Functional Urban Area

From Eurostat Glossary:

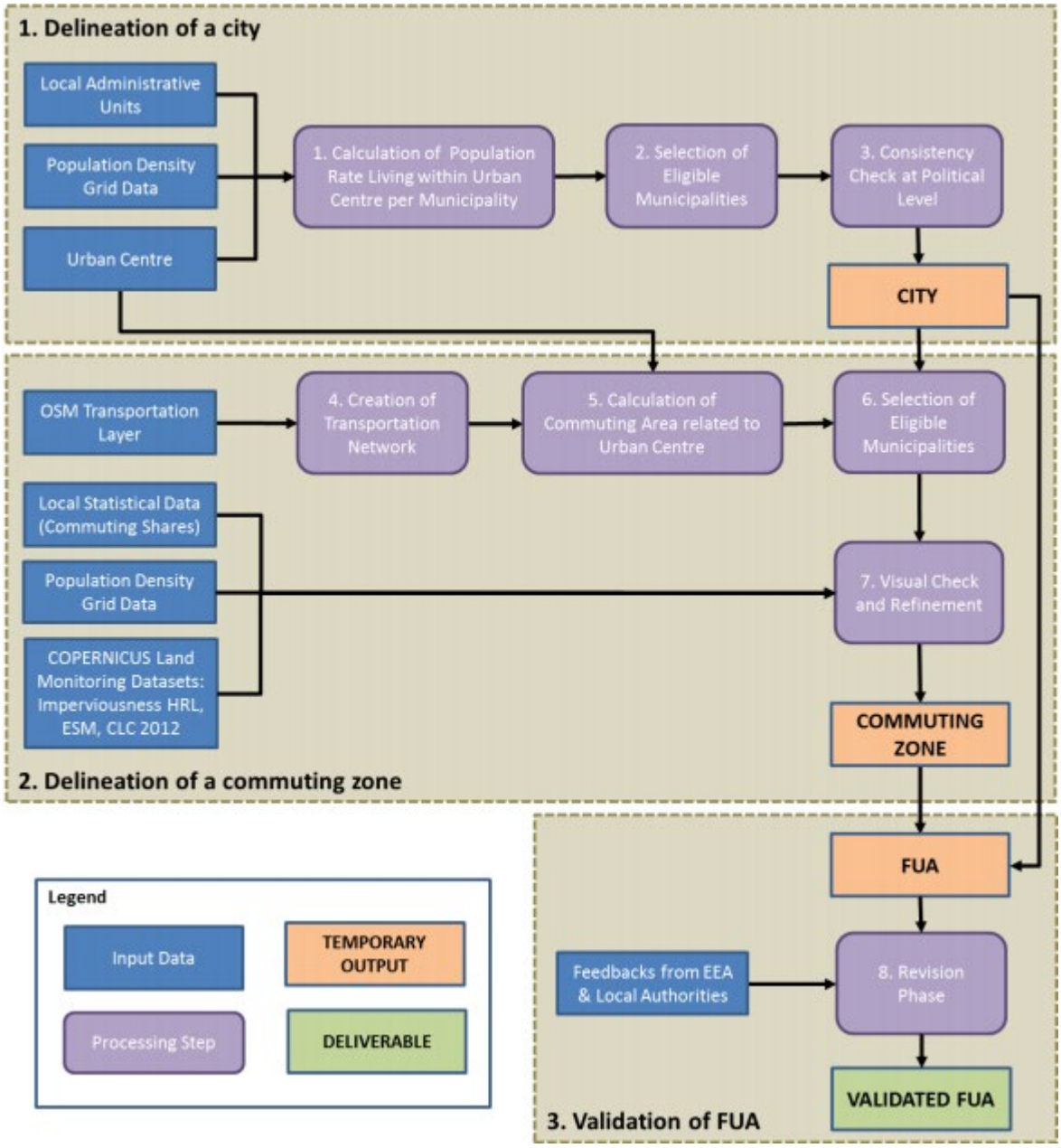
Common term: Functional urban area (FUA); Plural: Functional urban areas (FUAs); Technical term: a city and its commuting zone.

Short definition: a functional urban area consists of a city and its commuting zone. Functional urban areas therefore consist of a densely inhabited city and a less densely populated commuting zone whose labour market is highly integrated with the city (OECD, 2012).

Formerly known as larger urban zone (LUZ). See Dijkstra et al (2019) for detailed methodology summarizing the EU-OECD definition.

The delineation of FUAs within Urban Atlas 2012 and 2018 (for the Copernicus Land Monitoring Service) has two sources:

1. EU-27 and the UK, Switzerland, and Iceland: provided by DG Regio to EEA in Autumn 2017 (originated in Member States and collected originally by Eurostat).
2. West Balkans and Turkey delineated for EEA by Urban Atlas service providers (CLS). The task was conducted during the first quarter of 2017 and the results validated by EEA and DG REGIO by the end of March.107 Functional Urban Areas have been defined over this geographical extension; the methodology applied is the OECD-EC definition from 2012, adapted and summarized below:



West Balkan countries:

The input data collected and used for delineating a city (step 1) were the following:

- Urban centres (i.e. high density clusters) provided by EEA / DG REGIO
- GEOSTAT 2011 grid dataset produced by Eurostat as population density grid data
- Local administrative units at the most detailed level (LAU2 equivalent) made available from different sources depending on the country (see Table below).

COUNTRY	LAU source
ALBANIA	Euro Boundary Map (EBM) v11
BOSNIA_HERZEGOVINA	Republic Administration for Geodetic and Property Affairs
KOSOVO	Euro Boundary Map (EBM) v11
NORTH MACEDONIA	Euro Boundary Map (EBM) v11
MONTENEGRO	Statistical Office of Montenegro
SERBIA	Euro Boundary Map (EBM) v11

The main problem was linked to the administrative division which can be quite different from one country to another, leading potentially to the delineation of cities larger than expected regarding the actual urban extent.

For delineating a commuting zone (step 2), as no local statistical data (commuting shares between municipalities) was made available following CLS request to local authorities, TomTom road network was used by DG REGIO for generating for each FUA the service area based on 30-minute travel time by road around the centroid of the high-density cluster (urban centre). Then, CLS calculated the population rate living within the 30-minute service area per municipality in order to select all the ones which have at least 50% of their population inside the service area (still using GEOSTAT 2011 population grid data). In that way, municipalities which are only marginally covered by the service area or whose urban centre is outside, are excluded from the commuting zone and thus not included in the final FUA extent.

Topological check was finally made to detect any boundary inconsistency between two contiguous Functional Urban Areas due to the use of different sources of administrative units from one country to another. Only one FUA extent had to be adjusted.

Turkey:

The input data collected and used for delineating a city (step 1) were the following:

- Urban centres provided by EEA / DG REGIO
- LandScan 2010 © UT BATTELLE, LLC as population density grid data
- Turkish Districts (LAU1 equivalent) as the most detailed level of administrative units made available by the national authorities through the Statistical portal or CORDA platform

As districts cover very large areas and no local commuting data was made available following CLS request to local authorities, only step 1 was implemented for delineating the Functional Urban Areas in Turkey. Consistency check at administrative and political level was additionally performed for the biggest metropolitan areas which are Istanbul, Ankara (capital city) and Izmir.

Especially the FUA of Istanbul would require fine-tuning (normally size reduction) in the future. Its territory is huge and the geometric features created are not only numerous but also sometimes complex (i.e. large number of vertices making data processing very difficult). This would require access to finer administrative boundaries (LAU2 equivalent) can be obtained from the Turkish authorities.

Before starting the large-scale production phase of 2018 LC/LU, the UA 2012 extent (i.e. FUA extent) had to be refined to eliminate any topological artefacts between FUA boundaries such as (very) small overlaps and gaps along contiguous boundaries in several countries. Two main reasons were identified:

- Pre-existing inconsistencies in the native GIS layers of FUA boundaries provided by the national agencies and collected by Eurostat;
- Inconsistencies along the national borders because of different sources of administrative units from one country to another.

Therefore, the relevancy of eliminating such artefacts.

Methodological approach applied:

Detection of overlaps:

Figure 1: Overview of automatically detected overlaps between FUAs

Figure 2: Zoom on automatically detected overlaps between two FUAs in Albania

Figure 1 gives an overview of the geographical distribution of the overlaps between FUAs detected automatically, while Figure 2 shows the border between two Albanian FUAs where most of the

overlaps are located. This was confirmed by the results of the automatic detection reported in Table 1.

Table 1: Results of the automatic detection of overlaps between FUAs

FUA_CODE	FREQUENCY	SUM_area (m²)	MEAN_area (m²)	MIN_area (m²)	MAX_area (m²)
AL001L1	187	293.06	1.57	0.00	18.58
ES022L2	1	0.16	0.16	0.16	0.16
ES025L3	3	208.47	69.49	5.60	193.50
ES034L1	1	0.44	0.44	0.44	0.44
ES054L1	1	1.92	1.92	1.92	1.92
ES547L1	2	9,440.44	4,720.22	441.89	8,998.56
FR099L2	2	126.39	63.19	20.60	105.79
FR324L1	2	4.93	2.47	0.01	4.92
IT010L2	10	0.60	0.06	0.01	0.11
NL007L3	5	7.85	1.57	0.58	3.24
UK023L1	2	32,145.44	16,072.72	41.48	32,103.97
TOTAL	**216**	**42,229.71**	**20,933.81**	**512.69**	**41,431.18**

Note: Only one FUA identifier is reported for each case in the table, but it is obvious that another neighbouring one is systematically concerned too.

The overlap issue concerns only a few FUAs over different countries with a total of 216 overlaps and only Albanian case shows a large series of errors. In terms of area, individual overlaps generally are (very) small and only 5 errors represent more than 100 m². The total overlapping area in the current UA2012 extent is equal to 42,230 m² or 0.4 km².

Detection of gaps:

Figure 3: Overview of automatically detected gaps between FUAs

Figure 4: Zoom on automatically detected gaps between two FUAs in Albania

Figure 5: Zoom on automatically detected gaps between FUAs in the Netherlands and Germany

Figure 3 gives an overview of the geographical distribution of the gaps between FUAs detected automatically, while Figure 4 and Figure 5 show locations in different countries where a large number of such topological errors can be found. This was confirmed by the results of the automatic detection reported in Table 2.

Table 2: Results of the automatic detection of gaps between FUAs

FUA_CODE	FREQUENCY	SUM_area (m²)	MEAN_area (m²)	MIN_area (m²)	MAX_area (m²)
AL001L1	181	347.20	1.92	0.00	23.90
AT001L3	104	7,415.64	71.30	0.17	385.13
DE038L1	1	0.64	0.64	0.64	0.64
DE549L1	54	11,816.35	218.82	0.51	1,770.60
DK004L3	1	0.25	0.25	0.25	0.25
ES002L2	2	13.26	6.63	5.08	8.18
ES006L2	1	104.13	104.13	104.13	104.13
ES025L3	8	3.78	0.47	0.26	0.75
ES034L1	2	9.66	4.83	0.02	9.64
ES505L1	1	1.06	1.06	1.06	1.06
ES546L1	2	2.41	1.20	0.69	1.72
FI003L4	5	38.93	7.79	0.18	34.47
HU001L2	21	4,047.80	192.75	35.04	381.45
HU002L2	15	2,995.10	199.67	6.08	434.68
HU007L2	6	1,372.43	228.74	2.13	394.70
HU009L2	21	9,799.76	466.66	27.95	1,541.05
HU010L1	9	3,722.32	413.59	90.67	883.81
HU011L1	1	38.22	38.22	38.22	38.22
HU012L1	67	6,172.28	92.12	0.00	590.98
HU013L1	57	10,584.03	185.68	0.02	1,541.23
HU016L1	38	4,370.73	115.02	0.01	435.40
HU017L1	13	1,415.22	108.86	0.01	836.38
HU018L1	26	4,949.92	190.38	0.00	878.90
IT001L3	1	52.77	52.77	52.77	52.77
IT008L3	1	0.21	0.21	0.21	0.21
IT052L1	3	219.98	73.33	0.18	118.67
IT054L1	4	52.58	13.15	2.11	29.80
IT061L0	2	23.97	11.99	4.63	19.34
IT064L1	1	13.18	13.18	13.18	13.18
IT525L0	1	0.06	0.06	0.06	0.06
NL007L3	1	0.19	0.19	0.19	0.19
NL008L3	22	10,567.24	480.33	4.73	1,768.75
NL507L3	1	3.07	3.07	3.07	3.07
NO002L1	1	2.73	2.73	2.73	2.73
NO005L1	3	62.35	20.78	1.50	39.86
PT001L3	1	5.90	5.90	5.90	5.90
SK001L1	49	6,716.47	137.07	14.05	380.55
TR057L1	1	6.82	6.82	6.82	6.82
UK006L3	1	3.30	3.30	3.30	3.30
UK007L1	2	19.36	9.68	8.41	10.96
UK012L2	1	8.57	8.57	8.57	8.57
UK014L1	2	3.36	1.68	0.04	3.32
UK520L2	1	387.10	387.10	387.10	387.10
UK551L1	11	50.19	4.56	0.02	11.70
UK562L2	2	188.08	94.04	3.32	184.76
UK568L1	2	0.25	0.12	0.01	0.24
TOTAL	**750**	**87,608.86**	**3,981.37**	**836.01**	**13,349.09**

Note: Only one FUA identifier is reported for each case in the table, but it is obvious that another one is concerned, just not useful to mention it.

The gap issue affects more FUAs and also more countries (14 in total) from different parts of Europe than the overlap one. The most affected countries regarding the number of FUAs are Spain, Hungary, Italy and the United Kingdom, while the ones concerned by large series of errors are

especially Albania, Austria and Hungary again. In terms of area, individual gaps vary a lot and even if a majority is pretty small, 236 errors out of 750 represent more than 100 m². The total area of discontinuity between FUAs in the current UA2012 extent is equal to 87,609 m² or 0.9 km².

It is worth to keep in mind that the inconsistencies highlighted are very small in terms of area and insignificant at the scale of Urban Atlas exploitation, as the cumulative surface reveals it (0.4 km² of overlaps and 0.9 km² of gaps).

The approach for correcting the topological issues, both overlaps and gaps, between FUAs:

1. Correction of all errors below 100 m² automatically by running a SQL script and using the appropriate GIS tools;
2. Correction of all errors above 100 m² manually using the native GIS tools and considering the visual interpretation of VHR2018 reference imagery

The correction was applied on both FUA boundary and UA2012 LU/LC layers.

However, during the 2018 production, FUA boundaries may still have changed for the following reasons:

- Addition of three FUAs, namely Fort-de-France, Saint-Denis and Ponta Delgada, still not covered in 2012 due to missing satellite data, and accounting for a total area of1745km²;
- Additional FUA coverage in case of newly built waterfront infrastructures (e.g. port, marina)
- Additional buffer area of 100 m along the coastlines wherever not yet applied in the previous release of UA2012 dataset, i.e. for all FUAs which were not part of UA2012 geographical extension and revision tasks, in order to ensure that all emerged lands are included.

Given this final update of the boundaries, UA2018 dataset covers well 788 FUAs representing 1.270.322km² over EEA38 and the UK. The coverage is strictly the same for the reference year 2012 with the exception of Fort-de-France, Saint-Denis and Ponta Delgada.

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To support SDI registration of FUA on SDI

03.08.2021