Spatial assessment of urban growth in Diwaniyah city, Iraq and its impact on sustainability development.

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Abstract one of the main concerns of master planning is the proper designation of appropriate sites for feasible and sustainable land use. A main importance of such issue is that it withdraws attention to the necessity of adopting a multidisciplinary approach to the zoning and site selection problem, also Sustainability of urban areas has the highest priority worldwide and developing countries in particular. Fertile urban areas in Iraq are constantly deteriorating due to random urbanization.
The use of remote sensing and Geographic Information System (GIS) was to explore best areas in the region. Sex sub-models were created for three themes using Spatial Analysis method and used as inputs to the final suitability model. These themes are: land resources, accessibility and cost of construction. A GIS-based model was designed following a sustainable development approach. Economic, social and environmental factors were introduced in the model to identify and map land suitable zones for urban development. The suitability index map for urban development was produced by weighted overlay of the three sub-models themes.
The most Appropriate areas for urban development in Diwaniyah city amounted to 22.29 km2 representing 25 % of total area of new master plan, whereas the Less appropriate areas in Diwaniyah city amounted to 56.23 km2 representing 63 % of total area of new master plan, while the Inappropriate areas for urban development in Diwaniyah city amounted to 9.59 km2 representing 12% of total area of new master plan.
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Keywords: Master Plan, Sustainable Development, Remote Sensing, GIS, Appropriate Areas, Residential Area, Euclidean Distance.

1 INTRODUCTION

The idea of sustainable development is the most important policy of the 21stcentury. It is a new paradigm of society, finances and the environment. It is regarded as a new philosophy, in which principles of futurity, equity, global environmentalism and biodiversity guide decision making. The concept is widely used in biology, economics, urban planning and other domains. Efforts towards sustainable development seek to establish a dynamic equilibrium among economic, environmental and social pillars [1]. Humanity has the ability to make sustainable development to ensure that it meets the needs of the present without compromising the ability of future [2]. Land use appropriateness assessment is an important fun a mental work in land use planning. The use of GIS technology in land suitability evaluation is a new technology and a new method in urban planning. Such techniques provide a quantitative analysis. The rapid development of remote sensing technology and gradually maturing of GIS technology applications provides the foundation for urban planning from the qualitative analysis to quantitative analysis. The core technology of the urban planning is land use suitability with comprehensive evaluation [3]. Spatial analysis combined with multi-criteria evaluation methods was proven to be useful for both facing the main issues relating to land consumption and minimizing environmental impacts of spatial planning [4].

The GIS-based land-use appropriateness analysis has been applied in a wide variety of situations counting ecological approaches for defining land suitability/habitat for animal and plant species [5, 6], geological favorability [7], appropriateness of land for agricultural activities [8, 9], landscape assessment and planning [10], environmental impact assessment [11] choosing the best site for the public and private sector facilities [12, 13], and district planning [14].In the present study, remote sensing and GIS techniques have been applied to explore the potentials of Diwaniyah city, Iraq for urban development.

The main objective of this work was to monitor and analyze long-term urban growth of Diwaniyah city and model the urban growth trend in Diwaniyah city, Iraq during the studied period 2011 to 2033.To achieve this objective, several factors influencing the Appropriate of the land for the required development are investigated, and the main sex effective factors include:

Accessibility, land stability, natural resources, costs of construction, and protection of natural protectorates and archaeological sites. For each of these themes, a special submodel was prepared based on analysis and interpretation of high resolution satellite images. Then, all of the sub-models were integrated, as layers, in a GIS environment, in order to

create an overall model to depict the most suitable zones for urban development in Diwaniyah city.

2. Area of Study

The study region is Diwaniyah city. It is located to the middle south of Iraq as shown in figure (1), about 180 km south of Baghdad and 320 km north of Basra. It lies between Latitudes 31.5 ° - 32.5° N, and Longitudes 44.5° - 45° E, with a total area of about 145 km2. It has a population of about 373594 people in 2014.The maximum temperature in the studied area ranges between 26.5 and 46.8°C, with an average value of about 36.5°C. The minimum temperature varied from 3.0°C to 21.7°C, with an average value of about 12.2°C. August is the hottest month and January is the coldest. Mean annual precipitation is about 105.5 mm [15]. Geological formations in the Governorate consist of sedimentary plain, buried depressions, flat sand land, western plateau and Al-Dalmaj marsh [16]. The sedimentary plain represents the majority of the area (about 77%), followed by the buried depressions (about 15%).

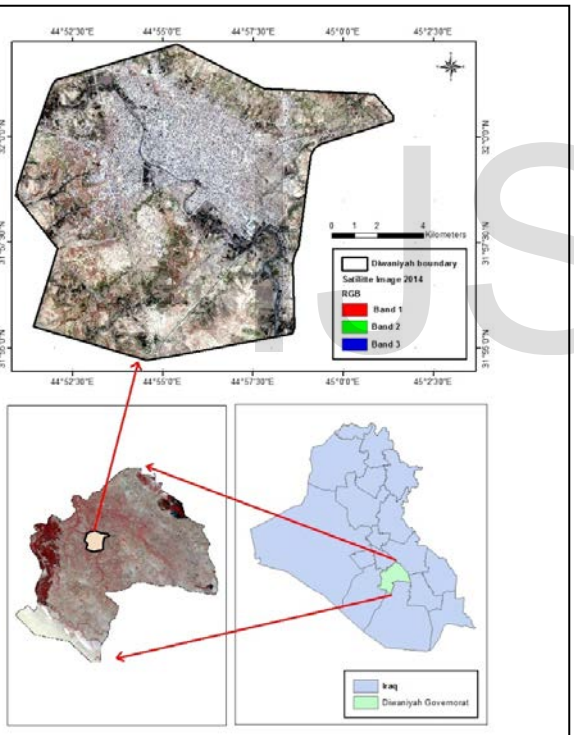

Fig.1. Location map of the study area in Iraq.

3. Materials

3.1. Geographic Information System Data

GIS is an important data acquisition means, it plays a vital role in land use appropriateness assessment. In the present study, parcel use, urban distribution, ecological elements are all obtained from the analysis and interpretation from satellite images including:

-Diwaniyah satellite images, acquired in 2014, for regional investigation of the whole Diwaniyah city.

3.2. Maps

Various thematic maps covering Sinai Peninsula at different scales have been collected from the specialized agencies.

They include the following:

1) Topographic maps at scale 1:500,000

2) The protected areas map was obtained from Diwaniyah municipality

5) Diwaniyah master plan 2011-2033 from Diwaniyah municipality.

All maps were obtained in hard copies, scanned, rectified, digitized in ArcGIS10.2 and saved as feature classes in a geographic database for further analysis.

4. Areas which must be provided to meet the housing deficit in the Diwaniyah city by the target year 2033

In order to be standing on the space required to accommodate future population growth for Diwaniyah city should be initially housing deficit account for Diwaniyah city by the difference between the numbers of families to the number of housing units And find out the number of units to be provided and then multiplying the number of units in the rate of family size in Diwaniyah city, even know how many people are should be providing housing for them and then hit that number in the standard schematic (100 m2/person , For all needs residential, utilizes, culture, recreational, commercial, educational and other needs), (Adopted from the Urban Planning Authority in the Iraqi city planning), Required for each different needs including residential., Will be in the number of housing units is good, it accounted for 10% of the housing units as is supported in most of the planning studies [17].

Housing deficit = 34.36- 917.2* (0.9) = 18.88 KM2

TABLE 1
THE CURRENT RESIDENTIAL AREA AND THE HOUSING DEFICIT FOR THE PERIODS 2014 AND 2033.

Year	Population	The current residential area (KM^2)	Residential area that must be Provided (KM^2)	Housing deficit (KM^2)
2014	373594	22.25	34.36	12.11
2033	818591	------	81.86	-----

5. METHODOLOGY

The selection of suitable sites for specific land uses must be based upon a set of local criteria to ensure that the maximum benefit and least cost for a selected site/zone are attained. The following general overlay analysis steps were followed based on ARCGIS 10.2 Spatial Analyst:

1. Identify the factors influencing the urbanization
A-Farmland and orchard area.
B-The road network in the city and easy access.
C-Distance from the city centre.
D-Interconnection with existing urban area.
E-Proximity of Water Resources.
F-Proximity of the main gas pipeline carrier. Shown as figure 2.

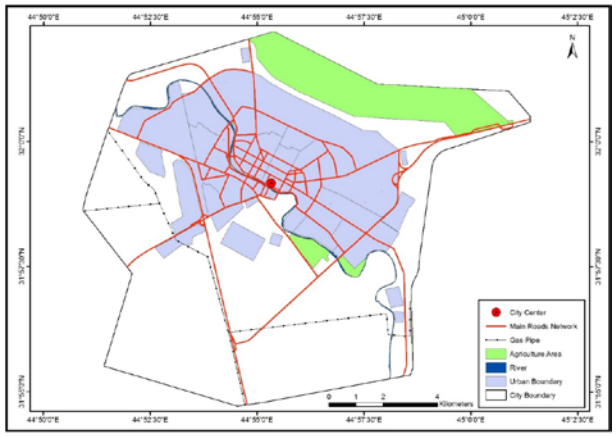

Fig.2. the selected Factors affecting in the expansion of the city

2. Classification of spatial data: The division into ten equidistant dimensions from the factor of influencing by application (Euclidean Distance)

3. Give the weights of the factors (layers) affecting: Depending on the impact degree in the urban expansion of the study area.

4. Determine the highest and least areas and inadequate spatially: Calculation the space adequate to meet the need of the land required for the target year.

A conceptual diagram of the applied methodology is shown in Figure 3.

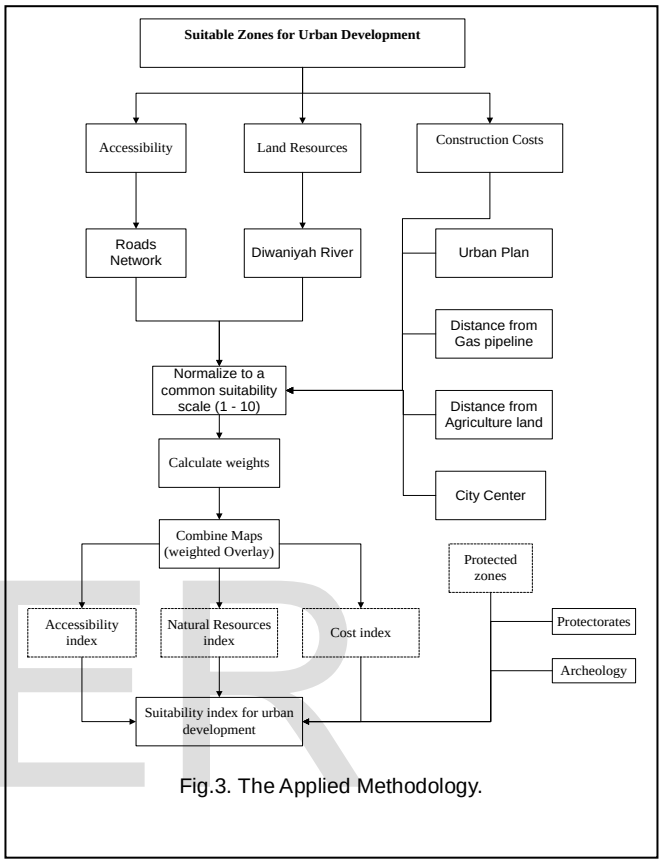

Fig.3. The Applied Methodology.

5.1 IDENTIFY THE FACTORS INFLUENCING THE URBANIZATION

These factors vary from one city to another and also vary according to the relative importance and nature site of the city, In our search, it was determined a number of factors affecting the urbanization of the city which is:

A- Farmland and orchards:

The preservation of farmland and orchards will take priority in the urban expansion in order to ensure the sustainability of natural resources, Where it will be given the less rating value (1) for the land which nearby of farmland, Where it will get, the less rating value (1) for the land which nearby of farmland And give the highest value (10) for the land which remote of farmland and orchards, To ensure that no expansion on the agriculture land and therefore maintain large tracts of fertile land, identification and classification of the degree of spatial dimension for farmland, shown as table 2 and figure 4.

TABLE 2
RATING THE DEGREE OF EUCLIDEAN DISTANCE FOR FARMLAND

Distance from the farmland (m)	Classification Level	Distance from the farmland (m)	Classification Level
0 - 831	1	4155 - 4986	6
831 - 1662	2	4986 - 5818	7
1662 - 2493	3	5818 - 6649	8
2493 - 3324	4	6649 - 7480	9
3324 - 4155	5	7480 - 8311	10

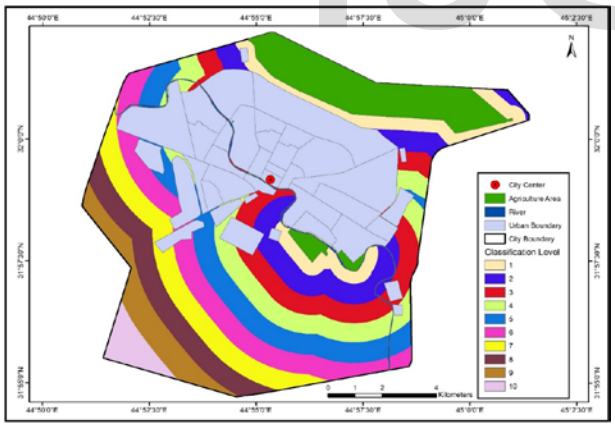

Fig.4 Classify the degree of spatial dimension for farmland and orchards.

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for the road network, shown as table 3 and figure 5.

TABLE 3
RATING THE DEGREE OF EUCLIDEAN DISTANCE FOR THE MAIN ROAD NETWORK

Distance from the main road network (m)	Classification Level	Distance from the main road network (m)	Classification Level
0 - 394	10	1972 - 2366	5
394 - 788	9	2366 - 2761	4
788 - 1183	8	2761 - 3155	3
1183 - 1577	7	3155 - 3549	2
1577 - 1972	6	3549 - 3944	1

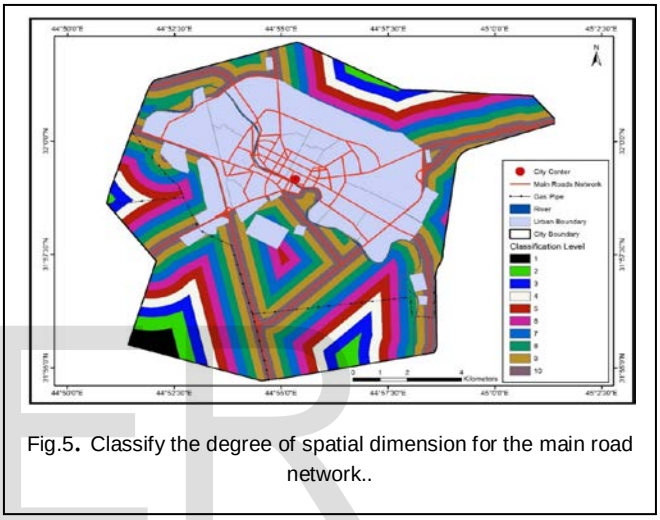

Fig.5. Classify the degree of spatial dimension for the main road network..

C- PROXIMITY TO URBAN AREA:

Contributes the proximity of the urban area to link the city with its current borders, and thus will contribute to reducing the economic cost to extend infrastructure services, And the expansion of the road network as well as it contributes to homogeneity of urban between existing residential areas and the future expansion areas, the Areas closest to the urban area will take the highest value (10), In remote areas will get the less rating value (1), According to gradation the spatial dimension for the urban area, shown as table 4 and figure 6.

TABLE 4
RATING THE DEGREE OF EUCLIDEAN DISTANCE FOR THE URBAN BOUNDARY

Distance from the Urban Boundary (m)	Classification Level	Distance from the Urban Boundary (m)	Classification Level
0 - 539	10	2695 - 3234	5
539 - 1078	9	3234 - 3773	4
1078 - 1617	8	3773 - 4312	3
1617 - 2156	7	4312 - 4851	2
2156 - 2695	6	4851 - 5390	1

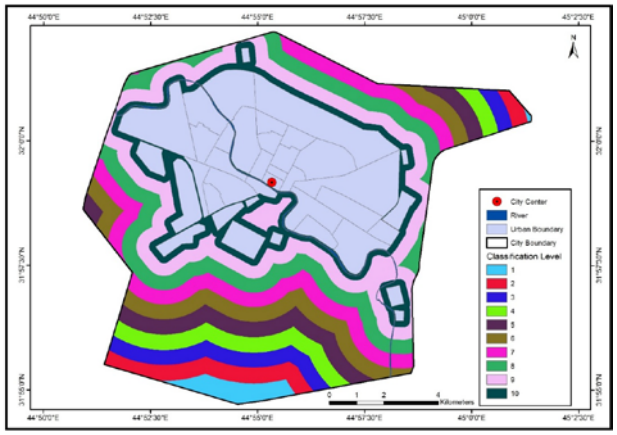

Fig.6. Classify the degree of spatial dimension for urban area

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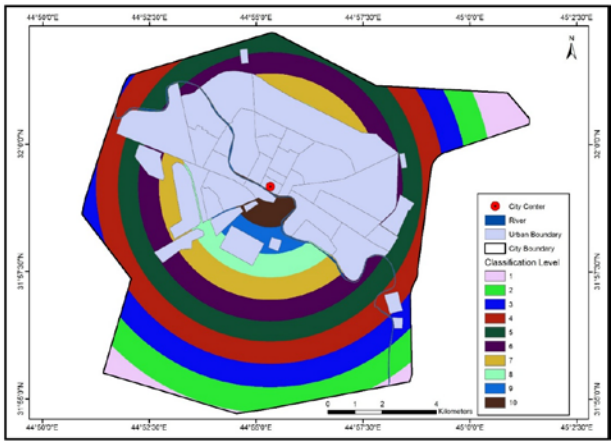

Fig.7. Classify the degree of spatial dimension for city centre.

D- PROXIMITY TO THE CITY CENTRE AND EASY ACCESS:

The distance from the city centre gives an indication of the accessibility of the events in the city centre whenever the area was close to the city centre become easily accessible best, Based this we give the closest areas from the city centre highest value (10) In remote areas will get the less rating value (1), According to gradation the spatial dimension for the city centre, shown as table 5 and figure 7.

TABLE 5
RATING THE DEGREE OF EUCLIDEAN DISTANCE FOR CITY CENTRE

Distance from City Center (m)	Classification Level	Distance from City Center (m)	Classification Level
0 - 985	10	4929 - 5914	5
985 - 1971	9	5914 - 6900	4
1971 - 2957	8	6900 - 7886	3
2957 - 3943	7	7886 - 8872	2
3943 - 4929	6	8872 - 9858	1

D-PROXIMITY OF THE WATER RESOURCES:

the water resources exist Contributes in attracting Human settlements and to promote in gathering population, also that most of the events and activities be near the water resources, and water resource is located (the Diwaniyah River in the city centre and divided it into two). Diwaniyah River, highest value (10) in remote areas will get, the less rating value (1), According to gradation the spatial dimension to the Diwaniyah River, shown as table 6 and figure 8.

TABLE 6
RATING THE DEGREE OF EUCLIDEAN DISTANCE FOR DIWANIYAH RIVER

Distance from the Urban Boundary (m)	Classification Level	Distance from the Urban Boundary (m)	Classification Level
0 - 539	10	2695 - 3234	5
539 - 1078	9	3234 - 3773	4
1078 - 1617	8	3773 - 4312	3
1617 - 2156	7	4312 - 4851	2
2156 - 2695	6	4851 - 5390	1

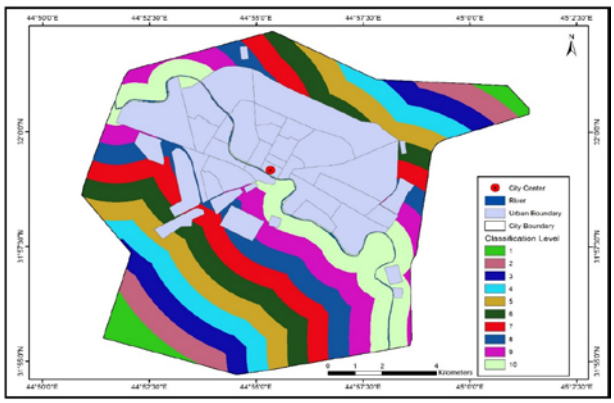

Fig.7. Classify the degree of spatial dimension for Diwaniyah River.

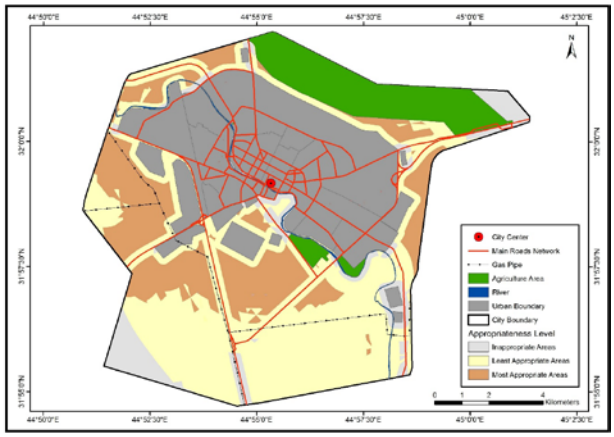

Fig.8. A result of appropriate spatial expansion of the weighted Overlay.

5.2 Evaluate the spatial Appropriate for the Urbanization by factors influencing:

After the statement of the effect of each of the factors affecting the urbanization of the city, Will be appropriate at this stage to evaluate the spatial Appropriate and according to the degree of relative importance, According to the justification given for each factor in terms of its importance mentioned during the classification process, This is done by giving weight to these factors and Weighted Overlay process, which Available in the GIS environment within spatial applications analyst, It was given weights according to the relative importance of factors, shown as table 7.

TABLE 7
Rating the degree of Euclidean Distance for the Urban Boundary

No	The Factors Influencing the Urbanization	Degree of Importance
1	Farmland and orchard area.	20%
2	The road network in the city and easy access.	17%
3	Distance from the city centre.	15%
4	Interconnection with existing urban area.	22%
5	Proximity of Water Resources.	14%
6	Proximity of the main gas pipeline carrier.	12%

6. Result

After process of weighted Overlay, the results reflect the existence of three types of ground types will appear, the most appropriate and least appropriate and inappropriate areas of urban expansion, and after giving the weights table 8 has emerged as a result of appropriate and spatial separation of each type of areas according to the degree of the appropriate and scan for overlapping areas between the layers, Results as shown in the figure 9.

When you study the master plan design for Diwaniyah until the year 2033, found that the total area of land that has been expanding in the basic design of the city stood at 88 km2 and 35.79 km2 for residential uses, this means continued deficit in housing until after Attain the target year The fact that the city is currently suffering from a shortage of housing 12.11 km2 and we need a 47.5 km 2 to fill the need for residential land to the year 2033 and also found that 4% of the land are allocated for housing for year 2033 in inappropriate areas identified previously, 67% are located in appropriate less areas with only 29% are located in appropriate areas, as shown in the table 8 and figure 10.

TABLE 8
Land use areas in 2033 and their spatial Suitability

Land use type	Land use area 2033		Inappropriate areas		Less appropriate areas		Appropriate areas	
	Area km^2	%	Area km^2	%	Area km2	%	Area km2	%
commercial	0.04	0.05	0.04	100.00	0.00	0.32	0.00	0.00
cultural	0.23	0.26	0.17	73.91	0.05	23.83	0.00	0.00
green belt	9.18	10.43	1.61	17.54	4.78	52.07	2.79	30.39
industrial	5.46	6.20	1.17	21.43	2.44	44.67	1.84	33.76
recreational	8.12	9.23	1.17	14.41	6.03	74.26	0.92	11.30
reserve land	25.48	28.95	2.14	8.40	16.80	65.92	6.54	25.68
residential	35.79	40.66	1.78	4.97	24.26	67.77	9.84	27.49
sport hall	0.40	0.45	0.33	82.50	0.08	18.77	0.00	0.00
tourism	2.16	2.45	0.92	42.59	0.90	41.75	0.33	15.35
utilities	1.16	1.32	0.24	20.69	0.89	76.94	0.03	2.34
Total	88.02	100.00	9.59		56.23		22.29	

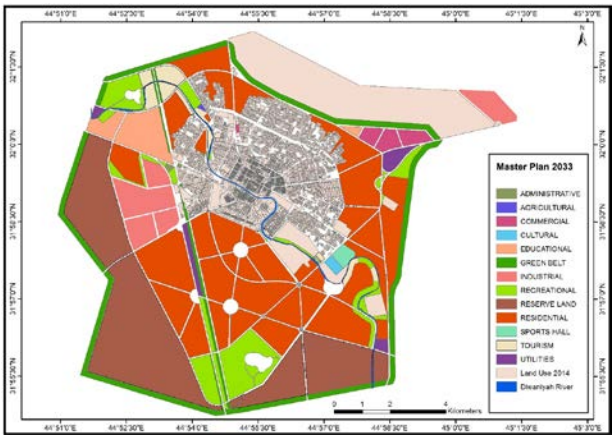

Fig.9. . Master plan design for Diwaniyah until the year 2033

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7. CONCLUSION

It could be concluded that both RS data and GIS could play an important role in studying and monitoring changes in land cover and urban growth and supporting decision makers with more accurate, less expensive and time-wise information.

According to the Iraqi standards there was a shortage in current residential areas by about 12.11 km2. This shortage is expected increase by about 11.71 km2 in 2033,

Some of the areas proposed for accommodation will be in some inappropriate and less appropriate areas for that propose.

In depend of the result we can say the Residential area should be increased and selected in the most suitable locations for that purpose according to the Iraqi standards to fulfill the shortage.

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