System of Environmental Economic Accounting

Introduction to Core Accounting Principles on SEEA and SNA

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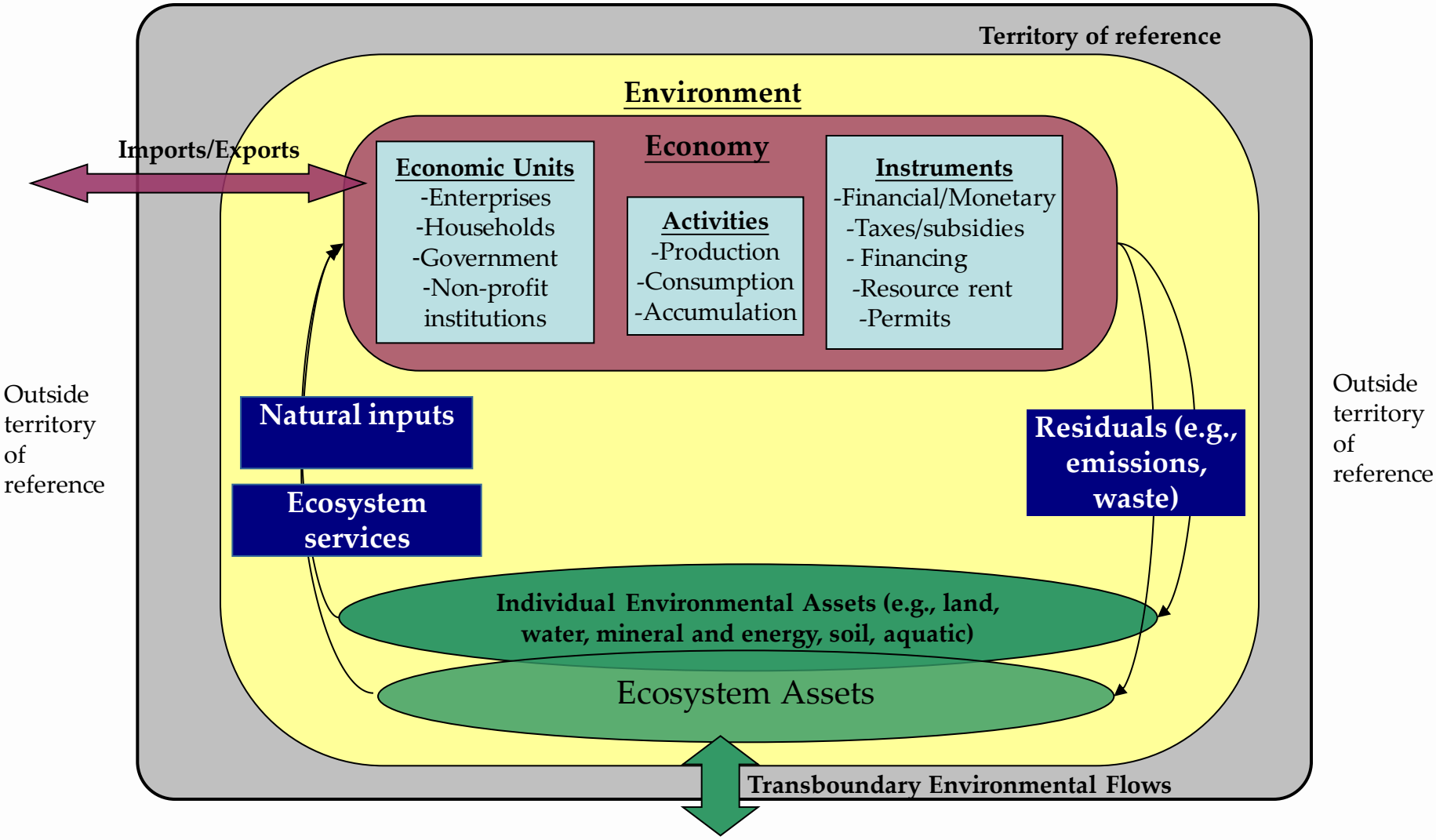
Objectives of the Session

- Define the scope of measurement in the SEEA
- The accounting structure of the SEEA
- SEEA Central Framework
- SEEA Experimental Ecosystem Accounting

The System of Environmental Economic Accounting (SEEA)

- An internationally agreed statistical framework to measure the environment and its interactions with economy
- The **SEEA Central Framework** was adopted as an international statistical standard by the UN Statistical Commission in 2012
- The **SEEA Experimental Ecosystem Accounts** complement the Central Framework and represent international efforts toward coherent ecosystem accounting

SEEA Conceptual Framework



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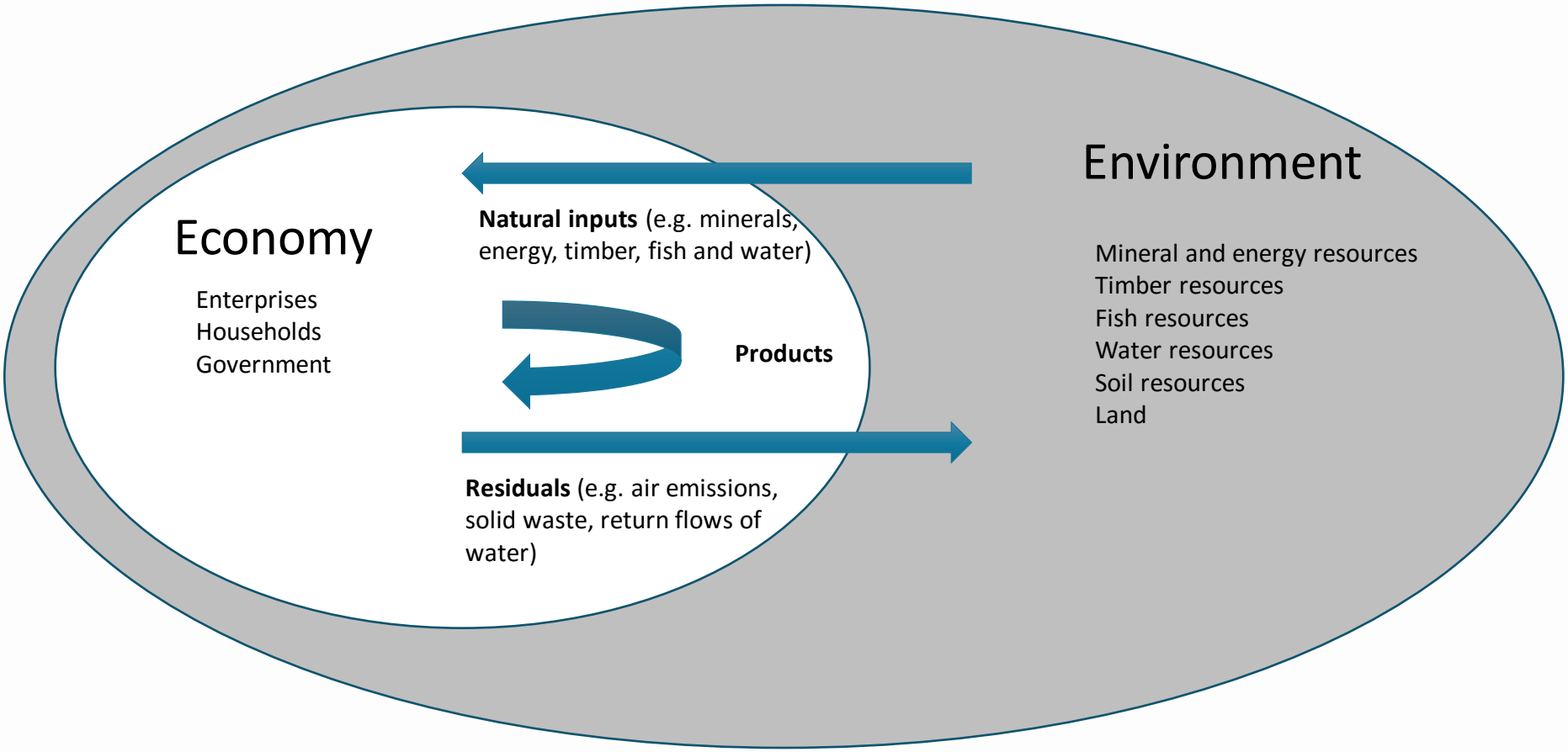
Physical Flows in the SEEA



Defining the Economy

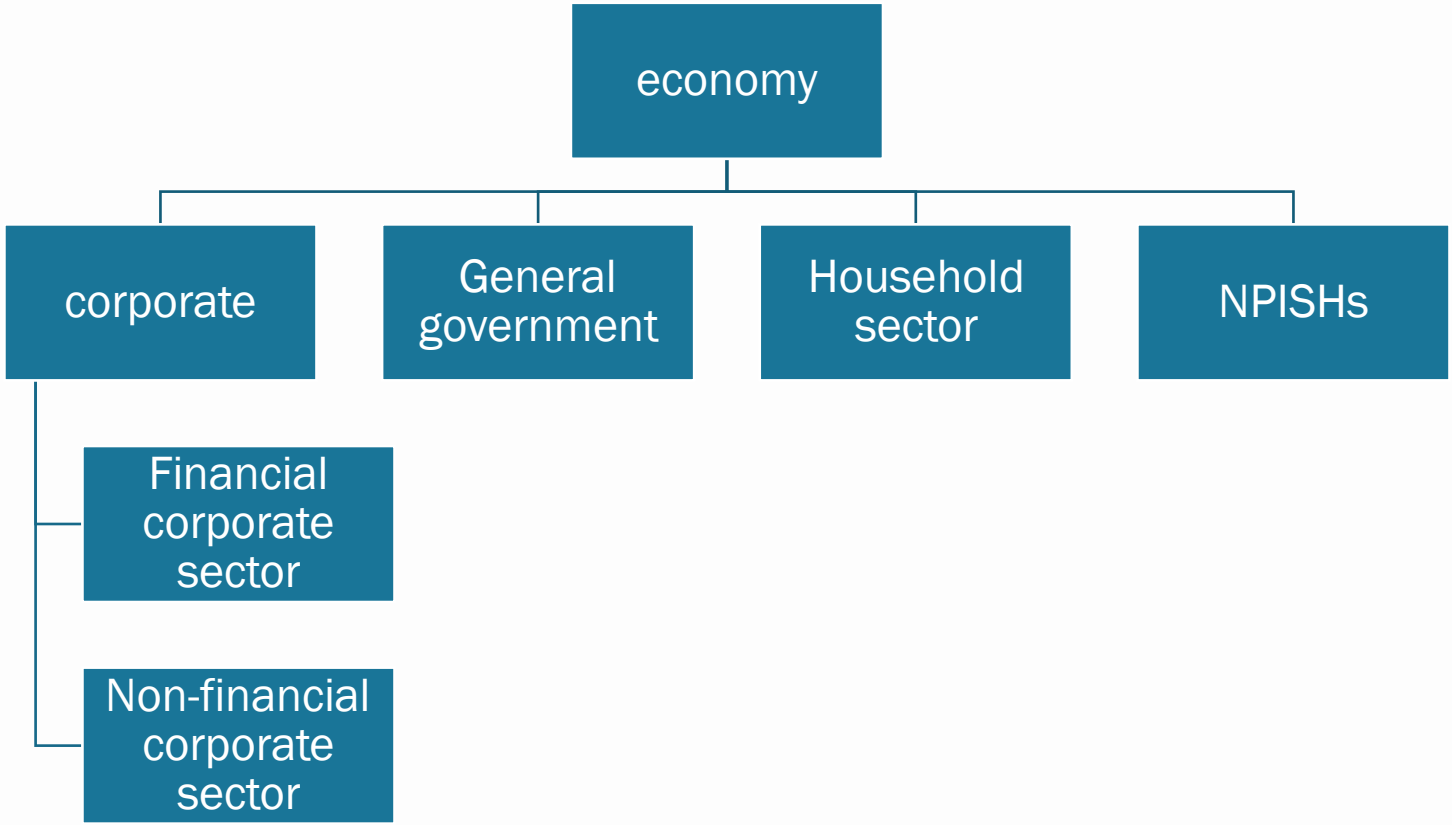
Defining the "Economy"

- Economic activities
  - Production, Consumption, Accumulation
- Economic products
  - Goods and services
- Economic assets
  - Produced, Non-produced, Financial assets
- Economic units
  - Establishments, enterprises, households, governments
- Economic territory
  - Residence, geographic coverage

Constituents of an economy

- All institutional units residing in the economic territory of a country during the accounting period constitute its economy.
  - ***Institutional unit***: an entity capable of owning assets, incurring liabilities, carrying out economic activities taking decisions on all aspects of economic life and engaging in transactions with other entities
  - ***Residing***: The economic territory in which an institutional unit has its centre of predominant economic interest [2008 SNA] is the residence of the unit.
  - ***Economic Territory:*** The geographic territory administered by the government of the country within which persons, goods, and capital can circulate freely.

Institutional sectors



Enterprises, Establishments and Industries

- Enterprises
  - Institutional units from the perspective of being producers of goods and services
- Establishments
  - Enterprises in a single location performing a single or predominant type of productive activity
- Industries
  - Groupings of establishments undertaking similar types of productive activity

The Production Boundary

- "Production is an activity carried out … by an institutional unit that uses inputs of labour, capital and goods and services to produce outputs of goods and services" (2008 SNA, 6.24)
- In practice:
  - Exclude things you do only for yourself
  - Exclude household production of services for itself
    - Except rent of owner-occupiers & wages of domestic staff
  - Include household production of goods for itself
    - Agricultural products, fishing, fuelwood, clothes, furniture, water, energy
  - Include concealed and illegal activity

Types of Output and Production

- Market output
  - Transactions between economic units at market prices
- Non-market output
  - Not transacted at market prices (government education, health)
  - Valued at cost of production
- Own-account production (within establishments)
  - For own final consumption (e.g. subsistence agriculture) : INCLUDED
  - For own final capital formation (e.g. building own house) : INCLUDED
  - For own intermediate consumption : EXCLUDED (except ancillary activity)

Key Messages

- Many aspects to defining the economy
- Measurement boundaries are important to understand
  - Production boundary key determinant of the size of GDP
- Own- account activity needs special consideration
- Economic (institutional) units can be seen from two key perspectives
  - Institutional sector: Similar economic behaviours / legal basis
  - Industry: Similar productive activities

Questions on the economy

State whether TRUE of FALSE.

1. Foreign students staying for three years are considered residents.

Q 1. FALSE

2. A branch of Citi Bank (an American bank) in Tokyo is a resident of Japan.

Q 2. TRUE

3. Australian crew of a ship of a Japanese company are residents of Japan.

Q 3. FALSE

Defining Environmental Assets

Definition of Environmental Assets

Individual environmental assets / resources

- Timber
- Water
- Soil
- Fish

Ecosystems

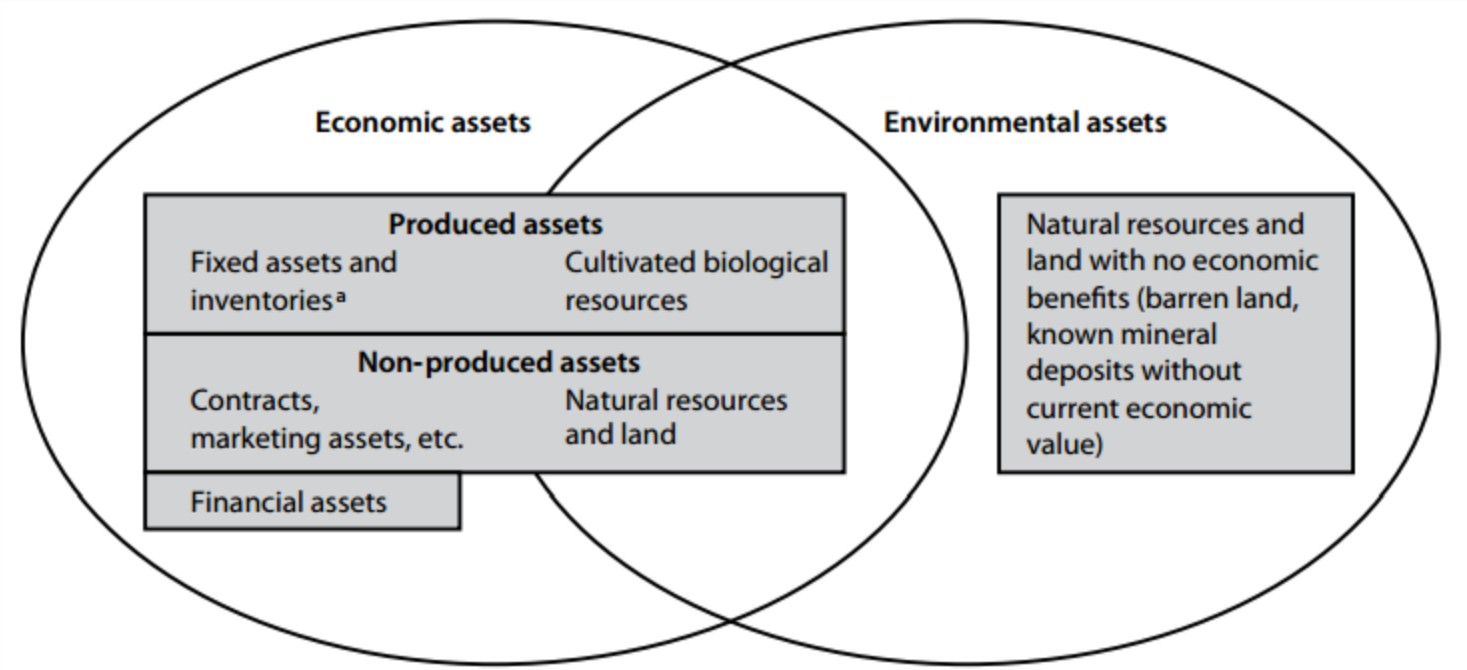
- Forests
- Lakes
- Agricultural areas

Some definitions

1. **Environmental assets** are the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity.
2. **Ecosystems** are a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit

In the SEEA CF has an environmental assets approach

Environmental and economic assets



Scope of Individual Resources

1	**Mineral and energy resources**
1.1	Oil resources
1.2	Natural gas resources
1.3	Coal and peat resources
1.4	Non-metallic mineral resources (excluding coal and peat resources)
1.5	Metallic mineral resources
2	**Land**
3	**Soil resources**
4	**Timber resources**
4.1	Cultivated timber resources
4.2	Natural timber resources
5	**Aquatic resources**
5.1	Cultivated aquatic resources
5.2	Natural aquatic resources
6	**Other biological resources** (excluding timber resources and aquatic resources)
7	**Water resources**
7.1	Surface water
7.2	Groundwater
7.3	Soil water

Physical and Monetary Scope

- In principle, when accounting for environmental assets in physical terms include all environmental assets whether or not they have a monetary value
  - All land in a country is included in physical land accounts
  - Also timber resources, other biological resources, soil, inland water resources
- Mineral and energy resources scope is known deposits
- Aquatic resources scope is all resources within EEZ plus rights on high seas
  - In practice limit to commercial stocks and subsistence

Key Points and Boundary Issues

- Environmental assets can be seen from two perspectives: individual resources & ecosystems

- Scope is generally broader in physical terms than in monetary terms

- Distinct treatment of land
  - Account for its provision of space / area not the resources that are within it
- Include natural and cultivated biological resources
- Oceans and atmosphere excluded
- Stocks of potential energy from renewable sources excluded
  - E.g. solar, wind, tidal power
  - Slight exception for hydropower

Physical flow accounting

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Physical flow accounting

- In accounting, mass and energy flows must balance across natural inputs, products and residuals (law of conservation of mass and energy)
- For a given accounting period the total flows into the economy must either return to the environment or accumulate in the economy.
- **Natural inputs:** all physical inputs that are moved from their location in the environment as a part of economic production processes or are directly used in production
- **Products:** Goods and services that result from a production process in the economy
- **Residuals:** flows of solid, liquid and gaseous materials and energy that are discarded, discharged or emitted by establishments and households through processes of production, consumption or accumulation

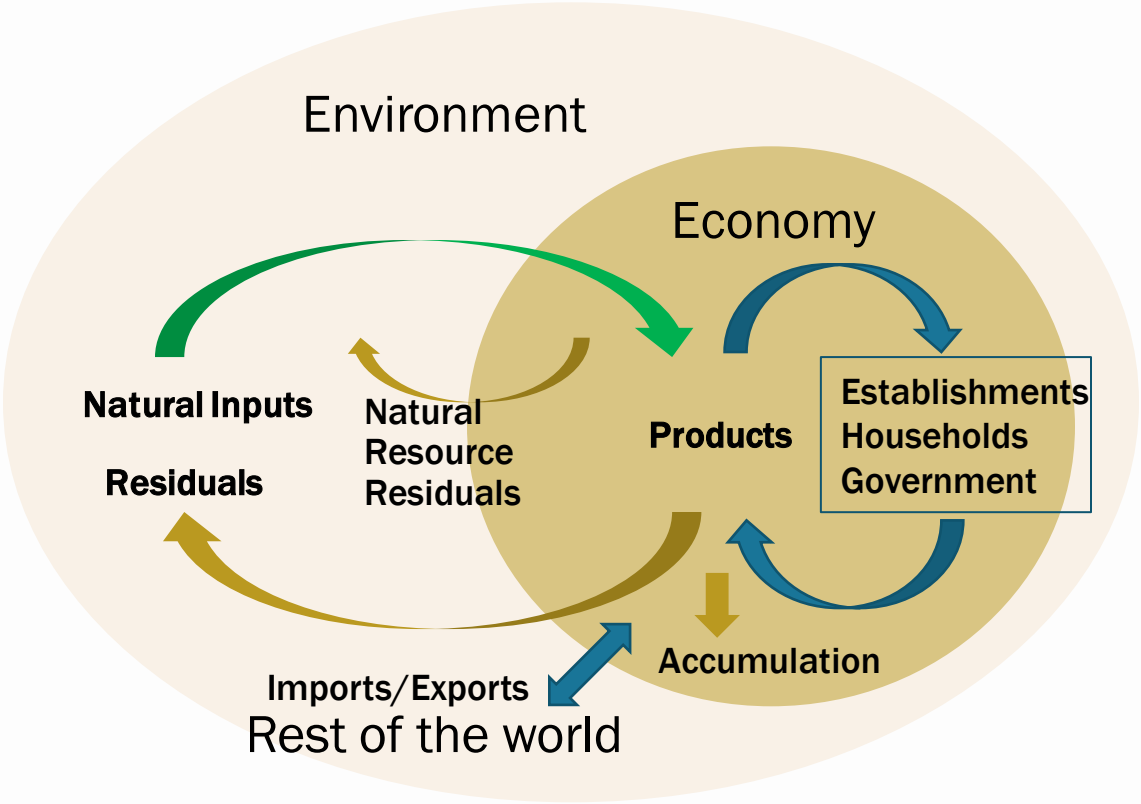
Physical flow accounting

Natural inputs are extracted and harvested to create

Products, which are consumed, accumulated and discarded, in the process creating

Residuals as by-products of production, consumption and accumulation including

Natural resource residuals (unused natural inputs)



Accounting and balancing identity

- Supply and use identity
  - Within the economy, the amount of a product supplied must also be used with the economy, most likely by a range of different economic units, or exported
  - Total supply of natural inputs = Total use of natural inputs
  - Total supply of products = Total use of products
  - Total supply of residuals = Total use of residuals

- Input-output identity
  - Over an accounting period, flows of materials into an economy must equal the flows of materials out of an economy plus any net additions to stock in the economy

Supply and use identity

Total Supply of Products

= Output + Imports

is identical to

Total Use of Productions

= Intermediate consumption

+ Household final consumption

+ Gross capital formation

+ Exports

Input-output identity

Materials into the economy = Flows from the environment + imports + residuals received from the rest of the world + residuals recovered from the environment

is equal to

Materials out of the economy = Residual flows to the environment + exports + residuals sent to the rest of the world

plus

Net additions to stock in the economy = Gross capital formation + accumulation in controlled landfill sites - residuals from produced assets and controlled landfill sites

Supply table – show the flows relating to the production, generation, and supply of natural inputs, products and residuals by different economic units by different economic units or the environment

Supply table

	Production; Generation of residuals		Accumulation	Flows from the rest of the world	Flows from the environment	Total
	Production; Generation of residuals by industries (incl. household production on own account) - classified by ISIC	Generation of residuals by households	Industries - classified by ISIC			
Natural inputs					A. Flows from the environment (incl. natural resource residuals)	Total Supply of Natural Inputs (TSNI)
Products	C. Output (incl. sale of recycled and reused products)			D. Imports of products		Total Supply of Products (TSP)
Residuals	I1. Residuals generated by industry (incl. natural resource residuals) I2. Residuals generated following treatment	J. Residuals generated by household final consumption	K1. Residuals from scrapping and demolition of produced K2. Emissions from controlled landfill sites	L. Residuals received from rest of the world	M. Residuals recovered from the environment	Total Supply of Residuals (TSR)
Total supply						

Use table

	Intermediate consumption of products; Use of natural inputs; Collection of residuals	Final consumption*	Accumulation	Flows to the rest of the world	Flows to the environment	Total
	Industries - classified by ISIC	Households	Industries - classified by ISIC			
Natural inputs	B. Extraction of natural inputs B1. Extraction used in production B2. Natural resource residuals					Total Use of Natural Inputs (TUNI)
Products	E. Intermediate consumption (incl. purchase of recycled and reused products)	F. Household final consumption (incl. purchase of recycled and reused products)	G. Gross Capital Formation (incl. fixed assets and inventories)	H. Exports of products		Total Use of Products (TUP)
Residuals	N. Collection and treatment of residuals (excl accumulation in controlled landfill sites)		O. Accumulation of waste in controlled landfill sites	P. Residuals sent to the rest of the word	Q. Residual flows to the environment Q1. Direct from industry and households (incl. natural resource residuals & landfill emissions) Q2.Following treatment	Total Use of Residuals (TUR)
Total use						

Use table – show the flows relating to the consumption and use of nature inputs, products and residual by different economic units or the environment

- Cover the use of natural inputs, the production and intermediate consumption of products, and the general of residuals by all enterprise in the economy.
- Classified by ISIC

Supply table

	Production; Generation of residuals		Accumulation	Flows from the rest of the world	Flows from the environment	Total
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Total use						

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- Cover the consumption of products by households and the generation of residuals from this consumption

Supply table

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- Accumulation – Concerns changes in the stock of materials and energy in the economy

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Total use						

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- Imports and exports of products and flows of residuals
- Exclude transboundary flows (e.g. polluted water flowing into other country) – they are considered flows within the environment.

Supply table

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- Record flows to and from the environment

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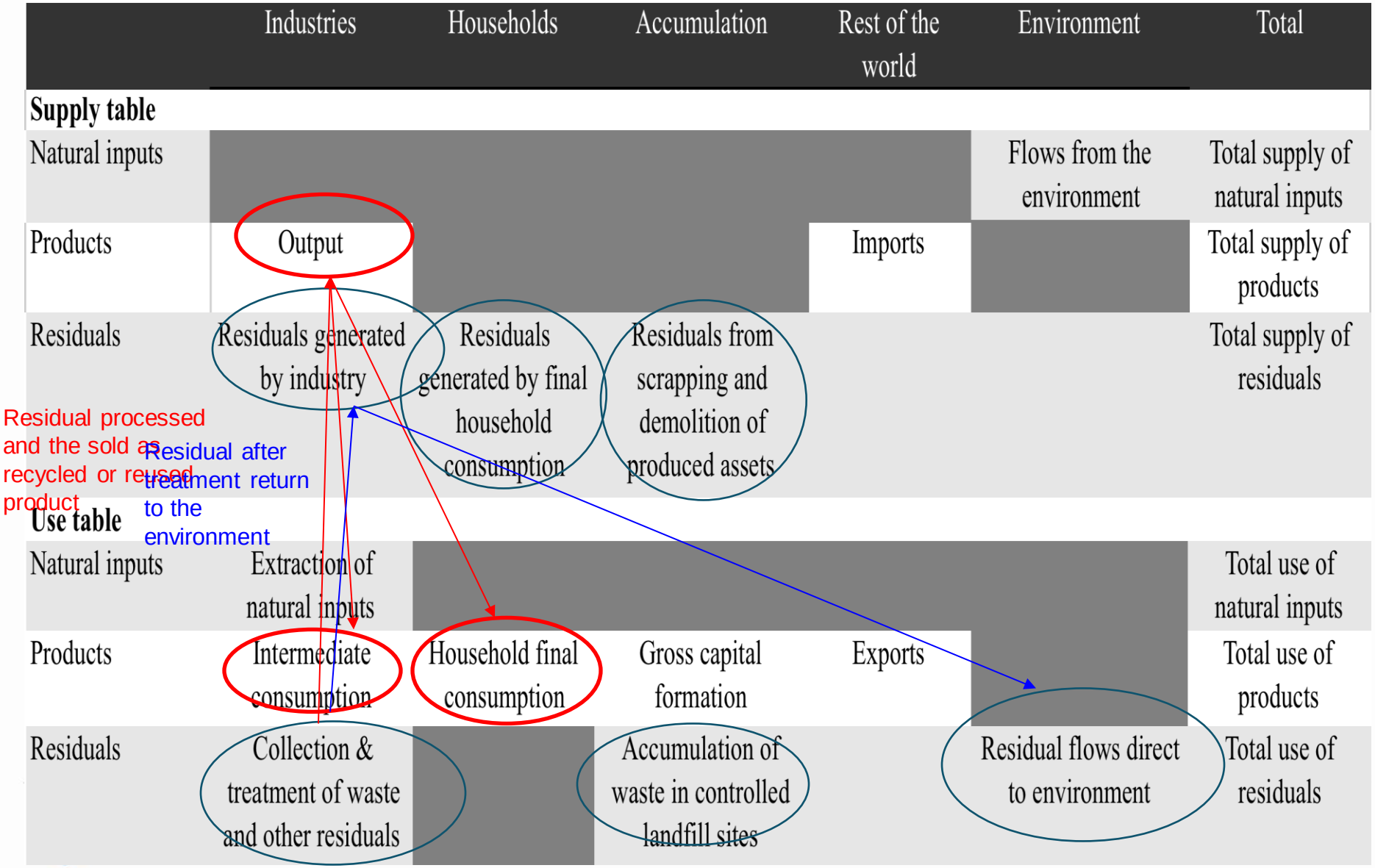
Exercise - Particular note regarding the flows of residuals



Basic form of monetary supply and use table

	Industries	Households	Government	Accumulation	Rest of the world	Total
Supply table						
Products	Output				Imports	Total supply
Use table						
Products	Intermediate consumption	Household final consumption expenditure	Government final consumption expenditure	Gross capital formation (including changes in inventories)	Exports	Total use
	Value added					

The Structure of Accounts

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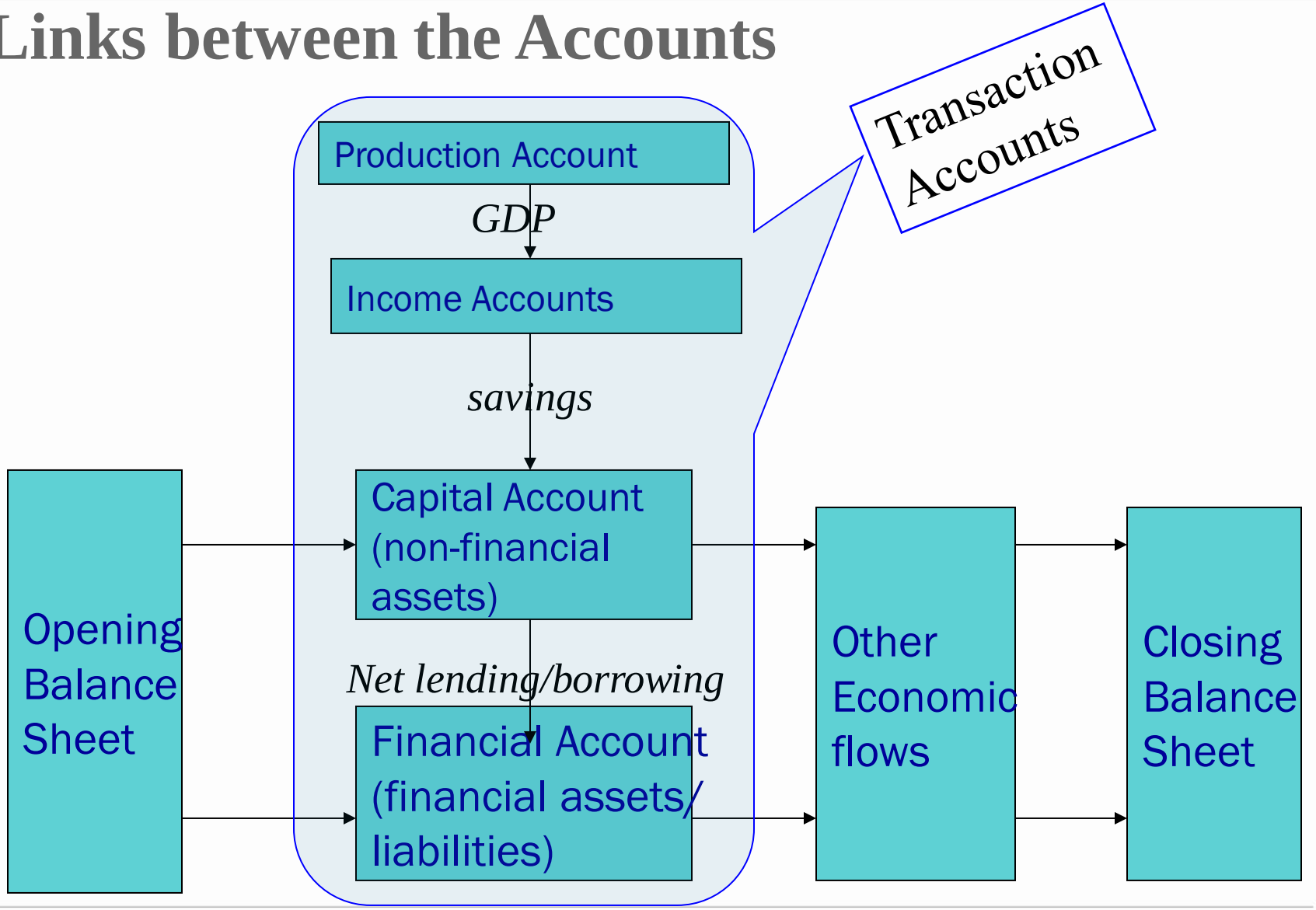
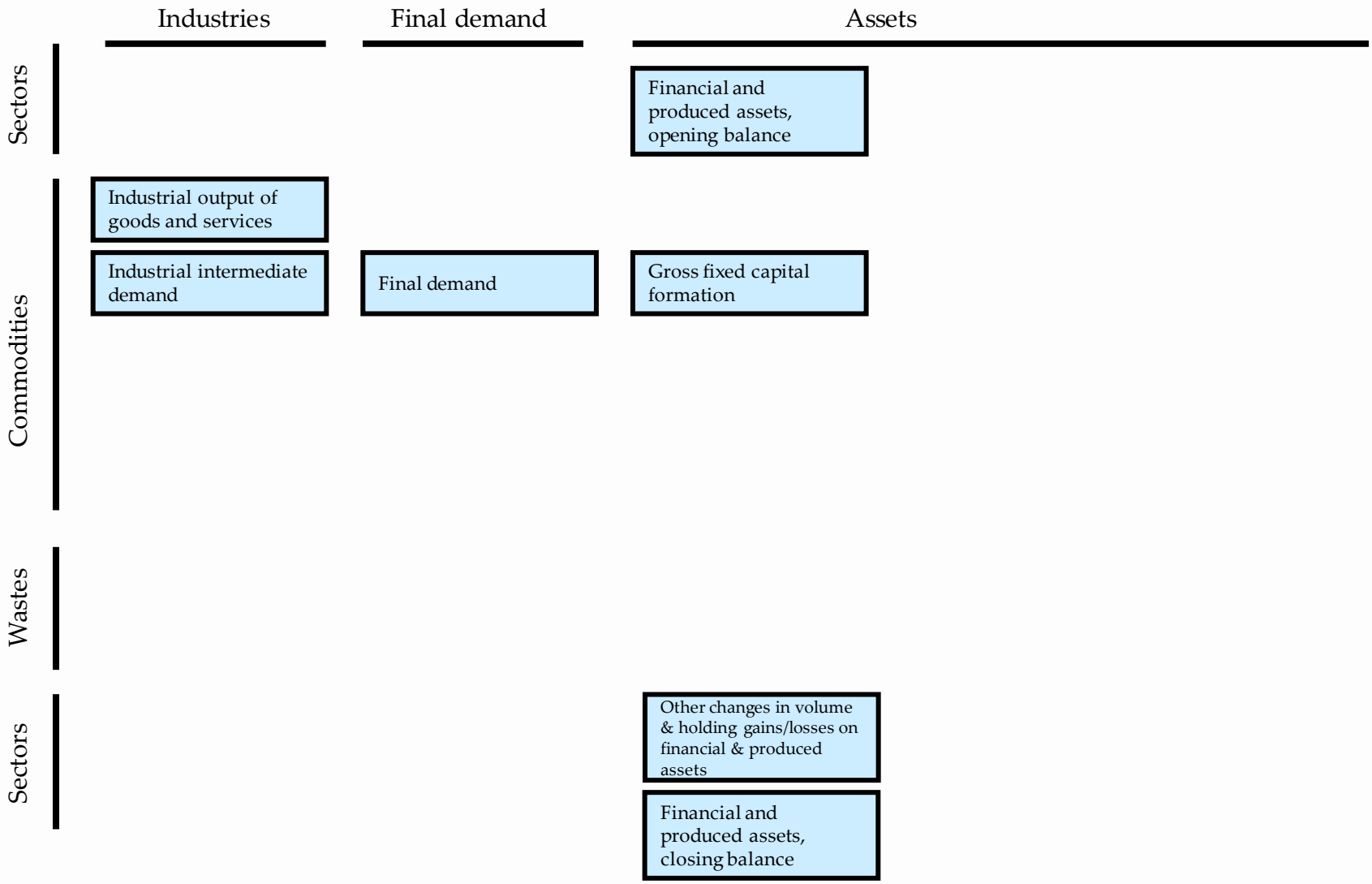
Sequence of Accounts

- Describes sequence of interconnected flow accounts linked to different types of economic activity taking place within a given period of time, together with balance sheets that record the values of the stocks of assets and liabilities held by institutional units or sectors at the beginning and end of the period
- Each flow relates to a particular kind of activity such as production, or the generation, distribution, redistribution or use of income

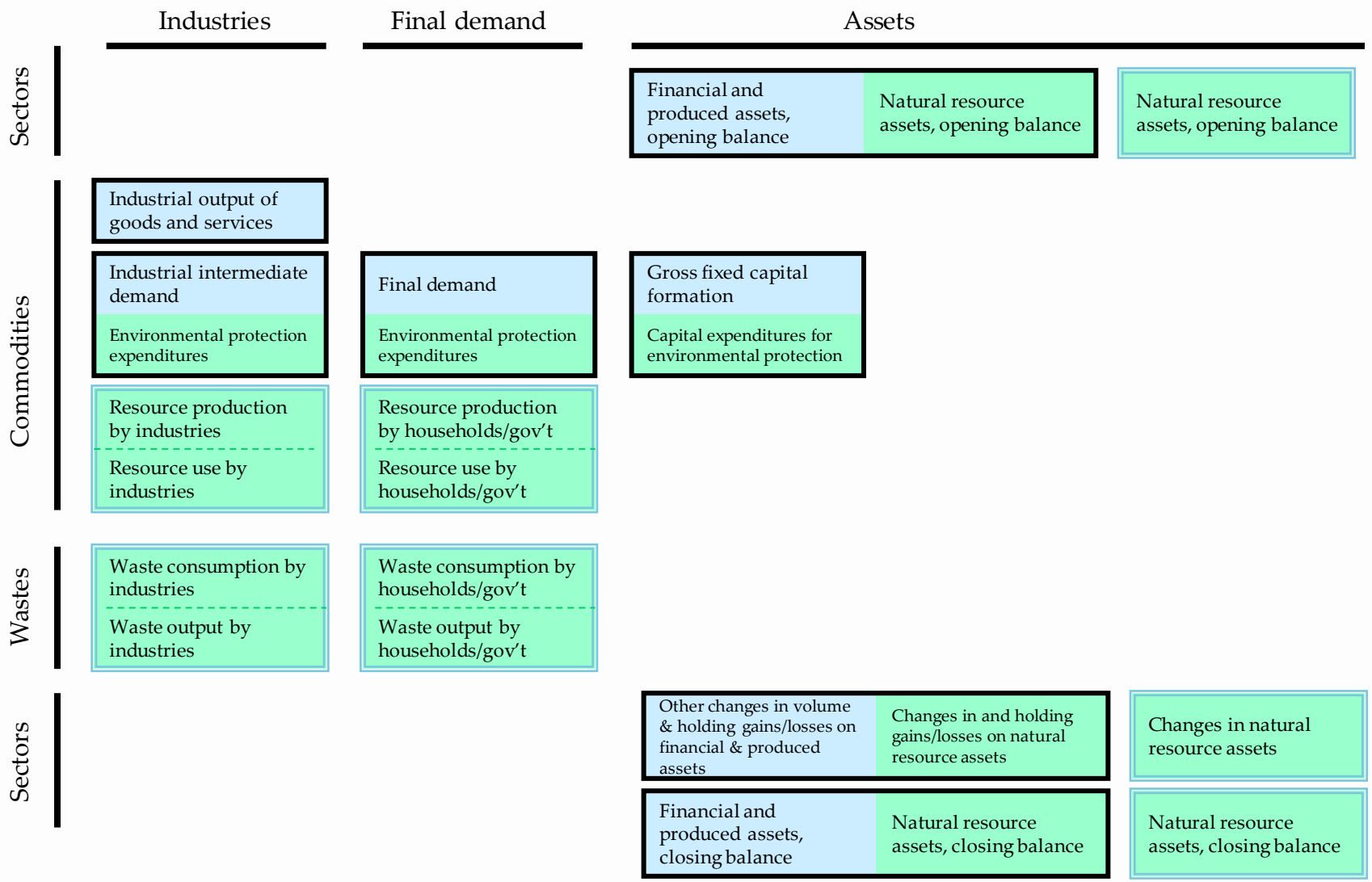
Links between the Accounts



SNA framework



SEEA framework



Basic form of asset accounts

Opening stock of environmental assets
Additions to stock
Growth in stock
Discoveries of new stock
Upward reappraisals
Reclassifications
Total additions of stock
Reductions of stock
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
Total reductions in stock
Revaluation of the stock[a]
Closing stock of environmental assets

Integration of Asset Accounts and Supply and Use Tables (1/2)

Accumulation Column

Environment Column

Supply table in monetary terms

	Production (incl. household production on own account) Industries – classified by ISIC			Flows from the Rest of the World		Total
Products	Output			Imports		
Total						

Use in monetary terms

	Intermediate consumption	Final consumption		Accumulation	Flows to the Rest of the World		Total
	Industries – classified by ISIC	Households	Government				
Products	Intermediate consumption	Household final consumption expenditure	Government final consumption expenditure	Gross capital formation	Exports		
Total							

Supply table in physical terms

	Production; Generation of residuals			Accumulation	Flows from the Rest of the World	Flows from the Environment	Total
	Industries (including household production on own account) – classified by ISIC	Generation of residuals by households					
Natural inputs						Flows from the environment	
Products	Output				Imports		
Residuals	Residuals generated by industry	Residuals generated by household final consumption		Residuals from scrapping & demolition of produced assets Emissions from controlled landfill sites	Residuals received from rest of the world	Residuals recovered from the environment	
Total							

Use in physical terms

	Intermediate consumption; Use of natural inputs; Collection of residuals	Final consumption		Accumulation	Flows to the Rest of the World	Flows to the Environment	Total
	Industries – classified by ISIC						
Natural inputs	Extraction of natural inputs						
Products	Intermediate consumption	Household final consumption		Gross capital formation	Exports		
Residuals	Collection and treatment of residuals			Accumulation of waste in controlled landfill sites	Residuals sent to the rest of the world	Residual flows to the environment	
Total							

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Integration of Asset Accounts and Supply and Use Tables (2/2)

						Asset accounts (Physical and monetary terms)	
		Industries	Households	Government	Rest of the world	Produced assets	Environmental assets
						Opening stock	
Monetary supply and use table	Product-supply	Output			Imports		
	Product-use	Intermediate consumption	Household final consumption expenditures	Government final consumption expenditures	Exports	Gross capital	
Physical supply and use table	Natural inputs-supply						Extracted natural resources
	Natural inputs-use	Inputs of natural resources					
	Product- supply	Output			Imports		
	Product-use	Intermediate consumption	Household final consumption		Exports	Gross capital formation	
	Residuals-supply	Residuals generated by industry	Residuals generated by household final consumption		Residuals received from the rest of the world	Residuals from scrapping and demolition of produced assets; emissions from controlled landfills	
	Residuals-use	Collection and treatment of waste and other residuals			Residuals sent to the rest of the world	Accumulation of waste in controlled landfills	Residuals flowing to the environment[a]
						Other changes in volume of assets (e.g., natural growth, discoveries, catastrophic losses)	
						Revaluations	
						Closing stock	

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Table 378-0005[3]

Natural resource assets and produced assets

annual (dollars x 1,000,000)

Data table | Add/Remove data | Manipulate | Download | Related information | Help

The data below is a part of CANSIM table 378-0005. Use the Add/Remove data tab to customize your table.

Selected items [Add/Remove data]

Geography= Canada

Categories	2008	2009	2010	2011	2012
Non-financial assets	7,416,200	6,629,425	7,313,829	7,960,934	8,041,096
Produced non-financial assets	4,187,815	4,246,166	4,408,493	4,639,292	4,895,157
Residential structures	1,654,058	1,687,356	1,778,316	1,871,006	1,980,938
Non-residential structures	1,319,709	1,328,319	1,393,163	1,489,886	1,588,777
Machinery and equipment	311,551	324,913	304,853	307,726	325,358
Intellectual property products	186,567	189,216	193,329	199,999	207,612
Consumer durable goods	465,860	476,435	495,912	513,720	525,196
Inventories	244,505	233,382	236,050	249,915	259,899
Weapons Systems	5,565	6,545	6,870	7,040	7,377
Non-produced non-financial assets	3,228,385	2,383,259	2,905,336	3,321,642	3,145,939
Land	1,805,153	1,931,790	2,037,456	2,202,114	2,360,816
Timber	131,789	71,567	122,276	120,499	113,133
Subsoil resource stocks	1,291,443	379,902	745,604	999,029	671,990
Selected energy resources[1]	987,017	256,900	516,642	679,642	441,628
Selected mineral resources[2]	304,426	123,002	228,962	319,387	230,362

Back to original table

Footnotes:

1. Includes crude oil, natural gas, crude bitumen and coal.
2. Includes gold, iron, copper, nickel, lead, zinc, molybdenum, uranium, diamonds and potash.
3. Corrections have been made to the following variables for 1990 to 2012: Selected energy resources; Subsoil resource stocks; Non-produced non-financial assets; Non-financial assets.

Source: Statistics Canada. *Table 378-0005 - Natural resource assets and produced assets, annual (dollars),* CANSIM (database). (accessed: 2014-06-06)

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Source: Statistics Canada

Key messages

- All economic stocks and flows can be organized and placed in context
- National accounting is not only output and intermediate consumption
- One account is not sufficient – different questions require a focus on different accounts and balancing items
- The accounting system is complete and internally consistent

The SEEA Central Framework

The SEEA Central Framework Accounts

1. **Stock accounts** for environmental assets: natural resources and land
    - physical (e.g. fish stocks and changes in stocks) and/or monetary values (e.g. value of natural capital, depletion)
2. **Flow accounts**: supply and use tables for products, natural inputs and residuals (e.g. waste, wastewater) generated by economic activities.
    - physical (e.g. m^2 of water) and/or monetary values (e.g. permits to access water, cost of wastewater treatment, etc.)
3. **Activity / purpose accounts** that explicitly identify environmental transactions already existing in the SNA.
    - e.g. Environmental Protection Expenditure (EPE) accounts, environmental taxes and subsidies
4. **Combined physical and monetary accounts** that bring together physical and monetary information for derivation indicators, including depletion adjusted aggregates

Asset accounts

Asset accounts	***Topics covered (detailed definition)***
Mineral and energy resources	Physical and monetary accounts for minerals and energy stocks (oil, natural gas, coal and peat, non-metallic minerals and metallic minerals) (CF 5.172)
Land	Physical and monetary accounts for land, land cover, land use and forest (CF 5.235)
Soil resources	Area and volume of soil resources (CF 5.318)
Timber resources	Physical and monetary accounts for timber resources (CF 5.343)
Aquatic resources	Physical and monetary accounts for fish, crustaceans, molluscs, shellfish and other aquatic organisms such as sponges and seaweed as well as aquatic mammals such as whales. (CF 5.393) (CO2, pollutants) (CF 3.233)
Other biological resources	Cultivated animals and plants including livestock, annual crops such as wheat and rice, and perennial crops such as rubber plantations, orchards and vineyards. (CF 5.462)
Water resources	Stock of water resources (CF 5.471)

General structure of the physical account for environmental assets (physical units)

	Mineral & energy resources	Land (incl. forest land)	Soil resources	Timber resources		Aquatic resources		Water resources
				Cultivated	Natural	Cultivated	Natural	
Opening stock of resources	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additions to stock of resources								
Growth in stock	na	Yes*	Soil formation Soil deposition	Growth	Natural growth	Growth	Natural growth	Precipitation Return flows
Discoveries of new stock	Yes	na	na	na	na	Yes*	Yes*	Yes*
Upwards reappraisals	Yes	Yes	Yes*	Yes*	Yes*	Yes*	Yes	Yes*
Reclassifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total additions to stock								
Reductions in stock of resources								
Extractions	Extractions	na	Soil extraction	Removals	Removals	Harvest	Gross catch	Abstraction
Normal reductions in stock	na	na	Erosion	Natural losses	Natural losses	Normal losses	Normal losses	Evaporation Evapotranspiration
Catastrophic losses	Yes*	Yes*	Yes*	Yes	Yes	Yes	Yes	Yes*
Downwards reappraisals	Yes	Yes	Yes*	Yes*	Yes*	Yes*	Yes	Yes*
Reclassifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	na
Total reductions in stock								
Closing stock of resources	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Example:
Monetary stock accounts for crude bitumen in Canada

Table 153-0005[1, 2]

Value of established crude bitumen reserves

annual (dollars x 1,000,000)

Data table | Add/Remove data | Manipulate | Download | Related information | Help

The data below is a part of CANSIM table 153-0005. Use the Add/Remove data tab to customize your table.

Selected items [Add/Remove data]

Geography= Canada

Value	2005	2006	2007	2008	2009	2010	2011
Reconciliation account, established crude bitumen reserves, opening stock[3]	107,560.2	111,305.7	197,972.4	167,541.6	437,070.6	143,720.4	301,647.0
Reconciliation account, established crude bitumen reserves, additions[3]	1,185.8	105,844.5	11,345.0	89,040.4	68.2	97.3	2,872.7
Reconciliation account, established crude bitumen reserves, depletion[3]	3,934.1	3,894.6	3,685.9	7,725.0	2,931.7	6,378.5	9,359.3
Reconciliation account, established crude bitumen reserves, revaluation[3]	6,493.8	-15,283.1	-38,089.8	188,213.5	-290,486.7	164,207.9	81,064.9
Reconciliation account, established crude bitumen reserves, closing stock[3]	111,305.7	197,972.4	167,541.6	437,070.6	143,720.4	301,647.0	376,225.2

Back to original table

Footnotes:

1. Data source: Statistics Canada, Environment Accounts and Statistics Division.
2. For concepts, sources and methods, see "Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts", catalogue number 16-505-GPE.
3. The reconciliation account entries are calculated using the present value methodology.
4. Negative values for net price I, net price II and present value are set to zero.

Source: Statistics Canada. *Table 153-0005 - Value of established crude bitumen reserves, annual (dollars),* CANSIM (database). (accessed: 2014-06-06)

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Source: Statistics Canada

Flows accounts

Physical flow accounts	***Topics covered (detailed definition)***
Full set of supply and use tables for materials	All resources and materials (energy, water, air emissions, water emissions, solid waste) (CF 3.45)
Economy-wide material flow accounts (MFA)	Supply and consumption of energy; air emissions, water emissions, and solid waste (CF 3.279)
Physical supply and use tables for water (PSUT water)	Supply (precipitation) and consumption of water (CF 3.186)
Physical supply and use tables for energy (PSUT energy)	Supply and consumption of energy (CF 3.140)
Air emissions accounts	Air emissions (CO2, pollutants) (CF 3.233)
Water emissions accounts	Water emissions (CF 3.257)
Waste accounts	Solid wastes (CF 3.268)

- CF = Central Framework, white cover edition, refers to paragraph number

Example: Supply and Use table for Air Emissions

SUPPLY

USE

	Supply table for air emissions									Use table for air emissions	
	Generation of emissions								Accumulation	Total supply of emissions	Flows to the Environment	Total use of emissions
	Industries					Households			Emissions from landfill		Emissions released to the environment	
	Agriculture	Mining	Manufacturing	Transport	Other	Transport	Heating	Other				
Type of substance												
Carbon dioxide	10 610.3	2 602.2	41 434.4	27 957.0	82 402.4	18 920.5	17 542.2	1 949.1	701.6	204 119.6	204 119.6	204 119.6
Methane	492.0	34.1	15.8	0.8	21.9	2.4	15.5	1.7	222.0	806.3	806.3	806.3
Dinitrogen oxide	23.7		3.5	0.8	2.6	1.0	0.2	0.1	0.1	32.0	32.0	32.0
Nitrous oxides	69.4	6.0	37.9	259.5	89.0	38.0	12.1	1.3	0.3	513.6	513.6	513.6
Hydroflourocarbons			0.3		0.4					0.7	0.7	0.7
Perflourocarbons												
Sulphur hexaflouride												
Carbon monoxide	41.0	2.5	123.8	46.2	66.2	329.1	51.2	5.7	1.1	666.9	666.9	666.9
Non-methane volatile organic compounds	5.2	6.5	40.0	16.4	27.2	34.5	29.4	3.2	0.9	163.3	163.3	163.3
Sulphur dioxide	2.7	0.4	28.0	62.4	8.1	0.4	0.4	0.1	0.0	102.5	102.5	102.5
Ammonia	107.9		1.7	0.2	0.9	2.3	11.4	1.2	0.2	125.9	125.9	125.9
Heavy metals												
Persistent organic pollutants												
Particulates (incl PM10, dust)	7.0	0.1	8.5	9.3	4.4	6.0	2.8	0.5	0.0	38.5	38.5	38.5

Example: Air emission accounts in Denmark

Air Emission Accounts by industry and type of emission Denmark 2012

	Carbon dioxide incl. biomass (CO2), 1000 tonnes	Carbon dioxide excl. biomass (CO2), 1000 tonnes	Carbon dioxide from biomass (CO2), 1000 tonnes	Suphur dioxide (SO2), tonnes	Nitrogen oxides (NOX), tonnes	Ammonia (NH3), tonnes	Nitrous oxide (N2O), tonnes	Methane (CH4), tonnes	Non-methane volatile organic compounds (NMVOC), tonnes	Particulate matter < 10 µm (PM10), tonnes	Sulphur hexafluoride (SF6), tons CO2-equivalents
Total	93 274	78 117	15 156	233 261	1089 108	76 222	21 557	262 535	108 838	48 188	117 852
Households	12 083	7 903	4 180	1 608	20 164	1 501	319	6 438	29 527	17 391	0
Total industries	81 190	70 214	10 976	231 652	1068 945	74 721	21 238	256 097	79 311	30 796	117 852
A Agriculture, forestry and fishing	2 528	2 264	264	1 336	19 908	73 447	17 515	200 933	4 258	7 176	0
B Mining and quarrying	1 932	1 777	155	180	7 380	0	37	2 663	3 982	116	0
C Manufacturing	6 537	5 801	736	4 999	12 331	379	101	2 606	31 492	811	66 369
D_E Utility services	24 017	14 599	9 419	2 833	15 111	703	917	48 443	1 681	797	11 036
F Construction	1 509	1 444	65	9	7 451	64	52	52	2 711	869	40 447
G_I Trade and transport etc.	42 969	42 793	176	222 148	1001 308	74	2 532	1 220	33 525	20 602	0
J Information and communication	101	96	5	5	304	4	3	11	92	21	0
K Financial and insurance	65	62	3	8	180	3	2	7	29	11	0
LA Real estate activities and renting of non-residential buildings	97	91	6	1	403	3	3	4	47	23	0
LB Dwellings	39	37	2	0	145	1	1	3	18	11	0
M_N Other business services	403	381	22	11	1 430	17	13	29	393	105	0
O_Q Public administration, education and health	846	727	119	98	2 489	19	57	109	863	230	0
R_S Arts, entertainment and other services	148	142	6	23	505	6	5	17	220	25	0

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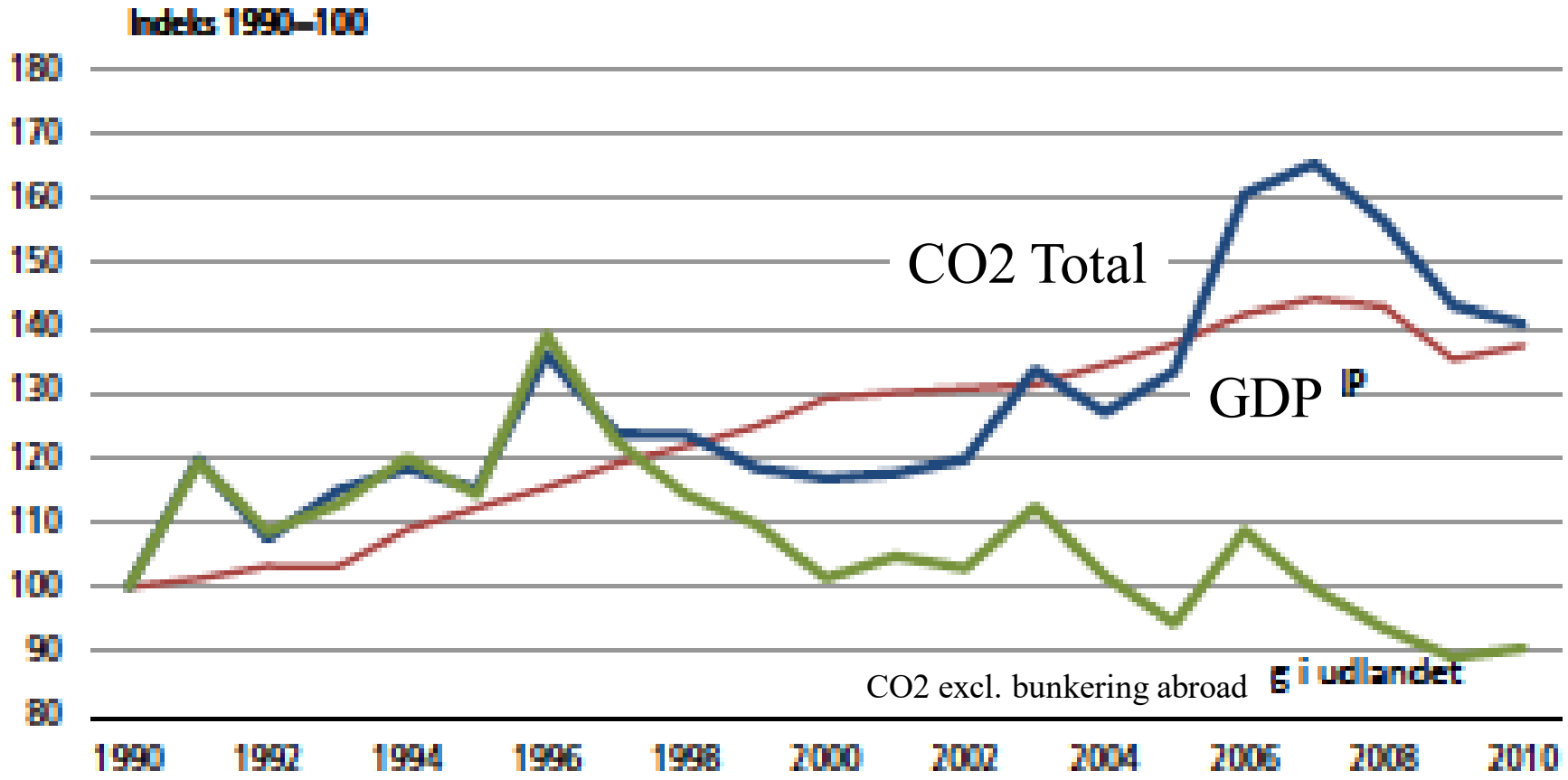
Source: Statistics Denmark

Indices (1990 = 100) for greenhouse effect and GDP (2000 prices)



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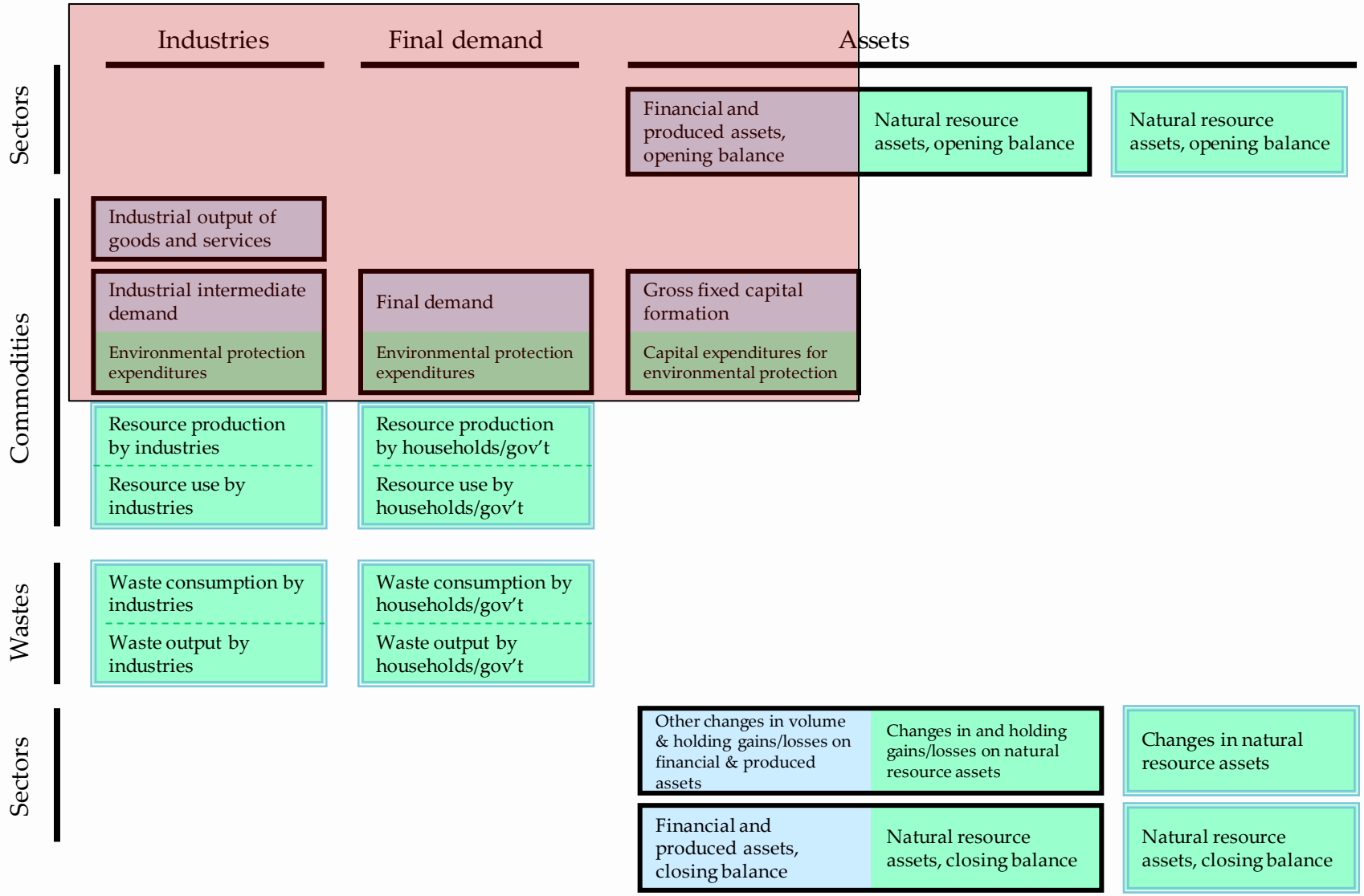
Source: Statistics Denmark

Environmental activity accounts



Activity/purpose accounts

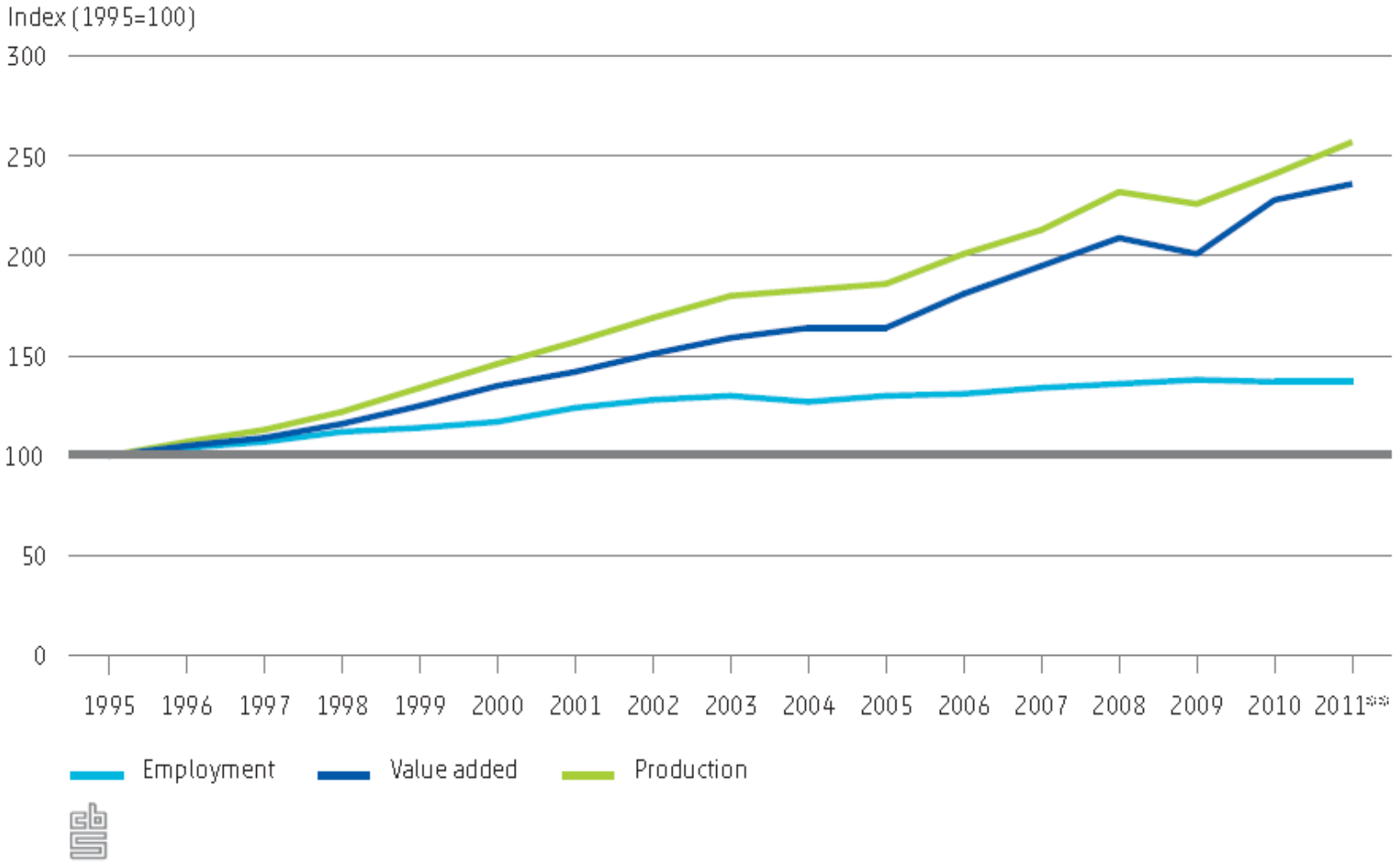
Monetary flow accounts	***Topics covered (detailed definition)***
Environmental protection expenditure accounts (EPEA)	Output of EP services in economy and expenditures on EP goods and services by resident units (CF 4.45)
Resource use and management accounts (RUMEA)	Production, supply and use, expenditures on and financing of resource management (CF 4.121)
Environmental goods and services sector (EGSS)	Characteristics of all producers of products intended for environmental protection and resource management (CF 4.95)
Environmentally related payments by government	Environmental subsidies, social benefits to households, investment grants and other current and capital expenditures (CF 4.138)
Environmentally related payments to government	Environmental taxes (taxes on products, production and income; other current taxes and capital taxes) and other payments to government (rent, sales of some goods and services, some fines and penalties) (CF 4.149, CF 4.159)
Permits and licenses to use environmental assets	Permits to extract and harvest natural resources (CF 4.174)
Emissions permits	Permits for the use of the environment as a pollution sink (emissions permits) (CF 4.182)
Costs related to termination of fixed assets	Environmental consequences of disposing of fixed assets (nuclear power plants, oil rigs and other equipment, landfills, mines, etc.) (CF 4.194)

Example: Environmental Goods and Services Sector (EGSS) in Netherlands

Activity	Main source
Sewage and refuse disposal services	National accounts, supply and use tables
Wholesale in waste and scrap	National accounts, supply and use tables
Environmental related inspection and control	Employment registers
Government governance related to the environment	Environmental Statistics, EPE statistics
Organisations and associations on the environment	Employment registers and business register
Internal environmental activities at companies	Environmental Statistics, EPE statistics
Renewable energy production	Energy Statistics, Renewable energy statistics
Energy saving and sustainable energy systems	Own constructed database and Production Statistics
Insulation activities	National accounts
Organic agriculture	Agriculture statistics, area of organic agriculture
Recycling	National accounts, supply and use tables
Second hand shops	Production Statistics
Water quantity control by waterboards	National accounts, Government accounts
Environmental advice, engineering and other services[1]	Own constructed database and Production Statistics
Industrial environmental equipment[1]	Own constructed database and Production Statistics
Environmental technical construction[1]	Own constructed database and Production Statistics
Environmental related education	Education statistics

Source: Statistics Netherlands

Employment, production and value added in the EGSS in Netherlands



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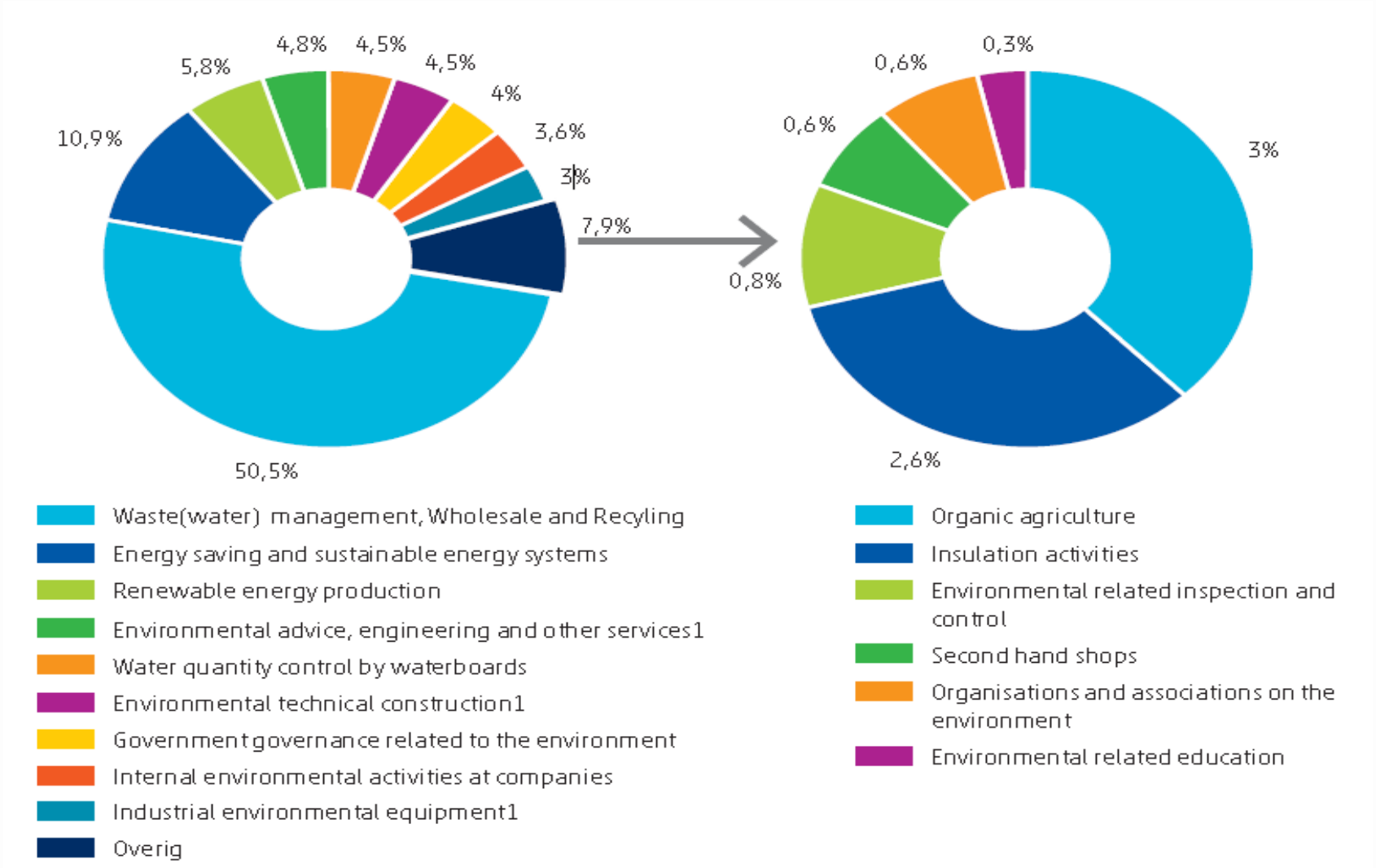
Source: Statistics Netherlands

Distribution of value added EGSS over different activities in Netherlands, 2011



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Source: Statistics Netherlands

SEEA Experimental Ecosystem Accounting

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One Environment: Two Perspectives

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Central Framework:
Individual Environmental Assets/Resources

- Timber
- Water
- Soil
- Fish

SEEA
Experimental Ecosystem Accounts:
Ecosystem Assets (spatially based)

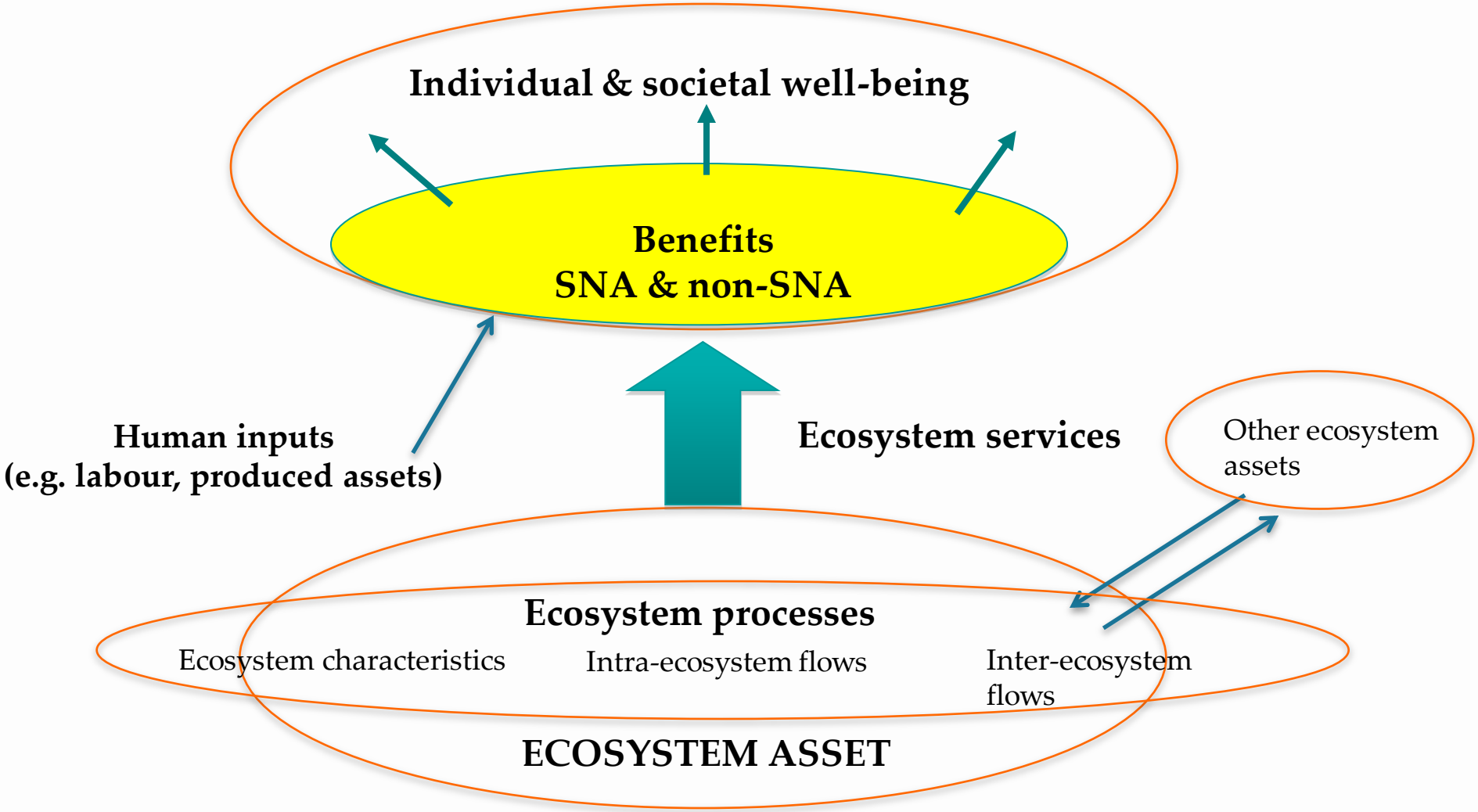
- Forests
- Lakes
- Agricultural areas

Ecosystem Assets are environmental assets viewed from a systems perspective

SEEA Experimental Ecosystem Accounting (SEEA EEA)

- An integrated accounting framework for ecosystem stocks (assets) and flows (services)
  - Measures the contributions of ecosystem to economic and other human activity
  - Takes a detailed spatial approach (geography and statistics)
- A synthesis of current knowledge on ecosystem services, ecosystem condition and related concepts
  - "Experimental" because significant measurement challenges remain and further testing of concepts is needed

Ecosystem Accounting model



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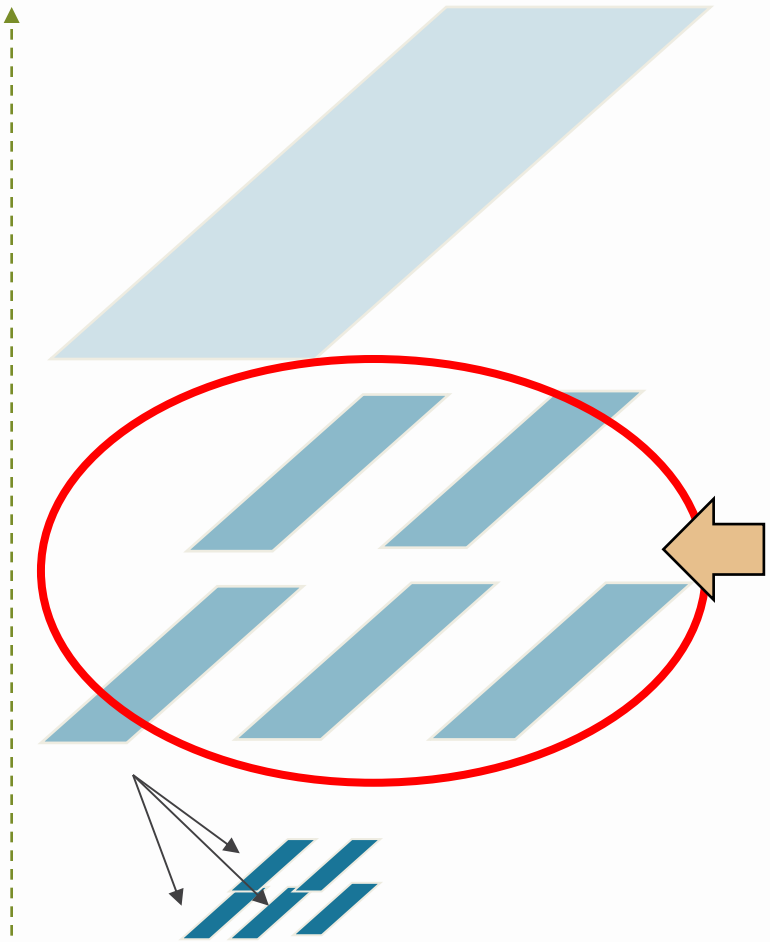
Statistical units

Geographical aggregation

Ecosystem Unit (EU)

Basic Spatial Unit (BSU)

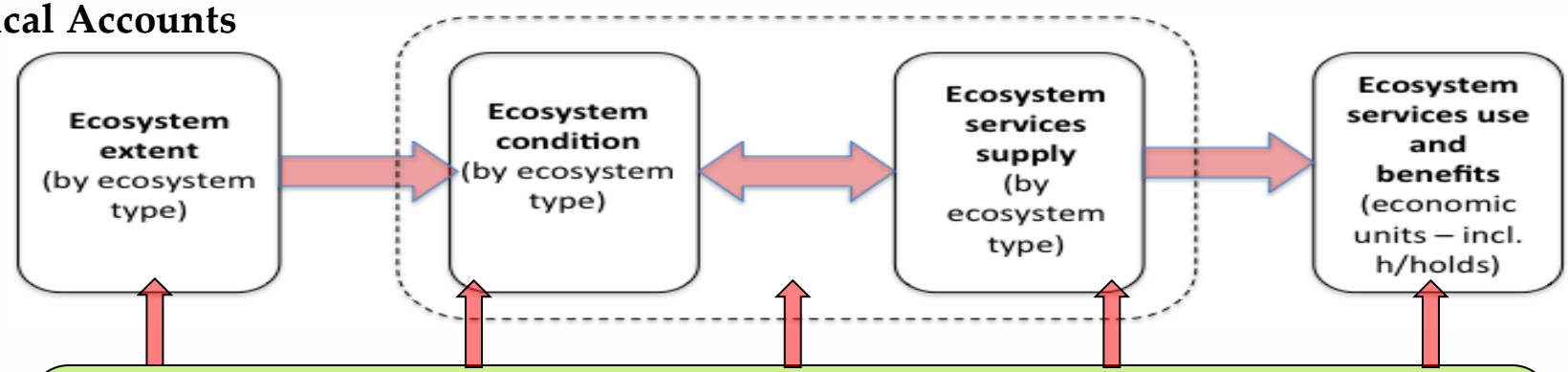


Ecosystem units

- Spatial areas that form the conceptual base for accounting and the integration of relevant statistics.
- Delineation is based on ecological characteristics
- Where various ecological data are not available, a land cover based delineation can be used as a starting point

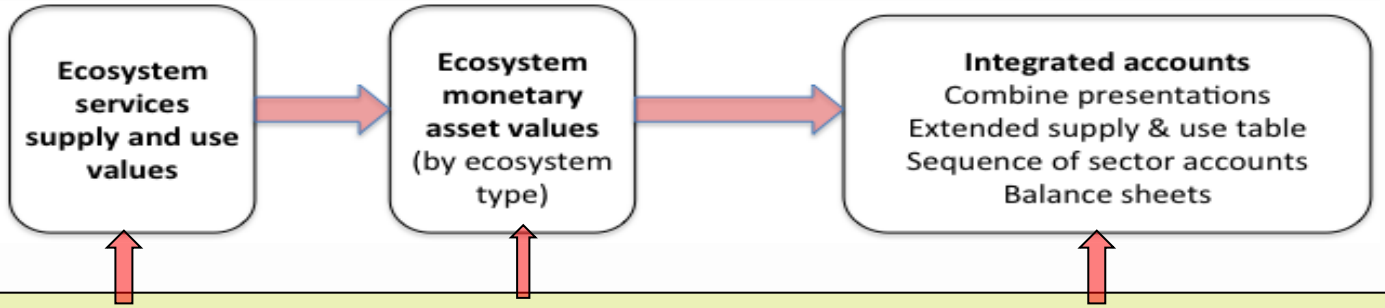
Broad steps in ecosystem accounting

a. Physical Accounts



Ecosystem thematic accounts: Land, Carbon, Water, Biodiversity
Supporting information: Socio-economic conditions and activities, ecological production functions
Tools: classifications, spatial units, scaling, aggregation, biophysical modelling
Source: Official statistics, spatial data, remote sensing data

b. Monetary Accounts



Supporting information: SNA accounts, I-O tables
Tools: Valuation techniques

Ecosystem condition

Table 4.4 Changes in ecosystem condition for an LCEU

		Characteristics of ecosystem condition				
		Vegetation	Biodiversity	Soil	Water	Carbon
		Indicators (e.g. Leaf area index, biomass, mean annual increment)	Indicators (e.g. species richness, relative abundance)	Indicators (e.g. soil organic matter content, soil carbon, groundwater table)	Indicators (e.g. river flow, water quality, fish species)	Indicators (e.g. net carbon balance, primary productivity)
Opening condition						
Improvements in condition						
	Improvements due to natural regeneration (net of normal natural losses					
	Improvements due to human activity					
Reductions in condition						
	Reductions due to extraction and harvest of resources					
	Reductions due to ongoing human activity					
	Catastrophic losses due to human activity					
	Catastrophic losses due to natural events					
Closing condition						

Using basic measures, can derive table of changes in condition.

Could also be done by referencing each indicator to a reference condition.

Ecosystem extent account

	Type of Ecosystem Unit															
	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Opening extent																
Additions to extent																
Managed expansion																
Natural expansion																
Upward reappraisals																
Reductions in extent																
Managed regression																
Natural regression																
Downward reappraisals																
Net change in extent																
Closing extent																

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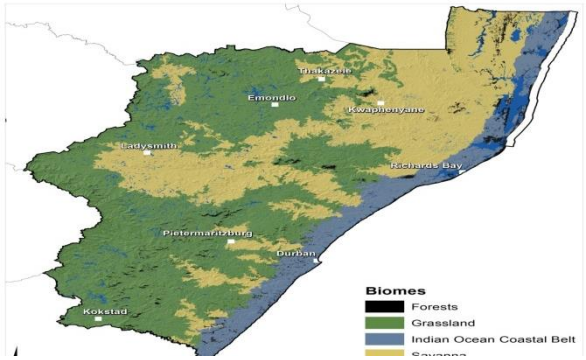
Example: South African pilot study - Ecosystem extent accounts (by biome) for KZN



Hectares	Grassland	Savanna	Indian Ocean Coastal Belt	Wetland	Forest
Opening balance 1840	4 581 933	3 259 059	893 967	393 718	202 822
Total reductions in stock	1 651 736	840 380	528 754	107 567	18 208
Total reductions as a % of 1840	36	26	59	27	9
Opening balance 2005	2 930 197	2 418 679	365 213	286 151	184 614
Total reductions in stock	277 108	208 607	59 723	18 276	9 792
Total reductions as a % of 1840	6	6	7	5	5
Opening balance 2008	2 653 090	2 210 072	305 490	267 875	174 822
Total reductions in stock	68 092	34 757	11 782	9 082	3 128
Total reductions as a % of 1840	1	1	1	2	2
Opening balance 2011	2 584 998	2 175 315	293 708	258 793	171 694

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Source:

Driver, A., Nel, J.L., Smith, J., Daniels, F., Poole, C.J., Jewitt, D. & Escott, B.J. 2015. Land and ecosystem accounting in KwaZulu-Natal, South Africa. Discussion document for Advancing SEEA Experimental Ecosystem Accounting Project, October 2015. South African National Biodiversity Institute, Pretoria.

Ecosystem condition account

(End of accounting period)

Type of Ecosystem Unit	Ecosystem characteristics						
	Vegetation	Water resources	Soil	Carbon	Biodiversity	Air	...
Artificial surfaces							
Herbaceous crops							
Woody crops							
Multiple or layered crops							
Grassland							
Tree-covered areas							
Mangroves							
Shrub-covered areas							
Regularly flooded areas							
Sparse natural vegetated areas							
Terrestrial barren land							
Permanent snow and glaciers							
Inland water bodies							
Coastal water and inter-tidal areas							
Sea and marine areas							

Example: An Experimental Ecosystem Account for the Great Barrier Reef Region 2015 by ABS

TABLE 3.5: VEGETATION CONDITION, BY NRM TERRESTRIAL REGION, GREAT BARRIER REEF REGION, 2000-01 to 2011-12, Index (2000-01 = 100)

NRM Region	2000-01 g C/m^2/day	2000-01 points	2001-02 points	2002-03 points	2003-04 points	2004-05 points	2005-06 points	2006-07 points	2007-08 points	2008-09 points	2009-10 points	2010-11 points	2011-12 points
Burdekin	1.70	100	68	53	63	50	72	73	106	106	95	131	100
Burnett Mary	1.90	100	87	105	116	93	101	72	117	114	110	148	125
Cape York	2.12	100	99	82	88	91	90	103	99	104	88	111	99
Fitzroy	1.84	100	71	80	82	69	81	64	119	107	108	151	112
Mackay Whitsunday	3.59	100	89	74	84	75	83	87	99	90	88	93	97
Wet Tropics	3.11	100	102	91	91	95	93	102	104	106	96	100	98
Total GBR Region	**2.38**	**100**	**88**	**81**	**88**	**80**	**87**	**86**	**106**	**103**	**96**	**117**	**103**

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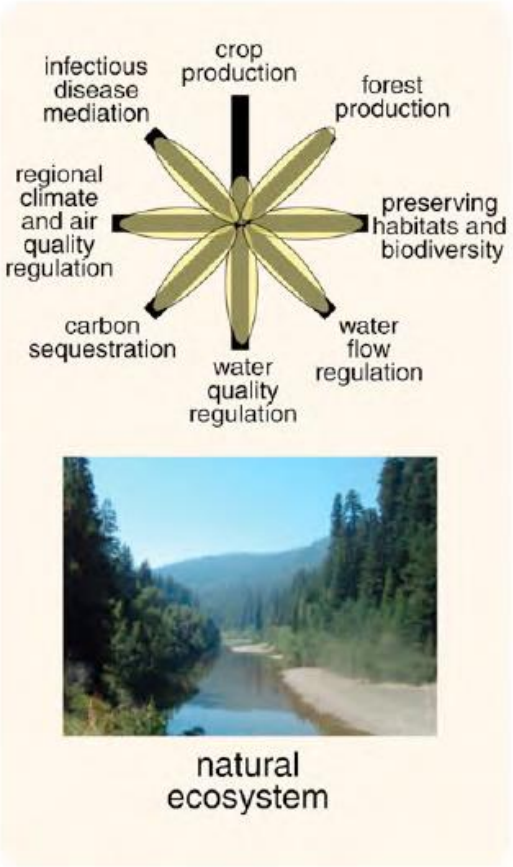
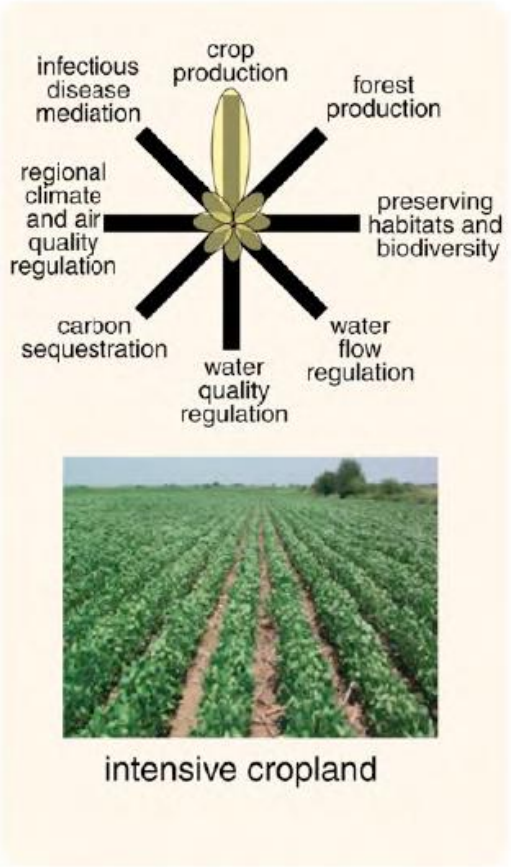
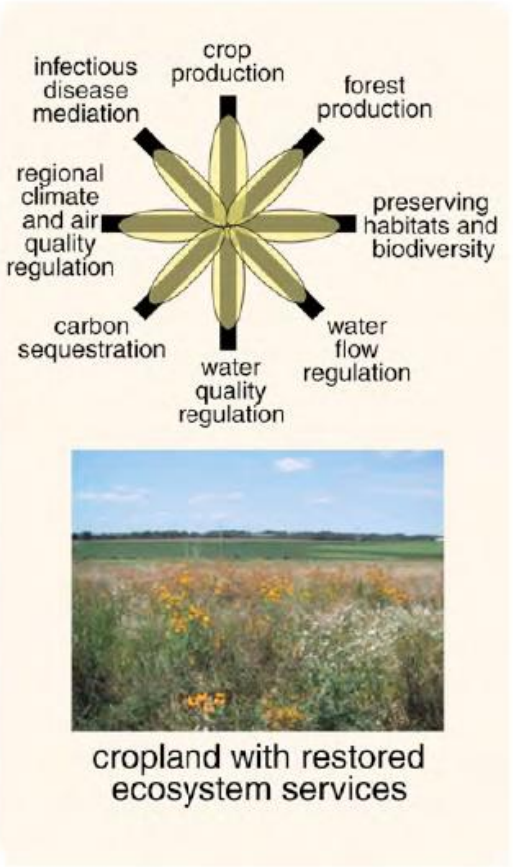
Source: *Information Paper: An Experimental Ecosystem Account for the Great Barrier Reef Region 2015*
http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/4680.0.55.001Main%20Features12015?opendocument&tabname=Summary&prodno=4680.0.55.001&issue=2015&num=&view=

Expected bundle of ecosystem services







(Foley et al. 2005 Science)

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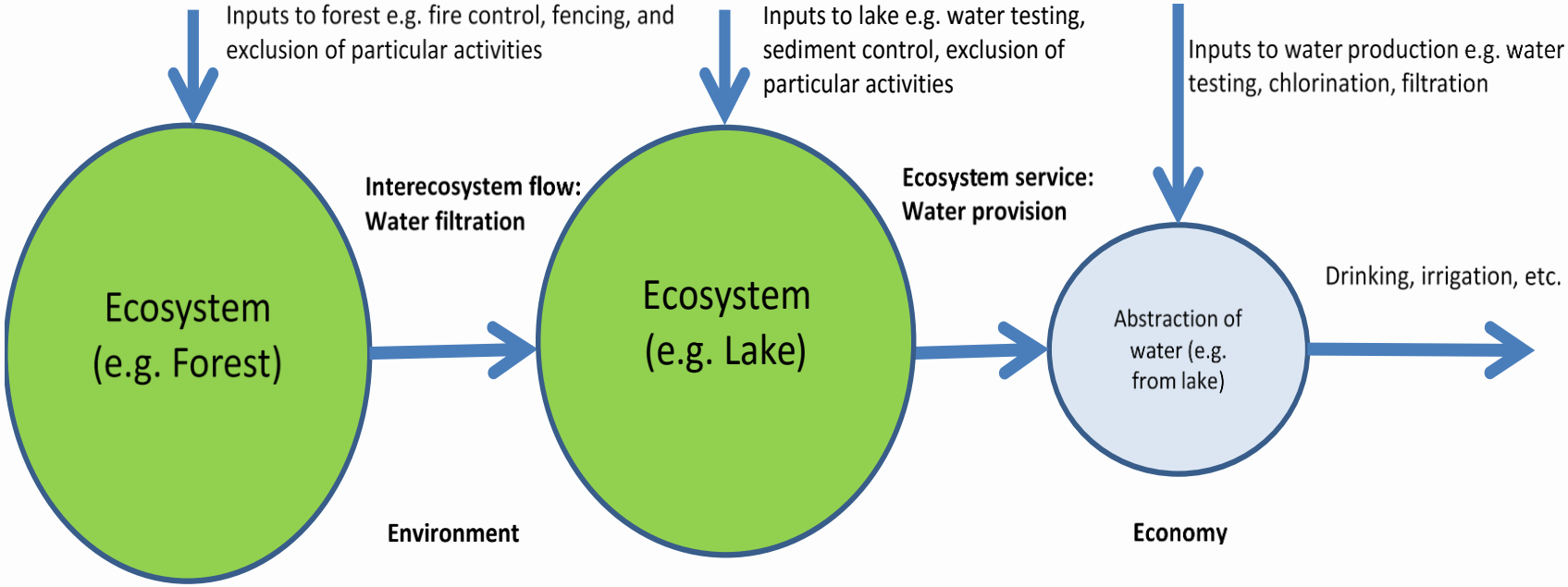
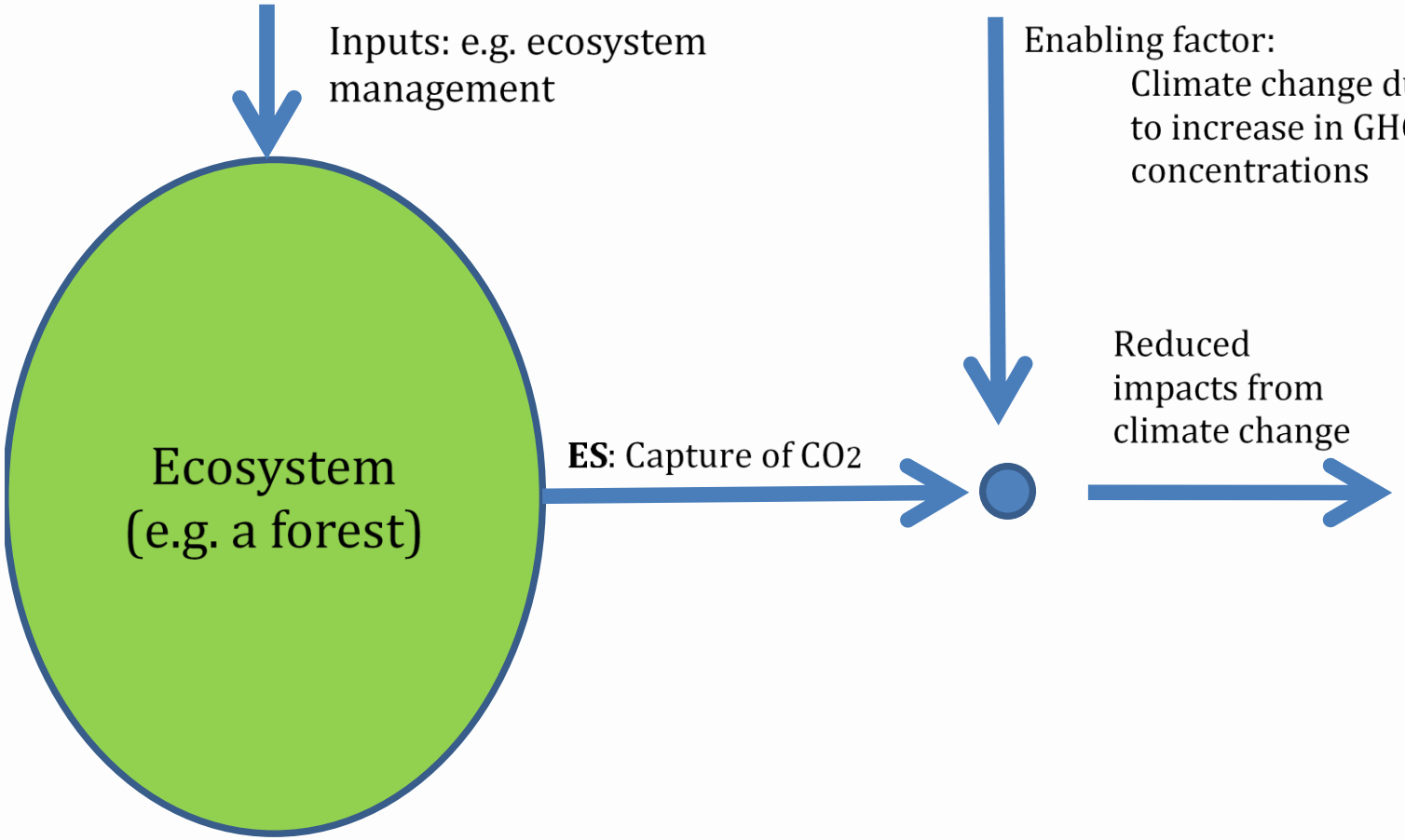
Ecosystem services: Water Provisioning



- SEEA only accounts for the final ecosystem service of water provisioning

Ecosystem services: Water Provisioning



Source: SEEA-EEA, Fig. A3.4, p. 71

Ecosystem services supply and use table

ECOSYSTEM SERVICES SUPPLY TABLE

	UNITS	Type of economic unit							Type of Ecosystem Unit															TOTAL SUPPLY
		Agriculture, forestry and fisheries	Electricity, gas supply	Water collection, treatment and supply	Other industries	Households	Accumulation	Rest of the world - Imports	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15								
Ecosystem services Provisioning services Regulating services Cultural services		A							B															
Products		C							D															

ECOSYSTEM SERVICES USE TABLE

	UNITS	Type of economic unit							Type of Ecosystem Unit															TOTAL USE
		Agriculture, forestry and fisheries	Electricity, gas supply	Water collection, treatment and supply	Other industries	Households	Accumulation	Rest of the world - Exports	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15								
Ecosystem services Provisioning services Regulating services Cultural services		E							F															
Products		G							H															

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Thematic accounts

- Standalone accounts on topics of interest in their own right
- Direct relevance in the measurement of ecosystems and in assessing policy responses.
- Thematic accounts include accounts for land, carbon, water and biodiversity.

Example: Carbon Accounting in Australia

Primary reservoir	Geocarbon (Mt C)	Hectares (million)	Biomass carbon (Mt C)	Soil organic carbon (Mt C)	Total biocarbon (Mt C)
Biocarbon					
Natural ecosystems					
Rangelands		596.3	6,374	6,603	12,977
Non rangelands:					
Eucalypt native forests		16.7	4,671	3,753	8,424
Shrub lands & woodlands		14.7	500	636	1,137
Grass, shrub & heath lands		1.6	37	51	87
Rainforests		2.3	1,225	252	1,477
Other		0.7	15	16	32
Marine ecosystems		1.8	114	1,084	1,198
Fresh water ecosystems		9.9	4	7	11
Total Natural ecosystems		**644.0**	**12,941**	**12,402**	**25,343**
Semi-natural ecosystems					
Highly modified rangelands		50.0	750	1,500	2,250
Grazing in modified pastures outside rangelands		32.9	132	1,315	1,447
Total Semi-natural ecosystems		**82.9**	**882**	**2,815**	**3,697**
Agricultural ecosystems					
Cropping		25.5	102	1,022	1,124
Irrigated agriculture		2.6	12	105	117
Plantation wood		2.4	177	120	296
Reservoir/dam		0.6	1	6	7
Other		6.3	120	244	363
Total Agriculture ecosystems		**37.4**	**412**	**1,497**	**1,907**
Settlements		2.6	30	79	108
Other		0.5	7	19	26
Total Settlements and Other		**3.1**	**37**	**98**	**134**
Total biocarbon[d]		**767.4**	**14,270**	**16,811**	**31,081**

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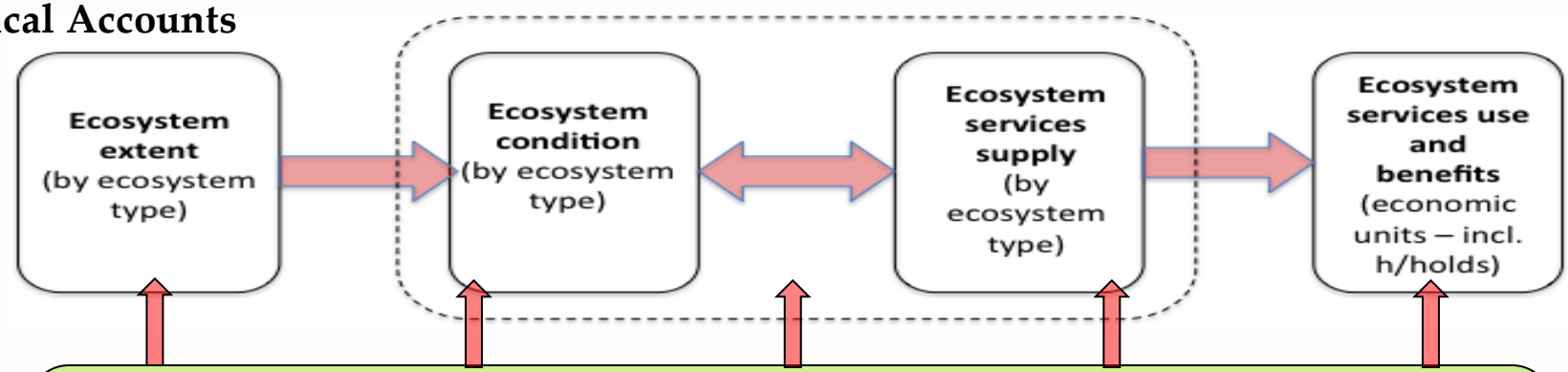
Source:
https://coombs-forum.crawford.anu.edu.au/publication/hc-coombs-policy-forum/4708/carbon-accounting-australia

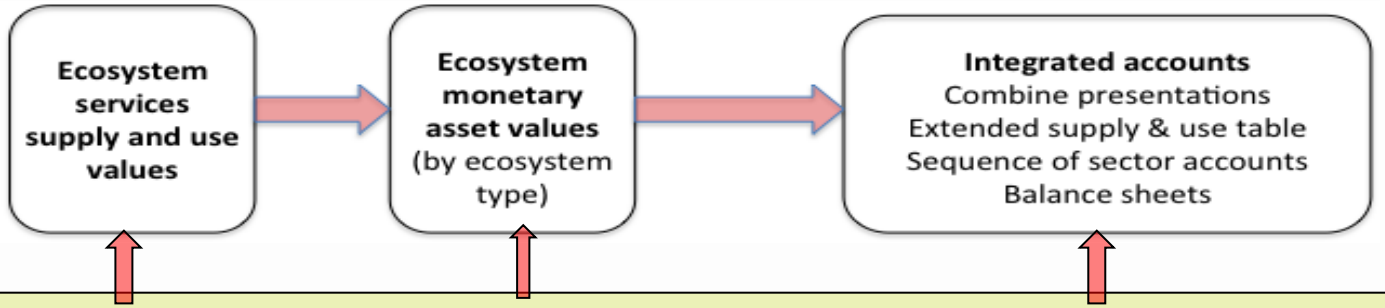
Broad steps in ecosystem accounting

a. Physical Accounts



Ecosystem thematic accounts: Land, Carbon, Water, Biodiversity
Supporting information: Socio-economic conditions and activities, ecological production functions
Tools: classifications, spatial units, scaling, aggregation, biophysical modelling
Source: Official statistics, spatial data, remote sensing data

b. Monetary Accounts



Supporting information: SNA accounts, I-O tables
Tools: Valuation techniques

THANK YOU

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