Using Hybrid Technique to Study the Changes in Al-Ahwaz Marshal Region with K-L Transformation Analysis and Unsupervised Classification process

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Abstract: In this paper, six bands data sets taken from the landsat-7 ETM (Enhanced Thematic Mapper).To determine the changes which occur in Al-ahwaz Marshal during 2000 and 2013. the K-L transformation has been used to detect the changes which occur during the years(2000 and 2013). The unsupervised classification process which is the modified (K-mean) is used to classify the changes occur in the marshal region and the area surrounding it. In addition the subtraction method which is one of the traditional change detection technique is used here with the K-L transformation and unsupervised classification. The hybrid methods which are the K-L transformation, the ratio with the K-mean has been implemented to produced the best change detection regions.

Keyword: PCA, K-mean, Statistical parameters, Rationing image

Introduction: Remote sensing can be defined as the collection and interpretation of information about an object without being in physical contact with the object. Aircraft and satellites are the common platforms for remote sensing of the earth and its natural resources **[1]**. Remote sensing can generally used to study the change detection which occur during different time. There are different methods which can be used to monitoring the changes. The most common one is the K-L transformation or which is also known as principal component analysis also, the classification process gives good indication about the changes which occurs during the years, the traditional change detection technique which is image ratio is an old method to study the changes during years. The best unsupervised classification method is the K-mean. The hybrid collection of these three methods gives a good result for studying the changes [2].

Study Area: Maysan is one of Iraq's eighteen provinces, it lies in southeastern section of Iraq, within the precipitation valley. The total area of the province is 16072 square kilometers representing 3.7% of the total area of Iraq. The total population in the province of Maysan is about 920,315 people living and resettle differentiated between rural and urban, and it is comprised of 6 districts and 9 regions .This province is bordered from the north by the Waist Province, from the east by Iran, from the west by Dhi Qar province, and from the south by Basra province figure (1). Regarding its astronomical

location, it lies between latitudes 35"15 – 32"45 north and longitudes 46"30 – 47"30 east **[3]** .

Figure (1) Maysan Province.

The geographical nature of the province is divided between land and water, where the marshlands form more than 40% of the total area extending between its southern and southeastern parts as well as the southwestern part. In addition to that, Degla River flows in the middle of the province, with its numerous branches such as Al-Magar River, al-Mashrah, and Al-Amara, in addition to many branches originating from the eastern side of the province. As for the land areas of the province, they are characterized by being flat in most part, except for some of the eastern areas bordering Iran, which are characterized by the presence of hills that are considered an extension to the Hamreen Mountain Series.

With respect to the features of the surface, it includes several forms, the most important of which are the Degla River banks and its high streams, the low riverbed areas, as well as the marshlands and swamp areas that were dried up during the previous regime, but efforts now continue to rehabilitate them once again. There are also sand dune hills on the western and northeastern sides, some are fixed and others mobile. There is also a series of high hills that extends along the international borders with the Islamic Republic of Iran, and whose height exceeds (135m) above sea level in some areas. Ripples of valleys lie at the bases of those hills. The province climate also the annual rate of maximum temperature is 31.5 degrees centigrade, and the minimum temperature is 17.1 degrees centigrade, With respect to rain, the total annual rainfall is 161mm, falling during the period from October till March, and rarely falls during the remaining months of the year . and various types of winds that blow over Maysan**[3]** .

K-L Transformation: The K-L transformation which is also known as Principal Component Analysis (PCA) is the general name for a technique which uses mathematical

principles to transforms a number of possibly correlated variables into a smaller number of variables called principal components[3]. Principal Component Analysis (PCA) is the transformation of the multivariate data to a new set of components where data variation can be expressed by a first few components. PCA achieves this by removing the redundancy in the data set. This redundancy is quantified by the correlation of the variables. Hence, PCA transforms a correlated set of data to an uncorrelated set[4][5].

The mean position of the pixels in the space is defined by the expected value of the pixel vector x, according to equation (1)

$$m = \varepsilon\{x\} = \frac{1}{k}\sum_{k=1}^{k} x_k \qquad \text{.....(1)}$$

Where(m) is the mean pixel vector and the$x_k$are the individual pixel vectors of total number k; ε is the expectation operator. While the mean vector is useful to define the average or expected position of the pixels in multispectral vector space, it is the value to have available means by which their scatter or spread is described. This is the role of the covariance matrix which is defined as covariance matrix **[6].**

The covariance matrix takes the form of correlation matrix whose elements represented the covariance between the images. The diagonal elements of covariance matrix are the variance of each element.

$$\Sigma_x = \begin{bmatrix} c_{11}c_{12}c_{13} & \dots & c_{1j} \\ c_{21}c_{22}c_{23} & \dots & c_{2j} \\ c_{31}c_{32}c_{33} & \dots & c_{3j} \\ \dots \quad \dots & \dots & \dots \quad \dots \\ c_{i1}c_{i2}c_{i3} & \dots & c_{ij} \end{bmatrix} \qquad \dots\dots\dots \text{(2)}$$

The eigenvector and eigenvalue of the covariance matrix denoted by a_i and λ_i respectively where i= 1, 2, 3……$N \times N$, where N is the dimension of the image.

The transformation matrix consists of the eigenvector of the covariance matrix.

$$\mathrm{A} = \begin{bmatrix} a_{11}a_{12}a_{13} & \dots & a_{1N} \\ a_{21}a_{22}a_{23} & \dots & a_{2N} \\ a_{31} \quad \dots \quad \dots \quad \dots & & a_{3N} \\ \dots \quad \dots \quad \dots \quad \dots & & \dots \\ a_{N1}a_{N2}a_{N3} & \dots & a_{N^2} \end{bmatrix} \qquad \dots\dots\dots \text{(3)}$$

Where A is unity matrix such that$A^{-1} = A^T$.

To compute the principal component the covariance matrix should be diagonalized.

$$A\,\Sigma_x\,A^T = \begin{bmatrix} \lambda & 0 & 0 & \dots & 0 \\ 0 & \lambda_2 & 0 & \dots & 0 \\ 0 & 0 & \lambda_3 & \dots & 0 \\ \vdots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & \lambda_{N^2} \end{bmatrix} \quad \dots\dots\dots (4)$$

The Eigen value are $\lambda_1 \dots\dots\dots \lambda_N$ which are uncorrelated **[7][2]** .

PCA has traditionally been used in remote sensing as a means of data compaction. For a typical multispectral image band set, it is common to find that the first two or three components are able to explain virtually all of the original variability in reflectance values. Later components thus tend to be dominated by noise effects. By rejecting these later components, the volume of data is reduced with no appreciable loss of information. Given that the later components are dominated by noise, it is also possible to use PCA as a noise removal technique[**8]**.

Image Division

Ratio images are one of the most commonly used transformations applied to remotely sensed images. Image ratioing consists of dividing the pixel values of one image by the corresponding pixel values in a second image. The two images must re-scaled in the same size **[9]**.

This has many advantages like reduction of the undesirable effects on radiance values which may result either owing to variable illumination or due to varying topography. Also, different aspects of spectral reflectance curves of different earth surface cover types can be brought out by this technique of image ratio **[9]**.

Division or ratioing of images is probably the arithmetic operation that is most widely applied to images in geological, ecological and agricultural applications of remote sensing, for the division operation is used to detect the magnitude of the differences between spectral bands. This can be represented by equation(5) **,[9]**[**10]**.

$$I_r(x,y) = I_1(x,y)/I_2(x,y). \dots\dots\dots (5)$$

Where

I_1=represents the first image
I_2=represents the second image
I_r=represents the result of image ratioing

Modified K-mean: In our study the modified k-mean clustering which depend on the color and distance of the classes has been used. The classes are grouped depend on the color and distance.

$$\boldsymbol{p} = \sum_{\boldsymbol{j=1}}^{\boldsymbol{k}} \sum_{\boldsymbol{i \in S_j}} distance\left(\boldsymbol{x_i}^{(j)}, \boldsymbol{c_j}\right) \quad \ldots\ldots\ldots (6)$$

Where *distance* is measured between points $\boldsymbol{x_i}^{(j)}$ and the cluster center $\boldsymbol{c_j}$, $\boldsymbol{S_j}$ is set containing elements of cluster $\boldsymbol{j}$ and $\boldsymbol{k}$ is number of clusters. Algorithm consists of following steps [**11**] :

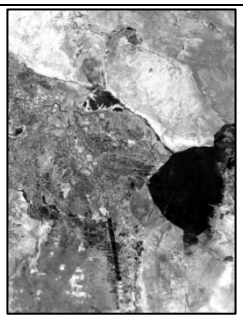
1.In a set of *N* points , corresponding to image pixels , choose $\boldsymbol{k}$ points as initial cluster centers (centroids)$\boldsymbol{c_j}$.

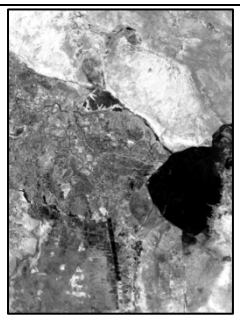
2.Assign each point to nearest cluster$\boldsymbol{S_j}$ based on its distance from cluster center $\boldsymbol{c_j}$.

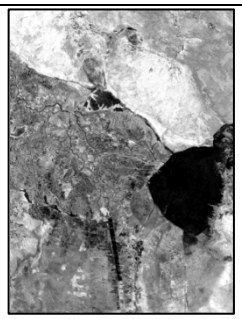
3.For each cluster$\boldsymbol{S_j}$ compute a meanμ_j of each cluster and set the mean as new cluster center $\left(c_j = \mu_j\right)$.

4.Repeat the steps 2 and 3 until the centroids no longer move.

Methodology: This search focused on detecting the changes occur during (2000 and 2013). Six bands have been taken for the south of Iraq. The first method which is used to detect the changes is the PCA, figure(2) shows the six bands images for south eastern section of Iraq for two different time, figure(3) shows the PCA of the images shown in figure(2).


Band 1of study area 2000

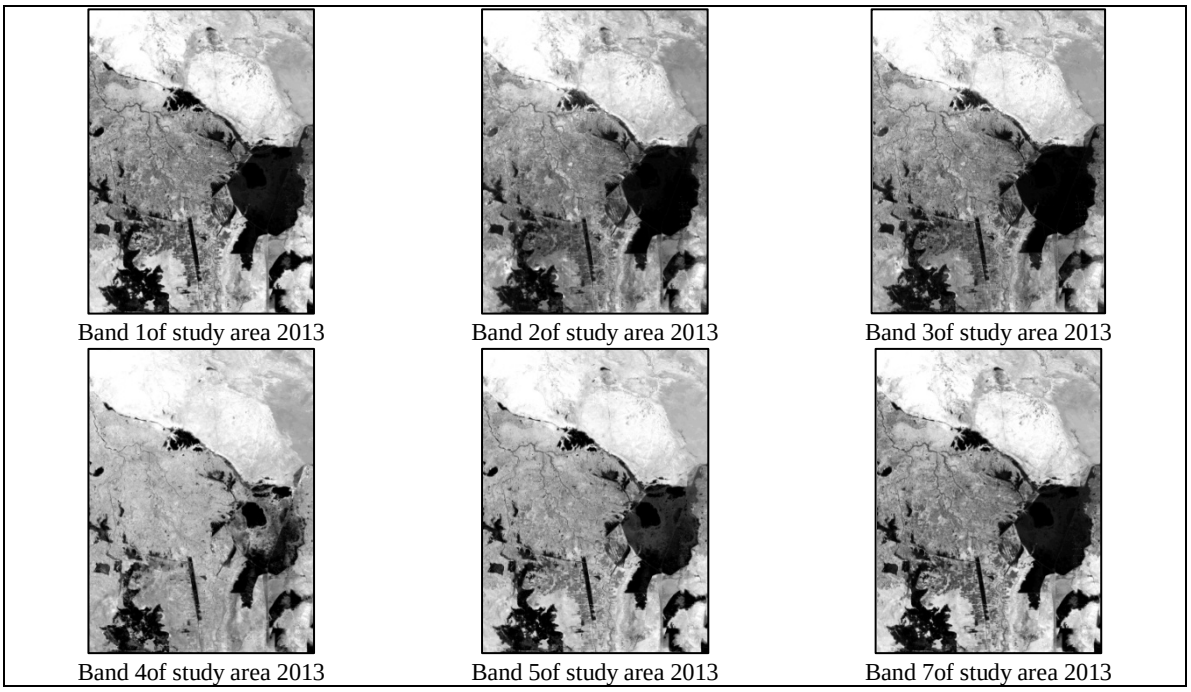

Band 2of study area 2000


Band 3of study area 2000


Band 4of study area 2000


Band 5of study area 2000


Band 7of study area 2000

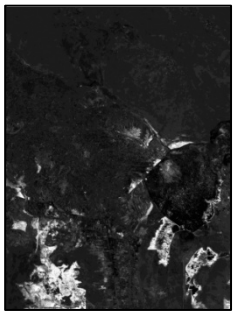


Figure(2) shows the six bands images for southeastern section of Iraq (2000,2013).

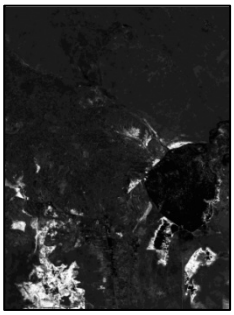
Image Ratioing

Image Ratio (IR) is one of the simplest and quickest change detection methods. We use this procedure in our work by divided the images of year 2000 to the corresponding images of year 2013 in landsat-7 ETM. (Band Pair Ratioing images (BPR)). Which is band (1) in 2000 divided to band (1) in 2013, thus, the operation was carried on all the bands in Figure(2) .

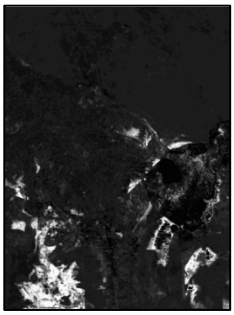
Values IR less than or greater than 1 are interpretable showing that there have been no change occurred. In the changed region, the ratio will be much greater than 1 or far less than 1 according to the different direction of changes.



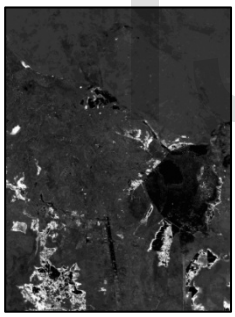
BPR1 of image ratio (2000 , 2013).



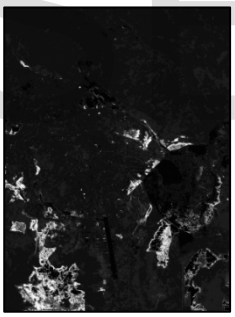
BPR2 of image ratio (2000 , 2013).



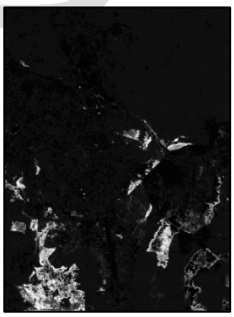
BPR3 of image ratio (2000 , 2013).



BPR4 of image ratio (2000 , 2013).



BPR5 of image ratio (2000 , 2013).



BPR6 of image ratio (2000 , 2013).

Figure (3) shows the Band Pair Ratio for study area.

PCA of Band-Pair Ratio Images (PCR)

Ratio images were obtained by dividing the 2013 images by the corresponding images in 2000. This will result in six images corresponding to Landsat-7 ETM+ bands 1, 2, 3 and 7. Each Band-Pair Ratio images (BPR) usually contains change information. The PCA was applied to the processed ratio images, since ratio is one of the methods used for studying the changes. Result of change detection using PCA, black denotes no changes, white stands for new changes and gray for changed. The PCR are shown in the Figure (4)).

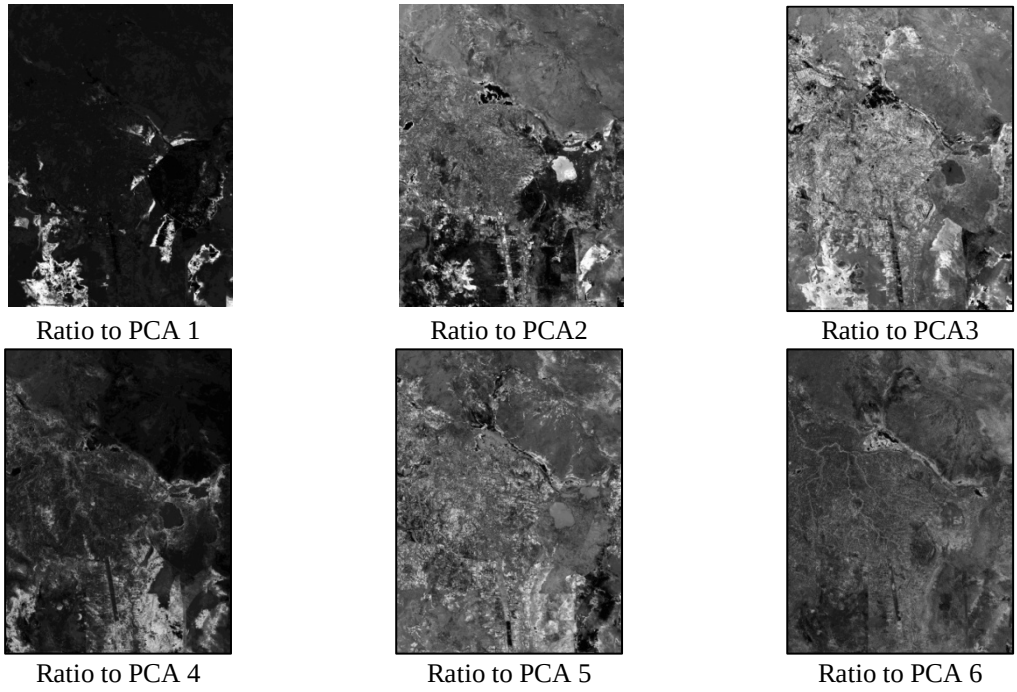
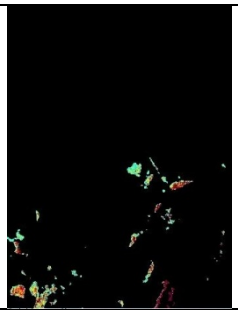
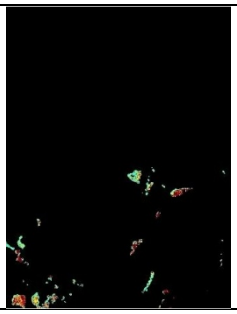
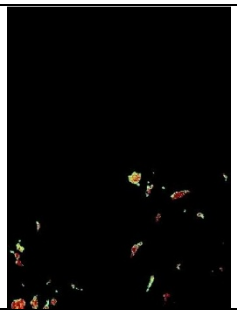


Figure (4)The Ratio to PCA for study area.

Classification Of Image Ratio

The image ratio is one of the methods which used in change detection process. the ratio of the pair of bands for different year (2000 and 2013) have been obtained . The result is colored then using these images in the K-means classification process, these can be seen in figure (5). Table (1) shows the statistical properties for each class . Which give indication about the changes since these images are just the changes between the 2000 and 2013.

Class of BPR 1	Class of BPR 2	Class of BPR 3
		
Class of BPR 4	Class of BPR 5	Class of BPR 7

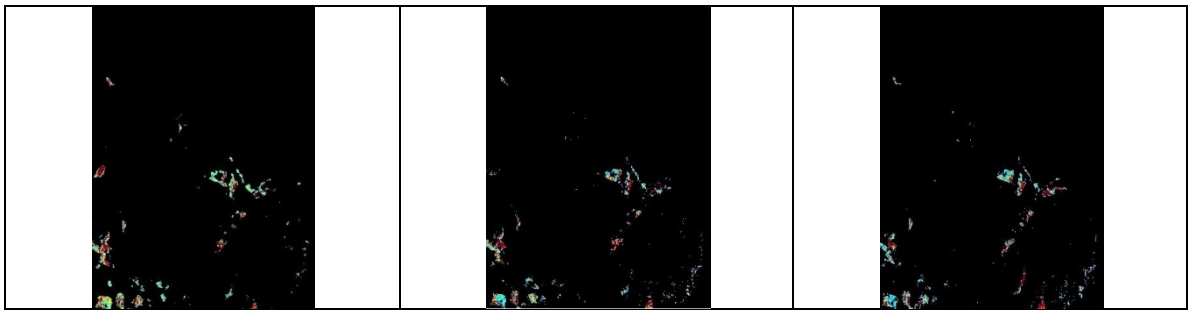
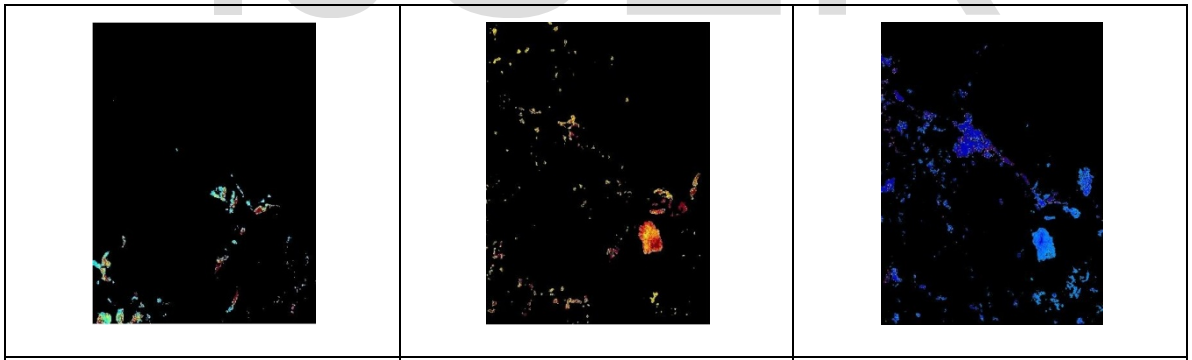


Figure (5)Shows The Classification of The Images Ratio

PCR Classification (classification of PCA after Images Ratio)

The principal component of the image ratio process gives the result for the most component which hold the changes in the area between the different years. so one can see we have only three component because the other (PCs) appear block it does not carry any information so instead of using six band one can use only three PCs which have the most information in the (BPR) for the six bands, figure(6) shows the classification of PCR . Table (1). Shows the statistical properties for these classes which represent the changes in the area.



Class of PCR 1	Class of PCR 2	Class of PCR 3

Figure(6) Shows the Classification of PCR .

Table (1) shows the statistical properties of the classification of Image ratio.

Class	Area	mean	Correlation	Stander devation
PC1	13564	0. 0216	0. 7357	0. 1159
PC2	23823	0. 0192	0.8342	0.0901
PC3	34197	0. 0214	0.9234	0.0693
Class1	12777	0. 0161	0.8818	0.0919
Class2	10968	0. 0135	0. 7481	0. 0851
Class3	9921	0. 0098	0. 7942	0. 0704
Class4	15971	0. 0144	0. 9305	0. 0829
Class5	16348	0. 0145	0. 8019	0. 0811
Class6	14733	0. 0124	0.8993	0.0728

Figure (7)Area of classes of Image ratio using K-Mean classifier technique.

Conclusion: This search Try to show the changes that occur between 2000 and 2013, the idea behind this search is to show how the areas changed the Al-Ahwaz Marshal has

changed in structure this is shown clearly in the classes and the statistical features. The PCA of the ratio of six bands during 2000 and 2013 have been taken but only PCR1, PCR2 and PCR3 has implemented in the K-mean because just these PCs gives result about the changes as we know that the first PCs contain the most information of the changed area, figure(7) shows the statistical distribution of the changed area in each class .

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