Spatial Analysis of Population, Urbanization and Transportation (2007 - 2014)

Aim of The Study

→ Exploring spatial relationship between Population, Land Use, and Transportation
→ Understanding how they interact in space & time

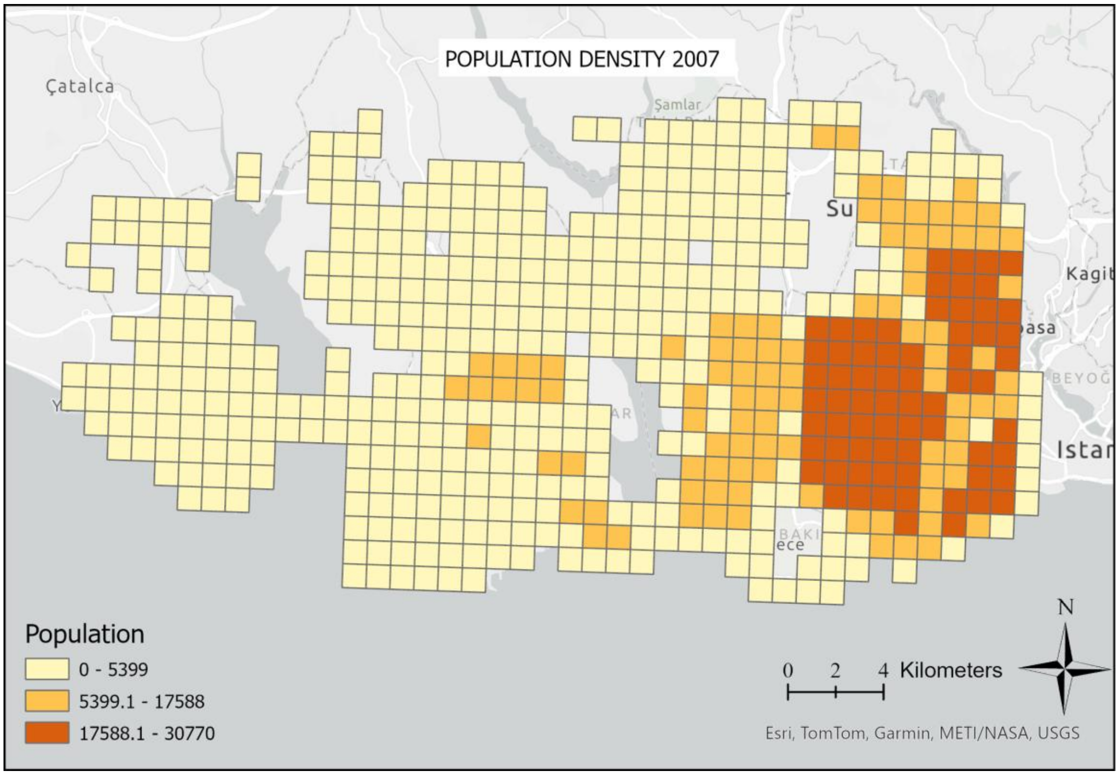
Keywords: Spatial Analysis, Urbanization, Road Network, Population Growth

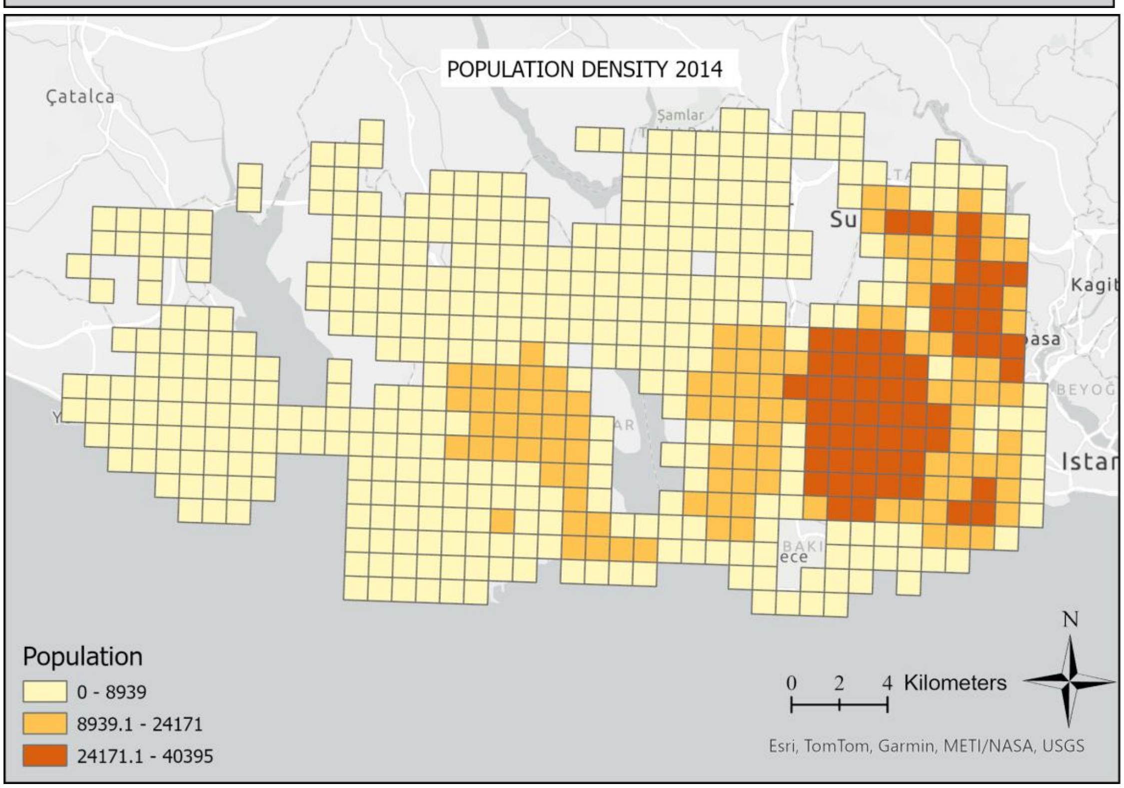
Input Data

Data	Year	Format
1km Grid	-	Polygon Vector
Population	2007 - 2014	Attribute
Urban Areas	2007 - 2014	Attribute
Road Length	2007 - 2014	Attribute
District Boundary	-	Polygon Vector

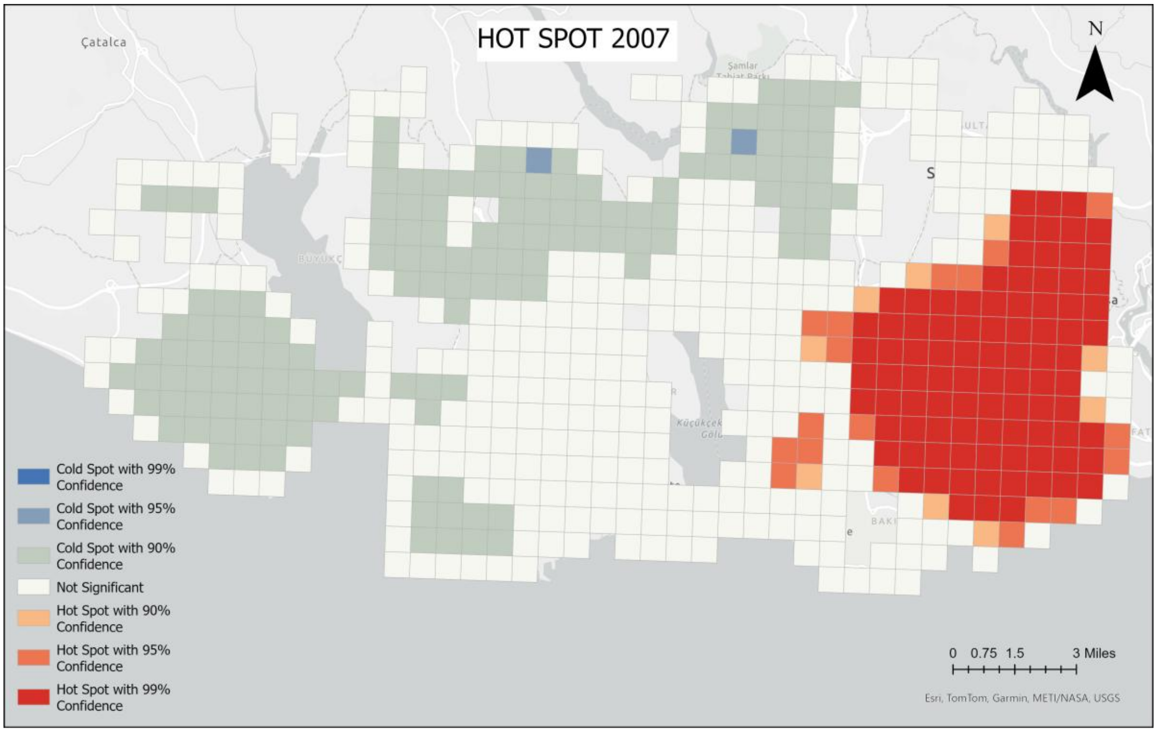
[Insert GIS Layer Screenshot Here]

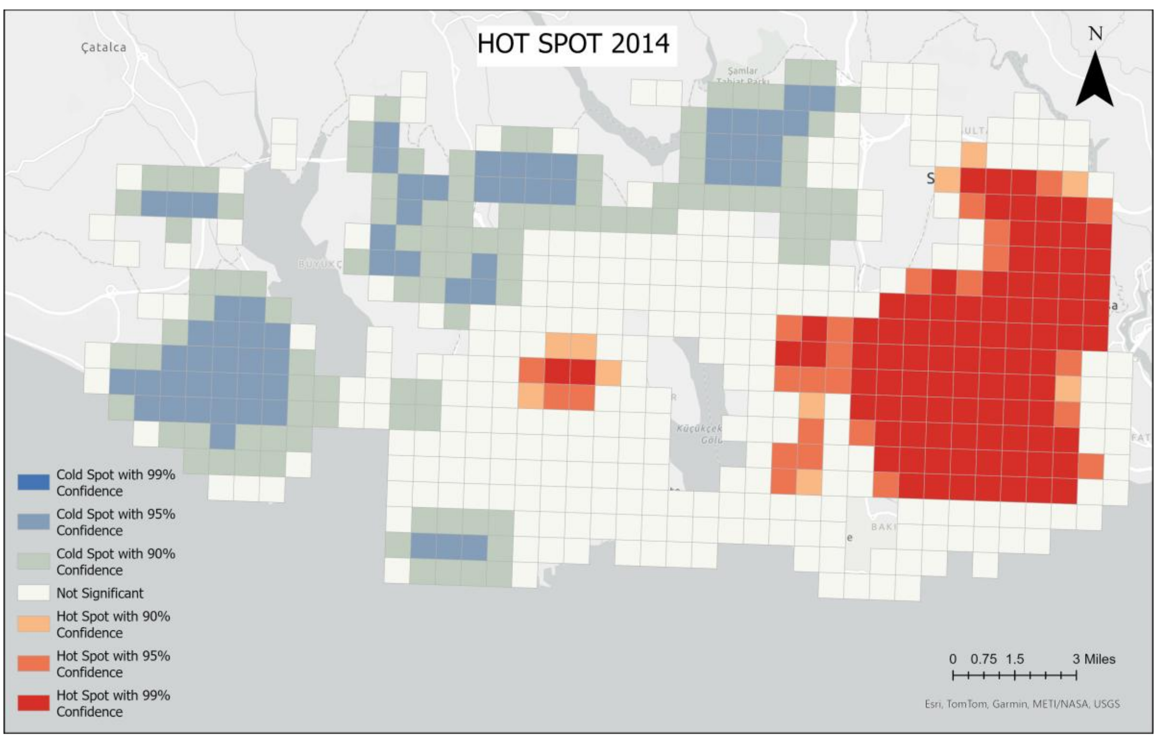
Maps & Visuals





Exploratory Spatial Data Analysis Hotspot Analysis

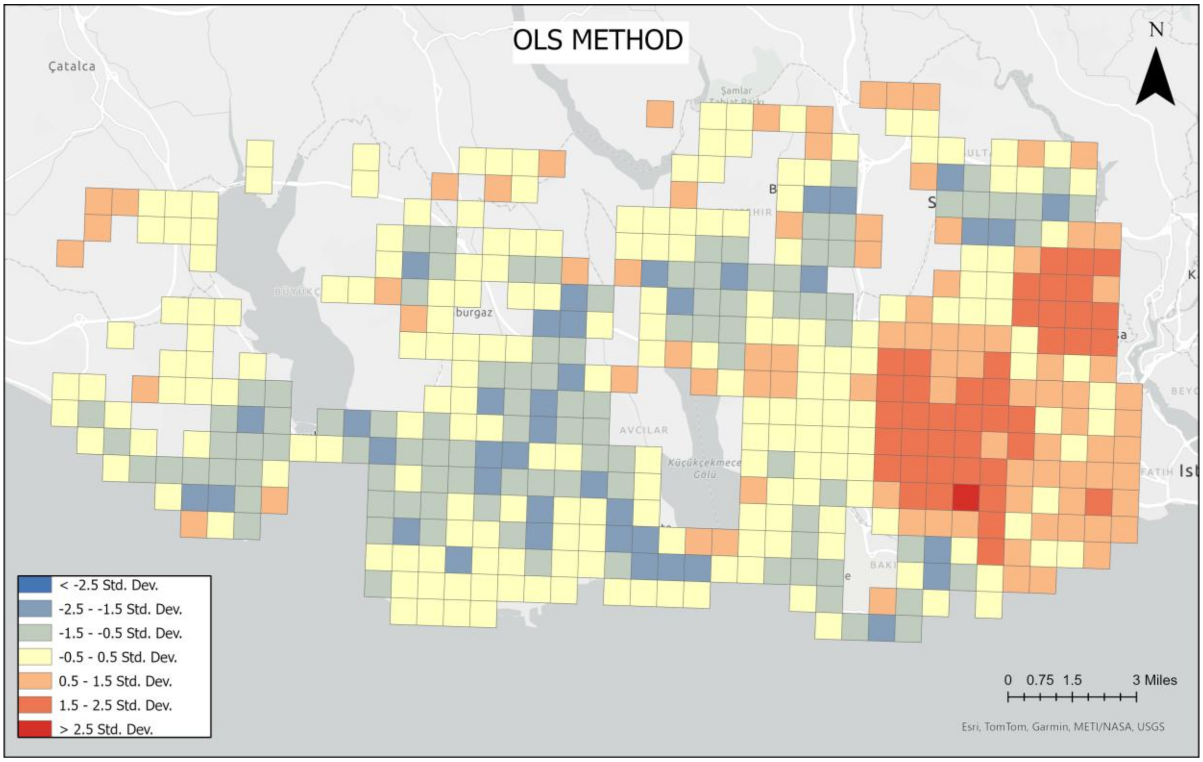




Regression Analysis

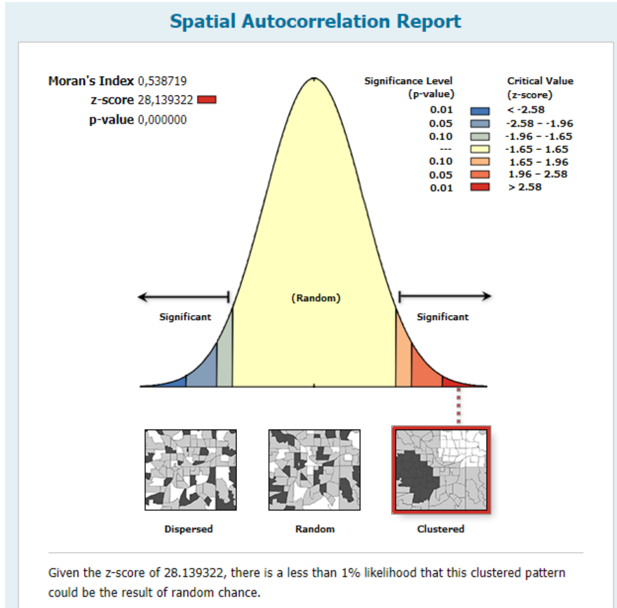
• Ordinary Least Squares (OLS) is the best known of the regression techniques.

• It provides a global model of the variable or process you are trying to understand or predict by creating a single regression equation.



After OLS, always run the Spatial Autocorrelation (Moran's I) tool on the regression residuals to ensure that they are spatially random.

Statistically significant clustering of high and low residuals (model under-and overpredictions) indicates a key variable is missing from the model (misspecification). OLS results cannot be trusted when the model is mis specified.



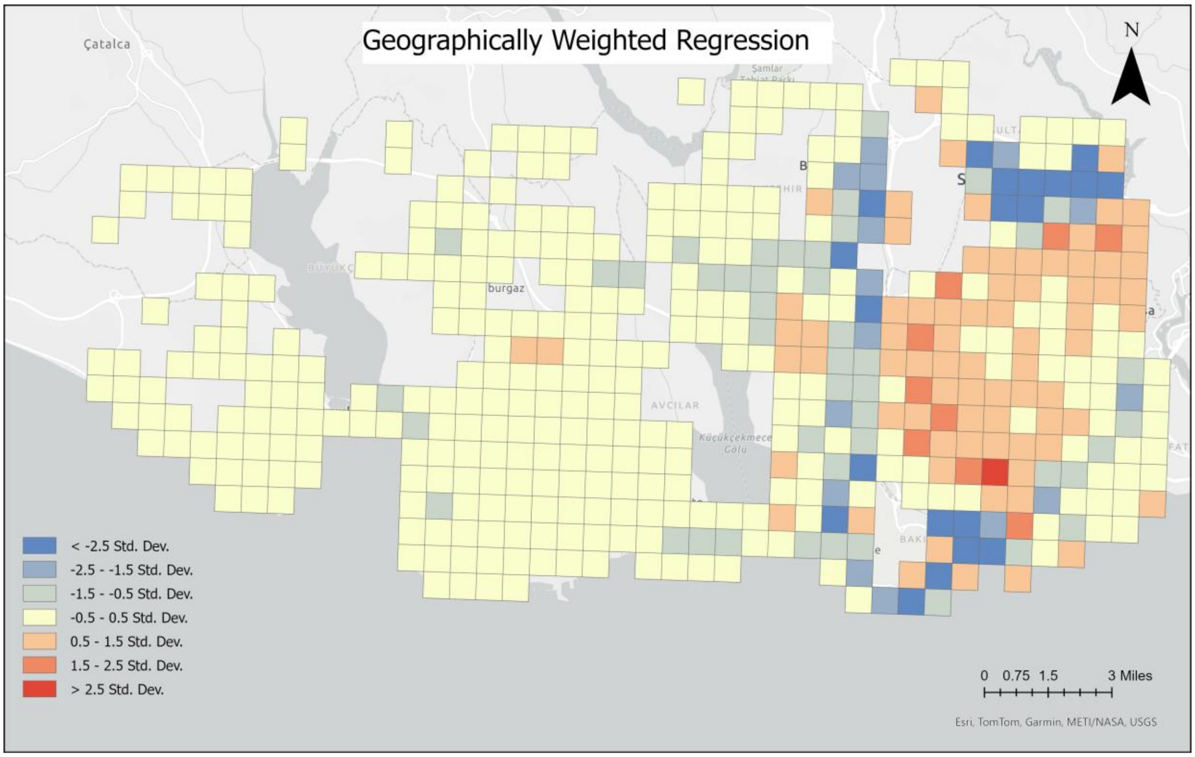
Global Moran's I Summary

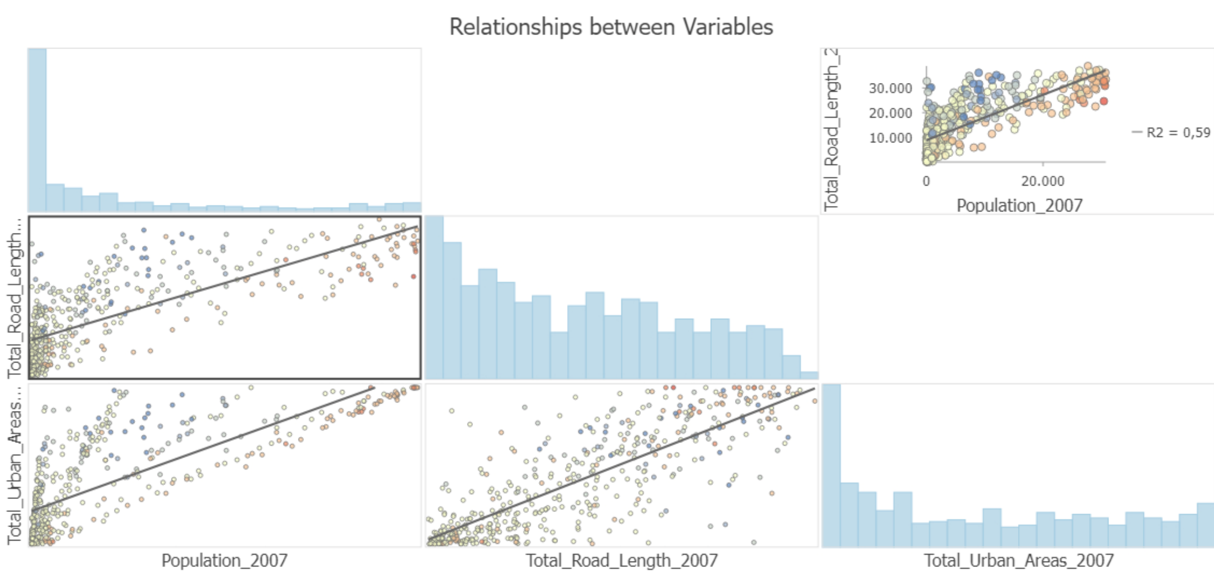
Moran's Index	0,538719
Expected Index	-0,002114
Variance	0,000369
z-score	28,139322
p-value	0,000000

According to the Spatial Autocorrelation (Moran's I) analysis, the population data of 2007 shows a significant clustering pattern (Moran's I = 0.5387, z-score = 28.13, p-value < 0.001). This result indicates that population values were not randomly distributed but rather concentrated in specific locations. The clustering pattern is statistically significant and reflects the spatial structure of urban growth and population concentration within the study area.

Geographically Weighted Regression (GWR)

Geographically Weighted Regression (GWR) is the local form of regression used to model spatially varying relationships. Local variations are interpreted better with GWR.





Population_2014	Predicted (POP_2007)
[illegible]	[illegible]
149	2822.890327
162	112.703213
163	839.969139
164	476.897369
167	-768.091646
170	196.263856
183	-93.798163
184	<Null>
184	145.152595
187	109.613595
188	-117.981146
196	7.080194
197	1853.22616
214	-3.222115
219	241.987657
221	377.481615
223	539.390461
224	755.3047
227	603.079808
235	85.994046

With GWR model, better statistical predictions were made. However, the predictions are still far from the real values. For a complex attribute such population, more exploratory variables are needed to calibrate the model.

Key Findings

There is a **positive correlation** between population, land use, and the density of the transport network; however, this connection **cannot be fully captured by linear models alone**.

Models based solely on **adjacent grid interactions** provide **better accuracy** for understanding the **spatial distribution** of variables, yet they are **limited in making broad, generalizable conclusions**.

The model was able to **correctly identify above-average densities** in areas like **Bağcılar, Bahçelievler, Esenler, Güngören, and Gaziosmanpaşa**, which are known for being among **Istanbul's most densely populated districts**.

In the model relying only on **land use and road data**, the strong results in these areas may be attributed to **vertical urban development and high-density housing**, rather than just horizontal expansion.

To address such **nonlinear relationships**, techniques like **logarithmic transformations**, **artificial neural networks**, or the **inclusion of additional independent variables** in linear models could provide more robust insights.