OpenGeoEdu Exercise: Basic
Measure and detection of changes in settlement and population density

Spatial level

Any administrative levels (city/municipality, district, spatial planning region, federal state, national)

Introduction

This exercise is about detection of changes in built-up settlement density and population density. This is basic information for spatial planning, evaluation, analysis, visualization, etc.

Which level?

Each administrative level (city/municipality, district, spatial planning region, federal state, national, also international)

Here you will find examples of interactive atlases and Web GIS services:

- Urban Data Platform: [Population density (Europe)](#)

- EU Science hub: [Spatio-temporal activity and population density (Europe, Worldwide)](#)

- IÖR-Monitor: [Population and settlement density (Germany)](#)

- Census2011 Atlas: [Population per km² (Germany)](#)

- Luminocity3D: [Settlement and population density (worldwide and UK)](#)

Problem

The change in built-up settlement density and population density is one of the elementary parameters for spatial planning, both for decision support and for planning evaluation (impact assessment). Therefore, this exercise needs to consider about quantification, visualization and interpretation in the spatial and temporal dimension.

In this exercise the following skills should be learned:

- How to extract and visualize changes in built-up settlement and population density at the administrative level by using open, small-scale data?

For this example we will work with the ArcGIS desktop application; however, any other GIS environment can be used that is compatible with raster and vector data formats. An urban example is presented here, taking into account the computational intensity, but this can be transferred to any other required administrative scale.

Preparation

For this exercise, you need spatial data on built-up settlement and population density for different periods on your chosen study area. There are different sources (official statistics, EU census data) for information in different spatial scales and formats (grid data, census shapefile).

You can use the open Global Human Settlement Layer (GHSL), which contains the built-up settlements and population from 1975 to 2015. Some highlights (according to EC-JRC-CIESIN):

- GHSL can be used as a robust source of information for change studies (BUILT-UP GRID as well as the POPULATION GRID) due to similar data sources and estimation procedures.

- The data are provided as a multi-temporal information layer, comprising a large number of multisource fine scale data sets including VGI (GLS1975, GLS1990, GLS2000 and ad-hoc Landsat 8 collection 2013/2014). Similarly, population data from the census or administrative units have been disaggregated into grid cells.

- GHSL data can be downloaded and used without restrictions.

To download, you should follow the "Access URL", it will take you to an FTP directory and you can download the data set for the settlement density in three possible resolutions (38m, 250m and 1km) and the population density in two possible resolutions (250m, 1km).

It is recommended to use a resolution of 250m for a reliable comparison between settlement and population density maps. The downloaded data set must be saved in your workspace after unpacking. Please have a short look at the documentation of your dataset and the methodology to create this dataset.

You will need another basic input data set (in this case administrative boundaries in Shapefile format, but you can select any other administrative area or data type according to your purpose), in addition to grid type density information, to define the desired area of interest.

Evaluation

The GHSL dataset offers the possibility to choose from all possible administrative scales; however, as mentioned above, you must decide on an area (e.g. your own city) taking into account your calculation environment and the availability of other datasets of your interest.

Evaluation 1: Clip area of interest

Once you have decided on an area, you should check the spatial reference system of GHSL and your basic boundary form. If there are similarities, edit the XY coordinate system of the GHSL dataset. Now we should already be able to clip our area of interest and save it in the workspace. These steps should be repeated for all work datasets for settlement and population density. Please note that adding a raster (.tiff) dataset in a GIS environment may require the creation of a pyramid, as this is helpful for faster display on your computer. The processing takes a little longer.

Evaluation 2: Density mapping

Now you should be ready to create a density map for the settlement and the population for each time period. Each raster data set should be used for density mapping for a specific year. In the raster dataset, each pixel contains a numerical value (check also the pixel depth corresponding to the possible number of classes), in this case each value corresponding to a density value.

You should work with layer properties to set display and symbology. Play with alternative display methods and combinations of symbology options. Try to understand the effects of choosing a different method and combination. The basic cartographic requirements should be considered when preparing the map layout (see our Map Design Tutorial https://learn.opengeoedu.de/en/tutorials/OGE-Tutorial_Kartengestaltung-en.pdf).

Settlement density: You should now be able to create four different settlements for the time periods 1975, 1990, 2000, 2014 by using 4 separate GHS build-up layers. The combination of the layer properties strongly depends on the purpose of the visualization and mapping. You should think of a final approach that fits well with your density map. Please note that a unique approach should be chosen for all 4 density maps.

Population density: Likewise, the GHS population layers must be used for mapping density for the years 1975, 1990, 2000, 2014. In order to allow a comparison of population density, it is better to choose a different color combination, but to keep a similar approach for the classification in density maps.

Evaluation 3: Change mapping

You now have the map basis for comparing settlement and population density at a given time. Now you can try to visualize the changing trend in density using GIS time series mapping. For this purpose you should use the combined GHS layer.

This is only available for built-up areas with a resolution of 38 m, so the changing map of population density remains outside this exercise area. In this case, the classification method should be chosen as a color map. For an explanation of the colors of the code (0 to 6), please refer to the technical information of BUILT-UP GRID (LDS).

Evaluation 4: Visual interpretation

You should have created two types of maps: (i) a time series density map for settlement and population and (ii) a map of changes (trends) in settlement area. At this point it is advisable to make a comparative interpretation of your map product. We recommend that you import thematic online maps from Open Street Map and Google and ESRI.

If you are further interested, please follow the advanced part of this exercise.