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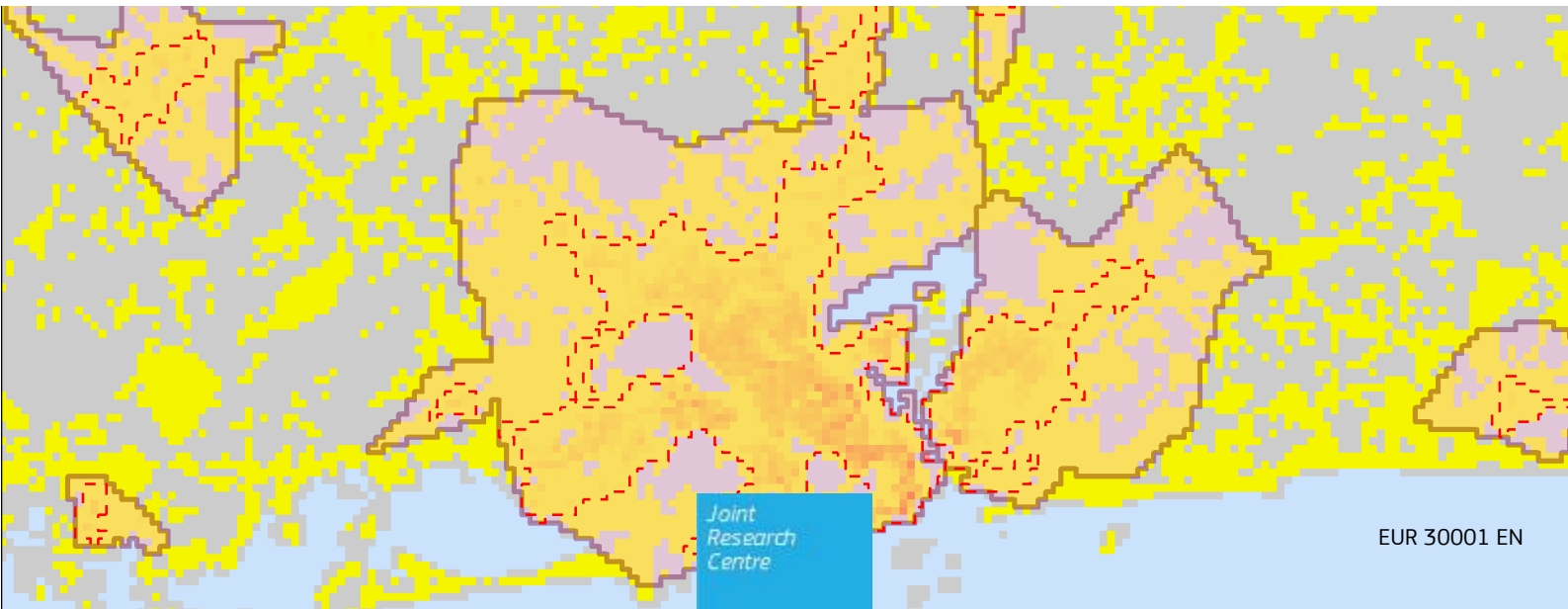
GHSL-OECD Functional Urban Areas

Public release of GHS-FUA

Schiavina M., Moreno-Monroy A., Maffenini L., Veneri P.

2019



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Contents

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Abstract

Function Urban Areas (FUAs), as defined by the OECD and the European Union, are sets of contiguous local (administrative) units composed of a 'city' and its surrounding, less densely populated local units that are part of the city's labour market ('commuting zone'). To be included in the commuting zone, local units should have at least 15% of their working population commuting to the city. This definition is limited to OECD countries and Colombia and is subject to both availability of commuting flows data at the local level and to the definition of administrative unit boundaries. In the context of international comparability of urban-related statistics and indicators, the aim of this document is to propose a FUA definition that does not depend on arbitrary and not harmonized administrative units and scale it to the globe.

To pursue this goal it is proposed an automated classification procedure of FUAs based on objective characteristics (travel time from the Urban Centre, area and population of the Urban Centre, local population and GDP per capita at national level), to classify areas within and outside FUAs. The automated classification of FUA is done in collaboration with the OECD and supported by DG REGIO.

This document describes the public release of the GHSL-OECD Functional Urban Areas 2019 (GHS-FUA).

1 Introduction

1.1 Overview

The Global Human Settlement Layer (GHSL) project produces global spatial information, evidence-based analytics, and knowledge describing the human presence in the planet. The GHSL relies on the design and implementation of new spatial data mining technologies that allow automatic processing, data analytics and knowledge extraction from large amounts of heterogeneous data including global, fine-scale satellite image data streams, census data, and crowd sourced or volunteered geographic information sources.

This document accompanies the public release of the GHSL Functional Urban Areas 2019 and describes the contents.

This product is named according to the standard GHSL naming convention:

GHS_<name>_<temporalCoverage>_<spatialExtent>_<releaseId>

Therefore the product name "GHS_FUA_UCDB2015_GLOBE_R2019A" indicates the GHSL Functional Urban Areas (GHS-FUA) for 2015 and a global spatial extent, release R2019A.

The dataset is named according to the standard GHSL naming convention:

GHS_<name>_<epochCode>_<extent>_<releaseId>_<EPSG>_<resolution>_<version>.<ext>

The dataset unique identifier "GHS_FUA_UCDB2015_GLOBE_R2019A_54009_1K_V1_0.gpkg" indicates the GHSL Function Urban Areas layer (GHS-FUA) of the epoch 2015 with global extent, release R2019A in World Mollweide projection at 1 km resolution v1.0 in GeoPackage format.

1.2 Rationale

Open data and free access are core of principles GHSL (Melchiorri et al., 2019). They are in-line with the Directive on the re-use of public sector information (Directive 2003/98/EC[1]). The free and open access policy facilitates the information sharing and collective knowledge building, thus contributing to a democratisation of the information production.

The GHSL Functional Urban Areas 2019 contains the new GHSL data produced at the European Commission Directorate General Joint Research Centre in the Directorate for Space, Security and Migration in the Disaster Risk Management Unit (E.1) in collaboration with the Organisation for Economic Co-operation and Development (OECD), Centre for Entrepreneurship, SMEs, Regions and Cities.

1.3 Terms of Use

The data in this data package are provided free-of-charge © European Union, 2019. Reuse is authorised, provided the source is acknowledged. The reuse policy of the European Commission is implemented by a Decision of 12 December 2011 (2011/833/EU). For any inquiry related to the use of these data please contact the GHSL data producer team at the electronic mail address: JRC-GHSL-DATA@ec.europa.eu

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[1] http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32003L0098
[2] JRC Data Policy https://doi.org/10.2788/607378

2 GHS Functional Urban Areas (GHS-FUA), derived from GHS-UCDB and GHS-POP, (2015) R2019A [GHS_FUA_UCDB2015_GLOBE_R2019A]

A Functional Urban Area (FUA) consist of a city and its commuting zone, where the latter represents the area of influence of the city in terms of labour market flows. The OECD defines and maps a FUA as the union of the administrative units in which at least 15% of the population is commuting to the main Urban Centre of the area (OECD, 2012). This definition is limited to OECD countries and Colombia and is subject to administrative unit boundary definitions and modifications and on the availability of commuting flows data between local units. To further international comparability of urban-related statistics and indicators with an explicit spatial dimension, GHSL, OECD and DG REGIO have proposed a method to estimate the number and extent of FUAs in the entire world. The proposed method does not rely on neither information on local unit boundaries nor on commuting flows data, which are usually unavailable in most countries. The estimation method uses a probabilistic model which is trained using information on actual FUA boundaries available in OECD countries and Colombia and defined using commuting flows data. The proposed estimation method produces a people-based definition of FUAs covering the entire world, using grid cells as spatial building blocks instead of local administrative units.

In more detail, GHS-FUA (GHS_FUA_UCDB2015_GLOBE_R2019A) for the epoch 2015 (Figure 1), also called eFUA to differentiate from the original boundaries of OECD-FUA, are delineated through an automated classification procedure (developed in collaboration with OECD, Moreno-Monroy et al., 2018, submitted) based on objective characteristics (i.e. travel time from Urban Centres; area of Urban Centres; local population; and country GDP per capita). Information on Urban Centres are derived from GHS-UCDB dataset (Florczyk et al., 2019a) (GHS_STATS_UCDB2015MT_GLOBE_R2019A); population information are derived from 2015 GHS-POP dataset (GHS_POP_E2015_GLOBE_R2019A); travel time is estimated from each grid cell toward the edge of the closest Urban Centre by using a global friction matrix (Weiss et al., 2018); and Urban Centre GDP is inherited from the country GDP per capita, as provided by The World Bank (source: NY.GDP.PCAP.CD; World Development Indicators, The World Bank). Missing 2015 country GDP per capita is filled through linear interpolation of data in different years for 11 countries.

2.1 GHS-FUA specification

GHS-FUA specifications are the following:

— 2015 Urban Centres, as classified and validated in GHS-UCDB are split by country (GADM 2.8), exploding multipart results (according to 4-connectivity rule) and dropping those not anymore compliant with GHS-SMOD class 30 (L2) logic (Florczyk et al., 2019)

— Urban Centres with area greater than 2500 km^2 and at least 20 million inhabitants are split into parts as following the GHS-SMOD level 3 classification (unpublished results, Florczyk et al., 2019)

— Each populated pixel (from GHS_POP_E2015_GLOBE_R2019A layer) is linked to an Urban Centre according to minimum travel time among all possible Urban Centres of the country

— Classification model applied to each pixel with more than 300 people: logit generalized linear model with binomial distribution:

$$FUA_{ijC} = \delta_0 + \sum_{k=1}^{2} \tau_k dist_{ijC}^{p} + \delta area_{ijC} + \sum_{k=1}^{2} \varphi_k pop_{jC}^{k} + \omega GDP\_PPP_C + \epsilon_{ijC}$$

where *FUA* is a dummy variable that takes the value of 1 if the grid cell belongs to a FUA and the value of zero otherwise; *dist* is the travel time from each grid cell to the edge of the closest Urban Centre; *area* is the area of the Urban Centre; *pop* is the grid cell population; and *GDP_PPP* is the country GDP per capita. The threshold above which cells are considered part of an eFUA is determined optimally by maximising prediction accuracy for each world region.

— Cells estimated to be part of an eFUA are aggregated through alpha-shape with median radius (among all alpha-shapes radii from convex hull to minimum one-region)

— Adjacent eFUAs are merged by keeping one single 500k inhabitants Urban Centre per aggregation

  - The main Urban Centre of the aggregation is the most populated
  - The population of the Urban Centres set the priority for the aggregation in case of multiple 500k-inhabitants Urban Centres

— eFUA attributes:

- eFUA_ID
- UC_num (number of Urban centres are contained)
- UC_ID1 (Urban Centre IDs contained in each eFUA, as GHS-UCDB "ID_HDC_G0")
- UC_ID2 (continue previous list when needed)
- UC_ID3(continue previous list when needed)
- eFUA_name (name of the primary Urban Centre in the eFUA)
- Commuting (logical: 1 eFUA with commuting area; 0 eFUA without commuting area => eFUA==UC)
- Cntry_ISO (GADM ISO3 code)
- Cntry_name (GADM country name)
- FUA_area
- UC_area (sum of UCs areas contained)
- FUA_p_2015 (2015 eFUA pop)
- UC_p_2015 (2015 Urban Centre pop)
- Com_p_2015 (2015 population in Commuting area per year)

2.2 Input data

The input data are: the 2015 GHS-UCDB (GHS_STATS_UCDB2015MT_GLOBE_R2019A version 1.1) and the multi-temporal GHS-POP grid of the GHSL Data Package 2019 (GHS P2019); the global friction surface map[3]; the Global Administrative Map 2.8[4]; and the World Development Indicators[5] produced by The World Bank.

2.3 Technical Details

Author: *Marcello Schiavina*, *Luca Maffenini* Joint Research Centre (JRC) European Commission; *Ana Moreno-Monroy*, *Paolo Veneri* Centre for Entrepreneurship, SMEs, Regions and Cities, Organisation for Economic Co-operation and Development - OECD.

Product name: GHS_FUA_UCDB2015_GLOBE_R2019A

Spatial extent: Global

Temporal extent: 2015

Coordinate System: World Mollweide (EPSG: 54009)

Resolution available: 1 km

Encoding: eFUA_ID integer16 [1, 13174]

Data organisation: The features are provided as polygons with attributes in a GeoPackage open format.

Table 1 outlines the technical characteristics of the datasets released in this data package.

Table 1. Technical details of the datasets in GHS_FUA_UCDB2015_GLOBE_R2019A

GHS_FUA_UCDB2015_GLOBE_R2019A			
ID	**Description**	**Resolution (Projection)**	**Size**
GHS_FUA_UCDB2015 _GLOBE_R2019A _54009_1K_V1_0	Features representing Functional Urban Areas	1 km (World Mollweide)	**9 MB**

[3] https://map.ox.ac.uk/research-project/accessibility_to_cities/
[4] https://gadm.org/data.html
[5] https://datacatalog.worldbank.org/dataset/world-development-indicators

How to cite

Dataset:

Schiavina, Marcello; Moreno-Monroy, Ana; Maffenini, Luca; Veneri, Paolo (2019). GHS-FUA R2019A - GHS functional urban areas, derived from GHS-UCDB R2019A, (2015), R2019A. European Commission, Joint Research Centre (JRC) [Dataset] doi:10.2905/347F0337-F2DA-4592-87B3-E25975EC2C95 PID: http://data.europa.eu/89h/347f0337-f2da-4592-87b3-e25975ec2c95

Concept & Methodology:

Moreno-Monroy, Ana; Schiavina, Marcello; Veneri, Paolo (submitted). Metropolitan areas in the world. Delineation and population trends. Journal of Urban Economics. DOI: ***under release, updated on:*** *http://ghsl.jrc.ec.europa.eu/documents/GHSL_FUA_2019.pdf*

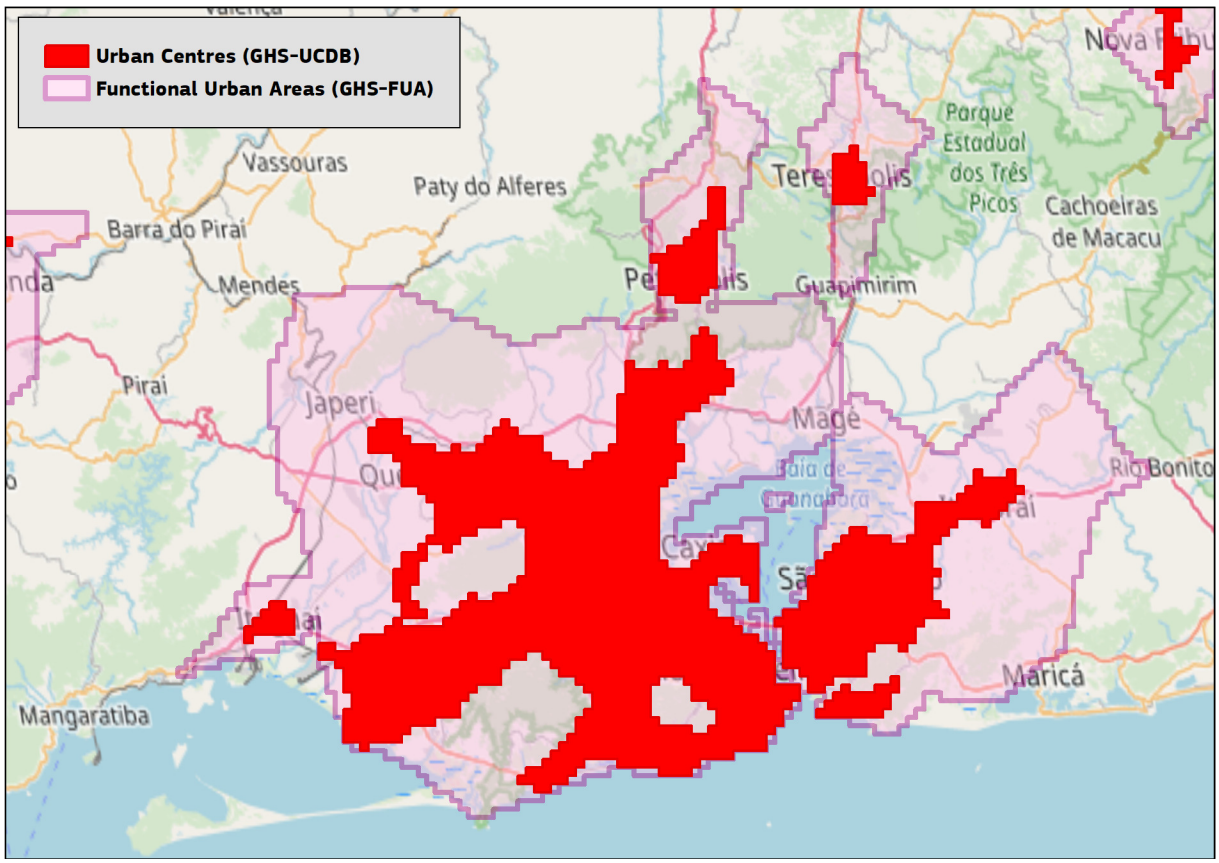

Figure 1 GHS Functional Urban Area (GHS-FUA) GHS_FUA_UCDB2015_GLOBE_R2019A_54009_1K_V1_0 in the area of Rio de Janeiro (Brazil) displayed together with Urban Centres from GHS-UCDB –FUA. The boundaries and the names shown on this map do not imply official endorsement or acceptance by the European Union © OpenStreetMap

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List of figures

List of tables

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