**15th Meeting of the London Group on
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Land cover classification proposed for SEEA

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1. Background

Land classification has bee discussed in the 14th meeting of the London Group in Canberra on the basis of a paper prepared by EEA on land cover (LG/14/9 Land Cover Classification for Land Cover Accounting) and FAO on land use (LG/14/10 Land Use Classification). The conclusion of this discussion was that 1/ an international classification standard for land use should remain restricted to 15-20 land cover classes and built up from the FAO LCCS system when going to details and 2/ that FAO land use classification should be the standard for agriculture, forests and fisheries, supplemented for other classes with the UNECE land use classification. The two classifications should be supplemented at a later stage with a classification of land functions reflecting the multiple "secondary" uses of a given piece of land and connecting to ecosystem services.

On demand of UNSD, FAO and EEA have jointly drafted and presented a paper to the June 2009 meeting of UNCEEA on the progress on land classification. The following figure summarizes the presentation.

1
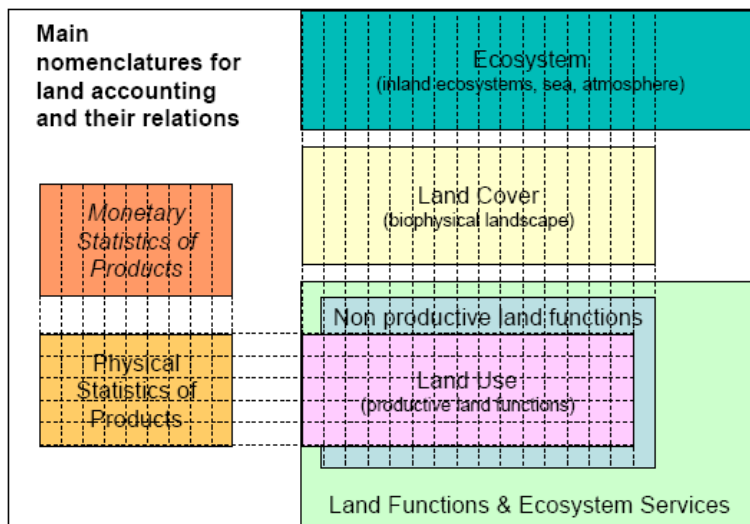
Early in July FAO and EEA met and come to the conclusion that no contradiction exist anymore between the Corine Land Cover nomenclature used in Europe and the new version of the LCCS. A conversion between LCCS based land cover map of Egypt and CLC has been easily done.

In November, the results of the feasibility study by ESA (the European Space Agency) and EEA of the GlobCorine map derived from the GlobCover process (see Annex 2) confirm the possibility of producing a global land cover map with frequent updates matching at the global scale the requirements of ecosystem accounting. Such map can be produced with satellites similar to MERIS such as MODIS, IRS, CBERS and others.

2. Proposal

The following legend of 14 classes is proposed as the backbone (Level 1) of an international classification.

Level 1 legend
- Cultivated/managed areas - Rainfed cropland
- Cultivated/managed areas - Irrigated cropland
- Cultivated/managed areas - Complex cropland
- Mosaic of cultivated/managed areas and natural/semi-natural vegetation
- Forest
- Woody/shrub vegetation
- Grassland/herbaceous vegetation
- Mosaic of natural and semi-natural vegetation
- Sparsely vegetated areas
- Bare soil
- Wetlands
- Water bodies
- Permanent snow and ice
- Artificial surfaces and associated areas

This legend should be submitted to competent organisations for validation and a limited possibility of extension (5 to 6 classes more).

It will be up to countries or regional authorities or research organisations to develop the detailed classes embedded into the international Level 1.

ESA/STAT/AC.189
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DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
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LAND COVER AND LAND USE CLASSIFICATIONS IN THE SEEA REVISION

Paper prepared by the European Environment Agency and FAO

(for discussion)

Land Cover and Land Use Classifications in the SEEA Revision

Drafted by Xiaoning Gong (FAO) & Jean-Louis Weber (EEA)

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Introduction and Background

Land classifications and accounting have been on the agenda of the recent London group meeting. In Canberra, April 2009, clarifications have been achieved both in terms of concepts and strategy for standardisation. The present paper summarises the main features of the discussion and indicates the way forward.

Because in many cases human activities interact positively or negatively with nature, land is an important feature of environmental accounting.

Land use (LU), land cover (LC), and land accounts (LAs) are mainly explained and described in Section F of Chapter 8 under the title of "Land and Ecosystem Accounts" in SEEA 2003. While there might be some controversy or incompleteness about the ecosystem accounts, for LU, LC, and LAs, the presentation of SEEA 2003 is in general quite clear.
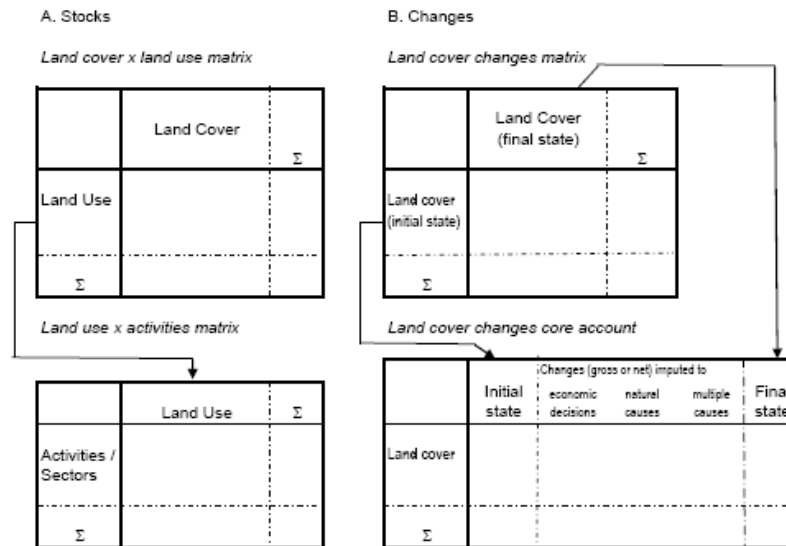
The important roles of land accounts are summarized as follows (§8.313, p373, SEEA 2003):

- To provide a complete picture of LC and LU for a nation and allow the derivation of trends and indicators of change.
- To aid the integration of diverse data sources on LC and LU themselves and with other data such as population, economic activity, water balances, species or fertilizer use.
- To allow changes in LU, LC, habitats, and biodiversity to be linked as far as possible to driving forces.
- To promote standardization and classifications of LC and LU.
- To be applied at national, regional, watershed or landscape type level.

The information of the basic set of LC/LU accounts to detect and identify the changes in LU and LC as causes and consequences of human and natural forces is very useful for land-related policies such as nature protection, agricultural, and transport policy. As demonstrated by the current active research, there is a strong relationship between "LU and LC change" and biodiversity loss, climate change, pollution, and other environmental impacts.

The structure and framework of the basic set of LC/LU accounts given in Figure 8.5 (below) are particularly instrumental. The basic set of LC/LU accounts is considered by SEEA 2003 as the standardization layout to be applicable across countries.

Figure 8.5 Structure of the basic set of land cover/land use accounts

A. Stocks

Land cover x land use matrix

	Land Cover	Σ
Land Use		
Σ		

Land use x activities matrix

	Land Use	Σ
Activities / Sectors		
Σ		

B. Changes

Land cover changes matrix

	Land Cover (final state)	Σ
Land cover (initial state)		
Σ		

Land cover changes core account

	Initial state	Changes (gross or net) imputed to			Final state
		economic decisions	natural causes	multiple causes	
Land cover					
Σ					

Land Use and Land Cover

The cover of land (cities, fields, rangeland, forests, wetlands…) reflects at the same time the use of land and the natural conditions within land use is taking place. Land cover, because it is easier to map (e.g. with earth observation satellites) is sometimes used as a proxy of land use – in the same way as it is used as a proxy of ecosystems. However land cover and land use should be kept separated. First, one reflects the bio-physical dimension of the earth's surface and another on the functional dimension of land for different human purposes or economic activities. Second, the variability of land uses is higher than the variability of land cover at a given place. For example, pastures in the countryside have an amenity value and could be important for biodiversity and nature conservation or be simply intensively used systems ploughed and regrown every few years. Third, land use statistics are closely related to the commodities delivered, data requirements will be different in many occasions. For example, the production of a given crop is related to arable land surface, not the surrounding hedgerows (which deliver fire wood) or paths (transport use); while land cover can be mapped as complex (mixed, mosaic) landscape units, land use requires generally scales where land is more closely correlated to products. For that reason land use statistics abundantly relies on area sampling survey (LUCAS in Europe for Agriculture, FAO-FRA2010 for forests…) and

LC is normally observed by satellite observation and aerial photographs. Fourth, observation units are different. LU is usually based on legal or economic units. LC is based on the basic land units. Land units are defined as surface areas with certain cover characteristics. In general, biotopes, ecosystems altogether with landscape artificial features and more heterogeneous land cover types as basic units for LC.

Land Cover Flows
Two accounts under "B. Change" at the right-hand side of the basic set of LC/LU accounts show LC flows. Land cover flows group the 1 to 1 changes of land cover between two dates according to the processes that they reveal (e.g. urban sprawl, internal conversions in agriculture, conversion of forest and natural land to agriculture…). These flows are recorded as "consumption of land cover" of the initial state and "formation of land cover" of the final state. They can be subdivided in turn by land cover types. Because of flows of internal conversions, the total of flows depends on the nomenclature and the detail of the original data but it doesn't change during further aggregations.

Classifications vs. Data Collection
To compile the basic set of LC/LU accounts, two equally important elements are indispensable: one is the classifications and another is data collection (including questionnaire design). They are closely related and supplement to each other but one cannot be replaced by the other.

In terms of classifications, to compile the basic set of LC/LU accounts, we will need four classifications: LU classification (LUC), LC classification (LCC), and ISIC for "Activities/Sectors," and classification on the types of land cover changes. ISIC is already available and the other three are to be reviewed and finalized.

The LU x LC matrix and LU x Activities/Sectors matrices for the "Stock" accounts here are parallel to "Supply and Use" matrices in the National Accounts in where the column and row are classified by ISIC and CPC.

Just like the relationship between CPC and ISIC, the relationship between LUC and LCC (as well as between LUC and ISIC) is not one-to-one. This is because a single LC unit can fulfill different functions, i.e. one or multiple LUs. Thus, it is better demonstrated by a correspondent table (i.e. a matrix) rather than a higher-and-lower level in a hierarchical system. In other words, the two classifications of LUC and LCC are closely related but still different as described in the Section above and thus need to be developed separately. A similar conclusion can be said on LUC and ISIC. It is not correct to think that LUC and ISIC should be "integrated" in a hierarchical system.

To establish the linkage between LU and LC, as well as between LU and ISIC ("Activities/Sectors") is equivalent to complete the cells in the two matrices under the "Stock" accounts in the basic set of land accounts, we will have to resort to the second element: data collection and questionnaire design but not by the classifications themselves. As pointed out in SEEA 2003, "a precondition for policy relevant and

scientifically sound land accounts is a good database with geo-referenced LU and LC data" (§8.352, p385, SEEA 2003).

For estimating economic activities matrix, it requires both highly disaggregated LUC and basic data, such as land for housing, kitchen gardens, use of land by industries from housing and industry surveys, which are available or can be estimated in a reliable way (§8.344, p380, SEEA 2003). As part of data collection, the questionnaires should be designed following the matrix, i.e. to inquire what kinds of activities are imposed on each unit of land.

Without separate LCC and LUC, geo-referenced and activity-referenced LU data, it is impossible to construct and interpret land stock accounts: LU / LC cross-tabulations for fixed points in time. Likewise, it will also be difficult to construct and interpret land change accounts: LU or LC change matrices showing the flows between categories of LU (or LC) during a period.

Needed Classifications

To revise and update SEEA 2003, from the above brief review, three classifications are needed and the references for two of them have also been given in SEEA 2003:

- <u>Land use classification</u>: "in general the more detailed ECE land use classification should be used. This classification is better suited to the analysis of types of land use with different environmental impacts rather than for the land classification in the SNA. The ECE classification is not entirely satisfactory and several international agencies (such as the FAO and Eurostat) were at work towards an improved land use classification at the time of writing of this handbook" (§8.333, p376, SEEA 2003).

- <u>Land cover classification</u>: "At the moment, internationally agreed land-cover classifications are available from FAO and for selected regions; for example, the CORINE land cover classification for Europe" (§8.332, p376, SEEA 2003).

- <u>Classification on the types of land cover changes</u>: so far this is an area where standard classifications are not readily available at the international level but have been used by some countries (§8.346, p381, SEEA 2003). Since then, land cover accounts have been produced in 2006 in Europe for 25 countries and have been implemented in Burkina Faso. Recent land cover change map produced in the FAO/Africover project lead to very similar classes of land cover changes.

In addition, the London Group meeting in Canberra has invited to reflect on a <u>classification of land functions</u>. It will help recording the other possible "uses" of a given piece of land which are often named "non productive land functions". The land functions classification would group together "Uses" and "Non productive functions". Land Functions (productive and non productive uses) generate Ecosystem Services (ES). In physical terms, ES will be quantified in volume or tons (provisioning services, products) or in land surface*beneficiary persons*time.

Land Use Classification

Generally, statistics and maps of land use are focussing on particular functions of a productive nature as the purpose of land use classification is to bridge land and the economy. We propose to keep this meaning of main productive land use and to refer to the main classifications used in international statistics: FAO statistic classifications for agriculture and forestry. This will deeply root the SEEA on a robust statistical base.

Upon the request of the London Group and UNSD, at the 14th Session of the London Group meeting in Canberra this year, a consolidated LUC has been proposed by FAO. This LUC is based on the major LU databases at the global level and more than 40 years of data collection experience and continuous researches carried out at FAO, including FAOSTAT (data collected since 1961), World Programme for the Census of Agriculture (WCA) (since 1945), and the Global Forest Resources Assessment (FRA) (since 1946). As a result of an effective joint effort and collaboration between various Departments and Divisions at FAO, the LUC proposed is fully applicable to LU data in different sectors and domains including agriculture, fisheries, and forestry at the global level.

Some distinct features of the proposed LU classification are as follows.

- While it strives hard to adhere to the commonly agreed principles resulting from previous theoretical and empirical researches in this field, at the same time, it is deeply rooted in the existing LU global statistical databases and incorporated the existing LU concepts, definitions, and classifications; by doing so to encourage and facilitate more comparability and compatibility among these datasets.

- The proposed LU classification provides a great flexibility in terms of application through its hierarchical structure. The higher levels related to LU of different industries, such as agriculture, forestry, fishery/aquaculture, and others. The lower levels include data on commodities or vegetation (e.g. crops such as cereals and oil seeds).

- The proposed LU classification establishes a linkage between itself with other major international classifications such as ISIC and CPC through the Indicative Crop Classification (ICC). This is because the ICC was originally developed and built based on the concepts and structures of CPC and ISIC.

The function of such a LU classification just like many currently used at the global level is mainly to serve as a correlation system through which land use classes from existing national systems could be correlated and global LU databases can be continuously maintained and developed. It is not realistic to expect that, through this proposed LU classification, countries would be asked to change their existing national classification systems that have been developed and applied in response to local decision-making needs.

As suggested by SEEA 2003, the next step is to incorporate UNECE land use classification for non-agricultural and non-forest land use (e.g. urban and other "artificial" uses) as the basis for a comprehensive LUC system.

Land Cover Classification/Nomenclature
The establishment of an international LCC should be based on the experience gained since two decades at the international level. The two major approaches are Land Cover Classification System (LCCS) developed by FAO and UNEP and Corine Land Cover (CLC) implemented in 35 European countries and tested in Africa and Latin America. The two approaches correspond in terms of two complementary purposes. LCCS aims at giving the possibility to elaborate "fit for purpose classifications" on the basis of strict composition rules, merging flexibility and comparability at the basic level of analysis. LCCS is scale and source independent. CLC is a nomenclature (or a legend in LCCS terms) aiming at comparability at the European scale of maps produced by satellite images – it is scale dependant. LCCS based legends de facto favour the description of vegetation patterns while CLC favour landscape patterns (earmarked by land use). LCCS based analyses are leading to different legends in different areas. CLC is a fixed standard which can be extended by other classes at the lower hierarchical levels. Because of the variety of specific landscapes around the world and of monitoring purposes, it is not appropriate to establish an international standard at the detailed level. Instead, it is proposed to establish a relatively aggregated standard of 15 to 20 classes, making the best use of LCCS and CLC. Such standard is under discussion. It will be "translated" into the LCCS set of rules and its feasibility at the global scale tested with the ESA/GlobCorine project (2009).

Correspondence between Classifications
The main relations between classifications are summarized in the following figure:
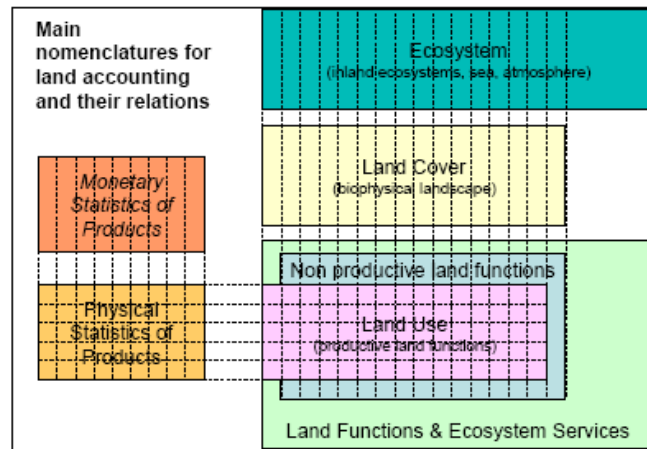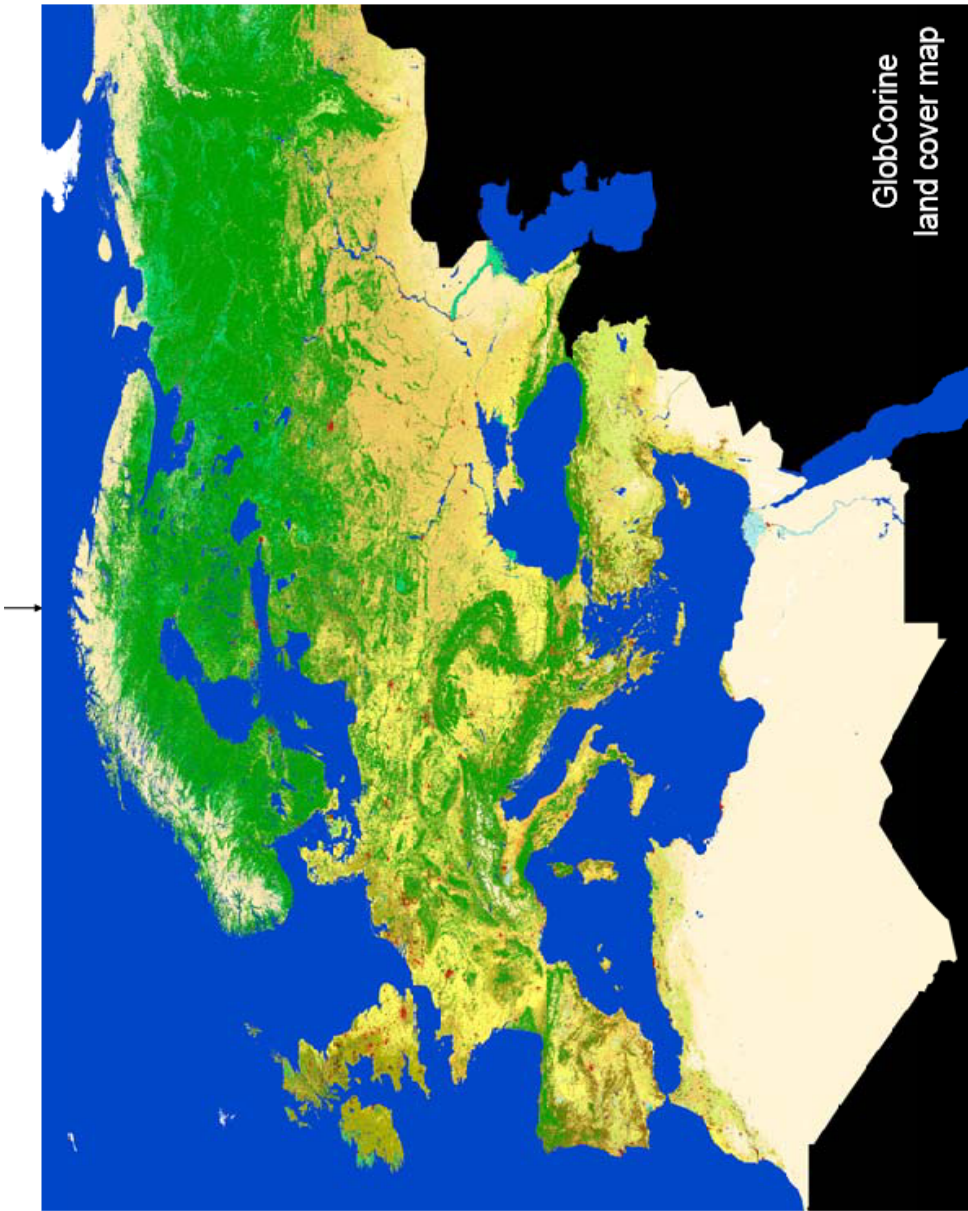
LEGEND

- Urban and associated areas
- Rainfed cropland
- Irrigated cropland
- Complex cropland
- Mosaic cropland (50-80%) / natural vegetation (20-50%)
- Mosaic natural vegetation (50-80%) / cropland (20-50%)
- Forest
- Shrubland
- Grassland
- Sparsely vegetated areas
- Vegetated low-lying areas on regularly flooded soil
- Bare areas
- Mosaic herbaceous vegetation (50-80%) / shrub-trees (20-50%)
- Mosaic shrub-trees (50-80%) / herbaceous vegetation (20-50%)
- Water bodies
- Permanent snow and ice

CONCLUSION

- GlobCorine is not a Corine map
  (different data, method and legend)
- ... but a compatible and complementary land cover map
  - short delivery time
  - high spatial coherence
  - fill in the gaps between CLC maps (in space and in time)

AKNOLEDGMENTS

T. Soukup and L. Brodsky from GISAT for their analytical support in the GlobCorine land cover map production.

**GlobCorine
land cover map**