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Monitoring and evaluating the attributes of retreated cultivated land under urban encroachment in South Giza Governorate, Egypt

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ABSTRACT

Land cover (LC) changes must be detected and monitored utilizing historical multi-temporal remote sensing data to provide an effective and reliable evaluation of human-induced environmental changes. It is highly suggested for LC studies involve the evaluation of the long-term viability of changing regions. Egypt's agriculture sector is one of the country's most important economic pillars. The study area was situated in South Giza Governorate covering 11356.17 hectares (27027.68 feddans). The primary objective of this article was to identify, monitor, and quantify historical LC changes in the study area using multi-temporal Landsat imageries for two different dates acquired from 1986 to 2021. The temporal and historical alterations that occurred were recognized with excellent accuracy (93%) utilizing unsupervised classification approache. In the year 1986, the cultivated area covering 8989.99 hectares (ha) decreased to 6912.33 ha in 2021 losing 2077.66 ha. Buildings increased from 846.10 ha in 1986 to 2747.10 ha in 2021 with a difference of 1928.0 ha. Archaeological site (*Memphis*) covered 113.90 ha and 113.80 ha in 1986 and 2021 respectively. The main roads and railways increased from 253.57 ha in 1986 to 403.2 ha in 2021 with an extension of 149.63 ha. Physiographic units include River Nile alluvium (levees, point bars, bow bars, and alluvial plain) and windblown sediments in the aeolian plain. The results concluded that the study area is a valued site of unique physiographic units as the most highly suitable land for most of LUTs.

KEYWORDS: Land cover, physiography, soils, land suitability, and urban encroachment.

1. INTRODUCTION

The cultivated area in Egypt should be considered as a cultural landscape being inherited agrobiodiversity. According to UNESCO Convention (2012), Cultural landscapes on the World Heritage List are cultural properties and represent the combined works of nature and of man. Afify *et al*. (2013) stated that the ancient cultivated study area can be imagined as the first human land use of managed valuable farm. In the current view, the crowd prevailing on this rural area with buildings that upstaged and uprooted the most profitable agricultural land in the world.

This valuable agrobiodiversity in the River Nile alluvium was named by Old Egyptians as *Ta Kemit*. According to the Latin English Dictionary by Chambers (1996), *Ta Kemit* from Hieroglyphy "*Ta*" = Land + "*Kemit*" = black. It can be interpreted that, *Ta Kemit* means the powerful black soils. Nile alluvium can be considered of closed relationship with the natural water flow of River Nile without engine to its inherited sediments. This harmony represents a high economical element that cannot be imitated even with very expensive technology. Accordingly, this denaturing of cultivated land under the urban encroachment should be stopped for socio-economic stability.

One of the main reasons that accelerate the loss of cultivated land is related to some decreed laws without appended strict conditions ensuring that the given fields must be practiced only for cultivation. These laws were named as the agrarian reform ones of number 178 in 1952 decreed by the Government of Republic of Egypt (1952) and number 127 in 1961 decreed by Republic Presidency of United Arab Republic (1961) for the welfare of Egyptian farmers. The distributed parcels were divided as inherited to be managed under multiple ownerships. Subsequently, law number 96 in 1992 was ratified by the People's Assembly of Arab Republic of Egypt (1992) to liberate the cultivated land for the original owners on the base of reforming the relationship between the owners and the tenants. This law allowed the landowners to sell their land without the consent of those tenants. Without conditions, the law accelerated urban extension in the sequent later durations.

Egyptian National Specialized Committee (2003) reported that Egypt lost 672227 ha from the year 1952 to the year 2002. It was expected that by that rate of losing agricultural land, Egypt will lose all its old cultivated land by the year 2080. Shalaby (2012) reported that urban sprawl is threatening the limited highly fertile land of the deltaic sediment in Egypt. The Author found that the urban expansion during a period from 1984 to 2006 denatured 79700.9 ha of highly suitable land. Within this deltaic sediment, Elbeih *et al*. (2013) stated that urban expansion denatured 10075 ha from the highly capable soils in El Gharbia Governorate during the duration from the year 1990 to the year 2011. Afify *et al*. (2012) reported that the degree of the loss of fertile soils in Quesna, District (Markaz), Menufeyah Governorate, grew substantially between 1984 and 2011. In North Giza Governorate, Afify *et al.* (2020) monitored the changes of the cultivated area from the year 1986 to the year 2020. Within that duration, the loss of cultivated fertile soils was 4337.48 ha as 16.47 % of that is in the year 1986.

Egyptian Official Gazette (2019) shed light on the Article 29 of Egypt's Constitution that considered agriculture as a basic component of the national economy. The state commits to protecting and increasing land under cultivation, and incriminating encroachments thereon. In the same Constitution, (Article 32) these natural resources are belonging to the people and the state commits to preserving their depletion considering the rights of future generations. Accordingly, it is urgently required to activate the Constitution's concept by a strict low otherwise the crises will still act without solution.

The article aims to update the spatial distribution of cultivated land retreatment as associated with certain physiographic units of specific soil attributes. The soils were aimed to be evaluated as land suitability assessment for agricultural use. These findings were manipulating as spectral signatures of landscape elements using recent remote sensing data, for tracing the loss of cultivated area. The manipulated spectral signatures can be retrieved later on to be updated for the same area by more recent remote sensing data and also to be a base of extrapolation process for other areas. The study is also aimed to launch a call for ceasing this informal mode and correcting the human-cultivated land relationship. A knowledgeable smart attitude is highly required to protect and maintain this inherited Cultural Landscape as an inevitable approach. This approach should be associated with developing the agro-ecosystems framework with formal land and water management as well as correcting the price levels of the agricultural products to realize its real profitable function.

2. MATERIALS AND METHODS

2.1 Study area

The study area is situated in South Giza Governorate including old rural area on the sediments of River Nile alluvium. The cultivated area is somewhat centered by the village Mit Rahina that is closing to an archeological site of *Memphis* the oldest capital of Egypt, which had been founded by Menes. Other villages are situated northwards (El Hawamdiya), southwards (Dahshour) and westwards (Saqqarah). The western outskirts of the study area represents a historical area with series of ancient pyramids. The study area is covering 11356.17 ha within the coordinates of latitude 29˚46' 09.75″ N and longitude 31˚13' 22.79″ E. in the lower-left corner. In the upper left corner, the latitude is 29˚ 54' 53.46″ N and the longitude is 31˚ 10' 40.96″ E, while the latitude is 29˚54' 58.54″ N and the longitude is 31˚ 16' 59.56″ E. in the upper right corner. In the lower right corner, the latitude is 29˚ 46' 13.19″N and the longitude is 31˚ 17' 29.15″ E (Fig. 1).

2.2 Remote sensing data

Remote sensing data is covering path 176 and row 39 as Landsat-5 (TM).1986; and Landsat-8 (OLI) 2021. The multispectral bands of Landsat-5 have a spatial resolution of 30 meters with spectral resolutions of Green (510-590 nm), Red (610-680 nm), and Near-Infrared (800-890 nm). For Landsat-8 the spectral bands are Green (530-590 nm), Red (640-670 nm), and Near-Infrared (850-880 nm). These data were merged with a panchromatic band of 15 meters spatial resolution with a spectral resolution of 500- 680 nm in the case of using Landsat-8 data.

2.3 Geometric correction and image sub-setting of remote sensing data

Remote sensing data were geometrically corrected according to Universal Transverse Mercator (UTM) projection, zone 36 Spheroid and Datum are WGS 84. Sub scene was breached out to fit the located study area using the cartographic software of (Guide, 2018) to reduce the data space and required time for processing them.

2.4 Visual interpretation and automated classification

Physiographic units were delineated according to the proposed physiographic approach by Zinck and Valenzuela (1990). The main roads, railways, and water-flowing canals were traced as linear features. For recognizing the components of landscape features, automated unsupervised classification is performed into classes using the natural groupings of pixels, which are based on the clustering method of the Iterative Self-Organizing Data Analysis Technique (ISODATA) algorithm of ERDAs-a (2010). The linear features were buffered as polygons to be calculated as areas.

2.5 Naming geographic features

Naming geographic features of the study area based on topographic maps of scale 1: 50000, which were produced by the Egyptian General Survey Authority (1990).

2.6 Fieldwork

Fieldwork was started to check the preliminary interpretation map by different ground observations for confirming or revising the borders of the physiographic units and the land cover classes. For soil morphological study and sampling, twelve soil profiles were selected to

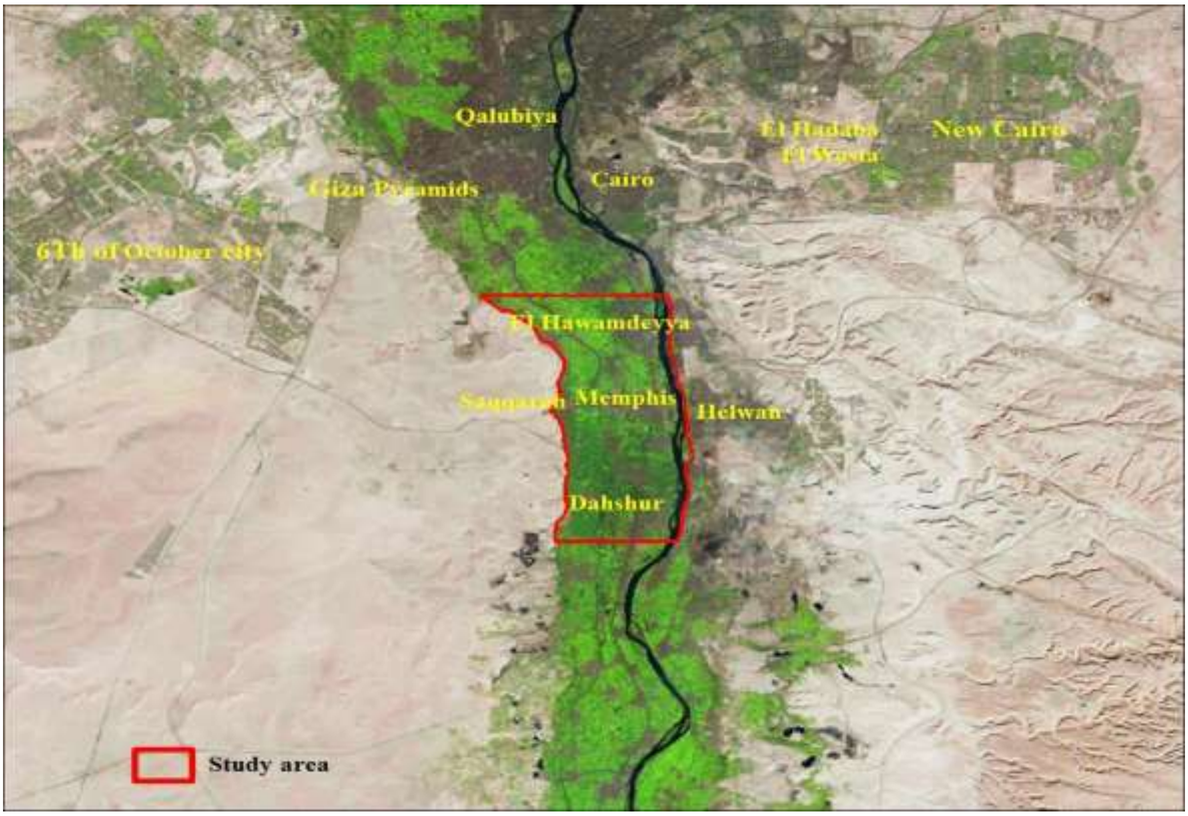

Figure 1. Location map of the study area.

represent the physiographic units using the Global Positioning System (GPS). Soil strata were described according to Boulding (2017).

2.7 Laboratory analyses

For determining texture classes, particle size distribution was measured according to Sparks et al. (2020) using the pipette after removing salts and organic matter. Sodium hexametaphosphate was added as a dispersing agent. According to Nelson (1982), the contents of calcium carbonate were measured by the calcimeter, while gypsum was determined by precipitation with acetone. In soil paste extract. Salinity was expressed as electrical conductivity (EC) according to Carter and Gregorich, (2007). Soil pH in soil paste and exchangeable sodium percentage (ESP) were determined according toRichard (1954).

2.8 Soil classification

Soils were classified following the criteria of the Keys to Soil Taxonomy of USDA (2014) to the level of soil family.

2.9 Land cover classification.

Land cover classes were defined according to the Land Cover Classification System (LCCS) by Di Gregorio (2005). The delineated land cover features were based on their spectral signatures, which were categorized by the unsupervised classification nodule in ERDAs-a (2010).

2.10 Land suitability assessment for agricultural use.

For irrigated agriculture, land evaluation was carried out using the guide of Sys *et al*. (1993) for arid and semi-arid regions.

2.11 Accuracy Assessment

Two separate accuracies were calculated: user and producer accuracy based on Kappa statistics according to Congalton and Green (1999).

3. RESULTS AND DISCUSSION

3.1. Monitoring of land cover changes in the study area.

The defined land cover features were delineated as a vegetated area and non-vegetated one. The data listed in Table 1 and shown in figures. 2 and 3 that represent land cover changes within the duration from 1986 to 2021and described as follows:

3.1.1. Vegetated area.

Vegetated areas include irrigated terrestrial cultivation, which is mostly under surface irrigation. This managed agriculture includes Land Utilization Types (LUTs) of sequentially herbaceous crops and permanently managed trees. In the year 1986, this land cover class covered 8989.99 hectares (ha), which

Table 1. Land cover changes within the duration from 1986 to 2021.

Land cover class	Year of monitoring			%
	1986	2021	Difference	
	Area per (ha)			
Irrigated agriculture	8989.99	6912.33	-2077.66	-23.11
Non linear surfaces (setllements)	846.1	2774.1	1928	227.9
Archaeological site	113.9	113.8	-0.1	-0.09
Linear surfaces (roads and railways)	253.57	403.2	149.63	59.01
Artificialwaterbodies (irrigation and drainage canals)	417.14	417.2	-0.06	-0.01
Natural water bodies (River Nile)	736	735.54	-0.46	-0.05
Total area	11356.7	11356.17		

decreased to 6912.33 ha in 2021 losing 2077.66 ha as 23.11 % % of the cultivated area in 1986.

3.1.2. Non-vegetated area.

3.1.2.1. Non-linear surfaces.

These non-linear surfaces represent the settlements or administrative affairs, archaeological sites, artificial water bodies and natural water bodies.

The settlements or administrative affairs were covering 846.10 hectares in 1986, while extent to 2747.10 ha in 2021 with an extension of 1928.0 ha as 227.9% of this class in 1986. Archaeological sites are rather non-linear surfaces is representing a historical area with an archaeological site in the village of Mit Rahina that represents the site of *Memphis* (the oldest capital of Egypt). This archaeological site was covering 113.90 ha in 1986 but appeared in 2021 with no significant change (113.80 ha). Artificial water bodies are flowing water as irrigation and drainage canals, which were traced and buffered as polygons covering 417.14 and 417.2 ha in 1986 and 3021 respectively with no significant change. Natural water bodies represent a local allocated part of the River Nile course in Egypt that covered 736.0 and 735.54 ha in 1986 and 2021 respectively with no significant change

3.1.2.2. Linear surfaces.

These linear surfaces were traced as lines of main roads and railways (111.1km length) were buffered considering their width to be calculated as areas in polygons. They covered 253.57 ha in the year 1986 but increased in the year 2021 to 403.2 ha with the extension of 149.63 ha as 59.01%.of them in 1986.

3.2. Physiographic units.

The physiographic units were delineated using remote sensing data of Landsat-8 (OLI) 2021 considering two groups of landscape genesis. One group includes River Nile alluvium as a meandering belt (Levees, point bars, and bow bar) and an alluvial plain, while another one includes an aeolian plain that was deposited by a wind agent. The areas of these physiographic units are shown in Table 2 and their associated soil attributes in Table 3. They were delineated in figure. 4 and are described as follows:

3.2.1. Levee

Afify *et al*. (2020) described this levee as alluvium aligning the River Nile course with relatively higher surfaces that were deposited at the side of the channel during an active discharge when the area was previously inundated. According to Huggett (2016), these levees occurred within the meandering belt of a meandering river. In the study area, these levees are covering 396.1 ha as 3.49 % of the total study area including coarser texture classes compared to those in the alluvial plain. The soil surface is clayey texture classes underlain by a control section that is dominated by clay loams (fine loamy). These soils are non-saline having electrical conductivity (EC) from 0.49 to 0.71 dS/m., while the values of Exchangeable Sodium Percent (ESP) range from 0.5 to 4.7. CaCO3 content ranges from 24.2 to 49.0 grams per kilogram of soil, while gypsum content ranges from 1.0 to 3.3 grams per kilogram of soil. These soils are recent (*Entisols*), developed under a toric moisture regime (*Torriorthents*) and realizing the central concept of this category (Typic). Accordingly, the soils at the level of soil family are fitting the taxonomic unit of *Typic Torriorthents, fine loamy, mixed, hyperthermic* (profiles 1 and 2).

3.2.2. Point bar

Point bars are curved polygons following the bend of the River Nile course and closing to the inside line of the river in the meandering sites. Alluvial material was deposited on the inside of the river curve after an erosion process from the outside bend covering 79.200 ha as 0.69 % of the total area. The soil control section is dominated by sandy loam texture class (coarse loamy) with non-saline soils (EC from 0.62 to 1.98 dS/m) and ESP from 0.7 to 5.1. CaCO3 content ranges from 23.0 to 39.4 grams per kilogram of soil, while gypsum content are from 2.2 to 6.0 grams per kilogram. The soils are fitting the taxonomic unit of *Typic Torriorthents, coarse loamy, mixed, hyperthermic* (profiles 3 and 4).

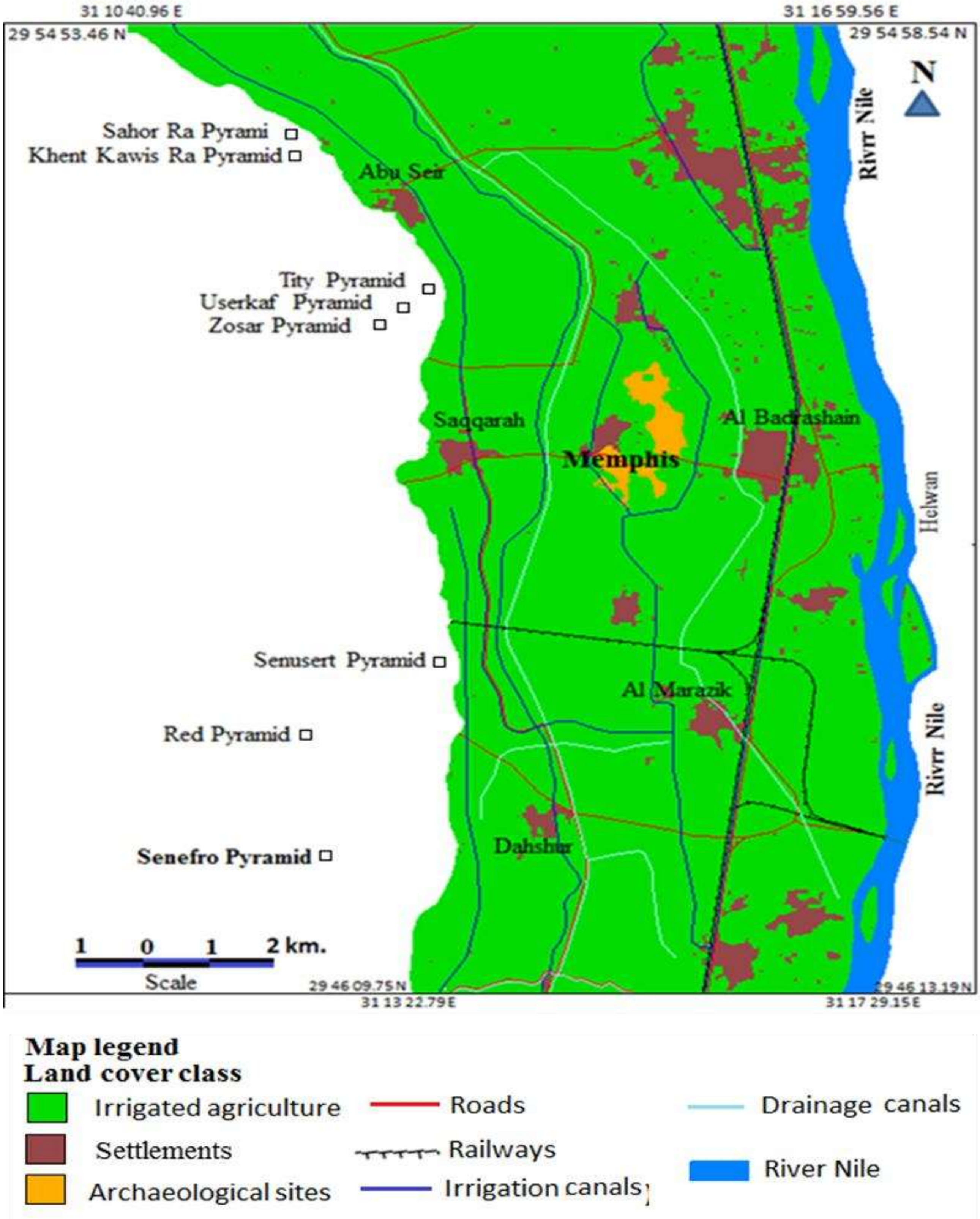

Figure 2. Land cover distribution in the year 1986.

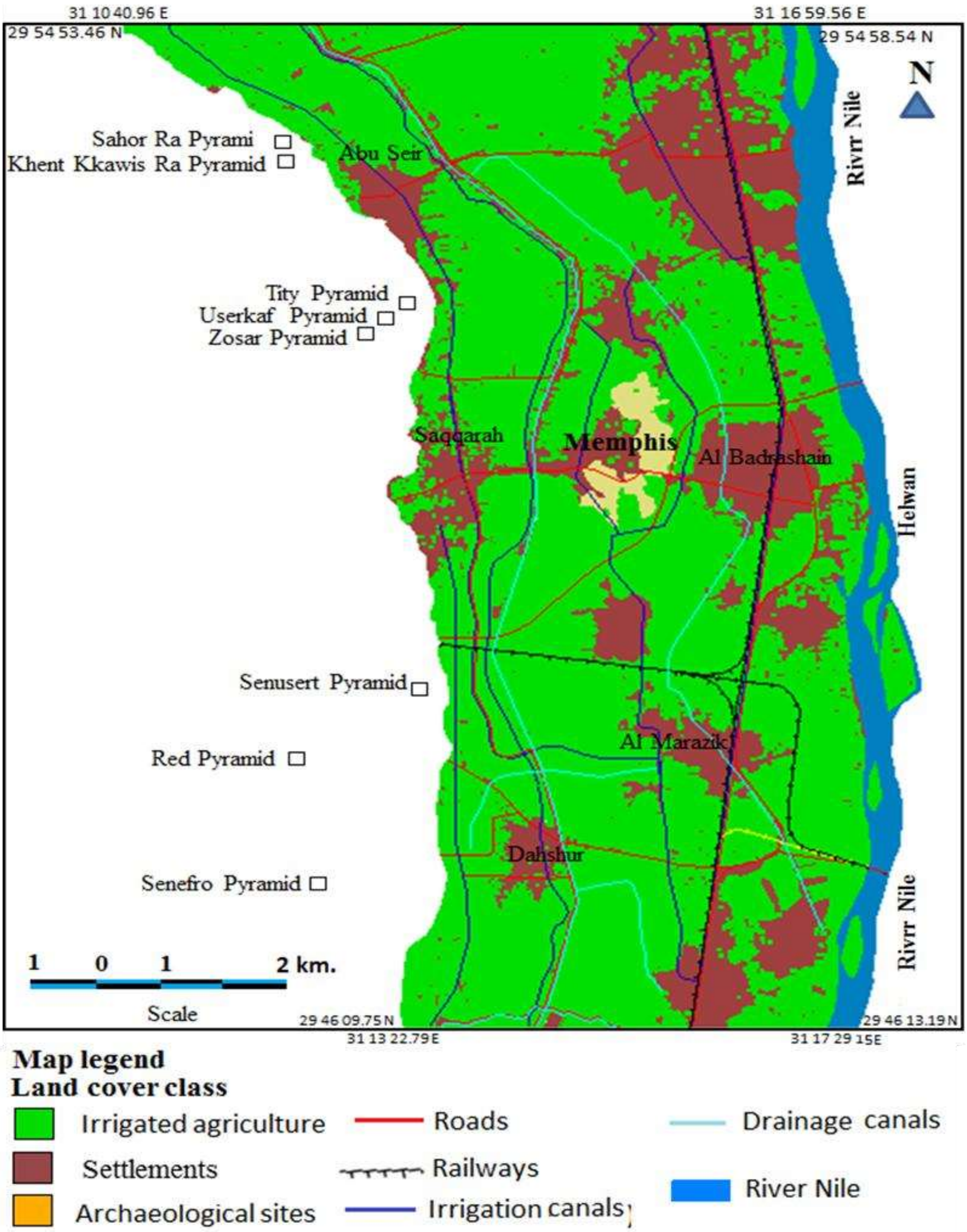

Figure 3. Land cover distribution in the year 2021

Table 2. The spatial distribution of physiographic units and other land features in 2021.

Physiographic unit	Area per hectares	Percent
Levee	396.12	3.49
Point bar	79.2	0.69
Bow bar	129.3	1.14
Alluvial plain	5534.61	48.74
Reworked aeolian plain	773.1	6.81
Other features	**Area per hectare**	**Percent**
Buildings	2774.1	24.43
Archaeological sites	113.8	1
roads and railways	403.2	3.55
water canals	417.2	3.67
River Nile)	735.54	6.48
Total area	11356.17	100

3.2.3. Bow bar

Bow bars are asymmetrical islands with flat surfaces that are surrounded by River Nile water with narrow channels on one side and wide one on the other side as being situated within a somewhat bending channel. According to Afify *et al*. (2020), these bars were deposited inside the meandering river during periods of more active flow within the River Nile course. They are elongated islands surrounded by water appearing in the middle of the channel when the channel is somewhat strait. These bow bars are covering 129.30 ha as 1.14 % of the total area. The soils are dominated by clay loam texture class (fine loamy) and are non-saline (0.49 to 0.95 dS/m) and ESP range from 1.2 to 5.1. CaCO3 content ranges from 17.7 to 40.3 grams per kilogram of soil and gypsum content ranges from 1.9 to 4.3 grams per kilogram. These soils were categorized as *Typic Torriorthents, fine loamy, mixed, hyperthermic* (soil profiles 5 and 7).

3.2.4. Alluvial plain

Alluvial plain occurred by the frequent flooding of River Nile in the relatively low area compared with the physiographic units of levees. This plain of flat surfaces is covering 5534.610 ha 48.74 % of the total area. The soils are clayey and are affected by shrinkage under dryness producing cracks to be filled from the surface by soil matrix. This soil matrix swells when the soil becomes wet resulting in compacted filling materials "slickensides" increasing soil volume and forming soil gilgai that appears as a surface feature. This case is fitting the soil order *Vertisols* [*Vert*.; etymology: Latin "*verto*" = to turn], which means that soil turn from epi pedon to the subsurface. In this alluvial plain, the soils are clayey with more than 40 % clay but less than 60 percent by weight (fine). These soils are non-saline having EC from 0.40 to 1.60 dS/m, while their ESP ranges from 1.1 to 4.0. CaCO3 content ranges from 25.2 to 38.7 grams per kilogram of soil, while gypsum content ranges from 1.0 to 4.0 grams per kilogram of soil. These soils were categorized as *Typic Haplotorrerts*, *fine*, *hyperthermic* (soil profiles 6, 9, and 10).

3.2.5. Aeolian plain

This aeolian; plain was a result of eroding and depositing sands by the agent of wind. El-Baz (1998) reported that those sands were born by water and sculpted by the wind relating these sands to the fluvial erosion of the exposed Nubian Sandstone in the western desert and were transported northwards following the paleo drainage courses. During the dry climate, the wind mobilized the sand to be deposited. This physiographic unit was delineated in the western side of the study area with almost flat surfaces at relatively high elevations compared to the Nile alluvium. It covers 773.1 ha as 6.81 % of the total area and has been managed under agricultural land use with reworked soil surface as mixed by transported loamy soils of the different parent materials. The surface layers are mostly sandy loams but the control section includes layers of sands. The soils are non-saline (EC from 0.34 to 1.53 dS/m) having an ESP range from 0.9 to 4.0. CaCO3 content ranges from 22.0 to 43.8 grams per kilogram of soil and gypsum content ranges from 1.2 to 4.3 grams per kilogram of soil. These soils were classified as *Typic Torripsamments mixed*, (soil profiles 8, 11, and 12).

Table 3 Physical and chemical attributes of the soils in physiographic units.

Physiographic Units	Profile No.	Depth (cm)	Particle size distribution			Texture class	$CaCO_3$ g/kg soils	CaSO4.2 H2O g /kg soils	pH	EC (dS/m)	ESP
			Clay	Silt	Sand						
Levee	1	0-30	40.81	29.14	30.05	C	38.3	1	7.5	0.66	2
		30-80	38.01	24.97	37.02	CL	41.4	1	7.4	0.6	1.5
		80-150	39.18	36	24.82	CL	49	2	7.5	0.71	0.6
	2	0-25	40.93	31.15	27.92	C	39.6	3.3	7.6	0.59	4.7
		25-80	39.93	31.15	28.92	CL	24.2	3	7.7	0.49	1.1
		80-150	13.44	18.65	67.91	SL	41.1	3	7.6	0.54	0.5
Point bar	3	0-35	18.26	12.74	69	SL	39.4	6	7.5	1.98	2.2
		35-90	19.75	21.25	59	SL	38.1	2.9	7.6	1.8	2.3
		90-150	9.21	9.25	81.54	LS	23.7	2.6	7.8	1.23	5.1
	4	0-30	14.31	12.17	73.52	SL	36.2	2.2	7.6	0.78	2.2
		30-85	18.69	14.46	66.85	SL	38	4.5	7.6	0.62	1.2
		85-150	9.75	9.25	82	LS	32.6	2.9	7.8	0.68	0.7
Bow bar	5	0-15	28.4	39.11	32.49	C L	34.1	1.9	7.5	0.76	2.2
		15-65	29.3	34.29	36.41	CL	40.3	3.1	7.4	0.8	2.3
		65-120	11.78	14.13	74.09	SL	39	2	7.8	0.81	5.1
	7	0-25	30.29	38.12	31.59	CL	34.2	4.3	7.6	0.95	2.2
		25-75	28.18	34.33	37.49	CL	27.1	3	7.7	0.49	1.2
		75-150	12.48	13.42	74.1	SL	17.7	3.8	7.8	0.64	2.7
Alluvial plain	6	0-35	46.18	26.87	26.95	C	34.6	1	1.53	1.53	1.3
		35-75	41.93	28.1	29.97	C	25.2	1	1.23	1.23	3.2
		75-150	45.75	31.25	23	C	35.2	1	1.6	1.6	3.3
	9	0-30	41.16	31.84	27	C	36	4	0.4	0.4	1.1
		30-70	46.77	22.31	30.92	C	38	3	0.71	0.71	1.3
		70-150	49	25.01	25.99	C	37.7	3	0.75	0.75	1.2
	10	0-30	40.53	24.54	34.93	C	38.7	3	1.3	1.3	2.6
		30-85	41.79	22.15	36.06	C	33.8	3	1	1	1.9
		85-150	27.33	22.61	26.95	SCL	36	3	1.1	1.1	4
Aeolian plain	8	0–30	19	13.99	67.01	SL	22	1.5	7.6	1.53	1.3
		30–80	4.21	4.87	90.92	S	33.4	1.2	7.8	1.23	0.9
		80-150	3.84	2.21	93.95	S	34.7	1.6	7.8	1.5	3.3
	11	0-35	15.29	11.34	73.37	SL	37.7	3.1	7.6	0.43	1.1
		35-75	6.08	7.02	86.9	S	2432	2.7	7.8	0.71	1.3
		75-150	4.57	4.21	91.22	S	33.5	2.3	7.8	0.75	1.2
	12	0-30	10.4	10.6	79	SL	4333	4.3	7.6	1.3	2.6
		30-65	1.69	4.25	94.06	S	32.9	3.4	7.7	1	1.9
		65-150	1.26	4.32	94.42	S	31.6	2.8	7.7	1.1	4

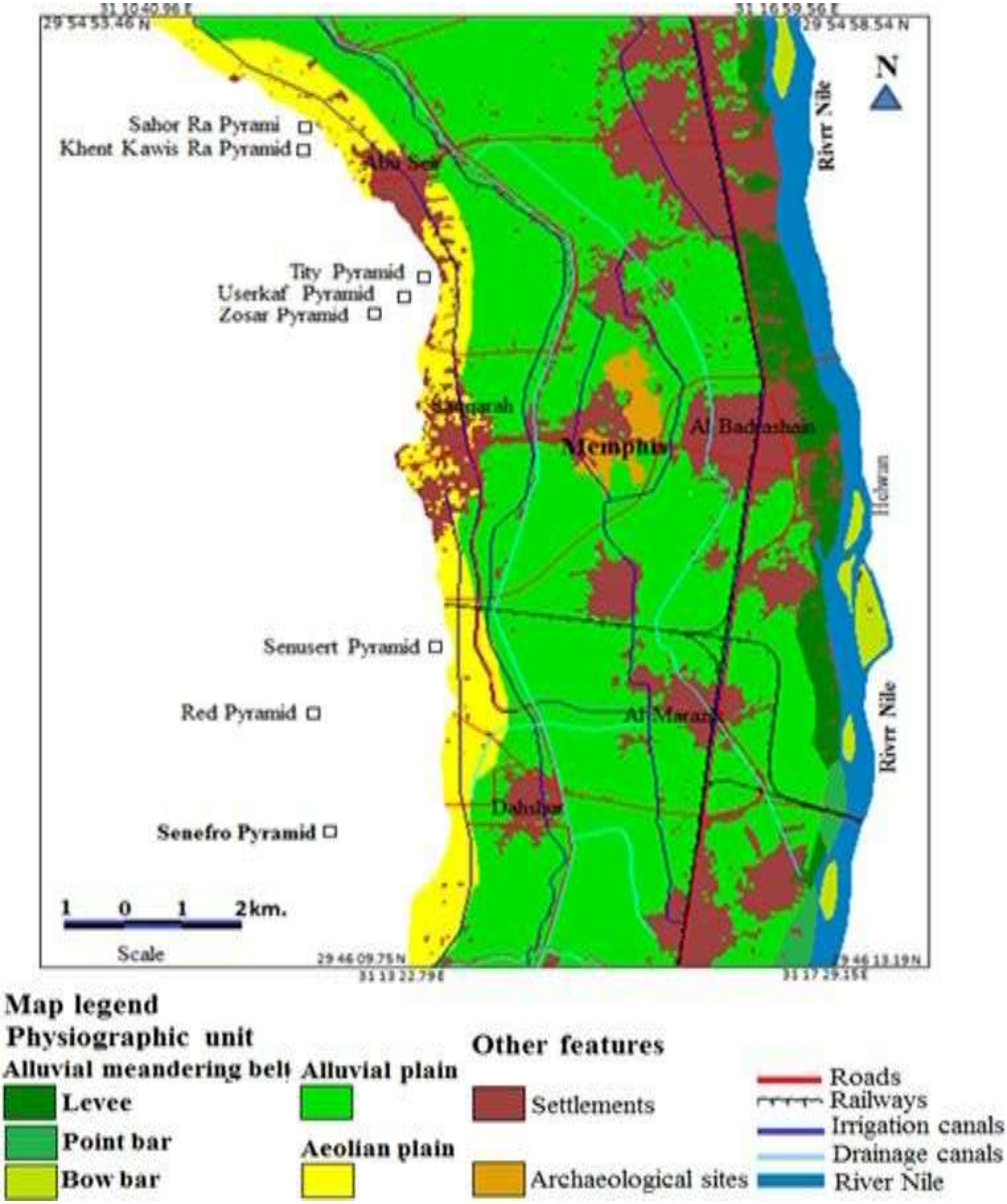

Figure 4. The spatial distribution of the physiographic units in the study area.

3.3. Suitability assessment of the physiographic units for land utilization type (LUTs).

Each physiographic unit was evaluated for certain LUT to determine the most productive LUT in the certain physiographic unit. The purpose was to maximize productivity in all the physiographic units. According to Sys *et al.* (1993), the land qualities were matched with each crop for its growth requirements. The selected soil characteristics are CaCO3 "c", drainage "d", alkalinity "n", soil depth "p", salinity "s", slope "t", texture "x", and gypsum "y". The land was evaluated for the LUTs that are traditionally cropped as terrestrial cultivation and mainly managed under surface irrigation. They are herbaceous crops including alfalfa, beans, cabbage, carrots, cowpea, cotton, green pepper, maize, onion, pea, potato, soya, sunflower, sweet potato, tomato, watermelon, and wheat, while trees include citrus, date palm, guava, mango, and olives. These collective LUTs were considered to satisfy the requirements in Egypt for edible and fodder crops as well as oilseed crops. The current land suitability classes for those LUTs are shown in Table 4. Levees and bow bars are highly suitable (S1).for all LUTs, while point bars are S1.for most of LUTs but moderately suitable (S2) for cotton, maize, and guava. Alluvial plain is S1 for most LUTs but is S2 for potato, sesame, watermelon, citrus, mango, and olive, while is marginally suitable (S3) for carrot. Aeolian plain is S2 for most of LUTs; S1 for mango and olive; while is S3 for barley, cotton, sorghum, wheat, and guava,

3.4. The value of the retreated cultivated land

3.4.1. Valued site of highly unique physiographic units

Soils in the study area are mostly representing unique alluvium, which cannot be developed anywhere even with an intensive investment. It is a site of highly promising land resources for agricultural purposes that can be easily utilized by the low level of management on soils of good land qualities. They are mostly alluvium including high soil values in flat to almost flat well-drained and very deep sediments. The soils are dominated by *Vertisols*, which are locally associated with *Entisols* having highly fertile soils that are highly suitable lands "S1" for most of LUT.

3.4.2. The Valued situation of unique agrobiodiversity in the cultural landscape

The value of this cultivated area is not only dependent on highly suitable lands but also depends on the situation of that site. The inherited demographic feature is attributed to specific accumulated skinless for a unique economical production and skilled agriculture. The required capital intensity is not to be high for managing the land successfully as its minor problem can be overcome by a small user in small-scale land tenures. The area includes an intensive network of local and national roads and railways that are spidery and centrally making the agricultural products easy to access with fewer expenses to the markets in Great Cairo of intensive population or anywhere in Egypt. Rather valued situation in this cultural landscape are those distributed archaeological sites, which centered the study area as *Memphis* the oldest capital of Egypt, or those aligning the western outskirts of the study area as sequent pyramids. It is an alarm that with the continues of this uncontrolled urban encroachment this cultivated area as unique agrobiodiversity will be fully denatured and its associated demographic and socio-economic features will be negatively affected. Also, the inherited glorious view of archaeological sites as well as their prestige and dignity will be dull, subdued, and distorted.

3.5. Accuracy assessment

For the analyzed classes, error matrices, overall accuracies, and Kappa statistics (K) values for the categorized images were generated (Table5). Overall classification accuracy in the year 2021 was 94 percent, with a Kappa index of 93 percent. The accuracy obtained was satisfactory as according to USGS the minimum overall level of accuracy is 85 percent.

4. CONCLUSION

This study seeks to detect the land-use change in South Giza Governorate using remote sensing and GIS methodologies. According to the results of the change detection, the cultivated area declined from 8989.99 hectares (ha) in 1986 to 6912.33 ha in 2021 losing 2077.66 ha. Buildings have expanded by 1928.0 hectares from 846.10 ha in 1986 to 2747.10 ha in 2021. In 1986 and 2021, the archaeological site (*Memphis*) covered 113.90 ha and 113.80 ha, respectively. With a 149.63 ha extension, the main highways and railways increased from 253.57 ha in 1986 to 403.2 ha in 2021. The research area is a valuable site of unique physiographic units as the most highly suited land for most LUTs, with physiographic units such as River Nile alluvium (levees, point bars, bow bars, and alluvial plain) and windblown sediments in the aeolian plain. This study discovered that spatial data and remotely sensed data are especially beneficial in providing time-series information on LC change, which provides intriguing decision-making support for future planning and monitoring strategies.

Table 4 Current land suitability of the certain physiographic unit for specific LUTs.

Physiographic units	Crops	Land suitability
Levee and bow bar	Alfalfa, barley, beans, cabbage, carrot, cowpea, cotton. green pepper, maize, onion, pea, potato, soya tomato, sweet potato, watermelon, wheat, sesame, sorghum, sunflower tomato, olive، citrus, guava and mango	Highly suitable (S1)
Point bar	Alfalfa, barley, beans, cabbage, carrot, cowpea, green pepper, onion, pea, potato, sesame, sorghum, soya, sunflower, sweet potato, tomato, watermelon, wheat citrus, olive and mango	Highly suitable (S1)
	Cotton, maize and guava	Moderately suitable (S2)
Alluvial plain	Alfalfa, barley, beans cabbage, cotton, cowpea, green pepper, maize, onion, pea, potato, sorghum, sunflower, soya, tomato, wheat and guava,	Highly suitable (S1)
	Potato, sesame, watermelon, citrus, mango, and olive.	Moderately suitable (S2)
	Carrot	Marginally suitable (S3)
Aeolian plain	Mango and olive	Highly suitable (S1)
	Alfalfa, beans, cabbage, carrot, cowpea, green, pepper, maize, onion, pea, potato, sesame, soya, sunflower, sweet potato, tomato, watermelon and citrus	Moderately suitable (S2)
	Barley, cotton, sorghum, wheat and guava,	Marginally suitable (S3)

Table 5. Accuracy assessment of LC in 2021 using confusion matrix method.

Land cover classes (2021)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total**
(A) Irrigated agriculture	154	1	0	0	1	0	0	0	156
(B) Settlements	2	117	0	5	1	0	0	0	125
(C) Archaeological sites	0	1	26	0	2	0	0	7	36
(D) Roads	0	0	0	13	0	0	0	0	13
(E) Railways	0	0	0	0	41	0	0	4	45
(F) Irrigation canals	0	0	0	0	0	33	0	0	33
(G) Drainage canals	0	0	0	0	0	0	8	0	8
(H) River Nile	0	0	0	0	1	0	0	51	52
Total	156	119	26	18	46	33	8	62	468

Kc Value =93%

Table 6. Overall accuracies and Kappa statistics values for the classified images for 2021.

Land cover classes (2021)	Reference Totals	Classified Totals	Number Correct	Users Accuracy	Producers Accuracy
Irrigated agriculture	156	156	154	99%	99%
Settlements	119	125	117	94%	98%
Archaeological sites	26	36	26	72%	100%
Roads	18	13	13	100%	72%
Railways	46	45	41	91%	89%
Irrigation canals	33	33	33	100%	100%
Drainage canals	8	8	8	100%	100%
River Nile	62	52	51	98%	82%

Overall accuracy = 94 %

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الملخص العربى

متابعة وتقييم صفات الأراضى المنزرعة المتراجعة تحت الزحف العمرانى فى جنوب محافظة الجيزة ,مصر

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اختيرت منطقة الدراسة فى جنوب محافظة الجيزة بمساحة مقدارها ١١٣٥٦.١٧ هكتار (٢٧٠٢٧.٦٨ فدان.) وتم استخدام البيانات الفضائية للاقمار الاصطناعية TM٥ و TM٨ لعامى ١٩٨٦ و ٢٠٢١ على التوالى لمتابعة تغيرات الغطاء الارضى فى منطقة الدراسة ففى عام ١٩٨٦ كانت المساحة المنزرعة ٨٩٨٩.٩٩ هكتار تناقصت الى ٦٩١٢.٣٣ هكتار فى عام ٢٠٢١ حيث تم فقد ٢٠٧٧.٦٦ هكتارا بينما زاد زحف المبانى من ٨٤٦.١٠ هكتار فى عام ١٩٨٦ الى ٢٧٤٧.١٠هكتار فى عام ٢٠٢١ بزيادة مقدارها ١٩٢٨.٠٠هكتار تضمنت المنطقة فى مركزها موقعا اثريا بمساحة ١١٣.٩ و ١١٣.٨٠ هكتار فى كل من ١٩٨٦و ٢٠٢١ على التوالى كما زادت مساحة الطرق الرئيسية متضمنة السكك الحديدية من ٢٥٣.٥٧ هكتار فى ١٩٨٦ الى ٤٠٣.٢ فى ٢٠٢١ بزيادة مقدارها ١٤٩.٦٣ هكتار.

اشتملت الوحدات الفيزيوجرافية فى رسوبيات نهر النيل على أكتاف النهر ، عوارض فى منحنى النهر ، عوارض فى مجرى النهر والسهل الرسوبى اضافة الى سهل الترسيبات الهوائية حيث اشتمل كل منها الوحدات التصنيفية للتربة كالتالى :

أكتاف النهر وعوارض مجرى النهر : *Typic Torriorthents, fine loamy, mixed, hyperthermic*

عوارض منحنى النهر :.*Typic Torriorthents, coarse loamy, mixed, hyperthermic*

السهل الرسوبى : *Typic Haplotorrerts, fine, hyperthermic*

سهل الترسيبات الهوائية : *Typic Torripsamments mixed*

أثبتت النتائج ان منطقطة الدراسة ذو قيمة عالية فى مكانها وموقعها حيث تشتمل على وحدات فيزيوجرافية فى غالبها ذات تربة خصبة عالية الصلاحية لمعظم المحاصيل المنزرعة كما ان هذه القيمة المكانية ارتبطت بقيمة عالية لموقعها حيث تتمركز بها شبكة كثيفة من البنية التحتية تتشعب محليا وقوميا بمساحة مقدارها ٤٠٣.٢ هكتار باطوال تصل الى ١١١ كم مما يحقق سهولة لتسويق المنتجات الزراعية الى اسواق القاهرة الكبرى او فى اى مكان اخر كما تتميز المنطقة بتنوع زراعى حيوى متوارث بخبرة فلاحية على امتداد أرضى تاريخى تتمركز فيه أقدم عاصمة فى مصر (ممفيس) ويمتد فى محازاتها غربا العديد من الاهرامات الاثرية.

ان تصحر هذا التنوع الحيوى النادر اصبح واضحا وان استمراره سوف ينتج عنه تاثيرا سلبيا على الامن الغذائى فى مصر وتشويها للملامح الديموجرافية والشموخ الحضارى للمواقع الاثرية مما يستدعى تصحيح هذا السلوك البشرى ومنعه واعتبار المنطقة محمية زراعبة تراثية