



Services Generation Account

(Levels 0, 1 and 2)

Project: Advancing the SEEA
Experimental Ecosystem Accounting



Convention on
Biological Diversity





Overview: Services Generation

1. Learning objectives

2. Review of Level 0 (5m)

- What is it?
- Why do we need it?
- What does it look like?
- Expertise & data required
- Links to related training materials

3. Level 1 (Compilers)

- Concepts (15m)
- Group exercise & Discussion (30m)

4. Level 2 (Data providers)

- Data options, examples & issues (15m)
- Group exercise & Discussion (15m)

5. Closing Discussion (10m)





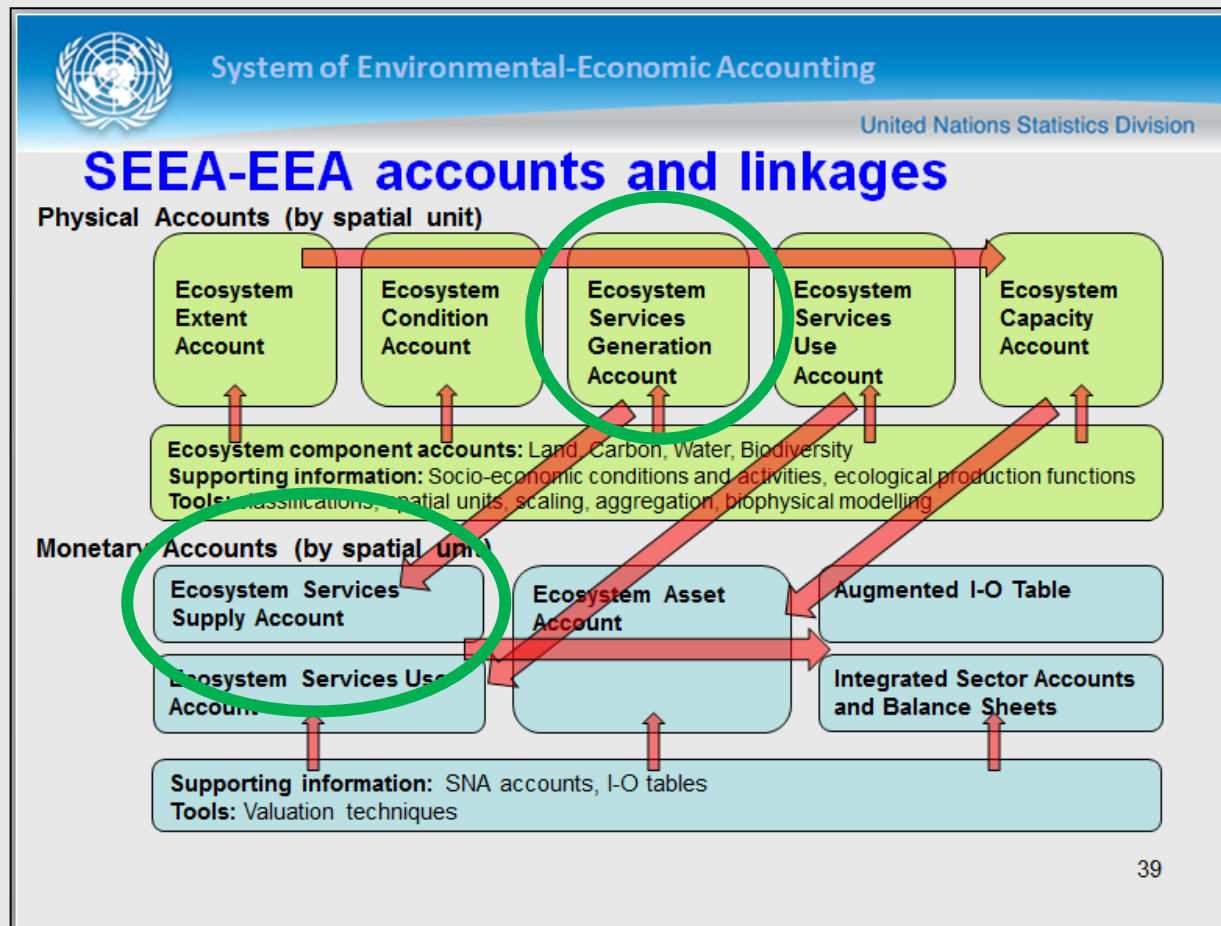
SEEA-EEA Training Levels 1 and 2

- **Learning objectives**

- Level 1: To understand:
 - Why accounting for Ecosystem Services is important
 - The basics of the “ecosystem services cascade” and the difference between its components
 - How Services Generation is treated in the SEEA, including basic concepts and the structure of the accounts that include services
 - How to start to build a Services Generation account
- Level 2
 - Understand the data options and sources
 - Be aware of how other countries have approached Ecosystem Services Generation



Account 6: Services Generation





Level 0: Account 6: Services Generation

- **What?**

- Physical and monetary flows of “final” ecosystem **services** from ecosystems to beneficiaries
- Directly used by (or affect) people

- **Why?**

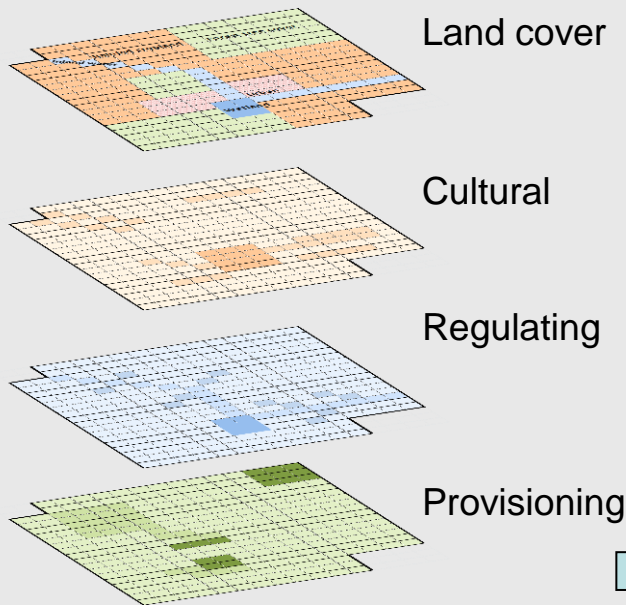
- Inform policies of contribution of ecosystems to human well-being
- Assess trade-offs between development and conservation
- Links to standard economic production measures in SNA
- Links to other SEEA-EEA accounts (**Condition, Supply and Use**) and tools (**Valuation**)
- Indicators:
 - Flows of individual services (physical and monetary) → change
 - Indices of aggregated services by ecosystem type → change



Level 0: Account 6: Services Generation

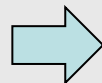
- What does a Services Generation Account look like?

Maps



Tables

Type of service	Ecosystem type			
	Urban and associated	Forest tree cover	Agricultural land	Open wetlands
Provisioning		e.g., tonnes of timber	e.g., tonnes of wheat	
Regulating	e.g., tonnes of CO ₂ stored / released	e.g., tonnes of CO ₂ stored / released	e.g., tonnes of CO ₂ stored / released	e.g., tonnes of P absorbed
Cultural	e.g., hectares of parkland	e.g., number of visitors / hikers		e.g., hectares of duck habitat



Lookup tables
Biophysical modelling



Level 0: Account 6: Services Generation

▪ Example (services in physical units)

Ecosystem service		Units	Land cover type								Provincial total
			Urban	Pasture	Cropland	Forest	Heath	Peat	Water	Other nature	
Provisioning	Hunting	kg meat	-	9,100	14,732	8,100	678	70		1,513	34,193
	Drinking water extraction	10 ³ m ³ water	4,071	7,026	11,227	3,117	214	-	478	862	26,995
	Crop production	10 ⁶ kg produce	-	-	1,868	-	-	-	-	-	1,868
	Fodder production	10 ⁶ kg dry matter		533	251						784
Regulation	Air quality regulation	10 ³ kg PM ₁₀	272	404	717	700	45	7	40	69	2,254
	Carbon sequestration	10 ⁶ kg carbon	875	8,019	273	50,664	393	149	-	1,056	61,429
Cultural	Recreational cycling	10 ³ trips	2,690	1,863	2,611	1,565	30	3	139	220	9,121

Source: Remme et al., 2014 (Limburg, the Netherlands)



Level 0: Account 6: Services Generation

- **What does a Services Generation Account look like?**
 - Spatially-detailed physical measures of “final” services according to common **classification**:
 - Provisioning
 - Regulating
 - Cultural
 - Physical measures (crops, flood control, clean drinking water, carbon sequestration, recreation, ...)
 - Monetary measures where appropriate and available
- **Ecosystem Services Supply Account**



Level 0: Account 6: Services Generation

- **What do you need to create a Services Generation Account?**
 - Ecosystem Extent Account, Ecosystem Condition Account
 - Common spatial infrastructure (**spatial units**)
 - Common **classification** of services
 - **Data:**
 - Field studies
 - Transfer from other locations (**benefits transfer, valuation**)
 - Economic production (agriculture, forestry, fisheries, water)
 - **Biophysical modelling**
 - **Expertise:** ecologists, geographers (GIS), economists, policy analysts, statisticians



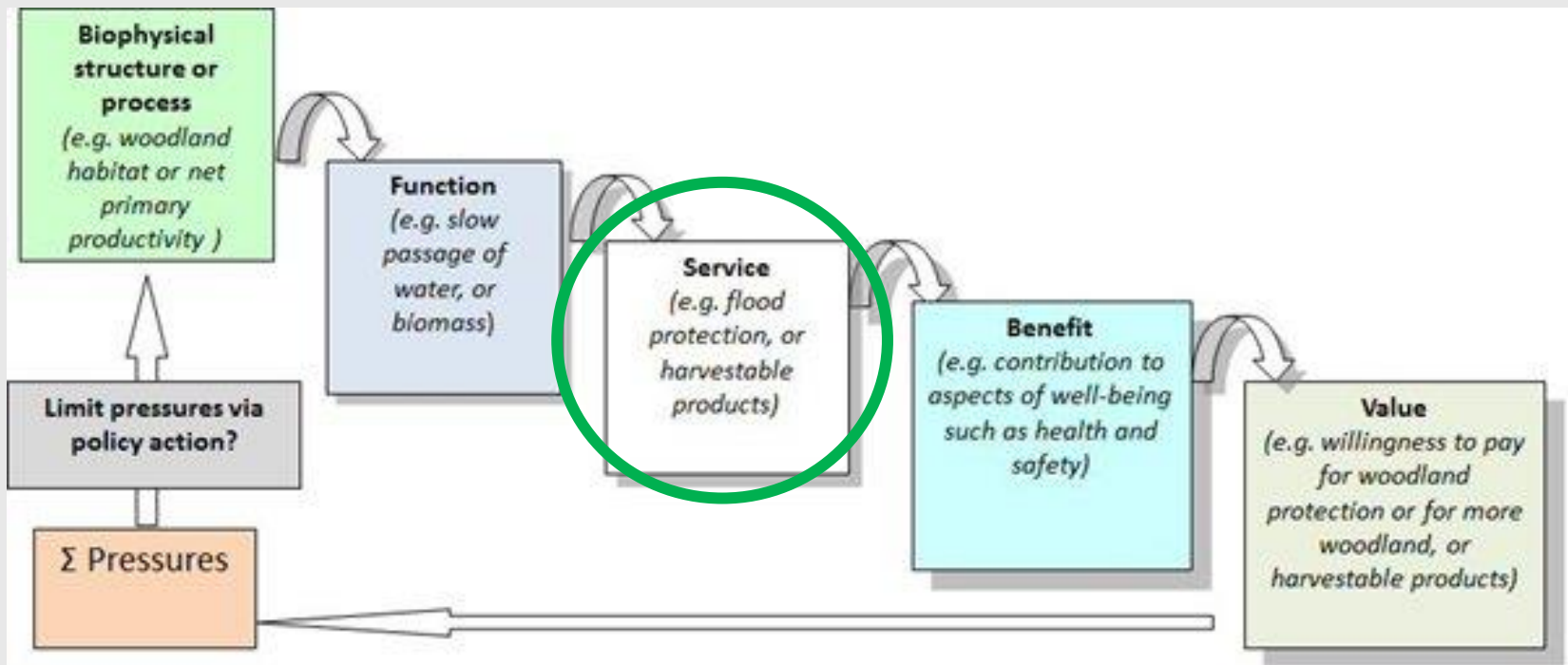
Level 1: Account 6: Services Generation

- **Why Services Generation Accounts?**
- Ecosystems provide services that are essential to the economy and human activities:
 - Food supply
 - Clean water
 - Flood protection
 - Carbon sequestration
 - Recreation, cultural and religious importance
- Ecosystems are being converted and degraded
 - Which ones are most important to conserve?
 - How can they best be managed to maintain services?
 - Link with national planning and accounting to ensure ecosystems are included in decisions



Level 1: Account 6: Services Generation

■ The Ecosystem Services Cascade

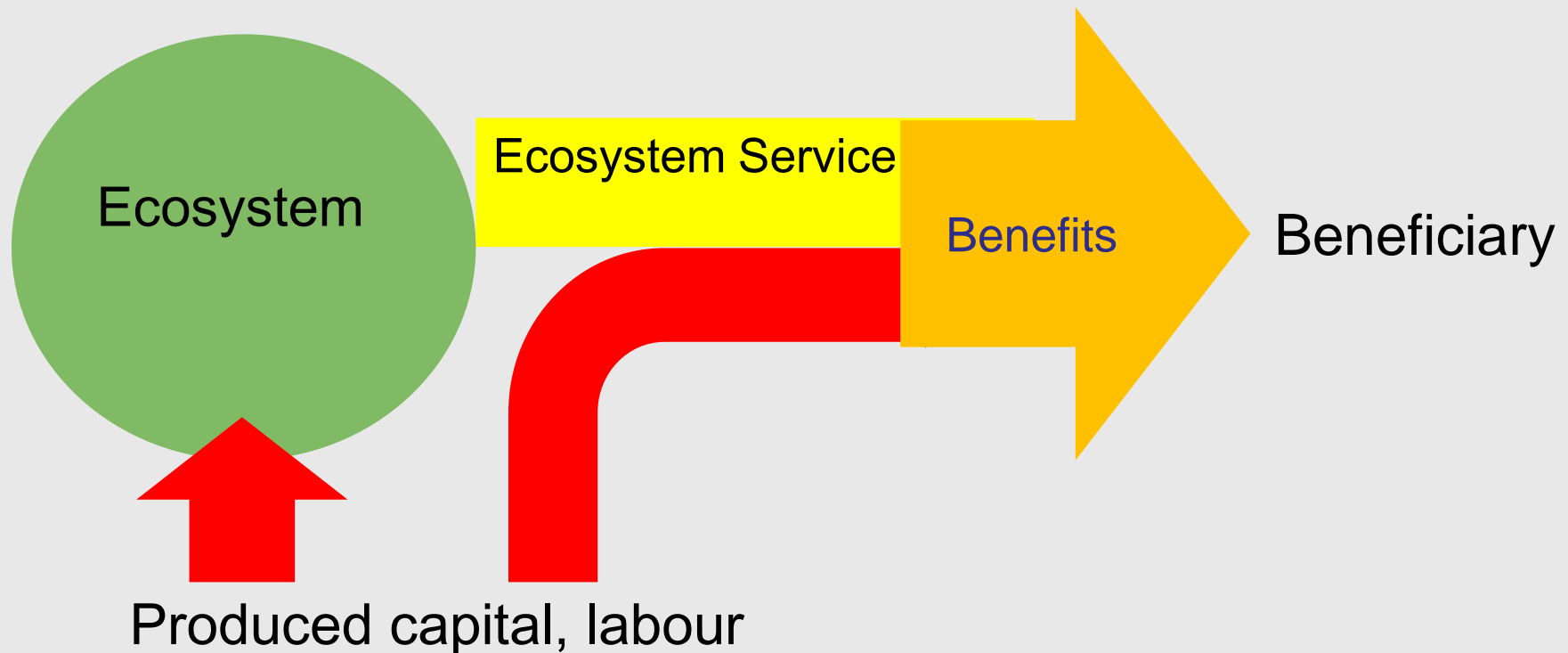


Source: Nottingham School of Geography

- **Services are the contribution of ecosystems to a benefit for people...**



Ecosystem services (versus benefit)



An ecosystem service is the contribution (by the ecosystem) to a benefit (for people)



Level 1: Account 6: Services Generation

- **Services are the contribution of ecosystem to the benefits for people...**
 - They are **not** the benefits; benefits require capital and labour to use
 - We need to calculate the contribution of ecosystems, for example:

Crops = $f(\text{nature, equipment, inputs, labour, energy...})$

To grow crops, nature provides biomass growth, nutrients, water, flood control, pollination...

Without these, there would be no crops. In the Services Generation Account, we measure the physical services (e.g., the crop).



Types of Ecosystem Services

Provisioning Services

= goods that can be harvested from, or extracted from ecosystems

Example: providing fish for fisheries, or providing wood for timber harvest

Regulating Services

= the regulation of climate, hydrological, ecological and soil processes

Example: pollination, carbon sequestration, flood control

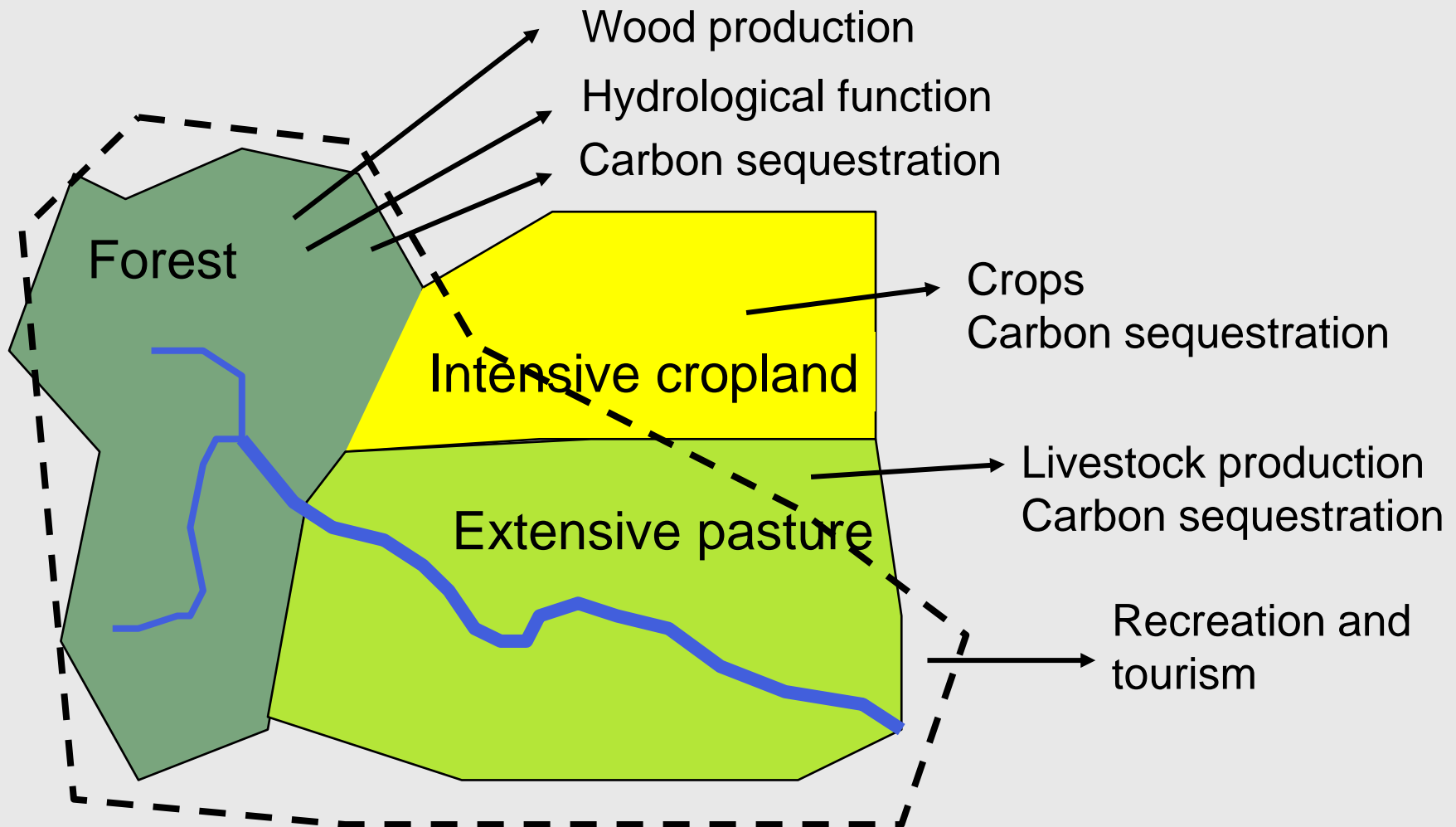
Cultural Services

= the non-material benefits provided by ecosystems

Example: recreation, tourism, providing a setting for cultural or religious practices



Ecosystem services and maps





Level 1: Account 6: Services Generation

- **The SEEA-EEA focuses on “final services”**
 - The point **before** human involvement transforms the services to benefits
 - e.g., biomass → harvesting; fish → capture...
 - Ecosystem processes and functions are **not** services
 - e.g., reproduction, predation, food web, nutrient cycle...
 - **Biodiversity** itself is not a “final” service
 - It is an aspect of **Ecosystem Condition** and is recorded in the **Biodiversity Account**.



Level 1: Account 6: Services Generation

- **Services**
 - Based on **Common International Classification of Ecosystem Services (CICES)**
 - Not mutually exclusive
 - A list of “final” services
 - More detail (4-digit)
 - Does **not** include “supporting services” (= ecosystem functions)

Section	Division	Group
01. Provisioning	01.01 Nutrition	01.01.01 Biomass
		01.01.02 Water
	01.02 Materials	01.02.01 Biomass
		01.02.02 Water
	01.03 Energy	01.03.01 Biomass-based energy sources
		01.03.02 Mechanical energy
02. Regulation & Maintenance	02.01 Mediation of waste, toxics and other nuisances	02.01.01 Mediation by biota
		02.01.02 Mediation by ecosystems
	02.02 Mediation of flows	02.02.01 Mass flows
		02.02.02 Liquid flows
		02.02.03 Gaseous / air flows
	02.03 Maintenance of physical, chemical, biological conditions	02.03.01 Lifecycle maintenance, habitat and gene pool protection
		02.03.02 Pest and disease control
		02.03.03 Soil formation and composition
		02.03.04 Water conditions
		02.03.05 Atmospheric composition and climate regulation
03. Cultural	03.01 Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	03.01.01 Physical and experiential interactions
		03.01.02 Intellectual and representative interactions
	03.02 Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	03.02.01 Spiritual and/or emblematic
		03.02.02 Other cultural outputs



Level 1: Account 6: Services Generation

- How?
 - Direct measure (e.g., socio-economic survey on recreational use, field survey of available fish...)
 - **Remember Level 0 – Biophysical modelling?**
 - **Lookup tables:** Take values from another location
 - **Statistical approaches:** Estimate based on known explanatory variables
 - **Geostatistical interpolation:** Estimate from nearby known locations
 - **Process-based modelling:** Use models of processes (e.g., land cover change, demand for services...)
 - The group exercise will use only **Lookup Tables...**



Level 1: Account 6: Services Generation

- Compilation Group Exercise (30m)
 - Situation:
 - **Know** total services for some LCEUs
 - **Need to** calculate:
 - Missing services for based on known data and lookup table
 - Objective (Groups of 3-5):
 1. Calculate missing services
 2. Calculate totals
 3. Report and discuss results



Level 1: Account 6: Services Generation

Group Exercise: Step 1 – Calculate unknown services

e.g., Crop for LCEU04 =
 $(18,700 / 500) * 281.3$

e.g., Carbon for LCEU04
 $= (500 * 20)$

Services Generation Database

LCEU	Extent (ha)	(C) Crop	(R) Recreation	(W) Water	(S) Carbon Sequestration	
		tonnes/year	trips/year	m ³ /year	tonnes /ha/year	tonnes /year
LCEU01 = Rainfed herbaceous cropland	500.0	18,700.0	500.0	600.0	20	
LCEU02 = Forest tree cover	262.5	0.0	1,500.0	500.0	30	
LCEU03 = Inland water bodies	68.8	0.0	1,600.0	15,000.0	5	
LCEU04 = Rainfed herbaceous cropland	281.3				20	
LCEU05 = Forest tree cover	75.0				30	
LCEU06 = Urban and associated developed	56.3	0.0	500.0	500.0	0	
LCEU07 = Urban and associated developed	68.8	0.0	700.0	400.0	0	
LCEU08 = Open wetlands	37.5	700.0	5,000.0	10,000.0	40	
LCEU09 = Inland water bodies	50.0				5	
LCEU10 = Forest tree cover	225.0				30	
LCEU11 = Rainfed herbaceous cropland	175.0				20	
Total	1,800.0					



Level 1: Account 6: Services Generation

- Is everyone clear on the objectives?
- 30 minutes group work
- Please ask questions!
- Results:
 - Each group report:
 - Totals for each service
 - Which LCEU generates the most of each service?
 - Were there any surprises?

Services Generation Database						
LCEU	Extent (ha)	(C) Crop	(R) Recreation	(W) Water	(S) Carbon Sequestration	
		tonnes/year	trips/year	m ³ /year	tonnes /ha/year	tonnes /year
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Total	1,800.0					



Level 2: Account 6: Services Generation

- Learning objectives (Level 2)
 - Understand the data options and sources
 - Be aware of how other countries have approached Services Generation Accounting



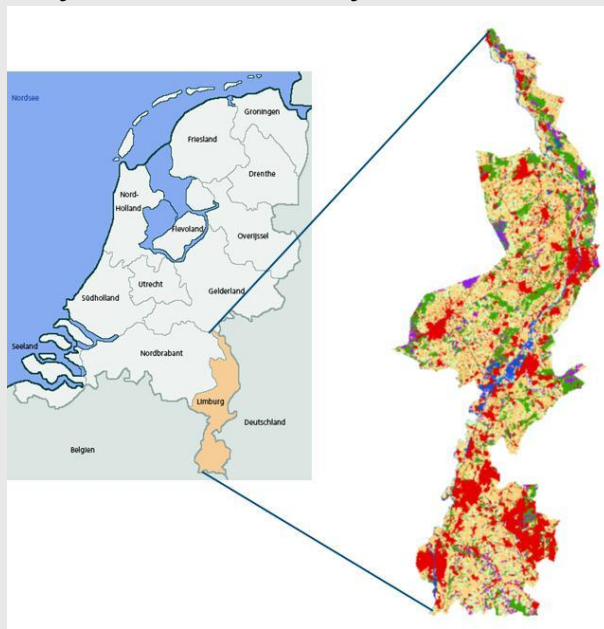
Level 2: Account 6: Services Generation

- A full Services Generation Account is more complex than the exercise:
 - More services (48 “final” services in CICES)
 - More types of data (tonnes, risks, visitors, air quality, cultural significance...)
 - Less measured data → need models to estimate
 - High variability among ecosystem types and region (e.g., salt marsh carbon = 650 to 1750 tCO₂/ha/year)
- **Do not** need to include all services:
 - High priority services → measure or estimate
 - Get started with available data



Ecosystem services in an account

- Ecosystem service account developed for Limburg Province, the Netherlands
- 2200 km², 1.1 million inhabitants
- Analysis of 7 ecosystem services



Source: Remme et al., 2014





Level 2: Account 6: Services Generation

▪ Example (services in physical units)

Ecosystem service		Units	Land cover type								Provincial total
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Cultural	Recreational cycling	10 ³ trips	2,690	1,863	2,611	1,565	30	3	139	220	9,121

Note: Units of measure are **very** different

Source: Remme et al., 2014 (Limburg, the Netherlands)



Level 2: Account 6: Services Generation

- Data options and sources
 - Field studies
 - Literature on similar sites or specific research
 - Transfer from other locations (**benefits transfer, valuation**)
 - Ecosystem valuation research databases (e.g., www.evri.ca)
 - Economic production (agriculture, forestry, fisheries, water)
 - Socio-economic statistics already available with spatial detail
 - **Biophysical modelling**
 - Know conditions, can estimate some services using production functions (e.g., hydrography → flood control)



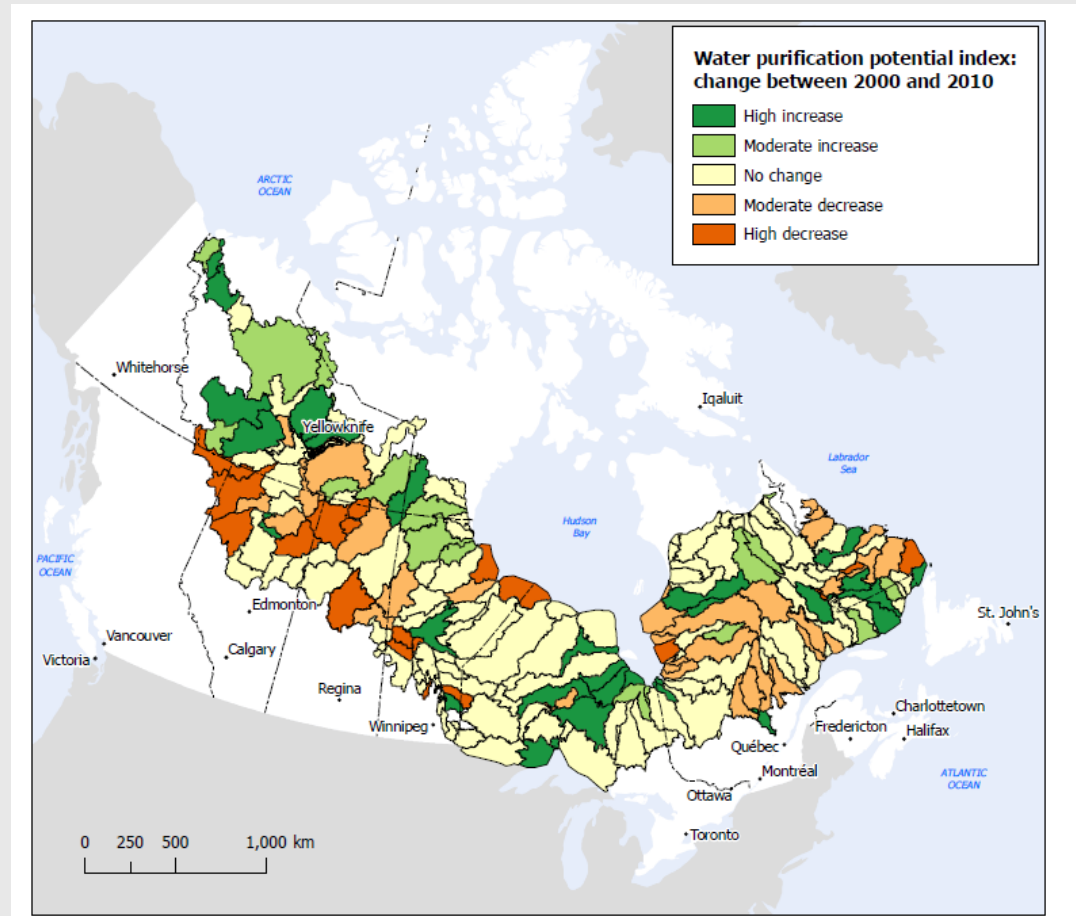
Level 2: Account 6: Services Generation

Canada Example:

Water purification potential and change by drainage area for boreal wetlands

Index based on:

- % forest cover
- % agricultural land
- % riparian forest
- % wetlands
- % anthropogenic disturbance
- % burn area
- Edge & linear density (fragmentation)
- Human footprint
- Slope
- Nitrogen & Sulphur exceedance (from atmospheric deposition)



Source: Statistics Canada, 2013



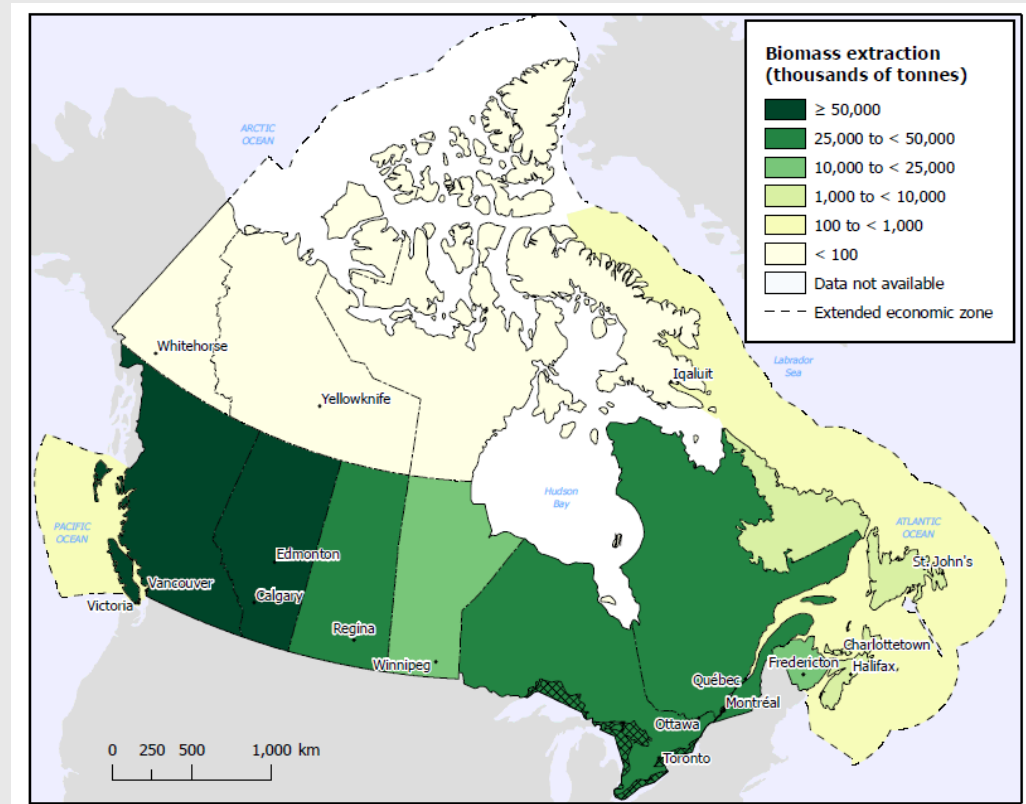
Level 2: Account 6: Services Generation

Canada example

Net biomass extraction for human use

Includes:

- Agricultural crops
- Livestock and poultry
- Milk
- Maple products and honey
- Forestry
- Fisheries (inland and marine)



Source: Statistics Canada, 2013



Level 2: Account 6: Services Generation

Canada example

Weight of commercial fish landings by marine statistical area

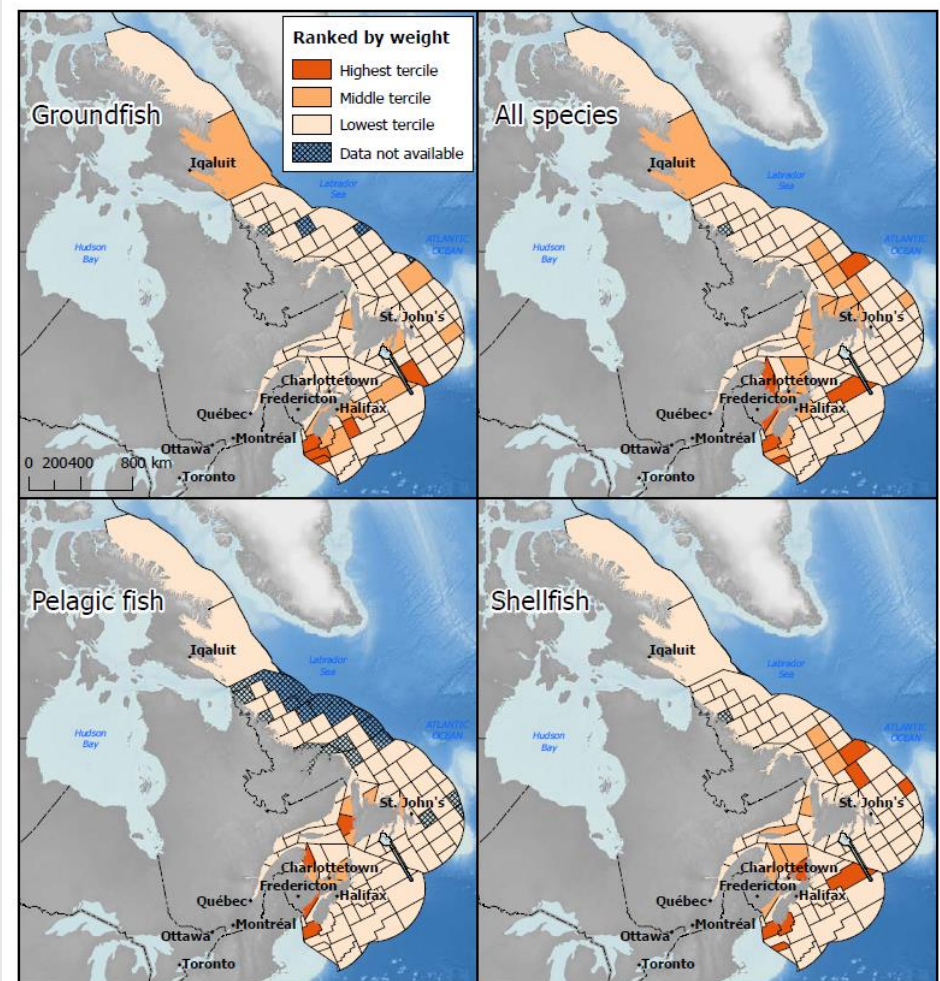
Includes:

- Groundfish
- Pelagic fish
- Shellfish

Also done for west coast

Statistical area defined by Ministry of Fisheries and Oceans

Source: Statistics Canada, 2013





Level 2: Account 6: Services Generation

■ Services flow data commonly available

Service	Flow measure
Provisioning services	
Timber services	timber increment
Crops	crop production
Livestock	livestock production
Water provision	annual freshwater supply
Regulating services	
Water quantity regulation	total amount of water stored
	total amounts of pollutants removed annually
Climate regulation	annual carbon fixation
Storm protection	total number of storms mitigated
Air quality regulation	total amount of pollutants removed via dry deposition on leaves
Erosion control	total amount of soil retained
Pollination	increased yield of crops due to pollination
Soil quality regulation	increased yield of crops attributable to soil quality
Cultural services	
Recreation	number of visitors

Source: (Maes, Paracchini et al. 2011)



Level 2: Account 6: Services Generation

- **Data sources: Socio-economic statistics**
 - Agricultural statistics: crop, livestock production
 - Energy statistics: biomass for fuel
 - Fisheries statistics: catch, stock
 - Forestry statistics: timber stock, harvest
 - Park surveys: visitors, use
 - Water statistics: withdrawals, consumption
 - Natural disasters: incidence of floods, erosion, storms
 - Soil inventories: erosion potential
 - Health statistics: regulation of biotic environment
- Are these spatially-detailed national data?
- Do we know the methods and classifications?



Level 2: Account 6: Services Generation

- **Data sources: Environmental statistics**
 - Iconic species & habitats
 - Land cover → carbon sequestration, air filtration
 - Hydrology & weather data: Flow rates, variability → flood risk
 - Topography, land cover, soil & weather data → erosion and landslide risk
 - Carbon storage and sequestration (see **Carbon Accounts**)
 - Remote sensing → primary production
- Are these spatially-detailed national data?
- Do we know the methods and classifications?



Level 2: Account 6: Services Generation

- **Data sources: Ecosystem valuation databases**
 - Based on codifying scientific studies
 - Include data for many countries, ecosystem type, physical services measures
 - Environmental Valuation Reference Inventory (www.evri.ca)
 - TEEB Ecosystem Service Valuation Database ([ESVD](#))
 - Gulf of Mexico Ecosystem Services Valuation Database (www.gecoserv.org)
 - Need to understand location, definitions and methods used



Level 2: Account 6: Services Generation

- **Data sources: Specific studies & models**
 - These may not be included in databases
 - Specific studies:
 - National or regional ecosystem assessments (Millennium Ecosystem Assessment, UK National Ecosystem Assessment)
 - Small-area studies (e.g., one park, one region)
 - TEEB studies and country studies (multiple ecosystems and services)
 - Decision-support models
 - There are landscape-scale and site-scale models that can help estimate service flows (AIRES, InVEST, LUCI...)
 - See **Biophysical Modelling**



Level 2: Account 6: Services Generation

- **Data sources: Special surveys and case studies**
 - High-priority data gaps may also be addressed by collecting new data
 - Ecological field studies to determine “production functions”
 - Socio-economic surveys to determine use of services (e.g., water, food, recreation)
 - Case-studies for specific locations or social groups (e.g., dependence on nature of low-income residents)
 - Possible to add questions to existing surveys, for example,
 - Households use of water, source of food, incidence of hazards (flooding, erosion, drought, disease), source of biomass for fuel



Level 2: Account 6: Services Generation

- Group exercise (15m) (Groups of 3-5)
 1. In your country, what are three important **ecosystem services** that should be included in a Services Generation Account?
 2. Which land cover types generate them?
 3. What **national data** are available in your country on the generation of these services?
 4. Report your results



Level 2: Account 6: Services Generation

- Concepts Group exercise (15m)
- Group reports
 - The **ecosystem services** you selected
 - The main land cover types for each
 - Are **national data** available in your country on the generation of these services?
- Discussion
 - What other ecosystem services would be important to measure?
 - On what topic might a special survey be used to fill priority data gaps?



Level 2: Account 6: Services Generation

- Discussion and questions
- Take home points
 - Services Generation in biophysical terms is one of the most important aspects of Ecosystem Accounting
 - Data on Services Generation are available from many sources
 - There are some simple methods available to start to integrate these data
 - Start by focussing on available data and priority services



Level 2: Account 4: Carbon

- Further Information
 - SEEA Experimental Ecosystem Accounting (2012)
 - SEEA-EEA Technical Guidance (forthcoming)
 - Detailed supporting documents
 - “Linking Flow and Asset Accounts” and
 - “Biophysical Modelling” by Lars Hein



References

- CICES, 2013. www.cices.eu
- European Commission, Organisation for Economic Co-operation and Development, United Nations and World Bank 2013, *SEEA Experimental Ecosystem Accounting*, http://unstats.un.org/unsd/envaccounting/seeaRev/eea_final_en.pdf
- Maes, J., Paracchini, M.L. and Zulian, G., 2011. A European assessment of the provision of ecosystem services: Towards an atlas of ecosystem services. Luxembourg: European Commission Joint Research Centre-Institute for Environment and Sustainability.
- Malouin, C., Doyle, M. and Liss, K., 2013. Toward an Ecosystem Potential Index for Canada (EPIC): A Boreal Case Study. ResearchGate.net, .
- Nottingham School of Geography, nd, Nature's services in decision making. <http://www.nottingham.ac.uk/geography/research/research-that-makes-a-difference/natures-services-and-decision-making.aspx>
- Remme, Roy P., Matthias Schröter, and Lars Hein. Developing spatial biophysical accounting for multiple ecosystem services. *Ecosystem Services* 10 (2014): 6-18.
- Statistics Canada, 2013. Human Activity and the Environment: Measuring Ecosystem Goods and Services 2013. 16-201-XWE. Ottawa: Government of Canada.



Evaluation of the training module

- Please complete the evaluation form for this module
- For this module
 - What did you learn that you could apply in your work?
 - Was the presentation clear and informative?
 - Was it too simple? Too complex?
 - Was there anything you did not understand?
 - What additions or deletions would you suggest (recognizing that the unit is intended for a general audience)?
 - Do you have any suggestions as to how the SEEA-EEA may be improved (concepts, principles) in this area?



Acknowledgements

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