

Technical note on the use of MADE

The MADE is completed by documentation explaining the information contained in the database. Understanding this documentation is a prerequisite for the correct use of the database.

This introduction is aimed at guiding the user through the different sections of the documentation:

Thematic description

1. Legend
2. LCCS glossary
3. Land Cover classifiers list
4. List of single thematic classes

Spatial description

5. List of Polygon codes

Geographic meaningfulness of the thematic information and its accuracy

6. The thematic information and its accuracy

1. Legend

The legend represents the thematic content of the study area. It is a list of all the land cover types identified and mapped in the study area. The legend land cover classes are a subset of the classes contained Land Cover Classification System applied to a specific geographic context with a given spatial scale/detail related to the remotely sensed data and interpretation methodology used.

Hence it gives a global vision of the land cover features present (thematic content) but does not provide information on their cartographic representation. To get this information the user must open the file called "Polygon codes".

The legend is composed by the following elements:

Belonging to the 8 major land cover type:

- A11 - Cultivated and managed terrestrial areas
- A12 – Natural or semi-natural terrestrial vegetation
- A23 – Cultivated aquatic or regularly flooded areas
- A24 – Natural or semi-natural aquatic vegetation
- B15 - Artificial surfaces and associates area(s)
- B16 – Bare area(s)
- B27 – Artificial water bodies, snow and ice
- B28 – Natural water bodies, snow and ice

In each one of the 8 LCCS land cover major groups the land cover classes have the following descriptive elements:

Class user name: class name developed by Africover. The function of the class user name is to provide a systematic class name that can be easily understood on the base of the classical naming of land cover classes.

LCCS class name :standard name automatically created by LCCS for each class created.

8 Major land cover types

KENYA LANDCOVER LEGEND			
Class User Name LCCS Class Name	Map Code	LCCS - GIS CODES	LCCS Classifiers
A 11-Cultivated Terrestrial Areas and Managed Lands			
Trees Forest Plantation, Broad Leaved Evergreen, Permanently Cropped Area With Rainfed Tree Crop(s) Crop Cover:	TBE47PL	10153-1-W7	A1 = Trees A7 = Broadleaved A9 = Evergreen B5 = Continuous C1 = Single Crop D1 = Rainfed D9 = Permanent W7 = Forest Plantation
Irrigated Tree Crop, Large to Medium Fields - Citrus spp. Permanently Cropped Area With Surface Irrigated Tree Crop(s) Dominant Crop: Fruits & Nuts - Citrus Fruits (Citrus spp.)	TBED57-cc	10499-1888-S0606	A1 = Trees A7 = Broadleaved A9 = Evergreen B1 = Large - Medium B5 = Continuous C1 = Single Crop D3 = Irrigated D4 = Surface D9 = Permanent S0606 = Citrus Fruits (Citrus spp.)

Class user name LCCS Class name

Map code: synthetic code used during the interpretation phase. It is built to facilitate class recognition: for a translation of the map codes see the Map code dictionary.

Although the information embedded in the user label is not as thorough as the original LCC Codes it gives an acceptable idea of the class characteristics. Each letter in the code describes a different attribute of the class. The letters *T*, *S* and *H* for example stands for *Tree*, *Shrub* or *Herbaceous* respectively. Appendix A gives a complete list of the abbreviations that are used in the user labels to describe the different characteristics of a class. A different abbreviation table exists for each of the major land cover types. A letter will not necessarily have the same meaning in the different tables. The letter *S* represents for example *Bare Soil* in the *Bare Areas* table while it represents *Shrubs* in all the other tables. Please note that the abbreviations must be used in the same order in which they appear in the tables. The first letter of the class indicates in which major land cover type the class fall (See the table below).

First letter	Major Land cover type
Alphabetic Letter	Cultivated terrestrial (A11) or Cultivated aquatic or regularly flooded areas (A23)
2	Natural and semi-natural terrestrial vegetation (A12)
4	Natural/semi-natural aquatic vegetation (A24)
5	Artificial surfaces and associated areas (B15)
6	Bare areas (B16)
7	Artificial water bodies (B27)
8	Inland water (B28)

LCCS GIS code: unique class code automatically assigned by LCCS; it is directly linked with the LCCS classifiers string.

LCCS classifiers: land cover attributes used in the definition of a land cover class. This, together with the LCCS GIS code, is the information on which the user must focus on. Class names (user and/or LCCS names) and map code are redundant information that will disappear in the near future. They have been put to maintain a bridge with the "old" way to characterize a land cover class. The sequence of the classifiers is the real reference for users to understand the information contained in the class and operate thematic aggregations. The meaning of the classifiers can be looked up in the LCCS glossary.

Class description: it is a detailed description of the class taking into account the classifiers used and their interrelationship in the class.

Example 1: how to read the LCCS classifiers for the first class in the example table

From the head of the page the user will know to which of the 8 land cover major groups the classes belong. In this case they are agricultural classes (Cultivated and managed terrestrial area). At this point he/she must analyze the characteristic classifier composition of the class. In the first case the class is defined by a sequence of 8 classifiers. The first one (A1) determine the crop life form the next two (A7, A9) the leaf type and leaf phenology of the crop. The next (B5) characterize the spatial distribution of the fields, the others (C1, D1, D9) relate to the crop combination (in this case only one crop per year) and to the cultural practices respectively, water supply and the cultivation time factor. The last one (W7) specify that the trees are used for "Forest plantation" instead of "Orchard or other type of plantation" that is the second option of this specific classifier. In other words the polygon associated to this class type represent a forest plantation of broadleaved evergreen trees. The cultivation is rainfed and permanent; no other types of crop life forms exist. The second class is characterized by a sequence of 9 classifiers. The first three (A1, A7, A9) are similar to the first class the fourth one (B1) is a new type of information related to the average size of the fields not present in the first case. Again the classifiers (B5, C1, D9) are similar to above. The classifiers related to the water supply (D3) are different as the one characterizing the tree crop as an "Orchard" specifically (S0606) Citrus fruit. The characterization of a land cover class by the smallest land cover elements (the classifiers) give to the end user an enlarged flexibility in the extraction of the information tailored to his own needs. Assuming for instance a specific user is not interested to the classes "forest plantation" and "citrus orchard" but he/she wants to know the amount of broadleaved evergreen tree crops of the area. In this case he/she will look not to the whole sequence of classifiers characterizing the two classes taken as example but only to the classifiers characterizing respectively the "life form" "leaf form" and "leaf phenology". In our case these three classifiers are similar in both classes therefore for this particular user these two classes can be combined in one that fulfills his/her own needs.

2. LCCS glossary

The LCCS glossary is a standard description of all the LCCS classes existing in the study area. The glossary for a specific study area is a subset of the glossary contained in the LCCS software, that can be used to look up the definitions.

The LCCS glossary is organized according to the 8 main land cover types:

- 1) Cultivated and managed terrestrial areas
- 2) Natural or semi natural terrestrial vegetation
- 3) Cultivated aquatic or regularly flooded areas

- 4) Natural or semi natural aquatic or regularly flooded vegetation
- 5) Artificial surfaces and associates area(s)
- 6) Bare area(s)
- 7) Natural and artificial water bodies
- 8) Snow and ice

The definitions of the LCCS classifiers found in the study area is grouped under each these major groups.

3. Land Cover classifiers list

It is a list of all the LCCS classifiers used in the study area. They are grouped under the 8 major land cover types. In addition to the standard classifiers contained in LCCS the user may find "user defined" classifiers used by the map producer to add additional information, not available in LCCS, to a specific class. The user-defined attributes are always coded with the letter "Z".

4. List of single thematic classes

It is a list of all the thematic LCCS classes developed to describe the study area and their count in relation to the cartographic standards adopted.

Due to the cartographic rules applied in the interpretation, if a feature is smaller than the minimum mappable area applied, in the interpretation process, a mixed unit can be developed by the combination of a maximum of three land cover classes; the first class covers always more than 50% of the unit (i.e. the polygon) while the second class must cover at least 20% of the surface.

Different classes in one unit (polygon) are separated by the "/" character to characterize a "mixed unit".

In the first row the class name is listed; the row *Class 1 single unit* displays the count of the polygons having class as a single unit, while the following 3 rows display the count of the class when occurring in mixed units.

The last row displays the sum of all the occurrences of the class both in single and mixed units.

Kenya		List of single thematic classes <i>(and their frequencies in a cartographic context - mixed unit)</i>				
CLASS	CLASS 1 Single unit	CLASS 1 Mixed unit	CLASS 2	CLASS 3	SUM	
2HC	74	119	80	0	273	
2HC78	147	68	144	0	359	
2HC8	220	197	156	0	573	
2HP	214	253	321	0	788	
2HP78	392	315	146	12	865	
2HP8	859	572	318	0	1749	
2HR	79	24	0	0	103	
2SCJ	76	26	54	0	156	
2SCJ7	86	0	0	0	86	

5. List of polygon codes

This section describes the relation between the thematic and the spatial dimension of the database, therefore its correct utilization depend from the comprehension the user has of this table.

The section lists all the combinations of the single land cover classes used to code the spatial units (represented by polygons in a vectorial GIS system) according to the Africover cartographic standards.

Kenya						
List of polygon codes						
<i>Code</i>	<i>Count</i>	<i>Hectare</i>	<i>Frequency %</i>	<i>Area %</i>	<i>Scale Adequacy (area)</i>	
<i>prim. code</i>	<i>Sum of values</i>	<i>Total n</i>	<i>Total Area Area of mixed codes +</i>			
2HC	193	361304	1.216	0.610	0.20	
2HC	74	71816	0.466	0.1213		
2HC/2SOJ67	26	160673	0.164	0.2714		
2HC/2SVJ67	17	74969	0.107	0.1266		
2HC/2TC8	24	14729	0.151	0.0249		
2HC/2TP8	38	30923	0.239	0.0522		
*2HC/HR14	14	8195	0.088	0.0138		
2HC78	215	637937	1.355	1.077	0.91	
2HC78	147	467851	0.926	0.7902		
2HC78/2SCJ	12	47801	0.076	0.0807		
*2HC78/HR14	19	27630	0.120	0.0467		
*2HC78/HR24	37	94656	0.233	0.1599		

Total area: 59207558 ha
Total number of polygons: 15869
Average adequacy or total scale adequacy: 0.522

The upper part of the table shows statistic of the study area; total area, total number of polygons, scale adequacy (see below)

The other part of the table is grouped by single thematic class (see figure); under each grouping (class) all the combinations of classes in mapping units are listed. Using the class 2HC as example the user can identify the number of polygons coded with 2HC as single class (100% of polygon area) and the different combinations of mixed code where 2HC is the dominant one (statistically 60-70% of the polygon area). The presence of 2HC class in a mixed code not as dominant class is shown in other part of the table under the grouping of the dominant class. For each unit the table displays:

- the count of the occurrences of that unit in the data base (*count*)
- the total surface in hectares (*hectare*)
- the frequency of the unit in the data base (the count of the unit on the total number of records of the data base expressed in percentage)
- the percentage of the unit relative to the total surface
- the scale adequacy per class

The scale adequacy is an empiric formula to assess how adequate is the scale used (MMA minimum mapable area) to correctly represent a land cover feature in a spatial context. Value equal to 1 is a perfect adequacy, it means the scale chosen was sufficient to always represent a feature with a single coding without be obliged to apply cartographic restrictions (mixed unit).

The scale adequacy of each grouping is calculated as:

$$\text{Total scale adequacy} = \frac{\text{Sum of the area of thematic classes as single unit}}{\text{Sum of the area of thematic classes as single unit} + \text{mixed unit}}$$

6. The thematic information and its accuracy

The new way in LCCS to create a class using a sequence of the smallest land cover attributes (classifiers) allow the map producer to re-use in the most efficient way ancillary information and local knowledge of the study area. This will for sure increase the thematic content of the database but will pose some problem of geographic validity of some of the information for the end user. As example let's consider a tea plantation in Kenya. Because the main purpose of Africover is to produce a land cover database the built up in LCCS of this class privilege mainly elements related to a land cover information. The specification of the "crop type" is considered additional information to the basic ones previous mentioned. For the specific case the class could be a sequence of the following elements:

Crop life formA2	Shrub
Field sizeB1	Large to medium
Crop combinationC1	Single crop
Water supplyD1	Rain fed
Cultivation time factorD9	Permanent
Crop typeS0804	Tea

The first 5 classifiers therefore give the basic land cover characterization. The last one (crop type) is put when ancillary data, local knowledge or the spectral characteristics of the remote sensing image allow the introduction of this information. Therefore is legitimate to have in the database for instance class A (created by the sequence of classifiers A2, B1, C1, D1, D9) representing a generic scrub crop and class B (created by the sequence of classifiers A2, B1, C1, D1, D9, S0804) representing a tea plantation. This does not mean that class B automatically represents the all tea plantation of Kenya. The map producer has explicitly mentioned the crop type when was possible in the other cases he/she has created a more generic scrub crop class. The geographic validity of the crop types must therefore be evaluated case by case. May be in a specific geographic area the crop type is representative (to see this in our example is enough to see if in our study area all the scrub crops polygons have the crop type information) however this situation will change according to the geographic area and the crop type considered. As general rule we can say that in the data spatially aggregated the crop type is never representative

countrywide. For the original data set this particular question must be addressed to the country or to FAO. In some cases the validity of a crop information can be linked to some other land cover parameters (in Kenya for instance the information about the crop type Tea is linked with the field size. When the fields are large or medium it is information at country level when the size is small not).

A situation as explained above can happen:

- in the classes related to "Cultivated and Managed land" predominantly when the classifier "Crop Type" (in some cases "Field size") is considered,
- in the classes related to "Natural Semi natural Vegetation" if a classifier of a sub-class of "Height", "Leaf type" and "Leaf Phenology" or "Vegetation Type" is being used,
- in the classes related to "Built up Areas" when a classifier "Built up object" is used.

However these are general indications. When selecting a geographic area in the data base the user should check if the information (classifier type) he/she wants to obtain is present in the all polygons or not. If for instance he/she wants to know the extend of small fields of herbaceous crops in the study area he/she must verify that all the classes of herbaceous crop have the classifier "Field Size" present in the list of classifiers determining the different classes of herbaceous crop. In the future all these operations will be done by ADG (Africover Data Base Gateway). For each classifier chosen and in relation to the geographic area selected the end user will get all the information related to the "geographic validity" of class selected. For the moment this operation must be done manually.

However if only the major aspects (classifiers) of the land cover classes are needed the above explained situation will not appears.

Regarding the thematic accuracy of the database, an intermediate accuracy test is done at the end of the first phase of the interpretation; only the classes having a minimum threshold (60-70%) are considered in the final phase. The accuracy of these classes is, then, further improved in another interpretation session (final interpretation phase). Due to the new concept of class definition (sequence of classifiers) the accuracy can be calculated not only by class but also by single classifier forming the class. If class A is formed by a sequence of 5 classifiers (A2, B1, C1, D1, D9) and have an accuracy of 70% (as entire class) the calculation of the accuracy in the second way (by single classifiers) give a bigger flexibility to the end user to manipulate the data. If an assessment of the accuracy by classifiers is done in the above example class A can have the following situation:

A2 accuracy 100%
B1 accuracy 100%
C1 accuracy 100%
D1 accuracy 100%
D9 accuracy 70%

It is obvious that considering the class as a whole the classifier having the lowest accuracy drives the accuracy. Having the possibility of aggregation and data manipulation (using the classifiers) the user can decide to have a better accuracy decreasing the level of thematic information (considering only the first 4 classifiers) or accept a lower accuracy having a higher level of information. In the Africover/LCCS concept of class creation the map producer is committed to give the maximum level of accuracy to the classifiers on the first position of the sequence (A2, B1). The level of the accuracy can decrease for the classifiers according to their importance (position in the class sequence).

The classes of the present database therefore have been checked at the end of the preliminary phase. They have a minimum accuracy level for the major classifiers forming the class. It is expected that due to the work done in the second phase of the interpretation the accuracy would be further improved. However no accuracy has been done yet for this level.