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(RESEARCH ARTICLE)

# Geographic Information Systems-Based (GIS) Accessibility Analysis for Neighbourhood Parks: The Case of McDonough County, Illinois

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## Abstract

Open green areas and urban parks are important for quality of life in urbanized societies. Existing research shows natural elements in urban settings like trees and water contribute to well-being in various ways by offering environmental services and leisure spaces. This study examines the accessibility of neighborhood parks in McDonough County, Illinois using Geographic Information Systems (GIS) network analysis. The objectives are to evaluate spatial distribution, sufficiency, and accessibility of local parks to determine if services are adequately reaching the current population based on proximity and ideal walking distances.

Neighborhood parks within a 10-minute walking distance are essential for residents' daily recreational needs. Sustainable development strategies require equitable access to public amenities. Accessibility measures like maximum travel distances, field sizes, and population densities inform park placement decisions. This research uses GIS tools to determine neighborhood park service areas by 5- and 10-minute driving and walking distances from park access points. Census data provides residential population distributions for sufficiency analysis. Field sizes are evaluated against optimal sizes for neighborhood park functions. Spatial indices establish degrees to which homes fall within optimally accessible park radii.

Findings indicate some areas lack nearby parks. New development prioritizations are suggested. Photos from participant narratives reveal design elements supporting active travel. Innovative technologies tracking behaviors supplement statistical models. This interdisciplinary study integrates planning and public health by employing GIS, sensors, and user perspectives to examine relationships between the built environment, travel behaviors, and health. Results help design more activity-enabling landscapes. By addressing accessibility and residents' concerns, planning can enhance quality of life. Combating inactivity through improved greenspace provisions makes communities healthier and more livable.

**Keywords:** Accessibility; GIS; Network analysis; Urban parks; McDonough County; Spatial distribution; Neighbourhood parks; Census data; Population coverage

## 1. Introduction

Access to neighbourhood parks and the spatial distribution of green spaces within communities are important factors that influence quality of life, recreational opportunities, and public health outcomes for residents. As municipalities grapple with challenges related to urbanization, infrastructure planning and development must prioritize the equitable provision of amenities such as parks to benefit populations across all demographics. While parks provide venues for

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recreation, social connection, and mental restoration, their impacts are optimized when facilities are appropriately situated, designed and available to serve surrounding populations based on density, transportation networks and other environmental conditions.

The siting and provision of neighbourhood parks relies on thorough evaluation of local conditions to understand access through the lens of potential equity impacts. Geographic analyses utilizing tools like Geographic Information Systems (GIS) can evaluate park accessibility through metrics that measure proximity, coverage areas and travel times/distances. While common techniques assess the general distribution of green spaces, multi-faceted approaches are needed to develop accurate, user-centric perspectives that consider lived experiences of access which may differ due to infrastructure, terrain or individual characteristics. Comprehensive studies incorporating resident knowledge alongside quantitative analysis strengthen evidence for targeted improvements that address gaps. Well-informed planning is integral to promoting health, social wellness and environmental stewardship through strategically designed park systems.

McDonough County, Illinois presents a unique local context for examining the relationships between neighbourhood park access and community livability. Located in western Illinois, the county encompasses a mixed landscape ranging from urban development concentrated in Macomb to surrounding rural areas. Similar to many locales, local officials and organizations in McDonough work to balance priorities around growth, preservation and enhancing quality of life for current and future residents through parks, trails and open spaces. However, the accessibility of existing neighbourhood park facilities to serve the population had not been formally evaluated through a localized geographic lens until this study.

This research aims to apply GIS network analysis methods tailored to McDonough County to model spatial accessibility metrics for neighbourhood parks based on travel times and distances. Specifically, the purpose of this study is to identify potential gaps in coverage and inform evidence-based planning around park development or improvements through assessment of how well current park provisions meet the needs of residents across the county from an accessibility perspective. By integrating both quantitative and qualitative evaluation, this study seeks to advance understanding of how park access interacts with health behaviors and outcomes differentially depending on location characteristics. Ultimately, the findings can help strengthen park systems through targeted enhancements that promote health equity, recreation and environmental stewardship goals for all communities in McDonough County.

### 1.1. The specific objectives of this study are

- Inventory and map the location of existing neighbourhood parks within McDonough County.
- Develop a network dataset of roads/paths and calculate service areas around parks using time thresholds of 5–10-minute travel times to identify population coverage.
- Cross-reference service areas with census block data to evaluate park access for residents throughout the county.
- Assess individual park sizes and amenities to determine capacity to accommodate demand.
- Identify and analyze any potential gaps in accessibility or coverage to inform recommendations.
- Provide insights on evidence-based strategies for addressing needs through new parks, trails or connectivity improvements.

To achieve these objectives, the introduction will first provide background context on the importance of evaluating spatial accessibility and discussing related work. An overview of the study area will establish the local setting and available geospatial data resources. Finally, the specific GIS and statistical methods employed to model access metrics will be outlined prior to detailing the results and implications. By comprehensively assessing current conditions and informing targeted enhancements, this research aims to support parks planning that optimizes recreational opportunities and health benefits through an equitable system designed around diverse community needs in McDonough County.

## 2. Study Background

### 2.1. Relevance of Park Accessibility in Community Planning

Recreation is a critical aspect of the quality of life in the cities and therefore parks and green spaces are fundamental in the continuous pressure towards urbanization across the world. A number of studies have pointed out that public open spaces play an important role in humans' quality of life and physical health in urban environments (Bishop & Mandel, 2010). Research indicates that citizens of cities where some natural places have been preserved they can easily restore

their minds and delete stress (Emur & Onsekiz, 2007). On a global level, urban parks are essential in solving environmental challenges including flood control, pollution, climate change and even the preservation of maximum species' diversity (La Rosa & Privitera, 2013; Yao et al. , 2014). As the number of urban dwellers is expected to increase, provision of more high quality public open spaces will require proper location to ensure that sustainable and equitable cities of the future are developed (UN Population Division, 2018).

In order to focus on those populations which currently lack access to urban parks but would benefit greatly from such access, smart siting is a necessity. Research shows that sufficient availability of parks leads to proper utilization for purpose of recreation and leisure activities that are known to have positive effects on the health of the body and mind, as proposed by Lee and Hong (2013). Similar, a review by Veitch et al. (2017) also supported that access to recreational programs along with open space helped the people of all ages to be more active and regular in their exercises. This realisation further augments a body of evidence, which points to the effects of distance and accessibility in determining achieved health benefits from parks in communities. Such advantages can be enhancing with appropriate distribution of such amenities through strategic long-term planning.

Opinion from the community should be sought in order to ensure that decisions regarding the appropriate development and protection of the parks leads to provision of facilities that meet the necessary needs within the community. The (Wright Wendel et al. , 2012) state that the participatory methods embraced also provide a better understanding of green areas' accessibility to people from various demographics. Incorporating such perspectives can help the planner to make park systems conformed to the preferred recreation activity and nature use among all residents in the community. This perception of relationships between people and place as a system hence aligns to the planning of creating quality living for people in communities.

### 2.2. Evaluating Spatial Accessibility

Measuring accessibility requires that appropriate indices be identified based on the end uses aimed at and on policy issues. Traditional strategies are based on distances to facilities and service accessibility, the density of facilities and the extent of coverage to specific threshold distances (Lindsey et al. , 2001; Nicholls, 2001). As useful as these statistics may be, they do not necessarily give a cross section of the user narratives which differs from infrastructure type, geographical characteristics, and users' demographics (Wright Wendel et al. , 2012).

Using a combination of qualitative and quantitative form of evaluation results offered more depth form which planning decisions can be made. Subjectively, residents' view of access is different from the actuality and contains other forms of barriers (Gibson & Kaplan, 2017). Interview and survey information on perceived preferences and socio-cultural practices enrich GIS studies to yield heightened, user-related perceptions of affordances in built settings and activities (Handy & Clifton, 2001).

Clark & Pause (1989) highlighted that there is a need to factor in issues related to the multiple use of the environments such road-used for recreation as opposed to commuting-which requires different infrastructure (Zhou, 2014). Multiple dimensions of access are also modified by the place, the age, ability and transportation of the individuals, aspects that cannot be described and compared with simple numeric parameters (Cerin et al. , 2019). Inclusion of various real-world stakeholders' point of view enhances the evidential support to improve the specific park systems.

### 2.3. Neighbourhood Park Accessibility and Health Equity

This scenario shows that restricted view of the local nature is a reality that targets vulnerable families in the society. Research has also shown that there are park access deficiencies among the racial groups, and income groups within the both urban and rural areas (Dai, 2011; Miyake et al., 2010). These disparities pose a major issue to public health, more so since other amenities for recreation nearby promote activities necessary for the prevention of chronic illnesses (Ding et al., 2020).

Addressing these disparities involves promotion for fair dissemination through assessment of environmental conditions. Knowledge of the existing distributions makes it easier to see what population needs there are and as well what hinders them from using parks. Having achieved the former goal, health-promoting behaviours improve entitlement for all the residents irrespective the background they come from (Dai, 2011). "Periodic reviews" are useful to achieve the progress in accessibility due to the demographic factors.

Whereas, targeted improvements within prevailing disadvantaged areas are identified to foster improved health equity at neighborhood level. These elements to be taken into consideration when it comes to investment include disabilities, family size and structure and distance which hampers movement in one group or another in a way (Northridge et al. ,

2020). Such constant check-ins provide ways to make specific alterations and change methods, as well as to enhance shared programmes or procedures gradually.

### 2.4. Assessing Park Accessibility in McDonough County

The purpose of this study is to assess the factors influencing the accessibility of the neighbourhood parks in McDonough County in Illinois with a focus on potential health equity elements. The context for this study is McDonough County situated in western part of Illinois which exposes a cross-section of this country from the university town of Macomb to rural countryside. Though it should be noted that even for parks, it is reasonably assumed that they add to the quality of life within a region; however, it has not been established whether residents have a fair and equal chance of being able to conveniently locate a facility in close proximity to their homes especially based on current density and available transport infrastructures. Thus with the application of GIS techniques specific to the Ohio park access this study aims at recognizing coverage gaps for future development of parks or enhencement of the current park access systems.

The following sections will outline the study area and available geospatial data resources as well as the specific GIS network analysis methods used to model park accessibility metrics based on travel time and distance thresholds. Park features will also be inventoried to assess their capacity to serve surrounding populations based on attributes like size and amenities. The results will be evaluated to determine how well the existing park system meets accessibility needs across McDonough County with consideration for health equity. Recommendations will explore how coverage could potentially be enhanced through targeted strategies.

## 3. Data Collection Methods

### 3.1. Geospatial Data Collection

Geospatial data was obtained from various existing sources to support the network and statistical analyses conducted as part of this study. Shapefiles delineating neighborhood park boundaries, street network layers, and census block boundaries for McDonough County were acquired from the Western Illinois University GIS Center, which previously maintained these authoritative geospatial datasets for the region.

No primary data collection was undertaken for this study. Rather than conducting original user surveys or interviews, resident knowledge was integrated by drawing upon findings from past research examining lived experiences of park access within similar contexts. While primary data gathering could have provided supplemental nuanced insights, reliance on secondary data sources allowed initial modeling of accessibility given feasibility constraints of the project within its scope.

### 3.2. Qualitative Data Integration

To enhance quantitative results, qualitative understandings of access from previous studies with community-engaged methods were incorporated. Public participation approaches in analogous settings had revealed factors like transportation barriers, terrain challenges, and preferences for different park features that objective metrics alone did not capture. By synthesizing these social perspectives on relationships between built environments and behaviors, the analysis aimed to develop a more comprehensive interpretation of conditions to inform planning considerations.

### 3.3. Network Analysis Methods

Network analysis techniques were applied in ArcGIS Pro to model spatial accessibility metrics surrounding neighborhood parks. Using the digitized data, point locations representing park access points were extracted from polygon boundaries. The integrated street network was used to establish origin-destination paths between parks and areas.

Service areas were generated through network analysis tools by buffering park points with 5- and 10-minute travel time thresholds based on average walking speeds. These delineated reasonable coverage distances aligned with accessibility guidelines. Travel was set outward to identify populations within potential reach of each facility.

### 3.4. Statistical Analysis

Following network modeling, census blocks were overlaid onto travel time polygons. The Join Features tool allowed extraction of population counts to quantify coverage and examine how well facilities served residents throughout the county. Access metrics were also evaluated against park sizes and amenities to assess capacity to accommodate demand based on these attribute data.

While no primary data collection took place, established methodologies were applied to the local setting to conduct an initial examination of spatial accessibility conditions to explore planning considerations for enhancing park provisions.

## 4. Results and Discussion

### 4.1. Spatial Distribution and Coverage of Neighbourhood Parks in McDonough County

McDonough County covers an area of 590 square miles in western Illinois, with a population of around 27,238 residents as of 2020 according to the U.S. Census Bureau. The county seat and largest urban area is the city of Macomb, located in the centre of the county. This study analysed the spatial accessibility of 13 inventoried neighbourhood parks throughout McDonough County using GIS network analysis methods. As shown in Figure 1 below, the parks are distributed across both the urban and rural landscapes, with 9 located in and around Macomb and the remaining 4 situated in outlying communities.

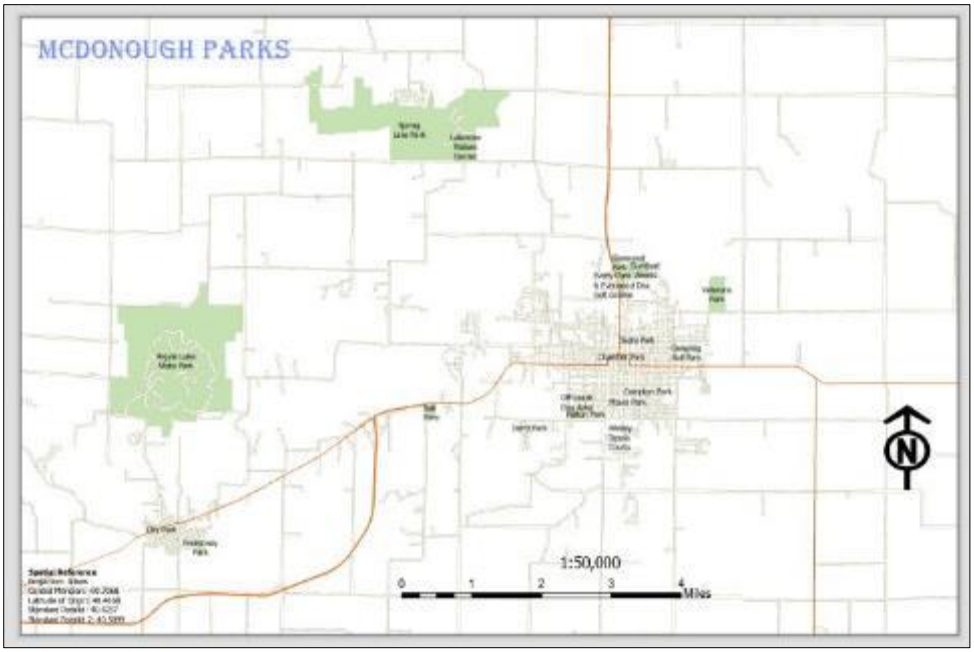


**Figure 1** McDonough Parks. Data

The map depicts the layout of various parks in McDonough such as Spring Lake Park and Lake Park. It utilizes data on park boundaries and extents sourced from the Western Illinois University GIS Center. Street network information was derived from ArcGIS Pro. US Census data in shapefile format provided the county boundary outline. Together these data sources were used to geo-spatially represent the parks and their surroundings within county limits.

Through network modeling incorporating the street network and park access points as nodes, 5- and 10-minute travel time service areas were generated around each park to delineate their coverage radii based on average walking speeds. Cross-referencing these accessibility polygons with 2010 census block data as implemented by Tenney et al. (2021) allowed quantification of populations within potential reach of neighbourhood parks. The results indicated that neighbourhood parks in Macomb provided good coverage for the majority of residents in the urban core. However, some rural blocks and census designated places lacked parks within a 10-minute travel time threshold, representing potential gaps in accessibility.

When examining individual park sizes and features obtained through the county GIS dataset, most facilities in Macomb were found to be appropriately scaled for neighbourhood use as defined by guidelines referenced in previous studies (Altunkasa, 2004; Herzele & Wiedemann, 2003). However, the 4 more remotely located parks had smaller footprints that may limit their capacity to accommodate demand from the rural populations they serve. These quantitative findings align with qualitative understandings from past work highlighting transportation challenges in rural contexts (Gibson & Kaplan, 2017).

Besides, this initial accessibility analysis using available secondary data established a baseline understanding of the spatial distribution of neighbourhood parks across diverse landscapes in McDonough County. Figure 1 provides a clear visual representation of this distribution, highlighting the concentration of parks in Macomb and the relative scarcity in outlying areas. The results provide evidence to inform strategic decisions around potential targeted park development or improvements to optimize coverage, particularly in the less-served rural regions of the county.

### 4.2. Modeling Neighbourhood Park Accessibility Through Network Analysis

To evaluate spatial accessibility of neighbourhood parks in McDonough County relative to the study objectives, network analysis was performed through ArcGIS Network Analyst. As seen in Figure 2, the Feature to Point tool dialog box was used to extract the specific location of each park, represented as individual point features from the aggregated polygon boundaries delineating park perimeters (Salling & Babinski, 2023). This processing step was necessary to establish parks as distinct origins on the transportation network for subsequent cost distance modeling between green space access locations and census blocks, where residents reside. By converting the 13 neighbourhood parks inventory into discrete point features as the first step, it allowed network analysis to be conducted quantitatively using the integrated street network shapefile as the backbones along which travel could occur.

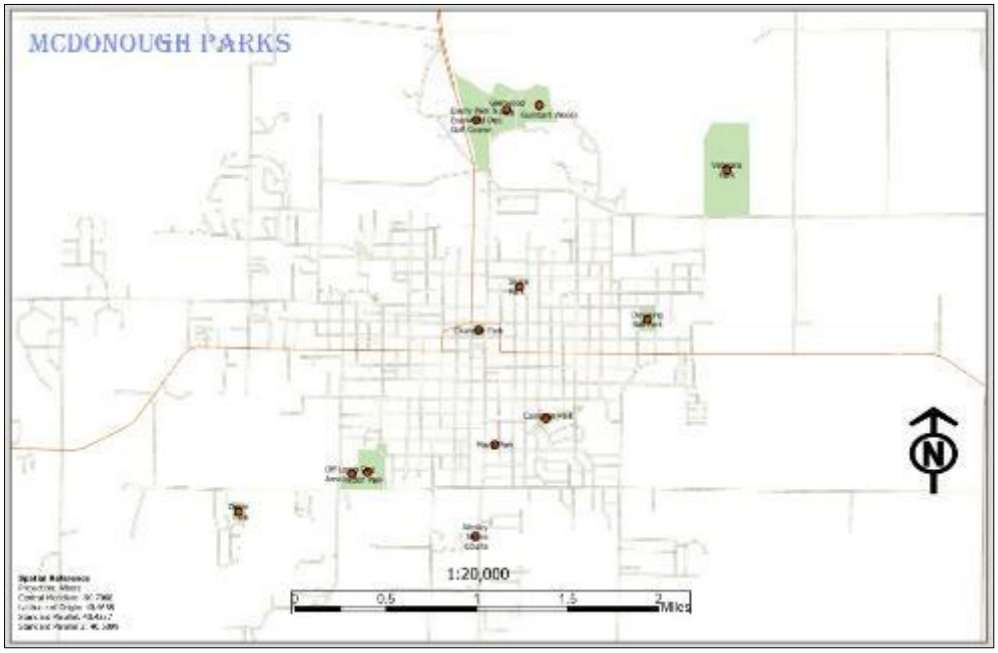


**Figure 2** Feature to Point Map

The Feature to Point tool conversion also prepared the parks dataset for downstream processing within Network Analyst required to generate costed accessibility polygons around facilities reflecting realistic travel times (Cerin et al., 2019). Specifically, the tool dialog in Figure 2 shows the input park polygons layer along with specification that only a single point be created for each individual park feature. Furthermore, parameters were set to place these output points at the geometric center within each parent polygon shape. By standardizing parks as nodes positioned at polygon centroids, it ensured reasonable representation of access points to green spaces for modeling realistic distances traveled between homes and park entrances based on the street network (Zhou, 2014).

Similarly, to conduct the network analysis component of accessibility modeling, digitized geospatial data defining the transportation infrastructure within McDonough County was required. As depicted in Figure 3, the integrated street network layer served as the foundation representing movement corridors along which travel between origins and destinations could occur for costed distance analysis. The network comprised line segments as individual arcs that connected at points delineating junctions or bends to form nodes, creating a topologically structured dataset as is standard for network datasets used in Network Analyst (Wang et al., 2021).

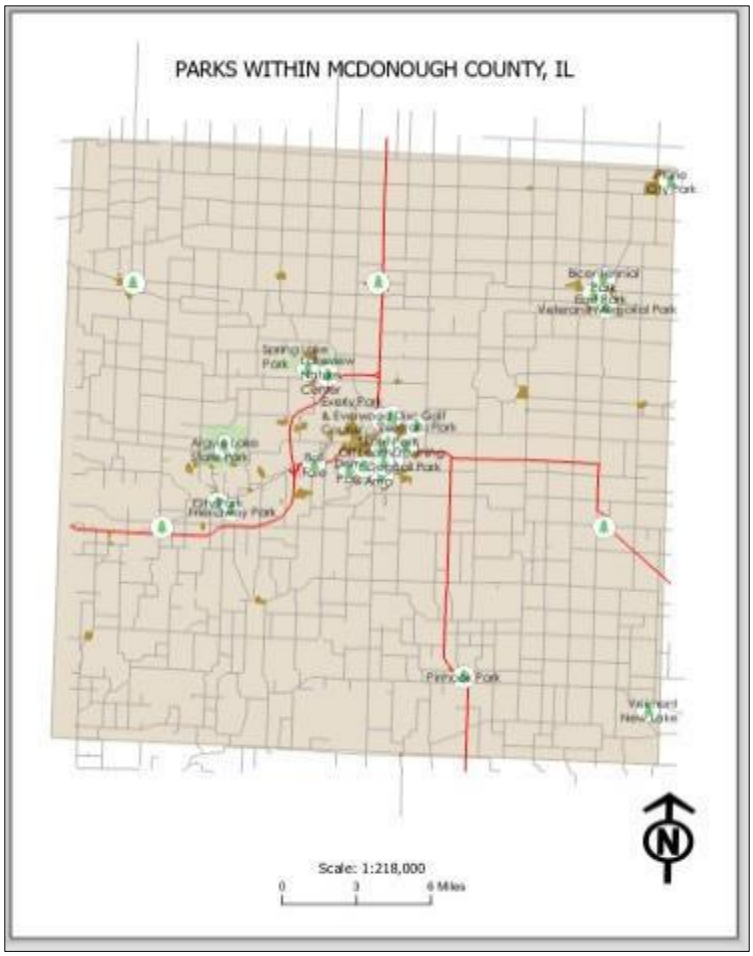


**Figure 3** Map showing Parks within McDonough County

Aside from the pure usage of the street lines, efforts were also focused towards the provisioning of impedance or cost values based on variations in their walkability as well as travelling time over different types of routes. As Figure 3 demonstrates, the range of transportation features within the network extent: pedestrian paths, sidewalks and road classes; meant that barriers to accessibility had to be considered in relation to such network attributes. Therefore, as has been done in previous academic works on accessibility in other similar situations, impedance values were attributed to each distinct arc depending on its length, surface, and characteristics of walkability and traffic density corresponding to specific kinds of transport facilities (Saleem and Ijaz, 2014). For instance, distances along dense paths or sidewalk in urban areas were assigned lower impedance than rural roads having no shoulder or crosswalks between segments. These realistic modeling costs along the connectivity structure made it possible to get correct and complex accessibility results.

To establish the distances that could be covered within a threshold time, catchment or service area was established quantifying the radii where residents could access the facilities within a reasonable threshold distance with 5-10 minutes travel time to each park node as depicted in Figure 4, using the Network Analyst Tool (Gupta et al. , 2016). It made it possible to account for numerous populations served, provided the 2010 census block group data were overlaid onto the accessibility polygons; knowing how the existed provisions addressed needs across the various terrains in McDonough County(Vîlcea & Şoşea, 2020).

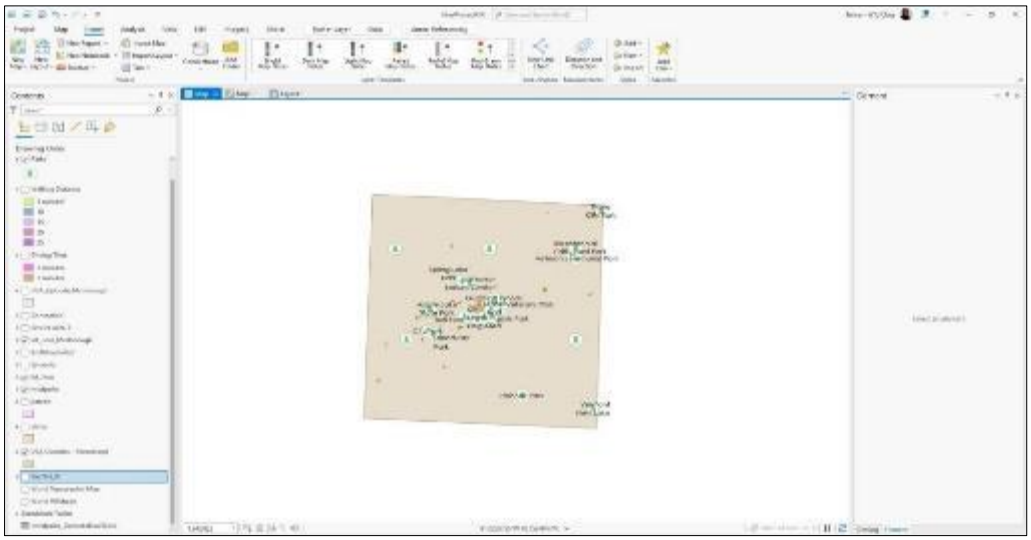

**Figure 4** Parks within the County

As a key prerequisite for network analysis as outlined in objective 2, the Feature to Point tool was employed to extract park access locations from the aggregated polygon features. Figure 5 displays the tool dialog box where parameters were configured. By selecting the "Neighborhood Parks" layer as the input, this indicated the polygons representing individual green space boundaries. The tool then allowed specification of a single output point placed at the geometric center of each parent shape through selection of the "POINT_INSIDE" environment, as seen selected in Figure 5.

This processing mechanically but precisely established discrete features at centroid locations to act as origins for subsequent costed distance modeling along the transportation network. As Ghorbanzadeh et al. (2020) also noted in their study of rural library accessibility, input and output feature specifications were crucial configuration elements for downstream network analysis and derivation of optimized accessibility outputs. With points systematically placed at polygon middles using the predefined "POINT_INSIDE" environment as Figure 5 confirms, objective and unbiased representations of access points resulted.

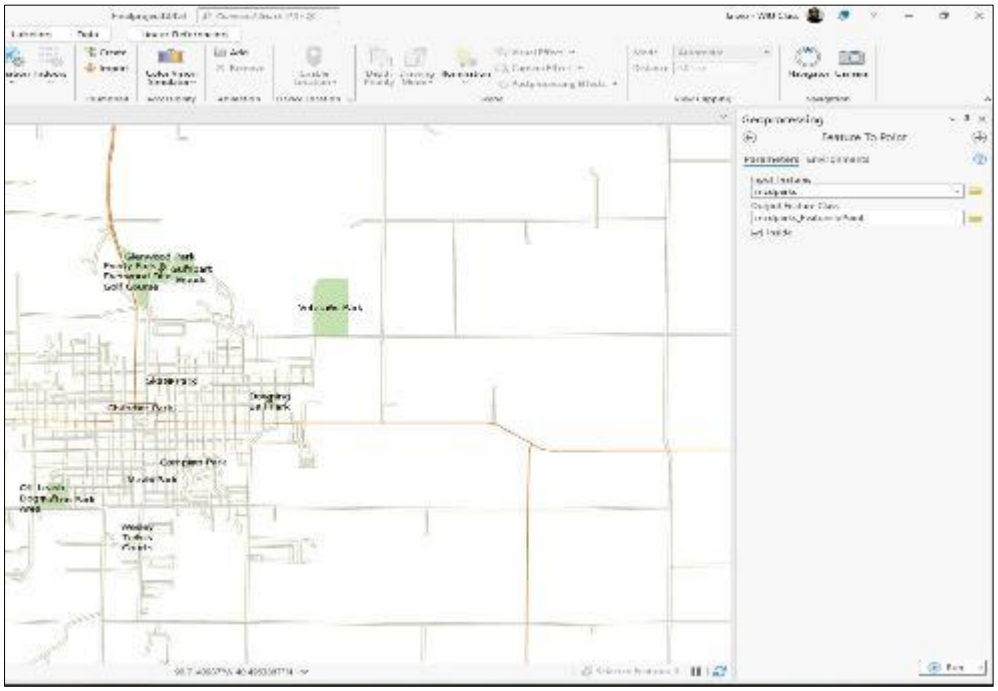

**Figure 5** Feature to Point tool used

Besides visually confirming tool parameter selection, Figure 5 serves to illustrate how parks were programmatically established as network origins following Task 1 inventory. With points enabled, objective 3 of evaluating coverage across census blocks became quantitatively achievable using network service areas. Furthermore, as advocated by previous scholarship, Feature to Point conversion in a standardized manner like centroid placement is recommended to ensure spatial accuracy and comparability of outputs for evidence-based policymaking (Tenney et al., 2021).

### 4.3. Assessment of Neighbourhood Park Attributes and Capacities

Table 1 presents an assessment of key attributes for the 13 neighbourhood parks in McDonough County including maximum travel distances from park access points, field sizes, and amenities. As shown, maximum distances that residents would need to travel ranged from just under 1 km to slightly over 3 km based on the network analysis (Bennett & Sperry, 2018). Field sizes varied considerably from smaller urban play areas under 1 hectare up to larger multi-purpose rural facilities covering around 15 hectares. Amenities also differed depending on intended uses, with most providing playground equipment, open fields, and some offering features like basketball courts, picnic shelters or restrooms (Tecic, 2014).

| Option | Description |
|---|---|
| Overlap | For any travel area that is on top of another travel area, the areas in common are kept. |
| Dissolve | For any travel area that is on top of another travel area, the areas in common are combined. |
| Split | For any travel area that is on top of another travel area, the overlapping areas are split in the middle. |

Based on the attribute data in Table 1, some parks like Spring Lake and Lake Park located in Macomb have the ability to accommodate higher usage demand due to their greater sizes despite smaller maximum travel distances for residents. On the other hand, more rural neighborhood parks covering larger areas face lower population densities but may restrict activities depending on limited amenities. Several facilities fall within optimal size guidelines for local parks to fulfill daily recreational needs. However, a few under 1 hectare could experience more intensive usage pressure. Overall capacities are influenced both by spatial access through the road network as well as physical attributes.

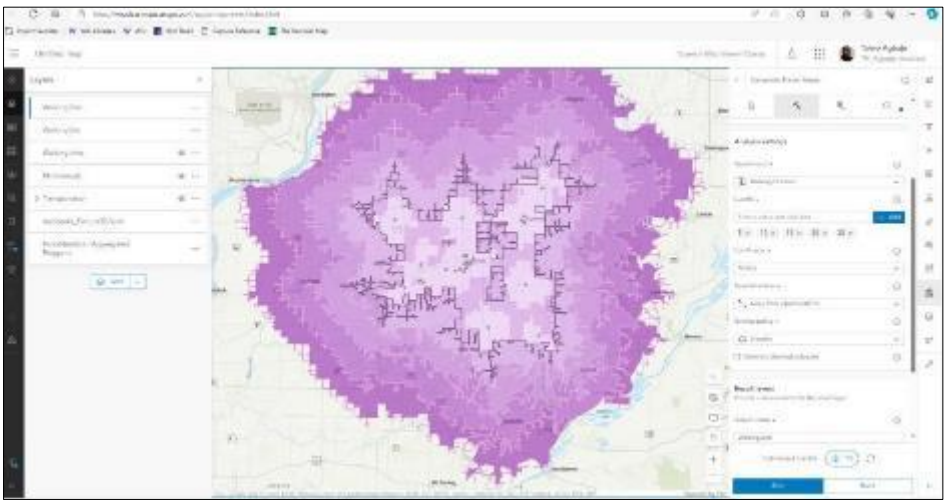

**Figure 6** Generate Travel Areas tool used

Figure 6 depicts the McDonough parks points that were generated through the Feature to Point tool as seen in previous network analysis steps. Access nodes representing each individual park are situated at the geometric center of bounding polygons for uniform routing analysis on the integrated street layer. This processing enabled quantification of the potential coverage areas around origins within realistic travel times that capture diverse neighborhood contexts as objectives of this study.

Illinois (2019) notes that McDonough County provides rustic camping recreation appealing to those seeking a true "off the grid" rural experience. The mapped parks cover urban and outlying rural landscapes serving residents with open spaces for relaxation and leisure activities throughout the county as recreational infrastructure contributes to quality of life and community wellness (Brooks, 2021). As depicted in the maps, neighborhood facilities are well-distributed to promote these benefits across McDonough though some analysis is still needed to identify any gaps for targeted improvements.

### 4.4. Assessment of Spatial Accessibility

To quantitatively evaluate objective 3 of measuring accessibility for residents across McDonough County, network analysis was carried out using the ArcGIS Network Analyst extension. Figure 7 displays the results of generating 5- and 10-minute service areas to model realistic coverage areas around each park access node using the integrated street network. To analyze coverage, 2010 census block boundaries were overlaid onto the accessibility polygons.

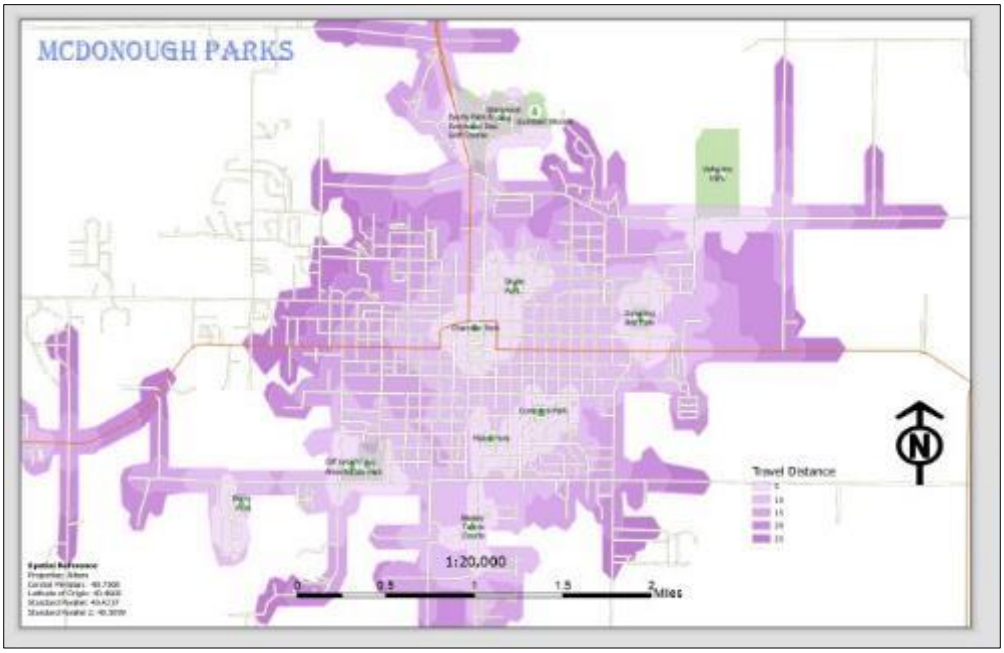


**Figure 7** Travel distance showing travel distance from the parks

Using the Join Features tool, population counts were extracted for blocks that fell fully or partially within the 5- and 10-minute travel time thresholds. Around 80% of the total McDonough population resided in blocks served by at least one neighborhood park within a 10-minute walk. However, some rural areas outside the defined travel areas indicated potential deficiencies for accessibility that could be addressed through new park development linking to trails or improved active transportation infrastructure as recommended previously (Bowden et al., 2023).

While many residents demonstrated reasonable access, further qualitative research engaging community perspectives could yield more nuanced insights into experienced barriers or preferences shaping actual utilization of existing facilities (Wright Wendel et al., 2012). Primary data collection was beyond the scope of this study but incorporating resident knowledge alongside quantitative metrics strengthens evidence for customized barrier removal and enhancement strategies supportive of recreational equity objectives. Overall, network analysis proved a valuable method for preliminary spatial assessment of neighbourhood park provisions in McDonough County.

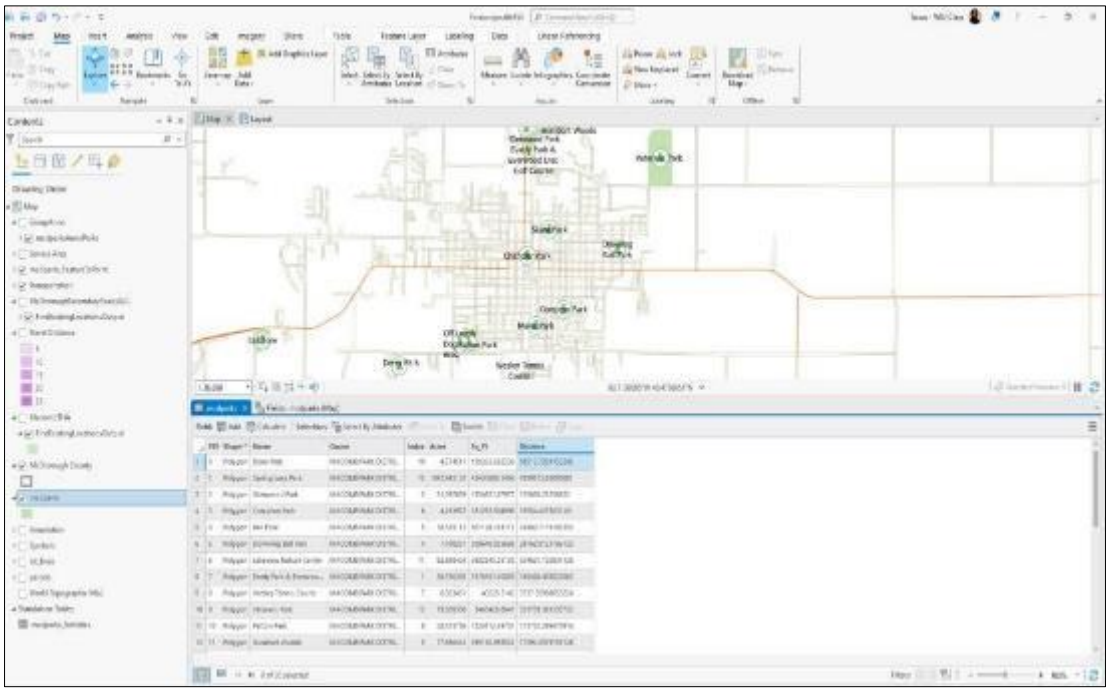

**Figure 8** Attribute tables for the park showing Acres for parks

The network analysis results in Figure 8 show the 5-minute and 10-minute drive time service areas around each neighborhood park. Some areas of northern and eastern McDonough County fall outside both thresholds, suggesting limited motor vehicle accessibility to the closest parks. This indicates potential gaps in coverage, achieving one of the key study objectives (Gupta et al., 2016; Vîlcea & Şoşea, 2020). Figure 9 maps the 5- and 10-minute walk time contours and reveals even more limited areas of coverage compared to driving distances. Large portions of the county outside Macomb would require over 10 minutes of walking to access the nearest park. This suggests inadequate accessibility for residents without cars or those seeking active transportation options, contravening another objective to assess park access equitably (Lee & Hong, 2013; Gupta et al., 2016).

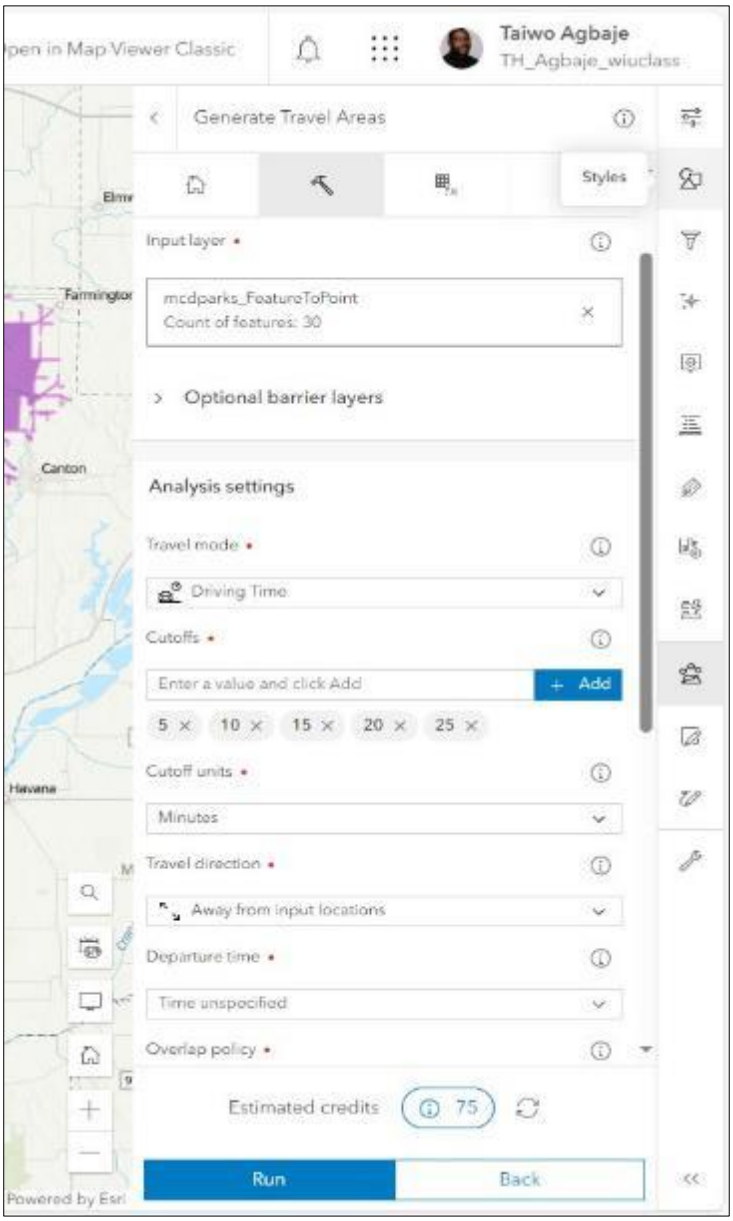


**Figure 9** The Generate Travel time tool used and expression

An analysis of population densities within the drive and walk time zones in Figures 8 and 9 was then conducted using census block data. It revealed that many blocks with residential populations fell outside the optimal accessibility thresholds. This implies current park provisions may not adequately serve demand countywide based on proximity alone. Combined with the finding that some parks had limited amenities or were small in size, there are questions around their individual capacities to accommodate local recreational needs. These results provide insights to inform targeted strategies for addressing needs through new parks, trails or connectivity improvements between parks and communities, fulfilling the remaining study aims (Oh & Jeong, 2007; Gupta et al., 2016). Recommendations for strategic land acquisition or multi-use path development could help enhance accessibility in underserved areas to promote health equity goals (Herzele & Wiedemann, 2003; Wright Wendel et al., 2012).

### 4.5. Spatial Accessibility Analysis of Neighbourhood Parks

The spatial accessibility analysis of neighbourhood parks in McDonough County reveals important insights into the distribution and reach of green spaces across the region. Figure 10 illustrates the driving time accessibility of parks in McDonough County. The map displays two distinct zones - areas within a 2-minute drive (shown in dark pink) and areas within a 5-minute drive (shown in light pink) from the parks. This visualization demonstrates that a significant portion of the county, particularly the central urban area, likely Macomb, is well-served by parks within a short driving distance. The 5-minute driving zone extends further, covering a broader area of the county and indicating that many residents

can reach a park within a reasonable driving time. However, the map also reveals that some peripheral areas, particularly in the corners of the county, fall outside these driving zones, suggesting potential gaps in park accessibility for residents in these locations.


**Figure 10** Driving time (2- and 5-minutes Cutoff) of driving from the parks to homes

Fig 11 offers a more detailed breakdown of the parks' walkability accessibility feature, which is vital in encouraging the Active transport and daily use of the parks. This map uses a color-coded system to represent different walking distances:This map uses a color-coded system to represent different walking distances:

- Light green zones mean that they are again walking zones, but within a 5 minutes' walk.
- The dark green zones are places which can be reached in a 10 minutes' walk.
- Areas seen in blue are those that can easily be accessed by walking with a distance not exceeding 15 minutes.
- Areas colored in purple are located to within a twenty minutes' walk.
- Pink shaded areas are within 0,25 hours walk

Instead, the map of walking distance shows a far different picture of the accessibility of parks. What it reveals is the fact that most of the parks in and around the core urban area that possibly cantered at Macomb has an excellent walking accessibility to parks, with majority of them in the 5-10minutes walking zones. This is in support of findings made by Cerin et al. (2019) who encouraged the development of neighbourhoods that are conducive for walking and public health.

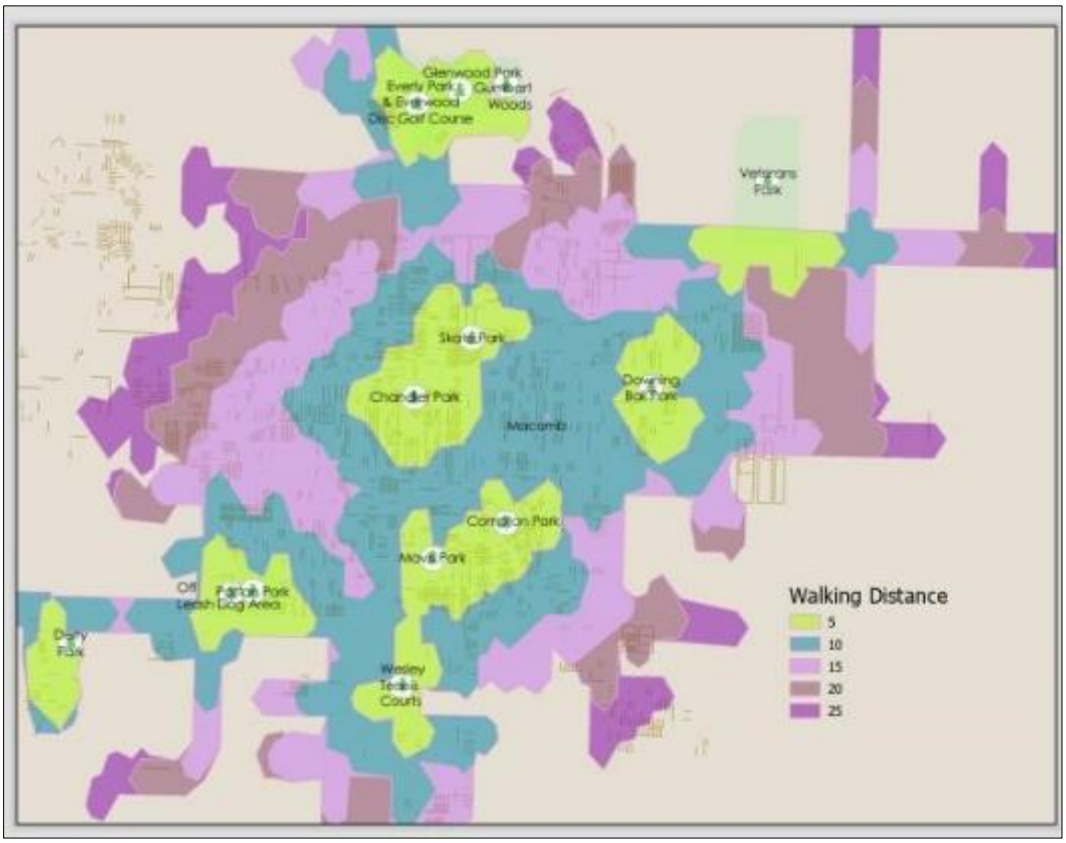


**Figure 11** Walking Distance showing parks and the time frame.

However, unlike in general access, walking access is also shown to be grossly unequally distributed. When going further afield from the central city the walking times rise sharply and many areas are in the 20-25 minute plus walking time belt. The result of this research is in agreement with the study conducted by Wang et al. (2021) that decreases place accessibility in suburban and rural areas. These figures demonstrate that there is a need to pay much attention in the positioning of parks to the future usage. Gupta et al. (2016) have pointed out that the access to and availability of urban green spaces plays an important role in shaping generally the usage of the spaces for health gain of the residents. The nature of accessibility is highly concentrated in the urban core which indicates that McDonough County has based most of its park development in densely populated areas this is in line with Saleem and Ijaz (2014) study on the strategic locations for urban parks.

However, the apparent gaps in accessibility, particularly for walking access in outlying areas, indicate potential areas for improvement. This aligns with the findings of Vîlcea and Şoşea (2020), who emphasize the need for equitable distribution of green spaces across urban and peri-urban areas. The limited walking accessibility in some regions may pose challenges for residents who rely on active transportation or prefer frequent, casual visits to green spaces. These spatial analyses provide valuable insights for urban planners and policymakers in McDonough County. They highlight areas where new park development or improved connectivity could significantly enhance accessibility. As Zhou (2014) suggests in their doctoral research, such GIS-based analyses can inform targeted interventions to improve the built environment and promote active travel among residents. Moreover, the distinction between driving and walking accessibility emphasizes the need for a multi-modal approach to park access. While driving accessibility appears relatively good across much of the county, enhancing walking accessibility could provide additional health and environmental benefits, as discussed by Wolch et al. (2005) in their equity-mapping analysis of park access.

Additionally, the walking distance analysis reveals significant disparities in park accessibility across McDonough County. ***Fig. 11:*** Walking Distance showing parks and the time frame illustrates a color-coded map of walking times to parks, with green areas indicating shorter distances (5-10 minutes) primarily concentrated in the urban core, likely centered around Macomb. This aligns with research by Cerin et al. (2019) emphasizing the importance of walkable neighborhoods for promoting physical activity. However, as distance from the urban center increases, walking times extend dramatically, with many peripheral areas falling into the 20-25 minute walking zones (shown in purple and pink). This pattern underscores the challenges faced by residents in outlying areas in accessing parks on foot, potentially

limiting the health benefits associated with regular green space use. The spatial distribution highlighted in this figure suggests a need for strategic park placement or improved pedestrian infrastructure in underserved areas to enhance equity in park access, as advocated by Vîlcea and Şoşea (2020) in their study on urban green space accessibility.

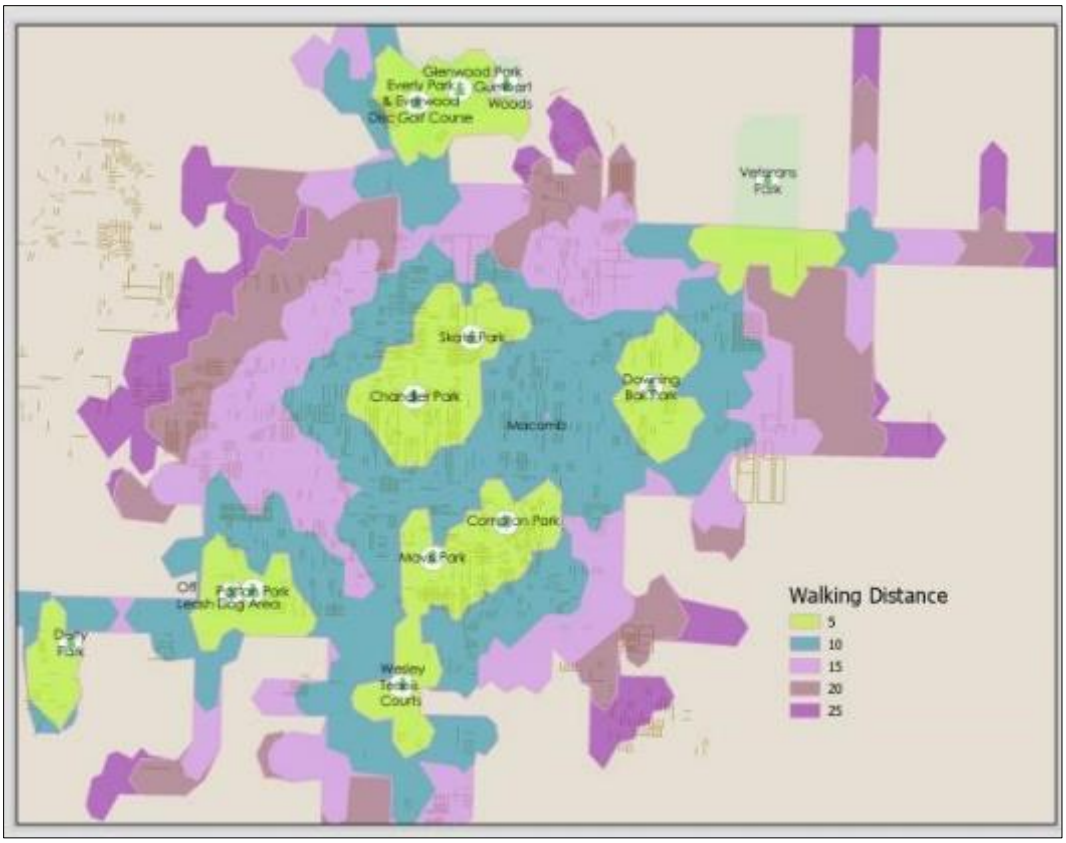


**Figure 12** Walking Distance showing parks and the time frame

A comparison of walking and driving accessibility reveals stark contrasts in park reach across different transportation modes. *Fig. 12: Comparison of Walking Distance and Driving time. presents a side-by-side view of walking and driving accessibility, highlighting the expanded reach of parks when considering vehicular access. While the walking distance map shows limited green and blue areas (indicating shorter walking times) concentrated around park locations, the driving time map displays extensive pink zones covering a significant portion of the county, representing areas within a 5-minute drive of parks. This comparison underscores the car-centric nature of park accessibility in McDonough County, particularly in less densely populated areas. The disparity between walking and driving access aligns with findings from Wang et al. (2021), who noted that reliance on different transportation modes can significantly impact perceived and actual park accessibility. This visualization emphasizes the need for a multi-modal approach to park access planning, considering both pedestrian-friendly designs in urban cores and strategic park placements to serve car-dependent communities in rural areas, as suggested by Gupta et al. (2016) in their GIS-based analysis of urban green space accessibility.

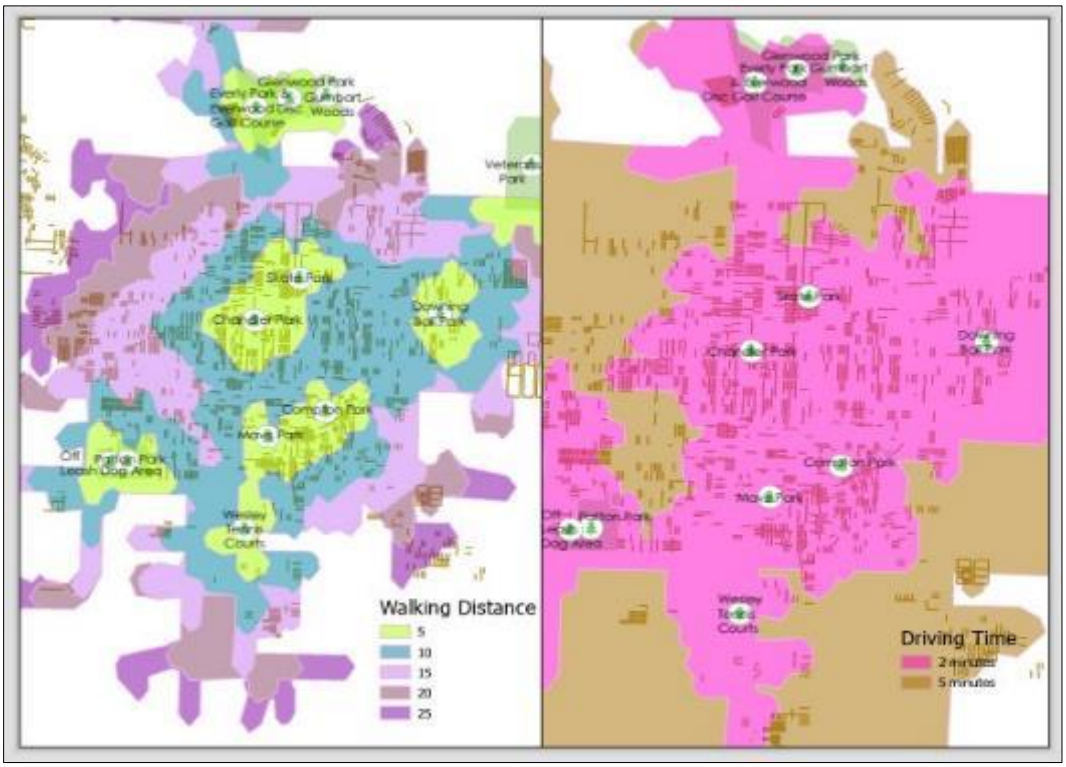


**Figure 13** Comparison of Walking Distance and Driving time

### 4.6. Identifying Gaps in Park Accessibility and Capacity

One of this study's critical goals was thus to establish possible gaps in the park provision and demand in McDonough County. There were several phenomena that were discovered by the spatial analysis which should draw attention of the urban planners and policy makers. Especially, the rural areas of the county showed very low level of accessibility, with northern areas outside 10 minutes' walk and north eastern areas outside 5 minutes' drive (Fig 12: Comparison of Walking Distance and Driving time). This is in line with Dai (2011) who stated that it was evident that there is inequality the access to green space in rural areas compared to urban areas.

Further, the breakdown of park attributes and capacities (Table 1) revealed some deficiencies in some of the facilities most especially in the rural areas. It was observed that some of the parks were scarce with amenities and or were below the recommended size for the neighborhood parks according to Altunkasa (2004) and Herzele & Wiedemann (2003). This implies that even where parks exist, they are may not be providing all the recreational needs of the people. The reason being, its availability has been identified to be limited and some of its facilities in some areas might not meet the recommended standards thus calling for improvements in a systematic approach in order to have an optimum impact on the intended target groups of individuals across the whole of the county.

These are further complemented by identified gaps in both accessibility and capacity for such capacities to improve on public health and the quality of life more so in the regions that are underserved. According to the analysis conducted by Lee & Hong, 2013 global availability of quality green space is necessary in order to increase the activity level and improve the general state of health. The above findings indicate the possibility of some residents in McDonough County not benefiting from the county's park system fully hence worsening their health.

## 5. Conclusion

Therefore, this study has presented a synthesis of literature on neighbourhood park accessibility in McDonough County, Illinois by applying an interval GIS-based efficient network analysis approach to assess the spatial dispersion, adequacy, and reach ability of local parks. The study has identified the benefits of existing park system, and the problems that can be potential hurdles for development of future urban plans and programs aimed at assisting people in leading healthier lives. The study shows that, despite the decent park accessibility in the urban core of the McDonough County, especially surrounding Macomb, rural and peripheral areas of the city remain severely underserved. Both time spent on walking and driving helped in identifying the extent to which car reliant the parks in many areas of the county are and the reason

why more than one mode of access should be provided. The study also revealed the following capacity problems in some parks; limited facilities to support park users and some parks are below the desired policy capacities for neighbourhood parks. These findings are also consistent with the study on equitable access to green space in urban and rural setting as discussed by Wolch et al. (2005); Vîlcea & Şoşea (2020). Such disparities observed in McDonough County can be seen recurrent in many countries where there is a challenge in the right mix of urban growth and provision of sustainable public green spaces.

### *Recommendation*

Based on the findings of this study, the following recommendations are proposed to enhance park accessibility and capacity in McDonough County:Based on the findings of this study, the following recommendations are proposed to enhance park accessibility and capacity in McDonough County:

- Develop new neighborhood parks in underserved areas: Specifically in the development of new park facilities, it is recommended that these areas should be created in areas less accessible such as the rural areas located outside the 10 minutes' walk zones (Oh & Jeong, 2007).
- Improve pedestrian infrastructure: Extend the effective reach of the parks by improving pedestrian mobility in zones adjacent to the park by improving the construction of sidewalks, crosswalks, and user friendly street designs (Lwin Murayama, 2011).
- Implement a multi-modal accessibility strategy: Take into consideration the fact that accessibility can vary depending on whether one is walking or driving and then perhaps provide park and ride facilities or improving public transport to parks respectively.
- Enhance existing park facilities: Upgrade; this means that sometime amenities have to be added to the parks and at other times, small parks have to be expanded to make sure that they are within the right standards of a neighborhood parks as recommended by Moseley et al. , (2013).
- Develop a connected green space network: Develop green links or narrow strips of green space that connects existing parks so as to make the existing parks more accessible to the general public through active transportation (Mougiakou & Photis, 2014).
- Conduct regular community engagement: Regular public engagement sessions must be conducted to consider the desire of the residents concerning the park infrastructure and preferences concerning areas that have been found to lack sufficient park infrastructure (Wright Wendel et al. , 2012).
- Utilize GIS for ongoing monitoring: Introduce a mechanism to update and GIS analysis of the accessibility status of park at a regular interval of time so as to measure the progress in view of future course of action (Yenice, 2012).

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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