Measurement and Valuation of Environmental Assets

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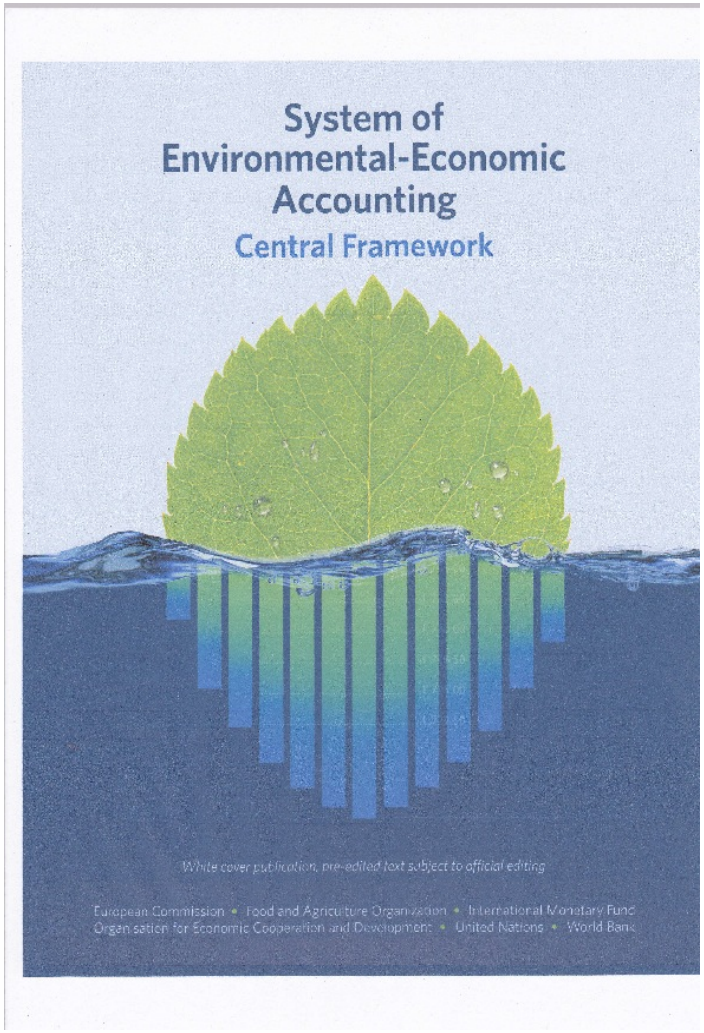
This session

- Environmental assets of the SNA and SEEA Central Frameworks
- Why measure?
- And how?



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What assets are we measuring?

SNA and SEEA Central Framework

- SNA records 'economic' assets
  - ownership rights enforced by institutional units;
  - asset owner must derive economic benefits from holding or using it over a period of time
    - Expressed in monetary ($) units
- SEEA Central Framework has a similar scope – 'components that may provide resources for use in economic activity'
    - Expressed in monetary ($) units
    - Expressed in physical units (extended boundary)

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SNA: What assets are we measuring?

2008 SNA natural resource[1.] assets:

1. Land;
2. Mineral and energy resources;
3. Non-cultivated biological resources;
4. Water resources; and
5. Other natural resources

- Items 3 & 4 are recorded in SNA accounts only for the value that can be separated from 'Land'

1. SNA 'natural resources' plus 'cultivated biological resources' equals SEEA 'environmental assets'

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SEEA: What assets are we measuring?

Environmental assets in the SEEA Central Framework

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

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Key concepts in environmental accounting: stocks and flows

		Produced assets	Natural resource stocks				
			Mineral and energy	Water	Biological resources		Land
					produced	non produced	
	Opening stocks						
Flows	***Changes due to transactions***						
	Gross fixed capital formation						
	of which land improvement						
	Changes in inventories						
	of which work in progress on cultivated assets						
	Consumption of fixed capital						
	Acquisitions less disposals of non-produced assets						
	Additions to stock levels						
	Discoveries						
	Reclassifications due to quality change						
	Reclassifications due to change of functions						
	Natural growth						
	Deductions from stock levels						
	Extraction of natural resources						
	Reclassifications due to quality change						
	Reclassifications due to change of functions						
	Environmental degradation of non-produced assets						
	Other changes in stock levels						
	Catastrophic losses and uncompensated seizures						
	Degradation of produced assets						
	Nominal holding gains/losses						
	Change in classifications and structure						
	Closing stocks						

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Why value environmental assets?

- To understand the wealth held in environmental assets - *in both physical and monetary terms*
  - cannot manage what we do not measure
  - Wealth per person?
  - Decisions related to taxation of wealth

- How much income is generated from these environmental assets?

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Why value environmental assets?

- How much is spent on maintaining and improving environmental assets?
- Asset accounts are needed to support measures of resource depletion in physical and monetary terms
  - Compare value of depletion with various other measures…

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Measuring environmental assets

- Physical asset accounts are usually compiled for specific types of assets
  - Because different units are usually used for different assets
- Reference dates of the asset account
  - t -> t+1
- Asset Account measures:
  - Stock level (opening and closing)
  - Additions to stock
  - Reductions in stock

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Measuring environmental assets

Table 5.3.1 General structure of the physical asset 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	Removal	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

na – not applicable

* - An asterisk indicates that this entry is not usually significant for the resource or it is typically not separately identified in the source data. In practice, not all cells that show the possibility of an entry here should be shown separately in published accounts for each type of resource.

SEEA Table 5.3.1

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Valuation of environmental assets

Both the SNA and SEEA recommend asset valuation based on market prices

- But these values are often not available, especially for environmental assets
- In particular, the following conditions may apply to environmental assets –
  - Never sold, or rarely sold;
  - Leased instead of sold;
  - have long production 'lead' times; or
  - sale price is unrepresentative of value of similar assets.

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Valuation of environmental assets

Both the SNA and SEEA recommend asset valuation based on market prices

- But where market prices are unavailable, or inappropriate;

- SNA and SEEA suggest a range of techniques to approximate *in situ* market values for environmental assets, including…

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Valuation methods

- Net present value (NPV) approach: resource rent derived using 'residual value method'
  - The discounted value of expected future economic benefits from the asset
- Rights-based valuation
  - On the basis of tradable rights to own or use the environmental asset e.g. fishing rights
- Appropriation method
  - Sum of taxes, levies, royalties collected by government
- Others....

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Valuation methods

- Remainder of session discusses valuation methods for environmental assets, using specific examples:
  - NPV of expected resource rents (residual value method) – mineral energy assets (Australia)
  - Rights – fish resources (New Zealand)
  - Market value – land (Australia)

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Net Present Value (NPV): key elements of the calculation

1. Measurement of returns on environmental assets – resource rent
2. Expected pattern of future benefits
3. Asset life of the resource
4. Rate of return on produced assets
5. Choice of discount rate

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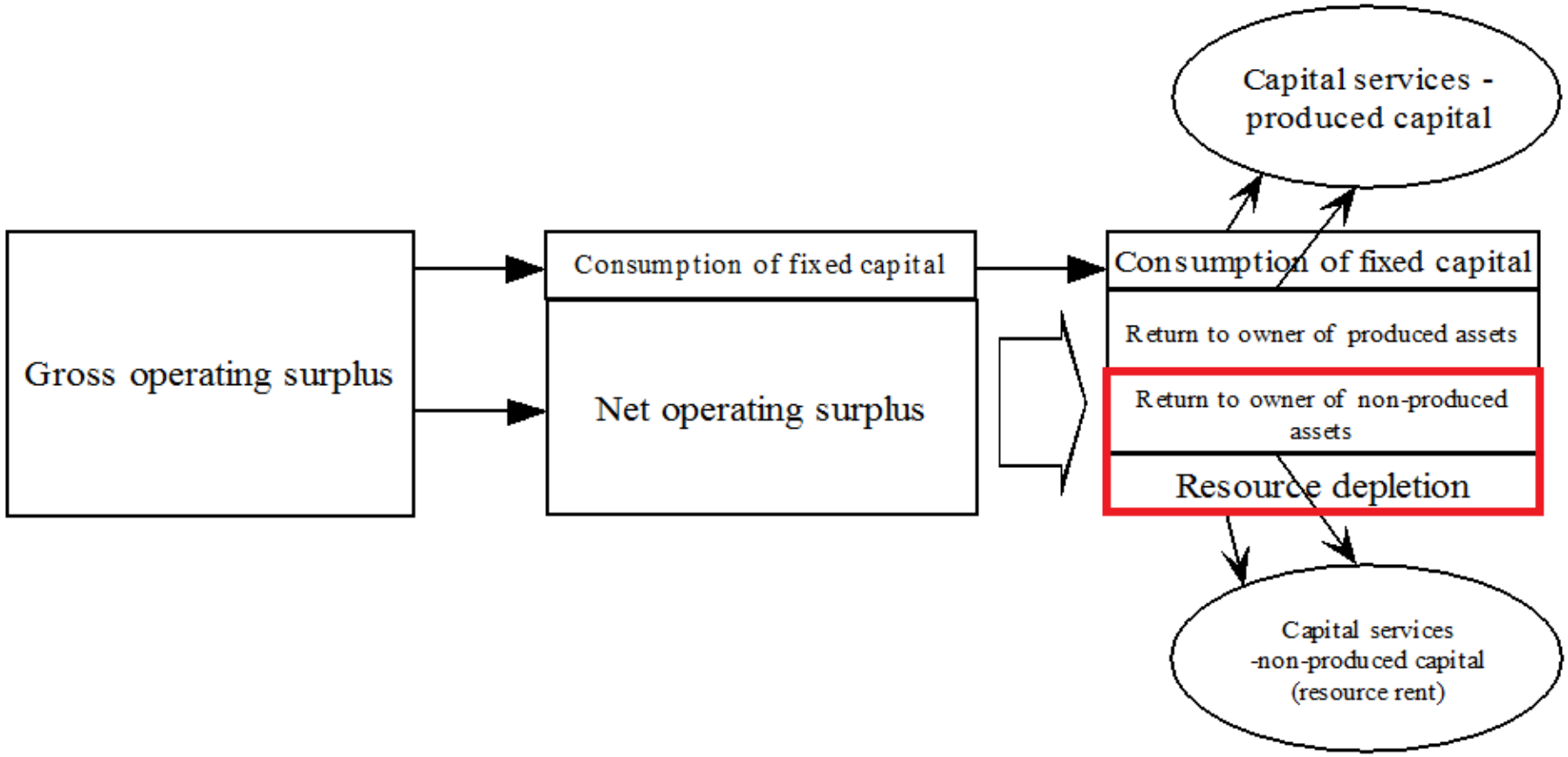
NPV of future returns

- Resource rent is the benefit expected from holding and using mineral resources
- Resource rent is a *derived* residual…



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2. **Net Present Value (NPV)**: expected pattern of future benefits

- Asset value derives from <u>expected</u> benefits (not past or current returns)
- But difficult to know future prices, extraction rates, extraction costs etc.
- Therefore, unless better information available, assume past / current extraction rates and resource rents will continue
  - Using a moving average of resource rent will reduce volatility of estimates
  - 'Abnormal' results require the re-estimation of NPV model

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3. **Expected Life** of the environmental asset

- Estimates of the asset life must be based on the available physical stock and on assumed rates of extraction
  - For renewable resources, also need to consider expected growth
- In practice, where asset lives are over 20 years NPV estimates are stable for this factor.

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4. **Rate of Return** on produced assets

- An expected rate of return on produced capital is needed to split Gross Operating Surplus (GOS) into:
  - A return to produced capital; and
  - Resource rent (residual)
- Rate of return should reflect the return/risk specific to the activity being undertaken
  - In many cases, there is a lack of suitable data
  - Realistically, use an economy-wide rate of return based on say government bond rates

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5. Choice of **Discount Rate** for stream of resource rents

- Discount rate needed to convert stream of resource rents into an estimate of asset value
- Rate expresses asset owner's time preference, and their attitude to risk
- Rate can be seen as the expected rate of return on the non-produced assets
- SEEA recommends a market-based discount rate equal to the assumed rate of return on produced assets

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Which mineral and energy asset classification should be used?

- United Nations Framework Classification for Fossil Energy and Mineral Reserves 2009 (UNFC-2009)
  - Other classifications exist
- UNFC-2009 categories:
  - Class A Commercially recoverable resources
  - Class B Potentially commercially recoverable resources
  - Class C Non-commercial and other known deposits

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Which mineral and energy assets should we value?

- Variability in price, extraction costs and technology mean that, over time, considerable scope for resources to move between Classes A, B and C
  - Justifies the use of a moving average in calculating NPV asset values
- SEEA framework: physical estimates of mineral and energy resources should indicate which resources have a corresponding monetary estimate

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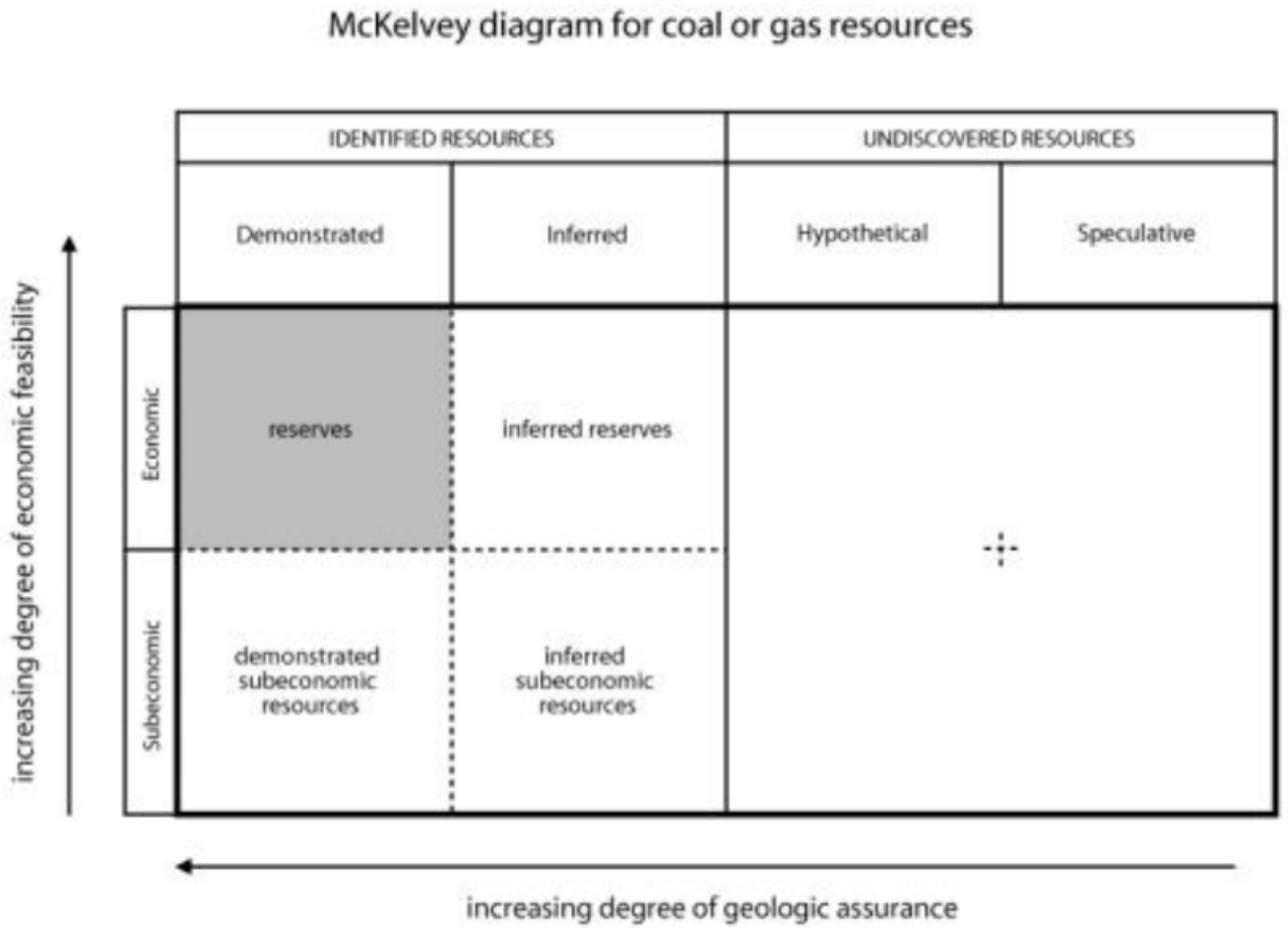
The ABS uses the McKelvey Box



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NPV: Valuing mineral and energy assets

- Australian SNA uses the NPV approach

$$V_t = \sum_{t=1}^{n} \frac{RR_t}{(1+r)^n}$$

- V = net present value, RR = resource rent, r = discount rate, n = asset life

- Asset life = Economically Demonstrated Reserve (EDR) at year end divided by the five year moving average of production.
- discount rate used is the "large business borrowing rate", as published by the Australian Central Bank. This rate represents the opportunity cost of the funds mining companies' invest in extraction.

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NPV: Valuing mineral and energy assets

- The share of gross operating surplus from mineral and energy assets exploited (i.e. resource rent).
- Resource rent (RR) = (p - c) * Q

  p = average price received per unit,

  c = average cost per unit (including a normal return to produced capital)

  Q = quantity extracted

  - costs per unit provided by a mining industry analyst
  - prices per unit from publicly available information sources such as ABARE, London Metal Exchange, and London Bullion Market Association.

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NPV: Valuing mineral and energy assets

- Example: valuing Crude Oil resource

- Price (P) = $1,000 per kilolitre
- Cost (C)of production $500 per kilolitre
- Production (Q) 10 megalitres per year
- Net income per year = [(p-c)*q]
  = [(1 - 0.5)*10,000,000] = $5m

- Mine life = 5 years

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NPV: Valuing mineral and energy assets

- Rate of discount = 7.5%
- Resource will yield net income of $5m per year for the next 5 years or $25m. However, expressed in current dollars $25m is equal to:

$$\sum_{t=0} \frac{\$25m}{(1+0.075)^n}$$

$$= \left(\frac{5}{1.075^1} + \frac{5}{1.075^2} + \frac{5}{1.075^3} + \frac{5}{1.075^4} + \frac{5}{1.075^5} \right)$$

$$= 4.65 + 4.32 + 4.02 + 3.75 + 3.48$$

= $20.2m

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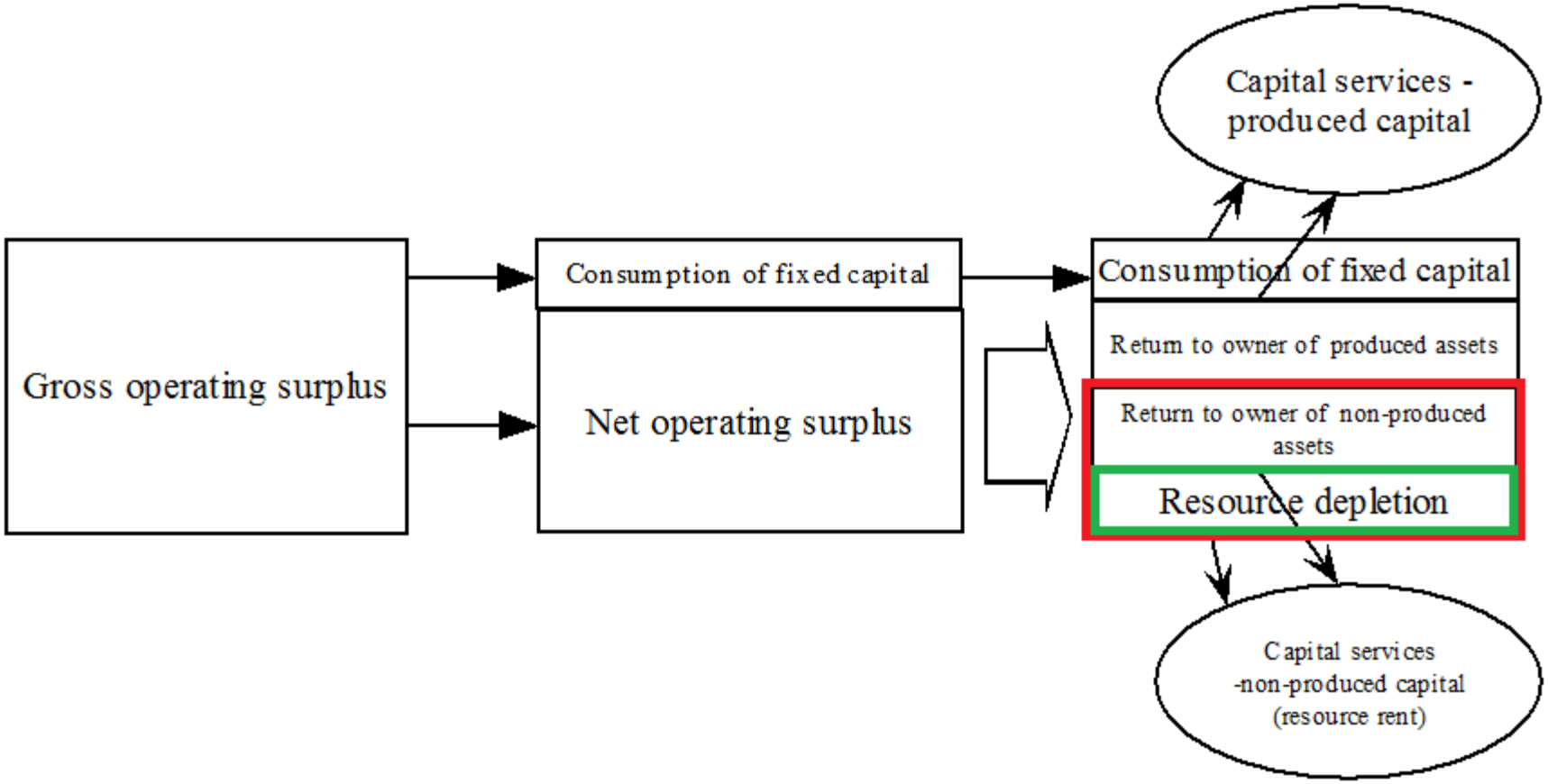
Valuing depletion

- **Depletion** in any one year is the change in the value of the asset between the beginning and end of the year arising purely from the extraction of minerals.



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Adjusting national accounting aggregates for depletion of environmental assets

		2007-08 $million	2008-09 $million	2009-10 $million	2010-11 $million
	GDP	1,175,949	1,252,218	1,293,380	1,401,168
less	Consumption of fixed capital	184,124	198,489	207,042	217,294
equals	**NDP**	991,825	1,053,729	1,086,338	1,183,874
less	Depletion of subsoil assets	5,358	5,414	5,065	5,302
equals	**Depletion adjusted NDP**	986,467	1,048,315	1,081,273	1,178,572

- Source: ABS *Year Book Australia, 2012*. Cat. no. 1301.0

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Workshop exercise

- Net Present Valuation (NPV) and environmentally adjusted GDP

- **See handouts for exercises…**

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Part 1 – deriving inputs to the NPV model SOLUTIONS

Output (sales) of mineral resources during the year	$58 million
Intermediate consumption of mining operations during the year	$22 million
Compensation of employees	$8 million
A. Gross operating surplus from mining during the year	$28 million
Value of produced capital (machinery & equipment) EOY used in mining	$50 million
Return on produced capital used in mining (excluding a return to replace fixed capital)	8%
Net operating surplus (mining) related to produced capital	$4 million
Consumption of fixed capital (produced capital) mining	$4 million
B. Gross operating surplus (mining) related to produced capital	$8 million
C. Resource Rent from mining activity during the year = A. - B.	$20 million
Return on natural resources used in mining (excl. return to replace fixed capital)	5%
D. NPV of natural resource (mineral resource) **PART 2 BELOW**	$86.6 million
E. Income component of Resource Rent = D * 5%	$4.3 million
F. Depletion component of Resource Rent = C. - E.	$15.7 million

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Part 2 - Applying the Net Present Value (NPV) model SOLUTIONS

	Year 1	Year 2	Year 3	Year 4	Year 5	
Expected Resource Rent	20	20	20	20	20	
Discount rate 5%	r^1	r^2	r^3	r^4	r^5	
Discount	1.05^1	1.05^2	1.05^3	1.05^4	1.05^5	
RR / $(1 + r)^n$ = depletion	19.0	18.1	17.3	16.5	15.7	
Sum of expected resource rents (discounted) = NPV of mineral resource						$86.6 mill

Questions and answers:

What is the value of the mineral resource at the end of year 1?

= opening value – value of depletion in first year

= $86.6 million - $15.7 million = $70.9 million

What is the value of depletion in the first year of mining activity?

= $15.7 million (it appears as 'Year 5' in the NPV calculations because it is the depletion component of the expected resource rent 5 years before the resource is exhausted)

Resource rent is expected to be $20 million in each year until the mine is empty. But what do you notice about the income and depletion proportions of resource rent as we approach the end of the mine life?

As the resource approaches the end of its life, the 'income' proportion of the expected resource rent declines and the depletion proportion increases. This is a function of our NPV method of estimating resource value and related depletion.

Note: The estimated value of the asset at the start of its life equals the sum of expected depletion amounts over the life of the mine.

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Part 3 - Environmentally-adjusted NDP and industry value added SOLUTIONS

National Accounts of Mineland

For the whole economy	
Gross Domestic Product (GDP)	$117 million
Consumption of fixed capital	$19 million
Net Domestic Product (NDP)	$98 million
Less depletion of mineral resources	$15.7 million
Net Domestic Product - environmentally-adjusted (NDPea)	$82.3 million

For the mining industry	
Industry Gross Value Added (mining)	$28 million
Consumption of fixed capital (mining)	$4 million
Industry Net Value Added (mining)	$24 million
Less depletion of mineral resources	$15.7 million
Net Domestic Product - environmentally-adjusted (NDPea)	$8.3 million

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Tradable rights: Fish resources

New Zealand operates a quota system for commercial fishing

Annual tonnage of fish catch allowed is determined by the government and registered fishers are allocated shares (i.e. a quota) of this total tonnage

Commercial fishers cannot exceed their allocated quota of fish

Fishers may trade their quota (i.e. right to fish) to others at prevailing market prices

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Depletion of natural biological resources

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- Where extraction is less than the sustainable yield, no depletion is recorded

Figure 5.4.1, source: SEEA Central Framework 2012

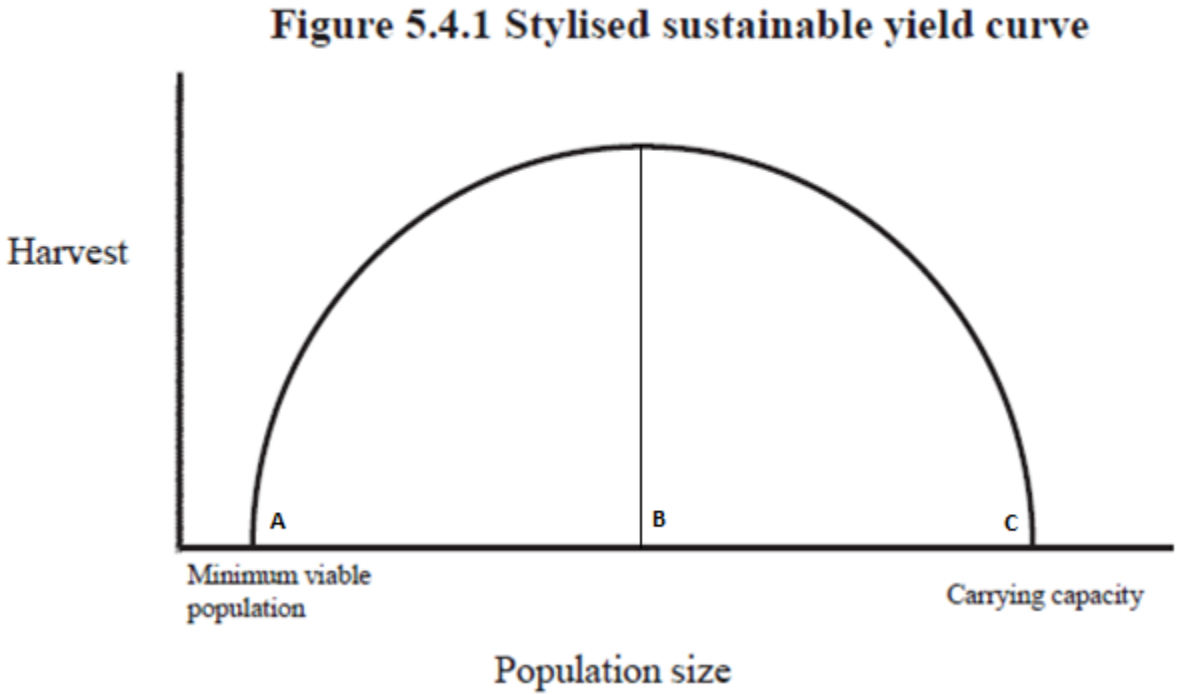

Figure 5.4.1, source: SEEA Central Framework 2012

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Tradable rights: Fish resources

Since these quotas are a *permanent* right to fish, the sum value of all tradable quotas represents the value of the commercial fish resource

-i.e. no need to apply a discount to this value

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Tradable rights: other resources

Tradable rights apply also to water resources in Australia

- The use of other environmental assets are also governed by tradable rights

- Depending on the operation of the scheme, these tradable rights may support valuation of the underlying environmental asset

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Market values

- Market valuation is used to derive values for Land assets in Australia
- Market valuation is not necessarily easy!

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Valuing residential land

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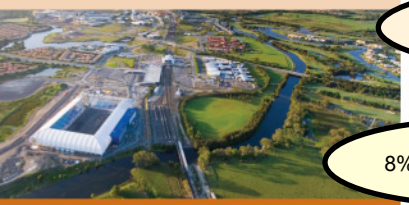

ABS Census of Population and Households

Contractor (Australian Property Monitors)

Elemental sales data

Valuers-General

RBA

Dwelling count

Mean sales data

Residental land and dwelling stock ($)

8% to Other sectors

92% to Household sector (published by RBA)

ABS

Minus ABS estimate of household capital stock of dwellings

Household residental land ($)

Scaled back up to 100%

Residental land + dwelling stock ($) for all sectors

minus ABS estimate of capital stock of dwellings for all sectors

Total residential land ($)

Minus Household Residential land

Residual assigned to NFC and GG *

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* NFC and GG split using data from the Valuers-General and Public Finance

Estimating land, Australia, 2006-07
($ billion, current prices)

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		Dwellings	Land & dwellings combined	Land by type of use			
				Residential	Commercial	Rural	Other
Land by institutional sectors	Households	1210.6	3316	2105.4	51.6	227.2	0.0
	Non-financial corps.	49.9	269.9	220	175.4	19.8	0.0
	Financial corps.	0.0	0.0	0.0	30.9	0.0	0.0
	General government	4.6	18.4	13.8	0.0	0.0	171.8
	All sectors	1265.1	3604.3	2339.2	257.9	247	171.8

Source: ABS National Accounts balance sheet compilation data

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Value of Australia's environmental assets?

ABS National Balance Sheet (Australian System of National Accounts):

Australia's Total Assets, Current Prices as at 30 June ($ billion)

Asset Type	1992	2002	2012
Building & structures	991.5	1672.4	3473.1
Machinery & equipment	240.8	346.2	588.0
Other non-financial produced assets	193.8	347.3	616.4
Environmental assets	749.4	1875.7	4557.9
Other non-financial non-produced assets	0.0	8.3	11.5
Financial assets	127.0	524.5	1241.1
TOTAL ASSETS	2302.5	4774.4	10488.0
Environmental assets (% of total)	32.5%	39.3%	43.5%

SOURCE: adapted from Table 10 *National Balance Sheet* — Volume | Real and Current Prices (electronic), in ABS Cat.No.5204.0 *Australian System of National Accounts*, 2011-12

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Value of Australia's environmental assets?

ABS National Balance Sheet (ASNA):

Australia's Environmental Assets, Current Prices as at 30 June ($ billion)

Asset Type	1992	2002	2012
Produced assets			
Plantation standing timber	4.5	7.0	9.2
Non-produced assets			
Land	683.9	1703.3	3684.1
Subsoil assets	59.6	163.4	862.7
Native standing timber	1.4	2.0	1.9
ENVIRONMENTAL ASSETS	749.4	1875.7	4557.9

SOURCE: adapted from Table 10 *National Balance Sheet* — Volume | Real and Current Prices (electronic), in ABS Cat.No.5204.0 *Australian System of National Accounts*, 2011-12.

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