International Journal of Innovative Studies in Sociology and Humanities
ISSN 2456-4931 | Open Access | Volume 7, Issue 11, 2022
DOI: https://doi.org/10.20431/2456-4931.071102

Assessment of Land Suitability for Urban Growth Using Multi-Criteria Decision Analysis by Integrating (GIS) and the (AHP) Method in Setif, Algeria

Mohammed Khelili[1], Nourdine Anoune[2], Cherif Haoues[3]

[1, 2, 3]Natural Hazards and Territory Planning Laboratory"LRNAT", Geography and Territory Planning Department, University of Batna2, Algeria.

Recieved: October 01, 2022 **Accepted**: October 26, 2022 **Published**: October 31, 2022

Abstract

Urban planning is a process on which actors rely for urban development, and multi-criteria analysis is one of the most important methods used in several fields, including the evaluation of the suitability of lands for urban growth, which affects the urban dynamics of cities.

This study aims to evaluate the most suitable sites for urban growth in the city of Setif using the Analytical Hierarchy Process (AHP) based on Geographic Information Systems (GIS).

Criteria affecting urban growth are classified as follows: physical characteristics of the land, socio-economic, environmental, finally accessibility and buffer.

The results revealed that 16% of the total municipality of Setif is very high areas suitable for urban growth, 31% are high, 26% are moderate, 15% are low and 12% are non-suitable.

Key words: Urban planning, Suitability of lands for urban growth, Urban dynamics, Analytical Hierarchy Process (AHP), Geographic information systems (GIS)

INTRODUCTION

Urban growth refers to the increasing significance of towns and cities as population concentrations within a specific economy and society. It is a spatial and demographic dynamic.[1] And urban growth is a serious and alarming issue that has been present in the majority of cities worldwide[2] because it necessarily reduces the sustainability of land use and the ecosystem.[3]

Rapid urbanization and the uncontrolled growth of cities that follows cause various microclimatic changes, the deterioration of infrastructure, and the loss of agricultural land, water bodies, and open spaces. Urban amenities were under strain from this unheard-of urban population growth, which also caused an including unplanned sprawl, inadequate housing options, traffic congestion, sewerage problems, and a lack of other amenities.[4]

Given their impact on how policy decision-making is made, comprehending the dynamics of urban expansion is one of the most crucial jobs in urban planning.[5] The aim of urban planning is to ensure that all groups receive appropriate and equal services. They have an impact on regional development patterns, the environment, and the preservation of socially acceptable standards of living.[4] Most cities in developing countries have unplanned and haphazard urban growth as a result of extreme population pressure, which encourages urban sprawl. Because of this, the selection of suitable places for urban growth while maintaining ecosystem equilibrium has become an essential component of sound urban planning.[2]

Land planning has grown more complex in our current time[6] where the selection of suitable sites for urban growth is one of the most important concerns in urban planning.[7]Thus, it is urgently important to apply innovative ways to develop the idea of sustainable growth.[3] in this regard, a collection of land-use suitability maps would be quitehelpful[6]

GIS has evolved in tandem with computer technology and has been instrumental in advancing the analysis of land-use suitability.[8] which is of significance for city planning.[9] In the context of a GIS, suitability analysis is a geographic

process used to assess an area's suitability for a particular use.[4] As the traditional map overlay approaches for land-use suitability analysis have considerably advanced with the integration of MCDA techniques into GIS[8] and the AHP method takes into account the largest number of environmental, economic, social, and other criteria, making it a useful tool for MCDA in urban planning.[4]

Study Area

Setif was established on 1847, as this city replaced the ancient city of Sitifis.[10] According to the National Statistics Office (NSO), today it has a population of around 300,000 people and covers nearly 130 km^2.

The city of Setif is considered one of the inland cities located in northeastern Algeria within the region of the High Plateaus. It is bordered by six municipalities: to the north by Bin Fouda and Al-Orisia; to the east by Oulad Saber; to the south by Qajal and Mazlouq; and to the west by Ain Arnat. Setif is sandwiched between longitudes 5,506285° East and 5,337056° West and latitudes 36,13433° south and 36,24869° north (figure1).

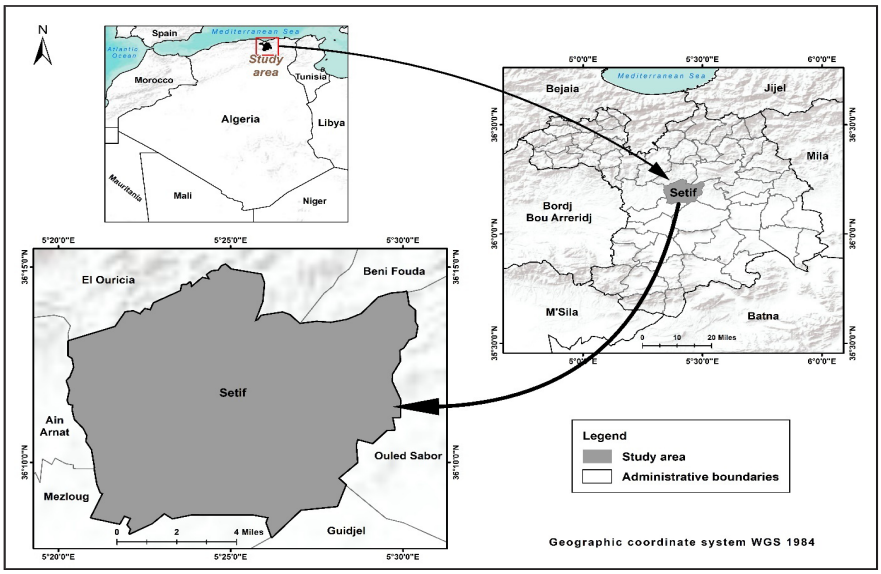


Figure 1. Location of the study area (Source: www.openstreetmap.org, treated by authors 2022)

MATERIALS AND METHODS

In order to handle complicated decision-making problems in a hierarchical way, MCDA offers a set of methods and techniques.[11] One of the most popular MCDA site selection methods is AHP,[12]which is an appropriate way to support land suitability assessment.[11]

This study underwent three fundamental phases in order to assessment the land's suitability for urban growth in the city of Setif (figure 2).

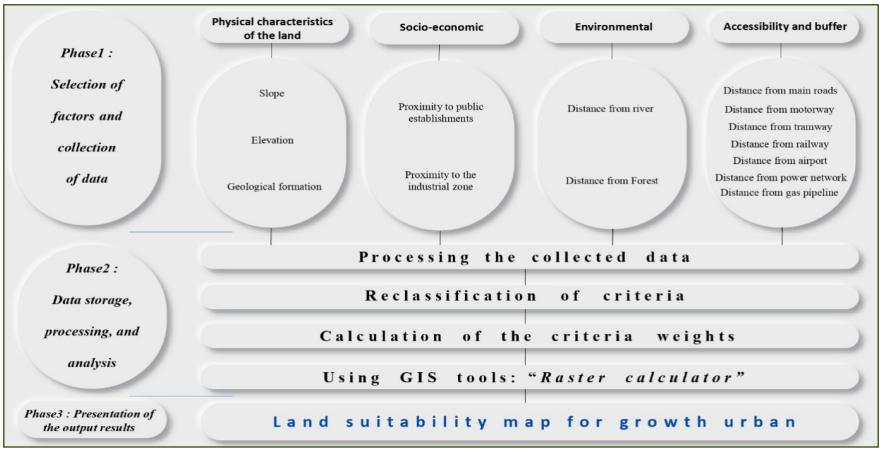


Figure 2. Study phases.(Source: by authors 2022)

Selection of Factors and Collection of Data

Using prior research investigations and the opinions of experts, determining factors that define suitable sites for urban growth were discovered. Additionally, at the local level, factors were determined based on remarks obtained through interviews with stakeholders, i.e., regional authorities who have been involved in tasks pertinent to them.[13]

A- Physical characteristics of the land

Slopes and elevations are among the most important topographical factors affecting the dynamics of urban growth. where the areas with high elevations are difficult to prepare and the low-slope terrain is suitable for urban planning. Also, knowing the geological formation of the study area is important to determine the appropriate sites for construction.

B- Socio-economic

One of the most important criteria affecting urban planning is the proximity to public establishments, so that the closer the areas of future urban expansion are to these institutions, the easier the lives of citizens and the lower the cost of transportation. In this study, various public establishments were selected, whether educational, health, security, cultural, religious, etc.The criterion of proximity to industrial zones was also introduced due to the importance of this other in urban planning, taking into account the easement area.

C- Environmental

In order to maintain the ecosystem, the most important environmental criteria in Setif were determined, which is the use of land-use in order to reduce the consumption of vegetation cover and give priority to urban expansion in the barren wastelands.The second and third criteria is the distance from the valleys and forests by respecting the easement distance and taking into account the urban growth balanced with the surrounding environment, where the valleys and forests in Setif are considered a public space for hiking.

D- Accessibility and buffer

Accessibility to public amenities usually indicates the city sustainability because all citizens in the city should access their basic needs. The distance to main roads, highways, tramways, and airports is seen as the accessibility to transportation due to the lack of public transportation. Additionally, the proximity to power networks and gas facilitates the process of delivering energy to the new urban areas, taking into account their easement zones.

After determining the factors affecting urban planning, the necessary data was collected from different sources (table 1) and moved to the processing phase.

Table 1. Selected criteria and sources of data; (Source: by authors 2022).

Classification criteria	Criteria	Data	Source	Type of data
Physical characteristics of the land	Slope	SRTM Digita lElevation Model	USGS earthexplorer	Raster data
	Elevation	SRTM Digital Elevation Model	USGS earth explorer	Raster data
	Geological formation	Geological map1/50000	Service of the Geological Map of Algeria	Raster data
Socioeconomic	Proximity to public establishments	Open street map data	www.openstreetmap.org	Vector data
	Proximity to the industrial zone	Open street map data	www.openstreetmap.org	Vector data
Environmental	Land use	Sentinel-22022	USGS earth explorer	Raster data
	Distance from river	Open street map data	www.openstreetmap.org	Vector data
	Distance from Forest	Open street map data	www.openstreetmap.org	Vector data

Accessibility and buffer	Distance from main roads	Open street map data	www.openstreetmap.org	Vector data
	Distance from motorway	Open street map data	www.openstreetmap.org	Vector data
	Distance from railway	Open street map data	www.openstreetmap.org	Vector data
	Distance from tramway	Open street map data	www.openstreetmap.org	Vector data
	Distance from airport	Open street map data	www.openstreetmap.org	Vector data
	Distance from power network	Master Plan of Urban Planning	Municipality of Setif	Vector data
	Distance from gas pipeline	Master Plan of Urban Planning	Municipality of Setif	Vector data

Processing the Collected Data

At this phase, the data obtained from various sources was processed through the use of GIS and remote sensing tools, as follows:

- Create a geodatabase to store data
- Determining a unified coordinate system for the geographical database using the Georeferencing tools
- Pre-treatment of vectors and rasters data using Clip, Union, Dissolve and Marge tools
- Create an elevation and a slope map using the digital elevation model SRTM
- Making a Supervised classification for sentinel 2 imagery to obtain a map of the land-use after doing the radiometric correction based on remote sensing tools with the calculation of the kappa index to evaluate the accuracy of the classification
- Convert all vectors data to rasters data using Euclidean distance and Conversion tool

Reclassify Rasters of Criteria

The selection of the criteria and their sub-criteria is an important step in the AHP process because it affects the judgment by separating the criteria from one another and, at the same time, by giving one criterion greater weight than the others. [14] Based on their level of suitability, each criterion and their sub-criteria were ranked by weight. (table2)

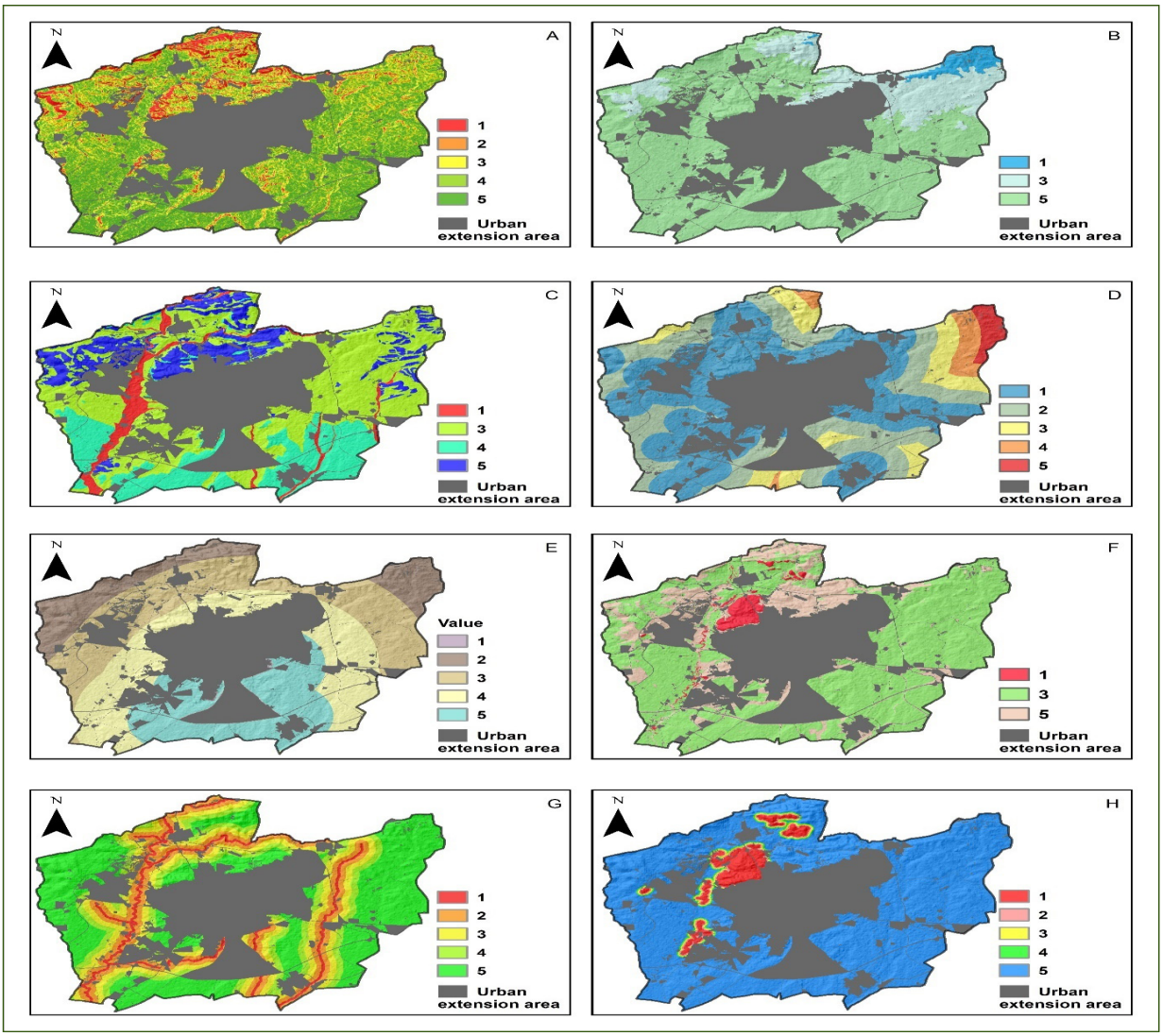
Table 2. Criteria and sub-criteria for suitability analysis

Criteria	Sub-criteria	Level of suitability	Ranking
Slope	0- 5%	Highly suitable	5
	5- 10%	Suitable	4
	10- 15%	Moderately suitable	3
	15- 20%	Poorly suitable	2
	>20%	Unsuitable	1
Elevation	990-1150m	Highly suitable	5
	1150- 1220m	Moderately suitable	3
	1220- 1275m	Unsuitable	1
Geological formation	Ypresien-Lutetien lime stone	Highly suitable	5
	Maastrichtian Campanian	Highly suitable	5
	Lime stone and marl	Highly suitable	5
	Quaternary lime stone	Suitable	4
	Quaternary-arable lands	Moderately suitable	3
	Detrital rocks	Moderately suitable	3
	Alluvia	Unsuitable	1

Proximity to public establishments	0- 800m	Highly suitable	5
	800-1600m	Suitable	4
	1600- 2400m	Moderately suitable	3
	2400- 3200m	Poorly suitable	2
	3200-4150,1m	Unsuitable	1
Proximity to the industrial zone	0- 50m	Unsuitable	1
	50-2000m	Highly suitable	5
	2000- 4000m	Suitable	4
	4000- 6000m	Moderately suitable	3
	6000-8514,1m	Poorly suitable	2
Land use	Wasteland	Highly suitable	5
	Agricultural lands	Moderately suitable	3
	Building area	Unsuitable	1
	Forest lands	Unsuitable	1
Distance from river	0- 50m	Unsuitable	1
	50-250m	Poorly suitable	2
	250-500m	Moderately suitable	3
	500-750m	Suitable	4
	750-3417,4m	Highly suitable	5
Distance from Forest	0- 50m	Unsuitable	1
	50-100m	Poorly suitable	2
	100-150m	Moderately suitable	3
	150-200m	Suitable	4
	200-8560,4m	Highly suitable	5
Distance from main roads	0- 30m	Unsuitable	1
	30-700m	Highly suitable	5
	700-1400m	Suitable	4
	1400- 2100m	Moderately suitable	3
	2100-2960,1m	Poorly suitable	2
Distance from motorway	0- 50m	Unsuitable	1
	50-2000m	Highly suitable	5
	2000- 4000m	Suitable	4
	4000- 6000m	Moderately suitable	3
	6000-9255,3m	Poorly suitable	2
Distance from tram way	0- 10m	Unsuitable	1
	10-1500m	Highlysuitable	5
	1500- 3000m	Suitable	4
	3000- 4500m	Moderately suitable	3
	4500-6717,9m	Poorlysuitable	2
Distance from railway	0- 10m	Unsuitable	1
	10-1500m	Poorly suitable	2
	1500- 3000m	Moderately suitable	3
	3000- 4500m	Suitable	4
	4500-6717,9m	Highly suitable	5

Distance from airport	0- 1000m	Unsuitable	1
	1000- 4000m	Highly suitable	5
	4000- 7500m	Suitable	4
	7500-11000m	Moderately suitable	3
	11000-15023,4m	Poorly suitable	2
Distance from power network	0- 30m	Unsuitable	1
	30-500m	Highly suitable	5
	500-1500m	Suitable	4
	1500- 2500m	Moderately suitable	3
	2500-2936,2m	Poorly suitable	2
Distance from gas pipeline	0- 30m	Unsuitable	1
	30-500m	Highly suitable	5
	500-1500m	Suitable	4
	1500- 2500m	Moderately suitable	3
	2500-2936,2m	Poorly suitable	2

After determining the weights of the criteria and their sub-criteria (table 2), based on the opinions of experts and previous studies, all raster maps were reclassified using the Reclassify tool into five classes, with values ranging from 1 to 5, where a value of 5 was taken to be highlysuitable and a value of 1 to be unsuitable for all criteria taken into account. By using this method, all measurements will be able to have an equivalent value before any weights are applied.[14] (figure 3).



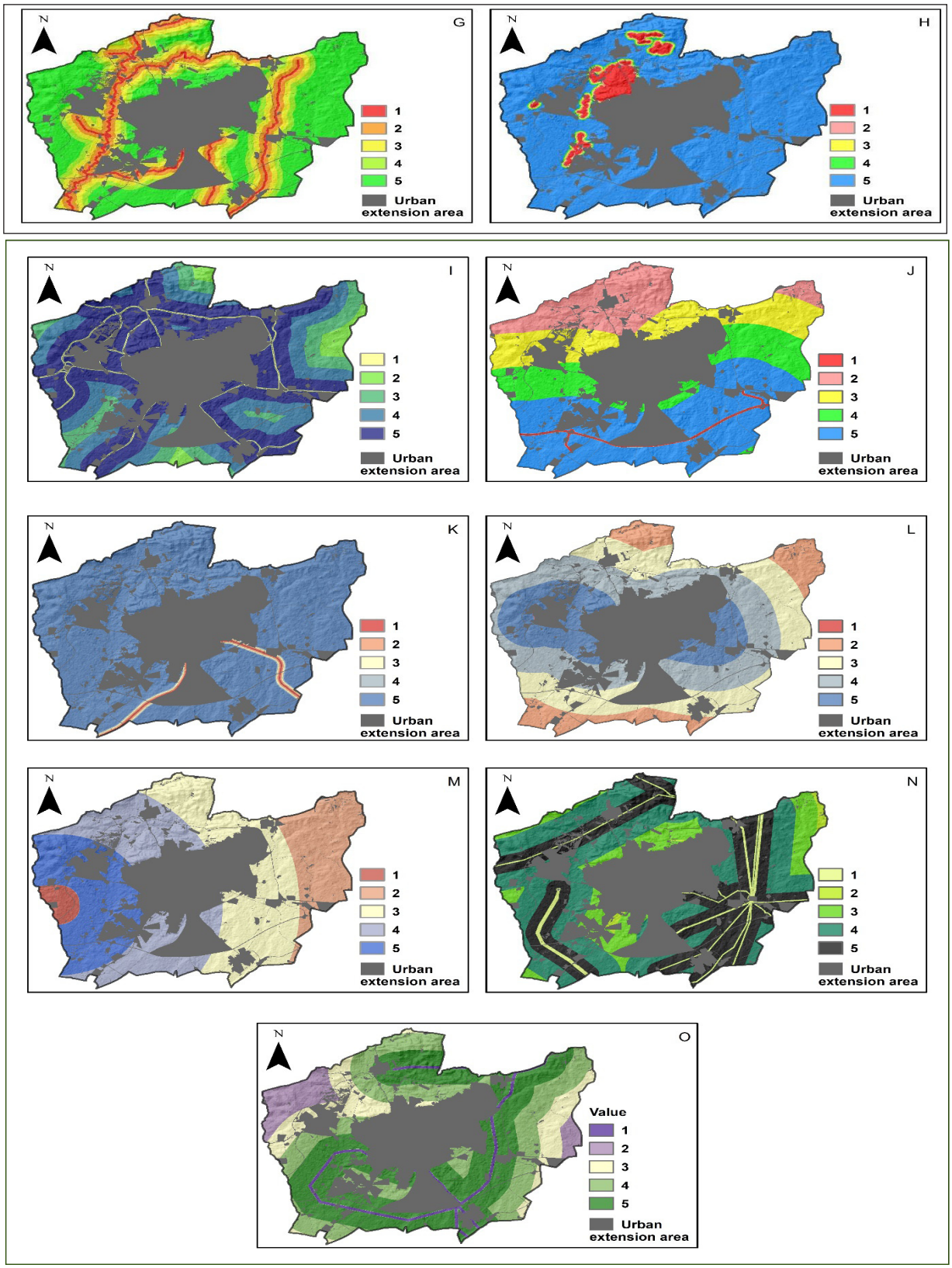


Figure 3. maps of criteria.(Source: by authors 2022). (A) Slope (B) Elevation (C) Geological formation (D) Proximity to public establishments **(**E) Proximity to the industrial zone **(**F) Land use(G)Distance from river (H) Distance from Forest(I) Distance from main roads(J) Distance from motorway (K) Distance from railway(L) Distance from tramway(M) Distance from airport (N) Distance from power network (O) Distance from gas pipeline.

Calculating Weightage by AHP

Using a pair-wise comparison matrix, the analytical hierarchy process (AHP) was used to calculate the weights of each criterion.[2] To do comparisons, we need a scale of numbers that shows how much more significant or dominant one element is over another element with regard to the criterion or property with which they are compared.[15] (table 3).

On the basis of limitations, literature, and the opinions of scientific experts, the criteria for grading and importance of their priority were set.[16]

Table 3. The fundamental scale of absolute numbers for AHP;[12](Source: Saaty, T.L.)

Intensity	Definition	Explanation of importance
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight importance	
3	Weak importance of one over another	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong to demonstrated importance	An activity is favoured very strongly over another, its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity *i* has one of the above non zero numbers assigned to it when compared with activity *j*,then *j* has the reciprocal value when compared with *i*	A reasonable assumption
Rationals	Ratio arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

A- Pair wise comparison matrix and normalized pair wise comparison matrix

Through the priority of the importance intensity of one criterion over another using a numerical scale of nine points, a pairwise comparison was implemented in the matrix for all criteria.[17] (table 4).

Table 4. Pairwise comparison matrix by AHP; (Source: by authors 2022).

Pair wise comparison matrix															
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
A	1	7	5	0,5	2	0,33	4	6	1	7	8	2	8	6	7
B	0,14	1	0,25	0,14	0,17	0,11	0,25	0,5	0,14	1	2	0,2	1	0,33	0,5
C	0,2	4	1	0,17	0,33	0,14	1	2	0,2	3	5	0,5	5	1	3
D	2	7	6	1	3	0,5	4	6	2	7	9	3	8	5	7
E	0,5	6	3	0,33	1	0,25	2	5	0,5	6	7	1	7	4	5
F	3	9	7	2	4	1	5	7	2	8	9	4	9	7	7
G	0,25	4	1	0,25	5	0,2	1	3	0,33	5	7	1	7	2	5
H	0,17	2	0,5	0,17	0,2	0,14	0,33	1	0,25	2	5	0,33	5	1	1

I	1	7	5	0,5	2	0,5	3	4	1	5	7	3	7	2	5
J	0,14	1	0,33	0,14	0,17	0,12	0,2	0,5	0,2	1	3	0,2	3	0,33	1
K	0,12	0,5	0,2	0,11	0,14	0,11	0,14	0,2	0,14	0,33	1	0,17	1	0,25	0,33
L	0,5	5	2	0,33	1	0,25	1	3	0,33	5	6	1	6	3	4
M	0,12	1	0,2	0,12	0,14	0,11	0,14	0,2	0,14	0,33	1	0,17	1	0,33	0,5
N	0,17	3	1	0,2	0,25	0,14	0,5	1	0,5	3	4	0,33	3	1	2
O	0,14	2	0,33	0,14	0,2	0,14	0,2	1	0,2	1	3	0,25	2	0,5	1
Sum	9,45	59,5	32,8	6,1	19,6	4,04	22,8	40,4	8,93	54,7	77	17,2	73	33,7	49,3

(A)Slope (B) Elevation (C) Geological formation (D) Proximity to public establishments **(**E) Proximity to the industrial zone **(**F) Land use(G)Distance from river (H) Distance from Forest(I) Distance from main roads(J) Distance from motorway (K)Distance from railway(L)Distance from tramway(M) Distance from airport (N) Distance from power network (O) Distance from gas pipeline

The relative weight values are determined using theformula:

$$w_i = \frac{1}{n}\sum_{j=1}^{n} \bar{a}_{ij} \qquad (1)$$

Where: w_i: the value of the relative weight for the row parameter.

$\frac{1}{n}\sum_{j=1}^{n} \bar{a}_{ij}$: sum of the percentages of the preference values for a row parameter.

n: the number of criteria considered in the analysis.

Table 5. pairwise comparison matrix and computation of criterion weightage; (Source: by authors 2022).

Normalized pair wise comparison matrix																
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**CW**	**Rank**
A	0,11	0,12	0,15	0,08	0,1	0,08	0,18	0,15	0,11	0,13	0,1	0,12	0,11	0,18	0,14	0,128	3
B	0,01	0,02	0,01	0,02	0,01	0,03	0,01	0,01	0,02	0,02	0,03	0,01	0,01	0,01	0,01	0,015	13
C	0,02	0,07	0,03	0,03	0,02	0,03	0,04	0,05	0,02	0,05	0,06	0,03	0,07	0,03	0,06	0,041	8
D	0,21	0,12	0,18	0,16	0,15	0,12	0,18	0,15	0,22	0,13	0,12	0,17	0,11	0,15	0,14	0,162	2
E	0,05	0,1	0,09	0,05	0,05	0,06	0,09	0,12	0,06	0,11	0,09	0,06	0,1	0,12	0,1	0,084	5
F	0,32	0,15	0,21	0,33	0,2	0,25	0,22	0,17	0,22	0,15	0,12	0,23	0,12	0,21	0,14	0,212	1
G	0,03	0,07	0,03	0,04	0,26	0,05	0,04	0,07	0,04	0,09	0,09	0,06	0,1	0,06	0,1	0,058	7
H	0,02	0,03	0,02	0,03	0,01	0,03	0,01	0,02	0,03	0,04	0,06	0,02	0,07	0,03	0,02	0,028	10
I	0,11	0,12	0,15	0,08	0,1	0,12	0,13	0,1	0,11	0,09	0,09	0,17	0,1	0,06	0,1	0,113	4
J	0,01	0,02	0,01	0,02	0,01	0,03	0,01	0,01	0,02	0,02	0,04	0,01	0,04	0,01	0,02	0,018	12
K	0,01	0,01	0,01	0,02	0,01	0,03	0,01	0,10	0,02	0,01	0,01	0,01	0,01	0,01	0,01	0,011	15
L	0,05	0,08	0,06	0,05	0,05	0,06	0,04	0,07	0,04	0,09	0,08	0,06	0,08	0,09	0,08	0,067	6
M	0,01	0,02	0,01	0,02	0,01	0,03	0,01	0,10	0,02	0,01	0,01	0,01	0,01	0,01	0,01	0,012	14
N	0,02	0,05	0,03	0,03	0,01	0,03	0,02	0,02	0,06	0,05	0,05	0,02	0,04	0,03	0,04	0,033	9
O	0,01	0,03	0,01	0,02	0,01	0,03	0,01	0,02	0,02	0,02	0,04	0,01	0,03	0,01	0,02	0,021	11

(A)Slope (B) Elevation (C) Geological formation (D) Proximity to public establishments **(**E) Proximity to the industrial zone **(**F) Land use(G)Distance from river (H) Distance from Forest(I) Distance from main roads(J) Distance from motorway (K)Distance from railway(L)Distance from tramway(M) Distance from airport (N) Distance from power network (O) Distance from gas pipeline

Through (table 5)the largest weight is related to the land use criteria(0.212), while the distance from the railway criteria takes the lowest weight (0.011).

B- Consistency Ratio (CR) Calculation

To confirm that the weight distribution obtained is logical, the coordination between the significance of each criterion must be evaluated, and the contradictory situation between the relative weights of each criterion can be avoided by using the consistency test.First, the consistency index CI of the judgment matrix is calculated.[18]

$$CI = \frac{\lambda max - n}{n-1} \qquad (2)$$

Where λmax: he principal eigenvalue of the matrix,*n*: the number of criteria

After that, the consistency ratio (CR) index is computed to determine the likelihood that matrix ratings are created at random.[17]CR is calculated according to Eq 3.

$$CR = \frac{CI}{RI} \qquad (3)$$

Where R is the random consistency index based on the number of criteria selected from (table 6)

Table 6. Random Consistency Index (RI)[15];(Source: Saaty, T.L.)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.9	1.12	1.24	1,32	1,41	1,45	1,49	1,51	1,54	1,55	1,57	1,59

The values for consistency must be within a consistent range that does not exceed 0.1 (i.e., 10%), as the higher the value over 0.1, the greater the consistency conflict.[19]

The result of the consistency ratio (CR) is 0.4 (i.e., 0.4%), so it can be said that the pairwise comparison matrix is consistent and acceptable.

RESULTS AND DISCUSSIONS

Using the GIS tool Raster Calculator, the criteria maps were compiled and overlaid to create the final map showing the land's suitability for urban growth using the following formula[13]:

*Land suitability map=(Slope*0.128+Elevation*0.015+Geological formation*0.041)+(Proximity to public establishments *0.162+Proximity to the industrial zone*0.084) +(Land use*0.212+Distance from river*0.058+Distance from Forest*0.028) +(Distance from main roads*0.113+Distance from motorway*0.018+Distance from railway*0.011+Distance from tramway*0.067+Distance from airport*0.012+Distance from power network*0.033+Distance from gas pipeline*0.021).*

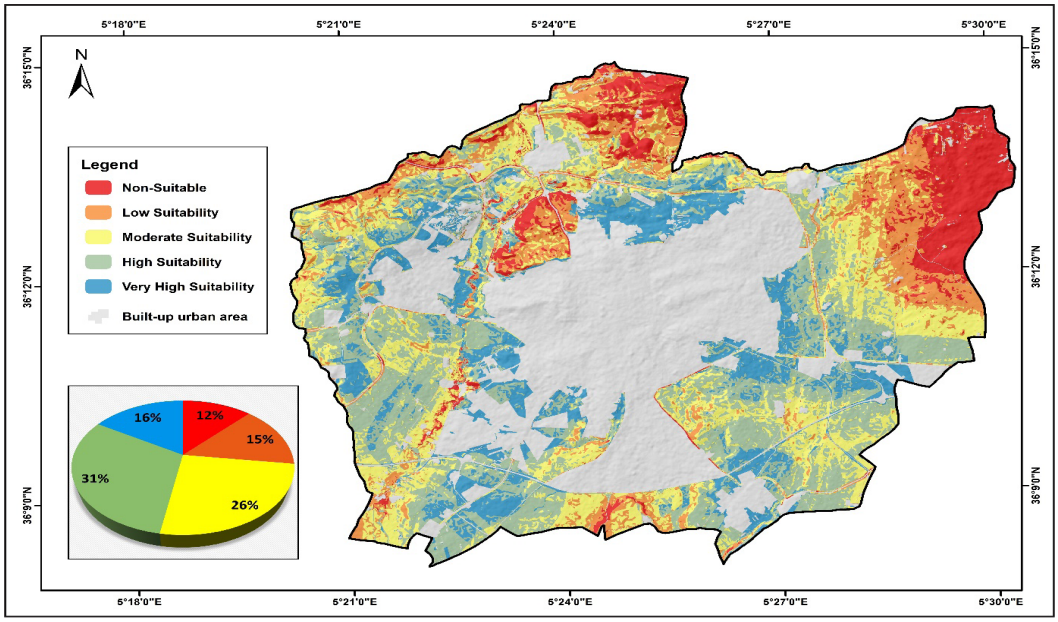


Figure 4. Final suitability map for urban growth (Source: by authors 2022)

The final suitability map reveals that Setif can be divided into five suitablecategories(figure 4). Whereas it appears that the northern and northeastern regions are unsuitable for urban growth because of their location away from urban areas,

public utilities, main roads, as well as harsh topography. The same applies to the Znadia Forest Park, the territories near to the Bousselam Valley, and the lands to the south of the industrial area.

As for the high suitability areas for urban growth in general, they are close to the built-up areas, especially in the El Hidhab neighborhood, the Brarma tramway station, the city of Ain Trick, the Al-Hassi neighborhood, the city of Ain Sfiha, and next to the National Road No. 28 leading to the city of Mezloug, and finally the areas located near Farhat Abbas University.

According to the findings, 12% of the area of Setif is unsuitable for urban growth, equivalent to 10.66 km2, and 15% is low suitability land, with an area of 13.29 km2. As for the moderate suitability areas, they constitute 26%, which is equivalent to 22.62 km2, and as for the high suitability category, its area is 27.36 km2, with an estimated percentage of 31% of the area of Setif. Finally, the very high suitability areas for urban growth occupy an area of 14.36 km2, or an estimated rate of 16% (table 7).

Table 7. Area of sustainability categories in the final suitability map of urban growth. (Source: by authors 2022).

Suitability categories	Area in km²	Area in %
Non-suitable	10,66	12
Low suitability	13,29	15
Moderate suitability	22,62	26
High suitability	27,36	31
Very high suitability	14,36	16
Total	88,29	100

CONCLUSION

Using an integrated GIS-AHP model, this study conducted a land suitability analysis to identify the appropriate areas for urban growth in Setif. According to the results obtained, the GIS-AHP model is an excellent tool for managing the environment and planning urban areas that helps and enables actors to easily decide on complex problems. The findings illustrate that a wide strip of land in Setif has high suitability or very high suitability for urban growth. This refers to the availability and appropriateness of the majority of the factors that must be considered in urban planning in order to ensure balanced urban development and thepreservation of the ecological system in Setif.

REFERENCES

1. B. Bhatta, *Analysis of Urban Growth and Sprawl from Remote Sensing Data*. Springer Science & Business Media, 2010.
2. A. Saha and R. Roy, "An integrated approach to identify suitable areas for built-up development using GIS-based multi-criteria analysis and AHP in Siliguri planning area, India," *SN Appl. Sci.*, vol. 3, no. 4, p. 395, Mar. 2021, doi: 10.1007/s42452-021-04354-5.
3. M. Aburas, Y. Ho, M. Ramli, and Z. Ashaari, "A Review of Land Suitability Analysis for Urban Growth by using the GIS-Based Analytic Hierarchy Process," pp. 2321–893, Dec. 2015.
4. A. Parry, S. A. Ganaie, and M. Sultan Bhat, "GIS based land suitability analysis using AHP model for urban services planning in Srinagar and Jammu urban centers of J&K, India," *Journal of Urban Management*, vol. 7, no. 2, pp. 46–56, Sep. 2018, doi: 10.1016/j.jum.2018.05.002.
5. Y. Kim, A. Safikhani, and E. Tepe, "Machine learning application to spatio-temporal modeling of urban growth," *Computers, Environment and Urban Systems*, vol. 94, p. 101801, Jun. 2022, doi: 10.1016/j.compenvurbsys.2022.101801.
6. "Using GIS and outranking multicriteria analysis for land-use suitability assessment: International Journal of Geographical Information Science: Vol 15, No 2." https://www.tandfonline.com/doi/abs/10.1080/13658810051030487 (accessed Sep. 18, 2021).
7. A. AlFanatseh, "Land suitability analysis of urban development in the Aqaba area, Jordan, using a GIS-based analytic hierarchy process," *GeoJournal*, Aug. 2021, doi: 10.1007/s10708-021-10488-1.

8. Malczewski, "GIS-based land-use suitability analysis: a critical overview," *Progress in Planning*, vol. 62, no. 1, pp. 3–65, Jul. 2004, doi: 10.1016/j.progress.2003.09.002.

9. E. Ustaoglu, S. Sisman, and A. C. Aydınoglu, "Determining agricultural suitable land in peri-urban geography using GIS and Multi Criteria Decision Analysis (MCDA) techniques," *Ecological Modelling*, vol. 455, p. 109610, Sep. 2021, doi: 10.1016/j.ecolmodel.2021.109610.

10. S. Madani, "Mutations urbaines récentes des villes intermédiaires en Algérie: Cas de Sétif," Thesis, Ferhat Abbas University Setif 1, 2014. Accessed: Sep. 30, 2022. [Online]. Available: http://dspace.univ-setif.dz:8888/jspui/handle/123456789/71

11. A. K. Tripathi, S. Agrawal, and R. D. Gupta, "Comparison of GIS-based AHP and fuzzy AHP methods for hospital site selection: a case study for Prayagraj City, India," *GeoJournal*, May 2021, doi: 10.1007/s10708-021-10445-y.

12. T. L. Saaty, "A scaling method for priorities in hierarchical structures," *Journal of Mathematical Psychology*, vol. 15, no. 3, pp. 234–281, Jun. 1977, doi: 10.1016/0022-2496(77)90033-5.

13. M. M. Aburas, S. H. O. Abdullah, M. F. Ramli, and Z. H. Asha'ari, "Land Suitability Analysis of Urban Growth in Seremban Malaysia, Using GIS Based Analytical Hierarchy Process," *Procedia Engineering*, vol. 198, pp. 1128–1136, Jan. 2017, doi: 10.1016/j.proeng.2017.07.155.

14. E. Gelan, "GIS-based multi-criteria analysis for sustainable urban green spaces planning in emerging towns of Ethiopia: the case of Sululta town," *Environmental Systems Research*, vol. 10, no. 1, p. 13, Feb. 2021, doi: 10.1186/s40068-021-00220-w.

15. T. Saaty, "Decision making with the Analytic Hierarchy Process," *Int. J. Services Sciences Int. J. Services Sciences*, vol. 1, pp. 83–98, Jan. 2008, doi: 10.1504/IJSSCI.2008.017590.

16. K. Alkaradaghi, S. S. Ali, N. Al-Ansari, and J. Laue, "Landfill Site Selection Using GIS and Multi-Criteria Decision-Making AHP and SAW Methods: A Case Study in Sulaimaniyah Governorate, Iraq," *Engineering*, vol. 12, no. 4, Art. no. 4, Apr. 2020, doi: 10.4236/eng.2020.124021.

17. T. L. Saaty, *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. McGraw-Hill International Book Company, 1980.

18. Y. Wang *et al.*, "Method multi-criteria decision-making method for site selection analysis and evaluation of urban integrated energy stations based on geographic information system," *Renewable Energy*, vol. 194, pp. 273–292, Jul. 2022, doi: 10.1016/j.renene.2022.05.087.

19. A. Abdelkarim, H. M. Alogayell, I. I. Alkadi, and I. Youssef, "Spatial–temporal prediction model for land cover of the rural–urban continuum axis between Ar-Riyadh and Al-Kharj cities in KSA in the year of 2030 using the integration of CA–Markov model, GIS-MCA, and AHP," *Applied Geomatics*, vol. 14, no. 3, pp. 501–525, 2022, doi: 10.1007/s12518-022-00448-w.

Citation: **Mohammed Khelili, Nourdine Anoune*, et al.*** *Assessment of Land Suitability for Urban Growth Using Multi-Criteria Decision Analysis by Integrating(GIS)and the(AHP) Method in Setif, Algeria. Int J Innov Stud Sociol Humanities. 2022;7(11): 14-25. DOI: https://doi.org/10.20431/2456-4931.071102.*