DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
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System of Environmental Economic Accounting

An ecosystem type classification for the SEEA EEA

A paper for the 25th meeting of the London Group on environmental accounting Melbourne, 7-10 October 2019

This paper is based on the work of the SEEA EEA Revision Working group 1 spatial units[1] coordinated by the United Nations Statistics Division.

Questions for the London group:

1. Do you agree with we next steps as described in section 4 ?
2. What is needed in addition to test and implement a reference classification for ecosystem types ?
3. Would you want to volunteer and help in the testing ?

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1. Introduction

Spatial areas are at the heart of ecosystem accounting. The conceptual model of the SEEA EEA envisages the delineation of areas within a country or a specific region into contiguous, mutually exclusive units, each covered by a specific ecosystem, i.e. dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (CBD, 1992, Article 2, Use of Terms). Each of these units comprises an ecosystem asset, and these form the conceptual base for accounting, in terms of the organization of data on relevant stocks and flows, and the integration of these data within accounts. The stocks are represented by the ecosystem assets, and the flows by the ecosystem services that are supplied by these stocks. Each ecosystem asset is therefore considered to supply a specific basket of ecosystem services. Generally, ecosystem accounts will be compiled and presented according to each ecosystem type (the aggregate area of all ecosystem assets representing each ecosystem type) rather than for individual ecosystem assets. Thus, a classification describing the ecosystem types and a map showing their occurrences in the ecosystem accounting area are essential components of ecosystem accounting as it allows tracking changes in ecosystem assets over time.

The spatial delineation of ecosystems may include a range of ecological and non-ecological characteristics, including vegetation type, soil type, hydrology, climate, land management, land use, and ownership. Approaches to classifying ecosystems vary depending on the particular application for which the classification is being developed, with different emphases on environmental characteristics and ecosystem structure and function. The UN SEEA ecosystem accounting concept requires ecosystem classifications suitable for statistical analysis and accounting. Moreover, to achieve standardization in national reporting and to allow for inter-comparison of results across nations, a set of global, higher order, major ecosystem groupings is necessary. The SEEA Experimental Ecosystem Accounting (2012) and the recent Technical Recommendations (2017) recommended the use of an interim, land-cover classification as a starting point for an ecosystem classification. However, it was recognized that this classification is very coarse, and lacks a clear ecological basis. For ecosystem accounting, in principle, we need to go beyond land cover and consider a wider range of characteristics in delineating ecosystem assets. Furthermore, the initial classes were recognized as emphasizing satellite image derived terrestrial ecosystems, with inadequate or no emphasis on urban, freshwater, marine water, and seabed ecosystems. **Therefore, a key revision issue for SEEA EEA is to develop a proposal for a reference classification for ecosystem types that better represents the concept and coverage of ecosystems to be used for ecosystem accounting.**

The Working Group on spatial units (WG#1) has developed proposals for a statistically based reference classification of ecosystem types (ET) for ecosystem accounting based on assessment of existing classifications of this type. This paper first reiterates in *section 2* these proposals as were described in more detailed a discussion paper prepared by the working group[2]. In *section 3* the main conclusions are presented based on an expert review and the discussions ion the Glen Cove meeting. Finally, in *section 4* the way forward is discussed with regard to testing the chosen ET reference classification and cross walking it with other classification schemes.

[2] https://seea.un.org/sites/seea.un.org/files/documents/EEA/seea_eea_revision_wg1_discussion_paper_1.1_classification_ecosystemtypes.pdf

2. Options for a (high level) reference classification scheme

Working group 1 proposed five options for a high-level international reference classification for ecosystem types. **The starting point for choosing these options is that we want to propose an existing international classification that complies with all (or most) of the design criteria that we have defined.** For each option it is explained why this as an option, a short description of the classification is provided and the main strengths and weaknesses are identified.

2.1 Option 1: The IUCN RLE classification

Why choose this as an option?

- *Complies to all design criteria*
- *This classification takes ecosystems as its conceptual base*
- *Includes approach for further disaggregation*

Short description

The Red List of Ecosystems (RLE) classification (IUCN ET classification) as has been developed by IUCN (Keith et al. 2019 in prep.) represents a global typological framework that applies process-based approach to ecosystem classification across the whole planet. The primary aim of this framework is to develop a scalable framework that support generalizations about groups of functionally similar ecosystems and recognizes different expressions within these groups defined by contrasting biotic composition. Ecological assembly theory is used to identify key properties that distinguish functionally related ecosystems, and synthesize traditionally disparate classification approaches across terrestrial, freshwater and marine environments.

The hierarchical structure consists of six levels (see Annex 1): three upper levels differentiate functional properties. The top level of classification defines four realms of the biosphere: marine (M); freshwaters and saline wetlands (F); terrestrial (T); and subterranean (S). The second level of classification broadly follows the 'modern biome concept' (Mucina 2018). The ecosystem typology recognizes 25 biomes: four marine; three freshwater; seven terrestrial; four subterranean; and seven in transitional realms. Many of the units recognized at Level 2 by their distinctive ecological traits are familiar as 'traditional' biomes, including rainforests, deserts, reefs, freshwater lakes and others. In addition, four biomes are 'anthromes' defined by anthropogenic processes, where human activity is pivotal to ecosystem assembly and maintenance of ecosystem components and processes. Level 3 of the classification describes functionally distinctive groups of ecosystems within a biome. Ecosystem types within the same Functional group are united by a distinctive set of traits that result from unique combinations of assembly filters that come to the fore in particular environments.

Strengths

- The IUCN ET classification complies with all design criteria (see section **Fout! Verwijzingsbron niet gevonden.** of the Discussion paper).
- Of key Importance is that this classification is one of the few that has an explicit theoretical foundation and takes ecosystem as its conceptual base. The conceptual model underlying the classification is based on ecological processes that help frame ecosystem assets (stocks) and the services they provide (flows), as required in UN SEEA-EEA.
- Other key qualities of the typology including representation of biota, scalability, comprehensiveness and parsimony are intimately linked to its structure, and are supported by a clearly defined terminology and explicit descriptions of units to aid ecosystem identification.
- Clear hierarchal structure.
- Includes an approach to further disaggregation on national / regional level.
- Linked to other policy-relevant tools such as IUCN Red List of Ecosystems, with substantial existing buy-in at national and international levels.

- Developed by a large global network of terrestrial, freshwater and marine ecosystem specialists.
- Support infrastructure for users provided by IUCN.

Weaknesses

- For use in ecosystem accounting, the classification would have to be mapped out across the ecosystem accounting area. A map of the global distribution of the spatial occurrences of the ecosystem classes is not currently available.
- The classification has not yet been officially published, this will probably occur in May / June 2019.
- The classification focusses on natural ecosystems and less so on agriculture / urban areas
- Number of classes (at level 3) may be too high (100)?

2.2 Option 2: USGS/Esri GDBBS

Why choose this as an option?

- *Complies to all design criteria*
- *Manageable set of units*
- *Includes practical approach for further disaggregation*

Short description

This classification provides a high-level set of global ecosystem reporting categories representing globally distinct biophysical and biogeographic settings (GDBBS) that can be used as ecosystem proxies for SEEA ecosystem reporting. It is based on several USGS/Esri/GEO Global Ecosystems Mapping Products (Sayre et al, 2014; 2016; 2017; 2018). The categories were developed using strict criteria that ecosystems spatial units be geographically mutually exclusive (non-overlapping), and conceptually and geographically exhaustive. The new units are biome-level ecosystem groupings, and the new classification represents a map-based partitioning which first assigns all geographic space into an environmental domain, and then further partitions those domains into mutually exclusive and exhaustive biomes as high order ecosystem groups. A number of recognized global ecosystems and global land cover classifications and maps were reviewed and contributed to the development of the revised units. The new set of classes is distinguished from previous classifications in that it is comprehensive across all environmental domains, mutually exclusive, spatially and conceptually exhaustive, and readily understood by the broadest possible user groups.

The units of the first two tiers in a hierarchical classification represent all ecosystems on the planet (see Annex 2). Subsequent levels in the classification are determined by the primary, secondary, and successive key drivers that influence biotic distributions within each major ecosystem type. These types are both domain comprehensive and geographically exhaustive in x (longitude), y (latitude), and z (elevation/depth) spatial dimensions, such that any location on Earth will fall into one and only one major ecosystem type and its parent domain. It thus provides a flexible approach for further disaggregation on a national / regional level.

Strengths

- This classification complies to all design criteria (see section **Fout! Verwijzingsbron niet gevonden.** of the Discussion paper)..
- Very comprehensive in environmental descriptions and factors (e.g. for terrestrial: climate, landform, substrate chemistry – the three main drivers for vegetation distributions).
- Includes an approach to further disaggregation on national / regional level.
- Geodata (at 250m resolution) for the terrestrial domain is available on ArcGIS Online.

Weaknesses

- Not explicitly based on biotic factors
- Number of units for terrestrial environment quite small (7, including the built environment)

- The derivation of the finest level units is well described in multiple publications (Sayre et al., 2014, 2017, 2018). The logic for and method of aggregation of these building block units into the higher order classes is not yet published (manuscript in preparation – Sayre et al., 2019).

2.3 Option 3: Bridging IUCN ET and USGS/Esri

Why choose this as an option?

- *Fully hierarchic approach, allowing for mapping on multiple scales*
- *Explicit links with USGS/ESRI major ecosystems (option 2 units) on the coarse levels of the hierarchy to warrant mappability, especially for areas lacking in ecological ground-truth data.*
- *Maximal use of IUCN RLE units (option 1) to populate the fine levels to maximize ecological meaningfulness.*

Short description

Both the IUCN ET classification and the USGS/Esri mapping system have many strengths, but there are some issues making each of these less usable for SEEA EEA accounting purposes in their original form. Below we describe some points where gaps can be filled and synergy can be maximized. The starting point here is the set of IUCN "functional groups" (level 3).

1) Enhance mappability by explicit linking the IUCN classes to e.g. the USGS/ESRI global ecological land units (i.e., Option 2).

2) Provide more detail for agricultural and urban/built-up areas. The focus of the IUCN ET is on natural ecosystems, although semi natural ecosystems and non-natural ecosystems are recognized as ecosystem types (e.g. T7 Intensive anthropogenic terrestrial systems and analogues in freshwater and marine realms). A few additional types and urban and rural mosaics are introduced.

3) Marine units are strictly two-dimensional, i.e. integrating pelagic and benthic zones, and focusing on photic zone characteristics.

4) Restructure hierarchy to implement the above points, based on a pragmatic approach starting with realms and major ecotones, then move on to land cover (which probably can be mapped without detailed ecological data) and finally arrive at the IUCN classes for the quasi-natural ecosystem types.

Strengths

- It is still mainly based on the IUCN ET classification for the definition of ecosystem types, which complies to all design criteria (see section **Fout! Verwijzingsbron niet gevonden.** of the Discussion paper).
- Maximizes use of information available through the USGS/Esri mapping system.
- It incorporates in the classification some key issues making it more relevant for SEEA EEA accounting.
- Naturally allows for a tiered approach: USGS/Esri land cover (tier 1); IUCN functional groups (tier 2); 3D oceanic units or other refinements (tier 3).

Weaknesses

- It deviates from existing, published, classification schemes.
- Discussion is needed to reach consensus on the modifications.
- If not carefully crafted, potentially weakens the operational links between the SEEA-EEA, USGS/Esri and IUCN ET and their respective applications.
- This option does not have an established process by which it would be maintained.

2.4 Option 4: Existing habitat classifications (e.g. IUCN or EUNIS)

Why choose this as an option?

- *Habitat is often used as a proxy for ecosystems*
- *Habitat classifications are well developed and widely used*

Short description

A habitat is "*the living place of an organism or a community characterized by its physical and biotic components*". Habitats are not the same as ecosystems (see Section **Fout! Verwijzingsbron niet gevonden.** in the Discussion paper for a more elaborate discussion), but may serve as a good proxy for them. Options of existing international classification schemes that are internationally used are the IUCN and EUNIS habitat classification systems.

Strengths

- Habitat is a widely used concept and habitat classifications are used for several policy areas.
- Well described international classification systems are available.

Weaknesses

- Species' habitat classifications were not designed explicitly to represent ecological processes.
- The available habitat classifications do not have a clear conceptual basis.
- IUCN habitat classification: Limited descriptive information makes classes difficult for different users to interpret them consistently, even though many of the classes will be familiar to many users.
- EUNIS habitat classification: This is a classification developed for only Europe, it is not comprehensive conceptually or spatially at the global level.

2.5 Option 5: Existing land cover classification (e.g. FAO or Corine)

Why choose this as an option?

- *Land cover classifications are highly developed, well documented and widely used.*
- *Land cover can, with caution, be used as a proxy for ecosystems.*

Short description

Land cover is often used as a proxy for ecosystem type. There are several international land cover classifications that may be used, providing well documented and tested metadata. This option basically falls back to the original proposal in SEEA EEA and SEEA EEA TR to use the (interim) SEEA land cover classification as a starting point for an ecosystem classification. A land use classification may be used to further disaggregate certain land cover classes.

Strengths

- Land cover classifications like LCCS from FAO and the European Corine classification are highly developed, well documented and widely used.
- When ecological and land use characteristics are not available, a land cover based classification may be used as a starting point. Land cover data is widely available.
- Land cover classes are usually easy to interpret.

Weaknesses

- Land cover classifications are more directly concerned with the physical aspects of ground cover mainly for land use planning and management than with biodiversity or community aspects of vegetation aspects. It is therefore a poor proxy of ecosystems making it less suitable for ecosystem accounting.

- The focus of land cover classifications is on the terrestrial and freshwater realms, often they do not include the marine realm.

3. Conclusions from Glenn Cove meeting

The discussion paper describing the options was sent out for review in May 2019. The different options for an ecosystem and were also discussed at the Glenn Cove meeting in June 2019. Based on the expert review and the discussion in Glen Cove the following conclusions were reached:

- During the June 2019 Meeting of Experts in Glen Cove (NY), **consensus was reached that the IUCN Global Ecosystem Typology level 3 units (EFGs) will be proposed as the basis of the revised SEEA-EEA ecosystem type classification**. Elements of the other two options will be considered for operationalization and optimization from an ecosystem accounting purpose.
- The USGS/Esri WES maps (and underlying data) may provide a method to map some EFGs, especially when no ground observations are available (this can still be thought of as a tier-1 approach), but requires a cross-walk (underway) to identify potential congruencies and gaps (in particular where key abiotic and biotic processes aren't captured by the USGS approach, such as seasonality). See also next Section on testing. Other approaches may also provide useful mapping units (e.g. EUNIS).
- IUCN is beginning on a three-year long project to map the IUCN RLE; thus, in the medium term, IUCN will provide global maps of the EFGs. Notably some EFGs are already mapped (e.g. mangroves, tidal mudflats).
- The RLE is based on ecosystem assembly theory and focuses on ecosystem function. In addition, levels 1 and 2 are on a strictly ecological basis (i.e. organization in biomes). For SEEA-EEA purposes, it may be desired to integrate other characteristics, such as land use, management and/or ownership, to ensure that the accounts can be readily used for policy and management purposes. One option would be to have a standardized socio-economic aggregation scheme, based on these characteristics, to reduce the (potentially many) individual ecosystem types to the (fewer) columns in accounting tables (for example, grouping all undisturbed nature together, all agriculture, all build-up + urban).
- In many cases, the EFGs may be too coarse for accounting on a national scale, and countries may seek finer disaggregation of units. Linked to this is the potential requirement for a standardized subdivision of some of the EFGs. Although many countries will have more detailed national ecosystem classifications, it might be useful from an international comparison point of view to have some standardization here as well, where appropriate. This can be accommodated at lower levels (5 and 6) of the IUCN Global Ecosystem Typology. Disaggregation on base of socio-economic grounds is also an option, which could be standardized.
- It was also agreed that having crosswalks to aggregate the EFGs to existing classifications such as the SEEA LC classification would be necessary. These crosswalks will be facilitated by the hierarchical classification framework and support materials for the IUCN Global Ecosystem Typology.
- Some additional guidance for further disaggregation of EFGs is needed to represent the diversity of agricultural ecosystem types in more detail.

4. Next steps: testing

In order to evaluate the suitability of the above proposed approach the following tests have been identified:

1. **Crosswalking the 'global' EFGs with selected 'local' national ecological classifications.** The goal of this test is to
    i. test the unambiguous mapping of local classes to the EFGs
    ii. identify possible gaps in the EFGs, i.e. cases where local classes cannot be satisfactory mapped to an EFG
    iii. identify patterns where, for multiple test cases (e.g. countries), a similar set of local classes maps to the same EFG, and so may become a candidate for a standardized subdivision of this EFG at levels 5 and 6 of the IUCN Global Ecosystem Typology.
    iv. Identify other issues, e.g. related to gradients and ecotones

It should be noted that for SEEA-EEA accounting purposes it will not always be required to distinguish between all locally known ecosystem types. Since the product of accounting is to have information on ecosystems and their services at a fairly high level of aggregation, the (local) ecosystem type classification should reflect this.

2. **Assessing the usability of the USGS/Esri WES product.** The goal of this test is to
    i. Assess the correspondence between WES mapping units to locally (country-scale) known ecosystems. This may differ between WES mapping units and ecosystems.
    ii. For cases where this correspondence is insufficient for adequate SEEA-EEA accounting purposes, identify if, and which, additional global data sets underlying the WES product, may be helpful to increase this correspondence.
    iii. Idem, for locally available data.
    iv. It should be noted that for this test one should distinguish between the WES classes and definitions, and the WES spatial units.

3. **Crosswalking EFGs with other international classification schemes**, i.e. IUCN habitat classification, RAMSAR, EUNIS, MAES etc. Some of this work is in progress within IUCN.

Annex: IUCN Red List of Ecosystems

Table 4. Upper three levels of the IUCN Red IUCN Red List of Ecosystems (RLE), as described in Section 0 and Keith et al. (2019). Realms listed are Terrestrial (T), Freshwater and saline wetlands(F), Marine (M), Subterranean (S), and transitions between these.

Realm(s)				Biome	Functional group (ecotype)
T	F	M	S		
▯				T1 Tropical-subtropical forests	T1.1Tropical/Subtropical lowland rainforests
▯					T1.2 Tropical/Subtropical dry forests and scrubs
▯					T1.3 Tropical/Subtropical montane rainforests
▯					T1.4 Tropical heath forests
▯				T2 Temperate-boreal forests & woodlands	T2.1 Boreal and montane needle-leaved forest and woodland
▯					T2.2 Temperate deciduous forests and shrublands
▯					T2.3 Cool temperate rainforests
▯					T2.4 Warm temperate rainforests
▯					T2.5 Temperate pyric humid forests
▯					T2.6 Temperate pyric sclerophyll forests and woodands
▯				T3 Shrublands & shrub-dominated woodlands	T3.1 Seasonally dry tropical shrublands
▯					T3.2 Seasonally dry temperate heaths and shrublands
▯					T3.3 Cool temperate heathlands
▯					T3.4 Rocky pavements, screes and lava flows
▯				T4 Savannas and grasslands	T4.1 Trophic savannas
▯					T4.2 Pyric tussock savannas
▯					T4.3 Hummock savannas
▯					T4.4 Temperate wooded savannas
▯					T4.5 Temperate grasslands
▯				T5 Deserts and semi-deserts	T5.1 Semi-desert steppes
▯					T5.2 Thorny deserts and semi-deserts
▯					T5.3 Sclerophyll deserts and semi-deserts
▯					T5.4 Cool temperate deserts
▯					T5.5 Hyper-arid deserts
▯				T6 Polar/alpine	T6.1 Ice sheets, glaciers and perennial snowfields
▯					T6.2 Polar/alpine rocky outcrops
▯					T6.3 Polar tundra
▯					T6.4 Temperate alpine meadows and shrublands
▯					T6.5 Tropical alpine meadows and shrublands
▯				T7 Intensive anthropogenic terrestrial systems	T7.1 Croplands
▯					T7.2 Sown pastures and old fields
▯					T7.3 Plantations
▯					T7.4 Urban and infrastructure lands

Table 4 (continued)

Realm(s)				Biome	Functional group (ecotype)
T	F	M	S		
	☐			F1 Rivers and streams	F1.1 Permanent upland streams
	☐				F1.2 Permanent lowland rivers
	☐				F1.3 Freeze-thaw rivers and streams
	☐				F1.4 Monsoonal upland stream
	☐				F1.5 Monsoonal lowland rivers
	☐				F1.6 Arid episodic lowland rivers
	☐			F2 Lakes	F2.1 Freeze-thaw freshwater lakes
	☐				F2.2 Large permanent freshwater lakes
	☐				F2.3 Small permanent freshwater lakes
	☐				F2.4 Ephemeral freshwater lakes
	☐				F2.5 Permanent inland salt lakes
	☐				F2.6 Ephemeral salt lakes
	☐			F3 Artificial wetlands	F4.1 Large reservoirs
	☐				F4.2 Rice paddies
	☐				F4.3 Constructed lacustrine wetlands
	☐				F4.4 Canals and storm water drains
		☐		M1 Subtidal shelves and shelf breaks	M1.1 Seagrass meadows
		☐			M1.2 Kelp forests
		☐			M1.3 Photic coral reefs
		☐			M1.4 Shellfish beds and reefs
		☐			M1.5 Marine animal forests
		☐			M1.6 Rocky reefs
		☐			M1.7 Subtidal sandy bottoms
		☐			M1.8 Subtidal muddy bottoms
		☐			M1.9 Upwelling zones
		☐		M2 Pelagic ocean waters	M2.1 Epipelagic ocean waters
		☐			M2.2 Mesopelagic ocean waters
		☐			M2.3 Bathypelagic ocean waters
		☐			M2.4 Abyssopelagic ocean waters
		☐		M3 Deep sea floors	M3.1 Continental slope and island slopes - soft substrate
		☐			M3.2 Continental slope and island slopes - hard substrate
		☐			M3.3 Marine canyons
		☐			M3.4 Abyssal plains - soft substrate
		☐			M3.5 Hadal zones
		☐			M3.6 Seamounts, plateaus, hills, knolls
		☐			M3.7 Deepwater biogenic systems
		☐			M3.8 Chemosynthetically-based ecosystems
		☐		M4 Artificial marine systems	M4.1 Artificial reefs

Table 4 (continued)

Realm(s)				Biome	Functional group (ecotype)
T	F	M	S		
☐	☐			FT 1 Palustrine wetlands	FT1.1 Tropical flooded forests and peat forests
☐	☐				FT1.2 Seasonal floodplain marshes
☐	☐				FT1.3 Subtropical/temperate forested wetlands
☐	☐				FT1.4 Episodic arid floodplains
☐	☐				FT1.5 Boreal, temperate and montane peat bogs
☐	☐				FT1.6 Boreal and temperate fens
☐	☐				FT1.7 Artesian springs and oases
☐	☐				FT1.8 Geothermal wetlands
	☐	☐		FM1 Transitional waters	FM1.1 Deepwater coastal inlets
	☐	☐			FM1.2 Permanently open riverine estuaries and bays
	☐	☐			FM1.3 Intermittently closed coastal lagoons
☐		☐		MT1 Shoreline systems	TM1.1 Rocky Shores
☐		☐			TM1.2 Muddy Shores
☐		☐			TM1.3 Sandy Shores
☐		☐			TM1.4 Boulder/cobble shores
☐		☐		MT2 Coastal vegetation	TM2.1 Coastal shrublands and grasslands
☐		☐		MT3 Artificial shorelines	TM3.1 Artificial shores
☐	☐	☐		MFT1 Brackish tidal systems	MFT1.1 Coastal river deltas
☐	☐	☐			MFT1.2 Intertidal forests and shrublands
☐	☐	☐			MFT1.3 Intertidal marshes
			☐	S1 Lithic subterranean systems	S1.1 Aerobic caves
			☐		S1.2 Endolithic systems
			☐	S2 Subterranean freshwaters	S2.1 Underground streams and pools
			☐		S2.2 Groundwater aquifers
			☐	S3 Tidal subterranean systems	S3.1 Anchialine caves
			☐	S4 Anthropogenic subterr. systems	S4.1 Subterranean excavations
			☐	S4 Anthropogenic subterr. systems	S4.2 Water pipes and subterranean canals

Annex: USGS/Esri GDBBS classifications

Ecosystem reporting categories for the UN SEEA ecosystem accounting based on the USGS/ESRI map products (Sayre et al, 2014; 2016; 2017; 2018). These maps follow a stratification approach using layers for e.g. land cover, climate and topography, resulting in many (>>100) combinations. On the largest levels there are 4 environmental domains and 20 major ecosystem types.

Table 5. Major ecosystem types within the USGS/Esri GDBBS

Environmental domain	USGS/ESRI Major Ecosystem Type
Terrestrial	1 Forestlands
	2 Shrublands
	3 Grasslands
	4 Woodlands and Savannas
	5 Barren Lands
	6 Croplands
Freshwater	7 Rivers and Streams
	8 Lakes and Ponds
	9 Freshwater Wetlands
Marine waters	10 Estuaries
	11 Sunlit Ocean Waters
	12 Twilight Ocean Waters
	13 Deep Ocean Waters
Marine seabed	14 Intertidal Seabed
	15 Sunlit Shelf
	16 Twilight Shelf
	17 Continental Slope
	18 Deep Ocean Floor
	19 Trench Floor
Any	20 Built Environment

For the terrestrial domain, lower level ecosystem types can be defined by combining these major types with classifications of climate (18 classes) and landforms (4 classes):

Table 6. Climatic and Landform classifications for refinement of the USGS/Esri GDBBS (terrestrial domain only)

9 Major ecosystem types		18 World Climate regions				4 Global landforms
1 Forestlands		Polar		Moist		Tablelands
2 Shrublands		Boreal		Dry		Mountains
3 Grasslands	×	Cool Temperate	×	Desert	×	Hills
4 Woodlands and Savannas		Warm Temperate				Plains
5 Barren Lands		Subtropical				
6 Croplands		Tropical				
7 Rivers and Streams						
8 Lakes and Ponds						
9 Freshwater Wetlands						