

Water Resources and Surveying Engineering

**Monitoring Land Cover Change Using Remote Sensing and GIS Techniques:
a Case Study of Al-Dalmaj Marsh, Iraq**

Marwah Moojid Kadhim*

Assistant Lecturer

College of Engineering, University of
Al-Qadisiyah

Email: marwah.alkhuzai@qu.edu.iq

ABSTRACT

Al-Dalmaj marsh and the near surrounding area is a very promising area for energy resources, tourism, agricultural and industrial activities. Over the past century, the Al-Dalmaje marsh and near surroundings area endrous from a number of changes. The current study highlights the spatial and temporal changes detection in land cover for Al-Dalmaj marsh and near surroundings area using different analyses methods the supervised maximum likelihood classification method, the Normalized Difference Vegetation Index (NDVI), Geographic Information Systems(GIS), and Remote Sensing (RS). Techniques spectral indices were used in this study to determine the change of wetlands and drylands area and of other land classes, through analyses Landsat images for different three years (1990, 2003, 2016). The results indicated that there was an annual increase in vegetation was from 1990 with 980.68 km², and 1420.35km² in 2003 to 2072.98km² in 2016. Whereas, the annual water coverage was about 185.95km² in 1990 then dropped to 68.27km² in 2003, and rose to 180.23 km² in 2016. The water coverage increasing was on the account of barren lands areas, which were significantly decreased. These collected data can be used to deliver accurate information of the values of vegetation, water, wetlands and drylands sustainability of resources which can be used to make plans to increase tourism and protected areas by using barren lands which cannot be reclaimed for agriculture, and cultivate a new renewable energy can be set up as solar power stations.

Key Words: Marsh of Iraq, Change detection, Land cover, NDVI, Landsat image.

**رصد تغير الغطاء الأرضي باستخدام الاستشعار عن بعد وتقنيات نظم المعلومات الجغرافية:
دراسة حالة هور الدلماج - العراق**

مروة موجد كاظم

مدرس مساعد

كلية الهندسة - جامعة القادسية

الخلاصة

تعتبر منطقة الدلماج والمناطق القريبة منها منطقة واعدة جدا لموارد الطاقة والسياحة والأنشطة الزراعية والصناعية. حيث شملت الدراسة العديد من التغيرات على مدى القرن الماضي. تعنى الدراسة الحالية في الكشف عن التغير المكاني والزمني في الغطاء الأرضي بمنطقة الدلماج والمناطق المحيطة بها باستخدام طريقة التصنيف المراقب ومؤشر الغطاء النباتي

*Corresponding author

Peer review under the responsibility of University of Baghdad.

<https://doi.org/10.31026/j.eng.2018.09.07>

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Article accepted: 18/12/2017



(NDVI) بالاستفادة من تقنيات نظم المعلومات الجغرافية (GIS) والاستشعار عن بعد (RS) لتحديد التغير في المياه والأراضي الرطبة والأراضي الجافة وغيرها من فئات الأرض، من خلال صورة لاندسات لمدة ثلاث سنوات (1990, 2003, 2016). وأظهرت النتائج أن الزيادة السنوية في مياه الأهوار والنباتات من (1990 إلى 2016). وأظهرت النتائج أن الزيادة السنوية في الغطاء النباتي كانت حوالي 980.68 كم² في عام 1990، 1420.35 كم² في عام 2003 و 2072.98 كم² في عام 2016، وبلغت الزيادة السنوية في المياه حوالي 185.95 كم² في عام 1990، 68.27 كم² في عام 2003 و 180.23 كم² في عام 2016 وتزايدت تغطية المياه على حساب مناطق الأراضي الجرداء التي انخفضت بشكل ملحوظ. ويمكن استخدام هذه البيانات المجمع لتقديم معلومات دقيقة عن قيم الغطاء النباتي والمياه والأراضي الرطبة واستدامة الأراضي الجافة للموارد التي يمكن استخدامها لوضع خطط لزيادة السياحة والمناطق المحمية باستخدام الأراضي الجرداء التي غير قابلة لاستصلاحها للزراعة وزراعة الطاقة المتجددة الجديدة يمكن إنشاء محطات للطاقة الشمسية.

1. INTRODUCTION

Iraqi marshes are considered the largest wetland in the Middle East, Iraqi Marshlands subjected to many environmental changes **Aoki, et al., 2014**. Change detection is the process of monitoring differences in the circumstances of a phenomenon or object by monitoring it at different periods; it implies the capability to quantify temporary effects using different multi-temporal sets of data. The degradation of the land does not necessarily mean land cover changes by land use. However, lots of land shifting where due to socialite causes which have resulted in changing of land cover and that will affect the radiation, trace gas emissions, and biodiversity water budgets, and other procedure that comes beneficial to climate and biosphere **Riebsame, et al., 1994, Rawat and Kumar, 2015**. Nowadays, by investing the remote sensing and Geographical Information System (GIS) techniques, using mapping of the land cover has been found useful to select better industrial, agricultural or urban areas of designed areas **Selçuk, et al., 2003**. The remotely sensed data is providing the scientist with enormous information to study the effect of the use land at low cost and good accuracy within no time with the cooperation of the GIS company. GIS company has been supplied a retrieval and update data analysis by using an appropriate juncture (platform). Using of the high-resolution spatial satellite images, and another imagery processing analysis with GIS technologies have enabled to control the monitoring process to be more consistent and routine, which allows creating a patterns model of land-use to land-cover. The collective images and data of land cover mapping by GIS techniques have a good significant impact on of remote sensing applications **Rawat and Kumar, 2015**. The main aim of this search is to provide a change detection in Al-Dalmaj marsh and near surroundings area, through analysis of Landsat images for selected three years (1990, 2003, 2016) to determine the change of marsh water, wetlands area, drylands area and of other land classes, the resulting of drying procedures which has a huge effect on the environment in marshland of Iraq. The combination of remote sensing and GIS techniques with geophysical analysis have been found to be successful and effective for monitoring the spatial and temporal changes detection in land cover.

2. DESCRIPTION OF STUDY

This study selected a large wetland area with the coordinates: N 32° 12' 00", E 45° 28' 00" located between Al-Diwaniya state west and east Wasit state which is known as Al-Dalmaj marsh. Al-Dalmaj marsh has a different type of fishes, also several kind birds emigrate annually from Europ and Asia in winter, as shown in **Fig.1, Walli, 2015**. The previous studies showed that the water analysis of most location in the marsh is an alkaline, however, at very few locations in Al-Delmaj marsh where the water is found to be slightly acidic. The range of pH



was acidic to alkaline between 6.6 to 7.4 during the summer, while in winter it was acidic (7.9 to 8.8). Urban land has been found to be low at the Al-Dalmaj marsh. Mesopotamian plain is covering the most agricultural lands of the Al-Dalmaj marsh. The Al-Dalmaj marsh has different kinds of water depth; shallow and deep water. Also, The barren land includes marsh with dry salt flats and sand dunes transported by wind **Walli, 2015, Al-Sheikhly and Nader, 2013.**

Al-Delmaj marsh was selected to study and monitoring the environment change of the southern and central parts of Iraq. The Iraq soil is considered a sedimentary soil, especially in the central and southern parts. The medium vaporization exceeds $2450 \text{ mm year}^{-1}$ with medium annual rain below 100 mm. The rain is over than 30% during the day and humidity ratio is more than 50% annually. The desert plants are affected by climate and acclimatized to these differences of meteorological and correspond to 66% of the total covering; these plants being to grow immediately after rain and perfect their life cycle by the end of the rainy period, and after the temperature begins to increase as show **Figuer.1.** last year, the population were increased alongside with amelioration of employment environment and economic growth **Hadeel, et al., 2010.** Some species are of global conservation importance **Mohammad, 2014.**

3. MATERIALS AND METHODS

The studied area is covered by the Landsat image for selected three years (1990, 2003, 2016) from Landsat 5(TM), Landsat 7 and Landsat 8 (OLI-TIRS) respectively with different sensor is being downloaded from the USGS Earth Explorer for every (13) year for the purpose of coverage during the drying period and the consequences on the environment in marshland of Iraq, the imagery is free of clouds, haze, and dust (distortions of interfering atmospheric) **Chavez, 1996.** Processing the images and imagery interpretation for the development of cover maps and land use were achieved by using imagine software (Arc GIS and ERDAS). The collected data were obtained and analyzed and calculated to detect the change in land cover. Prospect prediction is done based on past data, a fifth flow chart of the methodology is shown in the **Fig. 2.**

3.1 Image Preprocessing

Digital image processing was manipulated using Arc GIS. The geometric is corrected and calibrated. Data were classified according to the type of cover land into 'zones', each zone has similar spectral properties. The data of ground truth were classified according to every single classifier collected by its signatures spectral for three years (1990,2003,2016) as shown in **Table 1. and Fig. 3.**

3.2 Classification of Images

In this study, the supervised land use/cover classification was applied. Maximum likelihood method was to analyze the image by using Arc GIS, this method is considered most sophisticated and achieves good separation of classes **Bruzzone, et al., 2001.** Each point had specific color tone and the pixel value which was recognized by the software itself when the datasets were trained during supervised land use cover classification **Choudhary, et al., 2017.** All the randomly generated points were then identified by the user and assigned to different classes. The supervised classification was done for three years (1990, 2003 and 2016). The correctly identified points were considered as classified values.



3.3 Estimation Land Cover

The equation below shows the Normalized Difference Vegetation Index (NDVI), **Huete, 1988**:

$$\text{NDVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red}) \quad (1)$$

In which, NIR represents the nearby infrared reflectance in a section of the band. Red is the reflectance in the red portion of the band. NDVI value ranged between -1.0 and +1.0, where distributed between positive values which indicated green vegetation and not vegetated land covers represented by negative or near zero value such as deserts, water bodies, and urban area. Snow has larger visible reflectance than NIR reflected, these features yield negative values. Rock and bare soil areas have a similar reflectance in the two bands and result in NDVI near zero **Dalezios, 2002**.

3.4 Land use Cover change Detection

Three satellite images were collected to detect the spatial and temporal changes in land cover for the same area. All images from each individual year have been classified according to a various-date, post classification, change-detection in order to detect the changes during three interval periods (1990– 2003, 2003–2016 and 1990-2016). The post-classification approach provides changes data from - to. Classified pairs of two different decade data have been compared using the cross-table in order to determine qualitative of the changes for the periods of 1990–2016.

4. RESULTS AND DISCUSSIONS

4.1 Supervision Classification

Statistical analysis of the supervised results of the classification has shown that estimated vegetation lands were about 914.06, 1420.53, and 1898.62, km² in 1990, 2003 and 2016, respectively. The collected images analysis presented increasing of the vegetation coverage in the selected lands from 22.2 in 1990 to 46.2% at 2016 as shown in **Table 2**.

However, there was a fluctuation in water coverage for the same period from 185.95 km² (with 4.5%) in 1990 then it had dropped to 68.27 km² (with 1.7%) in 2003, followed by returning about the old range value with a 180.23 km² (with 4.4 %) in 2016. The data analyses of the wetlands had been approved by the same behavior of the water coverage founds at the same period as shown **Table 2**. This fluctuation in the water coverage and wetland can be explained due to UN human rights investigator for two main reasons. The first reason according to UN human rights was that Turkey held back a large volume of the flow of the Euphrates River, by filling of the huge reservoir behind the Ataturk Dam. The second reason was the completed Third River project in 1990 which drain the Marsh area and destroyed the environment **Merry, 1992**.

Holding the flow of the Euphrates River and the drain the Marsh by Third River project were having a huge impact on the area. That dramatic impact reduced the wetland and water coverage in 1990 which had a bad reflection on the increasing of barren lands in the period between 1990-2003 from 1388.82 to 2211.74 km². However, this dramatic impact has been nearly demolished in 2016 by shrinking the percentages of barren lands to 27.1% table 2. The detected changes were a result of a United Nations Environment Program assessment of the Iraq marsh restoration in 2006 to restore the marsh **Partow, 2001**.



It turns out that Vegetation areas in the marsh were increased on the account of wet and barren areas that significantly decreased during 2016. On the other hand, the water areas significantly decreased during the period from 1990 to 2003, which increased this values during the period from 2003 to 2016, as shown in **Table 2.** and **Fig. 4.**

4.2 Normalized Difference Vegetation Index (NDVI)

Statistical analysis based on the NDVI index has confirmed the Statistical analysis of supervision. NDVI analysis showed that estimated vegetation lands were increased gradually from 1990 (980.68 km²) to 2016 (2072.98 km²) and the percentages reached up to 50.41%, in 2016. On the other hand, estimated non-vegetation lands were about 3131.67, 2691.82, and 2039.37 km² in 1990, 2003 and 2016, respectively and their percentages were about 76.15, 65.46, and 49.59%, respectively. This showed that vegetation areas in the marsh were increased on the account of non-vegetation areas that significantly decreased during 2016, as shown in **Table 3.** and **Fig. 5.**

4.3 Change Detection

Statistical Change Detection Images is based on the NDVI index percentage at different years periods different years periods in (1990-2003), (2003-2016) and (1990-2016) is represented, estimated increase vegetation lands were about 317.24, 415.87, and 301.87 km² respectively and their percentages were about 7.71, 9.99, and 7.34% respectively. Estimated regression vegetation was about 757.10 (18.41%), 1063.32 (25.86%), and 1394.17 (33.90%) km² respectively. Whereas, the estimated areas of no change lands were about 3038.01(73.88%), 2638.16 (64.15%) and 2416.30 (58.76%) km² respectively as shown in **Table 4.** and **Fig. 6.**

Moreover, statistical Change Detection Images is based on the supervision classification Maximum likelihood method percentage at different years periods in (1990-2003), (2003-2016) and (1990-2016) is represented an estimated regression water of marsh were about 185.36, 66.36, and 79.13 km² respectively. Whereas, the estimated areas of no change lands were about 3859.31, 3867.67 and 3959.80 km² respectively and increase the percentages of marsh water were about 1.65, 4.34, and 1.79% (1990, 2003, and 2016), respectively.

These results confirm that the vegetation lands and the water areas in Al-Dalmaj marsh were significantly increased during the period from 2003 to 2016. That increase was on the account of barren lands areas, which were significantly decreased as shown in **Table 5.** and **Fig. 7.**

5. CONCLUSIONS

The Change Detection analysis is a beneficial method of describing the changes in each land use category. Results obtained from the classification Maximum likelihood method, there are noticeable and visible changes in land use and land cover in the region for the period 1990-2016. Increasing trend in vegetation and water areas, and reduction in wetlands and barren lands. Where water is reduced between (1990 - 2003) and water increase from (2003 - 2016), the recovery of the marshes and the surrounding area. On the other hand, increasing in vegetation areas region for the period 1990-2016, study and analysis of the changes and the sustainability of the completion can be used to make plans to increase tourism and protected areas by using barren lands which cannot be reclaimed for agriculture, and catch and cultivate a new renewable energy can be set up as solar power stations.



REFERENCES

- Al-Sheikhly, O. F., & Nader, I. A., 2013, *The Status of Iraq Smooth-Coated Otter Lutrogale Perspicillata Maxwell Hayman 1956 And Eurasian Otter Lutra Lutra Linnaeus 1758 In Iraq*. IUCN Otter Specialist Group Bulletin, Vol.30, PP.18-30.
- Aoki, C., Al-Lami, A., & Kugaprasatham, S., 2014, *Environmental management of the Iraqi marshlands in the post-conflict period, Water and post-conflict peacebuilding*
- Bruzzone, L., & Prieto, D. F., 2001, Unsupervised retraining of a maximum likelihood classifier for the analysis of multitemporal remote sensing images. *IEEE Transactions on Geoscience and Remote Sensing*, 39(2), 456-460.
- Chavez, P. S., 1996, Image-based atmospheric corrections-revisited and improved. *Photogrammetric engineering and remote sensing*, Vol.62, No. 9, PP.1025-1035.
- Choudhary, K., Boori, M. S., & Kupriyanov, A., 2017, Spatial modeling for natural and environmental vulnerability through remote sensing and GIS in Astrakhan, Russia. *The Egyptian Journal of Remote Sensing and Space Science*.
- Dalezios, N. F., 2002, *Environmental Remote Sensing*, University Teaching, University of Thessaly, Volos.
- Hadeel, A. S., Jabbar, M. T., & Chen, X., 2010, *Environmental change monitoring in the arid and semi-arid regions: a case study Al-Basrah Province, Iraq*. *Environmental monitoring and assessment*, Vol. 167, No. 1, PP.371-385.
- Huete, A. R., 1988, A Soil-Adjusted Vegetation Index (SAVI). *J. Rem. Sens. Of Envir*, Vol. 25, PP. 295-309.
- Merry, M., 1992, *Iraq Builds "Third River" Project Despite no-fly Zone and Embargo*. *Executive Intelligence Review*. Vol. 19, No 46, PP.8-10.
- Mohammad, K. M., 2014, *The current status of the vertebrate diversity in Al-Dalmaj marsh, Al-Diwaniya Province*. *Bull. Iraq Nat. Hist. Mus*, Vol. 13, No, 1, PP.5-14.
- Othman, A. A., Al-Saady, Y. I., Al-Khafaji, A. K., & Gloaguen, R., 2014, *Environmental change detection in the central part of Iraq using remote sensing data and GIS*. *Arabian Journal of Geosciences*, Vol.7, 3, PP.1017-1028.
- Partow, H., 2001, *The Mesopotamian Marshlands: Demise of an Ecosystem. Division of Early Warning and Assessment*. United Nations Environment Programme. Nairobi, Kenya.
- Rawat, J. S., & Kumar, M., 2015, *Monitoring Land use/Cover Change Using Remote Sensing and GIS Techniques: A Case Study Of Hawalbagh Block, District Almora, Uttarakhand, India*. *The Egyptian Journal of Remote Sensing and Space Science*, Vol.18, No. 1, PP.77-84.
- Riebsame, W. E., Meyer, W. B., & Turner, B. L. 1994, *Modeling Land use and Cover as part of Global Environmental Change*. *Climatic Change*, Vol. 28, No.1-2, PP. 45-64.
- Salim, M. A., Abd, I. M., Abdulhassan, N. A., & Munjal, M. S., 2009, *Key Biodiversity Survey of Southern Iraq*. *Nature*. PP.1-117
- Selçuk, R. E. I. S., Nisanci, R., Uzun, B., Yalcin, A., Inan, H., & Yomralioglu, T., 2003, *Monitoring land-use changes by GIS and remote sensing techniques: Case Study of Trabzon*. In *Proceedings of 2nd FIG Regional Conference, Morocco* PP. 1-11.



- Walli, H. A., 2015, *Determination of Pahs In Surface Water of Al-Dalmaj Marsh, Al-Diwaniya Province, Iraq*. Journal of Environment and Earth Science, Vol.5, No.12, PP.,67-72
- Walli, H. A., 2015, *Determine of Heavy Metals Concentrations by Using Scanning Electron Microscopy and Enumerate of Bacteria in Al-Dalmaj Marsh*. Vol. 6, No, 7, PP.5277-5282.

NOMENCLATURE

GIS = geographic information system

NDVI= Normalized Difference Vegetation Index

RS= Remote Sensing

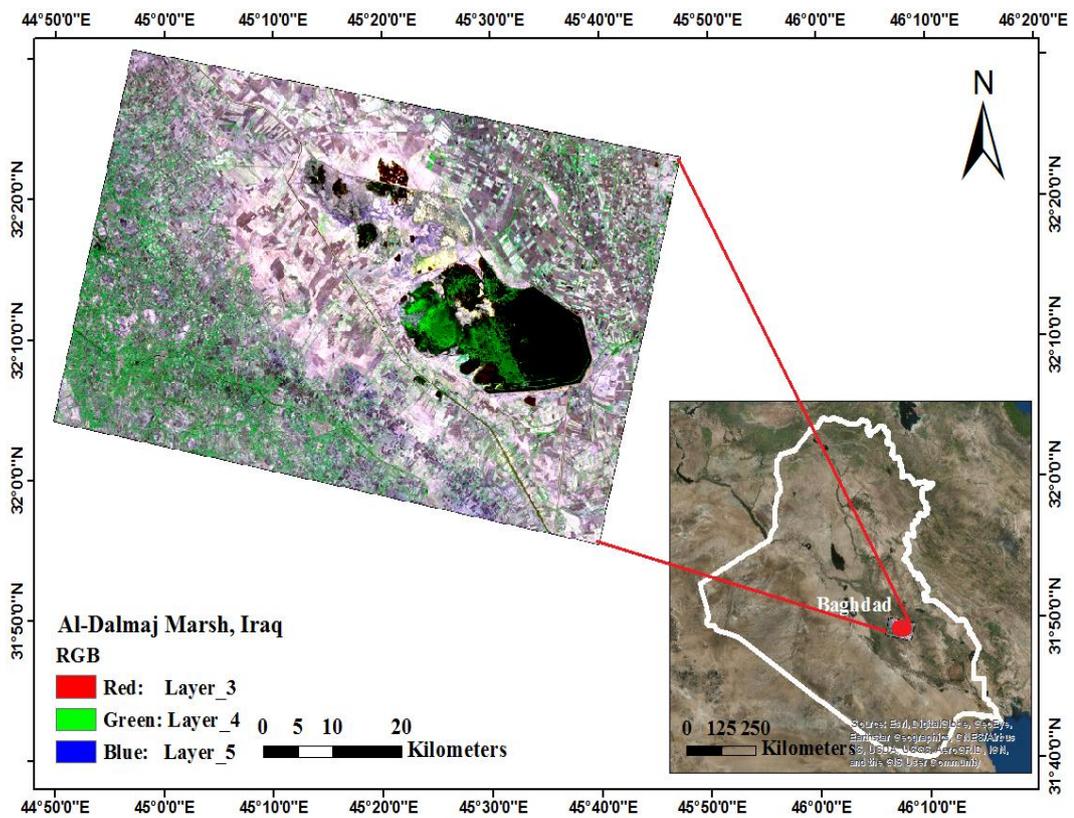


Figure 1. Location of study area in Iraq and location of Al-Dalmaj marsh.

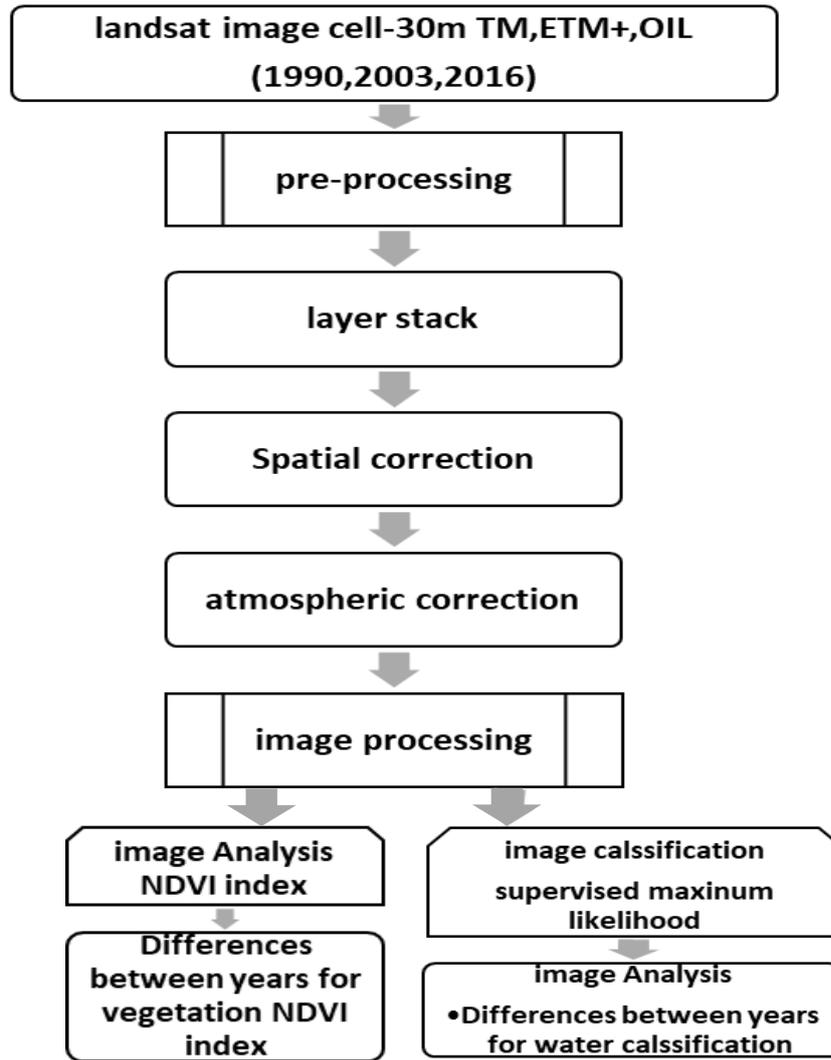


Figure 2. Flow chart of data analyses and manipulations.

Table. 1. Acquisition dates of the studied Landsat images.

Image year	Sensor type
1990	Landsat 5(TM)
2003	Landsat 7
2016	Landsat 8(OLI-TIRS)

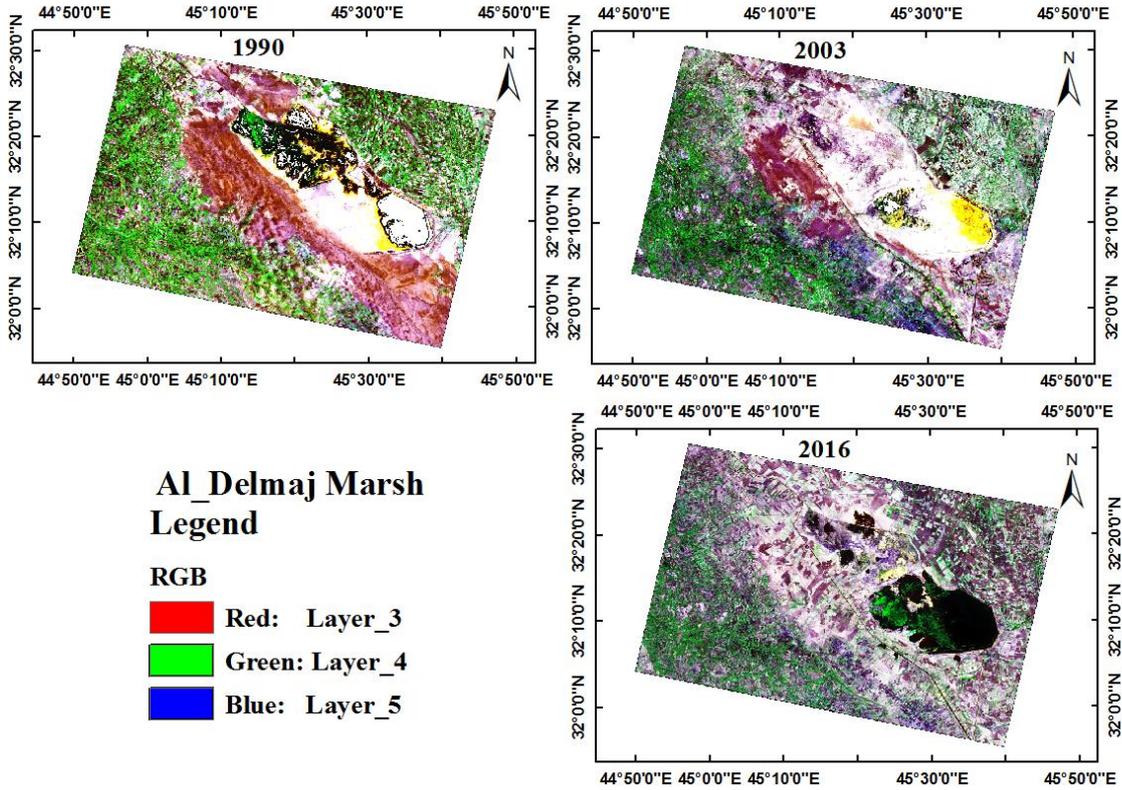


Figure 3. Digital image of the study area for three years (1990,2003 and 2016).

Table 2. Areas of supervised classification Maximum likelihood method of Al-Dalmaj marsh (1990,2003 and 2016).

Class	supervised classification					
	1990		2003		2016	
	Area km ²	Area %	Area km ²	Area %	Area km ²	Area %
Water	185.95	4.5	68.27	1.7	180.23	4.4
Wet land	1623.52	39.5	411.81	10.0	918.28	22.3
Barren land	1388.82	33.8	2211.74	53.8	1115.22	27.1
Vegetation land	914.06	22.2	1420.53	34.5	1898.62	46.2
SUM	4112.35	100%	4112.35	100%	4112.35	100%

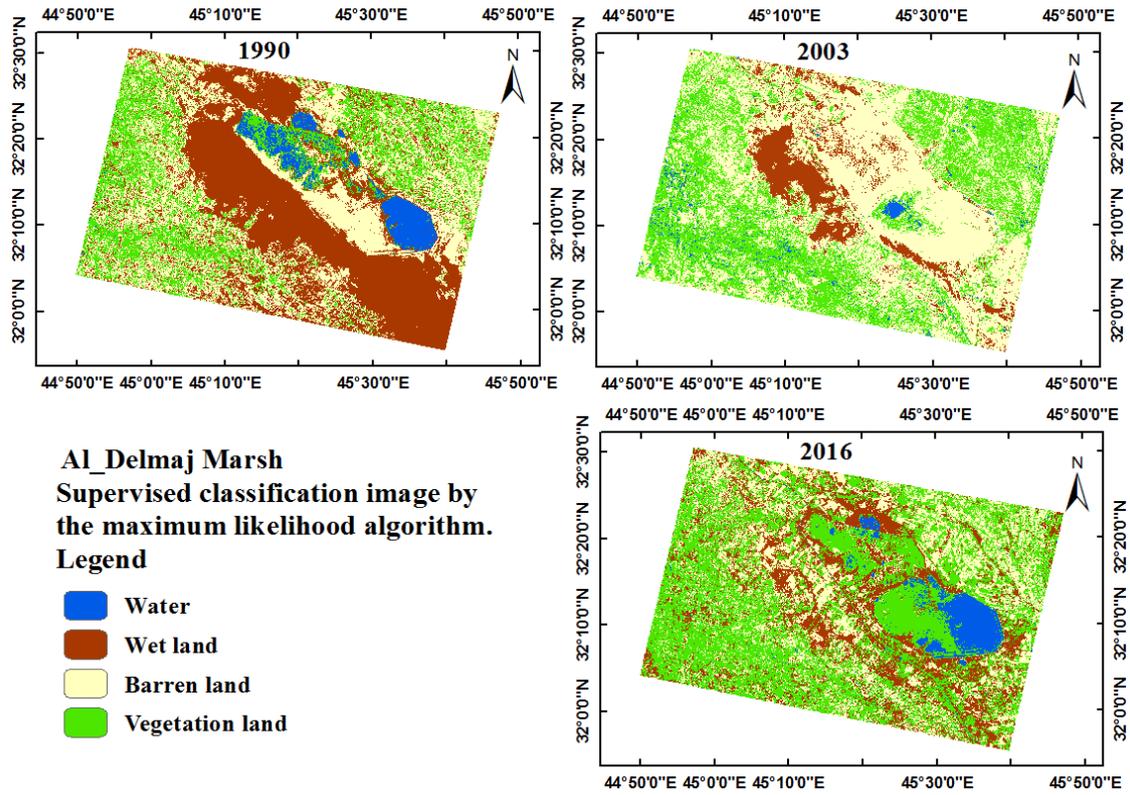


Figure 4. Supervised classification analysis Maximum likelihood method of Al-Dalmaj marsh (1990,2003 and 2016).

Table 3. Areas of vegetation and nonvegetation lands and their percentage in Al-Dalmaj marsh based on the NDVI index from 1990 to 2016.

Class	NDVI Index					
	1990		2003		2016	
	Area km ²	Area %	Area km ²	Area %	Area km ²	Area %
Without Vegetation	3131.67	76.15	2691.82	65.46	2039.37	49.59
Vegetation land	980.68	23.85	1420.53	34.54	2072.98	50.41
SUM	4112.35	100%	4112.35	100%	4112.35	100%

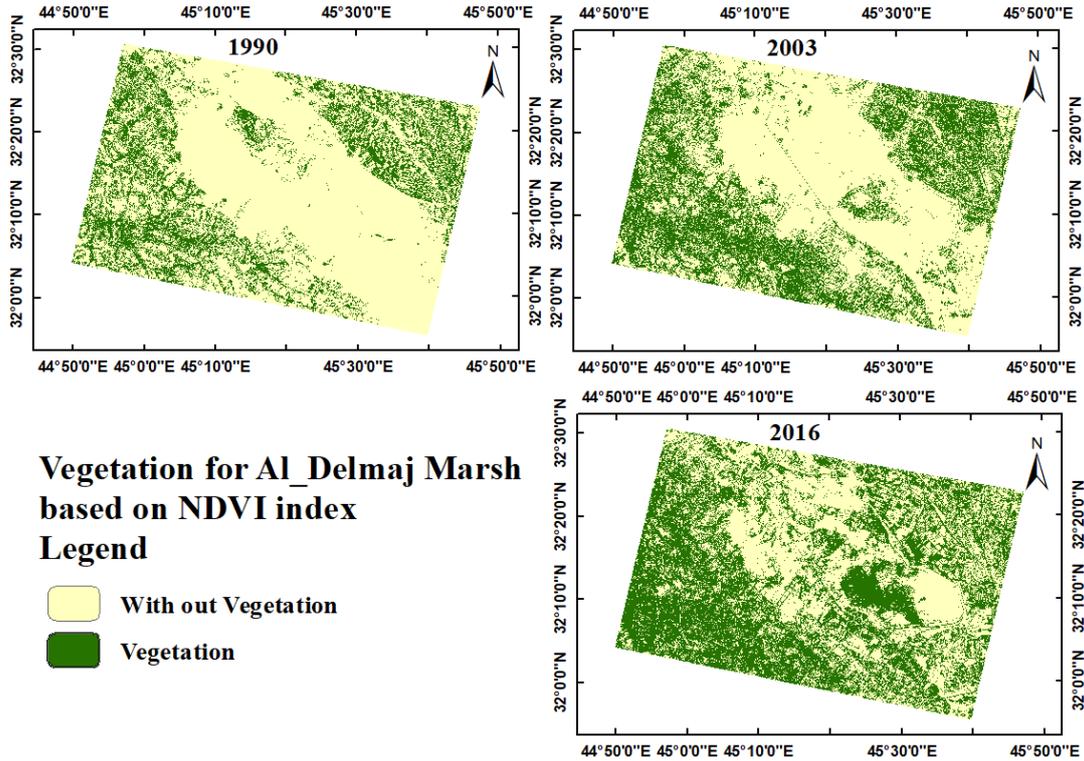


Figure 5. Spatial distribution of land use obtained from the NDVI index in Al-Dalmaj marsh (1990,2003 and 2016).

Table 4. Change Vegetation by NDVI Index analysis of Al-Dalmaj marsh (1990,2003 and 2016).

Class	Change Vegetation by NDVI Index					
	1990-2003		2003 - 2016		1990 - 2016	
	Area km ²	Area%	Area km ²	Area%	Area km ²	Area%
Without Vegetation	317.24	7.71	410.87	9.99	301.87	7.34
No Change	3038.01	73.88	2638.16	64.15	2416.30	58.76
Vegetation	757.10	18.41	1063.32	25.86	1394.17	33.90

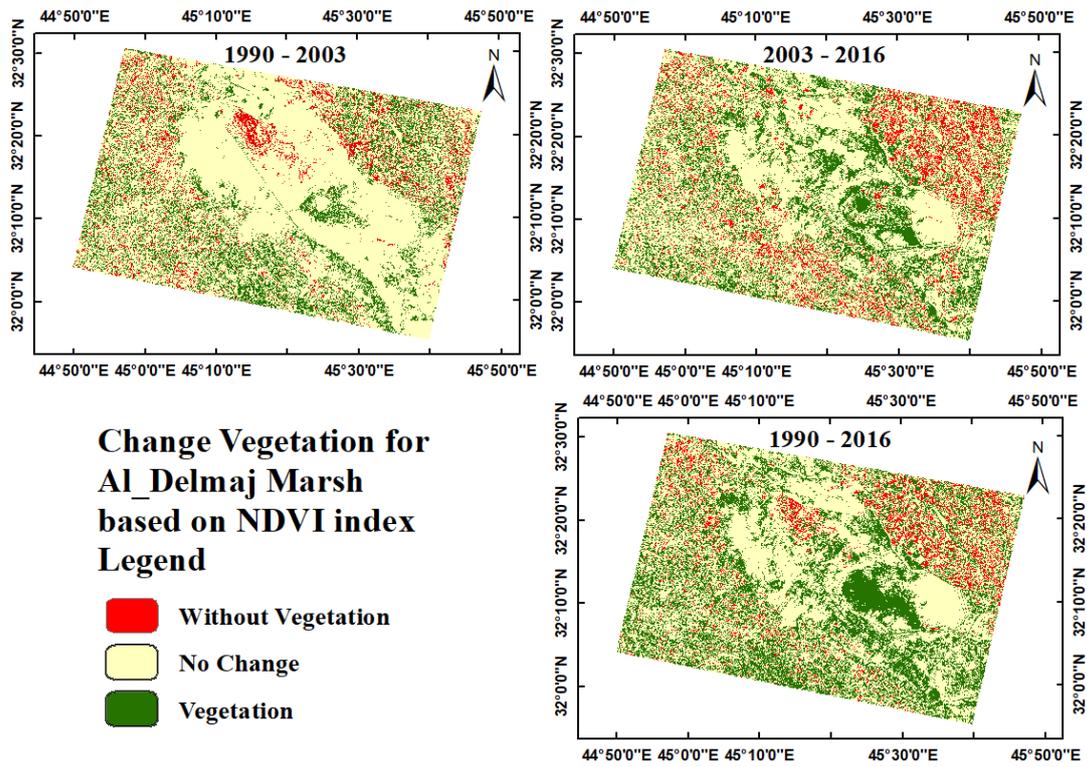


Figure 6. Areas of vegetation differentiating (NDVI) analysis of Al-Dalmaj marsh.

Table 5. Change Water by supervised classification analysis of Al-Dalmaj marsh (1990,2003 and 2016).

Class	Change Water by supervised classification					
	1990-2003		2003 - 2016		1990 - 2016	
	Area km ²	Area%	Area km ²	Area%	Area km ²	Area%
No Water	185.36	4.51	66.36	1.61	79.13	1.92
No Change	3859.31	93.85	3867.67	94.05	3959.80	96.29
Water	67.68	1.65	178.32	4.34	73.41	1.79

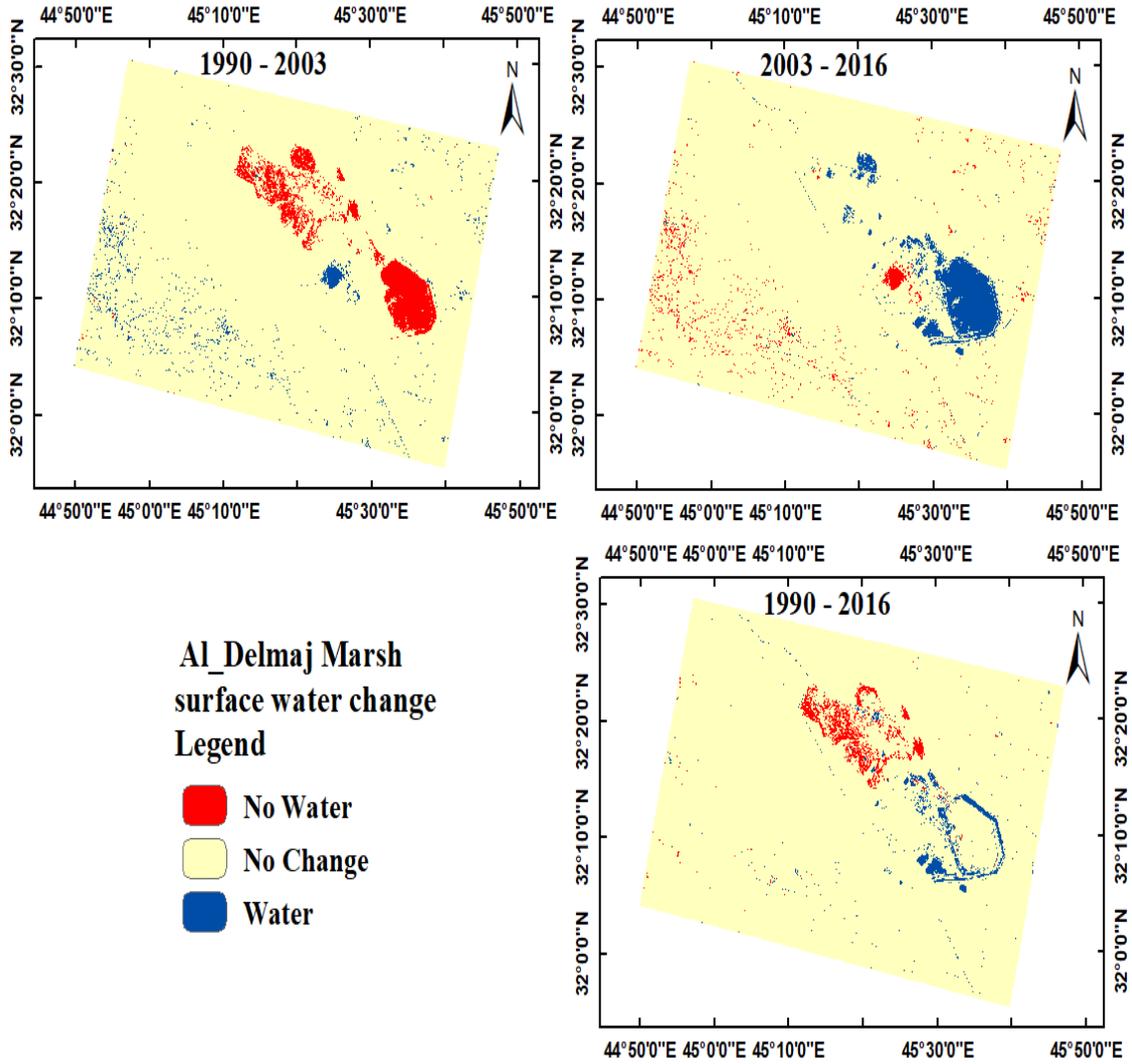


Figure 7. Differences water areas between three years of Al-Dalmaj marsh (1990,2003 and 2016)(No water = receding the water)(Water= grown the water)