Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 08, August-2023

Assessment And Optimization of The Distribution of Urban Green Space and Its Accessibility using Gis (A Case Study From Amman/Jordan)

*Ayah Al-Mrayat[a], Samer Abu Ghazaleh[a]
[a] Department of Architectural Engineering
University of Jordan
Amman, Jordan

Abstract**—***As public service amenities, Urban Green Space (UGS) provides numerous benefits to inhabitants' daily lives and social activities. However, the coverage of UGS to urban residents is usually unequal, resulting in underutilized areas. This study assessed the UGS per inhabitant in Marka, Amman/Jordan in order to determine the categories of UGS that comprise the area's per capita value and to compare them to international standards. Gini coefficient and Lorenz curve were used to assess the spatial equity of public parks per capita in Marka area. This research also examined pedestrian accessibility to UGS in Marka according to the NRPA standards, employing the geographic information system network analysis approach (GIS). Furthermore, Location Allocation analysis was used to suggest a new public park locations and to assess the impact of this on improving accessibility for Marka's population. According to the study results, the actual per capita for the existing public parks in Marka is only .5 m^2/capita, which is far below international standards, and the public parks are unevenly distributed according to Lorenz curve and Gini coefficient. However, the percentage of the served residential areas from the existing public parks is only 18.9 %, that should increase to 27.5 % after proposing three new public parks based on the location allocation analysis results. According to the findings of this study, GAM and municipalities should take a systematic approach to address the spatial distribution of UGS, in addition to a proactive engagement of planners, landscape architects, and designers in the planning process.*

Keywords; Per capita, Accessibility, Network Analysis, Service area, Location Allocation.

I. INTRODUCTION

The cornerstone of the city's natural system is green space, which includes public parks and open spaces. They are also essential for the quality of the surrounding environment since they often improve microclimates, absorb pollutants from the air, reduce noise levels, and contribute to the sustainability of urban environments [1]. According to a number of studies, Urban green space (UGS) is being converted into impermeable hard concrete surfaces as the population grows and urbanization intensifies [2]. This not only affects the economy's and human settlement's sustainability but also leads to environmental degradation and a decrease in green space. As a result, while UGS are always required, they become even more critical in the areas of high population density, where residences often lack yard space, and in areas of intense development, where landscaping is limited [3].

Therefore, it may be argued that well-placed and well-designed parks are not an amenity but a necessity for the modern city and should be accessible to all its residents.

II. LITERATURE REVIEW

A. *Definitions of UGS*

Currently, there is no generally recognized definition of UGS. However, the most commonly used definition of UGS in European studies is based on the definition from the European Urban Atlas [4]. UGS as defined by Urban Atlas code 14100 include public green areas mainly used for leisure such as gardens, zoos, parks, and suburban natural areas and forests, as well as green areas bordered by urban areas and maintained or used for recreational purposes. In terms of policy, it is critical to focus on UGS that are available to the public, especially when discussing universal green space access for all urban inhabitants, regardless of socioeconomic status.

B. *UGS as spatial equity issue*

Equity is closely related to inadequacy of resources [5]. Only when resources, goods, or services become scarce do distribution and equity become issues for both providers and users. Since urban parks are local public goods designed to cover a variety of needs by providing unrestricted and equitable access to people from various social and economic backgrounds, traditional market mechanisms are unable to meet a growing demand for these services [6]. Instead, public parks are usually created by municipalities, which, due to budget limitations, are likely to struggle to include a sufficient number of high-quality parks to satisfy community demand[7] The provision of UGS and public parks, as well as the associated benefits, is a recognized spatial equity issue around the world[8], which warrants frequent checks and countermeasures, By performing regular neighborhood level green space distribution assessments. This evaluation is extremely significant for the developing countries which will house 80% of the world's urban population by 2030[9].

III. MATERIALS AND METHODS

The equity of UGS distribution, as represented by the relationship between access and spatially referenced census data, should ideally be investigated using specialized research methods that explicitly used for spatial data and therefore differ from those used to analyze non-spatial data.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 08, August-2023

The study dealt with its objective through two Phases: Phase No. 1. Evaluating the spatial distribution of UGS in the study area using the following measures:1) Measuring per capita value for the study area. 2) Measuring service areas, and the percentage of the served residential areas using GIS-network analysis according to three scenarios. 3) Investigating the spatial equity in terms of per capita value in Marka's neighborhoods using Gini coefficient and Lorenz curve. Phase No. 2. Analyzing potential park's locations using the Location-Allocation analysis in GIS and evaluating accessibility effectiveness after the process of determining the optimized park's distribution. In this study, GIS is employed, and the main tools are Network Analyst and Spatial Analyst in ArcMap 10.3

A. Study area

Marka area is in the north-east of Amman, having a population of 167,648 inhabitants in 2020 with an area of 17.8 km^2. It was adopted as the study area in which it represents the center of the most populous district in Amman (Marka district). It consists of five neighborhoods which are: Hamzah, Al-Zahra'a, Al-Matar, Al Jadeed and Al-Mushyirfeh neighborhoods.

Marka area is characterized by a high population density and an industrial character. The land use chart shows the presence of many industrial lands which has a variety of detrimental consequences for the surrounding areas, including daily traffic congestion, visual, air, and noise pollution, and land value deterioration. However, all residential lands are classified as C, D and folk residences, and there are no A and B residence classes according to the land use chart. (Fig. 1).

B. Data Processing

To identify UGS within the study area. All UGS were classified into one of four types according to their size and nature in the land use along with NRPA standards, Table I . Fig. 1 shows the percentage of each of the UGS types which were generated using the GIS data.
The forest and green spaces make up 30.69% of the total area of those UGS in Marka. If all these sites were implemented effectively, the city supposed to have a better UGS system, it is important to note that these spaces must be of good quality to meet users' needs and demands.

TABLE I. URBA GREEN SPACE CATEGORIES IN MARKA AREA

Code	Type	Definition
T1	Existing Public Parks	All open public parks that are located within Marka area boundaries.
T2	Proposed Urban Parks	All unbuilt public parks that are located in Marka area, (proposed in the land use).
T3	Green spaces	The small plots (less than 232 m^2) that were classified as public parks in the land use of GAM but do not meet the minimum size of public parks according to NRPA standards.
T4	Forest Land	The existed forest land in the land use.

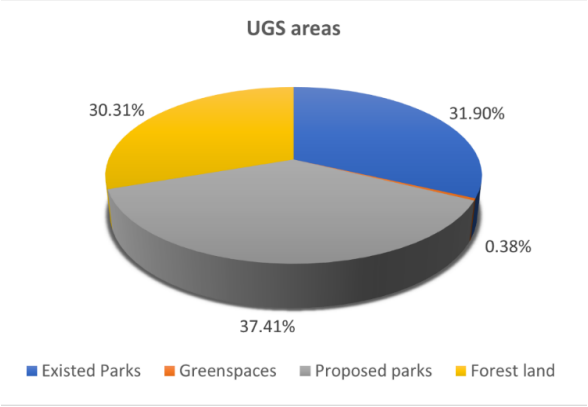

Fig. 1. Percentage of Urban Green Space types in Marka area according to the study category.

Scenarios:
The methods regarding the study area are presented through three scenarios discussing the analysis according to the classification of UGS in Table 1.

- **Scenario 1.** The first scenario looks at the existing public parks (T1). This type is for all parks in Marka area. All other spaces, such as forest land, green spaces, and other proposed public parks, are excluded from this scenario.
- **Scenario 2**. In this scenario, green spaces (T3) in Marka are added to the first scenario in addition to the forest land (T4), of which there is only one in the study area. The reason for including these two types together is because they both considered in the land use for the study area by GAM as a UGS, However, both are underutilized since the forest land is a high slope land and virtually almost all of (T3) are used as parking by residents.
- **Scenario 3.** This scenario presents the future and the proposed total area of UGS according to the data from GAM by adding the proposed parks in the land use (T2) to the results of the previous analysis.

1) *Per capita value*

Following the creation of the graphs and maps, UGS will be compared to demographic data, and the types of UGS in Table 1 will be determined using the three scenarios to illustrate the findings. For Marka, the results of UGS per capita were compared with international standards produced by the WHO, the Public Health Bureau USA, the European Union, and the United Nations.

UGS per capita was computed differently using Equation (1).

$$PC=TPC \div P \qquad (1)$$

Where PC is the per capita, TGS is the total area of green space, and P is the population.

2) Lorenz curve and Gini Coefficient.

In our study, Lorenz curve was used to indicate the relationship between the distribution of urban parks and the resident population in Marka. All spatial units (Neighborhoods) in the study area were ranked from low to high in terms of urban park per capita, the cumulative proportion of urban park areas

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 08, August-2023

distribution and the cumulative proportion of Marka's neighborhoods population was also calculated.

3) *Network Analysis / Service area*

Service area of a public facility is the service distance which is equivalent to the accessibility to a green space that supplies service via roads network [10]. Accessibility analyses were performed using the ArcGIS 10.3 network analyst extension "Service area analysis". This phase included the preparation of the road network and the running of the Network Analysis tool with a default break of 400 meters for the mini parks and 800 meters for neighborhood Parks, According to NRPA standards which represents the recommended walking distance for pedestrians. However, the indication of the people served is measured by the percentage of the served residential areas to the total residential areas.

4) *Location-Allocation (LA)*

In order to optimize the distribution of green spaces in Marka area it is required to propose a new public park in the scarce regions revealed from the results of the evaluation phase.

The GIS-location-allocation analysis was considered as a highly powerful tool for planning public utilities to locate the optimal locations for facilities in order to achieve maximum benefit and equitable service sharing. It is possible to understand the connections between access and facility location, using its models [11]. considering both existing service distribution patterns and potential future terms. The majority of models will allocate demand to the closest available facility. Therefore, the purpose is to reduce overall travel expenses, time, or distance travelled for all people or a specific geodemographic group.

The chosen locations as a result of LA may be rejected due to suitability factors such as: elevation (slope) considerations, land use factor, property factor, and vacancy factors etc. Therefore, studying these elements is required to either approve or relocate the sites. The spatial analyst extension of ArcGIS provides a method for considering these factors.

To identify the best practices criteria, an extensive examination of the literature and many associated sectors (e.g., ecology, environment, planning, local government, stakeholders, and residents) was conducted as shown in Table II. Followed by a schematic diagram of the Location Allocation approach for selecting the potential locations for the proposed public parks in Marka area, (Fig. 2). Therefore, Spatial analyst tool in ArcGIS was applied to select the most suitable locations of the proposed public parks as a supplemental phase within Location allocation analysis.

TABLE II. DESCRIPTION OF THE MAJOR CRITERIA AND SUB-CRITERIA USED TO DEFINE SUITABLE LOCATIONS FOR THE PROPOSED PUBLIC PARKS IN MARKA AREA. (SOURCE: AUTHOR)

Major Criteria	Sub-Criteria	Data Source	Description
Accessibility	Street network	GAM ,2020	The new public park sites should be accessible by streets network to serve the largest area of the residential zones.
	Residential area		The new public parks should be near or within the residential area to ensure that their service areas are intersected with the residential zones (NRPA).
Availability	Land vacancy		Vacant land is given priority in the selection to decrease the cost of reimbursing owners and restructuring.
	Land area		The potential sites should be at least 4,000 m^2 in size [12]
	Land property		GAM lands are given priority to avoid land acquisition issues.
			Private sector property as a potential solution in case that the budget in GAM is available to acquire land.
Ecologic criteria	Slope	Derived from ALOS PALSAR DEM (Alaska Satellite Facility, 2020)	The slope should not exceed 20 degrees to guarantee that the potential site is suitable for use as public park and to keep the design cost low [13]

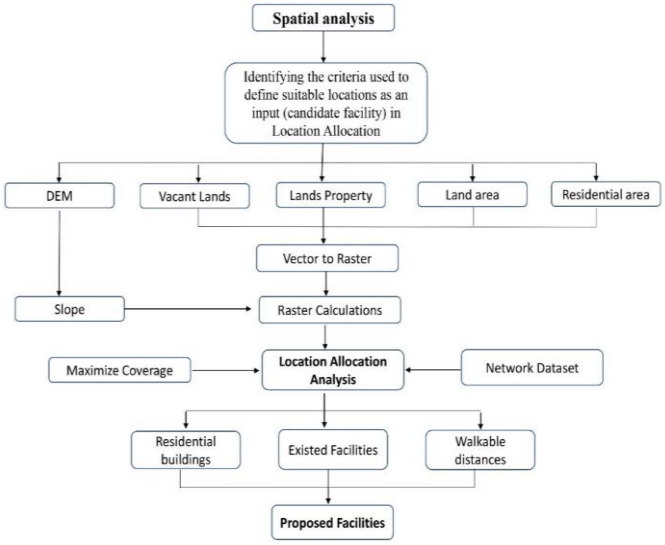

Fig. 2. Schematic diagram of the GIS-LA model for selecting the new Public Parks locations in Marka area. (Source: Author)

IV. RESULTS

A. *Per Capita*

Scenario 1. According to the first scenario, the finding reveals that the per capita value for the existing public parks equates to 0.5 m^2/capita in Marka area. This Figure is well below international standards, as shown in Table III. To meet the minimum standard of the WHO, there is a need to plan and design a total area of 1,425, 253 m^2 which is equal to 8% of the total area of Marka, and an area of 4,945,861 m^2 would be required to meet the United Nations' standard.

Scenario 2. We find that the total area of the UGS equates to .98 m^2/capita according to the second scenario. This result is still far from international standards of UGS per capita. Comparing the result with the WHO minimum indicates that Marka area still needs to increase the total area of UGS by 1,423,253 m^2. Furthermore, to meet the United Nations' 30 m^2/capita, there is a need for an additional 4,865,420 m^2 of UGS Table IV.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 08, August-2023

Scenario 3. In pursuit of adding the total area of the proposed parks in Marka area to the total from the previous scenario, we find that the per capita value of UGS (T1, T2, T3, and T4) equates to 1.6 m^2/capita. This result is still far from international norms. Comparing the result with the WHO minimum value indicates that GAM needs to increase the total area of UGS in Marka area by approx. six times the existing areas. Furthermore, to meet the United Nations' 30 m^2/capita, there is a need for an additional 4,767,271 m^2 of UGS as shown in Table (V).

TABLE III. COMPARISON OF MARKA UGS PER CAPITA WITH INTERNATIONAL STANDARDS, SCENARIO 1. (SOURCE: AUTHOR)

Organization	Standards (m^2/Capita)	UGS per capita (m^2/Capita)	Required area of UGS to achieve standards (m^2)	Shortage (m^2)
World Health Organization (WHO)	9	**.5**	1,508,832	1,425,253
Public Health Bureau (PHB) USA	18		3,017,664	2,934,085
European Union	26		4,358,848	4,275,269
United Nations	30		5,029,440	4,945,861

TABLE IV. COMPARISON OF MARKA UGS PER CAPITA WITH INTERNATIONAL STANDARDS, SCENARIO 2. (SOURCE: AUTHOR)

Organization	Standards (m^2/Capita)	UGS per capita (m^2/Capita)	Required area of UGS to achieve standards (m^2)	Shortage (m^2)
World Health Organization (WHO)	9	**.98**	1,508,832	1,344,812
Public Health Bureau (PHB) USA	18		3,017,664	2,853,644
European Union	26		4,358,848	4,194,828
United Nations	30		5,029,440	4,865,420

TABLE V. COMPARISON OF MARKA UGS PER CAPITA WITH INTERNATIONAL STANDARDS, SCENARIO 3. (SOURCE: AUTHOR)

Organization	Standards (m^2/Capita)	UGS per capita (m^2/Capita)	Required area of UGS to achieve standards (m^2)	Shortage (m^2)
World Health Organization (WHO)	9	1.6	1,508,832	1,246,662.8
Public Health Bureau (PHB) USA	18		3,017,664	2,755,494.8
European Union	26		4,358,848	4,096,678.8
United Nations	30		5,029,440	4,767,270.8

B. *Lorenz Curve and Gini Coefficient*

The Gini coefficient of urban park areas distribution for all residents within the 5 neighborhoods in Marka area is 0.29, which is in the range between .2 and .5 that indicates a medium inequality, and it is close to the warning line of 0.4[14] .The analysis reveals that Al-Zahra'a neighborhood has 50.6 % of the total area of public parks, even though its population are just 28.4% of the total population in the study area. However, Hamzah neighborhood has 34.1 % of public park areas, with a population of approximate 50% of Marka's total population, contributing significantly to the inequality value as shown in Fig. 3.

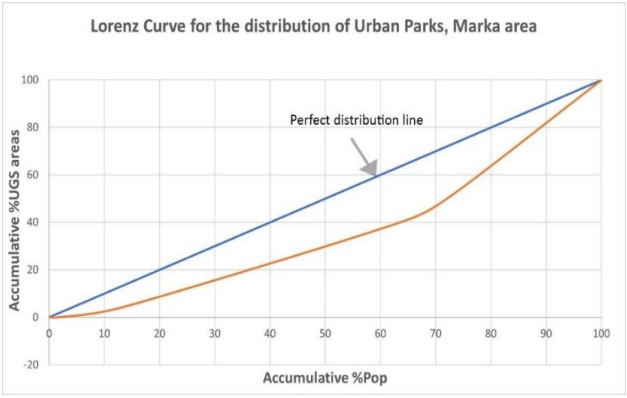

Fig. 3. Lorenz curve for the distribution of Urban Parks in Marka area.

C. *Network analysis/Service area*

Accessibility is measured by the walking distance to green spaces. This distance was inserted in ArcMap network analysis extension to determine the service area for each type of UGS based on the three previous scenarios. **Scenario 1**. By applying the walking distances of 400 m for mini parks and 800 m for the existing neighborhood parks (first scenario) according to the NRPA standards, as shown in Fig. 4, the finding shows that the study area performs poorly regarding the service area with only 13.3% served area of the total area of Marka and only 18.9% of the total residential areas was served. However, when investigating the neighborhood level, we found that 55% of Al-Zahra'a residential area was served by the existing parks, while Al-Jadeed neighborhood was severely underserved, with only 9.5 percent served of its residential area. Revealing that those public parks are not placed within suitable walking distance of residents' houses. **Scenario 2.** When applying the NRPA standards of walking distances to the second scenario, the finding reveals that the main change occurred in Al-Zahra'a neighborhood particularly in the urban development area, and it caused by the small green spaces that was scattered all around the zone, as well as in Hamzah neighborhood because of the forest land. According to the residential area as shown in Fig. 5, it is clearly visible that Al-Zahra'a neighborhood has an appropriate served proportion of around 68% of its overall residential area, while Hamzah neighborhood only has around one-third of its residential area served. Then subsequently Al-Matar, with 26.8%, and Al-Jadeed neighborhood, with only 9.8 %, while Al-Mushyirfeh has no residential area served which is identical to the previous scenario. For whole Marka the percentage has increased from 18.9% in the first scenario to 25.5% in the second scenario.

Scenario 3. When applying the NRPA standards of walking distance to the third scenario, where we added the proposed parks that was classified as public parks in the land use chart but still not implemented on site yet, to the previous scenario, by

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 08, August-2023

using 400 m walking distance to those proposed parks in which all of them are classified as mini parks Fig. 6. According to the findings the observed increase occurred in Al- Mushyirfeh neighborhood, where the service area expanded from 0% to 52%, as a result of proposing only one public park near the residential area, and in Al-Jadeed area, where the proportion increased by 12% between the two scenarios.

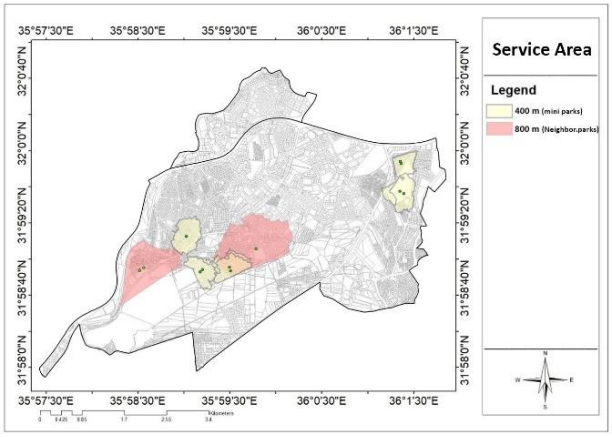

Fig. 4. Service area for UGS, scenario 1. (Source: Author)

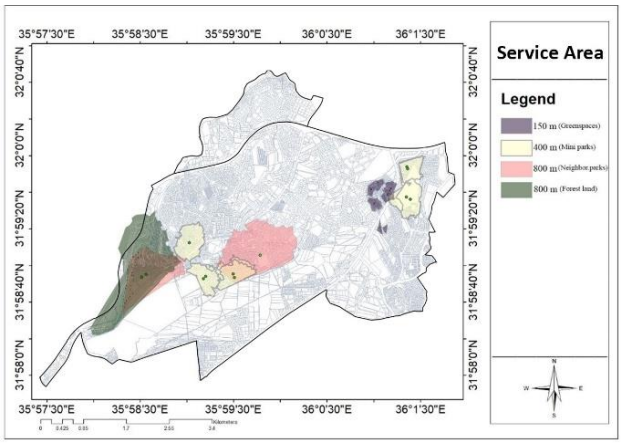

Fig. 5. Service area for UGS, scenario 2. (Source: Author)

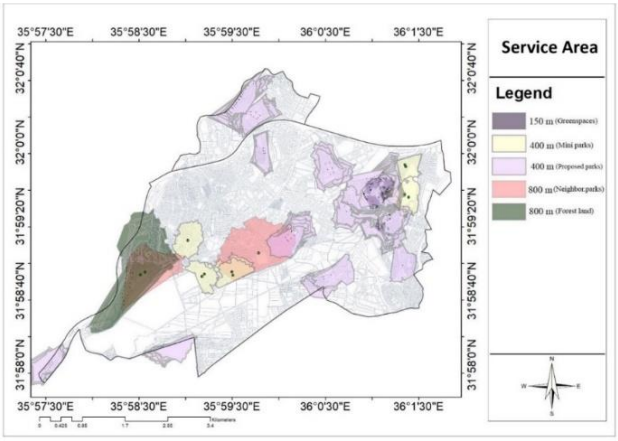

Fig. 6. Service area for UGS, scenario 3. (Source: Author)

D. Location Allocation

1) *Candidate facilities*

This study investigated the state of the candidate-facility for the study area which represents the potential sites for allocating the new public parks based on the integration of the five criteria features (Vacant land, more than 4,000 m^2 size, slope equal or less than 20 degrees, suitable land use, and near the residential area) as shown in Fig. 2 using raster calculation in spatial analysis extension in ArcMap GIS. The rseult shows that 93 locations of the study area were identified as a potential site for locating the new public parks and are all classified as mini public park type according to their sizes. As a result, these sites were selected to perform the candidate facilities in the Location-Allocation analysis.

2) Location Allocation analysis

In this study, residential buildings were determined as the demand points. the "maximum coverage" location-allocation model was applied to the required facilities (existing parks) first. The main objective of analyzing these facilities is to identify areas that are far from the nearest public park in Marka area, and therefore, to introduce new parks in the scarcity appeared areas. Distance is a cost feature that is utilized as an impedance in network analysis settings, 400 meters distance were used to represent the walkable distance to mini parks and 800 meters for neighborhood parks, according to the NRPA standards. After applying the location allocation analysis for the candidate facilities, Fig. 7 demonstrates that 15 of the 93 locations were found appropriate for the proposed parks in the scarce areas and the top three candidates were determined.

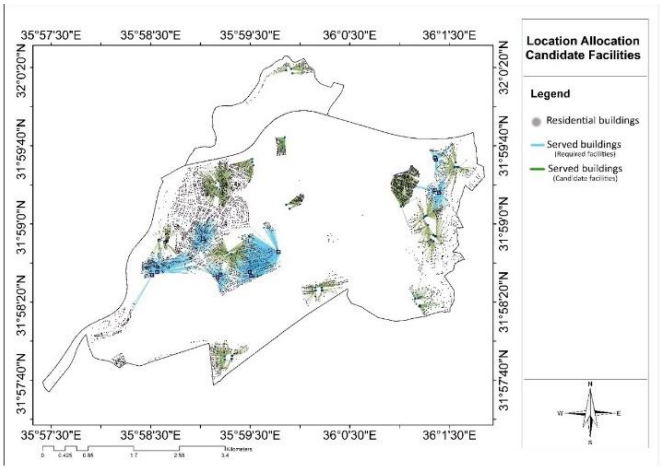

Fig. 7. Served buildings with the existing parks and the new proposed parks. (Source: Author)

The outcomes of solving the location allocation to the candidate-facilities nodes and residential buildings resulted in 1201 demand nodes (Residential building) allocated within the service area of the first three new proposed park facilities, representing 20.8% of the total demand nodes in Marka area. While applying the whole 15 potential locations resulted in serving 2405 demand nodes which represents 41.7% of the total demand nodes in the study area. The priority in the proposed parks' implementation was in terms of the number of demand points (residential buildings) within the new proposed parks' service areas, which was used to represent the population densities. The results investigated that within response distances of 400 meters for the proposed mini parks, the top three proposed parks caused an increasing of the served residential areas from **18.9%** to **27.5%,** as shown in Fig. 8**,** and when establishing the total 15 new parks the ratio will increase to reach

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 08, August-2023

46.3% of the total area of the residential zone in Marka, as shown in Fig. 9 and Table VI.

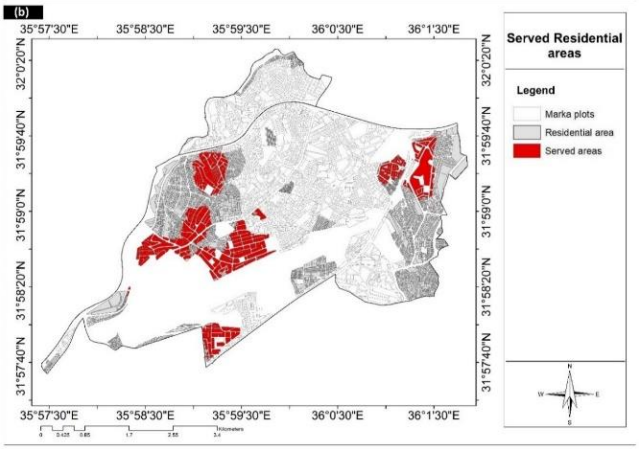

Fig. 8. served residential areas of the top three proposed parks. (Source: Author)

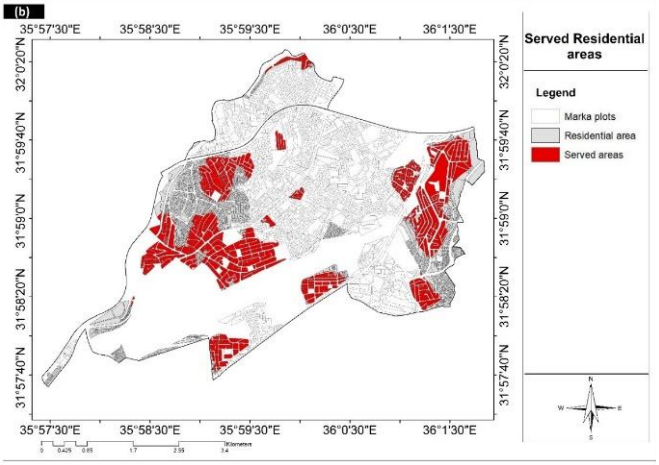

Fig. 9. Served residential areas of the total 15 proposed parks. (Source: Author)

TABLE VI. A COMPARATIVE OF THE SERVED RESIDENTIAL AREAS WITH THE EXISTING UGS AND AFTER PROPOSING THE NEW PUBLIC PARKS. (SOURCE: AUTHOR)

Neighbor	Existing Facilities		Proposed Facilities (First three)		Proposed Facilities (Total 15)	
	Service area (m^2)	Percentage to the residence area (%)	Service area (m^2)	Percentage to the residence area (%)	Service area (m^2)	Percentage to the residence area (%)
Al-Zahra'a	918,079.5	54.7%	1066475.3	71%	1516698.0	95.8%
Hamzah	608,488.7	20.4%	924691.3	34.6%	1639097.0	45.5%
Al-Jadeed	367,727	9.5%	367727.0	9.5%	1261621.7	30.4%
Al-Matar	474,337.7	23.9%	737882.5	45.2%	985284.4	65.9%
Al-Mushyirfeh	0.0	0%	0.0	0%	27005	61.8%
Marka	**2,368,632.9**	**18.9%**	**3096775.9**	**27.5%**	**5672755.7**	**46.3%**

V. DISCUSSION

A. *Per Capita:*

When investigated the reasons that caused the server shortage in the per capita results it was clearly noticed that the regulations in GAM were one of the main issues due to the types of residences in the study area of C and D with no A and B types which led to increase the crowding in the residential area, this is because, in the last few years, the focus has been on providing additional residential land, and this has led to rapid urban expansion in the city besides the neglect of the -green infrastructure with having no accurate and clear regulations or standards to manage the operation of organization the area and determining the land use.

B. *Accessibility and Service Area*

The findings reveal that the study area suffers from a lack of accessibility to recreation areas, and most of the residents could not be served, Since the UGS comprise a very small area in terms of the land use of each neighborhood under each of the three scenarios. This is clear evidence of the lack of understanding of the importance of UGS, and that the planners do not consider these spaces as important land use in the city. In General, Combined, the societal requirements, the acquisition and maintenance costs and the obsolete planning of the city make it difficult for the GAM to realize the optimal park area per capita, and the most important is that without security and supervision, even the existed parks will turn into havens of perversion and in some cases crime.

C. *Location Allocation Analysis*

The main objective of the research is to discover results on how to optimize the distribution of public parks and how to establish new services close to the populous environment. It can be noted that the distribution is not equal, with public parks services being particularly abundant in the southern and western boundaries of Hamzah and Al-Zahra'a neighborhoods, while they are rare or non-existent elsewhere in Marka area. The increase of these services should, of course, follow a methodological approach; nevertheless, this does not preclude scattered population groups from sharing service opportunities. Residents from these areas travel long distances to visit public parks, exceeding the norm in the served areas. This distance variation could be noticed from the Location Allocation and Service area analyses outcomes. As a result, some people must travel more than 2.2 kilometers from their homes to reach the nearest public park, while other places, notably the southern and western parts of Hamzah and Al-Zahra'a neighborhoods, have public parks constructed within less than 400 meters of each other. Regarding the new proposed public parks, It is worth noting that the first two new proposed parks are GAM properties, while the third proposed park is a private property land.

Taking into consideration that the optimization outcomes were insufficient due to late attempts to improve the current situation,

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 08, August-2023

this indicates that the longer we ignore these concerns, the worse the situation will become.

VI. CONCLUSION

From the review of the first and second scenarios, which present the existing situation in Marka, we found evidence that the area suffers from a lack of UGS, and a lack of understanding of the importance of the provision of UGS and public parks. From the findings of analyzing the spatial distribution of UGS the followings could be concluded:
1. The actual green space per capita in Marka area is 0.5 m2/capita which is significantly below the minimum standards and less than Amman's per capita which is equal to (2 m2/capita).
2. It's required to establish green space with an area of 1,425,253 m2 which is 17 times the existing green area to fulfill the World Health Organization standards in Marka area which is equal to 8% of Marka's total area.
3. UGS in Marka area are not evenly distributed according the Gini coefficient and Lorenz curve.
4. More than 81% of Marka's residential area is not served with neither a mini public park with a walkable distance of 400 meters nor a neighborhood park with a walkable distance of 800 meters.
5. Three potential park locations are proposed, all of which meet the four requirements of (minimum size of 4,000 m2, adequate slope, proximity to a residential area, and vacant land), with the top two being GAM property and the third being a private property. And will increase the percentage of the served residential area in Marka from 18.9% to 27.5%
6. The Organizational Law for Cities, Villages, and Buildings" in Jordan does not take into account any standards relating to the planning of public park services, such as per capita value, accessibility, or the minimum size for parks.

Appendix A

UGS: Urban Green Space
GAM: Greater Amman Municipality
NRPA: National Recreation and Park Association
WHO: World Health Organization
LA: Location Allocation

REFERENCES

[1] Avissar, R. J. A. e. (1996). "Potential effects of vegetation on the urban thermal environment." Atmospheric environment **30**(3): 437-448. https://doi.org/10.1016/1352-2310(95)00013-5

[2] Shi, S. (2002). Research on the urban spatial structure guided by the urban green space system. *Central China University, Wuhan (in Chinese).*

[3] Neema, M., et al. (2008). Analyzing existing condition and location of open spaces in Dhaka city. Proceedings of 6th Int. Symposium on City Planning and Urban Management in Asian Countries.

[4] European Union (2011). Mapping Guide for a European Urban Atlas. E. Environment and E. Agency, Copenhagen, Denmark. https://land.copernicus.eu/user-corner/technical-library/urban-atlas-mapping-guide

[5] Elster, J. (1992). Local justice: How institutions allocate scarce goods and necessary burdens, Russell Sage Foundation.

[6] Brainard, J., et al. (2006). Equal access for all? Ethnicity and public park availability in Birmingham (UK), CSERGE Working Paper.

[7] Choumert, J. and J. J. L. R. Salanié (2008). "Provision of urban green spaces: some insights from economics." Landscape Research **33**(3): 331-345. https://doi.org/10.1080/01426390802045996

[8] Rigolon, A., Browning, M., & Jennings, V. (2018). Inequities in the quality of urban park systems: An environmental justice investigation of cities in the United States. *Landscape and Urban Planning*, *178*, 156-169. https://doi.org/10.1016/j.landurbplan.2018.05.026

[9] Montgomery, M. J. P. (2007). "United Nations Population Fund: State of world population 2007: Unleashing the potential of urban growth." Population Development Review **33**(3): 639-641. https://link.gale.com/apps/doc/A169022401/AONE?u=anon~e1d7146f&sid=googleScholar&xid=0ed46a20

[10] Oh, K. and S. J. L. Jeong (2007). "Assessing the spatial distribution of urban parks using GIS." Landscape urban planning **82**(1-2): 25-32. https://doi.org/10.1016/j.landurbplan.2007.01.014

[11] Nemet, G. F., & Bailey, A. J. (2000). Distance and health care utilization among the rural elderly. *Social science & medicine*, *50*(9), 1197-1208. https://doi.org/10.1016/S0277-9536(99)00365-2

[12] City of Keizer (2008). City of Keizer, Parks and Recreation Master Plan. CHAPTER 4: PARK DESIGN AND DEVELOPMENT STANDARDS

[13] Guo, D., et al. (2014). "An empirical model for landslide travel distance prediction in Wenchuan earthquake area." Landslides **11**(2): 281-291. https://doi.org/10.1007/s10346-013-0444-y

[14] Wen, J. N., Yang, Y. H., Jiang, Y., Li, L. G., Wang, X. Y., & Cui, X. G. (2016). Analysis on equity of Ningxia's health resource allocation based on Gini coefficient and index of Dissimilarity. *Chin Health Econ*, *35*(4), 61-64.