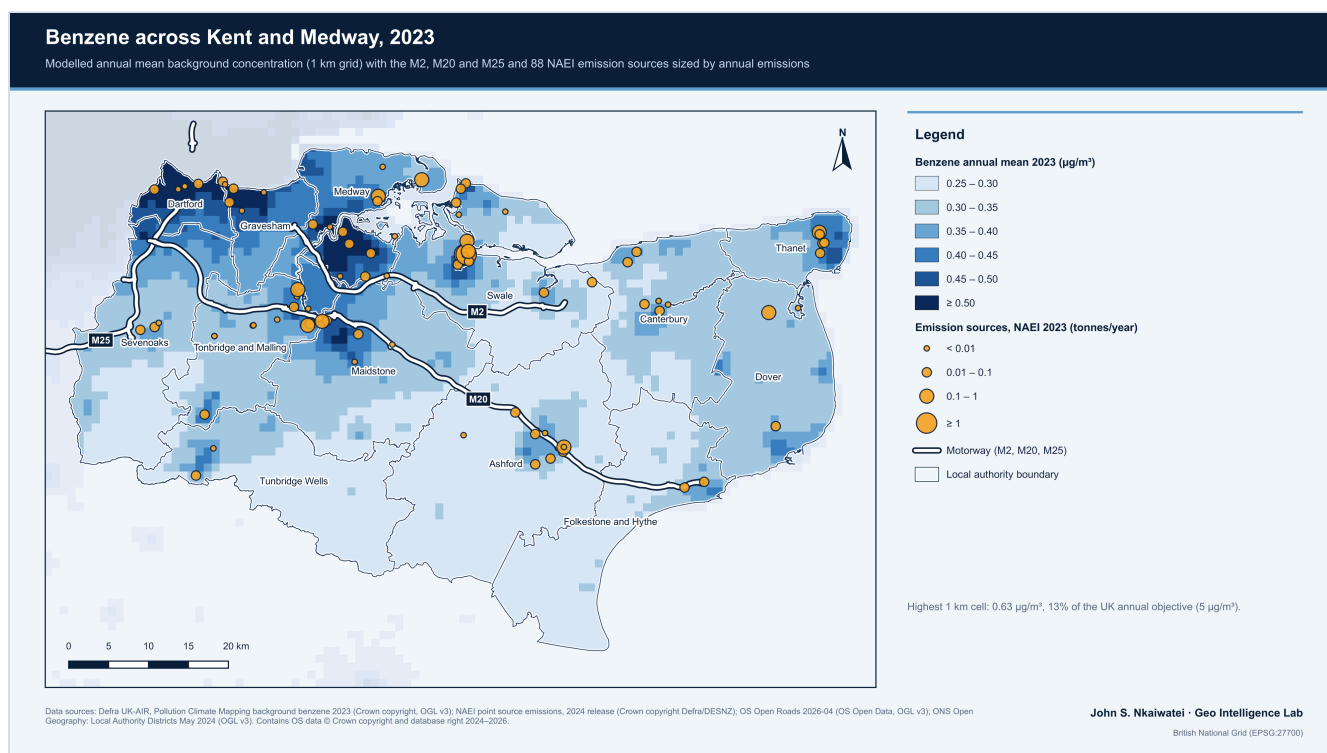


# Background benzene and the people who live with it

Kent and Medway, 2023: a reproducible exposure analysis from open UK data



**John S. Nkaiwatei**  
Geo Intelligence Lab

**Tools**  
QGIS 3.34, PyQGIS, Python

**Study area**  
12 Kent districts and  
Medway

**Date**  
October 2026

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## At a glance

Benzene causes leukaemia, and the WHO sets no level below which it is considered harmless. This study asks two things: **where in Kent and Medway is background benzene highest**, and **how many residents live in those places?**

**0.63**

**µg/m<sup>3</sup> peak 1 km cell**

13% of the UK annual objective and  
37% of the WHO reference level

**337,566**

**residents at or above 0.50 µg/m<sup>3</sup>**

18.2% of the population; 92% of them  
in three north-west authorities

**ρ = 0.11**

**emissions vs local concentration**

88 point sources released 12.3 t, but  
barely shape the map

### The short answer

Every part of the county sits far below the legal limit. The modelled annual mean runs from 0.25 to 0.63 µg/m<sup>3</sup>. The pattern is still uneven. Concentrations rise towards the Thames estuary and its towns, and Dartford averages 1.8 times the level of Ashford. The residents in the top band are clustered in Medway, Dartford and Gravesham. The large industrial emitters, such as the paper-mill power plants at Kemsley, do not line up with the highest cells. That points to traffic and the urban background, not single plants, as the main driver.

### What this project shows

- **Data engineering:** five public sources downloaded by script and logged with URL, date, SHA-256 and licence
- **Raster analysis:** converting a national CSV grid to a raster, clipping it, and area-weighted zonal statistics
- **Population exposure:** Census 2021 residents allocated through 5,734 Output Area centroids
- **Spatial statistics:** rank correlation between emitters and concentration, and threshold sensitivity
- **Cartography:** three print layouts in British National Grid with a shared class scheme
- **Reproducibility:** seven numbered PyQGIS and Python scripts rebuild every number and map from scratch

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## Finding 1 · Levels are low everywhere

No 1 km cell comes near a standard (see the overview map on the cover). The highest, in Dartford, reaches 0.63 µg/m<sup>3</sup>: about one-eighth of the UK objective of 5 µg/m<sup>3</sup> and just over a third of the WHO reference level of 1.7 µg/m<sup>3</sup>. The population-weighted mean for all 1,855,811 residents is 0.416 µg/m<sup>3</sup>. So the question is not whether Kent breaches a limit. It is where the relative burden falls, and on whom.

# Data and method

## Data sources

| Source                                   | What was used                                                                          | Licence                     |
|------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------|
| Defra UK-AIR, Pollution Climate Mapping  | Modelled background benzene, annual mean 2023, 1 km grid ( $\mu\text{g}/\text{m}^3$ )  | OGL v3.0                    |
| National Atmospheric Emissions Inventory | Benzene from point sources, 2023 (2024 release), tonnes/year                           | Crown copyright Defra/DESNZ |
| ONS Open Geography Portal                | Local Authority Districts (May 2024); Output Area population-weighted centroids (2021) | OGL v3.0                    |
| ONS Census 2021 via Nomis                | TS001 usual residents by Output Area                                                   | OGL v3.0                    |
| OS Open Roads                            | Motorways (M2, M20, M25), for map context                                              | OGL v3.0                    |

All layers are in British National Grid (EPSG:27700). Every download is logged in `raw/MANIFEST.csv` with its URL, retrieval date and SHA-256 checksum. Contains public sector information licensed under the Open Government Licence v3.0. Contains OS data © Crown copyright and database right 2024–2026.

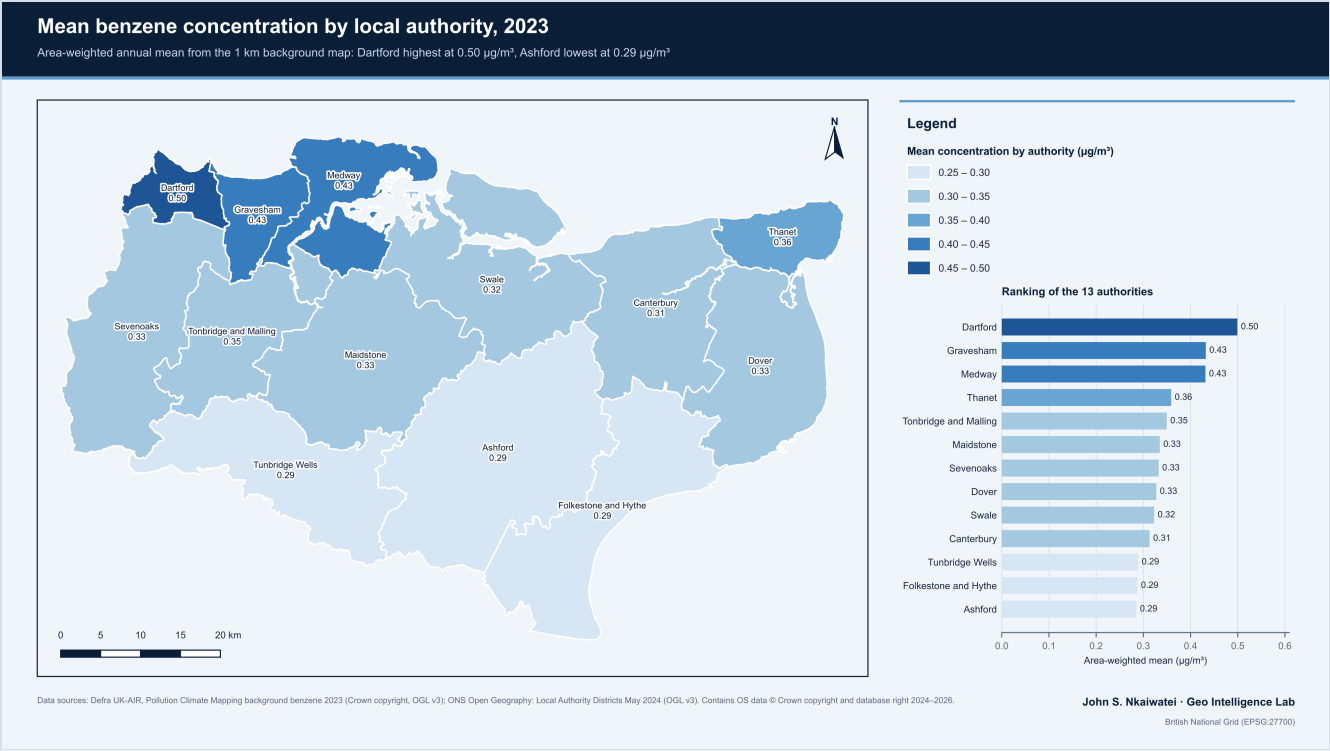
## Method

- 1. Build the surface.** The national 1 km PCM grid was converted to a raster and clipped to the 12 Kent districts and Medway. The PCM map was chosen over Defra's LAQM background maps because the LAQM benzene projections still rest on a 2001 base year.
- 2. Summarise by authority.** The grid was resampled to 100 m by nearest neighbour, which leaves values unchanged. Each authority's mean therefore weights every 1 km cell by the area it covers inside the boundary, not by whether its centre falls inside.
- 3. Allocate residents.** Each Output Area's 2021 usual residents took the value of the 1 km cell under its population-weighted centroid. Residents were then totalled by concentration class and authority.
- 4. Test the emitters.** Each NAEI site was given the concentration of its own cell. Spearman's rank correlation measures whether larger emitters sit in higher-concentration cells.

## Why not interpolate between emission sites?

Interpolating facility emissions (for example with IDW) produces a surface in tonnes per year spread across the land. That is not a concentration, and it ignores road traffic and the urban background, which dominate benzene in the UK. A modelled concentration surface answers the exposure question directly, and it can be compared with the emitters afterwards.

## Finding 2 · A clear gradient from the estuary to the Weald



Area-weighted means fall from 0.499 µg/m³ in Dartford to 0.285 µg/m³ in Ashford. The three Thames-side authorities lead clearly. The rural south and east, from the Weald to Romney Marsh, sit at the bottom.

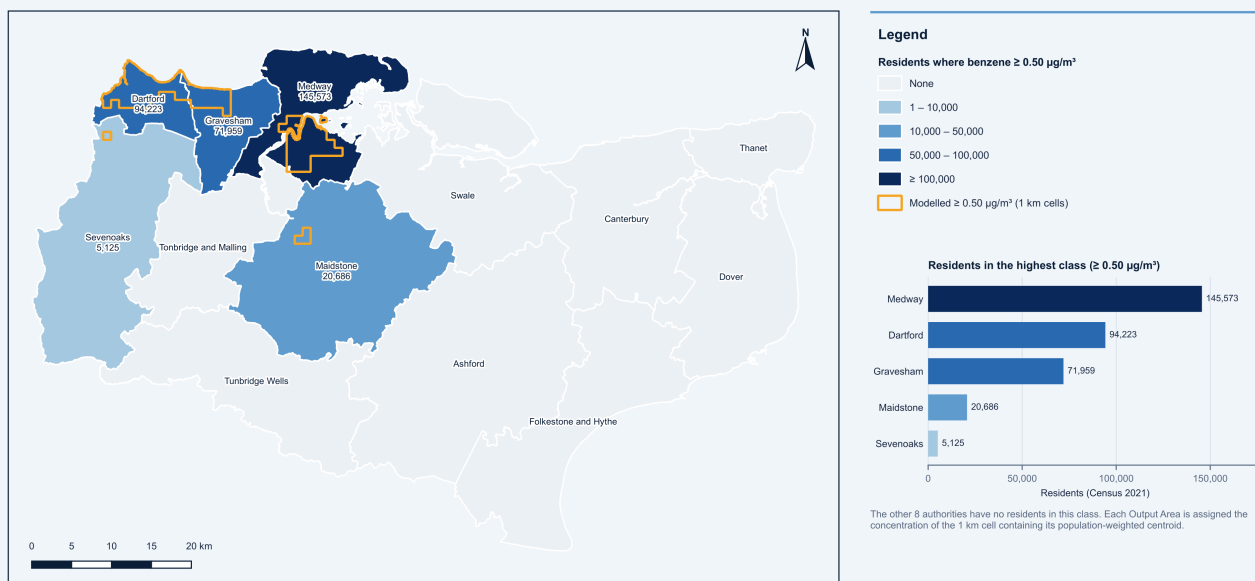
| Authority             | Area (km²) | Mean  | Min   | Max   |
|-----------------------|------------|-------|-------|-------|
| Dartford              | 73         | 0.499 | 0.409 | 0.627 |
| Medway                | 194        | 0.432 | 0.332 | 0.620 |
| Gravesham             | 99         | 0.432 | 0.351 | 0.605 |
| Thanet                | 104        | 0.359 | 0.300 | 0.482 |
| Tonbridge and Malling | 240        | 0.350 | 0.287 | 0.501 |
| Maidstone             | 393        | 0.335 | 0.267 | 0.516 |
| Sevenoaks             | 370        | 0.332 | 0.282 | 0.512 |
| Dover                 | 315        | 0.327 | 0.295 | 0.428 |
| Swale                 | 373        | 0.323 | 0.279 | 0.480 |
| Canterbury            | 309        | 0.313 | 0.281 | 0.415 |
| Tunbridge Wells       | 331        | 0.289 | 0.263 | 0.441 |
| Folkestone and Hythe  | 357        | 0.287 | 0.254 | 0.427 |
| Ashford               | 581        | 0.285 | 0.263 | 0.407 |

Concentrations in µg/m³. Means are area-weighted from the 1 km grid. Min and max are the extreme 1 km cells touching each authority.

### Finding 3 · One resident in five lives in the top band

### Residents in the highest benzene class, 2023

337,566 people (18.2% of Kent and Medway) live where modelled background benzene is  $\geq 0.50 \mu\text{g}/\text{m}^3$



Data sources: Defra UK-AIR, Pollution Climate Mapping background benzene 2023 (Crown copyright, OGL v3); ONS Census 2021 TSO01 usual residents and Output Area population-weighted centroids (OGL v3); ONS Open Geography: Local Authority Districts May 2024 (OGL v3). Contains OS data © Crown copyright and database right 2024–2028.

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British National Grid (ED50:27700)

337,566 people (18.2%) live where modelled background benzene is at least 0.50 µg/m³. Only 5 of the 13 authorities have anyone in this band. Medway, Dartford and Gravesham account for 92% of them, and in Dartford it covers four residents in five.

| Authority             | Residents        | ≥ 0.50 µg/m³   | Share        | Pop.-weighted mean |
|-----------------------|------------------|----------------|--------------|--------------------|
| Medway                | 279,769          | 145,573        | 52.0%        | 0.508              |
| Dartford              | 116,752          | 94,223         | 80.7%        | 0.537              |
| Gravesham             | 106,891          | 71,959         | 67.3%        | 0.520              |
| Maidstone             | 175,793          | 20,686         | 11.8%        | 0.417              |
| Sevenoaks             | 120,504          | 5,125          | 4.3%         | 0.385              |
| Thanet                | 140,584          | 0              | 0.0%         | 0.411              |
| Ashford               | 132,754          | 0              | 0.0%         | 0.338              |
| Tonbridge and Malling | 132,193          | 0              | 0.0%         | 0.393              |
| Dover                 | 116,403          | 0              | 0.0%         | 0.373              |
| Swale                 | 151,683          | 0              | 0.0%         | 0.395              |
| Folkestone and Hythe  | 109,750          | 0              | 0.0%         | 0.347              |
| Canterbury            | 157,427          | 0              | 0.0%         | 0.355              |
| Tunbridge Wells       | 115,308          | 0              | 0.0%         | 0.351              |
| <b>Kent + Medway</b>  | <b>1,855,811</b> | <b>337,566</b> | <b>18.2%</b> | <b>0.416</b>       |

The count depends on where the top break sits. A cut-off of  $0.48 \mu\text{g}/\text{m}^3$  gives 417,126 people and  $0.52 \mu\text{g}/\text{m}^3$  gives 254,523, so treat it as a range rather than an exact figure.

## Finding 4 · The biggest emitters are not where the air is worst

The 88 NAEI point sources in the study area reported 12.3 tonnes of benzene in 2023, and three sites account for 74% of it. The largest, a combined heat and power plant at Kemsley, sits in a cell of 0.40  $\mu\text{g}/\text{m}^3$ . That is below the Dartford average of 0.499  $\mu\text{g}/\text{m}^3$ . Across all sites, emission size and the concentration of the surrounding cell are almost unrelated (Spearman  $\rho = 0.11$ ).

| Site                           | Authority             | Sector                                   | t / year | Cell $\mu\text{g}/\text{m}^3$ |
|--------------------------------|-----------------------|------------------------------------------|----------|-------------------------------|
| Kemsley                        | Swale                 | Paper, printing & publishing industries  | 7.37     | 0.396                         |
| Kemsley Mill CHP               | Swale                 | Paper, printing & publishing industries  | 1.14     | 0.396                         |
| Isle of Grain LNG Installation | Medway                | Processing & distribution of natural gas | 0.58     | 0.362                         |
| Kemsley Generating Station     | Swale                 | Waste collection, treatment & disposal   | 0.43     | 0.386                         |
| Allington Quarry               | Tonbridge and Malling | Waste collection, treatment & disposal   | 0.39     | 0.424                         |
| Smurfit Kappa Townsend Hook    | Tonbridge and Malling | Paper, printing & publishing industries  | 0.34     | 0.474                         |
| Ashford                        | Ashford               | Waste collection, treatment & disposal   | 0.21     | 0.325                         |
| Kingsnorth Oil Treatment Plant | Medway                | Waste collection, treatment & disposal   | 0.20     | 0.418                         |
| Margate                        | Thanet                | Chemical industry                        | 0.20     | 0.402                         |
| Aylesford                      | Tonbridge and Malling | Waste collection, treatment & disposal   | 0.20     | 0.412                         |

64 of the 88 sites, carrying 99.8% of the tonnage, are flagged in NAEI as wholly or partly modelled rather than reported by the operator. Site and operator names are as published by NAEI.

## Limitations

- **Background only.** At 1 km the PCM map smooths out roadside and near-plant peaks, so kerbside exposure is higher than shown.
- **No local check.** No national-network benzene monitor was found in Kent or Medway. Local diffusion-tube data could not be retrieved while UK-AIR was offline in October 2026, so the surface is not validated against measurements.
- **Approximate allocation.** Residents are placed at Output Area centroids, which hold about 324 people each on average, not at home addresses.
- **Mixed years.** Concentrations and emissions are for 2023, and population is from Census 2021.
- **Annual means.** Short episodes, such as a plant upset or a winter inversion, do not show in a yearly average.

## Who this helps

- **Council air-quality officers:** where a diffusion-tube survey would add most, starting with the Thames-side towns.
- **Public health teams:** which communities to prioritise for risk communication.
- **Planners:** background context for housing and school sites along the estuary corridor.
- **Residents:** a sourced, plain-language picture of the air where they live.

### Need an analysis like this for your area?

I build air quality, exposure and site-screening studies from open and client data, from data sourcing to print-ready maps. See more work and get in touch at [johnsaita.github.io](https://johnsaita.github.io).