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Introduction to Forest Accounting

National Workshop on Shared Environmental Information Systems (SEIS) and Environmental Statistics for the Sustainable Development Goals (SDGs)

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FORESTS

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Agenda

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1. Some general words
2. Asset accounts for land (land use and land cover)
3. Forest Accounts
4. Timber Account
5. Exercise
6. Flow accounts and ecosystem accounts

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1 Some general words

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Why forest accounts?

Some good reasons

- Comprehensive view (all forests, all timber etc.)
- SEEA uses same classifications as SNA → link to economic statistics
- Consistent units of measure (hectares, tons, etc.) and consistent valuation methods
- Identification of inconsistencies in the data (coverage, errors, concepts)

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Different sources

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TABLE 2: Coverage of accounting frameworks with respect to forests

Framework	Type of forest information								
	Flow of forest products		Timber resources		Economic activity connected to forestry	Forest-land	Forest condition	Forest ecosystem services	
	Physical	Monetary	Physical	Monetary				Physical	Monetary
SNA		✓		✓	✓				
SEEA CF			✓	✓	✓	✓			
SEEA AFF	✓	✓	✓	✓	✓	✓			
SEEA EEA						✓	✓	✓	✓

SNA = System of National Accounts: records economic production, investment and wealth
SEEA-CF = System of Environmental-Economic Accounting: records assets and flows
SEEA-AFF = Agriculture, Forestry and Fisheries: Industry focus on assets and flows
SEEA-EEA = Experimental Ecosystem Accounting: records contribution of ecosystems

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SEEA Central Framework

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SEEA-CF

1. **5.6.3 Physical asset accounts for land**
   - **Table 5.13** Land Cover: Tree-covered area (hectares)
   - Land Use: Land used for forestry (also other uses) (hectares)
2. **5.6.4 Physical asset account for forest and other wooded land**
   - **Table 5.15** Physical asset account for forest and other wooded land (hectares)
   - **Table 5.16** Monetary asset account for land (currency units)
3. **5.8 Asset accounts for timber resources**
   - **Table 5.19** Physical asset account for timber (cubic meters)
   - **Table 5.20** Monetary asset account for timber (currency units)

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2 Asset accounts for land (land use and land cover)

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Land as an asset

"Land is a unique environmental asset that delineates the space in which economic activities and environmental processes take place and within which environmental assets and economic assets are located."

SEEA Central Framework

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Why, what and how?

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Physical asset accounts for land

- **Objective**: describe the area of land and changes in the area of land over an accounting period
- Measurement units: **hectares and square meters**
- Different types of physical asset accounts for land:

(by industry or institutional sector)

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Land use?

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Land use

- Reflects both:
  - **undertaken activities**
  - the **institutional arrangements** put in place for a given area for the purposes of economic production, or the maintenance and restoration of environmental functions
- Includes **both**:
  - Land in use
  - Land not in use
- Multiple uses? → **principle of primary or dominant use** should be employed

Table 5.11
Land use classification

1	**Land**
1.1	Agriculture
1.2	Forestry
1.3	Land used for aquaculture
1.4	Use of built-up and related areas
1.5	Land used for maintenance and restoration of environmental functions
1.6	Other uses of land n.e.c.
1.7	Land not in use
2	**Inland waters**
2.1	Inland waters used for aquaculture or holding facilities
2.2	Inland waters used for maintenance and restoration of environmental functions
2.3	Other uses of inland waters n.e.c.
2.4	Inland waters not in use

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Land cover?

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Land cover

- Refers to the observed **physical and biological cover** of the Earth's surface
- Includes **natural vegetation and abiotic** (non-living) **surfaces**
- Includes only land and inland waters, excludes coastal waters
- Uses the Land Cover Classification System (LCCS) developed by FAO

Table 5.12
Land cover classification

	Category
1	Artificial surfaces (including urban and associated areas)
2	Herbaceous crops
3	Woody crops
4	Multiple or layered crops
5	Grassland
6	Tree-covered areas
7	Mangroves
8	Shrub-covered areas
9	Shrubs and/or herbaceous vegetation, aquatic or regularly flooded
10	Sparsely natural vegetated areas
11	Terrestrial barren land
12	Permanent snow and glaciers
13	Inland water bodies
14	Coastal water bodies and intertidal areas

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Changes in stock for land cover?

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Possible changes to stock in the land cover account

Managed expansion	Increase in the area of a land cover type due to human activity
Natural expansion	Increase in area resulting from natural processes
Managed regression	Decrease in the area of a land cover type due to human activity.
Natural regression	Decrease in area resulting from natural processes
Reappraisals (upward or downward)	Changes due to the use of updated information that permits a reassessment of the size of the area of different land covers

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What does it look like?

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Table 5.13
Physical account for land cover *(hectares)*

	Artificial surfaces	Crops	Grassland	Tree-covered area	Mangroves	Shrub-covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	Coastal water and inter-tidal areas
Opening stock of resources	12 292.5	445 431.0	106 180.5	338 514.0	214.5	66 475.5	73.5	1 966.5		12 949.5	19 351.5
Additions to stock											
Managed expansion	183.0	9 357.0									
Natural expansion			64.5								1.5
Upward reappraisals			4.5								
Total additions to stock	183.0	9 357.0	69.0								1.5
Reductions in stock											
Managed regression		147.0	4 704.0	3 118.5	9.0	1 560.0	1.5				
Natural regression					1.5	64.5					
Downward reappraisals						4.5					
Total reductions in stock		147.0	4 704.0	3 118.5	10.5	1 629.0	1.5				
Closing stock	12 475.5	454 641.0	101 545.5	335 395.5	204.0	64 846.5	72.0	1 966.5		12 949.5	19 353.0

Note: Crops include herbaceous crops, woody crops, and multiple or layered crops.

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Tree-covered area?

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05 Grassland

This class includes any geographical area dominated by natural herbaceous plants (grasslands, prairies, steppes and savannahs) with a cover of 10 per cent or more, irrespective of different human and/or animal activities, such as grazing or selective fire management. Woody plants (trees and/or shrubs) can be present, assuming their cover is less that 10 per cent.

06 Tree-covered areas

This class includes any geographical area dominated by natural tree plants with a cover of 10 per cent or more. Other types of plants (shrubs and/or herbs) can be present, even with a density higher than that of trees. Areas planted with trees for afforestation purposes and forest plantations are included in this class. This class includes areas seasonally or permanently flooded with freshwater. It excludes coastal mangroves (→07).

07 Mangroves

This class includes any geographical area dominated by woody vegetation (trees and/or shrubs) with a cover of 10 per cent or more that is permanently or regularly flooded by salt and/or brackish water located in the coastal areas or in the deltas of rivers.

08 Shrub-covered areas

This class includes any geographical area dominated by natural shrubs having a cover of 10 per cent or more. Trees can be present in scattered form if their cover is less than 10 per cent. Herbaceous plants can also be present at any density. The class includes shrub-covered areas permanently or regularly flooded by inland fresh water. It excludes shrubs flooded by salt or brackish water in coastal areas (→07).

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What does it look like?

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Table 5.14
Land cover change matrix (*hectares*)

Land cover	Opening area	Increases (positive numbers) and decreases (negative numbers) from other land covers: Artificial surfaces	Crops	Grassland	Tree-covered area	Mangroves	Shrub-covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	Coastal water and intertidal areas	Net change (increase-decrease)	Closing area
Artificial surfaces	12 292.5		147.0	27.0		9.0							183.0	12 475.5
Crops	445 431.0	-147.0		4 677.0	3 118.5		1 560.0	1.5					9 210.0	454 641.0
Grassland	106 180.5	- 27.0	- 4 677.0				69.0						- 4 635.0	101 545.5
Tree-covered area	338 514.0		- 3 118.5										- 3 118.5	335 395.5
Mangroves	214.5	-9.0										-1.5	-10.5	204.0
Shrub-covered area	66 475.5		-1 560.0	-69.0									-1 629.0	64 846.5
Regularly flooded areas	73.5		-1.5										-1.5	72.0
Sparse natural vegetated areas	1 966.5													1 966.5
Terrestrial barren land														
Permanent snow, glaciers and inland water bodies	12 949.5													12 949.5
Coastal water and intertidal areas	19 351.5					1.5							1.5	19 353.0

Note: Including herbaceous crops, woody crops and multiple or layered crops.

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Forest Account

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What is a forest account?

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Physical asset account for forest and other wooded land

Is a specific version of the land account

Is often compiled in conjunction with the **asset account for timber resources**

Asset Account for **forest and other wooded land**

- **Area of land**
- Changes due to **deforestation and afforestation**
- Does not consider trees outside of forests

Asset account for **timber resources**

- **Volume**
- Changes due to **quantity and quality of timber removed**
- **NOT** limited to timber from forest and other wooded land

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How are forests classified?

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Basic distinction

- **Naturally regenerated forest**

"Naturally regenerated forest is forest that is predominantly composed of trees established through natural regeneration. In this context, "predominantly" means that the trees established through natural regeneration are expected to constitute more than 50 per cent of the growing stock at maturity"

- **Planted forest**

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How are forests classified?

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Primary forest

is **naturally regenerated** forest of native species where there are **no clearly visible indications of human activities** and the ecological processes are not significantly disturbed.

Other naturally regenerated forest

is forest with **more than 50 per cent naturally regenerated trees** or clearly visible indications of human activities or naturally regenerated trees of introduced species.

Planted forests

are **predominantly** composed of trees established through **planting** or deliberate seeding which constitute more than 50 per cent of the growing stock.

Other wooded land

spans more than 0.5 hectares with trees higher than 5 meters and a canopy cover of 5 – 10 per cent, or with a combined cover of shrubs, bushes and trees above 10 per cent.

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Changes in stock?

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Possible changes to stock in the forest account

Afforestation	Increase due to the establishment of new forest on land that was previously not classified as forest land
Natural expansion	Increase in area resulting from natural seeding, sprouting, suckering or layering
Deforestation	Decrease due to the complete loss of tree cover and transfer of forest land to other uses
Natural regression	Decrease in area for natural reasons

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What does it look like?

Table 5.15
Physical asset account for forest and other wooded land *(hectares)*

	Type of forest and other wooded land				
	Primary forest	Other naturally regenerated forest	Planted forest	Other wooded land	Total
Opening stock of forest and other wooded land	20	100	150	130	400
Additions to stock					
Afforestation		2	5		7
Natural expansion		3			3
Total additions to stock		5	5		10
Reductions in stock					
Deforestation	2	10		5	17
Natural regression				3	3
Total reductions in stock	2	10	0	8	20
Closing stock of forest and other wooded land	18	95	155	122	390

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Timber Account

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What are timber resources?

"Timber resources are defined by the volume of trees, living or dead, and include all trees regardless of diameter, tops of stems, large branches and dead trees lying on the ground that can still be used for timber or fuel."

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What is included?

Basic principles

- Timber resources may or may not be available for felling (→ wood supply)
  - areas in which logging operations are restricted or prohibited
  - areas that are inaccessible or remote (not economically viable)
  - from a biological perspective, trees don't belong to a commercially useful species

Accounts in physical terms: **Included!**
Accounts in monetary terms: **Excluded!**

- The volume should be measured as the stem volume over bark at a minimum breast height from the ground level or stump height up to the top (principle: commercially usable)
- Cultivated vs. natural timber resources

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Changes in stock?

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Possible Additions to stock in the timber account

Natural growth	Is measured in terms of the **gross annual increment**
Reclassification	Increase in the **areas of land** that lead to increases in the volume of available timber resources

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Changes in stock?

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Possible Reductions to stock in the timber account

Removals	Volume of timber resources removed from forest land including removals of trees felled in earlier periods and trees killed or damaged by natural causes
Felling residues	Timber resources that are rotten, damaged or in excess in terms of size requirements
Natural losses	Due to mortality from causes other than felling (e.g. insect attack, fire etc. than are **reasonably expected**)
Catastrophic losses	Losses that are **exceptional and significant** losses due to natural causes (only if there is no possibility that the timber resource can be removed)
Reclassification	Decrease in the **areas of land** that lead to decreases in the volume of available timber resources

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What does it look like?

Table 5.19
Physical asset account for timber resources (*thousands of cubic metres over bark*)

	Type of timber resource		
	Cultivated timber resources	Natural timber resources	
		Available for wood supply	Not available for wood supply
Opening stock of timber resources	8 400	8 000	1 600
Additions to stock			
Natural growth	1 200	1 100	20
Reclassifications	50	150	
Total additions to stock	1 250	1 250	20
Reductions in stock			
Removals	1 300	1 000	
Felling residues	170	120	
Natural losses	30	30	20
Catastrophic losses			
Reclassifications	150		150
Total reductions in stock	1 650	1 150	170
Closing stock of timber resources	8 000	8 100	1 450
Supplementary information			
Fellings	1 250	1 050	

- ✓ Distinction cultivated vs. natural
- ✓ Distinction available vs. not available

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Exercise

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6 Flow accounts and ecosystem accounts

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Physical and monetary flows

- **Timber is only one product (= goods and services)**
  - Other marketed goods (fuelwood, NTFP)
  - Non-market ecosystem services
    - Regulating and maintenance: flood control, habitat,
    - Cultural: recreation, scientific, spiritual
- **SNA defines monetary flows of forest products**
  - Attributed to supplying sector (usually Forestry Industry)
- **SEEA-CF defines Material Flow Accounts**
  - Physical and monetary supply and use of marketed products
- **SEEA-EEA**
  - Includes marketed forest products (provisioning services)
  - Also defines Ecosystem Services

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Example material flows

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Physical and monetary supply and use (marketed)
– based on SEEA-CF Material Flows

Supply (Million tonnes)		Industry		Households	Import	Environment	Total
		Forest	Other				
Natural Inputs	Timber					100	100
	Fuelwood						
	NTFP (cork, gum, fodder, medicine, peat, food, etc.)					150	150
Products	Lumber	90			10		100
	Furniture		90		15		105
	NTFP (cork, gum, fodder, medicine, peat, food, etc.)		140		5		145
Residuals	Wood waste, etc.	10	20				30
Total		100	250		30	250	630

Use (Million tonnes)		Industry		Households	Export	Environment	Total
		Forest	Other				
Natural Inputs	Timber	100					100
	Fuelwood						
	NTFP (cork, gum, fodder, medicine, peat, food, etc.)		150				150
Products	Lumber		100				100
	Furniture			60	45		105
	NTFP (cork, gum, fodder, medicine, peat, food, etc.)			95	50		145
Residuals	Wood waste, etc.					30	30
Total		100	250	155	95	30	630

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Physical and monetary flows

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- **Monetary flows already in SNA**
  - Value of timber harvested by timber industry
  - Value of lumber sold and imports (to furniture industry)
  - Value of furniture sold and imports to households and exports
- **Physical flow accounts**
  - Include flows from the environment (natural inputs)
  - Include flows to the environment (residuals)
  - Can be estimated from price/volume (e.g., $/ton of lumber)

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Ecosystem services

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Ecosystem services

- **Can be valued, but not all within SNA; Why?**
  - SNA records market exchanges between economic units
- **SNA Benefits: (e.g., timber, NTFP)**
  - Produced by economic units
  - Potential to be bought and sold on market
  - Value in terms of potential market value
- **Non-SNA Benefits: (e.g., water regulation, air purification, carbon sequestration, spiritual)**
  - Not produced by economic units
  - Not bought and sold on market
  - Still very important to human well-being (health, stable climate, clean air, lower risk from extreme events, exposure to nature…)
- **Important to measure in physical terms first**
  - Can apply valuation methods appropriate to purpose

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Ecosystem services

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Ecosystem services

- Based on Common International Classification of Ecosystem Services (CICES)
- Not mutually exclusive
- A list of "final" services
- Detailed (48 at 4-digit)
- Does not include "supporting" or "intermediate" services (= ecosystem processes & conditions)
- Physical measures and valuation methods not standardized (yet)

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

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Which services are provided by forests?

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Tree covered areas

- **Provisioning**
  - Nutrition
    - Food
    - Drinking water
  - Materials
    - Biomass
    - Water
  - Energy
    - Biomass
- **Regulation & Maintenance**
  - Mediation of wastes, toxics…
  - Mediation of flows (mass, water…)
  - Maintenance of physical, chemical and biological conditions
    - Carbon sequestration
- **Cultural**
  - Physical
  - Intellectual
  - Spiritual

Ecosystem type	01.01.01 Biomass	01.01.02 Water	01.02.01 Biomass	01.02.02 Water	01.03.01 Biomass-based energy sources	01.03.02 Mechanical energy	02.01.01 Mediation by biota	02.01.02 Mediation by ecosystems	02.02.01 Mass flows	02.02.02 Liquid flows	02.02.03 Gaseous / air flows	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	03.01.01 Physical and experiential interactions	03.01.02 Intellectual and representative interactions	03.02.01 Spiritual and/or emblematic	03.02.02 Other cultural outputs
01. Artificial surfaces																				
02. Herbaceous crops	●		●		●												●	·	•	
03. Woody crops	●		●		●												●	·	•	
04. Multiple or layered crops	●		●		●												●	·	•	
05. Grassland	●		●				●	●	•			●		●			●	·	●	
06. Tree covered areas	•	●	●	·	•		●	●	•	•	·	•	·	●	•	●	●	·	●	
07. Mangroves	●	●	●		•			●	●	•	•	•					●	·		
08. Shrub covered areas			•					●									●	·	●	
09. Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	●	●	●	●	·		●	●	●	●	·	·	●	●	·		●	●	●	
10. Sparsely natural vegetated areas		●	●		·				·					●			●	·	●	
11. Terrestrial barren land		●	●						·					●			●	·	●	
12. Permanent snow and glaciers																				
13. Inland water bodies	●	●	●	●	·		●	●	·	·	·						●	·	●	
14. Coastal water bodies and inter-tidal areas	●		•					·	•	·	·	·					●	·	·	
15. Open ocean	·		•														●	·	•	
16. Atmosphere																				
17. Groundwater																				
18. Soil																				

Note: The circles show the proportion of cells within a cluster of ecosystem and service types for which there was consensus of four authors:

2/3 - 1	●
1/3 - < 2/3	•
0 - < 1/3	·

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Example

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Example in physical units

Ecosystem service		Units	Land cover type: Urban	Pasture	Cropland	Forest	Heath	Peat	Surface Water	Other nature	Provincial total
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**

Note: Units of measure are very different!

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Thank you!
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