Fragmentation of land by urbanisation, transport infrastructure and agriculture

Background

The survival of threatened species depends on populations which are large enough to maintain their genetic diversity and to continue reproduction. If the habitats of these species are reduced or fragmented, it may lead to isolation of individuals and groups of the main population. The assessment of the extent of undisturbed habitats is the first step in taking action to preserve them from further decline.

A 10 x 10 km grid size has been chosen as the best coarse representation of a fragmentation index at European scale. The methodology has been elaborated in collaboration between the European Topic Centre on Land Cover and European Topic Centre on Nature Conservation. The methodology can be refined to smaller grids and shorter influence area.

Methodology

Scientific references

European Topic Centre on Land Cover (1998): Proceedings from Workshop on land cover applications - needs and use .- EEA; see : Application 10 - Influence from urbanisation, agriculture and infrastructure

Concept

For the analysis of land fragmentation the major land cover types have been aggregated to three classes of varying human influence. Areas acting as pressure areas on their neighbouring land have been identified as well as areas sensitive to these pressures and neutral areas (see also Table 7).

The fragmentation of these sensitive areas (= potential natural and semi natural areas) by pressure from surrounding artificial territories (urban and industrial areas), intensive agriculture as well as transport networks is examined in the maps included in this report. Because CORINE land cover does not account for linear features for transport (roads and railways) these data have been integrated in the analysis from the EUROSTAT GISCO database.

The fragmentation index is calculated for a 10 x 10 km grid which is overlaid on the land cover data, assessing the distribution of natural complexes within each grid cell. For each grid cell is investigated how many natural complexes are found within the cell and the compactness of these complexes (average size of complex in cell versus total area of complexes in cell). From these statistics an index of fragmentation is calculated for each grid cell.

To asses the connectivity of natural and semi-natural grid cells (pixels) specific algorithms are used. Non-connected pixels or groups of pixels remain independent natural complexes. Infrastructure is considered to have a linear effect (cutting) on sensitive areas.

All connected natural and semi-natural pixels (i.e. sensitive areas) are combined into one individual natural complex. Non-connected pixels or groups of pixels remain independent natural complexes.

Only those cells are considered connected which share a common boundary.

In the process of converting the original vector data (lines) into raster data, lines that run diagonally across are converted to a series of pixels which are connected only via a common corner. By only allowing pixels that share a common boundary to identify sets of contiguous pixels, the fragmenting effect of roads is taken stronger into consideration.
(figure 1)

Figure 1: Neighbouring cells considered in connectivity analysis

All sensitive areas affected by the pressure area or the transport network are considered disturbed, the remainder is called . remote. .

A buffer around sensitive areas is used to stress the existence of even small areas of great value for nature conservation. The buffering process is constrained to the fact that it can not extend into pressure areas, only into neutral areas.

The fragmentation index is calculated with the following formula:

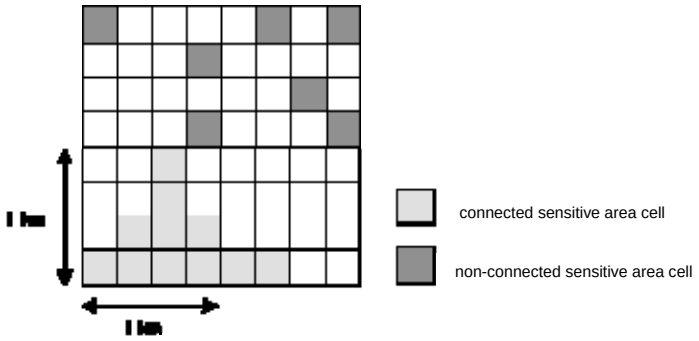
fragmentation index = freq / ((mean count / 16) * (sum count / 16))

freq = number of connected . sensitive pixels. (complexes) in each grid cell (1x1, 5x5 or 10x10 km)

mean count / 16 = average size of the clusters in km^2

sum count / 16 = total area of all nature pixels in km^2

Remark: each pixel has a size of 250 m, therefore 4x4 = 16 pixels represent 1 km^2.



Example for a 2 x 2 km grid cell:

No. of connected sensitive area cells: 11

Total number of sensitive cells: 18

Number of complexes: 8 (7 non-connected + 1 connected)

freq = 11

mean count = 18 / 8 = 2.25

sum count = 18

index = 11 / ((2.25 / 16) x (18 / 16)) = 69.53

Figure 2: Example of fragmentation index calculation

The index of fragmentation is divided into classes from minimal to extreme as follows:

minimal:	fragmentation index < 0.01
little:	fragmentation index 0.01 - 0.1
average:	fragmentation index 0.1 - 1
rather:	fragmentation index 1 - 10
strong:	fragmentation index 10 - 100
extreme:	fragmentation index > 100

Grid cells without any (semi-) natural area are represented in white. No (semi-) natural land in a 10 x 10 km cell can be of three origins:

1. the cell is totally occupied by a land cover type acting as pressure;

2. the cell contains only neutral areas or

3. a combination of the first two (pressure area and neutral area)

Common to all cases is the absence of any (semi-) natural area.

Results for all Europe are presented. For the map see annex 17.

Data input

The data sets used in the application are:

- major land cover types
- DMEER, 250 grid (Digital Map of Ecological Environmental Regions)
- transport network (roads and railways from the GISCO database)
- country boundaries

Actions

Step 1:

Overlay of major land cover types with the DMEER map.

Step 2:

Overlay of major land cover types with the country boundaries from the NUTS (Nomenclature for Statistical Territorial Units) database.

Step 3:

Creation of a transport network grid with 250 m cell size.

Step 4:

Selection of sensitive habitats and creation complexes of connected sensitive habitats, considering only those grid cells as connected that share a common boundary.

Step 5:

Creation of a 500 m buffer around sensitive areas (in grid), extending only into neutral and other sensitive areas, not into pressure areas. If the buffer areas around two sensitive areas overlap each other, they are grown together.

Step 6:

Obtain sensitive areas remote from artificial features (P).

Step 7:

Combination of the roads and railways in one grid data set and overlay of this one with the sensitive areas remote from artificial areas (P) to obtain sensitive areas remote from P and transport network. In this step . sensitive. grid cell are eliminated when the contain . transport. .

Step 8:

Creation of an empty fishnet coverage (regular grid structure with resolution depending on analysis cell size) which is subsequently converted to a GRID data set.

Step 9:

Determination of the number of undisturbed sensitive area in each grid cell and the number of all sensitive pixels in each analysis grid cell.

Step 10:

Determination of the number of connected natural complexes in each grid cell, their average size in that particular cell and the total area covered by the complexes in that cell.
Using these values the indicator is calculated (see above for details on calculation of the index).

Created data sets:

- data set with a regular grid (10 x 10 km)

- INFO file with area statistics, can be linked to data set for illustration.