IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 12, Issue 6 Ver. II (June. 2018), PP 31-38
www.iosrjournals.org

Mapping Wetland Degradation in the Iraqi Marshlands for the period 1985-2000 from Landsat Satellite Imagery

Muhammad Ali Bukar,[1] Dr Wakil Mala Bukar[2]
[1]*Department of Geography, University of Portsmouth, Portsmouth, UK.*
[2] *Department of Geography, Kashim Ibrahim College of Education Maiduguri Borno State, Nigeria*
Corresponding Author: Muhammad Ali, Bukar

Abstract *:Natural ecosystems of wetlands and lakes had experienced a great destruction by human activities in all the regions of the world. This paper demonstrated the application of remote sensing and Geographical Information Systems (GIS) in the Mesopotamianwetland in the southern Iraqi for the purpose of monitoring the environmental change induced by severe human activities. Using open source available satellite imagery from Landsat achieve in United State Geological Survey (SUGS). Supervised classification, unsupervised classification techniques and maximum likelihood algorithm were used to produce maps to detect the changes that had occurred between 1985 and 2000(15 years). The study revealed that land cover decreased by 85.37%, desert increased by 46.32%, deep water dropped to only 2.31% and shallow water disappeared completely.*

Key words:*Degradation, Marshland, Mesopotamian, wetland, Landsat imagery.*

Date of Submission: 16-06-2018 Date of acceptance: 02-07-2018

I. Introduction

The Mesopotamian marshland located between the border of Iraq and Iran has an area of 7,750 km^2 provide ground for most commercial fishing, and shelter for millions of birds in that region. In the early 1990s, anthropogenic activities such as water supply diversions, dam construction, war and restoration consequently affected the ecosystems of the region significantly (Handal & Hu, 2014). Iraqi marshes happen to be one of the biggest marshland in the southwest region of Asia; it is also famous for its cultural richness and biodiversity, and it provides habitat that contained millions of species of birds that later migrated to Africa and Siberia. Nevertheless, by the year 2000 only below 10% of the marshland remained active because of the Iraqi government plan to construct dike, ditch and drain the area. The international and national water demand for Euphrates and Tigris's urban use and agriculture, the widespread drought, has also significantly affected future water supply(Richardson, 2010).

The giant ecosystem of lakes and wetlands that once in Mesopotamia southern region of Iraq. The extensive drainage that took place the early 1990s destroyed both the landscape and its components (Al-Hilli *et al*, 2009). The southern Iraqi Mesopotamian marshland is obliterated by human activities particularly in the year 2000. Therefore, it has resulted in a tremendous destruction of marshes and led to the extinction of numerous species of flora and fauna in the region (Richardson & Hussain, 2006). In the 1990s the southern Iraqi degraded marshland has risen to 514.9 km^2, it equally resulted from an increase in accumulation of sand dune of about 438.6km^2 and this account for 10.1% and 10.6% respectively(Hadeel *et al*, 2011). Because of an increase in population as well as demand for food has led to severe cultivation, which on the other hand increased the total farmland to about 39.2% between the periods of 1988-2008. Subsequently, it affected the desert land cover (Faid & Abdulaziz, 2012).

The demands for fresh water which led to the practice of water management that hinders the natural ecosystems to flow worldwide. The downstream of Mesopotamian Marshes has experienced more than 60 construction projects between1964- 1998, one of the most affected systems include Tigris and Euphrates marshes (Jones *et al.*, 2008). The Lake Basins has suffered a great land use and land cover changes within the tropical forests and woodlands because of fast conversion of land areas into settlement and agricultural purposes. On the other hand, this change had faster land degradation, loss of biodiversity and accelerated climate change (Berakhi *et al.*, 2014). The water management project in Euphrates-Tigris basin existed for a very long time. The construction of large dams has been one of the major effects on the basin (UNEP, 2001).

From the foregone discussion, it is an established fact that the Iraqi Marshland had degraded due to both natural and anthropogenic factors. However, these changes can better be understood when presented in maps and graphically.This paper therefore, re-examines the Iraqi Marshland degradation by employing remote sensing and GIS technologies with the view of portraying the changes on maps and graphs.

II. Methods And Study Area

2.1 Data Sources

Table 1: Characteristics of the satellite imagery used for the classification.

Data type	Sources	Pixel resolution	Bands	Date
Landsat 5 TM	http://earthexplorer.usgs.gov/	28.5 x 28.5 m	4-7	19/05/1985
Landsat 7 ETM+	http://earthexplorer.usgs.gov/	28.5 x 28.5 m	1-8	13/05/2000

The process of classification of image includes classifying all the pixels in a satellite image into different land cover themes or classes. Boundaries should be precise and clear (Kumar, 2005). Maps are used to know the classification scheme. For many years, researchers are trying to create classification schemes of many types at a scale for different purpose by using certain data (Lu et al, 2010). The classification methods used in this study is categorised into two: supervised classification using maximum likelihood algorithm and unsupervised classification techniques. The study also included Normalised Difference Vegetation Index (NDVI) and highlight change. ERDAS Imagine 2015 was used to make all classification processes and ArcGIS I0.3.1 was used to include map marginalia. For the supervised classification, the training data were collect through polygon method, using spectral editor the selected signatures of the same pixel were merged as one class, therefore, five different classes emerged which include: Desert, Marshland vegetation, Deepwater, Shallow water and degraded marshland. Both accuracy level and statistics were checked and recorded, the area of land cover types was also calculated and then thematic map was produced, and this process was applied for both Landsat 5 TM and Landsat 7 ETM+. The unsupervised classification is an automated computer process. Its application is determined by the spectral image data to group the individual pixels that has similar spectral characteristics into the same cluster or category (Kumar, 2005). The unsupervised classification in this study was obtained by using ISODATA algorithm to classify both 1985 and 2000 Landsat images. Initially the image was classified into fifteen distinct classes, these classes are decided by ERDAS Imagine base on the spectral characteristics of each pixel in the image. These fifteen classes were manually recorded and merged into five land cover classes. The NDVI and change detection analysis were applied to both 1985 and 2000 images. Blend and swipe tools were also used to compare the difference between the images.

2.2 The Study Area

The Mesopotamian area contained swamps and marshland on the Euphrates and Tigris river systems in the southern part of Iraq; it is also locally known as Al-Hammar meaning very shallow water inland lakes 1-2 metres depth, the Al Hawizeh marshes and the central marshes (Figure 1). Until recently, these marshes happened to be the most widespread wetland in the Middle East (Fitzpatrick, 2004). The lower Mesopotamian region is located on the 29° 55' to 32° 55' N and 45° 25' to 48° 30' E (Handal, 2014).

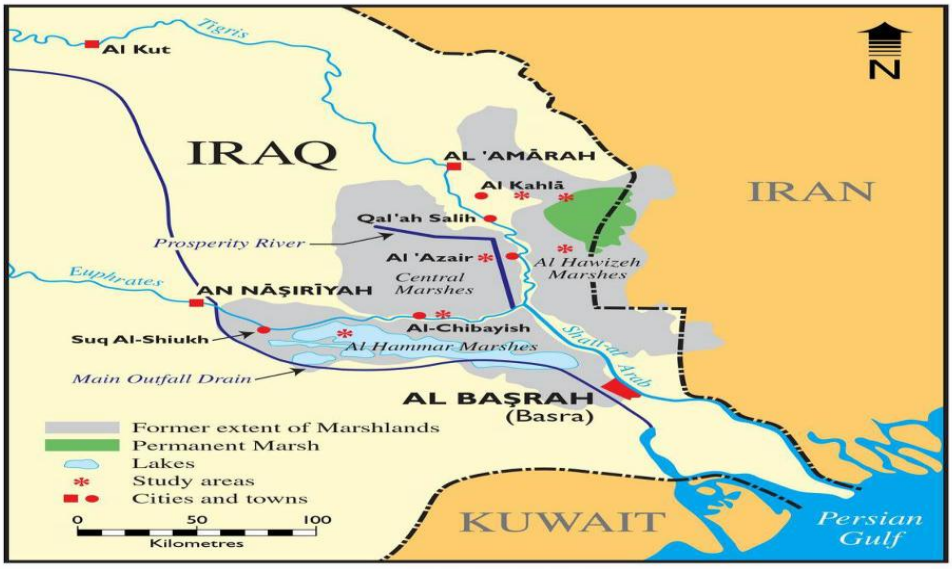

Figure 1: Southern Iraqi showing: Mesopotamian Marshlands, the existing marshland & study areas. Source: Adapted from (Fitzpatrick, 2004).

Adriansen, (2004) cites (Maxwell, 1957; Thesiger, 1964; Young, 1977) the Marsh Arabs, who are also known as Ma'dan, who claimed that they are the descendants of Sumerians, they occupied the marshlands on the confluence of Tigris and Euphrates rivers of the southern Iraqi wetlands with an area of 20,000 km^2. The

occupation of the Arabs was tuned to the wetlands which comprised of rice cultivation, fishing, and livestock breeding (buffalos). Houses were built with swamp reeds.

III. Results: Trennds & Percentage Of Changes In Vegetation And Water Coverage.

The results of land cover changes that took place on the southern Iraqi wetland is presented in Table 2 while the magnitudes of change detection percentage for both years 1985 & 2000 is shown in Table 3. Figure 1 shows the study areas that include Euphrates and Tigris rivers. Figure 2 and 3 represent detailed land cover types map of both years. The NDVI and vegetation change in the southern Iraqi marshland within the study period is presented in figure 4 & 5 respectively. Figure 6 & 7 show the spectral response and reflection of different land cover classes for the accuracy of the images. The figure 8 & 9 presented the land cover classes and their Area/percentage coverage for both the two different years 1985 and 2000.

Table 2: Land cover Classes and their Area/percentage coverage.

Year	Land Cover Classes	Area (Ha)	Percentage (%)
1985	Desert	145287	19.29
	Marshland vegetation	284946	37.81
	Deep water	45840.5	6.08
	Shallow water	37989.1	5.04
	Degraded marshland vegetation	239392	31.78
Total		753454.6	100 %
2000	Desert	298273	39.59
	Marshland vegetation	79026.1	10.48
	Deep water	17414.7	2.31
	Shallow water	9805.89	1.30
	Degraded marshland vegetation	348935	46.32
Total		753454.69	100 %

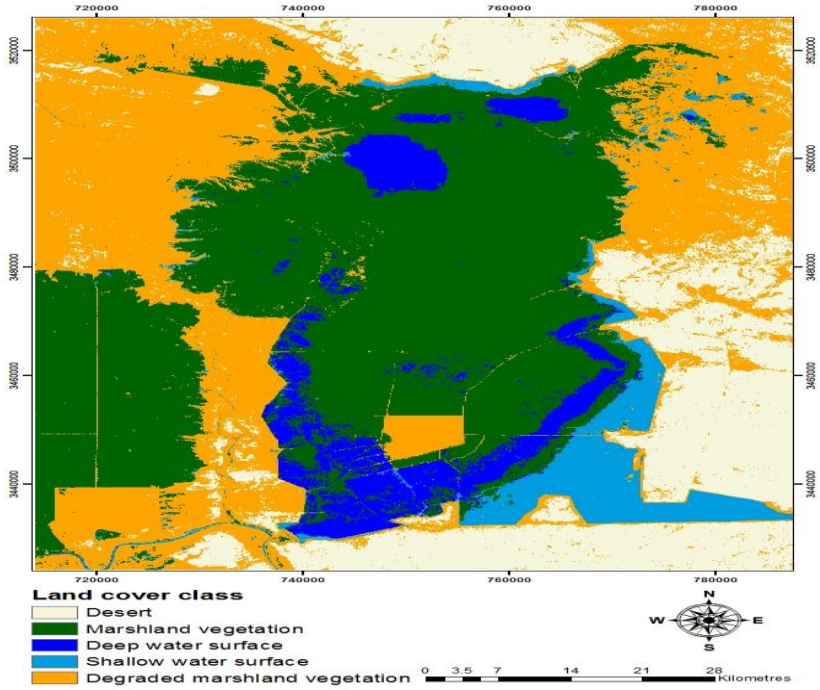

Figure 2: Classified Map of Southern Iraqi Wetland Degradation 1985.

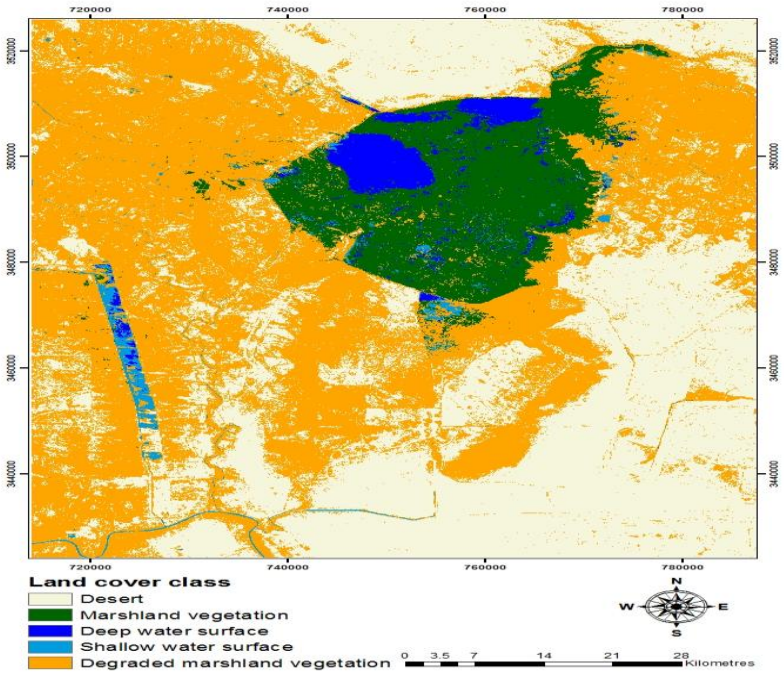

Figure 3: Classified Map of Southern Iraqi Wetland Degradation 2000.

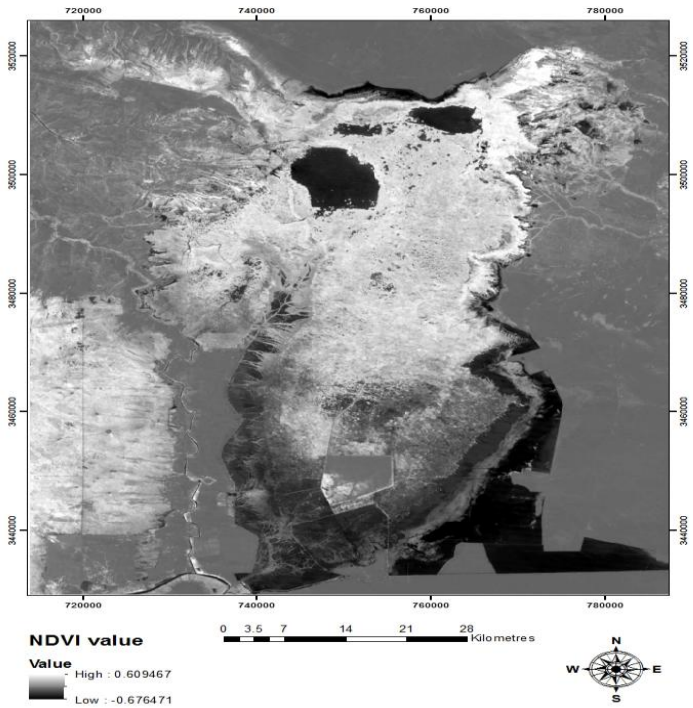

Figure4: NDVI and Change Detection Map of Southern Iraqi Wetland 1985.

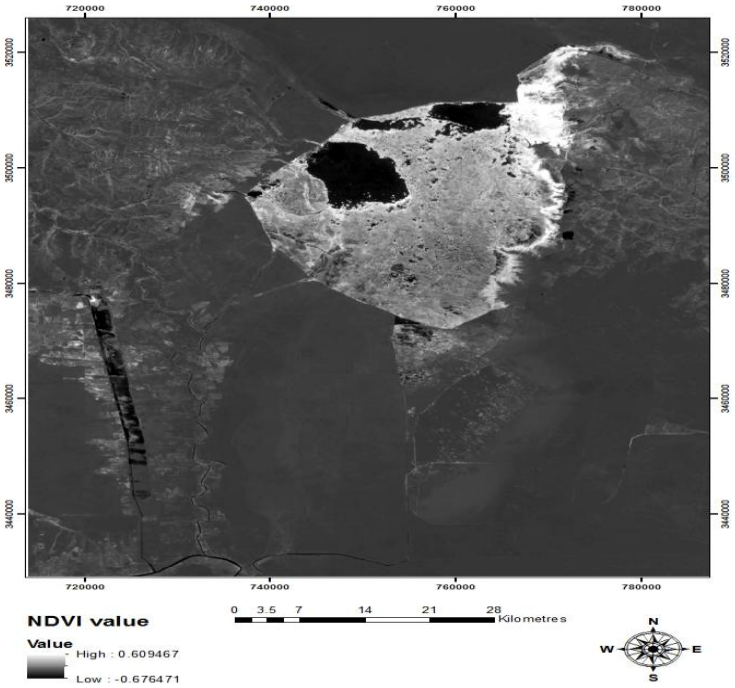

Figure 5: NDVI and Change Detection Map of Southern Iraqi Wetland 2000.

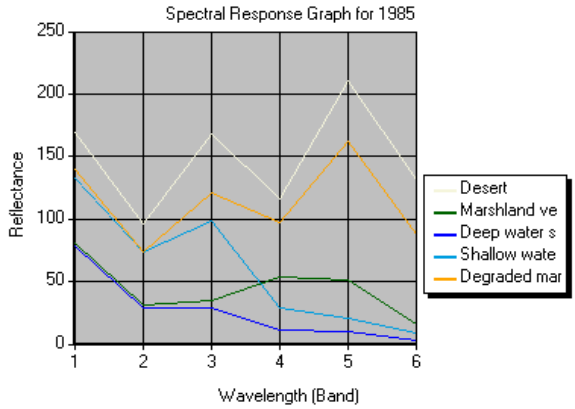

Figure 6: Spectral response and reflectance of land cover types for accuracy level 1985.

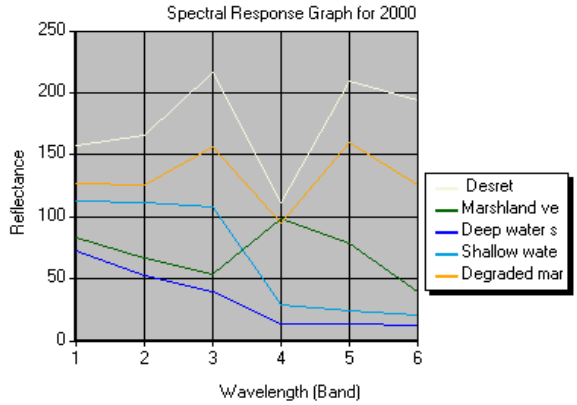

Figure 7: Spectral response and reflectance of land cover types for accuracy level 2000.

Table 3: Change DetectionPercentage on vegetation cover (NDVI) 1985 and 2000.

Class Name	Area (Ha)	Percentage (%)
Background	210.698	0.02
Decreased	627060	85.37
Some Decreased	33045.7	4.50
Unchanged	292.816	0.04
Some increase	2123.9	0.29
Increased	71817.5	9.78
Total	734550.614	100 %

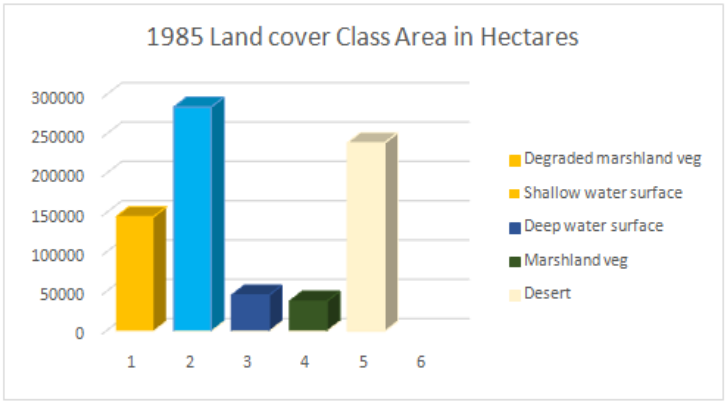

Figure 8: Land cover Classes and their Area/percentage coverage 1985.

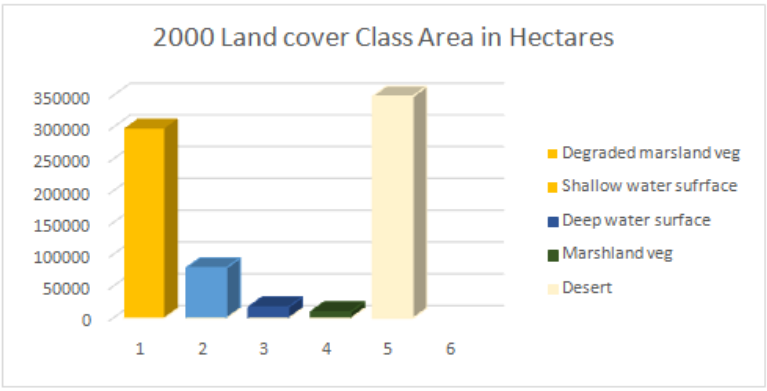

Figure 9: Land cover Classes and their Area/percentage coverage 1985-2000.

IV. Discussion

Table 2 shows the level of land cover change regarding percentage and area coverage of each class of the southern Iraqi wetland from 1985 to 2000. It was revealed that the degraded wetland covered 753454.6 km^2 in 1985, it had slightly increased to 753454.69 km^2 in 2000. The desert area increases from 19.29% in 1985 to 46.32% in 2000. Furthermore, the marshland vegetation covered about 37.81% in 1985 decreased to 10.48% in 2000; there was about 6.08% of Deepwater surface coverage in 1985 has dropped to 2.31% in 2000. The shallow water surface was 5.04% in 1985 and significantly reduced to only 1.30% in 2000. Degraded marshland vegetation was 31.78% in 1985, has raised up to 46.32% in the year 2000. This significant changes that took place within this period in the southern Iraqi wetland could be possibly attributed to the intensive human activities; such as dam construction, agriculture settlement and many more that has taken place in alarming rate, as noted by (Handal & Hu, 2014; Jones et al, 2008; UNEP, 2001). Table 3 revealed from the NDVI image difference and highlight change analysis between the two years that the total affected land cover is 734550.614 km^2, the background area is 0.02%, decreased extent up to 85.37% it is the highest value indicating significant level of change, most parts of the wetland and its natural resources in the study area are devastated by human actions (Al-Hilli et al., 2009). While some decreased is 4.50% and unchanged is 0.04% which means very small portion that remained untouched by anthropogenic activities, there was 0.29% of some increase, and increased is 9.78%. There is indication of significant loss in vegetation cover in the area. According to Singh (1989 cited in Weismiller et al.,1977 & Miller et al., 1978) the techniques of image differencing and highlight change have

been widely applied by many people for change detection and it used in different geographical regions, it is found that from the techniques of change detection image differencing and highlight change method performed very well.

Figure 2 show the extensive land cover of marshland vegetation of about 284946km^2 in 1985, on the other hand, degraded marshland vegetation was only 31.78% and desert covered about 19.29% and then the Deepwater and shallow water had experienced slight changes as highlighted by (Hadeel et al, 2011). Figure 8 presented the detailed information. While Figure 3 show that the degraded marshland extended up to 46.32% in 2000, which has the highest frequency indicating a very significant level of land cover change, the second is the desert surface which extended up to 145287km^2. Reduction of deep water surface to only 2.31%, shallow water and marshland vegetation reduced to 1.30% and 10.48%, this might be because of intensive human activities in the southern Iraqi wetland as reported by (UNEP, 2001) the wetland degradation processes in both the Central marshland and Al Hammar were accelerated by intensively divided by the use of dykes. Canals of 20-30 km long were constructed to drain the wetland (Figure 3). The rate at which land cover change in the southern Iraqi wetlands has been unusual possibly comparable to the rates of deforestation in the Amazon forest. Figure 9 is showing the level at which the Iraqi wetland ecosystem is desiccated consequently resulted in environmental degradation in the year 2000 (Figure 3). The area of vegetation cover and water surface that existed within the marshes had experienced a tremendous decrease in size and this could be connected to the completion of dams that have a great influence particularly on the hydrological and to the ecosystem as also noted by (Munro & Touron, 1997). Figure 4 &5 show the NDVI and vegetation change over the period of 1985-2000. From the two images the NDVI map was produced based on the vegetation cover characteristics and reflectance from the original imagery. However, the black and white images presented the stronger whiter colour corresponds to denser vegetation cover, on the other hand, darker areas correspond to patchier vegetation or bare ground. The NDVI analysis determines the reduction or increase in vegetation cover, areas defined in black and white indicate a high or low presence of vegetation(Fung & Siu, 2000). The 1985 NDVI image show a wide range of white colour which equally mean extensive vegetation cover, during that time there was many vegetation existed possibly due to less human activities in the marshland (Figure 4). As claimed by (Richardson, 2010). Moreover, the 2000 image show wider coverage of black or grey colour that is indicative of a loss in vegetation cover, consequently led to the rise in the percentage of degraded marshland from 31.78% to 46.32% (Table 2) as indicated by (Richardson & Hussain, 2006). Figure 6 & 7 show the accuracy level based on spectral respond and reflectance of the different land cover types on various wavelength or band, for both Landsat 5 TM and Landsat 7 ETM+.

V. Conclusion And Summary

This study used remotely sensed data (Landsat imagery) to map the southern Iraqi wetland degradation using the supervised and unsupervised techniques to classify land cover types and NDVI analysis for change detection from 1985-2000. The study revealed that there is a significant change that took place within this period of fifteen years. The vegetation cover decreased by 85.37%, desert increased by 46.32%, deep-water surface dropped to only 2.31% and shallow water disappeared. The study revealed that intensive human activities such as dam construction and extensive agriculture possibly led to the collapse of the southern Iraqi wetland.

VI. References

[1]. Abdullah, A. D., Masih, I., van der Zaag, P., Karim, U. F. A., Popescu, I., & Al Suhail, Q. (2015). Shatt al Arab river system under escalating pressure: A preliminary exploration of the issues and options for mitigation. *International Journal of River Basin Management*, *13*(2), 215–227. 10.1080/15715124.2015.1007870

[2]. Adriansen, H. K. (2004). *What happened to the Iraqi Marsh Arabs and their land? The myth about Garden of Eden and the noble savage* (No. 2004: 26). DIIS Working Paper.

[3]. Al-Hilli, M. A., Warner, B. G., Asada, T., & Douabul, A. (2009). An assessment of vegetation and environmental controls in the 1970s of the Mesopotamian wetlands of southern Iraq. *Wetlands Ecology & Management*, *17*(3), 207-223. Doi: 10.1007/s11273-008-9099-1.

[4]. Berakhi, R. O., Oyana, T. J., & Adu-Prah, S. (2014). Land use and land cover change and its implications in Kagera river basin, east Africa.*African Geographical Review*, *34*(3), 209–231. 10.1080/19376812.2014.912140

[5]. Faid, A. M. & Abdulaziz, A. M. (2012). Monitoring land-use change-associated land development using multitemporal Landsat data and geoinformatics in Kom Ombo area, south Egypt. *International Journal of Remote Sensing*, *33*(22), 7024–7046. 10.1080/01431161.2012.697207.

[6]. Fitzpatrick, R. W. (2004). Changes in soil and water characteristics of natural, drained and re-flooded soils in the Mesopotamian marshlands: Implications for land management planning. *CSIRO land and water: client report*.

[7]. Fung, T. & Siu, W. (2000). Environmental quality and its changes, an analysis using NDVI. *International Journal of Remote Sensing*, *21*(5), 1011–1024. 10.1080/014311600210407

[8]. Hadeel, A., Jabbar, M., & Chen, X. (2011). Remote sensing and GIS application in the detection of environmental degradation indicators.*Geo-spatial Information Science*, *14*(1), 39–47. 10.1007/s11806-011-0441-z

[9]. Handal, A. Al- & Hu, C. (2014). MODIS observations of human-induced changes in the Mesopotamian marshes in Iraq. *Wetlands*, *35*(1), 31–40. 10.1007/s13157-014-0590-6.

[10]. Jones, C., Sultan, M., Yan, E., Milewski, A., Hussein, M., Al-Dousari, A., & ... Becker, R. (2008). Hydrologic impacts of engineering projects on the Tigris–Euphrates system and its marshlands. *Journal of Hydrology*, *353*59-75. doi: 10.1016/j.jhydrol.2008.01.029

[11]. Kumar M (2005) Digital image processing. Photogrammetry and Remote Sensing Division. *Indian Institute of Remote Sensing, DehraDun*. http://www.wamis.org/agm/pubs/agm8/Paper-5.pdf.

[12]. Moran, E. F. (2010). Land cover classification in a complex urban-rural landscape with QuickBird imagery. *Photogrammetric engineering and remote sensing*, *76*(10), 1159.

[13]. Munro, D. C. & Touron, H. (1997). The estimation of marshland degradation in southern Iraq using multitemporal Landsat TM images. *International Journal of Remote Sensing*, *18*(7), 1597–1606. 10.1080/014311697218304

[14]. Richardson, C. J., & Hussain, N. A. (2006). Restoring the Garden of Eden: An Ecological Assessment of the Marshes of Iraq. (Cover story). *Bioscience*, *56*(6), 477-489.

[15]. Richardson, C. J. (2010). The Status of Mesopotamian Marsh Restoration in Iraq: A Case Study of Transboundary Water Issues and Internal Water Allocation Problems In K. Korhonen-Kurki & M. Fox (Eds.), *Towards New Solutions in Managing Environmental Crisis* ed., pp. 59–72) Singh, A. (1989). Review article digital change detection techniques using remotely-sensed data. *International Journal of Remote Sensing*, *10*(6), 989–1003. 10.1080 01431168908903939 Finland: Helsinki University Printing House.

[16]. UNEP (2001) *The Mesopotamian Marshlands: Demise of an Ecosystem.* Early Warning and Assessment Technical Report, UNEP/DEWA/TR.01-3 Rev. 1Division of Early Warning and AssessmentUnited Nations Environment ProgrammeNairobi, Kenya.

Muhammad Ali Bukar "Mapping Wetland Degradation in the Iraqi Marshlands for the period 1985-2000 from Landsat Satellite Imagery." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 12.6(2018): 31-38.