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ORIGINAL ARTICLE

Study of Land Use Changes in AmirKelayeh Wetland using Remote Sensing Techniques (From 1981 to 2011)

Firoozeh Sedigh Chaafjiri[1], Hassan KarimZadegan[2], Seyed Armin Hashemi[3], Mahsa Hakimi Abed[4]
[1] Department of Forestry ,LahijanBranch ,Islamic Azad University ,Lahijan ,Iran
[3]Department of Forestry, Lahijan Branch ,Islamic Azad University ,Lahijan ,Iran
[2,4]Department of Environment, Lahijan Branch ,Islamic Azad University ,Lahijan ,Iran
Email: firuzeh2020@yahoo.com

ABSTRACT
Detecting changes is one of the basic needs in the management and assessment of natural resources. Providing maps of land use and land cover in order to gain information about the existing types of land use and planning for appropriate land use form the basis for optimum utilization of available resources on the earth. AmirKelayeh Wetland, with an area of approximately 1,131.6 acres, is located 30 km north of the city of Lahijan.MSS (1978) and the IRS (2007) satellite imagery was used for investigating the changes in land use of AmirKelayeh Wetland through a supervised classification method. The map of land use in Wetland in 1978 indicated three types of land use, namely: paddy fields, water lagoon areas and canebrake. The map of land use in 2007 indicated another type of land use, i.e. forest, besides the three given above. Changes occurred during this period mostly consist of a 48 percent reduction in canebrake and a 25 percent land use change to forest. The region was intact in 1978 in terms of land use; but in 2007, the extent of taking over lands and land use change to paddy fields increased 22 percent. Land use change from canebrake to paddy fields was due to the lack of water channels in wetland margins. Indigenous people took over lands and changed the type of land use by plowing the land and destroying the canebrake.
433 acres (38.3%) of the total land did not undergo land use change and were in the previous state. The remaining 698 acres (61.7 percent) underwent land use change, 111.75 acres of which included change from canebrake to water lagoon areas and vice versa. Also, land use change from canebrake to the paddy (271.97 hectares) and from canebrake to forest (188.11 acres) were significant changes in the region.
Keywords: land use change, remote sensing, satellite imagery, Wetland, AmirKelayeh, Lahijan

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INTRODUCTION

Basically, the nature of the earth is not static as it is constantly changing. Identification of a land and optimized exploitation of natural resources have always been important. Regarding the irregular increase in population during the recent years, the limitation and the indiscriminate use of renewable resources have led to their rapid exhaustion. Due to these problems, land planning has become the focus of attention by planners of soil and water resources. In fact, land use studies are the science of land zonation for different uses. Land use planning is the wise management of space in order to optimize the distribution pattern of human activity. In this regard, the knowledge of land use and land cover is important for a lot of planning and management activities related to the land. The term land cover refers to the condition of the earth's surface, but land use refers to providing basic information about the characteristics of the land with regard to human or economic activity in a particular piece of land. Therefore, the knowledge of land use and land cover can be important for planning and land management activities. In the past, land use mapping using traditional methods was expensive and time-consuming besides lacking enough efficiency and accuracy; but today, using satellite data and Geographical Information System (GIS) not only will compensate for the shortcomings of traditional methods, but also makes possible the study of multi-temporal remote sensing satellite and GIS data because of its analytical facilities.

AmirKelayeh Wetland is located 30 km north of the city of Lahijan. This wetland, with an area of approximately 1,131.6 acres (the approved map after implementation only includes an area of 1,230 acres), is located near the Caspian Sea, between 50 09' 57.6" to 50 12' 22.5" north longitude and 37□ 18' 07.9" to 37 22' 16.8" east latitude. AmirKelayeh Wetland has been announced as a wildlife refuge since

July 12, 1975 (Guilan Department of Environment). Regarding the fact that this wetland, with an approximate distance of 500 meters from the sea, contains freshwater, it is can be concluded that AmirKelayeh Wetland feeds from underground springs and some water input from agricultural drainage. The most common mammals of the region include a variety of rodents, otters, weasels and coyotes. Wild boars were also reported in the area, but due to habitat destruction and uncontrolled hunting in the region, there is no report in recent years. Around 133 species of birds have been identified in AmirKelayeh which includes different species of ducks, coots, eggerts, and birds of prey and seabirds.(Environmental Protection Office of Guilan Province, Iran, 1994. “Preliminary report on the fauna and flora of the province”).

Literature review

Processed and examined coastline changes in China's Pearl River estuary using Landscape and Spot multi-temporal satellite images and a combination of topographic and marine data. The results of this study indicate that sedimentation is the main cause of shoreline changes in the area under study.

Used image subtraction method and principal component analysis using Landsat ™ satellite imagery to detect and evaluate changes in Maragheh area by modeling land use change using detrimental index. He modeled and evaluated the destruction of agricultural areas and surrounding orchards of Maragheh as a detriment to the environment due to the physical development of this city.

Used image subtraction method, principal component analysis, and classification and comparison after classification using Landsat ™ satellite imagery to detect and evaluate changes in the Qazvin plain by modeling land use change using detrimental index. He concluded that classification and comparison after classification was the best method and that land cover and land use changes were associated with the highest degree of environmental impacts.

In a research ecological changes in Neiriz wetland, Fars province, were examined. These changes occurred between 1998 and 2009, and the best remote sensing methods were exploited for applying image processing on Landsat ™ satellite images. Supervised classification method and the maximum likelihood algorithm were used to classify images. Finally, information processing indicated a 129 percent increase in salt area and a 52 percent reduction in water area which comprised the most significant changes of the wetland within the timeframe of the study.

Importance and objectives of the research

Optimal Identification of land and exploitation of its natural capacities have long been important. The skyrocketing of population is in recent years,and limitation in and indiscriminate using of renewable resources have led to a rapid degradation of land resources. Thus, reviewing and evaluating changes in each of four regions in Guilan Environmental Protection area during a certain period of time using high-resolution satellite images, and digital and print data, are necessary and preparing maps of land use at the present situation can assist managers to better protect and preserve the four areas including AmirKelayeh Wetland.

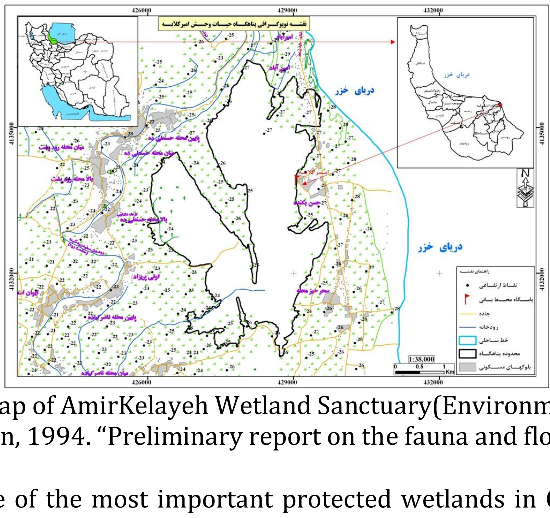

Figure 1 - Topographic Map of AmirKelayeh Wetland Sanctuary(Environmental Protection Office of Guilan Province, Iran, 1994. “Preliminary report on the fauna and flora of the province”)

AmirKelayeh Wetland is one of the most important protected wetlands in Guilan province. Besides the ecological significance of the wetland and its other functions, it has a significant role in the wintering of birds. In recent years, the economic and social needs of local communities and a lack of effective regulatory mechanisms have exposed the wetland to various threats. Drying pieces of the wetland and converting them into agricultural land, tree-planting, drainage of wetland for fish farming, dividing the wetland into various pieces and converting them into areas of tourist attraction, and manipulation of the wetland by human beings besides other destructive factors have led to a reduction in the surface area of the wetland each year. Thus, analyzing the trend of change in the wetland using satellite images and aerial photography over the past three decades and tracing the reasons for these changes can prepare the ground for restoring and conserving the wetland. This study is concerned with the main tension in the changing status of the wetland area and how this problem can be overcome.

MATERIALS AND METHODS

Remote Sensing is the science and art of obtaining information about an object, area, or phenomenon through analyzing the resulting data using a means which is not in physical contact with the object, area or phenomenon under investigation.
Remote sensing can be defined as the technique of identification and characterization of environmental phenomena based on data that are obtained from afar. Two quite distinct stages in the process of remote sensing can be identified: data preparation and extraction of useful information.
In order to model land use changes in AmirKelayeh wetland, satellite images were used from teo time periods:

1. MSS satellite images since 10/07/1978
2. IRS satellite images in 2007

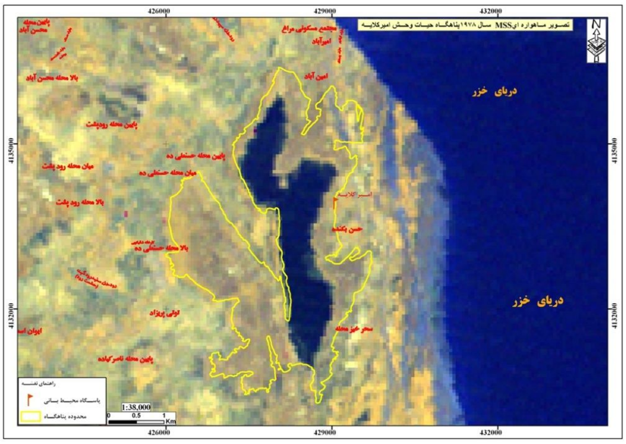

Figure 2 - MSS satellite images since 10/07/1978

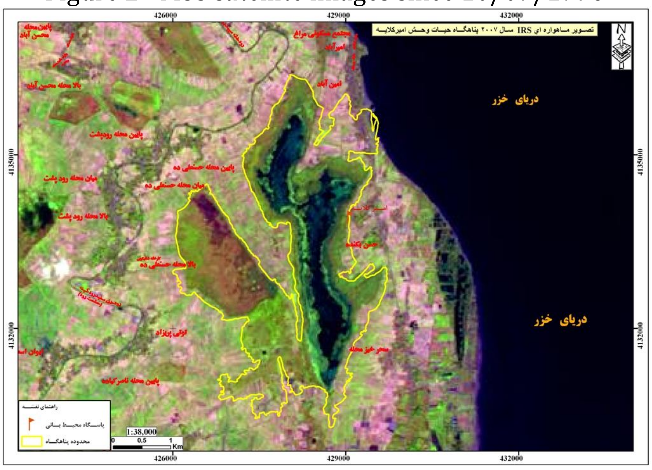

Figure 3 - IRS satellite images in 2007

Change detection includes the application of multi-temporal data sets in order to identify the areas that had changed in land cover at different dates of imaging. These changes may result from changes in short-term cover such as snow, flood and land use changes such as urban development and conversion of agricultural land to residential and industrial. The sample should be similar in images of the same area and in the same spectral band at two or more different dates, and areas that have changed should differ from each other in situation.
Selecting methods and algorithms for detecting and recovering these changes is an essential action because the method and algorithm for detecting and recovering changes in satellite images have a significant impact on data analysis and interpretation. Basically, change detection methods can be divided into two categories: methods based on identifying changed areas and methods based on the nature of change (from what type of land use to another).
Classification methods generally are divided into two categories: supervised and unsupervised.

Supervised classification methods are based on the precise introduction of classes and events needed by the user in analysis systems. This means that a small set of pixels on the image are determined as samples of the classes. These samples, usually gathered from fieldwork, large-scale aerial photographs and thematic maps, should be representative of the classes in the best way.

There are different algorithms for the supervised classification method like: Minimum Distance to Mean, Parallel piped, Maximum Likelihood, and Box Classifier. These algorithms differ in thought and principles to set boundaries for pixel values in order for classification. The Maximum Likelihood method has been reported as the most accurate and the most common method of classification . The maximum likelihood method assesses the variance and covariance of the classes. It is assumed that all training areas have a normal distribution. In fact, examples of training classes should be representative of a class; therefore, as more samples as possible should be used so that many changes of the properties of the spectrum lie on this continuous range. The maximum likelihood method is done in three steps:

1. Calculating the mean vector, variance and correlation for classes in the training samples;
2. Considering the distribution of pixels around the mean vector using the likelihood function;
3. Presentation of the entire data to classes that have the highest likelihood of membership in that class.

After assessing probabilities in each class, pixels are allocated to the most similar classes.

Classes in the MSS satellite imagery of 1978 fell into three categories namely: paddy fields, water lagoon areas and canebrake. Classes in the IRS satellite imagery of 2007 fell into four categories namely: paddy fields, water lagoon areas, canebrake and forest.

After identifying training samples and determining classes on the images, spectral values were classified using the supervised classification method. There are various algorithms in the supervised classification method: The method of maximum likelihood has been used in this study.

RESULTS

After the pixels are determined in each class using the classification method, raster files are converted into vector using the ArcGIS software according to the value of the pixels, that is, land use. The following figures are classified maps that show the method mentioned above.

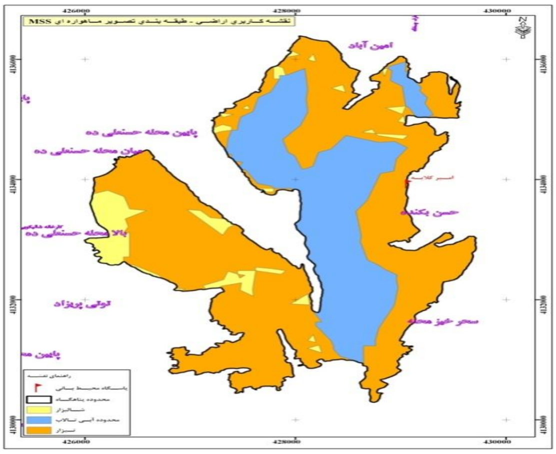

Figure 4 - Land Use Classification Map using the MSS Satellite Imagery (1978)

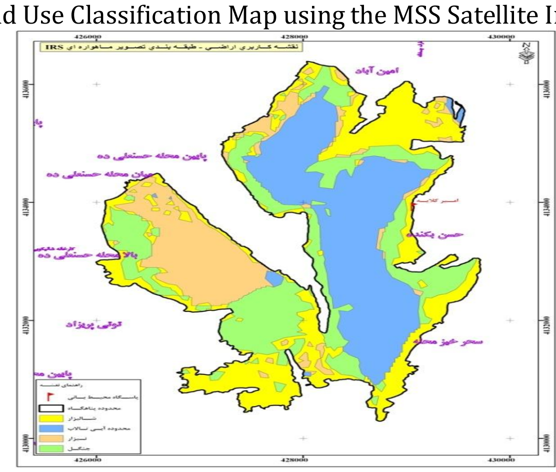

Figure 5 - Land Use Classification Map using the IRD Satellite Imagery (2007)

After implementing the supervised classification method on AmirKelayeh wetland and determining the types of land use, the level of each type of land use in MMS and IRS imagery is laid out in tables below:

Table 1 - Statistics regarding the MSS Satellite Imagery Classification (1978)

Land Use	Area (Acres)	Percentage
Paddy fields	68.51	6.05
Canebrake	728.14	64.35
Water lagoon areas	334.96	29.60

Table 2 - Statistics regarding the IRS Satellite Imagery Classification (2007)

Land Use	Area (Acres)	Percentage
Canebrake	186.93	16.52
Paddy fields	318.83	28.18
Forest	278.75	24.63
Water lagoon areas	347.09	30.67

Using the method of overlaying land use maps in the two images, the map of land use changes in the region under study from 1978 to 2007 is as follows:

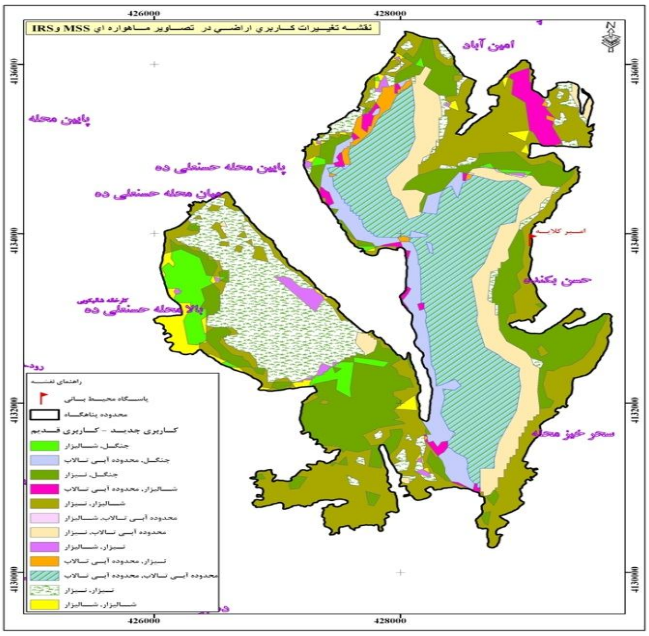

Figure 6 – Map of Land Use Changes in Amir Kelayeh Wetland (from 1978 to 2007)

Table 3 – Statistics for Land Use Changes

Land Use in 1978	Land Use in 2007	Area (Acres)
Paddy fields	Canebrake	10.63
Paddy fields	Forest	35.91
Paddy fields	Water lagoon areas	0.26
Canebrake	Paddy fields	271.97
Canebrake	Forest	188.11
Canebrake	Water lagoon areas	101.75
Water lagoon areas	Paddy fields	25.15
Water lagoon areas	Forest	54.73
Water lagoon areas	Canebrake	10
Water lagoon areas	Water lagoon areas	245.08
Canebrake	Canebrake	166.3
Paddy fields	Paddy fields	21.71

According to the statistics given above, the results stated are as follows:

1. The region was intact in 1978 in terms of land use; but in 2007, the extent of taking over lands and land use change to paddy fields increased 22 percent.
2. In recent years, wild forest land cover has grown within the canebrake, mostly in the margins due to an excessive use, and loss, of water by local farmers. That is why canebrake land cover has decreased (about 48%). However, some part of the forest grows in the west side of water lagoon

areas due to gradual drying. Meanwhile, forest land use, with a level of approximately 279 acres (25 percent), has added up to the former land use pattern.

3. 433 acres (38.3%) of the total land did not undergo land use change and were in the previous state. The remaining 698 acres (61.7 percent) underwent land use change, 111.75 acres of which included change from canebrake to water lagoon areas and vice versa. Also, land use change from canebrake to the paddy (271.97 hectares) and from canebrake to forest (188.11 acres) were significant changes in the region.

DISCUSSION

The 2010 AmirKelayeh Wildlife Management Plan, by the School of Natural Resources at Tehran University, has mapped types of agricultural land use, forest land cover, wetland cover rooted in water and wetland cover immersed in water using ETM + satellite images of 2002 [1]. It is noteworthy that wetland cover rooted in water means water lagoon areas; wetland cover immersed in water means the canebrake; and agricultural land use means paddy fields. Noting that the wetland area used by the consultant in the plan had not been approved by the Environmental Protection Agency, the results obtained in this project showed that agricultural land use, forest land cover,wetland cover rooted in water, and wetland cover immersed in water form respectively 9, 8, 53, and 30 percent of the whole region.

With respect to the results of the project and the difference between the borders of the region under study and the officially approved scope of the wetland, it can be concluded that the percentages of land use levels are close to each other and that the differences are due to the fact that the natural habitats of alder trees overlap with the canebrake, creating the probability of pixel distinction error in supervised classification.

CONCLUSIONS AND INTERPRETATIONS

Land use change from canebrake to paddy fields was due to the lack of water channels in wetland margins. Indigenous people took over lands and changed the type of land use by plowing the land and destroying the canebrake.

The level of water reduced to less than half especially during the summer. The three causes of this decrease are as follows: climate change; pumping water into marginal paddy fields; and the annual sedimentation – in other words, deposits of silt and animal or plant waste at the bottom of the lagoon, in addition to lowering the water level, increase turbidity and toxic gasses and sulfur emissions like H2S as a result of incomplete, anaerobic decomposition of the sediments.

The loss of security for the lagoon as a result of inappropriate methods of hunting and fishing by transgressors, such as air and water nets, has caused great damage to plant and animal genetic register of the region. Besides, transgression of rural farmers into the wetland has increased the level of paddy fields that has led to an increase in hunting and fishing in the lagoon (Figures 5-3 and 5-4).

The advancing of Caspian Sea in the northeastern parts of the lagoon has flooded the lands in the margins. Because of the agricultural potential of the soil and high groundwater levels, indigenous people moved more toward west - that is, into the wetland - and caused land use changes. However, water pumps at the edge of the lagoon lead to lowering the water level, especially in the margins. This, in turn, causes an increase in forest cover and a greater penetration of people that leads to land use change from canebrake to paddy fields in parts of the lagoon that lack channels in the borders.

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