

Program

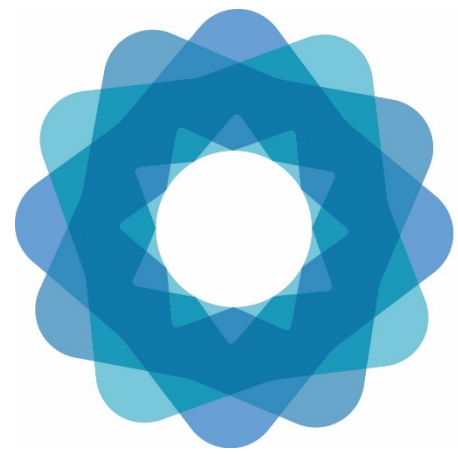
Morning:

- Recap on extent
- Condition account + exercise in ARIES for SEEA Explorer
- Coffee: 10.30-11.00
- Modeller: uploading shapefile + semantic annotation

Lunch: 12:30-13:30 lunch

Afternoon:

- Break-up per country
- Coffee: 15.00 -15.30
- ES recap



System of
Environmental
Economic
Accounting

Extent and condition accounts

Bram Edens, PhD

Senior Statistician, Environmental-Economic Accounts Section

United Nations Statistics Division



United Nations

Land accounts

SEEA land accounts

- Multiple accounts:
 - > Physical asset accounts
 - Land cover
 - Land use
 - *Ownership*
 - > Monetary asset account
- Different formats of land accounts:
 - > Asset accounts
 - > Change matrices
- Accounts – but derived from underlying maps
- Land accounts should be complete (cover whole territory of the country)

Land cover

- *The observed physical and biological cover of the Earth's surface and includes natural vegetation and abiotic (non-living) surfaces*
- Current land cover is a function of natural changes in the environment and of previous and current land use
- Sometimes combined with land use
- SEEA Land cover classification (interim)
- Based on definitions from the Land Cover Classification System (LCCS) of the FAO

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 inter-tidal areas

Land use

- Land use
 - > *reflects both (i) the activities undertaken and (ii) the institutional arrangements put in place; for a given area for the purposes of economic production, or the maintenance and restoration of environmental functions*
 - > Land that is “used” implies existence of some human intervention, including active management, e.g. protected areas
 - > Comprehensive: includes land in use and land not in use
- Differences with land cover:
 - > Clear-cutting
 - > Forest (part is protected area; part is used for logging)
- Categories not defined on economic activity, but rather general purpose and role of the user of the area
 - > If multiple uses, go with primary/dominant use

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

2.3 Other uses of inland waters n.e.c.

2.4 Inland waters not in use

Land asset account: basic form

	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								
<i>Total additions to stock</i>	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					
<i>Total reductions in stock</i>		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

- Managed → due to human activity
- Natural → resulting from natural processes
- Reappraisals → reflect changes due to use of updated information (e.g. new satellite imagery)
- Most countries only distinguish additions and reductions

Asset accounts: example South Africa

- Most countries only distinguish additions and reductions

Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Opening stock 1990	100 710 016	16 156 026	3 003 883	2 096 528	121 966 453
Additions to stock	3 366 559	1 991 959	597 238	288 754	6 244 510
Reductions in stock	2 540 175	2 339 226	400 503	964 606	6 244 510
Net change in stock	826 384	(347 267)	196 735	(675 852)	
<i>Net change as % of opening</i>	0.8%	-2.1%	6.5%	-32.2%	
Unchanged (opening - reductions)	98 169 841	13 816 800	2 603 380	1 131 922	
<i>Unchanged as % of opening</i>	97.5%	85.5%	86.7%	54.0%	
Turnover (additions + reductions)	5 906 734	4 331 185	997 741	1 253 360	
<i>Turnover as % of opening</i>	5.9%	26.8%	33.2%	59.8%	
Closing stock 2014	101 536 400	15 808 759	3 200 618	1 420 676	121 966 453

Source: Statistics South Africa 2020

Land account change matrix: example India

- Extremely useful and policy relevant, as it shows conversions

Table 1: Extent account for India's land use and land cover between 2011-12 and 2015-16

Land use / land cover classes		2015-16							Grand total (2011-12)		
		Agriculture	Barren / un-culturable	Built-up	Forest	Grass / grazing	Snow and glacier	Wetlands / water bodies	Area	% of geo-graphic area	
2011-12	Agriculture	1,809,033	5,103	2,648	2,299	94	8	2,547	1,821,732	55.41	
	Barren / unculturable	4,237	348,460	589	2,285	61	68,471	614	424,717	12.92	
	Built-up	238	442	118,239	48	2	0	29	118,998	3.62	
	Forest	5,085	6,838	205	712,342	207	637	230	725,543	22.07	
	Grass / grazing	147	408	118	368	22,502	1,333	521	25,397	0.77	
	Snow and glacier	0	1,643	0	131	7	30,799	1	32,581	0.99	
	Wetlands / water bodies	2,536	966	49	155	679	77	133,833	138,294	4.21	
Grand total (2015-16)		Area	1,821,276	363,860	121,848	717,629	23,551	101,325	137,774	3,287,263	99.99
		% of geo-graphic area	55.40	11.07	3.71	21.83	0.72	3.08	4.19	99.99	

Source: India Policy Brief 2021

Physical asset account for forest (and other wooded) land

- Distinguishes different types of forests
 - > Primary forest
 - > Planted forest
 - > Other woodland
- Sometimes distinguish between different species
- **Ideally consistent with land account**
- Follows FAO definition of forest
 - > Afforestation
 - > Deforestation
- Expressed in ha

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

	Type of forest and other wooded land				Total
	Primary forest	Other naturally regenerated forest	Planted forest	Other wooded land	
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

Ecosystem Extent Accounts

Land accounts vs ecosystem extent accounts

- Land cover/use data required for deriving ecosystem extent account:
 - > Land cover is a fundamental layer, but extent requires more.
 - > Identification of ecosystem types through delineation of various ecosystem characteristics (temperature, aridity, topography/elevation maps)
 - > Example: land cover = trees; temperature > 30 C = tropical forest
- SEEA EA recommends IUCN GET (Global Ecosystem Typology) as reference classification
 - > Realms (terrestrial) -> biomes (tropical forest) -> Ecosystem Functional Groups -> montane tropical forest
 - > 98 different EFGs
 - > National classifications (vegetation, ecozones) can be linked



IUCN Global Ecosystem Typology 2.0
Descriptive profiles for biomes and ecosystem
functional groups

David A. Keith, Jose R. Ferrer-Paris, Emily Nicholson and Richard T. Kingsford (editors)



2 Approaches for compiling extent accounts

- A: Model extent on the basis of a multi-dimensional look-up table
 - > Inputs: land cover; DEM; climate data, etc.
 - > Model derives which ecosystem type is to be found where.
 - > Ecosystem boundaries **dynamic**: e.g. can change due to climate change
 - pros: fully aligned with SEEA (e.g. directly derive IUCN GET classes); easy to derive other accounts in ARIES.
 - cons: no ecological ground-truthing i.e. ecosystem types are predicted by the model; conversion assumed to be instantaneous
- B: Assess land cover change within **static** biome/ecosystem type boundaries, a disaggregation of the land account
 - > **Historic** ecosystem types boundaries function as Ecosystem Accounting Areas
 - > Needs authoritative ecosystem map
 - pros: consistency with RLE assessment; can be done in ARIES but also in Arc/QGIS
 - cons: may require additional cross-walk to IUCN GET; may be difficult to define / obtain a historical extent

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.

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

Data
Lookup table to model IUCN EFGs , based on: temperature, landform, elevation, aridity, land cover ² , ca. 1992-2019

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.

Multi-dimensional look-up table

IUCN Global Ecosystem Typology v. 2.0 (SEEA)			ARIES Ecosystem Types Parameters					
Level 1 (realms)	Level 2 (biomes)	Level 3 (functional group)	ARIES ecosystem types	Landcover	Aridity index	Annual mean temperature (degree C)	Landform	Elevation (m)
		T1.1 Tropical-subtropical lowland rainforest	Tropical-subtropical lowland rainforest	Forest	> 0.65	> 18	all but mountain	all
		T1.2 Tropical-subtropical dry forests & thicket	Tropical-subtropical dry forest and thicket	Forest	0.05-0.65	> 18	all	all
		T1.3 Tropical-subtropical montane rainforests	Tropical-subtropical montane rainforest	Forest	> 0.65	> 18	mountain	all

Land cover data

- A key objective of accounting is to assess changes over time. This requires:
 - > a time series of land cover maps
 - > comparable maps (i.e. same classification; preferably also same techniques)
- Aries uses ESA-CCI data set as default for global (European Space Agency – Copernicus Climate Initiative)
 - > 300 m resolution, 22 land cover classes
 - > 1992-2019 (ESA-CCI will continue until 2025)
- Overall accuracy: 70 %
- New generation EO data has higher resolution (e.g. 10m), but:
 - > Shorter time series (e.g. 2017-2021)
 - > Few land cover classes (10 or so)
- At the moment we continue to use ESA CCI

Examples Ecosystem Extent

Example of ecosystem extent – South Africa



Table 14. Extent account for terrestrial ecosystem types summarised by biome, 1990 and 2014, in hectares***

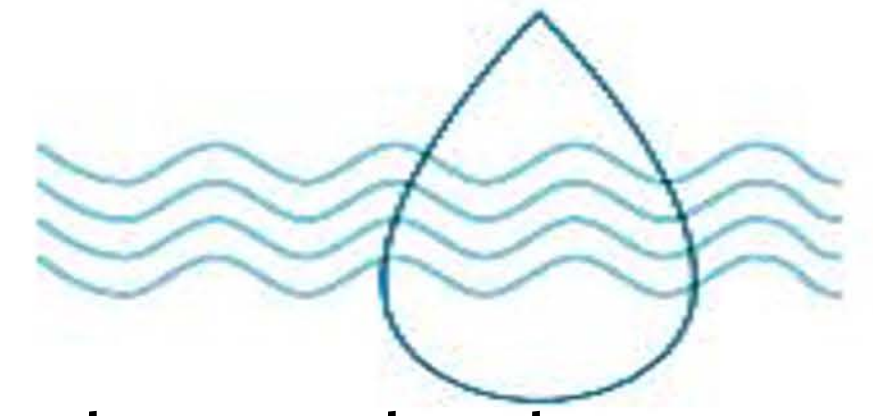
	Albany Thicket	Desert	Forest	Fynbos	Grassland	IOCB	Nama-Karoo	Savanna	Succulent Karoo	Azonal vegetation	Cultivated*	Built-up*	Water-bodies**	Total
Historical extent	3 531 231	626 207	462 518	8 165 366	33 090 325	1 171 284	24 936 548	39 418 522	7 821 579	2 742 873				121 966 453
Additions to extent	0	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.

** Changes in the extent of waterbodies between 1990 and 2014 reflect primarily that 1990 was a much wetter year than 2014. Waterbodies include both natural and artificial water bodies (such as dams).

*** Blank cells represent no data.

Example Brazil – SEEA and Goal A monitoring



Ecosystem extent accounts in Brazil (2000-2018)



- The ecosystem extent accounts (2000-2018), by biomes, show that Brazilian terrestrial biomes lost about 500 thousand km² of their natural areas, due to conversion into modified areas such as land used for crops and grazing.

Example – SEEA and Goal A monitoring

Variáveis	Total		Bioma			
			Amazônia		Cerrado	
	Áreas naturais	Áreas antropizadas	Áreas naturais	Áreas antropizadas	Áreas naturais	Áreas antropizadas
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

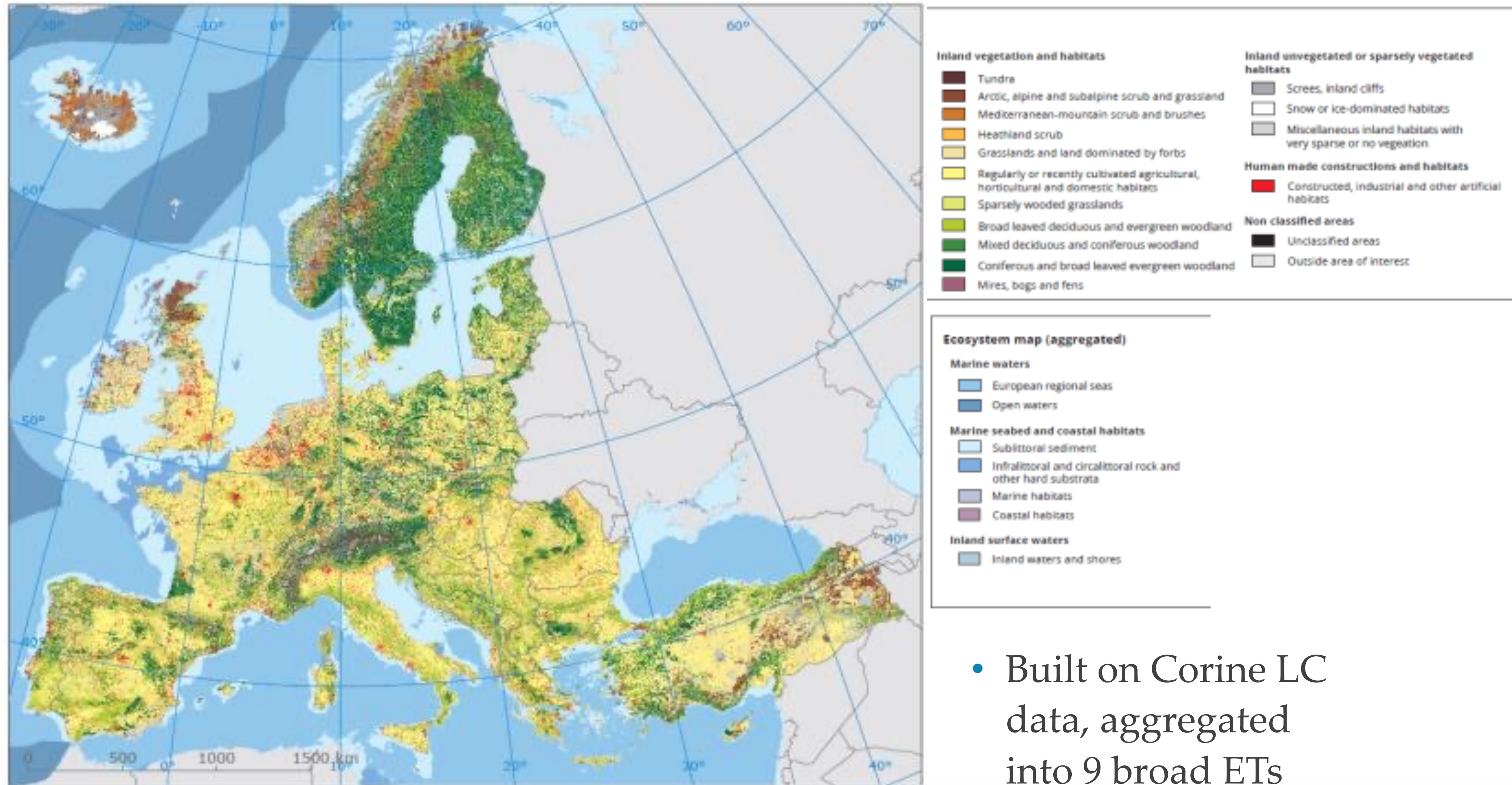
The **higher** absolute totals of **natural area reduction** were concentrated on the **Amazônia** and **Cerrado** biomes (**86,2%**)

Example: Ecosystem accounts in EU (1/3)

- In 2015, the EU launched a pilot project for an integrated system of ecosystem accounting, INCA
 - > Resulted in the compilation of extent, condition and ecosystem services accounts (Vysna et al., 2021)
- 2011 EU Directive on Environmental-economic accounts covers 6 modules
 - > Being expanded to include also ecosystems accounts; forest accounts and accounts for environmental subsidies + similar transfers



Ecosystem extent account (2/3)

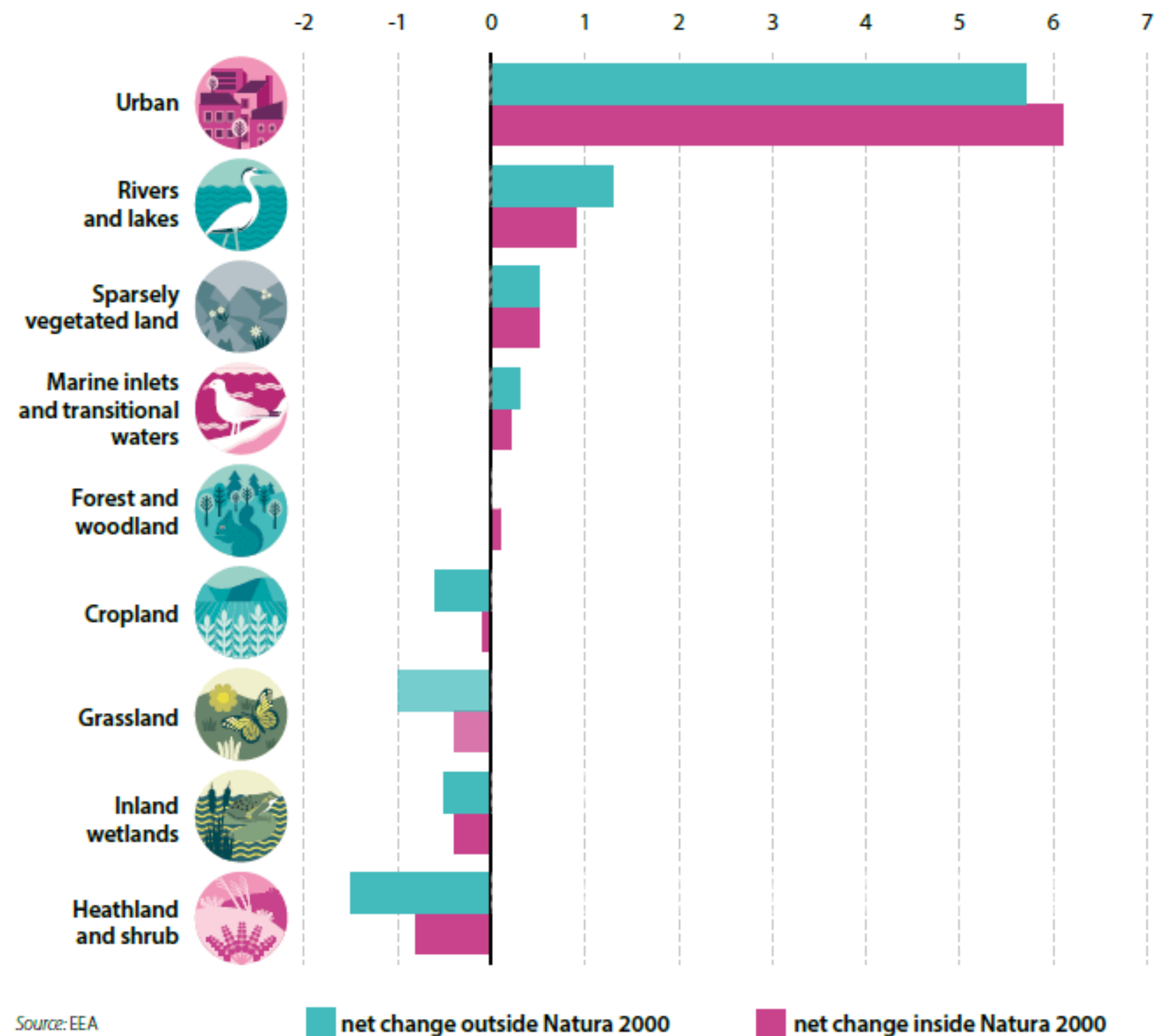


- Built on Corine LC data, aggregated into 9 broad ETs

Extent example, cont. (3/3)

- Some of the findings are:
 - > Urban ecosystems increased in extent by 5.8% (2000 – 2018) At the expense of farmland and semi-natural ecosystem.
 - > Changes in the extent of semi-natural ecosystem types are mostly smaller within the Natura 2000 areas than outside.

Figure 3: Changes in ecosystem extent inside and outside Natura 2000 areas, 2000-2018, EU28 (%)



Ecosystem Condition accounts

Ecosystem condition

- Ecosystem condition: **quality of an ecosystem** measured in terms of its abiotic and biotic characteristics.
- Condition is assessed wrt composition, structure and function which, in turn, underpin the integrity of the ecosystem, and support its capacity to supply ecosystem services on an ongoing basis.
- Naturalness and intactness are sometimes also used to describe the distance of an ecosystem from an (undisturbed) reference.
- Measures of ecosystem condition may reflect multiple values and may be undertaken across a range of temporal and spatial scales.
- Condition accounts **complement environmental monitoring systems** by using data from different monitoring systems, for example concerning biodiversity, water quality and soil properties.
- Key role is integrating data
- Ecosystem condition is often defined by measuring the similarity (or the distance) of a current ecosystem to a reference state, such as minimally impacted by people or a historical state

Condition accounts

- SEEA EA: a three-stage approach to account for ecosystem condition.
 - > The move from one stage to the next requires a progressive building of data and the use of additional assumptions.
 - > Outputs at each stage are relevant for policy and decision making
 - > The primary spatial units are ecosystem assets and these are expected to be delineated such that they are reasonably homogeneous in terms of their main characteristics
- Ecosystem condition indicators are rescaled versions of ecosystem condition variables
- The simplest conversion uses two reference levels to reflect a high or low condition score. In this case, the indicator is calculated by a linear transformation shown in the formula below.

$$I = (V - VL) / (VH - VL)$$

where I is the value of the indicator, V is the value of the variable, VH is the high condition score and VL is the low condition score.

Table 5.1: The SEEA Ecosystem Condition Typology (ECT)

ECT groups and classes

Group A: Abiotic ecosystem characteristics

- Class A1. Physical state characteristics:** physical descriptors of the abiotic components of the ecosystem (e.g., soil structure, water availability)
- Class A2. Chemical state characteristics:** chemical composition of abiotic ecosystem compartments (e.g., soil nutrient levels, water quality, air pollutant concentrations)

Group B: Biotic ecosystem characteristics

- Class B1. Compositional state characteristics:** composition / diversity of ecological communities at a given location and time (e.g., presence / abundance of key species, diversity of relevant species groups)
- Class B2. Structural state characteristics:** aggregate properties (e.g., mass, density) of the whole ecosystem or its main biotic components (e.g., total biomass, canopy coverage, annual maximum normalized difference vegetation index (NDVI))
- Class B3. Functional state characteristics:** summary statistics (e.g., frequency, intensity) of the biological, chemical, and physical interactions between the main ecosystem compartments (e.g., primary productivity, community age, disturbance frequency)

Group C: Landscape level characteristics

- Class C1. Landscape and seascape characteristics:** metrics describing mosaics of ecosystem types at coarse (landscape, seascape) spatial scales (e.g., landscape diversity, connectivity, fragmentation)

Variable account

Table 5.2: Ecosystem condition variable account

SEEA Ecosystem Condition Typology Class	Variables		Ecosystem type		
	Descriptor	Measurement unit	Opening value	Closing value	Change
Physical state	Variable 1				
	Variable 2				
Chemical state	Variable 3				
Compositional state	Variable 4				
	Variable 5				
Structural state	Variable 6				
Functional state	Variable 7				
Landscape/seascape characteristics	Variable 8				

Reference levels

- A reference level is the value of a variable at the reference condition, against which it is meaningful to compare past, present or future measured values of the variable
- A reference condition is the condition against which past, present and future ecosystem condition is compared to in order to measure relative change over time.

Possible reference conditions
Undisturbed or minimally-disturbed condition of an intact ecosystem. The condition of an ecosystem with maximal ecosystem integrity with no or minimal disturbance.
Historical condition: The condition of an ecosystem at some point or period in its history that is considered to represent the stable natural state (e.g., the pre-industrial period or pre-intensive agriculture).
Least-disturbed condition: the currently best available condition of an ecosystem.
Contemporary condition: The condition of an ecosystem at a certain point or period in its recent history for which comparable data are available.

Indicator account

Table 5.3: Ecosystem condition indicator account

SEEA Ecosystem Condition Typology Class	Indicators	Measure ment unit	Ecosystem type						
			Variable values		Reference level values		Indicator values (rescaled)		
	Descriptor		Opening value	Closing value	Upper level (e.g., natural)	Lower level (e.g., collapse)	Opening value	Closing value	Change in indicator
Physical state	Indicator 1								
	Indicator 2								
Chemical state	Indicator 3								
Compositional state	Indicator 4								
	Indicator 5								
Structural state	Indicator 6								
Functional state	Indicator 7								
Landscape/seascape characteristics	Indicator 8								

Condition index

Table 5.4: Ecosystem condition indices reported using rescaled indicator values ('mean values' approach)

SEEA Ecosystem Condition Typology Class	Indicators	Ecosystem type				
		Indicator value			Index value	
	Descriptor	Opening value	Closing value	Indicator weight	Opening value	Closing value
Physical state	Indicator 1	0.5	0.25	0.05	0.025	0.013
	Indicator 2	0.9	0.7	0.05	0.045	0.035
	<i>Sub-index</i>				<i>0.07</i>	<i>0.048</i>
Chemical state	Indicator 3	0.625	0.5	0.1	0.063	0.05
Total Abiotic characteristics					0.133	0.098
Compositional state	Indicator 4	0.94	0.89	0.067	0.063	0.062
	Indicator 5	0.75	0.50	0.033	0.025	0.017
	<i>Sub-index</i>				<i>0.088</i>	<i>0.079</i>
Structural state	Indicator 6	0.5	0.25	0.12	0.06	0.03
Functional state	Indicator 7	1	0.66	0.08	0.08	0.053
Total Biotic characteristics					0.228	0.162
Landscape and seascape characteristics	Indicator 8	0.5	0.2	0.5	0.25	0.1
Ecosystem condition index	Index			1.0	0.611	0.360

Condition index - alternative

Table 5.5: Ecosystem condition indices reported using discretised ranges (i.e., area (%) in each range of condition)

SEEA Ecosystem Condition Typology Class	Indicators		Ecosystem type					
	Descriptor	Indicator weight	Opening value			Closing value		
			High	Medium	Low	High	Medium	Low
Physical state	Indicator 1	0.05	10	80	10	5	45	50
	Indicator 2	0.05	70	25	5	60	20	20
	<i>Sub-index</i>		40	52.5	7.5	32.5	32.5	35
Chemical state	Indicator 3	0.1	30	40	30	20	50	30
Compositional state	Indicator 4	0.067	80	15	5	80	10	10
	Indicator 5	0.033	100	0	0	0	0	100
	<i>Sub-index</i>		86.6	10.1	3.4	53.6	6.7	39.7
Structural state	Indicator 6	0.12	30	30	40	10	20	70
Functional state	Indicator 7	0.08	100	0	0	50	30	20
Landscape and seascape characteristics	Indicator 8	0.5	30	30	40	20	20	60
Ecosystem condition index	Index	1.0	42.2	28.9	28.9	25.8	23.7	50.5

Multiple ecosystem types

Table 5.6: Ecosystem condition account (condition indices) for multiple ecosystem types

Accounting entries	Stylized ecosystem types					
	Forests	Lakes	Cropland	Urban areas	Wetlands	Seagrass
Opening condition value						
Change in abiotic ecosystem characteristics (physical and chemical state)						
Change in biotic ecosystem characteristics (composition, structure and function)						
Change in landscape/seascape characteristics						
Net change in condition						
Closing condition value						

Table 5.7: Examples of ecosystem condition variables for selected ecosystem types⁵²

		A1 Physical state	A2 Chemical state	B1 Compositional state	B2 Structural state	B3 Functional state	C1 Landscape / seascape
T1	Tropical-subtropical forests	Soil water availability in the driest quarter; Wetness	Soil organic carbon content; Leaf and litter nitrogen concentration	Tree species richness; Bird species richness	Tree cover density; Dominant tree height; Number of canopy layers; Deadwood volume; Forest age class distribution; Density of epiphytes	Dry matter productivity; Presence of seed dispersing species (capacity for regeneration); Water stress index	Forest area density; Landscape diversity; Forest connectivity; Ratio of edge distance to interior area of forest patches
T2	Temperate-boreal forests & woodlands biome	Vegetation water content (NDWI)	Soil organic carbon content; Air pollutant concentration; Foliar and litter nitrogen concentration	Tree species richness; Lichen species richness; Bird species richness	Forest floor depth (soil layer thickness); Tree cover density; Deadwood volume; Forest age class distribution	Dry matter productivity; Density of trees with hollows for nesting; Presence of top predator species (food web functionality); Vegetation index (NDVI); Water stress index	Forest area density; Landscape diversity; Forest connectivity;
T3	Shrublands & shrubby woodlands	% Burnt area; Soil layer thickness	Soil organic carbon content; Soil phosphorus concentration	Bird species richness	Tree cover density	Dry matter productivity; Proportion of re-sprouting species after fire (capacity for regeneration)	Landscape diversity; Shrubland/forest connectivity
T4	Savannas and grasslands	% Bare ground	Soil organic carbon content; Soil pH	Bird species richness; Butterfly species richness; Proportion of non-native species	The presence/density of trees/shrubs	Dry matter productivity Abundance of termite mounds (organic matter turnover)	Connectivity of trees; Grassland connectivity
T5	Deserts and semi- deserts	Water availability; Degree of surface crusting	Soil pH	Reptile species diversity or abundance	Vegetation cover	Density of viable seeds in soil (capacity for regeneration)	Spatial distribution of waterholes
T6	Polar-alpine (cryogenic)	% Bare ground; Snow depth; Extent of sea ice	Pollutant concentrations	Lichen species richness	Vegetation cover; Lichen cover or abundance on rocks		Diversity of habitat types; Connectivity of routes for migratory species
T7.1	Annual croplands	Water holding capacity; Soil bulk density; Vegetation water content (NDWI)	Soil organic carbon content; Soil nutrient availability	Bird species richness	Share of organic farming; Crop diversity; Share of time or area as fallow land	Soil respiration rate (decomposition); Gross primary production	The presence/ share of semi-natural vegetation fragments (small woody features); Landscape diversity (mosaic)
T7.4	Urban and	Imperviousness	NO ₂ concentration	Bird species richness	Share of urban green		Average distance of residents to

Examples Ecosystem Condition

EU: Forest condition variable account

Table 2: Forest condition variable account for EU28 (spatially averaged values)

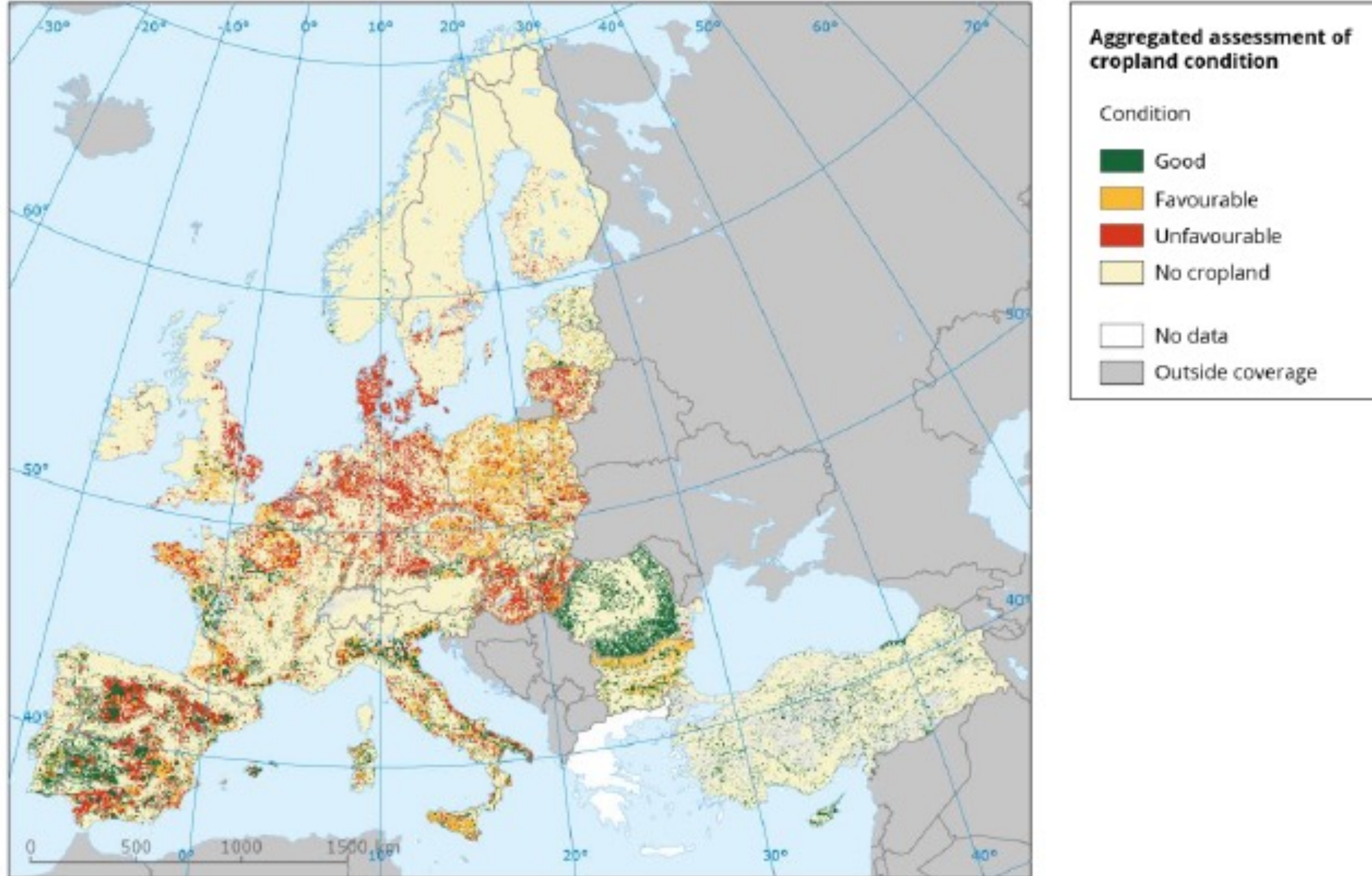
Condition group	Condition class	Descriptor	Units	Opening stock (2010)	Closing stock (2020 - projected)	Change (% per decade)	Confidence
Abiotic characteristics	Physical state	Soil moisture content	%	13.50	13.45	-0.4	medium
	Chemical state	Effective rainfall	mm/year	-32	-44	-38	high
		Exceedances of critical loads for eutrophication	equivalent/ha/ year	251.8	173.7	-31	medium
		Tropospheric ozone concentration	ppb hours	19 265	13 293	-31	high
Biotic characteristics	Composition	Common forest birds index (*)	Index (1990 = 100)	93.23	104.86	17.8	medium
	Structure	Biomass volume	m³/ha	200	220	10	medium
		Dead wood	tonne/ha	4.1	4.5	10.3	medium
		Defoliation	%	20	22	10	high
	Function	Evapotranspiration	mm/year	482.0	490.2	1.7	high
		Dry matter productivity	tonne/ha/year	11.8	13.1	11.1	high
Landscape characteristics		Forest area density	%	72.0	72.1	0.1	high

Source: sdg_15_60, EU Ecosystem Assessment

(*) Closing stock for the common forest bird index uses year 2017

- Some findings:
 - > Forest pollution levels are declining across the EU28 but absolute levels of still very high
 - > Forest productivity increased.
 - > Pressures from climate change are increasing (evapotranspiration up; effective rainfall down)
 - > Concerning trend is defoliation
 - > Fragmentation remained virtually constant since 2010.

Ecosystem condition account - EU





Experimental System of Ecosystem Accounts in Spain



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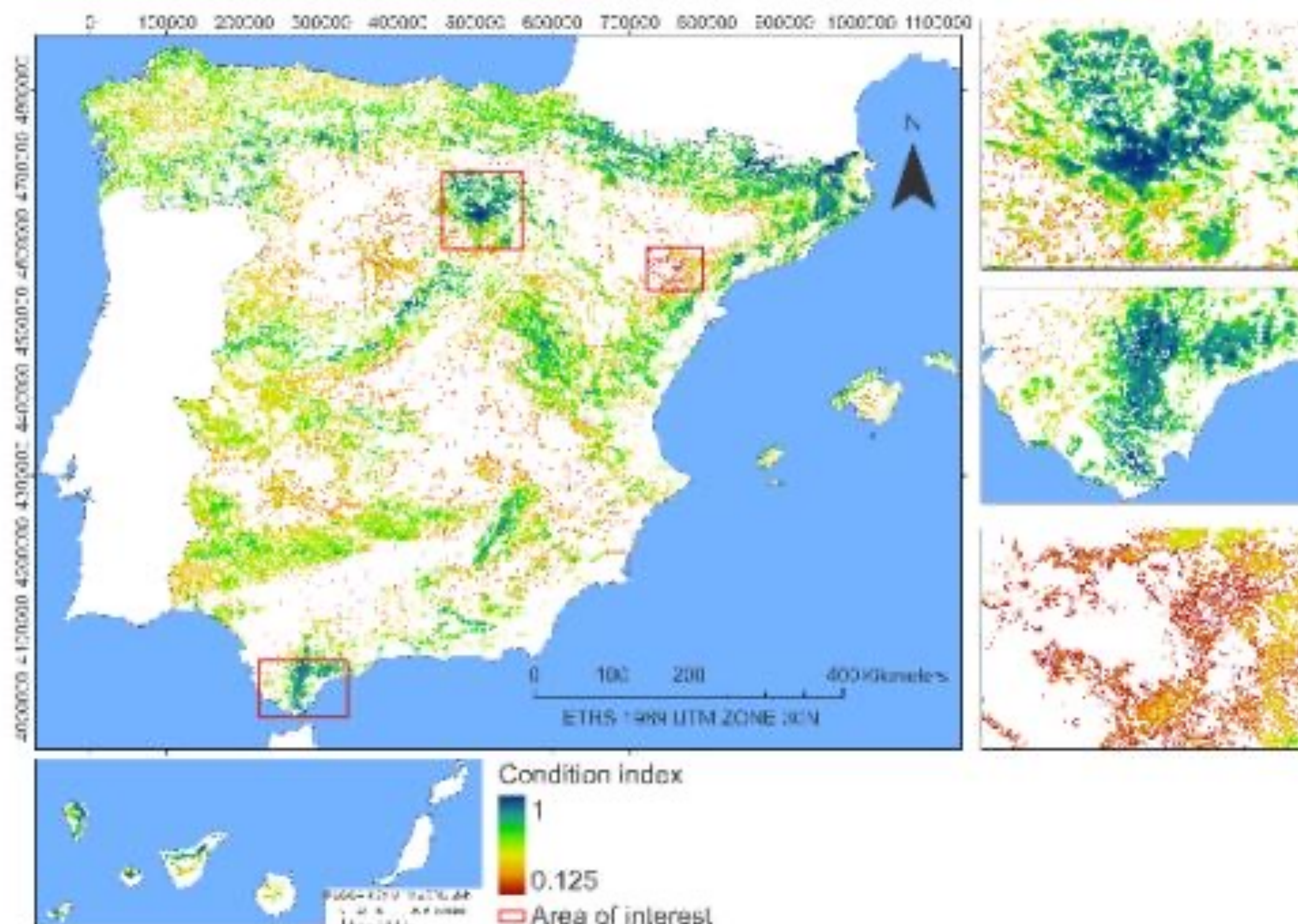
2. CONDITIONS ACCOUNTS: The SEEA-EA condition is a metric that captures, through a set of key indicators, the state and functioning of the ecosystem in relation to both its ecological condition and its capacity to provide ecosystem services.

Indicators used in the forest condition in Spain

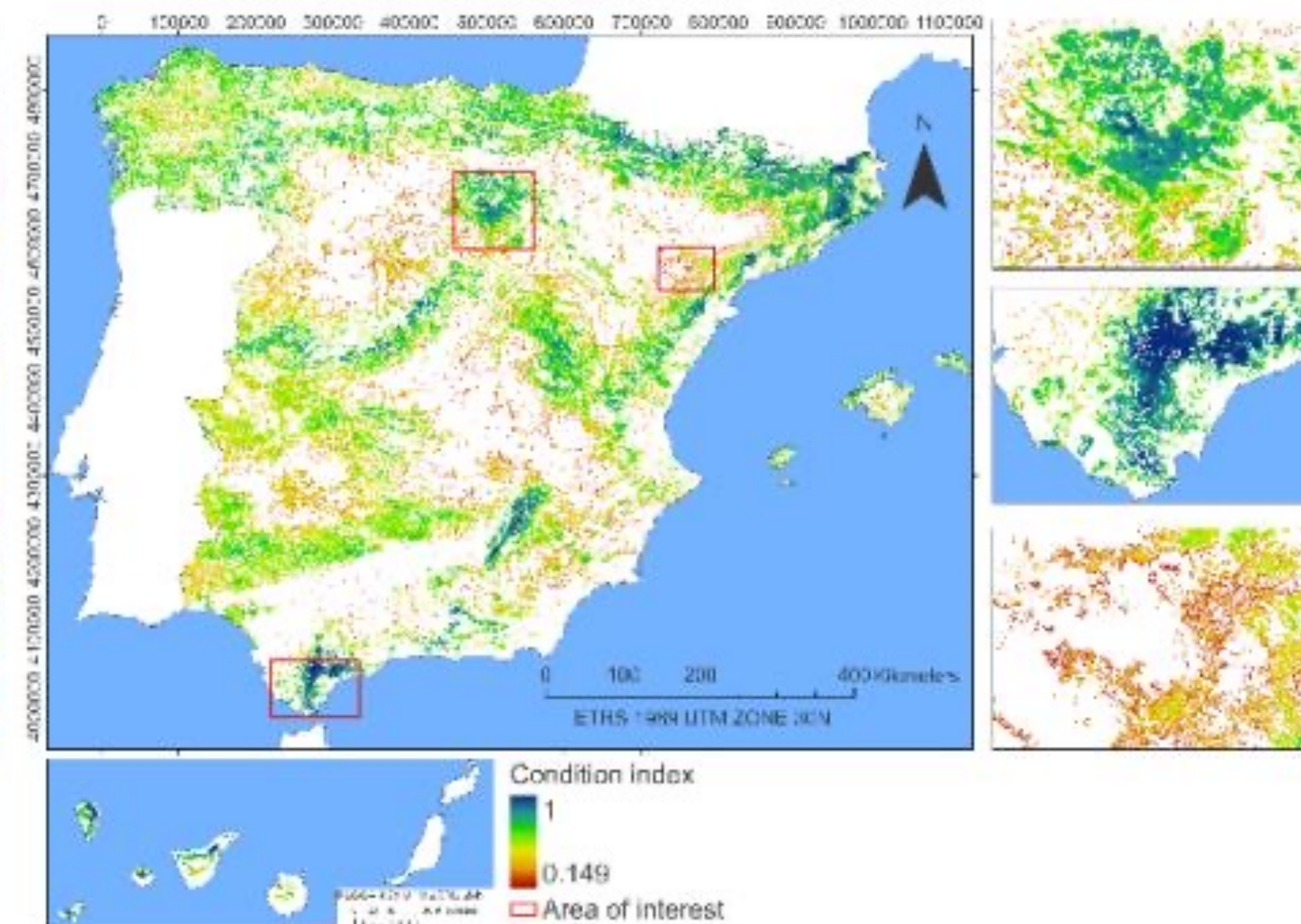
Group	Class	Weight	Indicator	Source	Resolution (m)
Abiotic characteristics	Physical state	0,07	NDWI	Landsat	30
		0,07	Soil organic carbon	Lucas	1000
	Chemical state	0,07	Ozone (AOT40f)	EEA	2000
		0,07	Nitrogen Deposition (Critical Loads)	EEA	5000
Biotic characteristics	Composition state	0,1	Forest bird richness	MITERD	1000
		0,1	Richness of forest flora	MITERD	1000
	Structural state	0,12	Tree cover	Modis	250
	Functional state	0,1	NDVI	Landsat	30
		0,08	Gross primary production	Modis	500
Landscape characteristics	Landscape characteristics	0,12	Forest area density	Guidos	50
		0,1	Naturalness index	Guidos	50

2. CONDITIONS ACCOUNTS: results are presented in maps for forest ecosystems for different time periods between 2000-2015.

2000



2015





Experimental System of Ecosystem Accounts in Spain



MAIA
Mapping and Assessment for
Integrated ecosystem Accounting

2. CONDITIONS ACCOUNTS: results are presented in **accounting tables** for forest ecosystems for different time periods between 2000-2015.

Condition index by forest type

Forest Type	2000	2015	Change	Forest Type	2000	2015	Change
Broad. Sclerophyllous Med.	0.536	0.561	0.025	Con. Atlantic	0.601	0.630	0.029
Broad. Continental Med.	0.556	0.565	0.009	Con. Alpine	0.735	0.730	-0.005
Broad. Mountain Med.	0.607	0.598	-0.009	Con. Insular	0.585	0.660	0.075
Broad. Atlantic	0.568	0.602	0.033	Mixed Sclerophyllous Med.	0.571	0.601	0.030
Broad. Alpine	0.661	0.693	0.032	Mixed Continental Med.	0.602	0.606	0.005
Broad. Insular	0.661	0.712	0.050	Mixed Mountain Med.	0.591	0.601	0.009
Con. Sclerophyllous Med.	0.546	0.573	0.027	Mixed Atlantic	0.580	0.616	0.036
Con. Continental Med.	0.593	0.596	0.003	Mixed Alpine	0.758	0.775	0.017
Con. Mountain Med.	0.609	0.606	-0.003	Mixed Insular	0.654	0.716	0.063

India – condition index (alt)

- NCAVES project:
 - > Uttrara Kanada district
- Integrates 20 different variables
 - > multiple soil characteristics such as organic carbon, nitrogen, pH;
 - > status of flora and fauna in terms of endangered species;
 - > structural state variables such as above and belowground biomass;
 - > net primary productivity as key measure for functional status;
 - > land surface temperature and forest fragmentation
- Each of these variables were assessed using spatial data and models

Table 1: Condition accounts of Uttara Kannada (2005-2020)

Districts	SEEA -EA Conditions	Indica tor	Para meter	Opening -2005 (%)				Closing - 2020 (%)			
				Weight	High	Med.	Low	High	Med.	Low	
Uttara Kannada	Abiotic ecosystem	Soil	K	0.017	0.0	84.4	15.6	0.0	99.3	0.7	
		Soil	N	0.017	100.0	0.0	0.0	0.0	0.0	100.0	
			P	0.017	0.0	0.0	100.0	37.6	62.4	0.0	
			OC	0.017	0.0	72.4	27.6	0.0	100.0	0.0	
			S	0.017	45.4	54.6	0.0	45.4	54.6	0.0	
			Zn	0.017	0.0	85.8	14.2	0.0	100.0	0.0	
			Fe	0.017	0.0	100.0	0.0	0.0	100.0	0.0	
			B	0.017	0.0	0.0	100.0	0.0	0.0	100.0	
			Cu	0.017	0.0	99.3	0.7	0.0	99.3	0.7	
			Mn	0.017	0.0	100.0	0.0	0.0	100.0	0.0	
			EC	0.017	100.0	0.0	0.0	100.0	0.0	0.0	
			pH	0.017	94.4	5.6	0.0	100.0	0.0	0.0	
			Biotic - Compositional State	Flora		0.05	87.8	5.5	6.7	73.1	5.5
	Fauna			0.05	56.3	11.0	32.7	46.9	11.0	42.1	
	Biotic - Structural State	AGB		0.05	46.2	35.2	18.6	33.1	42.1	24.8	
		BGB		0.05	46.2	35.2	18.6	33.1	42.1	24.8	
	Biotic - Functional State	NPP		0.10	32.4	55.2	12.4	1.4	84.8	13.8	
	Landscape Level	Fragmentation			0.25	55.0	10.8	34.2	45.8	13.5	40.8
		LST			0.25	20.6	53.2	26.2	0.6	69.9	29.6
	Ecosystem condition Account			Index	1.00	39.6	35.9	24.5	25.8	46.3	28.0

Note: N: Nitrogen, P: Phosphorous, K: Potash, OC: Organic Carbon, Zn: Zinc, Fe: Iron, B: Boron, Cu: Copper, Mn: Manganese, S: Sulphur, EC: Electrical conductivity, AGB: Above ground biomass, BGB: Below ground Biomass, NPP: Net Primary Productivity, LST: Land Surface Temperature

