Release Statement

Ease of Social Distancing Index, mapped for urban areas in sub-Saharan Africa (single country update for Sierra Leone), version 1.1

28 July 2021

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ABSTRACT

Social distancing is a public health measure intended to reduce infectious disease transmission, by maintaining physical distance between individuals or households. In the context of the COVID-19 pandemic, populations in many countries around the world have been advised to maintain social distance (also referred to as physical distance), with distances of 6 feet or 2 metres commonly advised. Feasibility of social distancing is dependent on the availability of space and the number of people, which varies geographically. In locations where social distancing is difficult, a focus on alternative measures to reduce disease transmission may be needed.

To help identify locations where social distancing is difficult, we have developed an ease of social distancing index. By index, we mean a composite measure, intended to highlight variations in ease of social distancing in urban settings, calculated based on the space available around buildings and estimated population density. Index values were calculated for small spatial units (vector polygons), typically bounded by roads, rivers or other features. This dataset provides index values for small spatial units within urban areas in sub-Saharan Africa. Measures of population density were calculated from high-resolution gridded population datasets from WorldPop, and the space available around buildings was calculated using building footprint polygons derived from satellite imagery (Ecopia.AI and Maxar Technologies, 2020).

These data were produced by the WorldPop Research Group at the University of Southampton. This work was part of the GRID3 project with funding from the Bill and Melinda Gates Foundation and the United Kingdom's Foreign, Commonwealth & Development Office (INV-009579, formerly OPP1182425), and GRID3 COVID-19 Support Scale-up (INV-018067). Project partners included the United Nations Population Fund (UNFPA), Center for International Earth Science Information Network in the Earth Institute at Columbia University, and the Flowminder Foundation. Method development, geospatial data processing, coding and dataset production was led by Heather R. Chamberlain. Assistance with assembly of input datasets was provided by Maxwell McCann and Polly Marshall. Support in methods development was provided by Silvia Renn and Chris Jochem. Oversight of the work was provided by Attila N. Lazar and Andrew J. Tatem. Edith Darin, Oliver Pannell, Sarchil Qader, Attila N. Lazar and Jolynn Schmidt provided internal WorldPop and GRID3 peer reviews that helped to improve the results and documentation.

The authors followed rigorous procedures designed to ensure that the used data, the applied method and thus the results are appropriate and of reasonable quality. If users encounter apparent

errors or misstatements, they should contact WorldPop at release@worldpop.org.

WorldPop, University of Southampton, and their sponsors offer these data on a "where is, as is" basis; do not offer an express or implied warranty of any kind; do not guarantee the quality, applicability, accuracy, reliability or completeness of any data provided; and shall not be liable for incidental, consequential, or special damages arising out of the use of any data that they offer.

RELEASE CONTENT

1. * XXX_SocialDistancing_v1_1_index.zip
2. * XXX_SocialDistancing_v1_1_extents.zip

*This data release (v1.1) is a single country update for Sierra Leone, however data are available for 50 countries in v1.0, and countries can be identified using the alpha-3 country code (ISO 3166) in the filename (in place of XXX above). For example, SLE refers to Sierra Leone. A full list of countries included in each data release is provided in Appendix A.

LICENSE

SUGGESTED CITATIONS

Chamberlain, H.R., Lazar, A.N. and Tatem, A.J. 2021. Ease of Social Distancing Index, mapped for urban areas in sub-Saharan Africa (single country update for Sierra Leone), version 1.1. WorldPop, University of Southampton. doi:10.5258/SOTON/WP00721

FILE DESCRIPTIONS

All spatial data files are in geographic coordinate system WGS84 (World Geodetic System 1984: EPSG 4326).

XXX_SocialDistancing_v1_1_index.zip

This zip file contains one shapefile:

XXX_SocialDistancing_v1_1_index.shp

This polygon dataset in shapefile format consists of spatial units (polygons) within urban areas. For each spatial unit, there is an index value for ease of social distancing (*INDEXvalue).* The attribute table contains the following fields:

- *uext_ID:* ID of the urban extent, which can be used for selecting urban areas. This is also the common ID which can be used to link with the **XXX_SocialDistancing_v1_1_urban_extents.shp** and **XXX_SocialDistancing_v1_1_urban_points.shp** files.
- *adm0_ISO3:* The 3 letter ISO code of the country dataset
- *UNIT_AREA:* The area of the spatial unit (polygon) in metres squared, calculated in the relevant UTM zone projection.
- *BUILT_AREA:* The summed area of all building footprint polygons within the spatial unit. Units are metres squared.
- *BUILT_PROP:* The proportion of the spatial unit that is built, calculated as

BUILT_AREA / UNIT_AREA.

- *NBUILTPROP:* The proportion of the spatial unit that is not built, calculated as 1-*BUILT_PROP.*
- *POP_DENS:* The mean population density (population per km^2) of the spatial unit, calculated for all grid cells that have their centroid within the spatial unit.
- *BUILTscore:* Built score (0-10), classified based on the *BUILTPROP* field, with a value of 10 corresponding to over 90% of the unit area being occupied by buildings and a value of 1 corresponding to less than 10% of the unit area being occupied by buildings, but with at least 1 building present. A value of 0 indicates a spatial unit with no buildings present. See methods section for classification details.
- *POPscore:* Population density score (0-10), classified based on the *POP_DENS* field, with a value of 1 corresponding to low population density and a value of 10 corresponding to very high population density. A value of 0 indicates a spatial unit where the mean population density is 0 people per km^2. See methods section for classification details. A no data value (-99) indicates missing data.
- *INDEXvalue:* Ease of social distancing index value (0-10), calculated as the mean of the *BUILTscore* and *POPscore* field values. A value of 1 is indicative of relative ease of social distancing due to low population density and ample space around buildings. A value of 10 is indicative of high difficulty in maintaining social distancing due to very high population density and very little space around buildings. A no data value (-99) indicates missing data.

Note: This zipped folder contains a .shp file and the necessary associated files of the same name (with extensions .prj, .dbf, .shx, .cpg, .sbn, .sbx), that make up the shapefile format.

XXX_SocialDistancing_v1_1_extents.zip
This zip file contains two shapefiles:

XXX_SocialDistancing_v1_1_urban_extents.shp
This polygon dataset in shapefile format consists of polygons of the urban extents within which ease of social distancing index values were calculated. The attribute table contains the following fields:

- *uext_ID:* ID of the urban extent. This is the common ID which can be used to link with the **XXX_SocialDistancing_v1_1_urban_points.shp** and **XXX_SocialDistancing_v1_1_index.shp** files.
- *adm0_ISO3:* The 3 letter ISO code of the country dataset

Note: This file consists of a .shp file and the necessary associated files of the same name (with extensions .prj, .dbf, .shx, .cpg, .sbn, .sbx), that make up the shapefile format.

XXX_SocialDistancing_v1_1_urban_points.shp
This point dataset in shapefile format consists of points, located within the urban extent polygons. Each point corresponds to an urban centre and has an associated name. Urban centre names and locations are derived from the GHS Urban Centre Database 2015 v1.2 (Florczyk *et al.*, 2019a), subset to the country and urban extents included for each country in the ease of social distancing index (mapped outputs) for urban areas in sub-Saharan Africa, version 1.1 dataset. Missing names have been added, based on visual comparison with OSM and Google Maps, as far as possible. The attribute table contains the following

fields:

- *PNT_LAT:* Latitude of urban centre point location (decimal degrees)
- *PNT_LON:* Longitude of urban centre point location (decimal degrees)
- *adm0_NAME:* Name of country
- *adm0_ISO3:* The 3 letter ISO code of the country
- *urb_NAME:* Name of urban centre
- *uext_ID:* ID of the urban extent. This is the common ID which can be used to link with the **XXX_SocialDistancing_v1_1_urban_extents.shp** and **XXX_SocialDistancing_v1_1_index.shp** files.

Note: This file consists of a .shp file and the necessary associated files of the same name (with extensions .prj, .dbf, .shx, .cpg, .sbn, .sbx), that make up the shapefile format.

RELEASE HISTORY

Version 1.1 (28 July 2021) [doi:10.5258/SOTON/WP00721]

- Single country update for Sierra Leone only. The gridded population dataset (WorldPop and Statistics Sierra Leone, 2021), used in calculating the mean population density, has been updated due to errors in the input population dataset of version 1.0. **The original data release (v1.0) for Sierra Leone should no longer be used**.

Version 1.0 (10 May 2021) [doi:10.5258/SOTON/WP00711]

- Original release of the dataset (50 countries).

SOURCE DATA

Building footprints were used in calculating the proportion of space occupied by buildings. The data consist of vector polygons, extracted from recent high-resolution satellite imagery (Ecopia.AI and Maxar Technologies, 2020).

Gridded population (counts) were used in calculating mean population density for each spatial unit. For most countries, gridded datasets of 2020 population counts, disaggregated from census projections and spatially constrained to grid cells containing building footprints (Bondarenko *et al.*, 2020a) were used. The exception to this was for countries where recent, bespoke datasets were available. The countries for which alternative datasets were used are: Sierra Leone (WorldPop and Statistics Sierra Leone, 2021), Mozambique (Bondarenko *et al.*, 2020b), Zambia (WorldPop, 2020a), Burkina Faso (WorldPop and Institut National de la Statistique et de la Démographie du Burkina Faso, 2020), Ghana (Leasure *et al.*, 2021), Nigeria (WorldPop, 2019) and South Sudan (WorldPop, 2020b). Two sources of gridded population data were used for Democratic Republic of the Congo (DRC) due to data availability, with index values calculated from modelled population estimates for 5 provinces in the west of DRC (Boo *et al.*, 2020), and from census projection disaggregated counts for the remaining 21 provinces (Bondarenko *et al.*, 2020a). All gridded population datasets had a spatial resolution of 3 arc seconds (0.0008333333 decimal degrees or approximately 100 m at the Equator).

Grid cell surface area rasters for each country (WorldPop and Center for International Earth Science Information Network (CIESIN), Columbia University, 2018) with a spatial resolution of 3 arc seconds, were used in creating population density rasters from the population count rasters.

National administrative boundaries as vector polygons were used in defining the spatial extent of the dataset for each country (WorldPop and Center for International Earth Science Information Network (CIESIN), Columbia University, 2018). These national administrative boundaries do not necessarily reflect official national borders and should be considered accordingly.

Urban area extents were defined using two datasets GHS (Global Human Settlement) datasets: GHS Urban Centre Database 2015 v1.2 (Florczyk *et al.*, 2019a) and GHS-SMOD v2.0 (Settlement Model grid; Pesaresi *et al.*, 2019). The GHS Urban Centre Database (GHS-UCDB) consists of polygons representing urban centres (Appendix B) based on population density and built-up area, with the degree of urbanisation methodology applied (Florczyk *et al.*, 2019b).

Settlement extents for each country (Center for International Earth Science Information Network (CIESIN), Columbia University; Flowminder Foundation; United Nations Population Fund (UNFPA); WorldPop, University of Southampton. 2020) in vector polygon format were used in identifying the edge of built-up areas. A full list of the settlement extent datasets for each country are provided in Appendix C.

OpenStreetMap (OSM) line and way features. Features from OpenStreetMap (OpenStreetMap contributors, 2020) were used in creating the spatial unit (polygons) for which index values were calculated. The features used were predominantly roads, waterways and railways, supplemented by additional landuse features such as industrial areas, military complexes, cemeteries, golf courses, parks, waterbodies, mines, airports and residential areas. The OSM line and polygon features were intersected to create polygons within urban extents. OSM data were primarily sourced from Geofabrik, with additional data downloaded through the QGIS QuickOSM plugin (Trimaille, 2020). A full list of features is provided in Appendix D.

METHODS OVERVIEW

This dataset provides an index of ease of social distancing for urban areas across sub-Saharan Africa. The index values are calculated for small spatial units within urban areas in 50 countries/ territories/dependencies in sub-Saharan Africa. The first step in processing was to define the extent of urban areas. The focus is on urban areas where social distancing is expected to be most needed but most difficult to comply with. Urban area extents were defined using two GHS (Global Human Settlement) datasets: GHS Urban Centre Database 2015 v1.2 (Florczyk *et al.*, 2019a) and GHS-SMOD v2.0 (Settlement Model grid; Pesaresi *et al.* 2019). The GHS Urban Centre Database (GHS-UCDB) consists of polygons representing "urban centres" based on population density and built-up area with the degree of urbanisation methodology applied (Florczyk *et al.*, 2019b). The GHS-UCDB v1.2 dataset includes a data quality code (QA2_1V), with a value of 1 indicating true positives. Only

urban centres classified as being true positives were selected for inclusion in the mapped index outputs.

The spatial extent of the polygons surrounding urban centres was determined based on GHS-SMOD v2.0. Class values of 21–30, representing urban/peri-urban clusters of varying densities in the GHS SMOD raster, were all considered as urban and reclassed to create a binary urban/rural raster. All grid cells in the urban raster that were spatially contiguous with an urban centre, were considered to be part of the urban area associated with each urban centre. These urban areas were then buffered by 3 km, and a convex hull created around each contiguous urban area. In the case of overlapping convex hull polygons, the urban areas within the convex hull were grouped together and a new convex hull created. Urban extent polygons were clipped to the national administrative boundary for each country and in coastal locations were clipped to the coastline (OpenStreetMap contributors, 2020). For the 50 countries for which mapped outputs have been created, in total there were 1373 urban extent polygons, associated with 1551 named locations; a full list is provided in Appendix B.

Within each urban extent, spatial units were created to be the unit of analysis for the index values. The small spatial units were created from features such as roads, rivers and railways which were intersected to create polygons, forming homogeneous spatial units which commonly have similar layouts of built structures. Roads, rivers and railways were supplemented with other line and polygon features to enable sufficiently small units to be created, including boundaries of different landuse types and features (e.g. industrial areas, military areas, golf courses, airports). All the line and polygon features (detailed in Appendix D), used to create the small spatial units, were extracted from OpenStreetMap (OpenStreetMap contributors, 2020). Efforts were made to sub-divide very large polygons on the urban fringe, defined as being intersected by a BUA (built up area) or SSA (small settled area) polygon from the settlement extent datasets listed in Appendix C, and greater than 100,000 m^2 in area. For these selected polygons on the urban fringe, residential area polygon features from OSM were introduced where available, intersecting with existing polygons to sub-divide polygons into smaller spatial units. The spatial unit polygons were then iteratively merged with neighbouring polygons, based on the longest shared border, to ensure a minimum area constraint of 1 hectare (10,000 m^2) was met. Urban extents with less than 30 spatial units were not included in the output dataset.

For each small spatial unit, the ease of social distancing index value was calculated, based on (1) the mean population density and (2) the proportion of space occupied by buildings. Population density rasters for each country were created by dividing rasters of population counts by the grid cell surface area, from which a mean value for each spatial unit was calculated (the spatial resolution of all rasters was maintained at 3 arc second resolution). If the size or the shape of a spatial unit polygon meant that it was not possible to calculate a mean value from the population density raster, a centroid of the polygon was created, and an interpolated value extracted from the population density raster. In some locations close to national borders, population density values were not available due to differences in the spatial extents of datasets. Small spatial units that are affected

by this have a no data value (-99) in the *POPscore* field and consequently the calculated index value (*INDEXvalue)* also has a no data value (-99).

Values for mean population density were classified based on the maximum possible population density achievable with different distancing parameters. We use an idealised model of perfect spacing between people, based on a hexagon tessellation, with one person per hexagon at the hexagon centroid (Figure 1). For example, for all individuals in a unit to maintain 2 m social distancing, whilst still being able to move freely between and around other people, a hexagon with an apothem of 3 m is required (i.e. the distance between the hexagon centre and mid-point of a side). An apothem of 3 m ensures that any person can move 2 m in any direction, and still maintain a 2 m distance from any other person. With an apothem of 3 m, each hexagon is 31.18 m^2 which allows a population density of 32,075 people per km^2. Any unit with population density greater than 32,075 people per km^2 is assigned a population density score value of 10 (the maximum value).

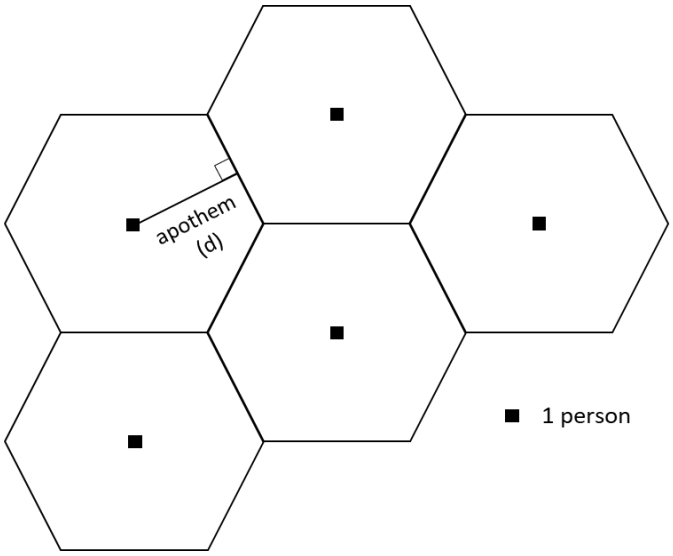

Figure 1: Population density thresholds were calculated based on a hexagon tessellation with 1 person per hexagon, situated at the centroid of the hexagon

Table 1: Classification of *POPscore* variable based on distancing parameters and associated theoretical population densities based on a hexagon tessellation

d [m]	Hexagon area [m^2]	Population density [pop per km^2]	*POPscore* value
≤ 3	≤ 31.18	≥ 32,075.01	10
(3 – 4]	(31.18 - 55.43]	(18,042.20 - 32,075.01]	9
(4 – 5]	(55.43 - 86.60]	(11,547.01 - 18,042.20]	8
(5 – 6]	(86.60 - 124.71]	(8,018.75 - 11,547.01]	7
(6 – 7]	(124.71 - 169.74]	(5,891.33 - 8,018.75]	6
(7 – 8]	(169.74 - 221.70]	(4,510.55 - 5,891.33]	5

(8 – 9]	(221.70 - 280.59]	(3,563.89 - 4,510.55]	4
(9 – 10]	(280.59 - 346.41]	(2,886.75 - 3,563.89]	3
(10 – 11]	(346.41 - 419.16]	(2,385.74 -2,886.75]	2
> 11	> 419.16	(0.0 -2,385.74]	1
-	-	0.0	0

To derive the remaining population density threshold values, the hexagon apothem was increased in 1 m increments up to 11 m. An apothem of 11 m corresponds to an area of 419.16 m^2 and a maximum population density of 2385.74 people per km^2. All non-zero population density values less than 2385.74 people per km^2 are assigned a variable of 1. Values of 0 are assigned to spatial units where the mean population density is 0 people per km^2. The thresholds are summarised in Table 1 and the hexagonal tessellation is shown graphically in Figure 1. These calculations are idealised and these distances in reality will most likely be reduced due to the space within built environments rarely being open and free of obstructions.

The proportion of an area occupied by buildings was calculated by summing the total building footprint area within each spatial unit, from which the proportion of the total area taken up by buildings was calculated. If a building footprint polygon spanned more than one spatial unit, the building footprint polygon was split using the spatial unit polygon boundary, enabling the total area occupied by buildings to be calculated for each spatial unit. Classified values for the proportion of space occupied by buildings were assigned linearly such that a value of 1 corresponds to less than or equal to 10% of the area being occupied by buildings, 2 corresponds to more than 10% but less than or equal to 20% etc, up to a value of 10 corresponding to over 90% of an area being occupied by buildings (Table 2). Values of 0 are assigned for spatial units with no buildings present.

Table 2: Classification of *BUILTscore* variable based on the proportion of a spatial unit being occupied by buildings

Proportion of area occupied by buildings	*BUILTscore* value
(0.9 – 1.0]	10
(0.8 - 0.9]	9
(0.7 - 0.8]	8
(0.6 - 0.7]	7
(0.5 - 0.6]	6
(0.4 - 0.5]	5
(0.3 - 0.4]	4
(0.2 - 0.3]	3
(0.1 - 0.2]	2
(0.0 - 0.1]	1
0.0	0

The mean value of the two variables (mean population density and the proportion of space occupied by buildings) is calculated to give an index value, that ranges between 0 and 10. An index value of 10 would indicate a very high population density and a very high density of buildings, with little space available between and around buildings to enable social distancing. Conversely, a low index value (near-zero) would indicate little difficulty in social distancing based on open space and population density, i.e. population density is low and the space is largely free from built structures.

Code for data processing and analysis was written in Python (version 3.6.9), using ArcPy in an ArcGIS Notebook (ESRI, 2020).

ASSUMPTIONS AND LIMITATIONS

The ease of social distancing index is based on two variables (population density and space available around buildings) for which data are available in all 50 countries with national coverage. The index values are intended to indicate locations where social distancing may be difficult within urban areas, considering these factors. Other locations (including some locations in smaller towns and more rural areas) may also pose difficulties for maintaining social distance, for example, transport hubs and markets or similar locations where people congregate throughout the day or at particular times. Difficulties in social distancing due to large numbers of people congregating are not reflected in this index. Conversely, areas with many large buildings but few people, such as warehouses, industrial estates or commercial greenhouses may have a high index value, depending on the mean population density for that location. Ease of social distancing may also be affected by the arrangement of buildings. For example, if there are two areas with the same *BUILTscore* value (same proportion of the area occupied by buildings) but one has many small buildings (A) and the other has a single, very large building (B), it will likely be harder to maintain social distance when moving between buildings in area A compared to area B. The layout and arrangement of buildings, or other obstructions which may hinder social distancing, are not reflected in the index value.

Index values were calculated for small spatial units within urban area extents. Urban centres and their spatial extents are based on the GHS Urban Centre Database 2015 v1.2 (Florczyk *et al.*, 2019a) and GHS-SMOD v2.0 (Pesaresi *et al.* 2019) respectively. The small spatial units within each urban extent were created using feature data from OSM, an example of Volunteered Geographic Information for which completeness of data varies spatially. In smaller cities and urban areas, OSM data may only include a small number of features, leading to large spatial units, particularly on the urban fringe. As an index value is calculated for each spatial unit, a single value can hide variation in ease of social distancing within a unit, particularly for larger spatial units. This may result in a low index value for a spatial unit, but there still being areas within that unit where ease of social distancing is difficult. The index values are only applicable to the spatial units for which they are calculated, therefore rasterizing index values is not advised.

The input building footprint data (Ecopia.AI and Maxar Technologies, 2020) were produced by Ecopia using feature extraction techniques with high resolution satellite imagery from Maxar. The

acquisition date for the satellite imagery used in the creation of the building footprints varies temporally. For urban extents across all 50 countries, over 80% of the imagery used was from 2018 or 2019 (Dooley *et al.*, 2020). Cloud cover in satellite imagery may affect the completeness of the building footprint datasets. No specific quality check of these data have been carried out by us prior to their use in producing the index outputs, however quality checks were carried out by the data producer as standard.

The input gridded population datasets for most countries, are based on projected census figures for 2020 that have been spatially disaggregated (Bondarenko *et al.,* 2020a). As explained further in the source data section of this release statement, bespoke datasets were used for Sierra Leone, Mozambique, Zambia, Burkina Faso, Ghana, Nigeria, South Sudan and Democratic Republic of the Congo as these were considered to more accurately reflect the population. The timepoint of the population estimates for these datasets however varies from 2015 to 2019 and they have not been projected to 2020.

This ease of social distancing index does not consider building height or the number of floors in a building, which particularly in some high density population settings could affect the ease of social distancing. Examples of specific locations in which potential issues with the index datasets have been identified through our internal review process, are included in Appendix E.

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APPENDIX A

This appendix provides a full list of countries/territories/dependencies included in the dataset.

ISO3	Country, Territory or Dependency	Version 1.0 release	Version 1.1 release
AGO	Angola	1.0	
BDI	Burundi	1.0	
BEN	Benin	1.0	
BFA	Burkina Faso	1.0	
BWA	Botswana	1.0	
CAF	Central African Republic	1.0	
CIV	Côte d'Ivoire	1.0	
CMR	Cameroon	1.0	
COD	Democratic Republic of the Congo	1.0	
COG	Comoros	1.0	
COG	Republic of Congo	1.0	
CPV	Cape Verde	1.0	
DJI	Djibouti	1.0	
ERI	Eritrea	1.0	
ESH	Western Sahara	1.0	
ETH	Ethiopia	1.0	
GAB	Gabon	1.0	
GHA	Ghana	1.0	
GIN	Guinea	1.0	
GMB	Gambia	1.0	
GNB	Guinea-Bissau	1.0	
GNQ	Equatorial Guinea	1.0	
KEN	Kenya	1.0	
LBR	Liberia	1.0	

LSO	Lesotho	1.0	
MDG	Madagascar	1.0	
MLI	Mali	1.0	
MOZ	Mozambique	1.0	
MRT	Mauritania	1.0	
MUS	Mauritius	1.0	
MWI	Malawi	1.0	
NAM	Namibia	1.0	
NER	Niger	1.0	
NGA	Nigeria	1.0	
REU	Réunion	1.0	
RWA	Rwanda	1.0	
SDN	Sudan	1.0	
SEN	Senegal	1.0	
SLE	Sierra Leone	1.0	1.1
SOM	Somalia	1.0	
SSD	South Sudan	1.0	
STP	São Tomé and Príncipe	1.0	
SWZ	Eswatini	1.0	
TCD	Chad	1.0	
TGO	Togo	1.0	
TZA	Tanzania	1.0	
UGA	Uganda	1.0	
ZAF	South Africa	1.0	
ZMB	Zambia	1.0	
ZWE	Zimbabwe	1.0	

APPENDIX B

This appendix provides a full list of named urban centres included in the dataset for each country, territory or dependency.

Country, Territory or Dependency	**Urban areas** (derived from the GHS Urban Centre Database 2015 v1.2 (Florczyk *et al.*, 2019a))
Angola	Andulo, Bailundo, Balombo, Benguela, Bocoio, Cabinda, Caconda, Cafunfo, Calilongue, Calulo, Camacupa, Catabola, Caxito, Cazombo, Chinguar, Chitembo, Cubal, Dundo, Gabela, Ganda, Huambo, Katchiungo, Kuito, Lobito, Luanda, Luau, Lubango, Lucapa, Luena, Malanje, Matala, M'banza Congo, Menongue, Mungo, Namibe, N'dalatando, Negage, Ondjiva, Panguila, Porto Amboim, Quipungo, Saurimo, Soyo, Sumbe, Uíge, Vila Nova do Seles, Waku Kungo
Burundi	Bubanza, Bujumbura, Butihinda, Gatumba, Gitega, Kayanza, Kayogoro, Kirundo, Makamba, Muramvya, Muyinga, Ngozi, Nyanza Lac, Rugombo, Rumonge, Ruyigi

Benin	Allada, Banikoara, Bohicon, Cobli, Cotonou, Dassa-Zoumé, Djougou, Kandi, Kétou, Lokossa, Malanville, Natitingou, Nikki, Ouèssè, Parakou, Pobè, Porto-Novo, Savalou, Tanguieta, Tindji, Whydah
Burkina Faso	Banfora, Bitou, Bobo-Dioulasso, Bogandé, Boulsa, Cinkassé, Dédougou, Djibo, Dori, Fada N'Gourma, Gaoua, Gourcy, Houndé, Kaya, Kombissiri, Kompienga, Kongoussi, Koudougou, Koupéla, Leo, Manni, Niangoloko, Nouna, Ouagadougou, Ouahigouya, Pouytenga, Solenzo, Tenkodogo, Tougan, Yako, Ziniaré
Botswana	Francistown, Gaborone, Kanye, Lobatse, Maun, Mmopane, Palapye
Central African Republic	Badokwa, Bambari, Bangui, Bouar, Bria, Carnot
Chad	Abéché, Am Timan, Ati, Bol, Bongor, Doba, Faya-Largeau, Gore, Guélendeng, Kokanti, Koumra, Laï, Lere, Mao, Massakory, Mongo, Moundou, N'Djamena, Pala, Sarh, Tina, Umm Hajar, أدري Adré, فيانكا Fianga, كيابي Kyabé, كيلو Kelo, مويسالا Moïssala, نيتكتن Bitkine
Côte d'Ivoire	Abengourou, Abidjan, Aboisso, Adzopé, Agboville, Agnibilékrou, Bondoukou, Bonon, Bouaflé, Bouaké, Bouna, Dabou, Daloa, Danané, Daoukro, Diégonéfla, Divo, Duekoue, Ferkéssédougou, Gagnoa, Grand-Bassam, Guiglo, Issia, Korhogo, Lakota, Man, Méagui, Ouangolodougou, Oumé, San-Pédro, Sinfra, Soubré, Tengréla, Vavoua, Yamoussoukro
Cameroon	Bafia, Bafoussam, Bamenda, Banki, Banyo, Batouri, Bertoua, Douala, Dschang, Ebolowa, Edéa, Foumban, Foumbot, Gamboru, Garoua, Garoua-Boulaï, Guider, Kaele, Karewa, Kribi, Kumba, Kumbo, Limbé, Mamfe, Maroua, Mbalmayo, Mbouda, Meiganga, Mokolo, Mora, Muyuka, Ndop, Ngaoundal, Ngaoundéré, Nkambe, Nkongsamba, Sangmélima, Tcholliré, Tiko, Touboro, Wum, Yagoua, Yaounde, Yokadouma
Democratic Republic of the Congo	Aketi, Ariwara, Aru, Bandundu, Baraka, Basankusu, Bena Tshishimbi, Beni, Boende, Boma, Bondo, Bukavu, Bumba, Bunia, Businga, Buta, Butembo, Butondo, Butusande, Demba, Dilolo, Dungu, Elila, Fungurume, Gbadolite, Gemena, Goma, Idiofa, Iga Barriere, Ilebo, Isiro, Jupujuro-sii, Kabalo, Kabinda, Kabondo-Dianda, Kahinda, Kakanda, Kakenge, Kalemie, Kalimva, Kamanyola, Kambove, Kamina, Kamituga, Kananga, Kanyabayonga, Kanyama, Karawa, Kasaji, Kasenga, Kasongo, Kasumbalesa, Kenge, Kibomango, Kikwit, Kilwa, Kimpese, Kindu, Kingombe, Kinshasa, Kinzao, Kipushi, Kirumba, Kisangani, Kisantu, Kitenge, Kolwezi, Kongolo, Kwilu-Ngongo, Kyolo, Lemba Village, Likasi, Lisala, Lubumbashi, Lubutu, Luena, Luiza, Lukalaba, Lwambo, Lwebo, Mahagi, Makanza, Malemba Nkulu, Mambasa, Manono, Matadi, Mbandaka, Mbanza-Ngungu, Mbuji-Mayi, Misisi, Moanda, Mongbwalu, Mukanga, Mukubu, Mulongo, Mululu, Mutabi, Mwadingusha, Mweka, Mwene-Ditu, Ndalama, Ngandajika, Nyamilima, Nyunzu, Oicha, Punia, Pweto, Rubaya, Sake, Samba, Sandoa, Shabunda, Tshela, Tshikapa, Tshimbulu, Uvira, Walikale, Yakoma
Comoros	Fomboni, Moroni
Republic of Congo	Bétou, Brazzaville, Dongou, Impfondo, Mongo Kamba, Nkayi, Ouésso, Owando, Pointe-Noire, Sibiti
Cape Verde	Mindelo
Djibouti	Djibouti
Equatorial Guinea	Bata, Malabo
Eritrea	Adi Guadad, Adi Keyh, Asmara, Barentu, Keren, Teseney, دقمحري Dekemhare
Eswatini	Manzini, Matsapha
Ethiopia	Abomsa, Achefer, Adaba, Adama, Addis Ababa, Addis Alem, Addis Kidan, Adele, Adet, Adi Gudom, Adigrat, Adwa, Agarfa, Agaro, Agre Salam, Akesta, Alaba Kulito, Alamata, Aleltu, Aletawendo, Amanuel, Ambo, Arba Minch, Arbe Gona, Arboye, Areka, Arerti, Arsi Negelle, Asaita, Asassa, Asella, Asosa, Ataye, Axum, Aykel, Bahir Dar, Bako, Bale, Basha, Bati, Bechena, Bedele, Beigi, Bekoji, Bila, Bishoftu, Boditi, Boloso Sore, Bonsa Bota, Bui, Burie, Butajira, Chagni, Chefedonsa, Chiro, Chucko, Chwahit, Cima, Dalocha, Dambidollo,

	Dangla, Dasgahbur, Debark, Debre Birhan, Debre Markos, Debre Sina, Debre Tabor, Deder, Degolo, Dejen, Deksis, Delgi, Dembea, Dera, Dessie, Didimtu, Digna, Dilla, Dire Dawa, Dodolla, Dolo, Duba, Dukem, Durame, Durbete, Ebbenat, Ejaji, Enjebara, Enseno, Filakit Gereger, Fital, Gambela, Gebre gurach, Gedeb, Gedo, Gelemso, Gesuba, Gezaber, Ginido, Ginir, Ginsi, Goba, Gobesa, Gode, Gojo Town, Gonder, Gorabee, Gouder, Gulisso, Gunchire, Gundo Meskel, Gurage, Guyi, Hadero, Harar, Harbu, Haro, Hawassa, Holeta, Hossana, Huruta, Itiya, Jara, Jiga, Jijiga, Jinka, Karamile, Katab, Kebri Dehar, Kefole, Kemse, Kersa, Kibre Mengist, Kobo, Kokir, Kombolcha, K'Ore / Qoree, Korem, Kuch, Kula, K'Umbabe, Lalibela, Lemen, Maksegnit, Maychew, Mekane Yesus, Mek'elē, Meki, Meliyu, Melkane Selam, Merawi, Mersa, Mertule Mariam, Meslo, Meti Chafi / Tilk u Meti, Metu, Mojo, Morocho, Mota, Moyale, Muketuri, Nedjo, Nefas Meewcha, Negele, Nekemte, North Gondar, Omonada, Passo Saefti, Quiha, Sagure, Sambatee, Seka, Seyo, Shahura (Alefa), Shambu, Shano, Shashamane, Shehibi, Shewa Ghimira, Shinshicho, Shire, Shoa Robit, Shone, Sinkille, Sodo, Sululta, Tarcha, Tepi, The State Of Tigray, T'Ora, Tulu Bolo, Uallaga, Waliso, Wegel Tena, Welayita, Weldiya, Welenchete, Welkite, Wereta, Wogdi, Wukro, Yabelo, Yebu, Yejube, Yirgalem, Ziway, ቡሌ ሆራ / Bule Hora, ፊንጫዋ / Finchawa
Gabon	Libreville, Moanda, Port-Gentil
Ghana	Accra, Agona Swedru, Akatsi, Akim Oda, Asamankese, Assin Fosu, Atebubu, Bawku, Berekum, Bimbila, Bole, Bolgatanga, Cape Coast, Dambai, Dormaa Ahenkro, Dunkwa-on-Ofin, Ejura, Garu, Gushiegu, Ho, Hohoe, Kete Krachi, Kintampo, Koforidua, Konongo, Kumasi, Mampong, Nalerigu, Navrongo, New Tafo Akim, Nkawkaw, Nkoranza, Nsawam, Obuasi, Salaga, Savelugu, Somanya, Suhum, Sunyani, Takoradi [Sekondi-Takoradi], Tamale, Techiman, Wa, Walewale, Wenchi, Winneba, Yeji, Yendi
Guinea	Banankoro, Boké, Conakry, Faranah, Fria, Guéckédou, Kamsar, Kankan, Kindia, Kissidougou, Labé, Macenta, Mamou, Nzérékoré, Sangarédi, Siguiri, Sinko
Gambia	Brikama, Farafenni, Serrekunda, Yundum
Guinea-Bissau	Bafatá, Bissau, Gabú
Kenya	Bungoma, Busia, Dadaab, El Wak, Eldoret, Embu, Free Area, Garissa, Hagadera Refugee Camp, Isebania, Kakamega, Kakuma, Kiambu, Kilifi, Kimilili, Kisii, Kisumu, Kitale, Kitengela, Machakos, Malindi, Mandera, Meru, Molo, Mombasa, Mtwapa, Nairobi, Naivasha, Nakuru, Narok, Ndenderu, Ngong, Nyahururu, Nyeri, Ongata Rongai, Ruaka, Ruiru, Thika, Ukunda, Wajir
Liberia	Buchanan, Ganta, Gbarnga, Kakata, Monrovia
Lesotho	Maseru
Madagascar	Ambatolampy Tsimahafotsy, Ambohidrabiby, Andoany, Antananarivo, Antsirabe, Mahajanga, Manakara, Maroantsetra, Toliara
Mali	Bamako, Bougouni, Gao, Kati, Kayes, Kita, Koutiala, Mopti, Niono, San, Ségou, Sénou, Sikasso, Socoura, Timbuktu, Virage de Dioila
Mozambique	Alto Molócue, Beira, Caia, Catandica, Chibuto, Chimoio, Chiure-Sede, Cuamba, Dondo, Gorongosa, Gurue, Iapala, Inhambane, Lichinga, Maganja, Malema, Manga, Maputo, Marrupa, Massinga, Maxixe, Messica, Milange, Moatize, Mocímboa da Praia, Mocuba, Moma, Monapo, Montepuez, Morrumbala, Nacala, Namacurra, Nametil, Namialo, Nampula, Nhamatanda, Nicoadala, Quelimane, Pemba, Ribaue, Tete, Xai-Xai
Mauritania	Kaédi, Kiffa, Nouadhibou, Nouakchott, Rosso Sénégal
Mauritius	Port Louis
Malawi	Blantyre, Likuni, Lilongwe, Limbe, Mangochi, Mchinji, Mzuzu, Zomba
Namibia	Walvis Bay, Windhoek

Niger	Agadez, Aguié, Baléyara, Birni N'Konni, Diffa, Dogondoutchi, Dosso, Filingué, Galmi, Gaya, Gazaoua, Guidan Roumdji, Madaoua, Magaria, Maradi, N'Guigmi, Niamey, Tahoua, Tanout, Tchadoua, Téra, Tessaoua, Tibiri, Tillabéri, Zinder
Nigeria	Abaji, Abakaliki, 0, Abeokuta, Abiriba, Achara Ndiagu Omegio, Adikpo, Ado, Ado Ekiti, Agaie, Agbor, Agenebode, Ago Are, Ago-Iwoye, Agwa, Aiyete, Akabuka, Akugba, Akure, Akwanga, Alesa, Amaba, Amaigbo, Amakofia, Anchau, Ankpa, Aramoko-Ekiti, Argungu, Asaba, Ata, Auchi, Avodim, Awak, Awala, Awbere, Awgu, Awka, Ayangba, Azare, Badagry, Baga, Bagudo, Bajoga, Barakin Gangare, Batsari, Bauchi, Bela, Benin City, Biantubu, Bichi, Bida, Biliri, Birnin Kebbi, Birnin Kudu, Biu, Bodinga, Bodo, Bokkos, Bonny, Bori, Brass, Bugama, Buni Yadi, Bununu Dass, Bunza, Bwari, Calabar, Dakingari, Dakri, Damask, Damaturu, Damban, Dambarta, Damboa, Daura, Dawaki Kudu, Deba Kowa, Dengi, Dikwa, Dirinbaji, Djibia, Doka, Doka Ashafa, Dukku, Dutse, Ebute Irele, Ede, Ediene, Effon Alaiye, Egbe, Egosi, Ejigbo, Eket, Ekogboro, Ekpoma, Elele, Elu, Emure, Enugu, Enugu-Ezike, Enwan, Epe, Erin-osun, Eripa, Eruwa Titun, Funtua, Gamawa, Gashua, Gaya, Gboko, Gbongan, Geidam, Gembu, Giade, Gombe, Gombi, Goniri, Goronyo, Gubio, Gulak, Gumel, Gummi, Gusau, Gwadabawa, Gwagwalada, Gwarzo, Gwolong, Gwoza, Hadejia, Ibadan, Ibi, Ibiaku Ikot Ukpong, Idah, Idanre, Idembia, Idiroko, Ido Ekiti, Ife, Igbara-Odo, Igbe, Igbeti, Igbo Ora, Igboho, Ijagbo Offa, Ijebu-Igbo, Ijebu-Ode, Ijero-Ekiti, Ikerre, Ikire, Ikole, Ikolo, Ikom, Ikorodu, Ikot Akpanata, Ikot Ekpene, Ikot Ide, Ila Orangun, Ilaro, Ilawe-Ekiti, Ile Oluji, Ilero, Ilesa, Ilishan, Ilorin, Imorun, Inisa, Iragbiji, Irri, Isa, Isanlu Mopo, Isarun, Ise, Iseyin, Ishara, Ishiagu, Itaja, Iwere, Iwo, Jada, Jahun, Jakusko, Jalingo, Jaudiri, Jega, Jemma'are, Jimeta, Jos, Kabba, Kadafa, Kaduna, Kafanchan, Kagoro, Kaiama, Kaltungo, Kamba, Kano, Katagum, Katsina, Katsina Ala, Katsiro, Kauran Yankwani, Kaura-Namoda, Kazaure, Keffi, Kishi, Koi, Koko, Koko Town, Kontagora, Kpam, Kpeyi, Krakrama, Kuje, Lafia, Lafiagi, Lagos, Lakuwe, Langtang, Lawmu Umunze, Lokoja, Madagali, Madalla, Mafara, Magagindoke, Maiduguri, Maigatari, Maji, Makurdi, Malumfashi, Mara-Mawa, Mashi, Masuri, Maturrumi, Maya Belwa, Meko, Michika, Minna, Misau, Mogho, Mongu Arna, Monguno, Mubi, Mutum Biyu, Nassarawan Eggon, New Bussa, Ngoshe, Nguru, Ningi, Nshebori, Nsukara Offot, Nsukka, Numan, Obinomba, Oboama Nguru, Obudu, Obukpa, Oburigbene, Ogbomosho, Ogharefe, Ogunrun-Ori, Ogwashi Uku, Ojaima, Oka-Akoko, Oke Atan, Okene, Okitipupa, Okrika, Okuku Lepuole, Okwuohia, Okwuzu, Omema, Omenama, Omoko, Omu Aran, Omuo-Obadore, Ondo, Onitsha, Onitu, Onne, Opaetensm, Ore, Orogwe, Oron, Osina, Osogbo, Otukpo, Otun, Ovwian, Owerre, Owerri, Owo, Owode, Oyigbo, Oyo, Ozizza, Ozoro, Ozu, Pategi, Port Harcourt, Potiskum, Rano, Ribah, Rijau, Ringim, Rubuchi, Sagamu, Saki, Salka, Samammiya, Samaru, Samunakar, Sangasumi, Sapele, Shellem, Shema, Shendam, Shinkafi, Shira, Sokoto, Song, Tafawa-Balewa, Takum, Tamaha, Tambawal, Tarzoho, Tsanyawa, Tuga Nama, Tukurwa, Uba, Uduagba, Ugep, Ughelli, Umu Lawlaw, Umuahia, Umundi, Umuokorola, Ungwan Maidawa, Ungwan Sarki, Ungwan Shekaro, Ungwan Tamowa, Uromi, Uyo, Vande Ikya, Wakama, Warri, Wase, Wudil, Wukari, Wurno, Yarogye, Yelwa, Yenagoa, Yola, Zaki Biam, Zango, Zaria, Zinna, Zuru
Réunion	Le Port, Le Tampon, Saint-André, Saint-Denis
Rwanda	Huye, Kabuga, Kigali, Muhanga, Musanze, Nyundo, Ruhango
Sudan	Abu Jibeha, Ad Da'ein, Ad-Damazin, ad-Damer, Al ʻAbbāsiyya, Al Hasahisa, Al Hilaliyah, Al Kamilin, Al Managil, Al Quwaysi, Al Rahad, Al Uk, Al-Fashir, Al-Qadarif, Al-Ubayyid, Atbara, Babanusah, Baqayr al Quddami, Barah, Buram, Dilling, Dongola, Ed Dueim, El Hawata, El Suki, En Nahud, Er Roseires, For Baranga, Geneina, Ghaliya, Giad Industrial Complex, Jebel Aulia, Kaduqli, Kas, Kassala, Kebkabiya, Khartoum, Khashm El Girba, Kosti, Mazrub, Mellit, Muglad, Murnei, New Halfa, Nyala, Port Sudan, Qurayshah, Rabak, Rufaah, Saraf `Umrah, Sawakin, Sennar, Shendi, Sifeiya, Singa, Sinkāt, Tandalti, Umm Kadadah, Umm Ruwaba, Wad Madanī, Wad Rawah, Zalingei, أش شلال
Senegal	Bambey, Bignona, Dagana, Dahra Djoloff, Dakar, Darou Mousti, Diourbel, Fatick, Gossas, Goudomp, Guinguinéo, Kaffrine, Kaolack, Kedougou, Kolda, Koungheul, Louga, Madina

	Gounass, MBour, Podor, Richard-Toll, Saint-Louis, Sédhiou, Tambacounda, Thiès, Tivaouane, Touba, Vélingara, Ziguinchor
Sierra Leone	Bo, Daru, Freetown, Kenema, Koidu Town, Mahera, Makeni, Mile 91, Waterloo
Somalia	Baidoa, Barawa, Beledweyne, Berbera, Borama, Bosaso, Burao, Buurhakaba, Dara Salaam, Dhuusamareeb دوسمريب, Erigavo, Galkayo, Garoowe, Hargeisa, Kismayo, Las Anod, Merca, Mogadishu, Qardho City, Qoryooley, Xawo Tako
South Africa	Atlantis, Azaadville, Bethlehem, Bloemfontein, Botshabelo, Botshabelo Rural, Bronville, Cape Town, Centurion, Daveyton, De Rust Caravan Park, Diepsloot, Durban, East London, Edendale, eGobhoza, eHlau-Hlau, Emalahleni, eMbalenhle, Ermelo, Evaton, Ezakheni, Ga-Rankuwa, George, Johannesburg, Jouberton, Khutsong, Kimberley, Klipgat, Komani (Queenstown), Kroonstad, Kutlwanong, KwaMhlanga, KwaNobuhle 1, Lenasia, Lenasia South, Lilian Ngoyi Village, Mafikeng, Makhanda (Grahamstown), Mankweng, Middelburg, Midrand, Mnandi A.H., Modderspruit, Mokopane, Mossel Bay, Mpumalanga, Naas, Osizweni, Oudtshoorn, Paardekraal, Paarl, Phuthaditjhaba, Pietermaritzburg, Polokwane, Port Elizabeth, Potchefstroom, Pretoria, Rustenburg, Salubindza, Sasolburg, Sikhalasenkosi, Somerset West, Standerton, Stanger, Stellenbosch, Stesa AH, Tongaat, Tsakane, Uitenhage, Uitkomsdal, Upington, Vanderbijlpark, Vosman, Wells Estate, Wheielers farm settlement, Worcester
South Sudan	Akon, Aweil, Bor, Juba, Kuajok, Malakal, Malualkon, Nimule, Raja, Renk, Rumbek, Torit, Wau, Yambio, Yei
São Tomé and Príncipe	São Tomé
Togo	Aného, Anié, Atakpamé, Bassar, Blitta-Gare, Dapaong, Kara, Kpalimé, Lomé, Notsé, Sansanné-Mango, Sokodé, Sotouboua, Tchamba, Tsévié
Tanzania	Arusha, Babati, Bukala, Bukoba, Bunda, Dodoma, Geita, Ifakara, Igunga, Iwambi, Kahama, Karatu, Katoro, Kilima Hewa, Kyela, Makambako, Mbeya, Mirerani, Morogoro, Moshi, Mpanda, Mtwara, Murubona, Musoma, Mwanza, Nansio, Ndiuka, Nzega, Picha Ya Ndege, Shinyanga, Singida, Songea, Sumbawanga, Tabora, Tanga, Tarime, Vwawa, Zanzibar City
Uganda	Amagoro B Central, Arua, Busesa, Entebbe, Fort Portal, Gulu, Hoima, Iganga, Jinja, Kampala, Kasese, Katikati, Kayanja, Koboko, Lira, Lugazi, Masaka, Matugga, Mbale, Mbarara, Mityana, Mubende, Opuyo
Western Sahara	Boujdour, Dakhla
Zambia	Chililabombwe, Chingola, Chinsali, Chipata, Choma, Isoka, Kabwe, Kafue, Kalomo, Kaoma, Kapiri Mposhi, Kasama, Kitwe, Livingstone, Luanshya, Lundazi, Lusaka, Luwingu, Maamba, Mansa, Mazabuka, Mbala, Mkushi, Mongu, Monze, Mpika, Mpulungu, Mufulira, Mumbwa, Mwinilunga, Nchelenge, Ndola, Petauke, Samfya, Serenje, Solwezi, Tunduma, Zambezi
Zimbabwe	Bindura, Bulawayo, Chakari, Chegutu, Chinhoyi, Chitungwiza, Chizhanje, Glenclova, Gweru, Harare, Kadoma, Kwekwe, Marondera, Masvingo, Mbizo, Mutare, Norton, Ruwa, Triangle

APPENDIX C

This appendix provides details of the Settlement Extent dataset (Center for International Earth Science Information Network (CIESIN), Columbia University; Flowminder Foundation; United Nations Population Fund (UNFPA); WorldPop, University of Southampton, 2020) for each country, including the dataset DOI.

ISO3	Country, Territory or Dependency	Dataset Version	DOI
AGO	Angola	01	https://doi.org/10.7916/d8-pc2y-f224
BDI	Burundi	01	https://doi.org/10.7916/d8-963j-wp65
BEN	Benin	01	https://doi.org/10.7916/d8-b84x-g695
BFA	Burkina Faso	01	https://doi.org/10.7916/d8-h47k-8637
BWA	Botswana	01	https://doi.org/10.7916/d8-r3ey-4x75
CAF	Central African Republic	01	https://doi.org/10.7916/d8-y2ax-p859
CIV	Côte d'Ivoire	01	https://doi.org/10.7916/d8-b3xv-y048
CMR	Cameroon	01	https://doi.org/10.7916/d8-pc2y-f224
COD	Democratic Republic of the Congo	01	https://doi.org/10.7916/d8-cpry-wv37
COG	Comoros	01	https://doi.org/10.7916/d8-pmfj-9j47
COG	Republic of Congo	01	https://doi.org/10.7916/d8-0x0f-wc48
CPV	Cape Verde	01	https://doi.org/10.7916/d8-v430-5w77
DJI	Djibouti	01	https://doi.org/10.7916/d8-k2p6-1e60
ERI	Eritrea	01	https://doi.org/10.7916/d8-q1sx-gb54
ESH	Western Sahara	01	https://doi.org/10.7916/d8-m2yb-q916
ETH	Ethiopia	01	https://doi.org/10.7916/d8-y936-w110
GAB	Gabon	01	https://doi.org/10.7916/d8-hay7-2n57
GHA	Ghana	01	https://doi.org/10.7916/d8-nsa3-0f74
GIN	Guinea	01	https://doi.org/10.7916/d8-zcrh-cm17
GMB	Gambia	01	https://doi.org/10.7916/d8-7wzh-5792
GNB	Guinea-Bissau	01	https://doi.org/10.7916/d8-4z41-9d73
GNQ	Equatorial Guinea	01	https://doi.org/10.7916/d8-s7ze-ya13
KEN	Kenya	01	https://doi.org/10.7916/d8-3tn0-1686
LBR	Liberia	01	https://doi.org/10.7916/d8-xeax-6h85
LSO	Lesotho	01	https://doi.org/10.7916/d8-5n6q-jt71
MDG	Madagascar	01	https://doi.org/10.7916/d8-t9xn-k215
MLI	Mali	01	https://doi.org/10.7916/d8-pejd-bf71
MOZ	Mozambique	01	https://doi.org/10.7916/d8-v3zn-yf15
MRT	Mauritania	01	https://doi.org/10.7916/d8-hzv3-f435
MUS	Mauritius	01	https://doi.org/10.7916/d8-mzqk-th30
MWI	Malawi	01	https://doi.org/10.7916/d8-n4yb-5a62
NAM	Namibia	01	https://doi.org/10.7916/d8-45tz-em54
NER	Niger	01	https://doi.org/10.7916/d8-vp86-0y10
NGA	Nigeria	01	https://doi.org/10.7916/d8-7778-9948
REU	Réunion	01	https://doi.org/10.7916/d8-6np8-f730
RWA	Rwanda	01	https://doi.org/10.7916/d8-bmw0-x763
SDN	Sudan	01	https://doi.org/10.7916/d8-bt9v-wk47
SEN	Senegal	01	https://doi.org/10.7916/d8-x8gh-ms26
SLE	Sierra Leone	01	https://doi.org/10.7916/d8-p5mw-9282
SOM	Somalia	01	https://doi.org/10.7916/d8-4n5t-wd59

SSD	South Sudan	01	https://doi.org/10.7916/d8-67xa-ta47
STP	São Tomé and Príncipe	01	https://doi.org/10.7916/d8-nc1k-4z96
SWZ	Eswatini	01	https://doi.org/10.7916/d8-7etg-x863
TCD	Chad	01	https://doi.org/10.7916/d8-7gwt-nc47
TGO	Togo	01	https://doi.org/10.7916/d8-qdxc-0c73
TZA	Tanzania	01	https://doi.org/10.7916/d8-ve7a-dm77
UGA	Uganda	01	https://doi.org/10.7916/d8-s1yg-pc20
ZAF	South Africa	01	https://doi.org/10.7916/d8-g5mw-3b13
ZMB	Zambia	01	https://doi.org/10.7916/d8-wadt-6z78
ZWE	Zimbabwe	01	https://doi.org/10.7916/d8-ryrv-dk72

APPENDIX D

This appendix provides details of the OSM data, used in creating the spatial units (polygons).

Feature type	Tag	Source
Roads and paths	highway = *	geofabrik.de
Railways	railway = rail	geofabrik.de
Waterways	waterway = * water = * natural = bay	geofabrik.de
Industrial	landuse = industrial	geofabrik.de
Cemetery	landuse = cemetery	geofabrik.de
Military	landuse = military	geofabrik.de
Golf course	leisure = golf_course	geofabrik.de
Park	leisure = park	geofabrik.de
Wetland	natural = wetland	geofabrik.de
Water	natural = water	geofabrik.de
Quarry	landuse = quarry	geofabrik.de
Mine	industrial = mine	QuickOSM plugin
Airport	aeroway = aerodrome	QuickOSM plugin
University	amenity = university	geofabrik.de
Hospital grounds	amenity = hospital	geofabrik.de
Landfill	landuse = landfill	QuickOSM plugin
Reservoir	landuse = reservoir	geofabrik.de
Basin	landuse = basin	QuickOSM plugin
Residential	landuse = residential	geofabrik.de

APPENDIX E

This appendix includes examples of specific locations in which potential issues with the ease of social distancing index datasets have been identified through our internal review process. Locations are described with coordinates provided in terms of latitude and longitude (WGS84).

- **Angola (AGO)**: There are grid cells in the input population raster dataset which incorrectly have 0 population, most likely due to misclassification of grid cells in the waterbody mask used in creating the population raster. This results in an inaccurate 0 value of the *POPscore* variable and has been observed for several areas within the coastal city of Cabinda, for example at 12.179°E, 5.578°S and 12.175°E, 5.611°S.

- **Democratic Republic of the Congo (COD)**: There are grid cells in the input population raster dataset which have 0 population despite being within a populated urban area. This results in an inaccurate 0 value of the *POPscore* variable. The southern part of Kolwezi, south of 10.710°S, is known to be affected by this data issue.

- **Ghana (GHA)**: There are some locations where buildings are missing from the building footprint dataset, likely due to cloud cover. An example of this is west of Accra, near to Kasoa, covering an area of approximately 3km x 0.8km, centred on 0.419°W, 5.527°N.

- **Réunion (REU)**: Covered structures that are not necessarily enclosed buildings may be included in the input building footprint dataset, used in calculating the *BUILTscore* variable. For example, some of the highest index values in Réunion are for a spatial unit covering a shopping centre and car park on the outskirts of Le Port (55.308°E, 20.957°S). Covered structures intended to provide shaded parking for cars, contribute to a high *BUILTscore* value.

- **South Africa (ZAF)**: There are grid cells in the input population raster dataset which have 0 population, likely due to recent urban expansion. This results in an inaccurate 0 value of the *POPscore* variable. An area in south-west Mankweng is affected by this, centred on 29.689°E, 23.899°S.

- Urban centres and their spatial extents are based on the GHS Urban Centre Database 2015 v1.2 and GHS-SMOD v2.0 respectively. It has been observed that in some instances, the urban extents derived from GHS-SMOD v2.0 do not cover the full extent of the urban area visible on recent satellite imagery, including for Bulawayo, **Zimbabwe (ZWE)** and Banjul, **The Gambia (GMB).** In other instances, urban centres are not included in the GHS Urban Centre Database or are not confirmed as true positives. As the ease of social distancing index spatial extents are based on the GHS datasets, such locations will not be included in the ease of social distancing index dataset. Known omitted locations include Laayoune, **Western Sahara (ESH)**, and Lobamba and Mbabane, **Eswatini (SWZ).**