CHAPTER: 2

MATERIAL

AND

METHODS

CHAPTER 2
MATERIALS AND METHODS

STUDY AREA

In India, large numbers of seasonal and perennial fresh water bodies are located in rural as well as urban areas of different parts of the country. The flow of river is captured by dams and stored in large reservoirs behind the dam increasing the annual supply by collecting fresh water during wet periods. Dams control the flow of rivers and can reduce the danger of flooding in downstream areas. Dams and reservoirs are the life supporting systems for people living around. Dams are effective in recharging aquifers and also winter resort for a variety of birds for shelter and breeding. They also provide a suitable habitat for fishes and other flora as well as fauna.They have often been regarded as man's response to nature's eccentricity, to alleviate flood and drought by containing water and releasing it as per demand and supply. These days dams are used more often as hydropower generators with flood mitigation, irrigation and drinking water supply only being additional benefits (Niti Aayog, 2018). Irrigation Projects are usually multi-purpose projects, catering to the needs of not only irrigation but also of urban and rural domestic consumers and industrial users.

Three water bodies of Northern Maharashtra called Khandesh were selected for present study. The study area lies in Districts Nandurbar and Dhule.Nandurbar is an administrative district in the northwest corner of Maharashtra state in India. On 1st July 1998, Dhule was bifurcated as two separate districts now known as Dhule and Nandurbar. The district headquarters are located at Nandurbar city. The district occupies an area of 5035 km² and has a population of 1,311,709 of which 15.45% were urban (as of 2001).

The Reservoirs selected for present study are located between 21^{o}16' to 21^{o}26' latitude and 74^{o}17' to 74^{o}33' longitude. The reservoirs are:

(1) Malpur dam reservoir (21^{o}16'43" N, 74^{o} 29'40" E ; 212 AMSL)

(2) Baldanetank reservoir (21^{o}21'28" N, 74^{o} 27'50" E ; 175 AMSL)

(3) Krishna Park reservoir (21^{o} 20'41" N, 74^{o} 17'49" E, 263 AMSL).

All these reservoirs selected for study are man-made and the water resources are utilized for various purposes such as irrigation, domestic use, pisciculture, recreation, *etc*.

2.1 Topography

2.1.1 Malpur dam:

In the present study,Malpur dam is selected for investigation. It is a medium project recently built on the confluence of Amrawati and Nai rivers west to village Malpur at Shindkheda Tehsil of Dhule District, Maharashtra, India. The elevation of Amrawati river is 220.7 meters above mean sea level and geographical location is 21^{o}, 19` 31.55 N latitude and $74^{o}$ 29` 26.94 E longitude. (Plate1&2). The project was started in 1984 but completed in 2005. It stores 982 mcftwater. Maximum height of the dam is 228.90 metersAMSL. The dam is about 3850 meters long with an earthen embankment. It has 148.3 meter long spill way having 12 x 5 meter sized ten gates. Left canal is 7.50 kms long and right canal 14.20 kms long. These canals cover 2606 hectares of land for irrigation. The catchment area is 341.76 sq.kms.and available water source is 26.86 million cubic meter (0.906 TMC). The submerged total land is about 468.66 hectares. The area of irrigation, water storage and utilization of water are given in the Tables - (1, 2 &3).

2.1.2 Baldanereservoir:

Baldane reservoir, the second reservoir selected for the study is constructed on Amravati Nallah and Lauki Nallah near village Baldane, in Nandurbar district. Two pickup weirs, namely Amravati Nallah pick-up weir and Laukki Nallah pick-up weir are the low barriers proposed across the river to check the flow of water. Though the reservoir is a reasonably small tank, it is significant in this drought prone area as its water is used for drinking as well as irrigation purpose. The construction of dam started in the year 2000 and completed in June 2004. Irrigation area of the reservoir is 1268 hectares with irrigation capacity of 1458 hectares. Two canals were proposed tobe constructed with a length of 2.02 kmsfor right canal with an irrigation capacity of 317 hectares while 3.91kms for left canal with an irrigation capacity of 951 hectares.

2.1.3 Krishna Park reservoir:

The Krishna Park reservoir is a small project constructed on local Nallah near the village Wavad, Nandurbar District. The construction of earthen embankment was completed in the year 1975. Now-a-days it has been used as Recreation Park.

Table 2.1: Area of irrigation atMalpur dam.

Sr. No.	Name of area	Area (hectare)		
		Left canal	Right canal	Total
1.	Irrigation coverage area	745	1861	1606
2.	Cultivation coverage area	1170.04	2422.53	3592.54
3.	Gross coverage area	1332.60	2761.75	4094.35

Table 2.2 : Water storage, Malpur dam.

Sr.No.	Water Storage	Million Cubic meter	TMC
1	Catchments area (sq km)	341.76	0.906
2	Available water(million cu)	25.68	0.906
3	Live water use (million cu)	27.78	0.981
4	Live water storage (m cu)	21.78	0.75
5	Dead storage (million cu)	6.53	0.23
6	Gross storage (million cu)	27.78	0.981

Source: Executive Engineer, Dhule, Irrigation Project Division, Dhule.

Table 2.3: Area of irrigation, Baldane Reservoir.

Sr. No.	Name of area	Area (hectare)		
		Left canal	Right canal	Total
1.	Irrigation coverage area	951	317	1278
3.	Gross coverage area	---	---	1458

Table 2.4 : Water storage,Baldane Reservoir

Sr.No.	Water Storage	Million Cu.m	TMC
1	Catchments area (sq km)	95.95	---
2	Available yield (million cu)	9.25	.326
3	Live water use (million cu)	9.30	.328
4	Live water storage (m cu)	9.34	.33
5	Dead storage (million cu)	2.74	.096
6	Gross storage (million cu)	12.06	.426

Table 2.5: Area of irrigation, Krishna Park.

Sr. No.	Name of area	Area in Hectare	
		Canal	Total
1.	Irrigation coverage area	522.26	522.26
2.	Cultivation coverage area	334	334
3.	Gross coverage area	856.26	856.26

Table 2.6: Water storage, Krishna Park.

Sr.No.	Water Storage	Million Cu.Mt.	TMC
1	Catchments area (sq km)	11.33	---
2	Available yield (million cu)	1.87	---
3	Live water use (million cu)	1.36	---
4	Live water storage (m cu)	---	0.136
5	Dead storage (million cu)	0.13	0.013
6	Gross storage (million cu)	1.49	0.14

Source: Executive Engineer, Dhule, Irrigation Project Division, Dhule.

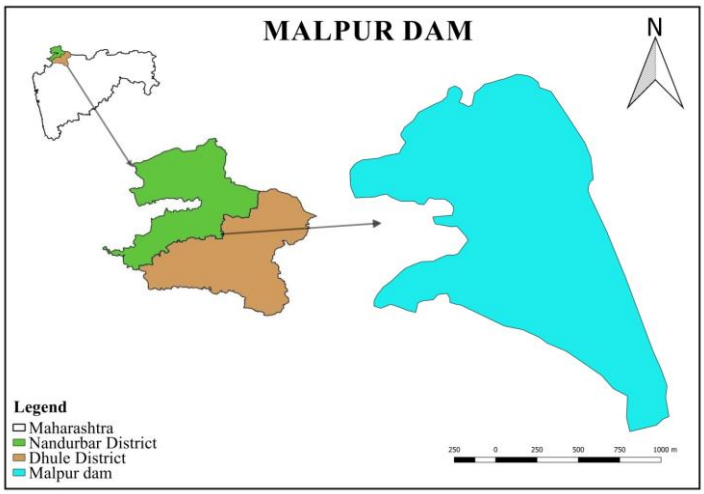
2.1.2 Climatic conditions:

Bio-climaticallyall the three reservoirs come under the semi-arid zone where the climate is hot and non-forested steppe (a large area of land with grass but no trees). As the rest of India, Nandurbar District has three distinct seasons; summer, monsoon and winter. Summer is from March to mid June and is usually hot and dry. During the month of May summer is at its peak with Temperatures reaching 45° Celsius. The monsoon sets in during the mid or end of June. During this season, the weather is usually humid and hot. The northern and western regions receive more rainfall than the rest of the region. The average rainfall is 767 mm throughout the district. Winter starts in the month of November and ends in February during which the weather is mildly cold but dry.

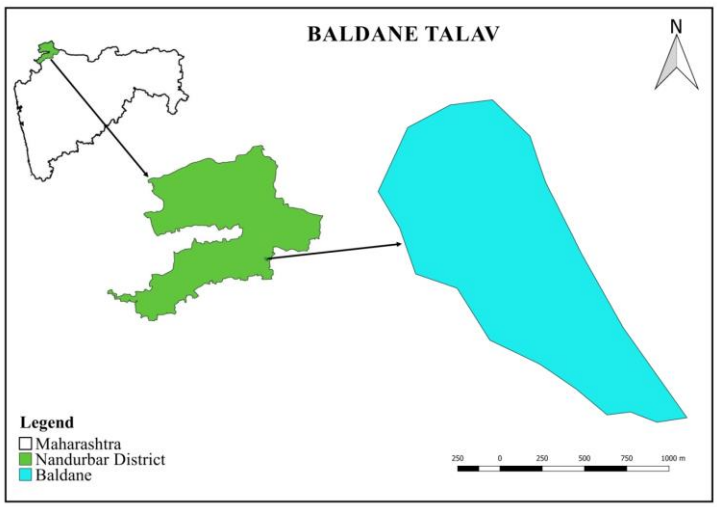
The South-West monsoon contributes about 90% of the precipitation during the year, which is confined to the months of June to September. The area as a whole is affected by water scarcity due to inadequate rain. As is usually observed the burst of rain starts in the first week of June and generally increases in July and August. These are the highest precipitation months. By September to mid October rainfall gradually declines. Apart from some amount of rainfall is also received from thunder showers in the post- monsoon.

The cultivated land in the study area falls under dry crop land (Jirayati) and irrigated land (Bagayati). In general, there are two main seasons of agriculture, one is Kharip season, which commence from June and terminates in September and another is Rabi season, which starts from November and comes to an end in March-April. Use of chemical fertilizers and pesticides in both seasons is common in this area along with the use of extensive manure during the farm practices. The dug wells and bore wells in the command area of reservoirs are used as drinking water source and agriculture are dependent on these reservoirs for recharge. The villagers and nearby people use these reservoirs for bathing, cattle, pisciculture, recreation and other domestic activities. All the water bodies selected for the study are used mainly for drinking and irrigation purpose. Hence it is significant to evaluate the water quality status of these reservoirs.

Location Map of Malpur Dam



Location Map of Baldane Reservior



Location Map of Krisna Park

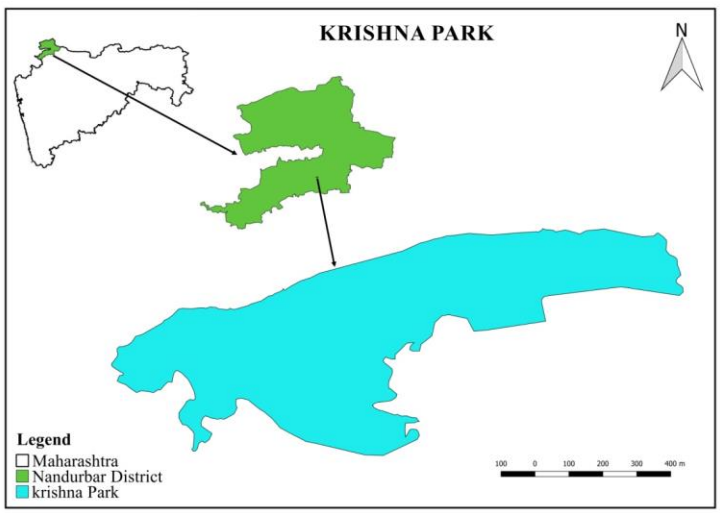


Fig.1.1 Goole image showing location of Malpur dam, Baldane reservoir and Krishna Park

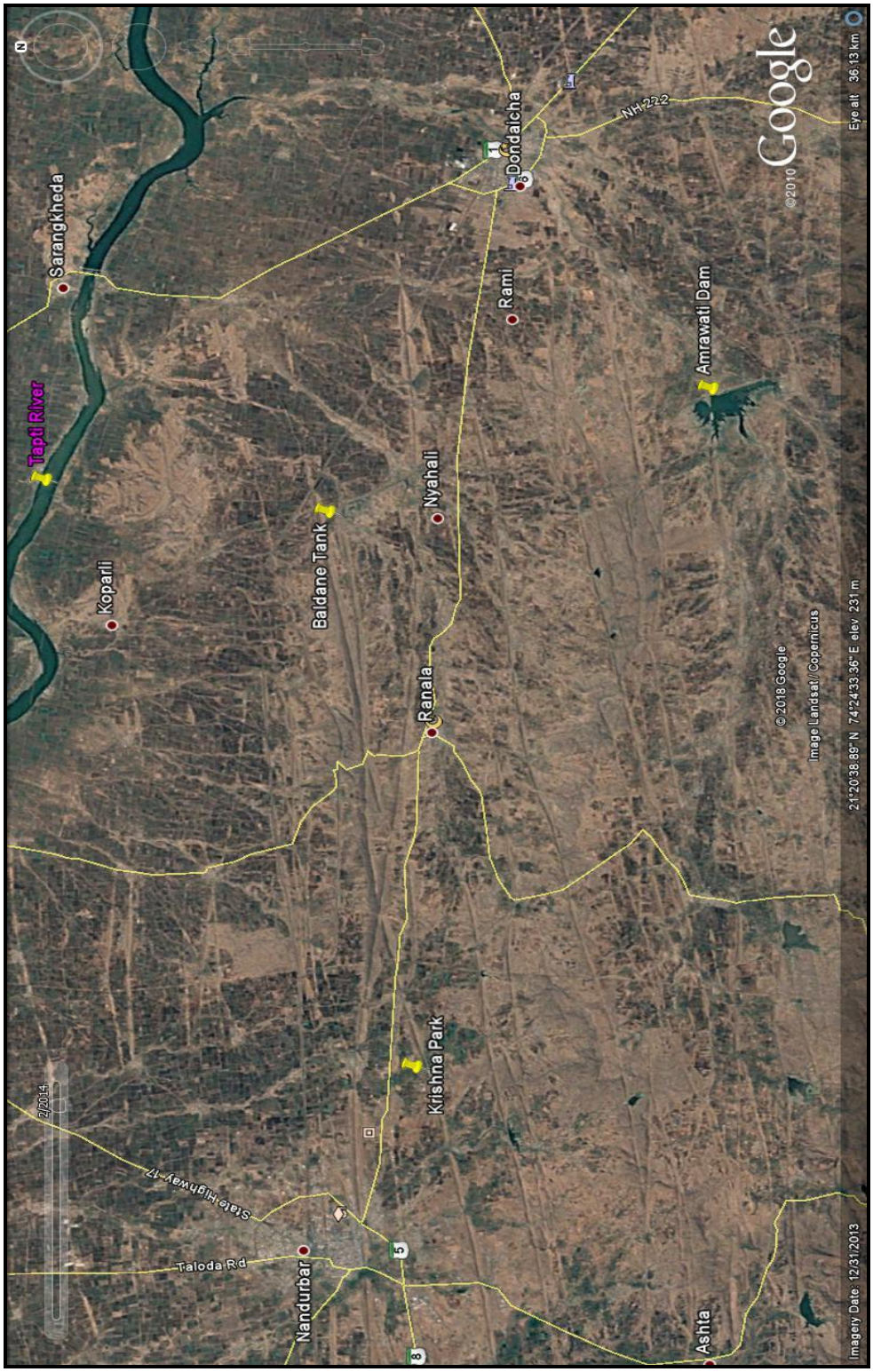


Fig. 1.2 Google images of three wetlands selected for the study in North maharashtra.

Fig.1.3 Google image of Malpur dam showing three stations

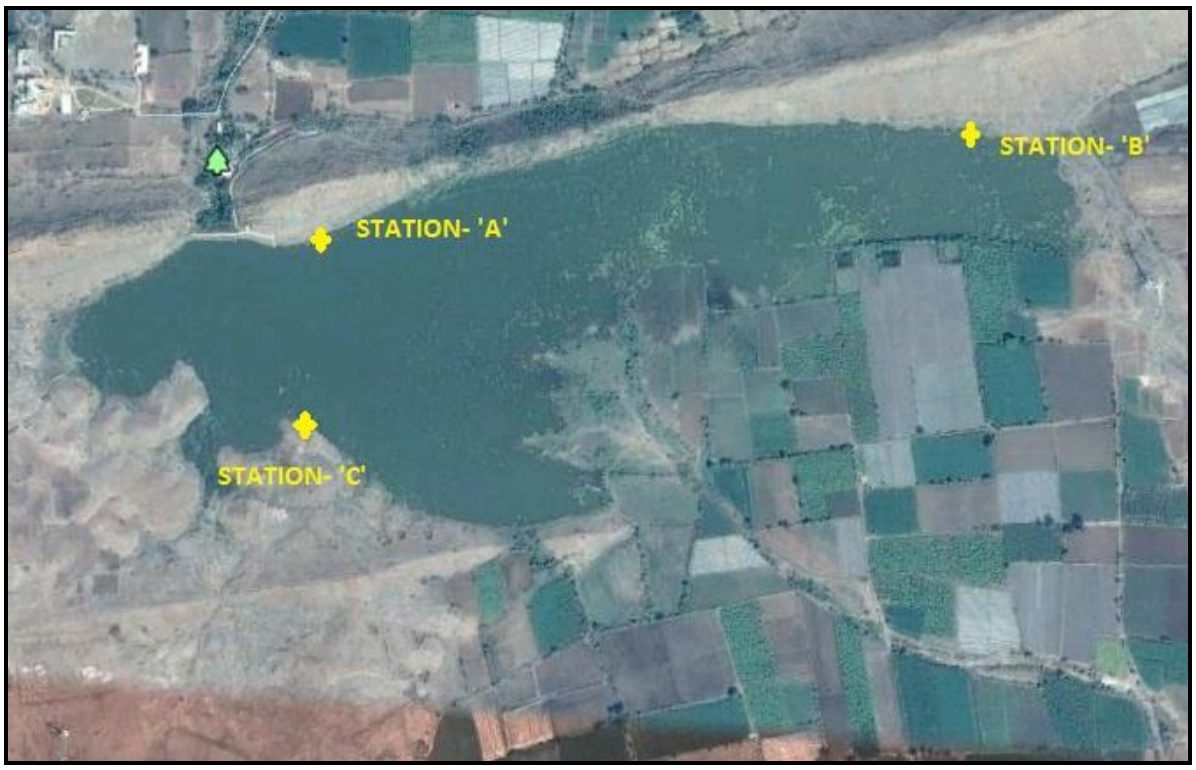


Fig.1.4 Google imageof Baldane reservoir showing three stations

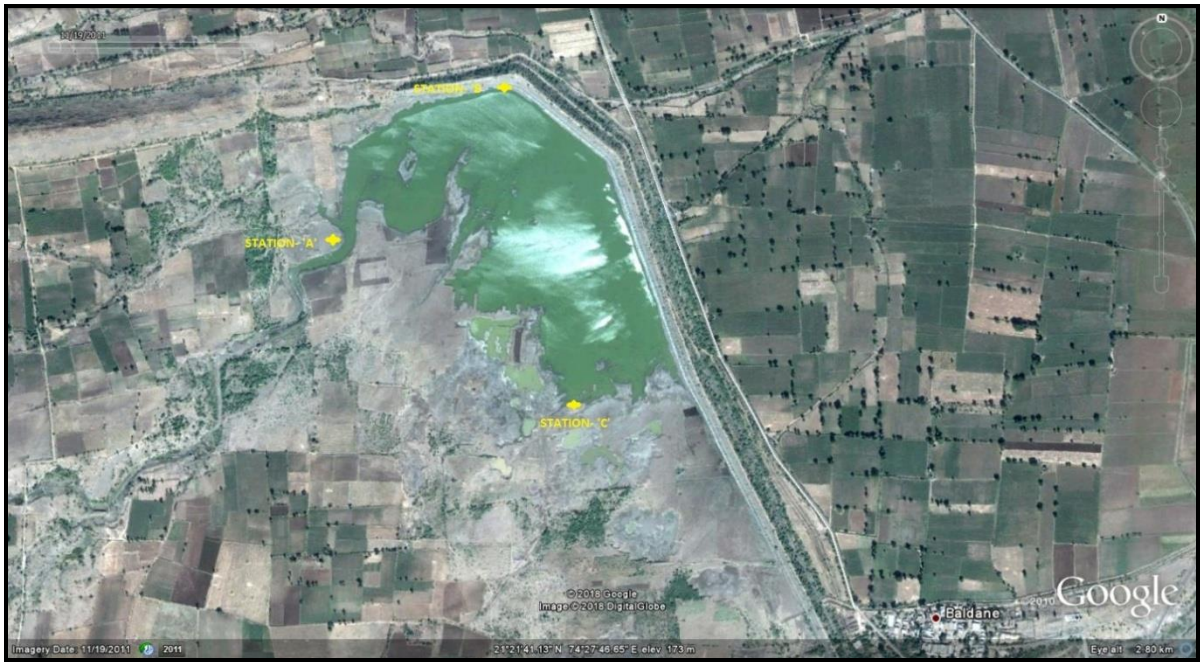


Fig.1.5 Google image of Krishna Park

(Photographs of three wetlands selected for study Malpur dam, Baldane reservoir and Krishna Park)

Fig.1.6 Photograph of Malpur dam showing decreased water level in summer.

Fig. 1.7 Photograph shhowing side view of Malpur dam

Fig. 1.8 Panoramic view of Baldane reservoir in rainy season

Fig.1.9 Photograph of Baldane Reservoir

Fig.1.10 Photograph of Krishna Park showing the recreation activities

Fig.1.11 Panoramic view of Krishna Park showing wind chimneys

MATERIAL AND METHODS

Three water bodies namely Malpur dam, Baldane reservoir and Krishna park reservoir selected for the study were visited monthly for the collection of water samples fromOctober 2011 to September, 2013 i.e. for two years. The study sites were visited between 8.00 a.m to 10.00 a.m. and a total of 24 visits were made for every water body during the study period. For the assessment of physicochemical parameters, surface water samples (2 L) each consisting of three replicateswere collected from three stations, station-A, station-B and station-C. A total of 2160 samples were collected in thoroughly rinsed, washed and cleaned polyethylene water bottles before every collection and were labeled station wise at each study site to indicate the date and location.The samples collected were brought to the laboratory for further analysis.Means were calculated monthly.
The parameters such as Atmospheric Temperature (AT), Water Temperature (WT), Transparency (Trans.), Water Cover (WC) and Carbon-dioxide(CO_2) were analyzed at the field station itself while Dissolved Oxygen (DO) was fixed in separate BOD sample bottles. Analysis of other parameters such as Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), pH, Total Hardness (TH), Calcium Hardness (CaH), Magnesium Hardness (MgH), Chlorides (Cl^-), pH, Nitrite (NO_3^-),Phosphate (PO_4^{-3}) and Sulphates (SO_4^{-2}) were carried out in the laboratory. To retain the chemical properties, all the samples were protected from heat and direct sunlight during transportation as well as until estimated.

PHYSICAL PARAMETERS

Temperature

Both the Atmospheric and Water Temperatures were measured using Mercury thermometer and noted in degree celsius(°C).

Water Cover

Estimation of water cover was done visually in terms of percentage as compared to maximum capacity of that particular reservoir.

Transparency

A metallic called ‘Secchidisc of 20 cm diameter painted with four alternate black and white quarters on the upper surface and centrally placed weight was used to determine the transparency. The disc is suspended with a cord graduated with centimeter/meter scale is lowered gradually at respective sampling stations and depth at which the

coloured quarters disappeared was measured. The depths at which the Secchi disc disappears (A) and reappears (B) in the water were noted. The transparency of the water was calculated as follows,

Secchi disc light penetration = A + B / 2

Where, A = The depth at which Secchi disc disappears.

B = The depth at which Secchi disc reappears.

Total Solids **(TS)**

Total solids were measured as the residues left after evaporation of the unfiltered sample. The evaporating dish of 100 ml capacity was first ignited at 550 ± 50 °C in a muffle furnace for half an hour, cooled in a desiccator and weighed. 100 ml of unfiltered well mixed sample was evaporated in this evaporating dish on a hot plate at 98 °C, and the residues were re-heated at 103-105 °C in an oven for an hour. The evaporating dish was then cooled in a desiccator and weighed again. TS was calculated as,

$$\text{Total Solids in mg/L} = \frac{(A - B) \times 1000}{V}$$

Where, A = Final weight of the dish in gm.

B = Initial weight of the dish in gm.

V = Volume of sample taken in ml.

Total Dissolved Solids **(TDS)**

For measuring TDS same procedure was used but here the samples were first filtered to remove suspended matter and the evaporated. Thus Total dissolved solids were determined as the residues left after evaporation of the filtered sample. TDS was calculated as,

$$\text{Total Dissolved Solids in mg/l} = \frac{(A - B) \times 1000}{V}$$

Where, A = Final weight of the dish in gms.

B = Initial weight of the dish in gms.

V = Volume of sample taken in ml.

Total Suspended Solids (TSS)

Total Suspended Solids is the difference between the total solids and total dissolved solids.

$$TSS\ (mg/l) = TS\ (mg/l) - TDS\ (mg/l)$$

CHEMICAL PARAMETERS

***pH* (Electrometric method, Michael, 1984)**

The pH was measured by electronic portable pH meterusing electrodes that are free from interference.pH meter was calibrated with phosphate buffer of known pH.At constant temperature, a pH change produces a corresponding alteration in the electrical property of the solution. These alterations were interpreted by the electrode and the accuracy is the greatest in the middle pH ranges.

***Dissolved Oxygen* (DO) [Winkler's method – APHA, 1998]**

The Manganese sulphatesolution reacts with alkali (KOH) to form a white precipitate of manganous hydroxide.It gets oxidized to form a brown coloured manganese oxyhydratein presence of oxygen which is equivalent to the amount of dissolved oxygen present in water. In the presence of iodide ion acidification, oxides of manganese revert to divalent state with the liberation of iodine equivalent to originally dissolved oxygen content in the sample. The iodine liberated is then titrated with standard solution of sodium thiosulphate using starch as an indicator.

For the Dissolved Oxygen estimation, water samples were collected in BOD bottles with great care avoiding bubble formation. DO was fixed at the station itself by adding 1 ml each of Manganese Sulphate and Alkali-iodide azide reagents. The precipitates formed were dissolved by adding 2 ml. of concentrated Sulphuric acid. From this precipitate,100ml sample was taken and titrated against 0.1N Sodium thiosulphate. To estimate iodine generated, starch is used as indicator and the end point is noted as the solution turns from blue to colourless. The DO is calculated using following formula,

$$\text{DO mg/L} = \frac{\text{B.R.} \times \text{N} \times 1000}{\text{Amount of sample taken (ml)}}$$

Where, B.R. = Burette Reading (Amount of titrant used).

N = Normality of Sodium thiosulphate.

Free Carbondioxide **(APHA, 1998)**

The free carbon dioxide in water reacts with sodium hydroxideNaOH) to form sodium bicarbonate ($NaHCO_3$) and the end point is indicated by development of pink colour with phenolphthaleinas indicator at pH 8.3. In the sample of 100 ml. 2 to 3 drops of phenolphthalein were added and the sample was titrated against 0.05N Sodium hydroxide (NaOH), until a pink colour was obtained. The free carbondioxide was calculated using following formula,

$$\text{Free carbondioxide mg/L} = \frac{\text{B.R.} \times \text{N} \times 44 \times 1000}{\text{Amount of sample taken (ml)}}$$

Where, B.R. = Burette Reading (Amount of titrant used).

N = Normality of Sodium Hydroxide (0.05N).

44 = Equivalent weight of CO_2.

Total Hardness **(EDTA Titrimetric Method, APHA, 1998)**

The hardness of water is mainly due to calcium and magnesium ions present in the water. EDTA (Ethylene di-amine tetra acetic acid) and its sodium salts as well as Eriochrome Black-T form a chelated soluble complex when added to a solution of certain metal cations. When a small amount of Eriochrome Black-T indicator is added to the aqueous solution containing calcium and magnesium ions at pH 10.0 it forms calcium and magnesium ion complexes and the solution becomes wine red. Since EDTA has strong affinity towards calcium and magnesium ions, with the addition of EDTA as titrant, the complex binds to EDTA and Erichrome Black T is released free. As a result the solution turns from wine red to blue, indicating the end point.

Total hardness was estimated by using 100 ml. of sample by adding 1 to 2 ml of buffer solution and a pinch of Eriochrome Black-T as an indicator. After the appearance of wine red colour, the mixture was titrated against EDTA stirring continuously till end point change of wine red to blue is achieved. The total hardness is calculated using following formula:

$$\text{Total hardness expressed as mg } CaCO_3/l = \frac{A \times N \times 1000}{\text{Amount of sample taken (ml)}}$$

Where A = ml of titrant (EDTA) used.
N = Normality of EDTA.

***CalciumHarness* :(EDTA Titrimetric Method, APHA, 1998)**

To estimate calcium hardness, in a 50 ml sample of water ,2 ml NaOH solution was added to make thepH to 12-13 and titrated with standard solution of EDTA using ammonium perpurate (Murixide) as indicator.

$$\text{Mg/ l Calcium as CaCO3/l} = \frac{\text{Ml of EDTA titrated} \times 1 \times 1000}{\text{ml of sample taken for determination}}$$

1 ml EDTA = 1 mg $CaC0_3$

***Magnesium Hardness* (APHA, 1998)**

Magnesium was calculated as the difference between the total hardness andcalcium hardness.

Mg (as CaCl) mgl/1 = mgl/1 Total hardness as $CaCO_3$/l - mg/1 Calcium hardness as$CaC0_3$/l.

***Chloride* (Cl^-) (ArgenometricTitremetric method, APHA, 1998)**

Silver nitrate reacts with chloride to form slightly soluble white precipitateof $AgCl_2$. In a neutral or slightly alkaline solution, chloride is estimated with silver nitrate as titrant using potassium chromate as an indicator. Silver chloride is precipitated quantitatively before red silver chromate is formed.

In 100 ml. sample, 1 ml. of K_2CrO_4 indicator was added and titrated against 0.02N $AgNO_3^-$till brick red precipitates were produced. The formula used to calculate mg. of Cl^-/Lit is as follows,

$$\text{mg of } Cl^- /L = \frac{\text{B. R. s as fol1000}}{\text{Amount of sample taken (ml)}}$$

Where, B.R. = Burette reading (Amount of titrant used).

N = Normality of Silver Nitrate.

35.45 = Equivalent weight of Chloride.

Nitrates **(NO_3^-): (Cadmium Reduction Method, APHA, 1998)**

Nitrite (NO_2^-) is reduced to nitrate (NO_3^-) in the presence of Cadmium (Cd). In this method commercially available Cadmium granules coated with copper sulphate ($CuSO_4$) were taken and packed in a glass column. The Nitrate (NO_3^-) produced was determined by diazotizing it with colour reagent containing sulfanilamide coupled with N-(1-naphthyl)-ethylenediaminedihydrochloride (NEDD) to form highly coloured azo dye. The colour developed was measured colorimetrically at 410 nm. A correction was made for any NO_3^- present in the sample by analyzing the sample without the reduction step.Nitrates were calculated as,

$$NO_3^- \text{ mg/L} = \frac{\text{O. D.} \times \text{Factor}}{\text{Amount of sample taken (ml)}}$$

Where, O.D. = Optical Density

Phosphates **(PO_4^{-3}) (APHA, 1998)**

The reaction of phosphates with ammonium molybdate is carried out in water sample to form complex of molybdophosphoric acid which gets reduced to form a complex of blue colour in the presence of Stannous chloride($SnCl_2$). The light absorption by this blue colour is measured at 690 nm to calculate the concentration of phosphate.

100 ml. of sample was taken in a conical flask and 4ml of strong acid and 4 ml of ammonium molybdate were added to it followed by 10 drops $SnCl_2$. The blue colour formed was measured after 10 minutes at 690 nm with colorimeter model Photochem 5.0. Standard graph making is necessary before the analysis of sample to obtain the factor. The instrument was set by running a reagent blank. The Phosphates were calculated as,

$$PO_4^{-3} \text{ as mg/L} = \frac{\text{O. D.} \times \text{Factor}}{\text{Amount of sample taken (ml)}}$$

Where, O.D. = Optical Density

Sulphate **(SO_4-3) (Trivedi and Goel, 1987)**

5 ml of conditioning reagent along with a spatula full of barium chloride crystals were added and mixed well in a magnetic stirrer for one minute in a 100 ml sample.

Spectrophotometer was calibrated with sulphate standard solution and made blank prior to the estimation of the sample. The sample concentration was noted down.

Plankton (Phytoplankton and Zooplankton)

Both the groups of plankton *i.e.* the phytoplankton and the zooplankton were studied.Plankton collection (both phytoplankton and zooplankton) was done from surface water of each water body. Three water bodies selected for the study were visited once in the month from October 2011 to September 2013.Samples were collected from the three stations and average of these three stations is taken.

Ten liters of water was filtered through the plankton net No. 25 of bolting silk with mesh size 64 micron as given by Edmondson, (1963). Plankton net was washed thoroughly with the water by inverting it to collect the planktons attached to the net and the final volume of sample was managed to 100 ml. All the samples were taken in separate vials and fixed with 1 ml. of 4 % formalin and 1 ml. of Lugol's Iodine at the collection sites. Only 10 ml. of well mixed sample from each station was further concentrated by centrifugation at 2000 RPM for 10 minutes. For quantitative estimation of plankton, 1 ml. well mixed sample was taken on 'Sedgewick Rafter Cell'. To calculate density of plankton the averages of 5 to 8 counts were made for each sample and the results are calculated as numbers of organisms per liter of sample. Qualitative study of phytoplankton and zooplankton were carried out up to the genus/species level using the standard keys given by Sarode and Kamat (1984) for phytoplankton while Edmondson (1963), Philipose (1967), and Battish (1992) for Zooplankton.The species richness of each group of plankton wasconsidered as number of species of each group observed per visit. The number of species present in a region may be considered as its 'species richness' a frequently used measure. The phytoplankton study includes four major groups the Bacillariophyceae, Chlorophyceae, Cyanophyceae, and Euglenophyta, while the zooplankton studied includes two main groups the Rotatoria and the Microcrustacea. The Microcrustacea are further represented as Cladocera, Copepoda and Ostracoda.

Molluscs

During the period of investigation (from October 2011 to September 2013), molluscs were collected once in month from three stations selected for the study at all the three water bodies. A corer with 10 cm height and 8 cm radius was inserted 5 to 6 times at each field station. The soil collected was sieved and the molluscs were collected in a

separate sample bottle as described by Michael (1984) and Tronstad*et al*. (2005). The collected molluscs were preserved in 4 % formalin and carried to the laboratory for quantitative and qualitative estimation. The collected molluscs were identified as per the key provided by Subba Rao (1989).

Analysis of physico-chemical parameters

The data collected were pooled for all the three selected water bodies for the alleviate of analysis as three seasons: Winter (October, November, December and January), Summer (February, March, April and May) and Monsoon (June, July and August, September). The results given are in the form of Mean ± SEM. The data is subjected to ANOVA across the season with the help of Prism 3 software (Graphpad software, San Diego, California U.S.A.). The P value for ANOVA was considered to be nonsignificant if $P > 0.05$ (ns), significant if $P < 0.05$(*), significantly significant (**) if P is < 0.001 and highly significant (***) if $P < 0.0001$. The Pearson Correlation between various parameters was also calculated with the help of SPSS 7.5.1 for windows 7. At (**) Correlation is significant at the 0.01 level (two-tailed), whereas at (*) correlation is significant at 0.05 level (two-tailed).

Analysis of plankton (Phytoplankton and Zooplankton)

The pooled data of the two years (from October 2011 to September 2013) was used for the analysis. The Mean, Standard Error of Mean (SEM) and One-Way ANOVA with No post test for various parameters for three seasons was performed using Graph Pad Prism version 3.00 (Graph Pad Software, San Diego California USA). The correlation between the abiotic factors and the plankton density was calculated. The Pearson correlation was calculated by keeping plankton as dependent variable and other biotic factors as independent variables with the help of SPSS 7.5.1 for Windows. The P value for ANOVA was considered to be nonsignificant if $P > 0.05$ (ns), Significant if $P < 0.05$ (*), Significantly significant (**) if $P < 0.001$ and highly significant if $P < 0.0001$.

Analysis of Molluscs

The densities of molluscs were calculated on the basis of the volume of the corer used for the collection of soil samples using following formula:

Density = Number of mollusc/volume of the corer.

Further, the mean and standard error of mean (SEM) were used for performing one way ANOVA (Fowler and Cohen,1986) for analysing seasonal

variations in density of mollusc across four seasons using Graph Pad Prism version 3.00 (Graph Pad Software San Diego California USA). The P value for ANOVA was considered to be non significant if $P > 0.05$ (ns), significant if $P < 0.05$ (*), significantly significant (**) if $P < 0.001$ and highly significant (***) if $P < 0.0001$.

To find out the relation between molluscan density and various abiotic and biotic parameters like density and species richness of various biota studied, Pearson correlation test of was carried out using SPSS 7.5.1 software for windows, where ** correlation is significant at the 0.01 level (two tailed) and * correlation is significant at the 0.05 level (two-tailed).

The percentage density of each species was calculated as domination index (Iga and Adam, 2006) as follows:

$$D_0 = \frac{na}{N} \times 100$$

Where, na = the number of individuals of species a.

N = the total number of individuals in a sample.