



# Spatial Analysis WITH GIS

## Toolkit for Smarter URBAN MAPPING



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URBAN DESIGN LAB

## **Spatial Analysis with GIS: Toolkit for smarter Urban Mapping**

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Spatial Analysis with GIS: Toolkit for Smarter Urban Mapping is a compact guide that introduces key map types and spatial thinking strategies essential for urban planning and design. It helps readers translate geospatial data into actionable insights using open-source tools like QGIS. Developed as a companion to the UDL GIS Masterclass, this book lays the conceptual foundation for participants to think critically, map effectively, and engage with real-world urban challenges through spatial analysis.

# Preface

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In an era marked by accelerating urbanization, climate uncertainty, and spatial inequality, the ability to interpret, analyze, and act upon geospatial data has become indispensable for urban professionals. Cities are no longer understood purely through physical form or demographic metrics—they are viewed as layered systems shaped by infrastructure, governance, environment, and human behavior. The tools we use to see, analyze, and intervene in these systems must evolve accordingly.

*Spatial Analysis with GIS: Toolkit for Smarter Urban Mapping* is designed as a conceptual companion to the UDL GIS Masterclass, equipping architects, urban designers, planners, and researchers with the critical vocabulary and spatial frameworks needed to approach urban complexity. This book focuses not on software mechanics, but on the intellectual scaffolding that underpins geospatial thinking—how we define, layer, and interpret space through mapping.

Organized around key map typologies—from base maps and thematic visualizations to density surfaces and composite overlays—this volume offers a structured pathway for understanding how spatial data can inform design, support policy, and reveal inequities. It draws from international best practices, planning pedagogy, and urban design theory to frame GIS not merely as a technical tool, but as a means of spatial reasoning and urban intelligence.

Whether you are preparing for the masterclass or exploring GIS for the first time, this book encourages a mindset shift: from mapping as representation to mapping as analysis. It is our hope that this toolkit helps you see your city differently—and equips you to design it more intelligently.





# Contents

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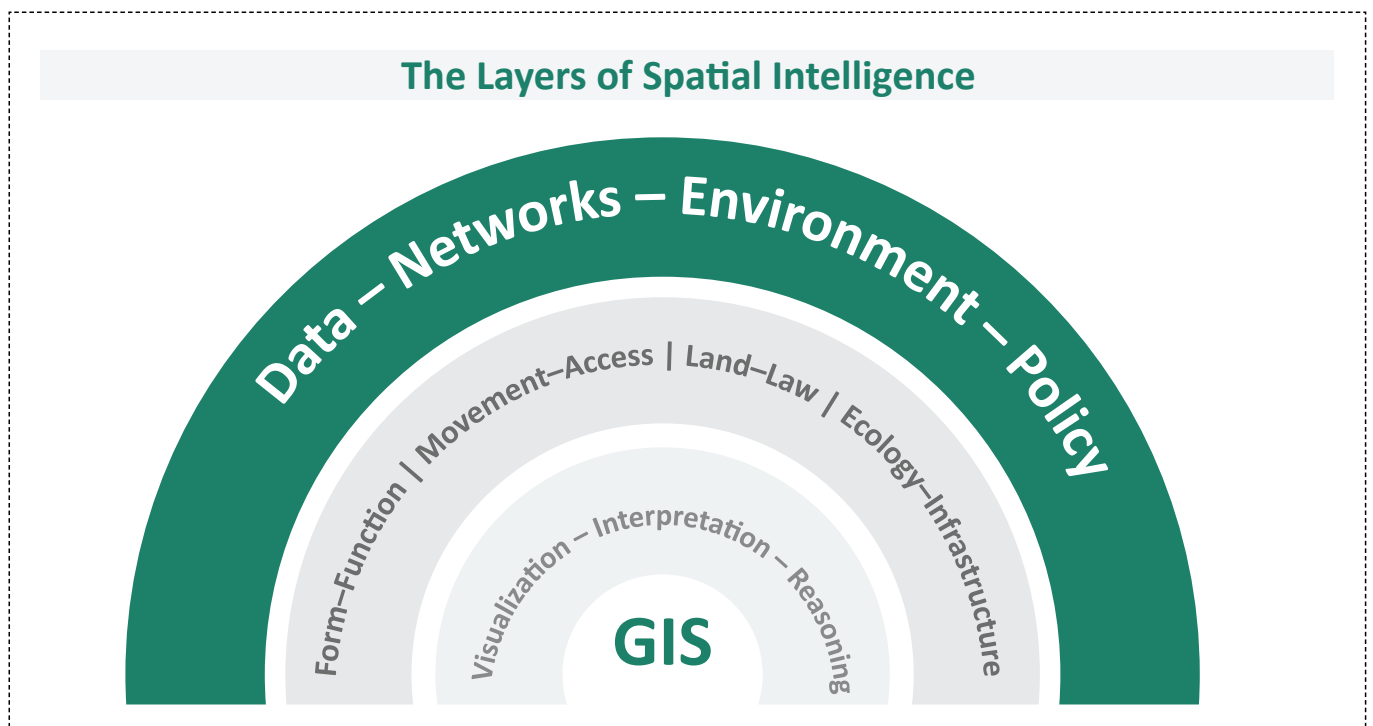
1. Introduction
2. Basemaps - Contextualizing the Urban Terrain
3. Thematic Maps - Visualizing Urban Conditions
4. Real-World Applications - Mapping for Policy, Design, Equity, and Decision-Making
5. Building a Spatial Mindset - Toward a Culture of Data-Driven, Context-Aware Urbanism
6. Sources of Spatial Data for Urban Mapping

### Spatial Intelligence in Urban Professions

In the evolving landscape of urbanization, the **capacity to think spatially** has emerged as a foundational skill across design and planning disciplines. **Spatial intelligence—the cognitive ability to visualize, interpret, and reason with spatial relationships**—enables urban professionals to understand cities not merely as collections of built forms, but as dynamic systems embedded within socio-political, environmental, and economic structures.

For architects, landscape designers, and urban planners, spatial intelligence allows the conceptualization of relationships between form and function, movement and accessibility, land and legislation, infrastructure and ecology. It is this integrative thinking that underpins the generation of sustainable, equitable, and responsive urban solutions.

Unlike conventional design intuition or formal aesthetics alone, spatial intelligence involves critical interpretation of data-driven realities—how populations are distributed, how networks operate, how environmental conditions shape usability, and how regulations interact with topography. As cities become increasingly complex, spatial intelligence provides the epistemological bridge between design intent and territorial logic.



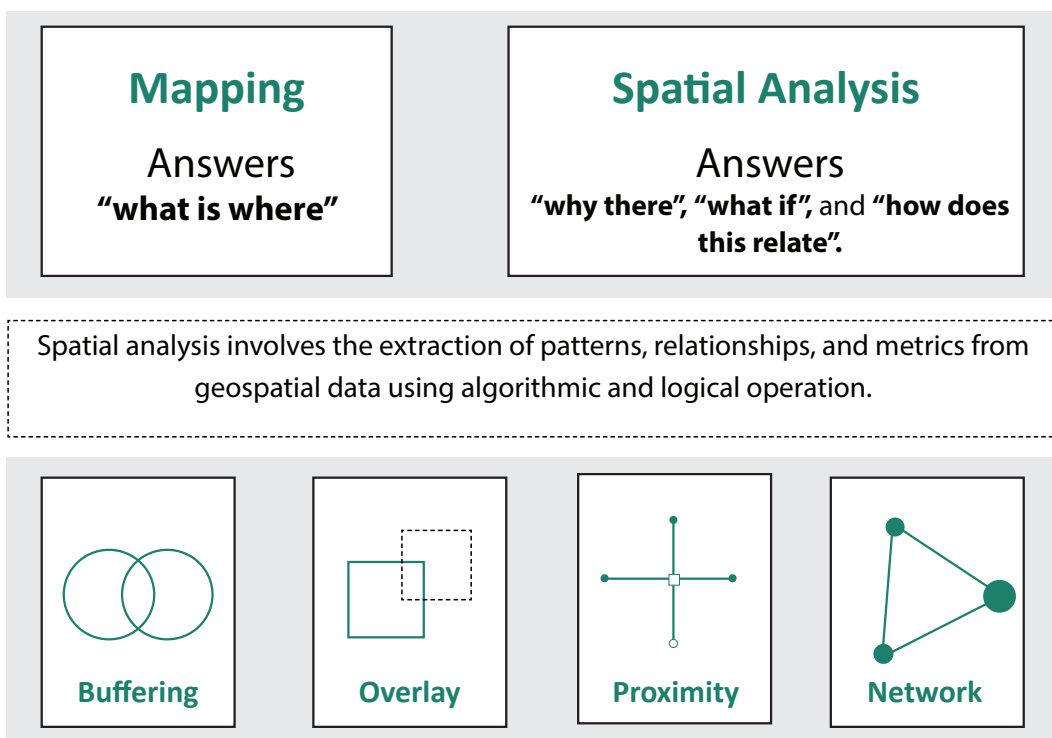


## From Mapping to Spatial Analysis: Key Differences

While mapping has historically served as a vital means of representing the built environment, spatial analysis transcends representation to offer insight. Mapping answers **“what is where”**; spatial analysis asks **“why there”**, **“what if”**, and **“how does this relate”**. The distinction is not simply one of detail, but of purpose and method.

Spatial analysis involves the extraction of patterns, relationships, and metrics from geospatial data using algorithmic and logical operations—such as buffering, overlay, proximity evaluation, and network analysis. This enables urban professionals to move from *visualization* to *evidence-based reasoning*. For example, while a land use map might display zones of residential and commercial activity, a spatial analysis can identify conflicts, transition zones, or non-conforming developments using intersect and dissolve functions. Similarly, mobility patterns can be visualized through transit maps, but accessibility analysis can reveal underserved areas, inequities in last-mile connectivity, or mismatches between transit infrastructure and population density. In essence, spatial analysis allows design practitioners to embed rigour, quantifiability, and systemic awareness into their workflows.

### From Mapping to Spatial Analysis



Enables urban professionals to move from visualization to **evidence-based reasoning**.

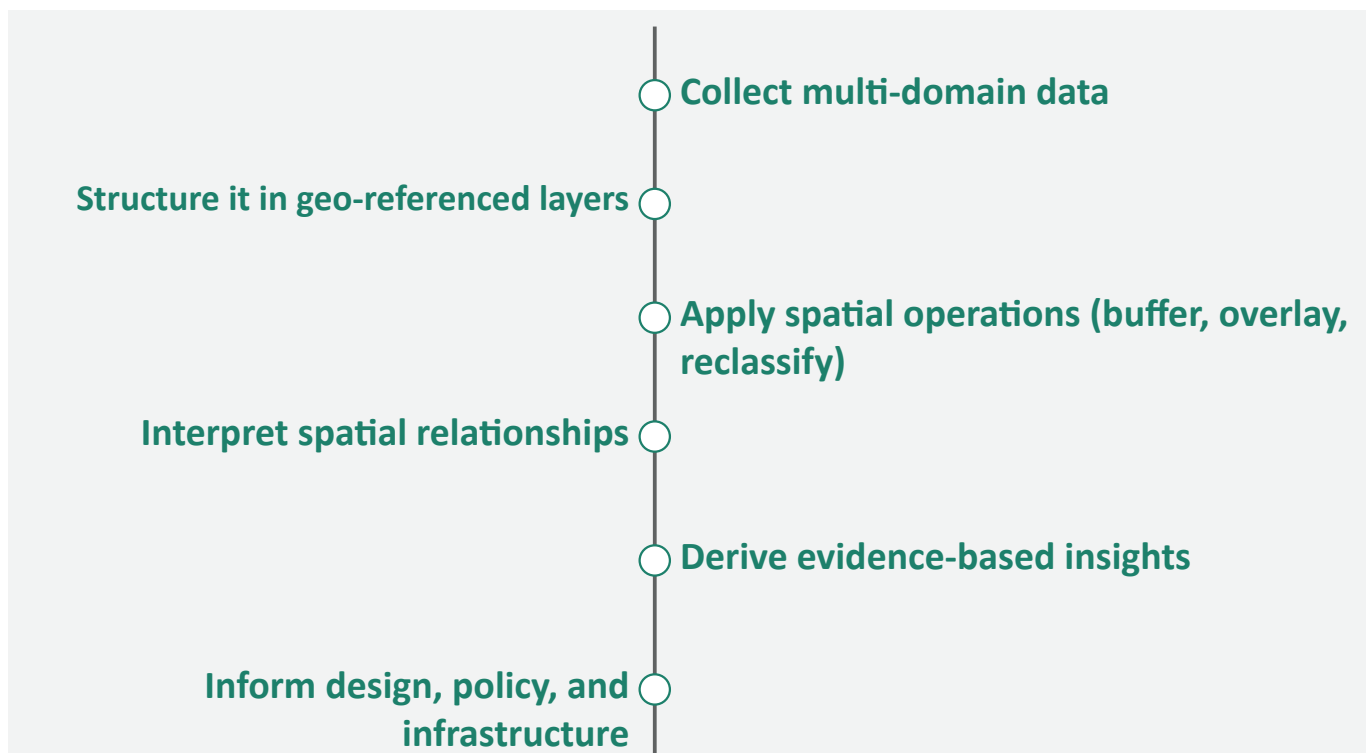
## GIS as a Tool for Design Reasoning and Planning Logic

**Geographic Information Systems (GIS)** are not merely tools for map-making; they are platforms for spatial reasoning. By structuring urban information into layered, geo-referenced datasets, GIS facilitates a multi-scalar, multidimensional view of the city. It allows the designer to ask **“What constraints operate on this site?”** or **“Where do opportunities for intervention align across social and physical variables?”**

1. GIS empowers practitioners to:
2. Model spatial phenomena (e.g., accessibility, density, slope, visibility)
3. Test design scenarios through overlays and simulation
4. Quantify spatial justice and service delivery gaps
5. Visualize interdependencies among land use, mobility, environment, and demography

In the context of urban design and architecture, GIS reinforces a logic of site analysis, contextual responsiveness, and evidence-based design—particularly vital in public projects, policy planning, infrastructure design, and climate-sensitive development. Moreover, GIS promotes transdisciplinary integration, linking data from environmental sciences, transportation engineering, demography, and public policy into coherent spatial outputs that inform better planning decisions.

### GIS: From data chaos to spatial clarity





## QGIS: Democratizing Spatial Analysis through Open-Source

**QGIS** represents a paradigm shift in how spatial analysis is accessed and applied within the built environment professions. As an **open-source GIS** platform, **QGIS** removes the financial and institutional barriers traditionally associated with proprietary software like **Esri's ArcGIS**. It empowers independent designers, students, academic researchers, NGOs, and municipal governments to engage with geospatial technologies in a flexible and adaptable manner.

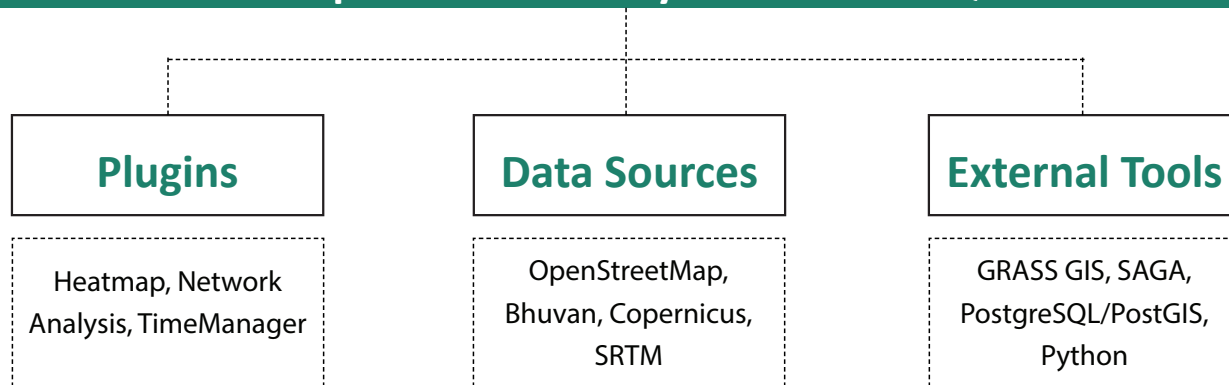
Key advantages of QGIS include:

1. Compatibility with a vast range of spatial data formats (Shapefile, GeoJSON, GeoTIFF, etc.)
2. An extensive plugin ecosystem supporting everything from network analysis to environmental modeling
3. Community-driven development that ensures relevance, transparency, and scalability
4. Seamless integration with other open-data platforms like OpenStreetMap, Copernicus, and national datasets

By leveraging QGIS, designers and planners can incorporate real-time data, public spatial repositories, and custom-built analytical models into their workflows—whether mapping green infrastructure in a metropolitan plan or evaluating slope and access for a housing site.

More importantly, QGIS encourages **a culture of experimentation and learning**, allowing users to go beyond static maps to develop interactive spatial narratives, perform site sensitivity evaluations, and co-create knowledge with communities and stakeholders.

### The Open-Source Ecosystem Around QGIS





# **Core Types of Maps in Urban Spatial Analysis**

## A. Contextual & Foundational Maps

1. Base Map
2. Topographic Map
3. Administrative Boundary Map
4. Satellite Imagery Map

## B. Thematic Maps (Single Variable)

1. Choropleth Map
2. Graduated Symbol Map
3. Proportional Symbol Map
4. Dot Density Map
5. Categorical (Qualitative) Map
6. Isarithmic / Interpolation Map
7. Heatmap / Kernel Density Map

## C. Comparative & Composite Maps

1. Temporal Change Map
2. Before–After (Scenario) Map
3. Overlay / Composite Map
4. Bivariate Choropleth Map
5. Conflict Map (e.g., Zoning vs. Reality)

## D. Analytical Maps

1. Buffer Analysis Map
2. Catchment / Service Area Map
3. Network Accessibility / Isochrone Map
4. Suitability Analysis Map

## E. Environmental & Risk Maps

1. Slope and Elevation Map
2. Flood Risk / Vulnerability Map
3. NDVI / Vegetation Cover Map
4. Urban Heat Island Map



## Purpose: Establishing Site and City-Scale Context

In the spatial sciences, a **base map** is far more than a backdrop—it is the **cartographic scaffold upon which urban inquiry is built**. It anchors all subsequent layers of data within a coherent spatial framework, allowing designers and planners to interpret urban systems relationally rather than in isolation.

Whether framing a micro-scale housing site or assessing a city-wide mobility network, base maps provide geographical orientation, establish spatial references, and embed the project within its environmental, infrastructural, and administrative reality. They serve as the interpretive lens through which **landform, connectivity, edge conditions, and site constraints are made visible and intelligible**.

By establishing both locational fixity and spatial fluidity, base maps allow for the layering of analytical variables, such as population density, green cover, or zoning boundaries, while also grounding design proposals in empirical spatial logic. They are the critical starting point in transforming space into place—and data into design knowledge.

## Applications: Studio Context, Design Briefs, Baseline Studies

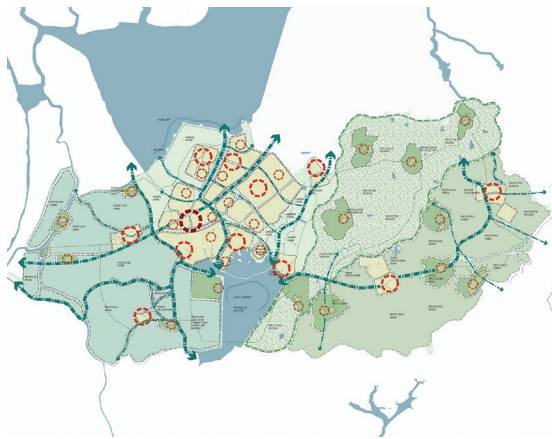
Site documentation and reconnaissance	Urban morphology and density studies	Participatory planning:
Design briefs and stakeholder reports	Scenario planning and phasing studies	Topographic Suitability and Buildability Mapping
Heritage and Conservation Area Mapping	Community Asset & Service Location Inventory	Ecological Buffer Zone Identification
Housing Typology and Density Profiling	Disaster Risk and Vulnerability Mapping	Mobility Corridor and Transit Node Visualization
Environmental Impact Assessment (EIA) Mapping	Design Guidelines and Urban Codes Integration	Infrastructure Coordination and Utility Planning



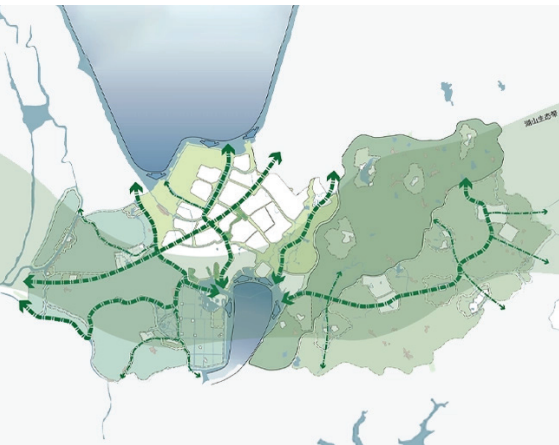


## Data: Roads, Rivers, Boundaries, Elevation, Imagery

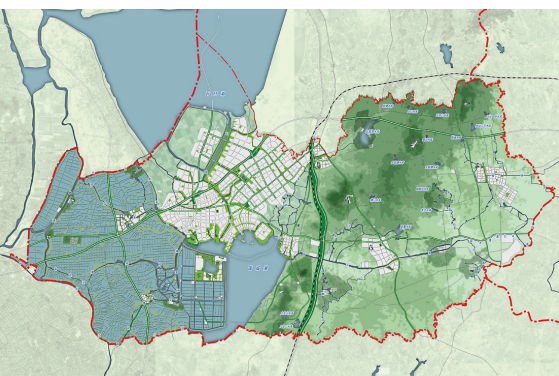
The strength of a base map lies in the curation of essential spatial elements that collectively reflect the terrain and structure of the urban landscape. At a minimum, an effective base map should convey:



**Transportation networks:** Hierarchies of roads, rail lines, and transit nodes define movement patterns and site accessibility.



**Natural features:** Rivers, canals, water bodies, and topographic contours shape ecological functions and design constraints.



**Administrative boundaries:** Ward, zone, or parcel boundaries are fundamental to governance, jurisdiction, and planning policies.

**Landform and elevation:** Terrain influences drainage, visibility, and the cost of development—especially in slope-sensitive zones.

**Imagery and textures:** Satellite or aerial imagery offers a contextual 'reality check', revealing built densities, vegetation, and surface conditions.

### Purpose: Establishing Site and City-Scale Context

Thematic maps lie at the heart of spatial analysis. Unlike base maps, which provide geographic context, **thematic maps are instruments of interpretation**—designed to communicate one or more spatial phenomena in relation to geographic space. They reveal patterns, disparities, concentrations, and trends that are not immediately visible through tabular data or static drawings.

In urban design and planning, thematic maps serve to **translate abstract variables**—such as **literacy, income, or housing quality**—into **spatially legible narratives**. This process enables designers and policymakers to make evidence-based decisions about resource allocation, zoning strategy, infrastructure development, and social equity interventions. Through visual encoding of numerical or categorical data, thematic maps enhance diagnostic clarity, uncover spatial anomalies, and support multi-criteria decision-making. For urban practitioners, these maps bridge the critical gap between **quantitative data analysis and territorial thinking**.



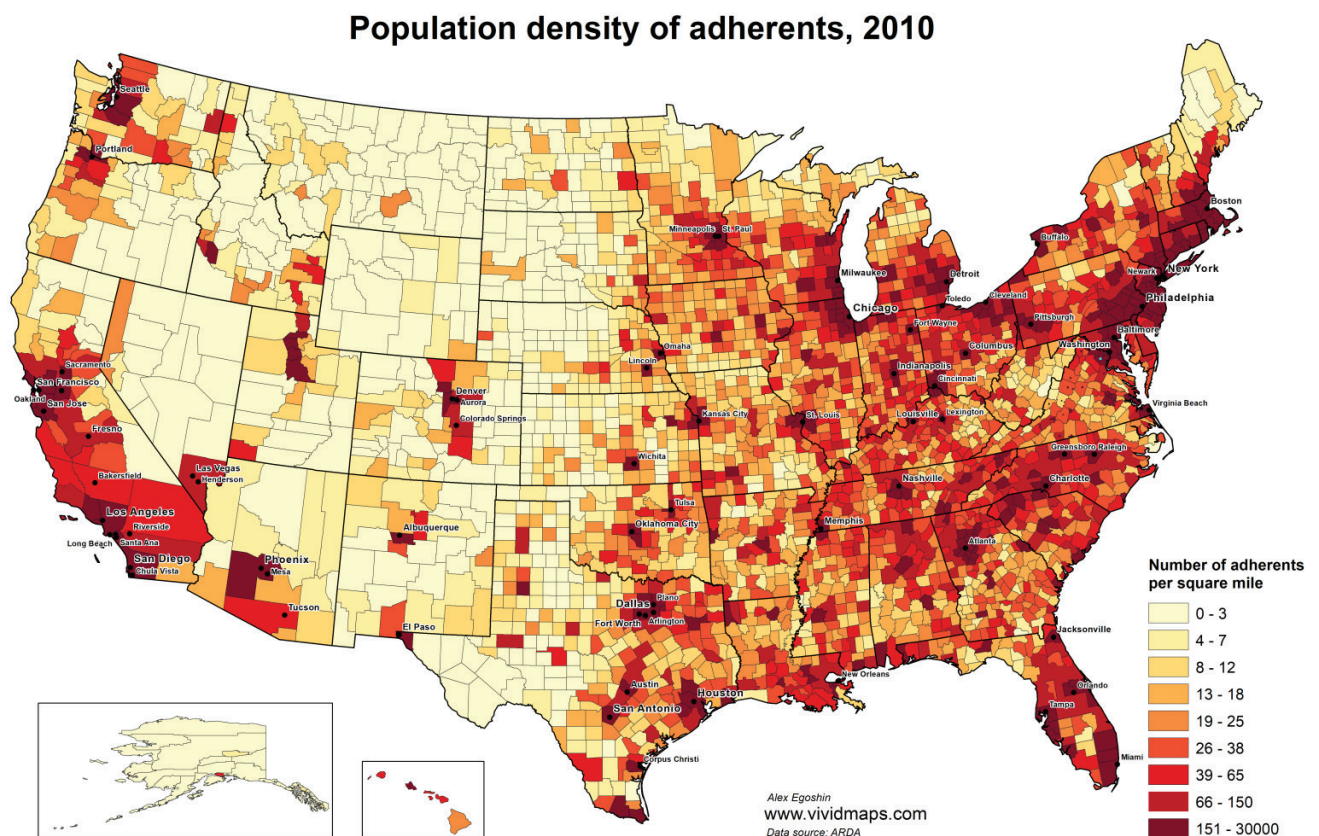


## 1. Choropleth Maps

**Definition:** Use color gradients or patterns to represent a quantitative attribute within administrative units (e.g., wards, zones, blocks).

**Use Case:** Population density, literacy rate, slum population %, access to clean water.

**Critical Value:** Effective for visualizing spatial intensity, patterns, and regional disparities. Must be normalized to avoid misleading visual dominance by large-area polygons.



This choropleth map visualizes the population density of religious adherents across U.S. counties in 2010, using graduated color tones to represent the number of adherents per square mile. Darker shades indicate higher concentrations, with notable clustering in the Eastern Seaboard, parts of the Midwest, and major urban regions in California and Texas. The map demonstrates how choropleths effectively communicate spatial intensity of a single variable within defined administrative boundaries.

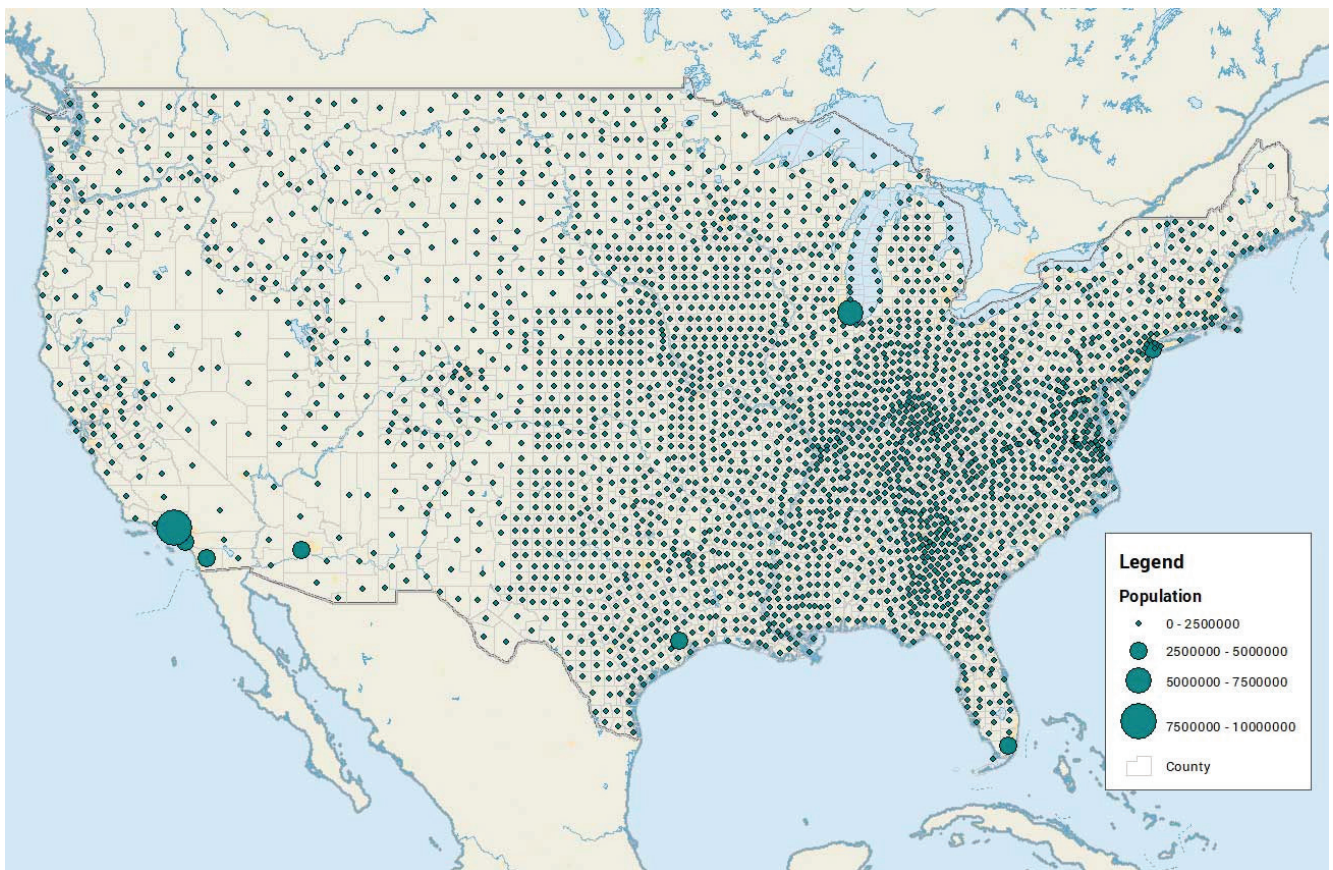


### 2. Graduated Symbol Maps

**Definition:** Represent numerical data using point symbols (typically circles) whose sizes vary based on the data values they represent.

**Use Case:** Number of schools, public toilets, housing units, or clinics per location.

**Critical Value:** Good for comparing relative magnitudes across locations, especially when geographic units are small or not uniform.



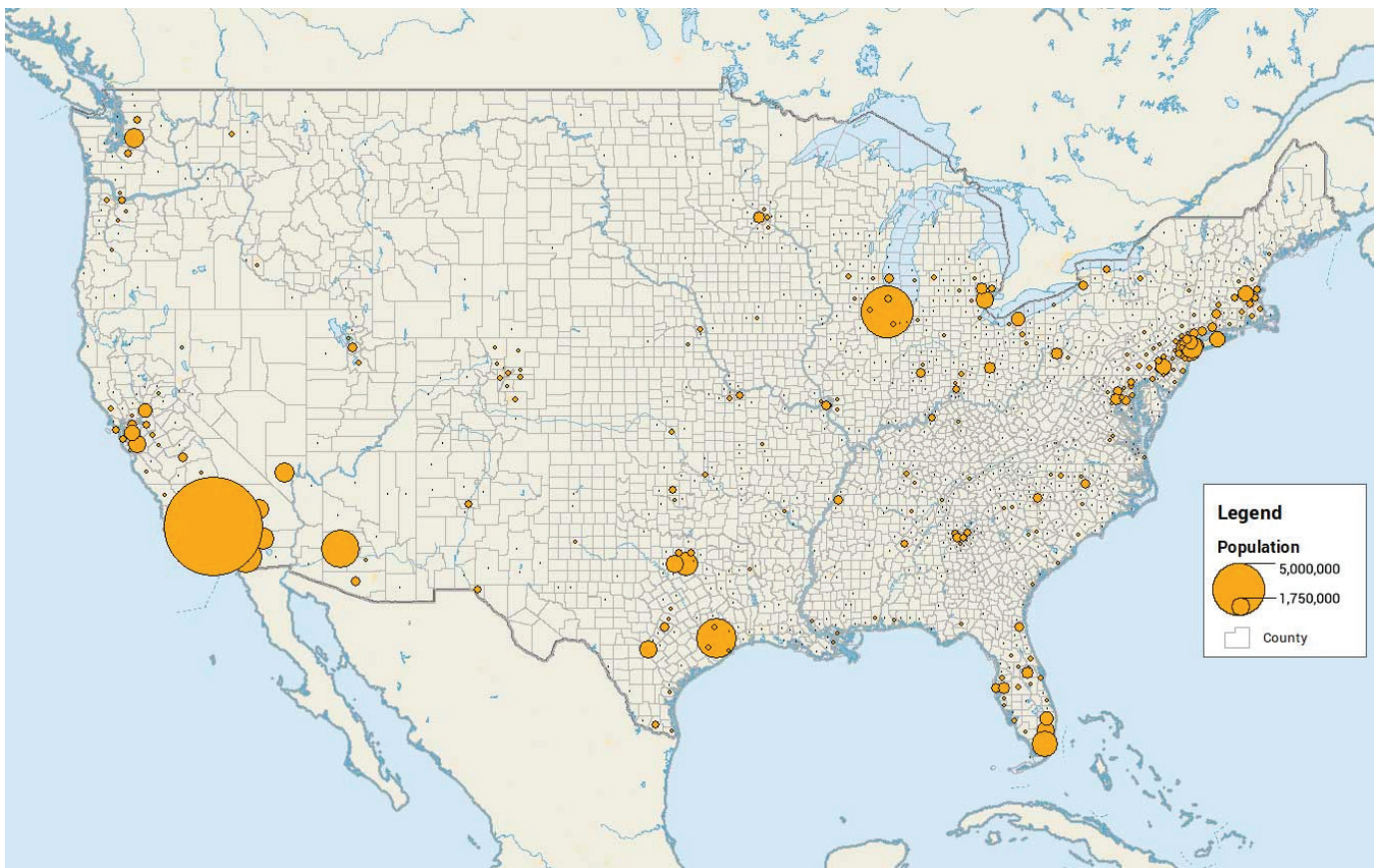
This graduated symbol map visualizes population distribution across U.S. counties using proportionally scaled circles. Each symbol represents total population within a county, with larger circles indicating higher population counts. This technique effectively highlights urban agglomerations—such as Los Angeles, Chicago, and Houston—while maintaining legibility across smaller or rural geographies. Graduated symbol maps are ideal for comparing relative magnitudes in point-located data where uniform administrative boundaries may not capture spatial concentration.

### 3. Proportional Symbol Maps

**Definition:** Similar to graduated symbols, but the symbol size is directly proportional to the actual value (not grouped into classes).

**Use Case:** Water usage, electricity consumption, built-up area, population by settlement.

**Critical Value:** Allows accurate magnitude representation, but can be visually cluttered when values vary drastically or locations are dense.



This proportional symbol map depicts the population of U.S. cities using circles scaled in exact proportion to population size. Unlike graduated symbols, where data are grouped into classes, each symbol here reflects the actual value it represents, enabling precise magnitude comparison. The map highlights extreme urban concentrations, notably Los Angeles, Houston, and Chicago, while maintaining visual clarity across smaller cities. Proportional symbol maps are particularly effective when representing continuous numeric variables over non-uniform spatial distributions, offering immediate visual insight into urban hierarchy and demographic dominance.



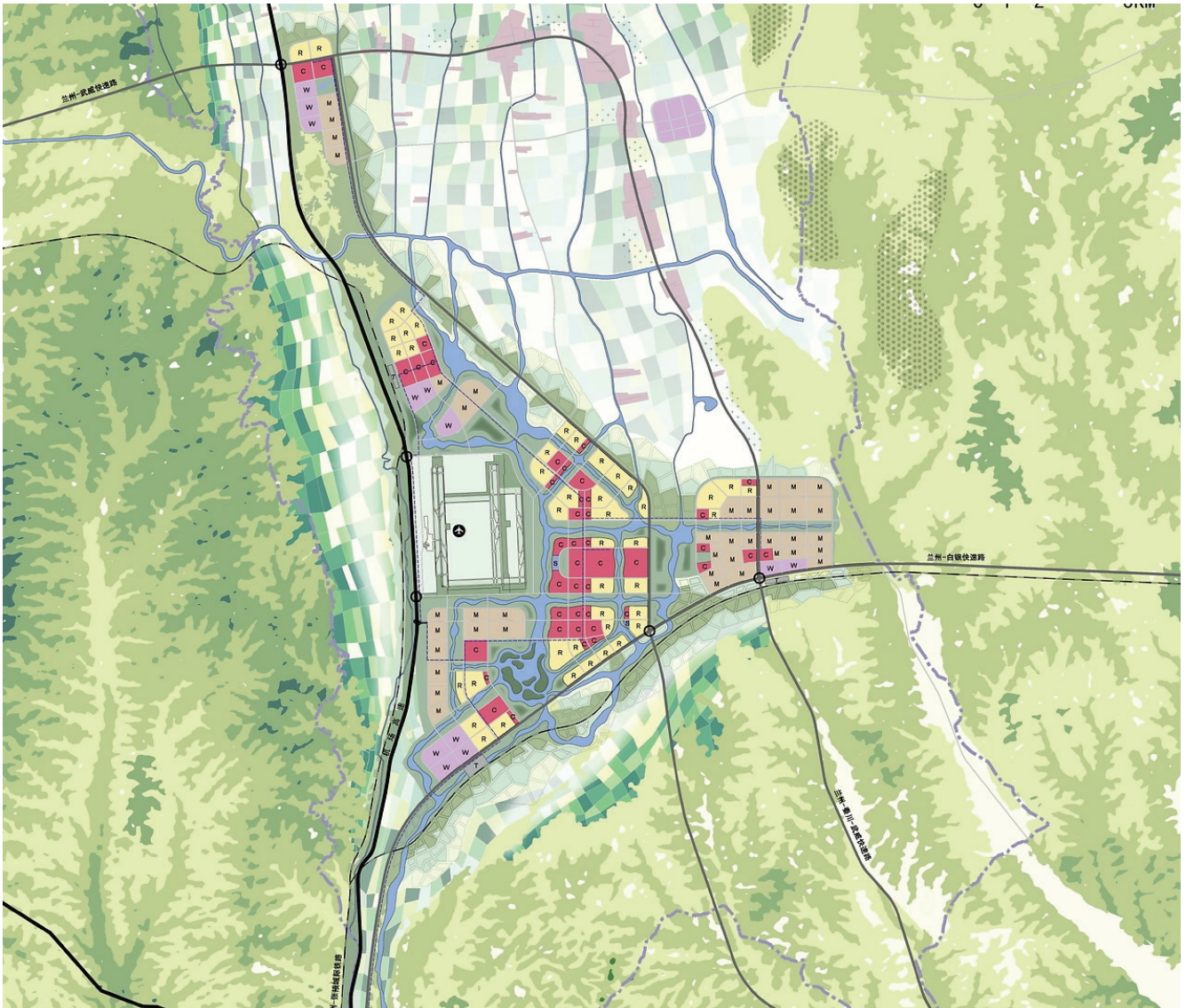


### 4. Categorical (Qualitative) Maps

**Definition:** Depict discrete, non-numeric data categories using distinct colors, textures, or patterns.

**Use Case:** Land use classification, building typologies, ownership categories, religious or cultural zones.

**Critical Value:** Excellent for visualizing spatial distribution of distinct types, especially when analyzing planning conformity or spatial zoning logic.





## 5. Dot Density Maps

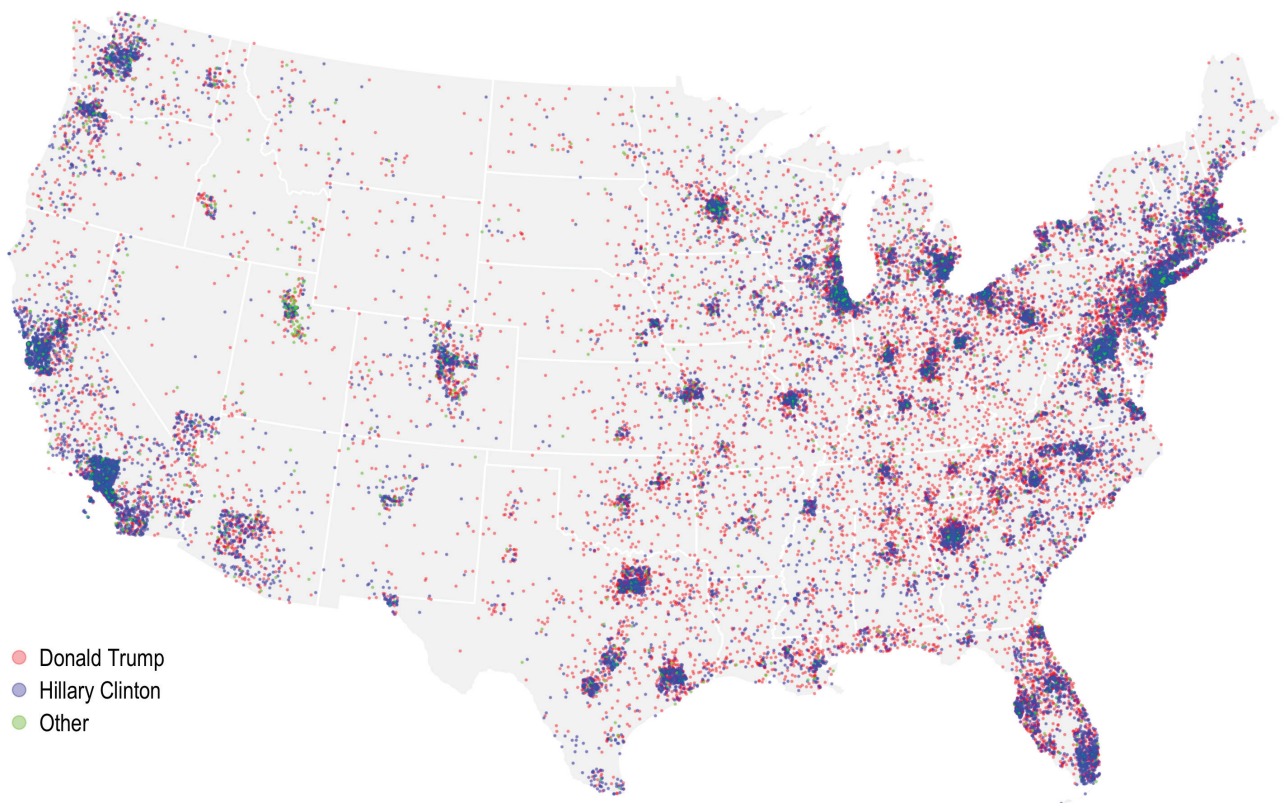
**Definition:** Represent frequency or concentration of phenomena by placing dots, where each dot corresponds to a fixed number of occurrences.

**Use Case:** Population distribution, crime incidence, housing registrations.

**Critical Value:** Useful for showing spatial dispersion or clustering, especially when working with raw count data. Scale and dot value must be carefully chosen.

### US 2016 Presidential election results

Each dot represents 5,000 voters



This dot density map illustrates the distribution of votes in the 2016 U.S. Presidential Election, with each dot representing 5,000 voters. Red, blue, and green dots represent votes for Donald Trump, Hillary Clinton, and other candidates respectively.



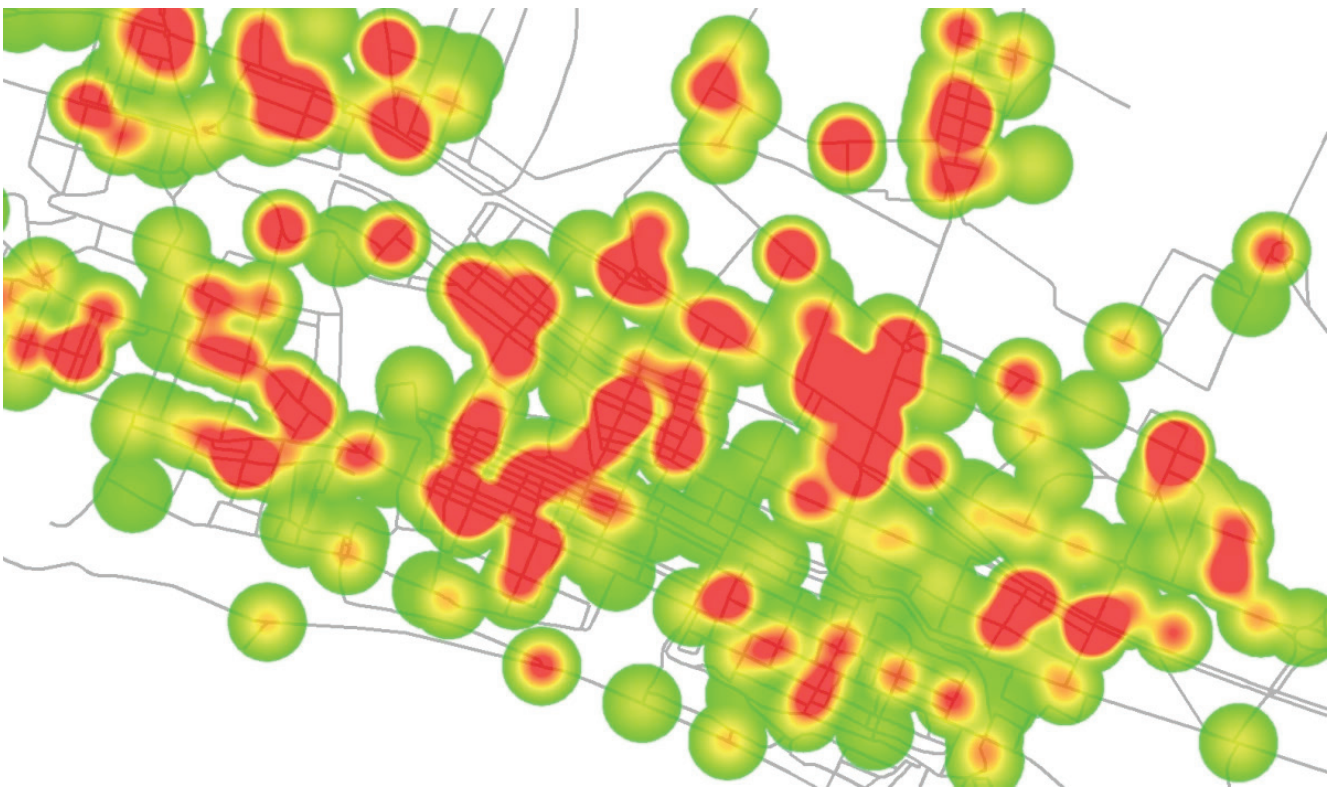


## 6. Heatmaps (Kernel Density or Intensity Maps)

**Definition:** Visualize concentration of points by interpolating their density across a surface to reveal hotspots.

**Use Case:** Public activity zones, traffic accidents, informal vendor locations, sanitation hotspots.

**Critical Value:** Intuitively communicates spatial intensity. Kernel size (smoothing radius) affects output, so interpret with methodological care.



This heatmap visualizes spatial intensity through kernel density estimation, with warmer colors (red) indicating higher concentrations of a specific phenomenon—such as foot traffic, accidents, or vendor activity—within a defined urban area. The green-to-red gradient reveals spatial clustering patterns without fixed administrative boundaries, making it an effective tool for identifying hotspots and high-activity zones. Heatmaps are ideal for visualizing point density over continuous space, supporting decision-making in mobility planning, resource allocation, and urban risk assessments.

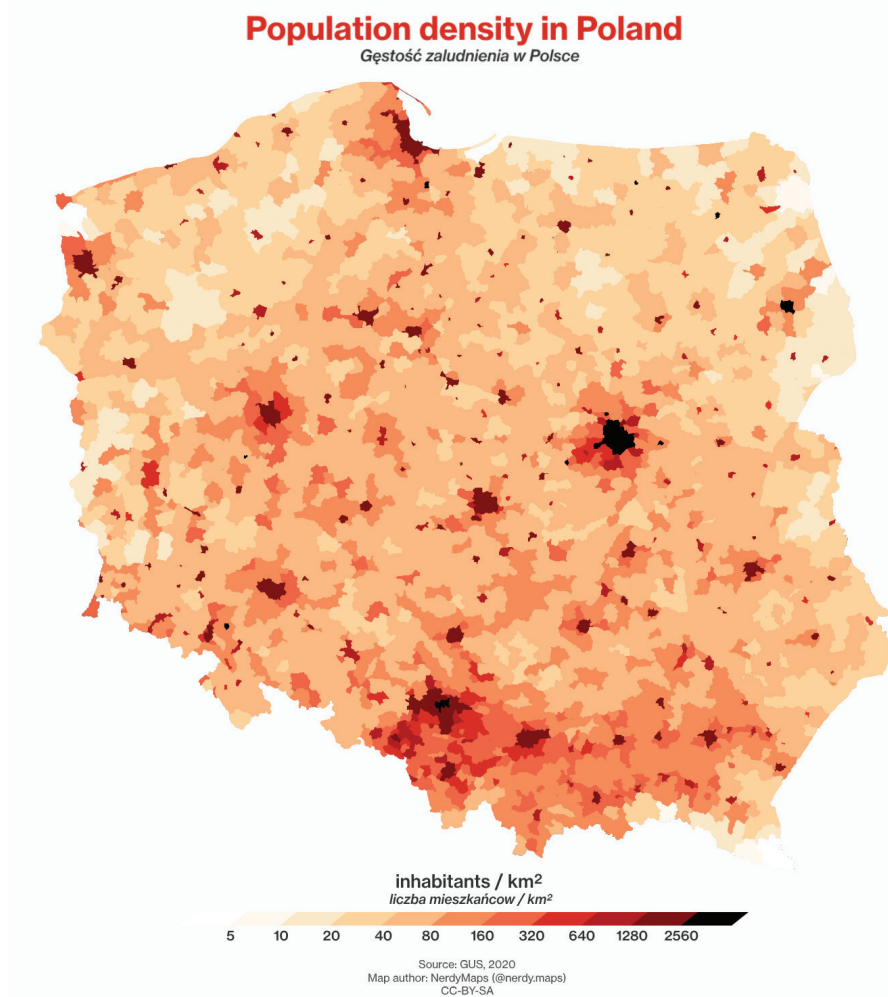


## 7. Isarithmic or Interpolation Maps

**Definition:** Use lines (isopleths) or color bands to represent continuous surface data, typically derived from point-based values.

**Use Case:** Pollution concentration, temperature variation, noise levels, land value gradients.

**Critical Value:** Ideal for environmental and risk data visualization. Requires statistically reliable input data for interpolation (e.g., IDW, Kriging).



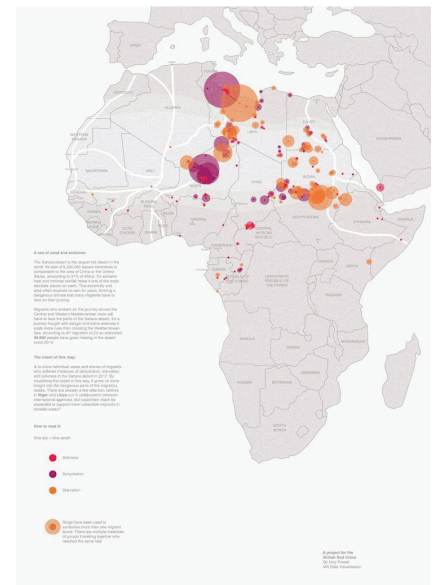
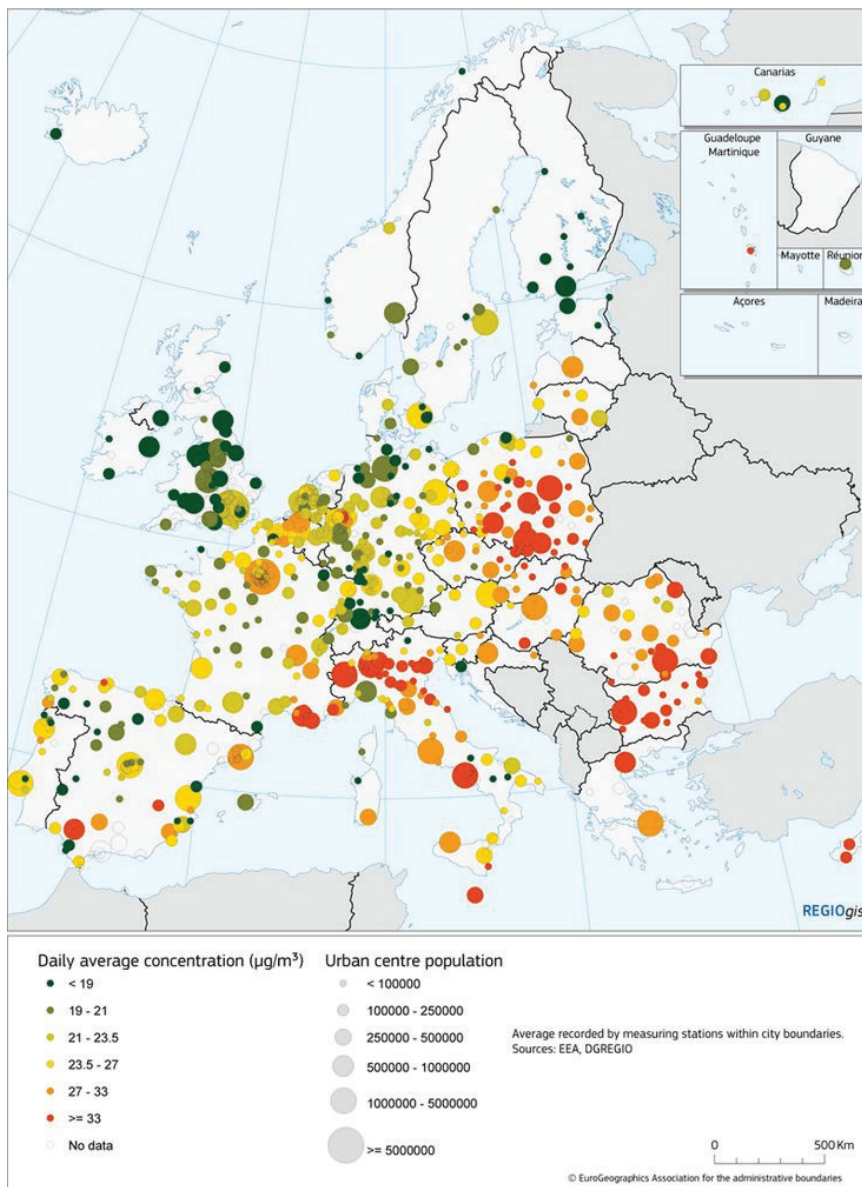
The gradation—from light beige to deep red—visually represents density intensities without being confined to administrative boundaries, allowing for a more nuanced spatial interpretation of demographic distribution.

### 8. Bivariate or Multivariate Maps

**Definition:** Combine two or more datasets using overlaid color schemes, patterns, or symbol combinations to show relationships.

**Use Case:** Income + education levels; green space access + population density; zoning vs slum presence.

**Critical Value:** Allows complex spatial correlation to be visualized in a single map. Must be designed with caution to avoid misinterpretation.



Each color represents a unique combination of the two variables, allowing for the visualization of spatial correlations and disparities. For instance, areas with high population density and low green space availability can be easily identified, highlighting regions that may require urban greening initiatives.

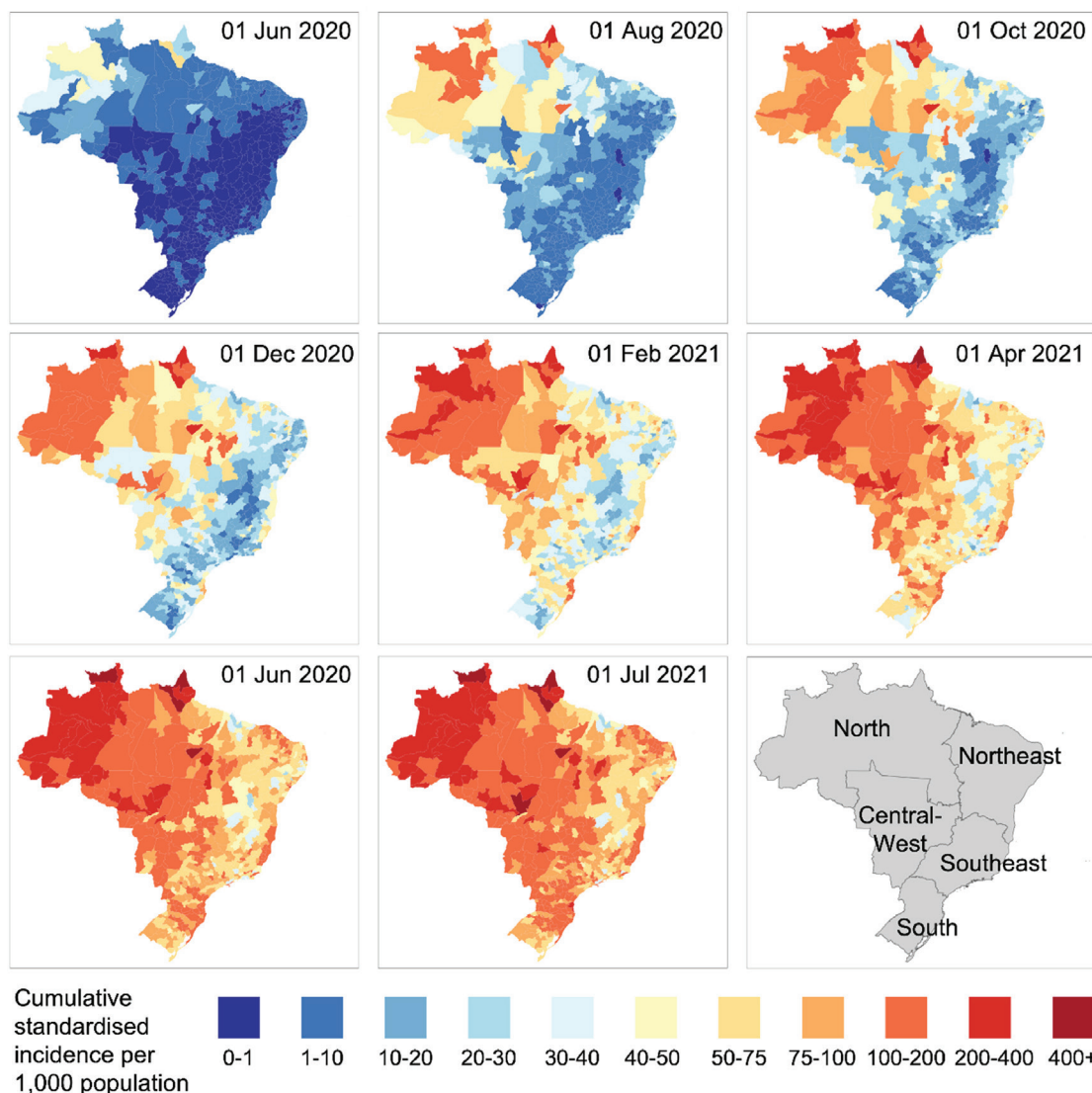


## 9. Change/Temporal Maps (Comparative Thematic Maps)

**Definition:** Show spatial change over time using either side-by-side maps, overlaid layers, or difference mapping.

**Use Case:** Urban expansion, land cover change, slum area reduction, infrastructure growth.

**Critical Value:** Crucial for tracking development trends and evaluating the impact of interventions. Requires consistent data formats and temporal intervals.



# 03

## Thematic Maps

### Visualizing Urban Conditions

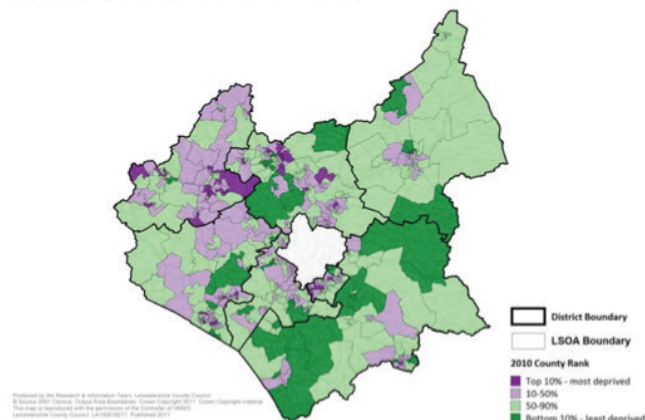
### 10. Cartograms (Distorted Area Maps)

**Definition:** Distort geographic space to represent variables (e.g., area size corresponds to population rather than land area).

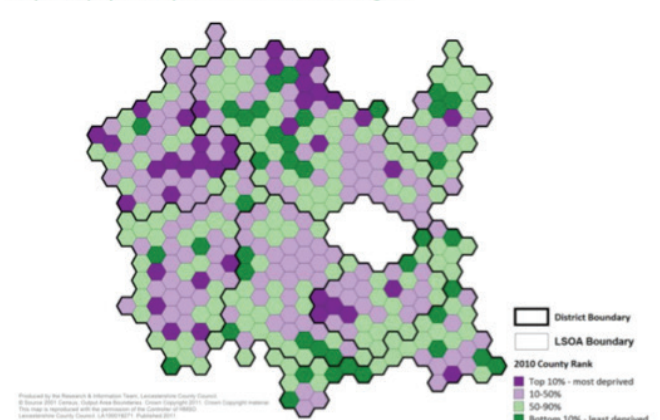
**Use Case:** City-wise migration patterns, state-wise urban funding, transport load capacity.

**Critical Value:** Engaging for policy storytelling, but sacrifices geographic accuracy. Best used for high-level overviews or infographics.

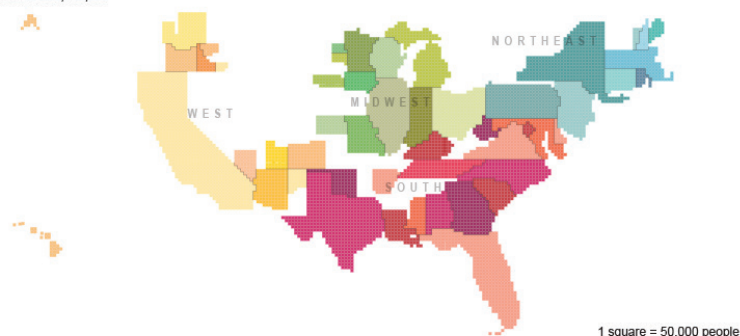
Map 5 - Employment Deprivation - Leicestershire map



Map 6 - Employment Deprivation - Leicestershire cartogram



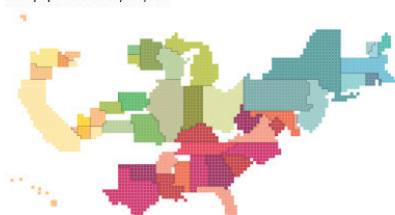
2010  
Total population: 308,745,538



1890  
Total population: 62,979,766



1950  
Total population: 151,325,798







Spatial mapping is no longer a specialist's tool—it is a foundational language across urban sectors. Thematic and spatial analysis maps, when developed with clarity and rigour, serve as critical instruments for evidence-based policy, design innovation, resilience planning, and equitable development. This chapter explores how such maps are applied in real-world urban contexts to support decision-making across scales and disciplines, without delving into technical procedures.

### 1. Mapping for Urban Governance

Municipal agencies use administrative **polygon layers (wards, zones, parcels)** linked with regulatory data to monitor land use compliance, infrastructure gaps, and encroachment patterns. Attribute queries and overlay analysis help align **Development Plan** provisions with ground realities, informing land allocation, policy enforcement, and budget targeting at city or sub-ward levels.

### 2. Mapping for Urban Governance

For architects and urban designers, **base and thematic maps** support site suitability analysis. **Raster overlays** (e.g., slope, NDVI) and **vector intersections** reveal topographic constraints, green linkages, and access hierarchies. These insights inform form generation, street layout, and open space design, anchoring spatial narratives in measurable terrain and socio-spatial logic.

### 3. Mapping for Social Equity

Spatial joins between **population attribute tables (e.g., Census data)** and **infrastructure point layers** expose service delivery gaps. **Catchment buffers** around clinics, toilets, or schools highlight underserved zones, while **choropleth symbology** helps visualize disparities in income, literacy, or housing tenure—supporting targeted interventions in informal or peripheral settlements.

### 4. Mapping for Urban Resilience

By combining **DEM-derived terrain layers** with land use polygons, planners can identify **flood-vulnerable zones, slope-sensitive areas, and heat stress localities**. Spatial filtering and raster classification support the modeling of environmental risk. These maps inform mitigation strategies—such as zoning overlays, buffer regulations, or eco-sensitive development controls.

Across governance, design, equity, and resilience, spatial mapping offers a **relational understanding of place—helping urban actors move beyond static maps to interpret layered realities**. QGIS-based outputs, when structured through clear classification, georeferencing, and topological awareness, enable decisions that are not only spatially valid but socially and environmentally grounded.

## 05

## Building a Spatial Mindset

### Toward a Culture of Data-Driven, Context-Aware Urbanism

In an age of urban complexity, the capacity to **think in layers is essential**. Spatial reasoning is not just about working with maps—it is about understanding how **territories function as interdependent systems**. Thematic layers in QGIS represent more than datasets; they are conceptual frames that allow designers and planners to observe, decode, and respond to urban realities with nuance.

Cultivating a spatial mindset means moving beyond singular visions of form to ask: *What exists beneath and beyond the surface? How do socio-economic, environmental, and regulatory forces intersect? And most importantly—how can we design with this knowledge in mind?*

#### Observe

Collect spatial data (raster, vector, tabular).

#### Layer

Structure the data thematically (land use, infrastructure, terrain, social)

#### Analyze

Use overlays, joins, buffers, and classification to interpret relationships

#### Visualize

Design clear maps for decision-making or community engagement

#### Reflect

Evaluate bias, gaps, and meaning behind mapped outputs

#### Act

Inform design strategy, spatial policy, or research

The spatial thinking cycle underscores that geospatial intelligence is not a linear checklist but a **dynamic, reflexive process**. At its core, it invites urban professionals to shift from mapping as representation to mapping as reasoning—where each layer added deepens understanding, and each map created refines insight. By moving fluidly between observation, analysis, visualization, and reflection, designers and planners cultivate a mindset that is both systemic and adaptive, capable of navigating complexity through clarity. This cycle, when internalized through tools like QGIS, becomes not just a workflow—but a way of thinking about cities.



The foundation of any effective GIS project lies in the quality, reliability, and relevance of spatial data. Whether for base mapping, thematic visualization, or spatial analysis, access to accurate geospatial datasets is essential. This chapter presents a curated list of major global and open-access data sources that urban designers, planners, and researchers can use to build robust GIS workflows in QGIS or other open-source environments.

## 1. Administrative Boundaries and Base Maps

### 1. Natural Earth

Description: Public domain vector and raster data for cultural and physical features.

Link: <https://www.naturalearthdata.com/>

### 2. Global Administrative Areas (GADM)

Description: High-resolution administrative boundary data for all countries.

Link: <https://gadm.org/>

### 3. OpenStreetMap (OSM)

Description: Collaboratively edited map of the world, including roads, buildings, and land use.

Link: <https://www.openstreetmap.org/>

### 4. GeoBoundaries

Description: Open license political administrative boundaries dataset.

Link: <https://www.geoboundaries.org/>

### 5. Esri Living Atlas

Description: A curated collection of geographic information from around the globe.

Link: <https://livingatlas.arcgis.com/>

## 2. Satellite Imagery and Remote Sensing

### 1. USGS Earth Explorer

Description: Access to satellite imagery and aerial photography.

Link: <https://earthexplorer.usgs.gov/>

Maptionnaire

### 2. Copernicus Open Access Hub

Description: Provides free access to Sentinel satellite data.

Link: <https://scihub.copernicus.eu/>

### 3. NASA Earthdata

Description: Comprehensive data on Earth's atmosphere, land, and oceans.

Link: <https://earthdata.nasa.gov/>

### 4. OpenAerialMap

Description: A platform for searching and sharing openly licensed satellite and aerial imagery.

Link: <https://openaerialmap.org/>

### 3. Elevation and Terrain Data

1. ASTER Global Digital Elevation Model (GDEM)  
Description: High-resolution global elevation data.  
Link: <https://asterweb.jpl.nasa.gov/gdem.asp>
2. Shuttle Radar Topography Mission (SRTM)  
Description: Elevation data collected by NASA's SRTM.  
Link: <https://www2.jpl.nasa.gov/srtm/>
3. FABDEM  
Description: Global digital elevation model with forests and buildings removed.  
Link: <https://fabdem.org/>
4. OpenTopography  
Description: Provides high-resolution topographic data and tools.  
Link: <https://opentopography.org/>
5. Viewfinder Panoramas  
Description: Free global digital elevation data.  
Link: <http://viewfinderpanoramas.org/>

### 4. Land Use and Land Cover

1. European Space Agency (ESA) Climate Change Initiative - Land Cover  
Description: Global land cover maps at 300m resolution.  
Link: <https://www.esa-landcover-cci.org/>
2. MODIS Land Cover  
Description: Land cover data from NASA's MODIS satellite.  
Link: <https://modis.gsfc.nasa.gov/data/dataproduct/mod12.php>
3. GlobCover  
Description: Global land cover maps at 300m resolution.  
Link: [http://due.esrin.esa.int/page\\_globcover.php](http://due.esrin.esa.int/page_globcover.php)
4. Global Land Cover Facility (GLCF)  
Description: Provides free land cover data and imagery.  
Link: <https://glcf.umd.edu/>
5. Corine Land Cover (CLC)  
Description: European land cover data.  
Link: <https://land.copernicus.eu/pan-european/corine-land-cover>





## 5. Population and Demographics

1. Gridded Population of the World (GPW)  
Description: Population data at a gridded format.  
Link: <https://sedac.ciesin.columbia.edu/data/collection/gpw-v4>
2. WorldPop  
Description: High-resolution population data.  
Link: <https://www.worldpop.org/>
3. Global Human Settlement Layer (GHSL)  
Description: Data on human settlements and population density.  
Link: <https://ghsl.jrc.ec.europa.eu/>
4. LandScan Global Population Database  
Description: Ambient population distribution data.  
Link: <https://landscan.ornl.gov/>
5. Demographic and Health Surveys (DHS) Program  
Description: Health and population data for developing countries.  
Link: <https://dhsprogram.com/>

## 6. Transportation and Infrastructure

1. OpenStreetMap (OSM)  
Description: Detailed data on roads, railways, and other infrastructure.  
Link: <https://www.openstreetmap.org/>
2. Global Roads Open Access Data Set (gROADS)  
Description: Global dataset of roads between settlements.  
Link: <https://sedac.ciesin.columbia.edu/data/set/groads-global-roads-open-access-v1>
3. OpenFlights  
Description: Airport, airline, and route data.  
Link: <https://openflights.org/data.html>
4. World Port Index  
Description: Information on major ports and terminals worldwide.  
Link: <https://msi.nga.mil/Publications/WPI>
5. UNAVCO  
Description: Geodetic data including GPS and seismic data.  
Link: <https://www.unavco.org/>



## 8. Urban Footprint and Built Environment Data

1. Global Urban Footprint (DLR)  
High-resolution global map of built-up areas  
[https://www.dlr.de/eoc/en/desktopdefault.aspx/tabid-9628/16557\\_read-40454/](https://www.dlr.de/eoc/en/desktopdefault.aspx/tabid-9628/16557_read-40454/)
2. Atlas of Urban Expansion  
Global database on urban growth, densities, and expansion patterns  
<https://www.atlasofurbanexpansion.org>
3. OpenBuiltMap  
Building footprint data aggregated from OSM and other sources  
<https://openbuiltmap.org>
4. Microsoft Building Footprints  
Global building footprint dataset using AI extraction  
<https://github.com/microsoft/GlobalMLBuildingFootprints>
5. Humanitarian Data Exchange (HDX)  
A repository of socio-spatial datasets from NGOs and UN agencies  
<https://data.humdata.org>

## 9. Urban Policy, Development, and Social Data

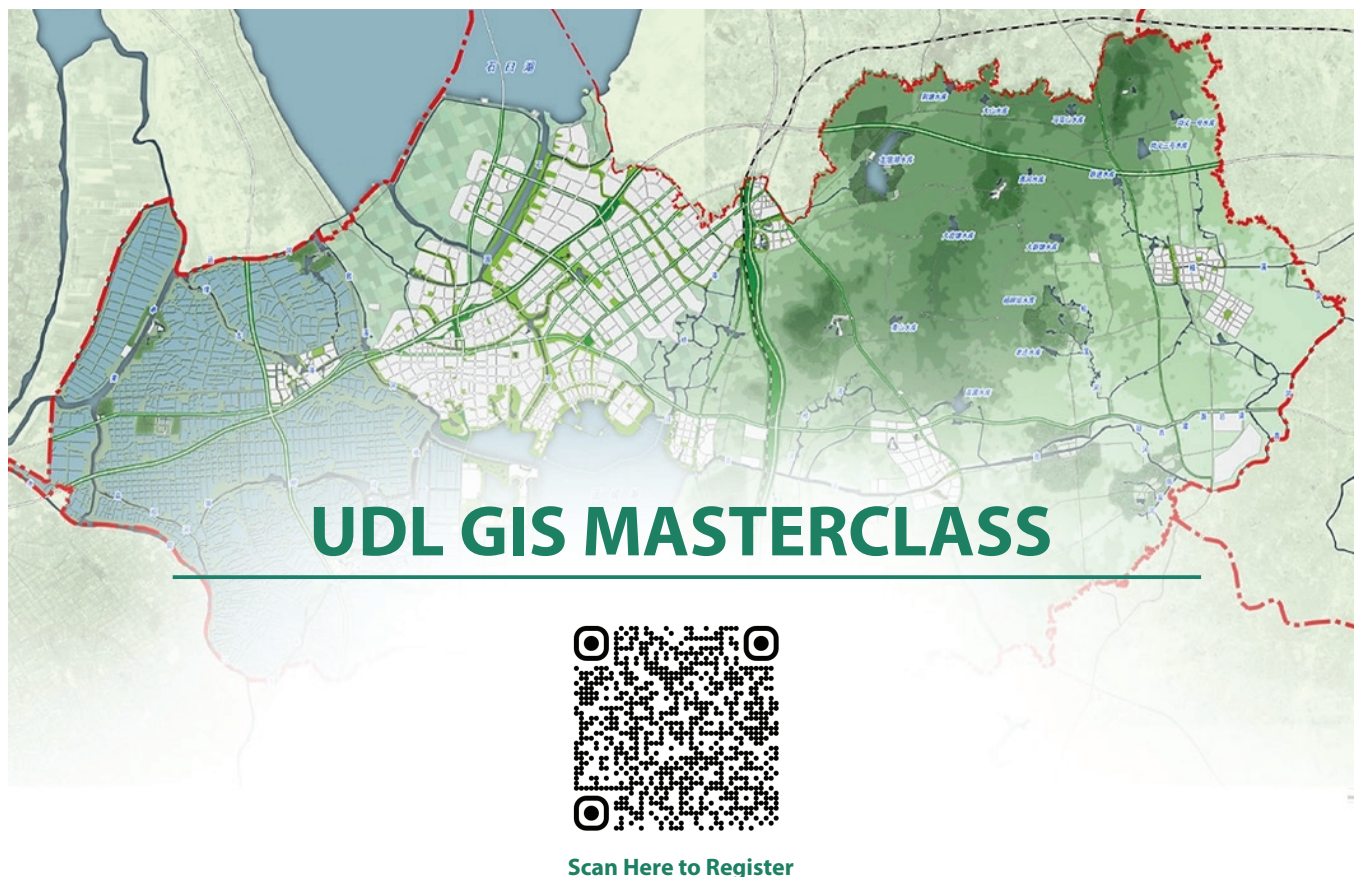
1. World Bank Open Data  
Urban, demographic, and economic indicators  
<https://data.worldbank.org>
2. UN Habitat Urban Data  
Global urban indicators and SDG metrics  
<https://data.unhabitat.org>
3. OECD Regional Statistics  
Socio-economic and environmental datasets for global cities  
<https://stats.oecd.org>
4. Eurostat GISCO  
Spatial statistics and datasets for Europe  
<https://ec.europa.eu/eurostat/web/gisco>
5. Indian Bhuvan Portal (NRSC/ISRO)  
India-specific spatial datasets including administrative, topography, and satellite imagery  
<https://bhuvan.nrsc.gov.in>



## Afterword: Take the Next Step with the UDL GIS Masterclass

Hands-On Learning to Transform How You Map, Analyse, and Design Cities

As this book has shown, spatial analysis is not simply a technical process—it is a way of thinking that enables urban professionals to better understand complexity, diagnose inequity, and shape more intelligent futures. To translate this knowledge into practice, we invite you to join the upcoming UDL GIS Masterclass — a live, immersive training experience designed for planners, architects, urban designers, and researchers seeking practical skills in QGIS.

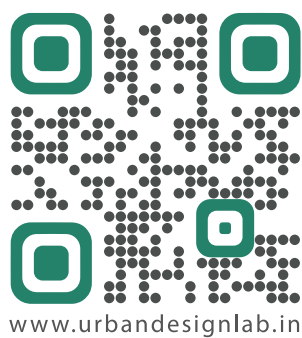


**GIS Made Easy – Learn to Map, Analyse, and Transform Urban Futures**

**Dates: 14th–18th July, 2025**

**Register: <https://urbandesignlab.in/events/masterclass/udl-gis-masterclass>**

Over five intensive sessions, participants will build foundational and advanced skills in spatial mapping—learning to navigate QGIS, work with real datasets, and produce professional-quality outputs relevant to urban planning, zoning, mobility, environmental risk, and demographics. Each session is thematically structured and includes downloadable data, guided exercises, and personalized feedback.



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LinkedIn  
[@urbandesignlab](#)



Email  
[editor@urbandesignlab.in](mailto:editor@urbandesignlab.in)



Instagram  
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