



Physical flow accounts: principles and general concepts

Julian Chow

United Nations Statistics Division

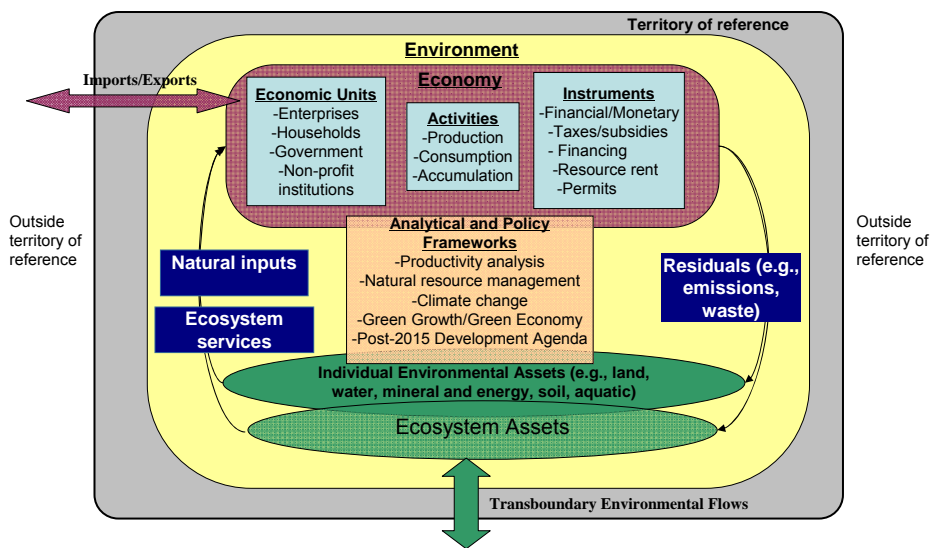
1st Sub-Regional Course on SEEA

23-27 September 2013

Malaysia



SEEA Conceptual Framework





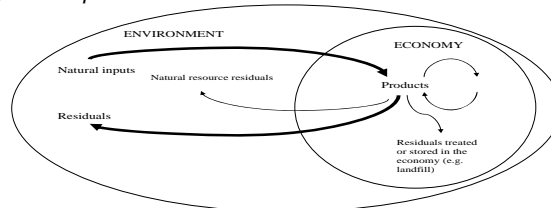
The SEEA Central Framework Accounts

- 1. Flow accounts:** supply and use tables for products, natural inputs and residuals (e.g. waste, wastewater) generated by economic activities.
 - physical (e.g. m² of water) and/or monetary values (e.g. permits to access water, cost of wastewater treatment, etc.)
- 2. 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)
- 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



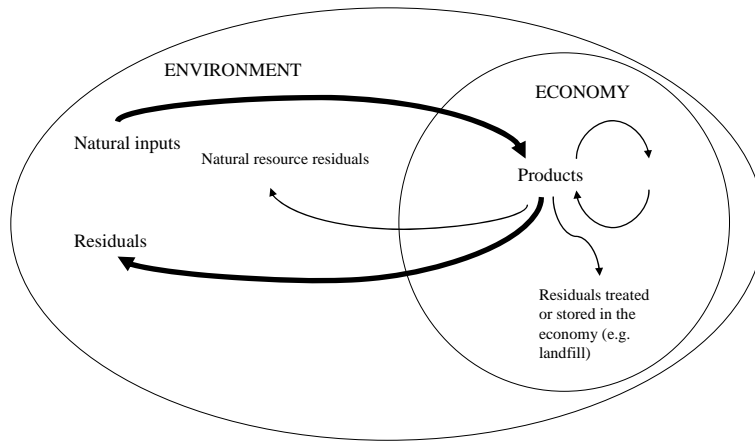
SEEA Physical Flow Accounting

- 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 flows in relation to the production boundary of the economy



Types of physical 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 (CO ₂ , 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



Accounting and balancing identities

- 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
= Domestic production + Imports

Is identical to

Total Use of Productions
= Intermediate consumption
+ Household final consumption
+ Gross capital formation
+ Exports



Input-output identity

Materials into the economy = Natural inputs + 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 Industries - classified by ISIC	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				
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		Accumulation Industries - classified by ISIC	Flows to the rest of the world	Flows to the environment	Total
	Industries - classified by ISIC	Households				
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 world	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
		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)
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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 world	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							

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

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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)
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Total use							

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

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)
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Residuals	I1. Residuals generated by industry (incl. natural resource residuals)	J. Residuals generated by household final consumption	K1. Residuals from scrapping and demolition of produced		L. Residuals received from rest of the world	M. Residuals recovered from the environment	Total Supply of Residuals (TSR)
	I2. Residuals generated following treatment		K2. Emissions from controlled landfill sites				
Total supply							
Use table		Intermediate consumption of products; Use of natural inputs; Collection of residuals		Accumulation	Flows to the rest of the world	Flows to the environment	Total
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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 world	Q. Residual flows to the environment	Total Use of Residuals (TUR)
						Q1. Direct from industry and households (incl. natural resource residuals & landfill emissions) Q2. Following treatment	
Total use							

- 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		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				
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Total supply							
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						Q1. Direct from industry and households (incl. natural resource residuals & landfill emissions) Q2. Following treatment	
Total use							

Record flows to and from the environment

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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							

Exercise - Particular note regarding the flows of residuals

	Industries	Households	Accumulation	Rest of the world	Environment	Total
Supply table						
Natural inputs					Flows from the environment	Total supply of natural inputs
Products	Output			Imports		Total supply of products
Residuals	Residuals generated by industry	Residuals generated by final household consumption	Residuals from scrapping and demolition of produced assets			Total supply of residuals
Use table						
Natural inputs	Extraction of natural inputs					Total use of natural inputs
Products	Intermediate consumption	Household final consumption	Gross capital formation	Exports		Total use of products
Residuals	Collection & treatment of waste and other residuals		Accumulation of waste in controlled landfill sites		Residual flows direct to environment	Total use of residuals

Residual processed and the sold as recycled or reused product
Residual after treatment return to the environment



Natural inputs

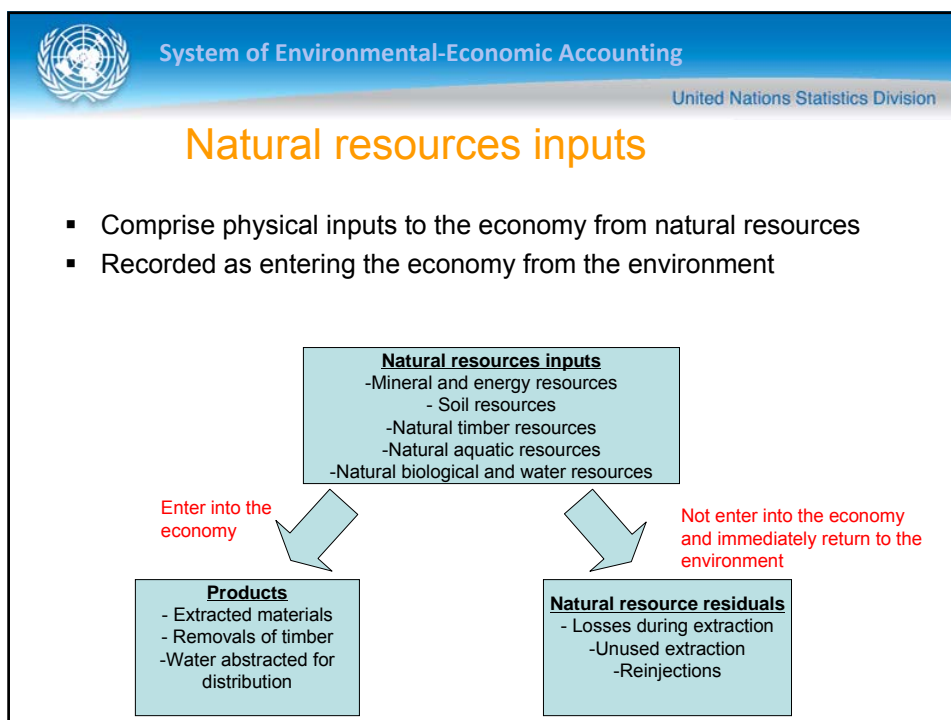


Natural inputs

- Natural inputs are 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
- 3 broad classes
 - Natural resource inputs
 - Inputs from renewable energy sources
 - Other natural inputs

Classes of natural inputs

1 Natural resource inputs		2	Inputs of energy from renewable sources
1.1	Extraction used in production	2.1	Solar
1.1.1	Mineral and energy resources	2.2	Hydro
1.1.1.1	Oil resources	2.3	Wind
1.1.1.2	Natural gas resources	2.4	Wave and tidal
1.1.1.3	Coal and peat resources	2.5	Geothermal
1.1.1.4	Non-metallic mineral resources (excl. coal & peat resources)	2.6	Other electricity and heat
1.1.1.5	Metallic mineral resources	3 Other natural inputs	
1.1.2	Soil resources (excavated)	3.1	Inputs from soil
1.1.3	Natural timber resources	3.1.1	Soil nutrients
1.1.4	Natural aquatic resources	3.1.2	Soil carbon
1.1.5	Other natural biological resources (excluding timber and aquatic resources)	3.1.3	Other inputs from soil
1.1.6	Water resources	3.2	Inputs from air
1.1.6.1	Surface water	3.2.1	Nitrogen
1.1.6.2	Groundwater	3.2.2	Oxygen
1.1.6.3	Soil water	3.2.3	Carbon dioxide
1.2	Natural resource residuals	3.2.4	Other inputs from air
		3.3	Other natural inputs n.e.c.





3 types of natural resource residuals

Groups	Definition
Losses During extraction	Cover resources that the extractor would prefer to retain •Example: losses of gas through flaring and venting
Unused extraction	Covers resources in which the extractor has no ongoing interest •Examples: mining overburden, mine de-watering and discarded catch
Reinjections	Cover natural resources that are extracted but are immediately returned to the deposit and may be re-extracted at a later time •Examples: water injected into an aquifer and natural gas reinjected into a reservoir

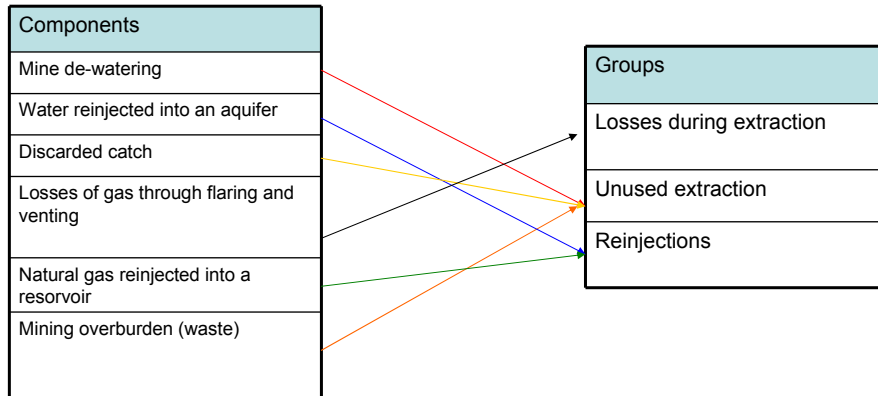


Exercise: Products vs. Natural Resource Residuals

	Products	Natural resource residuals
Losses during extraction		☆
Unused extraction		☆
Extracted materials	☆	
Reinjections (extracted but are immediately returned to the deposit)		☆
Removals of timber	☆	
Water abstracted for distribution	☆	



Exercise: Natural Resource Residuals



Examples of natural resources input

Natural resource	Extraction used in production	Natural resource residual
Mineral and energy resources	Gross ore; Crude oil; Natural gas	Mining overburden; Flaring, venting at well head; Re-injection of natural gas
Soil resources	Excavated soil used for agricultural, construction and land reclamation purposes	Dredgings; Unused excavated soil
Natural timber resources	Removals of timber	Felling residues
Natural fish resources	Gross catch less discarded catch	Discarded catch
Other natural biological resources	Harvest/capture	Harvest/capture residues
Water resources	Abstracted water	Mine dewatering



Natural resources input – other notes

- In general term, the point of entry to the economy is at the point at which the resource is available for further processing
 - Processing includes the transportation of resources
- In situation where a natural resources residual is subsequently sold, the flows are recorded as extraction used in production



Energy and other natural inputs

- **Inputs of energy from renewable resources**
 - Non-fuel sources of energy provided by the environment
 - Examples: Solar energy, hydropower, wind energy, wave energy
- **Inputs from soil**
 - Comprise nutrients and other elements present in the soil that are absorbed by the economy during production process
 - Examples: nitrogen, phosphorous, potassium
- **Inputs from air**
 - Comprise substances taken in the economy from the air for purpose of production and consumption
 - Examples: Nitrogen, oxygen and carbon dioxide used by cultivated resources



Residuals



Definition of residuals

Flows of

...solid, liquid and gaseous materials and energy

...that are discarded, discharged or emitted

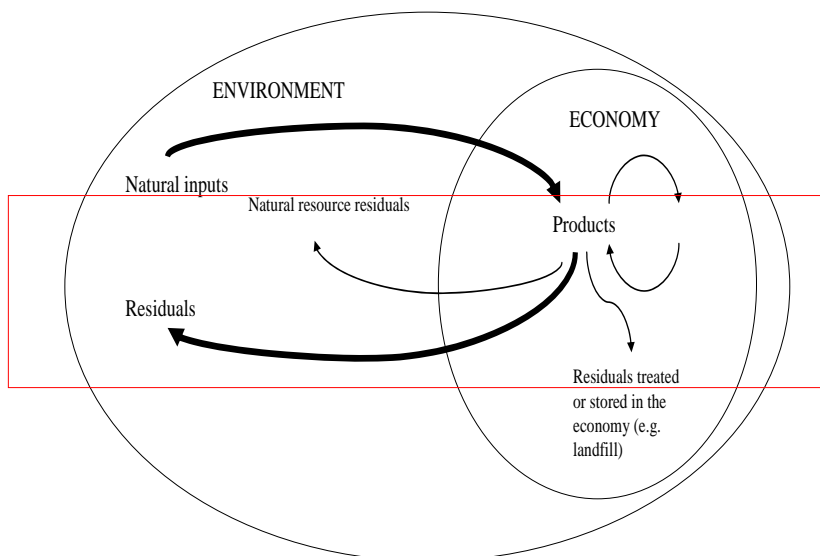
...by establishments and households

...through process of production, consumption
or accumulation



Residuals

- Residuals may be discarded, discharged or emitted directly to the environment or captured, collected, treated, recycled, or reused by economic units.
- If a payment is made, the flow is a transaction and the object a product, not a residual
- Major groups of residuals:
 - Solid waste
 - Wastewater
 - Emissions
- Dissipative uses: products that are deliberately released to the environment as part of production processes, e.g. fertilizers and pesticides
 - A portion becomes incorporated in new products, the remainder becomes residuals
 - Natural resource residuals: resource inputs immediately returned to the environment as part of production process, e.g. flaring/venting during natural gas extraction, discarded fish catch, and timber felling residuals



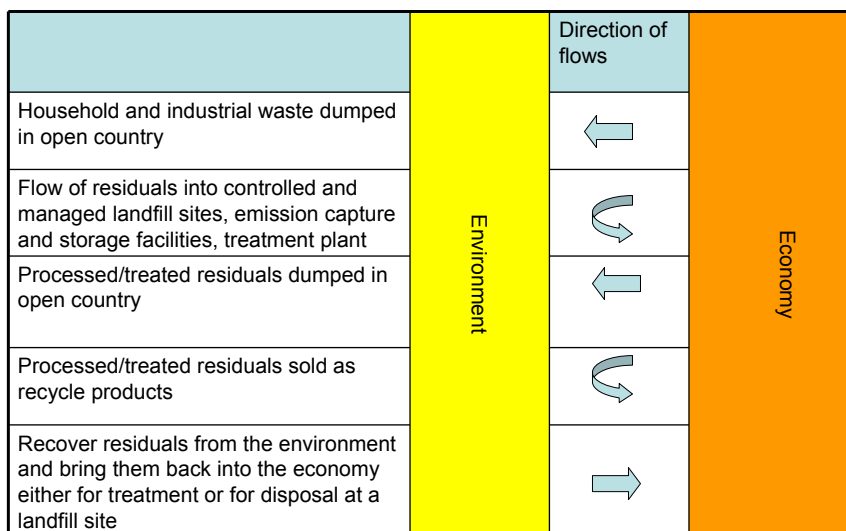


Exercise

	Residuals flows	Non-residuals flows
Discarder receives money in exchange for discarded product		Products flows
Payments made by a generator of residual to establishments that collect or transform residuals		Products transactions
Flows of residuals from generator to establishment that collect or transform residuals	Residuals flows	
Payment for the services provided for transportation and treatment of waste by other country		Services import/export
Physical flow of solid waste between countries	Residual flows	



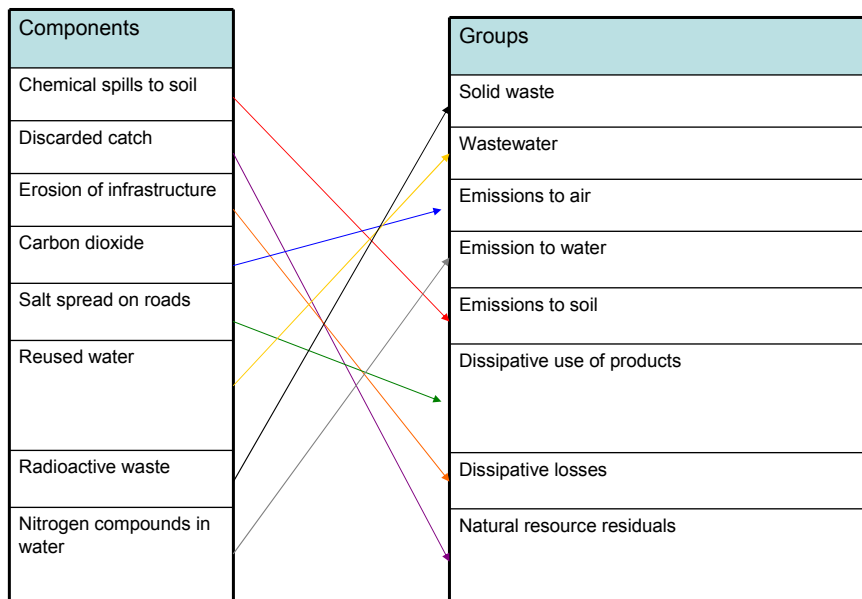
Exercise



Groups of residual

Groups	Definition
Solid waste	Discarded materials that are no longer required by the owner
Wastewater	Discarded water that is no longer required by the owner or user
Emissions	Substances released to the environment by establishments and households as a result of production, consumption and accumulation process
Dissipative use of products	Cover products that are deliberately released to the environment as part of production process
Dissipative losses	Material residuals that are an indirect result of production and consumption
Natural resource residuals	Natural resource input that do not subsequently become incorporated into production processes and instead immediately return to the environment

Exercise





Typical components for groups of residual

Group	Typical components
Solid waste (includes recovered materials)*	Chemical and healthcare waste, Radioactive waste, Metallic waste, Other recyclables, Discarded equipment and vehicles, Animal and vegetal wastes, Mixed residential and commercial waste, Mineral wastes and soil, Combustion wastes, Other wastes
Wastewater*	Water for treatment and disposal, Return flows, Reused water
Emissions to air	Carbon Dioxide, Methane, Dinotrogen oxide, Nitrous oxides, Hydrofluorocarbons, Perfluorocarbons, Sulphur Hexafluoride, Carbon monoxide, Non-methane volatile organic compounds, Sulphur dioxide, Ammonia, Heavy metals, Persistent organic pollutants, Particulates (e.g. PM10, dust)
Emissions to water	Nitrogen compounds, Phosphorous compounds, Heavy metals, Other substances and (organic) compounds
Emissions to soil	Leaks from pipelines, chemical spills
Residuals from dissipative use of products	Unabsorbed nutrients from fertilisers, salt spread on roads
Dissipative losses	Abrasion (tyres/brakes), Erosion/corrosion of infrastructure (roads, etc)
Natural resource residuals	Mining overburden, felling residues, discarded catch



Losses

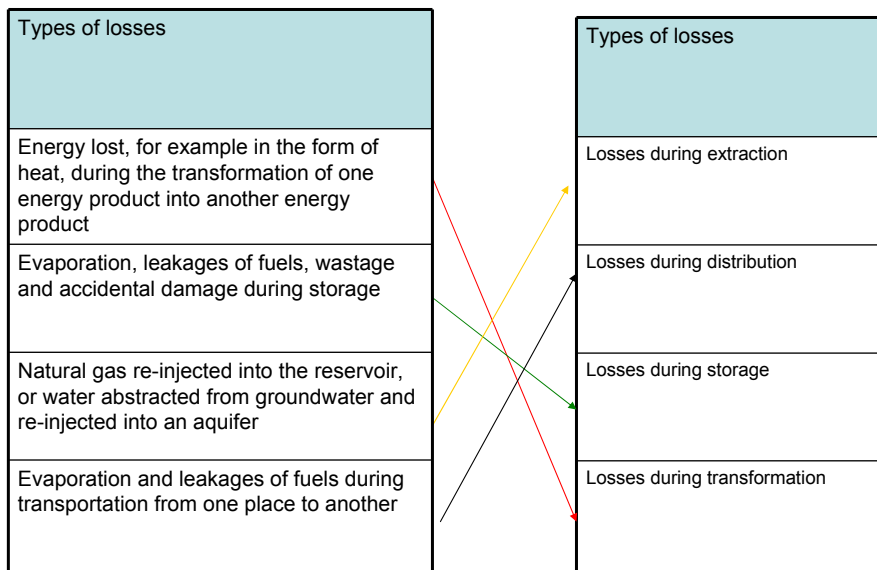
- Another way in which residuals are considered is in terms of loss
- Losses should be recorded if there is a preference on the part of the economic unit to retain the physical quantities that return to the environment



4 types of losses

Types	Definition
Losses during extraction	Losses that occur during extraction of a natural resource before there is any further processing, treatment or transportation of the extracted natural resource
Losses during distribution	Losses that occur between a point of abstraction, extraction or supply and a point of use
Losses during storage	Losses of energy products and materials
Losses during transformation	Losses during transformation

Exercise





Thank you