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Assessing and Mapping Changes in Agricultural Lands and Water Features in El-Hammam area, Northern Coast of Egypt

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ABSTRACT

Changes in land use are evident in the north-western parts of Egypt mainly due to agricultural, industrial, tourism and urbanization activities. Accordingly, the main aim of the current study was to estimate the changes in agricultural lands and water features in El-Hammam area from 1987 to 2017 using remotely sensed data and techniques. For that purpose, Landsat data were collected during four periods (1987, 2001, 2007 and 2017). These data were preprocessed and analyzed. Two vegetation and water indices were used to study the changes in agricultural lands and water features in the studied area during these four periods of time. The two vegetation indices include the NDVI and the SAVI, whereas the two water indices are the NDWI and the MNDWI. The obtained results indicated a significant increase in agricultural areas, which is mainly due the increase in land reclamation and cultivation projects. The areas of water bodies were also increased, which could be attributed to the increase in agricultural irrigation and drainage. This reveals the importance of the studied area in agricultural development and sustainability.

INTRODUCTION

The natural resources in Egypt are limited compared to the continuous increase of population growth. Therefore these resources including cultivated area and water require adequate management to face the human pressure. One of the main goals of the national plan of Egypt is the agricultural expansion outside the Nile old valley. The north-western coast of Egypt has a great attention due to its characteristics and diversity. So, it is of vital importance to study the management of natural resources in such regions. In this study El-Hammam area was chosen as a case study, which lies between longitudes 29° 15‘ and 29° 30‘E and latitudes 30° 45‘ and 31° N, with a total area of 234137.4 fed. In general, one of primary objectives and an urgent problem to be addressed by our society is sustainable development. These studies depend on the availability of more accurate and up-to-date data about these resources. Both remotely sensed data and GIS techniques can help in providing these data.

Elachi and Zyl, (2006) defined remote sensing (RS) as the obtaining of information about objects or areas without being in physical contact with it”. Agriculture has intrinsic characteristics make RS an ideal technique for its management and monitoring (Zhongxin *et al.,* 2004). Also GIS (Geographic Information System) is consisted of collection of computer software, hardware, spatial and non-spatial data which organized to help users for the efficient storage, capture, manipulation, update, management and analysis of all geographically referenced information. RS in combination with GIS proved to be efficient techniques in planning and sustainability studies (Rajitha *et al.,* 2006; Quan *et al.,* 2007). Recently, RS data and GIS techniques provide up-to-date and reliable information which can help for monitoring recent changes in land cover dynamics and land degradation (Goossens *et al*., 1993; Casas, 1995). In recent times, more and more data integration, complex analysis and multi-disciplinary are required for land use planning (LUP) approach. Also, faster or more precise information are needed for the participants in the LUP approaches. Undoubtedly, Geographic Information System become the main tool to support LUP approaches where it is strong capacity in data integration and visualization and analysis. The application of GIS in LUP is well documented by many such as Fedra, 1995; Alshuwaikhat and Nassef, 1996; Brazier and Greenwood, 1998; Cromley and Hanink, 1999; Bojorquez Tapia *et al.*, 2001; Ball, 2002; Hoobler *et al*., 2003; Malczewski, 2004; Trung *et al.*, 2006.

Undoubtedly, RS and GIS technologies enabled natural resources managers and ecologists to observe periodical changes and obtain timely data. Although airborne and space borne generated data are becoming basic tools for the activities of conservationists, ecologists, natural resources managers and others, whereas its full reliability and potential are still unused in many programmes of ecosystem conservation (Muzein, 2006).

Spectral indices have been widely used for direct and indirect detection of land cover. Vegetation indices such as the normalized difference vegetation index (NDVI) and the soil adjusted vegetation index (SAVI) have been used as indirect indicators for soil salinity (Huete, 1988). Water logging indices as the normalized difference water index (NDWI) and the modified NDWI; have also been used as indirect indicators for poor drainage (Mcfeeters, 1996; Elnaggar *et al*., 2017).

This study mainly aims to estimate the changes in agricultural lands and water features in El-Hammam area from 1987 to 2017 using remotely sensed data and techniques.

MATERIALS AND METHODS

Description of the study area:

The study area in this research is located in the north-western coast of Egypt as illustrated in Fig. 1. It lies between longitudes 29° 15‘ and 29° 30‘E and latitudes 30° 45‘ and 31° N, with a total area of 234137.4 fed. It falls within the Egyptian coast of Mediterranean which experiences very short rainy winters and long dry summers. The mean of annual rainfall is 14.91 mm/month and it frequently varies from month to month. It varies from 54.60 mm in January to 0.1 mm in June and the long dry season begins in April and continues to September. The mean monthly temperature ranges from 13.70°C in January to 26.55°C in August (according to data obtained from El-Dekhila metrological station).

The Egyptian north-western coast extends from westward of Alexandria to Al-Salloum, its width from the shoreline is about 10-30 km. The topography of the area is characterized by a succession of ridges and deposits from the shore to the plateau (Shata, 1955). These ridges are oolitic limestone in composition. They were produced by consolidation of ancient littoral dunes which formed along the shoreline (Mahmoud *et al*., 2009). Three ridges are located in the study area. In general, the north-western coast of Egypt is distinguished by: a southern table land and a northern coastal plain (Yasser and Guenet, 1990). Soils of class "I" usually occupy the areas between depressions because they are formed from materials which washed from the neighboring hills and ridges (Balba, 1965). Further, the main potential agricultural land is constituted from these areas. The most significant factors affecting soil formation in the western and eastern regions of the Egyptian Mediterranean coast are parent material, climate and topography. The dominant factor is soil transportation by wind and water. Limestone is the dominant parent material. Metamorphic rocks and sandstone may also be encountered in the subsurface. A major part of the soil in some areas is constituted from wind-blown sand. Usually, water deposits fill the depressions forming the deep soils and overlaying a thick limestone layer. Gypsum occurs at different depths in the profiles and it is occasionally found in thick deposits where it is mined from. Water-borne materials fill the depressions between ridges constituting the main potential agricultural soils. Topography of the area plays an important role also. The lowlands are highly saline in usual. Hillock "Karms" surround some of areas which usually receive more deposits and water than other areas. The effect of vegetation on soil formation is not pronounced because of the aridity of the area. The low precipitation and hot summer accelerate the plant residues decomposition.

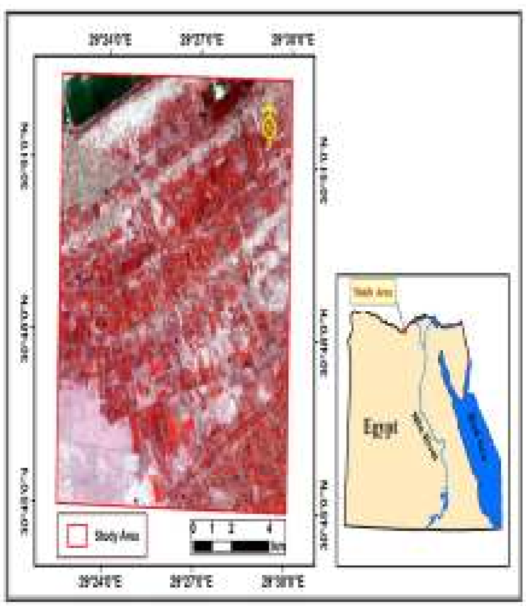

Fig. 1. Location map of the studied area.

The study area is in a semi-arid zone, where the precipitation in winter varies by place and time and water resources are mainly derived from atmospheric precipitation. In the study area the average of annual rainfall is 178.9 mm. The amount of rains falling on any given area in the region of north-western coast of Egypt is insufficient for agriculture (Mohamed, 2002). Wells (deep, shallow, boreholes and hand-dug wells) and shallow open trenches are essentially used to discharge groundwater. Furthermore the study area was provided with tow canals, El-Hammam and Bahieg Canals. For planning the most sustainable land use, there are three land use types groups; summer crops, winter crops, and orchards such as Barley, Wheat, Maize, Sorghum, Clover, Groundnut, Guava, Figs, Olive and Citrus (Mahmoud *et al*., 2009).

Satellite data and their pre-processing

In this work, landsat imagery was used to evaluate agriculture lands and water features in the study area. The studied area covers a smaller portion of one land sat image (path 178 and row 39). Four images were acquired at four different dates (1987, 2001, 2007 and 2017). The acquisition dates of these images and the type of sensor are represented in Table 1. These images were downloaded from the earth explorer website (http://earthexplorer. usgs.gov/) for free. This website is developed by the USGS (United States Geological Survey).

Table 1. Acquisition dates and types of sensor of the studied land sat images.

No	Sensor type	path	Row	Date
1	Land sat 5 (TM)	178	39	10-08-1987
2	Land sat 5 (TM)	178	39	01-09-2001
3	Land sat 5 (TM)	178	39	30-06-2007
4	Land sat 8 (OLI)	178	39	11-07-2017

These images were pre-processed through carrying out the atmospheric and radiometric corrections to remove the effects of smoke, haze and dust from these images. Also, ERDAS imagine software (version 2014) was used to convert the digital numbers (DNs) to atmosphere reflectance. To align all the studied images geometric correction was also carried out. It was performed under ERDAS imagine using the polynomial projection tool, where twelve grounded control points in this process were used and the error of RMS was less than 1. The UTM projection was used to projecte the images, zone 35 N, and datum WGS 1984. They were also subset to cover the study area only. Fig. 2 illustrates a false colour composite of these images.

Vegetation Indices:

Two vegetation indices were used to study the changes in vegetation cover (agricultural lands) and the spatial distribution within the studied area. These indices are the Normalized Difference Vegetation Index (NDVI) which developed by (Rouse *et al*., 1973) and the Soil Adjusted Vegetation Index developed by (Huete, 1988). The Soil Adjusted Vegetation Index (SAVI) is a modification of the Normalized Difference Vegetation Index (NDVI), where it is used to correct the effect of soil brightness in low vegetative cover areas using a correction factor (L). The Normalized Difference Vegetation Index (NDVI) is calculated according to the following equation:

$$\mathbf{NDVI} = \frac{(NIR-Red)}{(NIR+Red)} \qquad \mathbf{(1)}$$

Where, NIR and Red are the reflectance in the near infrared and red portions of spectrum, respectively.

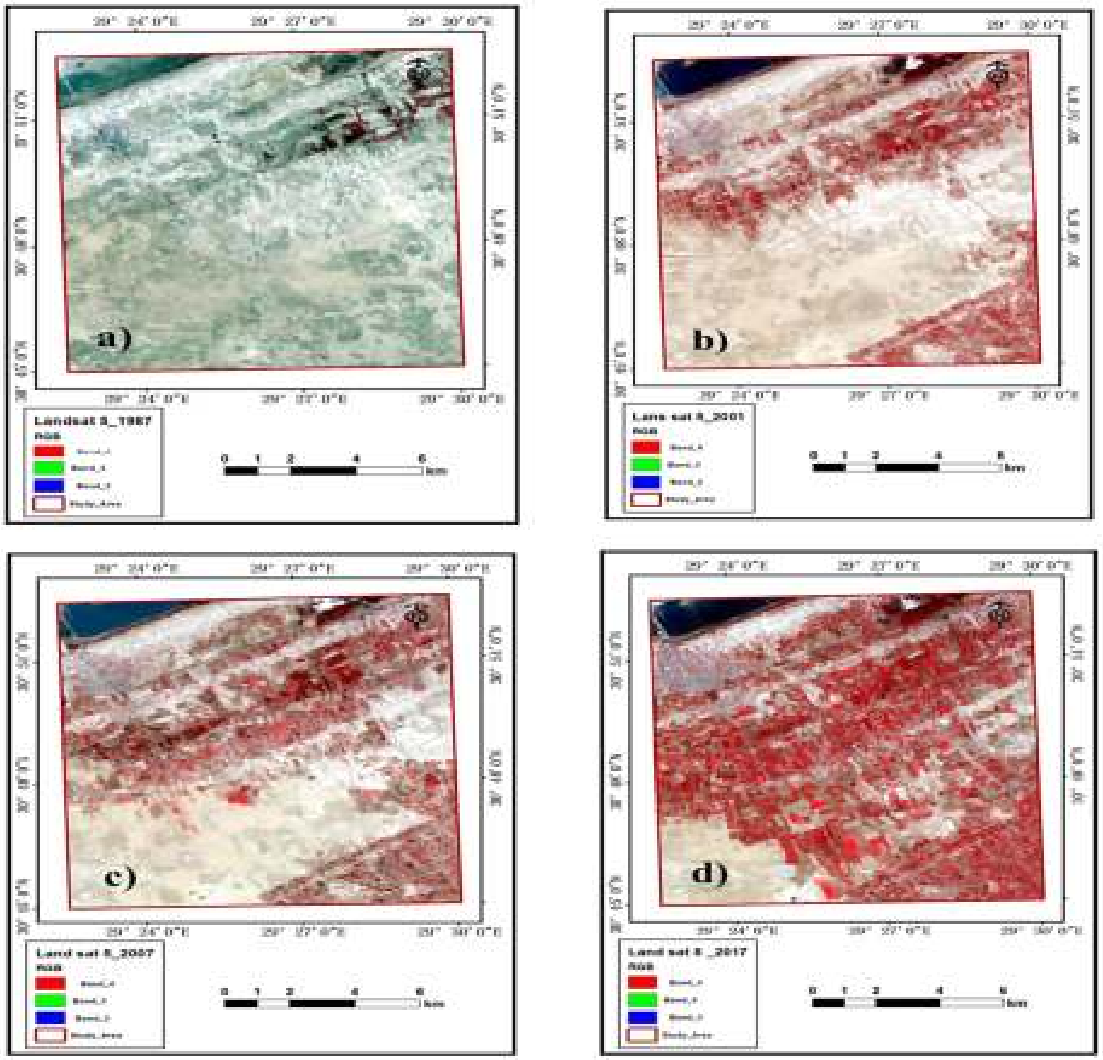

Fig. 2. False colour composite of the studied land sat images in: a) 1987, b) 2001, c) 2007 and d) 2017.

The SAVI is calculated according to the following equation:

$$\mathbf{SAVI} = \frac{(NIR - Red)(1 + L)}{(NIR + Red + L)} \qquad (2)$$

Where,(L) in the equation is the correction factor. It ranges between zero and one based on the vegetation cover density. At very high plant densities, L takes a value of zero, where in this case the SAVI will be equal to the NDVI. On the other hand, at very low plant densities L will take a value of one. Also, a value of 0.5 was used in this study. Xu (2008) stated that the SAVI works better than the NDVI in areas with plant cover less than 15%, whereas in areas with plant cover greater than 30% the NDVI works well.

4 Water Indices

Two water indices were also used to study the spatial distribution of water features and their changes over time in the area of the study. These two indices are the McFeeters's normalized difference water index (NDWI) and the modified NDWI (MNDWI). The McFeeters's NDWI is calculated according to the following equation of McFeeters, (1996):

$$\mathbf{NDWI} = \frac{(\rho\ \text{Green} - \rho\ \text{NIR})}{(\rho\ \text{Green} + \rho\ \text{NIR})} \qquad (3)$$

Where; ρ Green is the reflectance of the green and ρ NIR is the near infrared bands.

The MNDWI is computed according to the following equation of Xu, (2006):

$$\mathbf{MNDWI} = \frac{(\rho\ \text{Green} - \rho\ \text{MIR})}{(\rho\ \text{Green} + \rho\ \text{MIR})} \qquad (4)$$

Where; ρ MIR refer to the reflectance of the middle infrared band.

5 Area calculation of agricultural lands and water features

In this study, to separate agricultural from non-agricultural areas a threshold value for the studied vegetation index was used. It was used also to convert each of NDVI and SAVI images into a binary-image which contains two-classes only: agricultural and non-agricultural areas. Also, differentiate water features from dry lands was done by using a similar method. The allocated areas for each class were calculated according to the number of pixels in that class.

6 Changes in land covers:

Changes in land covers within the research area were carried out through subtracting the binary images obtained from each of the studied indices for two successive years. A new image with three values was obtained as a result of this process. The positive value (+1) indicates positive toward the studied land cover (agricultural lands or water features), Zero refers to no change in land cover, and the negative value reveals negative change in the studied land cover toward other activities.

RESULTS AND DISCUSSION

1- Agricultural land in El-Hammam area

Table 2 represents the estimated areas of agricultural lands from 1987 to 2017 based on the NDVI index. These areas were about 1.64, 30.59, 38.61 and 90.79 km^2 in 1987, 2001, 2007 and 2017; respectively. Their percentages were about 0.98, 18.32, 23.12 and 54.37%; respectively. The highest increase was observed from 2007 to 2017, which may be because the increase in the activities of land reclamation in this area. Fig. 3 illustrates the spatial distribution of these areas.

On the contrary, the areas of non-agricultural lands were estimated, they were about 165.35, 136.40, 128.38 and 76.20 km^2 in 1987, 2001, 2007 and 2017; respectively. Their percentages were about 99.02, 81.68, 76.88 and 45.63%; respectively.

Table 2. Estimated agricultural lands in El-Hammam area from 1987 to 2017 based on the NDVI index:

Agric. Cover	1987		2001		2007		2017	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
Non-agric.	165.35	99.02	136.40	81.68	128.38	76.88	76.20	45.63
Agric.	1.64	0.98	30.59	18.32	38.61	23.12	90.79	54.37
Total	166.99	100	166.99	100	166.99	100	166.99	100

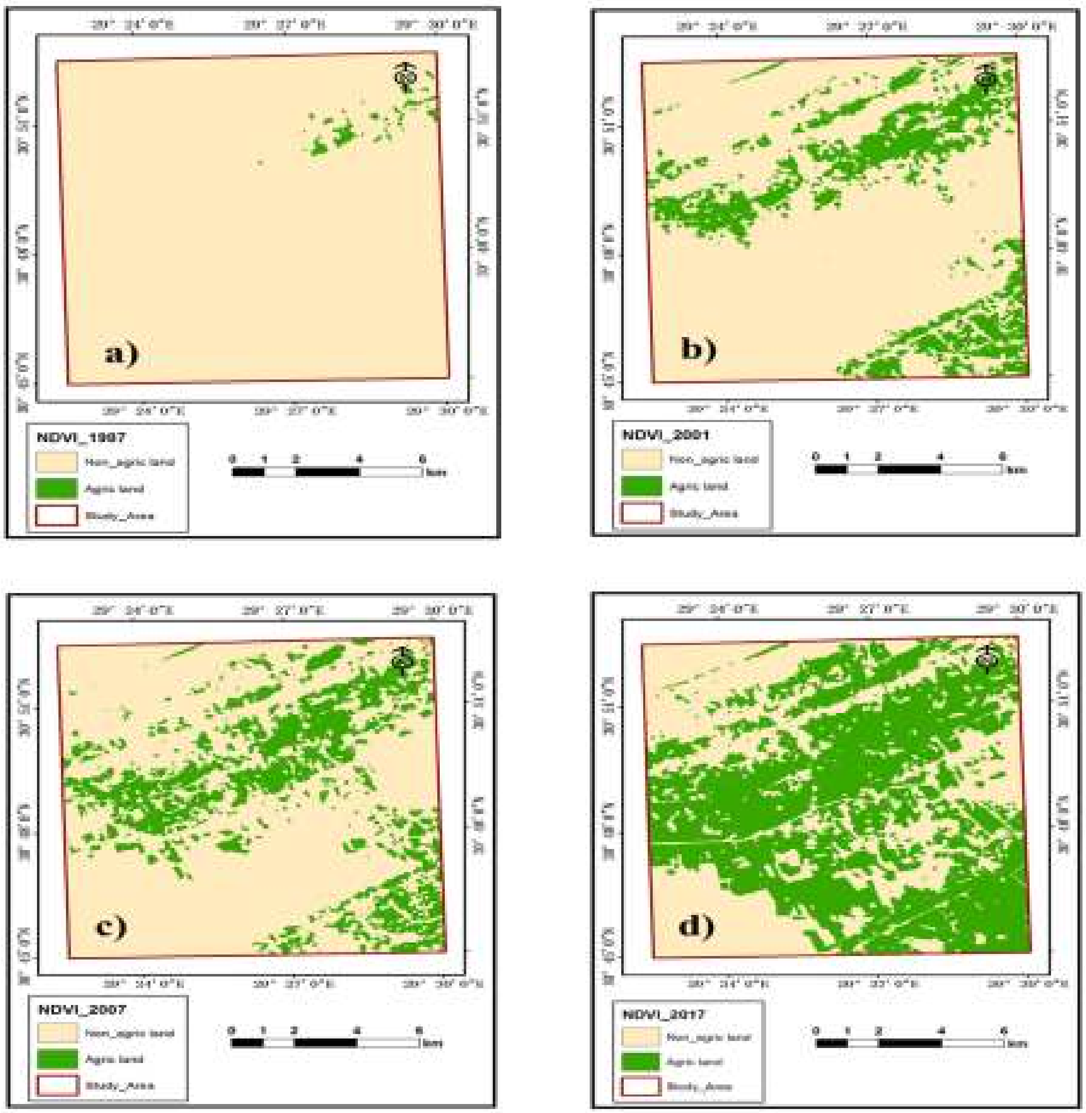

Fig. 3. Spatial distribution of agricultural lands in El-Hammam area based on the NDVI index in: a) 1987, b) 2001, c) 2007 and d) 2017.

Agricultural areas were also estimated during the same years based on the SAVI index as showed in Table 3. These areas were found to be about 2.18, 20.45, 37.111 and 104.96 km^2 in 1987, 2001, 2007 and 2017; respectively. Their percentages were about 1.30, 12.25, 22.22 and 62.85%, respectively. Fig. 4 represents the spatial distribution of these areas. On the contrary, the areas of non-agricultural lands were estimated, they were about 164.82, 146.54, 129.88 and 62.03 km^2 in 1987, 2001, 2007 and 2017; respectively. Their percentages were about 98.70, 87.75, 77.78 and 37.15%; respectively. The obtained results reveal a considerable increase in agricultural areas from 1987 to 2017, the highest observed increase was between 2007 and 2017 which reached 62.85%.

Table 3. Estimated agricultural area in El-Hammam area from 1987 to 2017 based on SAVI index:

Agric.	1987		2001		2007		2017	
Cover	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
Non-agric.	164.82	98.70	146.54	87.75	129.88	77.78	62.03	37.15
Agric.	2.18	1.30	20.45	12.25	37.11	22.22	104.96	62.85
Total	166.99	100.00	166.99	100	166.99	100	166.99	100

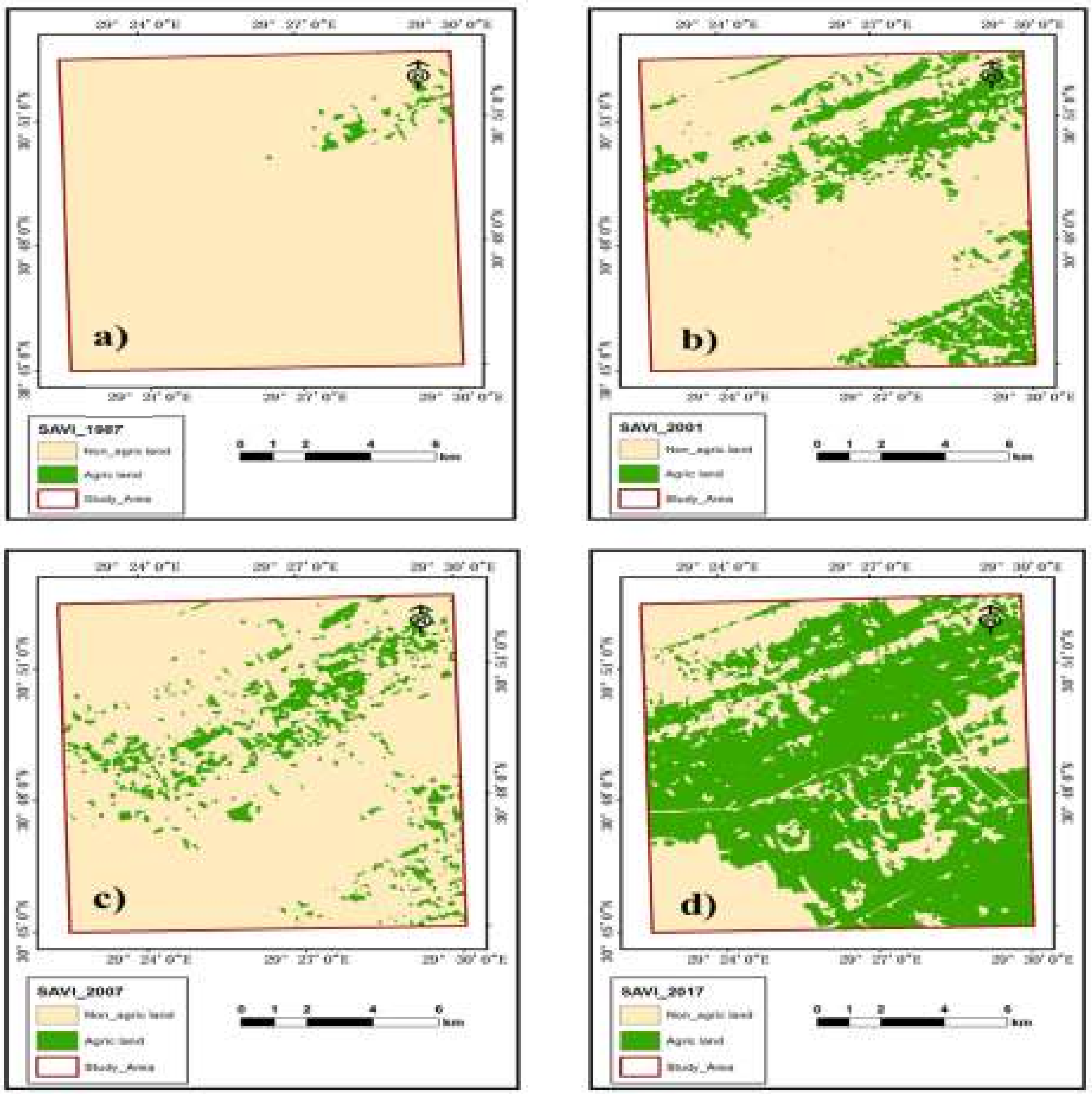

Fig. 4. Spatial distribution of agricultural areas in El-Hammam area based on the SAVI index in: a) 1987, b) 2001, c) 2007 and d) 2017.

2- Water features in El-Hammam area:

Table 4 shows the water features estimated in El-Hammam area based on the NDWI from 1987 to 2017. Water bodies were found to be about zero, 4.23, 4.50 and 4.17 km^2 in 1987, 2001, 2007 and 2017; respectively. As a percentage, they represented about zero, 2.53, 2.69 and 2.49% of the study area; respectively. The spatial variability within water bodies in the study area is represented in Fig. 5. A little increase in water features is indicated by the obtained results within the studied area, especially in the north-western parts. This increase may be attributed to the increase in cultivation projects and land reclamation and consequently the increase in agricultural drainage. In contrast, the estimated dry areas were found to be about 166.99, 162.76, 162.49and 162.82 km^2 in 1987, 2001, 2007 and 2017, respectively. As a percentage, they represent about 100.00, 97.47, 97.31 and 97.51%; respectively.

Table 4. Estimated water features in El-Hammam area from 1987 to 2017 depending on the NDWI index.

Water Features	1987		2001		2007		2017	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
Dry land	166.99	100.00	162.76	97.47	162.49	97.31	162.82	97.51
Water bodies	0.00	0.00	4.23	2.53	4.50	2.69	4.17	2.49
Total	166.99	100	166.99	100	166.99	100	166.99	100

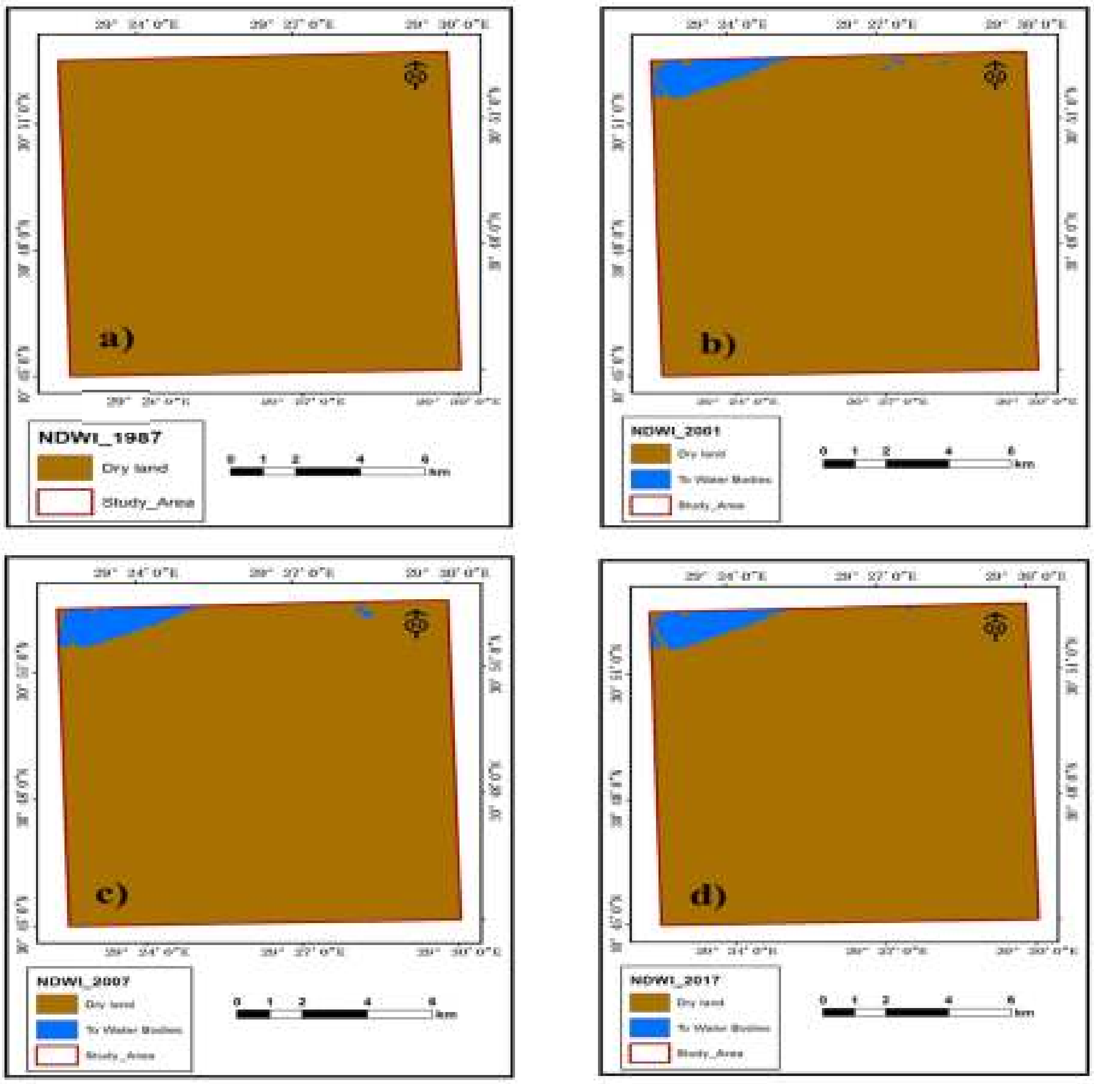

Fig. 5. Spatial distribution of water features in El-Hammam area based on the NDWI index in: a) 1987, b) 2001, c) 2007 and d) 2017.

Water features in the studied area were also estimated based on the MNDWI from 1987 to 2017. Data in Table 5 represent that water bodies in the studied area were about 0.09, 4.47, 4.39 and 4.41 km^2 in 1987, 2001, 2007 and 2017; respectively. As a percentage, they represented about 0.06, 2.68, 2.63 and 2.64% of the study area, respectively. Fig. 6 represents the spatial distribution of water bodies within the studied areas. In contrast, the estimated dry areas were found to be about 166.90, 162.52, 162.60 and 162.58 km^2 in 1987, 2001, 2007and 2017, respectively. As a percentage, they represent about 99.94, 97.33, 97.37 and 97.36% of the study area; respectively. These results indicate the same trend obtained from the NDWI.

Table 5. Estimated water features in El-Hammam area from 1987 to 2017 depending on the MNDWI index.

Water Features	1987		2001		2007		2017	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
Dry land	166.90	99.94	162.52	97.33	162.60	97.37	162.58	97.36
Water bodies	0.09	0.06	4.47	2.68	4.39	2.63	4.41	2.64
Total	166.99	100.00	166.99	100	166.99	100	166.99	100

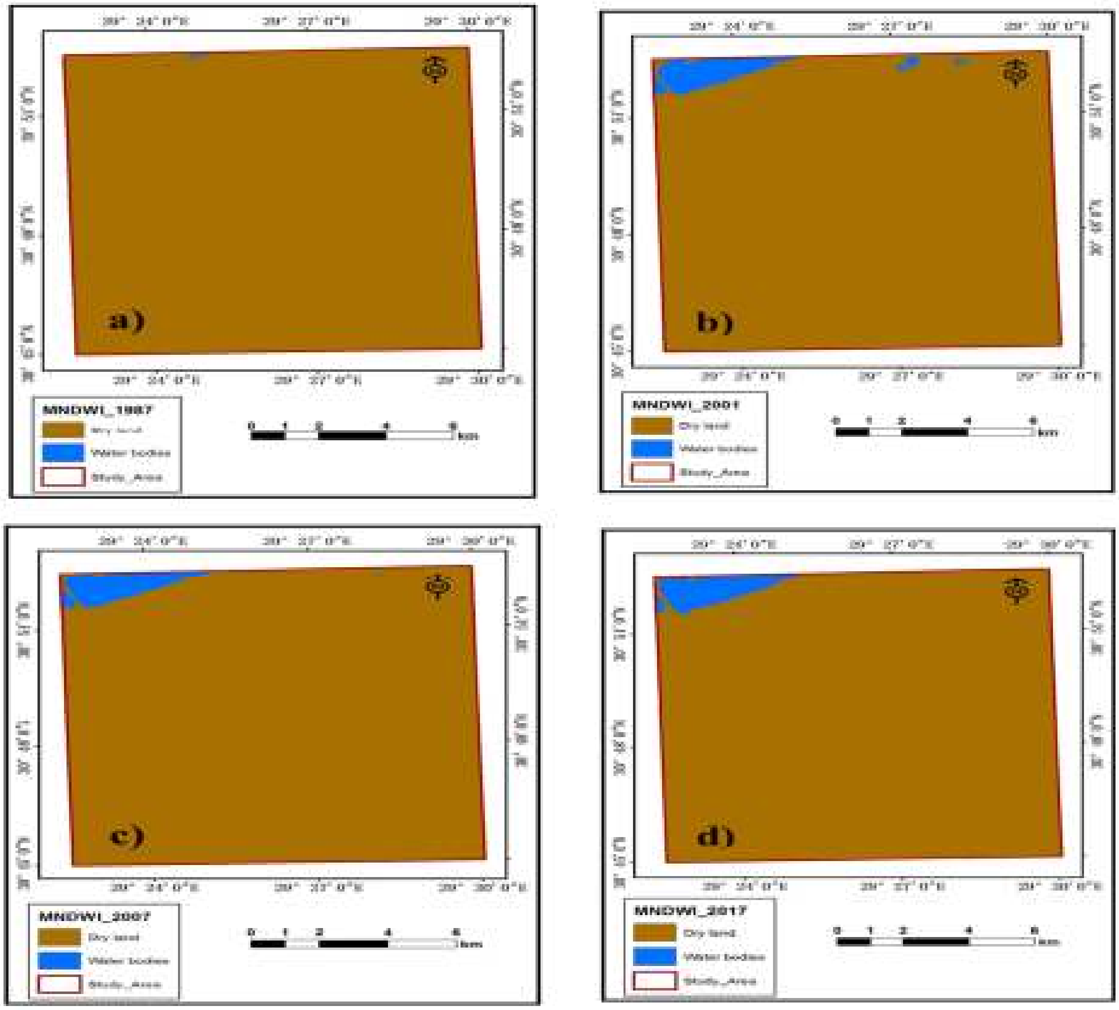

Fig. 6. Spatial distribution of water features in El-Hammam area based on the MNDWI index in: a) 1987, b) 2001, c) 2007 and d) 2017.

3 Changes in vegetation cover:

Determination of changes in agricultural areas versus non-agricultural in El-Hammam area from 1987 to 2017 were done based on the NDVI data. Table 6 and Fig. 7 show changes within each six successive years. The change from agricultural to non-agricultural areas was about 0.31 km^2 between 1987 and 2001, whereas the change to agricultural areas was about 29.25 km^2 during the same period. Also, the change from agricultural to non-agricultural areas was about 0.33 km^2 between 1987 and 2007, whereas the change to agricultural areas was about 37.29 km^2 during the same period. About 0.11 km^2 were the total changes from agricultural to non-agricultural areas between 1987 and 2017, whereas about 89.25 km^2 were the total changes to agricultural areas at the same period. The obtained results reveal obviously increase in agriculture areas in El hammam area between 1987 and 2017. It may be due to the development in projects of land reclamation.

Table 6. Changes in agricultural versus non-agricultural lands in El-Hammam area from 1987 to 2017.

NDVI Years	To Non-agric.		No-change		To agric. land	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
1987-2001	0.31	0.18	137.43	82.30	29.25	17.52
1987-2007	0.33	0.20	129.37	77.47	37.29	22.33
1987-2017	0.11	0.06	77.63	46.49	89.25	53.45
2001-2007	9.93	5.94	139.12	83.31	17.95	10.75
2001-2017	2.20	1.32	102.40	61.32	62.40	37.37
2007-2017	3.01	1.80	108.79	65.15	55.19	33.05

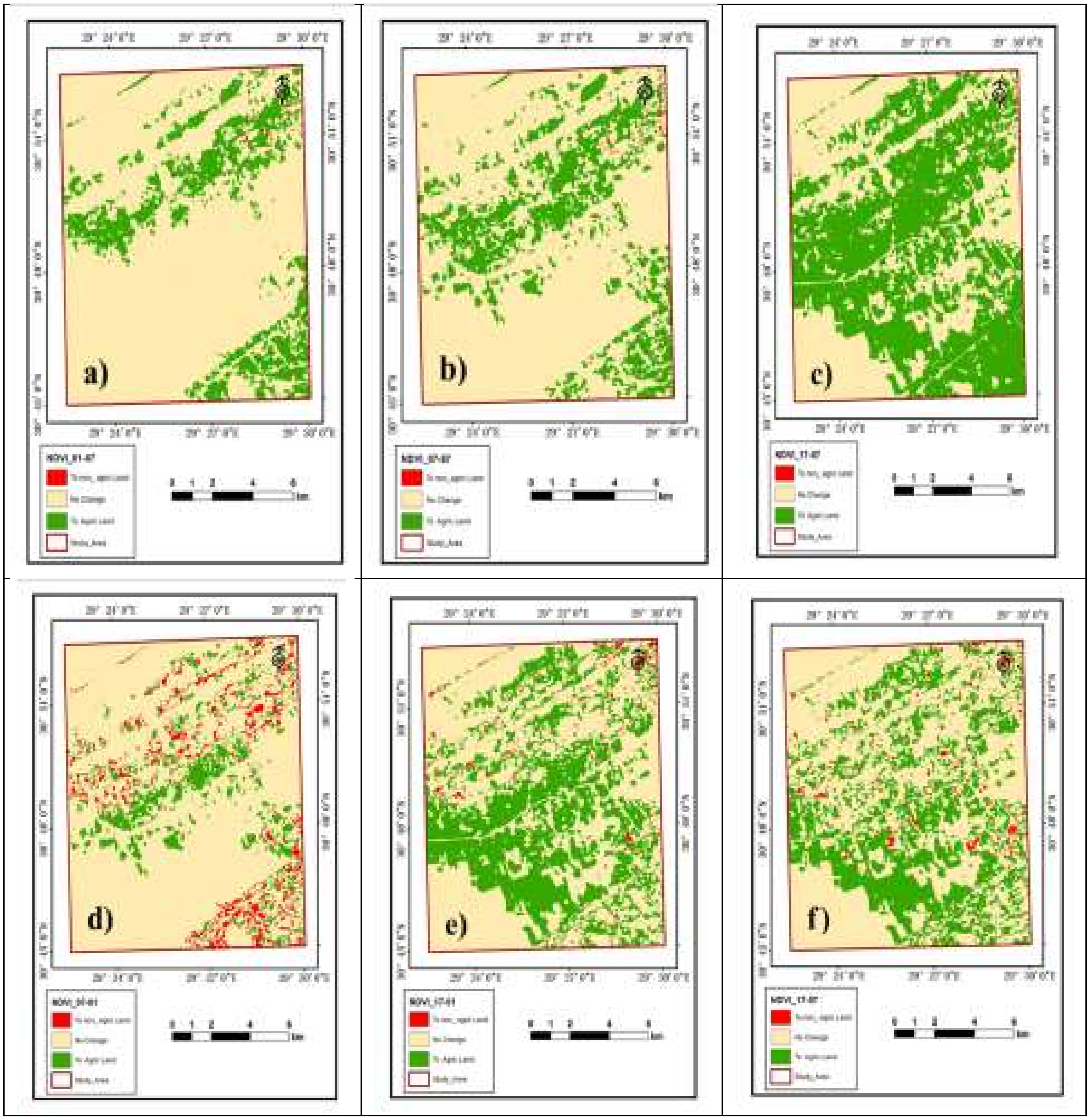

Fig. 7. Changes in agricultural and non-agricultural areas in El-Hammam area based on the NDVI index from: : a) 1987 to 2001, b) 1987 to 2007, c) 1987 to 2017, d) 2001 to 2007, e) 2001 to 2017 and f) 2007 to 2017.

Determination of changes in agricultural areas versus non-agricultural in El-Hammam area from 1987 to 2017 were done based on the SAVI data. Table 7 and Fig. 8 show changes within each six successive years. The change from agricultural to non-agricultural areas was about 0.32 km^2 between 1987 and 2001, whereas the change to agricultural areas was about 35.52 km^2 during the same period. Also, the change from agricultural to non-agricultural areas was about 0.86 km^2 between 1987 and 2007, whereas the change to agricultural areas was about 17.91 km^2 during the same period. About 0.1 km^2 were the total changes from agricultural to non-agricultural areas between 1987 and 2017, whereas about 103.77 km^2 were the total changes to agricultural areas at the same period. The obtained results reveal obviously increase in agriculture areas in El hammam area between 1987 and 2017. It may be due to the development in projects of land reclamation.

Table 7. Changes in agricultural versus non-agricultural areas in El-Hammam area from 1987 to 2017.

SAVI Years	To Non-agric.		No-change		To agric. land	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
1987-2001	0.32	0.19	131.15	78.54	35.52	21.27
1987-2007	0.8559	0.51	148.23	88.76	17.91	10.72
1987-2017	0.1008	0.06	63.12	37.80	103.77	62.14
2001-2007	24.97	14.95	135.20	80.96	6.82	4.09
2001-2017	1.43	0.86	95.65	57.28	69.91	41.86
2007-2017	0.57	0.34	79.24	47.45	87.19	52.21

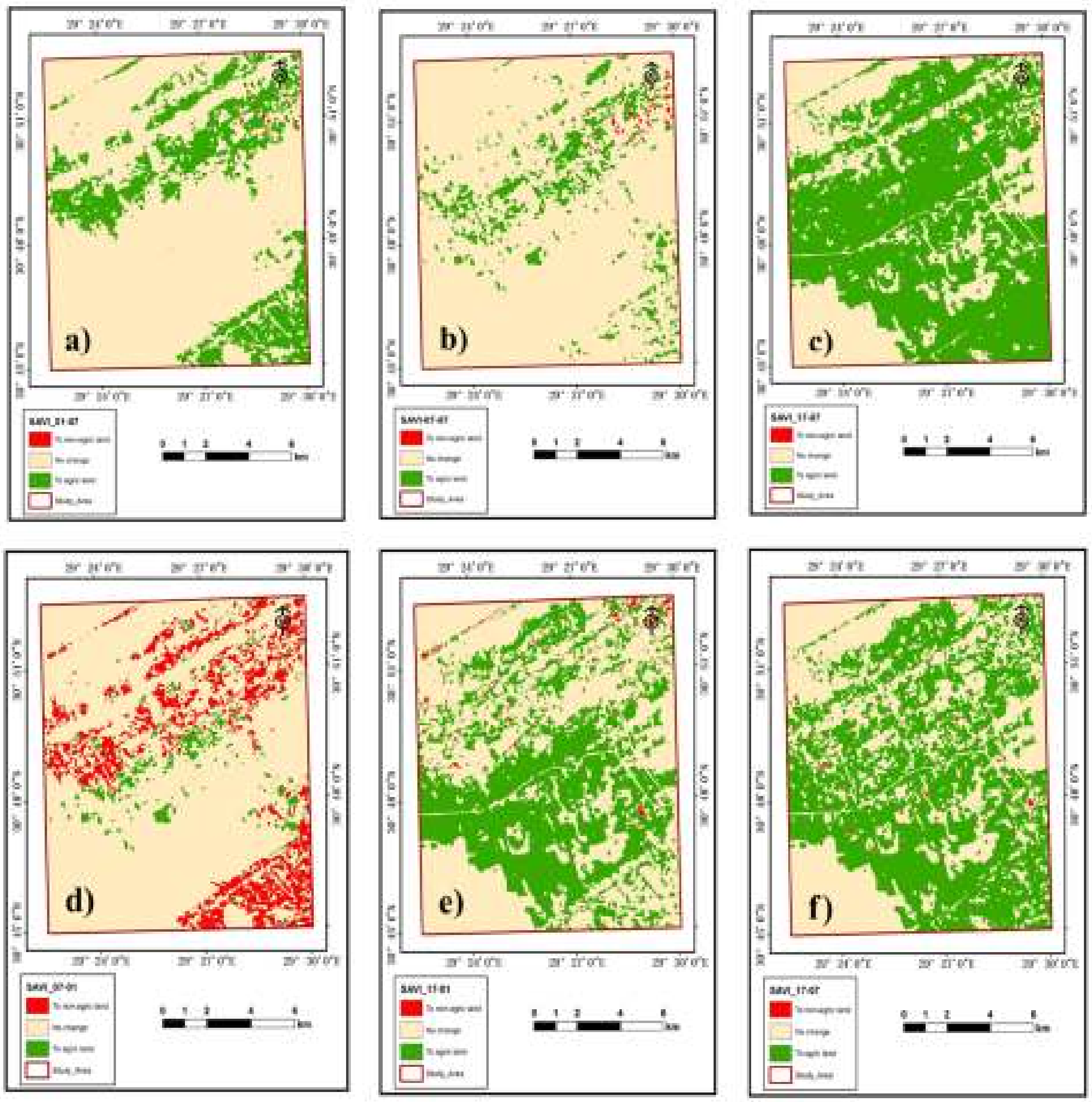

Fig. 8. Changes in agricultural and non-agricultural areas in El-Hammam area based on the SAVI index from: a) 1987 to 2001, b) 1987 to 2007, c) 1987 to 2017, d) 2001 to 2007, e) 2001 to 2017 and f) 2007 to 2017.

4 Change in water features

Determination of changes in water bodies versus dry land areas in El-Hammam area from 1987 to 2017 were done based on the NDWI data. Table 8 and Fig. 9 show changes within each six successive years.

About zero km^2 were changed from water-logged to dry land areas between 1987 and 2001, whereas about 4.23 km^2 were changed to water-logged areas during the same period. Also, about 0.19 km^2 were changed from water-logged to dry land areas between 2001 and 2017, whereas about 0.13 km^2 were changed to water-logged areas during the same period. About zero km^2 were the total changes from water-logged to dry land areas during the studied period between 1987 and 2017, whereas about 4.17 km^2 were the total changes to water-logged areas during the same period. The obtained results reveal a considerable increased in water-logged areas in the study area between 1987 and 2017. This also could be attributed to the increase in crop irrigation and poor drainage within the area.

Table 8. Changes in water bodies versus dry land areas in El-Hammam area from 1987 to 2017.

NDWI Years	To dry land		No-change		To water bodies	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
1987-2001	-	-	162.76	97.47	4.23	2.53
1987-2007	-	-	162.49	97.31	4.50	2.69
1987-2017	-	-	162.82	97.51	4.17	2.49
2001-2007	0.13	0.08	166.47	99.69	0.39	0.24
2001-2017	0.19	0.11	166.67	99.81	0.13	0.08
2007-2017	0.37	0.22	166.59	99.76	0.04	0.02

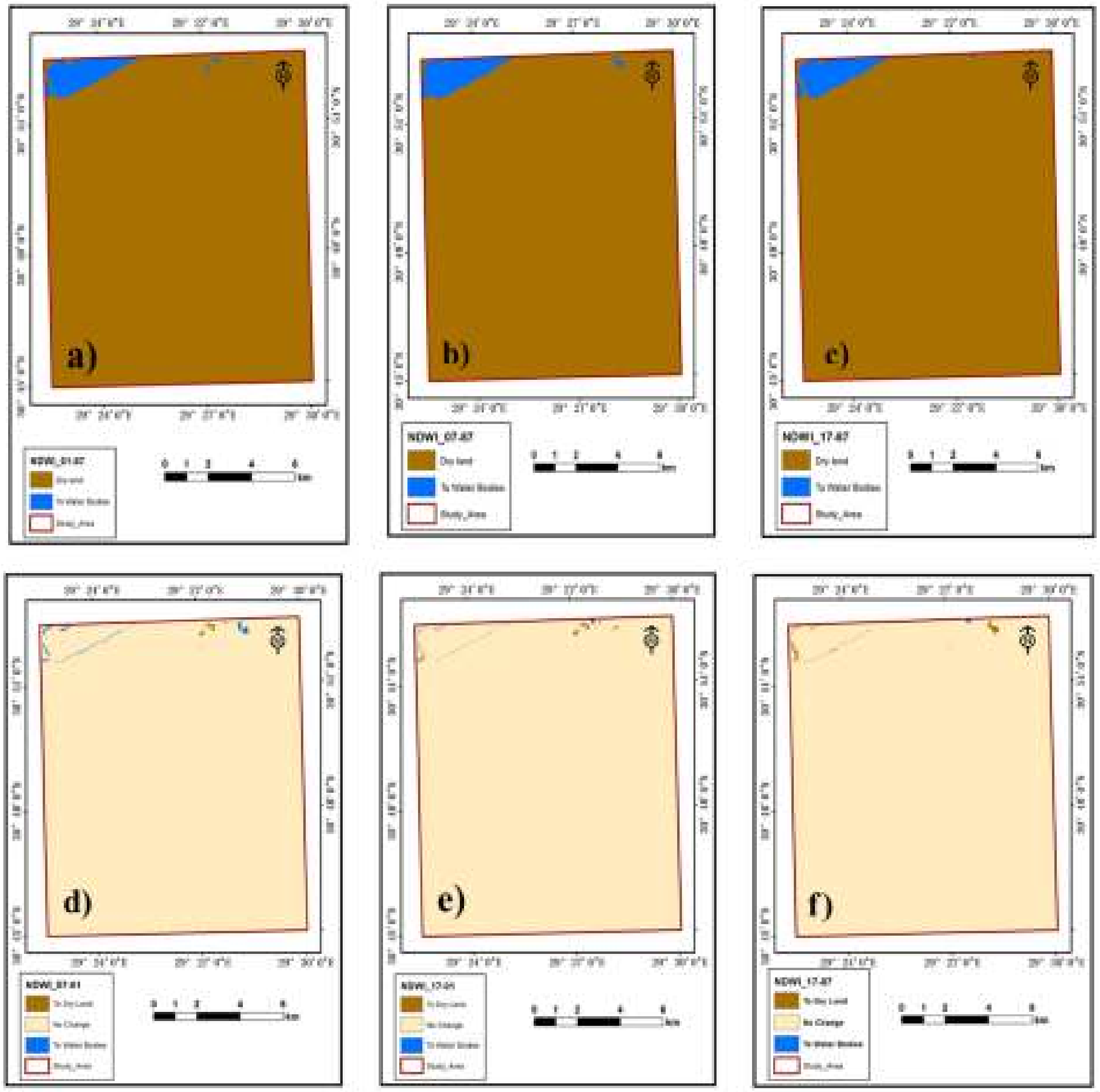

Fig. 9. Changes in water bodies and dry lands in El-Hammam area from 1987 to 2017 based on the NDWI index from: a) 1987 to 2001, b) 1987 to 2007, c) 1987 to 2017, d) 2001 to 2007, e) 2001 to 2017 and f) 2007 to 2017.

Determination of changes in water bodies versus dry land areas in El-Hammam area from 1987 to 2017 were done based on the NDWI data. Table 9 and Fig. 10 show changes within each six successive years.

About 0.01 km^2 were changed from water-logged to dry land areas between 1987 and 2001, whereas about 4.38 km^2 were changed to water-logged areas during the same period. Also, about 0.38 km^2 were changed from water-logged to dry land areas between 2001 and 2017, whereas about 0.32 km^2 were changed to water-logged areas during the same period. About zero km^2 were the total changes from water-logged to dry land areas during the studied period between 1987 and 2017, whereas about 4.32 km^2 were the total changes to water-logged areas during the same period. The obtained results reveal a noticeably increase in water-logged areas in the study area between 1987 and 2017. This also could be attributed to the increase in crop irrigation and poor drainage within the area.

Table 9. Changes in water bodies versus dry land areas in El-Hammam area from 1987 to 2017.

MNDWI Years	To dry land.		No change		To water bodies	
	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
1987-2001	0.01	0.00	162.60	97.37	4.38	2.62
1987-2007	0.00	0.00	162.69	4.30	2.57	10.72
1987-2017	-	-	162.68	97.42	4.32	2.58
2001-2007	0.31	0.19	166.45	99.67	0.23	0.14
2001-2017	0.38	0.23	166.29	99.58	0.32	0.19
2007-2017	0.15	0.09	166.67	99.81	0.17	0.10

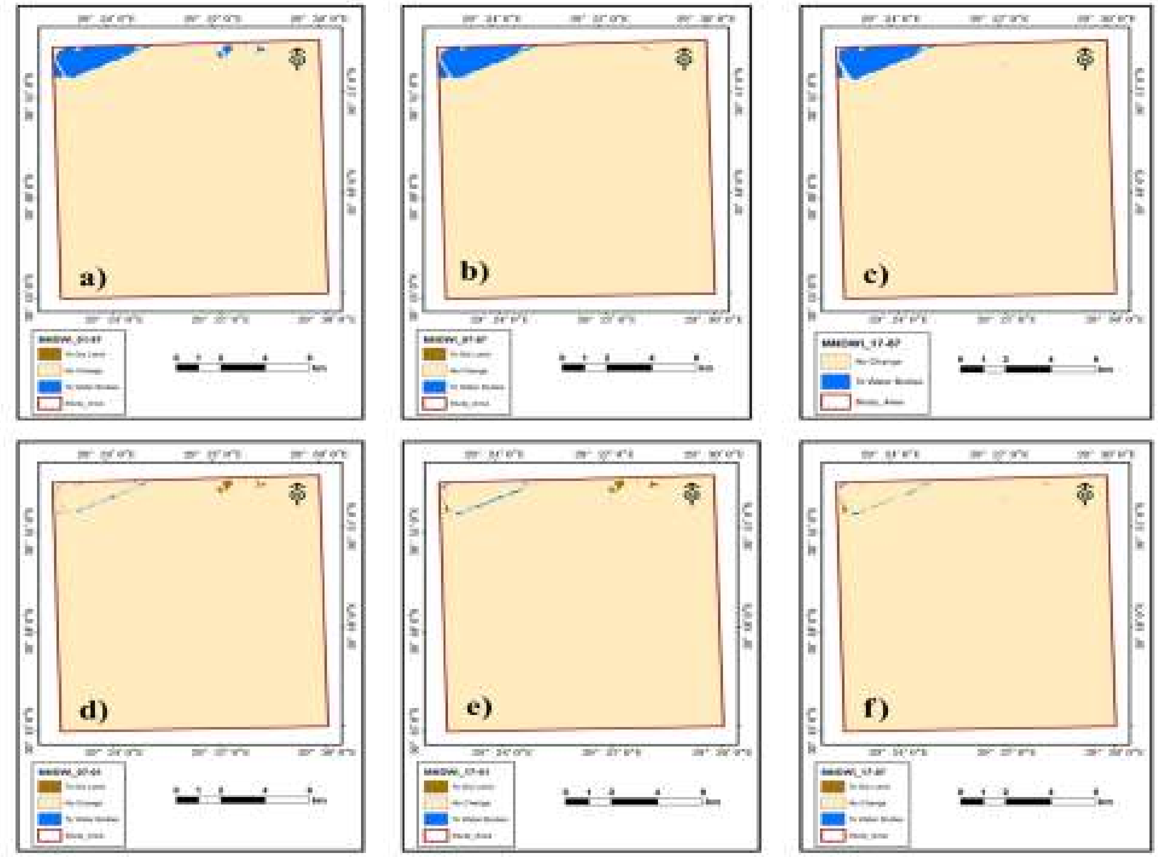

Fig. 10. Changes in water bodies and dry lands in El-Hammam area from 1987 to 2017 based on MNDWI index from: a) 1987 to 2001, b) 1987 to 2007, c) 1987 to 2017, d) 2001 to 2007, e) 2001 to 2017 and f) 2007 to 2017.

CONCLUSION

It could be concluded that the integration between remotely sensed data and GIS techniques could provide valuable help in estimating agricultural lands and water features as well as their changes over time. The use of vegetation indices such as NDVI and SAVI could provide more accurate estimations of agricultural lands even in remotely accessed areas and save time, money and efforts. Water indices (e.g., NDVI and MNDWI) could also provide accurate estimation of water features. These indices indicated an increase in both agricultural areas and water bodies within the studied area from 1987 to 2017. This could be attributed to the increase in land reclamation and cultivation projects. This also indicates the productivity and suitability of soils in studied area for agricultural activities.

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تقييم ورسم خرائط التغيرات في الأراضي الزراعية والمظاهر المائية في منطقة الحمام - الساحل الشمالي لمصر

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التغيرات في استخدام الأراضي واضحة في الأجزاء الشمالية الغربية من جمهورية مصر العربية ويرجع ذلك بشكل أساسي إلى الأنشطة الزراعية والصناعية والسياحية والحضرية. وبناءً على ذلك ، كان الهدف الرئيسي من هذا العمل هو تقدير التغيرات في الأراضي الزراعية والمظاهر المائية في منطقة الحمام فى الفترة من 1987 إلى عام 2017 وذلك باستخدام بيانات وتقنيات الإستشعار عن بعد. ولهذا الغرض، تم جمع بيانات للقمر الصناعي الأمريكى لاندسات خلال أربع فترات (1987 و 2001 و 2007 و 2017). وتمت معالجة هذه البيانات وتحليلها. كما تم استخدام اثنين من المؤشرات النباتية والمؤشرات المائية لدراسة التغيرات في الأراضي الزراعية والمظاهر المائية في المنطقة المدروسة خلال هذه الأربع فترات الزمنية. وتضمنت المؤشرات النباتية كلا من مؤشر التغير فى الغطاء النباتى NDVI و مؤشر الغطاء النباتى المعدل بالنسبة للتربة SAVI ، في حين اشتملت المؤشرات المائية على كلٍ من مؤشر التغير فى الغطاء المائى NDWI والمؤشر المعدل له MNDWI. وأشارت النتائج التي تم الحصول عليها إلى وجود زيادة ملحوظة في المناطق الزراعية ، وذلك بسبب الزيادة في مشاريع استصلاح واستزراع الأراضي. كما وجدت أيضا زيادة فى مساحة المسطحات المائية ، والتي يمكن أن تعزى إلى الزيادة في عمليات الري والصرف الزراعي. وهذا يوضح عن أهمية منطقة الدراسة في التنمية الزراعية واستدامتها.