Fractional Land Cover Classification and Temporal Change Evaluation of Deh Akro-II Wetland Complex and Chotiari Wetland Complex, Sindh, Pakistan, Using Google Earth Engine

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Abstract
Wetlands are one of the most important and rich eco system. Deh akro II wetland complex is unique inland type of wetlands comprise of 35 wetlands in middle of Nara desert on bank of Nara Canal. They face a lot of degradation because of anthropogenic activities in the surrounding areas and lack of rainfall in last 2 decades. Chotiari wetland complex located in south east of Deh akro II wetland complex, it comprises of several fresh water lakes converted into reservoir in year 2003 for better irrigation purposes. This conversion of wetlands into reservoir does not did very well for surrounding agricultural lands and natural vegetation. So in this study two technique of Fractional cover mapping were used to classify three types of land covers in both study areas. Temporal analysis was performed using the Landsat 7 ETM+ image of year 2000 and Landsat 8 OLI image of year 2018. For better results NDVI, EVI and NDWI were also calculated. For Deh akro II wetland complex Kappa accuracy statistics for year 2000 is 84% and for year 2018 its 87%. Several changes were recorded in this time span of 18 years as 42% of water bodies area has been decreased, 48% of Agriculture area has been increased and 68% of natural vegetation area has been increased. Increase in amount of vegetation and agriculture indicates that with better management and planning, effects of climate change over the area can be minimized. Kappa accuracy statistics for Chotiari Wetland complex for year 2000 is 71% and for year 2018 it’s 73%. Enormous changes were noted in 18 years as Agriculture area has been decreased up to 91%, water area has been increased up to 15% and vegetation has unluckily decreased up to 98% in reservoir area. This huge decrease in Agriculture and natural vegetation is an alarming situation for the wildlife and native population as well as authorities of Chotiari wetland complex.
Key-words: Land Cover Classification, Temporal Change Evaluation, Deh Akro-II, Chotiari.

1. Introduction and Literature Review

Wetlands are most vital ecological part of earth’s landscape. Wetlands drive the economy, create exclusive eco systems and unique cultures of the adjacent communities. They provide fish and wildlife habitat, water quality protection and purification, filtering impurities in water, acting as nutrient and sediment sinks, erosion control and protection, aquatic productivity and abundant opportunities for hydrological and geological education and recreation. (Rai, 2008 and 2010; Liu et al). Other beneficial functions provided by wetlands are water storing, shoreline maintenance, ground water restoration, storm defense, flood control, ground water discharge, stabilization of local climate conditions particularly rainfall and temperature. (Olhan et al., 2010; Munyat, 2011).

Pakistan has diverse range of wetlands from lakes in high mountains, inland lakes in plain areas, to coastal swamps and mangroves forests, covering area of approximately 7.8 million hectors, representing 9.7% of the total country mass. (Izhar 2016). Out of total wetlands 19 wetlands are recognized as of international importance and therefore they are categorized under Ramsar convention. Haleji Lake is a perennial freshwater lake in Thatta, Sindh, a Ramsar site, is presently damaged and on a loss as a nature reserve for fauna, because of sedimentation, increase in marine flora and water shortages that leads to degradation of the wetland. Ormara Turtle Beaches, has comprised of 10.5 km long section of beautiful sandy seashore in Balochistan, home of significant amount of marine turtles which includes the endangered species of green turtles and olive ridley. The famous Uchhali Complex comprised of three salty lakes: Jahlar Lakes, Khabikki Lake and Uchhali Lake, present in Khushab District in Punjab. It is the only conservation complex in Pakistan which is supporting the winter season itinerant groups of White-headed duck, as well as other species of winter birds; sociable lapwing, Cinereous vulture, Greater flamingo, Eastern imperial eagle, pied harrier, ferruginous duck and greylag goose. Nearly all Pakistani wetlands also support neighboring humans by providing them with fresh water for domestic, agriculture uses and for their livestock, fisheries and unique plant species which are used for different purposes.

In Pakistan, at one time all the wetlands were the safe haven for migratory birds and other dependent wildlife but nowadays because of embanking of river, misuse of ground water, reservoirs construction, soil eutrophication, unregulated use of pesticides which is harmful for ecological processes and most prominent one the climate change, unluckily these wetlands remain to be one of the world’s most endangered bionetworks and are needed to be preserved and monitored regularly. To
quantify the changes occurring in these wetland proper monitoring of land cover is required. Landcover is a human struggle to change its surroundings into favorable environment such as roads, urban areas, agricultural land, settlements and plantation. Farda 2017 has defined Land use as "a number of human arrangements, activities, and inputs on a particular land" (FAO 1997, FAO and UNEP 1999). Remote sensing has developed as the utmost significant science in wetland land cover landuse (LCLU) monitoring. Commonly wetlands are isolated and difficult to reach areas so most of the time it’s challenging to gather information through old-style field visits. Earth-observation satellites are striking source of monitoring information as it is continuing 24/7 data coverage. Many studies like Ozesmi and Bauer (2002), Davranche (2009), Adam (2010), Wright and Gallant (2007) and Na et al (2010) have shown that Geographical Information System (GIS) and Remote sensing (RS) techniques are providing vital gears for wetland inventory tracking and update. The usage of hyperspectral and multispectral satellite’s data produces valued results on wetland classification and delineation. Multi-temporal Landsat data has been used in several studies for the purpose of LCLU mapping as it had advantages of high spectral resolution and free availability of new and historical data. (Mach et al. 2017; Gudex-Cross et al. 2017). Many studies like Jiaying et all (2018) and Julia Reschkea, Christian Hüttich (2014) have done a mapping and LCLU of wetlands, by using a pixel-based method for wetland delineation based on multi-temporal Landsat data.

Google Earth Engine (GEE), a cloud-based computing platform, it resolves the utmost major issues regarding land cover mapping of remote areas by using, a web-based Integrated Development Environment (IDE) code editor, which can examine and analyze all accessible remote sensing data without the need of downloading the data sets to the local device. This is how, operators can effortlessly access, choose and process bulks of information. GEE also provide many packages and several algorithms which can be simply approached by all types of experienced and fresh remote sensing researchers. Similar to our research, based on the GEE cloud computing platform and 30-m Landsat 7 and 8 and spectral indices like NDVI, ID, NDWI, many studies have explore machine learning and its accuracy for multi-temporal land use mapping of wetland area (Domínquez-Beisiegel, M (2016). Bumsuk Seo, et al (2016), Farda (2017), Wand C. et. al. (2018), Md. Inzamul Haque, Rony Basak (2017), Bian et. al. (2020). Mahdianpari, M et. al. (2020) Alam and Hussain (2020)) Zang et. al. (2020) In this study an effort has made to identify and analyze the Land cover land use temporal changes of Deh Akro 2 wetland complex and Chotiari Wetland complex using Fractional cover mapping techniques on the GEE platform, over the time span of 18 years since year 2000 to 2018.
2. Study Area

Two study area Deh Akro-II Wetlands Complex and Chotiari Wetland Complex/Reservoir have been selected for this study. Both of them are present in Nara Desert region of Sindh province, Pakistan.

Deh Akro-II Wetlands Complex (26°49'N latitude and 68°19'E longitude) located in the south-west of Sindh Province, comprises of 36 perennial lakes (designed by the Seepage of Jamrau Canal and also rain fed) and contains four main habitat types: wetland, desert, agricultural land and marshes. Total area covered by lakes is of 50 sq. km, out of which smallest one cover area of 0.5 sq. km and largest covered 7.5 sq. km. The whole complex ranges over 205 sq. km with elevation of about 50 m. Out of 36 lakes, five has drinkable water, rest of them have brackish water with the depth of lakes ranges between 2 to 15 m. These wetlands have been shrunk because of the canal water diversification to the agriculture area and shortage of rainfall during last 20 years. In south west of Deh akro 2, two large town Jam Datar (30 km) and Nawabshah at 60 km, are present. Boundaries of North east of the wetlands complex meets with Nara Desert. From the south west, landscape is dominated by agricultural fields. This wetland complex is also known as wild life sanctuary because it is home to an extensive variety of flora and fauna, habitats of both wetlands and desert, supporting more than 16 classes of reptiles, 18 type of mammals, 101 kinds of birds and 14 sort of fishes. Rare fauna hosted here includes 1. Desert cat Felis libyca, 2. Darter Anhinga melanogaster pennant, and Garganey Anas querquedula, etc and endangered includes Marsh crocodile crocodylus palustris, Hog deer, White-eyed pochard, and contains many native fish types. Deh akro II experience hot summers with mean temperature of 48-52°C, in hottest months of May to July. Winters are dry, mild and short, with the coldest month of January, they experience 11°C of temperature. Most of the rain is experienced in Monsoon season which ranges from 88 mm to 135 mm, along with low intensity winter rains during December to March. Fish is one of the source of food for local people. Main source of livelihood for local people are agriculture and livestock. Main crops cultivated in this area are Cotton and wheat, secondary crops included pulses, vegetables, oil seeds, sugarcane, fodder, oil seed and barely. Natural resources are facing environmental degradation because of the overgrazing of vegetation and the cut down of woods for fuel usage. Deh Akro II wetland was proclaimed as a Wildlife Sanctuary of global prominence in 1988. On 5 November 2002, Deh Akro Wetlands Complex was declared as a Ramsar site. (Ramsar sites information service).
The Chotiari Wetland Complex/Reservoir (26°9’15” N latitude, 69°2’48” E longitude) is situated 30-35 km of northeast of Sanghar Town. District Sanghar, Province Sindh, Pakistan. It is situated at an elevation of 60 meters above sea level by covering an area of about 18,000 ha. Area has been surrounds by the Nara Canal on the south and west and Thar Desert on east, north, north-east and south-east. The complex includes many brackish and fresh water bodies. Warm bone-dry environment win through the space. Most sultry months are May and June with normal greatest every day temperature of more than 40°C. Coolest months are December to February, with the most extreme day by day temperatures scope of 25 to 30°C. Most of the rainfall is experienced between July and August and averages 40 mm monthly and about 125 mm annually. (Rais et al., 2008; Rais et al., 2013; WWF, 2008). Chotiari Reservoir was constructed in an already existed low lying area in 2003, along the left bank of Nara Canal. Its 58km long bank has been separated into Western Bund (14 km), Southern Bund (16km) and South Eastern Bund (9km). Chotiari Dam is re-energized through Ranto Canal. Its water has been supplied to areas of Mir Pur Khas, Umer Kot, Tando Mitha Khan and Khipro (WWF, 2008). Water from the dam and Nara Canal is also used for human, livestock consumption, and irrigation.
purposes (Rais et al., 2008). Leakage from Nara Canal and Chotiari Dam has generated numerous small wetlands which are serving a mutual purposes of ground water replenishment, flood water storing and wintering park land for migrant birds, chiefly ducks and shorebirds. Chotiari wetland complex is also supports a wide range of fauna and flora, mainly desert and wetland habitat including, 136 birds, 32 species of mammals, three amphibians and 32 reptiles (Rais et al., 2011).

The Chotiari reservoir project was planned and executed in order to provide irrigation for dry but fertile land in Pakistan and increase the storage capacity of the existing lakes in the Chotiari wetlands but this comes with pros and cons as it has affected and induced social and environmental problems by harmfully affecting arable land, pastures, forests as well as the cruel displacement of native populations. The upsurge of water level in the reservoir has caused seepage, which has waterlogged nearby agricultural land. (Magsi and Torre 2014).

Fig. 2 - Map Showing Location of Chotiari Wetland Complex
3. Materials and Methodology

Data Sets for Deh Akro II Wetland Complex

For accurate and target oriented results and to save time and cost, suitable and accurate spatial data is the best option. (Heipke, 2004). For conventional hard classification Two Landsat ETM images obtained in post monsoon season: Landsat 7 ETM+(Collection 1 Tier 1 calibrated top-of-atmosphere (TOA) reflectance) image of 31st August for year 2000(Path 152, Row 42, Time of capture 10:47:36.9641269Z) and Landsat 8 ETM+ (Collection 1 Tier 1 calibrated top-of-atmosphere (TOA) reflectance) image of 19th September for year 2018 (Path 151, Row 42, Time of capture 10:50:11.1407460Z). For linear Classification Another Two Landsat images have been obtained from google earth engine, Landsat 7 ETM+ (calibrated top-of-atmosphere reflectance, orthorectified) image of 2nd April for year 2000 (Path 151, Row 42) and Landsat 8 ETM+ (calibrated top-of-atmosphere reflectance, orthorectified) image of 4th April of year 2017 (Path 151, Row 42).

Data Sets for Chotiari Wetland Complex

For conventional hard classification Two Landsat ETM images obtained in post monsoon season: Landsat 7 ETM+(Collection 1 Tier 1 calibrated top-of-atmosphere (TOA) reflectance) image of 08th August for year 2000(Path 151, Row 42, Time of capture 10:41:37.1835887Z) and Landsat 8
ETM+ (Collection 1 Tier 1 calibrated top-of-atmosphere (TOA) reflectance) image of 19th September for year 2018 (Path 151, Row 42, Time of capture 10:50:11.1407460Z).

For linear Classification Another Two Landsat images have been obtained from google earth engine, Landsat 7 ETM+ (calibrated top-of-atmosphere reflectance, orthorectified) image of 14th April for year 2000 (Path 151, Row 42) and Landsat 8 ETM+ (calibrated top-of-atmosphere reflectance, orthorectified) image of 20th April of year 2018 (Path 151, Row 42).

**Selection Criteria**

The selection of the Landsat satellite images dates was influenced by the quality of the image especially for those with limited or low cloud cover, removal of other distortions and with the post monsoon season also as we need image containing maximum amount of water in lakes. We need resolution of 30 meters for the analysis, so the following bands of Landsat 7 and 8 were used.

| Landsat 7 ETM+ Bands (um) | Landsat 8 OLI and TIRS Bands (um) |
|---------------------------|-----------------------------------|
| Band 1 30m Blue 0.44-0.51  | Band 2 30m Blue 0.45-0.51         |
| Band 2 30m Green 0.51-0.61  | Band 3 30m Green 0.53-0.59        |
| Band 3 30m Red 0.63-0.69    | Band 4 30m Red 0.63-0.67          |
| Band 4 30m NIR 0.77-0.89    | Band 5 30m NIR 0.85-0.87          |
| Band 5 30m SWIR-1 1.54-1.74 | Band 6 30m SWIR-I 1.56-1.65       |
| Band 7 30m SWIR-2 2.06-2.34 | Band 7 30m SWIR-2 2.10-2.29       |

**1. Fractional Cover Mapping**

In Fractional cover planning the mapping of a space that is covered by each individual from a pre-characterized set of land cover types has been assessed. In RS the essential unit is for the most part a pixel and the assessment of fragmentary cover is a sort of sub-pixel classification.

Various methods for assessing fractional cover from remotely-sensed data have been broadly utilized and described by Fernandes et al. (2004) and Scanlon et al. (2002):

- **Conventional “Hard” Classification** - "Hard" classes are rigorously characterized as far as their cover and arrangement and, and are by and large found in land cover maps. The verifiably expected to be that the "pure" classes comprise of tiny fraction of the other landform, and that the combined class contains equivalent degrees of both. Processes like Supervised Classification or Unsupervised Classification utilized his way to deal with attempt to straightforwardly characterize or plan the “hard” classes.
Linear Modeling - linear modeling endeavor to narrate field measurements of fractional cover with reflectance data documented by a sensor, by using linear regression techniques. For example vegetation indices like NDVI.

Other techniques include:

- Spectral Unmixing Models
- Artificial Neural Networks (ANN)
- Physical Models

In this study Two types of fractional cover mapping have been performed including conventional hard classification and linear modeling.

2. Conventional Hard Classification

Landsat 7 (Collection 1 Tier 1 calibrated top-of-atmosphere (TOA) reflectance) and Landsat 8 imagery (Collection 1 Tier 1 calibrated top-of-atmosphere (TOA) reflectance) were called and imported in GEE code editor. Selected reflective bands of both images were used explained in table 1. After that samples of three land cover classes: 1. Agriculture 2. Water 3. Natural vegetation, were selected in GEE as pure regions. Both study areas have both man made vegetation(agriculture) and natural vegetation. Then image was further processed with the help of FCM algorithm written in code editor and final results were generated, displayed and downloaded in the form of multi band image. Then these classified images were exported for further analysis and accuracy assessment. Fundamental concentration for precision appraisal or accuracy assessment tests determination was that they could be plainly distinguished on Landsat image, Google earth and Google Map. Classified images from GEE were reclassified band by band in Arc Map by using reclassification tool in order to identify required Landcover clearly, vectorized by using conversion tool, clipped with study area boundary. After that training samples were selected with the help of subset features tool for each class, tables contain values of each polygon were prepared. Then vectorized shape file have verified with the help of Quick Bird image. At least 65% to 70 % of total polygons were taken as training sample and get checked to get more exact and precise outcomes. All the final maps of each classes have been assessed using spatial overlay to get idea of change in area cover. Further total area was calculated for each class and compared for both years. As it was expected a lot of changes were noted in each class. Final maps showing the changes in area were created.
3. Linear Modelling Classification

For the purpose of linear modelling classification, four auxiliary datasets, namely the Normalized Difference Vegetation Index (NDVI), Enhanced vegetation index (EVI) and Normalized Difference Water Index (NDWI) were derived and calculated from the Landsat 7 and Landsat 8 information to expand the precision of land cover arrangement. Formulas used are mentioned below.

\[
\text{NDVI (Landsat 7)} = \frac{(\text{Band 4} - \text{Band 3})}{(\text{Band 4} + \text{Band 3})}
\]

\[
\text{NDVI (Landsat 8)} = \frac{(\text{Band 5} - \text{Band 4})}{(\text{Band 5} + \text{Band 4})}
\]

\[
\text{NDWI (Landsat 7)} = \frac{(\text{Band 4} - \text{Band 5})}{(\text{Band 4} + \text{Band 5})}
\]

\[
\text{NDWI (Landsat 8)} = \frac{(\text{Band 5} - \text{Band 6})}{(\text{Band 5} + \text{Band 6})}
\]

\[
\text{EVI (Landsat 7)} = \frac{2.5 \times (\text{Band 4} - \text{Band 3})}{(\text{Band 4} + 6 \times \text{Band 3} - 7.5 \times \text{Band 1} + 1)}.
\]

\[
\text{EVI (Landsat 8)} = \frac{2.5 \times (\text{Band 5} - \text{Band 4})}{(\text{Band 5} + 6 \times \text{Band 4} - 7.5 \times \text{Band 2} + 1)}.
\]

4. Results

Remote sensing and GIS techniques end up being valuable in Landcover/landuse change detection of Deh Akro II wetland complex and Chotiari wetland complex. The overall results of Landcover/landuse change using temporal analysis shows significant amount of changes in given classes. (see table 2).

| LULC Classes       | Study Areas                   |
|--------------------|-------------------------------|
|                    | Deh Akro II wetland complex   |
| Agriculture        | increased by 110%             |
| Water              | decreased by 91%              |
| Natural Vegetation | increased by 49%              |
|                    | Chotiari wetland complex      |
| Water              | decreased by 94%              |
| Natural Vegetation | decreased by 98.8%            |

5. Accuracy Assessment of Deh Akro II Wetland Complex

Accuracy assessment of classification results yield overall accuracy of 91.95% and Kappa coefficient of 84.144% for year 2000. For year 2018 overall accuracy was 91.96% and Kappa coefficient of 87.27 %. Producers and user’s accuracy for each class are given bellow in table.
Table 3 - Showing Accuracies of Deh Akro II Wetland Complex of Year 2000 and Year 2018

| Landcover Classes                | Producers Accuracy 2000 | Producers accuracy 2018 | Users Accuracy 2000 | Users accuracy 2018 |
|----------------------------------|-------------------------|-------------------------|---------------------|---------------------|
| Agriculture                      | 79.90599295            | 89.68407                | 64.82364156         | 84.3030303          |
| Water                            | 83.3538445             | 83.94161                | 99.34829833         | 99.85528            |
| Natural Vegetation               | 97.17465753            | 97.7532                 | 95.80080186         | 92.53927            |

Accuracy assessment of Chotiari Wetland Complex

Accuracy assessment of classification results yield overall accuracy of 80.77% and Kappa coefficient of 71% for year 2000. For year 2018 overall accuracy was 70.64% and Kappa coefficient of 73.52%. Producers and user’s accuracy for each class are given below in Table 3.

Table 4 – Showing Accuracies of Deh Akro II Wetland Complex of Year 2000 and Year 2018

| Landcover Classes                | Producers Accuracy 2000 | Producers accuracy 2018 | Users Accuracy 2000 | Users accuracy 2018 |
|----------------------------------|-------------------------|-------------------------|---------------------|---------------------|
| Agriculture                      | 82.35909963            | 69.21405                | 78.78484393         | 68.79875            |
| Water                            | 72.7654217373059       | 76.56676                | 94.62482947         | 81.63858            |
| Natural Vegetation               | 96.86452848            | 58.11416                | 66.12745098         | 50.72267            |

Maps Created by using Conventional Hard Classification for Deh Akro II Wetland Complex

Fig. 4 - Map Showing Agriculture Area Change of Deh Akro II Wetland Complex
In year 2000 the agricultural area was 14.415 sq. km and in 2018 it is increased up to 110% by covering the area of 30.0908 sq kms. According to the local sources, for irrigation purposes most of the water has been taken from the canals directly. This increase of agriculture has been observed as most of the sand dunes has been converted into agricultural fields, to cater the needs of food for humans and animals both, and also cash crops have been cultivated for better economy of the area. As it can be observed in the map, maximum agriculture happened away from wetlands as the most of the land near by the lakes has been badly affected by waterlogging and salinity.

Fig. 5 - Map Showing Water Bodies Area Change of Deh Akro II Wetland Complex

In year 2000 wetlands have covered the area of 6.3544 sq. km and in year 2018 it has been decreased to 2.6848 sq. km. 42% area of lakes has been decreased. Some lakes are officially declared as dry. The main reason of this unfortunate change is the changing climate, as these lakes are both rain fed and seepage fed from Jam Rao canal and Nara canal. According to historical archives of World climate. Org the precipitation of deh akro 2 was 1-26 mm in month of August 2000 and was 0-16 mm in the month of August 2018 as graphically represented in Figure 3. So water level of lakes has been clearly effected by lack of precipitation, hence climate change.
In the year 2000 the area covered by natural vegetation in deh akro II wetland complex was 20.2310 sq km and in year 2018 this area increases up to 49% by covering 29.3948 sq km of land. According to the local sources monsoon rains of year 2016 and 2017 increases the amount of natural vegetation after a long drought (Figure 3). Local population use wood and dry vegetation as a fuel because of lack of awareness about importance of ecosystem and biodiversity of area. Many small NGO’s work on this aspect, providing awareness and finally locals are switching to other sources of fuel in order to save flora of the area.

Maps Created by using Linear Modelling Classification of Deh Akro II Wetland Complex

![Map Showing NDVI of Deh Akro II Wetland Complex](image-url)
By comparing both year NDVI and EVI results it can easily be assessed that amount of scattered natural vegetation and vegetation around the lakes has been visibly increased. This increase in vegetation is a new hope for a betterment of both locals and wildlife of the area, it will also help in minimize the negative effects of climate change on area.

By comparing both year NDWI results it can easily be assessed that amount of water in lakes has decreased and more water is visible in agricultural areas, as irrigation water.
Maps Created by using Conventional Hard Classification for Chotiari Wetland Complex

Fig. 10 - Map Showing Agriculture Area Change of Chotiari Wetland Complex

According to findings of (Magsi and Torre 2014), later the alteration of complex into dam, rise of water level caused seepage, hence a lot of arable land has been converted into waterlogged land and this phenomenon can be observed here as year 2000 the agricultural area was 622 sq. km and in 2018 it is decreased up to 91% by covering only the area of 55.5 sq kms.

Fig. 11 - Map Showing Water Bodies Change of Chotiari Wetland Complex
The water surface area increased after transformation of Chotiari wetland into the artificial lake as it is observed that the area of water was 293 sq. km in year 2000 before the construction of reservoir, now it has been increased up to 15% by covering area of 336 sq. km in year 2018. The fertile lands in the reservoir has been flooded by the amplified water level and due to outrageous water spillage from western and southern margins adjoining farming grounds and rangelands, beside infrequent flash floods in the region (Rind et.al., 2018), a great deal of waterlogged, salt influenced and useless land has been made (Raza 2009), affecting more than 50,000 acres of fertile agriculture land, because of waterlogging and salinity produced by Chotiari Dam (Daily Times 2010).

In the year 2000 the area covered by natural vegetation was 138 sq km and in year 2018 this area decreased by 98% by covering only 1.67 sq. km of reservoir land. After the change of the lake into the repository the vegetated region has diminished to undeniably less as compare to original. The generous upsurge in the water level have lowered trees, normal rangelands, grass species, and furthermore destroyed the environment and biodiversity of the lake and delivered feed instability for domesticated animals which is significant living hotspots for the local individuals. (Siddiqui, 2009).
Maps Created by using Linear Modelling Classification of Chotiari Wetland Complex

Fig. 13 - Map Showing NDVI of Chotiari Wetland Complex

Fig. 14 - Map Showing EVI of Chotiari Wetland Complex

Fig. 15 - Map Showing NDWI of Chotiari Wetland Complex
By comparing both years NDVI, EVI and NDWI it can easily have assessed that amount of vegetation has been decreased as previously vegetated area has been undertaken by water of reservoir. This increase in water have created several problems for ecosystem and local residents.

6. Conclusion

The study explores a successful use of fractional cover mapping using google earth engine for LULC change detection. LCLU changes of both the study areas have been has been successfully assessed with the help of google earth engine. The technique used, proved to be very effective to fulfill the aims with effective application. Increase in vegetation and Agriculture of Deh Akro II wetland complex proves that these changes are directly climate induced. As per our finding, decrease in amount of water in lakes over the period of 18 years, is an alarming situation and can cause serious damage to local ecosystem. Better monitoring and management has been required by the concerned local authorities and departments. Conversion of Chotiai natural wetland into the manmade Chotiari reservoir results in waterlogging, soil salinity and vegetation lose as according to present study 98% of vegetation inside of reservoir boundary has been submerged under rising water level. Authorities and local management needs to look out for the issue before further damage to the ecosystem and biodiversity of the area.

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