ORIGINAL RESEARCH ARTICLE

PHYSICOCHEMICAL PROFILE IN RELATION OF FIVE PONDS AT KHANDWA (M.P.), INDIA

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ABSTRACT:

Khandwa has ponds like Nagchoon Talab, Doodh Talai, Singhad Talai, Padam Kund and Rameshwar Kund, for a long time they supplied potable water to the residents. They are however not in use now-a-days. No work on their Limnological parameters has so far been reported, with increasing population and depleting sources of potable water their assessment has become a matter of great importance. So it has become highly imperative to conduct such investigation.

KEYWORDS: Limno; Physico-Chemical parameters; East Nimar.

INTRODUCTION:

Water is one of the most vital factors in the existence of living organisms. Water covers about 70% the earth of which more than 95%, exists in gigantic oceans. The term "Limnology" is derived from the Greek word, limne or limnos, meaning "pool, marsh or lake". Limnology is a very complex scientific subject and we owe its first definition (the oceanography of lakes) to Professor F.A. Forel (1892) who has been called the father of "Limnology". Now-a-days limnology is defined as the "science of inland waters," concerned with all the factors that influence living organism within those waters (Singh, H.R. 1989).

One feature that we may find in common in all the bodies of water is the presence of some algal growth in equilibrium with the physico-chemical characteristics. Freshwater system of India received due scientific attention rather late the pioneering works of Prasad (1972), Prescott (1968), Welch (1948), Chacko & Krishnamurthy (1954) and Krishnamurthy V. (1954) the milestones in the history of Indian Limnology. The distribution of the various aquatic organisms are affected by many factors such as temperature, transparency, concentration of oxygen, carbon-di-oxide, nutrients and other dissolved organic substances.The ponds can then be used for pisciculture and cultivation of plants of economic importance. The study of ponds will have a social significance also. Studies on freshwater ecosystem were started by Gepp (1908). Later on Ghose (1920); Ganapati (1943); Chacko and Ganapathi (1949); Randhawa and Desikachary (1959); Jeejibai (1962); Sarma (1963); Zafar (1967); Verma (1969); Philipose (1969); Vidyavati (1983); Unni (1985); Ventakeshwarlu (1989) and many others contributed to it. Patil and Maratha (1982) reported the diurnal variations in the physico-chemical factors and plankton on the surface layers of three tropical freshwater fish tanks of Nagpur.

Recently Mahajan, S.K.(1987, 1990 a and 1991, 1995 a and b) had conducted in west Nimar, and Mahajan, S.K. and Mishra, S.,(1986, 1988a, 1988b, 1990a, 1990b, 1990c, 1990d, 1991a, 1991b, 1991c, 1993, 1994a, 1994b, 1994c, 2007, 2008) Mishra, S., *et al*(2005) and Mishra, S., (2004,2007a,b&c) had conducted investigation in East Nimar. Thus the literature review suggests that studies on M.P. freshwaters dates back to the later half of the last century and were in the nature of presenting species list and descriptions of taxa, new to then Madhya Pradesh. Attempts on the seasonality of freshwater plankton were made, followed by a long series of Hydrobiological studies of freshwater impoundments, mostly on ponds and reservoirs. However such studies at Khandwa are scanty, keeping this in mind the present study is designed to survey the impact of physico-chemical parameters on the phytoplankton, selecting five ponds, at Khandwa (M.P.).

STUDY AREA:

Khandwa, the district headquarter of East Nimar is a Junction of Central Railway. It has a very long history. Infect its name itself is supposed to originate from Khandwan, a forest mentioned in the epic Mahabharata. It has been a connection between North and South India. Its area is 10779 Km^2 and is situated at 21^0, $05'$ to 22^0, 25' N latitude and 75^0, 57' to 77^0, 33' E longitude and 304 m above MSL. Topographically it lies on the uplands between the Valleys of Narmada and Tapti flowing parallel to each other from East to West. The average annual rainfall is 736.8

mm. The climate is in general hot. The city itself has many ponds is in all the directions with rich aquatic flora. The fresh water ecosystems are very important to urban men just like parks etc.

Khandwa district of M.P. has many natural and manmade impoundments. These are among the five ponds selected as a site for monitoring of limnolgical parameters. These ponds are present in and around Khandwa city, which situated on central railway, namely I. Nagchoon Talab, II. Doodh Talai, III. Singhad Talai, IV. Padam Kund and V. Rameshwar Kund. The better supply of potable water for the town of Khandwa had been a pressing question for years past and numerous schemes had been elaborated and discussed in the report given by Mr. C.S.R. Palmer, E.E. dated 28th may 1890. On 15th July 1890, by J.H. Glass, Esqr., Superintending E. Control provinces on Khandwa water works.

Nagchoon Talab:

Lakes as such in the District are none, but a few ponds exist of which one at Nagchoon situated at a distance of 6.4 Km. North-West of Khandwa city deserves mention. The talab covers an area of about 202.3 hectares (500 acres). This was formed by damming up a stream. Later on its catchments area was enlarged to nearly 23.3 sq. Km. (9 sq. miles) by the construction of at canal 6.4 sq. Km. (4 miles) long to Ajainti. It is one of the water supplying sources of the Khandwa town. The Nagchoon Talab established by R. Mitra E.E., agent of Khandwa Municipality, dated 18th July 1899, agreement with Rajputana Malva Railway company to supply water. The talab has a total surface area about 26,502,000 sq. ft. and a total capacity 275,205,000 in feet. The main source of water is natural. Large Ajainti nallah through which rain water is carried into talab, having one outlet naming small Ajainty nallah. The reservoir is primarily used for drinking purposes and others.

Doodh Talai:

Doodh Talai is situated western part of Khandwa city. Talai has a surface area of 140337 sq. fit. and a shore line of talai is irregular, interrupted at one side by road, colony and a half Km. wide area attached with it. Its basin is shallow with a slite slope. The talai is eutrophic and receives several effluents of domestic sewage. The maximum depth of water in the talai was near about 10 to 12 fit during monsoon (July-August) and minimum 3-5 fit in summer (May-June).

Singhad Talai:

The talai has a total surface area of about 27014 sq. fit. and a peripheral circumference is irregular and completely covered with grass. The main source of water is domestic sewage. Its basin is shallow with a slite slope. The talai is eutrophic and receives domestic, human and animal excreta and city debris. Long time ago, the Trapa (singhada) were harvested in Talai, so place known as Singhad Talai. Now-a-days it is free from macrovegetation. The maximum depth of

water in the talai was near about 8 to 10 fit. during monsoon (July-August) and minimum 3-5 fit in summer (May-June). Saify Nagar and Shrinagar colonies are attached with Singhad Talai,

Padam Kund:

The Padam Kund under investigation is in colony Padam Nagar and Sanjay Nagar situated at western part of Khandwa city. The reservoir was constructed approximately 1800 years ago. The reservoir impounds an area of 96 sq. fit. and depth is 15x18 fit. The Kund used to bloom with Lotus flowers and hence it is named as Padam Kund. It is rectangular in shape and embodied with ancient lithics that are as old as Kund itself. It is rectangular in shape and maximum depth of water in the Kund is 15 to 18 fit. and overflow during monsoon (July-August) and minimum 10-12 fit. in summer (May-June). The Kund is puccka and has straight embankment. Sources of water supply to the Kund are rains.

Rameshwar Kund:

Mr. Palmer, passes in review the several schemes which have from time to time been put forward for Khandwa, and comes to the conclusion that the Rameshwar gravitation scheme, which was first brought to notice in 1871 by Mr. A.R. Binnic, E.E.. Thus the Rameshwar gravitation scheme was projected by Mr. Binnic and Mr. Plaus and estimates were prepared by Mr. Hooper in 1874. The proposals were to construct a reservoir on the Rameshwar Nallah and to lead thence a 9" main to the clock tower. The tank was shown to be able to supply 8 gallons per head for 15,000 people and 2000 gallons per diem for the each of the two Railways, and to have a surplus of 3 million cubic feet. The Rameshwar Kund under investigation at the Rameshwar Nallah, bears many macrophytes at both side. The substratum of the spot is dominated by mud and gravel.

MATERIALS AND METHODS:

The water bodies in general appeared to be relatively similar for many biologist till recently. But with advent of limnology and environmental science, it is established that these water bodies manifest the most amazing physical, chemical and biological diversity. As proposed a survey of the local water bodies were conducted on a fixed duration of every month and different parameter were determined form 01.03.2014 to 28.02.2014. Periodic sampling was done at five sampling stations, naming 1.Nagchoon Talab 2.Doodh Talai 3.Singhad Talai 4.Padam Kund and 5.Rameshwar Kund. A Glass bottle sampler was used to take the water sample from the sampling stations for chemical analysis. The analysis of physico-chemical parameters were carried out by following standard methods as described by Welch (1952); APHA, (1955).

RESULTS AND DISCUSSION:

In the present investigation, characters accounting for the ponds diversity are studied, over a period of 12 months selecting five representative, permanent ponds and results are analyzed on the basis of earlier literature.

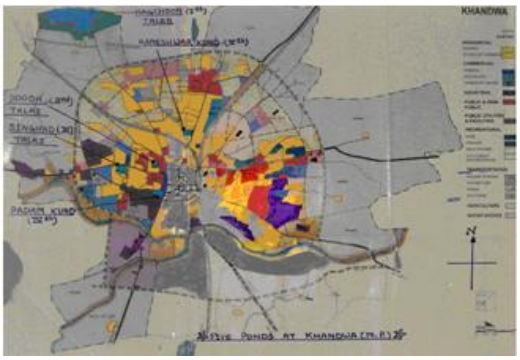
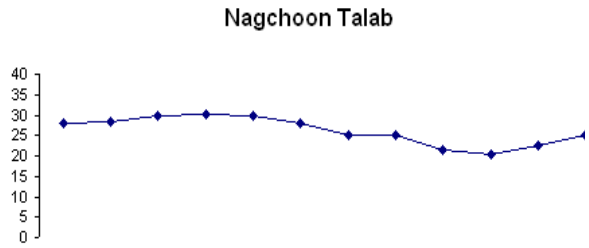
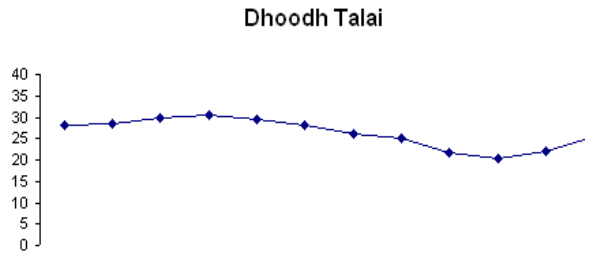


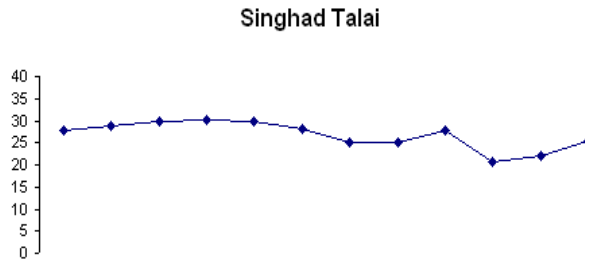
Figure 1: Map showing study area

Graphs showing Seasonal variation of Physical Parameters during the year March 2014 to February 2015:

Temperature in ^{0}C







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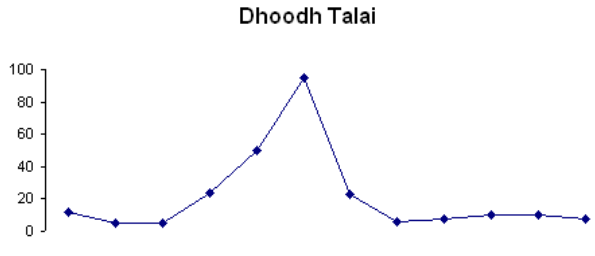
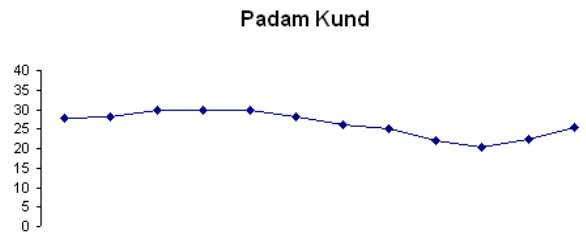
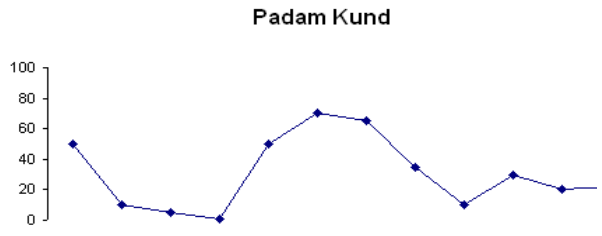
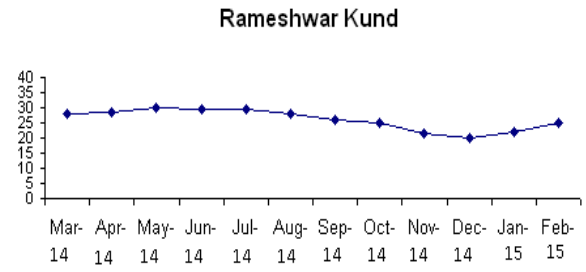
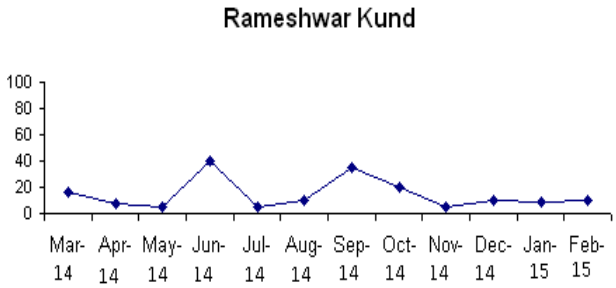


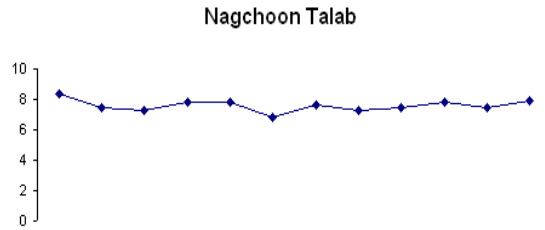


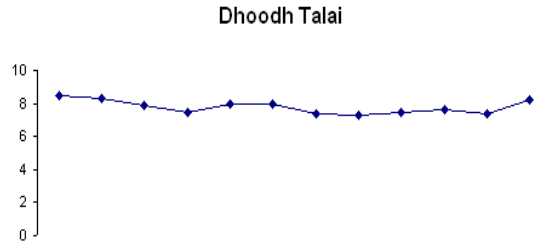


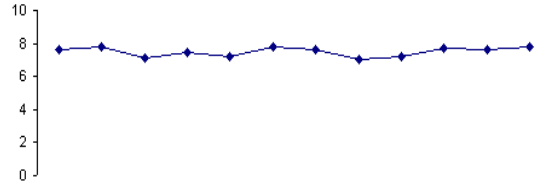




Hydrogen Ion Concentration







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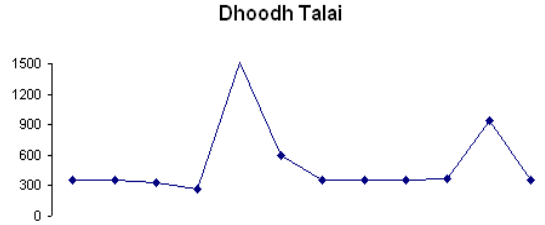
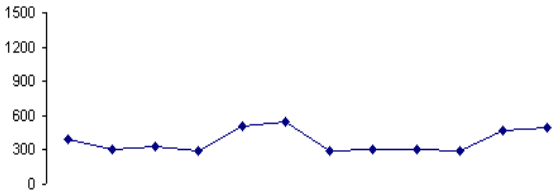
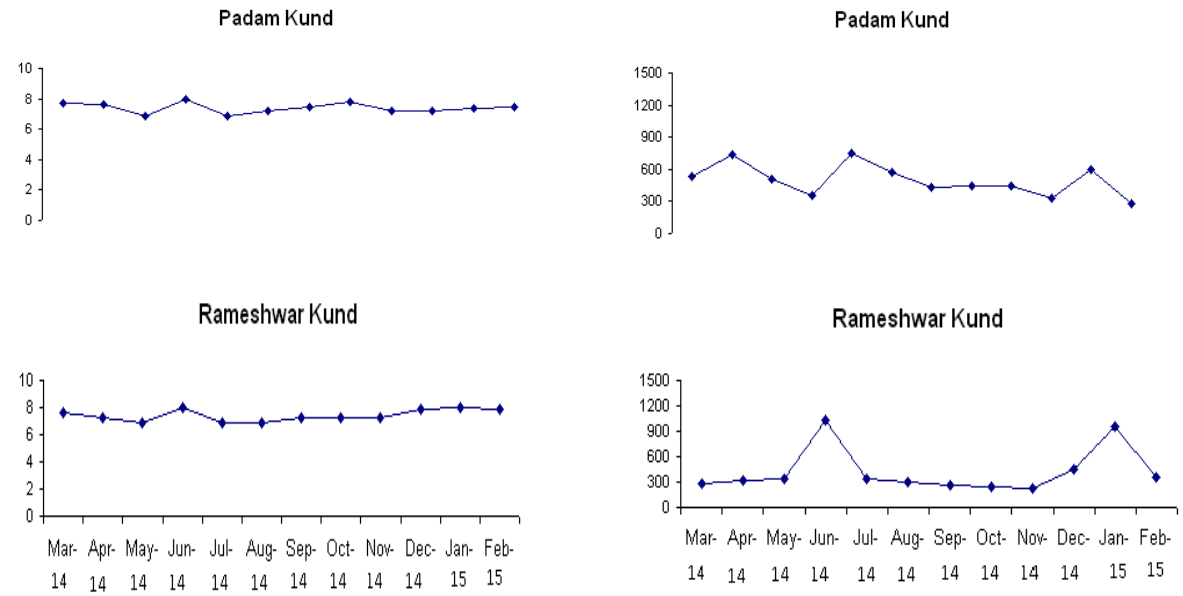
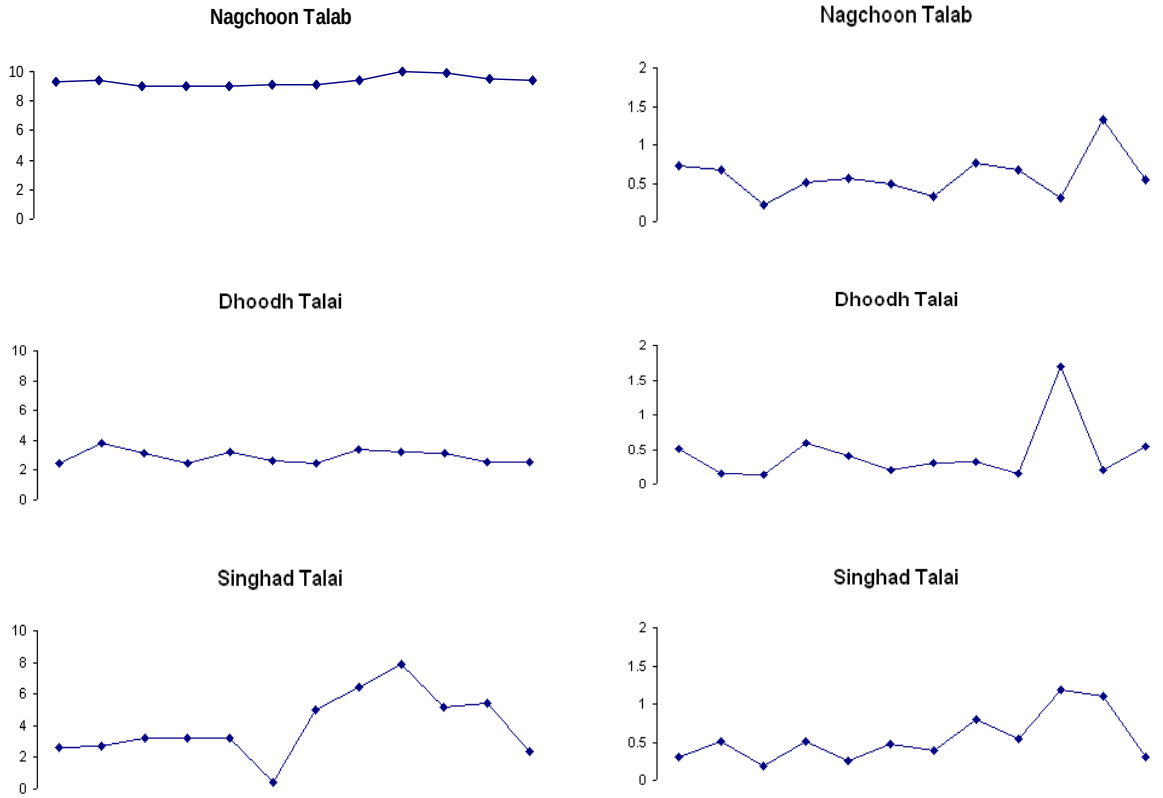


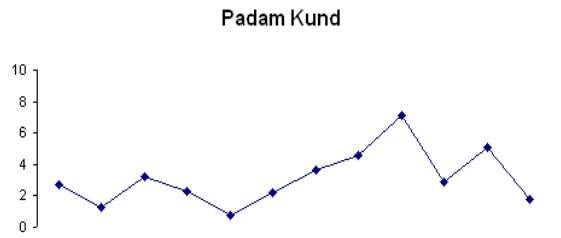


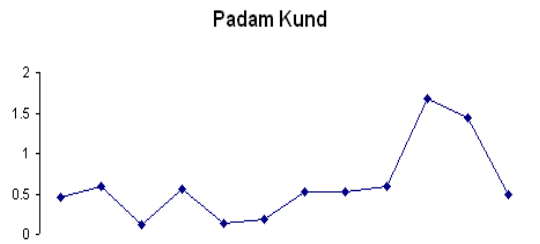


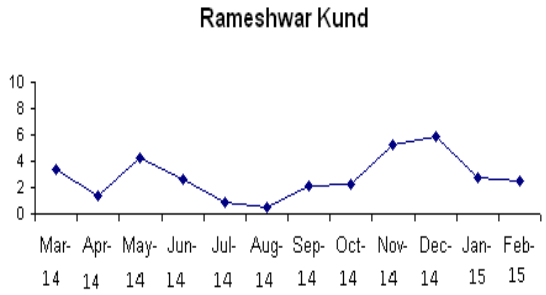
Graphs showing Seasonal variation of Chemical Parameters during the year March 2014 to February 2015:

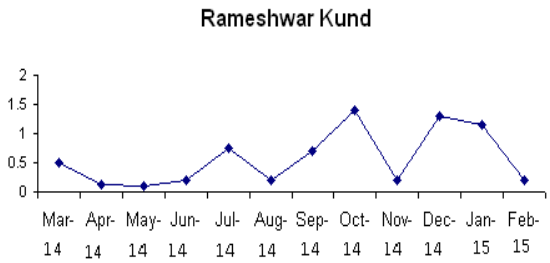
Dissolved oxygen mg / lit **Free carbon - di - oxide mg / lit.**





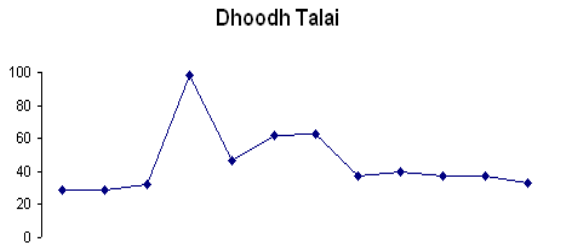


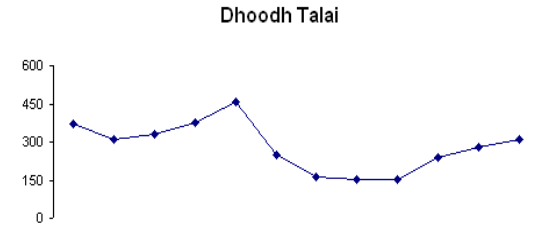


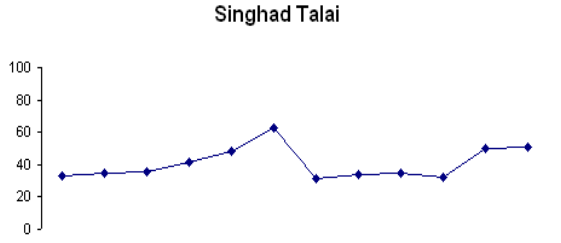


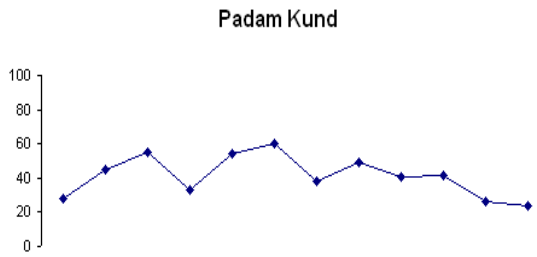
Total inorganic carbon mg / lit,

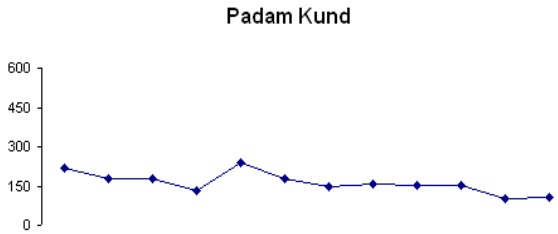
Alkalinity mg/lit.

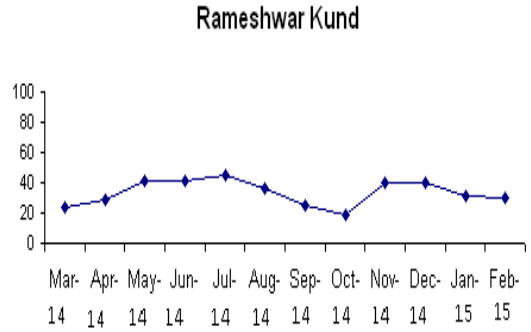


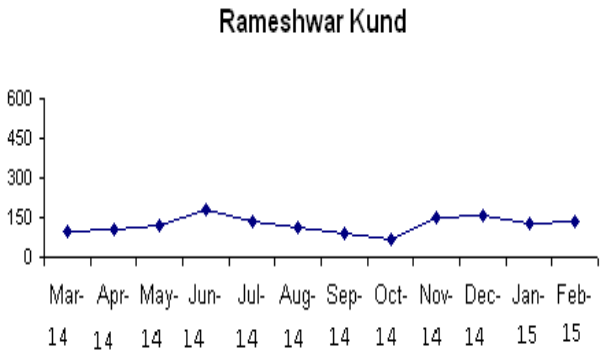






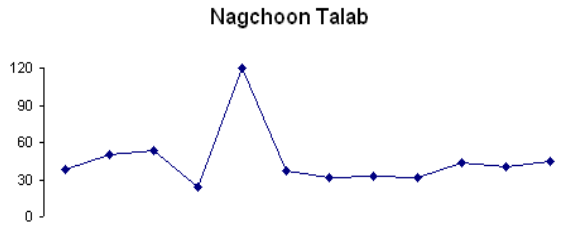


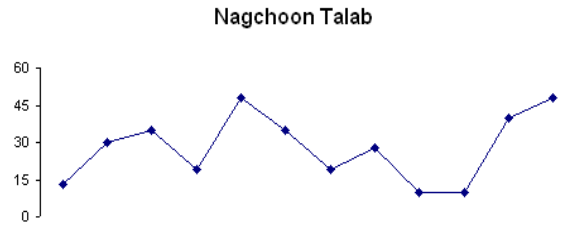


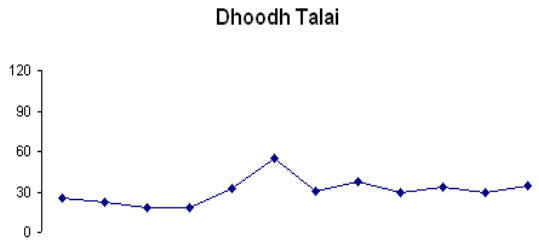


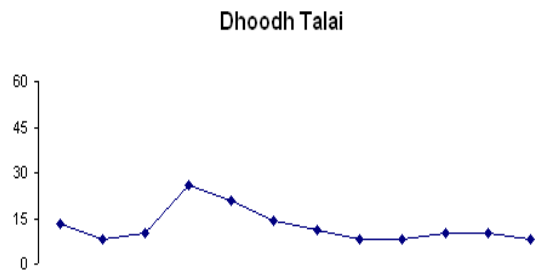
Calcium mg / lit.

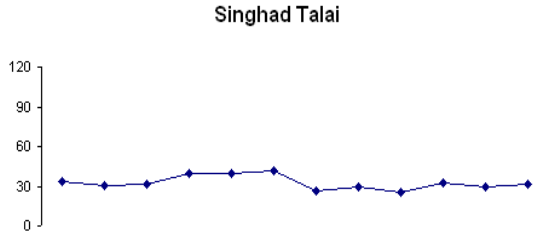
Magnesium mg/lit.

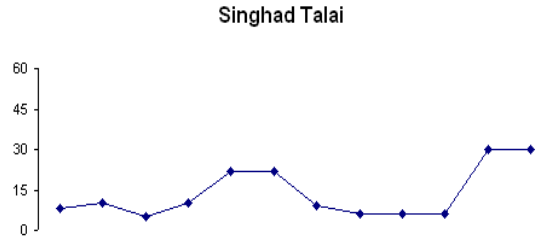


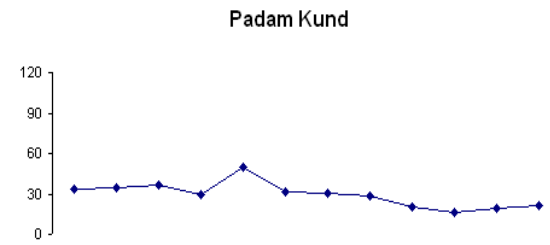


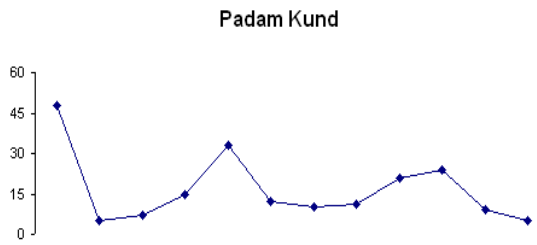


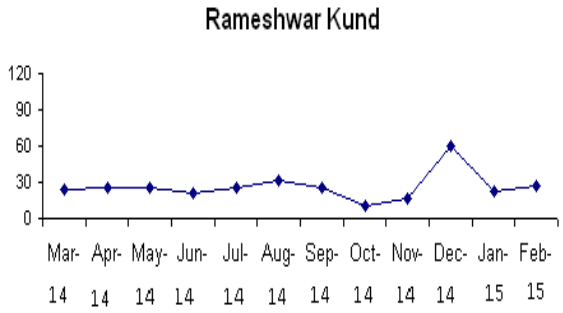


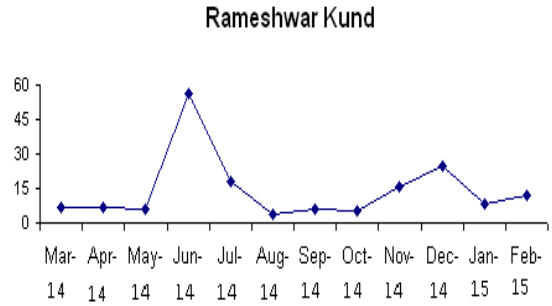






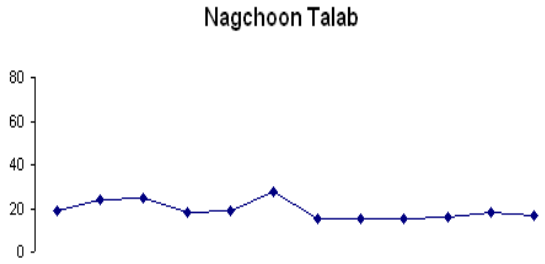


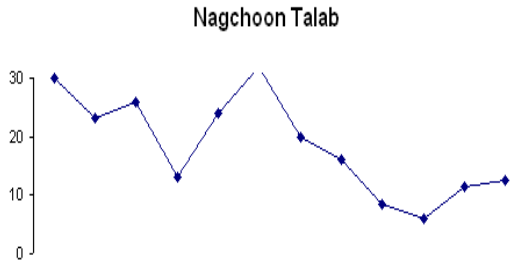


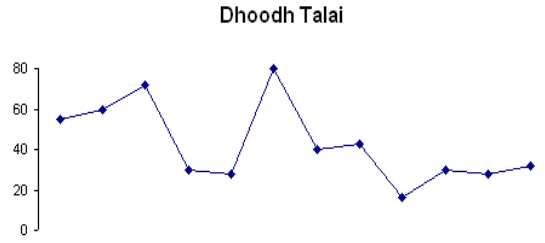


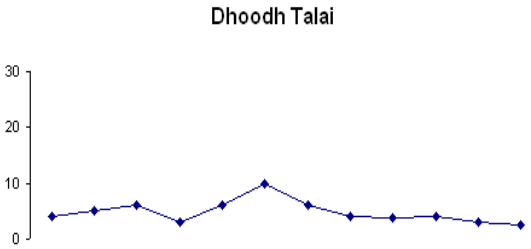
Sodium mg / lit.

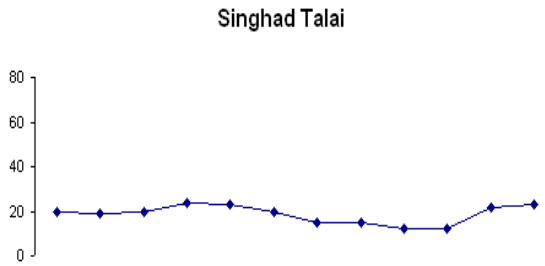
Potassium mg / lit.

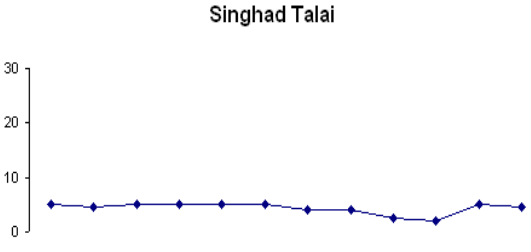


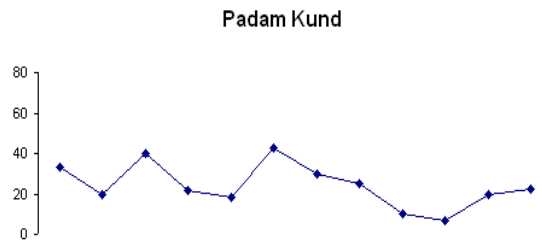


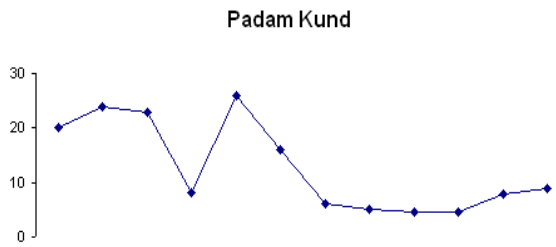


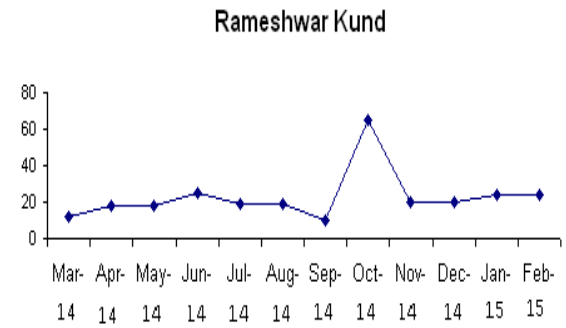


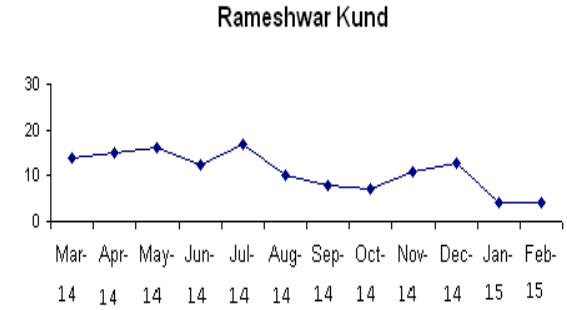




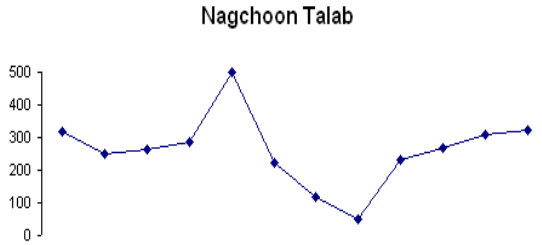


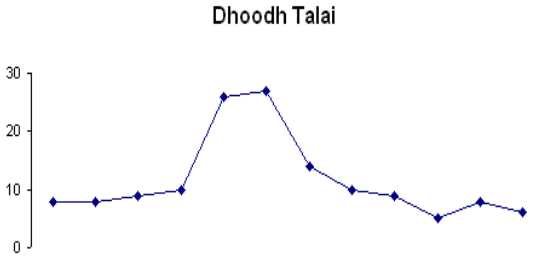


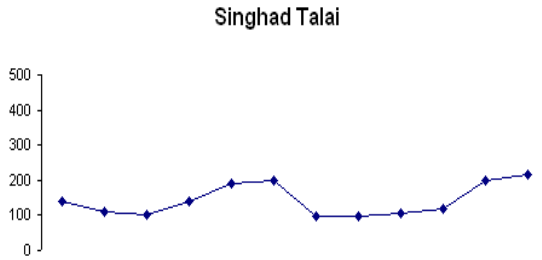


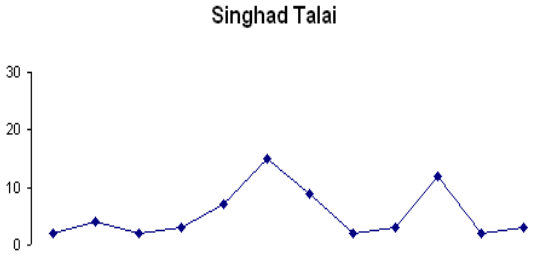


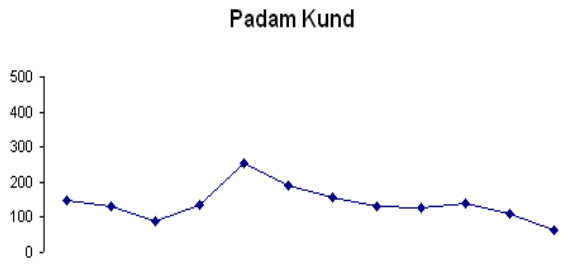
Total hardness mg / lit. **Nitrate mg / lit.**

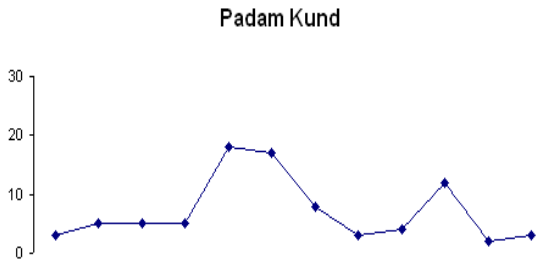


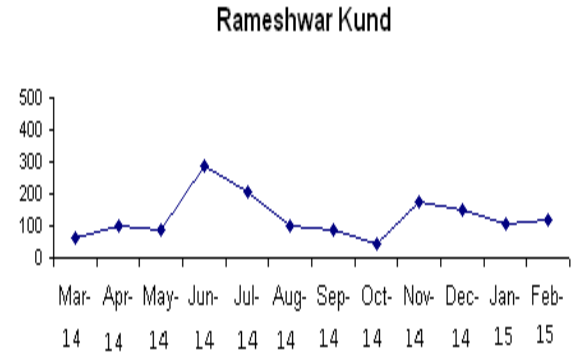


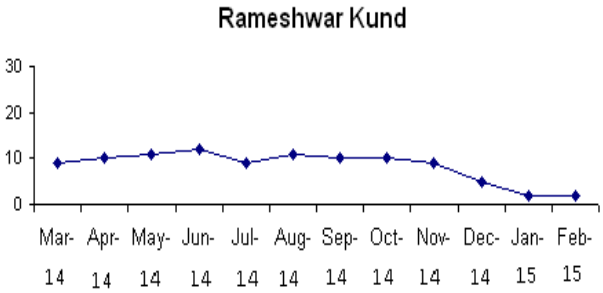




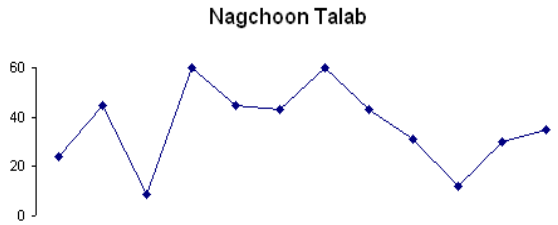


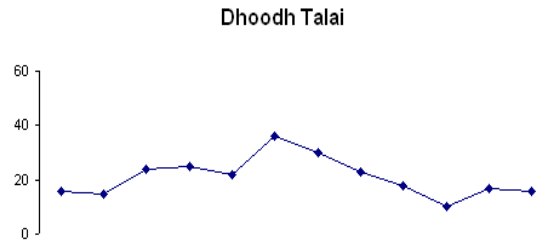


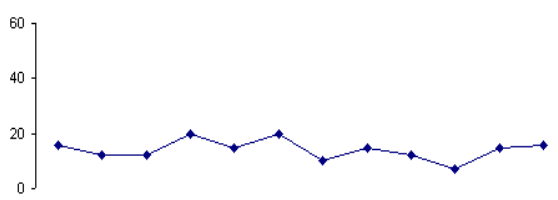




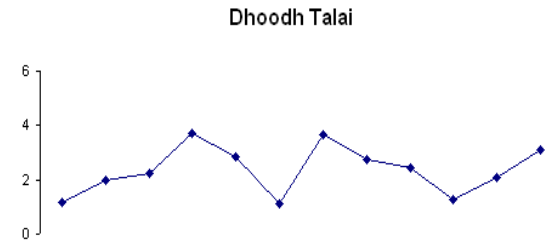
Sulphate mg / lit.

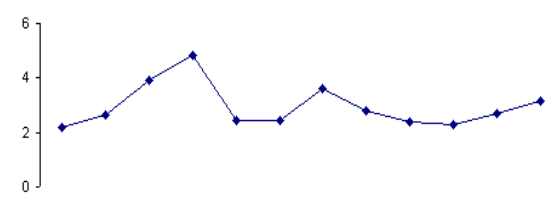


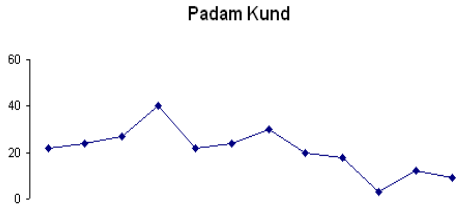


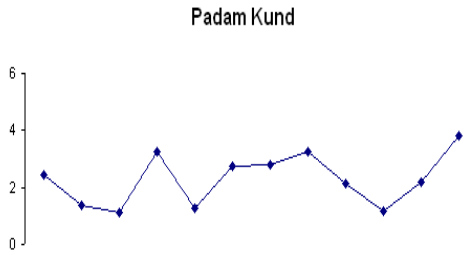


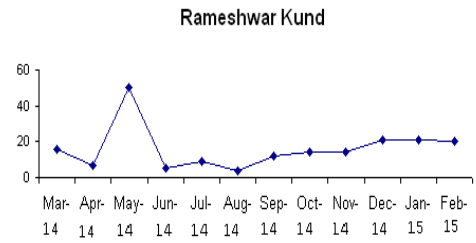
Silicate mg / lit.

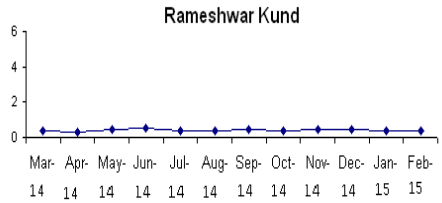




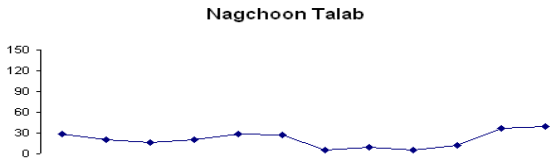


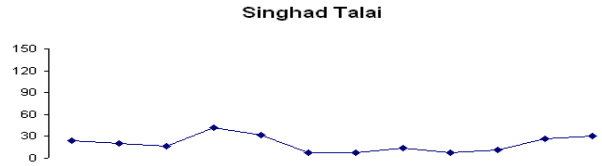


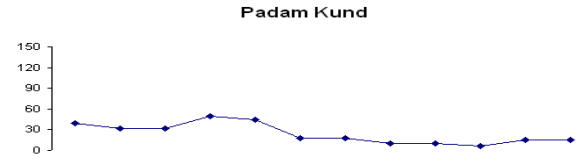




Chloride mg / lit.







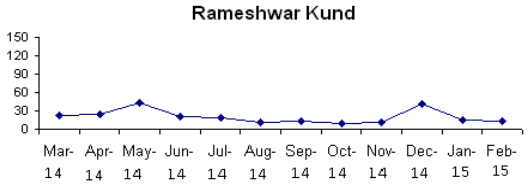


Table 2: Physicochemical Properties of Water collected from five sites during March 2014 to February 2015

Sr. No.	Parameters	Nagchoon Talab	Doodh Talai	Singhad Talai	Padam Kund	Rameshwar Kund
1.	Temperature(^{0}C)	25.2±5	25.45±4.95	25.40±4.8	25.2±4.7	25.15±4.65
2.	PH	7.58±0.74	7.9±0.6	7.31±0.49	7.44±0.6	7.45±0.55
3.	Turbidity(NTU)	35±30	50±45	30±25	35.5±34.5	22.5±17.5
4.	Electrical Conduct. Micromho	Min. Max. 383-1468	Min. Max. 266-1518	Min. Max. 287-545	Min. Max. 275-745	Min. Max. 220-1027
5.	Dissolved Oxygen mgL^{-1}	9.49±0.47	2.91±0.44	4.16±3.73	3.91±3.18	3.21±2.7
6.	Free Carbon-di-oxide mgL^{-1}	0.77±0.56	0.92±0.78	0.69±0.5	0.89±0.78	0.70±0.59
7.	Total Inorganic carbon	59.05±40.75	63.4±35	47±16	42±18	31.75±13.45
8.	Alkalinity mgL^{-1}	156±44	304.5±154	159.5±40.5	169±31	124±56
9.	Calcium mgL^{-1}	72±48	36.5±18.5	33.5±8.5	33±17	35.5±24.5
10.	Magnesium MgL^{-1}	30.5±17.5	17±9	17.5±12.5	26.5±21.5	30±26
11.	Sodium mgL^{-1}	18.5±6.5	48±32	21.5±6.5	24.75±18.25	37.5±27.5
12.	Potassium mgL^{-1}	19±13	6.5±3.5	3.5±1.5	15.25±10.75	6.5±3.5
13.	Total hardness mgL^{-1}	275±225	294±206	156±58	159.5±95.5	167.5±122.5
14.	Nitrate mgL^{-1}	8.5±6.5	16.5±10.5	15±10	10±8	7±5
15.	Sulphate mgL^{-1}	13.5±6.5	23±13	34.5±25.5	21.5±18.5	27±23
16.	Silicate mgL^{-1}	3.81±1.81	3.83±1.8	3.5 ± 1.33	2.48±1.34	0.39±0.11
17.	Chloride mgL^{-1}	22.5±7.50	70.0±58.0	25±17	28±22	27±17

DISCUSSION:

PHYSICAL PARAMETERS:

Temperature:

In present investigation, water temperature fluctuated between 20.1^{o}C to 30.2^{o}C at the site of Nagchoon. The minimum temperature was recorded during the month December 2014 at all the sampling sites. The maximum temperature was recorded during the month April and

May 2014 at all sites. A direct relationship between temperature and inorganic carbon, total hardness, free carbon-di-oxide, pH, chloride, calcium, magnesium, total dissolved solids, alkalinity, sodium and inverse relationship with dissolved oxygen in all the 5 ponds, with nitrate in pond III and pond V, with silicate in pond II, and V, with sulphate in pond III and pond V with potassium in pond II and pond III was observed. Studies on the effect of temperature on various physico-chemical as well as biological activities have been studied.

Turbidity:

Turbidity in water is caused by the substances which are not present in the form of true solution. In the study, turbidity values ranged between 5 NTU and 95 NTU in Doodh Talai, 5 NTU and 55 NTU in Singhad Talai, 1 NTU 70 NTU in Padam Kund, 5 NTU and 40 NTU in Nagchoon Talab and 5 NTU and 65 NTU in Rameshwar Kund. High turbidity makes the water unfit for domestic purposes, proper growth of aquatic organisms and many other uses. Turbidity shows seasonal variation, thus in the present study, turbidity was high during spring season (July, August and September 2014). Low in summer and winter seasons. Thus higher turbidity values were recorded in Doodh Talai and lower value in Nagchoon Talab. Present work reveals that turbidity is negatively correlated to dissolved oxygen as observed in Padam Kund and Rameshwar Kund in month of July 2014 and August 2015.

pH (Hydrogen Ion Concentration):

In general the ponds under study showed alkaline pH, however there was a fluctuation during certain months thus the pH range was from 6.85 to 8.32 in Nagchoon Talab 6.82 to 8.03 in Singhad Talai 6.85 to 8.04 in Padam Kund, 6.9 to 8.05 in Rameshwar Kund and 7.3 to 8.5 in Doodh Talai. Verma and Shukla (1970), believed that pH would prove to be an ecological factor of prime importance in controlling the activities and in the distribution of aquatic flora and fauna. In the present study the pH value decreased slightly during monsoon period. Occurrence of large number of Cyanophyta is attributed to alkaline pH (Philipose 1959). High pH also favoured the distribution of Cyanophyta (Prescott 1948; Rao 1955); Adoni (1975), observed changes in pH during different seasons. The present studies are indicative of the fact that the wastes released in ponds to make the water more alkaline.

In the present study, Doodh Talai showed fairly high pH along with their higher values for other parameters like bicarbonates, chloride and calcium. Doodh Talai is one of the storage of domestic sewage and rainy water. The pH of water was reported to be always on alkaline side and showed high range of fluctuation. Anacystis, Anabaena and Staurastrum showed significant positive correlation with

total radiation and air temperatures. Gloeocapsa, Tetraedron, Nitzschia depicted positive correlation with chlorides, orthrophosphates and negative correlation with dissolved oxygen content, members like Melosira and Synedra did not show any significant relationship with other physicochemical parameters (Adoni and Vaishya 1990). Fritsch has mentioned this to be characteristic of all tropical waters. Cyanophycean abundance coincided with absence of nitrates and they are capable of growing in minimal quantities of nitrates and phosphates (Pearsall 1924)

A direct correlation between pH, bicarbonates, chloride, calcium, was also reported (Y.Singh 1979). Thus in the present study, all ponds showed fairly high pH along with higher values for other parameters like bicarbonates, calcium and chlorides. In the present study, total phytoplankton in all the sampling ponds were found to be more during summer months when the pH was also fairly high.

Electrical Conductivity:

The conductivity of distilled water rages from 1 to 5 µ mho. The conductivity values of the sampling ponds rages from 383 µ mho (June 2014) to 1468 µ mho (July 2014) in Nagchoon Talab, 287 µ mho (June 2014) to 510 µ mho (Feb. 2015) in Singhad Talai, 535 µ mho (March 2014) to 275 µ mho (Feb. 2015) in Padam Kund, 360 µ mho (March 2014) to 355 µ mho (Feb.2015) in Doodh Talai, 290 µ mho (March 2014) to 1027 µ mho (June. 2014) in Rameshwar Kund.

CHEMICAL PARAMETERS

Dissolved Oxygen:

Dissolved oxygen is one of the most important parameters in the assessment of water quality. It is essential for the metabolism of all aerobic aquatic organisms. Dissolved Oxygen also affects the solubility and availability of many nutrients and therefore productivity of aquatic ecosystem (Wetzel, 1983). Non polluted surface water remain normally saturated with dissolved oxygen. The oxygen balance in the water becomes poorer as the input of oxygen at the surface and the photosynthetic activity decreases and as the metabolic performance of the heterotrophic organisms becomes greater. Higher temperature during summer months, resulted in low level of DO , due to low temperature during winter and monsoon months resulted in higher level of DO. The present study reveals that the concentration rapidly declines in polluted water. The normal value of 9.49 $\pm$ 0.47 mg/l in Nagchoon Talab-non polluted; reduced to 4.16 $\pm$ 3.73 mg/l in Singhad Talai-polluted site; further depleted to 3.9 $\pm$ 3.18 mg/l in Padam Kund; 3.21 $\pm$ 2.7 mg/l in Rameshwar Kund and 2.91 $\pm$ 0.44 mg/l in Doodh Talai (Polluted site). The present investigations also indicates variations in DO

concentration at the different sampling stations and was found to decline in the water which contained the effluents.

Maximum dissolved oxygen content was recorded in the month of November 2014, in Nagchoon Talab, 9.96 mg/l and in Padam Kund, 7.069 mg/l and in Rameshwar Kund, 5.19 mg/l and in the month of October, in Doodh Talai, 3.35 mg/l, and Singhad Talai, 6.43 mg/l, respectively. So all the five ponds showed the maximum dissolved oxygen during the rainy period, in the winter season which may be attributed to the phenomenon of reoxygenation of water in monsoon period due to circulation and mixing by inflow of water after monsoon rains. Dissolved oxygen content showed minimum value in Nagchoon Talab, 9.02 mg/l during May and June 2014, whereas Doodh Talai, 2.47 mg/l Singhad Talai, 2.5 mg/l during February 2014; Padam Kund, 0.73 mg/l during July 2014; Rameshwar Kund, 0.52 mg/l, during June 2014. Even through the minimum values of dissolved oxygen were recorded during February 2014 to July 2014. It also shows a negative correlation with carbon-di-oxide, inorganic carbon, total hardness and other ions. The inverse relationship of dissolved oxygen with carbon-di-oxide was also reported by Zafar (1964) and Munawar (1970). This present result was in conformity with Kumar and Singh (2000). Nutrient salts like nitrate, calcium, magnesium attained its maximum values during the rainy months due to inflow of rain water and its minimum value was observed during summer months, showing negative correlation with phytoplankton population. This is in conformity with results of Singh (1993); Mishra and Yadav (1978).

Free Carbon dioxide:

Atmosphere, ground water, decomposition of organic matter, respiration of biota are the main sources of free-carbon-di-oxide in aquatic ecosystem. Minimum values of Carbon dioxide were recorded during May 2014 in Doodh Talai, Singhad Talai, Padam Kund and Rameshwar Kund and during June 2014 in Nagchoon Talab. This may be attributed to the fact that respiration of aquatic organism is also decreased by increased light and temperature during summer months, resulting in decreased carbon-di-oxide level. Present study also shows minimum level in the months of May in all sites. Carbon-di-oxide was maximum in winter season and minimum in rainy season (Adony and Vaishya, 1990). Arvind Kumar 1996; reported that free carbon-di-oxide was maximum in monsoon months and minimum in the month of May which was attributed to the decomposition of organic matter in the pond.

Table indicates the free carbon-di-oxide values of pond water samples which range from 0.21 mg/l (May 14) to 1.33 mg/l (January 15) in Nagchoon Talab ; 0.14 mg/l (May 14) to 1.7 mg/l (December 15) in Doodh Talai ; 0.19 mg/l (May 14) to 1.19

mg/l (December 15) in Singhad Talai; 0.12 mg/l (May 14) to 1.67 mg/l (December 15) in Padam Kund and 0.11 mg/l (May 14) to 1.41 mg/l (October 15) in Rameshwar Kund.

Total Inorganic Carbon:

Inorganic Carbon is a major nutrient in photosynthetic metabolism. In the present study total Inorganic Carbon showed no seasonal variation. The total Inorganic Carbon varied from 37.5 mg/l (December 2014) to 98.4 mg/l (June 2014) in Doodh Talai, 31 mg/l (September 2014) to 63 mg/l (August 2014) in Singhad Talai, 28.0 mg/l (March 2014) to 60 mg/l (August 2014) in Padam Kund, 24mg/l (March 2014) to 30mg/l (Feb. 2015) in Rameshwar Kund and 18.36mg/l (Oct.2014) to 46.8mg/l (July 2014) in Nagchoon Talab. Statistical data exhibits a significant positive correlation of inorganic carbon with total hardness and calcium in Nagchoon Talab and Doodh Talai; with free carbon-di-oxide alkalinity, magnesium and total hardness in all of five water reservoir; with nitrate and sulphate in Nagchoon Talab and Doodh Talai; and a significant negative correlation with free carbon-di-oxide in all five sites.

Alkalinity:

During the course of observation, there was increase in alkalinity in June 2014 and July 2014 and decrease from January 2015 and February 2015, again up to December 2014, there was a decline trend. The alkalinity was found to be comparatively low during winter season in all ponds, except Rameshwar Kund (68 mg/l, 91 mg/l, 120 mg/l, 132 mg/l, 138 mg/l,) and high during summer seasons (180 mg/l, 238 mg/l, 332 mg/l, 374 mg/l, 458 mg/l,). Alkalinity revealed a direct correlation with temperature, inorganic carbon, total hardness, chloride, calcium, magnesium, nitrate, potassium and sulphate and negative correlation with rainfall, carbon-di-oxide, DO and silicate, represented in Graphs. The present study also infers that the BOD values at site Doodh Talai, Singhad Talai, Padam Kund and Rameshwar Kund, which receive the wastes, show a rise in the BOD values and can be used as an indicator for investigating the pollution load of water. The value of 2.43 $\pm$ 0.14 mg/l at Nagchoon Talab; 3.9 $\pm$ 0.35 mg/l at Rameshwar Kund; 3.95 $\pm$ 0.37 mg/l; at Singhad Talai; 4.00 $\pm$ 0.32 mg/l at Padam Kund with a further enhancement at site Doodh Talai (5.23 $\pm$ 0.34 mg/l).

Calcium:

Calcium is one of the most abundant elements in the natural waters. Disposal of sewage and other wastes are important sources of calcium. Concentration of calcium is reduced at higher pH due to its precipitation as calcium carbonate (Trivedy and Goel; 1986). Large amounts of calcium are generally precipitated photosynthetically and phosphorus is also co- precipitated.

Calcium contents of the water sample at different sampling stations are presented in Table. In the present study the

values of calcium were ranging from 24 mg/l (June 14) to 120 mg/l (July 14) in Nagchoon Talab; 18 mg/l (May-June 14) and 55 mg/l (August 14) in Doodh Talai ; 25 mg/l (November 14) to 34 mg/l (March 14) in Singhad Talai; 16 mg/l(December 14) and 50 mg/l (July 14) in Padam Kund ; 11 mg/l (October 14) and 60 mg/l (December 14) in Rameshwar Kund. Main water reservoir of Nagchoon is free from phytoplankton and with few macrophytes. Higher values of calcium were recorded during winter season and lower values during summer months by Adony and Vaishya (1990).

Magnesium:

Magnesium also occurs in all kinds of natural water with calcium, but its concentration remains generally lower than calcium. The concentration of magnesium also depends upon the present of sodium. Magnesium contents of water sample at different sampling stations are recorded and tabulated and range was found to be from 10 mg/l (November 14) to 50 mg/l (February 14) in Nagchoon Talab ; 8 mg/l (October 14) to 26 mg/l (June 14) in Doodh Talai; 5 mg/l (May 14) to 32 mg/l (February 14) in Singhad Talai; 5 mg/l (April 14) to 33 mg/l (July 14) ; Padam Kund and 4 mg/l (August 14) to 56 mg/l (June 14) in Rameshwar Kund. Most probably the data that the magnesium level was high during summer months. These values show that magnesium is not the determining factor for population of phytoplankton, other factors also act together.

Sodium:

Sodium content of sampling ponds is tabulated. The sodium content ranged from 15 mg/l (November 14) to 28 mg/l (August 14) in Nagchoon Talab ; 16 mg/l (November 14) to 80 mg/l (August 14) in Doodh Talai ; 12 mg/l (November 14) to 25 mg/l (February 14) in Singhad Talai ; 10 mg/l (November 14) to 43 mg/l (August 14) in Padam Kund and 10 mg/l (September 14) to 65 mg/l (October 14) in Rameshwar Kund. Maximum growth of several blue green algae was found at 40 mg/l of sodium level (Wetzel, 1966). Present study also support their observation as higher levels of sodium support the growth of blue green algae.

Potassium:

The observed values were tabulated. The values of potassium content ranged from 6.0 mg/l (December 14) to 32 mg/l (August 14) in Nagchoon Talab; 2.5 mg/l (February 14) to 10 mg/l (August 14) in Doodh Talai; 2 mg/l (December 14) to 5 mg/l (July 14) in Singhad Talai; 4.5 mg/l (December 14) to 26 mg/l (July 14) in Padam Kund and 4 mg/l (February 14) to 17 mg/l (July 14) in Rameshwar Kund. In the present investigation during months of lower concentration of potassium, higher total phytoplanktons were observed than during months of high potassium content.

Total Hardness:

Principal cations imparting hardness are calcium and magnesium. The anion responsible for hardness may be mainly bicarbonate, carbonate, sulphate, chloride, nitrate and silicate. The values obtained for total hardness at different sampling ponds are tabulated. The values ranged between 50 mg/l (October 14) and 500 mg/l (July 14) in Nagchoon Talab ; 88 mg/l (May 14) and 500 mg/l (July 14) in Doodh Talai ; 98 mg/l (October 14) and 214 mg/l (February 14) in Singhad Talai ; 64 mg/l (February 14) and 190 mg/l (August 14) and 45 mg/l (October 14) to 290 mg/l (June 14) in Rameshwar Kund.

Nitrate:

Nitrate content of the water samples at different sampling ponds are presented in table. The recorded range of nitrate content is between 5 mg/l (February, April and October 14) to 25 mg/l (August 14) in Nagchoon Talab; 5 mg/l (December 14) to 27 mg/l (August 14) in Doodh Talai; 2 mg/l (March and October 14) to 15 mg/l (August 14) in Singhad Talai; 2 mg/l (February 14 and January 15) to 18 mg/l (July 14) Padam Kund and 2 mg/l (February 14 and January 15) to 12 mg/l (June 14) in Rameshwar Kund. Nitrate showed direct relation with temperature, alkalinity, pH, DO and phytoplankton density (Adony and Vaishya, 1990). Present study showed a positive relation with rains in all water reservoirs.

Sulphate:

Sulphate content of water samples collected at different sampling sites are given in table. The Sulphate content varied from 9 mg/l (May 14) to 60 mg/l (September 14) in Nagchoon Talab ; 10 mg/l (December 14) to 36 mg/l (August 14) in Doodh Talai; 7 mg/l (December 14) to 20 mg/l (June and August 14) in Singhad Talai; 3 mg/l (December 14) to 40 mg/l (June 14) in Padam Kund; and 4 mg/l (August 14) to 50 mg/l (May 14) in Rameshwar Kund.

Silicate:

Silicate is naturally occurring content. It is found in lower concentration. It is due to domestic waste. Mostly low concentration of silicate was observed during January and March 14 in all ponds. Silicate content of the sampling ponds ranged between 2.01 mg/l (July 14) to 5.62mg/l (April 14) in Nagchoon Talab; 1.14 mg/l (August 14) to 3.73 mg/l (June 14) in Doodh Talai; 2.18 mg/l (March 14) to 4.83 mg/l (June 14) in Singhad Talai ; 1.14 mg/l (May 14) to 3.82 mg/l (February 14) in Padam Kund and 0.29 mg/l (April 14) to 0.50 mg/l (June 14) in Rameshwar Kund. Maximum range occurs in month of May and June 2014 in all ponds. Due to death and decay of phytoplankton and macrophytes in front of Nagchoon Talab, silicates are increased. Nutrients such as silicate, nitrate and phosphates are necessary for the growth of phytoplankton. Doodh Talai, Singhad Talai and Padam Kund are also showed optimum value of silicates for growth of phytoplankton.

Chloride:

Chloride shows a positive correlation with total phytoplankton, Chlorophyta and Cyanophyta in Doodh Talai, Singhad Talai Padam Kund, Nagchoon Talab and Rameshwar Kund, respectively. The minimum and maximum values of chloride were recorded as 6 mg/l (September and November 14) to 38 mg/l (February 14) in Nagchoon Talab; 12 mg/l (November 14) to 128 mg/l (July 14) in Doodh Talai; 8 mg/l (August, September and November 14) to 42 mg/l (June 14) in Singhad Talai; 10 mg/l (October and November 14) to 50 mg/l (June 14) in Padam Kund and 10 mg/l (October 14) to 44 mg/l (May 14) in Rameshwar Kund.

CONCLUSION:

- Generally the water temperature exhibited variation in the sampling sites (Table-II) and it ranged from 20.2^{0}C to 30.2^{0}C in Nagchoon Talab, from 20.5^{0}C to 30.4^{0}C in Doodh Talai, from 20.6^{0}C to 30.2^{0}C in Singhad Talai, from 20.5^{0}C to 29.9^{0}C in Padam Kund and from 20.2 to 29.8^{0}C in Rameshwar Kund. The blue green algae as a group, generally much more tolerant to higher temperature, than other algal groups, during present study pH of five sites of water reservoir ranges from 6.82 to 8.5 under natural condition. However, the blue green algae are tolerant of high organic matter (Krishnamurthy, 1981).
- This is found to be true with Doodh Talai and Singhad Talai. In the present study the pH values slightly decreased during monsoon period. Besides, direct correlation was found between pH and temperature, inorganic carbon, total hardness, carbon-di-oxide, calcium, magnesium, silicate, alkalinity, potassium and an inverse correlation with nitrate, sodium and sulphate in Nagchoon Talab; a positive correlation with temperature, silicate, alkalinity nitrate, sodium, total hardness and comparatively negative correlation with the other parameters in Doodh Talai; a positive correlation between pH and temperature, total hardness, dissolved oxygen, silicate, alkalinity, sodium and a negative correlation with the other factors in Singhad Talai; a positive correlation with temperature, carbon-di-oxide, magnesium, nitrate, silicate, alkalinity, sulphate and a negative correlation with remaining parameters in Padam Kund; a positive correlation with temperature, total hardness, calcium, magnesium, sodium, sulphate and a negative correlation with other parameters in Rameshwar Kund.
- Total Cyanobacterial forms shows positive correlation with total hardness in all ponds except Nagchoon Talab.
- Eutrophic polluted ponds support luxuriant growth of blue green algae particularly in summer and the occurrence of Microcystis bloom in the

pond are used as bioindicators of pond ecosystem dynamics.

- Algal species occurring at high concentration so as to discolor the water or produce potent toxins included 'taxonomic groups' comprising-dinoflagellates (Plumley, 1997; Baden *et. al.,* 1998), other flagellates and Cyanophytes.
- The driving forces and mechanism of charges are related to variation in the physical, chemical and biotic environment and to the many possibilities brought about by their mutual interactions, which together affect to growth of hydrophytes and phytoplankton. Through physico-chemical analysis of water and vegetation, strategies and research plan are needed for a better understand, use a protection of ecologically sensitive water ecosystems.
- This region has so far been unexplored from the Limnological point of view. This study will be a step towards greater exploration of the water bodies of the region, leading to many significant findings.
- The present work affords good scope for future limnologists as experimental limnology holds the key to determine water quality, than observational limnology.

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