The Sugarland-Water Exercise

An Introduction to Environmental –Economic Accounts for Water (SEEA-Water)

ACKNOWLEDGEMENTS

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Water in Sugarland

Sugarland is an island of 1 700 km^2 with nearly 615 thousand inhabitants in 2010. The economy of the island is mainly based on the export of sugar. Sugarland also receives income from services of accommodation and food offered to the tourists that visit the island. Tourism to Sugarland is rapidly growing and offers great opportunities for development; however, it also increases significantly the demand of water, which may put the island at risk.

Sugarland receives abundant precipitation, 1 300 mm of rainfall per year, but it is mainly concentrated in the summer. The island does not have lakes or artificial reservoirs to store water, so most of the runoff generated by precipitation flows to the sea through small rivers and streams. About 5% of the precipitation infiltrates to a large aquifer that is the main source of water for the island.

All the water needed for the irrigation of sugarcane, for the hotels and restaurants, for households, and for other activities is abstracted from the subjacent aquifer. The aquifer is vulnerable to seawater intrusion. This means that if the water table drops below a certain level, seawater will penetrate the aquifer and salinize all the groundwater in the country.

The overexploitation of the aquifer has already caused a significant drop of the water table. If the water table continues to drop, it will cause salinization of the aquifer. At the current rate of water abstraction it is expected that the aquifer will salinize after the year 2025; however, with the quick growth of the economy, the aquifer may have problems much sooner than that.

Table 1. Summary of information about Sugarland

Population in 2010	614 977
Proportion of population with piped water (%)	99%
Proportion of population connected to the sewer network (%)	96%

Area of the island (km^2)	1 700
Average precipitation (mm/year)	1 300
Surface runoff (as proportion of precipitation)	65%
Infiltration to aquifers (as proportion of precipitation)	5%

Water abstracted by the water utility (hm^3/year)	100
Losses in the drinking water distribution network (%)	50%
Water abstracted for agriculture (hm^3/year)	54
Losses in conveyance of water in agriculture	40%
Water abstracted by sugar mills (hm^3/year)	5
Water abstracted by various manufacturing activities (hm^3/year)	5

NOTE: 1 hm^3 = 1 million cubic meters

There are no sales taxes in Sugarland. There are no subsidies on products either.

The Economy of Sugarland

Tables 1 and 2 present information about the economy of Sugarland. It is a very simple economy, with only six economic activities, shown in the columns.

The rows of the supply table show the products produced by each economic activity (for example, the activity of sugar milling produces sugar worth 261 million dollars). The rows of the use table show the products consumed by each of the economic activities, as well as by households and government (for example, to produce the 261 million dollars worth of sugar, it was necessary to consume 190 million dollars worth of sugar cane and 10 million dollars worth of manufactured goods).

It can be noted that the total sum of each row in the supply table is equivalent to the sum of each row in the use table, since supply is equal to use. The supply table is usually compiled in basic prices and the use table is compiled in purchasers' prices. However, for this example purchasers' prices and basic prices are the same.

Additional Assumptions

- 40% of the losses in the drinking water supply distribution network infiltrate to the aquifer, the rest go to the sea.
- "Water consumption" (water evaporated or transpired by an activity. Not to be confused with consumption as defined in the SNA) is:
    - 27.5% for households.
    - 20% for hotels and restaurants.
    - 60% in sugar mills.
    - 60% in the different manufacturing activities.
    - 55% in growing sugar cane.
- The losses in conveyance of water in agriculture infiltrate to the aquifer.
- Returns from sugarcane fields are discharged to surface water bodies.
- Wastewater from sugar mills is discharged to surface water bodies, after treatment.
- Wastewater from manufacturing industries is discharged to the sea, after treatment..
- The sewerage utility discharges the wastewater collected to the sea, after treatment.
- Of the water delivered through the drinking water supply network, 80% is delivered to households and the rest is delivered to restaurants and hotels.

Exercise

1. For the supply and use tables of the economy of Sugarland provided, identify the industrial activities and products according to the ISIC and CPC standards, and calculate the Gross Domestic Product (GDP). For each activity record the

amount of water abstracted, and draw a diagram of the water flows in the island. Record the information in supply and use tables.

2. If everything remains the same in Sugarland, when will the aquifer have problems of seawater intrusion? Assume that in the year 2010 the amount of water in the aquifer was 250 million cubic meters, and when the aquifer reaches the level of 50 million cubic meters there is seawater intrusion. Assume that the precipitation is the same every year and that the population remains the same. Record the calculations in asset account tables.
3. Calculate the economic growth if tourism to the island increases causing the demand for restaurant and hotel services to increase 20% each year. Also assume that as a consequence of economic growth, the population in the island increases at a rate of 3% per year, and the demand for goods and services increases in the same amount.
4. Is the economic growth calculated above sustainable? Why? Why not? When will the aquifer be affected? Provide policy relevant indicators.

Abbreviations

CPC	Central Product Classification (version 2 is used in this example).
GCF	Gross 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 Sugarland exports products or from which Sugarland imports products.
SEEA-Water	System of Environmental-Economic Accounts for Water.
SNA	System of National Accounts.

Table 2 Monetary supply table for the economy of Sugarland, year 2010 (in millions of Sugarland dollars per year)

SUPPLY (at basic prices)	Growing sugar cane	Sugar milling	Manu-facture	Restau-rants and hotels	Water Supply	Sewerage	**National production (at basic prices)**	RoW (imports)	**Total Supply (at basic prices)**
Sugar cane	190						**190**	0	**190**
Sugar		261					**261**	0	**261**
Manufactured goods			312				**312**	500	**812**
Restaurant and hotel services				250			**250**	0	**250**
Water					30		**30**	0	**30**
Sewerage						24	**24**	0	**24**
Total Supply	**190**	**261**	**312**	**250**	**30**	**24**	**1 067**	**500**	**1 567**

Table 2 Monetary supply table for the economy of Sugarland, year 2010 (in millions of Sugarland dollars per year)

USE (at purchasers' prices)	Growing sugar cane	Sugar milling	Manu-facture	Restau-rants and hotels	Water Supply	Sewerage	**Inter-mediate consum-ption**	RoW (exports)	GCF	Household consumption	Government consumption	**Total Use (at purchaser's prices)**
Sugar cane		190					**190**	0		0	0	**190**
Sugar				1			**1**	255		5	0	**261**
Manufactured goods	5	10	152	15	5	5	**192**	60	250	310	0	**812**
Restaurant and hotel services				5			**5**	225		20	0	**250**
Water				10			**10**	0		20	0	**30**
Sewerage				6			**6**	0		18	0	**24**
Total Supply	**5**	**200**	**152**	**37**	**5**	**5**	**404**	**540**	**250**	**373**	**0**	**1567**

Abbreviations:
RoW = Rest of the World
GCF = Gross Capital Formation

The Sugarland-Water Exercise

An Introduction to Environmental –Economic Accounts for Water (SEEA-Water)

WORKBOOK

6 November 2013
Rev. 7

1. For the supply and use tables of the economy of Sugarland provided, identify the industrial activities and products according to the ISIC and CPC standards, and calculate the Gross Domestic Product (GDP). For each activity record the amount of water abstracted, and draw a diagram of the water flows in the island. Record the information in supply and use tables

Carefully review the summary of information and additional assumptions provided with the exercise to fill in the tables below and draw the diagrams.

Activity	ISIC code	Water abstraction
Growing of sugarcane		
Manufacture of sugar		
Various manufacturing activities		
Accommodation, food, and beverage		
Water supply		
Sewerage		
Households		

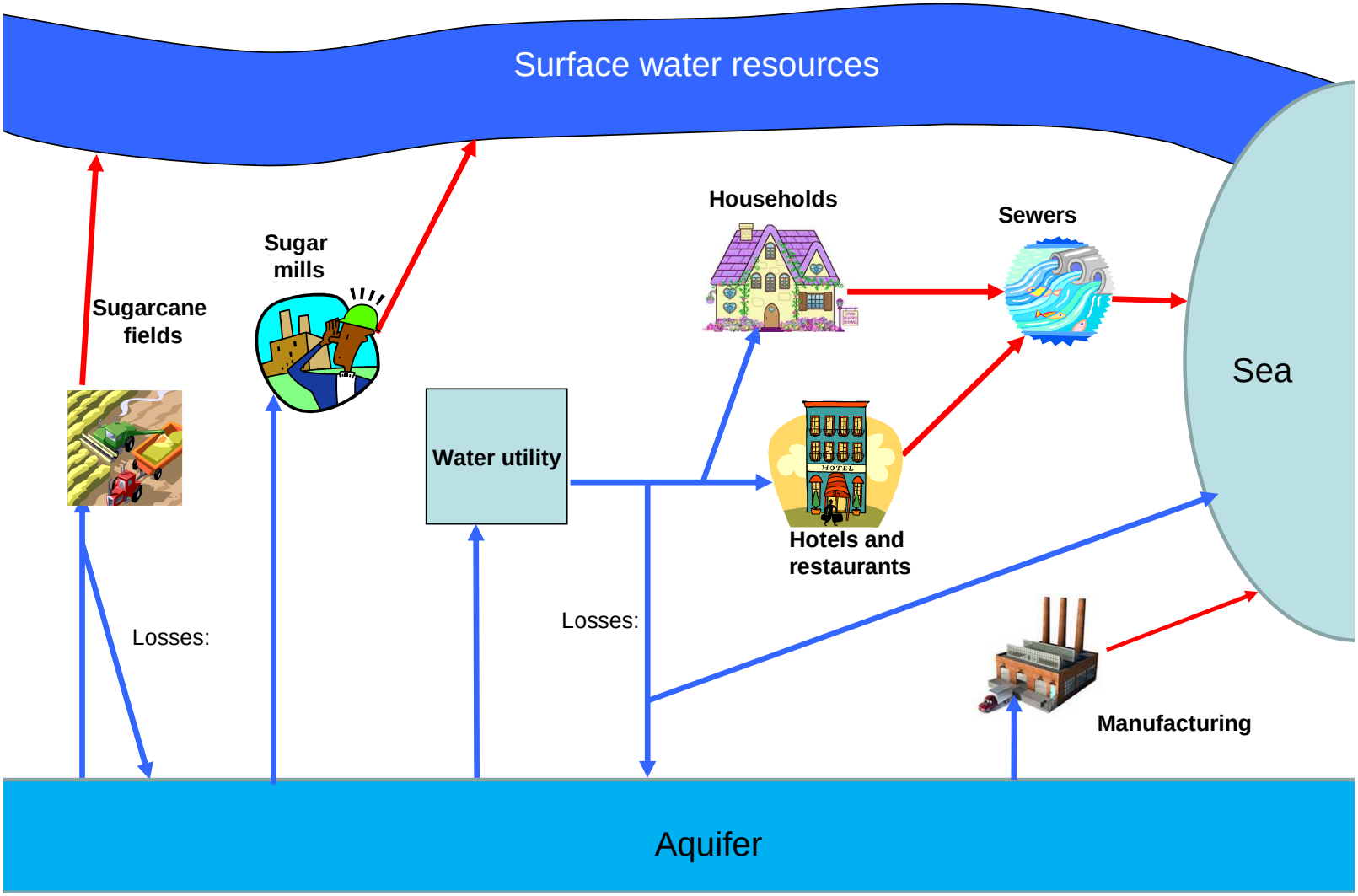
Products	CPC code
Sugarcane	
Sugar	
Manufactured goods, services, and minerals	
Restaurant and hotel services	
Water	
Sewerage	

IRWS code and description	Quantity	Calculation
B.1. Precipitation		
C.1. Evapotranspiration		
D.5. Surface runoff		
D.6. Infiltration		

GDP =

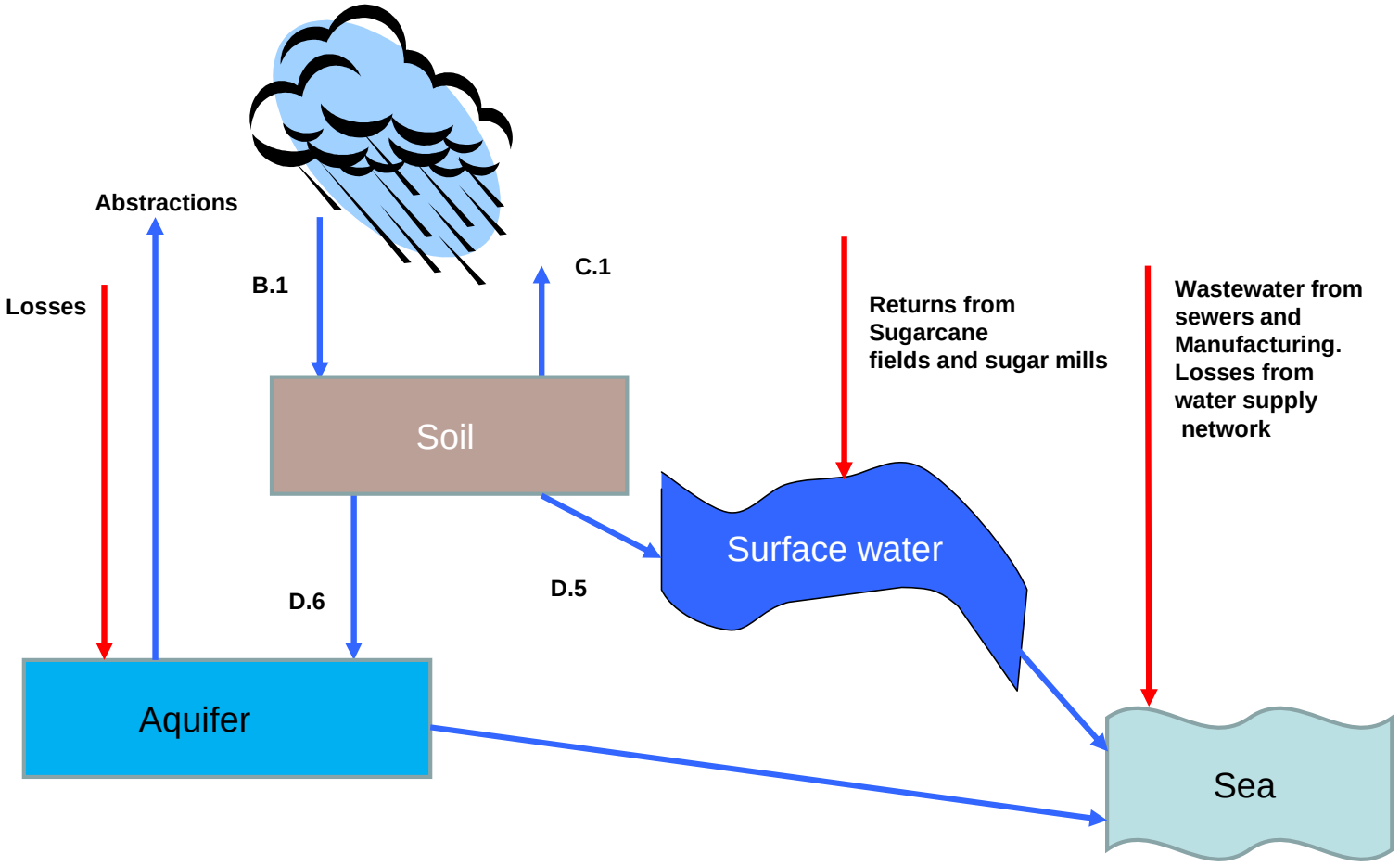
Sugarland. Water flows in the economy.

(Flows of water in million cubic meters per year)



Sugarland. Water flows to and from inland water resources

(Flows of water in million cubic meters per year)



	SUPPLY	Sugar cane	Sugar milling	Manufacture	Restaurants and hotels	Drinking Water	Sewerage	Households	Environment to Economy	SUM
Natural inputs	Surface water									
Natural inputs	Groundwater									
CPC 18000	Water									
CPC 94110	Sewerage									
Residuals	Losses of water									
Residuals	Sewage									
Residuals	Treated wastewater									
Residuals	Water returns									
Residuals	Water vapor ("water consumption")									
	SUM									

	USE	Sugar cane	Sugar milling	Manufacture	Restaurants and hotels	Drinking Water	Sewerage	Households	Economy to Environment	SUM
Natural inputs	Surface water									
Natural inputs	Groundwater									
CPC 18000	Water									
CPC 94110	Sewerage									
Residuals	Losses of water									
Residuals	Sewage									
Residuals	Treated wastewater									
Residuals	Water returns									
Residuals	Water vapor (evapotranspiration)									
	SUM									

2. If everything remains the same in Sugarland, when will the aquifer have problems of seawater intrusion? Assume that in the year 2010 the amount of water in the aquifer was 250 million cubic meters and when the aquifer reaches the level of 50 million cubic meters there is seawater intrusion. Assume that the precipitation is the same every year and that the population remains the same Record the calculations in asset account tables..

YEAR 1		**Groundwater**	**Surface waters**
Initial stock of water			
Additions to stock	Flows within IWR		
	From the economy		
Reductions of stock	Flows within IWR		
	To the sea		
	Abstractions		
Final stock of water			

YEAR 2		**Groundwater**	**Surface waters**
Initial stock of water			
Additions to stock	Flows within IWR		
	From the economy		
Reductions of stock	Flows within IWR		
	To the sea		
	Abstractions		
Final stock of water			

YEAR N		**Groundwater**	**Surface waters**
Initial stock of water			
Additions to stock	Flows within IWR		
	From the economy		
Reductions of stock	Flows within IWR		
	To the sea		
	Abstractions		
Final stock of water			

3. Calculate the economic growth if tourism to the island increases causing the demand for restaurant and hotel services to increase 20% each year. Also assume that as a consequence of economic growth, the population in the island increases at a rate of 3% per year, and the demand for goods and services increases in the same amount.

Demand of restaurant and hotel services.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Demand of restaurant and hotel services by tourists (in million dollars)									

Projected household consumption

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Sugar cane									
Sugar									
Manufactured goods									
Restaurant and hotel services									
Water									
Sewerage									

Projected total demand

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Sugar cane									
Sugar									
Manufactured goods									
Restaurant and hotel services									
Water									
Sewerage									

Year	**GDP**	**Increase**
2010		
2011		
2012		
2013		
2014		
2015		
2016		
2017		
2018		

4. Is the economic growth calculated above sustainable? Why? Why not? When will the aquifer be affected? Provide policy relevant indicators.

Year	Water sold by utility (USD)	Water sold by utility (hm3)	
2010			
2011			
2012			
2013			
2014			
2015			
2016			
2017			
2018			

YEAR 1		**Groundwater**	**Surface waters**
Initial stock of water			
Additions to stock	Flows within IWR		
	From the economy		
Reductions of stock	Flows within IWR		
	To the sea		
	Abstractions		
Final stock of water			

YEAR 2		**Groundwater**	**Surface waters**
Initial stock of water			
Additions to stock	Flows within IWR		
	From the economy		
Reductions of stock	Flows within IWR		
	To the sea		
	Abstractions		
Final stock of water			

YEAR N		**Groundwater**	**Surface waters**
Initial stock of water			
Additions to stock	Flows within IWR		
	From the economy		
Reductions of stock	Flows within IWR		
	To the sea		
	Abstractions		
Final stock of water			

Some indicators

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GDP (million dollars/year)												
GDP growth (%)												
water abstracted from aquifer (million m3/year)												
returns to aquifer (million m3/year)												
recharge of aquifer (million m3/year)												
net abstraction from aquifer (million m3/year)												
GDP/water abstracted (dollars/m3)												
MDG 7.5 (water abstraction/TRWR)												

Stock of water in the aquifer, end of year (million m3)												
								SEAWATER INTRUSION				

The Sugarland-Water Exercise

An Introduction to Environmental –Economic Accounts for Water (SEEA-Water)

SOLUTION BOOKLET

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Exercise solutions

1. For the supply and use tables of the economy of Sugarland provided, identify the industrial activities and products according to the ISIC and CPC standards, and calculate the Gross Domestic Product (GDP). For each activity record the amount of water abstracted, and draw a diagram of the water flows in the island. Record the information in supply and use tables.

The table below shows the ISIC (revision 4) codes for the different activities included in the supply and use tables of the economy of Sugarland. The code has up to four digits. Two digits are for divisions (more generic) and four digits are for classes (more specific).

The table also shows the abstractions of groundwater (data item E.1.2 in the IRWS) for each activity. According to the information provided for the exercise, there are no surface water abstractions.

Activity	E.1.2 in hm3/year	ISIC code	Remarks
Growing of sugarcane	54	0114	
Manufacture of sugar	5	1072	
Various manufacturing activities	5	13 to 33	
Accommodation, food and beverage	0	55 to 56	Water is received from the drinking water supply network, not abstracted.
Water supply	100	3600	
Sewerage	0	3700	
Households	0		Water is received from the drinking water supply network, not abstracted.

The table below shows the CPC (version 2) codes for the products. Two digits identify divisions (more generic) and five digits identify subclasses (more specific).

Products	CPC code
Sugarcane	01802
Sugar	235
Manufactured goods, services, and minerals	21-35 except 235
Restaurant and hotel services	63
Water	18000
Sewerage	94110

According to the System of National Accounts (SNA 2008 paragraphs 2.138, 2.139, 2.140, and 6.83), the Gross Domestic Product (GDP) is:

GDP = Sum of the gross value added at basic prices + all taxes on products – all subsidies on products.

Since there are no taxes or subsidies on products, then GDP is simply the sum of gross value added at basic prices for each activity or groups of activities. In this case, according to the supply and use tables, GDP = 185+ 61 + 160 + 213 + 25 + 19 = 663 million USD per year, which is the difference of supply (at basic prices) less use (at purchaser's prices) for each column of the table.

GDP can also be calculated as the sum of final uses of goods and services, less the value of imports of goods and services. GDP = 1020 +250 +373 + 0 – 980 = 663 million dollars per year.

The diagrams on the next pages show the flows of water in the economy and in nature. The flows are calculated based on the information provided as follows:

Flows of water in the economy

- Of the 54 hm^3 of water abstracted for growing sugarcane 21 hm^3 (40%) is lost in conveyance (data item I.1) and returns to the aquifer. 18 hm3 (55%) is "consumed" and the rest (15 hm^3) is returned to surface water bodies.
- Of the 5 hm^3 of water abstracted for the sugar mills, 3 hm^3 is "consumed" and the rest is returned to surface water resources (data item H.1.1).
- Of the 5 hm^3 of water abstracted for the different manufacturing activities, 3 hm^3 is "consumed" and the rest, 2 hm^3, is returned to the sea (data item H.2).
- Of the 100 hm^3 abstracted for drinking water supply 50 hm^3 is lost (data item I.1), 20 hm^3 recharges the aquifer (40% of losses) and 30 hm^3 flow to the sea. Of the 50 hm^3 delivered through the drinking water supply network (data item F.1), 40 hm^3 is delivered to households (80%) and 10 hm^3 is delivered to hotels and restaurants.
- Households receive 40 hm^3 of water and "consume" 11 hm^3 (27.5%), the rest (29 hm^3) becomes wastewater and is discharged to the sewer network (data item F.3).
- Hotels and restaurants receive 10 hm^3 of water and "consume" 2 hm^3 (20%). The rest (8) becomes wastewater and is discharged to the sewer network (data item F.3).
- The sewerage utility receives 37 hm^3 of wastewater (29 hm^3 from households and 8 hm^3 from hotels and restaurants) and discharges it to the sea without treatment.

Note that 1 hm^3 = 1 million cubic meters.

The flows can also be presented in using the SEEA standard tables:

		ISIC 0114	ISIC 1072	ISIC 13-33	ISIC 55-56	ISIC 3600	ISIC 3700			
	SUPPLY	Sugar cane	Sugar milling	Manufacture	Restaurants and hotels	Drinking Water	Sewerage	Households	Environment to Economy	SUM
Natural inputs	Surface water									0
Natural inputs	Groundwater								164	164
CPC 18000	Water					50				50
CPC 94110	Sewerage									0
Residuals	Losses of water	21				50				71
Residuals	Sewage				8		37	29		74
Residuals	Treated wastewater		2	2						4
Residuals	Water returns	15								15
Residuals	Water vapor ("water consumption")	18	3	3	2			11		37
	SUM	**54**	**5**	**5**	**10**	**100**	**37**	**40**		

	USE	Sugar cane	Sugar milling	Manufacture	Restaurants and hotels	Drinking Water	Sewerage	Households	Economy to Environment	SUM
Natural inputs	Surface water									0
Natural inputs	Groundwater	54	5	5		100				164
CPC 18000	Water				10			40		50
CPC 94110	Sewerage									0
Residuals	Losses of water								71	71
Residuals	Sewage						37		37	74
Residuals	Treated wastewater								4	4
Residuals	Water returns								15	15
Residuals	Water vapor (evapotranspiration)								37	37
	SUM	**54**	**5**	**5**	**10**	**100**	**37**	**40**		

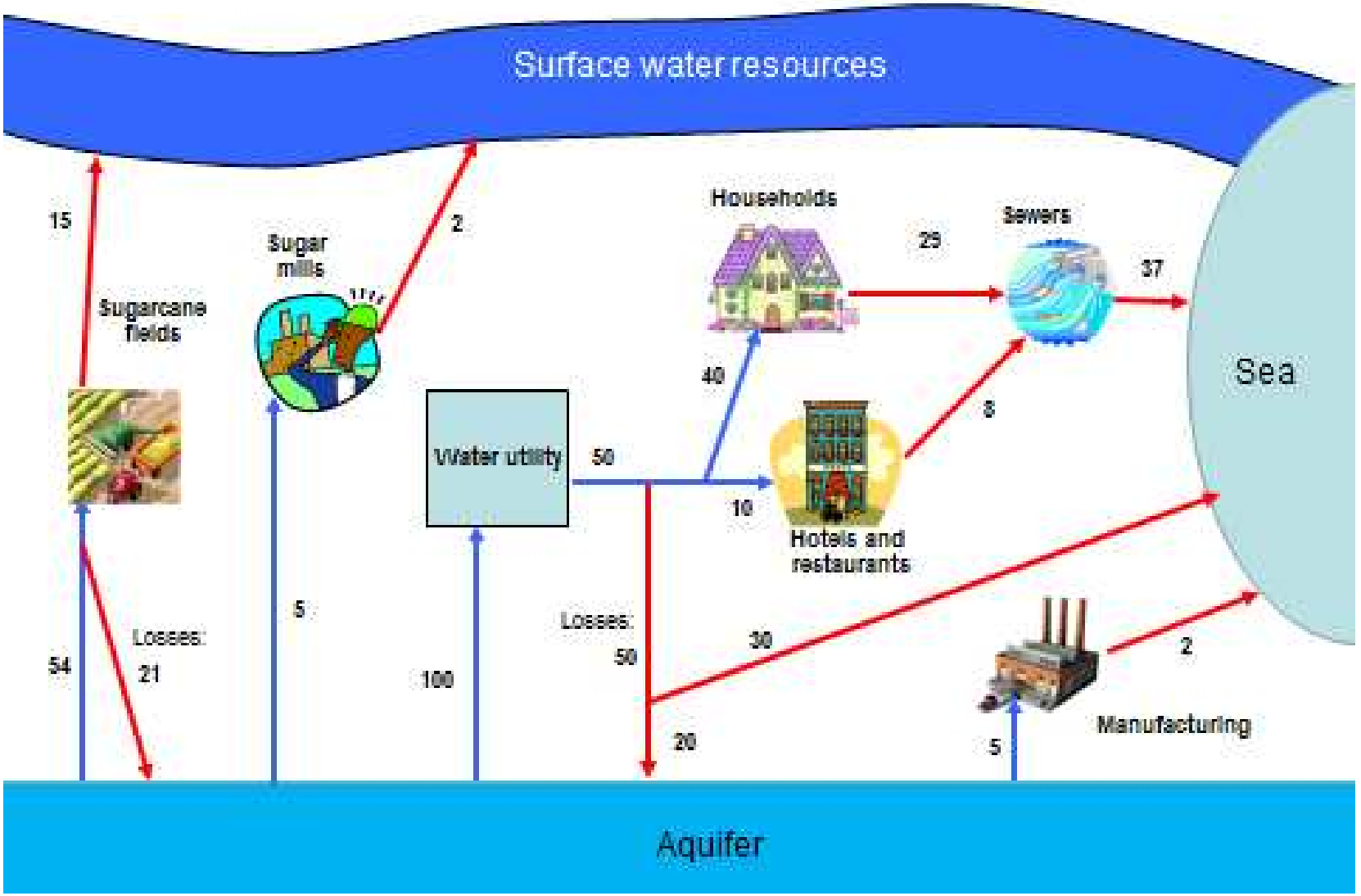
Flows of water from and to inland water resources

It can be assumed that all the precipitation falls on the soil (data item B.1). A portion of the rain returns to the atmosphere as evapotranspiration (data item C.1), and the rest flows as surface runoff (data item D.5) or infiltrates to the aquifer (data item D.6).

IRWS code and description	Quantity	Calculation
B.1. Precipitation	2 210	Given 1700 km^2 x 1300 mm/year.
C.1. Evapotranspiration	663	(100%-65%-5%) of B.1
D.5. Surface runoff	1 437	65% of B.1
D.6. Infiltration	111	5% of B.1

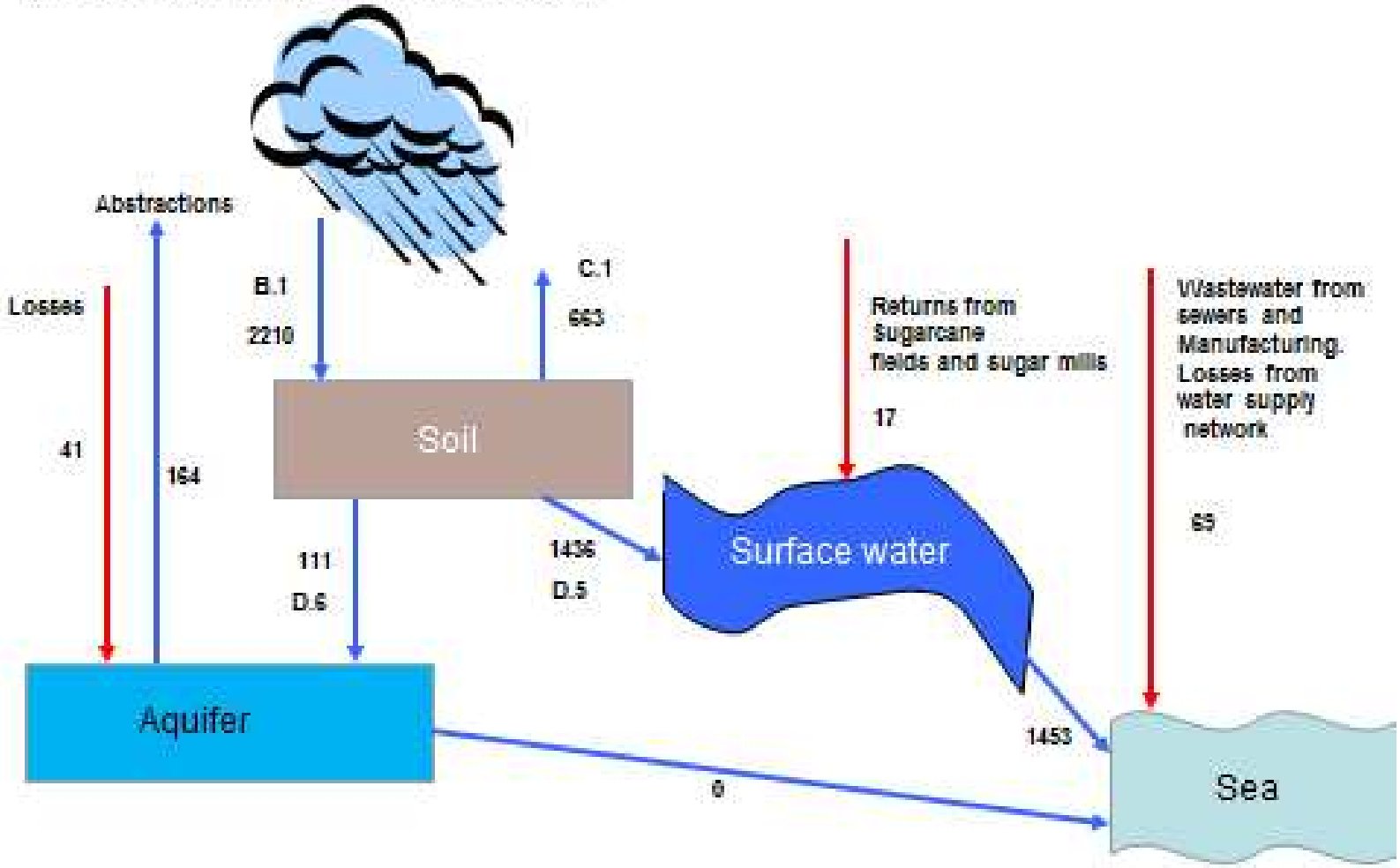
Sugarland. Water flows in the economy.

(Flows of water in million cubic meters per year)



Sugarland. Water flows to and from inland water resources

(Flows of water in million cubic meters per year)



2. If everything remains the same in Sugarland, when will the aquifer have problems of seawater intrusion? Assume that in the year 2010 the amount of water in the aquifer was 250 million cubic meters and when the aquifer reaches the level of 50 million cubic meters there is seawater intrusion. Assume that the precipitation is the same every year and that the population remains the same. Record the calculations in asset account tables.

The aquifer receives flows from the economy due to losses in the conveyance of water to the sugar cane fields (21 hm^3), and losses from the drinking water supply network (20 hm^3). A total of 41 hm^3.

69 hm^3 are discharged to the sea by the economy = 37 hm^3 of sewage discharged by the sewerage utility + 30 hm^3 of losses from the drinking water supply network + 2 hm^3 of treated wastewater from the manufacturing industries.

The flow diagrams make it clear that more water is abstracted from the aquifer than water is recharged. **Therefore the stock of water in the aquifer is reduced every year by the amount of 12 hm^3** = 111 hm^3 + 41 hm^3 – 164 hm^3.

If at the beginning of the year 2010 the aquifer had a stock of 250 hm3 then by the end of 2010 would have 250 hm^3 – 12 hm^3 = 238 hm^3. If everything continues the same, **by the end of the year 2026 the aquifer would have 250 hm^3- 17 x 12 hm^3 = 46 hm^3 , which causes seawater intrusion and the main, or only, source of water for Sugarland is lost.**

Instead of using diagrams, all the information above can be recorded in the SEEA standard tables, making it easy to combine the information about water with the national accounts. The following asset account tables show the calculations in a standardized format:

YEAR 1 (2010)

		Groundwater	Surface waters
Initial stock of water		250	0
Additions to stock	Flows within IWR	111	1436
	From the economy	41	17
Reductions of stock	Flows within IWR	0	0
	To the sea	0	1453
	Abstractions	164	0
Final stock of water		**238**	**0**

YEAR 2 (2011)

		Groundwater	Surface waters
Initial stock of water		238	0
Additions to stock	Flows within IWR	111	1436
	From the economy	41	17
Reductions of stock	Flows within IWR	0	0
	To the sea	0	1453
	Abstractions	164	0
Final stock of water		**226**	**0**

Similarly for the following years. At the end of the 17th year (year 2026) the stock of groundwater is less than 50 million cubic meters, as shown below.

YEAR 17 (2026)

		Groundwater	Surface waters
Initial stock of water		58	0
Additions to stock	Flows within IWR	111	1436
	From the economy	41	17
Reductions of stock	Flows within IWR	0	0
	To the sea	0	1453
	Abstractions	164	0
Final stock of water		**46**	**0**

3. Calculate the economic growth if tourism to the island increases causing the demand for restaurant and hotel services to increase 20% each year. Also assume that as a consequence of economic growth, the population in the island increases at a rate of 3% per year, and the demand for goods and services increases in the same amount.

The economic growth can be calculated using the Gross Domestic Product (GDP), based on the supply and use tables provided with this exercise.

In order to perform the calculations, the national accountant requires information about the demand for the different products that the economy of Sugarland generates. The use table provided with the exercise shows the demand for the different products in 2010. The quantities are expressed in millions of Sugarland dollars at purchasers' prices.

CPC code	USE (at purchasers' prices)	RoW (exports)	GCF	Household consumption	Government consumption
CPC 01802	Sugar cane	0		0	0
CPC 235	Sugar	255		5	0
CPC 21-53 except 235	Manufactured goods	60	250	310	0
CPC 63	Restaurant and hotel services	225		20	0
CPC 18000	Water	0		20	0
CPC 94110	Sewerage	0		18	0
Total use	**Total Supply**	**540**	**250**	**373**	**0**

Restaurant and hotel services are shown as exports (demand from the Rest of the World [RoW] economy), since the tourists are considered non-resident consumers. For the exercise it is assumed that the column of exports remains the same with the exception of Restaurant and hotel services, which grows with a rate of 20% per year. Therefore, the demand will grow as shown in the following table:

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Demand of restaurant and hotel services by tourists (in million dollars)	225	270	324	389	467	560	672	806	967

The column of household consumption will change in proportion with the growth of the population. The demand for each product will increase 3% each year. The table below shows the calculations for the years 2010 to 2018.

Table showing projected household consumption (3% increase)

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Sugar cane	0	0	0	0	0	0	0	0	0
Sugar	5	5	5	5	6	6	6	6	6
Manufactured goods, services and minerals	310	319	329	339	349	359	370	381	393
Restaurant and hotel services	20	21	21	22	23	23	24	25	25
Water	20	21	21	22	23	23	24	25	25
Sewerage	18	19	19	20	20	21	21	22	23
	373	**384**	**396**	**408**	**420**	**432**	**445**	**459**	**473**

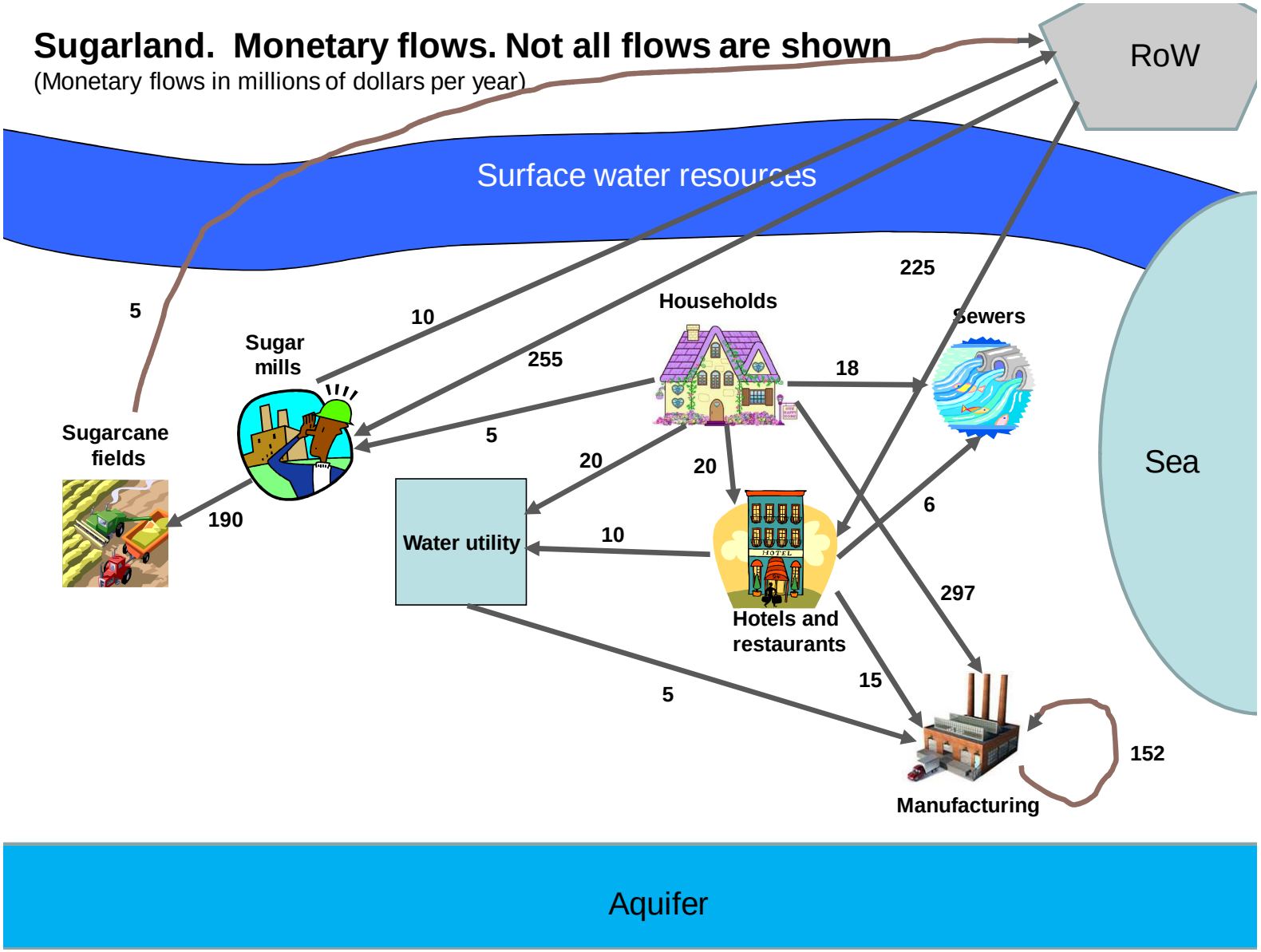
The demand vector (a column of the table) used for the calculations, is simply the sum of the household demand (or consumption), exports, Gross Domestic Fixed Capital Formation (GDFCF), and government demand (or consumption), less the exports. The demand vector is then:

Demand vectors for the projected years.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Sugar cane	0	0	0	0	0	0	0	0	0
Sugar	260	260	260	260	261	261	261	261	261
Manufactured goods, services and minerals	120	129	139	149	159	169	180	191	203
Restaurant and hotel services	245	291	345	411	489	583	696	831	993
Water	20	21	21	22	23	23	24	25	25
Sewerage	18	19	19	20	20	21	21	22	23

Sugarland. Monetary flows. Not all flows are shown

(Monetary flows in millions of dollars per year)



With this information the national accountant can calculate the supply and use tables (SUTs) for the projected years, as well as the GDP. The results are the following.

Year	GDP	Increase
2010	663	
2011	719	8.5%
2012	785	9.1%
2013	861	9.8%
2014	951	10.4%
2015	1 057	11.1%
2016	1 182	11.8%
2017	1 330	12.5%
2018	1 505	13.2%

The increase of approximately 20% in the food and accommodation services has an impact of a continuous growth of the whole economy of Sugarland of almost 11% per year. In the period analyzed the demand for water increased about 9% per year.

4. Is the economic growth calculated above sustainable? Why? Why not? When will the aquifer be affected? Provide policy relevant indicators.

From the projected use tables it is possible to identify the amount of water that is projected to be abstracted in the future. The column row of water in the supply tables provides the information about the water production each year. The results are the following, expressed in millions of dollars:

Year	water	increase
2010	30	
2011	32.46	8.2%
2012	35.3085	8.8%
2013	38.6159	9.4%
2014	42.4722	10.0%
2015	46.9837	10.6%
2016	52.2781	11.3%
2017	58.5082	11.9%
2018	65.8576	12.6%

From the use tables and the demand vector it is possible to see how much water is used by households and how much by hotels and restaurants.

For 2011, the amount of water used by households is 21 million USD, according to the projections shown above (see question 3 with 3% increase per year). For the same year, the use of water by hotels and restaurants was 11.86 million USD, as seen in the 4th column and 5th row of the use table shown below:

0	190.25	0	0	0	0
0	0	0	1.19	0	0
5	10.01	164.22	17.79	5.41	5.35
0	0	0	5.93	0	0
0	0	0	11.86	0	0
0	0	0	7.12	0	0

If it is assumed that water prices remain the same, then:

- 20.6 million USD of water used by households is equivalent to 41.2 million cubic meters of water (each cubic meter of water is paid at 0.50 USD/m3).
- 11.86 million USD of water used by restaurants and hotels is equivalent to 11.86 million cubic meters of water (each cubic meter of water is paid at 1 USD/m3).

Since 50% of the water abstracted is lost in distribution, then in order to produce 53.88 million cubic meters of water (41.2 +11.86), the water utility has to abstract 106.1 in the year 2011. For the production of sugar cane 54.07 hm^3 are needed, for sugar, 5, for manufacturing 5.4. The total abstractions from the aquifer are therefore 170.6 hm^3

Other flows of water can be determined using SUTs that combine physical data (quantities of water) with monetary data (dollar amounts of transactions). Keeping the proportions, the combined SUTs for the following years can be calculated. The previous pages show the SUTs for the years 2010 and 2011.

The SEEA asset accounts show the depletion of water in the aquifer for each year. The year 2010 remains the same as in question 2. The table for the year 2011 is as follows:

YEAR 2 (2011)

		Groundwater	Surface waters
Initial stock of water		238	0
Additions to stock	Flows within IWR	111	1436
	From the economy	42.3	17
Reductions of stock	Flows within IWR	0	0
	To the sea	0	1453
	Abstractions	170.6	0
Final stock of water		**220.7**	**0**

In 2011 the stock of water in the aquifer was depleted by 17 million cubic meters. This is 42% larger than in the year 2010.

If the calculations are repeated for several years, it is found that at the end of the year 2016 the stock of water in the aquifer is less than 33 million cubic meters, and therefore the aquifer is polluted by seawater intrusion and the whole economy of the island collapses.

It is concluded that the growth projected in this example is not sustainable. There is an average annual growth of 9.8% that can only be sustained until the year 2015.

The following page shows some indicators.

Indicators

Yearly growth of restaurant and hotel demand	20%	Water losses in drinking water distribution	50%
Yearly growth of population	3%	Water losses in conveyance of water for agriculture	39%

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GDP (million dollars/year)		663	719	785	861	951	1 057	1 182	1 330	1 505	1 713	1 959
GDP growth (%)			8.5%	9.1%	9.8%	10.4%	11.1%	11.8%	12.5%	13.2%	13.8%	14.4%
water abstracted from aquifer (million m3/year)		164	171	178	186	196	207	220	235	252	272	295
returns to aquifer (million m3/year)		41	42	44	45	47	49	52	55	58	62	66
recharge of aquifer (million m3/year)		111	111	111	111	111	111	111	111	111	111	111
net abstraction from aquifer (million m3/year)		12.0	17.3	23.4	30.2	38.0	46.9	57.2	69.1	82.9	99.0	117.8
GDP/water abstracted (dollars/m3)		4.04	4.22	4.41	4.62	4.85	5.10	5.38	5.67	5.98	6.30	6.64
MDG 7.5 (water abstraction/TRWR)		10.6%	11.0%	11.5%	12.1%	12.7%	13.4%	14.2%	15.2%	16.3%	17.6%	19.1%

Stock of water in the aquifer, end of year (million m3)	250	238.0	220.7	197.3	167.1	129.0	82.1	24.9	-44.2	-127.1	-226.1	-343.9
								SEAWATER INTRUSION