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Seasonal variation in the physico-chemical variables of Western Himalayan Sacred Lake Prashar, Himachal Pradesh, India

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Abstract

A study was conducted to evaluate the 12 physico- chemicals variables of Prashar lake. The sample were collected from three different sampling sites (S_1, S_2, and S_3) for the periods of two years. The variables included water temperature, pH, conductivity, Total Dissolved Solids (TDS), Dissolved Oxygen, Biochemical oxygen demand, Calcium, Magnesium, Total Hardness, Chlorides, Nitrates, Phosphates were analyzed by following standard methods. Five seasons were covered during the study which includes winter (November- February), spring (March-April), summer (May-June), monsoon (July-August) and autumn (September-October). Dissolved Oxygen and pH observed maximum during the winter season, where as conductivity, TDS and BOD were observed maximum during summer season. Nitrates and Phosphates observed maximum during monsoon season.

Keywords: Prashar lake, Physico-chemical variables, water quality.

Introduction

The lakes comprise the one of the most productive ecosystem. Lake environments are comprised of physical, chemical and organic properties contained inside these water bodies. Numerous living beings rely upon freshwater for endurance and humans commonly depends upon lakes for a considerable number of 'goods and services', for example, drinking water, waste removal, fisheries, agricultural irrigation, industrial activity and recreation. Hence lakes represent imperative biological communities[1]. The study of water variables of a lake ecosystem plays an important role to determine the biological production. The changes in these variables of aquatic ecosystem also showed considerable impact on the biological diversity. Therefore an accurate evolution of the physico-chemical variables in lake ecosystem is of ultimate importance for controlling pollution.

Studies on the physico-chemical variables of lake have been done by many workers all over the world Mosello et al.[2] studied on water chemistry of high altitude lakes in Europe, Karakoc et al.[3] studied on Water quality of Eymir and Mogan Lakes (Turkey); Muvanga and Barifaijo[4] studied on physico-chemical study on lake Victoris basin (Uganda), Hameed et al.[5] studied on water quality index for assessment of Dokan lake Kurdistan region, Iraq; Prasanna et al.[6] studied on Curtin lake in East Malaysia, Vandeberg[7] studied on on Upper Devils Lake in North Dakota, French et al.[8] studied on water quality and availability on Lake Poopó Basin, Bolivian Altiplano.

Studies on the physico-chemical variables of lake have been done by many workers in India; Sedamkar and Angadi[9] studied on Physico-chemical variables of two fresh waterbodies of Gulbarga-India; Devaraju et al.[10] studied in physicochemical parameters of Muddur lake; Ambastha et al.[11] studied on Kabartal wetland; Coimbatore; Singh et al.[12] studied on Ramgrah lake, Gorakhpur; Chaudhry et al.[13] studied on Water quality assessment of Sukhna lake (Chandigarh); Singh and Manaan[14] studied on Spatial and Temporal Analysis of Water Quality Parameters of a Himalayan Lake (Dal Lake). Babu and Mohan[15] studied on physico-chemical parameters of Errarajan Lake of Bangalore.

Some of the important works on physico-chemical variability of water quality have also been done in Himachal Pradesh by some workers; Das and Kaur[16] conducted study on Renuka lake, Das and Dhiman[17] conducted study on Himalayan lakes in Spiti valley, Kumar et al.[18] conducted study on Maharana Pratap Sagar lake, Sharma and Walia[19] conducted study on Gobind Sagar Lake, Sharma et al.[20] studied the physico-chemical parameters of lentic water bodies from Mid- Himalayan region (H.P.), Gaury et al.[21] studied on Hydrochemistry and water quality of Rewalsar Lake.

The study area: An extensive number of freshwater sacred lakes subsist in the Western Himalaya. These lakes are a significant wellspring of water for lots of reasons, for example, water system, drinking, other residential uses, pisciculture and amusement. These lakes assume a considerable role in keeping up the hydrological, biological and natural adjust of the area[22]. Himachal Pradesh, the land of gods, known as 'Dev Bhoomi' has several sacred lakes. One of most sacred lake in Himachal Pradesh is Prashar lake. Prashar lake is located in the Mandi district of Himachal Pradesh (Latitude 31°45′15.80″N;

longitude 77°06′04.20”E) at an altitude of 2,614 m above sea level in the western Himalaya. The lake is oval in shape with an area of 1.30 ha and a depth of 4-5m (Figure-1). This sacred lake is revered by a large number of local people. Water of Prashar lake is being used for the purpose of drinking. It attracts large number of religious pilgrims and tourists from different areas. As the name suggested the Prashar Lake is dedicated to Maharishi Parashar, who is the father of Saint Ved-Vyas, the Raj Purohit of Kurav dynasty, stated in Mahabharata. Maharishi Vashishtha, the Religious and spiritual counselor of Lord Rama, was the grandfather of Maharishi Parashar. The Sage Prashar Rishi is the narrator of first Purana, the Vishnu Purana of Hindu mythology. He also narrated many other important text scripts such as “The science of life of trees” (botany) in Hindu mythology. He meditated at this place; hence the lake was gets his name after the sage Parashar. Thus, this natural site of Prashar Lake sacred and named after the great seer of Rigvedic period, Parashar. The local people believed that the Prashar lake has many legends and beliefs which make this lake a sacred place in terms of Hindu mythology. One of the prominent legends was that the lake was formed by Pandavas after Mahabharata when he was on his way, with deity Kamrunag to find place for their teacher to meditate. The Kamrunag like the place so on his request, Bheem one of the brother of Pandava’s formed the lake by pushing his elbow and forearm on the peak of the mountain of the area[23]. Enduring in notice the significance of the lake the current examination was conceded to evaluate the physicochemical variation in sacred Lake Prashar.

Materials and methods

Three sampling sites S_1, S_2 and S_3 were selected for the analysis of physico chemical variables, in Prashar. Sampling was undertaken between 08:00 to 10:00 hrs during November 2015–October 2016, in such way that all representing five seasons: winter season include November to February months, spring season include March to April, summer season include May- to June, monsoon season include July to August months and autumn season include September to October months were covered. Three reproduces of water tests were gathered for every parameter from all the three sites. Standards methods were followed for the collection and analyses of physico-chemical variables. Water temperature was measured with the help of Centigrade Mercury thermometer (0–110˚C). TDS and pH was measured with the Toshcon Multiparameter Analyser. Dissolved Oxygen, alkalinity, BOD, hardness, nitrates, phosphates, Sodium and Potassium were analysed by using standard methods[24,25].

Results and discussion

Seasonal variations of physico-chemical variables of Prashar lake were presented in Figure-2a-2b.

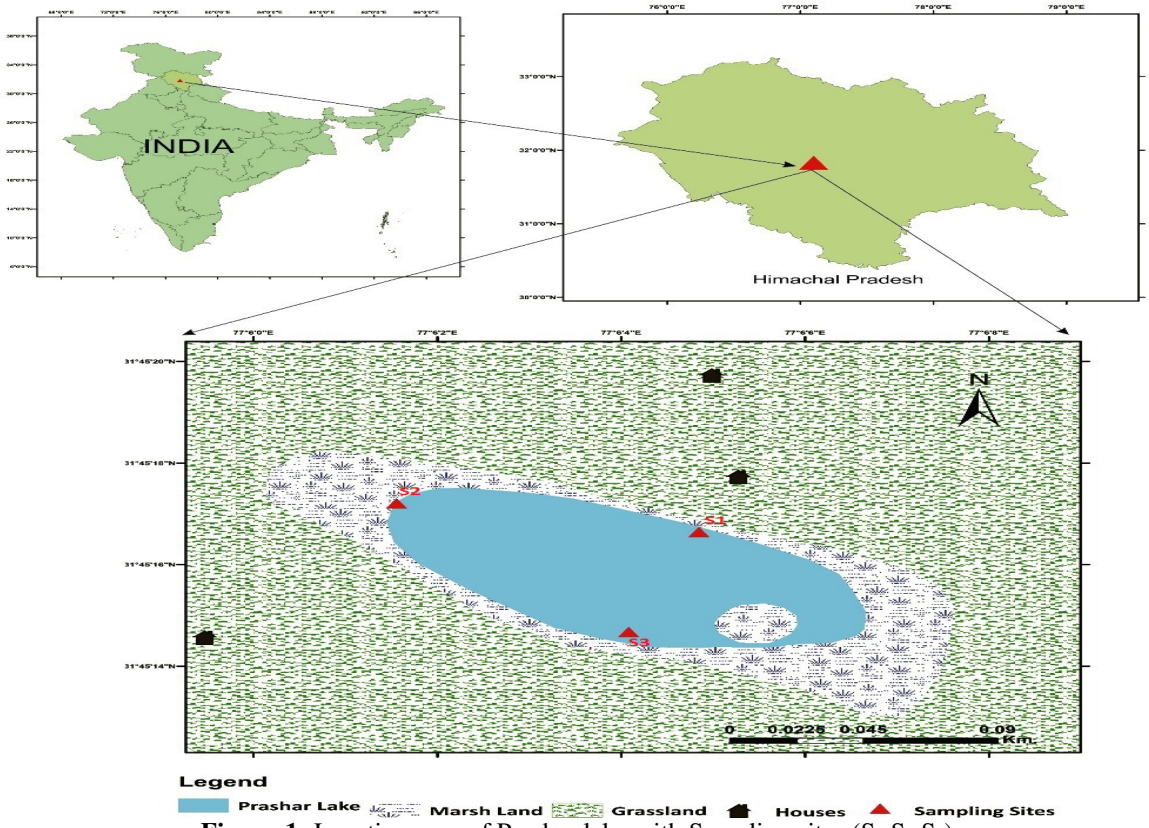

Figure-1: Location map of Prashar lake with Sampling sites (S_1,S_2,S_3).

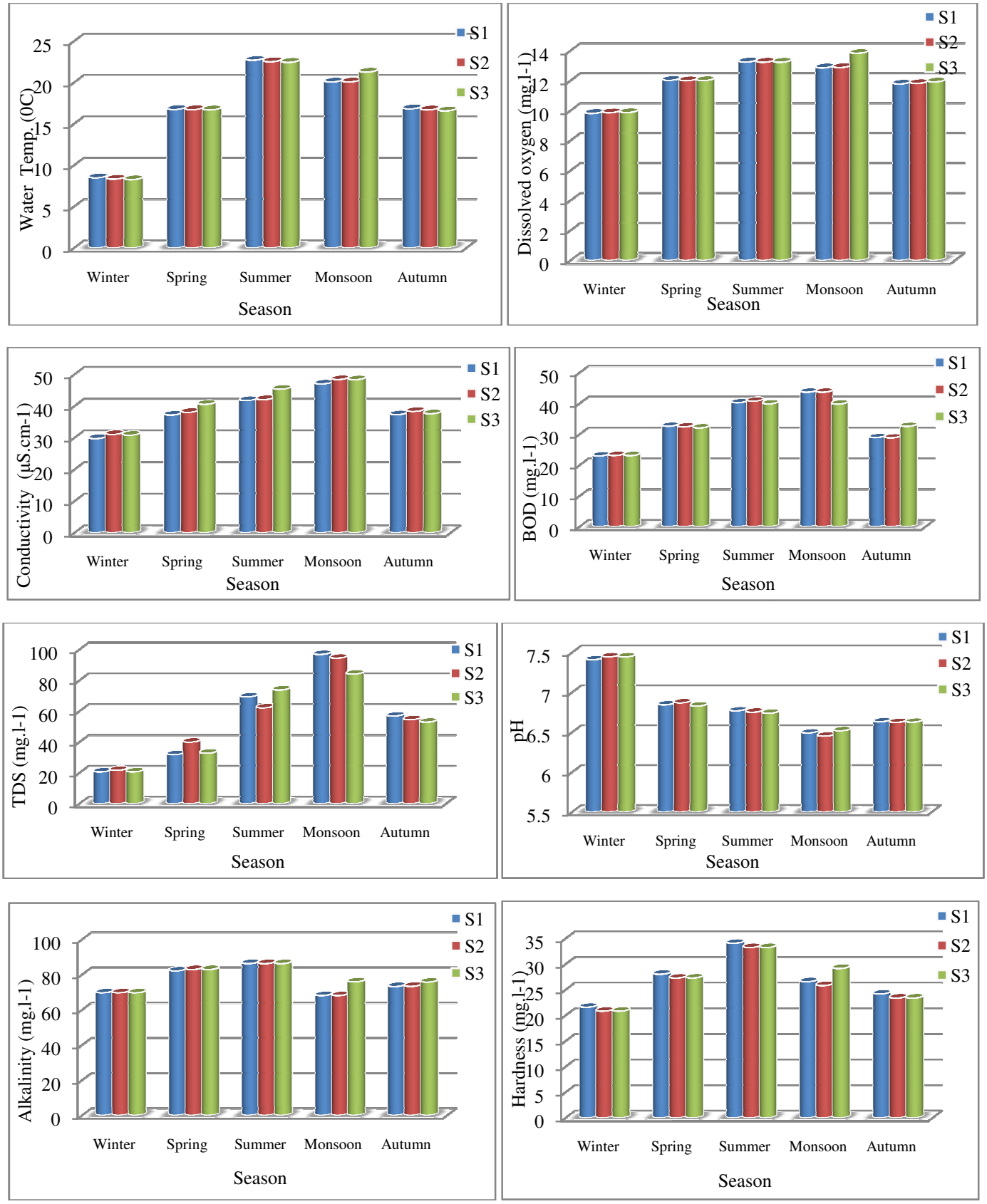

Figure-2a: Seasonal variation in physico-chemicals parameters of Prashar lake.

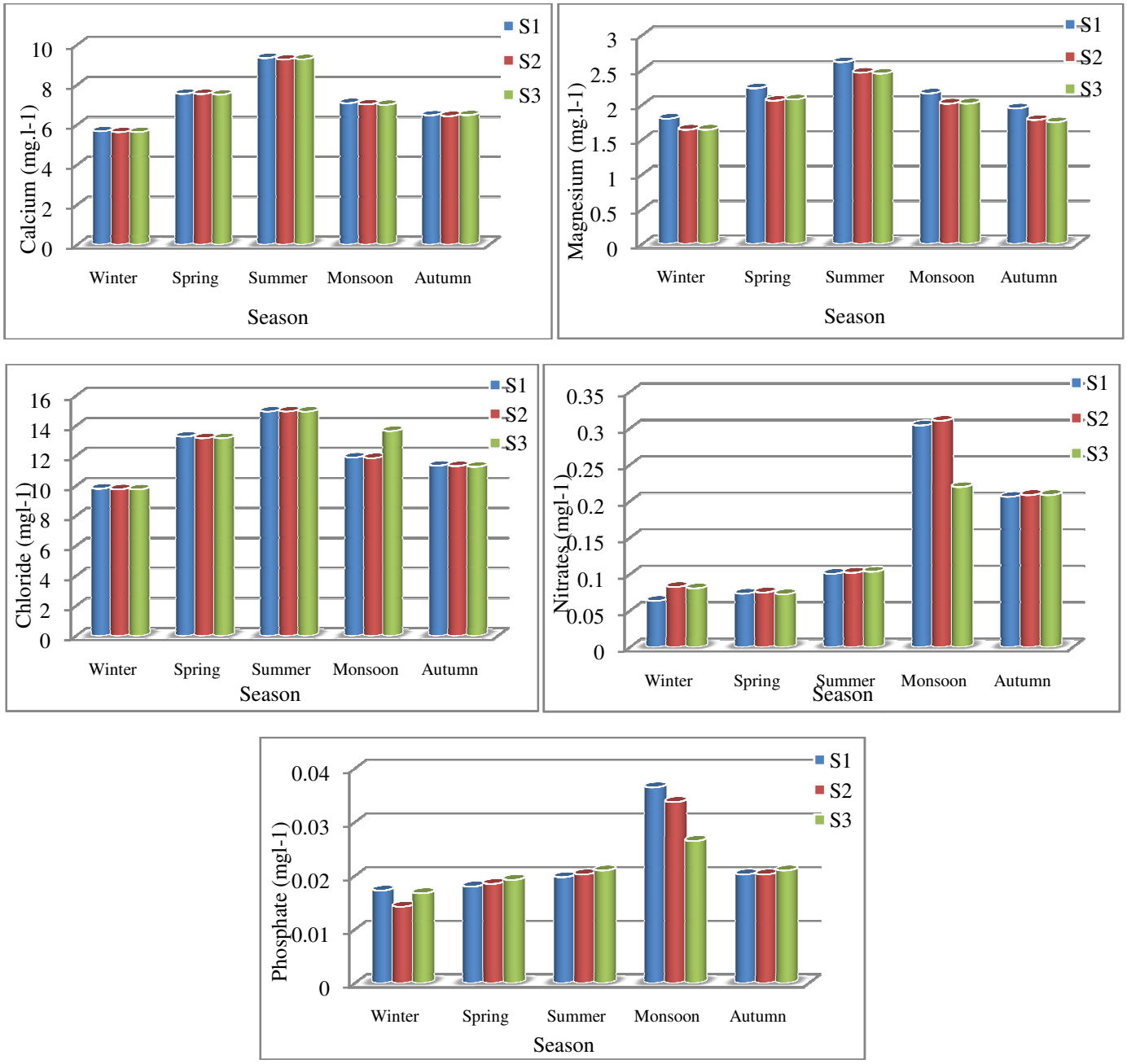

Figure-2b: Seasonal variation in physico-chemicals parameters of Prashar lake.

Water temperature: Water temperature differs from place to place. Temperature may change because of different districts incorporate climate changes, evacuation of shading stream bank vegetation, impoundments, release of cooling water, urban tempest water and groundwater inflows to the stream[26]. Water temperature has remarkable impact on water density. Commonly changes in temperature also depend on the geographical location and conditions which includes rainfall, humidity, wind velocity *etc*. Water temperature plays an important role in regulation in biotic and abiotic ecosystem. Seasonally, the water temperature was found to be minimum (7.60^0C) at S_1 and S_2 in winter and (19.70^0C) at S_1 in summer season during the first year of observations. The same trend was observed in the successive year of observations.

Conductivity: Conductivity was more appropriate and fast method to evaluate the total dissolved solids. The value of conductivity is directly related to total solids[27]. Higher the value of dissolved solids, grater will be the amount of ions in water. The conductivity of water of Prashar Lake was recorded to be maximum (91µS.cm^{-1}) at S_2 and S_3 in May and minimum (39 µS.cm-1) at S_2 and S_3 in January during the first year of observations.

Water Conductivity is a determination of capacity of water to pass the electric current. This is directly influenced by the concentration of ions present in the water. Seasonally, conductivity was found to be maximum (86.00µS.cm^{-1}) at S_2 in summer season and minimum (45.50µS.cm^{-1}) at S_1 in winter season during the first year of observations. It was found to be maximum (86.50µS.cm^{-1}) at S_3 in summer and minimum (47.75µS.cm^{-1}) at S_1 in winter during the second year of study. Also studied by Kumar and Sivakumar[28], Garg et al.[29]. The increase in the value of conductivity during summer season reported by the Sharma and Rathore[30].

Total Dissolved Solids (TDS): Total dissolved solids in water was consist of inorganic salts including calcium, magnesium, potassium, sodium, chlorides, sulfates *etc.* and also very less amount of organic matter present in the water. Seasonally, TDS was found to be maximum (93.23mgl^{-1}) at S_1 in summer season and minimum (21.43mg.l^{-1}) at S_3 in winter season during the first year of observations. However, TDS were found to be maximum (95.47mg.l^{-1}) in summer season at S_1 and minimum (19.24mg.l^{-1}) at S_1 in winter season during the second year of observations.

TDS occurred during summer and monsoon months while minimum during winter months. The maximum amount of total dissolved solids was recorded during summer and minimum during winter season which was in confirmation with observation of Jemi and Balasingh[31]. Qumerunsisa[32] found the maximum TDS during summer season and minimum during monsoon months.

Dissolved Oxygen: Dissolved oxygen is a estimation of concentration of oxygen which is dissolved into the water. The dissolved oxygen was found to be maximum (13.17mg.l^{-1}) at S_1 in January and minimum (6.40mg.l^{-1}) at S_1 in June during the first year of observations. The same trend was observed in the second year of observations. Seasonally, dissolved oxygen was found to be maximum (11.71mg.l^{-1}) at S_1 in winter and minimum (6.9mg.l^{-1}) at S_1 in summer during the first year of observations, same pattern were observed during second year of study.

DO is very important parameter as maximum physico-chemical and biological processes are influnced by its variation[33]. Dissolved oxygen concentration more than 5.00mg/l favors the growth of living organisms[34]. Higher concentration of dissolved oxygen during winter season. Simillar finding were also reported by Rawat and Sharma[35] in Deoria tal and Tiwari and Mishra[36] in Seetadwar lake. Dissolved oxygen is important for many flora and funa growth. Dissolved oxygen also affects the solubility and availability of many nutrients. Thus, the dissolved oxygen varies extensively from one water body to other. In summer season dissolved oxygen decreased due to increased temperature of water also observed by Naz and Turkmen[37] in Harsi reservoir. The dissolved oxygen in this reservoir was sufficiently very to help natural life. Similar results were also reported by Garg et al.[29]. During summer season, dissolved oxygen decreases due to raise in temperature and also due to increased microbial activity[19].

Biochemical oxygen demand: The BOD was found to be maximum (1.12mg.l^{-1}) at S_3 in July and minimum (0.37mg.l^{-1}) at S_3 in January during the first year of observations. It was found to be maximum (1.64mg.l^{-1}) at S_1 in June and minimum (0.31mg.l^{-1}) at S_3 in January during the second year of observations. Seasonally, BOD was found to be maximum (1.12 mg.l^{-1}) at S_2 in monsoon and minimum (0.41mg.l^{-1}) at S_3 in winter during the first year of observations, same pattern were seen during the successive year of study.

Hydrogen Ion Concentration (pH): The evaluation of pH of water is most widely performed tests in laboratories. At any given temperature, the intensity of acidic and basic property of a sample is specified by pH or hydrogen ion activity. Hydrogen ion concentration (pH) in Prashar Lake water was found to be maximum (7.75) at S_1 in February and minimum (6.50) at S_2 and S_3 in July during the first year of observations. It was found to be maximum (7.60) at S_1 in January minimum (6.32) at S_3 in May during the second year of observations. Seasonally, pH was found to be maximum (7.39) at S_1 in winter season and minimum (6.53) at S_2 in monsoon season during the first year of observation. It was found to be maximum (7.51) at S_3 in winter season and minimum (6.38) at S_2 in monsoon season during the second year of observations. The pH of water influenced by the productivity of aquatic ecosystem[38]. The maximum pH was recorded during winter and minimum during monsoon season. Dhanalakshmi et al.[39] found that the excessive microbial decomposition increased production of CO_2 which in turn decreases the pH of water mainly during monsoon season.

Calcium: Calcium ion in the Prashar lake was found to be maximum (9.63mg.l^{-1}) at S_3 in the month of June and minimum (5.41mg.l^{-1}) at S_3 in the month of February during the first year of study. In the second year, calcium was found to be maximum (9.40mg.l^{-1}) at S_1 in the month of June and min. (4.90mg.l^{-1}) at S_2 in the month of January during the second year of the study. Seasonally, the calcium was found to be maximum (5.94mg.l^{-1}) at S_2 in winter season and minimum (5.94mg.l^{-1}) at S_2 in winter season in the first year. It was found to be max (9.10mg.l^{-1}) in summer season at S_1 and minimum (5.32mg.l^{-1}) at S_2 and S_3 in winter season during the second year of study.

Magnesium: Magnesium ion in the Prashar lake was found to be maximum (3.55mg.l^{-1}) at S_1 in the month of April and minimum (1.40mg.l^{-1}) at S_3 in the month of January during the first year of study. In the second year, magnesium was found to be maximum (2.63mg.l^{-1}) at S_2 in the month of May and minimum (1.45mg.l^{-1}) at S_2 in the month of August during the second year of the study. Seasonally, the magnesium was found to be maximum (2.83mg.l^{-1}) at S_1 in monsoon season and minimum (1.59mg.l^{-1}) at S_2 in winter season during the first year of study. It was found to be maximum (2.45mg.l^{-1}) at S_2 in

summer season and minimum (1.51mg.l^{-1}) at S_1 in monsoon season during the second year of observations.

Total Hardness: Hardness is basically two types which is caused by calcium and Magnesium ions present in the water. Hardness in Prashar Lake was found to be maximum (33.29 mg.l^{-1}) at S_1 in May and minimum (18.06mg.l^{-1}) at S_2 and S_3 in February during the first year of observations. It was found to be maximum (30.12mg.l^{-1}) at S_1 in May and minimum (16.09mg.l^{-1}) at S_2 in January during the successive year of study. Seasonally, hardness was found to be maximum (31.55mg.l^{-1}) at S_1 in summer and minimum (18.87mg.l^{-1}) at S_2 in winter during the first year of observations. It was found to be maximum (30.07mg.l^{-1}) at S_1 in summer and minimum (17.74mg.l^{-1}) all site in winter during the successive year of observations.

Alkalinity: The Alkalinity is a measure of the acid buffering capacity of water. The alkalinity is the expression of the total amount of base calculated by titration with a strong acid. Alkalinity in Prashar Lake was recorded to be maximum (90.08 mg.l^{-1}) at S_1 in May and minimum (66.4mg.l^{-1}) at S_1, S_2 and S_3 in August during the first year of observations. It was found to be maximum (88.92mg.l^{-1}) at S_3 in June and minimum (64.10 mg.l^{-1}) at S_3 in August during the second year of study. Seasonally, alkalinity was found to be maximum (87.28 mg.l^{-1}) at S_1 in spring and minimum (69.60mg.l^{-1}) at S_2 in monsoon during the first year of observations, same pattern were seen during the successive year of study. Alkalinity of water is a determination of weak acid present in the water body. Indresha and Patra[40] during the study in Kanjia lake observed that alkalinity of water shows the presence of natural salts in lake. The concentration of total alkalinity was highest during summer season and low during monsoon. The same observation was made by Adebisi[41] on upper Ogun River. Kataria et al.[42] observed that the presence salts of weak acids and bicarbonate ions are the cause of alkalinity in water.

Chlorides: The amount of chlorides in Prashar Lake was found to be maximum (16.86mg.l-1) at all sites in May and minimum (8.21mg.l-1) at S_1 in the month of January during the first year of observations while, it was found to be maximum (15.84mg.l-1) at S_1 in April and minimum (8.62mg.l-1) at S_1 in January during the second year of observations. Seasonally, the chlorides fluctuated from 16.15mg.l^{-1} in spring at S_1 and minimum 9.57mg.l^{-1} at S_3 in winter during first year of observations. While, chlorides found to be maximum in 14.34mg.l^{-1} in spring at S_1 and minimum 9.96mg.l^{-1} at S_2 in winter during the second year of observation.

Nitrates: Nitrates in Prashar Lake were found to be maximum (0.360mg.l^{-1}) at all sites (S_1, S_2 and S_3) in August and minimum (0.047mg.l^{-1}) at all sites (S_1, S_2 and S_3) in February during the first year of observations. However, the nitrates were found to be maximum (0.331mg.l^{-1}) at all sites August and minimum (0.047mg.l^{-1}) at S_3 during the second year of observations. Seasonally, the nitrates were found to be maximum (0.128mg.l^{-1}) at S_4 in winter and minimum (0.075mg.l^{-1}) at S_4 in monsoon during the first year of observations. However, nitrates were found maximum (0.33mg.l^{-1}) at S_2 and S_3 in monsoon season and minimum (0.06mg.l^{-1}) at S_1 in spring season during the second year of observations. The concentration of nitrates was found to be maximum during monsoon season in Prashar lake. Similar findings were reported by Mustapha et al.[43] on the study of Oyun reservoir, Nigeria.

Phosphates: Concentrations of phosphates in Prashar lake were found to be maximum (0.369mg.l^{-1}) at S_1 S_2 and S_3 in July and minimum (0.114mg.l^{-1}) at S_1 S_2 and S_3 in October during the first year of observations. Phosphates concentrations were found to be maximum (0.369mg.l^{-1}) at s_3 in July and minimum (0.114 mg.l^{-1}) at S_1 during the second year of observations. Seasonally, phosphates were found to be maximum (0.36mg.l^{-1}) at S_1 in monsoon and minimum (0.16mg.l^{-1}) at S_2 in winter during the first year of observations. It was found maximum (0.34mg.l^{-1}) at S_3 in monsoon season and minimum (0.14mg.l^{-1}) at S_2 in winter season during the second year of observations. Total hardness of water influenced by the dissolved minerals, hardness determines presence of presence of bicarbonates, sulphates, chloride and nitrates of calcium and Magnesium. Total hardness was recorded maximum in summer season in Prashar lake. Maximum concentration of total hardness during summer season may be due to higher temperature, resulting in the increased concentration of salts by excessive evaporation[44]. Magnesium showed a significant positive correlation with alkalinity and total hardness.

Conclusion

During the present investigation the Prashar lake highest concentration of phosphorus was found during monsoon. Similar pattern recorded by Rawat and Sharma[35], Garg et al.[29]. During rainy season phosphate concentration increase may due to decay of phytoplanktons. Phosphorous is one of the most important micronutrients in deciding the productivity of an aquatic ecosystem. It presents in different forms, including particulate phosphorous, active phosphate, orthophosphate *etc*. By evaluating the physico chemical variables it was observed that the quality of water in sacred lake shows degradation during the monsoon season as comparing to other season. That may be due to the inflow of surrounding runoff into the lake.

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