

SPATIO-TEMPORAL CHANGE ASSESSMENT OF LAKE MANCHAR PAKISTAN AND LAKE ARAL KAZAKHSTAN USING NORMALIZED DIFFERENCE VEGETATION INDEX

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ABSTRACT

Water is an essential nutrient for life on the Earth, which is found in Oceans, Rivers, and Lakes. Lakes played a vital role to maintain the ecosystem and developed the socio-economic balance. Climate change is responsible for flooding and drought on the Earth's surface, and directly affects wetlands, depend upon the nature of the topography. Owing to the raising of world temperature, glaciers are melting, and sea-levels are continually rising. On the contrary, a lot of regions are facing drought due to a shortage of River water and precipitation. Fertile lands are converting into deserts, which causes socio-economic deprivation. Lake Manchar is one of the largest lakes of South Asia, located in Sindh Province. The Lake is fighting for its survival, the Lake being degraded by the 1990s owing to the construction of the Right Bank Outfall Drain (R.B.O.D). The Aral Lake was the 4th Largest Lake in the world till the 1960s, which was a direct or indirect source of income for a million people. From 1960 to 2014 local fishermen migrated to another place for their live hood, a white desert has appeared at the place of the lake. GIS and RS are important tools to monitoring and calculate the Water, Vegetation, Barren Land Desert, and Wetland covered area by using of Normalized Difference Vegetation Index (NDVI) model. The results exposed that 23.8% of the water-covered area of Aral Lake has been shirked in the last 34 years, and 6.73% of water covered area has been reduced in the last 30 years.

KEYWORDS: Spatial temporal Changes, NDVI, water, Ecosystem, Manchar Lake, Aral Lake

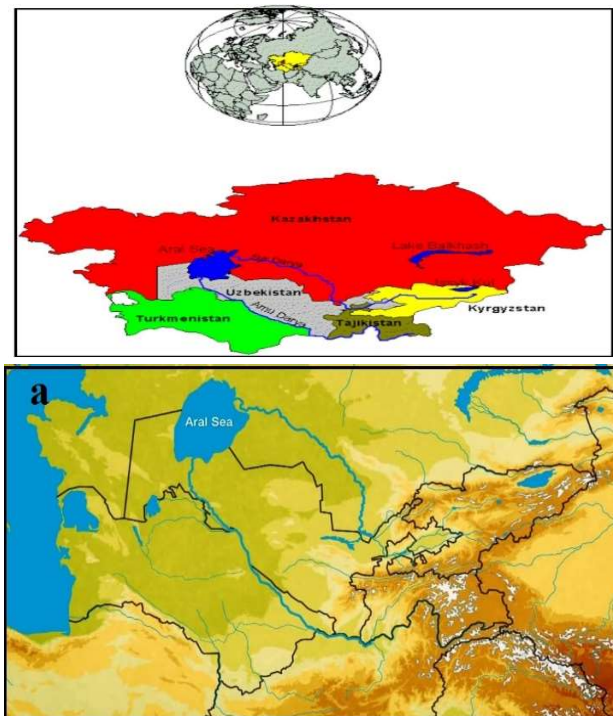
INTRODUCTION

Aral Lake

The Aral Sea/Lake was the 4th largest Lake in the world, situated in Central Asia. Geographically its located between 45°N 60°E / 45°N 60°E and 45°N 60°E / 45°N 60°E, it is extended over the area of two countries' Kazakhstan and Uzbekistan. It covers 68000 km² (Glantz M.H 1999). The Aral is a landlocked Sea/lake which has no ocean surrounds it. The main Source of water of the Lake is two Rivers (the *Syr Darya* and the *Amu Darya*) (Ekaterina P.2009) the lake starts to shirk in the 1960s by a Soviet Irrigation Project (SIP), by this project the water of both rivers (*the Syr Darya* and the *Amu Darya*) diverted for an irrigation purpose. The irrigation

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system of Central Asia fully depends upon the Syr River and Amu River (Rakhmatullaev *et al.*, 2009). An area of the Aral Sea Basin was comprised of the mentioned Rivers. The Syr River is 3100 kilometers long and the Amu River is 2700 kilometers long, the fed area of both rivers is snow-covered high mountains of Kyrgyzstan and Tajikistan-with precipitation of 800-1600mm, resulting in permanent snowfields at top of the mountains (Murray-Rust *et al.*, 2003). The catchment area of Syr River is 3100 sq. Kilometers and Amu Rivers have 3000 sq. kilometers, as shown in (Fig:1) The catchment area of both rivers is known as *Aral Sea Basin*. In the 1960s the Soviet Union starts its Irrigation Project and diverted the water of both rivers in a newly constructed canal (*Karakurm Canal*) to irrigate the desert of Turkmenistan (Zonn I.S. (2012). After that the desert of Turkmenistan appeared as the top of the world irrigated basin, consequently, the lake started to reduce its size, and right now converting into deserted at present the lake has been changed into a desert (Conrad, C. Schonbrodt S, 2016)



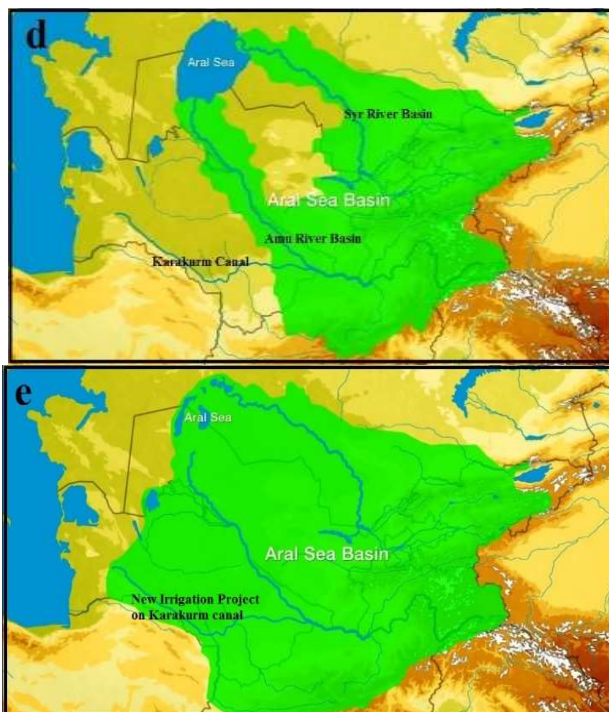


Fig 1. Geographical Location of Aral Lake and Aral Basin, Kazakhstan
Source: Author 2020

Manchar Lake:

In Sindh Province, there are more than 100 natural lakes of different sizes covering an area of about 100,000 ha. Among them, Halijee, Kinjhar, Hamal, Drigh, and Manchar lakes are quite important for fishing purposes, and Manchar alone supports 2000 fishing families. The Manchar Lake is the largest freshwater lake in Pakistan and one of the largest Lake in Asia (FAO, 2003), it's situated at the foothills of Khirthar Mountain Range at Right Bank of the River Indus and 18 kilometers away from the Sehwan city in Sindh Province, Pakistan (Mahar M.A, al, at 2000).

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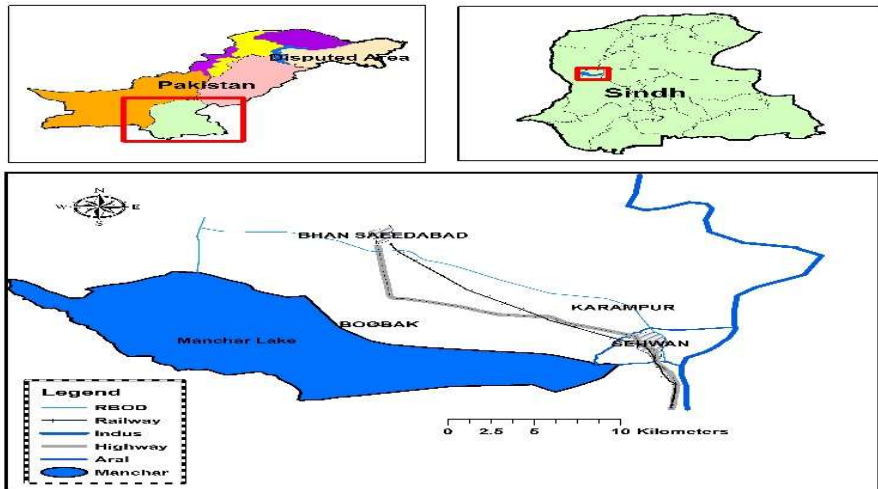


Fig: 2: Geographical Location of Lake Manchar, Pakistan

Source: Siyal.A.A.2016

The lake extends over 250 square kilometers in normal days and is more extended in Monsoon Season over the 500 square kilometers; its depth is varied 2.6 meters to 3.8 meters (Anadolu 2020). The main source of water of the Manchar is *Nai Gaj* which comes from the uplands of Khirthar Mountain. In the early 1990s, Federal Government started a project to drain out the effluent water of Balochistan and Sindh into the Arabia Sea through R.B.O.D, this water is just wasted water of agriculture drainage (pesticide), and municipals of two provinces. The discharge design of RBOD is 4500 cusecs of effluent water (Mahessar al at, 2019).

Nai Gaj is a main source of freshwater for Manchar Lake, which fully depends upon the rainwater of Balochistan Plateaus and Khirthar Mountain, so the water flow of the *Nai Gaj* is uneven, plenty of water found in the Monsoon Season and drought in the winter season. The effluent water of RBOD falls through the MNVD in Manchar Lake, so the MNVD drains out 0.525 Million Acre Foot (M.A.F) water in the Lake, and the water of *Nai Gaj* is 0.188 MAF which is 0.337 MAF less than MNVD flow. The water quality of MNVD is highly toxic and contaminated, this is the main reason for the degradation of Manchar Lake. The rapid increase in salinization at both lakes, not a positive indication. A white crust has appeared at the surface area of Aral Lake, which is the main indication of salts accumulation at the surface. Consequently, deposits of salts from the soil profile have appeared replacing the grasses/weeds (Mahmoud A.E.I-Kawy, et al 2015). The scenario of Manchar Lake is different from the Aral, the history of Manchar tells us that Manchar has been dried two times in the past, but this time situation is worst owing to the inlet of polluted

water of MNVD. The Manchar was the second home of *Siberian Birds* in the Winter Season and it was the source of income (direct or indirect) for more than 20,000 fishermen. At present only 4,000 to 5,000 people are settled on banks of the lake, compared to 20,000 back in the 1980s when the “water was sweet” (PBoS 1988) due to contaminated water of RBOD the fishing is just a dream.

Soil salinization is a fast process of desertification as it accompanied the sharp decline in groundwater level and drying of subsoil. The water budget of any area is determined by a few constituents: River water, net evaporation (*the difference between the evaporation of precipitation*), Precipitation (Micklin, P. 2007). Here, the water of Nai Gaj is just like river water, but the volume of water is not enough to maintain the restoration of the Lake, but since the 1990s polluted water of MNVD is increasing day by day.

On the contrary, the water of both river Syr Darya and the Amu Darya has been stopped since the 1960s and the rate of precipitation is not enough to cover this shortage of water to restore the Aral Lake. So that the balance gap between rates of evaporation, river water flow, and precipitation is not in favour of Aral and Manchar Lake. The Aral Sea has physically disappeared into the thin, dry, desert. Between 1973 and 1989 just 16 years the Aral Sea lost a volume of water equivalent to one and a half times that of Lake Eire. In 1987, it split into two parts/lakes. On other hand, Manchar Lake is fighting for its survival since 1990, now it is almost filled with polluted Water of RBOD (Micklin, P. 2016).

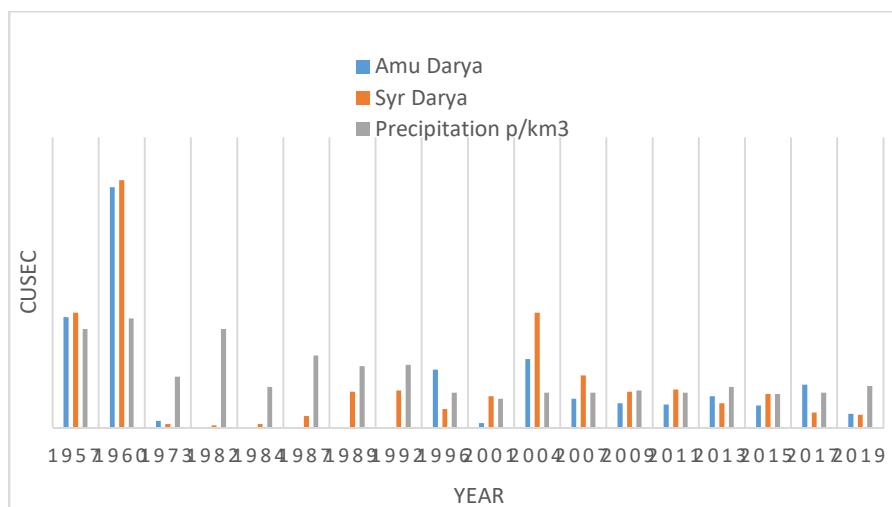


Fig.3: Hydrological flow of Amu river, Syr river and precipitation in the Lake Aral (1957 to 2019)

Source: Behzod G,al et 2012, 2019

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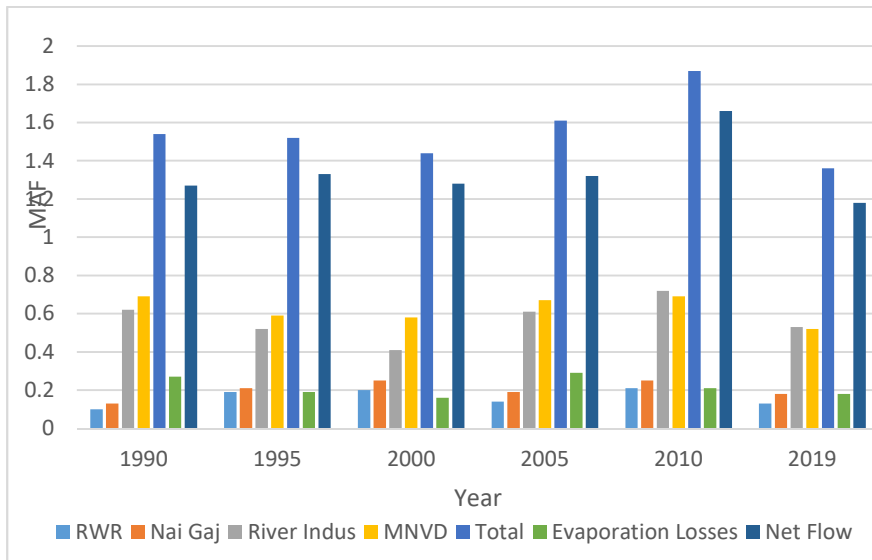


Fig 4: Hydrological Flow of Manchar

Source: (Sindh Irrigation Department, 2017. Wapda, 2018. PMD, 2017. Mahessar al at, 2019)

METHODOLOGY

This is Spatio-Temporal Study (STS) and the difference has been evaluated with the help of satellite data, research is based on satellite images of different periods (*Aral Lake from 1985*) and (*Manchar Lake from the 1990s*) with the help of Google Earth Pro, Google Earth Engine (Google time-lapse) of different years. The digital data were processed using different software. A few software such as GIS 10.3, ERDAS Imagine version 9.4, Microsoft office 2013 (Word, Excel) were used during the research (Jain, K.P. and Garg, R., 1991). Apart from this Garmin e Trex H (GPS) A digital camera was also used. Two different research areas in different parts of the world are selected to compare both research areas. The main purpose of this method was to monitor the STS changes in the study area by using NDIV model and calculate the Water, Vegetation, Barren land, Wetland, and Deseret to prepare the latest maps with the help of the latest technology (Elbeih, 2015). For the collection required to achieve the objectives, Landsat is an ideal satellite to provide the required data. For temporal changes on the surface of the Aral, and Manchar Lake different images were downloaded from Landsat TM from 1986 to 2020.

RESULTS AND DISCUSSION

Assessment of Spatial-Temporal Changes (STC) of both research areas is economically important (Anji 2002). Mapping and calculation of Water, topography, vegetation, wetland, barren land, desert, and settlement are very important parameters, possible with help of Geographic Information System (GIS) and Remote Sensing (RS). (Choudhury, 1999, Chandio, N.H.et al, 2019). The Satellite images of Aral and Manchar Lake were digitalized, Water, Vegetation, Wetland, Barren Land and Desert areas of both the lakes have been calculated (figure 5, 6). Water and Desert are both such types of parameters, which does not find both together, if the water will increase, automatically desertification may reduce. But the water-covered area may reduce, the desertification may be increased. Here, 23.8% of the water-covered area of Aral Lake is shirked from 1986 to March 2020, on the contrary, desertification has been increased at large, and it is interesting that 312% desertification is increased as shown in figure 5, this is an alarming situation.

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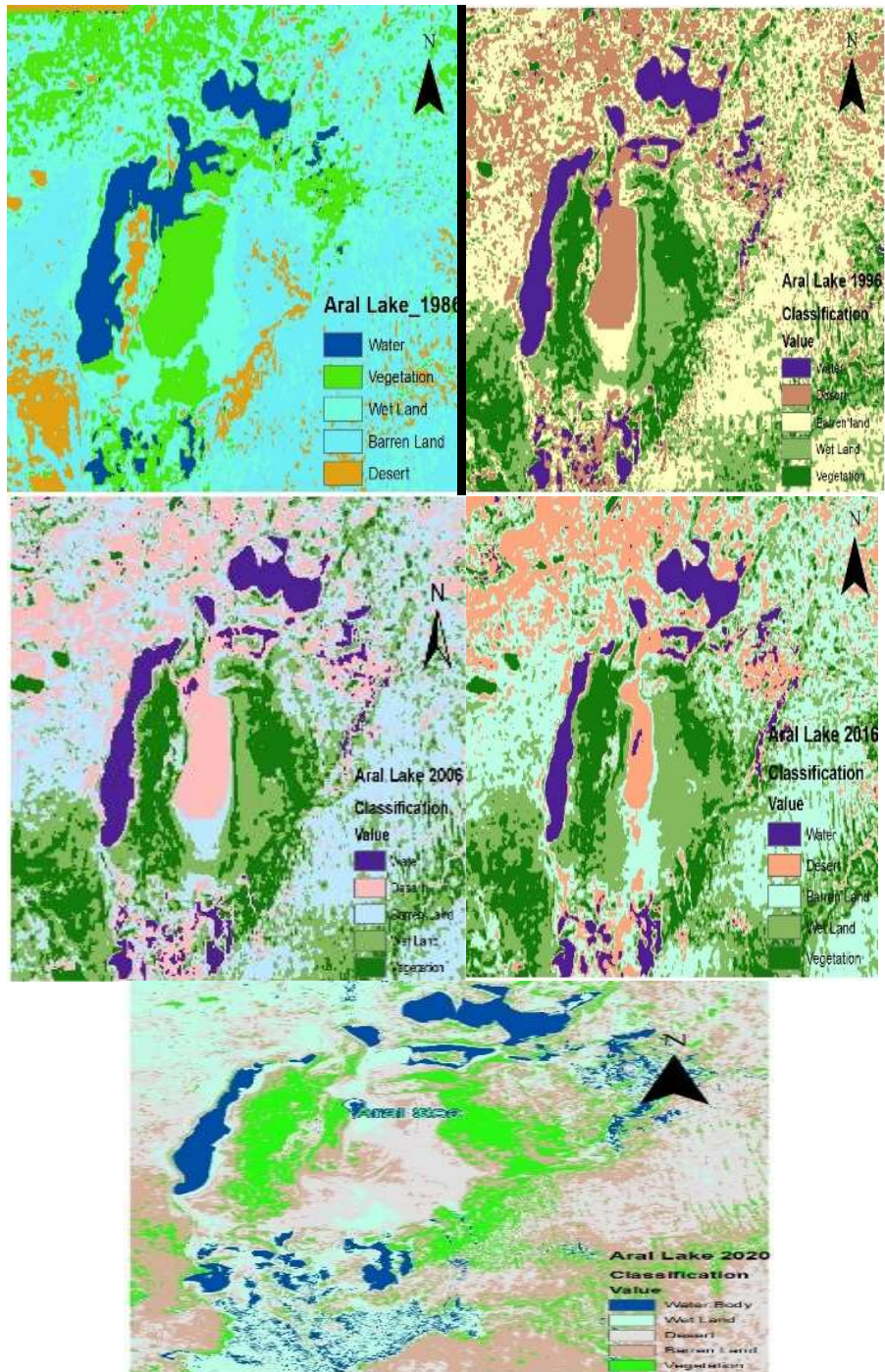


Fig: 5: Shrinking of Aral Lake (1986 to 2020)
Source: Author 2020

Similarly, the ratio of Barren Land, Wetland, and Vegetation is also reduced at a different level. So that at present; the Aral Sea is not a sea but just a mound of white sand, and barren land. Aral, Lake Manchar is also facing an identical type of situation, Once Manchar Lake was a huge platform for fishing. Annual fish catch from the lake has dropped dramatically from 2,300 metric tons in 1944, to 700 metric tons in the 1980s (PFFF, 2018).

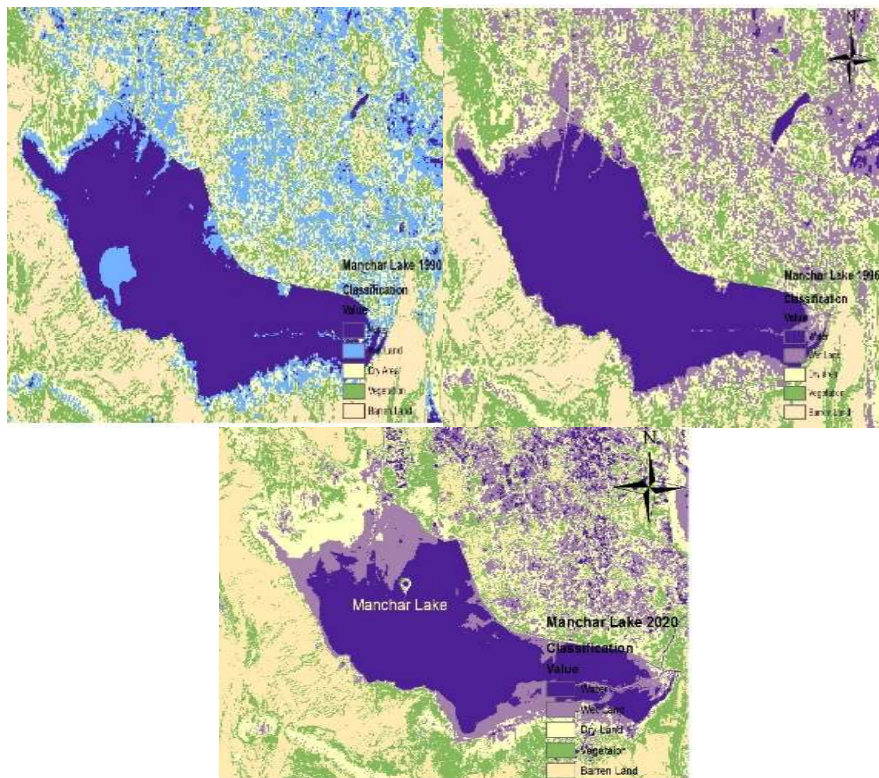


Fig: 6: Shrinking of Manchar Lake (1990 to 2020)

Source: Author 2020

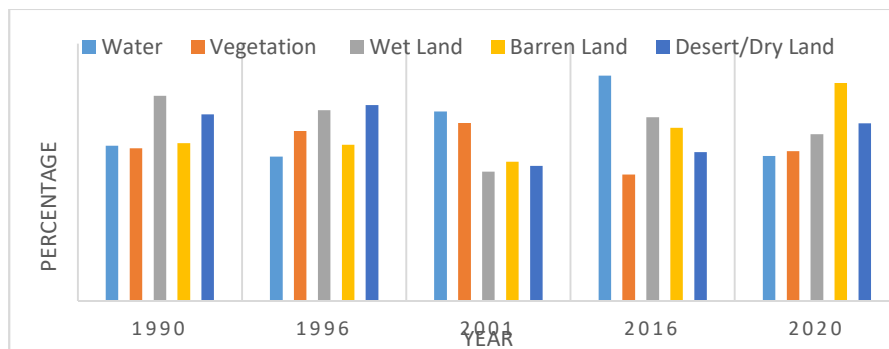


Fig: 7: Shirking of Manchar Lake (1990- 2020)

Source: Author 2020

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Generally, 80% of species of fishes are only for freshwater, so that different fish species were found at Lake in abundance (Mahessar al at, 2019). Now only 20% of fish species are available in the Lake, that 20% of species are not enough to earn for local fishermen.

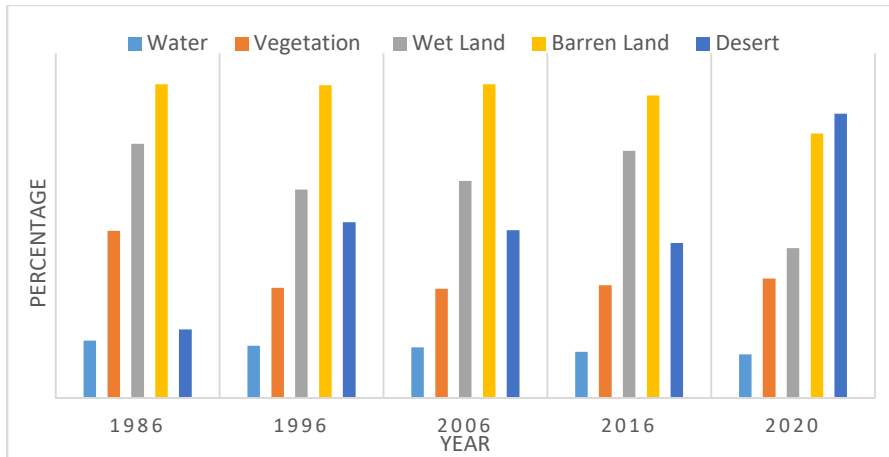


Fig: 8: Shirking of Aral Lake (%)

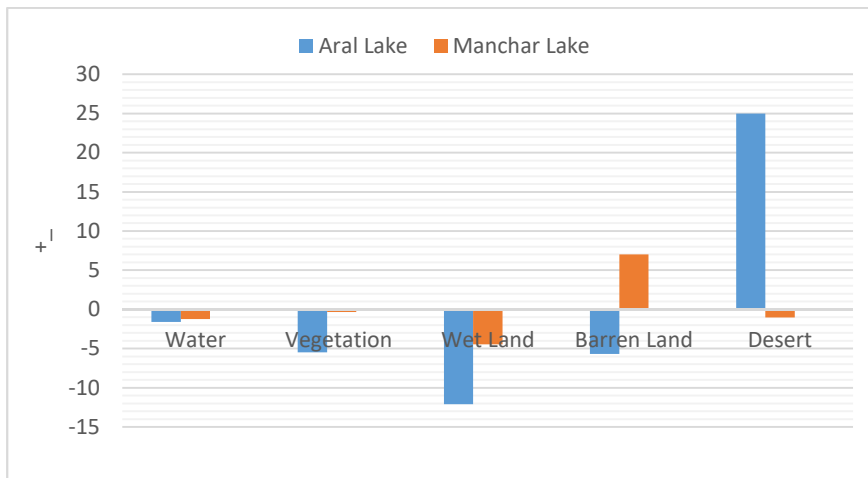


Fig: 9: Comparison of Manchar Lake with Aral Lake (+ -)

Source: Author 2020

From 1990 to 2020, 6.73% water, 1.79% vegetation, 18.68% wetland, 4.77% desert area has been reduced, but **38.1%** of Barren land area has been increased, so this is alarming that the fertile soil of the Manchar is converting into barren land/soil salinity. The lake is facing two types of problems, low precipitation or low hydrological flow of water and polluted

water of R.B.O.D and MNV Drain which is highly contaminated by agriculture and drainage effluent of Sindh and Balochistan.

CONCLUSION AND SUGGESTION

Aral Lake: Main reason for the shrinking of the Lake is the diverted water of the Syr Darya and the Amu Darya, it is suggested that 08 MAF water from the Syr Darya and 08 MAF water of Amu River should be release for the survival of Aral Lake. A huge level **Tree Plantation Project** (TPP) should be launch to stop the desertification. Mangrove plants should be plants in the Delta region of both rivers near the coastal area of the Lake.

Manchar Lake: The Lake is facing a shortage of water from Nai Gaj, but the Nai depends on Rainfall that comes from the uplands of Khirthar Mountain. So, in the light of this research, we must suggest that River Water from Dadu Canal may cause the revival of the Lake. Dadu canal is only 01 km away from the Lake and 15 ft above the lake bottom. The second issue of the lake is the polluted water of the MNV Drain. In the light of the processing of satellite images, the MNV drain can be diverted at the western side of the lake, which is a natural depression between Lake Manchar and the slope of Khirthar Mountain.

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