System of Environmental Economic Accounting

Ecosystem extent accounts in the SEEA Ecosystem Accounting

Training Workshop on an Accounting Approach to Climate Change and Biodiversity in Central Asia

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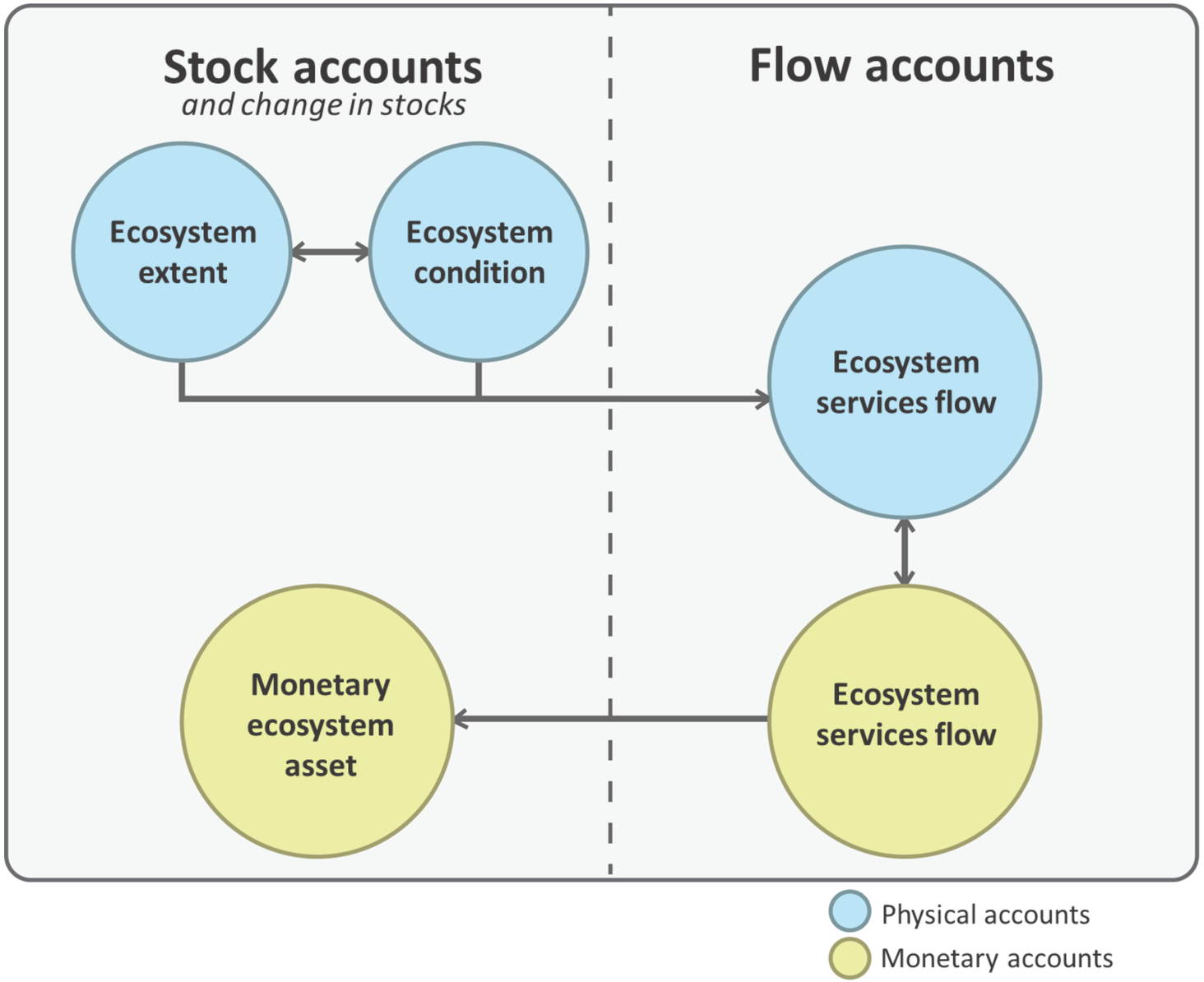
Ecosystem accounts – core accounts



Ecosystem extent account - overview

- What?
  - Starting point for ecosystem accounting
  - Records the areas of different ecosystems, and changes in the areas
  - National coverage of terrestrial, freshwater, coastal and marine areas
  - Mutually exclusive and exhaustive coverage
  - In physical units – i.e., ha, km^2, etc.

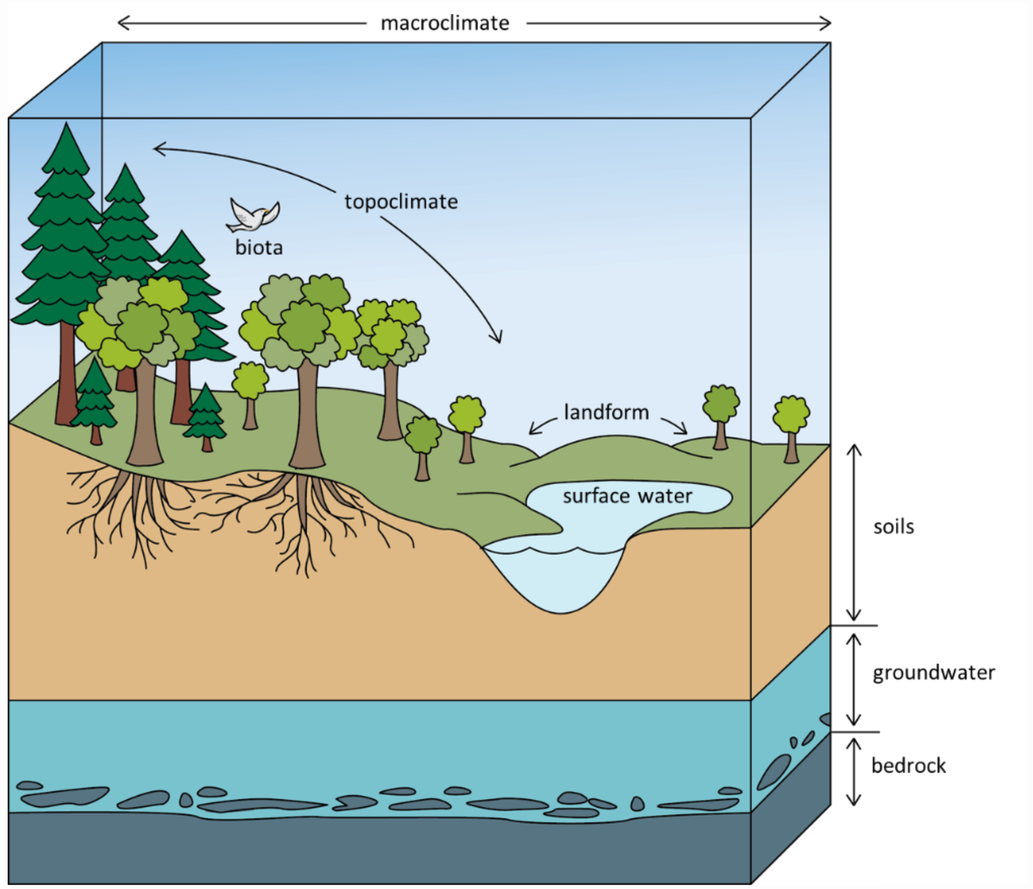
- Why?
  - Input for land management, conservation policies
  - Supports the derivation of coherent indicators of deforestation, desertification, agricultural conversion, urbanization, ecosystem diversity etc.
  - Spatial foundation for other accounts → basis for allocating macro data to spatial units

Ecosystem assets

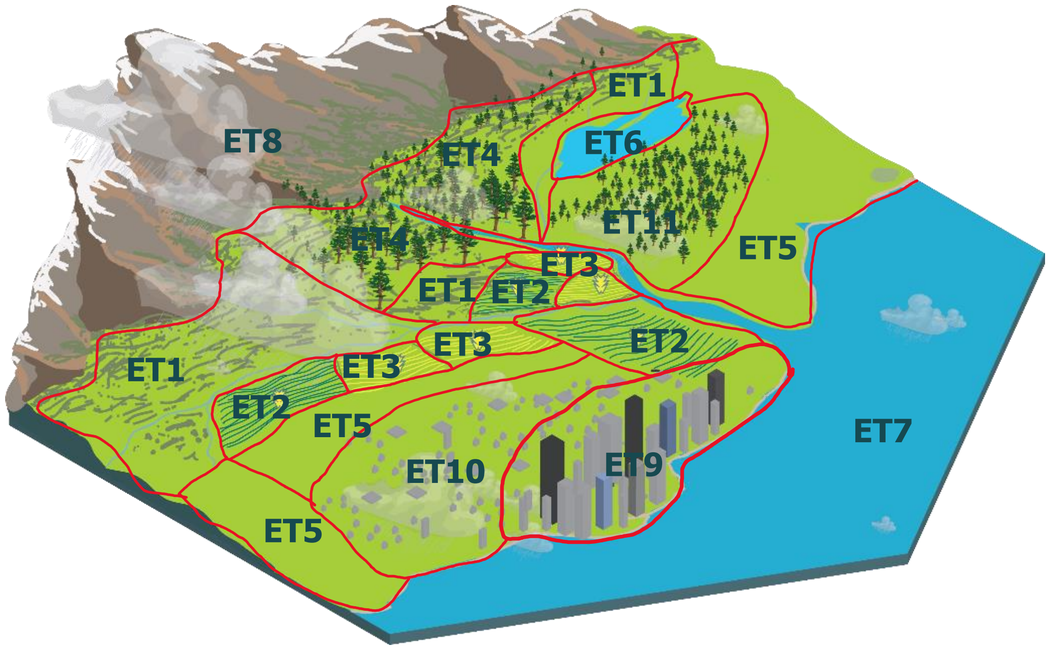
Types of spatial units:

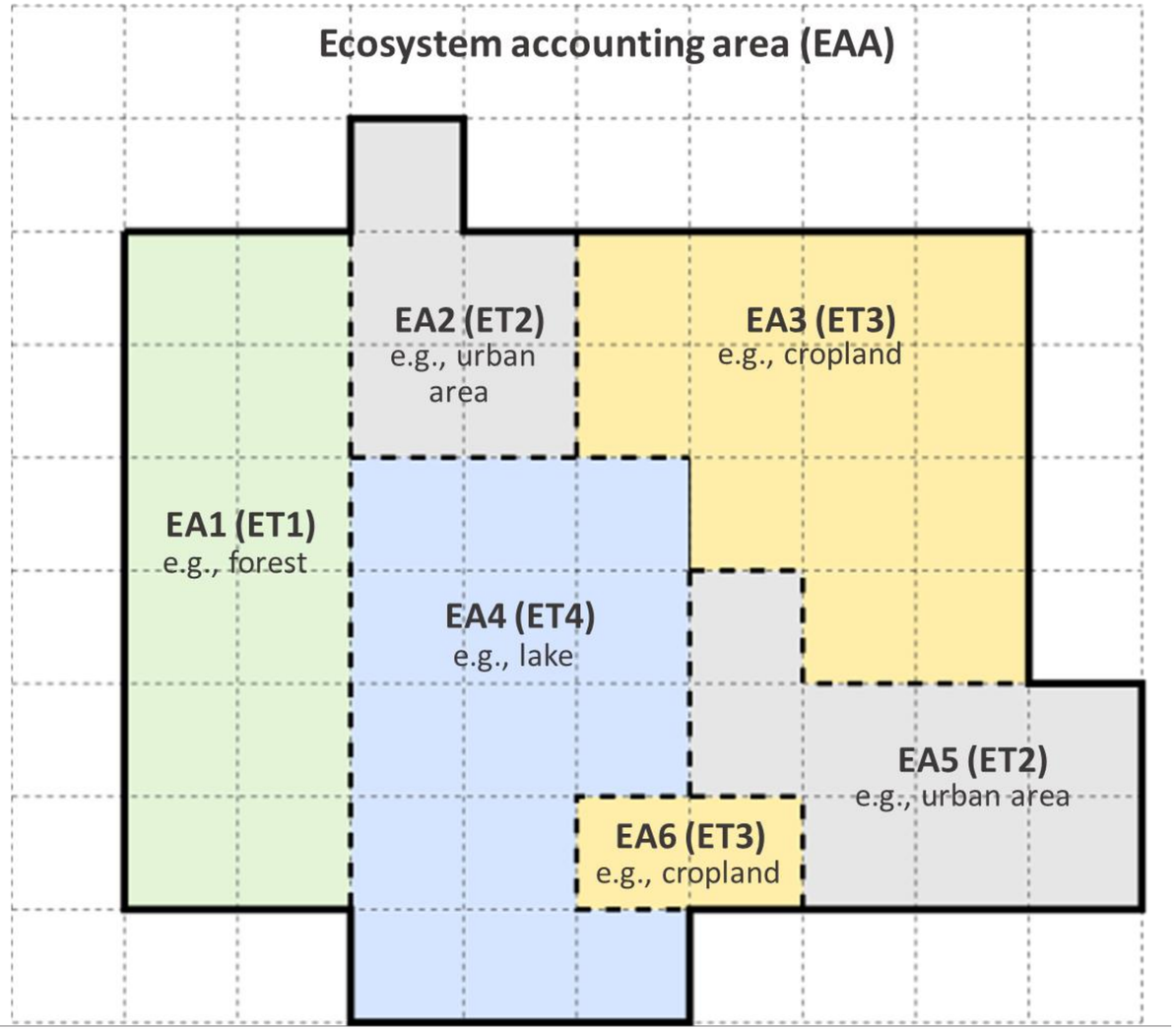
- **Ecosystem assets (EAs)** are contiguous spaces of a specific ecosystem type characterized by a distinct set of biotic and abiotic components and their interactions
- **Ecosystem assets** are classified by **ecosystem type (ET)**
- **Ecosystem accounting area (EAA)** is the geographical territory for which an ecosystem account is compiled

- **IUCN Global Ecosystem Typology** is the SEEA Ecosystem Type reference classification
  - > UN Statistical Commission endorsed it as an international statistical classifications, and recommended it be included in the international family of classifications



Spatial units in SEEA EA

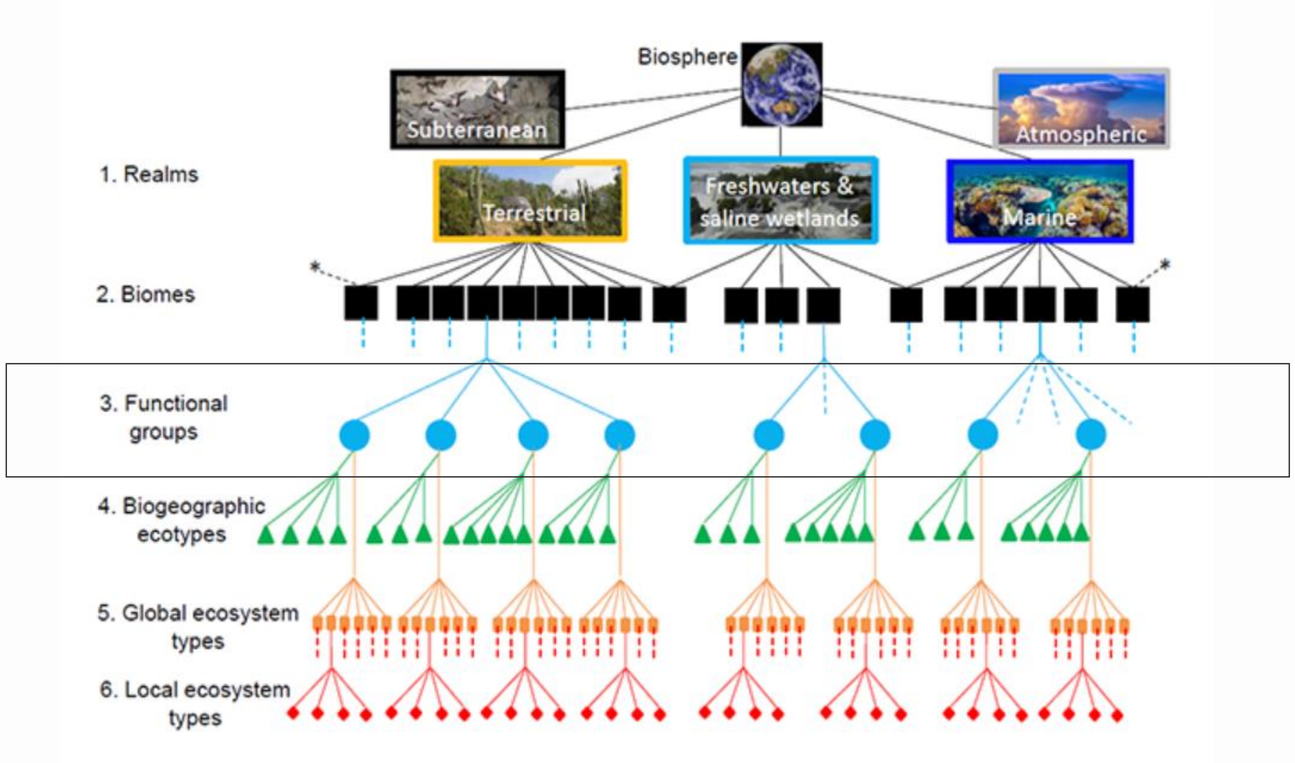




Linking land cover and ecosystem extent

- Both are spatially explicit
- Land accounts, particularly land cover, are a basis for ecosystem accounting
  - > Land cover is a fundamental layer, but extent requires more
- For terrestrial and freshwater areas, should be a reasonable concordance between land cover and ecosystem extent
- But key differences between land cover and ecosystems
  - > Definition of ecosystems in SEEA EA: a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit
  - > vs. definition of land cover: the observed physical and biological cover of the Earth's surface and includes natural vegetation and abiotic (non-living) surfaces

IUCN Global Ecosystem Typology



5 Realms (level 1)

25 Biomes (level 2)

110 Ecosystem functional groups (level 3)

National ecosystem classifications typically at level 5/6

Of the 110 ecosystem functional groups, 98 are natural and 12 are anthropogenic

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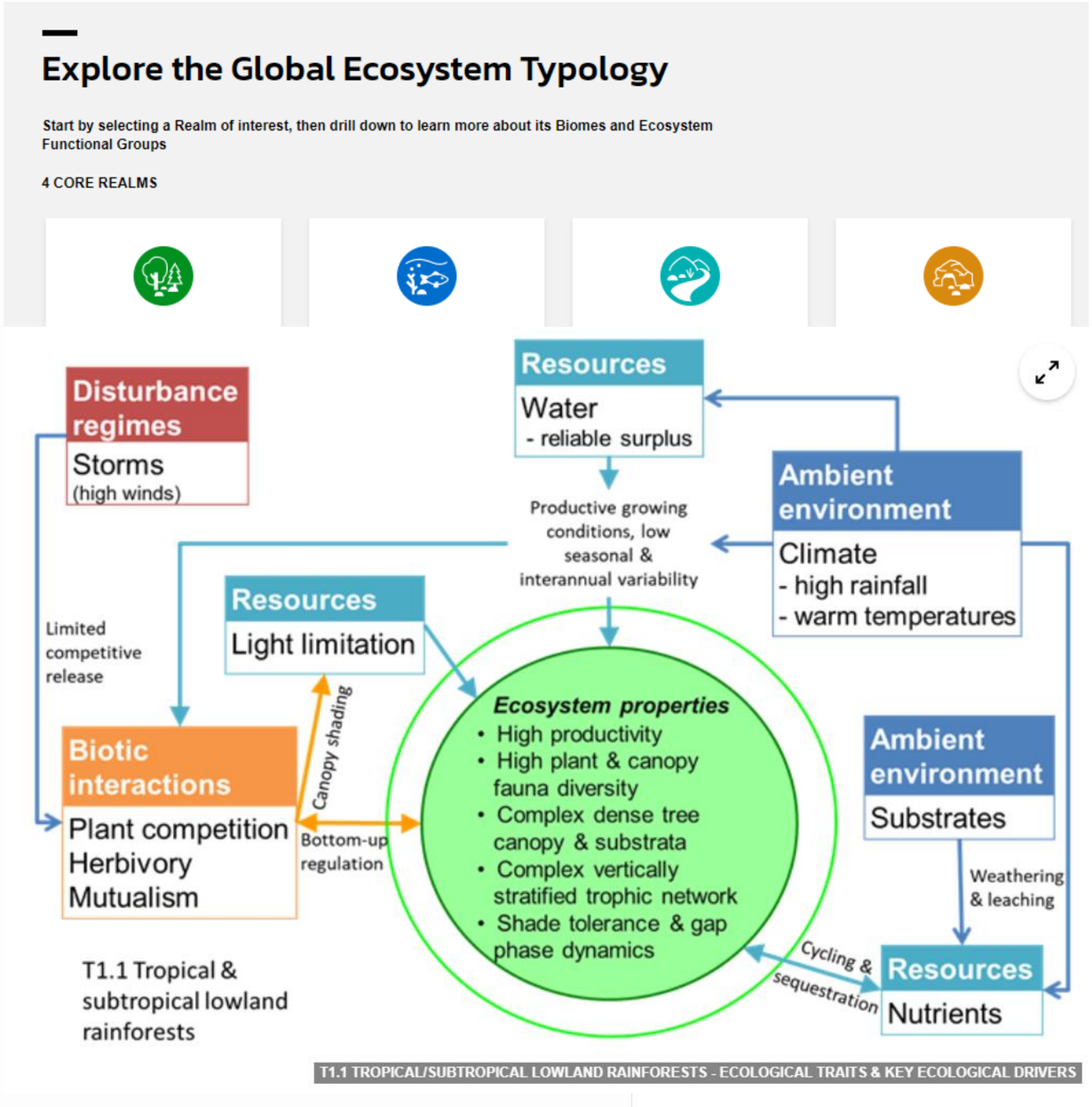
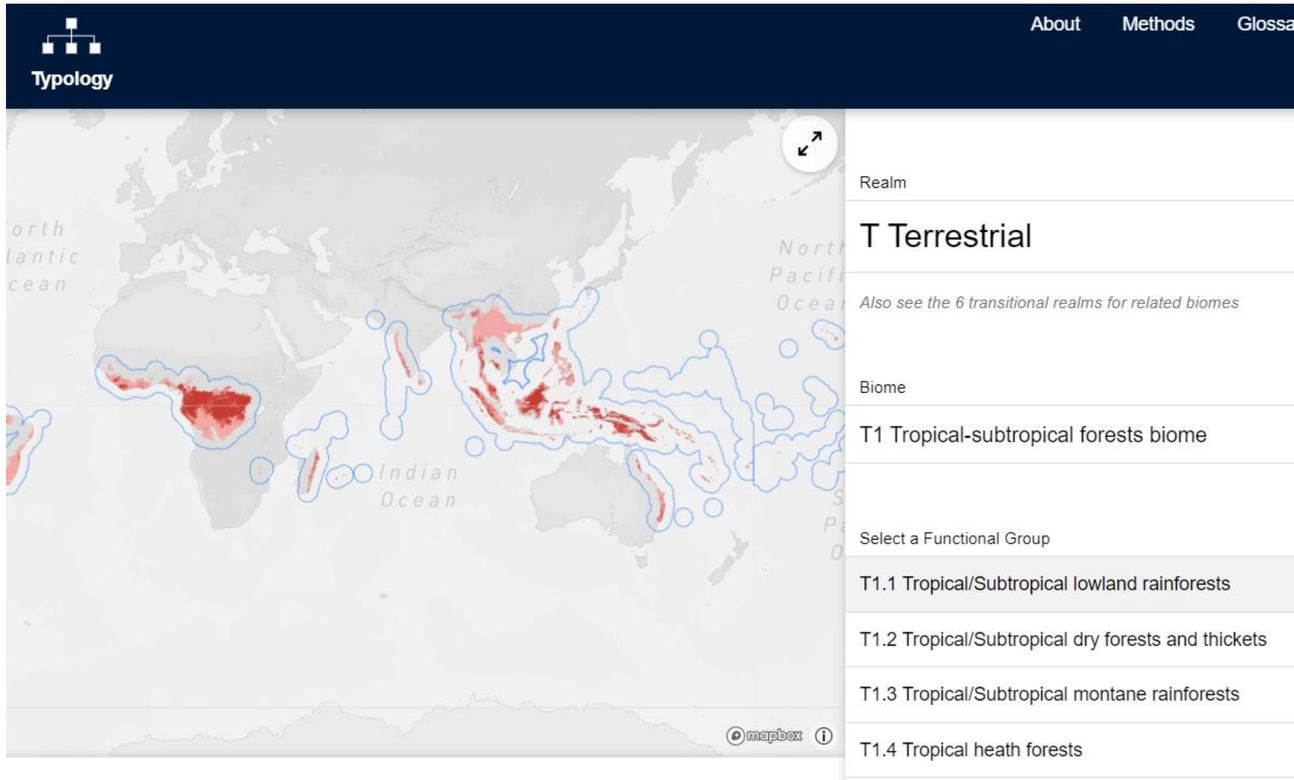
Ecosystem types https://global-ecosystems.org/explore



- Probabilistic maps with major and minor occurrences
- Can show if an ecosystem is **likely** found in your country
- Description of ecosystem properties, ecological drivers, global distribution



Principles of ecosystem asset delineation

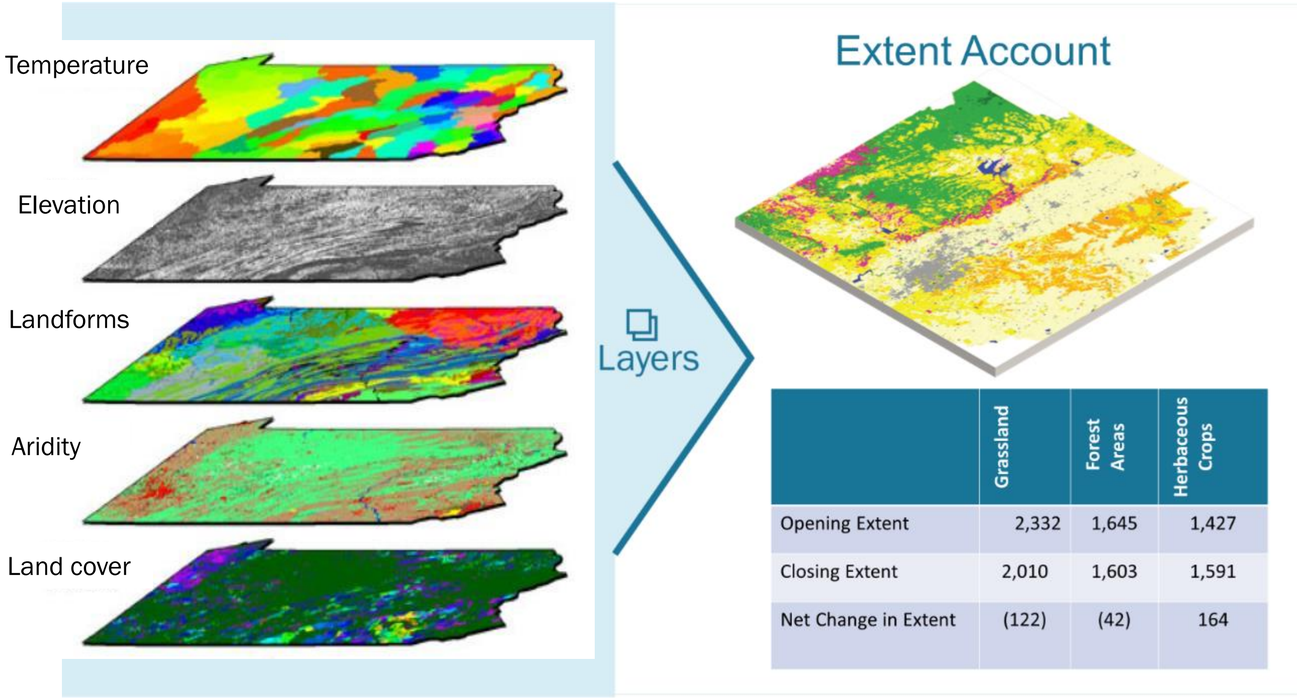
- Ecosystem assets should **represent ecosystems**
  - Alignment with CBD ecosystem definition (consideration of organisms, their environmental setting and ecosystem processes)
  - Keep it realistic: perfect is the enemy of good
- Ecosystem assets should be **capable of being mapped**
  - Location; size; shape
- Ecosystem assets should be **geographically and conceptually exhaustive** across ecological realms
  - Spatially comprehensive (no gaps)
  - Conceptually comprehensive
- Ecosystem assets should be **mutually exclusive**
  - Conceptually (single ecosystem type)
  - Geographically (no overlaps between e.g. land and ocean).

Three ways to to compile ecosystem maps

- Use existing national ecosystem classification / maps
  - > Cross walk to IUCN classification
- Use existing global maps & tools
  - > GeoAtlas, ARIES, WES, IUCN, etc.
- Construct your own ecosystem classification / maps
  - > Based on combining different maps, such as land cover, elevation, rainfall, temperature, etc.
  - > Based on historical ecosystem (vegetation) types overlaying with anthropogenic changes

Compiling extent accounts

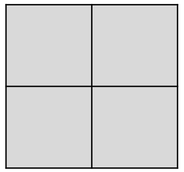
- Maps based on ecological ground-truthing would be ideal, but probably not practical/feasible
- Model extent on the basis of a multi-dimensional look-up table
  - > Inputs: land cover map, digital elevation model, temperature and landforms, etc.
    - Time series of land cover maps
    - Comparable maps (i.e. same classification; preferably also same techniques)
  - > Model derives which ecosystem type is to be found, where.



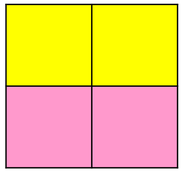
	Grassland	Forest Areas	Herbaceous Crops
Opening Extent	2,332	1,645	1,427
Closing Extent	2,010	1,603	1,591
Net Change in Extent	(122)	(42)	164

Compiling extent accounts

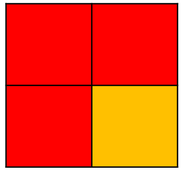
- Combining maps--simple example for illustration purposes only!



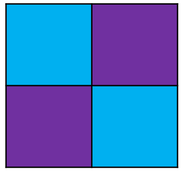
- Land cover
  - > Grey = tree-covered area
  - > Green = non tree-covered area



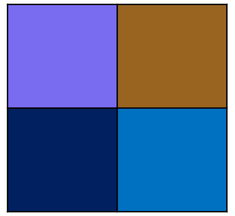
- Temperature
  - > Yellow = annual mean temperature > 18 C
  - > Pink = annual mean temperature <= 18 C



- Aridity
  - > Red = aridity index >.65 (moist)
  - > Orange = aridity index <= .65 (dry)



- Elevation
  - > Purple = elevation < 300m
  - > Blue = elevation >= 300m



- Hot, humid, elevated forest
  - > **T1.3** Tropical/subtropical montane rainforests
- Hot, humid, low-lying forest
  - > **T1.1** Tropical/subtropical lowland rainforests
- Temperate, humid, low-lying forest
  - > **T2.5** Temperate pyric humid forests
- Temperate, dry, elevated forest
  - > **T2.6** Temperate pyric sclerophyll forests and woodlands

ARIES for SEEA extent model

Methods

Maps **29 ecosystem functional groups** (EFGs, primarily terrestrial & wetland) based on IUCN GET 2.0 methods.[1] Consulted virtually with D. Keith & colleagues.

Data

Lookup table to model **IUCN EFGs,** based on: **temperature, landform, elevation, aridity, land cover**

Outputs

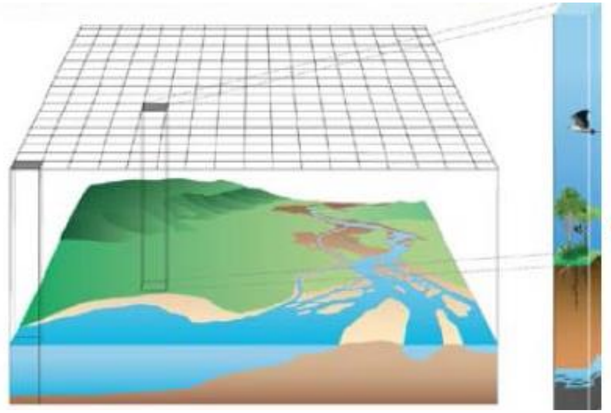
Net change, additions & reductions, change matrix for ecosystems & land cover types

Current work

Expanding to 39 terrestrial/wetland EFGs, including all forest EFGs, collaborating with IUCN GET team, expand to further freshwater/marine EFGs in future

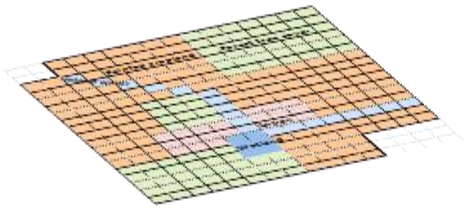
1: **Keith, D. et al. 2020**. IUCN Global Ecosystem Typology 2.0. IUCN: Gland, Switzerland. - **2:** Using thresholds from **Sayre, R., et al. 2020**. An assessment of the representation of ecosystems in global protected areas using new maps of World Climate Regions and World Ecosystems. Global Ecology and Conservation 21:e00860.

Extent account



- Vegetation
- Hydrology
- Pedology
- Elevation
- Bio-climate
- Etc.

Maps



Ecosystem type

Spatial units
Classifications

Ecosystem types (based on the EFG level 3 of IUCN GET)																			
	Terrestrial												Freshwater			Marine			
	T1 Tropical-subtropical forests				T2 Temperate-boreal forests and woodlands				…		T7		F1	…	FM1	M1	…	MFT1	
	Tropical/subtropical lowland rainforests	Tropical/subtropical dry forests and scrubs	Tropical/subtropical montane rainforests	Tropical heath forests	Boreal and temperate montane forests and woodlands	Deciduous temperate forests	…	Temperate pyric sclerophyll forests and woodlands	…	…	…	Derived semi-natural pastures and old fields	Permanent upland streams	…	Intermittently closed and open lakes and lagoons	Seagrass meadows	…	Coastal salt marshes and reedbeds	TOTAL
	T1.1	T1.2	T1.3	T1.4	T2.1	T2.2	…	T2.6	…	…	…	T7.5	F1.1	…	FM1.3	M1.1	…	MFT1.3	
Opening extent																			
Additions to extent																			
Managed expansion																			
Unmanaged expansion																			
Reduction in extent																			
Managed reductions																			
Unmanaged reductions																			
Net change in extent																			
Closing extent																			

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Extent account - structure

Ecosystem types (based on the EFG level 3 of IUCN GET)																			
	Terrestrial												Freshwater			Marine			
	T1 Tropical-subtropical forests				T2 Temperate-boreal forests and woodlands				…		T7		F1	…	FM1	M1	…	MFT1	
	Tropical/subtropical lowland rainforests	Tropical/subtropical dry forests and scrubs	Tropical/subtropical mon-tane rainfor…	Tropical h…	Boreal a… tane for…	Decidu… rests	…	Tempe… forests	…	…	…	Derive… tures a…	Perma… ms	…	Intermitte… and open la kes	Seagrass meadows	…	Coastal salt marshes and reedbeds	TOTAL
	T1.1	T1.2	T1.3	T1.4	T2.1	T2.2	…	T2.6	…	…	…	T7.5	F1.1	…	FM1.3	M1.1	…	MFT1.3	
Opening extent																			
Additions to extent																			
Managed expansion																			
Unmanaged expansion																			
Reduction in extent																			
Managed reductions																			
Unmanaged reductions																			
Net change in extent																			
Closing extent																			

Ecosystem classification

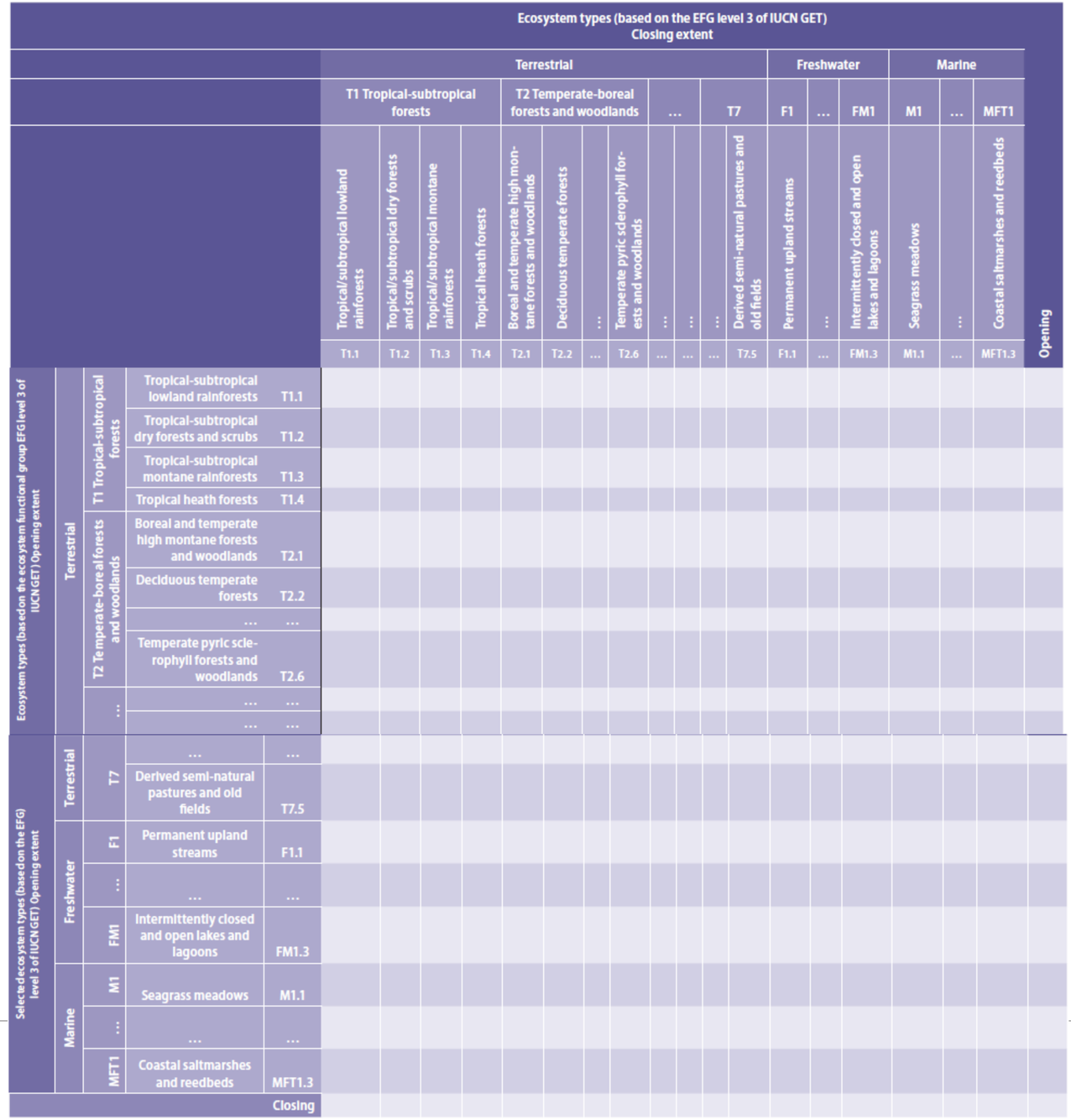
Additions to extent

Reductions in extent

Ecosystem type change matrix

The ET change matrix shows :

- the area of different ecosystem types at the beginning of the accounting period;
- **the increases and decreases in this area according to the ecosystem type it was converted from or to;**
- the area covered by different ecosystem types at the end of the accounting period.



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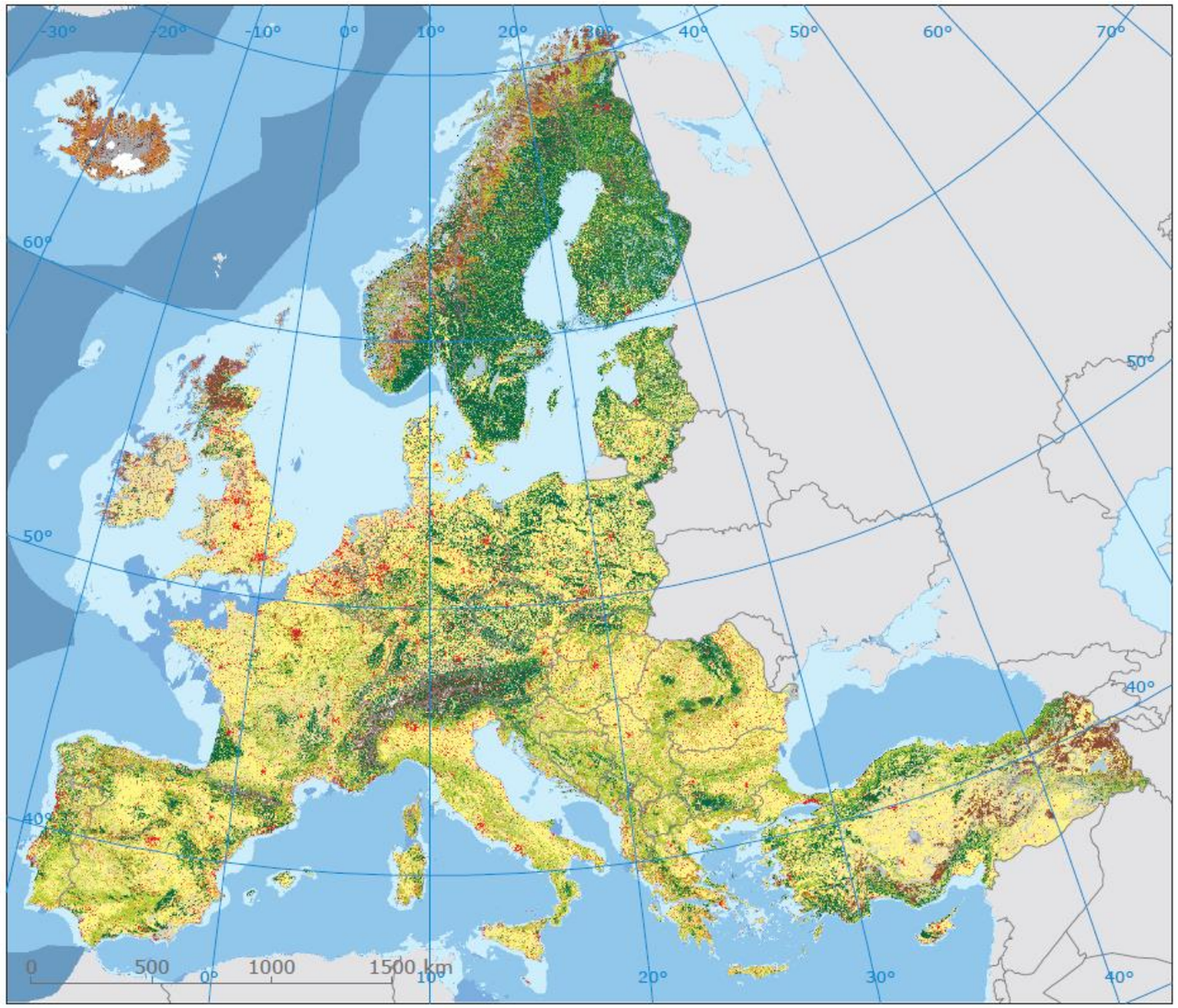
Example from the EU: Ecosystem extent account



Ecosystem map (aggregated)

Marine waters
- European regional seas
- Open waters

Marine seabed and coastal habitats
- Sublittoral sediment
- Infralittoral and circalittoral rock and other hard substrata
- Marine habitats
- Coastal habitats

Inland surface waters
- Inland waters and shores

Inland vegetation and habitats
- Tundra
- Arctic, alpine and subalpine scrub and grassland
- Mediterranean-mountain scrub and brushes
- Heathland scrub
- Grasslands and land dominated by forbs
- Regularly or recently cultivated agricultural, horticultural and domestic habitats
- Sparsely wooded grasslands
- Broad leaved deciduous and evergreen woodland
- Mixed deciduous and coniferous woodland
- Coniferous and broad leaved evergreen woodland
- Mires, bogs and fens

Inland unvegetated or sparsely vegetated habitats
- Screes, inland cliffs
- Snow or ice-dominated habitats
- Miscellaneous inland habitats with very sparse or no vegeation

Human made constructions and habitats
- Constructed, industrial and other artificial habitats

Non classified areas
- Unclassified areas
- Outside area of interest

Source: EEA, 2015a, *European ecosystem assessment: Concept, data, and implementation,* EEA Technical Report No 6/2015, European Environment Agency

Ecosystem extent account for the Netherlands

	Extent (km²) 2013	Increase (km²) 2013-2015	Decrease (km²) 2013-2015	Net change (km²) 2013-2015	Extent (km²) 2015	Increase (km²) 2015-2018	Decrease (km²) 2015-2018	Net change (km²) 2015-2018	Extent (km²) 2018
Total	41.542	3.357	3.357	0	41.542	3.629	3.629	0	41.542
Forest	3.475	74	106	-32	3.443	84	106	-22	3.422
Open nature	1.892	230	246	-17	1.876	240	235	5	1.881
Wetlands	612	42	29	13	625	44	38	6	631
Dunes, beach	497	18	20	-3	494	32	27	5	499
Water	7.861	64	47	17	7.879	86	45	41	7.920
Cropland	8.719	938	1.271	-332	8.386	1.238	1.208	30	8.416
Grassland	9.697	1.467	1.124	343	10.040	1.347	1.471	-123	9.917
Horticulture	203	12	19	-7	196	15	13	2	198
Other agr.	61	27	44	-18	43	34	31	2	46
Build up	7.636	382	373	9	7.645	399	370	29	7.674
Public green	888	104	78	27	915	111	86	25	940

Ecosystem extent account for South Africa

Natural or semi-natural biomes **Intensively modified biomes**

Biomes	Albany Thicket	Desert	Forest	Fynbos	Grassland	IOCB	Nama-Karoo	Savanna	Succulent Karoo	Azonal vegetation	Cultivated*	Built-up*	Water-bodies**	TOTAL
Historical extent	**3 531 231**	**626 207**	**462 518**	**8 165 366**	**33 090 325**	**1 171 284**	**24 936 548**	**39 418 522**	**7 821 579**	**2 742 873**	-	-	-	**121 966 453**
Additions to extent	0	0	0	0	0	0	0	0	0	0	16 156 026	3 003 883	2 096 528	21 256 437
Reductions in extent	230 091	8 237	70 673	2 253 375	11 330 606	619 656	420 995	5 396 119	251 373	675 312	-	-	-	21 256 437
Net change in extent	(230 091)	(8 237)	(70 673)	(2 253 375)	(11 330 606)	(619 656)	(420 995)	(5 396 119)	(251 373)	(675 312)	-	-	-	
Net change as % of historical	-6,5%	-1,3%	-15,3%	-27,6%	-34,2%	-52,9%	-1,7%	-13,7%	-3,2%	-24,6%	-	-	-	
Closing extent 1990	**3 301 140**	**617 970**	**391 845**	**5 911 991**	**21 759 719**	**551 628**	**24 515 553**	**34 022 403**	**7 570 206**	**2 067 561**	**16 156 026**	**3 003 883**	**2 096 528**	**121 966 453**
Opening extent 1990	**3 301 140**	**617 970**	**391 845**	**5 911 991**	**21 759 719**	**551 628**	**24 515 553**	**34 022 403**	**7 570 206**	**2 067 561**	**16 156 026**	**3 003 883**	**2 096 528**	**121 966 453**
Additions to extent	44 432	1 142	24 900	241 184	1 444 446	75 114	146 910	1 160 055	38 422	189 954	1 991 959	597 238	288 754	6 244 510
Reductions in extent	36 008	1 260	7 689	196 035	1 180 183	63 783	78 038	885 303	33 631	58 021	2 339 226	400 503	964 606	6 244 286
Net change in extent	8 424	(118)	17 211	45 149	264 263	11 331	68 872	274 752	4 791	131 933	(347 267)	196 735	(675 852)	
Net change as % of opening	0,3%	0,0%	4,4%	0,8%	1,2%	2,1%	0,3%	0,8%	0,1%	6,4%	-2,1%	6,5%	-32,2%	
Net change in relation to historical extent	(221 667)	(8 355)	(53 462)	(2 208 226)	(11 066 343)	(608 325)	(352 123)	(5 121 367)	(246 582)	(543 379)	-	-	-	
Net change as % of historical	-6,3%	-1,3%	-11,6%	-27,0%	-33,4%	-51,9%	-1,4%	-13,0%	-3,2%	-19,8%	-	-	-	
Closing extent 2014	**3 309 564**	**617 852**	**409 056**	**5 957 140**	**22 023 982**	**562 959**	**24 584 425**	**34 297 155**	**7 574 997**	**2 199 270**	**15 808 759**	**3 200 618**	**1 420 676**	**121 966 453**

* Cultivated areas, built-up areas and waterbodies are treated as biomes for the purpose of the ecosystem extent account table. There is no reliable spatial information on the historical extent of waterbodies, subsistence cultivation or habitation.

** The large net decrease in the extent of waterbodies reflects primarily that 1990 was a much wetter year than 2014. Waterbodies include both natural and artificial water bodies (such as dams).

Ecosystem extent account: Example from Brazil

Ecosystem extent accounts in Brazil (2000-2018)

Variáveis	Total		Bioma			
			Amazônia		Cerrado	
	Áreas naturais	Áreas antro-pizadas	Áreas naturais	Áreas antro-pizadas	Áreas naturais	Áreas antro-pizadas
2000						
Extensão de abertura	**5 877 298**	**2 510 306**	**3 684 512**	**450 865**	**1 185 192**	**790 693**
Adições	2 955	460 530	1 282	248 427	509	135 983
Reduções	326 066	137 419	193 539	56 170	96 274	40 218
2010						
Extensão	5 554 187	2 833 417	3 492 255	643 122	1 089 427	886 458
Adições	1 509	107 787	385	39 064	284	37 357
Reduções	69 316	39 980	27 376	12 073	23 068	14 573
2012						
Extensão	5 486 380	2 901 224	3 465 264	670 113	1 066 643	909 242
Adições	3 592	93 615	2 043	39 654	320	35 913
Reduções	49 030	48 177	21 123	20 574	18 392	17 841
2014						
Extensão	5 440 942	2 946 662	3 446 184	689 193	1 048 571	927 314
Adições	2 118	60 715	644	36 413	314	16 599
Reduções	36 435	26 398	23 541	13 516	8 417	8 496
2016						
Extensão	5 406 625	2 980 979	3 423 287	712 090	1 040 468	935 417
Adições	12 894	74 296	8 185	38 566	2 706	25 583
Reduções	32 098	55 245	16 761	30 057	10 688	17 671
2018						
Extensão final	**5 387 421**	**3 000 030**	**3 414 711**	**720 599**	**1 032 486**	**943 329**
Saldo das mudanças						
Absoluto (km²)	(-) 489 877	489 724	(-) 269 801	269 734	(-) 152 706	152 636
Percentual (%)	(-) 8,34	19,51	(-) 7,32	59,83	(-) 12,88	19,30
Movimentação						
Absoluto (km²)	536 013	1104 162	294 879	534 514	160 972	350 234
Percentual (%)	9,12	43,99	8,00	118,55	13,58	44,29

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Source: IBGE (2020). Ecosystem Accounts: Land Use in Brazilian Biomes, 2000-2018.

THANK YOU

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