

Solid Waste Accounting

System of Environmental-Economic Accounting Central Framework (SEEA-CF)

<http://www.unescap.org/our-work/statistics>

Outline

- Learning objectives
- Review of basics (5 min.)
- Level 1 What? why? (compilers)
 - Concepts (15 min.)
 - Group exercise and discussion (30 min.)
- Level 2
 - Data sources, country examples and issues (15 min.)
 - Group exercise and discussion (15 min.)
- Closing discussion (10 min.)



Learning objectives

- **Level 1**
 - Understand what Solid Waste Accounts are and why they are important
 - Understand the basic concepts of solid waste accounting
 - Understand how solid wastes are treated in the SEEA
 - Learn the steps of compiling a Solid Waste Account
- **Level 2**
 - Understand the common data options and sources
 - Understand the important conceptual issues
 - Be aware of how other countries have approached solid waste accounting

In the news...



The collage features several news snippets and graphics:

- UN News Centre** header with navigation tabs: News, Radio, Television, Photo, Webcast, Meetings Coverage, Media Accreditation, Secretary-General.
- UN announces first-ever global standard to measure food waste**: A photo of a basket of tomatoes. Text: "Almost one-third of food produced for human consumption – approximately 1.3 billion tonnes – is lost or wasted globally. Photo: FAO/Giulio Napolitano".
- On World Day, UN urges meaningful action on oceans**: A photo of plastic bottles and garbage in a village in Timor-Leste. Text: "Plastic bottles and garbage waste from a village in Timor-Leste washed up on the sea. UN Photo/Martine Perret".
- South China Morning Post** article: **HEALTH & ENVIRONMENT**. **Hong Kong's illegal e-waste dumps ... whose fault? War of words between US watchdog and government**. Text: "Hong Kong's environmental protection department under fire for failing to prevent the import of electronic waste, with activists claiming they have been providing information on illegal dump sites since 2007." Published: Thursday, 07 July 2016, 6:05am. Updated: Thursday, 07 July 2016, 9:07am.
- Stanford Online Course**: "No GMAT needed. Earn a certificate in Innovation from Stanford." (with a right arrow icon).
- 8 June 2016 – Healthy oceans are critical to sustaining life**: Text: "Healthy oceans are critical to sustaining life and climate and providing a wide range of services, including jobs and jobs that benefit billions of people. United Nations Secretary-General Ban Ki-moon declared today, as the UN kicked off its celebrations to mark World Oceans Day." (with a right arrow icon).
- Graphic**: "Make #NotWasting A WAY OF LIFE" surrounded by various food items like broccoli, banana, fish, eggplant, carrot, avocado, apple, orange, and lemon.

Basic concepts

- Physical flow accounting
- Physical supply and use tables
- Accounting identities
- Definitions
 - Residuals
 - Institutional units

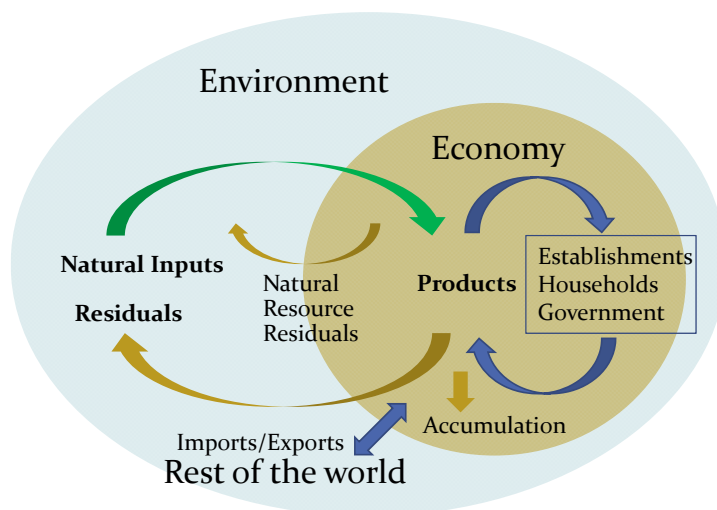
Physical flow accounting

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)





Physical supply table



Supply table

	Production; generation of residuals		Accumulation			Total
	Production; generation of residuals by industries (including household production on own account), classified by ISIC	Generation of residuals by households	Industries—classified by ISIC	Flows from the rest of the world	Flows from the environment	
Natural inputs					A. Flows from the environment (including natural resource residuals)	Total supply of natural inputs (TSNI)
Products	C. Output (including sale of recycled and reused products)			D. Imports of products		Total supply of products (TSP)
Residuals	I1. Residuals generated by industry (including natural resource residuals) I2. Residuals generated following treatment	J. Residuals generated by household final consumption	K1. Residuals from scrapping and demolition of produced assets 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						

SEEA-CF Table 3.1



Physical use table

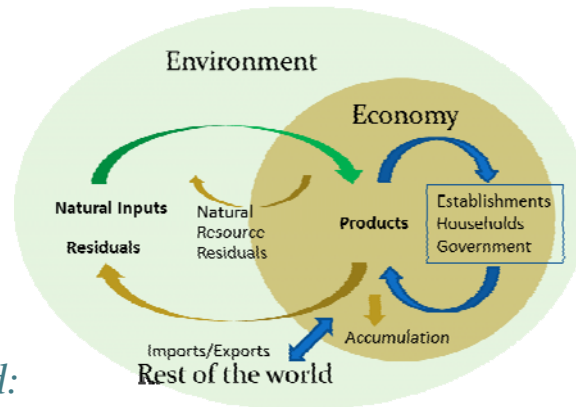


Use table

	Intermediate consumption of products; use of natural inputs; collection of residuals		Final consumption*		Accumulation		Total
	Industries—classified by ISIC		Households	Industries—classified by ISIC	Flows to the rest of the world	Flows to the environment	
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 (including purchase of recycled and reused products)	F. Household final consumption (including purchase of recycled and reused products)		G. Gross capital formation (including fixed assets and inventories)	H. Exports of products		Total use of products (TUP)
Residuals	N. Collection and treatment of residuals (excluding 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 (including natural resource residuals and landfill emissions) Q2. Following treatment	Total use of residuals (TUR)
Total use							

SEEA-CF Table 3.1

Accounting identities



Input-output identity

- *Over an accounting period:
flows of materials **into** an economy must equal
flows of materials **out** of an economy plus
any **net additions** to stock in the economy*

Accounting identities

Supply and use identity (double entry accounting)

- **Total Supply** (including imports) = **Total Use** (including exports)

Total Supply of	= Total Use of
Natural Resource Inputs	= Natural Resource Inputs
Products	= Products
Residuals	= Residuals

Definitions

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

- Emissions to air
- Effluents (wastewater)
- Solid wastes
- Natural resource residuals (natural inputs not used in production)

Institutional unit

an economic entity that is capable, in its own right, of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities

- Establishments
- Government
- Households
- Non-profit institutions

Level 1

- What are Solid Waste Accounts?
- Why do we need Solid Waste Accounts?
- Concepts
 - Definitions & Classifications

Level 1: What

- **Solid Waste Accounts:**

- Organized information on the **generation** of solid waste and the **management** of flows of solid waste to recycling facilities, to controlled landfills or directly to the environment

- **Solid wastes:**

- **Discarded** materials that are no longer required by the owner or user

Level 1: Why?



Solid wastes cause environmental & health impacts: pollution, aesthetic, land use...



They are wasted resources that could be valuable products



2030 Agenda for Sustainable Development:

- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12: Sustainable Consumption and Production



SEEA: Links to Economy-wide Material Flow Accounts



Level 1: Why?



Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

- Target 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and **municipal and other waste management**
 - 11.6.1 Percentage of urban solid waste regularly collected and with adequate final discharge with regard to the total waste generated by the city

Total waste use (collected → recycled, treated, landfill)

Total waste supply



Level 1: Why?



Target 12.2 By 2030, achieve the sustainable management and efficient use of natural resources

- 12.2.1 Material footprint and material footprint per capita

Total materials supply

Population



Level 1: Why?



Target 12.3 By 2030, halve per capita **global food waste** at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

- 12.3.1 Global food loss index

Total food materials supply – Total food materials used

Total food materials supply

Total food materials in solid waste

Total food materials supply



Level 1: Why?



Target 12.4 By 2030, achieve the environmentally sound **management of chemicals and all wastes** throughout their life cycle in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

- 12.4.2 Treatment of waste, generation of hazardous waste, hazardous waste management, by type of treatment

Total solid waste treated

Total solid waste supply

Total hazardous waste treated

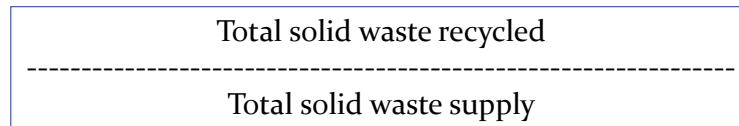
Total hazardous waste supply

Level 1: Why?



Target 12.5 By 2030, substantially reduce **waste generation** through prevention, reduction, recycling and reuse

- 12.5.1 National recycling rate, tons of material recycled



Level 1: Why?

- Waste statistics are not coherent
- Waste Accounts
 - Help organize statistics by types, sources, suppliers, users and final disposition
 - How much? Who? How treated?

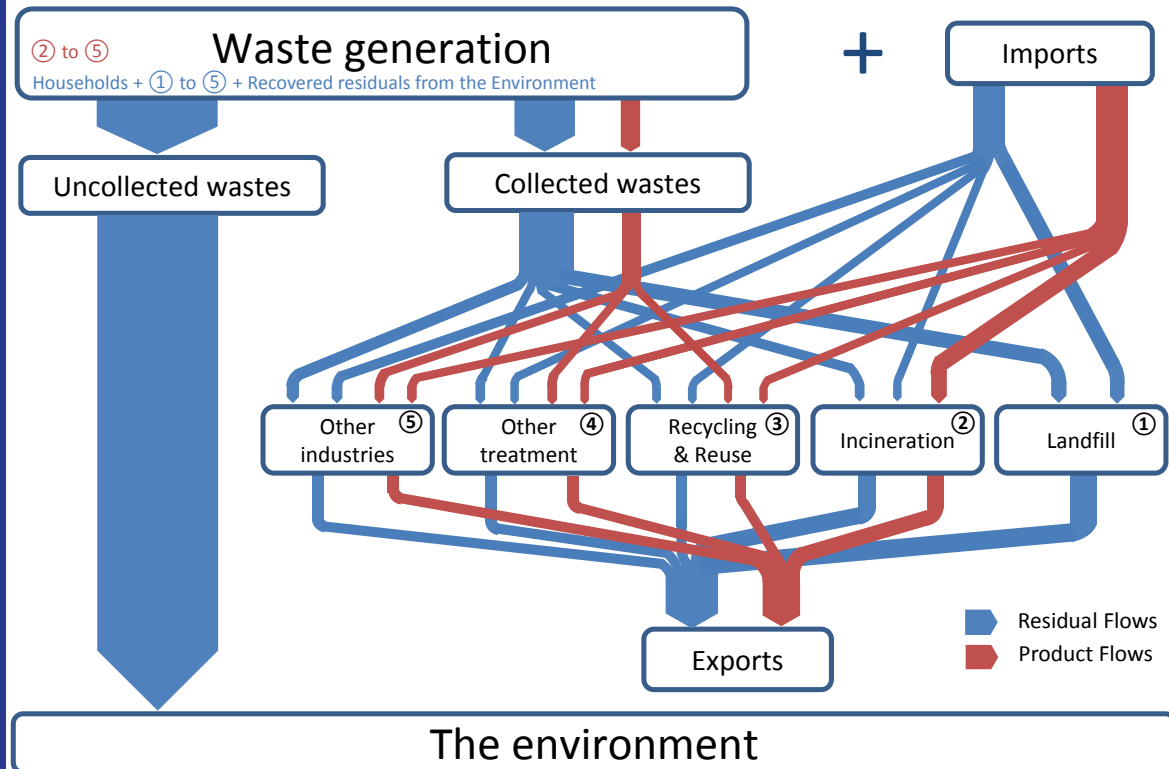


Concepts

- Product or residual?
 - If payment made = solid waste product (e.g., recycled materials)
 - Home:
 - Newspapers = solid waste → recycling, garbage
 - Recycling industry: recovered → product
 - Waste management industry → landfill
 - Business
 - Newspapers → recycling (product)
 - Recycling industry → product

Concepts

- Important industries
 - Other industries (Generate + Use)
 - Households (Generate)
 - Landfill (Use → accumulation)
 - Incineration (Generate + Use)
 - Recycling & Reuse (Recover + Use)
 - Other treatment (Generate + Use)



Group exercise: Solid waste audit

- Hotel/facility: Estimate amounts and types of solid wastes
 - Accounting period: estimate annual from daily, monthly...
 - Inputs (imports)
 - Natural inputs: sand, soil (not water, fuel)
 - Products: food, supplies, equipment
 - Processes
 - Guests (import products → disposal)
 - Food: consume → solid waste (not wastewater?)
 - Operations (Engineering/grounds) → generation?
 - Others: accumulation, incineration, treatment, recycling, reuse
 - Outputs
 - Solid waste → export, return to environment

Exercise: Solid waste audit

1. Total inputs:
- Natural inputs?
 - Products
 - Food
 - Supplies
 - Equipment
 - Guests?



5. Total outputs:
- Solid waste
 - Recycle
 - Treat
 - Environment
 - Accumulation?



- Processes:
- 2. Housekeeping
 - 3. Kitchen
 - 4. Operations



- Analysis
- How much?
 - Main sources?
 - Where does it go?
 - How to reduce?
 - Impacts?

Solid waste account (tonnes/year)

Materials	Supply	Use				
		Kitchen	Housekeeping	Operations	Total use	Residuals
	Group 1	Group 2	Group 3	Group 4		Group 5
Inputs						
Natural inputs						
Products						
Food						
Supplies						
Equipment						
Guests (+/-)						
Total						
Outputs						
Accumulation						
Solid waste						
Landfill						
Recycling						
Environment						
Total						

Solid waste account (tonnes/year)

Materials	Supply	Use				
		Kitchen	Housekeeping	Operations	Total use	Residuals
	Group 1	Group 2	Group 3	Group 4		Group 5
Inputs						
Natural inputs	10			10		
Products						
Food	50	45	5			
Supplies	20	4	10	6		
Equipment	30	5	5	20		
Guests (+/-)	20 (a)	-24 (b)	24 (c)			
Total	130					
Outputs						
Accumulation		5	6	31	42	
Solid waste		25	58 (d)	5	88	
Landfill						30
Recycling						55
Environment						3
Total					130	88

Analysis & recommendations

- **Groups together:**
 - Questions?
 - Compare and integrate data (tonnes/year)
 - Complete solid waste account
 - Check balances and estimate gaps
- **Answer:**
 - **How much** solid waste is produced per year?
 - **Where** does it go?
 - What are the main **sources** of solid waste in this facility?
 - What are some easy ways to **reduce** this waste?
 - What would be the **impacts** of reducing this waste?

Solid waste account (tonnes/year)

(tonnes/year)

Papers	Supply	Use				Residuals
		Division I	Division II	Other divisions	Total use	
	Group 1	Group 2	Group 3	Group 4		Group 5
Inputs						
Office papers						
Printed documents						
Other papers						
Total						
Outputs						
Accumulation						
Paper waste						
Of which: To trash bin						
To recycling bin						
To environment						
Total						

Solid waste account (tonnes/year)

(tonnes/year)

Papers	Supply	Use				Residuals
		Division I	Division II	Other divisions	Total use	
	Group 1	Group 2	Group 3	Group 4		Group 5
Inputs						
Office papers	10	7	2	1	10	
Printed documents	125	10	65	50	125	
Other papers	5	3	1	1	5	
Total	140	20	68	52	140	
Outputs						
Accumulation		8	60	45	113	
Paper waste		12	8	7	27	
Of which: To trash bin		10	8	5	23	23
To recycling bin		2	0	1	3	3
To environment		0	0	1	1	1
Total		20	68	52	140	27

Level 2: More concepts

- No standard international classification (may be listed in various regulations)
- In/Out
 - Natural resource residuals
 - Losses during extraction (losses: gases from flaring, spillage)
 - Unused extraction (no interest: mining overburden, discarded catch, chaff?)
 - Reinjections (may be re-extracted later: water injected into aquifer)
- Data sources
- Country examples

Natural resources inputs and residuals

Natural resource	Used in production	Residual
Mineral and energy	Gross ore Crude oil Natural gas	Mining overburden Flaring Venting at wellhead Reinjection of natural gas
Soil	Excavated soil (for agriculture construction and reclamation)	Dredgings Unused excavated soil
Timber	Removals of timber	Felling residues
Fish	Net catch	Discarded catch
Other biological	Harvest/capture	Harvest/capture residues
Water	Abstracted water	Losses, mine water

SEEA-CF Table 3.3

Data sources

- Waste management industry (private, government)
 - Administrative or survey
 - Collection by type & source
 - Disposition: recycle, treat, landfill
 - Expenditures
- General business, government, household surveys
 - Waste generation by type
 - Disposition: recycle, reuse, treat, collection, to environment
 - Expenditures
- Case studies/research reports/CSR/NGOs
- Alternative sources? Waste audit, photos, maps

Country examples

- Statistics Norway
- Australia Bureau of Statistics
- Statistics Canada
- HAE 2011 Waste in Canada
 - Account?
 - Costs
 - Quantities
- Mexico costs of management
- Others?

Statistics Norway

- Waste account for Norway
 - Amounts of waste by source of origin
 - Waste in Norway by treatment and material
 - Waste in Norway by source and material

Statistics Norway

Waste account for Norway, amounts of waste by source of origin			
	2014		Per cent change
	1000 tonnes	Share	2013 - 2014
Source of origin, total	11 937	100	7
Manufacturing industries	2 623	22	0
Construction	2 476	21	9
Service industries	2 156	18	1
Households	2 439	20	0
Other or unspecified	2 243	19	29

StatBank source table 10514

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Statistics Norway

Waste in Norway by treatment and material, 1 000 tonnes.

	2014																			
	In total, except slightly polluted soil	Wet organic waste	Park and gardening waste	Wood waste	Sludges	Paper and cardboard	Gas	Metals	EE-waste	Concrete and bricks	Cinders, dust bottom ash and fly ash	Plastics	Rubber	Textiles	Discarded vehicles	Radioactive waste	Hazardous waste	Mixed waste	Other	Slightly polluted soil
Treatment, total	11 937	688	179	1 347	236	769	97	811	153	979	781	211	54	2	223	0	1 392	2 804	1 212	1 481
Sent to material recovery	4 244	218	1	1 421	28	734	84	800	117	38	378	98	30	2	178	0	304	84	1 006	0
Biogas production	81	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Composting	408	190	160	4	1	0	0	0	0	0	0	0	0	0	0	0	0	51	1	0
Filling compound and cover material	616	0	0	4	5	0	0	0	0	569	30	0	0	0	0	0	0	2	6	7
Incineration	4 220	188	9	1 177	6	34	0	1	16	2	18	109	5	0	32	0	332	2 254	35	0
Landfill	1 952	0	0	0	21	1	7	0	16	224	355	2	0	0	13	0	432	195	133	1 424
Other disposal	467	3	8	8	4	0	3	0	1	46	0	0	18	0	0	0	325	37	13	0
Unknown	399	0	0	8	171	0	8	10	0	0	0	2	0	0	0	0	0	179	17	0

StatBank source table 10513
© Statistisk sentralbyrå

Waste in Norway by source and material, 1 000 tonnes.

	2014																			
	In total, except slightly polluted soil	Wet organic waste	Park and gardening waste	Wood waste	Sludges	Paper and cardboard	Gas	Metals	EE-waste	Concrete and bricks	Cinders, dust bottom ash and fly ash	Plastics	Rubber	Textiles	Discarded vehicles	Radioactive waste	Hazardous waste	Mixed waste	Other	Slightly polluted soil
Source of origin, total	11 937	688	179	1 347	236	769	97	811	153	979	781	211	54	2	223	0	1 392	2 804	1 212	1 481
Agriculture, forestry and fishing	147	48	9	1	0	5	0	2	3	0	0	23	0	2	10	0	2	41	1	0
Mining and quarrying	370	4	0	2	0	1	0	13	1	0	0	1	0	0	0	0	343	2	2	0
Manufacturing industries	2 623	305	0	678	84	74	11	156	5	50	271	12	1	0	1	0	619	121	177	12
Electricity, gas, steam and air conditioning supply	111	0	0	0	0	0	0	8	1	0	68	0	0	0	0	0	35	0	1	0
Water supply, sewerage, waste management and remediation activities	615	0	0	0	132	0	0	38	7	0	176	3	0	0	0	0	80	177	1	14
Construction	2 476	0	0	262	0	25	9	87	10	799	0	3	0	0	3	0	29	320	926	0
Service industries	2 356	88	11	125	15	386	20	194	33	14	1	34	53	0	33	0	109	1 030	4	9
Other or unspecified	1 000	0	0	4	3	1	0	230	45	116	265	97	0	0	0	0	121	89	28	1 446
Households	2 439	182	159	274	0	277	57	83	47	0	0	36	0	0	175	0	57	1 023	68	0

StatBank source table 10514
© Statistisk sentralbyrå

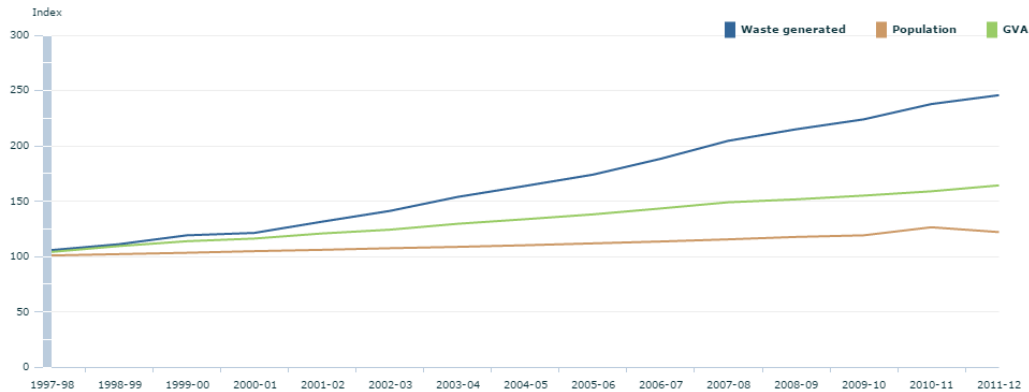
Statistics Norway

Data sources and sampling

- Household waste statistics (Statistics Norway)
- Manufacturing industry statistics (Statistics Norway)
- Hazardous waste statistics (Statistics Norway)
- Construction waste statistics (Statistics Norway)
- Waste from service industries (Statistics Norway)
- Waste treatment and disposal statistics (Statistics Norway)
- Household waste composition data (Statistics Norway)
- Building and construction statistics (Statistics Norway)
- Statistics on cars scrapped for deposit (Statistics Norway)
- Municipal wastewater statistics (Statistics Norway)
- Statistics on recycling on different types of waste by producers responsibility organisations and the recycling industry
- Forurensning (database for the businesses' self-reporting to the Climate and pollution agency)
- Oljeindustriens landforening, OLF
- WEEE-registry (ee-registeret, A registry on collected and treated electric and electronic equipment)

Australian Bureau of Statistics

Waste generation, Population & GVA, 1997-2012



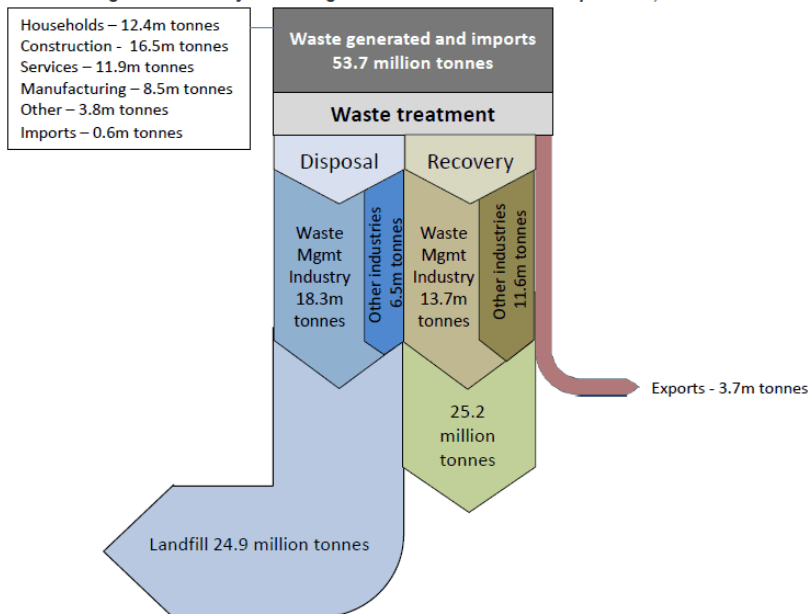
Save Chart Image

Australian Bureau of Statistics
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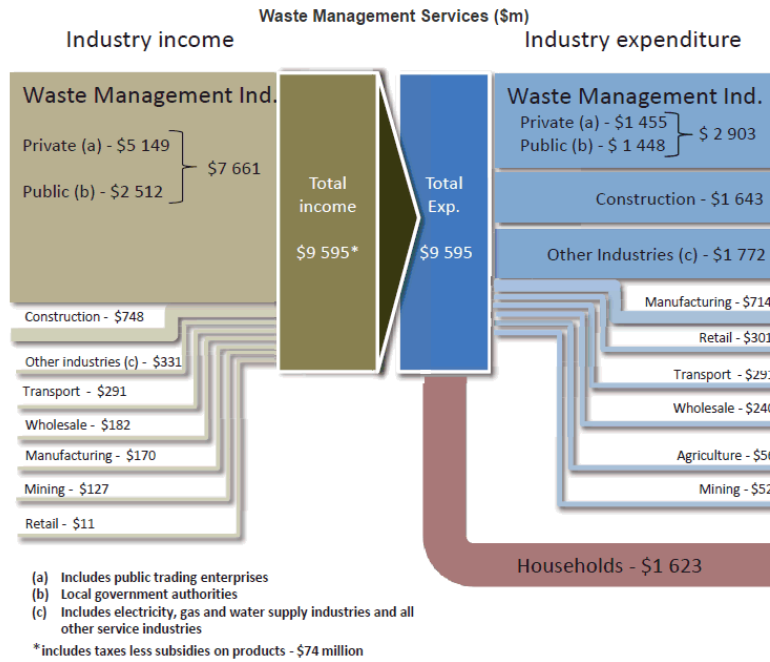
- GVA = Gross Value Added

Australian Bureau of Statistics

Figure 2 Summary of waste generated and waste services provided, 2009-10



Australian Bureau of Statistics



Statistics Canada

Catalogue no. 16-201-X

Human Activity and the Environment

Waste management in Canada

2012 — Updated



Statistics Canada / Statistique Canada

Canada

Contents

- Waste disposal by source, province and territory
- Disposal and diversion of waste, by province and territory
- Capital expenditures on pollution abatement and control (end-of-pipe) by medium and industry
- Capital expenditures on pollution prevention by medium and industry
- Expenditures on environmental protection by industry and activity
- Water use parameters in manufacturing industries, by industry group, Canada

Statistics Canada

Catalogue no. 16-201-X

Human Activity and the Environment

Waste management in Canada

2012 — Updated



Statistics Canada / Statistique Canada

Canada

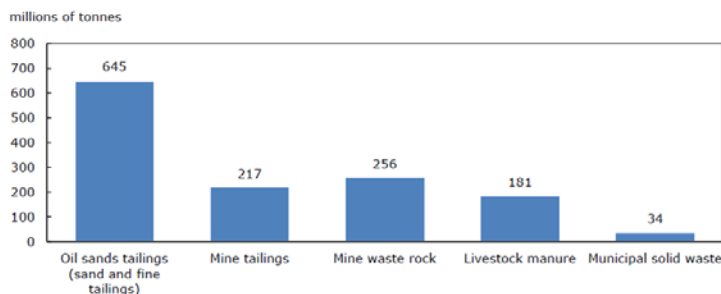
Data sources:

Statistics Canada:

- Waste Management Industry Survey: Government Sector
- Survey of Environmental Protection Expenditures
- Waste Management Industry Survey: Business Sector
- Households and the Environment Survey
- Industrial Water Survey

Statistics Canada

Chart 2.1
Major categories of solid waste, various years



Note(s): This chart shows waste generation from various sources and does not address the subsequent disposition of these waste residuals. A significant portion of these waste residuals are recycled, stored in permitted sites, used as inputs or converted to other products (for example, road building materials or fertilizers). Data for oil sands and mines are from 2008. Data for livestock manure are from 2006 and include both urine and feces. Municipal solid waste data are for 2008. Business and household waste generation does not cover any waste that is managed on-site by a company or household or that is transported directly to secondary processors.

Source(s): Statistics Canada, CANSIM tables 153-0041 and 153-0043 (accessed October 7, 2011). Government of Alberta, 2009, *Environmental Management of Alberta's Oil Sands*, <http://environment.gov.ab.ca/info/library/8042.pdf> (accessed May 23, 2012). Government of Alberta, 2011, *talk about oil sands*, www.energy.alberta.ca/OilSands/pdfs/FactSheet_OilSands.pdf (accessed October 7, 2011). Energy Resources Conservation Boards, 2008, *ST98-2008: Alberta's Energy Reserves 2007 and Supply/Demand Outlook 2008-2017*, www.ercb.ca (accessed October 24, 2011). Natural Resources Canada, *Annual Census of Mines, Quarries and Sandpits, 2008*. N. Hofmann, 2008, "A geographical profile of livestock manure production in Canada, 2006," *EnviroStats*, Vol. 2, no. 4, Statistics Canada Catalogue no. 16-002-X200800410751.

Challenges:

- Big picture
- Data gaps
- Multiple data sources
- Data from various years
- No on-site management data
- Non-Statistics Canada data
- No link to disposition

Additional information

ESCAP Waste to Resource Initiatives

- Approach
 - Resources
 - City case studies
- <http://www.unescap.org/waste-to-resource>
 - <http://waste2resource.org/>

Valuing Waste, Transforming Cities



Exercise

- Each group discuss (10min) & present
 - What are the most important sources of solid waste problems in your country?
 - Who is responsible for managing it?
 - What data sources do you have?
 - What data need to be developed?
 - What indicators would you suggest to monitor and report on these problems?

References

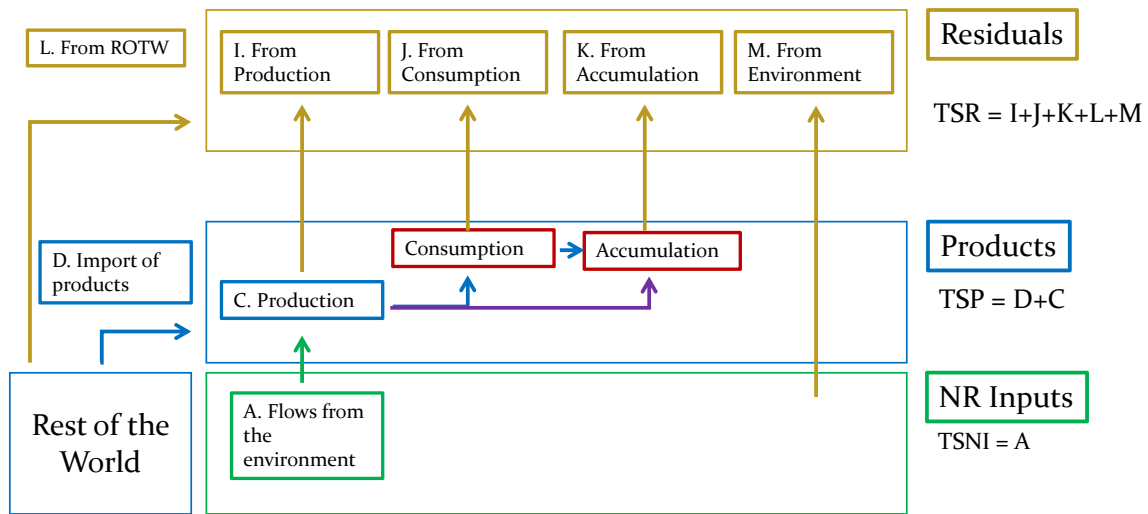
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- Statistics Canada. 2012. Human Activity and the Environment 2012: Waste management in Canada. <http://www.statcan.gc.ca/pub/16-201-x/2012000/part-partie1-eng.htm>
- Statistics Norway. 2014. Waste accounts. <https://www.ssb.no/en/natur-og-miljo/statistikker/avfregno/aar/2016-05-25>
- UN SEEA: <http://unstats.un.org/unsd/envaccounting/seea.asp>

Acknowledgements

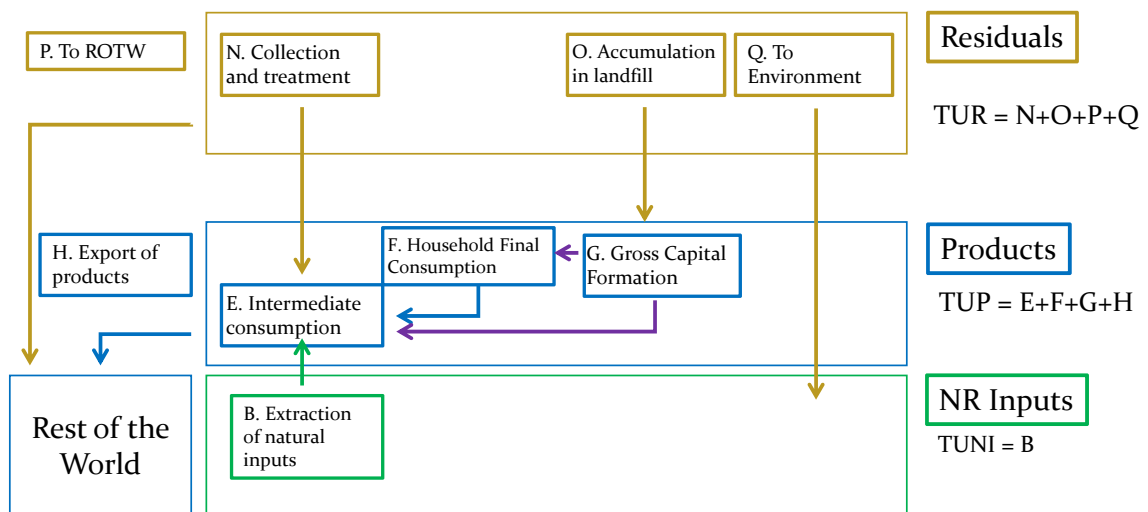
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 - Julian Chow (UNSD; Malaysia; Sept. 23, 2013)
 - Ole Gravgård (Statistics Denmark; Addis Ababa, Ethiopia; Feb. 2, 2015)



Physical supply



Physical use

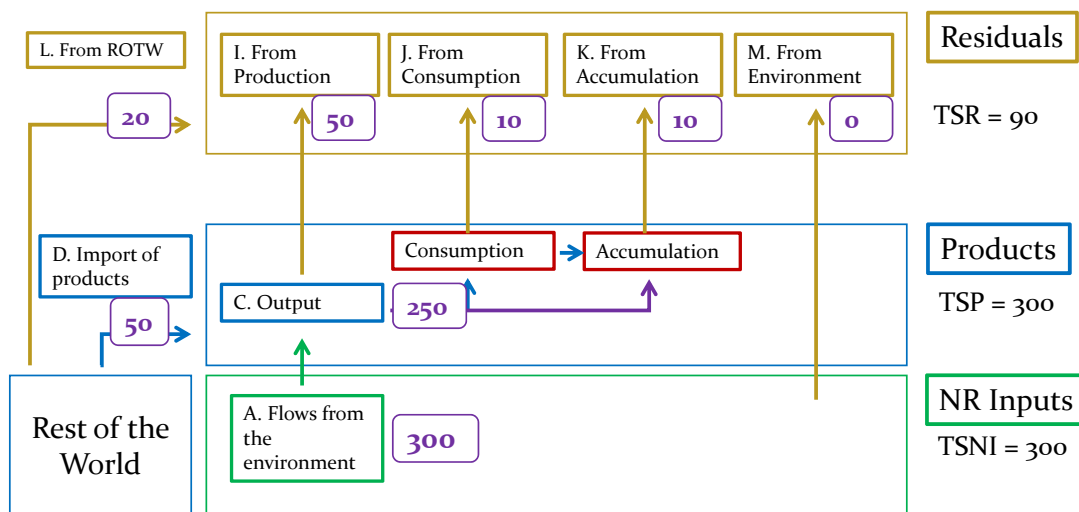


Example: Tires

• Supply

- A. Natural inputs: petroleum (300T)
 - $TSNI = A = 300T$
- D. Import of tires (50T)
- C. Manufacture of tires (250T)
 - $TSP = C + D = 300T$
- I. Residuals generated manufacturing tires (50T)
- J. Residuals generated by household final consumption (10T)
- K. Residuals from scrapping and demolition (10T)
- L. Residuals received from the Rest of the World (scrap tires) (20T)
- M. Residuals recovered from the environment (scrap tires) (0T)
 - $TSR = I + J + K + L + M = 90T$

Physical supply: Tires (Mtonnes)

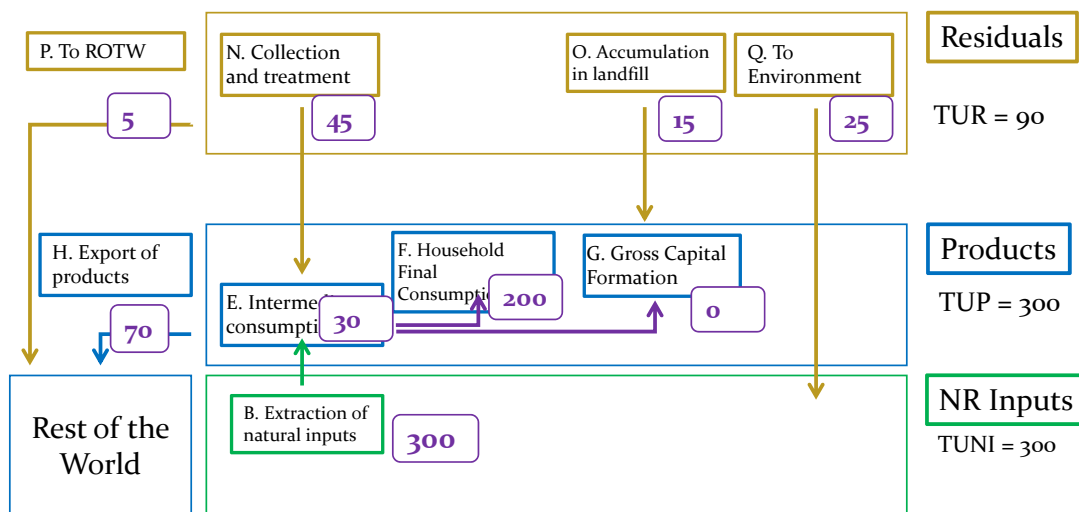


Example: Tires

• Use

- B. Extraction of natural inputs: petroleum (300T)
 - $TUNI = B = 300T$
- E. Intermediate consumption (30T)
- F. Household final consumption (200T)
- G. Gross fixed capital formation (0T)
- H. Export of tires (70T)
 - $TUP = E + F + G + H = 300T$
- N. Collection and treatment of residuals (recycling)(45T)
- O. Accumulation in controlled landfill (15T)
- P. Exported scrap tires (5T)
 - $TUR = N + O + P + Q = 90T$
- Q. Flows to the environment (uncontrolled) (25T)

Physical use: Tires (Mtonnes)





Exercise? Animal and vegetal waste

- Supply
 - Generation of solid waste residuals:
 - Other industries: 50T Agriculture, 200T Food and beverage, 100T Service
 - 100T Households
 - 90T Imported
 - TSR = 540T
 - Generation of solid waste products:
 - 200T generated by agriculture (fertilizer & animal feed)
 - 50T imported
 - TSP = 250T
- Use
 - Use of solid waste residuals
 - Waste collection and treatment industry: 40T landfill, 200T to incineration (40T to generate energy), 90T recycled and reused, 20T other treatment
 - Other industries: 50T used to make recycled products
 - Exported: 20T
 - Flows to the environment: 120T
 - TUR = 540T
 - Use of solid waste products
 - Recycling and reuse: 120T
 - Other industries: 130T
 - TUP = 250T