# Quantifying the Spatial Accessibility of Major Sports Infrastructure: A Geospatial Analysis of the Allegiant Stadium's Regional Reach in Nevada

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# Quantifying the Spatial Accessibility of Major Sports Infrastructure: A Geospatial Analysis of the Allegiant Stadium's Regional Reach in Nevada

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**Abstract**

Major sports infrastructure investments represent significant commitments of public and private capital, yet their spatial accessibility — the degree to which surrounding communities can physically access the venue — remains inadequately quantified in the urban planning literature. This study presents a geospatial analysis of the Allegiant Stadium in Las Vegas, Nevada, examining the spatial distribution of 517 towns across the state relative to the stadium using geodesic distance computation. The analysis employs a Geographic Information System (GIS) pipeline utilizing U.S. Census Bureau shapefiles processed with the GeoPandas library, coordinate reference system transformation from NAD 1983 Albers to WGS84, and geodesic distance calculation via the Geopy library's WGS84 ellipsoid model. Results reveal a highly uneven accessibility distribution, with 20 towns located within 26 kilometers of the stadium — predominantly in the Las Vegas metropolitan area — while rural communities in northern Nevada are situated over 500 kilometers away. Distance-based heatmap and bar chart visualizations illustrate the concentration of accessible communities and the sharp accessibility gradient across the state. The findings contribute to the growing literature on infrastructure accessibility assessment and provide a reproducible methodological framework applicable to spatial analysis of major infrastructure projects in urban and regional planning contexts. The methodology demonstrates the practical utility of open-source geospatial tools for quantifying the catchment area and regional reach of large-scale public amenities.

**Keywords:** geospatial analysis; spatial accessibility; sports infrastructure; GIS; geodesic distance; urban planning; allegiant stadium

## 1. Introduction

The construction of major sports venues represents one of the most significant categories of urban infrastructure investment in the United States. Between 1970 and 2020, state and local governments devoted approximately $33 billion in public funds to the construction of major-league sports venues (Bradbury et al., 2023). These investments are frequently justified on the basis of expected economic development, community revitalization, and regional accessibility benefits. However, while the economic impacts of sports facilities have been extensively studied (Bradbury et al., 2023; Santo, 2005), the spatial dimension of infrastructure accessibility — the physical relationship between a venue and the communities it ostensibly serves — has received comparatively less systematic quantitative attention.

The Allegiant Stadium, located in Paradise, Nevada, represents a particularly instructive case for spatial accessibility analysis. Opened in 2020 as the home of the Las Vegas Raiders (NFL) and the University of Nevada, Las Vegas (UNLV) Rebels football team, the 65,000-seat venue was constructed at an estimated cost of $1.9 billion, with $750 million in public financing approved by the Nevada legislature. The stadium's location in the southern tip of a geographically large and sparsely populated state creates a natural experiment in spatial accessibility: while communities in the Las

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Vegas metropolitan area enjoy proximity to the venue, the vast majority of Nevada's territory lies at considerable distance.

Understanding the spatial reach of such infrastructure is relevant to multiple stakeholders. For urban planners, accessibility analysis informs decisions about transportation infrastructure, public transit extensions, and land use planning in the vicinity of major venues. For policymakers who approve public financing, the geographic distribution of accessibility provides evidence regarding which communities derive spatial benefit from the investment. For economic impact researchers, the identification of a venue's catchment area establishes the geographic scope within which direct economic effects may be observed.

This study employs a GIS-based methodology to quantify the geodesic distance between the Allegiant Stadium and every recorded town in Nevada (N=517), using U.S. Census Bureau geospatial data. The analysis identifies the distribution of accessibility across the state, characterizes the nearest communities, and provides visualizations that communicate the spatial relationship between the venue and the population it serves.

### *1.1. Research Objectives*

This study pursues three specific objectives: (1) to compute the geodesic distance between the Allegiant Stadium and all 517 recorded towns in Nevada using authoritative geospatial data; (2) to characterize the spatial distribution of accessibility, identifying both the immediate catchment area and the accessibility gradient across the state; and (3) to demonstrate a reproducible geospatial methodology applicable to the spatial assessment of major infrastructure projects.

## 2. Literature Review

### *2.1. Economic Impact of Sports Infrastructure*

The economic effects of professional sports venues have been the subject of extensive scholarly investigation. Bradbury et al. (2023) provide a comprehensive survey of over 130 studies spanning more than 30 years, concluding that sports venues generally produce limited tangible economic impacts on host communities and that public subsidies typically exceed any observed economic benefits. Santo (2005) similarly found that the economic impact claims associated with stadium construction are frequently overstated, emphasizing the need for more rigorous analytical frameworks that account for the geographic scope of potential effects.

Despite this robust literature on economic impacts, relatively few studies have systematically quantified the spatial accessibility of sports venues — that is, the physical distance and travel burden that communities at varying distances must bear to access the facility. This gap is significant because the geographic distribution of accessibility directly affects who benefits from a public investment and informs debates about the equity of public financing arrangements.

### *2.2. Geospatial Analysis in Urban Planning*

Geographic Information Systems (GIS) have become fundamental tools in urban planning and infrastructure assessment. Modern geospatial analysis leverages open-source software ecosystems, with Python-based libraries such as GeoPandas, Shapely, and Geopy providing accessible platforms for spatial data processing and analysis. GeoPandas extends the Pandas data manipulation library to support spatial operations on geometric objects, enabling efficient processing of vector data formats including shapefiles (Jordahl et al., 2021). Geopy provides geocoding utilities and geodesic distance computation using the WGS84 ellipsoid model, which offers higher accuracy than great-circle approximations by accounting for the Earth's equatorial bulge.

Spatial accessibility analysis has been applied across multiple infrastructure domains, including healthcare facility access, public transit coverage, and educational institution reach. These studies typically employ distance-based metrics, travel time calculations, or gravity models to quantify the

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degree to which surrounding populations can access a given facility. The present study applies this established methodological approach to the domain of sports infrastructure, contributing a quantitative assessment that complements the existing economic impact literature.

### *2.3. The Allegiant Stadium Context*

The Allegiant Stadium occupies a significant position in contemporary discussions about sports infrastructure policy. The $750 million in public financing approved by the Nevada legislature in 2016 made it one of the largest public commitments to a sports venue in U.S. history at the time of approval. The stadium has since hosted NFL games, UNLV football, the Las Vegas Grand Prix (Formula 1), and numerous concerts and events, establishing it as a major regional amenity.

Nevada's geographic characteristics make it a particularly informative setting for accessibility analysis. The state encompasses approximately 286,000 square kilometers (110,500 square miles), making it the seventh-largest U.S. state by area. However, its population of approximately 3.1 million is heavily concentrated in the southern Clark County region surrounding Las Vegas, with the northern regions around Reno and vast rural areas representing substantially lower population densities. This geographic and demographic structure creates a pronounced accessibility gradient that the present analysis quantifies.

## 3. Methodology

### *3.1. Data Source*

The geospatial data for this study were obtained from the U.S. Census Bureau's geographic database. Specifically, the Nevada towns shapefile (nv_towns.shp) was utilized, containing point geometries and attribute data for 517 towns across the state. The shapefile attributes include town name (GNIS_NAME), county name (CNTYNAME), elevation (ELEV), latitude (LAT), longitude (LONG), feature classification (FEATURE), and FIPS codes for jurisdictional identification. The original coordinate reference system of the shapefile was NAD 1983 Albers (a projected coordinate system commonly used by U.S. federal agencies), which was transformed to WGS84 (EPSG:4326) — the standard geographic coordinate system — to enable geodesic distance computation.

### *3.2. Reference Point*

The Allegiant Stadium, located in Paradise, Nevada, was established as the reference point for all distance calculations. The stadium coordinates were specified as latitude 36.090794°N, longitude 115.183952°W, based on publicly available geographic data.

### *3.3. Distance Computation*

Geodesic distances between the stadium coordinates and each town's centroid were computed using the Geopy library's geodesic function, which implements the Karney (2013) algorithm on the WGS84 ellipsoid. This method was selected over great-circle distance computation because the ellipsoidal model accounts for the Earth's oblateness, providing higher accuracy particularly for longer distances. The computation was applied iteratively to all 517 town geometries, with input validation to ensure latitude values fell within the valid range of -90° to 90° and longitude values within -180° to 180°.

### *3.4. Coordinate Reference System Transformation*

The original shapefile employed the NAD 1983 Albers projection, which stores coordinates in meters as easting/northing values rather than latitude/longitude. Prior to distance computation, the GeoDataFrame was reprojected to WGS84 (EPSG:4326) using the GeoPandas to_crs() method, which applies the appropriate datum transformation to convert projected coordinates into geographic coordinates suitable for geodesic computation.

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*3.5. Visualization*

Three visualization approaches were employed to communicate the spatial distribution of distances. First, a heatmap was generated using the Seaborn library to display the full distribution of distances across all 517 towns, providing a synoptic view of the accessibility gradient. Second, a bar chart of all towns' distances was produced using Matplotlib to show the full range and distribution of distances. Third, a focused bar chart of the 20 nearest towns was generated to characterize the immediate catchment area in detail.

*3.6. Software Environment*

All analyses were conducted in Python 3.10 within a Google Colaboratory environment. The following libraries were utilized: GeoPandas (v0.13.2) for geospatial data handling, Geopy for geodesic distance computation, Matplotlib and Seaborn for visualization, and Pandas for data manipulation.

## 4. Results

*4.1. Distance Distribution Overview*

Geodesic distances were successfully computed for all 517 towns in the Nevada dataset. The distances ranged from approximately 1 kilometer (for Bracken, the nearest recorded town) to over 700 kilometers (for towns in the northwestern corner of the state near the Oregon border). The mean distance across all 517 towns was approximately 300 kilometers, with a standard deviation reflecting the geographic concentration of towns in the southern portion of the state.

The heatmap visualization (Figure 1) and bar chart of all towns (Figure 2) revealed a bimodal distribution pattern: a cluster of towns at relatively short distances (within the Las Vegas metropolitan area) and a dispersed set of towns at substantially greater distances throughout the rest of the state. This pattern reflects Nevada's demographic structure, where population concentration in the south creates a pocket of high accessibility surrounded by vast, sparsely populated territory.

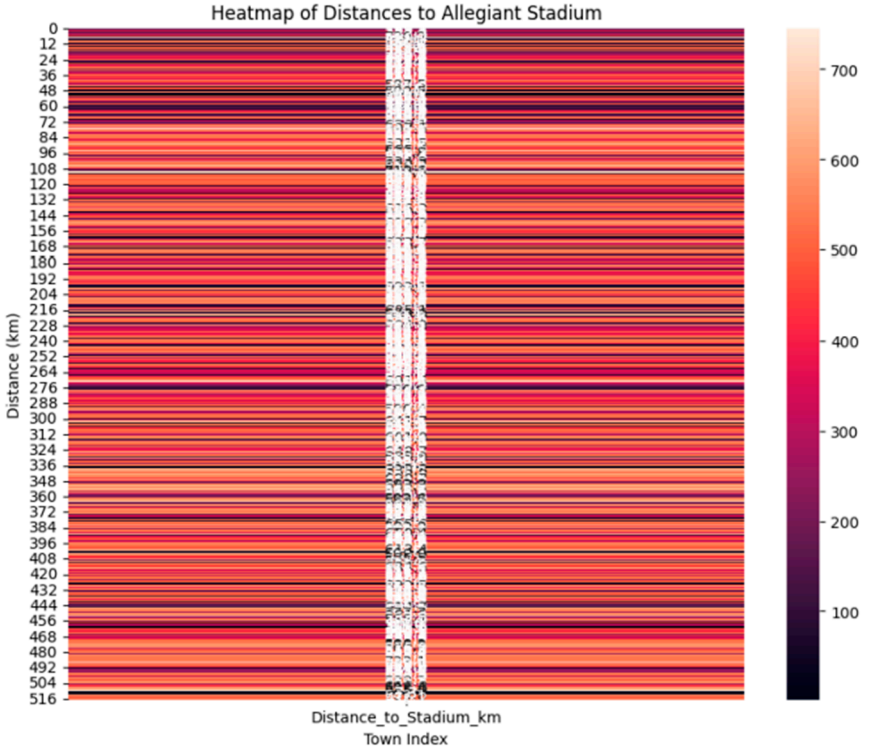


**Figure 1.**

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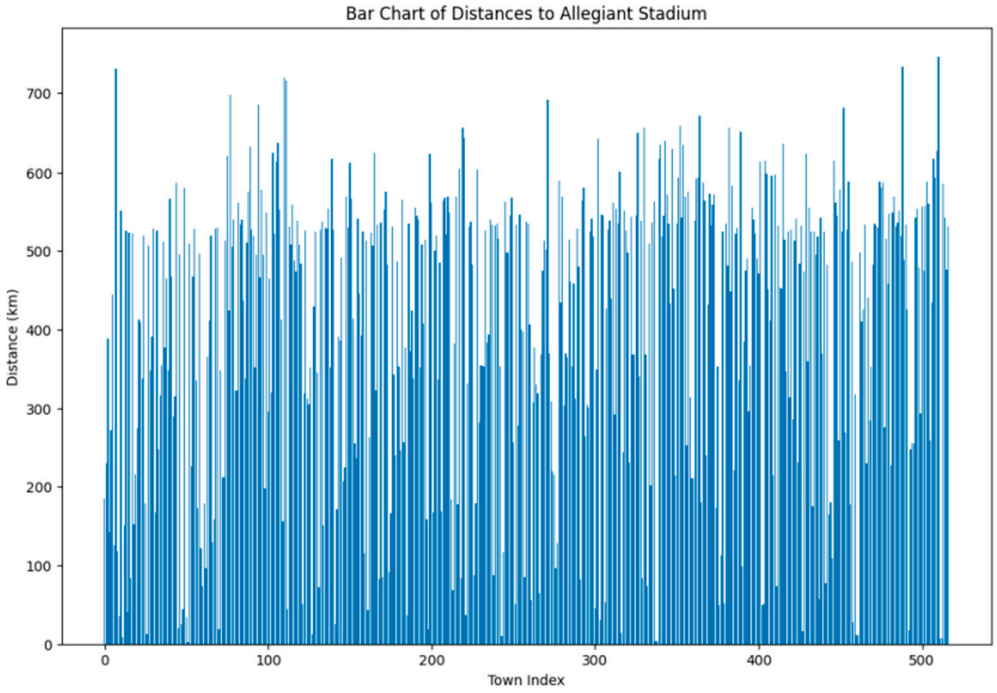


**Figure 2.**

*4.2. Immediate Catchment Area*

The 20 nearest towns to the Allegiant Stadium (Figure 3) are all located within the Las Vegas metropolitan area and surrounding Clark County communities. In ascending order of distance, these include Bracken (approximately 1 km), Paradise (approximately 2 km), Winchester (approximately 4 km), Arden (approximately 5 km), Las Vegas (approximately 6 km), The Lakes (approximately 7 km), Baird (approximately 8 km), East Las Vegas (approximately 9 km), North Las Vegas (approximately 11 km), Sloan (approximately 12 km), Warm (approximately 13 km), Henderson (approximately 15 km), Carver Park (approximately 17 km), Blue Diamond (approximately 19 km), Bonnie Springs (approximately 21 km), Erie (approximately 25 km), and Texas Acres (approximately 26 km).

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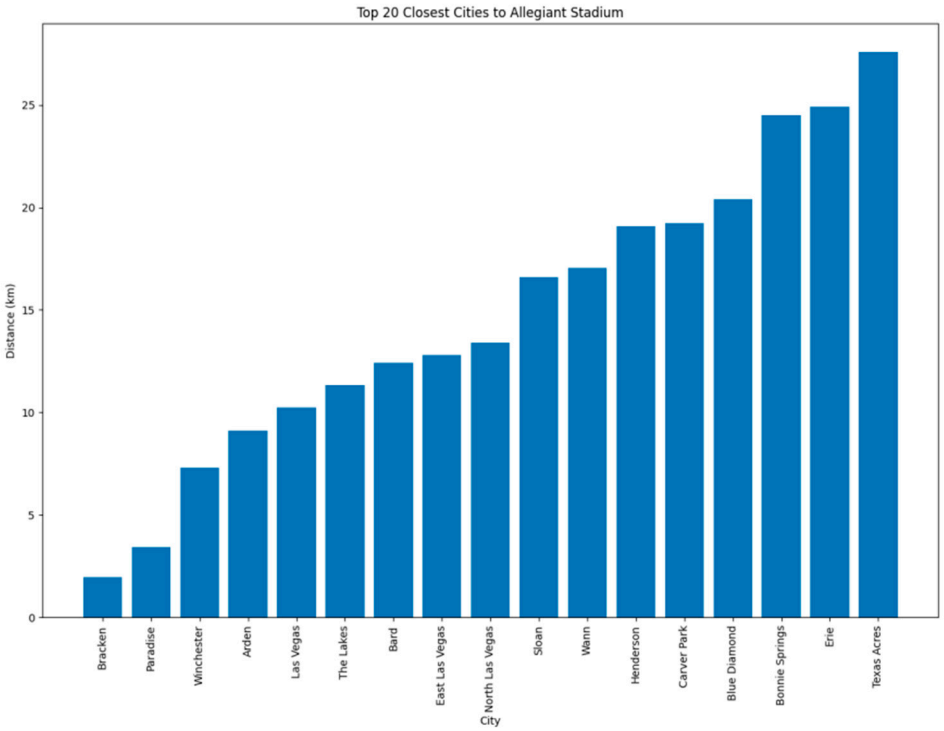


**Figure 3.**

This immediate catchment area encompasses the core of the Las Vegas metropolitan statistical area, which contains approximately 2.2 million residents — roughly 70% of Nevada's total population. The finding that the 20 nearest towns are all within 26 kilometers of the stadium indicates a concentrated accessibility footprint that aligns closely with the existing urban fabric.

### *4.3. Accessibility Gradient*

Beyond the immediate catchment area, distances increase rapidly. Towns in central Nevada (such as Tonopah) are located approximately 300-350 kilometers from the stadium, while the Reno-Sparks metropolitan area in the northwest — the state's second-largest population center — is situated approximately 440 kilometers away. The most distant recorded towns exceed 600 kilometers, representing travel times of 6-7 hours by automobile.

This steep accessibility gradient has implications for the interpretation of the stadium's regional reach. While the facility is highly accessible to the majority of Nevada's population by virtue of the state's demographic concentration in Clark County, it is effectively inaccessible as a regular amenity for communities in northern and central Nevada.

## 5. Discussion

### *5.1. Interpretation of Findings*

The geospatial analysis reveals a fundamental asymmetry in the Allegiant Stadium's spatial accessibility across Nevada. The facility's location in the Las Vegas metropolitan area ensures high accessibility for approximately 70% of the state's population, concentrated within 26 kilometers of the venue. However, this concentration also means that approximately 30% of Nevada's residents, distributed across the remainder of the state's large geographic area, face travel distances that effectively preclude regular access.

This finding contributes a spatial dimension to the broader literature on sports infrastructure impact. While Bradbury et al. (2023) and others have documented limited economic impacts of sports venues at the metropolitan level, the present analysis demonstrates that even the spatial footprint of

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a major venue is geographically constrained. The economic impact debate may benefit from explicit consideration of the accessibility gradient, as communities beyond the immediate catchment area are unlikely to derive direct benefits from proximity to the facility.

### *5.2. Methodological Contribution*

The GIS pipeline demonstrated in this study — combining U.S. Census Bureau shapefiles, coordinate system transformation, geodesic distance computation, and multi-format visualization — represents a reproducible methodology applicable to a wide range of infrastructure accessibility assessments. The use of open-source tools (Python, GeoPandas, Geopy) and publicly available data (U.S. Census Bureau) ensures that the methodology can be replicated by researchers and practitioners without proprietary software requirements.

This approach can be extended to analyze the spatial reach of other major infrastructure investments, including hospitals, universities, transit hubs, and commercial developments. The combination of precise geodesic computation with comprehensive census-derived town data provides a more accurate assessment than simplified straight-line or Euclidean distance measures.

### *5.3. Policy Implications*

For policymakers evaluating public financing of sports infrastructure, the accessibility analysis provides quantitative evidence regarding which communities can physically access the facility. In the case of the Allegiant Stadium, the finding that accessibility is concentrated within the Las Vegas metropolitan area suggests that the primary spatial beneficiaries are communities that already constitute the state's economic and population center. Rural and northern Nevada communities, while contributing to the state tax revenues that partially finance the facility, derive minimal spatial accessibility benefit.

This analysis does not address whether the economic or social benefits of the stadium reach beyond its spatial catchment area through indirect mechanisms such as tourism, state branding, or media exposure. However, it establishes the spatial boundaries within which direct accessibility benefits are concentrated, providing an empirical foundation for more nuanced policy discussions.

### *5.4. Limitations*

Several limitations should be acknowledged. First, the analysis uses geodesic (straight-line) distance rather than road network distance or travel time, which would provide a more realistic measure of practical accessibility. Geodesic distance systematically underestimates actual travel distance, particularly in terrain like Nevada's where mountain ranges and desert may necessitate circuitous routing. Second, the analysis uses town centroids as point locations and does not account for the spatial extent of communities or population distribution within them. Third, the temporal dimension of accessibility — including event scheduling, traffic congestion during events, and public transit availability — is not captured. Fourth, the U.S. Census Bureau shapefile represents officially recorded towns, which may not comprehensively cover all populated places or residential areas.

Future research should address these limitations by incorporating road network analysis (using tools such as OSRM or Google Directions API), population-weighted accessibility measures, and temporal accessibility modeling that accounts for event-related transportation dynamics.

## 6. Conclusion

This study conducted a comprehensive geospatial analysis of the Allegiant Stadium's spatial accessibility across Nevada, computing geodesic distances between the venue and 517 towns using U.S. Census Bureau data and open-source GIS tools. The analysis reveals a highly concentrated accessibility footprint, with 20 towns within 26 kilometers of the stadium — all within the Las Vegas metropolitan area — and a steep accessibility gradient that renders the facility effectively inaccessible as a regular amenity for communities in central and northern Nevada.

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The findings contribute to the literature on sports infrastructure assessment by providing a quantitative spatial dimension that complements existing economic impact analyses. The demonstrated methodology — combining shapefile processing, coordinate transformation, geodesic computation, and multi-format visualization — offers a reproducible framework applicable to the spatial evaluation of major infrastructure investments across multiple domains.

As public investment in sports infrastructure continues to generate policy debate, systematic spatial accessibility analysis provides evidence-based insights regarding the geographic distribution of facility benefits. By quantifying who can access what, and how far they must travel to do so, this approach supports more informed and equitable infrastructure investment decisions.

**Data Availability Statement:** The Nevada towns shapefile used in this study is derived from the U.S. Census Bureau geographic database and is publicly available through the Census Bureau's TIGER/Line Shapefiles program (https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html). The Allegiant Stadium coordinates are publicly available geographic information.

**Conflicts of Interest:** The author declares no conflict of interest.

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