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DOCUMENTATION FOR THE GREATER BOSTON URBAN LAND COVER AND URBAN HEAT ISLAND DATABASE

Overview

This document describes the types of land coverage and indicators of the urban heat island effect within the Boston metropolitan region. The database was constructed by Andrew Trlica of Boston University using a series of publicly available and novel spatial datasets. Its construction was partially funded by the Boston Area Research Initiative's Research Seed Grant program. Details on the preparation of these data, their provenience, and final analysis are available in the forthcoming article: "Albedo, land cover, and daytime surface temperature variation across an urbanized landscape", to be published in the journal *Earth's Future.**

The database consists of two data files: a geospatial raster stack, GeoTIFF file (.tif) and a corresponding data table file (.csv) without spatial information. The raster stack contains nine layers (detailed below) that correspond with the variables found in the data table file. All data are georeferenced using the NAD83 datum and projected to the UTM coordinate reference system in zone 19N (EPSG code 26919). All data has also been downscaled to the native Landsat 30m grid, using nearest-neighbor resampling. All data are readable by most commonly available GIS applications.

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1. Description of Data

This section details the data layers found within the raster stack file (NOTE: each layer's corresponding data table variable mnemonic is listed in parentheses after the name of the data layer). While some of these layers were constructed by the authors using standard geospatial data sources (i.e. Landsat), others were directly acquired from publicly available sources (i.e. MassGIS). The specific sources used for each layer are mentioned within their individual descriptions.

1.2 Description of Layers (Variables)

1.2.1 Land Use and Urban Heat Island Effect Indicators

- *Albedo* (*alb*) - measures surface reflectivity with darker surfaces reporting lower albedo scores (0 indicating no light reflected) and areas with brighter surfaces reporting higher albedo scores (1 indicating 100% of the light reflected). Albedo scores are often recorded as a decimal (e.g. 0.017). This layer was created for this study using data derived from combined Landsat (30 m) and MODIS (500m) observations in summer intervals (June 1–August 31) from 2003 to 2008 to produce 30m raster cells. See Shuai et al., (2011) for retrieval details.[1]

- *Tree canopy fraction* (*can*) - measures the percent of tree canopy coverage for 30m raster cells. A value of 0 (or 0%) indicates no tree canopy coverage while a value of 100 (or 100%) indicates full tree canopy coverage in the 30m raster cell. These data are derived from the National Land Cover Database's "NLCD 2011 USFS Tree Canopy cartographic" layer.[2] See Homer et al., (2015) for more information.[3]

- *Impervious surface fraction* (*isa*) - measures the percent of impervious surface coverage per 30m raster cell. A value of 0 (or 0%) indicates no impervious surfaces while a value of 100 (or 100%) indicates full impervious surface coverage in the 30m raster cell. ISA scores are often recorded as a decimal (e.g. 0.11). These data are derived from the MassGIS "Impervious Surface" datalayer.[4] These data were upscaled from original 1m grids using the mean total fraction per 30m grid cell.

- *Population density* (*pop*) - measures the number of persons per squared kilometer (using 1km raster cells). Ranges from 0 to 40,729. These data are derived from LandScan (2013) gridded population density dataset.[5]

- *Land surface temperature* (*lst*) - measures the land surface temperature in degrees Celsius (°C) per 30m raster cell. Values range from 6.8°C to 57.68°C. Data were

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[1] Shuai, Y., J.G. Masek, F. Gao and C.B. Schaaf. 2011. An algorithm for the retrieval of 30-m snow-free albedo from Landsat surface reflectance and MODIS BRDF. Rem. Sens. Env. 115: 2204–2216.

[2] **https://www.mrlc.gov/nlcd11_data.php**

[3] Homer, C.G., J.A., Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81(5): 345–354.

[4] http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/imperviousssurface.html

[5] http://web.ornl.gov/sci/landscan/

prepared for this study using Landsat 5 TM 120m and Landsat 7 ETM+ 60m observations in summer intervals (June 1–August 31) from 2002 to 2008. These data were downscaled by the author from original 50m and 120m grids of thermal data. See Melaas et al., (2016) for retrieval details.[6]

- *Land Use/Land cover* (*LUfull*) - indicates the land use classification for the 30m raster cell. Values range from 1-40 based on the MassGIS "Land Use 2005" datalayer (shapefile)[7] (SEE TABLE 1 IN APPENDIX FOR CLASSIFICATION CODE). Pixel classification determined as the class with greatest combined area in each 30m grid cell.

1.2.2 Geographic Indicators

- *Town boundaries* (*towns*) indicates the city or town where the 30m raster cell is located. Values range from 1-350 and are derived from the MassGIS "Community Boundaries (Towns)" datalayer (shapefile).[8] Values correspond to "TOWN_ID" field in the corresponding shapefile (SEE TABLE 2 IN APPENDIX FOR CITY/TOWN ID DESCRIPTIONS).

- *Census-Designated Places* (*CDP*) indicates whether the raster cell is located in a census-designated place (CDP). Values range from 0 (indicating outside a CDP) to 1 (indicating inside a CDP). These data are derived from the U.S. Census "Cartographic Boundary Shapefiles – Places (Incorporated Places and Census Designated Places)" 2010 Census files for Massachusetts (shapefile).[9]

- *Area of Interest or Study Area* (*AOI*) indicates whether the raster cell is located in the study area (AOI). Values range from 0 (indicating outside the AOI) to 1 (indicating inside the AOI). Data are derived from MassGIS "Community Boundaries (Towns)" and "Massachusetts Department of Transportation (MassDOT) Roads" EOTMAJROADS_RTE_MAJOR (shapefiles).[10]

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[6] Melaas, E.K., J.A. Wang, D.L. Miller and M.A. Friedl. 2016. Interactions between urban vegetation and surface urban heat islands: A case study in the Boston metropolitan region. Env. Res. Lett. 11: 054020.

[7] http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/lus2005.html

[8] **http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/townsurvey.html**

[9] https://www.census.gov/geo/maps-data/data/cbf/cbf_place.html

[10] http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/eotroads.html

APPENDIX

TABLE 1
Land use code descriptions. For further details on land use/cover classifications, see: (http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/lus2005.html.)

Code	Land Use Description
1	Cropland
2	Pasture
3	Forest
4	Non-Forested Wetland
5	Mining
6	Open Land
7	Participation Recreation
8	Spectator Recreation
9	Water-Based Recreation
10	Multi-Family Residential
11	High Density Residential
12	Medium Density Residential
13	Low Density Residential
14	Saltwater Wetland
15	Commercial
16	Industrial
17	Transitional
18	Transportation
19	Waste Disposal
20	Water
23	Cranberry bog
24	Powerline/Utility
25	Saltwater Sandy Beach
26	Golf Course
29	Marina
31	Urban Public/Institutional
34	Cemetery
35	Orchard
36	Nursery
37	Forested Wetland
38	Very Low Density Residential
39	Junkyard
40	Brushland/Successional

TABLE 2
City/Town ID codes and corresponding town names for Boston study region.

ID	TOWN	ID	TOWN	ID	TOWN
1	ABINGTON	142	HULL	258	SALEM
2	ACTON	144	IPSWICH	259	SALISBURY
7	AMESBURY	145	KINGSTON	262	SAUGUS
9	ANDOVER	146	LAKEVILLE	264	SCITUATE
10	ARLINGTON	149	LAWRENCE	266	SHARON
14	ASHLAND	155	LEXINGTON	269	SHERBORN
18	AVON	157	LINCOLN	274	SOMERVILLE
23	BEDFORD	158	LITTLETON	277	SOUTHBOROUGH
25	BELLINGHAM	160	LOWELL	284	STONEHAM
26	BELMONT	163	LYNN	285	STOUGHTON
28	BERLIN	164	LYNNFIELD	286	STOW
30	BEVERLY	165	MALDEN	288	SUDBURY
31	BILLERICA	166	MANCHESTER	291	SWAMPSCOTT
34	BOLTON	167	MANSFIELD	293	TAUNTON
35	BOSTON	168	MARBLEHEAD	295	TEWKSBURY
37	BOXBOROUGH	170	MARLBOROUGH	298	TOPSFIELD
38	BOXFORD	171	MARSHFIELD	305	WAKEFIELD
40	BRAINTREE	174	MAYNARD	307	WALPOLE
42	BRIDGEWATER	175	MEDFIELD	308	WALTHAM
44	BROCKTON	176	MEDFORD	310	WAREHAM
46	BROOKLINE	177	MEDWAY	314	WATERTOWN
48	BURLINGTON	178	MELROSE	315	WAYLAND
49	CAMBRIDGE	180	MERRIMAC	317	WELLESLEY
50	CANTON	181	METHUEN	320	WENHAM
51	CARLISLE	182	MIDDLEBOROUGH	322	WEST BRIDGEWATER
52	CARVER	184	MIDDLETON	324	WEST NEWBURY
56	CHELMSFORD	185	MILFORD	328	WESTBOROUGH
57	CHELSEA	187	MILLIS	330	WESTFORD
65	COHASSET	189	MILTON	333	WESTON
67	CONCORD	196	NAHANT	335	WESTWOOD
71	DANVERS	198	NATICK	336	WEYMOUTH
73	DEDHAM	199	NEEDHAM	338	WHITMAN
78	DOVER	205	NEWBURY	342	WILMINGTON
82	DUXBURY	206	NEWBURYPORT	344	WINCHESTER
83	EAST BRIDGEWATER	207	NEWTON	346	WINTHROP
88	EASTON	208	NORFOLK	347	WOBURN
92	ESSEX	210	NORTH ANDOVER	350	WRENTHAM
93	EVERETT	213	NORTH READING		
99	FOXBOROUGH	218	NORTON		
100	FRAMINGHAM	219	NORWELL		
101	FRANKLIN	220	NORWOOD		
105	GEORGETOWN	229	PEABODY		
107	GLOUCESTER	231	PEMBROKE		
116	GROVELAND	238	PLAINVILLE		
118	HALIFAX	239	PLYMOUTH		
119	HAMILTON	240	PLYMPTON		
122	HANOVER	243	QUINCY		
123	HANSON	244	RANDOLPH		
125	HARVARD	245	RAYNHAM		
128	HAVERHILL	246	READING		
131	HINGHAM	248	REVERE		
133	HOLBROOK	250	ROCHESTER		
136	HOLLISTON	251	ROCKLAND		
139	HOPKINTON	252	ROCKPORT		
141	HUDSON	254	ROWLEY		