System of
Environmental
Economic
Accounting

Extent

## Level 1 and 2

October 2017

United Nations

Overview: Extent account

1. Learning objectives

2. Review of "Level 0" (5m)

3. Level 1 (Compilers):

   Concepts (15m)

   Group exercise and discussion (15m)

4. Level 2 (Data Providers)

   Data options, examples and issues (15m)

   Group exercise and discussion (15m)

5. Closing discussion(10m)

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SEEA EEA accounts, tools and linkages
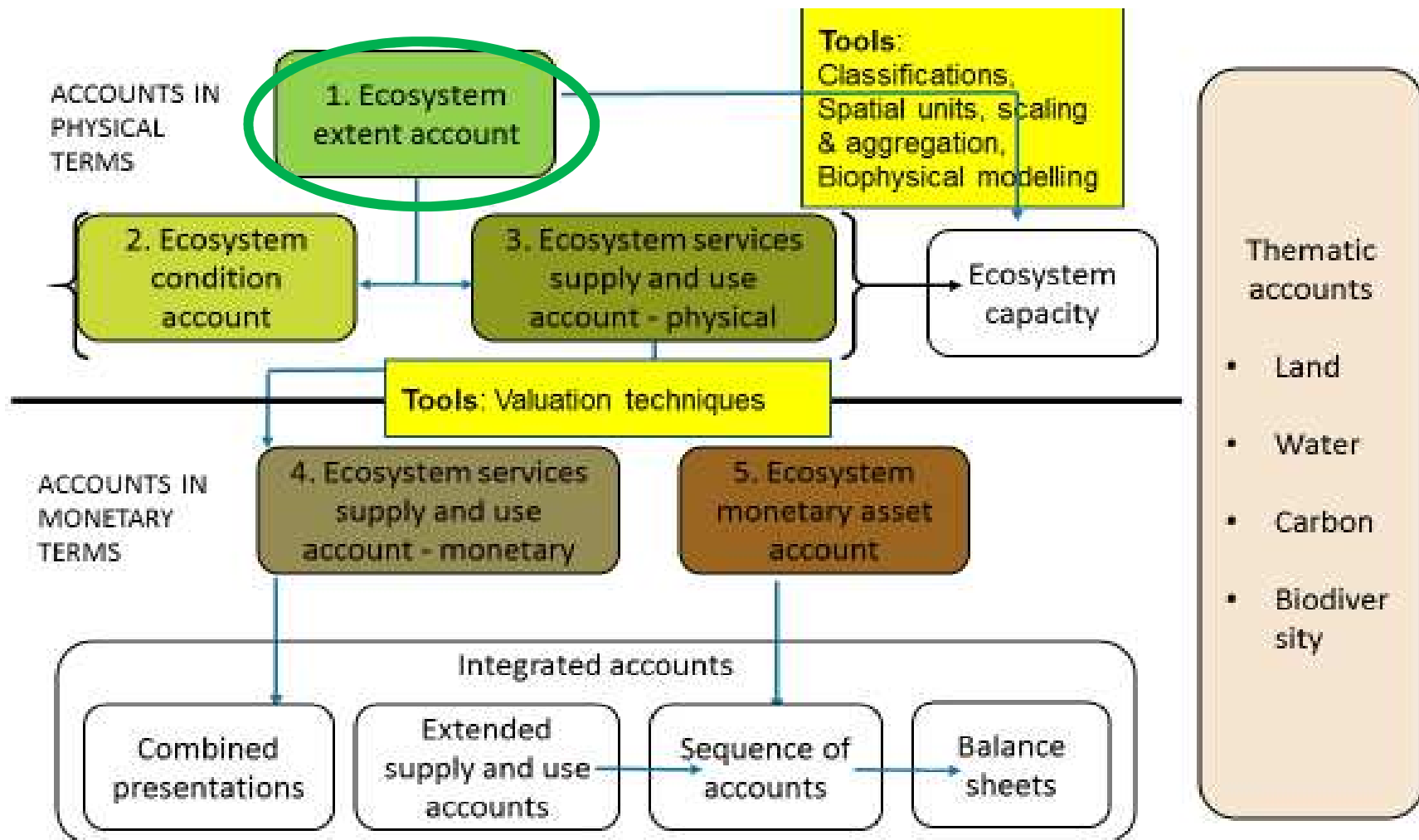
Review of Level 0:
Extent Account

Level 0: Account 1: Extent

- **What?**
  - *Ecosystem assets are spatial areas containing a combination of biotic and abiotic components and other characteristics that function together* (SEEA-EEA Sections 2.31, 4.1)
  - **National** coverage of terrestrial, freshwater, coastal and marine areas
  - Mutually exclusive and exhaustive coverage
- **Why?**
  - Land management, conservation policies
  - Spatial foundation for other accounts
    - → basis for allocating macro data to spatial units
  - Builds on SEEA-CF (land, forest, water)
  - Indicators:
    - Land cover change → where changes occurring
    - Land cover/use intensity → who owns it

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Level 0: Account 1: Extent

What does an Extent Account look like?
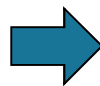
Maps   Tables

Ownership

Use

Cover

Cover	Urban and associated		Rainfed herbaceous cropland		Forest tree cover		Inland water bodies		Open wetlands	Total
Use	Infrastructure	Residential	Permananet crops	Maintenance	Forestry	Protected	Infrastructure	Aquaculture	Maintenance	
Ownership	Government	Private	Private	Private	Private	Government	Government	Private	Government	
Units					hectares					
Opening Stock										
Additions to Stock										
Managed expansion										
Natural expansion										
Reductions to stock										
Managed regression										
Natural regression										
Closing stock										

**Spatial units
Classifications**

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Level 0: Account 1: Extent

What does an Extent Account look like?

Maps
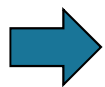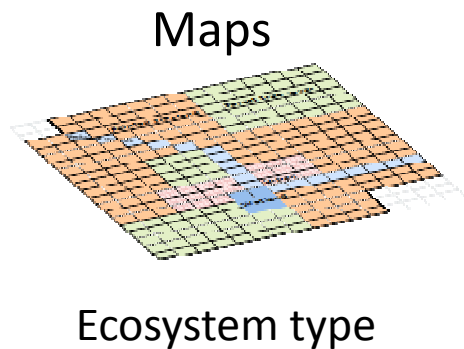
Ecosystem type

Spatial units
Classifications

		Proxy ecosystem type (based on land cover)															
		Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Opening extent																	
Additions to extent																	
Managed expansion																	
Natural expansion																	
Upward reappraisals																	
Reductions in extent																	
Managed regression																	
Natural regression																	
Downward reappraisals																	
Net change in extent																	
Closing extent																	

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Level 0: Account 1: Extent

- **What does an Extent Account look like?**

    An integrated spatial (GIS) database that overlays:
    - Land cover: forest, wetland, lake…
    - Use and intensity of use: agriculture, forestry, protected…
    - Ownership: business, private, government
    - Classified into **Spatial Units**
    - At high resolution (30m to 100m, maximum 500m) with national coverage
    - For two or more periods (change over time)
    - Based on comparable **Classifications**, quality, methods and **Spatial Units**
    - Units: hectares
    - Records: opening stock, closing stock, additions, reductions

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Level 0: Account 1: Extent

- **What do you need to compile an Extent Account?**
  - GIS platform: software, protocols, spatial units
  - Classifications: land cover, land use, ownership
  - National level data:
    - Existing land account would be useful
    - Satellite: land cover, aerial photography
    - Census: agriculture, population, settlements
    - Forest inventories
    - Hydrological, topographic (rivers, drainage areas, elevation, coastlines)
    - Cadastral (ownership, tax)
  - Expertise:
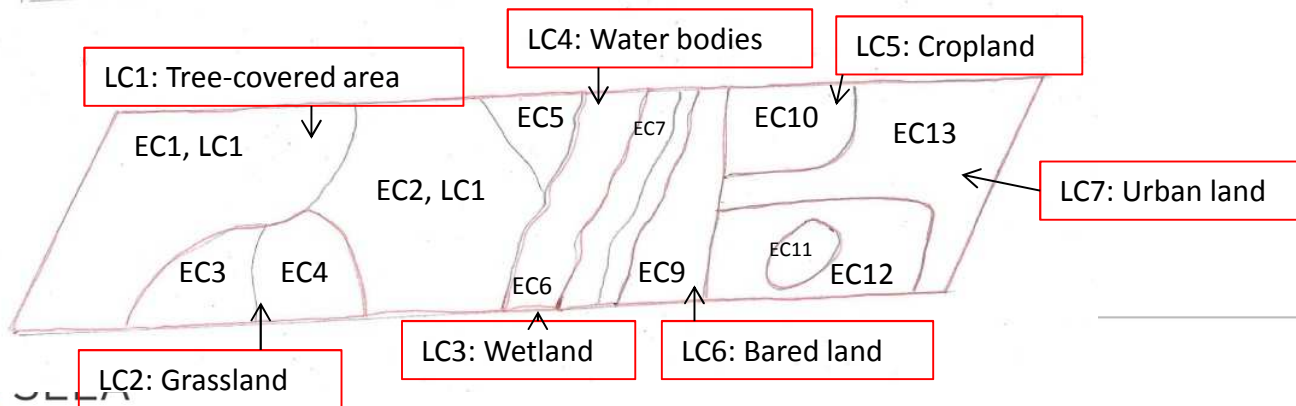   - Land managers, ecologists, geographers (GIS, satellite imagery, integration)

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Level 1: Account 1: Extent Account

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Level 1: Account 1: Extent

Ecosystem types can be derived from ecological classifications or from land cover data

What you see:

What you get:
Ecosystem = EC
Land cover = LC

LC1: Tree-covered area
LC4: Water bodies
LC5: Cropland
LC7: Urban land
LC2: Grassland
LC3: Wetland
LC6: Bared land

EC1, LC1
EC2, LC1
EC3 EC4
EC5 EC7
EC10 EC13
EC6 EC9 EC11 EC12

Level 1: Account 1: Extent

- Land cover, land use and land ownership

Land cover classification (SEEA-CF, Table 5.12, p.178)
1 Artificial surfaces (incl. urban and assoc. 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 herb. veg., aquatic or reg. 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

Land use classification (SEEA-CF, Table 5.11, p. 176)

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
2.1 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

Land ownership: by industry (e.g. agriculture, mining) or by sector (e.g. public or private)

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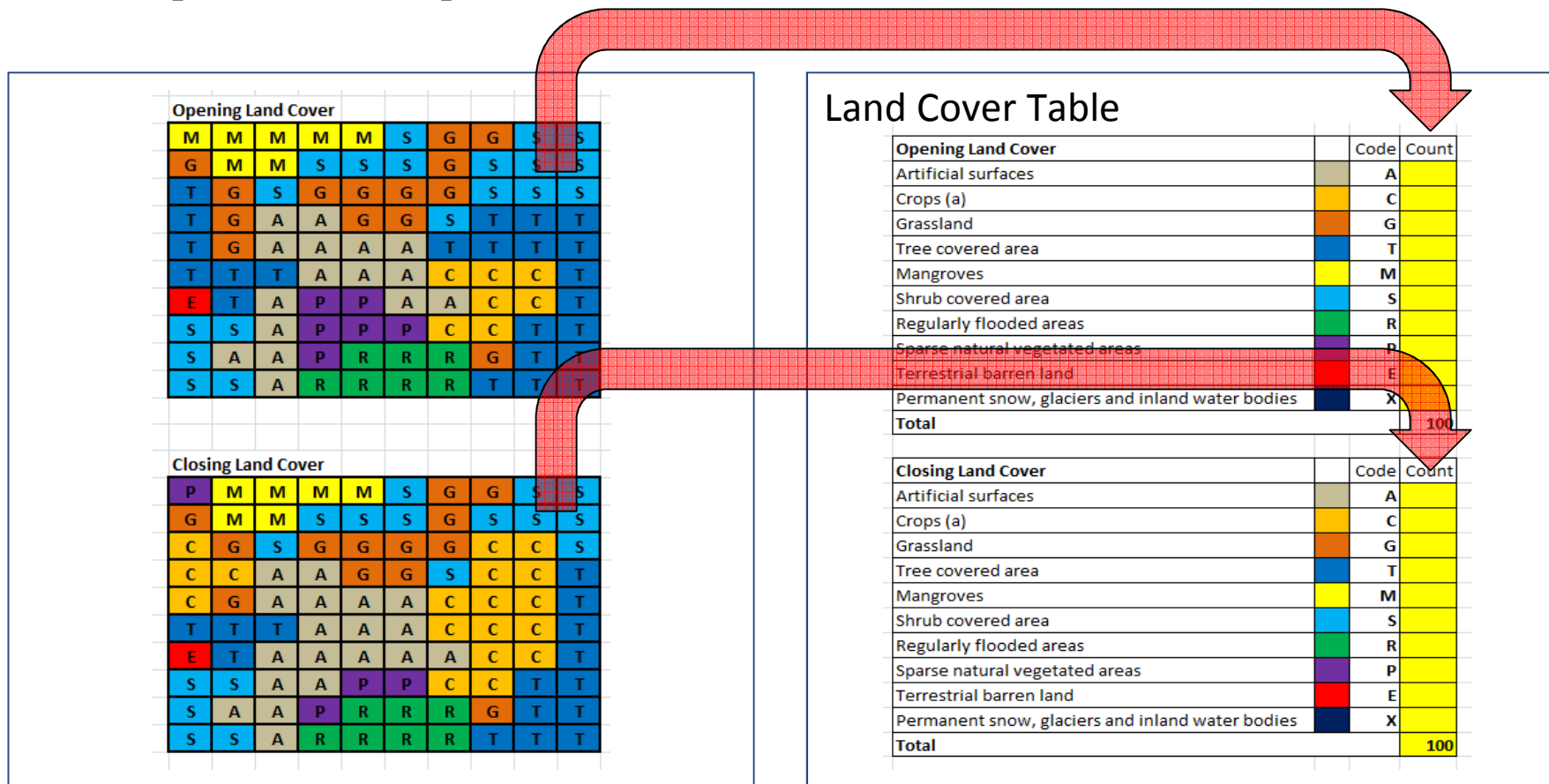# Level 1: Account 1: Extent

Compiling Extent Accounts (hectares)

	Proxy ecosystem type (based on land cover)															
	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Opening extent																
Additions to extent																
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Managed regression																
Natural regression																
Downward reappraisals																
Net change in extent																
Closing extent																

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Level 1: Account 1: Extent

- Compilation Group Exercise (30m)
  - Situation:
    - Land cover units defined for two periods (Opening and Closing)
    - Need to calculate:
      - •Land Cover Opening and Closing stocks,
      - •Land Cover Change per class (with additions and reductions)
      - •Physical Account for Land Cover
  - Objective (Groups of 3-5):
    1. Transfer Land Cover from map to table
    2. Calculate Land Cover Change Matrix
    3. Calculate Physical Account for Land Cover
    4. Report and discuss results

Level 1: Account 1: Extent

Group Exercise: Step 1 – Calculate Land Cover

Level 1: Account 1: Extent

Group Exercise: Step 2 – Calculate Land Cover Change

Land Cover Table

Opening Land Cover		Code	Count
Artificial surfaces		A	
Crops (a)		C	
Grassland		G	
Tree covered area		T	
Mangroves		M	
Shrub covered area		S	
Regularly flooded areas		R	
Sparse natural vegetated areas		P	
Terrestrial barren land		E	
Permanent snow, glaciers and inland water bodies		X	
Total			**100**

Closing Land Cover		Code	Count
Artificial surfaces		A	
Crops (a)		C	
Grassland		G	
Tree covered area		T	
Mangroves		M	
Shrub covered area		S	
Regularly flooded areas		R	
Sparse natural vegetated areas		P	
Terrestrial barren land		E	
Permanent snow, glaciers and inland water bodies		X	
Total			**100**

Land Cover Change Matrix

Table 1: Net Land Cover Change Matrix (hectares)

Opening Land Cover	Code	Closing Land Cover										Opening
		A	C	G	T	M	S	R	P	E	X	
Artificial surfaces	A											
Crops	C											
Grassland	G											
Tree covered area	T											
Mangroves	M											
Shrub covered area	S											
Regularly flooded areas	R											
Sparse natural vegetated areas	P											
Terrestrial barren land	E											
Permanent snow, glaciers and inland water bodies	X											
Closing												

Note: Rows represent reductions in stock; columns represent deletions in stock

Record "No change" in diagonal
Rows = No change + Reductions
Columns = No change + Additions

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Level 1: Account 1: Extent

Group Exercise: Step 23– Calculate Physical Land Cover

Land Cover Change Matrix

Table 1: Net Land Cover Change Matrix (hectares)

		Closing Land Cover										
Opening Land Cover	Code	Artificial surfaces (A)	Crops (C)	Grassland (G)	Tree covered area (T)	Mangroves (M)	Shrub covered area (S)	Regularly flooded areas (R)	Sparse natural vegetated areas (P)	Terrestrial barren land (E)	Permanent snow, glaciers and inland water bodies (X)	Opening
Artificial surfaces	A											
Crops	C											
Grassland	G											
Tree covered area	T											
Mangroves	M											
Shrub covered area	S											
Regularly flooded areas	R											
Sparse natural vegetated areas	P											
Terrestrial barren land	E											
Permanent snow, glaciers and inland water bodies	X											
Closing												

Note: Rows represent reductions in stock; columns represent deletions in stock

Additions to (A) Artificial surfaces

Physical Land Cover Account

Table 2.: Physical Account for Land Cover

	Artificial surfaces	Crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparsely natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers and inland water bodies	TOTAL
Opening extent											
Additions to extent											
Reductions in extent											
Closing extent											

Additions = Column total – no change
Reductions = Row total – no change

Level 1: Account 1: Extent

- Is everyone clear on the objectives?

- 30 minutes group work

- Please ask questions!

- Results:

  > Each group report:

  - Additions to extent
  - Reductions in extent
  - What were the largest sources of change?

Table 2.: Physical Account for Land Cover

	Artificial surfaces	Crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparsely natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers and inland water bodies	TOTAL
Opening extent											
Additions to extent											
Reductions in extent											
Closing extent											

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Level 1: Account 1: Extent

- **Answers**

  - > **Land Cover Change Matrix**
    - Rows add to Opening
    - Columns add to Closing

  - > **Physical Account for Land Cover**
    - Additions to Stock =

      3, 11, 0, 0, 0, 0, 0, 1, 0, 0
    - Reductions in Stock =

      0, 0, 1, 8, 1, 2, 0, 3, 0, 0

Table 1: Net Land Cover Change Matrix (hectares)

Opening Land Cover	Code	Artificial surfaces A	Crops C	Grassland G	Tree covered area T	Mangroves M	Shrub covered area S	Regularly flooded areas R	Sparse natural vegetated areas P	Terrestrial barren land E	Permanent snow, glaciers and inland water bodies X	Opening
Artificial surfaces	A	16	0	0	0	0	0	0	0	0	0	16
Crops	C	0	7	0	0	0	0	0	0	0	0	7
Grassland	G	0	1	13	0	0	0	0	0	0	0	14
Tree covered area	T	0	8	0	15	0	0	0	0	0	0	23
Mangroves	M	0	0	0	0	6	0	0	1	0	0	7
Shrub covered area	S	0	2	0	0	0	17	0	0	0	0	19
Regularly flooded areas	R	0	0	0	0	0	0	7	0	0	0	7
Sparse natural vegetated areas	P	3	0	0	0	0	0	0	3	0	0	6
Terrestrial barren land	E	0	0	0	0	0	0	0	0	1	0	1
Permanent snow, glaciers and inland water bodies	X	0	0	0	0	0	0	0	0	0	0	0
Closing		19	18	13	15	6	17	7	4	1	0	100

Note: Rows represent reductions in stock; columns represent deletions in stock

Table 2.: Physical Account for Land Cover

	Artificial surfaces	Crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparsely natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers and inland water bodies	TOTAL
Opening extent	16	7	14	23	7	19	7	6	1	0	100
Additions to extent	3	11	0	0	0	0	0	1	0	0	15
Reductions in extent	0	0	1	8	1	2	0	3	0	0	15
Closing extent	19	18	13	15	6	17	7	4	1	0	100

Note: Reductions are sum of row, excluding areas that remained the same.

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Level 2: Account 1: Extent

Level 2: Account 1: Extent

- **Learning objectives (Level 2)**

  - Understand the important conceptual issues:

    More detail than Land Cover may be needed

    Introduction to the EA (Ecosystem Asset)

  - Understand the data options and sources

    In relation to scale of analysis, pilot project objectives, available resources

  - Be aware of how other countries have approached measuring extent

    EA's MAES process, Canada's MEGS, Australian land accounts, Netherlands, South Africa

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Level 2: Account 1: Extent

- Ecosystem type (ET): a specific class of ecosystem assets of comparable ecology and ecosystem use

- In practice: start with a classification of ecosystem types in order to delineate ecosystem assets

    > Initial focus on ecological principles

    > But also relevant to consider services supplied -> high degree of commonality in ES supply within an ET

Level 2: Account 1: Extent

Delineating ecosystem assets - possible classification of ecosystem types

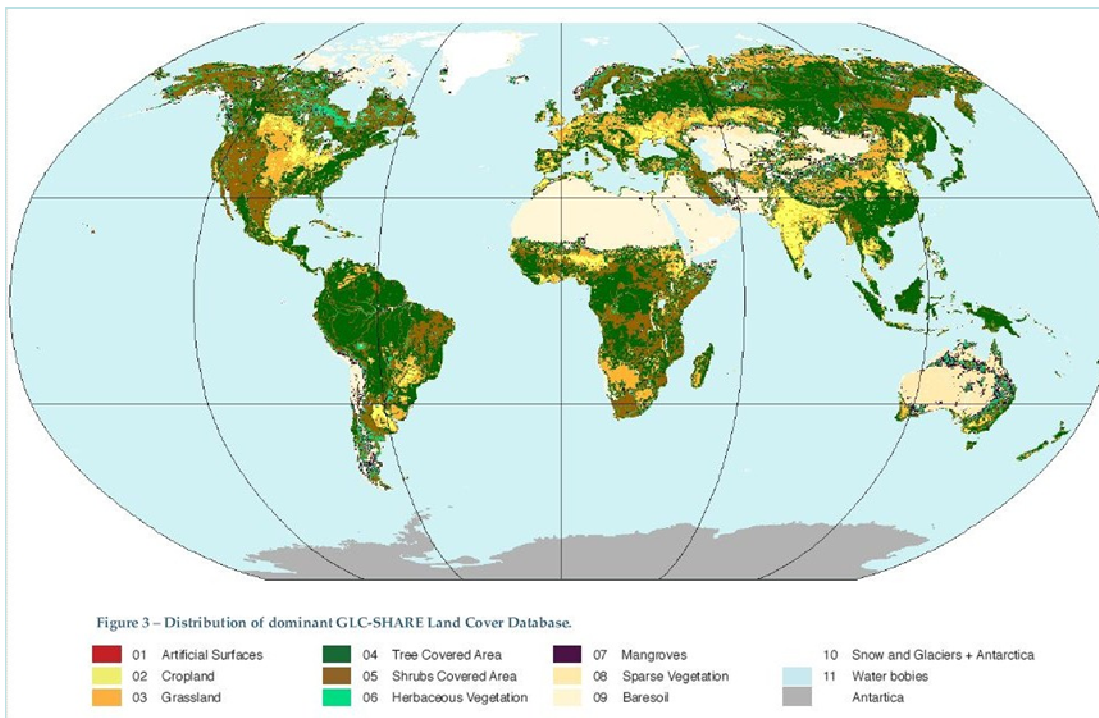| Description of land cover classes (SEEA Central Framework)	Possible ecosystem types
Artificial areas (including urban and associated areas)	Residential/housing Urban parks Industrial uses (e.g. factories) Road infrastructure Waste deposit sites
Herbaceous crops	Irrigated rice Other irrigated crops Rainfed annual croplands
Woody crops	Fruit tree plantation Coffee and tea plantation Oil palm plantation Rubber plantation
Multiple or layered crops	Two layers of different crops (e.g. wheat fields with olive trees in the Mediterranean area) One layer of natural vegetation (mainly trees) that covers one layer of cultivated crops (e.g. coffee grown under shade trees)
Grassland	Natural grasslands Improved pastures Steppe Savanna
Tree-covered areas (forests)	Deciduous forest Coniferous forest Plantation (planted) forest
Mangroves	Inland mangroves Nearshore mangroves
Shrub-covered areas	Natural dryland shrubland Degraded dryland shrubland
Shrubs, and/or herbaceous vegetation, aquatic or regularly flooded	Wetland shrubland
Sparsely natural vegetated areas	Periglacial vegetation
Terrestrial barren land	Sandy dunes
Permanent snow and glaciers	
Inland water bodies	Lakes Rivers
Coastal water bodies and intertidal areas	Coral reefs Seagrass meadows
Sea and marine areas	

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Level 2: Account 1: Extent

- Data options for ET mapping
  - > Detailed mapping of habitats and vegetation complexes would be best completed through in-situ inventories
  - > Remote sensing can be applied to update the base map:
    - ⁻ Very-high resolution remote sensing imagery (such as QuickBird and Ikonos) and aerial imagery
  - > Intermediate solution: produce detailed land cover and use maps that distinguish vegetation types at the level of community (e.g. with dominant species)
    - ⁻ Using High- and medium- resolution imagery such as Landsat, SPOT, etc.

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Level 2: Account 1: Extent

Global land cover datasets

FAO Global Land Cover-SHARE

Figure 3 – Distribution of dominant GLC-SHARE Land Cover Database.

01 Artificial Surfaces	04 Tree Covered Area	07 Mangroves	10 Snow and Glaciers + Antarctica
02 Cropland	05 Shrubs Covered Area	08 Sparse Vegetation	11 Water bobies
03 Grassland	06 Herbaceous Vegetation	09 Baresoil	Antartica

The FAO product Global Land Cover-SHARE (year 2014 version 1.0) is constructed using the best quality national and international data sources.

11 land cover classes were harmonized and reclassified according to the SEEA-CF land cover classification

http://www.fao.org/geonetwork/srv/en/main.home?uuid=ba4526fd-cdbf-4028-a1bd-5a559c4bff38

Level 2: Account 1: Extent

Global land cover datasets

- MODIS Land Cover
    > [Land Cover Type Yearly L3'](#) (version 51 is the latest)
    > Annual products based on NASA's MODIS imagery
    > Available at 500m x 500m spatial resolution.
    - Land Cover Type 1: IGBP global vegetation classification scheme
    - Land Cover Type 2: University of Maryland (UMD) scheme
    - Land Cover Type 3: MODIS-derived LAI/fPAR scheme
    - Land Cover Type 4: MODIS-derived Net Primary Production (NPP) scheme
    - Land Cover Type 5: Plant Functional Type (PFT) scheme
    > Downloadable from https://search.earthdata.nasa.gov/search

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Global land cover datasets

GLOBELAND 30
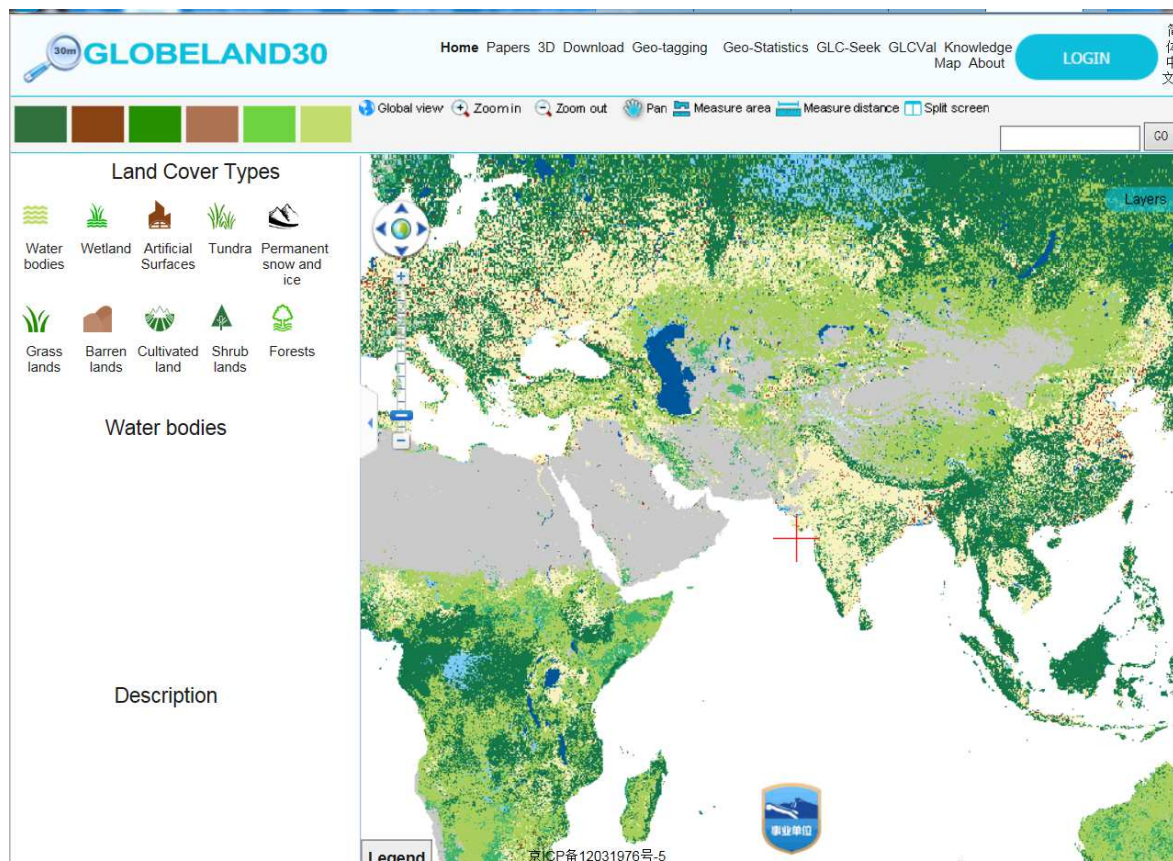
Very high resolution global land cover maps were produced by China, known as GlobeLand30, for years 2000 and 2010, with 10 classes and 30 m resolution, based on the freely available imagery from NASA's Landsat satellite instruments.

http://www.globallandcover.com/GLC30Download/index.aspx

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Level 2: Account 1: Extent

EU (MAES) Ecosystem types
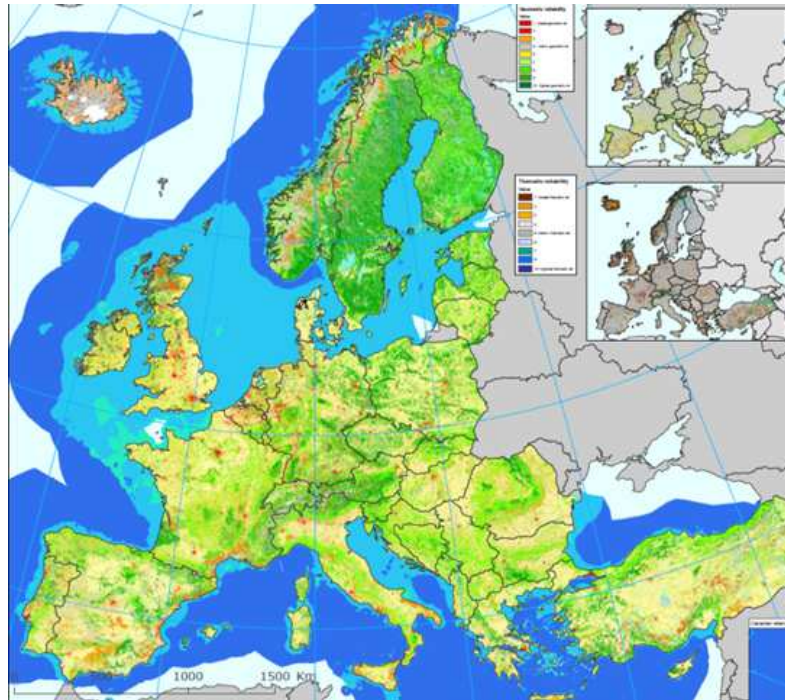
Souce: Biodiversity Information System for Europe

data source:
  * CLC 2006, HRL sealing 2006, JRC-Forest 2006, OSM 2013
  * EU-DEM
  * ESDB, Art. 17 (2006), pot. nat. vegetation ((c) BfN)
  * env-strata (Metzger)
  * HANTS-MODIS (Alterra, GISAT)

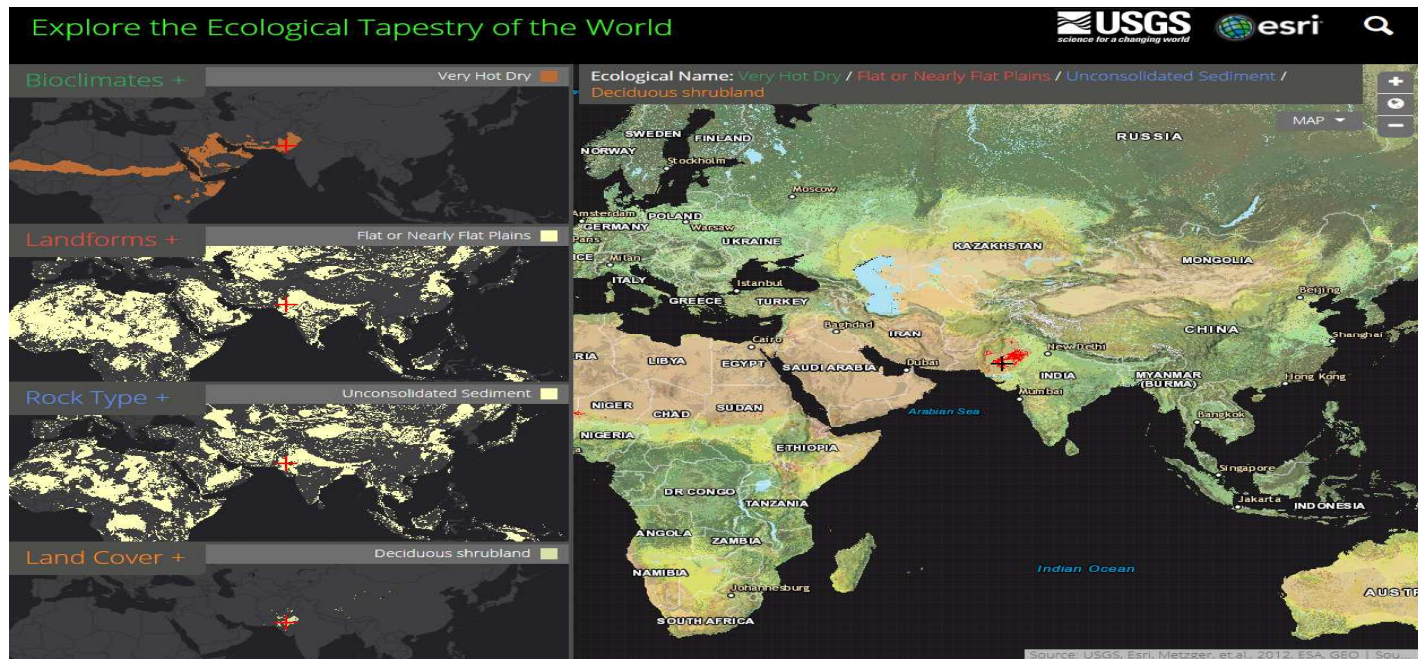crosswalk
  * CLC-EUNIS crosswalk
  * method: ETC-SIA (c) 2013

Map of ecosystem types V 2.1

Level 2: Account 1: Extent

USGS/ESRI Global Ecological Land Units (2014)

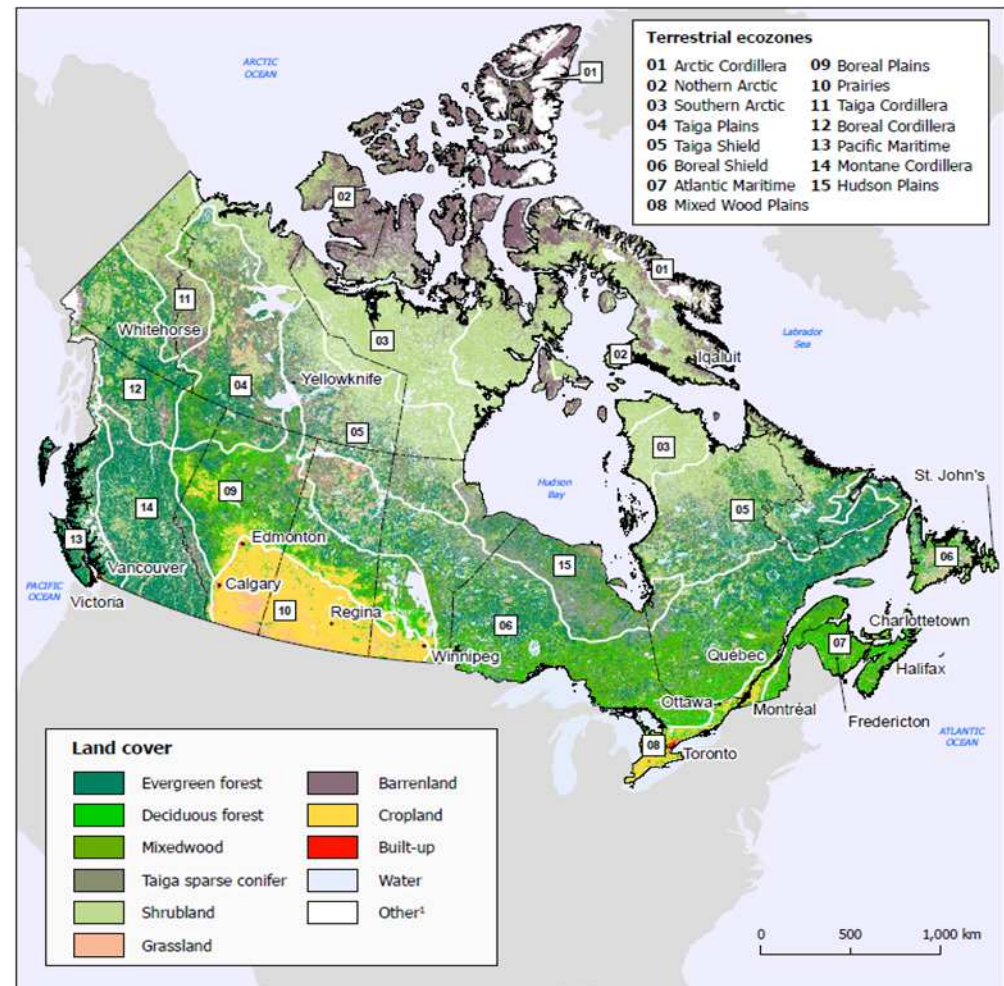- Ecological classification based on bioclimate, land form, rock type (lithology) and land cover

- At 250m resolution

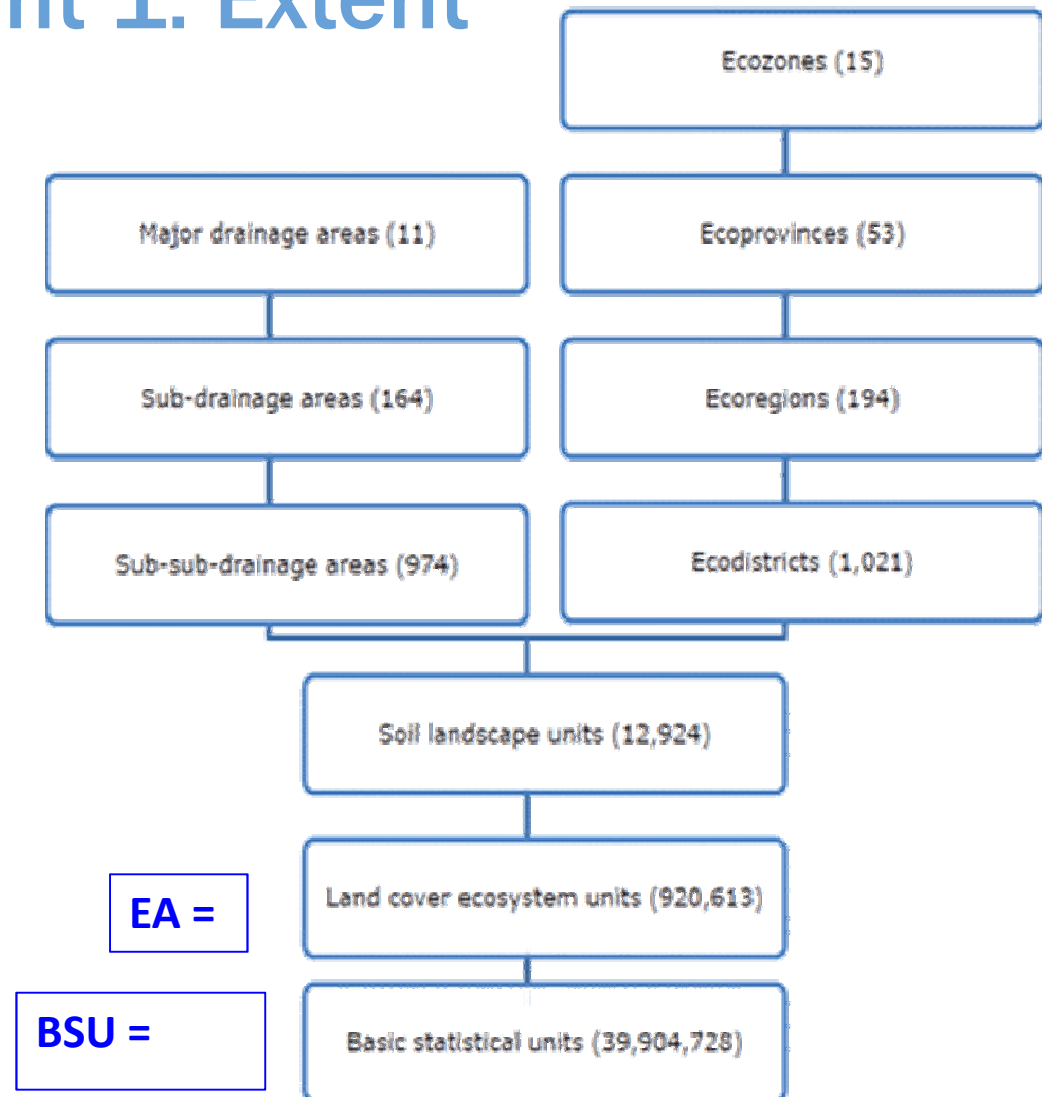See: http://ecoexplorer.arcgis.com/eco/ available in ArcGIS Online

Level 2: Account 1: Extent

- **Statistics Canada (Measuring Ecosystem Goods and Services – MEGS)**

- Based Extent Account on existing National Ecological Classification

- Further sub-divided Ecodistricts and Soil Landscape Units to EUs (See Spatial Units)

- Using MODIS (at 250m resolution), hydrology, topography, roads…

Terrestrial ecozones

01 Arctic Cordillera	09 Boreal Plains
02 Nothern Arctic	10 Prairies
03 Southern Arctic	11 Taiga Cordillera
04 Taiga Plains	12 Boreal Cordillera
05 Taiga Shield	13 Pacific Maritime
06 Boreal Shield	14 Montane Cordillera
07 Atlantic Maritime	15 Hudson Plains
08 Mixed Wood Plains	

Land cover

|	
Evergreen forest	Barrenland
Deciduous forest	Cropland
Mixedwood	Built-up
Taiga sparse conifer	Water
Shrubland	Other¹
Grassland	

Level 2: Account 1: Extent

- Statistics Canada MEGS Spatial Infrastructure

- Developed a hierarchy of spatial units that was consistent with the SEEA-EEA classification

Ecozones (15)

Major drainage areas (11)

Ecoprovinces (53)

Sub-drainage areas (164)

Ecoregions (194)

Sub-sub-drainage areas (974)

Ecodistricts (1,021)

Soil landscape units (12,924)

EA =

Land cover ecosystem units (920,613)

BSU =

Basic statistical units (39,904,728)

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Level 2: Account 1: Extent

- Australia's Land Accounts

- Based on MODIS 250m Land Cover, aggregating 25 classes to seven categories

Australian Dynamic Land Cover	AEEA presentation
Built Up Areas	Built Up Areas
Rainfed Cropping	Rainfed cropping and pasture
Rainfed Pasture	
Alpine Grasses - Open	Grasses and Sedges
Hummock Grasses - Open	
Sedges - Open	
Tussock Grasses - Open	
Hummock Grasses - Sparse	
Tussock Grasses - Sparse	
Trees - Closed	Trees
Trees - Open	
Trees - Scattered	
Trees - Sparse	
Irrigated Cropping	Irrigated cropping and pasture
Irrigated Pasture	
Shrubs - Closed	Shrubs
Shrubs - Open	
Chenopod Shrubs - Open	
Shrubs - Scattered	
Shrubs - Sparse	
Chenopod Shrubs - Sparse	
Extraction Sites	Other
Inland Water bodies	
Salt Lakes	
Wetlands	

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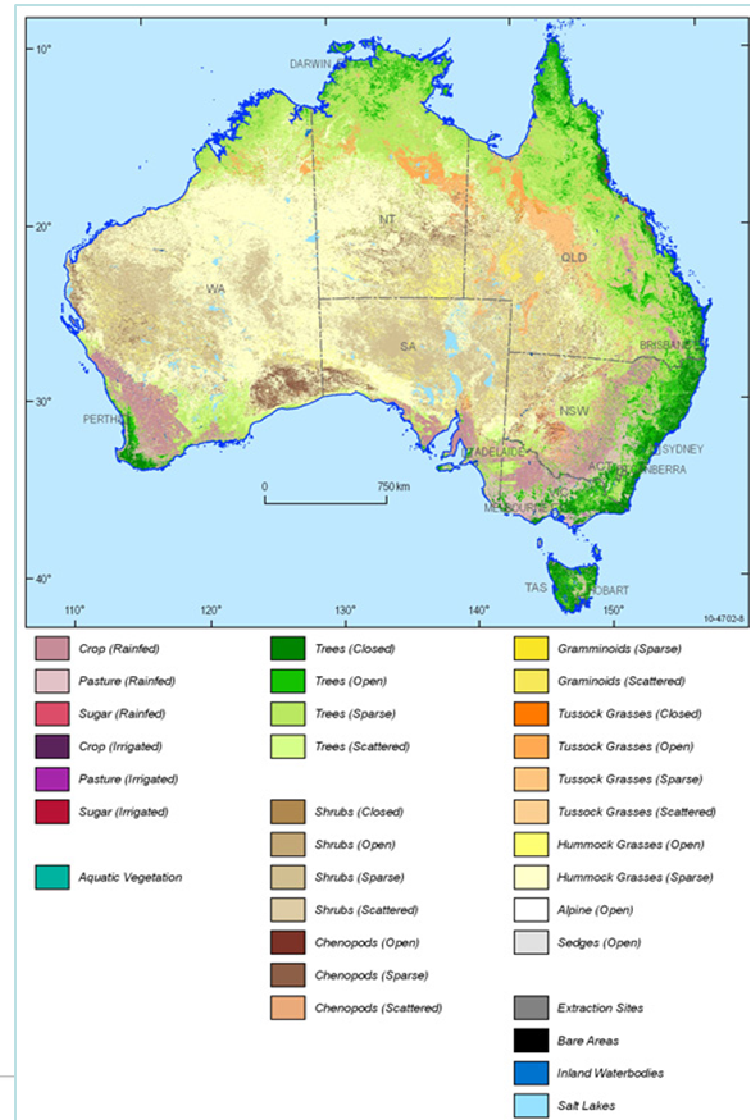
Level 2: Account 1: Extent

- Concepts group Exercise (15m)

- Group reports:
    - > National **data and classifications** for Ecosystem Extent already available for your country
    - > Alternative sources of data for Ecosystem Extent Accounts?

- Discussion
    - > Who would need to participate in creating a pilot Ecosystem Extent Account?

Level 2: Account 1: Extent

- Discussion and questions

- Take home points
  - > Land Cover data, classified by the recommended SEEA-EEA classification is a useful starting point for creating an Ecosystem Extent Account
  - > Data need to be national and consistent
  - > Alternatives exist to create more "optimal" units (such as the EA based on ecological classifications)
    - These can fit into the SEEA-EEA Land Cover classification
  - > Global data for Land Cover and Ecological Units may be used if there is no national alternative

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Level 2: Account 1: Extent

- References
    - STATISTICS CANADA, 2013. Human Activity and the Environment: Measuring Ecosystem Goods and Services 2013. 16-201-XWE. Ottawa: Government of Canada
    - AUSTRALIAN BUREAU OF STATISTICS **Land Account: Queensland, Experimental Estimates, 2011 – 2016**
    - **Biodiversity Information System for Europe (BISE)**

- Further information
    - SEEA 2012 Experimental Ecosystem Accounting
    - SEEA-EEA Technical Recommendations (2017)

Acknowledgements

These materials have been developed in partnership with various organizations including the United Nations Statistics Division, UN Environment, the Convention on Biological Diversity, supported by the Norwegian Ministry of Foreign Affairs, and the European Union.