EUROPEAN FORUM FOR GEOSTATISTICS 2012
Prague Conference

24-26 October 2012
Prague, Czech Republic

„If you cannot describe it, you cannot manage it“
Urban Morphological Zones for Spain: 
*Urban indicators from and Object Oriented Land Cover data base and a population grid* 

(in progress...) 

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Definition

• **Urban Morphological Zones (UMZ):** “A set of urban areas laying less than 200m apart”.

• Those urban areas are defined from land cover classes contributing to urban tissue and function.

• They have been created by the EEA for Europe from CORINE Land Cover (CLC) classes for 1990, 2000 and 2006:

Objective

• Create UMZ from high resolution land cover information (no reference to LAU2 boundaries).
• Use the EEA methodology, conveniently adapted to the structure of our data.
• Assign to each UMZ population figures from a population grid.
• Eventually, explore the possibility of developing urban indicators from the land cover dataset.
1. **High resolution and complex land cover dataset**: Information System on Land Cover in Spain (**SIOSE**). An object oriented database developed by our **National Geographical Institute** (IGN).

2. **A 1 Km² population grid**: constructed by top-down methods from SIOSE and census track population data for 2006 (presented at the EFGS 2012 Lisbon meeting).
SIOSE versus CLC

• Cartographic scale:
  1:25.000 SIOSE versus 1:100.000 CLC

• Minimum Mapping Unit:
  1ha. Urban zones, SIOSE versus 25ha. CLC

• Minimum width lineal elements:
  15 m. SIOSE versus 100 m. CLC

• Data Model:
  Object oriented, SIOSE versus hierarchical (44 classes) CLC
SIOSE versus CLC

• Spatial resolution:
  CLC2006  155,801 polygons
  SIOSE2005  2,477,593 polygons

• Average polygon size:
  CLC2006  3,24 Km²
  SIOSE2005  0,20 Km²

• Thematic resolution:
  CLC2006:  44 covers (= 44 classes)
  SIOSE2005:  820,632 covers (different combination of classes)
SIOSE versus CLC

SIOSE polygons

1 CLC polygon
In CLC only one cover is assigned to each polygon:
In SIOSE a polygon is characterized by many classes, with different spatial structures:
SIOSE versus CLC

• SIOSE does not classify a given polygon within a fixed hierarchical nomenclature, but it allows to assign one or more covers to the same polygon, using shares of occupation, that eventually add to 100%.

• The aim is not to classify each polygon, but to describe each polygon as accurate as possible.

• In addition, (simple) covers have attributes, providing additional information on the spatial distribution of covers, or signaling its potential use.

• Much more complex information than the usual thematic maps, but it is also much more versatile and adaptable to the researcher needs.
The data model begins with a basic list of 40 simple covers.

<table>
<thead>
<tr>
<th>CODIGO</th>
<th>NOMBRE</th>
<th>ETIQUETA</th>
<th>Km²</th>
<th>%</th>
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<tr>
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<td>EDF</td>
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<td>ZAU</td>
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<td>Cultivos Herbáceos</td>
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<tr>
<td>211</td>
<td>Arroz</td>
<td>CHA</td>
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<td>212</td>
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<td>Frutales</td>
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<td>Frutales Citrícos</td>
<td>LFC</td>
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<tr>
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<td>Frondosas Perennifolias</td>
<td>FDP</td>
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<tr>
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<td>GNP</td>
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<tr>
<td>336</td>
<td>Rambias</td>
<td>RMB</td>
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<tr>
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<tr>
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<td>Acantilados marinos</td>
<td>ACM</td>
<td>162</td>
<td>0.03%</td>
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<tr>
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<td>Atollamientos rocosos y roqueados</td>
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<td>HTU</td>
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<td>740</td>
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<tr>
<td>422</td>
<td>Salinas marinas</td>
<td>HSM</td>
<td>144</td>
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<tr>
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<td>COBERTURA DE AGUA</td>
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<td>3,470</td>
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<td>3,312</td>
<td>0.66%</td>
</tr>
<tr>
<td>511</td>
<td>Cursos de agua</td>
<td>ACU</td>
<td>874</td>
<td>0.17%</td>
</tr>
<tr>
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<td>Láminas de agua</td>
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<td>ALG</td>
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<td>Embalses</td>
<td>AEM</td>
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<tr>
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<td></td>
<td>158</td>
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<tr>
<td>521</td>
<td>Lagunas costeras</td>
<td>ALC</td>
<td>85</td>
<td>0.02%</td>
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<tr>
<td>522</td>
<td>Estuarios</td>
<td>AES</td>
<td>73</td>
<td>0.01%</td>
</tr>
<tr>
<td>523</td>
<td>Mares y océanos</td>
<td>AMO</td>
<td>0</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

Superficie Total de España: 506,040 100.00%
Simple covers are aggregated into composite covers to describe fully the composition and structure of a polygon.

Each simple cover is assigned its share of the surface of the polygon.

Complex covers can be nested.

A set of consistency rules are build into the database.
Some composite covers are predefined, and have a particular structure.

This is not an exhaustive list and can be adapted to particular needs.
In addition, covers can be assigned an attribute, that provides additional information on the particular cover.
SIOSE: Polygon labels

• Each polygon has a code label.
  1. Polygon with a simple cover:

     \[ 100FDCfr = FDCfr \]

  2. Polygon with a composite cover:

     \[ R(50LFNfzrr_{40CNFpl_{10SDNfc}}) \]

  3. Polygon with a composite predefined cover:

     \[ UER(30LFCfzsc_{25EDFva_{20CHLfzrr_{20FDPpl_{5LAA}}}}) \]

  4. Polygon with a nested composite cover:

     \[ R(80A(70MTRfr_{30ZQM})_{20OVD}(90LVfzsc_{10LOLfzsc})) \]
Example 1: Artificial area

1 homogeneous polygon:

Land cover 1.1.2: Artificial areas. Urban fabric. Discontinuous urban fabric
(100 % of polygon’s surface)

Land Cover Elements in it:
- Buildings (50 %)
- Roads (15 %)
- Trees (deciduous) (20 %)
- Herbaceous vegetation (10 %)
- Swimming pools (5 %)

Source: Guillermo Villa. IGN. EIONET OODMWG Meeting. Madrid 10-11 December 2009
Example 2: Agricultural area

1 non-homogeneous polygon:

Land cover 2.1.1: Agricultural Areas. Arable Land. Non-irrigated arable land (72 % of polygon’s surface)

Land Cover Elements in it:
- Soil (60 %)
- Herbaceous Vegetation (crop) (40 %)

Land cover 2.2.2: Agricultural Areas. Permanent crops. Fruit trees (28 % of polygon’s surface)

Land Cover Elements in it:
- Soil (12 %)
- Fruit Trees (80 %)
- Greenhouses (2 %)
- Irrigation reservoirs (6 %)

Source: Guillermo Villa. IGN. EIONET OODMWG Meeting. Madrid 10-11 December 2009
Example 3: Natural area

1 non-homogeneous polygon:

Land cover 3.1.1: Forest and seminatural Areas. Forest. Broad-leaved forest
(55 % of polygon’s surface)

Land Cover Elements in it:
- Soil (10 %)
- Trees (deciduous) (90 %)

Land cover 3.1.2: Forest and seminatural Areas. Forest. Coniferous forest
(45 % of polygon’s surface)

Land Cover Elements in it:
- Soil (5 %)
- Trees (coniferous) (95 %)

Source: Guillermo Villa. IGN. EIONET OODMWG Meeting. Madrid 10-11 December 2009
A nomenclature for SIOSE

- The power of SIOSE is also its weakness.
- For creating UMZ we need rules to determine the land cover classes to be considered as “urban areas”, so they can be included in the UMZ.
- **Step 1**: Create a nomenclature (hierarchical model) from SIOSE. Similar to CLC, but much more detailed: *SIOSE’s Hierarchical Model (SHM)*.
- We devised an automatic algorithm that classifies each SIOSE polygon into a given set of classes, and all polygons are classified.
SHM classes

(level 3)

- At level 4 SHM has 83 classes and at level 3 (comparable with CLC) it has 49 classes.
• The **algorithm** implements the following steps:

1. Create a correspondence table between SIOSE covers and the new SHM nomenclature.

2. Simplify SIOSE´s label into a “plain code” (simple/predefined composite cover and its associated share of surface, no nesting!)

3. Define **assignment rules**: majority and hierarchical simple rules and preference composite rules for polygons without a clear dominance structure.
Assignment rules does not alter SIOSE’s original polygons, so we can track the original information on each polygon.

SHM Code: 1314 - Airports

SIOSE’s ID_POLYGON: b382aa93-d59a-4a5d-bb81-3ebdaca6c5a6
SIOSE’s Label: NAP(70VAP_10EDFnv_10OCT_10SNE)
SIOSE’s dominant cover: 100NAP
SIOSE’s plain code: NAP
A nomenclature for SIOSE

• These rules mimics the technical information (photointerpretation manual) in developing CLC and SIOSE and are designed to minimize “heterogeneous covers”.

• A validation exercise against CLC gave more satisfactory results for our nomenclature (SHM) than for the nomenclature implemented in the Web Map Service (WMS) of IGN (IberPix).
Step 2: Given SHM create UMZ following a modified EEA’s methodology.

1. Core classes (CC): Urban fabric, Industrial and commercial units and Green urban areas.

2. Enlarged core classes (ECC): Port areas, Airports and Sport and leisure facilities if they are close (proximity rule) or neighbours (contiguity rule) to the CC. Iterative process.

3. Gaps: Forest, scrub, natural grassland, water treatment and desalination plants, dumps,... when they are completely within ECC.
4. Linear features (LF): Road and rail networks and Water courses if they are neighbours (contiguity rule) to the ECC, then clipped by a 100m buffer.

5. Contiguity core classes: Go back to look for additional contiguity core classes not previously included. Iterative process.

6. Merge: Polygons lying less than 200m apart are merged under a unique identifier.
• Eventually, UMZs less than a minimum threshold (20 ha) are dropped.
• In this way we generate about 5,000 UMZ.
• We work in vector format, the original geometry of polygons is not altered and we always keep the contents of each UMZ in terms of its composition: SHM polygons and the original SIOSE information.
• This implies that we can always recover the shares of simple SIOSE land covers for each UMZ.
• After population has been assigned a minimum threshold of population will be established.
UMZ: Barcelona

SIOSE polygons: 4,538
Area: 377.55 Km²
Population: 3,802,184
UMZ: Barcelona

SIOSE polygons: 4,538
Area: 377.55 Km²
Population: 3,802,184
• **Step 3**: The UMZ vector layer is overlaid with a population grid, so a population figure is assigned to each UMZ.

• We used a top-down grid build from census tracks (ED) population data and SIOSE as auxiliary information.
GRID STATISTICS
Total area - km² 506,011
Total population -
  Municipal registry 2010 47,021,031
Population in grid dataset 46,787,184 (99.5%)
Inhabited grid cells 94,440 (18.8 %)
Inhabitants per km² land area 93
Inhabitants per inhabited km² 495
Maximum population in one grid cell 54,228

SOURCE:
Total area is obtained in ArcGIS 9.3 from the commune boundary vector file from IGN (May 2011), originally in geographical coordinates, WGS84 for Canary Islands and ETRS89 for the rest of the country, and LAEA projection.

Land area deducts from total area the Water Bodies (500) surface from SIOSE2005, according to Eurostat (1999) recommendations.

Inhabitants per km²
- Not inhabited
- 1 - 5
- 6 - 10
- 11 - 50
- 51 - 100
- 101 - 500
- 501 - 1,000
- 1,001 - 5,000
- 5,001 - 10,000
- 10,001 - 25,000
- 25,001 - 55,000

Proj. LAEA. Datum ETRS 1989
Population

- We are in the process of disaggregating population characteristics; like sex, age or nationality, but this information has not yet been exploited.
• We find 735 UMZ of at least 5,000 inhabitants that accounts for 35,348,163 inhabitants. Very similar to the population living in Urban Clusters (35,579,555), using Eurostat definition.
• We find 415 UMZ of at least 10,000 inhabitants and 101 UMZ of at least 50,000 inhabitants, that accounts for 26,702,656 inhabitants. A bit higher that the population living in Urban Centers (22,258,510), using Eurostat definition.
• We find 56 UMZ of at least 100,000 inhabitants and 3 UMZ with more than a million of population.
UMZ and LAU2

- Intersecting UMZ with LAU2 boundaries we can relate urbanization to political boundaries.

- 22 UMZ spread over more than 10 LAU2, but most of the UMZ (4,339) are confined within the limits of only one LAU2.

The UMZ from Barcelona is the more dispersed across municipal boundaries. It is present in 67 LAU2.
UMZ: Madrid

Area: 605.90 Km²
Population: 4,833,124

UMZ Madrid: Share of simple covers (SIOSE)

- Buildings: 28.7%
- Artificial Green Areas: 17.7%
- Artificial Water Bodies: 5.0%
- Streets and Artificial Surface Areas: 5.7%
- Other Constructions: 22.6%
- Non-Built Soil: 18.6%
- Dump: 1.3%
- Open Areas: 0.5%
UMZ: Valencia

Area: 180.02 Km²
Population: 1,515,755

UMZ Valencia: Share of simple covers (SIOSE)

- Buildings: 47.3%
- Artificial Green Areas: 11.9%
- Artificial Water Bodies: 21.2%
- Streets and Artificial Surface Areas: 4.9%
- Other Constructions: 0.1%
- Non-Built Soil: 0.5%
- Dump: 2.4%
- Open Areas: 11.6%

Area: 180.02 Km²
Population: 1,515,755
Density (inhabitants/Km²) per UMZ
Sports, leisure and cultural facilities (m² - class 125) per person
Urban Morphological Zones for Spain: Urban indicators from and Object Oriented Land Cover data base and a population grid

Many thanks for your attention

Francisco J. Goerlich, University of Valencia and Ivie
Isidro Cantarino, Polytechnic University of Valencia