Spatial-Temporal Change Assessment of Manchar and Keenjhar Lake Using RS and GIS

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Abstract: To maintain sustainability of life on earth, water is an indispensable nutrient and truly a vital resource for aquatic ecosystem. It also plays an important role in the socio-economic development and is one of the key factors for driving the economy of any region. Rapid increase in population and change in climatic patterns has vigorously affected the water resources. The remote sensing is an efficient tool for monitoring of natural resources. This research is focused on spatio-temporal change analysis of Manchar Lake and Keenjhar Lake, Sindh, Pakistan using Landsat multi-sensor data MSS, TM, ETM+ & OLI to analyze land cover from 1972 to 2017 and calculating water indices using Principal Component Analysis (PCA) and supervised parallelepiped classification achieving an overall accuracy 98.86% and 0.1 of standard deviation value. The results revealed that the significant changes in land cover due to unusual climatic patterns, significant fall in precipitation rate and multiple anthropogenic activities. These changes had adverse impact on eco-system of lakes and as well as on public health.

Keywords: Climate Change, Remote Sensing, Landsat Satellite, Water Resources, Eco-system, Intervention, Management.

1. INTRODUCTION

Today the deterioration of natural environment is become a burning issue of the world *(Alvaro Enriquez-de-Salamanca. et al., 2017).* Many factors such as, soil degradation, deforestation, urbanization and industrialization plays a key role to increase the pace of natural disasters *(Lee. et al., 1998).* Current global population is around 7.6 billion *(worldometers.com)* and isstill growing with increasing pace, while the earth'stotal resources are shrinking and scattered unevenly. Current living standards of humans are extremely vulnerable to the earth's natural resources, as humans are consuming about three times more of the natural resources *(J.T Liberty. et al., 2013).* Increasing demand for food and shelter are creating serious impacts on freshwater resources *(A.K. Misra., 2014).* Water is one among three main resources on Earth which are depleting at higher rate *(Murray, S.J).* Only 2.5% of the world's total water is fresh, out of which 70% is frozen in the shape of glaciers and icebergs. The remaining is in the form of ground water, rivers and wetlands *(U.S Geological Survey, Reston, Virginia. 1993).* World's large freshwater lakes are an extremely valuable resource of countries, not just only because of the 68% of the global liquid surface freshwater is encompasses in them, but because they plays a key role to the economies, social structure, and source of drinking water of the countries *(Beeton, 2002).* Lakes and Wetlands are considered as the kidneys which serve to filter runoff water which sustain life in many ways. Lakes too need to be refreshed by periodic supplyof river water, precipitation and healthy biological

activities, this can dissolved the nitrogen into nitrogen gas by settle down the pollutants such as phosphorus and heavy metals in their soils, and solids were suspended to be neutralized harmful bacteria *(Seminara. et al., 2011).* The current situation of all the lakes is not very promising. The continuous environmental degradation, and pollution, scarcity of rainfall and shortage of inflow of river water, increasing human induced activities and atrocities with natural atmosphere like deposition of industrial drainage effluent tend to deteriorate the wetland eco-system with a steady and alarming pace *(Zhao. et al., 2016).* Today, physical and chemical properties of has been severely affected by different anthropogenic turbulence, such as rapid industrialization *(Dokuli, et al., 2000),* agricultural nonpoint source pollution *(Zhang. et al., 2004),* domestic sewage *(Rashid, et al., 2013),* aquaculture activities *(Zhou. et al., 2011)*, tourist activities *(Wen. et al., 2016),* climate change *(Delpla. et al., 2009),* and introduction of non-native species *(Pejchar. et al., 2009).* Various researchers have reported that the majorityof lakes in China have lost its natural ecological properties by industrialization *(Bao. et al., 2012)* and urbanization *(Qin. et al., 2013).* For the investigation, planning of natural resources and observing the earth surface, satellite images are used as a controlling system. This is the most essential and significant method due to the comprehensive coverage above the enormous landmarksanalysis to its cost and time effective *(Qureshi. et al., 2015).* In complex regions which are difficult to access, through this method is possibly the only way to acquire the essential

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information more efficiently and quickly *(Silva. 1996)*. To execute the distinguish changes and observing the earth objects there is significant variety of procedure and algorithm are present *(Mispan. et al., 1997)*.

Aims and Objectives of the study

Aim of this research is to appraise the nature, its consequences, and temporal change of wetlands from 1972 to 2017 and to find out the prior and present circumstances of LC to figure out the drifts of impacts.

Study Area

Manchar Lake: Manchar is considered as the Pakistan's largest shallow-water natural lake, located eighteen km to Sehwan, District Jamshoro, between 26.441°N 67.699°E. It covers an area of about 253km². There are three water sources which fed the Manchar Lake. The River Indus, the Hill Torrents and the Main Nara Valley Drain (MNVD) *(H.U.Abbasi. et al., 2014)*. In summer the environment of the Manchar region is intensively hot and freezing in winter. The human activities like development of the simulated channels connecting the river to it. During the last decay significant changes occur due to the constructions of flood embankments which alter the original regime of the lake. The MNVD carry domestic, industrial, agricultural, and brackish water constitutes are the continuous polluting factors for the lake.

Keenjhar Lake: It is situated in District Thatta, Sindh. The total area is about fourteen thousand hectors havingLat/Long 68° 03'E and 24° 56'N. Keenjhar is considered among the largest fresh water lakes of Sindh. Thatta, Karachi,Ketibunder are the main consumers of this lake. River Indus is the main feeder of Keenjhar. It is surrounded by many seepage lagoons and marshes which are connected with semi deserted areas bearing limestone rock beds. This lake is formed after the development of a dam at Bangla, when two small lakes named Keenjhar and Karli lakes, in 1930 *(Khan and Abbas, 2011)*.

2. METHODOLOGY

The process to observe the temporal change can frequently be separated into two most important categories first will be the pre-classification and second will be the post-classification schemes. First group usually paying attentionto the variations inthreatened area e.g. harsh surface and the second one is likely to observe on widespread LCLU changes (Herold*et al*, 2002). To accomplish the objectives of this research, the data were collected through various sources. **(Fig.2)** shows the methodology followed for the study.
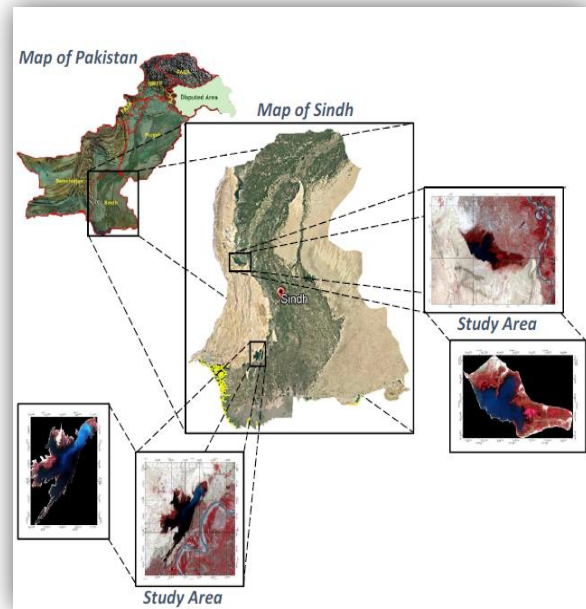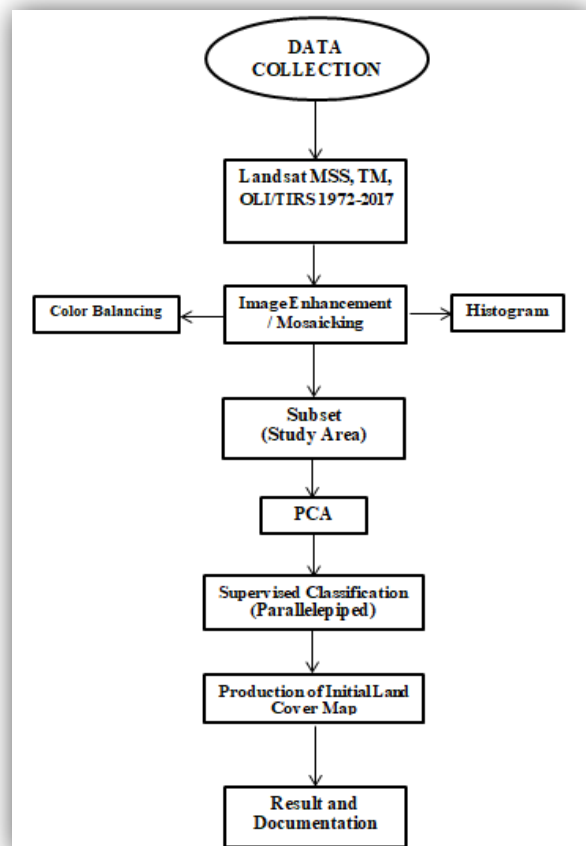

Fig.1 Study Area Extraction

Fig.2 Data Analysis Flowchart

Primarily, the satellite images were downloaded from the site USGS of earth explorer from 1972 to 2017.

Classification
Principal Component Analysis (PCA):

For the reduction of spectroscopic data, PCA is found to be an effective tool *(J.A. Richards., 1999).* PCA data usually is summarized by creating new components of the original components. In this study, PCA is applied to enhance the image pixels by reducing the spectral variations.

Parallelepiped Classification (PC):

To perform the PC n spectral bands are used as training data *(J.R.Jensen., 2005).* Different brightness values of each separate pixel are used to fabricate an n-dimensional mean vector, denoted as M_c. Where $M_c = (\mu_{c1}, \mu_{c2}, \mu_{c3}, \ldots, \mu_{cm})$ with μ_{ck}, represents the mean variable of the training data obtain for group c in band k out of m probable values.. S_{ck} denotes the deviation of the training group c in band k out of m which is probable classed. Via single standard deviation threshold, parallelepiped algorithms determine BV_{ijk} is in group c, if

$$\mu_{sk} - S_{ck} \leq BV_{ijk} \leq \mu_{ck} + S_{ck}$$
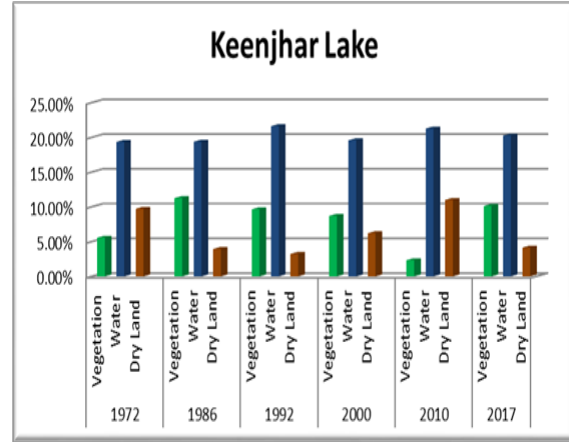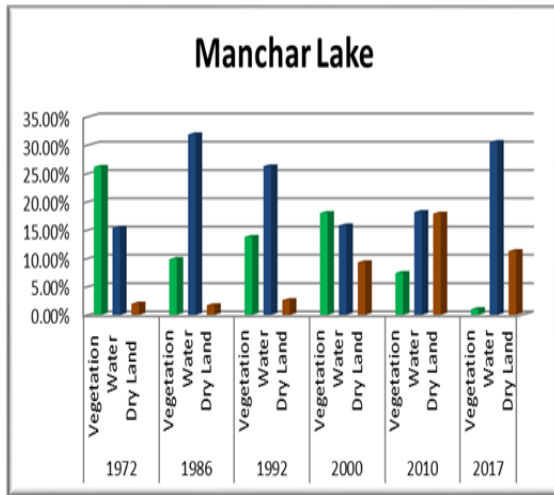
Here $c = 1,2,3,\ldots,m$ (no of groups), $k = 1,2,3,\ldots,n$ (no of bands); So, the low and high judgmental margins can be define as,

$$Low_{ck} = \mu_{ck} - S_{ck}$$

and

$$High_{ck} = \mu_{ck} + S_{ck}$$

Hence,

$$Low_{ck} \leq BV_{ijk} \leq High_{ck}$$

These judgmental margins form an n-dimensional parallelepiped in future.

3.   RESULTS AND DISCUSSIONS

The remotely sensed data were used to determine the temporal change of Manchar and Keenjhar lakes and to quantifying their water indices. We have done analysis from 1972 to 2017 in which we came to know that the water and vegetation rate has decreased year by year due to significant fall in precipitation, unplanned developments and multiple anthropogenic activities which results the increased in the dry land. The continuous release of industrial effluents and waste water in Manchar Lake leads to increase in water index but this contaminated water is vanished the vegetation cover.

Classified Maps of Manchar Lake
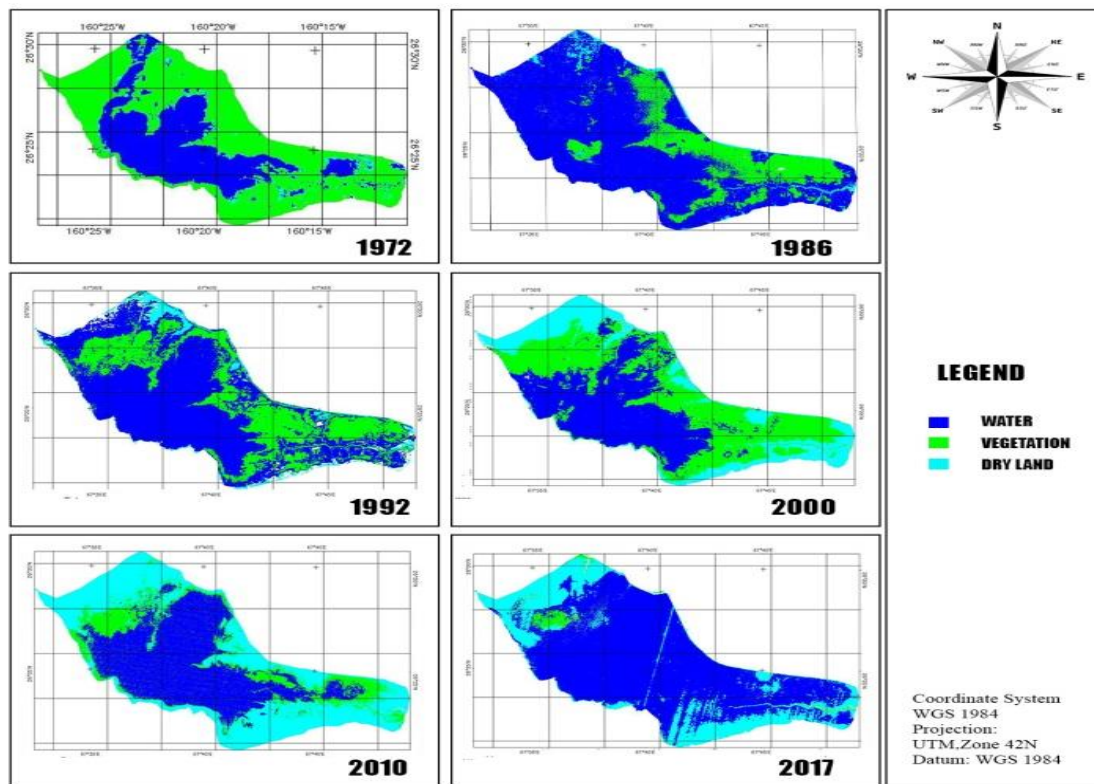
Classified Maps of Keenjhar Lake
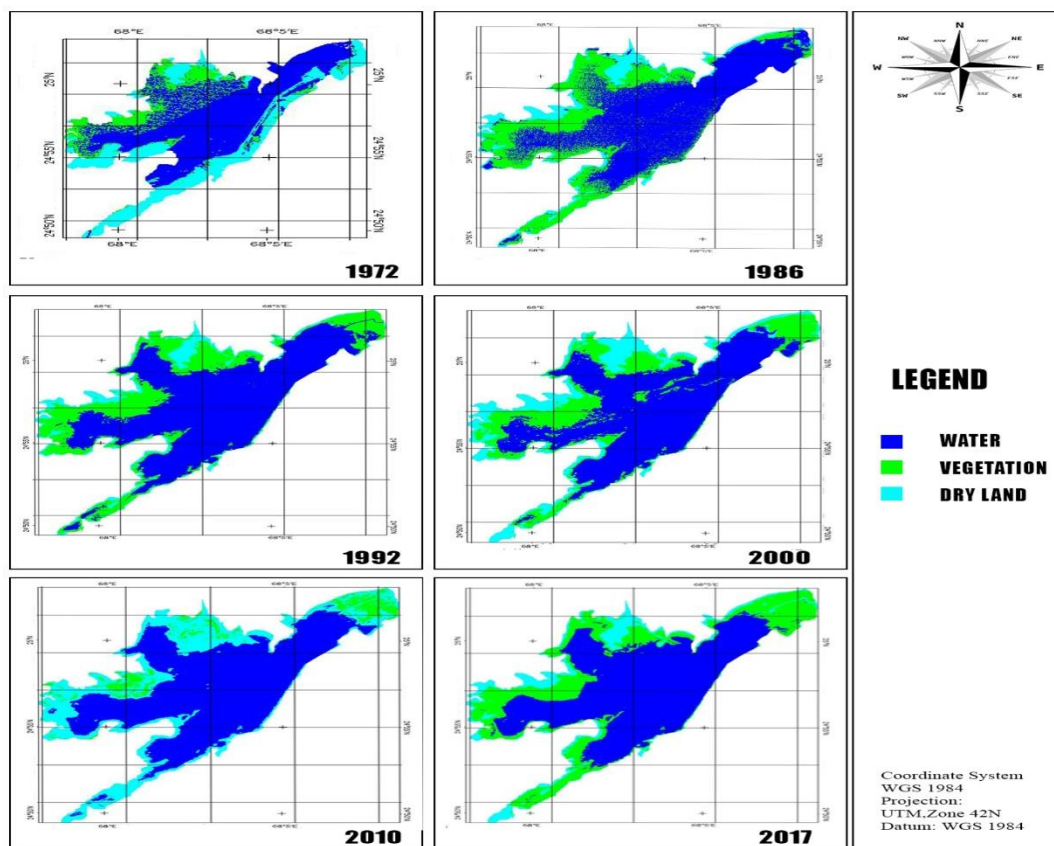
Precipitation

The mean annual precipitation data of Jamshoro and Thatta districts was collected from the Global Data for SWAT from 1972 to 2014. The precipitation graphs, shown in (**Fig.3a and 3b),** are computed in MS. Excel. The graphs shows the significant fall in precipitation year by year.
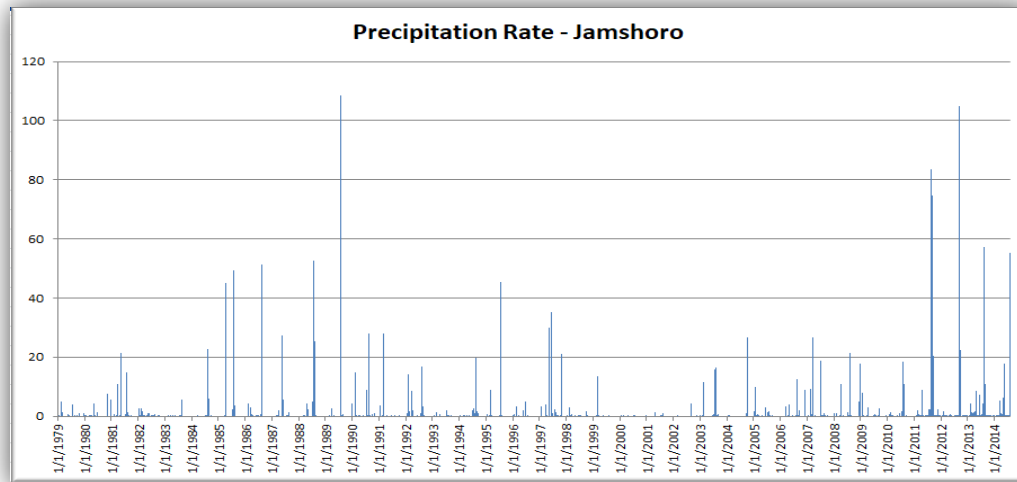
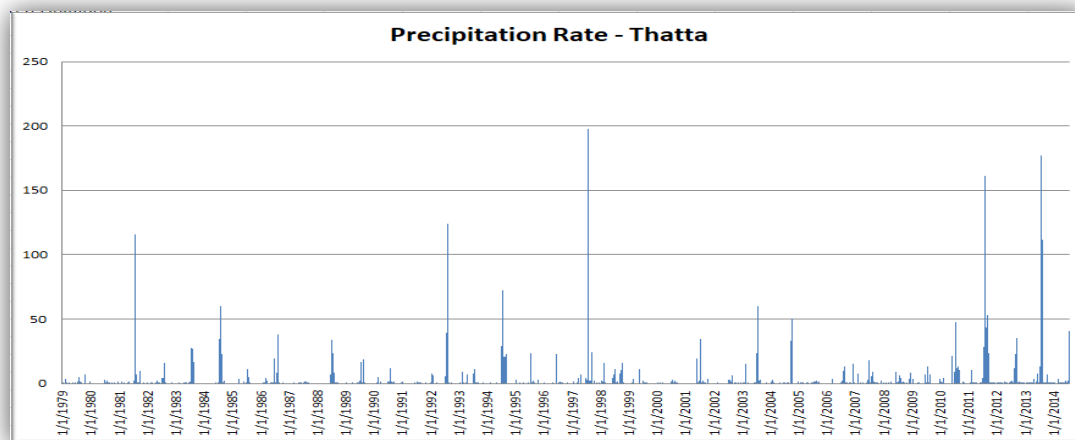**Fig.3a. Precipitation Graph (1972-2017)**

Fig.3b. Precipitation Graph (1972-2017)

Standard Deviation

The standard deviation method is used to check the accuracy of the results. The low deviate value is nearest from the average value and the high deviated value has large variance between the data and the average value. The low deviated values show the high accuracy of the results. The Standard Deviation graph, shown in (**Fig.4),** showed the high accuracy of the results.
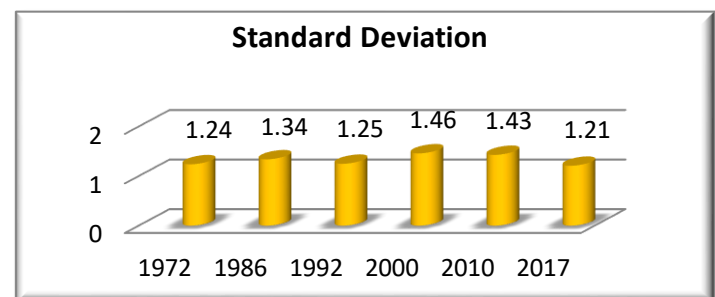
Fig.4 Deviation Graph of Results

4. CONCLUSION

Remote sensing and GIS based assessment is much more effective and accurate in land cover mapping than other traditional or manual methods and also can be calculated more effectively through land cover changes over time.The remotely sensed Landsat Satellite data of District Jamshoro and Thatta has been interpreted and processed to reveal the temporal change analysis within the freshwater lakes by developing digital images record during the study period showed the decreasing trend in vegetation and water is observed which lead to increase of dry land. The rapid increase of the water indices of Manchar Lake after 2010 is due to the continuous discharge of industrial effluents and waste water in Manchar through MNVD and others.This research concludes that the significant changes in the lakes are due to different natural and anthropogenic activities which consequences the extreme vulnerable situation and affecting the ecosystemof lakes adversely and it also deteriorate the natural aesthetics of the lakes.

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