Land Cover Change Detection and Land Evaluation of Burg El Arab Region, North West Coast, Egypt

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ABSTRACT

The identification of land use/land cover (LULC) classes and their changes over time as well as land evaluation help the decision makers in agricultural development planning. Burg El Arab area represents one of potential locations for future development in the north-western coast of Egypt. Supervised classification of remote sensing imagery and the calculation of Normalized difference vegetation index (NDVI) as effective tools were applied to monitor the LULC changes in this area. Data showed that the area was subjected to significant changes in the last three decades due to the increase of reclamation projects as well as industrial activities. From 1984 to 2014 the agriculture land, urban land and water bodies increased by about 10%, 17.6%, and 3.6 %, respectively. This increase took place on the expense of barren land.

Land evaluation serves as an essential tool for land use planning. The application of MicroLEIS system to determine land capability and suitability classes in a representative area at Burg El Arab region indicate that most of the area (about 60%) lies in class 3 (fair capability) with minor areas (21% and 19%) in class 2 (good capability) and class N1 (currently not capable), respectively. Data of land suitability classes exhibited that major area (61%) is not suitable for wheat, maize, melon, sunflower, cotton, and sugar beet. The marginally suitable area include (S3) represents 23.6% except for maize where it represents only about 3.5%, while the rest of the area is conditionally suitable (S4) for all the tested crops. The limiting factors which affect the land capability and suitability include erosion risk, bioclimatic deficit, slope and soil properties which comprise salinity, sodium saturation, texture and calcium carbonate content.

Key words: land use/land cover, change detection, Land evaluation, Burg El Arab.

INTRODUCTION

The Egyptian government has advocated development policies aimed at extending cultivated land and maximizing production of the existing agricultural land. Thus, there is an urgent need to determine the trend and rate of land cover change as well as the land capability and suitability for the developing sustainable land use planning. Using the know- how of multi-temporal satellite images and remote sensing techniques, the change in land use/ land cover (LULC) classes over a long period of time can be detected. Timely and precise information about LULC change detection of earth's surface is extremely important for better management.

The northwestern coast (NWC) region is exposed to significant spatial and temporal change in LULC, urban agriculture areas, and water bodies which essentially affect the development and management of this area.Burg El Arab area represents one of potential location for future developments in the northwestern coast of Egypt. It is subjected to regional development projects including land reclamation, establishing new factories and many economic, scientific and recreation centers.

Change detection is the process of identifying differences in the state of an object by observing it at different times (Singh, 1989). Timely and accurate change detection of Earth's surface features provides a better understanding of the interactions between human and natural phenomena to better manage and use resources. Remotely sensed satellite imagery is the most appropriate source of information to determine LULC change (Currit, 2005), as it offers the opportunity to assess the effects of reclamation processes and provide the data needed for the development of national agricultural strategies (Pax Lenney, et al., 1996). In Egypt, several researcher applied different change detection techniques to study the change in LULC.

Bahnassy et al., (2001) assessed the change in the vegetated cover of wadi el Natroun, west delta fringe, Egypt using RS/GIS techniques. They reported that the cultivated land increased from 3.5% of the studied area in 1984 to 11.47% in 1999. Suliman, (2001) used the integration of remote sensing and GIS technique to monitor the environmental change in the west Nile delta coast, Egypt. He reported that some changes in coastal line and the vegetated areas as well as the area of Burullus Lake took place in the period from 1984 to 1999. Abd El Kawy et al., (2011) applied a supervised classification to four Landsat images collected over time (1984 – 2009) for the western Nile delta. They found that approximately 28%, 14%, and 9% of barren land were changed to agricultural land in the periods 1984-1999, 1999-2005, and 2005-2009, respectively. In addition to these LULC changes, evidence of land degradation processes was observed, which were mainly due to human activities. Bakr et al. (2010) monitored land cover changes in the Bustan 3 newly reclaimed area, Egypt. The authors used multi-temporal Landsat images captured in 1984, 1990, 2004, and 2008. Temporal changes were determined using both a hybrid classification approach and NDVI in that time series. The hybrid classification results showed that this area involves four land cover classes: urban or built-up land, agricultural land, water, and barren land. Assessment carried out on the produced thematic images indicates accuracies of 94.5%–100% were achieved. From 1999 to 2004, around 62% of the area experienced land cover change. Generally, from 1984 to 2008, the area has experienced a transformation from 100% barren land to 79% agricultural land, as a result of successful land reclamation efforts. The NDVI results indicated less accuracy than hybrid classification. Hegazy and Kaloop (2015) studied the increasing rate of urbanization in Mansoura and Talkha cities in Daqahlia governorate, Egypt. The results showed that between 1985 and 2010 the built-up area has been increased by more than 30% and agricultural land reduced by 33%.

Land evaluation is a process of appraising and grouping specific types of lands in terms of their absolute or relative suitability for specific kinds of use. It is an assessment of land performance when used for specific purposes. The basic feature of land evaluation is the comparison of the requirements of land use with the resources offered by the land (FAO, 1976). The definition of land evaluation is the fitness of a given tract of land for a defined use (Sys, 1985). Generally the aim of land evaluation is to provide information on the opportunities and constrains for the use of land as a basis for making decisions on its use and management (FAO, 1993). Land evaluation is an essential tool in land use planning and any agriculture development programs. Land capability defined as "The potential of the land for use in specified ways, or with specified management practices" (Dent and Young, 1981). It is the assessment of land for using in the most widely major kind of land use. Capability classes are groups of land units that have the same degree of limitations and the risks of soil damage. Land suitability is the assessment of how suitable a particular site is for a particular use. De La Rosa, (2005) showed that suitability can be scored based on factor rating or degree of limitation of land use requirements when matched with the land qualities. Morsy (1994) used the system which was suggested by El-Fayoumy (1989) to study the land capability at El-Bangar area and showed that the study area was classified as class3 (Fair) and class4 (Poor).The MicroLEIS software has been used by Yehia (1998) to evaluate the soil of Banagr EL-Sokkar area (Egypt). He found that the dominant capability subclasses are S2I, S2TI and S3I with soil properties (I) and topographic conditions (T) as main limitation factors.

Khalifa (2004) studied the land suitability of El-Bostan Sector, West Nubaria using ALES-Arid program and indicated that the field crops, vegetables, forage crops, and fruit trees were belonged to class S1 (highly suitable) and (S3) marginally suitable. Massoud (2008) used MicroLEIS program to evaluate the land of El-Hagger farm, West Nubaria, Egypt and found that the land capability classes were S2 (good capability). She also found that the dominant land suitability classes for wheat, sunflower, corn, Soya bean, potato, melon, citrus, and peach were S2, S3 and S4while it was S2 and S3 for cotton, olive, alfalfa, and sugar beet.

Abd El-Maguid (2006) display land suitability at Abis region for six crops using MicroLEIS program and found that the most of the study area belonged to classes 2 and 3, with very small areas as class 4 for wheat, cotton, corn, alfalfa, citrus and sunflower.

Bakr (2003) applied MicroLEIS to evaluate land capability and suitability in Wadi Naghamish-Garawla watersheds at Northwest coast. She found that suitability classes for wheat were dominated by class S2, S3, and S4, while the land suitability classes for olive were S2, S3, and N. Abdel-Kader and Ramadan (1995) used the FAO system of land evaluation to evaluate the lands of Dabaa-Fuka area at north western coast for different land uses, namely, wheat, barley, and fig plantation, and concluded that the prevailing land use classes are S2, S3, and N.

Ali (2000) evaluated the soils of east Matrouh. He found that these soils belongs to S1 class for Wheat and Barely, S2 class for Wheat, Barley, and Grazing, S3 class for Grazing, and N class which is not suitable. Abdel Kawy et al., 2011 found that land capability classes in the western Nile delta resulting from the developed model of ASEL (Abd El Kawy et al., 2010) were 3.96% of the area is classified as Fair (C3), 68.46% is Poor (C4) and 27.58% is Very Poor (C5). The main reason for the low levels of land capability is very poor soil fertility. According to the suitability results, the most suitable crops to grow in the study area are alfalfa, barley, wheat, sugar beet, onion, and pear.

Atta (2010) applied both MicroLEIS and ASEL to evaluate soils of Abis agriculture research station at Alexandria, Egypt. She reported that higher levels of capability and suitability were obtained from MicroLEIS.

This research aims to study changes in land use/land cover and its impact on the agriculture situation during different periods (1984 – 2014) in some areas of Burg El-Arab, as well as evaluating and determining the land capability and suitability for some cultivated crops in a selected area in this region.

The study area

The area under investigation is located at Burg El Arab district between latitudes 30° 50` and 30° 57` N and longitude 29° 25` and 29° 38` E. It is geographically bounded by the Mediterranean Sea to the north, the tableland to the south, El Amerya area to the east, and El Hammam area to the west (Fig.1). The study area is occupying around 482 km^2; this area was subjected to change detection studies.

The climate of studied area belongs to Mediterranean climate. It characterizes by short rainy season, long hot summer, high relative humidity, small diurnal temperature variations. Summary of the agro-meteorological data of Burg El Arab area is illustrated in table 1 (FAO, Climwat 2). The surface of the area is created mainly of various Tertiary and Quaternary sedimentary deposits (Said, 1962, Gindi and Abd-Alla, 2000). The study area is characterized by a series of three parallel Pleistocene limestone ridges ranging in elevation up to 35 m separated by shallow depressions. The Quaternary deposits constitute the main groundwater source in the area. Ridges and depressions in the Burg El Arab area control the groundwater flow pattern (Gindi, 1989). The agricultural land is mainly cultivated by barley, beans, cabbage and melon. The irrigation water source is either El Hamman canal or ground water. However considerable area is bare with few scattered natural vegetation or built up land due to heavy industrial activities in Burg El Arab district.

MATERIALS AND METHODS

1 - Data Sources

A- Satellite images

Landsat 5, 7, and 8 satellites were used in this study. Six images were selected to support the selected time series analysis in this research: 1984, 1987, 2000, 2005, 2011 and 2014 (U.S. Geological Survey, 2015). All data scenes were acquired under clear atmospheric conditions when the weather is generally cloud free. Landsat 8 image acquired on Dec. 2014 was selected to extract the study area for the change detection studies (Figure.1).

B- Topographic maps

The entire study area for change detection analysis is covered by three topographic map sheets at scale 1: 50000. The paper sheet topographic maps were digitized to be converted from paper form to digital format. The IDRISI Selva software was used to convert the geographic coordinates system to Universal Transverse Mercator (UTM) coordinates system (zone 35).

C- Field Work and Sampling

For performing a detailed and a comprehensive field study, a smaller area was subset from the larger study area for land evaluation studies (Fig.1). According to the variations among the spectral mapping units in the classified image, the locations of the representative soil profiles were identified. Fourteen soil profiles were dug and described morphologically in the field according to FAO (2006) and classified according Soil Survey Staff (2010). Soil samples were collected for further chemical, physical, and fertility laboratory analyses. Five irrigation water samples from different artesian wells and three water table samples were also collected for laboratory analysis.

Table 1: Average of Meteorological data for study area region

Months	Rain mm	Min. Temp	Max. Temp	Humidity %
January	33	6.3	16.6	81
February	9	8	17.6	68
March	17	8.7	19	63
April	0	10.7	24.5	59
May	0	15	26	64
June	0	18	28.8	61
July	0	19.8	29.2	71
August	0	19.3	30.3	70
September	0	18.5	27.2	66
October	1	14.8	27.2	64
November	28	12	23	66
December	16	8.7	19.5	61
Total annual average	104	13.3	24.1	66

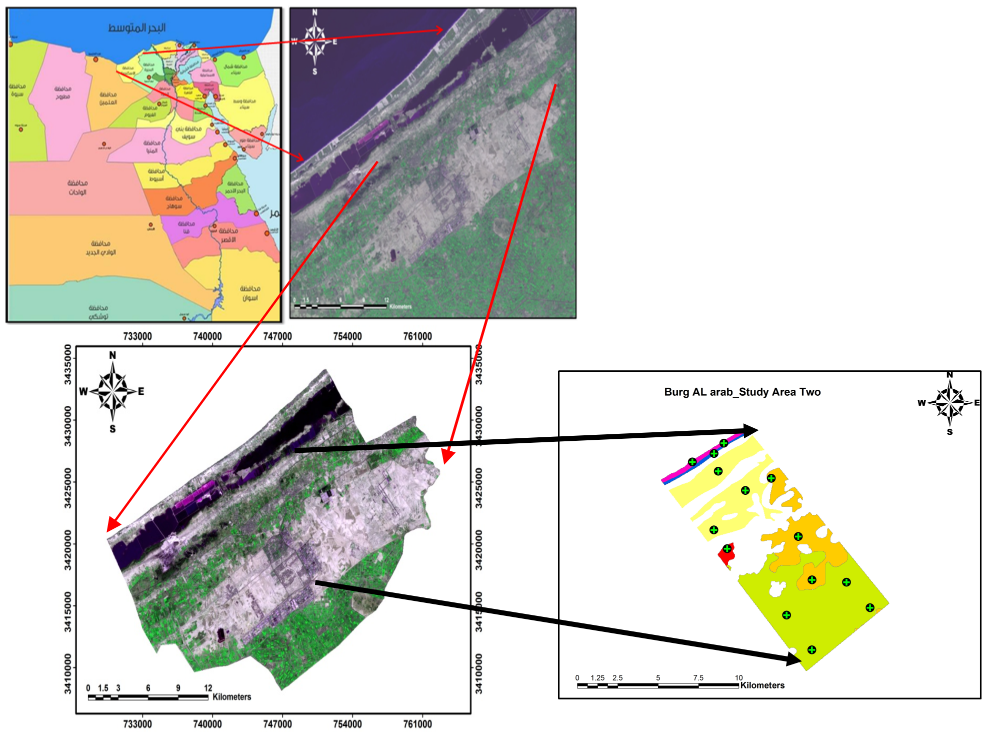


Fig. 1: Location of the study area(extracted from landsat 8 image)

2 - Image analyses

A- Image Pre-processing

All images dataset were geometrically corrected using both digitized topographic map and ground control points (GCP) using image-to-map procedure in IDRISI Selva software (IDRISI, 2012). The root mean square error (RMSE) obtained for this process was 0.35, which means that the positional error is 7.0 m deviated from the location on earth. This is a satisfactory accuracy since it is less than the assigned value of 0.5 pixel which was reported by (Lunetta and Elvidge, 1998). A combination of bands 4 (NIR), 5 (MIR), and 3 (Red) was used in this study for Landsat 5 and 7 images since it is the most useful band combinations for discrimination of land cover categories (Scepan et al., 1999). For Landsat 8, a combination of bands 7-4-2 gives the same tone colours of the 4-5-3 band combination of Landsat 5 and 7 images.

B - Image Processing

i - Satellite image classification

IDRISI image analyst extension and ArcGIS 10.1 software (ESRI, 2011) were used to carry out the image classification. The following steps were carried out to perform supervised classification for each satellite image in each chosen year separately:

Subset of study area: The area of interest was cut out (clip) from the entire image scene into a smaller more manageable file.

Identifying land cover classes*:* The land cover of study area was classified into four main classes include; water, urban area, bare land, and agriculture.

Developing the training sites*:* The first step of supervised classification is to delineate training sites in order to develop spectral signature for each land cover class. This is done by using “signature development” and “MAKESIG” modules in IDRISI software. A considerable number of training sites were assigned for each land cover class and verified through a digital topographic map, ground truth points, and the visual interpretation of different images.

Classification model: The Maximum Likelihoods Classification method was used for the supervised classification using “hard classification” module in image processing under IDRISI Selva environment.

Calculating the area coverage*:* For each land cover class in each subset image for each year, the “calculating area” module was used to produce the area coverage by Hectares and percentage.

Display the final classified images*:* Six final classified images were exported as shape files and import to ArcGIS 10.1 for better display of the outputs.

ii- Normalized Difference Vegetation Index (NDVI) calculation:

The NDVI is a widely index that is used commonly in the processing of satellite data especially in agriculture development areas. It is defined by Rouse et al., (1973) as the following:

NDVI= (NIR-R) / (NIR+R)

Where, NIR is near infrared (NIR) band and R is red (R) band. They stated that, values 0 represent water and non-vegetated areas, while values >0 represent vegetation. The NDVI was calculated for each image at each date using band 3 (R) and band 4 (NIR) in each image. However, for Landsat 8 image band 4 (R) and band 5 (NIR) were used.

Six NDVI continuous images, for all dates, resulted from this step. Each image at each date was recorded to only two values: 0 and 1. Zero for the non-vegetated land and one for vegetated land. The "VEGINDEX" module in image processing was used to calculate NDVI. After producing of NDVI images for each date, the "RECLASS" module was used and the area of vegetated versus non-vegetated were calculated and represented by Hectares and percentage.

iii - Change Detection

The change detection techniques was used to monitor the changes in the land cover classes in the area over 30 years based on different time series from 1984 to 2014. The land change modeler under IDRISI Selva software was used for change analysis through differencing of image pairs. The change detection between each pairs of the selected dates (1984-1987, 1987-2000, 2000-2005, 2005-2011, and 2011-2014) was achieved to produce different change maps.

3- Laboratory Analysis: The collected soil samples were analysed for physical, chemical and fertility properties ccording to the methods described by Page et al., (1982).Chemical analyses of the collected water samples were also determined.

4 - Land Evaluation

Microcomputer land Evaluation Information System (MicroLEIS) which introduced by (De la Rosa, 2000) was used to determine the land capability and the suitability classes for wheat, melon, maize, sugar beet, sunflower, and cotton under Mediterranean climate. Maps for spatial distribution of the capability and suitability classes and the area which occupied by each class were created and displaying using Arc GIS 10.1 software. The capability and suitability classes rating range were identified according to Storie (1978) and FAO (1976 and 1985). The crop requirement based on the data introduced by Sys et al. (1991). Creation Thiessen polygons under ArcGIS 10.1 software was used to display the land capability and the suitability maps.

RESULTS AND DISCUSSION

Supervised Classification

For each selected date, four land cover classes were determined in the study area: (water, urban or built-up land, bare land and agricultural land). Table (2) represents area for each land cover class across several dates.

The results show that in 1984 the bare land and agricultural land cover an area of 61% and 25%, respectively. Water and built-up land together covered around 14% only. By 1987, the built –up land increased by around 8% which gained from the bare land and agriculture land as the area coverage by these classes decreased to about 57% and 21%, respectively. In 2000, the area coverage by agriculture land clearly increased by around 12% to cover about 33% (15857 ha) of the study area. The bare land area coverage decreased to 42.5% while the built-up land was kept almost the same proportion compared to 1987 classification results.

As a result of urban progress in the study area, between 2000 to 2014, a substantial increase in the built-up land and considerable decrease in bare soil were observed. The urban land covered an area of 28% in 2014 compared to 17% in 2000, while the area of bare soil decreased from 42.5% to 30% in the same period. Additionally, agricultural land slightly increased from about 33% to 35% over this period. Between 2011 and 2014, no considerable change in the land cover was observed as shown in Table 2.

Table 2: The Area coverage by hectares and percentage of each land cover class at different dates based on supervised classified images in the studied area.

Year	Unit	Land cover classes				Total
		Water	Urban or built-up land	Bare land	Agricultural land	
1984	Hectares	1536.48	5065.65	29506.23	12088.26	48196.62
	%	3.18	10.51	61.22	25.08	100
1987	Hectares	1741.77	8801.82	27439.74	10213.29	48196.62
	%	3.61	18.26	56.93	21.19	100
2000	Hectares	3656.07	8302.32	20489.31	15748.92	48196.62
	%	7.58	17.22	42.51	32.67	100
2005	Hectares	3471.3	10442.07	18426.24	15857.01	48196.62
	%	7.20	21.66	38.23	32.90	100
2011	Hectares	3866.58	12848.49	13793.13	17688.42	48196.62
	%	8.02	26.65	28.61	36.70	100
2014	Hectares	3284.37	13554	14417.1	16941.15	48196.62
	%	6.81	28.12	29.91	35.15	100

Normalized difference vegetation index NDVI

According to the NDVI values, the land cover was divided into two main classes: non-vegetated and vegetated lands. The NDVI negative values or zero represents non-vegetated land, while the values greater than zero up to one represents vegetated land (agricultural land). Figure (2) shows the area for each land class across the different studied dates.

The results showed that in 1984, 1987, and 2000; the non-vegetated land covered around 85%, 84, and 82%, respectively. In contrast, higher decrease was observed in the non-vegetated land coverage in 2005, 2011, and 2014 as it covered 73%, 70%, and 64.26%, respectively. Comparing the NDVI results with the supervised classification results, the data indicated that the vegetated land in NDVI analyses (which represents the agricultural land in the supervised classified images) was under estimation by an average of 7% for all dates. These results are consistent with the literature as many researchers proved that NDVI values for bare fields are indistinguishable from vegetated fields whenever the vegetation density is low or the fields are temporarily fallow (eg. Maselli, 2004). However, Bakr et al., (2010) reported that even though the land is vegetated, the NDVI analysis may be classified the land as non-vegetated. The data exhibited also that NDVI values obtained from Landsat 8 (2014) was in full agreement with those obtained from supervised classification as illustrated in Table 2 and Figure 2.

Land Cover Change Detection

According to the results of supervised classification and NDVI, monitoring the changes in land cover between each two dates was achieved. Pairs of images from two different dates were used to produce land cover change images. Figure 3 shows the changes in the area between each two dates for each land cover class based on supervised classified images.

Taking the whole period (1984-2014) into consideration, results show that the studied area exposed to wide range of gain or loss in the area of different land cover classes as shown in Figure 4. The area of urban land, agriculture land and water bodies increased by about 17.6%, 10%, and 3.6%, respectively on the expense of decreasing the bare land where it loosed 31.3% as shown in Table 3. Actually, these changes reflect the changes in the farming, reclamation, demographic and urbanization activities.

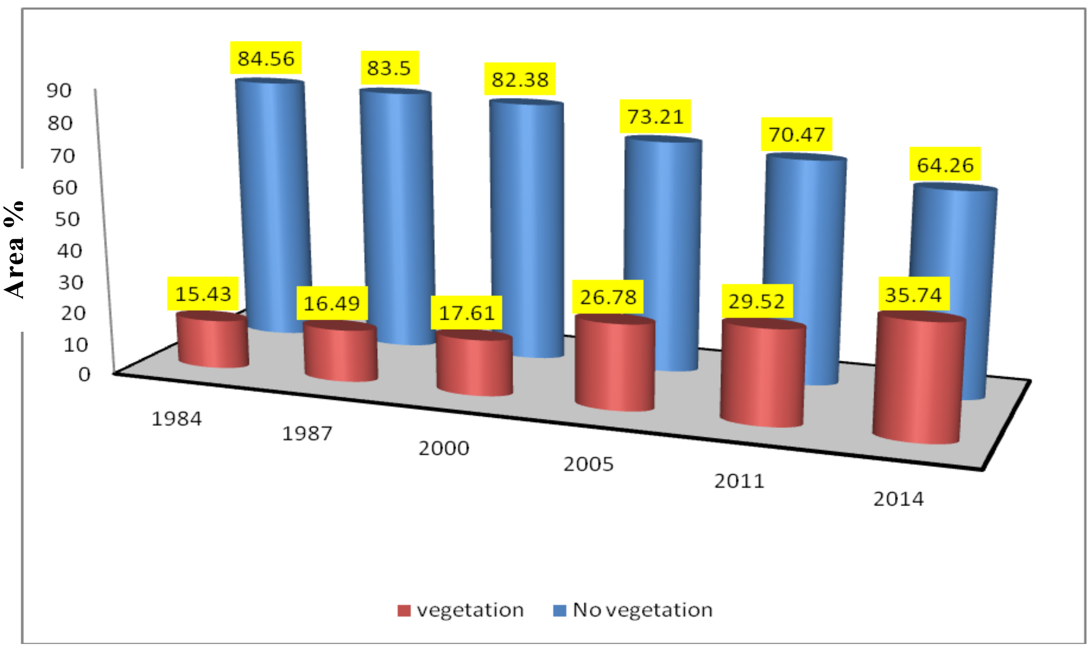


Figure 2: Area percentage of non-vegetated and vegetated land at different dates in the studied area

Table 3: Loss or gain in different land use / land cover (LULC) classes from 1984 to 2014

LULC class	Gain %	Loss %	Net change %
Agriculture	22.88	12.81	+ 10.07
Urban	22.54	4.92	+ 17.62
Bare land	3.97	35.28	- 31.31
Water	4.39	0.77	+ 3.62

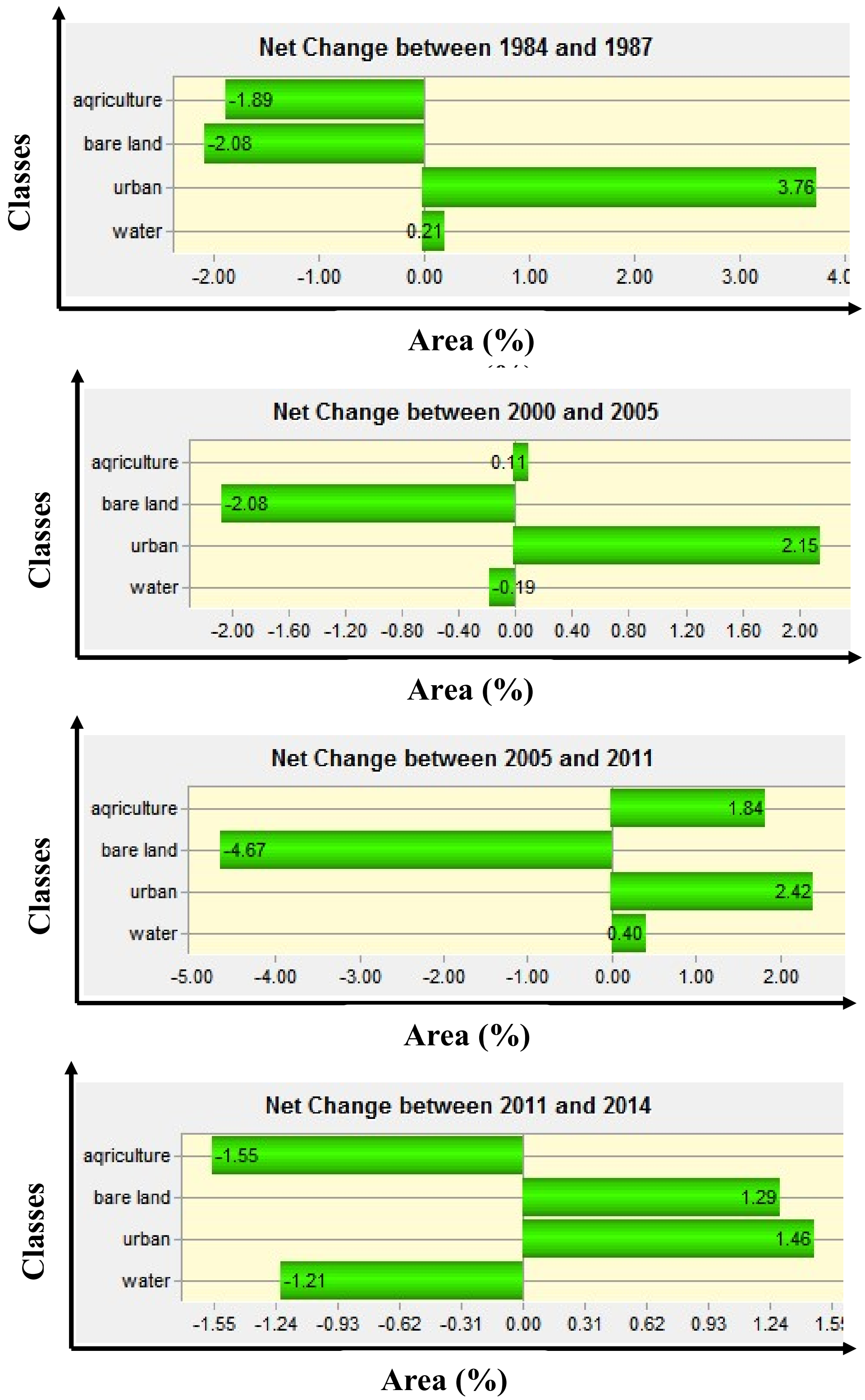


Figure 3: Net change detection (Gain or loss) in the different land cover classes between each two dates

Land Evaluation

Land capability

The application of Cervatana model in MicroLEIS system using weighted average to determine the land capability of the studied area revealed that most of the studied area (59.83%) belonged to C3 (moderate capability) as illustrated in Table (4) and Fig. (5), while Class2 (Good) comprised about 21.08%. However, the area of currently not capable (N) occupied 19.08%. Data exhibited also that erosion risk, soil properties, bioclimatic deficit, slop are the dominant limiting factors. From the practical point of view, these areas are under cultivation and the growth is relatively moderate and in agreement with the data that obtained from MicroLEIS.

Land suitability

Land suitability classes were obtained for 6 field crops (Wheat, Maize, Melon, sunflower, Cotton, and Sugar beet), using Almagra model in MicroLEIS software (De La Rosa, 2000) to determine suitability classes and the limitations. Data (Table 5) exhibited that major areas (61%) are unsuitable (NS) for the tested crops. The data revealed also that the marginally suitable areas represent 23.61% except for maize where it represents only 3.49%. The rest of the area is conditionally suitable (S4) and represents 35.42%, and 15.29% for maize and the other tested crops, respectively. Figures (6 and 7) illustrate the spatial distribution of suitability classes for wheat and maize, respectively. The distribution of suitability classes for other tested crops is almost similar to wheat. Regarding the limitation parameters, data indicate that EC, sodium saturation, texture and $CaCO_3$ content are the main limiting factors as shown in Fig 6 and 7.

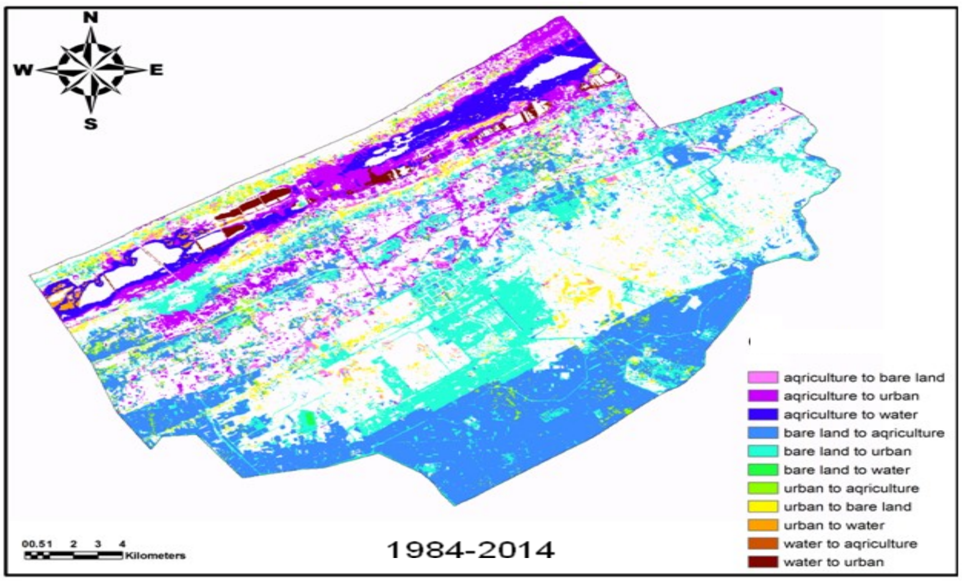


Figure 4: Change detection in land cover classes between 1984 -2014 based on supervised classification

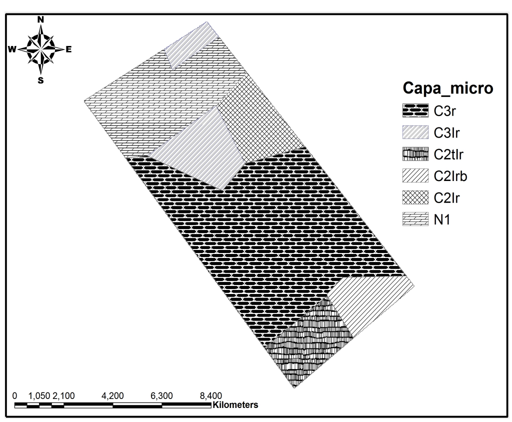
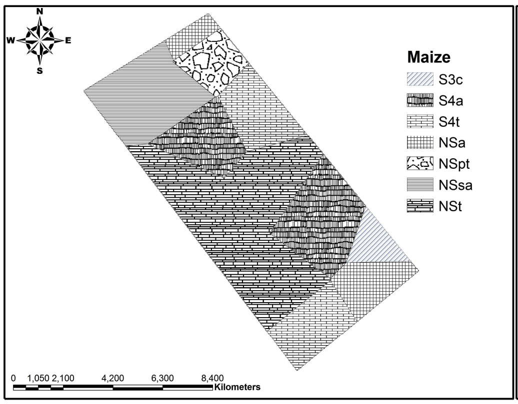


Fig. 5: Geospatial distribution of land capability classes
r: erosion risk, b: bioclimatic deficit, t: slop, I: soil properties

Table 4: Area percentage of capability classes and their limitations

Classes	Description and limitations	Area %
C3r	Fair Erosion risks	49.86
C3Ir	Fair Soil, Erosion risks	9.97
C2tIr	Good Slope, Soil, Erosion risks	7.50
C2Irb	Good Soil, Erosion risks, Bioclimatic deficit	5.79
C2Ir	Good Soil, Erosion risks	7.79
N1	Very poor (currently not capable)	19.08



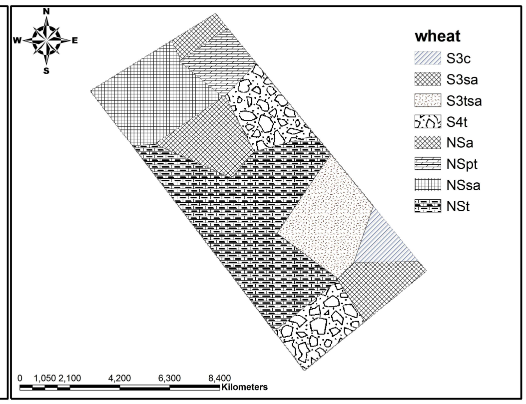


Fig. 6: Geospatial distribution of suitability classes for Maize

Fig. 7: Geospatial distribution of suitability classes for Wheat

c: $CaCO_3$ a: alkalinity t: texture s: salinity p: slope

Table 5: Areas percentage of suitability classes for the studied crops

crop	S3	S4	NS
Wheat	23.61	15.29	61.1
Melon	23.61	15.28	61.1
Maize	3.49	35.42	61.0
Cotton	23.61	15.29	61.1
Sunflower	23.61	15.29	61.1
Sugar beet	23.61	15.29	61.1

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الملخص العربى

رصد التغيرات فى الغطاء الأرضى وتقييم الأراضى لمنطقة برج العرب الساحل الشمالى الغربى – مصر

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رصد ودراسة مدى التغيرات مع الوقت فى الغطاء الأرضى والإستخدامات وكذلك تقييم الأراضى من حيث قدرتها الإنتاجية ومدى ملائمتها للمحاصيل المختلفة أحد الركائز الهامة فى التخطيط لتنمية منطقة برج العرب والتى تعتبر أحد المناطق الواعدة بالساحل الشمالى الغربى. وتهدف هذه الدراسة إلى رصد التغيرات فى الغطاء الأرضى والإستخدامات فى الفترة من عام ١٩٨٤حتى عام ٢٠١٤ وذلك من خلال صور الأقمار الصناعية باجراء التقسيم الموجه وحساب الدليل النباتى NDVI بالإضافة إلى تقييم القدرة الإنتاجية ومدى ملائمة الأراضى لزراعة بعض المحاصيل المختلفة بإستخدم برنامج MicroLEIS

أوضحت النتائج أن منطقة الدراسة تعرضت لتغيرات واضحة فى الغطاء الأرضى حيث إرتفعت نسبة الأراضى المنزرعة والمبانى والاراضى المغمورة بالمياه بنسب ١٠%، ١٧,٦%، ٦و٣% على التوالى خلال فترة الدراسة وذلك على حساب الأراضى البور(الجرداء).

ولقد أوضحت دراسة القدرة الإنتاجية أن حوالى ٦٠% من المساحة متوسطة الإنتاجية(C3) بينما الأراضى الجيدة الإنتاجية(C2) والتى ليس لها قدرة إنتاجية حاليا(N1) تمثل ٢١%، ١٩% على التوالى. وتبين من دراسة مدى ملائمة منطقة الدراسة لزراعة بعض المحاصيل أن ٦١% من المساحة غير ملائمة لمحاصيل القمح، الذره، عباد الشمس، القطن، بنجر السكر، البطيخ بينما المساحات المتوسطة الملائمة والمنخفضة جدا تمثل ٢٣,٦%، ١٥,٣% على التوالى للمحاصيل السابقة ماعدا الذره حيث أوضحت النتائج أن المساحات المتوسطة الملائمة منخفضة جدا (٣,٥ %)، كما أوضحت الدراسة أيضا أن العوامل المحددة للقدرة الإنتاجية والملائمة لزراعة المحاصيل السابقة هى مخاطر التعرية، ميل السطح، العوامل الجوية، وخصائص التربة والتى تسمل الملوحة ونسبة الصوديوم والقوام ونسبة كربونات الكالسيوم.