**Changes classification: Land Cover Flows**

Land Cover Accounts summarize and interpret the $44 \times 43 = 1892$ possible one-to-one changes between the 44 CORINE land cover classes. The changes are grouped to so-called **flows of land cover** and are classified according to major land use processes:

- lcf1 Urban land management
- lcf2 Urban residential sprawl
- lcf3 Sprawl of economic sites and infrastructures
- lcf4 Agriculture internal conversions
- lcf5 Conversion from forested & natural land to agriculture
- lcf6 Withdrawal of farming
- lcf7 Forests creation and management
- lcf8 Water bodies creation and management
- lcf9 Changes of Land Cover due to natural and multiple causes

The nomenclature of flows is organized on 3 levels. Flows are described in Annex 1.

The classification of land cover flows results from the feasibility studies and subsequent revisions after discussion with experts in agri-environment and forestry. Basically, the classification of land cover flows distinguishes change between broad land cover classes and changes internal to these classes. Analysis of land cover flows supplies a rapid vision of processes taking place.

In the LEAC database the Land Cover Flows are described in the FLATMATRIX table. This table can be modified according to new revisions of the nomenclature or aggregation. The changes on this table will affect the final results.

**Combination of two Land Cover Layers to produce a Change Database.** In the case of CORINE land cover (44 classes) the intersection between two layers produces 1936 possible combinations. 1892 are classified as changes and 44 are classified as “No change”. To interpret this amount of information, Land Cover Changes are classified according to major Land Use processes into about 50 Land Cover Flows.
**Land Cover Flows hierarchy.** Classification of Land Cover Changes Matrix into Land Cover Flows can be done in three levels of aggregation. An example of level hierarchy is shown below. Colors in the figure show the Level 1 classification. Go to the Annex 1 and 2 for a complete description of Land Cover Flow classification.

**LCF4** Agriculture internal conversions

- LCF41 Extension of set aside fallow land and pasture
  - LCF411 Uniform extension of set aside fallow land and pasture
# ANNEX 1: MATRIX OF LAND COVER FLOWS

## Part a – Formation of Artificial surfaces

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### Part b – Formation of Agricultural areas

| 111 | Continuous urban fabric | 112 | Discontinuous urban fabric | 121 | Industrial or commercial units | 122 | Road and rail networks and associated land | 123 | Port areas | 124 | Airports | 131 | Mineral extraction sites | 132 | Dump sites | 133 | Construction sites | 141 | Green urban areas |
|-----|-------------------------|-----|-----------------------------|-----|-------------------------------|-----|-------------------------------------------|-----|-------------|-----|-----------|-----|-------------------|-----|----------------|-----|-----------------|
| 211 | Non-irrigated arable land | 212 | Permanently irrigated land | 213 | Rice fields | 221 | Vineyards | 222 | Fruit trees and berry plantations | 223 | Olive groves | 231 | Pastures | 241 | Annual crops associated with permanent crops | 242 | Complex cultivation patterns | 243 | Agriculture mosaics with significant natural vegetation | 244 | Agro-forestry areas |
| 311 | Broad-leaved forest | 312 | Coniferous forest | 313 | Mixed forest | 321 | Natural grassland | 322 | Moors and heathland | 323 | Sclerophyllous vegetation | 324 | Transitional woodland shrub | 331 | Beaches, dunes and sand plains | 332 | Bare rock | 333 | Sparsely vegetated areas | 334 | Burnt areas | 335 | Glaciers and perpetual snow | 411 | Inland marshes | 412 | Peatbogs | 421 | Salt marshes | 422 | Salines | 423 | Intertidal flats | 511 | Water courses | 512 | Water bodies | 521 | Coastal lagoons | 522 | Estuaries | 523 | Sea and ocean |
### Part c – Formation of Forested or open natural surfaces

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**Legend:**
- LC: Land Cover Code
- CF: Class Name
- LCF: Land Cover Flow Code
- Number: Flow Pattern

- **Continuous urban fabric**
- **Discontinuous urban fabric**
- **Industrial or commercial units**
- **Road and rail networks and associated land**
- **Port areas**
- **Airports**
- **Mineral extraction sites**
- **Dump sites**
- **Construction sites**
- **Green urban areas**
- **Sport and leisure facilities**
- **Non-irrigated arable land**
- **Permanently irrigated land**
- **Rice fields**
- **Vineyards**
- **Fruit trees and berry plantations**
- **Olive groves**
- **Pastures**
- **Annual crops associated with permanent crops**
- **Complex cultivation patterns**
- **Agriculture mosaics with significant natural vegetation**
- **Agro-forestry areas**
- **Broad-leaved forest**
- **Coniferous forest**
- **Mixed forest**
- **Natural grassland**
- **Moors and heathland**
- **Sclerophyllous vegetation**
- **Transitional woodland shrub**
- **Beaches, dunes and sand plains**
- **Bare rock**
- **Sparsely vegetated areas**
- **Burnt areas**
- **Glaciers and perpetual snow**
- **Inland marshes**
- **Peatbogs**
- **Salt marshes**
- **Salines**
- **Intertidal flats**
- **Water courses**
- **Water bodies**
- **Coastal lagoons**
- **Estuaries**
- **Sea and ocean**
### Part d – Formation of Wetlands and Water surfaces

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**Continuous urban fabric** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Discontinuous urban fabric** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Industrial or commercial units** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Road and rail networks and associated land** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Port areas** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Airports** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Mineral extraction sites** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Dump sites** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Construction sites** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Green urban areas** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Sport and leisure facilities** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Non-irrigated arable land** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Permanently irrigated land** lcf99 lcf99 lcf99 lcf99 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93


**Vineyards** lcf62 lcf62 lcf62 lcf62 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Fruit trees and berry plantations** lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99


**Pastures** lcf62 lcf62 lcf62 lcf62 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93


**Complex cultivation patterns** lcf62 lcf62 lcf62 lcf62 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93

**Agriculture mosaics with significant natural vegetation** lcf62 lcf62 lcf62 lcf62 lcf93 lcf913 lcf99 lcf99 lcf99 lcf93


**Broad-leaved forest** lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Coniferous forest** lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Mixed forest** lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Natural grassland** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf913 lcf913 lcf99 lcf99

**Moors and heathland** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Sclerophyllous vegetation** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Transitional woodland shrub** lcf911 lcf911 lcf911 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Beaches, dunes and sand plains** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Bare rock** lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Sparsely vegetated areas** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Burnt areas** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Glaciers and perpetual snow** lcf94 lcf94 lcf94 lcf94 lcf94 lcf94 lcf94 lcf94 lcf94 lcf94


**Salines** lcf99 lcf99 lcf911 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Intertidal flats** lcf99 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99


**Water bodies** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

**Coastal lagoons** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99


**Sea and ocean** lcf912 lcf912 lcf912 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99 lcf99

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ANNEX 2: DEFINITION OF LAND COVER FLOWS

LCF1 Urban land management: Internal transformation of urban areas.
   lcf11 Urban development/ infilling: Conversion from discontinuous urban fabric, green urban areas and sport and leisure facilities to dense urban fabric, economic areas and infrastructures.
   lcf12 Recycling of developed urban land: Internal conversions between residential and/or non-residential land cover types. Construction of urban greenfields is not considered here but as lcf11.
   lcf13 Development of green urban areas: Extension of green urban areas over developed land as well as, in the periphery of cities, over other types of land uses.

LCF2 Urban residential sprawl: Land uptake by residential buildings altogether with associated services and urban infrastructure (classified in CLC 111 & 112) from non urban land (extension over sea may happen).
   lcf21 Urban dense residential sprawl: Land uptake by continuous urban fabric (CLC 111) from non urban land
   lcf22 Urban diffuse residential sprawl: Land uptake by discontinuous urban fabric (CLC 112) from non urban land.

LCF3 Sprawl of economic sites and infrastructures: Land uptake by new economic sites and infrastructures (including sport and leisure facilities) from non urban land (extension over sea may happen).
   lcf31 Sprawl of industrial & commercial sites: Non urban land uptake by new industrial and commercial sites
   lcf32 Sprawl of transport networks: Non urban land uptake by new transport networks (note that linear features narrower than 100 m are not monitored by CLC).
   lcf33 Sprawl of harbours: Development of harbours over non urban land and sea.
   lcf34 Sprawl of airports: Development of airports over non urban land and sea.
   lcf35 Sprawl of mines and quarrying areas: Non urban land uptake by mines and quarries.
   lcf36 Sprawl of dumpsites: Non urban land uptake by waste dumpsites.
   lcf37 Construction: Extension over non-urban land of areas under construction during the period (note: covers mainly construction of economic sites and infrastructures).
   lcf38 Sprawl of sport and leisure facilities: Conversion from developed as well as non-urban land to sport and leisure facilities.

LCF4 Agriculture internal conversions: Conversion between farming types. Rotation between annual crops is not monitored by CLC.
   lcf41 Extension of set aside fallow land and pasture: Conversion from crop land to grassland as an agricultural rotation or for cattle husbandry.
      lcf411 Uniform extension of set aside fallow land and pasture: Large parcels conversion from crop land to grassland.
      lcf412 Diffuse extension of set aside fallow land and pasture: Conversion from crop land to complex cultivation patterns (with grassland) and from mixed agriculture to large pasture parcels.
   lcf42 Internal conversions between annual crops: Conversions between irrigated and non-irrigated agriculture
      lcf421 Conversion from arable land to permanent irrigation perimeters: Extension of permanent irrigation (incl. rice fields) over arable land
      lcf422 Other internal conversions of arable land: Other conversions between arable land and irrigated perimeters, incl. rice fields
lcf43 Internal conversions between permanent crops: Conversions between vineyards, orchards and/or olive groves

lcf431 Conversion from olives groves to vineyards and orchards: Conversion from olives groves to vineyards and orchards

lcf432 Conversion from vineyards and orchards to olive groves: Conversion from vineyards and orchards to olive groves

lcf433 Other conversions between vineyards and orchards: Other conversions between vineyards and orchards

lcf44 Conversion from permanent crops to arable land: Conversion from vineyards, orchards and olive groves to irrigated and/or non-irrigated arable land

lcf441 Conversion from permanent crops to permanent irrigation perimeters: Conversion from permanent crops (incl. when associated with arable land - CLC 241) to permanent (large) irrigation perimeters and rice fields

lcf442 Conversion from vineyards and orchards to non-irrigated arable land: Conversion from vineyards and orchards to non-irrigated arable land and from associations of annual and permanent crops to uniform arable land.

lcf443 Conversion from olive groves to non-irrigated arable land: Conversion from olive groves to non-irrigated arable land, incl. conversions to associations of annual and permanent crops (CLC241) and of crops and pasture (CLC242).

lcf444 Diffuse conversion from permanent crops to arable land: Conversion from vineyards and orchards to associations of annual and permanent crops (CLC241) and of crops and pasture (CLC 242: complex cultivation patterns).

lcf45 Conversion from arable land to permanent crops: Plantation of vineyards, orchards and olive groves on arable land.

lcf451 Conversion from arable land to vineyards and orchards: Plantation of vineyards, orchards on arable land.

lcf452 Conversion from arable land to olive groves: Plantation of olive groves on arable land.

lcf453 Diffuse conversion from arable land to permanent crops: Conversion from uniform arable land to associations of permanent crops and annual crops (CLC241).

lcf46 Conversion from pasture to arable and permanent crops: Conversion from pasture to arable and permanent crops

lcf461 Conversion from pasture to permanent irrigation perimeters: Conversion of uniform pasture areas to permanent irrigation perimeters

lcf462 Intensive conversion from pasture to non-irrigated arable land and permanent crops: Conversion of uniform pasture areas to non-irrigated annual and permanent crops

lcf463 Diffuse conversion from pasture to arable and permanent crops: Conversion from complex cultivation patterns including pasture (CLC242) to uniform arable land and permanent crops as well as to associations of the last two (CLC241) and conversion of uniform pasture (CLC231) to complex cultivation patterns.

lcf47 Extension of agro-forestry: Conversion of cultivated land and open pasture to agro-forestry systems such as dehesas (note: conversion from 243, where natural vegetation is important, is recorded under lcf522)

lcf48 Other conversions from agriculture mosaics to arable land and permanent crops:
This land cover class is used only when changes are detected from a Corine land cover matrix combing classification of level2 for the initial year and level 3 for the final year. Agriculture mosaic classes being grouped in clc 24 only, it is not possible to differentiate the processes according to the type of land consumed. It includes in particular the sub-class lcf523, Conversions from agriculture-nature mosaics to continuous agriculture, not isolated in this case.

lcf481 Other conversions from agriculture mosaics to permanent crops: clc level2xlevel3 only. It includes conversion of agriculture-nature mosaics to arable land (see lcf48)

lcf482 Other conversions from agriculture mosaics to arable land (including conversion of agriculture-nature mosaics to permanent crops): clc level2xlevel3 only. It includes conversion of agriculture-nature mosaics to arable land (see lcf48)
**LCF5 Conversion from forested & natural land to agriculture:** Extension of agriculture land use

**lcf51 Conversion from forest to agriculture:** Deforestation for agriculture purpose, including agricultural conversion of transitional woodland shrub

**lcf511 Intensive conversion from forest to agriculture:** Deforestation, including agricultural conversion of transitional woodland shrub, for cultivation of annual and permanent crops (incl. in association, CLC241).

**lcf512 Diffuse conversion from forest to agriculture:** Conversion from uniform forest to complex cultivation patterns, mosaic agricultural landscape and agro-forestry. Due to possible uncertainties in monitoring extension of pasture vs. recent fellings, conversion from forests to pasture land (CLC231) is recorded here.

**lcf52 Conversion from semi-natural land to agriculture:** Conversion from dry semi-natural land (except CLC324, grouped with forests) to agriculture

**lcf521 Intensive conversion from semi-natural land to agriculture:** Conversion from dry semi-natural land (except CLC324, grouped with forests) to annual crops, permanent crops and their association.

**lcf522 Diffuse conversion from semi-natural land to agriculture:** Conversion from dry semi-natural land (except CLC324, grouped with forests) to pasture and mixed agriculture with pasture.

**lcf523 Conversions from agriculture-nature mosaics to continuous agriculture:** Conversion from clc243, where natural areas are distinctive feature of the land systems to continuous agriculture. This is an over-estimation from an agriculture perspective but is justified in terms of analysis of ecological potentials of complex land systems.

**lcf53 Conversion from wetlands to agriculture:** Conversion of wetlands to any type of farmland

**lcf54 Conversion from developed areas to agriculture:** Conversion of urban land to any type of farmland (CLC2)

**LCF6 Withdrawal of farming:** Farmland abandonment and other type of withdrawal of agriculture activity in favour of forests or natural land

**lcf61 Withdrawal of farming with woodland creation:** Forest and woodland creation (incl. transitional woodland shrub) from all CLC agriculture types. Withdrawal of farming with woodland creation is a broader concept than farmland abandonment with woodland creation, which results more from decline of agriculture than afforestation programmes. Additional information is necessary to identify an abandonment process (type of agriculture, landscape type, socio-economic statistics...).

**lcf62 Withdrawal of farming without significant woodland creation:** Farmland abandonment in favour of natural or semi-natural landscape (except forests and transitional woodland shrub), as long as they are a possible transition. Some odd cases are provisionally recorded as lcf99 Other changes and unknown.

**LCF7 Forests creation and management:** Creation of forests and management of the forest territory by felling and replanting. Due to the CLC cycle of 10 years, only one part of the shrubs are tall enough to be identified as trees. In order to taking stock of all recent plantations, conversions of semi-natural land to CLC324 are conventionally recorded as afforestation (although some natural colonisation may take place). In the case of conversion from farmland, see lcf61.

**lcf71 Conversion from transitional woodland to forest:** Conversion from transitional woodland to broadleaved, coniferous or mixed forest, taking place when shrubs can be detected as trees.

**lcf72 Forest creation, afforestation:** Forest creation and afforestation take place on all previously non agricultural landscapes where new forests can be identified. Extension of transitional woodland shrub over non-agricultural land is recorded as afforestation. Conversion from transitional woodland to broadleaved, coniferous or mixed forest are not a creation of forest territory and are therefore registered separately (lcf71).

**lcf73 Forests internal conversions:** Conversions between broadleaved, coniferous and/or mixed forest (CLC311, 312 and 313)

**lcf74 Recent felling and transition:** Conversion from broadleaved, coniferous and/or mixed forest to open semi-natural and natural dry land resulting more likely from felling. The main
transition is towards CLC324 Transitional woodland shrub, although some other types can be detected. Due to uncertainties, all are provisionally considered as transitional states of forests.

**LCF8**  
**Water bodies creation and management:** Creation of dams and reservoirs and possible consequences of the management of the water resource on the water surface area.

- **lcf81**  
  **Water bodies creation:** Extension of water surfaces resulting from the creation of dams and reservoirs

- **lcf82**  
  **Water bodies management:** Consequences of the management of the water resource on the water surface area of reservoirs

**LCF9**  
**Changes of Land Cover due to natural and multiple causes:** Changes in land cover resulting from natural phenomena with or without any human influence.

- **lcf91**  
  **Semi-natural creation and rotation:** Changes in natural and semi-natural land cover due to natural factors

  - **lcf911**  
    **Semi-natural creation:** Natural colonisation of land previously used by human activities. Note that extension of CLC324 is considered as the result of farmland abandonment or direct afforestation.

  - **lcf912**  
    **Semi-natural rotation:** Rotation between the dry semi-natural and natural land cover types of CLC (except forest and transitional woodland shrub).

- **lcf913**  
  **Extension of water courses:** Extension of water course results from natural erosion and artificial works. Due to the very incomplete detection of rivers with CLC, the lcf913 flow item has to be used very carefully.

- **lcf92**  
  **Forests and shrubs fires:** Forest and shrub fires. Due to the short cycle of recovery of vegetation from fire, burnt areas (which are well identified on satellite images) cannot be compared in a 10 years interval, except for very aggregated statistics.

- **lcf93**  
  **Coastal erosion:** Conversion of all land cover types to intertidal flats, estuaries or sea and ocean. The tide level when the satellite image is shot being unknown of the photointerpreters, the coastal erosion flow has to be used very carefully.

- **lcf94**  
  **Decrease in permanent snow & glaciers cover:** Decrease of permanent snow and glaciers due to climate change to semi-natural and natural land covers, mainly to bare rock, sparsely vegetated areas and water systems.

- **lcf99**  
  **Other changes and unknown:** In this category are recorded land cover changes that are rare or more likely improbable.