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Dolna 17, Warsaw, Poland 00-773
Tel: +48 226 0 227 03
Email: editorial_office@rsglobal.pl

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AUTHOR(S)	Abdaoui Gihen Rym, Jakjak Abderazak, Agaguenia Siham, Dahdouh Fatima, Bakiri Hadia, Tabet Ahmed Amine
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AN INTEGRATED APPROACH TO IDENTIFY SUITABLE AREAS FOR THE LOCATION OF PUBLIC FACILITIES USING MULTI-CRITERIA ANALYSIS BASED ON GIS AND AHP IN THE CITY OF EL KHROUB, ALGERIA

Abdaoui Gihen Rym
Institute of Urban Management Techniques, University of Oum El-Bouaghi, PO Box 358, Oum El-Bouaghi, Algeria
ORCID ID: 0000-0003-3650-2996

Jakjak Abderazak
Institute of Urban Management Techniques, University of Oum El-Bouaghi, PO Box 358, Oum El-Bouaghi, Algeria
ORCID ID: 0000-0003-4407-2543

Agaguenia Siham
Institute of Urban Management Techniques, University of Oum El-Bouaghi, PO Box 358, Oum El-Bouaghi, Algeria
ORCID ID: 0000-0002-4081-5672

Dahdouh Fatima
Institute of Urban Management Techniques, University of Oum El-Bouaghi, PO Box 358, Oum El-Bouaghi, Algeria
ORCID ID: 0000-0001-5910-1058

Bakiri Hadia
Institute of Urban Management Techniques, University of Oum El-Bouaghi, PO Box 358, Oum El-Bouaghi, Algeria
ORCID ID: 0000-0002-3440-4260

Tabet Ahmed Amine
Institute of Urban Management Techniques, University of Oum El-Bouaghi, PO Box 358, Oum El-Bouaghi, Algeria
ORCID ID: 0000-0002-8644-9575

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ABSTRACT

Random and spontaneous urban growth is the result of massive natural population growth, as it is in all developing countries. As for our study air, it also results from the unloading of the mother city of Constantine to the satellite city of El-Khroub, which gave urbanization the power to take over its vast environment, An uneven distribution of public facilities in the city's major districts, as well as traffic jams. This work attempted to determine the suitability of urban land for the location of public facilities in the city. It should be noted that land suitability assessment is a major factor in urban planning and management. Our land adequacy assessment is subject to the AHP model, calculating the weighting of various criteria including physical, socio-economic, environmental and urban. The final adequacy analysis revealed the proportion of land most suitable, estimated at 3.52% of the total area, covering mainly fallow land. The results of this study provide a detailed mapping of urban development potential, integrating both existing data and future projections.

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Introduction.

Public facilities (PF) play a major role in meeting the needs of the service, since urban studies often impose a restrictive definition of public services, restricting them only to facilities and services accessible to the general public (Albe-Tersiguel et al 2008). The PF plays a vital role in city life, and accessibility allows people to access their basic needs (Dembele Samba.2017). The PA provides services to citizens and must be accessible and open to all. They are usually carried out under the responsibility of the state, local authorities or a private establishment (Dubos-Paillard,E et al.2003).

One of the main determinants of quality of life in cities is access to urban PF (Clegg and Garlick 1979; Ali and Rahman 2004). The level of development of states and the availability of basic EPs are linked to a complex relationship, where it is not possible to determine with certainty whether more urbanized states have better access to these states (Ram B. Bhagat, 2010). In some cases, there may be developed countries with a shortage of certain basic services, while less urbanized territories have better availability of these services. Similarly, it cannot be established categorically whether large cities are better off than small ones in terms of availability of basic EPs (Ram B. Bhagat, 2010). We can find large cities with an uneven distribution of services, while we find others with better availability of these public facilities and a better quality of life in general. While basic public services are essential to society, their distribution is marked by flagrant injustice. Although these services are essential to survival and a decent life, we note significant variation in their availability between different geographic units and the individuals themselves (Henderson, et al, 2001; Anderson and Pomfret, 2004; Kenbur and Venables, 2005).

This is why urban planning plays an important role in achieving more just and inclusive societies by ensuring that all individuals, regardless of their social background or income, have equal access to basic public services and facilities such as health and education (Cervero, R. 2001; Murray, A.T. 2001; Maruna, M.et al 2018). Despite their crucial role in the daily lives of communities, access to infrastructure is unevenly distributed across the territory, both in rural and urban areas (Jahangeer A.P et al, 2018; Aderamo A.J. and Aina O.A.2011). The geographical distribution of facilities leads to spatial and social disparities in regions and within cities (Madu, 2007). The development of projects and plans for future development of facilities in a region requires a thorough prior knowledge of their nature and territorial distribution. The accelerated urban development of cities over the past three decades has put considerable pressure on urban social amenities, and the urban planning agency, overtaken by urban expansion, has been unable to adequately respond to needs, this resulted in an unequal distribution of civic infrastructure within cities (Aburas, M.M et al 2015; Zahoor A. et al 2017). Unequal access to urban facilities in southern cities has a negative impact on the physical well-being of populations. Urban growth and rural exodus are global phenomena, particularly marked in developing countries. Many small towns and rural areas are rapidly becoming large conurbations (Jain, K and Subbaiah, Y.V 2007; Mahrous, MS 2009). This exponential population growth is putting a strain on the urban environment and creating a multitude of problems, such as urban sprawl, lack of affordable housing, chronic congestion, a faulty drainage system, Sanitation problems and a glaring lack of other essential services (Liu,Y, and Phinn, S.R,2003; Kunze, A, 2012). Adequacy analysis assesses the extent to which a system meets stakeholders' expectations and needs. The adequacy analysis is the process, the procedures used to establish the adequacy of a system according to the needs of a stakeholder. In this context, it is all the more important to optimize the implementation of public works taking into account the specific needs and constraints of a territory in order to control the inappropriate urban growth and preserve the surrounding space of urban agglomerations (Ullah, K.M. and Mansourian, A, 2015; Kumar, M and Shaikh, V.R.2013, Jafari, S and Zaredar, N). Remote sensing and GIS techniques are used to provide data that will be used for development and research (Saha A and Roy R. 2021; Mallick SK, 2024). Persuading the best approveable geospatial specimens for possible development and planning requires issuing management privileges and using decision support engineering (Martellozzo et al. 2018; Huang et al. 2023). Using Geographic Information Systems (GIS), it is possible to analyse and map various relevant factors such as population density, distribution of existing services, accessibility of transport, socialeconomic and environmental constraints (Malczewski, J. 1999). Land suitability assessment is often based on the combination of GIS and multi-criteria hierarchy (MHM) method. Among these, hierarchical analysis (AHP) and weighted linear combination methods are particularly prevalent in the field of remote sensing (Shang and Luo. 2021, Zhu et al. 2022 and Shang et al. 2023). Assessment of adequacy is essential for informed decision making. The assignment of relative values, or weights, to the various combined factors is the crucial choice that the analyst must face when using this tool (Jallow,A.G, 2020). The GIS-based analytical hierarchy process (AHP) was used as a multi-criteria decision-making model to find an appropriate site for the construction of equipment in the city of El Khroub in northeastern Algeria. The migratory pressure exerted by the metropolis of Constantine on its satellite city, El Khroub, as well as rural migration flows have led to rapid and anarchic urban growth. This accelerated urbanization has undermined environmental balances, physical and social inequalities of access, resulting in overcrowding, sanitation problems, infrastructure shortages and degradation of natural spaces. To address these phenomena and promote sustainable urban development, it is crucial to assess the suitability of land for different uses. This assessment will help guide land use planning choices to meet the needs of the population while preserving ecological diversity.

The academic access feasible for this work are as follows, first of all, this article will be a model convertible to other similar areas, because it deals with the assessment of the suitability of land for the implantation of EPs in order to achieve equitable spatial distribution. This study can be used to enable urban planners to identify, compare and analyse the proper planning and management of urban development sites.

Study area.

Work on the town of El Khroub, which is located south of the Constantine wilaya in northeastern Algeria, between 6° 41' and 6° 43' E longitude, and between 36° 15' and 36° 17' N latitude (National Institute for Cartography and Remote Sensing, 2009). These elevations vary between 600 meters to the west and 750 meters to the east, it is extended on the surface of 968 hectares (hec) (Ahmed Amine Tabet, 2023). Its total population is 179,188 (Census of the commune, 2022). The climate is semi-arid, with annual rainfall varying between 500 and 560 mm (Bouteraa, 2019). The city’s infrastructure is quite considerable; towards Guelma by the national road n° 20, towards Tébessa by the RN n° 10 and towards Batna by the RN n° 03 (Hioul, 2002). (Figure1: (Ahmed Amine Tabet, 2023)).

Methods.

Data and material.

In this study, in order to know the real distribution of public facilities we adopted the method of Kernel density which clearly shows the parts of significant densification of equipment at the city of El Khroub, we also found the need to analyse the distribution trend using the nearest neighbour method, in order to assess the layout of equipment within the city. Then six different types of thematic respectively basic layers were created from different sources, for altitude maps, slope maps were prepared using the digital elevation model (DEM) ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) at a spatial resolution of 30 m downloaded from United States Geological Survey Earth Explorer (earthexplorer.usgs.gov). The map of land use and soil cover is obtained through previous work on automatic extraction of agglomerations from bare ground, whose evaluation values have an overall accuracy of 96.44% and the value of the Kappa (K) coefficient of 95.72% (Ahmed Amine Tabet, 2023). Guided by the zoning of the 2020 Master Plan for Urban Planning and Development, we have mapped out the major neighbourhoods and existing public facilities. In this study, all maps are made using ArcGIS 10.7 software.

AHP model processing.

Submitted by Saaty in (Saaty. T.L, 1977), the analytical hierarchical process (AHP) method consists of breaking down a complex problem into a hierarchical structure. By comparing two-to-two the elements of this hierarchy, it is possible to establish priorities between the different options Saaty, T.L 1977). The evaluation process, which comprises six stages (Saaty, 1980), consists of identifying relevant criteria, prioritising them and assigning weights to them reflecting their importance in the decision to be taken through the hierarchical decomposition of a complex problem, the development of pairs of comparison matrices, the assignment of numerical values to judgements, the calculation of relative weights of criteria, the synthesis and prioritization of criteria and finally the verification of the consistency of the model (Danumah,J.H et al, 2016).

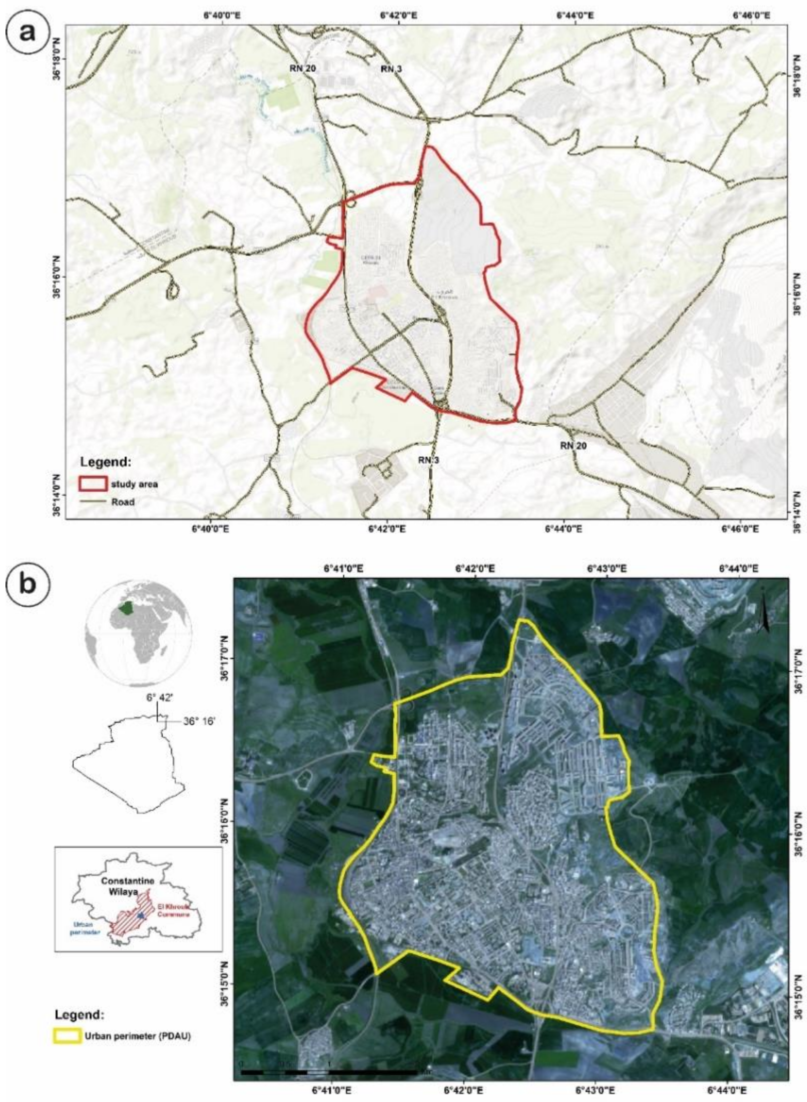


Fig. 1. a) main road. b) geographical location of El Khroub.

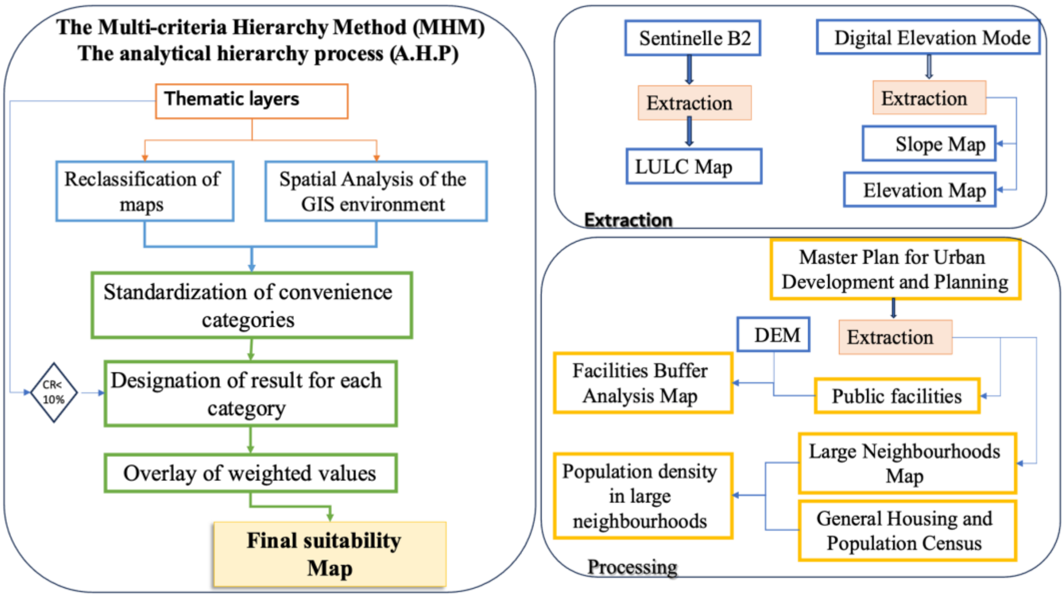


Fig. 2. Flow chart of methodology.

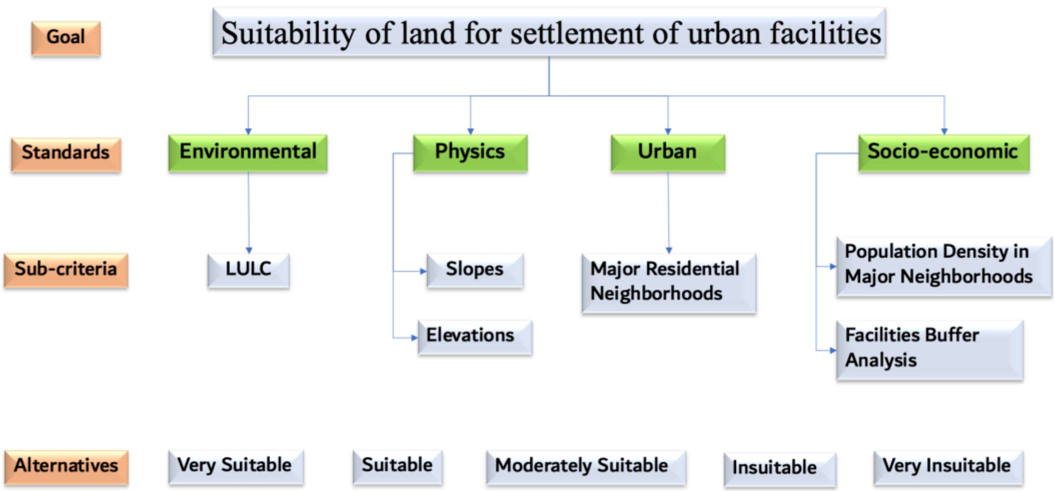


Fig. 3. Utilisation du modèle AHP dans la carte d'implantation des équipements public.

Pairwise comparison.

The binary scheme is based on the scale recommended by Saaty (Saaty, 1980) for comparative factor analysis in Table 1. Pairwise judgments are the fundamental element of the AHP process. For each criterion, two options are compared at a time and a relative weight is assigned to each on a scale of 1 to 9 (Table 1). This weight expresses the importance of one criterion over the other, and the weights assigned to each pair must be reciprocal. Any rating reveals the extent to which option "X" meets the "Y" criterion.

Table 1. Saaty's Scale.

Scale	Judgment of preference	Description
1	Equally important	Two factors contribute equally to the objective
3	Moderately important	Experience and judgment slightly favour one over the other
5	Important	Experience and judgment strongly important favour one over the other
7	Very strongly important	Experience and judgment strongly important favour one over the other
9	Extremely important	The evidence favouring one over the other is of the highest possible validity
2,4,6,8	Intermediate preference between adjacent scales	When compromised is needed

Summary of the assessments.

It is necessary to synthesize our assessments in order to obtain an overall estimate of the priorities relating to the criteria, this synthesis is made thanks to the establishment of the standardized matrix which allows meaningful comparisons between the elements (Saaty, 1984). This summary provides the percentages of the overall priorities to weight the priority vectors by the weight of the criteria and take the sum in relation to all the weighted priority values corresponding to those of the next lower level and so on. These operations result in an overall priority vector for the lowest level of the hierarchy. If several results are obtained, their arithmetic mean can be taken (Saaty, 1984).

After calculating the weights, it is necessary to calculate the consistency ratio (CR) to check the degree of consistency of the judgments made by any expert (Weldu WG, Deribew IA, 2016). This is an indication provided to justify whether the comparison matrix is consistent or not (Saaty TL, 1977). The formula to obtain the CR value is,

$$\boldsymbol{CR = (CI/RI) * 100}$$

Where CR is the coherence ratio,
CI is the ratio of the coherence index,
RI is the random inconsistency index of a randomly generated pairwise comparison matrix from 1 to 10 (Table 2), calculated by matching random indices using a sample (Saaty, T.L. 2001). In the Consistency Ratio (CR) formula, the CI is calculated by the following equation.

$$\boldsymbol{CI = (\lambda - 1)/(n - 1)}$$

Where CI is the consistency index,
λ is simply the mean of the consistency vector,
n refers to the total number of criteria. The coherence ratio of the hierarchy must be equal to or less than 10% (Saaty, t. l. 1980). If not, the quality of the information should be improved by possibly revising the way in which the questions are asked to make binary comparisons (Saaty, 1984).

Table 4. The random inconsistency value. (Saaty, T.L.1984).

Number of criterion	1	2	3	4	5	6	7	8	9	10
Random Inconsistency	0.00	0.00	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Development of sub-criteria maps.

After sorting the criteria for the location of public facilities, various thematic maps were drawn up. Six thematic maps were prepared in a GIS environment, the criteria used being six and most of them are in vector format, where we had to convert them into rasters to succeed in our analysis.

Incorporation of Criteria Maps and Final Suitability Map.

After assigning weights, in the ARCmap and using a weighted overlay tool, we integrated the maps to obtain the final suitability map.

Results and discussion.

At El Khroub, there is a considerable inequality in the distribution of equipment densities (fig.4), the kernel density method clearly shows the condensation points of the equipment. At the city level, there is a strong inequality in the distribution of the density of facilities, which is confirmed by the result of the analysis of the spatial distribution of public facilities. In particular by the method of the nearest neighbour, we can not only locate these facilities but also identify trends of grouping or dispersion within the urban territory (DEMBELE Samba, 2017). The fig.5 illustrates the dispersed nature of the equipment, this examination reinforces the previous one by providing the necessary answers based on reliable statistical indicators (z-score, average distance observed, average distance expected and the ratio of the nearest neighbour).

According to the results of the exit from the p-value program is low close to zero 0.10 we reject the hypothesis of nowhere between the distribution of equipment and space, the ratio is inadequate. Since the Z-score value is estimated to be -1.636, it is less than -1.65, which means that the confidence level is 90%. According to the results, since the value of the NNR is 0.95, it is close to 1, here we judge that the distribution of public facilities in the city has a random distribution.

Almost like all cities in developing countries will grow coincidentally (Arjun S, Ranjan R, 2020). In these cities, although PF is a fundamental pillar of sustainable urban growth, the identification of suitable sites for the establishment of PF is never subject to planning or programming. Conversely, it can be linked to population density, as is the case for the educational PFs of the first three phases. The search for suitable areas was used using six criteria and the integration of these criteria made it possible to identify different suitable locations for the future establishment of PF.

Fig.4. General Equipment Density (Core Density)

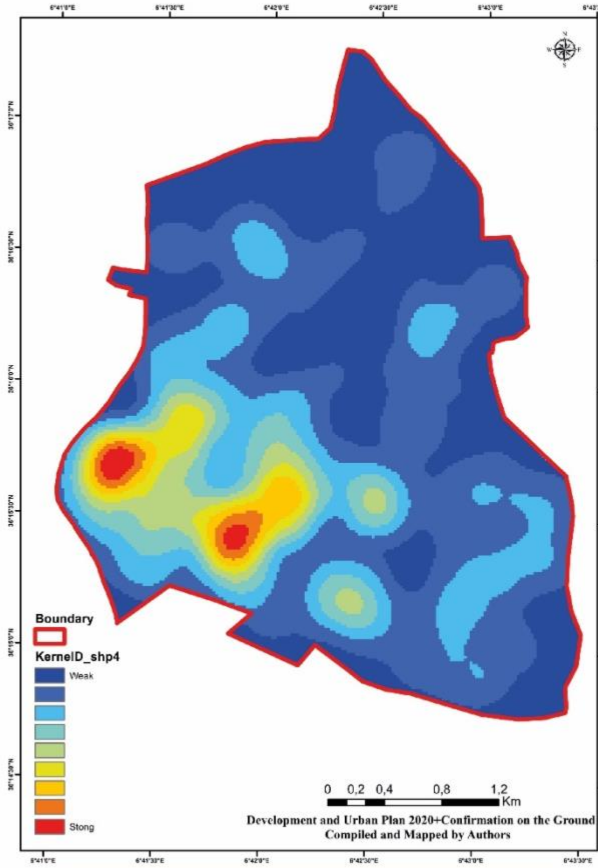
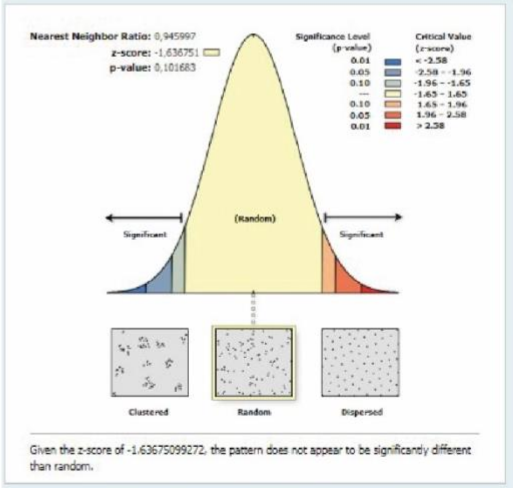


Fig.5. Trend in the distribution of public facilities (nearest neighbour)



Average Nearest Neighbor Summary

Observed Mean Distance:	98,0981 Meters
Expected Mean Distance:	103,6981 Meters
Nearest Neighbor Ratio:	0,945997
z-score:	-1,636751
p-value:	0,101683

Dataset Information

Input Feature Class:	equipement
Distance Method:	EUCLIDEAN
Study Area:	10796300,000000
Selection Set:	False

Environmental factors.

The environment and its factors play a critical role in finding suitable locations for connections, although this data is not always available. With improvements in satellite techniques, traditional methods have often been transformed by remote sensing data analysis to monitor changes including land use change. (Sertel & Akay 2015). Land use and operation Fig.6 is mentioned as a fundamental criterion for understanding the distribution of land use in the study area, the land use map was drawn from sentinel data A2 of April 6, 2020. It has been classified as built-up land, green spaces, barren land and asphalt. In the further analysis, sterile land was considered a very appropriate criterion because in the future new constructions could be carried out, including developments, after this sub-criterion we have the sub-criterion of green space, which is considered to be an appropriate standard for locating EPs. Buildings are moderately adapted as they may contain administrative equipment or branches. The last sub-criterion, asphalt (roads), is classified in a category not suitable for such development.

Socio-economic factor.

The highest population density is linked to the location of the EPs, which makes them closer to the citizen's service. In this work, the densest areas are best suited to the future public establishment in order to bring them closer to the citizen (fig.7). It should be noted that the population densities in force are distributed according to the major areas of the city, which we will discuss later. In our work the reality of PF distribution in the city of El-Khroub is a basic criterion for decision making of the ideal location of these in the future (fig.8), we considered that buffer zones from 0 to 200 m very inadequate for the realization of any public equipment; buffer zones medium adequate is suitable between 200 and 350 meters, while buffer zones adequate is between 350 and 500 meters, and the most suitable site for the implantation of future urban EPs in the city remains for the buffer zones confined between 500 and 650 meters and more than 650 meters.

Urban factor.

For this work, the urban factor is understood to mean all the major neighbourhoods (fig.9), which are part of the revision of the intercommunal master plan (Constantine-El Khroub-Aïn Smara-El Hamma-Didouche Mourad), which has the following designations A, B, C, D, E, F, G, N1 and N2. During the work, we distinguished adequacy according to the availability of PF in the major neighbourhoods, and it is natural that the adequacy be directly proportional to the lack of equipment. The urban standard is classified into four categories: very appropriate, appropriate, average fit and very inappropriate.

Physical factors.

Physical factors, such as elevations and slopes, are the fundamental criteria for building public facilities. A steep slope is not suitable for any type of construction because it requires higher construction costs, is also risky. Topographical characteristics (Fig.10, Fig.11) The criteria for suitability to construct equipment (environmental, physical and social) are classified into three categories: very suitable, appropriate, moderately suitable.

fig.6

LULC

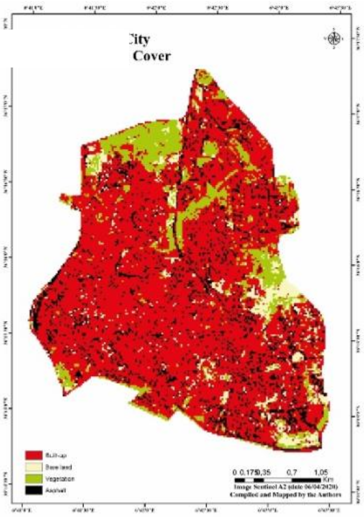


fig.7

Population density

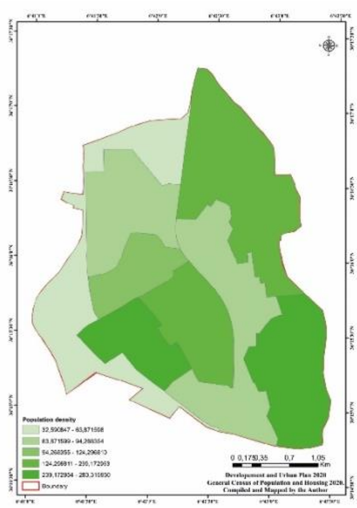


fig.8

Facilities Buffer

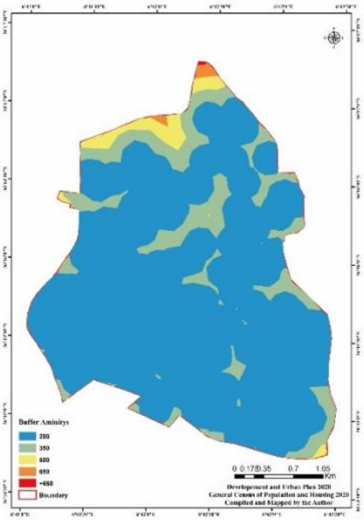


fig.9

Large District

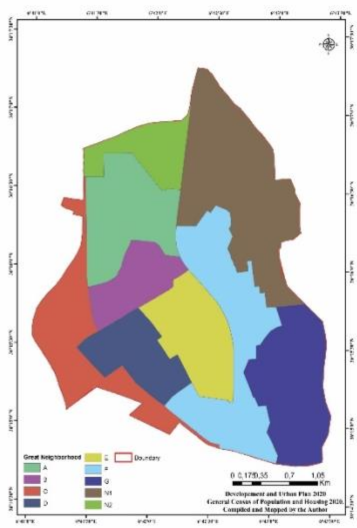


fig.10

Slope

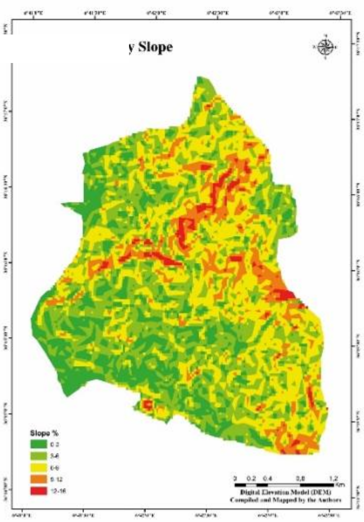
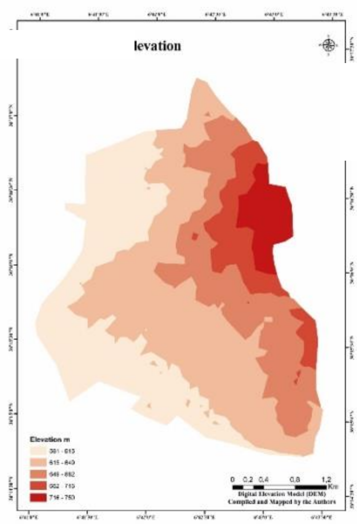


fig.11

Elevation



Pair wise comparison matrix and normalized pair wise comparison matrix.

Since we adopted six criteria for the analysis, a total of 15 subjects were constituted in the questionnaire that was prepared by five experts according to the Saaty scale. In the pairs comparison matrix (table 5), there are 36 boxes and we filled 36 boxes based on the value we get from the questionnaire. The diagonal value will always be 1 because the impact between identical criteria will be equal, and the rest of these reciprocal values.

The standardized pair comparison matrix (Table 6) is the second step to obtain the final weighting of each criterion. The normalized value was calculated by dividing each value of a matrix table by pair by their respective total column value. To determine the weight of each criterion, the arithmetic mean method was used line by line. Population density is the most important influence criterion (31.46%), followed by large neighbourhoods (19.45%), slope (19.41%) and public facilities (14.71%), while land use and land cover has the lowest influence on the location of public equipment, with only 3.83% weighting. Through this matrix, it is clear that socio-economic factors are the most important factors in decision making for the establishment of new public facilities.

Table 5. Pair wise comparison matrix by AHP.

Pair comparison matrix						
Criteria	SP	EL	LULC	EF	LD	PD
SP	1	3	7	1	1	0.33
EL	0.33	1	2	1	1	0.33
LULC	0.14	0.5	1	0.2	0.14	0.2
EF	1	1	5	1	1	0.33
LD	1	1	7	1	1	1
PD	3	3	5	3	1	1
Sum	6.47	9.5	27	7.2	5.14	3.2

SP Slope, *EL* Elevation, *LULC* Land use land cover, *EF* Existing Facilities, *LD* Large District, *PD* Population density.

Table 6. Normalized pair wise comparison matrix and computation of criterion weightage.

Normalised pair wise comparison matrix							weights (%)	Rank
Criteria	SP	EL	LULC	EF	LD	PD		
SP	0.15	0.31	0.25	0.13	0.19	0.1	19.45	2
EL	0.05	0.1	0.074	0.13	0.19	0.1	11.14	5
LULC	0.02	0.05	0.03	0.02	0.02	0.06	3.83	6
EF	0.15	0.1	0.18	0.13	0.19	0.1	14.71	4
LD	0.15	0.1	0.25	0.13	0.19	0.31	19.41	3
PD	0.46	0.31	0.18	0.41	0.19	0.31	31.46	1
Sum	1	1	1	1	1	1	100	

SP Slope, *EL* Elevation, *LULC* Land use land cover, *EF* Existing Facilities, *LD* Large District, *PD* Population density.

Calculation of the consistency ratio.

It is essential to examine the level of consistency in the assessments. Before calculating the CR value, it is necessary to calculate the value of the coherence index (CI) and λ. Table 7 illustrates the calculation of the coherence vector. The outcome of the consistency report (CR) is less than 10%, therefore the judgment is consistent, further analysis is allowed.

$$\mathbf{CI = (\lambda\text{-}n) / (n\text{-}1)} = (6{,}378-6) / (6-1) = 0.075$$

$$\mathbf{CR = (CI/RI) * 100} = (0{,}075/1{,}24) * 100 = 6{,}11\%$$

Tableau 7. Calcul du vecteur de cohérence.

Criteria	Weighted Sum Vector	Consistency Vector
SP	(1*0,235950454) +(2*0,144255116) +(0,5* 0,401770127) +(3* 0,125017301) +(6* 0,032360229) +(5*0,060646773)	6.389
EL	(0,5*0,235950454) +(1*0,144255116) +(0,33*0,401770127) +(0,5*0,125017301) +(7*0,032360229) +(4*0,060646773)	6.274
LULC	(2*0,235950454) +(3,03030303*0,144255116) +(1*0,401770127) +(6*0,125017301)+(6*0,032360229)+(8*0,060646773)	6.314
EF	(0,33333333*0,235950454)+(2*0,144255116)+(0,16666667*0,401770127)+(0,2*0,125017301)+(1*0,032360229)+ +(0,25*0,060646773)	6.415
LD	(0,16666667*0,235950454)+(0,14285714*0,144255116)+(0,16666667*0,401770127)+(0,2*0,125017301)+(1*0,032360229)+ +(0,25*0,060646773)	6.334
PD	(0,2*0,235950454) +(0,25*0,144255116) +(0,125*0,401770127)+(0,5*0,125017301)+(4*0,032360229)+(1*0,060646773)	6.544

Analysing final suitability map.

The overlay of the adequacy maps for the above sub-criteria (fig.12) (land use and occupation, population density, spatial sacredness of public facilities, metropolitan areas, slopes and elevations) enabled us to create a Geographic Information System (GIS) for the complete adequacy of suitable land for the correct location of PF throughout the urban area of the city of El Khroub (fig.13). This model, based on a weighted index system, generated a land suitability map for urbanization, classified into five categories ranging from 'highly adapted' to 'very unadapted' (table 8). The mapping of this capability is shown in the following figure. The areas of the different suitability areas are listed in Table 9. Approximately 3.52% of the total area, equivalent to 38 hectares (hec), is classified as very suitable area. The percentage is the lowest compared to the rest of the percentages in the various categories. This means that any new equipment can be installed in this area which includes sterile land, and will be at an appropriate height and slope and will be in service at a higher population density. Very few plots meet all the criteria, which also proves that this area is now in the best position thanks to its integrated features. The favourable areas, which account for 6.20% and are located in the north of the city, are characterized by a steep slope conducive to recreational facilities or public spaces. The appropriate median areas occupy 26.48% of the total area, most of which are located east of the city (east of National Highway 3), where population concentration is extremely high. The extreme northwest of the city. Inappropriate areas occupy an area of 422 (hec), or 39.07% of the total area. They are located in the northern part of the city and in its southernmost part, due to the availability of facilities. The category characterized by absolute lack of adequacy covers an area of 267 hectares, or 24.72%, and is the heart of the city with a significant concentration of facilities.

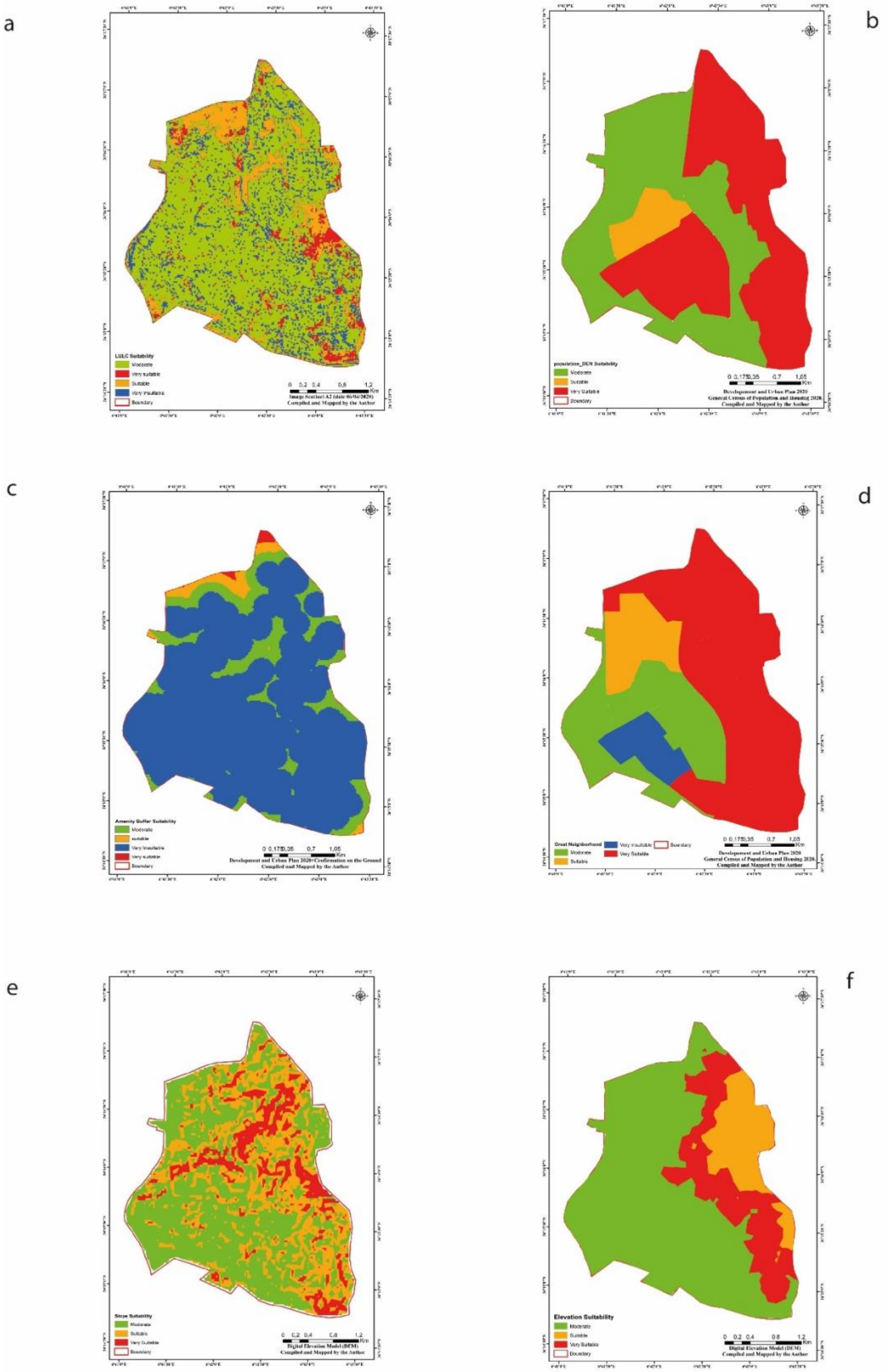


Fig.12. Adequacy maps for sub-criteria: a) LULC suitability, b) Population density suitability, c) Existing Facilities suitability, d) Large District Suitability, e) Slope suitability, f) Elevation suitability.

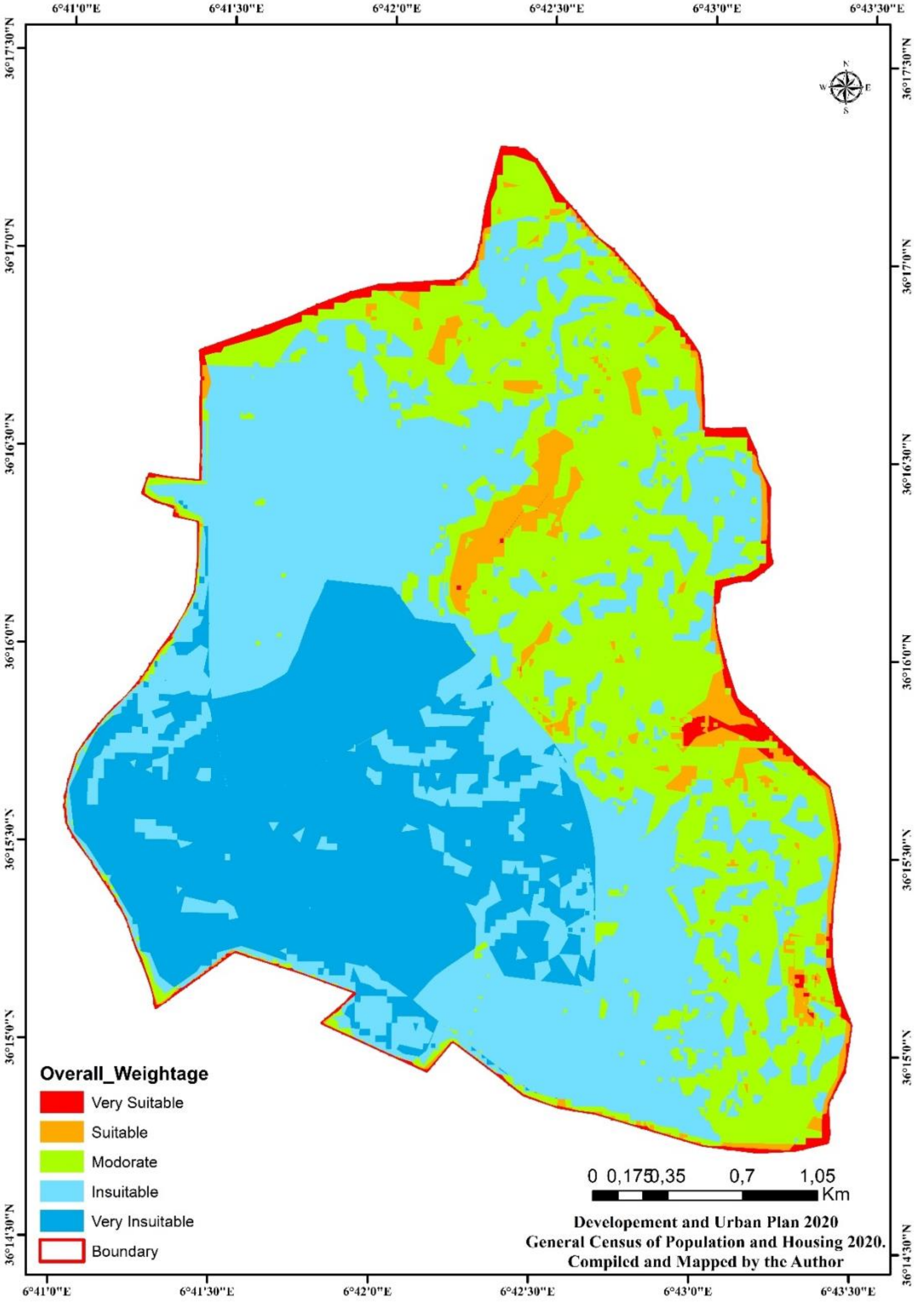


Fig.13. Suitability map for location of public facilities in El Khroub.

Table 8. Summary of criteria, sub-criteria, level of adequacy, subcriteria classification and weighting of criteria.

Criteria	Sub-criteria	Level of Suitability	Weightage (%)	Ranking
Population density	32,59-63,87	Modorate	4.78	3
	63,87-94,26	Modorate	4.78	3
	94,26-124,29	Suitable	14.05	2
	124,29-239,17	Very Suitable	38.20	1
	239,17-283,31	Very Suitable	38.20	1
Large District	N2	Very Suitable	20.54	1
	C	Modorate	3.30	3
	A	Suitable	6.32	2
	F	Very suitable	20.54	1
	B	Modorate	3.30	3
	E	Modorate	3.30	3
	N1	Very Suitable	20.54	1
	D	Suitable	1.59	4
	G	Very Suitable	20.54	1
Land use land cover	Built-up	Modorate	7.35	3
	Bare land	Very Suitable	52.47	1
	Vegetation	Suitable	36.12	2
	Asphalt	Insuitable	4.06	4
Elevation	581 - 615	Modorate	5.77	3
	615 - 649	Modorate	5.77	3
	649 - 682	Very Suitable	43.66	1
	682 - 716	Suitable	22.40	2
	716 - 750	Suitable	22.40	2
Slope	0% - 3%	Modorate	8.69	3
	3% - 6%	Modorate	8.69	3
	6% - 9%	Suitable	12.83	2
	9% - 12%	Very Suitable	34.89	1
	12% - 16%	Very Suitable	34.89	1
Existing amenity buffer	0-200	Insuitable	3.28	4
	200-350	Modorate	8.17	3
	350-500	Suitable	15.48	2
	500-650	Very Suitable	36.54	1
	>650	Very Suitable	36.54	1

Tableau 9. Different suitability categories and their area.

Suitability categories	Area in sq. km	Area in percentage
verry suitable	38	3,52
suitable	67	6,2
Moderate suitable	286	26,48
insuitable	422	39,07
Verry insuitable	267	24,72

Conclusion.

The work on the provision of public facilities in the city of El Khroub indicates that urban facilities are not distributed in a homogeneous and regular manner between the different districts of the city, on the contrary, they are distributed randomly. Thus, the need to choose suitable sites for proper urban planning is necessary in order to control the problem of non-proactive urban management. To address this challenge, the GIS-based analytical hierarchy process is a lucrative technique that determines multiple suitability classes. In the city of El Khroub, the old neighborhoods are very inappropriate for installing new public facilities because this is where the equipment is concentrated; In contrast, most neighbourhoods on the east side of the city are classified as suitable mid-range. The appropriate and very suitable areas are located south of the large N1 district, north of the G and f; they are compatible with wasteland and urban wasteland. On the other hand, this kind of land-use planning research would be fruitful for policymakers, planners, etc., ensuring that they could identify areas where comprehensive development programmes can be implemented in a proactive, far-sighted and effective manner.

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