Flood Behavior of Al-Hammar Marshes

Sarah T. Yaseen¹, Auday H. Shaban²*, Kareem A. Jasim¹

¹College of Education for pure science, Ibn Al-Haitham, University of Baghdad, Iraq
²College of Science, University of Baghdad, Iraq.

E-mail: auday.h.s@ihcoedu.uobaghdad.edu.iq

Abstract. The marshes of southern Iraq are among the most important and largest wetlands in the Middle East and the world are characterized by the freshness of their waters and their environmental diversity. The marshes have undergone many changes during the past decades and to discover and study these changes, remote sensing data will be used as sources of information and data in this study represented by the Landsat 8 satellite images (OLI), the images were collected for years from 2013 to 2019, and by applying remote sensing techniques and geographic information systems techniques, changes in Al-Hammar marsh were detected during the past seven years, the supervised classification method (maximum likelihood) was applied to classify the region. Were identified six main categories of the land cover (deep water, shallow water, small cane, large cane, plant, soil) using the software (ENVI 5.3), the final maps were produced for classification using (ArcGIS 10.4.1) software, the results showed Significant change in the water content of Al-Hammar marsh and the increase in the proportion of flooding during the year 2019 to the highest rate since 2013. In addition, the results showed the accuracy and success of the supervised classification method (maximum likelihood) in the classification of images as they are considered the best classification methods, the fastest and high accuracy.

Keywords: Remote sensing, Wetland, Al-Hammar marsh, Supervised Classification, Maximum Likelihood, Overall Accuracy.

1. Introduction

Remote sensing is an important and pervasive technology in modern technology science, as this technology can be used and applied to collect data about a target such as the features of the land cover and others and this data is analyzed, interpreted and processed to obtain information from it without direct contact with the target, and remote sensing can be defined as a technique Collecting data on a specific target, such as the Earth's surface, analyzing, interpreting, and processing it and extracting information from it without an actual connection between them[1][2]. It provides a great possibility to monitor and collect data about a specific area or goal for different time periods at the same time and with high accuracy and with simple costs for the purpose of analyzing, interpreting and studying them and discovering the changes that occur during these periods and many other processes provided by this science, it allows the possibility of studying the features of the land cover [3]. These data collected about the target are transferred from the target to the sensor in the form of electromagnetic spectrum as the physical medium between the target and the sensor is the electromagnetic spectrum [4]. In remote sensing, several areas of the electromagnetic spectrum are used through the sensed images where remote sensing deals with both the visible spectrum, the infrared (near, short and thermal) spectrum, th...
microwave, where these images are collected from sources Numerous such as satellites, radars, spacecraft or sensing images carried on board aircraft [5][6]. The wavelengths of these areas of the electromagnetic spectrum are reflected from the target and recorded as a digital number in the image pixels as the images that are dealt with in this technique are multi-spectral digital images that consist of a large number of picture elements (pixels) as each pixel has a specific digital number It represents the amount of the reflected electromagnetic spectrum from the target, the pixel in the image covers a specific area of the region covered by the image [5][7]. Remote sensing provides many and important data on the surface of the earth and its resources, and thus it represents an important and great source for many studies and applications that address the surface of the earth and its various and various features. Urban development, agriculture, and many other applications, using remote sensed data [8][9]. One of the important applications in remote sensing is the study and discovery of changes that occur in wetlands that affect their nature. The diversity in the environmental system and have a great importance in maintaining the balance and presence of wildlife. It is low areas on the surface of the earth that are submerged in water that are either deep or shallow in which many plants grow. These lands may be permanently submerged or seasonally and form a good habitat for different animals such as fish, migratory birds and many other animals. Wetlands exist in different forms on the surface of the ground Including swamps, marshes, shallow lakes, etc. They also differ in terms of the nature of the waters that are submerged, some of which are fresh and salty, and they represent an integrated ecosystem in biological terms, and they are either natural existence or artificial, wetlands constitute about 3-6% of the surface of the earth around the world and represent one of the main ecosystems on the earth's surface [10][11]. Among the important and major wetlands in the world are the Iraqi marshes, which are characterized as natural wetlands with fresh water. These marshes cover a large area in southern Iraq, where they occupy south and central the sedimentary plain in three southern governorates: Basra, Maysan, and DhiQar[12][13]. It also represents the largest natural wetland in the Southwest Asian region [14][8]. There are many marshes in southern Iraq, including permanent ones and seasonal ones, but mainly wetlands in Iraq can be represented by three major and large marshes: Al-Hammar marsh, Central Marshes and Hawizeh marsh [15]. The Iraqi Marshes have undergone great changes during the past forty years for a number of reasons, including drying and building dams, etc., which led to changing many of its features, characteristics, flooded areas, and even its environmental system and biological composition [16]. To study the changes that occurred in Al-Hammar marsh during the time period of 2013-2019, remote sensing and geographic information systems (GIS) techniques are used where the supervised classification method (maximum likelihood) will be used to know the change in the water content and the areas flooded during this period and is this is done by performing image processing on Landsat satellite images (L8), where image processing represents all the processes and applications that are implemented on digital images for analysis, processing, interpretation, and extracting the required information through the use of computers, for image processing multi applications on remote sensing images as classification, environmental assessment, changes detection taking occur in the land cover features and create maps and other [5]. The use of land cover in Dhaka Metropolitan of Bangladesh is studied by using the same supervised classification method as the maximum likelihood of classifying the sensed data and revealing the changes taking place in the region, Dewan 2008[17]. The same objectives of this study but using another program to apply the supervised classification to detect changes is the program (ERDAS), Abdul Jabbar and others 2010[16]. This study is similar to the current study where the supervised classification method (maximum likelihood) is used to classify attributes of the study area and reveal the changes that occurred in it, Soliman 2011[18]. The Landsat satellite imagery is categorized in the same way in this study to uncover changes in Kolkata Wetlands, Seema and others 2012[19]. Similar to the work of this study, where the study area is classified using the supervised classification method (maximum likelihood) and then revealed the changes that occurred, Muhsin and others 2017[13].

2. Classification
Classification is an important application in remote sensing and in image processing, where images are processed and some algorithms are applied to them in order to obtain certain information, and classification can be defined as the process of sorting and distributing image elements (pixels) on the features or classes of land cover based on the numerical value of the units of the image, as each of them possesses a numerical value representing the amount of spectral reflection of the attribute or class present in the image [20]. The classification is very important when dealing with multispectral images that consist of a number of spectral bands, and there are two main types of classification are supervised classification and unsupervised classification [21].

The supervised classification is considered the fastest, broader in use and application and the highest accuracy than the unsupervised classification, it gives very accurate results and close to the reference data that are compared with it when applied by a user with experience and good knowledge of the classified area and the land cover features for it, the supervisory classification provides great potential and freedom for the user in The identification and distribution of image pixels on the land cover categories, it makes the classification process easier and faster, and this type of classification needs in the beginning to identify and choose training sites in the area of interest, i.e. distribute the image pixels to the land cover categories It is distributes according to the spectral reflection of each of them, and then each training site is distinguished by a specific color or symbol, so that it can separate and define the interference regions in the land cover [21][22]. There are many types of supervisory classification including (parallelepiped, minimum distance, mahalanobis distance, maximum likelihood, spectral angle mapper, spectral information divergence, Binary encoding), where the maximum likelihood method will be used in this research paper to classify the Landsat 8 satellite images [23].

3. Maximum likelihood Classification method:

It is the most common and used method and the most accurate supervised classification method in the classification of remote sensed images as it is widely used to classify the features of the land cover in images with false colors, in this method all pixels in the image are classified and assigned to one of the categories of the land cover that have the highest probability [24][25]. In order for the results to be very accurate, the probability threshold limit that does not allow a pixel to be set to a category with a low probability [26]. Must be set. The discrimination functions for all pixels in an image classified in this way are calculated using the following formula:[27],

\[ g_i(x) = \ln P(\omega_i) - \frac{1}{2} \ln |\Sigma_i| - \frac{1}{2} (x - m_i)^T \Sigma_i^{-1} (x - m_i) \quad \ldots \quad \ldots \quad \ldots \quad (1) \]

Where: i: classes, x: dimensional information, \( P(\omega_i) \): Probability of occurrence of the class in the photo (presumably the same for all categories),\( |\Sigma_i| \): Specified for the information covariance matrix in the category(\( \omega_i \)),\( \Sigma_i^{-1} \): Inverse of covariance matrix, \( m_i \): The image classes mean vector.

4. Classification accuracy assessment

Despite the high accuracy of the classification and the proximity of the results of the classification to the real reference data for the study area or the classified target, it is necessary to verify the accuracy and validity of the classification by conducting an assessment of the classification accuracy, which represents an important and final step in the classification process that shows how accurate the classification. Confusion matrix (error matrix) is constructed, which is a matrix consisting of numbers (rows and columns) these numbers represent the classified image units where image pixels (number of image units) classified for each category of land cover are placed in one of the rows and the reference data for each category of land cover is placed in One of the columns for the matrix [28]. There are several methods for assessing classification accuracy such as user accuracy, product accuracy, overall accuracy, and Kappa coefficient. The overall accuracy is the ratio between correctly rated reference points to total reference points [28]. The accuracy of the user is the ratio between the numbers of pixels correctly classified to the total number of pixels in the row, while the product accuracy is the ratio between the numbers of pixels classified correctly to the total number of pixels in column [29]. Thus, the confusion matrix can be written using product accuracy and user accuracy [28]. Another metric that
represents a statistical measure of classification accuracy is the Kappa coefficient that has a value between +1 and -1, so whenever the classification accuracy is high and is close to reference data, its value is close to +1, if either its value is close to zero or negative, then this means that the classification is inaccurate and there is no affinity between it and the reference data. To calculate the overall accuracy, equation (2) is applied. To calculate the Kappa coefficient, equation (3) is applied, respectively [30].

\[
\text{Overall accuracy} = \frac{\text{Total number of correct classified}}{\text{Total number of pixels}} \times 100 \quad \cdots \cdots \cdots \cdots (2)
\]

\[
K = \frac{n \sum_{i=1}^{p} x_{ii} - \sum_{i=1}^{p} (\sum_{i} x_{i} \times x_{i+1})}{n^2 - \sum_{i=1}^{p} (\sum_{i} x_{i} \times x_{i+1})} \quad \cdots \cdots \cdots \cdots (3)
\]

Where:
\( n \) = total number of training pixels. \( p \) = number of classes. \( \sum_{i=1}^{p} x_{ii} \) = total number elements of confusion matrix. \( \sum_{i} x_{i} \times x_{i+1} \) = sum of row \( i \). \( \sum_{i} x_{i} \times x_{i+1} \) = sum of column \( i \).

5. Study area

Al-Hammar marsh is considered one of the main marshes in Iraq and occupies a wide area that extends across three governorates (Basra, DhiQar, Maysan), approximately 300 km south of Baghdad and is located within the coordinates of latitude (31.00 - 31.30) north and longitude (46.24 - 47.18) east, with a length of about 90 km either its width ranges between (25-30) km, ALHammar marsh is a distinctive and important ecosystem with social and economic impact in the region and has great importance and benefit as it represents the habitat for many migratory birds in addition to that the local population depends in their livelihood on the resources of marshes and animals [31].

5. Study area

Al-Hammar marsh is considered one of the main marshes in Iraq and occupies a wide area that extends across three governorates (Basra, DhiQar, Maysan), approximately 300 km south of Baghdad and is located within the coordinates of latitude (31.00 - 31.30) north and longitude (46.24 - 47.18) east, with a length of about 90 km either its width ranges between (25-30) km, ALHammar marsh is a distinctive and important ecosystem with social and economic impact in the region and has great importance and benefit as it represents the habitat for many migratory birds in addition to that the local population depends in their livelihood on the resources of marshes and animals [31].

Methodology

In this study, the changes that occur in the Al-Hammar marsh south of Iraq during the time period from 2013 to 2019 are revealed using remote sensing techniques and geographic information systems(GIS), where the study included classification of the study area and detect the changes in the water content and the percentage of submerged areas of the marsh and the factors causing changes, Using the Landsat 8 satellite images data and comparing it with the reference data taken from the Ministry of Water Resources, the Landsat 8 satellite advantage is that the images provided by it consist of 11 spectral bands.
distributed over two sensors, the first is the Operational Land Imager (OLI) and the second is the Thermal Infrared Sensor (TIRS), the sensor (OLI) senses the first nine bands either the sensor (TIRS) it only senses the last two bands [32][33]. Satellite images with 30m spatial resolution was collected from the United States Geological Survey (https://www.usgs.gov/) website covering the study area with two scenarios and coordinates (Path 166 - Row 39) and (Path 167 - Row 39) all taken during July and for all years that are within the studied time period of 2013-2019 with varying dates. As shown in Table (1) and Figure 2.

| Sensors   | WRS Scene       | Acquisition Dated |
|-----------|-----------------|-------------------|
| Landsat 8 | Path 166 Row 39 | 28/07/2013        |
| Landsat 8 | Path 167 Row 39 | 19/07/2013        |
| Landsat 8 | Path 166 Row 39 | 31/07/2014        |
| Landsat 8 | Path 167 Row 39 | 22/07/2014        |
| Landsat 8 | Path 166 Row 39 | 18/07/2015        |
| Landsat 8 | Path 167 Row 39 | 25/07/2015        |
| Landsat 8 | Path 166 Row 39 | 20/07/2016        |
| Landsat 8 | Path 167 Row 39 | 27/07/2016        |
| Landsat 8 | Path 166 Row 39 | 23/07/2017        |
| Landsat 8 | Path 167 Row 39 | 30/07/2017        |
| Landsat 8 | Path 166 Row 39 | 26/07/2018        |
| Landsat 8 | Path 167 Row 39 | 17/07/2018        |
| Landsat 8 | Path 166 Row 39 | 29/07/2019        |
| Landsat 8 | Path 167 Row 39 | 20/07/2020        |

**Figure 2.** Satellite images for Al-Hammar marsh – Iraq at 2013 before and after mosaic.

The experimental steps of this work are summarized in the following: Mosaic: which is the process of merging the images overlapping with each other in a way that allows the production of a new image covering the entire study area, each band from the first scene was merged with the band that corresponds
to it from the second scene in the mosaic method. After that, the numeric values of the Landsat 8 satellite images are converted from digital number into reflectivity using equation (4) [34].

\[
\rho_{\lambda} = \frac{(M_{\rho} \times Q_{\text{cal}} + A_{\rho})}{\sin \theta} \quad \ldots \quad \ldots \quad \ldots \quad (4)
\]

Where:
- \(\rho_{\lambda}\) = Top of Atmosphere Planetary Reflectance. (Unit less).
- \(M_{\rho}\) = Reflectance multiplicative scaling factor for the band.
- \(A_{\rho}\) = Reflectance additive scaling factor for the band.
- \(Q_{\text{cal}}\) = Level 1 pixel value in DN.
- \(\theta\) = Solar Elevation Angle.

Corrected spectral bands are combined by layer stacking using (ENVI 5.3) software to obtain multi-spectral images (stacked). The color combination (543) is chosen as a color image in pseudo colors, it represents a color image in the form (RBG) with three spectral bands from the Landsat 8 satellite image (near infrared band, red visible band, green visible band), and these are chosen. The color combination, because it is the most suitable color combination, to show the main features of the land cover of the study area which are (water, cane, plant, soil) as shown in Figure (3). The cane has different spectral reflectance than the plant and the cane growth inside the marshes, so, it should be separated.

Figure 3. Color combination (543) applied to Landsat 8 satellite images.

Al-Hammar marsh's area is cut off from the resulting image because the image covers a much larger area than Al-Hammar marsh's area and performs the cutting using (ArcGIS 10.4.1) software by creating a shape file for the boundaries of Al-Hammar marsh. Regions of interest (ROIs) are determined by using (ENVI 5.3) software. Six categories of land cover for the area are identified (deep water, shallow water, small cane, large cane, plant, soil), then the digital classification of the satellite images in which the categories were identified the supervised classification method (maximum likelihood), as shown in Figure 4.
6. Results and Discussion
The results obtained by conducting the methodology on the classified images that were conducted to change detection in the water content and the submerging ratios of Al-Hammar marsh in southern Iraq during the period from 2013 to 2019.

Figure (5) represents the outputs of the supervised classification process (maximum likelihood) that classified the land cover of the study area (deep water, shallow water, small cane, large cane, plant, soil), after the classification procedure, the percentage of the water area is calculated by Collecting percentages for each area (deep water, shallow water, small cane) and for all years respectively, Table (2) shows the percentage of the area of each of the swamp areas, graph (1) shows the change in the water level in the marshes.
Figure 5: Supervised classification (maximum likelihood) of color combination (543) for years (a. 2013-2013 b. 2014 c. 2015 d. 2016 e. 2017 f. 2018 g. 2019).
Table 2. The class’s area for Supervised classification (maximum likelihood) of color combination (543) for the years 2013 – 2019.

| Classes Year | Unclassified m² | Water m² | Cane m² | Plant m² | Soil m² |
|--------------|----------------|----------|---------|----------|---------|
| 2013         | 0              | 791,687,700 | 19,880,100 | 197,136,900 | 2,236,341,600 |
| 2014         | 0              | 1,067,350,500 | 123,702,300 | 285,183,000 | 1,768,810,500 |
| 2015         | 0              | 667,788,300 | 37,149,300 | 463,361,400 | 2,076,747,300 |
| 2016         | 0              | 423,976,500 | 425,566,800 | 368,420,400 | 2,027,082,600 |
| 2017         | 0              | 746,451,900 | 55,395,000 | 394,592,400 | 2,048,607,000 |
| 2018         | 0              | 671,757,300 | 3,850,200 | 446,243,400 | 2,123,195,400 |
| 2019         | 0              | 1,269,193,500 | 36,064,800 | 368,053,200 | 1,571,734,800 |

Figure 6. The Differences in the surface area of the water content in Al-Hammar marsh versus the years 2013 to 2019.

The results that appeared to us and by studying the figures and tables mentioned above, when comparing with reference data taken from the Ministry of Water Resources for the study area, we find that the color combination that was chosen and the classification method used to classify the satellite images, which is the supervised classification method (maximum likelihood) gave high accuracy results very close to Real data and what confirms this are when conducting an assessment of classification accuracy and calculating the overall accuracy and Kappa coefficient for all the classified images, a very high accuracy was obtained, as shown in Table (3). where it was found that there were a lot of changes that occurred in Al-Hammar marsh as the water content and the inundation percentage , as these rates varied during the successive years from 2013 to 2019 by increasing and decreasing, where we note that the percentage of water content rose slightly in the year 2014 from what was during 2013 either during the subsequent years either the percentage of water began to decline gradually and unevenly reached the lowest in the
year 2018, where the water covering the area of the marsh became scarce, and since the beginning of
the year 2019 the percentage of water began to increase in the marshes significantly, until in May it
reached twice what it was during the same month of 2018 as a result of the flood wave and torrential
rains that swept the country.

Table 3. Overall accuracy values and Kappa coefficients for supervised classification methods in
color combination (543) for all years.

| Year | Overall accuracy | Kappa coefficient (K) | Error percentage |
|------|-----------------|----------------------|-----------------|
| 2013 | 98.9698         | 0.988                | 1.0302          |
| 2014 | 99.9323         | 0.9992               | 0.0677          |
| 2015 | 99.9324         | 0.9992               | 0.0676          |
| 2016 | 85.6017         | 0.8324               | 14.3983         |
| 2017 | 99.6608         | 0.996                | 0.3392          |
| 2018 | 96.2526         | 0.9562               | 3.7474          |
| 2019 | 99.862          | 0.9984               | 0.138           |

7. Conclusions
We conclude from the results obtained that the color combination (543) chosen in this study, which is
the spectral bands (near infrared band, red visible band, green visible band) are the best color
combinations that can be applied to determine the features of the land cover of the marsh region, as the
required features are well and clearly demonstrated, in addition to that we conclude that the supervised
classification method (maximum likelihood) is the best and most accurate classification method that has
been applied to classify the land cover features in an easy, fast and highly accurate manner because it
gave very close results to the reference data with a very low error rate, reaching 0.0676%.

8. References
[1] Dawod GM 2015 Fundamentals and Applications of Remote Sensing (in Arabic), Cairo, Egypt, 2015.
[2] Schowengerdt RA 2007 Remote Sensing: Models and Methods for Image Processing, Third
Edition, 2007.
[3] Sharma AK and Shukla JB 2015 A Remote Sensing and GIS Based Approach to Evaluate the
GroundWater Prospects of Baghain Watershed, Panna and Satna Districts of M.P., India: A
Case Study J. Geol. Soc. India, 86 733-741, 2015.
[4] Hadi FA and Abdulwahhab RA 2012 Preparing a Map for the Surface Temperature Distribution
of Baghdad and the Marsh Area Using Remote Sensing Technique Iraqi J. Sci. 53, 1006-1016.
[5] Liu JG and Mason PJ 2016 Image Processing and GIS for Remote Sensing Techniques and
applications, second edition, John Wiley & Sons, Ltd.
[6] López-Serrano PM, Corral-Rivas JJ, Diaz-Varela RA, Alvarez-Gonzalez JG and Lopez-Sanchez
CA 2016 Evaluation of Radiometric and Atmospheric Correction Algorithms for
Aboveground Forest Biomass Estimation Using Landsat 5 TM Data Remote Sensing, 8 2.
[7] Petrou M and Petrou C 2010 Image Processing: The Fundamentals Second Edition, John Wiley
& Sons.
[8] Saleh SAH 2012 Temporal Change Detection of AL- Hammar Marsh – IRAQ Using Remote
Sensing Techniques Global J. Human Soc. Sci. Geogr. Environ. GeoSci. 12 6.
[9] Ghosh S, Biswas S, Sarkar D and Sarkar PP 2014 A Tutorial on Different Classification Techniques for Remotely Sensed Imagery Datasets Smart Comp. Rev. 4 34.

[10] Ghabadi Y, Pradhan B, Kabir K, Pirasteh S, Shafri HZM and Sayyad GA 2012 Use of Multi-Temporal Remote Sensing Data and GIS for Wetland Change Monitoring and Degradation IEEE Colloquium Human. Sci. Eng. Res. 103.

[11] Malekmohammadi B and RahimiBlouchi L 2014 Ecological risk assessment of wetland ecosystems using Multi Criteria Decision Making and Geographic Information System Ecol. Indic. 41 133.

[12] Al-Rubaie A and Kwyes A 2008 Ecological And Morphological Study Of Iraqi Southern Marshes Marina Mesopot. 23 437.

[13] Muhsi IJ and Kadhim MJabbar 2017 Monitoring of south Iraq marshes using classification and change detection techniques Iraqi J. Physics 15 78.

[14] Muhsin IJ, Mashe FK and Tawfeeq RJ 2011 Monitoring the Vegetation and Water Content of Al-Hammar Marsh Using Remote Sensing Techniques Baghdad Sci. J. 8 646.

[15] Hussein ZE, Hasan RH and Aziz NA 2018 Detecting the Changes of AL-Hawizeh Marshland and Surrounding Areas Using GIS and Remote Sensing Techniques Assoc. Arab Univ. J. Eng. Sci. 25 53.

[16] Shimal S and Shaban AH 2019 Estimation of groundwater pollution in Baiji / Salah Al-Deen province Iraq AIP Conf. Proc. 1968 020058-(1–7).

[17] Dewan AM and Yamaguchi Y 2008 Using remote sensing and GIS to detect and monitor land use and land cover change in Dhaka Metropolitan of Bangladesh during 1960–2005 Environ. Monit. Assess. 150 237.

[18] Soliman G and Soussa H 2011 Wetland change detection in Nile swamps of southern Sudan using multitemporal satellite imagery J. Appl. Remote Sens. 5 2011.

[19] Parivaral R and Nagarajan B 2014 Supervised Classification Methods For Object Identification Using Google Map Image International J. Eng. Sci. Manag. Res. 1 71.

[20] Parihar, SM, Sarkar S, Dutta A, Sharma S and Dutta T 2013 Characterizing wetland dynamics: a post-classification change detection analysis of the East Kolkata Wetlands using open source satellite data Geocarto Int. 28 273.

[21] Weng Q 2012 Remote sensing of impervious surfaces in the urban areas: Requirements, methods and trends Remote Sens. Environ. 117 34.

[22] Parivallal R and Nagarajan B 2014 Supervised Classification Methods For Object Identification Using Google Map Image International J. Eng. Sci. Manag. Res. 1 71.

[23] Shivali AK and Vishakha VK 2013 Supervised and Unsupervised Neural Network for Classification of Satellite Images Int. J. Comp. Appl. 25.

[24] Kumar M 2014 Digital Image Processing Satellite Remote Sensing and GIS Applications in Agricultural Meteorology 81.

[25] Tso B and Mather PM 2009 Classification Methods For Remotely Sensed Data, Second Edition, Boca Raton London New York: Taylor & Francis Group, LLC.

[26] Shaban AH, Resen AK and Bassil N 2020 Weibull parameters evaluation by different methods for windmills farms Energy Rep. 6 188.

[27] Richards JA 2013 Remote Sensing Digital Image Analysis, Fifth Edition, New York, London: Springer-Verlag Berlin Heidelberg, 2013.

[28] Congalton RG 1991 A Review of Assessing the Accuracy of Classifications of Remotely Sensed Data Remote Sens. Environ. 37 35.
[29] Sivanandam SN, Sumathi S and Deepa SN 2007 *Introduction to Fuzzy Logic using MATLAB*, New York: Springer-Verlag Berlin Heidelberg.

[30] Taufik A, Ahmad SSS 2016 Land cover classification of Landsat 8 satellite data based on Fuzzy Logic approach *IOP Conf. Series: Earth Environ.Sci.* **37**.

[31] Ziboon ART, Hammed SA and Abbas A 2010 Using Remote Sensing and GIS Tichenck to Study Soil Chemical Properties for Hour Al-Hammar (South of Iraq) *Eng. Tech. J.* **28** 6458.

[32] Acharya TD and Yang I 2015 Exploring Landsat 8 *Int. J. IT, Engin. Appl. Sci. Res. (IJIEASR)* **4**.

[33] Knight EJ and Kvaran G 2014 Landsat-8 Operational Land Imager Design, Characterization and Performance *Remotesensing* **6** 10286.

[34] Zanter K 2016 *Landsat 8 (L8) Data Users Handbook*, Version 2.0, USGS, science for a changing world.