FAOSTAT Domain Land Cover Metadata, release July 2020

Dataset Information: Land Cover	
Title	**Land Cover**
Abstract	The FAOSTAT **Land Cover** domain contains data on area by land cover class, aggregated at national level following the international land cover classification of the United Nations System of Environmental-Economic Accounting Central Framework (UN 2012). The FAOSTAT land cover data are compiled by national aggregation of geospatial information which is distributed *via* publicly available Global Land Cover mapping products.
Supplemental	The Land Cover domain of FAOSTAT Agri-Environmental Indicators disseminates land cover data (in 1000 ha) by country, year and FAOSTAT regional aggregations, for the following products: *1)* SEEA-MODIS, containing annual land cover area data for the period 2001–2018, derived from the MODIS Collection 6 Global Land Cover Classification Systems (LCCS) Land Cover Types product (MCD12Q1). In particular, the Land Cover Classification System (LCCS) land cover types are used in the analysis; *2)* SEEA-CCI-LC, containing annual land cover area data for the period 1992–2018, produced by the Catholic University of Louvain (UCLouvain) Geomatics as part of the Climate Change Initiative of the European Spatial Agency (version 2.0, CCI UCL Geomatics, 2017) and lately updated to version 2.1 under the European Copernicus program (2019). FAOSTAT Agri-environmental Indicators are calculated by FAO and may not coincide with data that countries report to relevant international processes. The aim of this domain is to provide a global knowledge product for assessing regional and global trends and in support of national data assurance/data quality processes.
International Standards	The FAOSTAT Land Cover domain is compliant with the System of Environmental-Economic Accounting in terms of: i) Definitions: It is consistent with definitions included in the SEEA CF (UN 2012) and SEEA AFF (FAO and UN, 2020), *Land Cover Chapters*; ii) Classifications: It follows the LCCS recommended in SEEA CF (Annex I B); iii) Applicability: Data can be used to compile relevant SEEA CF Tables. Land cover statistics are part of the Basic Set of Environmental Statistics of the UN Framework for the Development of Environmental Statistics (FDES, 2013).
Creation Date	2017
Last Update	2020
Data Type	Land, Land Cover
Category	Environment
Time Period	2001–2018 (SEEA-MODIS); 1992 – 2018 (SEEA-CCI-LC);
Periodicity	Annual
Geographical Coverage	World
Spatial Unit	In 2018, 198 countries and 43 other territorial entities
Language	Multilingual (EN, FR, ES)

Methodology and Quality Information:

Methods and processing

Overview

Land is a central component of economic-environmental accounting. As defined by the System of Environmental-Economic Accounting Central Framework (SEEA CF), land is *"a unique environmental asset that delineates the space in which economic activities and environmental processes take places and within which environmental assets and economic assets are located*" (UN, 2012). The land cover classification of the SEEA CF provides the international statistical standard needed to compile physical accounts for land cover. The SEEA Agriculture, Forestry and Fisheries SEEA-AFF (FAO and UN, 2020) applies the land cover classification of the SEEA CF. In physical terms, land comprises all of the individual features that cover the area within a country. Land cover refers to the observed physical and biological land cover of the Earth's surface, and includes natural vegetation and abiotic (non-living) surfaces (SEEA CF, 5.257). In the scope of the SEEA CF and SEEA AFF, land cover information is relevant for understanding the changing composition and condition of ecosystems, including agricultural and forest landscapes. A physical asset account for land cover with opening stocks, additions and reductions to stock, recording of net changes and closing stock is formulated in the SEEA AFF.

FAOSTAT "Land Cover" domain under Agri-Environmental Indicators section disseminates country statistics in support of physical asset accounts for land cover. The underlying information is derived from publicly available global land cover maps (GLC). Multiple GLC maps have been produced in the past decades from different imagery sources, temporal resolution, methods and classifications (Tsendbazar *et al.*, 2016) in support of a range of applications (e.g., climate modeling, carbon accounting, crop modeling and agricultural statistics). The FAOSTAT Land Cover domain applies a common methodology to two GLC products, providing users with a globally consistent, harmonized dataset:

1) The NASA *MODIS Land Cover Collection 6* (*MCD12Q1*) available for the years 2001–2018 (Sulla-Menashe et al., 2019) and in particular the *Land Cover Classification System (LCCS) land cover types* — spatial resolution 500m. This product supersedes previous MODIS Collection 5 (Friedl et al., 2010) which was used in the first release of the FAOSTAT Land Cover domain;
2) The land cover maps, hereinafter called *CCI-LC,* produced by the Catholic University of Louvain (UCLouvain) Geomatics as part of the Climate Change Initiative of the European Spatial Agency (version 2.0, CCI UCL Geomatics, 2017) and lately updated to version 2.1 under the European Copernicus program (2019).

The SEEA CF land cover classification includes 14 mutually exclusive and unambiguous land cover categories. The classification was developed by applying the UN Land Cover Classification System (LCCS) (Di Gregorio, 2005). The LCCS can be used to record in a standardized and harmonized way the biophysical characteristics of all areas of land within a given territory. The system is designed as a hierarchical classification that allows adjusting the thematic detail of the legend to the amount of information available in a standardised classification approach. It is applicable at all scales, independently of the method of observation, thus allowing cross-referencing of local and regional maps with continental and global maps. Table 1 provides a description and the LCCS rules underlying the 14 land cover classes of the SEEA CF. It represents the first explicit translation of the SEEA land cover classes to LCC classifiers.

Version 2 of the LCCS (Di Gregorio, 2005) was used in this work mostly for consistency with the original classification of the CCI-LC product.

Table 1. SEEA CF/AFF land cover classes and corresponding LCC classifiers*

Class value and label	Corresponding LCC classifiers
1 - Artificial surfaces (including urban and associated areas)	**B15**
Class 1 is composed of any type of areas with a predominant artificial surface. Any urban or related feature is included in this class, for example, urban parks (parks, parkland and laws). The class also includes industrial areas, and waste dump deposit and extraction sites.	
2 - Herbaceous crops	**A11 A3D1 // A3D3**
Class 2 is composed of a main layer of cultivated herbaceous plants (graminoids or forbs). It includes herbaceous crops used for hay. All the non-perennial crops that do not last for more than two growing seasons and crops like sugar cane, where the upper part of the plant is regularly harvested while the root system can remain for more than one year in the field, are included in this class.	
3 - Woody crops	**A11 A1D1 // A2D1 // A1D3 // A2D3**
Class 3 is composed of a main layer of permanent crops (trees or shrub crops) and includes all types of orchards and plantations (fruit trees, coffee and tea plantation, oil palms, rubber plantation, Christmas trees, etc.).	
4 - Multiple or layered crops	**A11 A1+A3 // A12A1 + A11A3**
Class 4 may include: a) two layers of different crops: a common case is the presence of one layer of woody crops (trees or shrubs) and another layer of herbaceous crop (e.g., typical coastal agriculture in Africa with herbaceous fields covered by palm trees). b) Class 4 may also include the presence of one important layer of natural vegetation (mainly trees) that covers one layer of cultivated crops (e.g. coffee plantations shadowed by natural trees in the equatorial area of Africa).	
5 - Grassland	**A12 A2A20**
Class 5 includes any geographical area dominated by natural herbaceous plants (grasslands, prairies, steppes and savannahs) with a cover of 10 per cent or more, irrespective of different human and/or animal activities, such as grazing or selective fire management. Woody plants (trees and/or shrubs) can be present, assuming their cover is less than 10 per cent.	
6 - Tree-covered areas	**A12 A3A20 // A24 A3A20-R1**
Class 6 includes any geographical area dominated by natural tree plants with a cover of 10 per cent or more. Other types of plants (shrubs and/or herbs) can be present, even with a density higher than that of trees. Areas planted with trees for afforestation purposes and forest plantations are included in this class. This class includes areas seasonally or permanently flooded with freshwater but excludes coastal mangroves (under class 7).	
7 - Mangroves	**A24 A1A20-R2 // A1A20-R3**
Class 7 includes any geographical area dominated by woody vegetation (trees and/or shrubs) with a cover of 10 per cent or more that is permanently or regularly flooded by salt and/or brackish water located in the coastal areas or in the deltas of rivers.	
8 - Shrub-covered areas	**A12 A4A20 // A24 A2A20-R1**
Class 8 includes any geographical area dominated by natural shrubs having a cover of 10 per cent or more. Trees can be present in scattered form if their cover is less than 10 per cent. Herbaceous plants can also be present at any density. The class includes shrub-covered areas permanently or regularly flooded by inland fresh water. It excludes shrubs flooded by salt or brackish water in coastal areas (under class 7).	
9 - Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	**A24 A2A20-R1 // A4A16-R1**
Class 9 includes any geographical area dominated by natural herbaceous vegetation (cover of 10 per cent or more) that is permanently or regularly flooded by fresh or brackish water (swamps, marsh areas, etc.). Flooding must persist for at least two months per year to be considered regular. Woody vegetation (trees and/or shrubs) can be present if their cover is less than 10 per cent.	
10 - Sparsely natural vegetated areas	**A12 A2A14 // A1A14 // A7A14 // A24 A2A16 // A1A16 // A7A16**
Class 10 includes any geographical areas were the cover of natural vegetation is between 2 per cent and 10 per cent. This includes permanently or regularly flooded areas.	
11 - Terrestrial barren land	**B16 A1 / A4 / A2 / A6 B1 // B13**
Class 11 includes any geographical area dominated by natural abiotic surfaces (bare soil, sand, rocks, etc.) where the natural vegetation is absent or nearly absent (i.e. cover is less than 2 per cent). The class includes areas regularly flooded by inland water (lake shores, river banks, salt flats, etc.). It excludes coastal areas affected by the tidal movement of saltwater (under class 14).	

12 - Permanent snow and glaciers	**B28 A2B1 // A3B1 // B27 A2B1 // A3B1**
Class 12 includes any geographical area covered by snow or glaciers persistently for 10 months or more.	
13 - Inland water bodies	**A27 A1B1 // A3B2 // A28 A1B1 // A3B2**
Class 13 includes any geographical area covered for most of the year by inland water bodies. In some cases, the water can be frozen for part of the year (less than 10 months).	
14 - Coastal water bodies and intertidal areas	**B28 A1B3V5**
Class 14 is defined based on geographical features of the land in relation to the sea (coastal water bodies, i.e., lagoons and estuaries) and abiotic surfaces subject to water persistence (intertidal areas, i.e., coastal flats and coral reefs).	

* According to the syntax of the LCCS (Di Gregorio, 2005): a) Single slash (/) indicates that both classes A and B are present in the polygon (A/B), with the first code covering the majority of the polygon; b) The + sign indicates a vertical layering in the same spatial cartographic unit; c) Two slashes (//) indicate that there is uncertainty regarding the presence of the two classes. There is either class A OR class B present in the polygon (A//B); X stands for unspecified parameters.

Geoprocessing methods

For each available land cover product, country area values for the different land cover classes were extracted using the FAO Global Administrative Unit Layer (GAUL National level – reference year 2014) from global yearly mosaics prepared in equal area projection (Mollweide). GAUL country codes are then mapped to country codes in FAOSTAT, taking into account the administrative changes that may have occurred during the data time series (e.g. the splitting of Sudan, former to Sudan and South Sudan).

Mapping GLC maps to the SEEA land cover classification

1) MODIS-LCCS combined Land Cover Types

MODIS (Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the NASA Terra and Aqua satellites. A MODIS-derived land cover product, the Collection 6 MODIS Global Land Cover Type – MCD12Q1 – was used to derive land cover information for the FAOSTAT Land Cover domain. The MODIS Collection 6 is composed of eight distinct classification schemes (Sulla-Menashe and Friedl, 2018; Sulla-Menashe *et al.*, 2019) including 3 new legends based on the FAO LCCS that distinguish between land cover, land use and hydrologic state. This FAOSTAT land cover update, is based on these three LCCS land cover types which were combined to derive for each map cell a mutually exclusive classification compliant with LCCS (see Tab. 2 below). The MODIS land cover data are available for cloud processing on the Google Earth Engine (GEE) platform. Rules to combine the Land Cover Property types 1 to 3 (LC_Prop1, LC_Prop2 and LC_Prop3) were applied directly in GEE and resulting data exported as yearly global images, hereinafter named MODIS-LCCS combined. Country statistics by land cover class and year were derived with internal geospatial routines using the GAUL administrative boundaries.

Table 2. MODIS-LCCS combined land cover type (LC_Prop1, LC_Prop2, LC_Prop3), class descriptions and corresponding LCCS classifiers

MODIS-LCCS combined	
Class value and label	**LCCS classifiers***
1 – Barren	**B16 // A12 A2A14 // A12 A4A14**
At least 60% of area is non-vegetated barren (sand, rock, soil) or permanent snow/ice with less than 10% vegetation.	
2 – Permanent snow and ice	**B28 A2 // A3 // B27 A2 // A3s**
At least** 60% **of area is covered by snow and ice for at least 10 months of the year.	

3 – Water Bodies	**B28 A1B1 // B27 A1B1**
At least 60% of area is covered by permanent water bodies.	
9 – Urban and built up lands	**B15**
At least 30% of area is made up of impervious surfaces including building materials, asphalt, and vehicles.	
10 – Dense forest	**A12 A3A10B2XXD2E1 // A11 A1** **A12 A3A10B2XXD1E1 // A11 A1** **A12 A3A10B2XXD2E2 // A11 A1** **A12 A3A10B2XXD1E2 //A11 A1** **A12 A3A10B2Z5 // A11 A1**
Tree cover >60% (canopy >2m). *This class includes areas with forests dominated by Evergreen Needleleaf; Evergreen Broadleaf; Deciduous Needleleaf; Deciduous Broadleaf; or Mixed types. These correspond to classes 11 to 16 in MODIS LCCS Land Cover Type LC_Proportion1. The class may include tree crops.*	
20 – Open forest	**A12 A3A14 // A11 A1** **A12 A3A21 // A11 A1**
Tree cover 10-60% (canopy >2m). Class includes forest with open (30-60%) and sparse (10-30%), corresponding to classes 21 and 22 in MODIS LCCS Land Cover Type LC_Proportion1.	
25 – Forest / Cropland Mosaics	**A11 A3B2 // A12 A3** **A11 A3B4 // A12 A3**
Mosaics of small-scale cultivation 40-60% with >10% natural tree cover.	
27 – Woody Wetlands	**A24 A1A20**
Shrub and tree cover >10% (>1m). Permanently or seasonally inundated.	
30 – Natural Herbaceous	**A12 A2A20**
Areas dominated by herbaceous annuals (<2m) with at least 10% cover. *This class includes areas with Dense Herbaceous (cover at least 60%) or Sparse Herbaceous (10-60% cover) corresponding to classes 31 and 32 in MODIS LCCS Land Cover Type LC_Proportion1.*	
35 – Natural Herbaceous/Croplands Mosaics	**A11 A3 // A12 A2 / A12 A4**
Mosaics of small-scale cultivation 40-60% with natural shrub or herbaceous vegetation.	
36 – Herbaceous Croplands	**A11 A3**
Class dominated by herbaceous annuals (<2m), with at least 60% cover. Cultivated fraction >60%.	
40 – Shrublands	**A12 A4A10B1–B10 // A11 A2**
Shrub cover >60% (1-2m). This class includes Dense, Sparse and Shrublands / Grasslands Mosaics corresponding to classes 41, 42 and 43 in MODIS LCCS Land Cover Type LC_Proportion1. The class may include shrub crops.	
50 – Herbaceous Wetlands	**A24 A2A20C1**
Areas dominated by herbaceous annuals (<2m) >10% cover. Permanently or seasonally inundated.	

*For syntax of LCCS coding, please refer to note in Tab. 1.

Based on corresponding LCCS classifiers and following a mutually-exclusive approach, the land cover classes of the MODIS-LCCS combined images were mapped to the SEEA CF classes (Tab. 3). When instead, SEEA land cover class could not be univocally identified from the underlying set of MODIS classes, the area value of the SEEA land cover class is set to null. The bridging between the two classifications resulted in a SEEA-compliant land cover annual dataset, available for FAOSTAT countries and territories and over the period 2001–2018.

Table 3. Mapping of the MODIS-LCCS combined land cover classes to the land cover classification of the SEEA

SEEA Land cover classes Class value and name	Mapping from MODIS-LCCS combined through corresponding LCC classifiers
1 - Artificial surfaces (including urban and associated areas)	**B15 [Class 9]**
2 - Herbaceous crops	**A11A3 [Equation 1: Class 36 + .6 (Class 25 + Class 35)]**
3 - Woody crops	*Not mapped: not available in MODIS land cover types*
4 - Multiple or layered crops	*Not mapped: not available in MODIS land cover types*
5 - Grassland	**A12A2A20 [Equation 2: Class 30 + .2(Class 35)]**
6 - Tree-covered areas	**A12A3 [Equation 3: Class 10 + Class 20 + .4 (Class 25)]**
7 - Mangroves	**A24A1A20 [Class 27] *with adjustments***
8 - Shrub-covered areas	**A12A4 [Equation 4: Class 40 + .2(Class 35]**
9 - Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	**A24A2A20 / A24A4A20 [Class 50] *with adjustments***
10 - Sparsely natural vegetated areas	*Not mapped: distinct classifiers not available in MODIS land cover types*
11 - Terrestrial barren land	**B16 [Class 1]**
12 - Permanent snow and glaciers	**B28A2 B28A3 B27A2 B27A3 [Class 2]**
13 - Inland water bodies	**B27A1 B28A1 [Class 3]**
14 - Coastal water bodies and intertidal areas	*Not mapped: Not available in MODIS land cover types*

More in detail, the following rules are applied to the MODIS-LCCS combined maps:

The area values for the **SEEA class 1** "Artificial surfaces" are derived directly from the MODIS-LCCS combined class 9 "Urban and Built-up Lands".

The area values for the **SEEA class 2** "Herbaceous crops" are calculated as the sum of area values of class 36 "Herbaceous Croplands" plus 60 percent of the area from mosaic classes 25 and 35 "Forest/Croplands" and "Natural Herbaceous/Croplands" respectively (Equation 1). Sixty percent is the maximum proportion of cultivated area in the cells of these mosaic classes according to MODIS-LCCS data description (Sulla-Menashe et al., 2019). This proportion is applied in the methodology to all countries indistinctly :

Eq. 1 $\textbf{SEEA class 2 "Herbaceous crops"}_{C,Y}\ \textbf{(1000 ha)} = (MODIS\text{-}LCCS\ combined\ classes:\ 36 + .6(class\ 25 + class35))_{C,Y};$

In all MODIS land cover types, croplands include only herbaceous crops whereas the perennial woody crops area classified under natural tree or shrub vegetation types of land cover (Herold *et al*., 2008). This implies that primarily natural vegetated areas (LCC main classifier A12), may include cultivated and managed areas (LCC main classifier A11). This is the case for instance for classes 10, 20 and 40 in MODISS-LCCS combined maps (Tab. 2). For this reason, the **SEEA class 3** "Woody crops" could not be mapped from this land cover product. Likewise, data for the **SEEA class 4** "Multiple or layered crops" (see description in Tab. 1) could not be derived from the MODIS-LCCS combined dataset.

The area values for **SEEA class 5** "Grassland" are matched to values of the MODIS-LCCS combined class 40 "Natural Herbaceous" plus 20 percent of the area from mosaic class 35 "Natural herbaceous/Croplands". For the latter class, the part of natural vegetation is

shared equally between natural herbaceous vegetation and shrubs based on the MODIS-LCCS description (Equation 2).

Eq. 2 **SEEA class 5 "Grassland"$_{c,Y}$ (1000 ha)** = *(MODIS-LCCS combined classes: 30 + .2(class 35))$_{c,Y}$;*

Values for the **SEEA class 6** "Tree-covered areas" are mapped to the sum of cells in MODIS-LCCS combined class 10 "Dense forest", class 20 "Open forest" plus forty percent of the area in the mosaic class 25 "Forest/Cropland" as in Equation 3:

Eq. 3 **SEEA 6 "Tree-covered areas"$_{c,Y}$ (1000 ha)** = *(MODIS-LCCS combined classes: 10 + 20 + .4 (class 25))$_{c,Y}$;*

Area values for the **SEEA class 7** "Mangroves" are matched to LCCS classifiers of the MODIS-LCCS combined class 27 "Woody Wetlands". However, to account for the unique features and geographical distributions of these forests, values for this class are populated only in countries where FAO detected the presence of mangroves (FAO, 2007). In countries where there are both mangroves and other types of woody wetlands, this adjustment may lead to overestimate of the total areas of mangroves.

Area values for **SEEA class 8** "Shrub-covered areas" are mapped to the sum of cells in MODIS-LCCS combined class 40 "Shrublands" plus twenty percent of the area from mosaic class 35 "Natural herbaceous/Croplands" as per Equation 4:

Eq. 4 **SEEA 8 "Shrub-covered areas"$_{c,Y}$ (1000 ha)** = *(MODIS-LCCS combined classes: 40 + .2(class35))$_{c,Y}$;*

Area values for the **SEEA class 9** "Shrub and/or herbaceous vegetation, aquatic or regularly flooded" are matched to classifiers of the MODIS-LCCS combined class 40 "Herbaceous Wetlands". Values of MODIS-LCCS combined class 27 "Woody wetlands" are also apportioned to this SEEA land cover category in all landlocked countries and in countries without mangroves (FAO, 2007). This adjustment may increase the woody component of this SEEA land cover class.

Distinct LCCS classifiers are not available in MODIS-LCCS combined classes to derive area values for the **SEEA class 10** "Sparsely naturally vegetated".

Direct mapping is made for SEEA classes 11 to 13 through matching classifiers of MODIS-LCCS combined classes. In particular, area values for the **SEEA class 11** "Terrestrial barren land" are mapped directly from class 1 "Barren"; the area values for the **SEEA class 12** "Permanent snow and glaciers" are mapped from class 2 "Permanent snow and ice"; finally, the area values for **SEEA class 13** "Inland water bodies" are mapped directly from class 3 "Water Bodies".

The MODIS-LCCS combined maps lacked LCCS classifiers to match the **SEEA class 14** "Coastal water bodies and intertidal areas".

2) Annual land cover maps from the ESA CCI initiative (CCI-LC)

Global land cover maps for the years 1992 to 2015 at 300m spatial resolution were first produced by the Catholic University of Louvain (UCL) Geomatics under Climate Change Initiative (CCI) of the European Spatial Agency (ESA) UCL Geomatics, 2017) and as part of the Land Cover CCI partnership. More recently in 2019, the process migrated under the framework of the European Copernicus Climate Change Service (C3S) and new land cover maps were released for the years 2016, 2017 and 2018 that are consistent with the earlier dates. A complete description of methods and satellite-sensors for this medium-resolution

land cover product is available in the Land Cover CCI-Product User Guide v2.0 (released in April 2017 - UCL Geomatics, 2017) and in Li et al., 2018.

The original CCI-LC classification is based on the UN LCCS system v.2 (Di Gregorio, 2005), and composed of two levels of detail. "Level 1" is characterized by land cover classes for which the information is available and applicable at the global scale, thus allowing the CCI-LC maps to be globally consistent while "Level 2" represents information of increased thematic detail that is only partially (regionally) available. The derived FAOSTAT Land Cover dataset is based on combined information from these two levels applying the Level 1 classification legend of the CCI-LC maps (see Tab. 4 below). In preparation of the country aggregates, the area values from the second level are thus aggregated at higher hierarchical level (e.g. classes 11 and 12 to corresponding "level 1", class 10). Tab. 4 also shows the LCCS coding of the CCI-LC maps as reported in the UCL Geomatics reference publication (UCL Geomatics, 2017).

The annual maps of the CCI-LC are a consistent representation of the stable components of land cover. Derived information organized in physical asset accounts can provide an indication of the net change within countries.

Table 4. Level 1 of the CCI-LC classification, LCCS coding and class descriptions

CCI-LC Class value and name – Level 1	LCCS Coding*
10 - Cropland, rainfed**	**A1XXXXXXD1 // A2XXXXXXD1 // A3XXXXXXD1**
Class 10 includes Rainfed tree crops // Rainfed shrub crops // Rainfed herbaceous crops	
20 - Cropland, irrigated or post-flooding	**A1XXXXXXD3 // A2XXXXXXD3 // A3XXXXXXD3 // A3XXXXXXD2**
Class 20 includes Irrigated tree crops // Irrigated shrub crops // Irrigated herbaceous crops // Post-flooding cultivation of herbaceous crops	
30 - Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous) <50%	**A11 / A12**
Class 30 includes mosaic of Cultivated and managed terrestrial areas and Natural and semi-natural primarily terrestrial vegetation	
40 - Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	**A12 / A11**
Class 40 includes mosaic of Natural and semi-natural primarily terrestrial vegetation and Cultivated and managed terrestrial areas	
50 - Tree cover, broadleaved, evergreen, closed to open (>15%)	**A12 A3A20B2XXD1E1 // A3A20B2XXD1E2-E4**
Class 50 includes natural vegetation of Broadleaved evergreen closed to open trees or Broadleaved semi-deciduous closed to open trees	
60 - Tree cover, broadleaved, deciduous, closed to open (>15%)**	**A12 A3A20B2XXD1E2**
Class 60 includes natural vegetation of Broadleaved deciduous closed to open trees	
70 - Tree cover, needleleaved, evergreen, closed to open (>15%)**	**A12 A3A20B2XXD2E1**
Class 70 includes natural vegetation of Needleleaved, evergreen closed to open trees	
80 - Tree cover, needleleaved, deciduous, closed to open (>15%)**	**A12 A3A20B2XXD2E2**
Class 80 includes natural vegetation of Needleleaved, deciduous closed to open trees	
90 - Tree cover, mixed leaf type (broadleaved and needleleaved)	**A12 A3A20B2XXD1 / A3A20B2XXD2**
Class 90 includes natural vegetation of tree cover of mixed leaf type, Broadleaved closed to open trees and Needleleaved closed to open trees	
100 - Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	**A12 A3A20 // A4A20 / A2A20**
Class 100 includes a mosaic of natural vegetation with prevailing woody vegetation: Closed to open trees or Closed to open shrubland (thicket) and Herbaceous closed to open vegetation	

110 - Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	**A12 A2A20 / A3A20 // A4A20**
Class 110 includes a mosaic of natural vegetation with prevailing herbaceous vegetation: Herbaceous closed to open vegetation and Closed to open trees or Closed to open shrubland (thicket)	
120 – Shrubland**	**A12 A4A20**
Class 120 includes natural vegetation of Broadleaved closed to open shrubland (thicket)	
130 - Grassland	**A12 A2A20**
Class 130 includes natural vegetation of Herbaceous, closed to very open	
140 - Lichens and mosses	**A12 A7A20**
Class 140 includes vegetation of closed to open lichens/mosses	
150 - Sparse vegetation (tree, shrub, herbaceous cover) (<15%)**	**A12 A3A14 // A4A14 // A2A14**
Class 150 includes natural vegetation with sparse cover: Sparse trees or Herbaceous sparse vegetation or Sparse shrubs	
160 - Tree cover, flooded, fresh or brackish water	**A24 A3A20B2C1D1-R1 // A3A20B2C2D1-R1**
Class 160 includes natural and semi-natural aquatic vegetation with of predominant tree type: Closed to open (100-40%) broadleaved trees on temporarily flooded land, water quality: fresh water or Closed to open (100-40%) broadleaved trees on permanently flooded land, water quality: fresh water	
170 - Tree cover, flooded, saline water	**A24 A3A20B2C1D1-C5-R2 // A3A20B2C1D1-C5-R3**
Class 170 includes natural and semi-natural aquatic vegetation of predominant tree type in saline water: Closed to open (100-40%) broadleaved trees on permanently flooded land (with daily variations), water quality: saline water or Closed to open (100- 40%) broadleaved trees on permanently flooded land (with daily variations), water quality: brackish water or Closed to open (100-40%) semi-deciduous shrubland on permanently flooded land (with daily variations), water quality: saline water or Closed to open (100-40%) semi-deciduous shrubland on permanently flooded land (with daily variations), water quality: brackish water	
180 - Shrub or herbaceous cover, flooded, fresh/saline/brackish water	**A24 A4A20B3C1 // A4A20B3C2 // A4A20B3C3 // A2A20B4C1 // A2A20B4C2 // A2A20B4C3**
Class 180 includes natural and semi-natural aquatic vegetation of predominant shrub or herbaceous type in fresh, brackish or saline water quality: Closed to open shrubs on permanently flooded land or Closed to open herbaceous vegetation on permanently flooded land or Closed to open shrubs on temporarily flooded land or Closed to open herbaceous vegetation on temporarily flooded land or Closed to open shrubs on waterlogged soil or Closed to open herbaceous vegetation on waterlogged soil	
190 - Urban areas	**B15**
Class 190 includes Artificial surfaces and associated areas	
200 - Bare areas**	**B16 A1 // A2**
Class 200 includes Bare areas of either Consolidated or Unconsolidated Materials	
210 - Water bodies	**B28 A1B1 // B27 A1B1**
Class 210 includes Natural water bodies or Artificial water bodies	
220 - Permanent snow and ice	**B27 A2B1 // A3B1 // B28 A2B1 // A3B1**
Class 220 includes Natural Perennial snow or Perennial ice or Artificial Perennial snow or Perennial ice	

*For the syntax of LCCS coding please refer to the note in Table 1; **Land cover classes with "Level 2" of detail in the original legend (regional/locally available data).

The correspondence of LCC classifiers has guided, for each country and year in the available time series (1992 to 2018), the mapping and completion of the SEEA land cover classes from underlying CCI-LC information. Tab. 5 below summarizes the steps and calculations made in this exercise.

Table 5. Mapping of the CCI-LC classes to the land cover classification of the SEEA

SEEA LAND COVER CLASSES CLASS VALUE AND NAME	MAPPING FROM CCI-LC THROUGH CORRESPONDING LCC CLASSIFIERS
1 - Artificial surfaces (including urban and associated areas)	**B15 [.75(Class 190)]**

2 - Herbaceous crops	**A11A3 [Indirect mapping with Equation 10]**
3 - Woody crops	**A11A1 A11A2 [Indirect mapping with Equation 11]**
4 - Multiple or layered crops	*Not mapped: missing matching classifiers*
5 - Grassland	**A12A2 [Equation 12: Class 130 + Class 140 + .20(Class 30) + .20(Class 40) + .3(Class 100) + .6(Class 110) + .10(Class 190) + .05(Class 10) + .05(Class 20)]**
6 - Tree-covered areas	**A12A3 [Equation 13: Class 50 + Class 60 + Class 70 + Class 80 + Class 90 + .1(Class 30) + .20(Class 40) + .35(Class 100) + .2(Class 110) + Class 160 + .15(Class 190) + .05(Class 10) + .05(Class 20)]**
7 - Mangroves	**A24A1 (woody vegetation) [Class 170]**
8 - Shrub-covered areas	**A12A4 [Equation 14: Class 120 + .1(Class 30) + .2(Class 40) + .35(Class 100) + .2(Class 110) + .05(Class 10) + .05(Class 20)]**
9 - Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	**A24A4 A24A2 [Class 180]**
10 - Sparsely natural vegetated areas	**A12A1A14 A12A4A14 A12A2A14 [Class 150]**
11 - Terrestrial barren land	**B16A1(A2/A4/A6) [Class 200]**
12 - Permanent snow and glaciers	**B27A2B1 B27A3B1 B28A2B1 B28A3B1 [Class 220]**
13 - Inland water bodies	**B28A1B1 B27A1B1 [Class 210]**
14 - Coastal water bodies and intertidal areas	*Not mapped: missing matching classifiers*

Based on exchanges with UCL Geomatics, the following operational choices for the interpretation and allocation of the areas of mosaic land cover classes were applied (Tab. 6).

Table 6. Allocation of the mosaic classes in the CCI-LC classification

CCI-LC mosaic class Value and name	Distribution to SEEA Classes (% of the mosaic area)
Mosaic with cultivated and natural vegetation	
30 - Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous) < 50%	**60%** to SEEA classes 2 + 3; **10%** to SEEA class 6; **10%** to SEEA class 8; **20%** to SEEA class 5
40 - Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (< 50%)	**20%** to SEEA class 6; **20%** to SEEA class 8; **20%** to SEEA class 5; **40%** to SEEA classes 2 + 3
Mosaic of different types of natural vegetation	
100 - Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	**35%** to SEEA class 6; **35%** to SEEA class 8; **30%** to SEEA class 5
110 - Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	**60%** to SEEA class 5; **20%** to SEEA class 6; **20%** to SEEA class 8

For each country and year, the area values for the **SEEA class 1** "Artificial surfaces" are derived directly from the CCI-LC Class 190 "Urban areas". High-resolution data from the Global Human Settlement Layer (http://ghsl.jrc.ec.europa.eu/) that are aggregated to 300m through a majority resampling method, represent the main source of information for the class "Urban areas" in the CCI-LC maps. Urban is therefore represented at 300m with urban proportions varying between >50 percent and 100 percent. A middle point is applied in this methodology and the class is considered purely urban at 75 percent. The remaining

25 percent of the area of pixels in Class 190 is allocated to trees and to herbaceous vegetation, with shares of 15 percent and 10 percent, respectively.

The CCI-LC classification provides only partial information to differentiate the Herbaceous and the "Tree or shrub" crops under the main class "Cropland, rainfed" (described with level 1 Class 10). Information from the FAOSTAT domain "Input/Land" is imported as proxy for the proportion of **SEEA class 2** "Herbaceous crops" and **SEEA class 3** "Woody crops". More specifically, for each country and year in the time series, the area values of Class 10 and Class 20 "Cropland, irrigated and post-flooding" are summed to the areas allocated from mosaic Classes 30 and 40 (Tab. 6) to derive the Total cropped area as in Equation 9. To account for the presence of natural vegetation in the cropped areas and to avoid overestimation of the cultivated area in national aggregates, UCL Geomatics suggested treating pixels of Class 10 and Class 20 as pure cropland at 85 percent. The remaining 15 percent of the area of these pixels is shared equally between the three types of natural vegetation (trees, shrubs and herbaceous cover).

Information from the FAOSTAT domain "Inputs / Land Use" (http://www.fao.org/faostat/en/#data/RL) is imported to derive: the share of the area used for "Arable land area" – applied as proxy for the land cultivated with temporary/herbaceous crops – and the share of the area used for "Permanent crops". These proportions are then used in Equations 10 and 11 below to derive the area cropped with herbaceous crops (corresponding to the **SEEA class 2**) and the area cropped with woody crops (corresponding to the **SEEA class 3**). For the few cases when the shares of temporary and permanent crops could not be derived from FAOSTAT land use data (e.g. Andorra, Aruba, Montserrat, Tokelau), the cropped area from the land cover maps was equally shared between the herbaceous and the woody crops. Despite this adjustment, in those countries where CCI-LC maps do not provide level 2 information on woody crops, these may actually be mapped under natural tree and shrub vegetation classes.

Eq. 9 Total cropland area $_{c,Y}$ **(1000 ha)** = $(.85\%\ Class\ 10_{c,Y} + .85\%\ Class\ 20_{c,Y} + .60(Class\ 30_{c,Y}) + .4(Class\ 40_{c,Y}))$

Eq. 10 (CCI-LC_SEEA 2) Areas covered with Herbaceous crops $_{c,Y}$ **(1000 ha)** = $Total\ cropland\ area_{c,Y} * Share\ land\ used\ for\ herbaceous\ crops_{c,Y}$

Eq. 11 (CCI-LC_SEEA 3) Areas covered with Woody crops $_{c,Y}$ **(1000 ha)** = $Total\ cropland\ area_{c,Y} * Share\ land\ used\ for\ permanent\ crops_{c,Y}$

Insufficient information prevents deriving area values for the **SEEA class 4** "Multiple or layered crops". For this reason, it is assumed that the cultivated areas are entirely allocated to either the herbaceous (SEEA class 2) or the woody crops (SEEA class 3). This SEEA class thus has null values in the corresponding country dataset.

The area values for the **SEEA class 5** "Grassland" correspond to area values of the CCI-LC Class 130 "Grassland" summed to the areas allocated from mosaic Classes 30, 40 and 100, 110 (Tab. 6) and 140 as in Equation 12. The percentage of land cover was the main rationale for allocating the area values for the Class 140 "Lichens and mosses" under this category. The herbaceous vegetation cover existing in urban and in cropped areas is also included in this class.

Eq. 12 (CCI-LC_SEEA 5) Areas covered with Grassland $_{c,Y}$ **(1000 ha)** = $(Class\ 130_{c,Y} + Class\ 140_{c,Y} + .2(Class\ 30_{c,Y}) + .2(Class\ 40_{c,Y}) + .3(Class\ 100_{c,Y}) + .6(Class\ 110_{c,Y}) + .1(Class\ 190_{c,Y}) + .05(Class\ 10) + .05(Class\ 20))$

The area values for the **SEEA class 6** "Tree-covered areas" correspond to area values of the forest classes in the CCI-LC legend (classes 50 to 90) summed to the areas allocated from mosaic Classes 30, 40 and 100, 110 (Tab. 6). In addition, based on the correspondence of the LCC classifiers A24A3 (for Trees under Natural and Semi-natural aquatic vegetation), the area values from CCI-LC class 160 are also added in Equation 12. The natural tree vegetation cover present in urban and in cropped areas is also included in this class.

Eq. 13 (CCI-LC_SEEA 6) Tree-covered Areas $_{c,y}$ **(1000 ha) =** $(Class\ 50_{c,y} + Class\ 60_{c,y} + Class\ 70_{c,y} + Class\ 80_{c,y} + Class\ 90_{c,y} + .10(Class\ 30_{c,y}) + .2(Class\ 40_{c,y}) + .35(Class\ 100_{c,y}) + .2(Class\ 110_{c,y}) + Class\ 160_{c,y}) + .15(Class\ 190_{c,y}) + .05(Class\ 10) + .05(Class\ 20))$

For each country and year, the area values for the **SEEA class 7** "Mangroves" are derived directly from the CCI-LC class 170 "Tree cover, flooded, saline water".

The area values for the **SEEA class 8** "Shrub-covered areas" correspond to area values of the CCI-LC class 120 "Shrubland" summed to the areas allocated from mosaic Classes 30, 40 and 100, 110 (Tab. 6) as shown in Equation 14 below. The natural shrub vegetation cover present in cropped areas is also included in this class.

Eq. 14 (CCI-LC_SEEA 8) Shrub-covered Areas $_{c,y}$ **(1000 ha) =** $(Class\ 120_{c,y} + .10(Class\ 30_{c,y}) + .2(Class\ 40_{c,y}) + .35(Class\ 100_{c,y}) + .2(Class\ 110_{c,y}) + .05(Class\ 10) + .05(Class\ 20))$

The area values for **SEEA class 9** "Shrubs and/or herbaceous vegetation, aquatic or regularly flooded" and **SEEA class 10** "Sparsely natural vegetated areas" are mapped without additional adjustments from the CCI-LC classes 180 and 150 respectively.

SEEA class 11 "Terrestrial barren land" is mapped directly from CCI-LC class 200, which describes bare areas.

SEEA class 12 "Permanent snow and glaciers" matched the classifiers of the CCI-LC class 220 that maps perennial snow and ice of both natural and artificial origin.

The area values for the **SEEA class 13** "Inland water bodies" are sourced from the CCI-LC class 210, which maps natural and artificial water bodies.

Finally, as for the MODIS-LCCS combined maps, the CCI-LC products lacked LCCS classifiers that match the **SEEA class 14** "Coastal water bodies and intertidal areas." Hence, this class has null values in the corresponding country dataset.

As a result of the incomplete one-to-one correspondence between the original classifications of the two global land cover products to SEEA classes, country totals for FAOSTAT SEEA-MODIS and SEEA-CCI data do not necessarily sum up to country totals from the FAOSTAT land area.

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FAOSTAT Domain Land Cover Metadata, release July 2020

Data Collection Method	Computed
Completeness	100%
Useful Links	http://unstats.un.org/unsd/envaccounting/seearev/ http://www.fao.org/economic/ess/environment/seea/en/ https://lpdaac.usgs.gov/products/mcd12q1v006/ http://maps.elie.ucl.ac.be/CCI/viewer/ https://www.esa-landcover-cci.org/?q=node/197 https://code.earthengine.google.com/

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