2021

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Population census | Luxembourg

STATEC
Institut national
de la Statistique et
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The distribution of Luxembourg's population according to a 1 km² grid : **a new representation of the demographic situation in Luxembourg**

This publication is the second in a series, presenting the results of the 2021 population census. Its objective is to analyse the distribution of the population according to a 1-km² grid. For the first time, STATEC publishes statistics at such a fine geographical level.

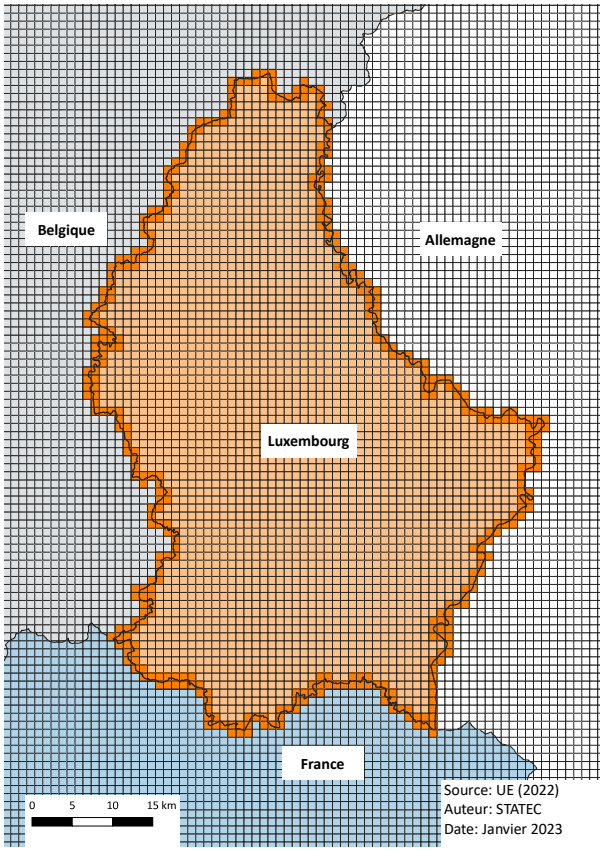
The 37e population census in the Grand Duchy of Luxembourg took place from 8 November to 5 December 2021. For the first time, Luxembourg must[1] publish the number of inhabitants per km². Until now, STATEC has regularly produced statistics by canton and by municipality, which have thus long been the finest level of geographical breakdown in Luxembourg.

Luxembourg is subdivided into 2,795 cells of 1 km²

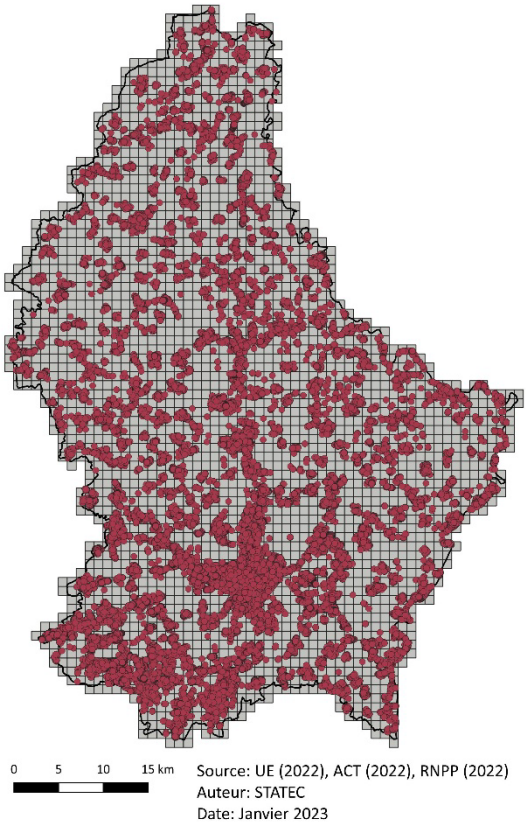
Map 1 shows an extract of the grid dividing the European territory into square cells with a resolution of 1 km². Thus, Luxembourg is subdivided into 2,795 squares of 1 x 1 km. These are all the squares that are completely (in grey) or partially (in orange) included in the territory of the Grand Duchy of Luxembourg. The cells coloured in orange run along the Luxembourg border. These cross-border cells extend over two or even three countries. The statistical value at European level of such a cell is obtained by adding up the values of the various national statistics.

[1] COMMISSION EXECUTIVE REGULATION (EU) 2018/1799 of 21 November 2018 on the establishment of a temporary direct statistical action for the dissemination of selected topics of the 2021 population and housing census geocoded on a 1 km² grid

MAP 1. THE 1 KM² CELL GRID ACCORDING TO THE EUROPEAN COORDINATE SYSTEM ETRS89-LAEA



MAP 2. OVERLAY OF GEO-REFERENCED ADDRESSES (RESIDENTIAL AND SEMI RESIDENTIAL BUILDINGS) ON THE GRIDS



How is the population calculated in a km² grid?

The calculation of the population per 1 km² cell is based on the method of aggregation of point information (see methodology section). Map 2 shows all the addresses where people live (red dots). Thanks to the geographical coordinates, the addresses can be overlaid on the cell grid. Knowing the number of people per address, the population per square kilometer is determined by addition.

Map 2 illustrates the distribution of residential and semi residential inhabited buildings across the territory of Luxembourg. The two main urban centres, namely the agglomeration of Luxembourg City and the former mining area in the south and south-west of the country are clearly visible. The urban axes to the north, west, east and south from Luxembourg City are also evident from Map 2.

Map 3 per municipality below is intended to facilitate the reading and interpretation of maps 2 and 4.

MAP 3. THE 102 MUNICIPALITIES OF LUXEMBOURG

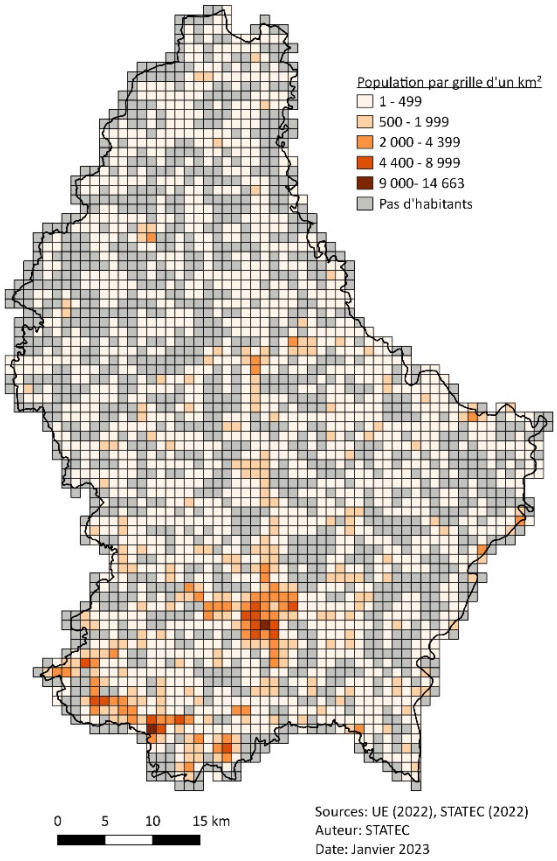
The city of Luxembourg and its surroundings, as well as the southwest of the country, are the most populated

Map 4 illustrates that the 643,941 inhabitants counted in the population census are not evenly distributed across the country. The one km² grid cells in the southern part of Luxembourg, which are more urbanised, are much more densely populated than those in the rural regions of the centre and north of the country. Note that 41.5% of the cells are not inhabited at all (in light grey). These are mainly agricultural and forest areas, where the construction of residential buildings is generally prohibited. In addition, the cells along the national borders are largely uninhabited.

Of the occupied cells, 48.0% are inhabited by 1 to 499 persons (in white). The overwhelming majority of the territory (89.5%) is not at all or only sparsely populated. Only 7.9% of the squares are already more densely populated, with between 500 and 1,999 people concentrated in one km² (in beige).

The cells with more than 1,999 inhabitants are relatively rare and cover the most urban areas of the country. 2.0% of the cells are populated by 2,000 to 4,399 inhabitants (in light orange), 0.5% by 4,400 to 8,999 inhabitants (in dark orange) and only 0.1% by more than 8,999 inhabitants (in dark red).

MAP 4. POPULATION BY 1 KM² GRID IN THE 2021 POPULATION CENSUS



It is in the City of Luxembourg and its surroundings, as well as in the former mining basin in the south and south-west of Luxembourg, that the cells of one km² have the highest populations. The most densely populated cell is located in the city of Luxembourg, with a population of 14,663 inhabitants over a distance of 1 km². The second most populated cell is in the municipality of Esch-sur-Alzette, with 11,196 residents.

Secondary urban centres, such as Ettelbruck and Diekirch, as well as Echternach, Grevenmacher and Mertert, are also shown on the map (in light orange). The urban axes between the City of Luxembourg on the one hand, and the municipalities of Hesperange (to the south), Strassen, Bertrange and Mamer (to the

west) and on the other hand the municipalities along the Alzette valley (to the north as far as Mersch) are also clearly visible on Map 4.

Focus on the canton of Luxembourg

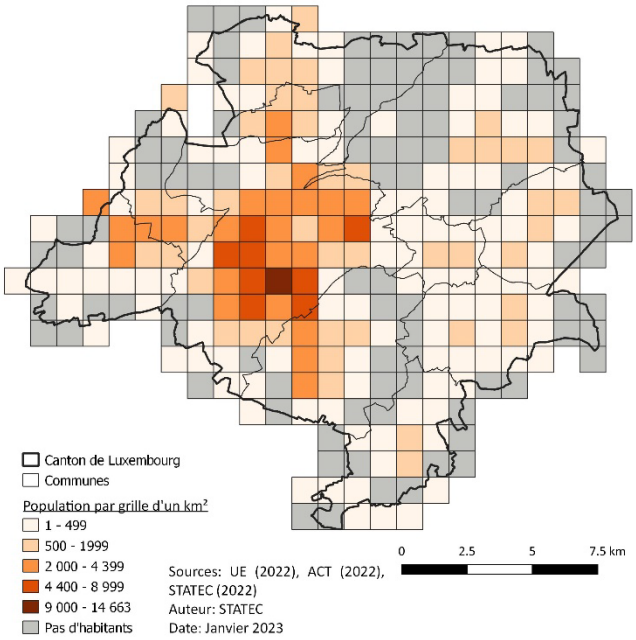
With 197,932 inhabitants, the canton of Luxembourg is the most populated canton in the 2021 population census. It alone accounts for 30.7% of Luxembourg's residents.

Map 5 shows the extent to which the population of the canton of Luxembourg is concentrated in Luxembourg City. The capital gathers 64.7% of the population of the canton (128,097 inhabitants).

The territory of the canton of Luxembourg is subdivided into 294 cells of one km^2 in size, which make up all or part of the territory in question. The grid cells of the City of Luxembourg are the most densely populated, while those covering the neighbouring municipalities are much less so. The urban extensions to the south, west and north mentioned above are clearly visible.

The grid cell of the City of Luxembourg that stretches between the districts of Gare, Bonnevoie-Nord and Bonnevoie-Sud is the most densely populated (14,663 inhabitants). The other adjacent squares are also densely populated. The further away from the urban centre, the more frequent are the low-population cells. 34.0% of them are not inhabited at all. The grey cells to the north-east of the capital, which cover the forest area of the Gréngewald, are a good example.

MAP 5. GRID CELLS OF THE CANTON OF LUXEMBOURG

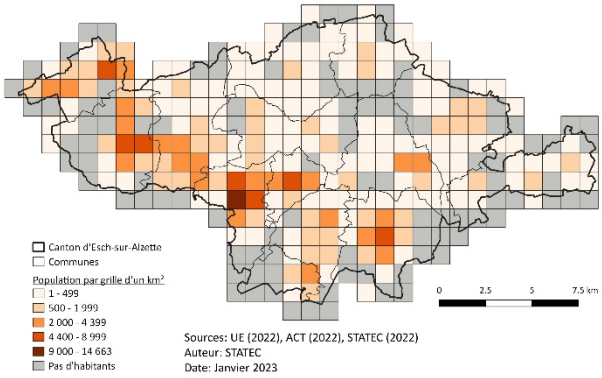


Focus on the canton of Esch-sur-Alzette

The canton of Esch-sur-Alzette is the second most populated canton in Luxembourg. On 8 November 2021, 186,224 residents, or 28.9% of the national population, were counted in the canton located in the south-west of the country.

Map 6 shows that the population is distributed polycentrically across the canton of Esch-sur-Alzette. The grids with the highest populations are those covering the urban centres of Esch-sur-Alzette, Dudelange, Schifflange, Differdange and Pétange. The most populated cell is located in Esch-sur-Alzette, with 11,196 people in a 1 km^2 area. This square kilometer covers mainly the Uecht district, as well as a small part of the Brill, Bruch and Al Esch districts. The other most densely populated squares have between 4,400 and 8,999 inhabitants. The less densely populated towns, such as Bettembourg, Rumelange, Kayl, Rodange, etc., also stand out on the map, with cells with between 2,000 and 4,999 inhabitants.

MAP 6: GRID CELLS IN THE CANTON OF ESCH-SUR-ALZETTE



Many cells are also very sparsely populated, or even deserted, especially in the northern and eastern parts of the canton. Thus, one third of the cells in the canton are not inhabited at all, while 40.8% are inhabited by 1 to 499 people. Finally, 16.1% of the cells are inhabited by 500 to 1,999 residents.

Population census maps on the national geoportal

STATEC, in collaboration with the Administration du cadastre et de la topographie, makes interactive maps with the results of the population census available on the Luxembourg geoportal at the following address

www.g-o.lu/population

or by scanning the following QR Code:

The grid cells of a km² - what is it?

Using a grid of square cells, a geographical space is subdivided into regular spatial units. A grid cell is the elementary unit of the geometric mesh system, the size of which depends on the spatial resolution of the grid. The higher the resolution of the grid, the smaller the cells and the more detailed the spatial analysis can be.

Following the INSPIRE Directive of 2007 and the European Regulation 2017/2391 on territorial typologies (Tercet), the European Commission has set up a flat geometric grid that allows the European Union space (former EU-28 and EFTA countries) to be subdivided into cells of one km² (INSPIRE, 2014). This geospatially referenced grid is called "Grid_ETRS89-LAEA" as it has been established based on the "European Terrestrial Reference System 1989 - Lambert Azimuthal Equal Area (ETRS89-LAEA)" coordinate system (European Commission, 2018). Each Member State has to provide statistical information on all cells comprising part of their national territory. In addition, there is a virtual cell that includes all observations that could not be located and therefore could not be attributed to one of the cells (EUROSTAT, 2017).

In this geographically referenced grid, each cell is identified by a unique identifier, which is composed of the characters "CRS3035RES1000m"[2], followed by the North (e.g. "N4014000") and East (e.g. "E2976000") planar coordinates of the grid point located in the lower left corner of the cell in question (European Commission, 2018). This code is preceded by the country code of the transmitting Member State, as defined in the inter-institutional drafting code published by the Publications Office of the European Union ("LU" in the case of Luxembourg), followed by the character "_". The full identifier of the Luxembourg cell used as an example is:

LU_CRS3035RES1000mN40140000E29760000

[2] *"CRS3035"* is a unique grid reference system identifier (ETRS89-LAEA), "*RES1000m*" gives the resolution of the cell (1000 metres)

Calculation of statistics according to a cell grid - aggregation method

Nowadays, cell grid data are most often compiled by **aggregation methods** (bottom-up approach). This aggregation requires the presence of geostatistical point data, which, thanks to the geographical coordinates, can be overlaid on the grid. They are then aggregated within each cell to which they correspond and a total value per cell can be defined (Kaminger, 2012).

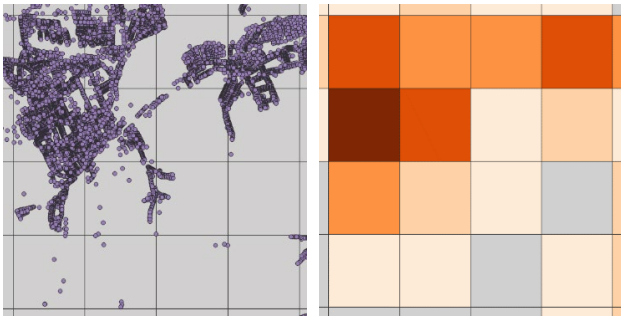
Map 7 shows all residential buildings that are inhabited by people (red dots). Using the coordinates of the buildings and the number of people per building, the population per cell is determined by addition.

MAP 7. AGGREGATION OF POINT DATA WITHIN EACH CELL

Source: Kaminger, 2012

The aggregated information from the point data can then be represented at the cell level by varying the colour according to the value of the variable.

MAP 8. CELLS WITH AGGREGATED POINT INFORMATION



Source: STATEC (2022)

Advantages and disadvantages of territorial division by cell grid

Traditionally, official statistics have largely been, and still are, compiled according to a hierarchical system of administrative or statistical units ranging from local to EU level. This is a simple division of space into administrative sub-areas in order to provide a framework for studying different frequency distributions (e.g. population distribution) (EUROSTAT and EFGS, 2017). In the EU, the NUTS[3] represents the most important example of such a production system. The processing of spatial information by administrative zoning, used in the last population and housing censuses, was for a long time the only feasible technique.

Compared to the NUTS territorial division, the spatial division according to a grid has many **advantages**.

Firstly, the homogeneity and neutrality of the grid division allows for a better comparison, on the same scale, of any demographic or socio-economic variable in very different territories. In this way, the grid dataset makes it possible to arrive at harmonised statistics that are comparable throughout the European Union.

Another great advantage is that the cells are constant in space and time and have a unique 'name'. This feature makes the cells independent of any administrative or functional boundary, as well as of its spatio-temporal fluctuations (extension of a town, merging of municipalities, etc.), and allows for much simpler and unambiguous evolutionary analyses of phenomena.

[3] NUTS is the nomenclature of territorial units for statistics which results from the subdivision of the countries of the European Economic Area.

Compared to traditional statistical areas, the very fine geometric mesh allows a considerable gain in precision and a better spatial representation of the phenomena to be studied.

Finally, it is relatively easy to compile statistics by square from specific georeferenced information (place of residence, place of work, etc.).

Despite the many advantages, the mesh system also has some **disadvantages** and poses several major **challenges**.

First of all, the square is an abstract and artificial spatial unit that is sometimes difficult for the general public to accept, as it is an unreal and unknown division. Although very useful in the spatial visualisation of phenomena, grid statistics are not very effective in tabular form.

The biggest challenge is the geo-referencing of administrative statistics and registers, a task that is essential for the production of grid-based statistics. Many public institutions have yet to be persuaded of the growing need to integrate geographical coordinates in the production of official statistics.

Confidentiality of sensitive information is considered one of the major challenges for producers and users of high spatial resolution statistics. Very sparsely populated areas, such as some rural areas, are particularly sensitive to confidentiality issues. Given the small number of observations (e.g. residents) per cell, the risk of identifying an individual is greater than in a densely populated area. Confidentiality methods have been developed in recent years to reduce the risk of disclosure to a level considered acceptable.

Sources:

- European Commission (2018). "Commission Implementing Regulation (EU) 2018/1799 of 21 November 2018 on the establishment of a temporary statistical direct action for the dissemination of selected topics of the 2021 population and housing census geocoded on a 1 km grid^2 "
- EUROSTAT (2017). "EU Legislation on the 2021 Population and Housing Censuses", Draft Explanatory Notes.
- EUROSTAT and EFGS (2017). "A point-based foundation for statistics", Final report from the GEOSTAT 2 project
- INSPIRE (2014). "D2.8.I.2 Data Specification on Geographical Grid Systems - Technical Guidelines"
- Kaminger, I. (2012). "Geodata - Access and Necessity of small area statistics. Grids in Austria and Europe", IAOS Conference, Kiev, 2012

FOR MORE INFORMATION

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