	2	18				24
55_Sewerage					6		6
Grand Total	**29**	**101**	**18**	**7**	**6**	**26**	**187**

PivotTable Field List

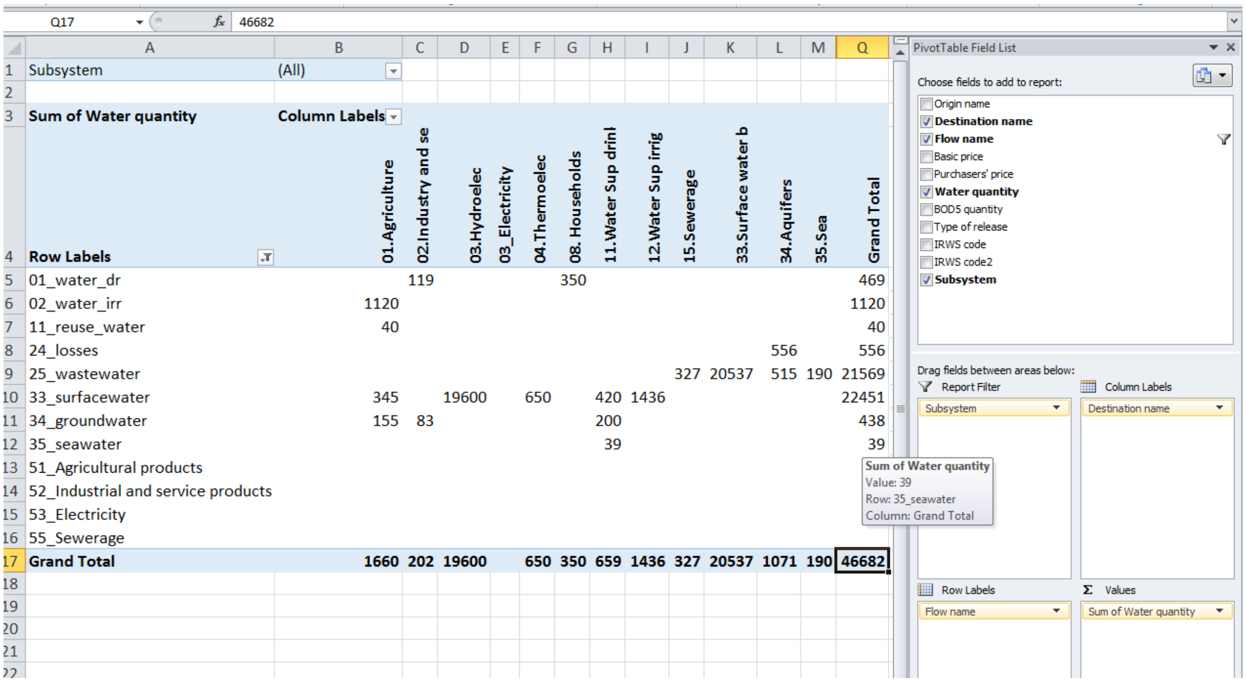
Choose fields to add to report:

☑ **Origin name**
☐ Destination name
☑ **Flow name**
☑ **Basic price**
☐ Purchasers' price
☐ Water quantity
☐ BOD5 quantity
☐ Type of release
☐ IRWS code
☐ IRWS code2
☑ **Subsystem**

Drag fields between areas below:

Report Filter: Subsystem
Column Labels: Origin name
Row Labels: Flow name
Values: Sum of Basic ...

Physical (water quantities) use table


Q17 46682

Subsystem	(All)											
Sum of Water quantity	**Column Labels**											
Row Labels	**01.Agriculture**	**02.Industry and se**	**03.Hydroelec**	**03_Electricity**	**04.Thermoelec**	**08. Households**	**11.Water Sup drinl**	**12.Water Sup irrig**	**15.Sewerage**	**33.Surface water b**	**34.Aquifers**	**35.Sea**	**Grand Total**
01_water_dr		119				350							469
02_water_irr	1120												1120
11_reuse_water	40												40
24_losses											556		556
25_wastewater									327	20537	515	190	21569
33_surfacewater	345		19600		650		420	1436					22451
34_groundwater	155	83					200						438
35_seawater							39						39
51_Agricultural products													
52_Industrial and service products													
53_Electricity													
55_Sewerage													
Grand Total	**1660**	**202**	**19600**		**650**	**350**	**659**	**1436**	**327**	**20537**	**1071**	**190**	**46682**

Sum of Water quantity
Value: 39
Row: 35_seawater
Column: Grand Total

PivotTable Field List

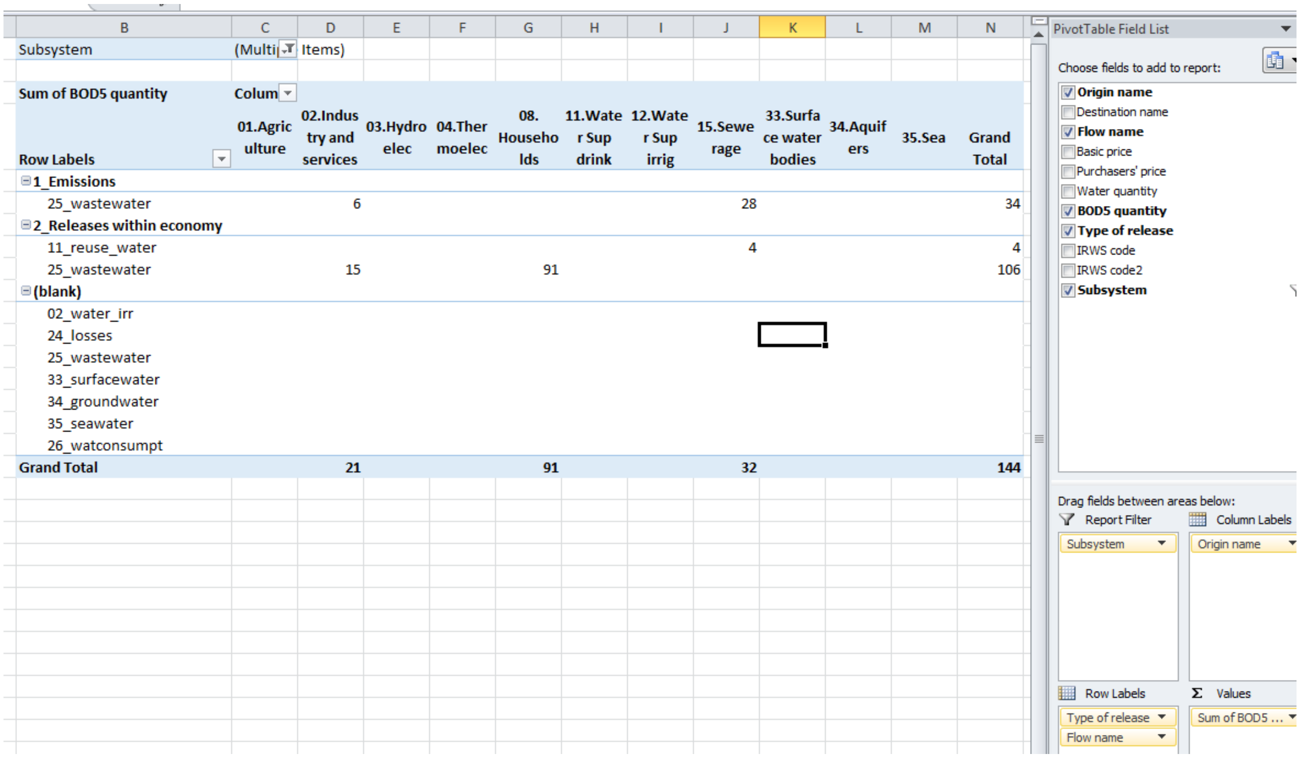
Choose fields to add to report:

☐ Origin name
☑ **Destination name**
☑ **Flow name**
☐ Basic price
☐ Purchasers' price
☑ **Water quantity**
☐ BOD5 quantity
☐ Type of release
☐ IRWS code
☐ IRWS code2
☑ **Subsystem**

Drag fields between areas below:

Report Filter: Subsystem
Column Labels: Destination name
Row Labels: Flow name
Values: Sum of Water quantity

Pollution supply table (from emission accounts)



B	C	D	E	F	G	H	I	J	K	L	M	N
Subsystem	(Multi	Items)										
Sum of BOD5 quantity	**Colum**											
Row Labels	**01.Agriculture**	**02.Industry and services**	**03.Hydroelec**	**04.Thermoelec**	**08. Households**	**11.Water Sup drink**	**12.Water Sup irrig**	**15.Sewerage**	**33.Surface water bodies**	**34.Aquifers**	**35.Sea**	**Grand Total**
⊟1_Emissions												
25_wastewater		6						28				34
⊟2_Releases within economy												
11_reuse_water								4				4
25_wastewater		15			91							106
⊟(blank)												
02_water_irr												
24_losses												
25_wastewater												
33_surfacewater												
34_groundwater												
35_seawater												
26_watconsumpt												
Grand Total		**21**			**91**			**32**				**144**

PivotTable Field List

Choose fields to add to report:

- ☑ **Origin name**
- ☐ Destination name
- ☑ **Flow name**
- ☐ Basic price
- ☐ Purchasers' price
- ☐ Water quantity
- ☑ **BOD5 quantity**
- ☑ **Type of release**
- ☐ IRWS code
- ☐ IRWS code2
- ☑ **Subsystem**

Drag fields between areas below:

Report Filter: Subsystem

Column Labels: Origin name

Row Labels: Type of release, Flow name

Values: Sum of BOD5 ...

Module IX: Dynamic behavior

1. Assume that the abstractions, inflows from other countries, and outflows to other countries and the sea remain the same, but precipitation decreases in the following years. However, the proportions of precipitation that becomes surface runoff, infiltration, and evapotranspiration remain the same. How are the stocks of inland water resources affected if the precipitation records, in million cubic meters per year, are as follows? Assume that the initial stock of inland water resources is 3 000 million cubic meters.

• in the second year it is	11 000
• third year	12 000
• fourth year	10 000
• fifth year	11 000

The same sequence of accounts of module VI exercise 4 can be performed for each year of the series. For the second year the sequence is as follows:

1	Renewable water	Resources	Uses	Balance
B.1	Precipitation	11 000		
B.2	Inflows from other countries or territories (OECD-Eurostat q. 4)	1 000		
C.1	Evapotranspiration		8 250	
Bal01	**Total Renewable Water Resources (TRWR)**			**3 750**

2	Ouflowing TRWR & returns	Resources	Uses	Balance
Bal01	Total Renewable Water Resources (TRWR)	3 750		
H.1	Returns of water to inland water resources	21 608		
E.1 (offstream)	Abstractions from inland water resources (offstream)		3 289	
E.1 (instream)	Abstractions from inland water resources (instream)		19 600	
Bal02	**Outflowing TRWR & returns**			**2 469**

3	Water supplied and received	Resources	Uses	Balance
E.1 (offstream)	Abstractions from inland water resources (offstream)	3 289		
E.1 (instream)	Abstractions from inland water resources (instream)	19 600		
E.2 & E.3	Abstractions from other sources (sea & precipitation)	39		
G.2	Imported water	0		
F.3.2/G.3.2	Reused water	40		
I.1	Losses in transportation and distribution		556	
F.2	Exported water		0	
Bal 03	**Water supplied or self supplied to resident users**			**22 412**

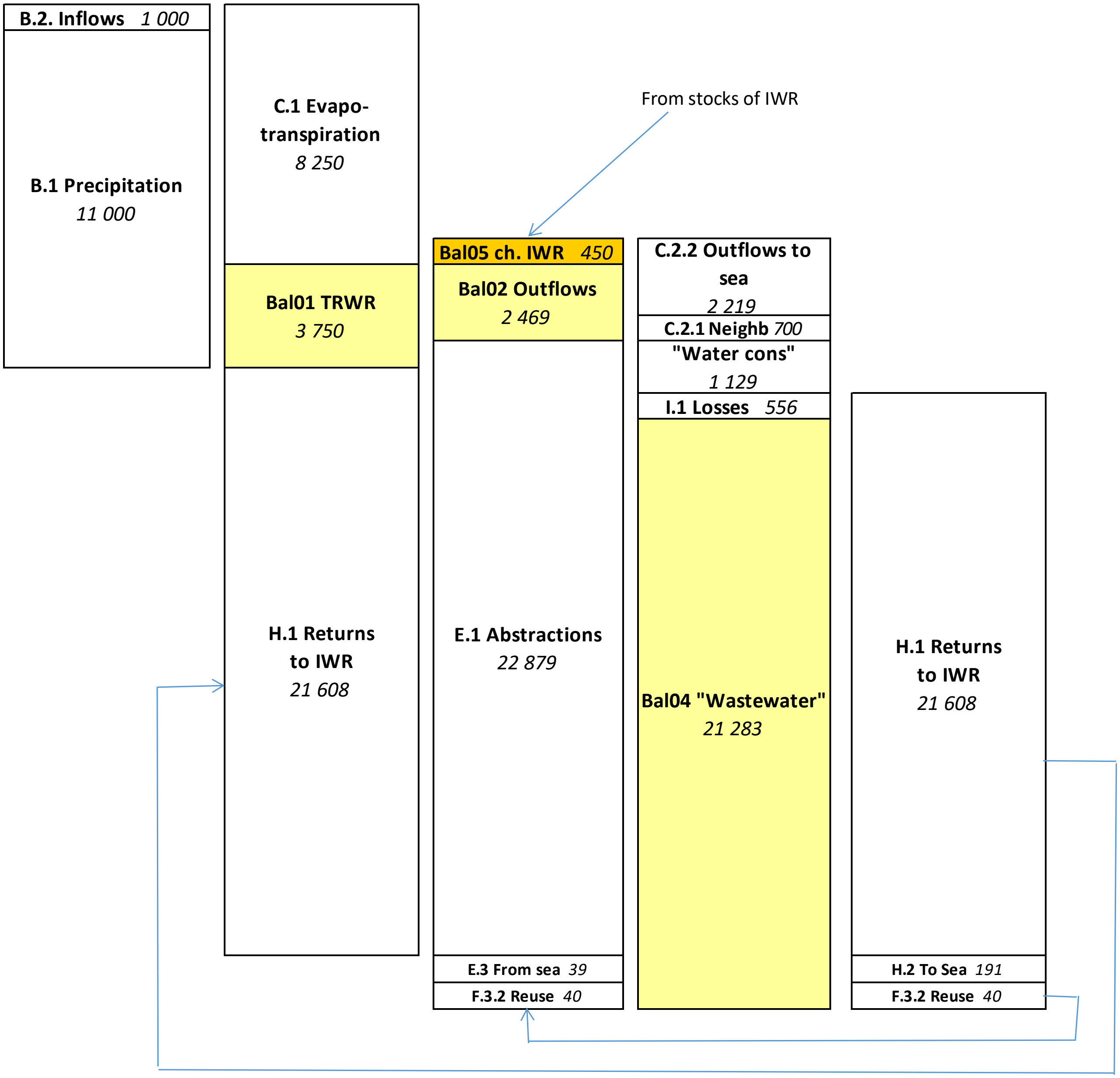
4	Wastewater generated	Resources	Uses	Balance
Bal 03	Water supplied/received by resident users	22 412		
	"Water consumption"		1 129	
Bal04	**Wastewater (as defined in SEEA, regardles of quality)**			**21 283**

5	Final balance of wastewater	Resources	Uses	Balance
Bal04	"Wastewater" (as defined in SEEA, regardless of quality)	21 283		
I.1	Losses in transportation and distribution	556		
H.2	Returns to the sea		191	
F.3.2/G.3.2	Water for reuse		40	
H.1	**Returns of water to inland water resources**			**21 608**

6	Final balance of discharges	Resources	Uses	Balance
Bal02	Outflowing TRWR & returns	2 469		
C.2.1	Outflows to neighboring countries or territories		700	
C.2.2	Outflows to the sea		2 219	
Bal05	**Net changes in Inland Water Resources**			**- 450**

7	Balance Sheet	Opening	Changes	Balance
A.	Inland water resources	5 900	- 450	5 450

The sequence can be represented graphically as shown below. Note that there is a negative change in the stocks of Inland Water Resources (IWR) in order to maintain the outflows to the sea and to neighboring territories.



Wastewater = Discarded water that is no longer required by owner or user. Includes returns from hydroelectric plants.
IWR = Inland Water Resources.

The calculations for each of the years can be simplified as shown below. The IRWS codes are shown on the left side, assuming the proportion of surface runoff and infiltration remain the same. The rest of the data remain the same. Figures in millions of cubic meters per year (hm^3/year).

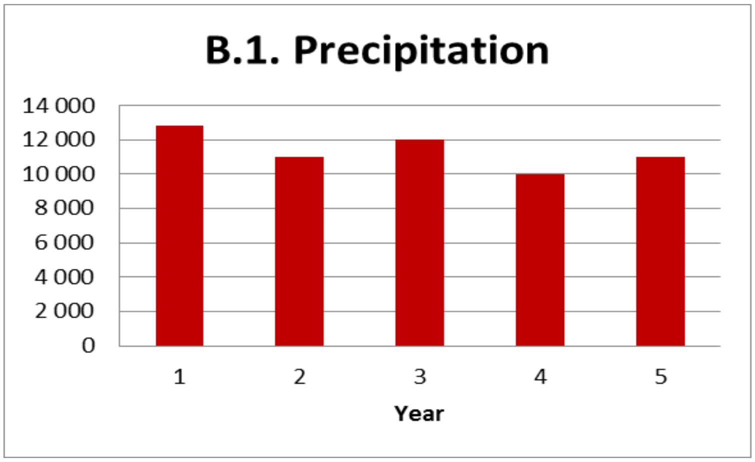
Year	**1**	**2**	**3**	**4**	**5**
B.1 Precipitation	12 800	11 000	12 000	10 000	11 000
D.5 Surface Runoff (20% of B.1)	2 560	2 200	2 400	2 000	2 200
D.6 Infiltration (5% of B.1)	640	550	600	500	550
B.2 Inflows	1 000	1 000	1 000	1 000	1 000
H.1 Returns	21 609	21 609	21 609	21 609	21 609
C.1 Evapotranspiration (B.1 - D.5 - D.6)	9 600	8 250	9 000	7 500	8 250
C.2.1 Outflows to other countries	700	700	700	700	700
C.2.2 Outflows to the sea	2 220	2 220	2 220	2 220	2 220
E.1 Abstractions	22 889	22 889	22 889	22 889	22 889

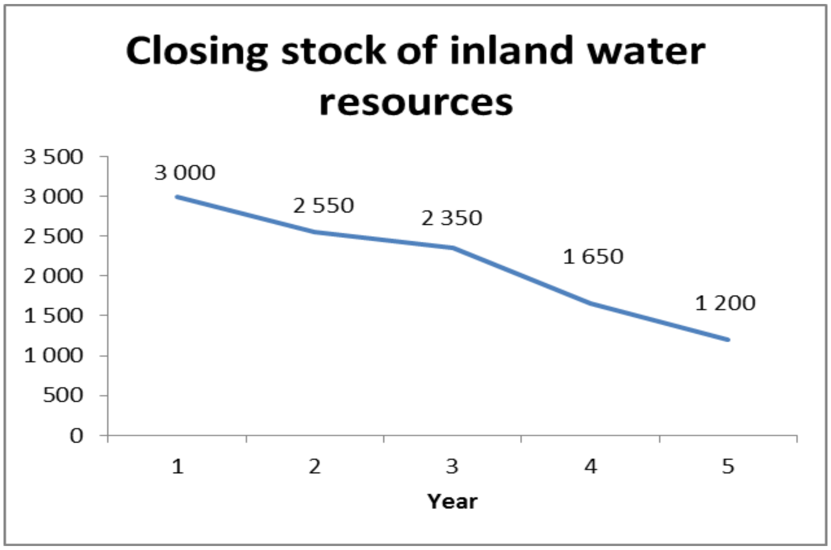
Adding the data in the previous table a simplified asset account can be performed as follows:

Additions to Stock (B.1 + B.2 + H.1)	35 409	33 609	34 609	32 609	33 609
Reductions in Stock (C.1 + C.2.1 + C.2.2 + E.1)	35 409	34 059	34 809	33 309	34 059
Difference	0	- 450	- 200	- 700	- 450

Initial stock of inland water resources	3 000	3 000	2 550	2 350	1 650
Closing stock of inland water resources	3 000	2 550	2 350	1 650	1 200

The information in the tables can be visualized using the graphs below.





It can be seen that, through the years, the inland water resources stock (e.g. water in the aquifers, and artificial reservoirs) is being reduced. The effects of this reduction through the years should be analyzed.

Module X: Adding Details to the Accounts

1. With the data provided by the UMWR recalculate the asset accounts and re-do the diagram to describe the natural hydrologic cycle. Make all the assumptions that you consider necessary.

The information provided by UMWR will be added to the simplified asset accounts constructed in module VI. Instead of recording that all the precipitation falls directly on “soil water,” the total precipitation will be split in the column of artificial reservoirs, lakes, and “soil water.” The same will be done with the evaporation.

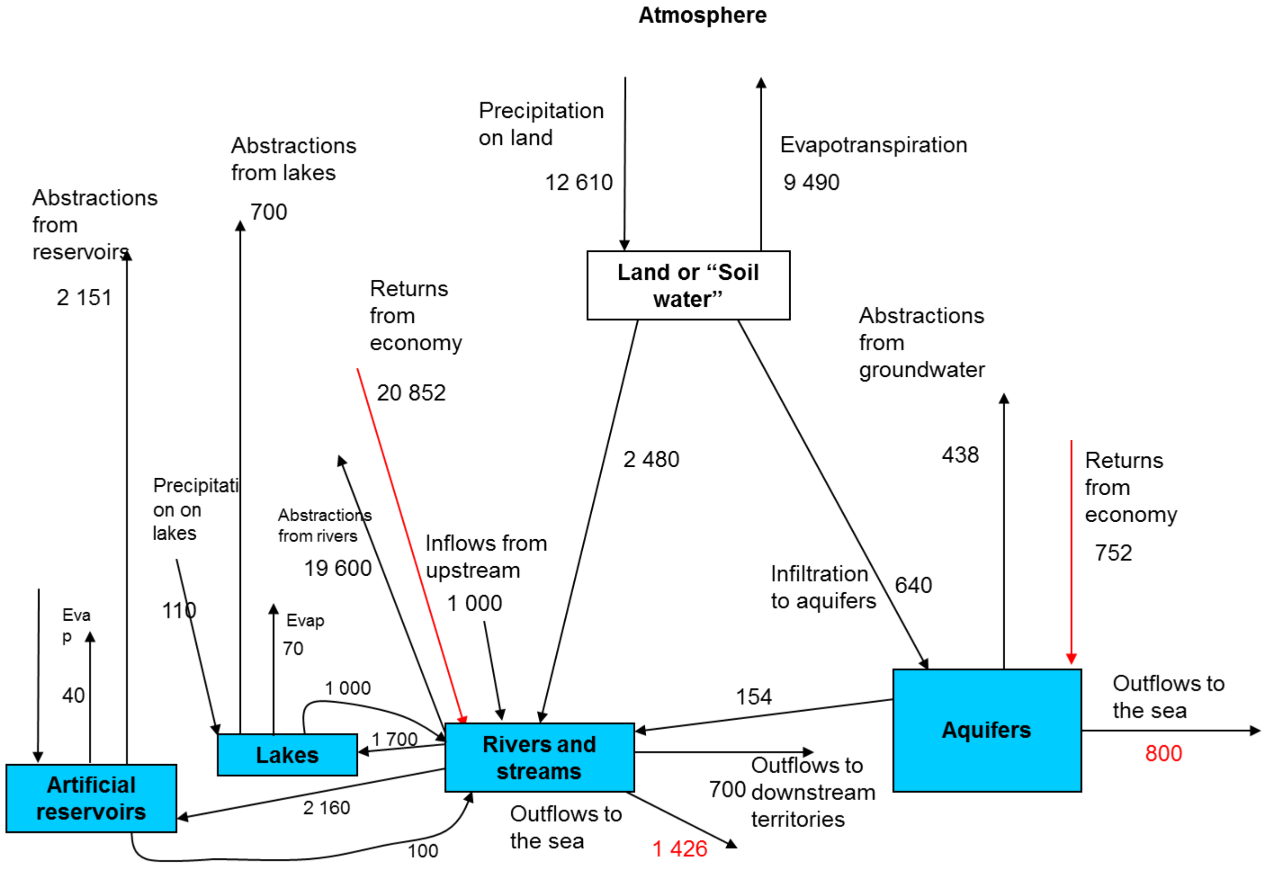
The rest of the information is added in the respective columns of artificial reservoirs and lakes. The information about water stored in artificial reservoirs and lakes is recorded as opening stocks of water in the respective columns (it is not clear when the stocks were measured or estimated, but it will be assumed that they were measured at the beginning of each year). It will be assumed that all the abstractions, except those for hydroelectricity, are from artificial reservoirs, lakes, and aquifers.

The information in the column of aquifers remains almost the same, except for outflows to the sea which are reduced to 154 hm^3/year, as there is a flow which goes from aquifers to surface waters. Since the amount of water stored in the aquifers is unknown, a large number (in this case 4 000 hm^3) is recorded until better information is found.

In the column of rivers and streams the inflows from other countries and outflows to other countries are recorded. The inflows from other inland water resources is the sum of all the outflows from the other inland water resources, less the inflows to the aquifers. The outflows to other inland water resources are the inflows to artificial reservoirs and lakes. This is because rivers and streams are assumed to connect all the other inland water resources.

	Artificial reservoirs	Lakes	Rivers and streams	Aquifers	Land or "Soil water"	TOTAL
Opening stock of water	**800**	**1 100**		**4 000**		**Opening A.1 + Opening A.2**
Additions to stock	**2 240**	**1 810**	**25 586**	**1 392**	**12 610**	**43 638**
Precipitation	80	110			12 610	12 800
Inflows from other countries			1 000			1 000
Inflows from other inland water resources	2 160	1 700	3 734	640		8 234
Returns from the economy			20 852	752		21 604
Reductions in stock	**2 291**	**1 770**	**25 586**	**1 392**	**12 610**	**43 649**
Evaporation and/or transpiration (evapotranspiration)	40	70			9 490	9 600
Outflows to other countries			700			700
Outflows to other inland water resources	100	1 000	3 860	154	3 120	8 234
Outflows to the sea			1 426	800		2 226
Abstractions	2 151	700	19 600	438		22 889
Closing stock of water	**749**	**1 140**		**4 000**		**Closing A.1 + Closing A.2**

More details are added to the diagram of module II:



The numbers in red show estimates used to balance the accounts. As more information becomes available these numbers will be adjusted, accordingly. Note that water cannot be stored in rivers and streams, therefore, all the water going into the rivers has to go out. This is how the outflows to the sea were determined. The ouflows to the sea estimated with the accounts can be compared with the flows measured with stream gauges at the mouth of rivers and streams.

Note that in the asset account the inflows and outflows to/from rivers and streams to/from other inland water resources are lumped together. Therefore, the inflow of 3 734 is the sum of 154 from the aquifers, plus 100 from artificial reservoirs, plus 1 000 from lakes, plus 2 480 from soil water.
Likewise, the outflow of 3 860 is the sum of 1 700 to lakes and 2 160 to artificial reservoirs.

The detail added to the accounts shows that the volume of water in artificial reservoirs is being reduced. Time series of the water storage in reservoirs may be useful for better understanding these changes in volume.

Symbols and Abbreviations

1 hm^3	1 million cubic meters = 1 gigaliter = 1 GL
1 t	1 metric ton = 1000 kg
CPC	Central Product Classification (version 2 is used in this example).
GCF	Gross Capital Formation
GFCF	Gross Fixed Capital Formation
IRWS	International Recommendations for Water Statistics
ISIC	International Standard Industrial Classification of All Economic Activities (Revision 4 is used in this example).
RoW	Rest of the World. Used to designate economies to which Unu exports products or from which Unu imports products.
SEEA-CF	System of Environmental-Economic Accounts, Central Framework
SEEA-Water	System of Environmental-Economic Accounts for Water.
SNA 2008	System of National Accounts, 2008 edition.