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Elements of a Sustainable Urban Form Between the Administrative Decision and the Natural Context

Luay Taha, and Ahmed A. Saeed
Centre of Urban and Regional Planning, University of Baghdad, Baghdad 10001, Iraq

Abstract: This study examines the composition and spread of slums in Iraqi cities, where informal settlements occupy up to 50% of urban areas. These settlements have begun to dominate the general urban form, developing their own urban elements while remaining inconsistent with municipal regulations and urban planning laws. The research aims to develop solutions that reconcile administrative requirements with community needs, focusing on identifying sustainable urban elements that integrate aesthetic, environmental, and functional characteristics. The case study focuses on Khalidya City in Anbar province, Iraq, strategically located along major transportation routes and overlooking Lake Habbaniyah. The city's unique combination of natural and human resources offers a potential model for sustainable urban development that could be replicated in other Iraqi cities.

Keywords: Khalidya, Habbaniyah, natural context, urban form, administrative decision, system.

1. Introduction

Urban growth rates in Iraq show no signs of slowing, with rapid urbanization driving extensive residential and commercial development that encroaches upon agricultural and undeveloped lands. This accelerated urbanization process, fueled by economic development, industrialization, and migration, has dramatically transformed land use patterns. The resulting urban sprawl, loss of vegetation cover, and declining environmental quality can be directly linked to population growth and the expanding footprint of urban areas.

Land use and land cover patterns have become fragmented to the extent that they now determine both existing infrastructure characteristics and future performance. Urbanization has become synonymous with frequent land use changes that typically generate negative environmental impacts. Poor land management practices have resulted in unscientific urban development that fails to align with land suitability assessments and environmental carrying capacities. These challenges create complex dilemmas for planners and policymakers, often compounded by decision-makers' neglect of resource availability and absorptive capacity when formulating long-term growth plans [1].

Al-Khalidya is representative of Iraqi cities that have long struggled with informal land acquisition and construction (irregularities), where both municipal boundaries and surrounding areas bear the marks of unplanned development. The local municipality, in collaboration with the city council, is now working to address and reduce this urban informality. Political dynamics over previous decades have significantly influenced the city's planning process, driven by competition for valuable land and population migration that outpaced the expansion of serviced land for planned uses, resulting in development schemes that failed to establish coherent land policies.

This study is particularly timely given the proliferation of slums and land use mismanagement across Iraq. There is an urgent need to analyze current land use patterns, identify problems stemming from inadequate planning, and develop optimal land use strategies that balance development needs with environmental sustainability.

Corresponding author: Luay Taha, Dr., full professor, research fields: micro-engineering and nano electronics.

Analyzing land uses and their spatial distribution within master plans provides critical insights that support comprehensive development processes and enable more precise alignment of planning objectives with on-the-ground realities. This analysis represents a fundamental stage in the planning and development of the study area.

2. Objectives of the Search

1. Examine the respective roles of natural context and administrative decisions in shaping the urban form of Al-Khalidya City.

2. Identify key factors influencing land use patterns, including natural conditions, human activities, and spatial relationships.

3. Compile and clarify comprehensive information on land uses, economic and social characteristics, and service provision in the study area to support evidence-based decision-making.

The main reasons for choosing Al Khalidya City are:

(1) Its strategically important geographic location along major transportation corridors.

(2) Its potential to serve as a vital hub and growth pole for agricultural, industrial, and tourism activities, enhancing its capacity to attract investment and generate employment opportunities.

3. Urban Form

3.1 The Concept

From a morphological perspective, cities represent extremely complex entities composed of interconnected components at multiple scales. Urban morphology addresses this complexity through a hierarchical framework that examines relationships between individual elements and the urban whole, structured around fundamental physical components [2].

At its most basic level, a city consists of urban tissue. Kropf (1996) [3] defines urban tissue as an organic whole that can be analyzed at varying levels of resolution, each revealing different elements of urban form. Higher resolution analysis reveals greater morphological detail, from basic street and block structures to specific characteristics like construction materials of individual spaces or buildings.

All cities and their tissues are fundamentally structured by four primary elements of urban form: streets, street blocks, plots, and buildings. However, each city combines these elements in unique configurations, creating distinctive urban tissues that give the city its character. These urban forms evolve over time, with many cities representing layers of development accumulated over centuries, where new construction overlays rather than completely replaces earlier urban patterns [2].

3.2 The Natural Context

The natural context provides the foundational conditions that shape urban form elements. Land relief, soil quality and suitability, climate conditions, solar and wind exposure, and natural landscape types all influence settlement patterns—from the initial establishment of paths and streets to subsequent infrastructure development, land subdivision, building construction, and even material choices. Throughout history, the configuration and geometry of land relief have consistently influenced both the location and form of human settlements [2].

In early human settlements, the first paths typically followed the natural structure of the landscape, reinforcing its inherent configuration and geometry. These movement corridors developed along lines of least topographic resistance, becoming established routes of travel over centuries. Convergence points of these movement lines naturally evolved into central places within the settlement (Fig. 1).

3.3 The Streets System

Street systems serve as the primary framework through which we navigate and experience cities. They define the street blocks that constitute urban areas and establish the boundary between public spaces (accessible to all citizens) and private or semi-public

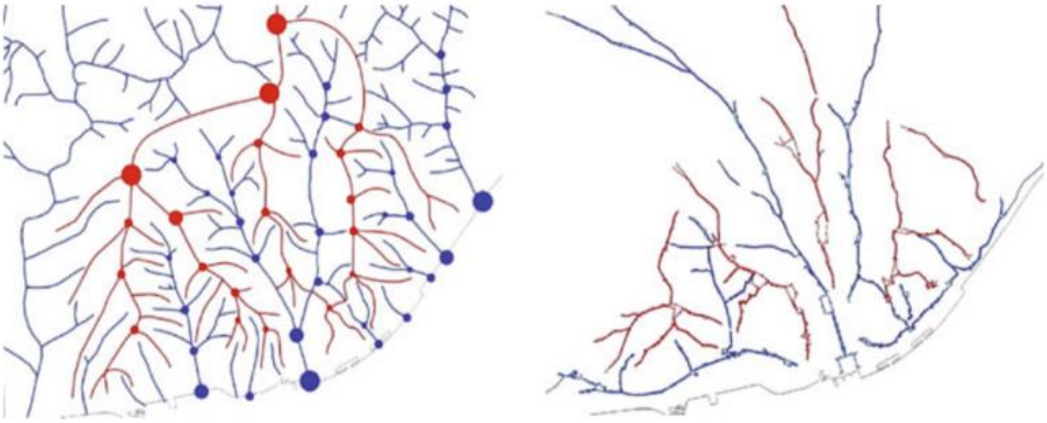


Fig. 1 Physiography of the physical support (ridges and thalwegs; distribution centres and encounter centres) and of the street system (ridge streets and thalweg streets) of Lisbon [4].

domains. Streets represent the fundamental public and democratic spaces of the city — places where citizens of diverse backgrounds meet and interact socially [2].

3.4 The Plots System

Plot systems represent one of the most important yet often overlooked elements of urban form, establishing the boundary between public and private domains. Despite their reduced visual prominence, plot systems play a critical role in urbanization processes and demonstrate remarkable stability over time. Defining a new plot structure typically involves subdividing existing large parcels or creating entirely new land divisions. Subsequent urbanization stages require precise definition of individual plots, including: (i) their relationship and orientation to adjacent streets, (ii) their position within the broader plot system (interior or edge of blocks), and (iii) their shape, dimensions, and proportions [2].

3.5 The Buildings System

While buildings lack the temporal stability of streets and plots, they remain among the most important and visible elements of urban form. Cities typically contain two distinct building types: ordinary buildings and exceptional buildings. These categories differ in both form and function. Ordinary buildings constitute the majority of urban fabric, exhibiting more similarities than differences. They primarily include buildings of residential utilization but also commerce and services buildings. The second type includes only a few buildings of the city: those buildings that by their shape are clearly distinguishable in the urban landscape. Within this second type there is a smaller set, a very special set of exceptional buildings whose form becomes indistinguishable from the form of the city they are part of.

Another critical characteristic of buildings is their height, particularly in relation to street width. This relationship significantly influences the urban landscape: buildings much shorter than the street width create minimal enclosure, while taller buildings produce a stronger sense of spatial enclosure [2].

4. The Study Area

The study area's characteristics are analyzed at two interconnected levels: regional and urban. This dual-scale approach is necessary due to the strong relationships and interactions between these scales, particularly in suburban areas.

4.1 Data Sources

- Central departments and institutions in Baghdad and Anbar province.

- Regional field reconnaissance of the city and its suburban, and accompanying recording of phenomena and observations.
- Rely on direct meetings with City community personalities, whether they are responsible for managing the city technically, or personalities representing the knowledge accumulation of the city's memory.
- Topographic maps issued by the General Surveying Institute.
- Spot Satellite image, 2008, R. 14 m.
- Quik Bird Satellite image, 2008, R. 0.6 m.
- Large and medium-sized enterprises and industrial and commercial activities were surveyed for economic activity and employment surveys.

4.2 Affecting Factors on the Elements of Urban Form

Political factors: These factors significantly influence development patterns, with national circumstances contributing to the prevalence of informal land use practices and weak regulatory compliance.

Economic factors: Economic conditions strongly shape land use patterns, with valuable urban locations becoming commodities subject to market forces of supply and demand.

Social factors: External and internal pressures influence family living arrangements, including decisions about independent dwelling units versus extended family co-residence. When combined with economic constraints, particularly the inability of household heads to afford formal housing, families often seek shelter near existing family residences, frequently extending beyond planned municipal boundaries.

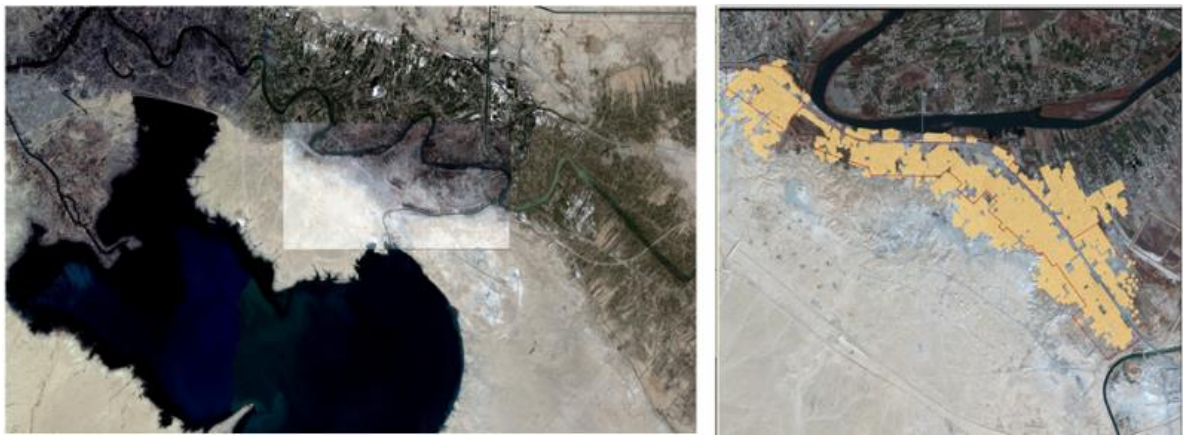
General factors: The city's development is influenced by its relative position among neighboring urban centers, service availability, employment opportunities, and transportation networks. Khalidya's location between two major centers of economic activity enhances its attractiveness for development.

Cultural factors: Cultural traditions significantly influence land use patterns and activity distributions, with individual behaviors reflecting inherited cultural norms and values.

Administrative and planning factors: These factors, managed by the municipality and directorate of physical planning under local government oversight, face implementation challenges due to limited enforcement capacity. Municipal officials often encounter resistance when attempting to address informal developments.

4.3 Location and Borders

Khalidya is located in Anbar Governorate between latitudes 33°22'-33°26' North and longitudes 43°48'-43°49' East, approximately 80 km from Baghdad. The city occupies an area of 714 km² (Fig. 2).



(a) (b)

Fig. 2 Khalidya: (a) regional , (b) land use/cover.

4.4 Topography and Geology

Khalidya's topography is generally flat, with elevations ranging from 35 to 103 meters above sea level. The landscape consists of four primary landforms: plateau, sedimentary plain, Euphrates River corridor, and Habbaniyah Lake shoreline.

4.5 Natural Resources

1. Euphrates River
2. Habbaniyah Lake: forms a natural southeastern boundary for the Khalidya area
3. Natural vegetation
4. Mineral resources: Limestone (49%), Gypsum (calcium sulfate, 24%), and River sand (15%)

4.6 Population Characteristics

Population dynamics reflect both natural increase and improved service provision, with employment opportunities contributing to greater residential stability. In 2018, the city's population reached 58,702 inhabitants across 11,309 households occupying 6,367 housing units, resulting in an average family size of 5.9 persons. The urban population density averages 53 persons per hectare (Tables 1 & 2).

Table 1 Distribution of population growth in Khalidya area starting 1977.

Year	population				
	Urban	%	Rural	%	Total
1977	20360	36	36129	64	56489
1987	24148	39	37136	61	61284
1997	29486	35	54754	65	84240
2007	56051	61	35896	29	91947
2018	58702	58	41752	42	100454

Table 2 Urban sprawl and population growth in Khalidya starting 1977 (Source: Figs. 3 & 5).

Year	Area		Population		Density Per/ha
	Ha.	% Growth/year	100	% Growth/year	
1977	198	-	20360	-	103
1987	245	2.13	24148	1.7	99
1997	451	6.1	29486	2	65
2007	602	2.8	46051	4.4	76
2018	1124	6.24	58702	2.2	53

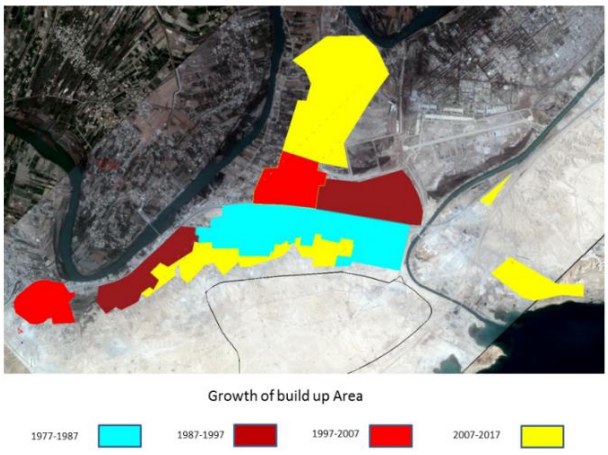


Fig. 3 Map of urban sprawl: 1977-2017 of Al-Khalidya City.

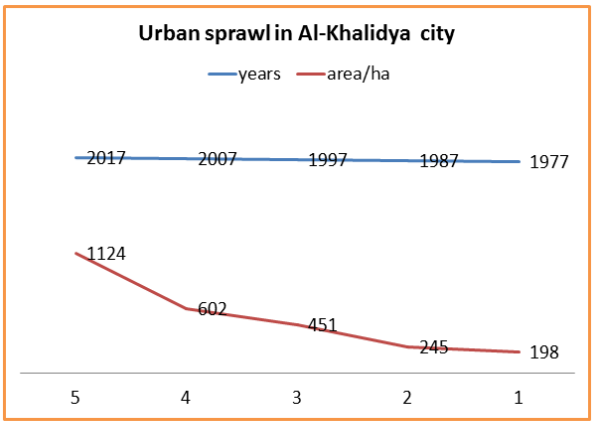


Fig. 4 Urban sprawl: 1977-2017 of Al-Khalidya City (Source: Table 2).

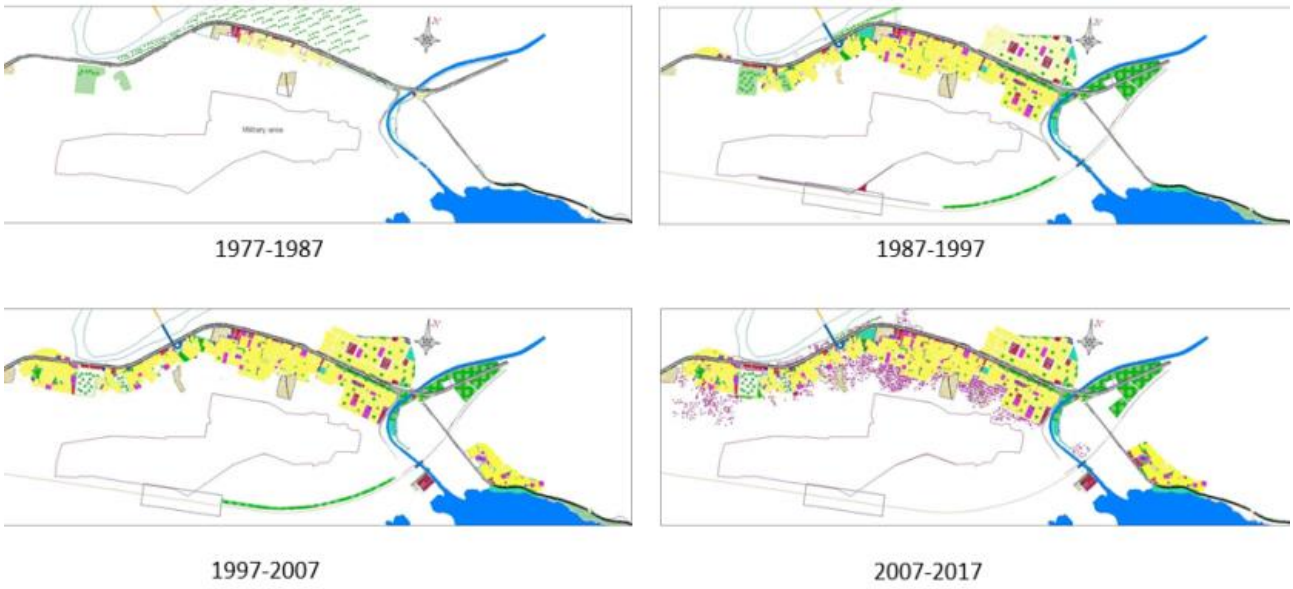


Fig. 5 Evolution of master plan of Al-Khalidya City over 40 years (4 stages).

4.6.1 Patterns of Urban form (Figs. 6 & 7)

Linear pattern: Settlements follow the alignment of the Baghdad-Ramadi highway and the Baghdad-Syria railway corridor.

Clustered pattern: Settlement centers form both regular and irregular groupings, typically small in scale but experiencing rapid population growth.

Scattered pattern: Settlement centers are distributed unevenly across extensive areas, resulting from factors such as limited water resources and fragmented land ownership.

Fig. 6 Khalidya/2018: Illegal expansion notes lack of planning or services.

Fig. 7 Khalidya 2018: The existing urban shape with the dominance of linear with land use and service on both sides.

4.6.2 Economic Activities

Agriculture: Rural areas occupy 14,895 ha, with 5,059 ha (34%) suitable for agriculture. Cultivated land represents 68.7% of arable area, producing seeds, industrial crops, vegetables, tubers, fodder, and date palms. Animal production utilizes 4.8 ha, while poultry farming operates across 57 facilities covering 10.25 ha.

Industry and Tourism: The city administration lacks comprehensive plans to leverage natural resources for industrial development or to formulate integrated territorial development strategies. Tourism currently relies solely on natural attractions, with no

attention to cultural or historical heritage sites.

4.6.3 Urban Land Use

The urban area of Khalidya covers 235.5 ha. As a relatively modern small town, the city contains no archaeological or cultural monuments. The built environment exhibits significant socioeconomic disparities, ranging from luxury villas to simple traditional houses.

Two distinct land use trends emerged between 1997 and 2017:

1) Intensification of urban development in central areas, with residential construction occupying remaining open spaces and elevated terrain.
2) Urban expansion into semi-urban and suburban areas, progressively replacing agricultural lands and palm groves.

Service distribution lacks systematic planning or needs-based criteria due to uncontrolled growth, with services typically located in fragmented spaces within the dense urban fabric (Table 3).

5. Statistical Analysis

Statistical analysis using SPSS software examined the relationship between various indicators and both natural expansion patterns and administrative decision-making processes. The analysis incorporated data from multiple sources, including field surveys and direct interviews with citizens, city council members, and urban planning officials.

Table 4 presents the indicators analyzed and their expected impacts on natural context and administrative decisions.

Table 3 Land use and coverage rates in Khalidiya by urban planning directorate.

Land use	Area /ha	%
Residential	199.36	33.66
Educational	7.42	1.25
Health	1.19	0.20
Commercial	2.73	0.46
Government offices	3.35	0.57
Public Services	2.4	0.40
Religious	2.81	0.47
Industrial	0.63	0.11
Warehouses	0.56	0.09
Green area	7.19	1.22
Sport	1.48	0.25
Cemeteries	7.55	1.28
Irregularities (slums)	236.67	39.96
Vacancy	153.66	25.97
Roads and squares	201.64	34.07
Total area/ha	591.97	100

Table 4 Increasing and decreasing effects (respectively) of indicators on the natural context and administrative decision.

No.	Indicators	Natural context	Exp. sign	Administrative decision	Exp. sign
1	Streets system	Irregular, non-paved, variable dimensions and organic shapes	+	Regularly ,Straight, Grid and paved by 65% with afforestation by 45%	+
2	Plots system	Random in distribution, varying in shape, area and direction. Not specified block	-	Geometric shape, Specific dimensions, static orientation and specified block	+
3	Buildings system	Similarity in building materials, design elements, style and height	-	Diversity in building materials, design elements, finishing materials and height	+
4	Political factors	There is no direct or obvious effect	-	Dominates all other factors significantly	+
5	Economic factors	Is important in the supply and demand of land and the lack of employment opportunities	-	The housing market depends on the system of land distribution by the municipality and the impact of supply and demand is weak	+
6	Social factors	Old customs and traditions lead society with a concentration of poverty, deprivation and ignorance by a large percentage	+	Government organization that relies on providing some community services, but it does not meet all requirements	+
7	General factors	Far from the city's potential (especially transport routes and water bodies)	+	Is representing the economic base of the city and its suburbs by the shape of the strip adjacent to the regional streets and railway	+

Table 4 to be continued

8	Cultural factors	Fading Local Inherited with one nationality and religion	-	Diversity of heritage and culture with more than nationality and religion	+
9	Administrative and planning factors	Population divides land by mutual consent and without planning or documentation	+	Adopting an objective approach within appropriate planning stages but for long periods (25 years)	+
10	Borders	There are no administrative boundaries, but natural borders such as the river	+	Clear administrative boundaries that define local powers	+
11	Topography	Construction and expansion follow mainly topography	+	A secondary factor in decision making	+
12	Natural Resources	Complete neglect of natural resources with crawling on their sources, although they are widely available	+	Complete neglect of natural resources with crawling on their sources, although they are widely available	+
13	population distribution	Scattered and agglomeration distribution	-	Geometric Grid with blocks	+
14	Agriculture	The abundance of agricultural land, but the crawl on them continues	+	There is no urban vegetated	+
15	Industry and Tourism	Not to exploit the potential to establish them economically, environmentally and culturally	+	Not to exploit the potential to establish them economically, environmentally and culturally	+
16	Urban Land use	Residential use by 98%	+	Distribution of uses and their percentages according to Iraqi planning standards	+
17	Population characteristics	Low density due to random distribution with waste in the ground	+	A decreasing population density with an interest in increasing it through the introduction of vertical housing but very little	+
18	Infrastructure	There is no infrastructure planning and reality, and the population has no rights to do so	-	Integrated in planning but weak in implementation and inefficient and provide only the minimum	+

6. Results and Discussion

Analysis of the SPSS regression results (Tables 5 & 6) reveals several key findings:

1. Khalidya's urban expansion has primarily responded to social and economic pressures to address housing deficits, with limited consideration for balanced land use, service provision, resource conservation, or sustainability principles.

2. Renewable resources (solar energy, wind potential) and existing assets (agricultural lands, tourist sites) remain underutilized in urban planning, reflecting limited environmental awareness and economic vision.

3. Planning decisions have followed traditional standards that do not incorporate smart city (ICT) or eco-city principles, despite favorable conditions for their implementation. This is evident in the imbalanced land use distribution ratios in official master plans (Fig. 8).

Significant gaps exist between different city stakeholders, resulting in conflicting design decisions and an urban form that largely neglects sustainable development principles.

Effective replanning requires developing planning criteria that integrate regional natural and human potential with local-level considerations. At the local scale, Khalidya needs comprehensive planning and redevelopment that prioritizes sustainable urban form elements, including natural resource conservation, green architecture principles, and expanded green spaces and open areas.

Table 5 SPSS program outputs about Natural context.

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	91.016	21.045		4.325	.000	48.094	133.937
	Streets system	2.602	2.350	.184	1.107	.277	-2.192-	7.396
	Plots system	-5.551-	2.475	-.372-	-2.243-	.032	-10.598-	-.504-
	Buildings system	-2.585-	2.164	-.212-	-1.195-	.241	-6.998-	1.828
	Political factors	-.207-	3.118	-.012-	-.066-	.947	-6.566-	6.152
	Economic factors	-3.485-	4.012	-.151-	-.869-	.392	-11.668-	4.698
	Social factors	1.946	3.055	.099	.637	.529	-4.284-	8.177
	General factors	3.666	4.731	.159	.775	.444	-5.983-	13.315
	Cultural factors	-1.820-	3.324	-.117-	-.548-	.588	-8.599-	4.959
	Administrative and planning factors	4.187	2.974	.241	1.408	.169	-1.879-	10.254
	Borders	1.396	3.105	.096	.450	.656	-4.937-	7.728
	Topography	6.949	2.503	.552	2.776	.009	1.844	12.054
	Natural Resources	9.450	4.686	.403	2.017	.052	-.107-	19.008
	population distribution	-3.294-	3.175	-.215-	-1.038-	.308	-9.770-	3.182
	Agriculture	3.636	2.613	.265	1.392	.174	-1.693-	8.964
	Industry and Tourism	8.895	5.944	.274	1.496	.145	-3.229-	21.018
	Urban Land use	4.975	6.117	.148	.813	.422	-7.500-	17.451
	Population characteristics	3.250	2.435	.220	1.335	.192	-1.716-	8.217
	Infrastructure	-2.069-	4.001	-.092-	-.517-	.609	-10.230-	6.091

a. Dependent Variable: Natural context

Table 6 SPSS program outputs about administrative decision.

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	199.593	.287		696.093	.000	199.009	200.178
	Streets system	1.001	.024	.211	42.030	.000	.952	1.049
	Plots system	.997	.019	.264	51.260	.000	.957	1.036
	Buildings system	.990	.016	.293	63.175	.000	.958	1.022
	Political factors	1.020	.023	.216	44.431	.000	.973	1.067
	Economic factors	1.000	.021	.262	48.541	.000	.958	1.042
	Social factors	.987	.029	.186	34.609	.000	.928	1.045
	General factors	1.024	.018	.285	56.136	.000	.987	1.061
	Cultural factors	1.080	.034	.172	31.581	.000	1.010	1.149
	Administrative and planning factors	1.008	.027	.208	37.959	.000	.954	1.062
	Borders	1.018	.032	.173	31.722	.000	.952	1.083
	Topography	.982	.045	.123	21.694	.000	.890	1.075
	Natural Resources	1.054	.043	.137	24.247	.000	.966	1.143
	Population distribution	.969	.039	.138	24.617	.000	.889	1.049
	Agriculture	1.016	.020	.261	51.460	.000	.976	1.056
	Industry and Tourism	1.003	.019	.282	52.634	.000	.964	1.042
	Urban Land use	.971	.019	.267	51.519	.000	.932	1.009
	Population characteristics	1.001	.023	.222	43.152	.000	.954	1.048
	Infrastructure	1.024	.025	.269	41.415	.000	.974	1.074

a. Dependent Variable: Administrative decision

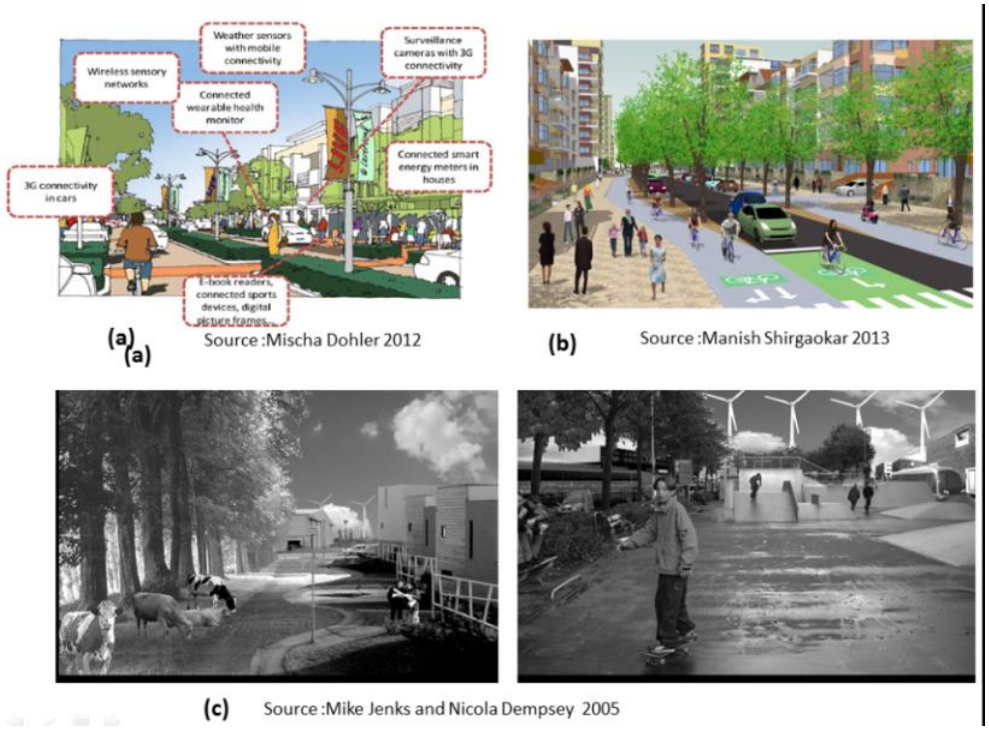


Fig. 8 Concept of: (a) ICT city, (b) Green street, (c) Eco-cities.

7. Recommendations

The research team has developed a 2025 master plan proposal that reconciles existing natural development patterns with Iraqi planning regulations while incorporating sustainable city principles. This proposal balances conservation with development needs through integrated land use planning (Figs. 9 & 10).

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Fig. 9 Proposal master plan 2025 by research team.

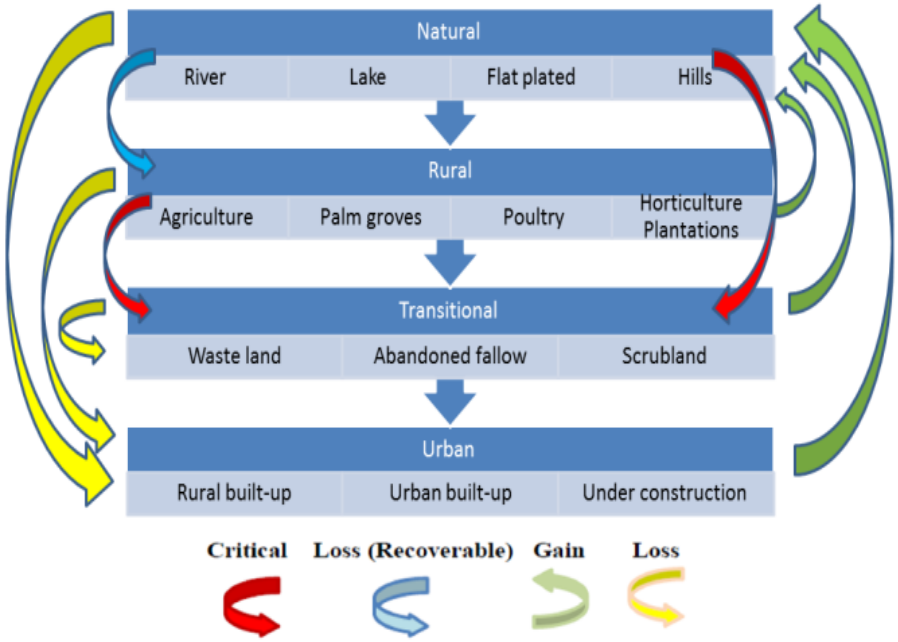

Fig. 10 Major land use/land cover transformation classes (Source: Venkatesh 2012).

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