

## ***Change Detection of Bakhtegan Lake, Fars Province, During 1956-2007***

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### **Abstract**

Change detection is process of identifying differences in the state of an object or phenomenon by observing it at different times when it can play an important role in regional planning. This study is an integration of remote sensing data and Geographic Information System in order to detect changes of land use/land cover around the Bakhtegan Lake in Fars province from 1956 to 2007. After geometric and atmospheric corrections, we have classified satellite images in five categories of water zone, land farming, shrubbery, bare and salt lands using maximum likelihood algorithm. Then, we have compared the output images using post- classification method. This method leads to calculating rates of changes. We have also maintained the effect of rainfall oscillation on water lake area because it has huge effect on ecologic condition of the lakes in semi-arid regions. Results showed whenever lake water decreases in a period of time, bare and saline lands increase, which correspond the dryness of the lake. Comparing water lake areas during a period of 51 years indicates a total decrease of 296 square kilometers from the water body of the lake. Calculated overall accuracy and kappa coefficients for output results showed maximum accuracy in classification of TM data and minimum accuracy for MSS images.

### **Introduction**

The Bakhtegan Lake is the second largest lake of Iran with a length of 77 km, average width of 10 km and an area of about 750 km<sup>2</sup>. It is located in eastern area of Fars province.

In this study the aerial images of 1/50000 zones where have been taken from the zone on 3/06/1956 as well as satellite images of ETM 13/05/2005, MSS 28/06/1976, TM 9/05/1990, and ASTER 15/06/2007 have been used as the material. The changes related to water width of lake as well as covering changes around the lake of Bakhtegan have been studied during time period from 1956 to 2007 and their relation was determined with the study of precipitation rate of the period.

### **Methods**

In this research the aerial images of 1/50000 related to the year 1956 (oldest accessible source) as well as the images of MSS in 1976, the TM of 1990, ETM of 2005 and the ASTER of 2007 related to Bakhtegan lake changes and the range around it have been studied during time period of 1956-2007. First, the aerial images have been used to prepare land use and land cover maps and to determine Lake Boundary in 1956. As two or more images are used in change detection methods and as these images should completely be coinciding with each other geometrically, they have been used by two hybrid methods that are the combination of image repairing methods to map and stabilize the images. First, the ETM image have been corrected geometrically based on 1/25000 topography maps then all images have been stabilized on this image. Re-sampling has been done to create the new image by using the prevalent closest neighborhood method. The internal average relative reflectance has been used in order to achieve an atmospheric correction and the images have been classified after correcting. Generally, the classification methods are divided into parametric, non parametric and non metric groups. The parametric classification method has considered the statistical distribution of educational data in image classes and uses a statistical model to distribute pixels in these classes. One of the most prevalent methods of parametric classification, the maximum likelihood method, has been used in this research and its accuracy have been evaluated and studied. The maximum likelihood algorithm allocates each unknown pixel to the most likely class. This method supposes that the distribution of educating data is in normal form in each class. In this

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article the images from different dates have been grouped into five classes of water width, agricultural covering, shrubbery, bare and saline lands. The water width class due to differences in water reflection in different depths has been divided into three parts, low depth, medium and deep and their total was considered as water width. After changing the outputs format to suitable format in geographic information system, the land covering area has been calculated separately in each time phase. The post processing method, considered as the most prevalent qualitative methods has been used to statistically evaluate the changes. In this method, at first the images of different dates are classified by one of the prevalent methods and following that, the corresponding pixels of images are compared to each other. Then digital results are presented and analyzed in confusion matrix. The images are also compared two by two to detect the changes in the study area. To compare the land covering in two time phases of 1956 and 2007, a ready GIS map, obtained from 1/50000 aerial images is compared with ASTER image to calculate rates of changes in a 51 years time distance. Then the accuracy of classification is calculated for different images using the parameters of general accuracy and Kappa coefficient calculated for output data. In the following to determine effect of precipitation on the lake water rate, the annual average rainfall in the period is calculated and its relation with water width of the lake is studied.

### Discussion

The interpretation of aerial images from 1956 and MSS satellite images processing in 1976, TM of 1990, ETM of 2005, ASTER of 2007, achieved the land use and land cover maps related to around Bakhtegan Lake in five classes of water width, agricultural cover, shrubbery, bare and saline lands in related years. The land use and land cover maps have indicated that the water width class has the maximum area of change compared with other classes and the change tone is not a linear process; the major known reason is the oscillation in precipitation. As the oscillation has the maximum effect on the water width changes and ecological conditions of the lake, it is strived to be dealt with in more details. The data from four rain gauging stations of Arsanjan, Neiriz, Abadeh tashk and Sahl Abad has been used to determine the effect of rainfall oscillation on water width area of Bakhtegan Lake. Due to the lack of data related to rainfall before 1976; the average annual precipitation was calculated for time period of 1976-2007 and it has been compared with water width change in lake. The surveys has indicated that in the time periods with low precipitation rate, the water width area of the lake has been decreased and during the time period of 1990-2005 when the annual precipitation rate was maximum, the Bakhtegan Lake also has the maximum water width area. To evaluate the accuracy, the educational samples of the zone using the topographical maps of 1/50000 and 1/25000 and the satellite images is determined. After data classification, the detection accuracy of each image is calculated using the parameters of general accuracy and Kappa coefficient of confusion matrix. The overall accuracy and Kappa coefficients for image are determined as 59/6 % and 0/54 % for MSS, 92/3 and 0/90 for TM image, 93/9% and 0/92 for ETM and 92.7% and 90% for ASTER images. The producer's accuracy related to each of the specified zones in image is obtained from the division of the number of the pixels that are placed in that class by the detection changing method, (Diagonal elements of confusion matrix) by the whole existing pixels in that classe which are existed in reference data. The user accuracy is obtained from the division of the number of the pixels (that are placed in that class using the detection changing method) by the number of the pixels allocated to that class using detection changing method. The results indicated that most of the data groups have been classified with high accuracy.

### Conclusion

To determine the land use and land covering changes in the limited area of Bakhtegan Lake, the maximum likelihood algorithm has been implemented on MSS satellite images in 1976, TM in 1990, ETM in 2005 and ASTER in 2007 and the images have been compared two by two. In addition, to determine the land use and land cover changes in the time period of 1956-2007, the GIS ready map resulted from the interpretation of 1/50000 aerial images have been compared with the similar map resulted from the classification of ASTER image. The studies have indicated that during a time period whenever there is a low precipitation rate, the water width area of the lake has also been reduced and during time period of 1990-2005 when the water width area has been increased, the under cultivation area indicated a decrease due to water salinity of the lake. In addition, the change of saline land area is in relation to water width area of the lake as during the time period of 1976-1990 when the lake has minimum quantity of water the width of saline land area was maximum and during the time period of 1390-2005 when the lake water is maximum, the width of saline land area decreases. The change detection during time period of 1956-2007 has indicated that the area of water width and shrubby covering around the lake has a decrease of 296 and 5/5 square km<sup>2</sup>, respectively. However, the bare lands, the agricultural covering and the width of saline lands had an increase of 130, 12 and 71 square km<sup>2</sup>, respectively.

**Keywords:** ASTER, Bakhtegan Lake, change detection, land use/land cover, landsat.