Indicator specification:

Groundswell collection of geographical and population health indicators

Unique Property Reference Number (UPRN) indicator: Multi-year satellite measures (UPRN_5_2)

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Overview

Indicator title

Unique Property Reference Number (UPRN) indicator: Multi-year satellite measures (UPRN _5_2)

Indicator family name

Unique Property Reference Number

Descriptor Plain English description

This indicator provides multi-year (2020-2025) satellite derived green and blue space indices at UPRN level.

Technical description

This indicator provides satellite derived green and blue space indices at UPRN level. The following indices were estimated:

- Normalised Difference Vegetation Index (NDVI)
- Enhanced Vegetation Index (EVI)
- Normalised Difference Water Index (NDWI)

The indicators were generated using remote sensing / satellite imagery. They are based on 300m buffers around each UPRN (i.e., to represent the broader area characteristics, since one pixel may capture only the roof of a building), although one can change the size of the buffer during the process. The reduce the amount of computation required, the actual calculations were done at TOID (Topographic Identifier, as defined by the Ordnance Survey: https://www.ordnancesurvey.co.uk/products/os-open-toid) level, then mapped to UPRNs.

Unique Identifier

UPRN_5_2

Construction

Data sources

There are two key data sources used here: (1) Household locations, and (2) Satellite imagery.

1. **Household locations**

The target household identifiers that we want to compute the indicators for are Unique Property Reference Numbers (UPRNs). UPRNs are unique identifiers for all unique properties across Great Britain. Data were downloaded on 10th December 2025 using the Office for National Statistic's open UPRN directory. The resource is based on Ordnance Survey's 'AddressBase' data product and includes a list of all UPRNs and their geographical location (Geographic Reference System: OSGB 1936, 27700). The population of interest for

our metric is Cheshire and Merseyside. An additional ONS lookup table linked to each UPRN was used to subset only UPRNs that fall within the Local Authorities of Cheshire and Merseyside (Chester and Cheshire East, Cheshire West, Halton, Knowsley, Liverpool, Sefton, St. Helens, Warrington and Wirral). If you wanted to recreate our indicators for a different region, one would have to change this step in the code.

Using UPRNs makes the code computationally intensive and results in very large file sizes (especially once we calculate buffers for each point). To improve the time spent processing UPRNs, we initially compute the metrics for Topographic Identifiers (TOIDs) rather than UPRNs. UPRNs are nested within TOIDs, since UPRNs will give each unique property and TOIDs give the unique building. For example, a tower block or student halls accommodation will have many UPRNs for the same TOID/building (e.g., Crown Place student halls at the University of Liverpool (UK) have ~1200 UPRNs for a single TOID). Through using TOIDs, we reduce the number of computations on the assumption that they will be similar for all UPRNs (note: there will be some small differences where TOIDs have multiple entrances, but the differences should be negligible here). The result is that using TOIDs gives us a dataset which is 23% smaller than if we use UPRNs only. In the workflow described below, we first estimate each indicator for TOIDs within Cheshire and Merseyside (using the datasets described above), then link the TOID values back to UPRNs using an Ordnance Survey lookup table. If you are using the code for smaller regions of UPRNS, then you may not need to do this.

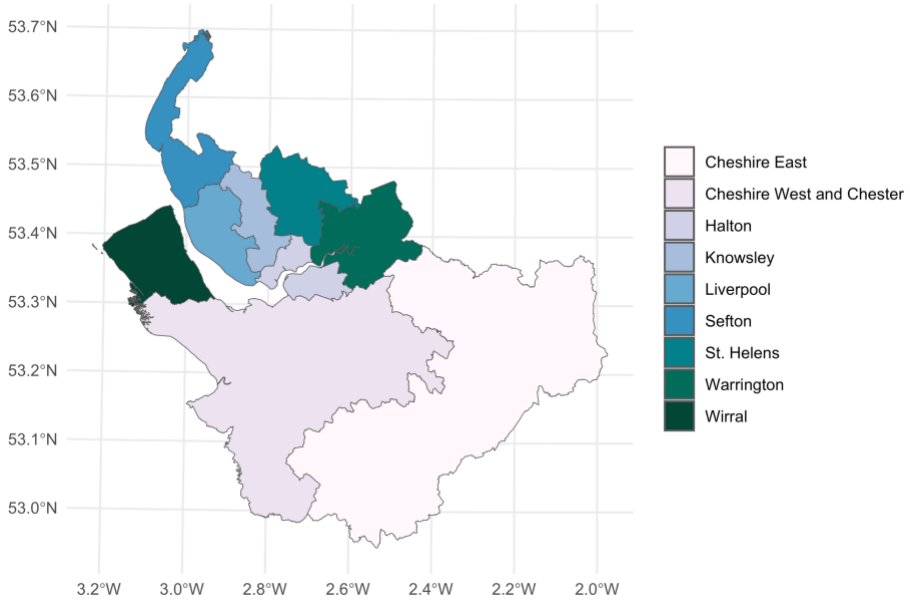

Figure 1. NHS Cheshire and Merseyside ICB region

2. Satellite imagery

We use Sentinel-2 imagery to estimate green and blue space metrics. Sentinel-2 is a satellite which has been providing remote sensing imagery data since 28th March 2017 and was selected since it has the highest resolution (10 metres) of all the available open satellite

datasets. One can accesses Sentinel-2 data via Google Earth Engine which is free to access for academic and not-for-profit organisations.

Working with satellite imagery brings its own challenges. Great Britain is a temperate climate that offers frequent cloudy or overcast days. To try and minimise this issue, we mask any detected clouds within the images so that they do not count towards the generation of indicators (since cloud values will give misleading estimates). A composite image is then compiled by taking the median value across the whole time period. If we wanted to take this further, we could have only used images where <= 20% of the image does not contain clouds too. To create multiple years (2020-2025) data here, we have used the time period of 1st May to 30th September - roughly the summer period. The final dates will be chosen to capture the spring/summer period where vegetation has grown and as it is peak, as well as to maximise the time period available to find suitable non-cloudy days of images. Once can easily adapt this time period in the code to what they need.

Methodology details and companion scripts can be found on the GitHub repository: https://github.com/groundswelluk/geographical_indicators

Presentation

Breakdowns

Time period

Longitudinal dataset (2020-2025) based on the Ordnance Survey Open UPRN product v2025.11.

Demographic

Not applicable

Geographic

Unique Property Reference Number (UPRN) level

Disclosure control

Not applicable. Whilst UPRNs can be used to identify unique properties, on their own they cannot be used to identify a particular individual.

Outputs:
UPRN_5_2_satellite_measures_cm_multiple_years.csv AND UPRN_5_2_satellite_measures_cm_multiple_years_with_coords.csv

Column name	Description

UPRN	Unique Property Reference Number as per the Ordnance Survey Open UPRN product v2025.11.
EVI_2025	Enhanced Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2025.
EVI_2024	Enhanced Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2024.
EVI_2023	Enhanced Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2023.
EVI_2022	Enhanced Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2022.
EVI_2021	Enhanced Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2021.
EVI_2020	Enhanced Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2020.
NDVI_2025	Normalised Difference Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2025.
NDVI_2024	Normalised Difference Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2024.
NDVI_2023	Normalised Difference Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2023.
NDVI_2022	Normalised Difference Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2022.
NDVI_2021	Normalised Difference Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2021.
NDVI_2020	Normalised Difference Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2020.
NDWI_2025	Normalised Difference Water Index (-1 to 1) for the following period: 1st May – 30th September 2025.
NDWI_2024	Normalised Difference Water Index (-1 to 1) for the following period: 1st May – 30th September 2024.
NDWI_2023	Normalised Difference Water Index (-1 to 1)

	for the following period: 1st May – 30th September 2023.
NDWI_2022	Normalised Difference Water Index (-1 to 1) for the following period: 1st May – 30th September 2022.
NDWI_2021	Normalised Difference Water Index (-1 to 1) for the following period: 1st May – 30th September 2021.
NDWI_2020	Normalised Difference Water Index (-1 to 1) for the following period: 1st May – 30th September 2020.
latitude (ONLY version with coords)	latitude of the UPRN, given in decimal degrees, where N is positive and S is negative.
longitude (ONLY version with coords)	longitude of the UPRN, given in decimal degrees, where E is positive and W is negative.

UPRN_5_2_EVI_multiple_years_recategorised.csv AND UPRN_5_2_EVI_multiple_years_recategorised_with_coords.csv

Column name	Description
UPRN	Unique Property Reference Number as per the Ordnance Survey Open UPRN product v2025.11.
EVI_2024	Enhanced Vegetation Index (-1 to 1) for the following period: 1st May – 30th September 2024, serve as the baseline.
EVI_2023	Recategorised Enhanced Vegetation Index (Positive and Negative) for the following period: 1st May – 30th September 2023, against to the baseline
EVI_2022	Recategorised Enhanced Vegetation Index (Positive and Negative) for the following period: 1st May – 30th September 2022, against to the baseline
EVI_2021	Recategorised Enhanced Vegetation Index (Positive and Negative) for the following period: 1st May – 30th September 2021, against to the baseline
EVI_2020	Recategorised Enhanced Vegetation Index (Positive and Negative) for the following period: 1st May – 30th September 2020, against to the baseline
latitude (ONLY version with coords)	latitude of the UPRN, given in decimal degrees, where N is positive and S is negative.

longitude (ONLY version with coords)	longitude of the UPRN, given in decimal degrees, where E is positive and W is negative.

Statistical Summary of Longitudinal Changes (2025 Baseline)

To support the longitudinal analysis of the Cheshire and Merseyside region, the mean and standard deviation (SD) of the actual magnitude of changes were calculated for each indicator relative to the 2025 baseline. The magnitude of change is defined as the absolute difference $\left(|Index_{year} - Index_{2025}|\right)$, representing the scale of shift in green and blue space regardless of direction.

Index	Year	Mean Magnitude of Change	Standard Deviation (SD)
EVI	2020	0.021	0.033
EVI	2021	0.021	0.029
EVI	2022	0.039	0.043
EVI	2023	0.033	0.036
EVI	2024	0.027	0.028
NDVI	2020	0.030	0.040
NDVI	2021	0.033	0.038
NDVI	2022	0.290	0.135
NDVI	2023	0.265	0.132
NDVI	2024	0.030	0.030
NDWI	2020	0.024	0.028
NDWI	2021	0.034	0.035
NDWI	2022	0.305	0.112
NDWI	2023	0.282	0.109
NDWI	2024	0.026	0.026

The results indicate that while environmental measures for Cheshire and Merseyside were highly stable in 2020, 2021, and 2024 , a significant deviation occurred during the 2022 and 2023 periods for NDVI and NDWI. This variance is primarily attributed to climatic sensitivity and the technical differences between indices. While the Enhanced Vegetation Index (EVI) is optimised to reduce atmospheric and soil background interference, the NDVI and NDWI are more sensitive to regional environmental anomalies, such as the distinct weather patterns (e.g., higher temperatures or drought conditions in 2022 and 2023) that altered vegetation 'greenness' and surface water levels more significantly than in other years.

Revision history

Version	Date	Summary of changes
2.00	2026-01-26	First release