European Commission

GHS-AGE: Global gridded estimates of the dominant age of the built stock (1975-2020)

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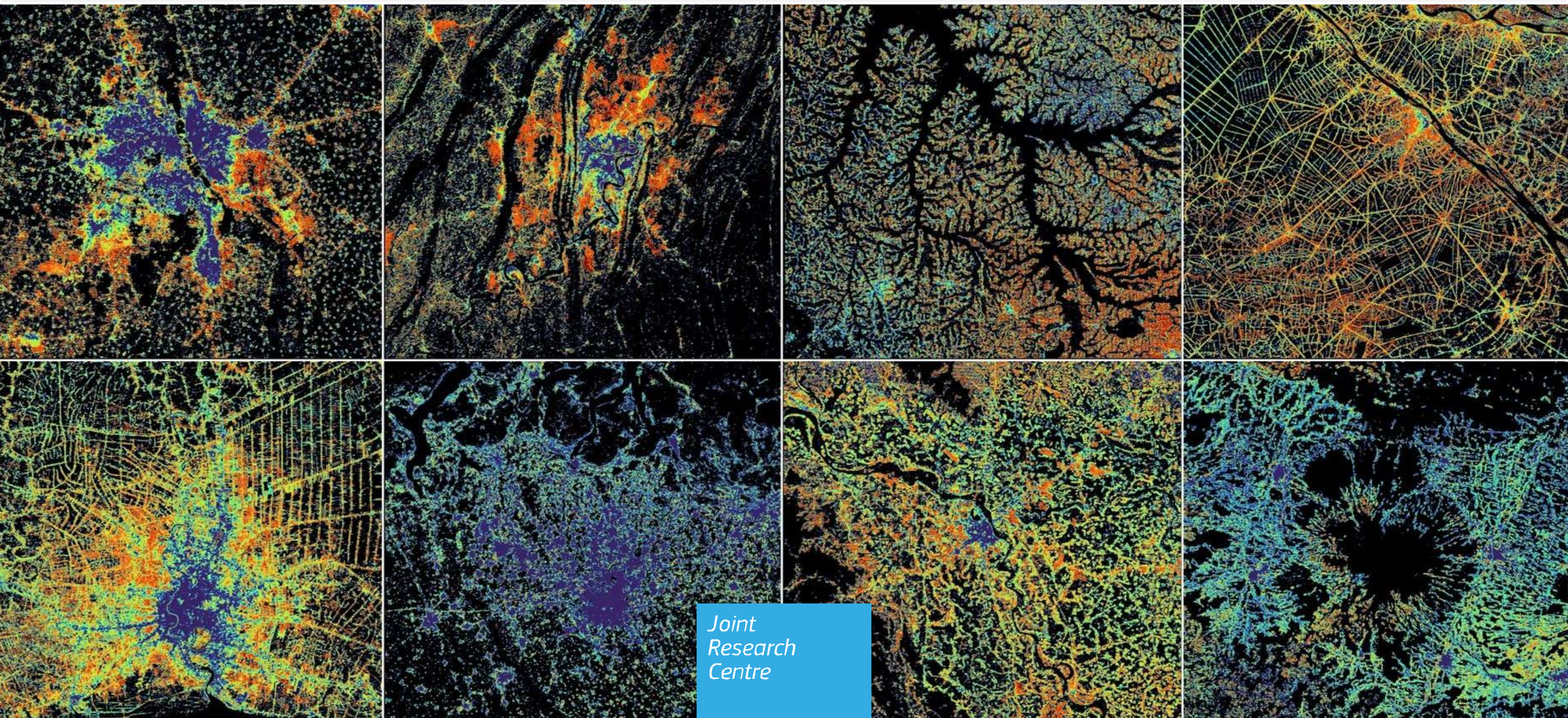

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Contents

Abstract

The Global Human Settlement Layer (GHSL) project produces global spatial data and evidence-based information describing the human presence on Earth. It operates in a fully open and free data and methods access policy. The knowledge generated by the GHSL supports the implementation and public discussion of European policies and the monitoring of international frameworks such as the United Nations Sustainable Development Goals. GHSL is the core dataset of the Exposure Mapping Component under the Copernicus Emergency Management Service (CEMS). Moreover, GHSL data support the GEO (Group on Earth Observations) Human Planet Initiative that is committed to develop a new generation of measurements and information products providing scientific evidence and a comprehensive understanding of human presence on Earth, supporting global policy processes with agreed, actionable and goal-driven metrics.

This document describes the public release of a new component of the GHSL data suite, the GHS-AGE dataset, providing gridded estimates of the built stock age at global scale, from 1975 to 2020. GHS-AGE enables the fine-grained modelling of building construction year information using a globally consistent methodology. GHS-AGE constitutes important baseline data for a multitude of applications related to energy efficiency, building stock resilience and vulnerability, urban studies, disaster preparedness and disaster risk management. GHS-AGE is available at https://doi.org/10.2905/d503bb56-9884-4e4d-bb8f-d86711d9f749.

Before citing this report, please access the updated version available at:
https://human-settlement.emergency.copernicus.eu/documents/GHS_AGE_R2025A.pdf

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 on Earth. The GHSL data suite encompasses a wide range of datasets covering different thematic aspects of the built environment. GHS-AGE ("Global Human Settlement Age") complements the GHSL data suite by providing gridded estimates of the age of the built stock. GHS-AGE is a derived data product, relying on a multi-temporal data cube of gridded built-up surface estimates (GHS-BUILT-S R2023A) from the data release GHSL R2023 which is based on information extraction from large amounts of heterogeneous data sources including global satellite imagery from the Landsat and Sentinel-2 missions. This document accompanies the public release of the GHS-AGE R2025A dataset and describes its contents.

Each GHSL data product is named according to the following convention:

GHS-<name>_<spatial extent>_<release>

For example, a product name GHS-AGE_GLOBE_R2025A indicates the age of the built stock (AGE) produced globally in the release R2025A. Each product may consist of one or more datasets and layers. A layer is named with a unique identifier according to the following convention:

GHS_<name>_<TemporalResolution>_<spatialExtent>_<release>_<projection>_<resolution>_<version>

For example, a layer name GHS_AGE_1975052020_GLOBE_R2025A_54009_100_V1_0 indicates the age of the built stock (GHS_AGE) ranging from 1975 to 2020 with a temporal resolution of 5 years (1975052020), included in the release R2025A, in World Mollweide Equal Area projection (ESRI:54009) at 100m spatial resolution, version 1.0.

1.2 Rationale

The open and free access to data is a core principle of the GHSL (Melchiorri et al., 2019). This is aligned with the Directive on the re-use of public sector information (Directive 2019/1024[1]), facilitating information sharing and contributing to the democratisation of collective knowledge building. The GHS-AGE data product represents a first, global attempt to map the age of the built stock produced at the European Commission's Joint Research Centre (JRC) in the Directorate for Societal Resilience and Security, Disaster Risk Management Unit (E.1), produced in the period 2022-2025.

1.3 Main Characteristics

This release of GHS-AGE includes gridded estimates of the dominant age of the built stock per 100m and 1km grid cell in World Mollweide Equal Area projection (ESRI:54009). This age estimate corresponds to the earliest year in which 50% or more of the contemporary (i.e., 2020) built-up surface in the grid cell is reached. Moreover, there are two ways how "age" (i.e., the approximate, median building construction epoch per grid cell) is discretised: 1) From 1975 (or earlier) to 2020, in 5-year time steps ("1975052020"), and 2) from 1980 (or earlier) to 2020, in 10-year time steps ("1980102020"). Hence, GHS-AGE consists of four gridded datasets in GeoTIFF format, covering two spatial resolutions and two levels of temporal granularity.

Terms of Use

The data described herein are provided free-of-charge © European Union, 2025. 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 production team at the email address: JRC-GHSL-DATA@ec.europa.eu

Disclaimer: The JRC data are provided "as is" and "as available" in conformity with the JRC Data Policy[2] and the Commission Decision on reuse of Commission documents (2011/833/EU). Although the JRC guarantees its

[1] Directive on open data / re-use of public sector information: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32019L1024

[2] JRC Data Policy: https://doi.org/10.2788/607378

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https://human-settlement.emergency.copernicus.eu/documents/GHS_AGE_R2025A.pdf

2 Products

2.1 GHS-AGE R2025A – Global, gridded estimates of the dominant age of the built stock

GHS-AGE R2025A is a data product derived from a global, multi-temporal stack of gridded built-up surface estimates (GHS-BUILT-S R2023A). The GHS-BUILT-S gridded data depict the global distribution of built-up surface between 1975 and 2030 in 5-year intervals, reported in square metres per 100 m and 1000 m grid cell (Pesaresi et al., 2024). While the individual layers of GHS-BUILT-S depict the distributions of built-up surface at a given point in time, on a continuous scale, they do not provide explicit information on the period in which a given plot of land (e.g., a grid cell) was predominantly built-up. GHS-AGE aims to provide a solution for that – a statistical estimate of the epoch in which a grid cell was predominantly built-up.

Specifically, GHS-AGE is based on a stack of gridded built-up surface estimates from GHS-BUILT-S R2023A from 1975 to 2020, identifying the epoch in which 50% of the built-up surface of 2020 has been exceeded for the first time, for each grid cell. This epoch is then encoded at a categorical scale and reported for each grid cell. This process is done globally, at both 100 m and 1000 m resolution, and for 5-year intervals from 1975 to 2020, as well as for 10-year intervals from 1980 to 2020 (see some examples in Figure 1).

The reported epoch in which more than 50% of the total built-up areas (i.e., the “built stock”) in each grid cell existed, should be understood as a measure of the dominant age of the built stock in each grid cell. In the hypothetical case that all buildings within a given grid cell have the same footprint area, the dominant age of the built stock represents a statistical estimate of the median building construction epoch in a given grid cell.

To understand the semantics and limitations of GHS-AGE, it is important to consider the definitions of the aforementioned spatial variables, and the relationships between them:

1) GHS-BUILT-S measures built-up surface (BUSURF), constituting the total gross surface of buildings per grid cell (see below, Sections 2.1.1.1, 2.1.1.2).
2) BUSURF represents the gross building surface. When aggregated over all buildings (or building parts) in a given grid cell, we speak of the “built stock” (BUSTOCK, Section 2.1.1.3). The BUSTOCK is different from the commonly used term “building stock” which discerns individual buildings, whereas the BUSTOCK encompasses all buildings in a given grid cell, in an aggregated way.
3) GHS-AGE reports the age of the built stock (BUAGE), a statistical estimate of the predominant epoch by which the built stock in a given grid cell was erected.
4) BUAGE can be used to infer the median construction epoch of buildings within a given grid cell, assuming that all buildings within a given grid cell have the same gross surface. The higher the variability of gross building surface within a grid cell, the less reliable is the BUAGE as a proxy variable for the building construction epoch at the individual building level.
5) Importantly, BUAGE does not take into account building renewals, nor does it reflect buildings that existed in the past, but not exist anymore in the anchor epoch of 2018. This is due to the way how BUSURF is extracted from the underlying satellite imagery in GHS-BUILT-S (Pesaresi et al. 2024). The higher the level of building stock renewal after 1975, the more limited is the usefulness of BUAGE as a proxy variable for the dominant building construction epoch. Moreover, grid cells that were not built-up by 2020 according to GHS-BUILT-S, but were developed in subsequent years, are not taken into account in this version of GHS-AGE.

2.1.1 Definitions

2.1.1.1 The building

Since the initial concept of the GHSL (Pesaresi et al., 2013) the adopted definition of the “building” as a geographic feature is largely identical to the INSPIRE “building” abstraction[3]. The adopted definition is limited to above-ground structures, but without being constraint to permanent built-up structures, thus enabling the inclusion of temporary settlements encountered in slums, or refugee camps hosting displaced people emerging from rapid migratory patterns due to natural disasters, violent conflicts or other crises: “… *Buildings are constructions above (and/or underground) which are intended or used for the shelter of humans, animals, things,*

[3] INSPIRE Data Specification on Buildings: https://inspire.ec.europa.eu/id/document/tg/bu

the production of economic goods or the delivery of services and that refer to any structure (permanently) constructed or erected on its site…". In short, and taking into account the characteristics and limitations of underlying remote sensing technology, the implicit GHSL abstraction of the "building" can be summarized as: "*any roofed structure erected above ground for any use*".

2.1.1.2 The built-up surface (BUSURF)

The built-up surface is the gross surface (including the thickness of the walls) bounded by the building wall perimeter (also informally called "building footprint"), with a spatial generalisation level approximately matching the cartographic generalisation applied to topographic maps at scale 1:10 000.

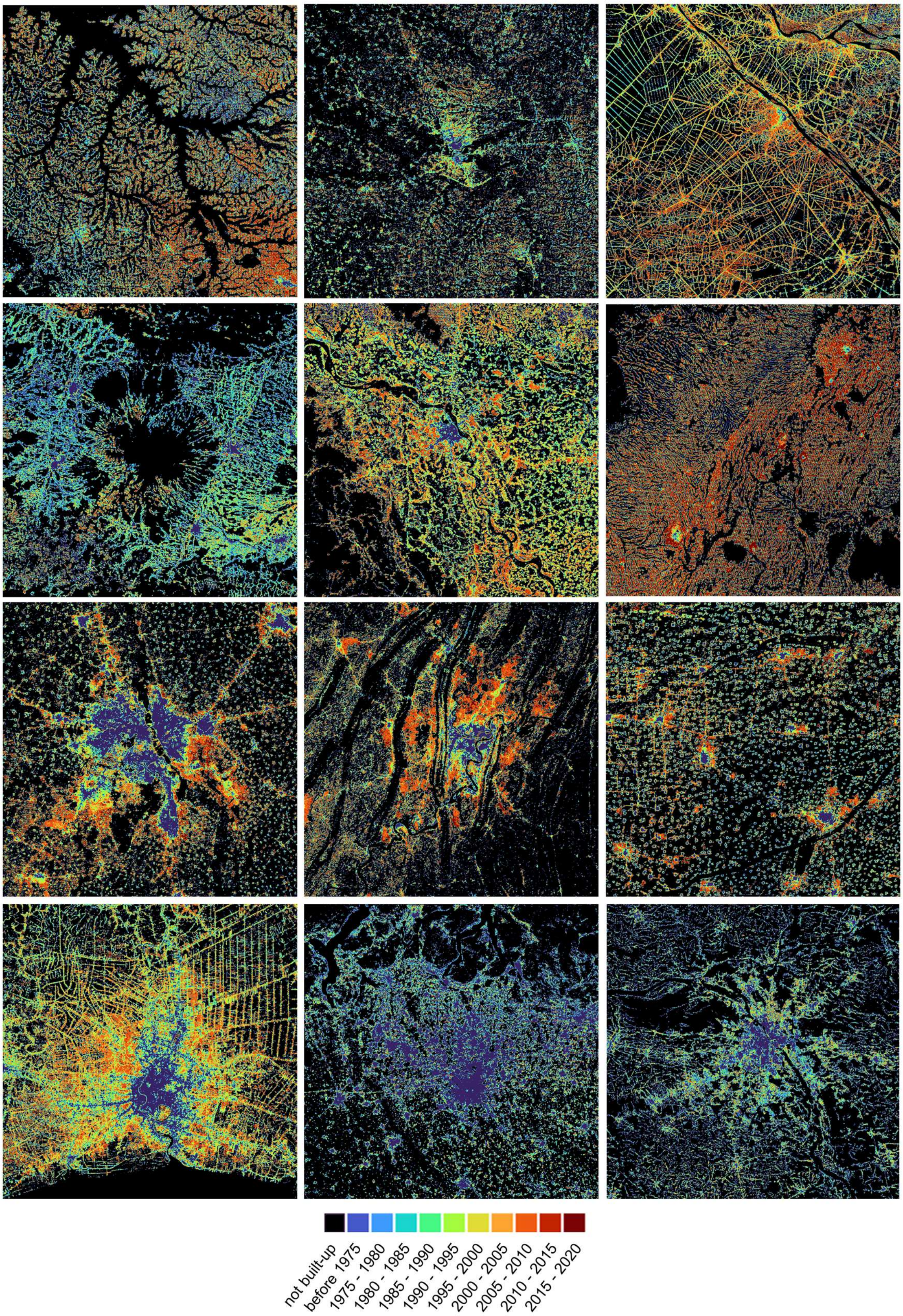
2.1.1.3 The built stock (BUSTOCK)

Herein, we refer to the "built stock" as the total BUSURF measured at a given point in time ***T*** within a given spatial unit (e.g., grid cell). While the "built stock" considers the building footprint area of all buildings existing in ***T***, it does not allow for discerning individual buildings, as opposed to the "building stock" which operates at the individual building level.

2.1.1.4 The age of the built stock (BUAGE)

BUAGE is a statistical estimate of the year by which the majority of the built stock in a given grid cell was built-up. It is based on the year in which 50% of the contemporary built-up surface (i.e., for the anchor epoch 2020) in a given grid cell has been exceeded for the first time. GHS-AGE reports BUAGE in a discretised way (i.e., 5-year and 10-year intervals).

Figure 1. Visualisation of GHS-AGE: Gridded age estimates of the built stock for 12 regions, each panel covering 100 km × 100 km. Shown is the GHS-AGE_1975052020_GLOBE_R2025A_54009_100_v1_0 dataset at 100 m resolution using 5-year time steps from 1975 to 2020. From left to right: Top row: Rural Uganda, Rural Thailand, Can Tho (Vietnam); 2nd row: Liman Volcano (Indonesia), Hanoi (Vietnam), Hosaina (Ethiopia); 3rd row: Delhi (India), Chongqing (China), China Central Plains; bottom row: Bangkok (Thailand), Milano (Italy), Warsaw (Poland).



Source: GHS-AGE R2025A, JRC analysis.

2.1.2 Technical Details

Authors:	Johannes H. Uhl, Panagiotis Politis, Martino Pesaresi
Product name:	GHS-AGE_GLOBE_R2025A
Spatial extent:	global
Temporal extent:	From 1975(1980) to 2020
Coordinate System:	World Mollweide Equal Area projection (ESRI:54009)
Spatial resolution available:	100 m, 1000 m
Encoding:	integer (UInt8), unit: age class code
Data organisation:	GeoTIFF file (100m, 1000m resolution)
Disclaimer:	The reprojection of the GHS-AGE_R2025A to other coordinate systems requires specific technical knowledge. No responsibility is taken for workflows developed independently by users.

Table 1. Technical details of the datasets in GHS-AGE R2025A.

Dataset	ID	Description
GHS-AGE 100 m, fine age classes	GHS_AGE_1975052020_GLOBE_R2025A_54009_100_V1_0	Age of the built stock from 1975 to 2020 in 5-year time steps (1975052020); World Mollweide Equal Area (ESRI:54009); 100 m spatial resolution; Encoding: UInt8; Value range: 0-10
GHS-AGE 1000 m, fine age classes	GHS_AGE_1975052020_GLOBE_R2025A_54009_1000_V1_0	Age of the built stock from 1975 to 2020 in 5-year time steps (1975052020); World Mollweide Equal Area (ESRI:54009); 1000 m spatial resolution; Encoding: UInt8; Value range: 0-10
GHS-AGE 100 m, coarse age classes	GHS_AGE_1980102020_GLOBE_R2025A_54009_100_V1_0	Age of the built stock from 1975 to 2020 in 10-year time steps (1980102020); World Mollweide Equal Area (ESRI:54009); 100 m spatial resolution; Encoding: UInt8; Value range: 0-5
GHS-AGE 1000 m, coarse age classes	GHS_AGE_1980102020_GLOBE_R2025A_54009_1000_V1_0	Age of the built stock from 1975 to 2020 in 10-year time steps (1980102020); World Mollweide Equal Area (ESRI:54009); 1000 m spatial resolution; Encoding: UInt8; Value range: 0-5

Source: JRC analysis.

Table 2. Raster data encoding used in GHS-AGE R2025A.

Coarse age classes, 10-year steps from 1980 to 2020 (1980102020)		**Fine age classes, 5-year steps from 1975 to 2020 (1975052020)**			
Code	**Description**	**Code**	**Description**	**Code**	**Description**
0	not built-up	0	not built-up		
1	< 1980	1	< 1975	6	1995 - 2000
2	1980 - 1990	2	1975 - 1980	7	2000 - 2005
3	1990 - 2000	3	1980 - 1985	8	2005 - 2010
4	2000 - 2010	4	1985 - 1990	9	2010 - 2015
5	2010 - 2020	5	1990 - 1995	10	2015 - 2020

Source: JRC analysis.

Additional files:

Each GeoTIFF file (<name>.tif) is accompanied by a

- **QGIS layer style file** (<name>.qml), tested for QGIS 3.28.0 (Firenze)
- **ArcGIS colormap file** (<name>.clr), tested for ESRI ArcMap 10.8
- **ArcGIS layer file** (<name>.tif.lyr), tested for ESRI ArcMap 10.8
- **Comma-separated values file** (<name>.csv), with grid code, description, and RGB colors, facilitating programmatic visualisation and processing of the data.
- **OVR raster pyramid file** (<name>.tif.ovr), for efficient display of the GHS-AGE GeoTIFF files in ESRI ArcGIS and QGIS.

2.1.3 How to cite

Dataset:

Uhl, J.H., Politis, P., Pesaresi, M. (2025). GHS-AGE R2025A – Global gridded estimates of the dominant age of the built stock (1975-2020). European Commission, Joint Research Centre (JRC) [Dataset]

DOI: https://doi.org/10.2905/d503bb56-9884-4e4d-bb8f-d86711d9f749

PID: http://data.europa.eu/89h/d503bb56-9884-4e4d-bb8f-d86711d9f749

Concept & Methodology:

Uhl, J.H., Pesaresi, M., Politis, P., Krasnodębska, K., Florio, P., Kemper, T. (forthcoming). GHS-AGE: Characterizing settlement age at planetary scale using the Global Human Settlement Layer.

3 Conclusions

Herein, the GHSL data product GHS-AGE R2025A has been described. GHS-AGE extends the GHSL data suite by providing global gridded datasets estimating the dominant age of the built stock, from 1975 to 2020, at 100 m and 1000 m resolutions. GHS-AGE is based on grid-cell level time series analysis of the gridded built-up surface estimates from GHS-BUILT-S, and represents a globally harmonized proxy variable for the dominant building construction epoch per grid cell, if specific conditions are met (i.e., grid cells contain buildings of similar footprint area, exhibiting low levels of building stock renewal after 1975). GHS-AGE aims to provide a statistically viable solution for the increasing demand of building construction year information, which constitutes important baseline information to support the implementation of policies tackling pressing global issues related to energy efficiency, building stock resilience and vulnerability, or disaster risk management.

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