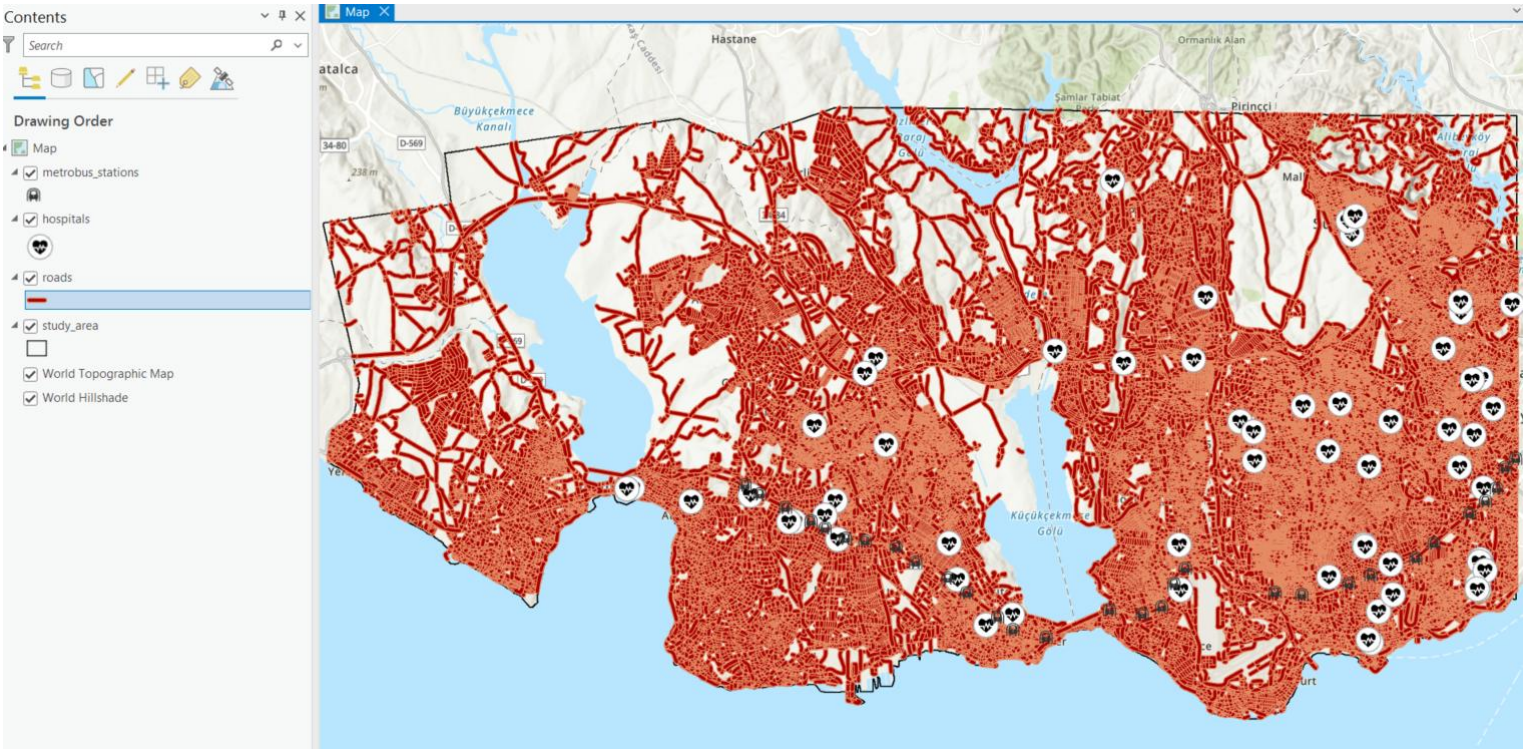
Network Analysis for Accessibility: Metrobus Stations and Hospitals in Istanbul

Aim of the Study

• To identify the shortest routes between metrobus stations.
• To generate service areas towards hospitals.
• To calculate OD (Origin-Destination) Cost Matrices for assessing accessibility between metrobus stations and hospitals using an inverse distance formula (1 / length).

Input Data

• Hospitals (Vector-Point)
• Metrobus Stations (Vector-Point)
• Road Network (Vector-Polyline)
• Study Area Boundary (Vector-Polygon)



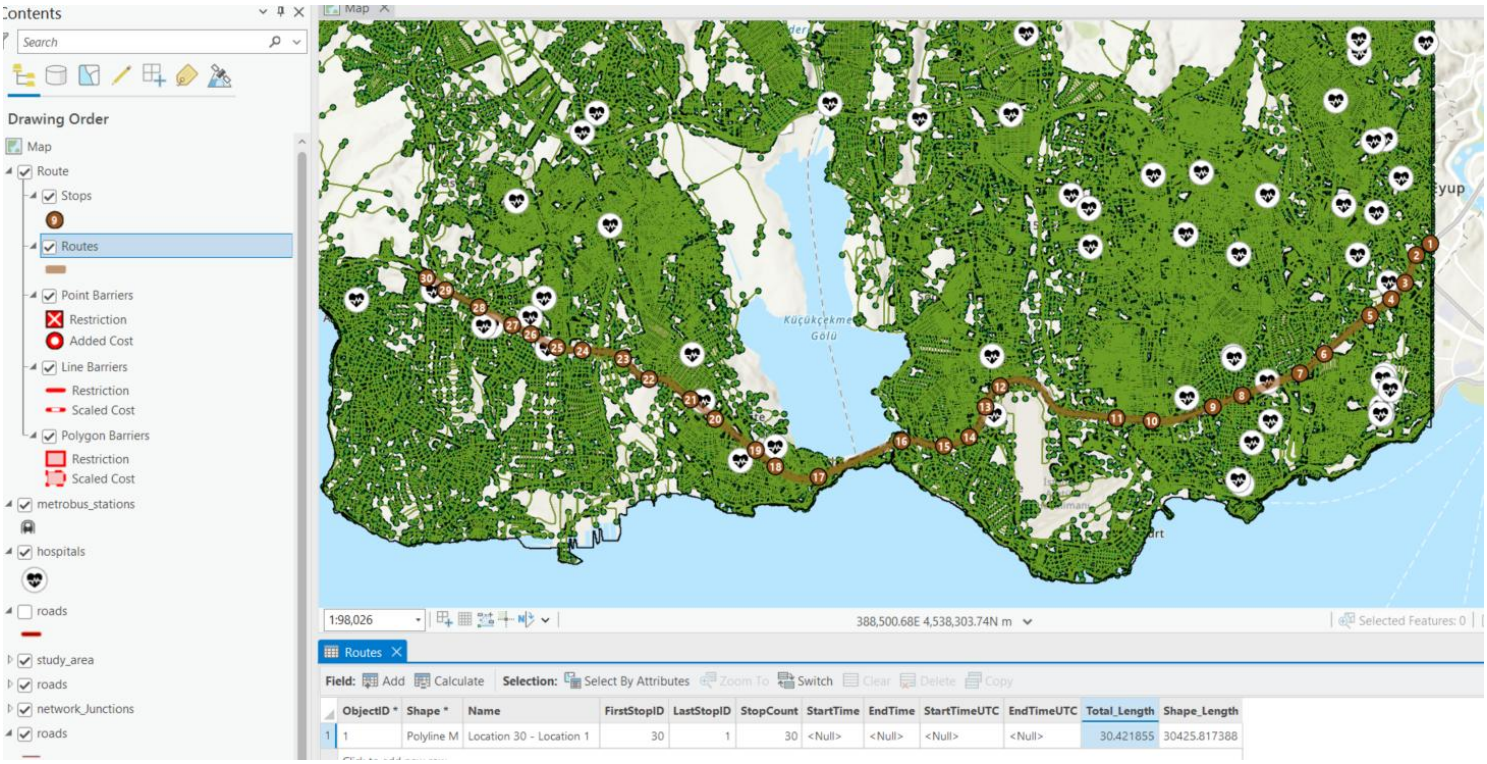
Methodology Overview

1. Create Network Dataset from road network data within the defined study area.
2. Perform Route Analysis to find the shortest path between metrobus stations.
3. Conduct Service Area Analysis to map hospital accessibility zones.
4. Generate OD Cost Matrix between metrobus stations (origins) and hospitals (destinations).
5. Calculate accessibility scores using the inverse of total route length (1/length).

Route Analysis

• Metrobus stations were imported as stops in the network dataset.
• Shortest routes between stations were calculated based on road network distances.
• The route results were exported for further analysis and visualization.

[Insert shortest route map between metrobus stations here]



This map illustrates the **optimized routes** between **30 metrobus stations** across Istanbul. The **brown lines** represent the **shortest paths** calculated through the road network dataset, ensuring efficient connectivity along the metrobus corridor.

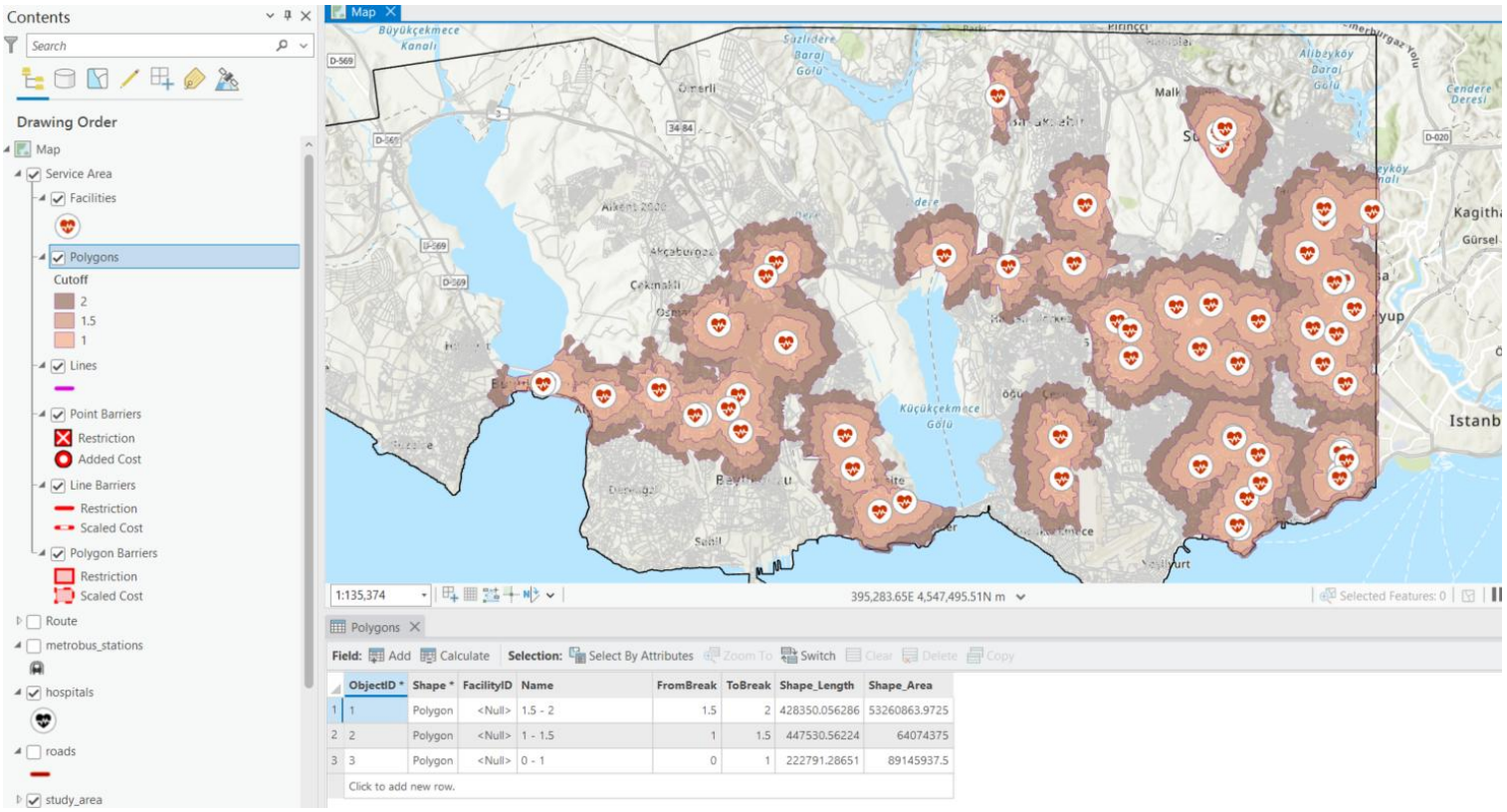
- Each station is marked with **sequential numbers** (1 to 30) for easy tracking.
- **Hospitals**, indicated by **heart icons**, are displayed for context but are not directly involved in the route calculations at this stage.
- The total route length between the **first and last station** is approximately **30.42 km**, as shown in the attribute table.

This route analysis forms the basis for **accessibility assessments** in the subsequent stages of the study.

Service Area Analysis

• Hospitals were used as facilities for generating service areas.
• Three proximity buffers were generated (1km, 1.5km, and 2km) around each hospital using network impedance.
• These service areas visualize hospital accessibility across the study area.

Hospital Accessibility Zones (Network-Based Service Area Analysis)



This map displays **network-based service areas** generated around **hospitals** in Istanbul. The service areas are classified into three distance-based zones:

- **0–1 km** (light brown)
- **1–1.5 km** (medium brown)
- **1.5–2 km** (dark brown)

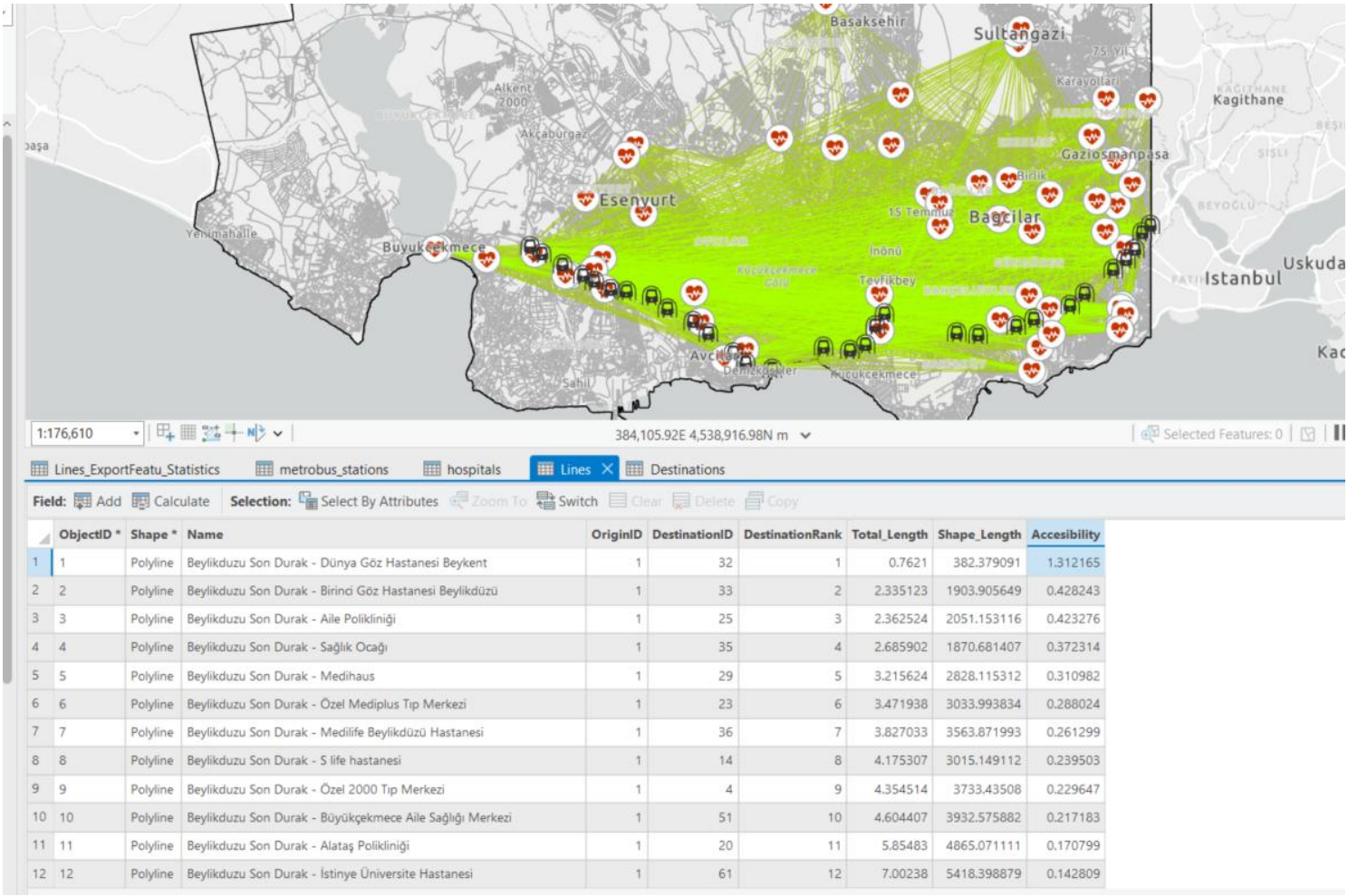
These zones represent the **maximum reachable areas** from hospitals using the **road network impedance**, reflecting **realistic access paths** rather than simple buffer distances.

The **attribute table** at the bottom shows the **area size** of each service zone, with larger areas representing more **accessible regions**. This analysis helps identify **well-covered** versus **underserved areas** in terms of healthcare facility access.

In a future analysis, these **distance-based zones** could be replaced with **time-based service areas** (e.g., 5-minute, 10-minute driving times) if travel time data becomes available.

OD Cost Matrix Analysis

• An OD Cost Matrix was generated to calculate the least-cost paths between 30 metrobus stations and 61 hospitals.
• A total of 1830 routes were computed, and the accessibility for each station-hospital pair was ranked based on distance.
• Accessibility scores were calculated using the formula 1 / Total Length to indicate better access for shorter paths.



	ObjectID *	Shape *	Name	OriginID	DestinationID	DestinationRank	Total_Length	Shape_Length	Accesibility
1	1	Polyline	Beylikduzu Son Durak - Dünya Göz Hastanesi Beykent	1	32	1	0.7621	382.379091	1.312165
2	2	Polyline	Beylikduzu Son Durak - Birinci Göz Hastanesi Beylikdüzü	1	33	2	2.335123	1903.905649	0.428243
3	3	Polyline	Beylikduzu Son Durak - Aile Polikliniği	1	25	3	2.362524	2051.153116	0.423276
4	4	Polyline	Beylikduzu Son Durak - Sağlık Ocağı	1	35	4	2.685902	1870.681407	0.372314
5	5	Polyline	Beylikduzu Son Durak - Medihaus	1	29	5	3.215624	2828.115312	0.310982
6	6	Polyline	Beylikduzu Son Durak - Özel Mediplus Tıp Merkezi	1	23	6	3.471938	3033.993834	0.288024
7	7	Polyline	Beylikduzu Son Durak - Medilife Beylikdüzü Hastanesi	1	36	7	3.827033	3563.871993	0.261299
8	8	Polyline	Beylikduzu Son Durak - S life hastanesi	1	14	8	4.175307	3015.149112	0.239503
9	9	Polyline	Beylikduzu Son Durak - Özel 2000 Tıp Merkezi	1	4	9	4.354514	3733.43508	0.229647
10	10	Polyline	Beylikduzu Son Durak - Büyükçekmece Aile Sağlığı Merkezi	1	51	10	4.604407	3932.575882	0.217183
11	11	Polyline	Beylikduzu Son Durak - Alataş Polikliniği	1	20	11	5.85483	4865.071111	0.170799
12	12	Polyline	Beylikduzu Son Durak - İstinye Üniversite Hastanesi	1	61	12	7.00238	5418.398879	0.142809

This map illustrates the **OD Cost Matrix analysis**, connecting **metrobus stations (origins)** to **hospitals (destinations)** across Istanbul. The **green lines** represent the **least-cost paths** calculated through the **road network dataset**.

- **Accessibility scores** were computed using the formula **1 / Total Length**, where **shorter distances** result in **higher accessibility values**.
- The **attribute table** shows key outputs:

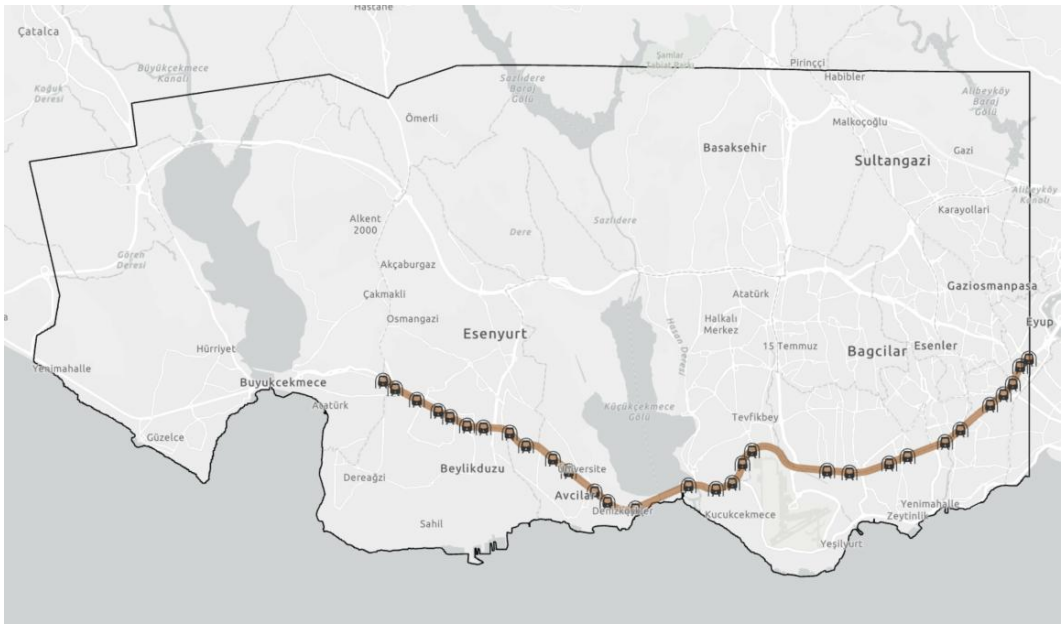
  - **OriginID & DestinationID** identify the **station-hospital pairs**
  - **Total_Length** represents the **network distance (km)** between each pair
  - **DestinationRank** orders hospitals by proximity for each station
  - **Accessibility** quantifies the **ease of access** (higher values = better access)

For instance, the **Beylikdüzü Son Durak metrobus station (OriginID 1)** has its **highest accessibility** to **Dünya Göz Hastanesi Beykent**, with a **network distance of 0.76 km**.

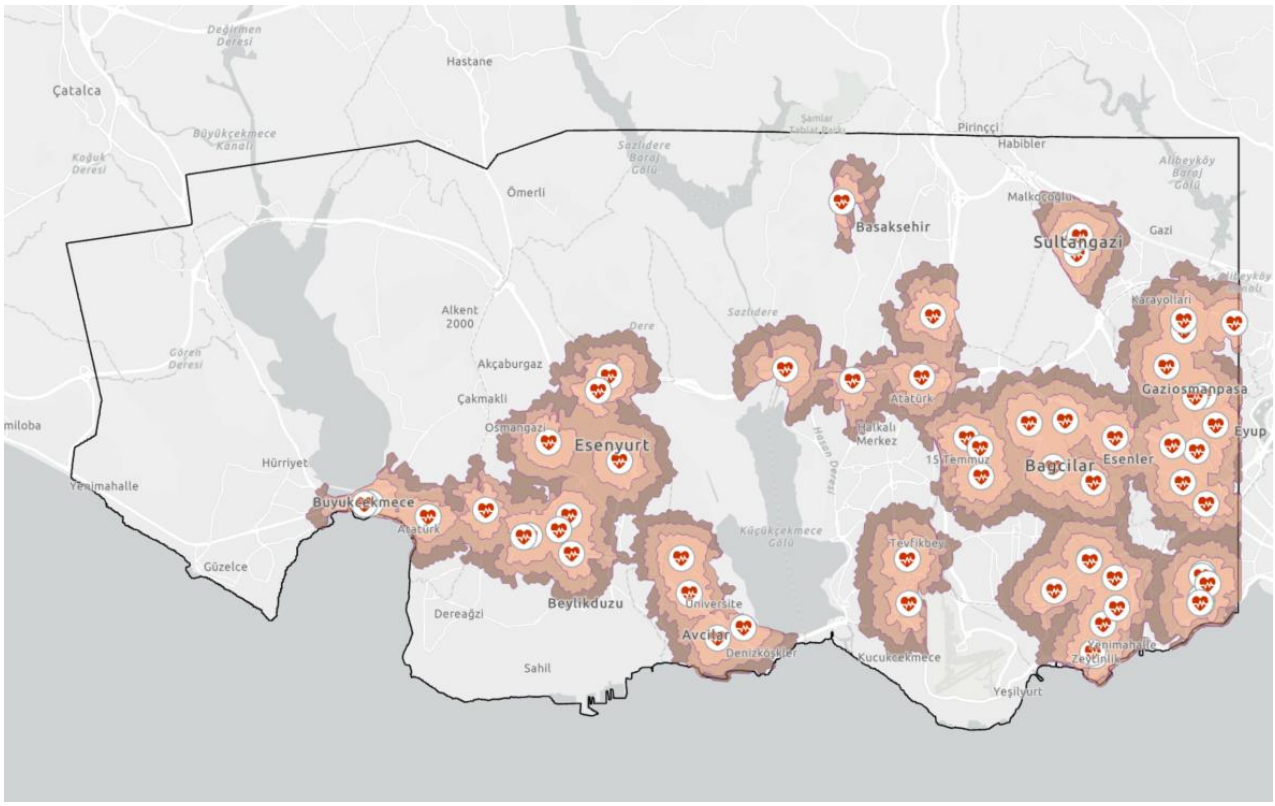
This analysis supports the **evaluation of healthcare accessibility** from **public transit nodes**, revealing **well-connected** and **underserved** areas within the study region.

Results & Evaluation

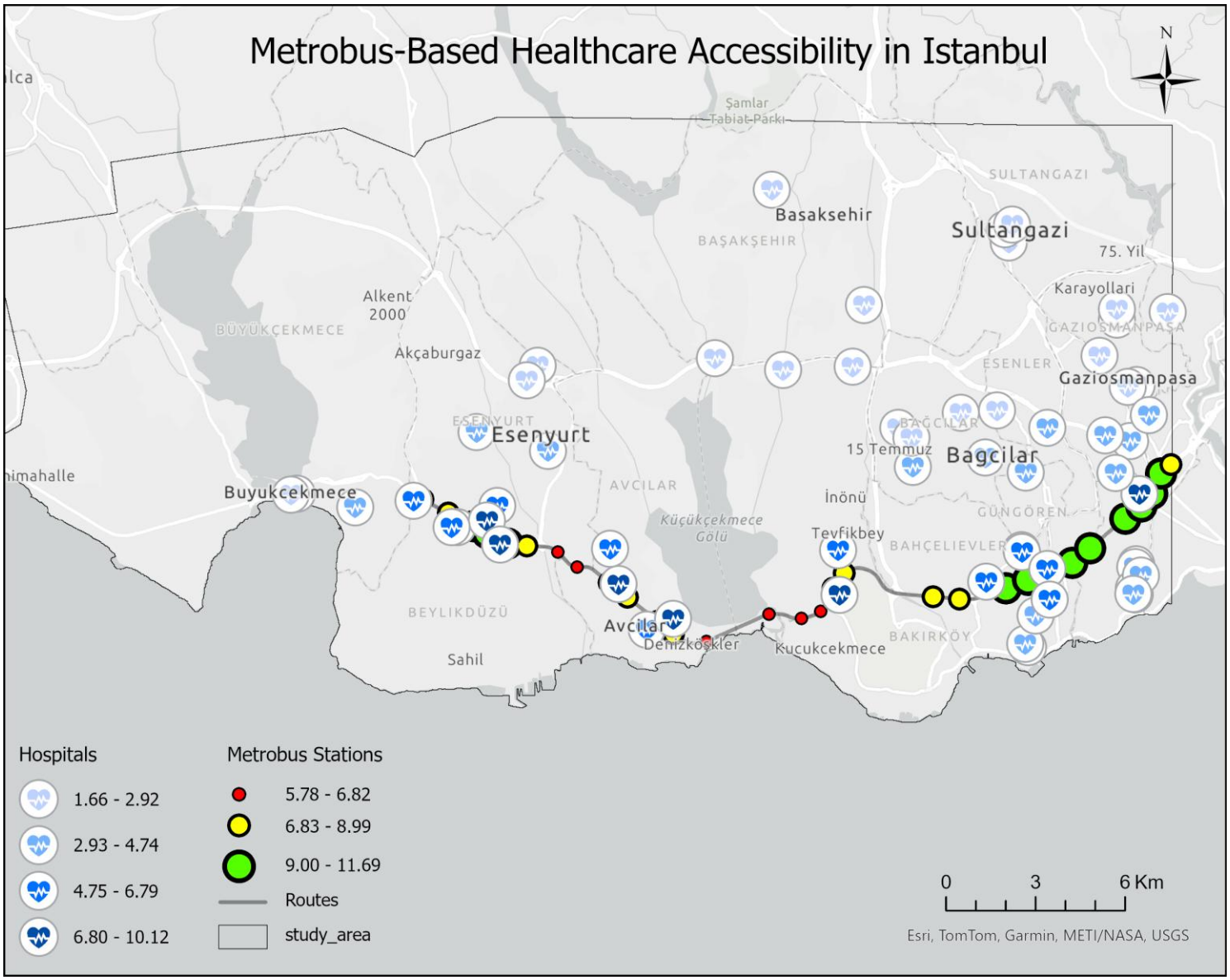
• **Shortest Routes:** Metrobus network optimized with shortest path calculations.



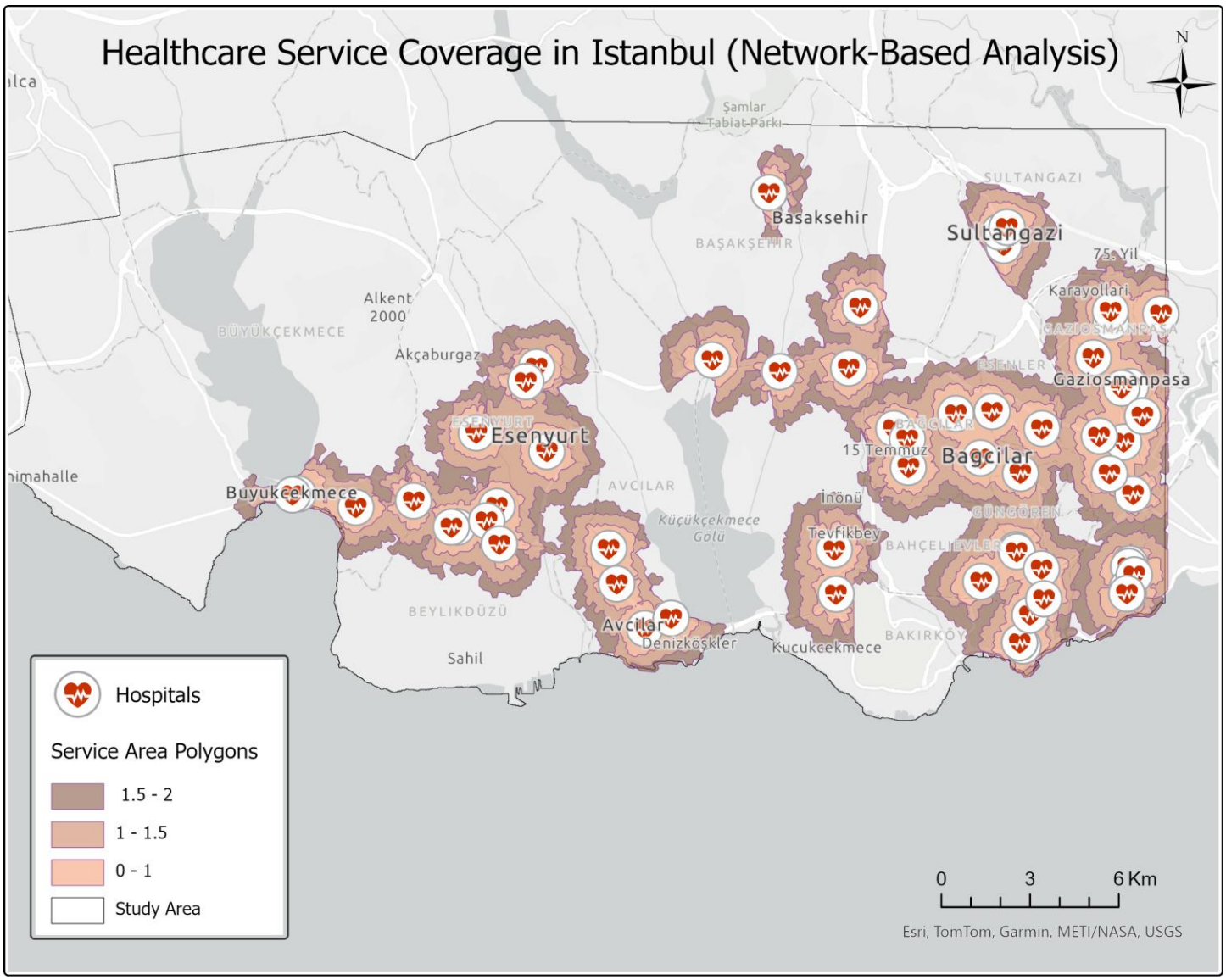
• **Service Areas:** Hospital accessibility visualized with 1km, 1.5km, and 2km network-based buffers.



Output Data:
• Hospitals with Accessibility values (Vector-Point)
• Metrobus Stations with Accessibility values (Vector-Point)
• Network Dataset (Network)
• Nodes (Vector-Point), Edges (Vector-Polyline)
• Shortest Route (Vector-Polyline)
• Service Area Polygons (Vector-Polygon)



Metrobus stations and hospitals are symbolized based on accessibility scores. The color ramp (red to green) for stations and blue shades for hospitals represent spatial variation in healthcare access across the city.



This map displays the healthcare accessibility zones across Istanbul, highlighting the areas within 1 km, 1.5 km, and 2 km road network distance from hospitals. The service area analysis helps identify both well-served regions and potential gaps in hospital coverage.