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WATER QUALITY ESTIMATION OF JAYAKWADI DAM BY USING REMOTE SENSING AND GIS TECHNIQUES.

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Abstract
Jayakwadi dam built in 1976, is located in Jayakwadi village in Paithan taluka of Chhatrapati Smbhaji Nagar district in Maharashtra, India. Monitoring the water quality of Jayakwadi Dam is important task because the main purpose of dam water is for drinking water for Chhatrapati Sam haji Nagar city people. The water quality is easily estimated with the help of remote sensing and GIS technique. The data used to estimate water quality is Landsat-8 and Sentinal-2 satellite multispectral data. Sentinal-2 is high resolution data than the Landsat-2 data. We used mainly data form 2016 to 2023. NDWI, NDTI, NDCI ratio indices mainly used to estimate water quality. Turbidity can be easily estimated with the help of NDTI indices while chlorophyll can also be estimated with the help of NDCI. The water surface area can be easily estimated with the help of NDWI. In this paper we try to find out water quality of reservoir and can be easily estimated with the help of Indices. NDTI and NDCI shows good results for turbidity and chlorophyll concentration. With the help of optical property satellite data we can easily determine water quality by indices of bands.

Keyword: List of keyword accepted by authors through their work]: Remote Sensing, Water Quality, Turbidity, Chall-a+, NDCI.

1. Introduction

Water is important resource. Water is one of the important element among five. Water require in huge amount for industry, Agriculture, Urban life I.e. City need too much amount of water for drinking and daily usage. But due to the water pollution and human intervention the water quality is low. Another major problem is water scarcity. There is many water quality parameter like Physical parameters Turbidity, temperature, color taste and odor, electrical conductivity. Chemical parameter like PH, acidity, chloride & bacteria, algal, viruses, protozoa. Biological parameters. Monitoring in specific time & water quality estimation to control surface water pollution is important. Water quality is estimate with the help of remote sensing and geographical information system. It provides best tool for a comprehensive water quality assessment and water body management. For lunately the new technologies of geoinformatics. Especially remote sensing and Geographic information system. The feature of remote sensing dataset offer synoptic view of ongoing earth surface processes [1]. Remote sensing techniques are valuables in monitoring land use land cover changes [2]. Mapping the spatial distribution of water quality parameter using geographic information system [3, 4]. In addition satellite images have been used successfully in water management such as to conduct inventory [5]. Remote sensing satellite dataset is uses to access information of flood areas for water quality assessment change detection and monitoring is also used [6]. It is feasible to detect water pollutants using spectral signature in visible and near infrared band [7]. The band 2 and band 3 of Landsat ETM+ imagery are relate to

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identify water pollutant [8]. To predict chlorophyll a the Eo-1 Hyperion data & Thematic mapper™ data is used [9]. Remote sensing is very cost effective tool to estimate water quality, by using Landsat ETM+ Visible and NIR data chlorophyll-a, turbidity, water color can be predicted [10]. Optical and thermal sensors on boats, aircrafts and satellites provide both spatial and temporal information to change in watter quality parameters [11].

2. Materials and Methods

A.Study Area:

Jayakwadi dam built in the period of 1965-1976, is located in Jayakwadi village in Paithan taluka of Chhatrapati Smbhaji Nagar district in Maharashtra, India. The lake covers an surface area of approximately and 350km2, at height of 40.30M and length of 9998KM. Jayakwadi dam was built in order to support the irrigate agriculture land in the drought-prone Marathwada region of the state. Jayakwadi is one of the longest earthen dam in Asia. The storage capacity is 102.74 Tmc. The total catchment area of dam is 21,750Km2. There are 27 water gates for dam and it is also known as Nathsagar dam [12] as shown in fig. A.

The main purpose was to irrigate land for agriculture in drought Marathwada region, other important purpose was to provide water for drinking and industrial usage to nearby towns and villages. 80% of water of dam is allocated for irrigation, 5-7% for drinking water and the rest for industrial purpose. The annual rainfall is around 726MM [13].

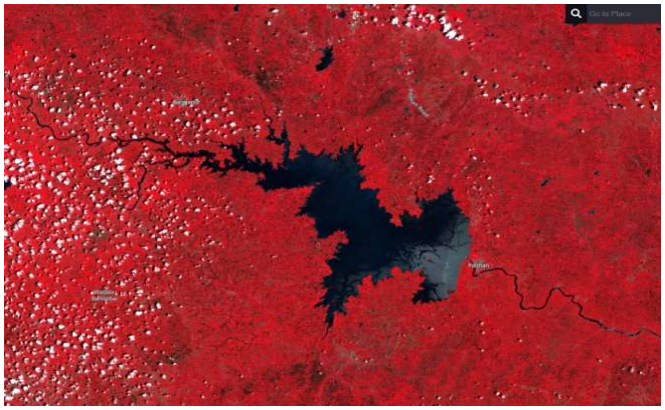

Fig:A Study Area Jayakwadi DAM.

B. Data Set:

1) Landsat-8 2) Sentinal-2

Band designations of Landsat-8 data is as per shown in table 1 that it has Blue, Green, Red, NIR, SWIR-1 and SWIR-2 OF TWO 30 meters Resolutions. Thermal band has 60 meter resolution but as compare to all band panchromatic band has resolution of 15 meters. Landsat-8 satellite was launched by uses in 2013. The feature of landsat-8 satellite is Ultra-blue band i.e. band-1 which is useful for coastal and aerosol studies. Thermal band 10 and 11 are useful to provide surface temperature. Sentinal-2 which shown in table 2 has 13 spectra bands blue, green and red, NIR band have 10 meter resolution while red edge while NIR, SWIR have 20 meters sampling distance. Table 3 shows the date of data acquisition.

Table 1. Landsat-8 Band Description

Band Number	Description	Wavelength	Resolution
Band 1	Coastal / Aerosol	0.433 to 0.453 µm	30 meter
Band 2	Visible blue	0.450 to 0.515 µm	30 meter
Band 3	Visible green	0.525 to 0.600 µm	30 meter
Band 4	Visible red	0.630 to 0.680 µm	30 meter

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Band 5	Near-infrared	0.845 to 0.885 µm	30 meter
Band 6	Short wavelength infrared	1.56 to 1.66 µm	30 meter
Band 7	Short wavelength infrared	2.10 to 2.30 µm	60 meter
Band 8	Panchromatic	0.50 to 0.68 µm	15 meter
Band 9	Cirrus	1.36 to 1.39 µm	30 meter
Band 10	Long wavelength infrared	10.3 to 11.3 µm	100 meter
Band 11	Long wavelength infrared	11.5 to 12.5 µm	100 meter

Table 2. Sentinal-2 Band Description

Band Number	Description	Wavelength	Resolution
Band 1	Ultra Blue (Coastal and Aerosol)	443 nm	60 meter
Band 2	Visible blue	490 nm	10 meter
Band 3	Visible green	560 nm	10 meter
Band 4	Visible red	665 nm	10 meter
Band 5	Visible and Near Infrared (VNIR)	705 nm	20 Meter
Band 6	Visible and Near Infrared (VNIR)	740 nm	20 meter
Band 7	Visible and Near Infrared (VNIR)	783 nm	20 meter
Band 8	Visible and Near Infrared (VNIR)	842 nm	10 meter
Band 8a	Visible and Near Infrared (VNIR)	865 nm	20 meter
Band 9	Short Wave Infrared (SWIR)	940 nm	60 meter
Band 10	Short Wave Infrared (SWIR)	1375 nm	60 meter
Band 11	Short Wave Infrared (SWIR)	1610 nm	20 meter
Band 12	Short Wave Infrared (SWIR)	2190 nm	20 meter

Table 3. Data used- Remote sensing data

Sr.No.	Data	Acquisition Date
1	Landsat-8	5-5-2016
2	Landsat-8	21-5-2016
2	Landsat-8	20-5-2017
3	Sentinal-2	24-5-2021
4	Sentinal-2	04-5-2021
5	Sentinal-2	11-10-2021
6	Sentinal-2	03-06-2022

C Methods:

The index which shown in the table 4 is computing with the help of more than two spectral bands that used to find out the water, vegetation, soil and other surface material of earth. The first index which was vegetation index and that is ratio index developed by Carl F Jorden in 1969[14].

Table 4. Ration Index used- Remote sensing data

Sr. No	**Ratio Index**	**Water Quality Parameter**
1	NDWI=(Green-NIR)/(Green+NIR)	Water Body

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2	(Red edge/Green)	Chall-a
3	NDTI=(Red-Green)/ (Red+Green)	Turbidity
4	(NIR-Red edge)/ (NIR+Rededge)	Chall-a
5	(Green/Red edge)	TSM
6	NDCI=(Green-Red edge)/ (Green+Rededge)	Chlorophyll.

The index is mainly type of ratio index. NDWI is normalized difference water index which is used to identify water body. It calculate with the help of Green and NIR band and by using type of Ratio index [15]. By using simple ratio index of Red edge and green band, we can find out the total suspended matter and chlorophyll-a [16]. Normalized difference turbidity index is used to find out turbidity of water. It calculate with the help of Red and Green band. It is also a ratio index the difference between red and green reflectnces is divided by their sum [17]. The ratio of near infrared and Red edge shows a presence of chlorophyll-a [18]. The simple ratio of red and near infrared band is use to estimate Total suspended matter [19]. Green and Red edge band used to find out Normalized difference chlorophyll index by ratio index. This index is used to find out Chlorophyll [20].

3. Results and Discussion

The characteristics of satellite bands play an important role to access water quality parameter. The blue band can be reach depths up to 20 to 30 meters in clear water, so with the help of blue band we can identify turbidity, sediment, aquatic vegetation [21]. The Spectral Reflectance of green is high in vegetation while spectral reflectance is low in blue and red region. The maximum reflectance of green in clear water shows Algal and cyanobacteria bloom. Red Spectral band is useful to identify iron-oxide because of rust color it have high reflectance. Near Infrared is used to identify chlorophyll absorption. The new yellow band is use to identify the yellowness of trees. Yellow band is found in worldview-2 satellite. It identify yellow object. The red edge band is useful to identify plant health and plant age with the help of leaf area index and with the help of chlorophyll content. For the precision farming and to distinguish between healthy and unhealthy monitoring the red edge band is useful. The Near Infrared Spectrum band is useful to identify water and healthy plant, the more energy of NIR spectrum is reflect in healthy plant while it absorbs in Water. NIR is use to identify biomass content, in NDVI calculation Nir-1 is mostly used because it extract vegetation precisely. Near Infrared-2 is mainly used to vegetation studies and Land/water boundaries detection. SWIR-1 identifies moisture of soil, Cloud or smoke penetration, Mineral exploration. SWIR-2 is helps to identify water properties and also useful for irrigation practices and mineral mapping. Panchromatic band is use to panshapning of satellite image. Cirrus band is used to cloud detection. Thermal infrared band (TIRS-1) is uses to understand surface temperature. TIRS-1 band is also used to weather prediction.

3.1. NDWI

Normalized difference water index is used to identify the water bodies. The index was proposed by Mc Feeters, in 1996. Water body strongly absorb light in visible to infrared electromagnetic spectrum [22]. Greater than 0.5 values indicate water bodies. While in between 0 to 0.2 value indicate the built up area. It is calculated using green and NIR band which allows to identify changes in water content of water reservoirs, lake, DAM. In the NDWI 21 May 2016 image we found water bodies in pink color while in the 20-May-2017 image water body shown in blue color and other green shows vegetation. Same way in the image of NDWI 24-may-2021 and 4-may-2022 black color shows water body and 11-may-2021, 3-June-2022 shows water bodies in blue color. In 3rd-June-2022 and 20-May-2017 image shows high vegetation.

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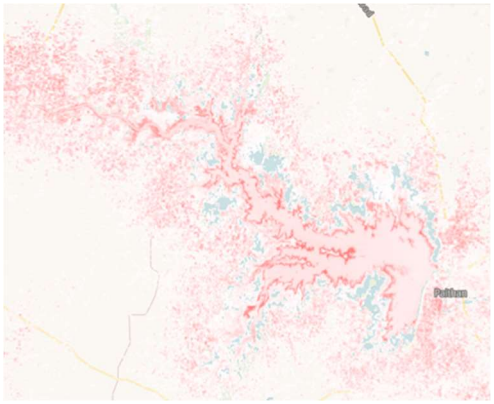	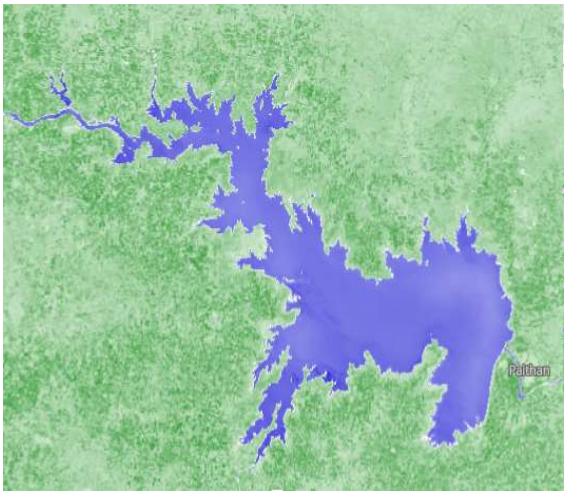
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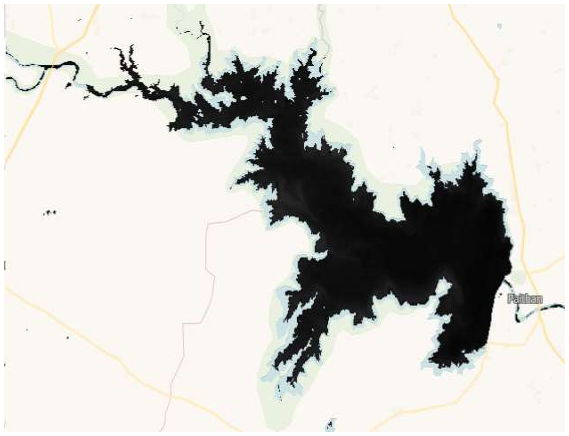
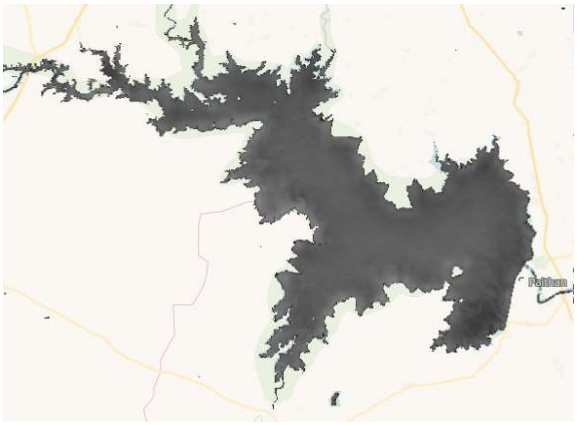
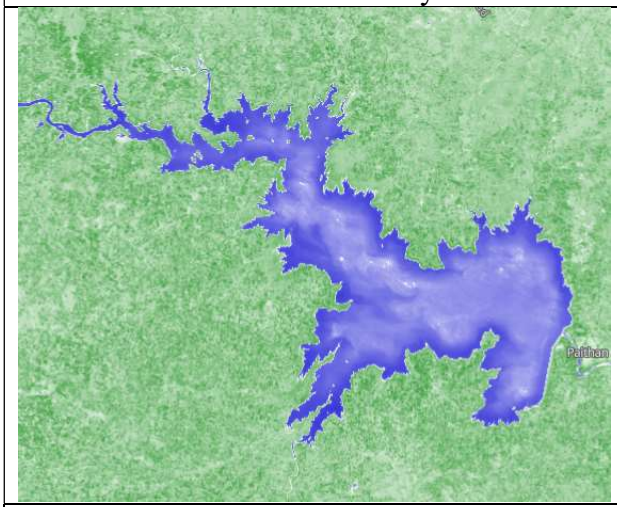
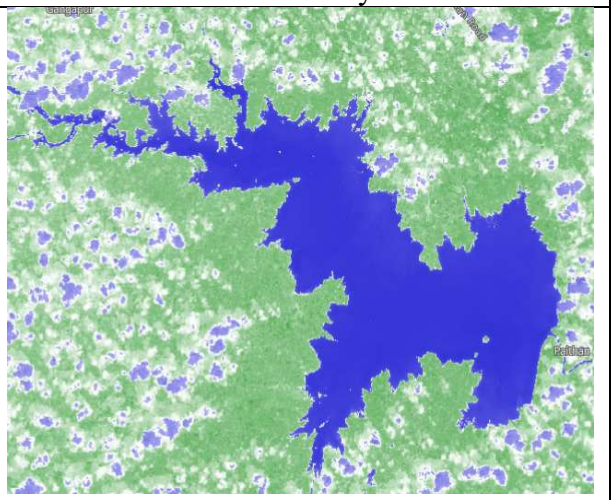
	
NDWI Date:24-May-2021	NDWI Date:4 May 2022
	
NDWI Date: 3-June-2022	NDWI Date: 11-May-2021

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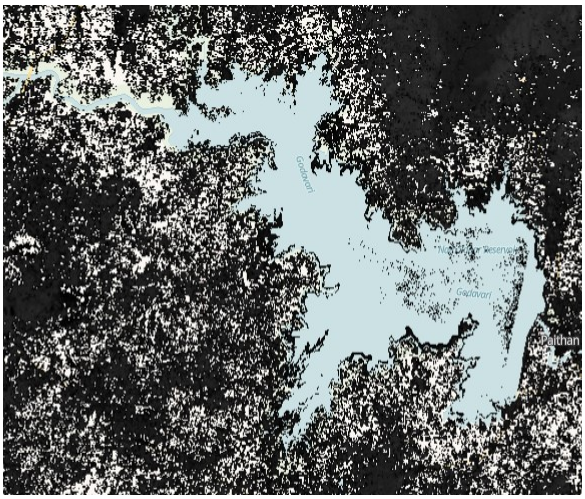
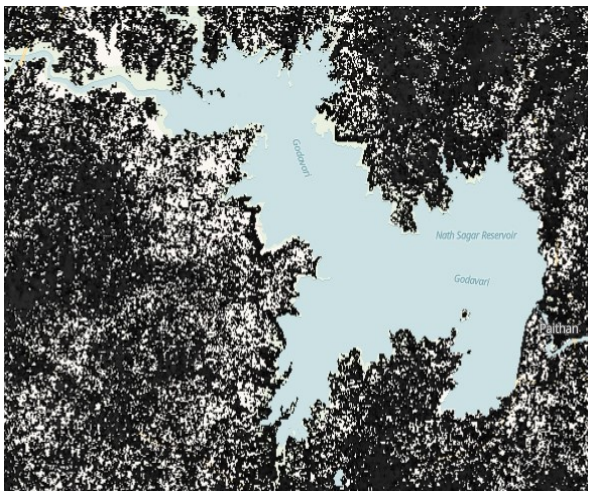
3.2. NDTI: Normalized difference turbidity index used to estimate turbidity with the help of spectral reflectance value of the water pixels. The electromagnetic reflectance is higher in green spectrum than the red spectrum for clear water. When the turbidity is increases then reflectance of red spectrum also increases [23]. This index is combination of red and green band. In the image of 20-may-2017 highly turbide water shows in black color. It is shows because there was low amount of water present in reservoir due to drought condition. Same condition in 24-may-2021 and 2-June-202 turbid water in black color. In the below images sky blue color indicates water and black color shows soil so in the in 24-may-2021 and 2-june-2022 image black spot in image shows turbidity. Due to rain in may-2022 huge amount of water is present in reservoir.

<table>
<tr><td>  </td><td> 
</td></tr>
<tr><td>Date:20-May-2017</td><td>Date: 21-May-2016</td></tr>
<tr><td> 
</td><td> 
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<tr><td>Date: 24-May-2021</td><td>Date:4-May-2022</td></tr>
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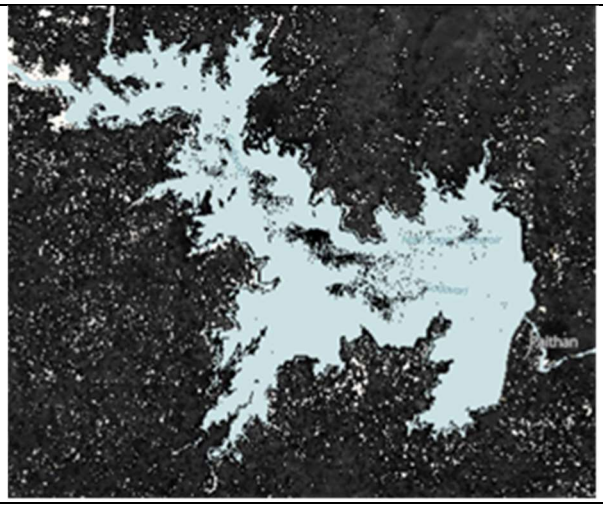
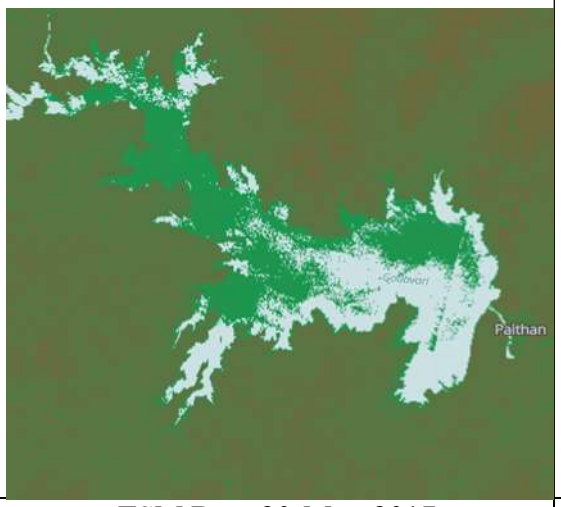
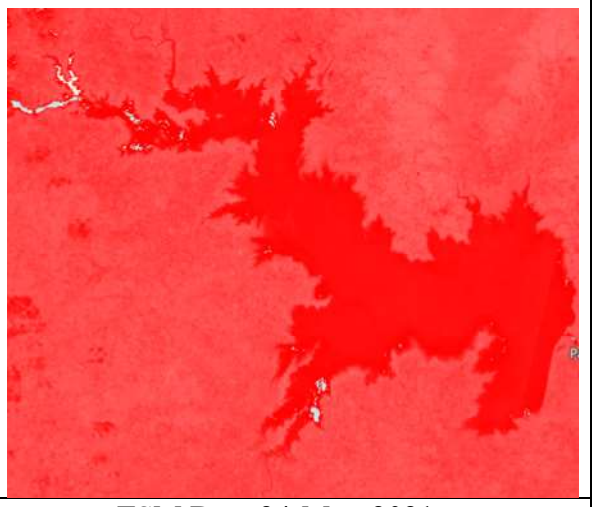


Date: 2-June-2022

3.3. TSM: Total suspended matter present in water can be estimated by using ratio of green and red-edge band. In the image of 20-May-2017 dark green color shows total suspended matter in the water. While in image 24-May-2021 while color indicate suspended matter in while color while water present in reservoir indicate by red color. In the image of 3-June -2022 suspended matter shows by black color and white color indicate water. There is no suspended matter present in the image of 4-May-2022.



TSM Date:20-May-2017



TSM Date:24-May-2021

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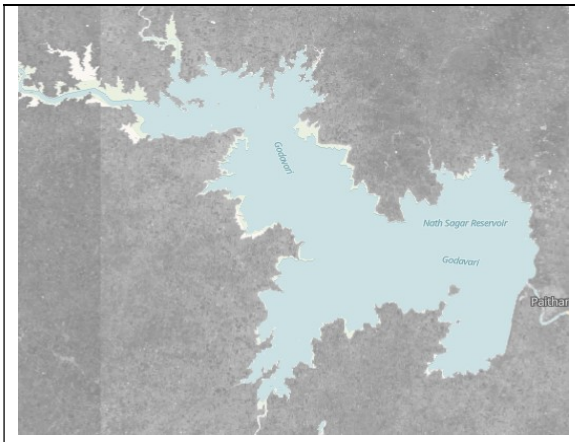
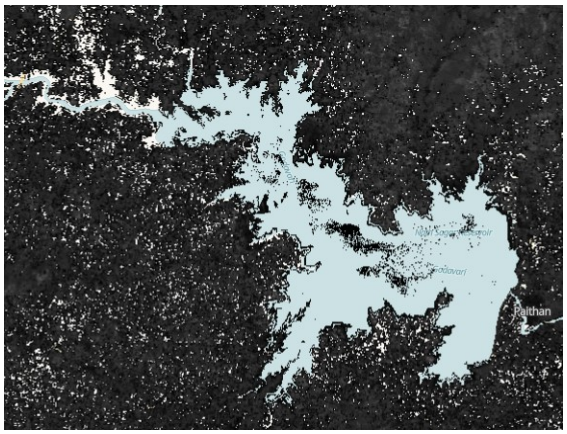
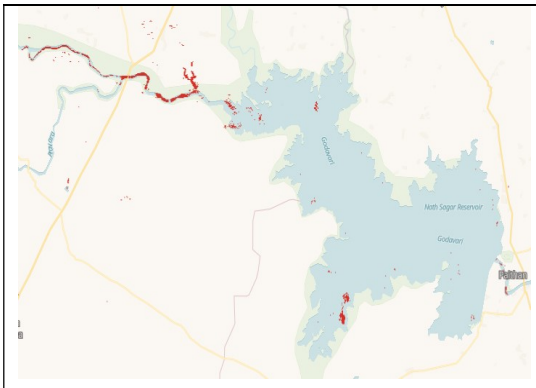
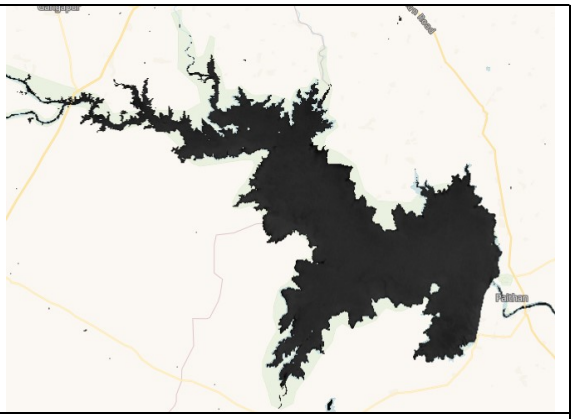
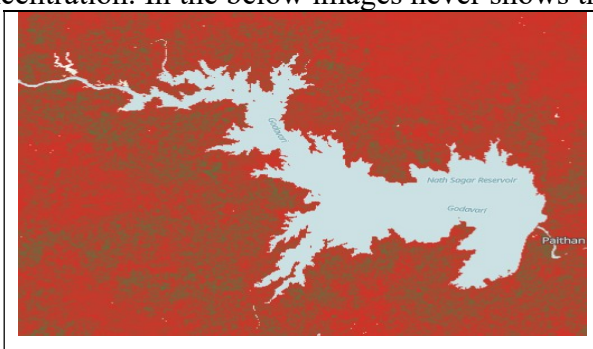
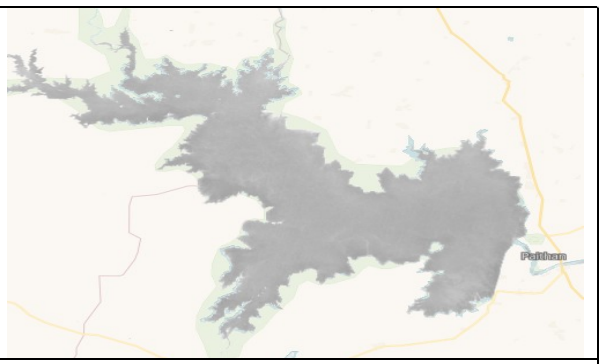
	
TSM Date:4-May-2022	TSM Date:3-June-2022

3.4 NDCI: NDCI is calculated by ratio of green band and red edge band. The spectral resolution is high in green color. When algal bloom is present in water the reflectance is also high. In the image of 24-May-2021 the water is indicated by blue color while red color indicates the chal+a content. It is present run off zone mostly but in the image of 4-May-2022 there is not presence of chlorophyll present in the water.

	
NDCI Date: 24-5-2021	NDCI Date: 04-5-2022

3.5 Chall-a+

It is calculated with the ratio of near infrared and Red edge band. It is used to find out chall-a+ Concentration. In the below images never shows the chall-a+ concentration.

	
Chall-a+Date: 24-5-2021	Chall-a+ Date:4-5-2022

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4. Conclusion

Water is important resource, so we have to take care of the resources of water. We have to monitor the water quality of water bodies by using remote sensing it is very easy to monitor optical property of water. It is very cost effective technique. The ratio indices of band is mostly used to monitor water quality. To extract water body we use NDWI indices while to find out turbide water we use turbidity index, Total suspended matter is also estimate by ratio green and red edge band. Normalized Difference Chlorophyll Index is use to identify algal bloom in to the water. But the combination of red edge and green is not able to find out presence of chall-a+, to find out concentration of chlorophyll content in many indices green band is mostly use. With the help of remote sensing technique we can monitor quality. When the dam is full of water then found no water pollutants is present. The combination of band is used to estimate the water quality parameter.

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