Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(5): 559-566

Received: 19-07-2018
Accepted: 21-08-2018

S Chandrakar
Fisheries Inspector, Office of the Assistant Director of Fisheries, Department of Fisheries, Govt. of Chhattisgarh, Gariaband, Chhattisgarh, India

SK Das
Professor, Department of Aquaculture, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, Chak Garia, Kolkata, West Bengal, India

B Biswas
Ph. D. Research Scholar, Department of Aquaculture, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, Chak Garia, Kolkata, West Bengal, India

Correspondence
SK Das
Professor, Department of Aquaculture, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, Chak Garia, Kolkata, West Bengal, India

Aquaculture potentials of the reservoirs of Mahasamund district, Chhattisgarh: morphometric and physico-chemical characteristics

S Chandrakar, SK Das and B Biswas

Abstract
The morphometric and physico-chemical status of the reservoirs in Mahasamund District, Chhattisgarh with regards to their aquaculture potentials were investigated during February, 2017 to April, 2017. The reservoirs were heterogeneous with regards to their physical morphometry and the small reservoirs were better managed with resultant planktonic turbidity which was manifested in low transparency. The productivity status of the reservoirs with high TDS encountered in the clay-loam dominated soil areas and most of the reservoirs have suitable range of specific conductivity for aquaculture. However, low values of total alkalinity in most of the unmanaged reservoirs with low calcium hardness indicated scope of environmental amelioration through lime application particularly in the small reservoirs towards enhancing aquaculture productivity.

Keywords: Reservoir, morphometry, water quality, aquaculture

1. Introduction

Fisheries and aquaculture remain important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world and emerged as a sunrise sector with varied resources and potentials. Fish communities are often used as indicators of environmental quality [11]. The World per capita fish supply reached a new record high of 20 kg in 2014 consequent to the recent vigorous growth in aquaculture [9]. India is the second largest fish producing and second largest aquaculture nation in the world next to China. The total fish production during 2015-16 was 10.79 million metric tonne (MMT) with a contribution of 7.2 MMT from the inland sector and 3.58 MMT from marine sector [8]. India is endowed with huge water spread of freshwater resources that exist in the form of rivers, canals, reservoirs, lakes etc. Fisheries play an important role in livelihood and nutritional security of the rural India. The climate of India has a wide range of weather conditions from extreme cold to very hot. From past decade the weather in India has become less predictable due to climate change, so these situations make it important to store river water in the form of reservoirs [16].

In India, reservoirs are playing a crucial role in the inland fisheries sector. The cumulative area of reservoirs in India is estimated to be 1,485,557 ha, 507,298 ha and 1,160,511 ha of small, medium and large reservoirs, respectively [19] Indian reservoirs are rich in food fishes 96.5% that are helpful in providing protein rich diet to the locality of the people living in nearby areas. Indian reservoirs with water spread of 3.15 m ha, and yield potential of 50, 20 and 8 kg $^{-1}$ha $^{-1}$year^{-1} only from small, medium and large reservoirs respectively, leave enough scope of enhancing fish yield from such resources through culture-based capture fisheries [16]. In Chhattisgarh, more than 2.10 lakh fishermen depend on fisheries and aquaculture for their livelihood. Fisheries sector occupies an important place in socio economic development of the state. A total number of 1467 reservoirs and tanks of the Water Resources Department are being used by the Fisheries Department for pisciculture and its overall development. The water-spread area of these reservoirs is 78,700 ha [2].

Several studies have been conducted to understand the morphometric features and physico-chemical status of lakes, ponds and reservoirs in our country. The limnology of Halai Reservoir was attempted by [14] whereas, [18] observed seasonal variations in Kalyani reservoir [17] investigated mmorphometric features and hydrology of Kadgaon freshwater reservoir in India.

The present study was envisaged to study the morphometric and physico-chemical status of the reservoirs in Mahasamund District, Chhattisgarh with regards to their aquaculture potentials. Therefore, the study was also attempted to assess the water quality status with a view to elaborate certain aspects of management for betterment of localities as a whole.

2. Materials and Methods

The study was carried out during February to April, 2017 in the Mahasamund district (between 20°47' to 21°31'30" latitude and 82°00' and 83°15'45" longitude), Chhattisgarh. Twenty five reservoirs were selected randomly; five each from all the five blocks namely Mahasamund, Bagbahara, Basana, Pithora, Saraipali.

The morphometric data were collected from the respective departmental offices, Govt. offices, Chhattisgarh. Water samples were collected from each of the surveyed water bodies early in the morning (9 AM to 10 AM) by completely dipping the collection bottle (250 ml) at 15 cm depth for physico-chemical analyses. During collection of water samples, cautions were taken so as to prevent air bubbling, which might influence water quality. Soil samples from each of the surveyed water body were collected by using a mini hand grab sampler. They were air-dried, pulverized with pestle and mortar and sieved through 150 µm mesh sieve and stored in labeled polythene packets for analyses. Water and soil quality parameters were analysed following the methods of [3] and [13] respectively.

3. Results and Discussion

3.1. Morphometric features

The reservoirs under the present study were heterogeneous so far, the physical morphometry was concerned. All the reservoirs belonged to perennial category with shape varied from round, spherical to more or less rectangular. The catchment area of the reservoirs was also extremely variable as the maximal catchment area (19754 ha) was recorded in Kodar reservoir and the minimal in Khatti reservoir (6.04 ha). Similarly, gross storage capacity (GSC) was also found to be highly variable as par the data obtained from the Department of Fisheries, Government of Chhattisgarh (Table 1).

Table 1: Important physical morphometric characteristics of the reservoirs of Mahasamund district under the present study.

S. No	Name of reservoir	Marked area (ha)	Gross storage capacity (m^3m)	Average water area (ha)
1	Parsada	421	0.15	41.04
2	Kodar	16754	149	2050
3	Piddhi	1073	5.05	100.66
4	Khatti	6.04	0.04	6.04
5	Soramsinghi	566	2.33	54.4
6	Khhallari	292	1.16	38.46
7	Chandidongri	1372	5.75	156
8	Roda	591	1.58	33
9	Bodrabandha	344	1.9	42.235
10	Keshwanala	3846	17.85	216
11	Shirko	1134	3.93	97.63
12	Shurhinala	593	1.21	15
13	Maidnipur	146	0.27	18.409
14	Kapsakhuta	1053	4.77	84.9
15	Arekel	145	0.25	13.975
16	Mahal	139	0.43	10.71
17	Chhirrapali	364	1.56	25.68
18	Thipapani	249	1.14	18
19	Kalidaraha	814	1.83	56.5
20	Lamkeni	637	4.79	85
21	Kishanpur	238	0.53	17
22	Godbahal	405	1.36	23.35
23	Rajadera	79	0.32	16.9
24	Sonasilli	454	1.23	50
25	Jamhar	160	0.51	12

3.2. Water quality

3.2.1. Temperature: Temperature is one of the most important factors for the physiological activities of all aquatic as well terrestrial organisms. Fish metabolic rate and their production are directly related to the temperature [20]. Surface water temperature of reservoirs investigated ranged from 16-25 °C (Fig. 1.). The variation in surface water temperature was because of the variability in the dates of observations as it extended from February, 2017 to April, 2017.

3.2.2. Transparency (cm): Seechi disc transparency is highly valuable and helps to determine the productivity zone of water body [11]. The transparency of water among the reservoirs was highly variable with maximum value (76 cm) encountered in Kapsakhunta and minimum (25 cm) in Maidnipur (Fig. 2.).

3.2.3. pH: The pH of water is highly governed by CO_2, carbonates and bicarbonates equilibrium [6]. The pH of water remained neutral to alkaline with values ranged from 6.9 (Maidnipur) to 9.5 (Shurhinala) during the period of investigation (Fig. 3.).

3.2.4. Total dissolved solids: Total dissolved solid of the reservoirs was highly variable and the values ranged from 42.76 mg L^{-1} (Kalidaraha) to 357.82 mg L^{-1} (Piddhi) (Fig. 4.). This might be due to the diverse soil type of the study area ranging from clay-loam to red laterite. Moreover, such variations have also been reflected in the productivity status of the reservoirs with high TDS encountered in the clay-loam dominated soil areas.

3.2.5. Specific conductivity: Parallel with total dissolved solids, specific conductivity of water varied widely from 132.2 µScm^{-1} (Roda) to 539.8 µScm^{-1} (Chhirrapali) (Fig. 5.).

3.2.6. Total alkalinity: Total alkalinity of water among the reservoir ranged from 56 mg l^{-1} (Roda reservoir) to 132 mg l^{-1} (Shirko) (Fig. 6.).

3.2.7. Total hardness: Water hardness was found congenial for aquaculture practices in most of the reservoirs with values ranged from 154 (Rajadera) to 340 mg l^{-1} (Kaosakhunta) (Fig. 7.).

3.3. Sediment quality

3.3.1. pH: Sediment pH remained acidic in most of the reservoirs with values ranged from 5.4 (Parsada) to 7.59 (Mahal) (Fig. 8.).

3.3.2. Specific conductivity: Specific conductivity of sediment varied more than 6.5 times with values ranged from 0.12 dSm^{-1} (Soramsinghi and Maidnipur) to 0.81 dSm^{-1} (Piddhi) (Fig. 9.). Such wide variability indicated significant difference of nutrient status of the reservoirs.

3.3.3. Organic carbon: Organic carbon content of the sediment varied widely among the reservoirs with values ranged from 0.03% (Khtti) to 0.9% (Chandidongri) (Fig. 10.).

3.3.4. Nutrient contents: High variability was observed in the total nitrogen, phosphorus and potassium content of the sediment of the studied reservoirs. Total nitrogen content of the sediment ranged from 188.16 kg/ha (Thipapani) to 439.04 kg/ha (Kalidaraha) (Fig. 11.). There was high variability in the phosphorus content of the sediment with values ranged from 15.32 kg/ha (Kapsakhunta) to 24.19 kg/ha (Sonasilli) (Fig. 12.). Likewise total nitrogen, potassium content of the sediment varied widely with minimal value in Kapsakhunta (139.32 kg/ha) and maximal in Soramsinghi (490.78 kg/ha)

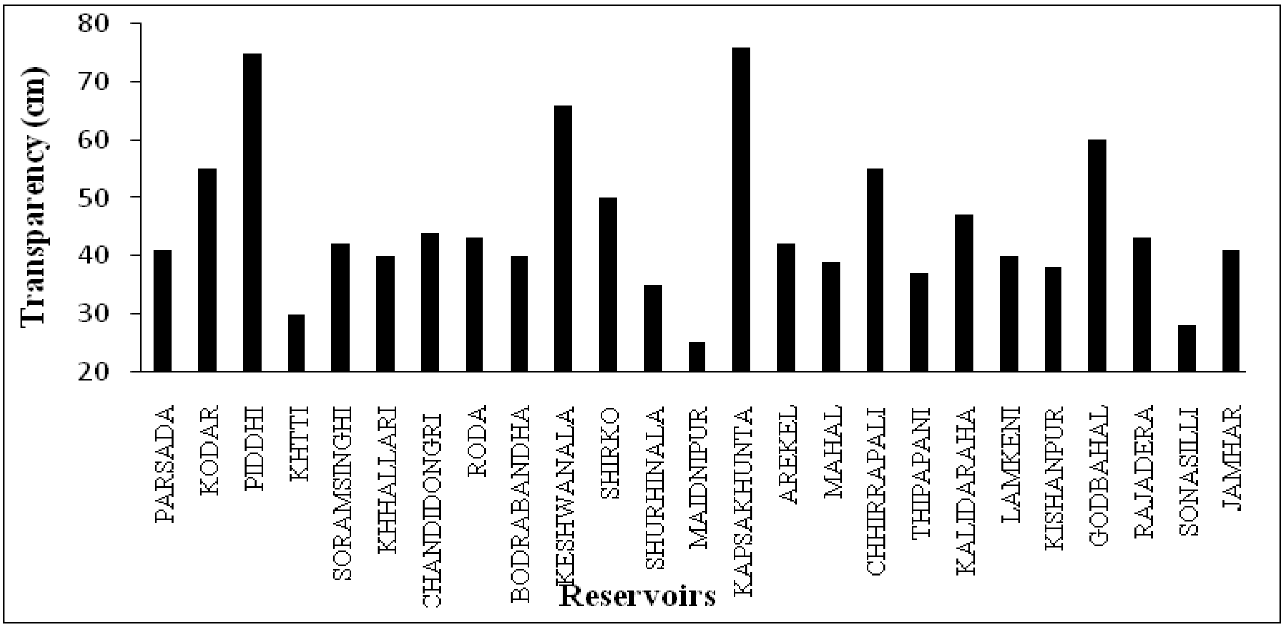

Fig 1: Transparency of water.

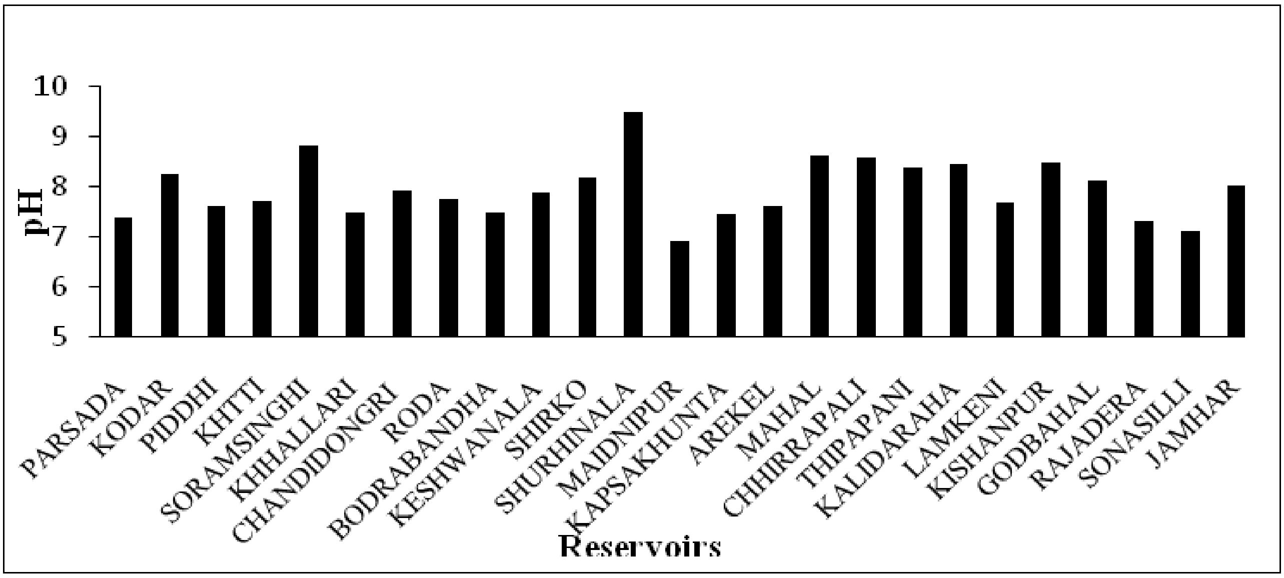

Fig 2: pH of water.

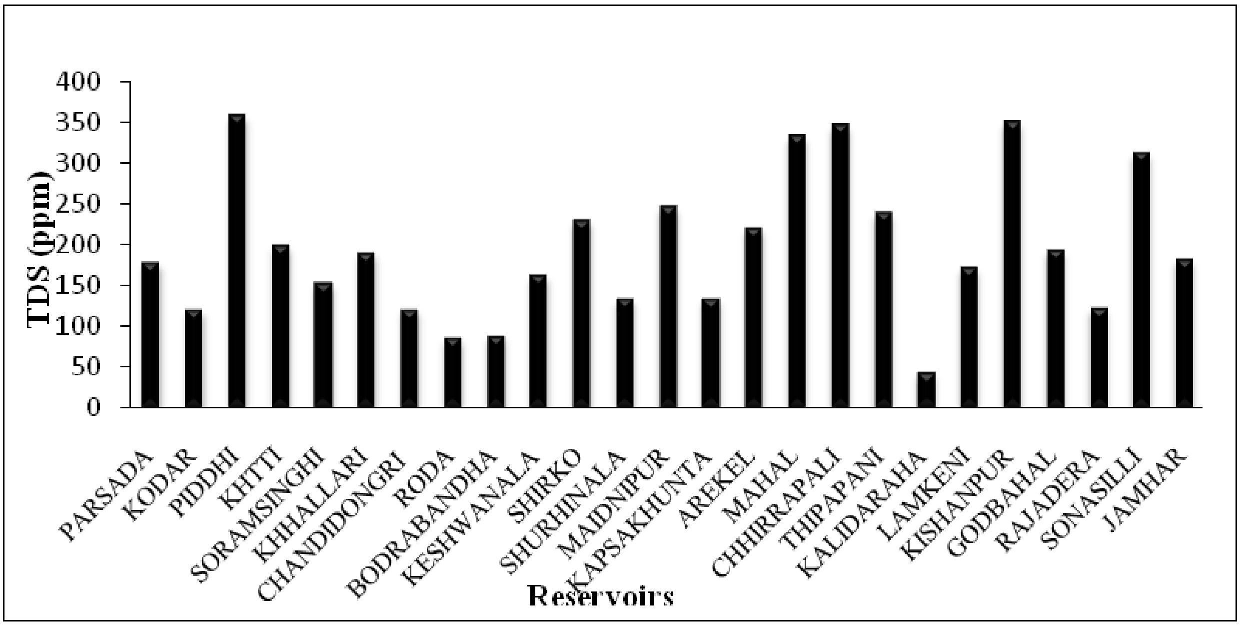

Fig 3: Total dissolved solids of water.

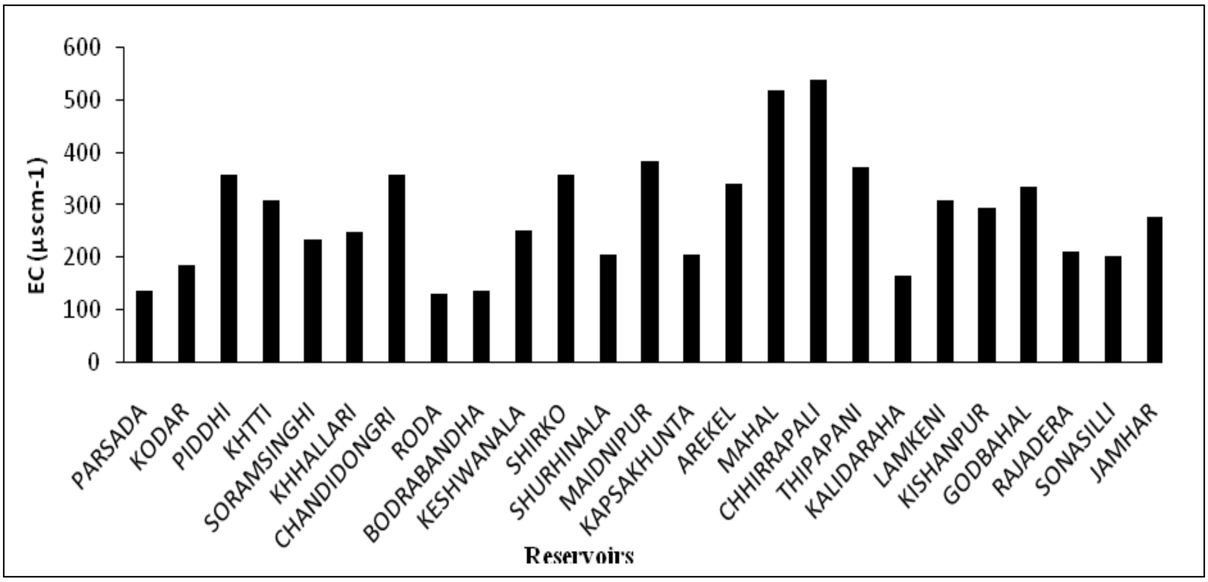

Fig 4: Specific conductivity of water.

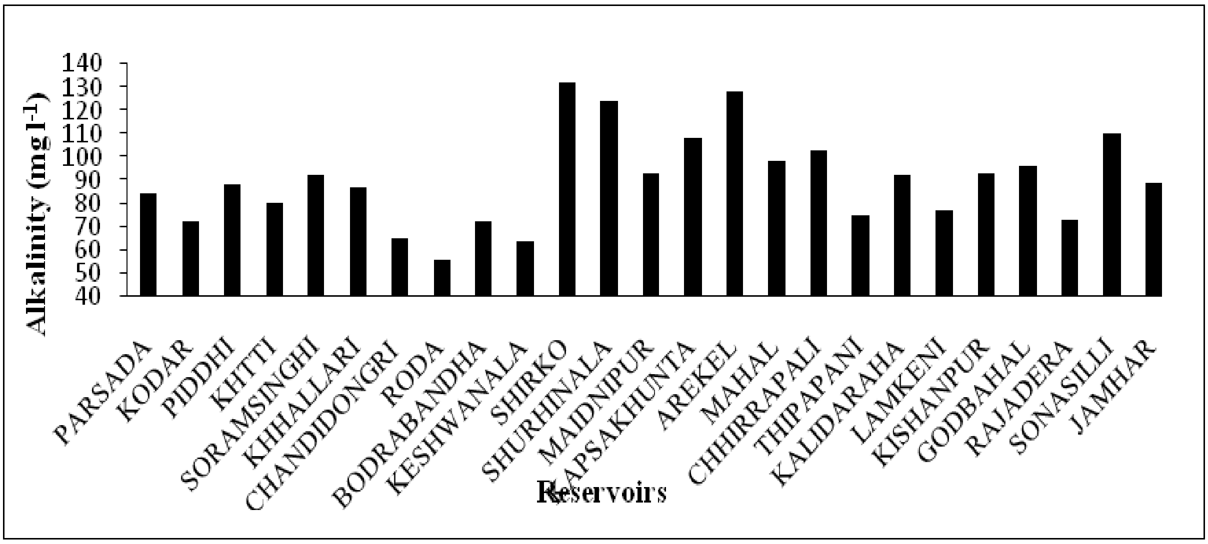

Fig 5: Total alkalinity of water.

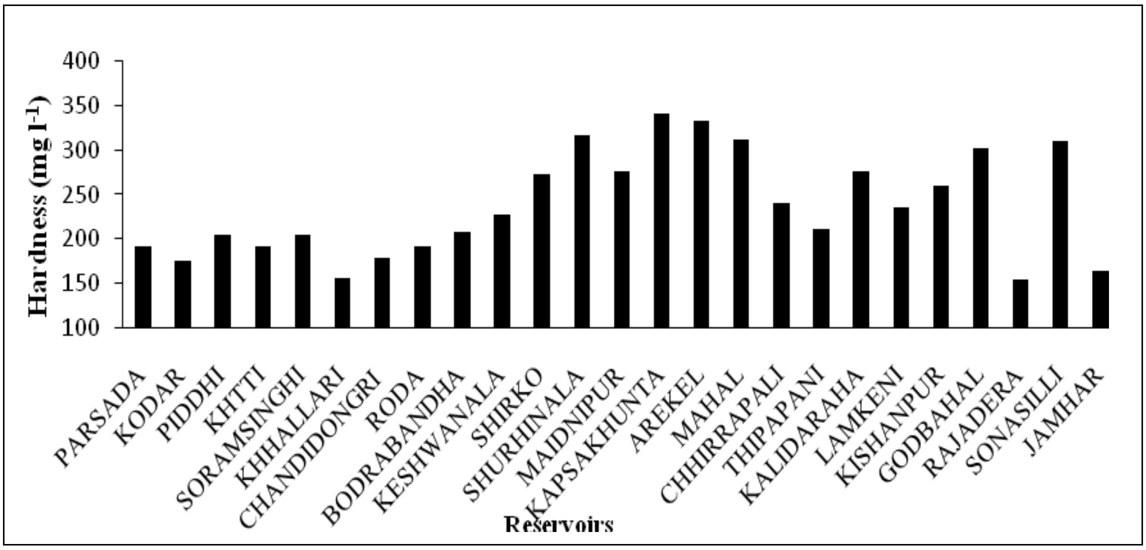

Fig 6: Total hardness of water

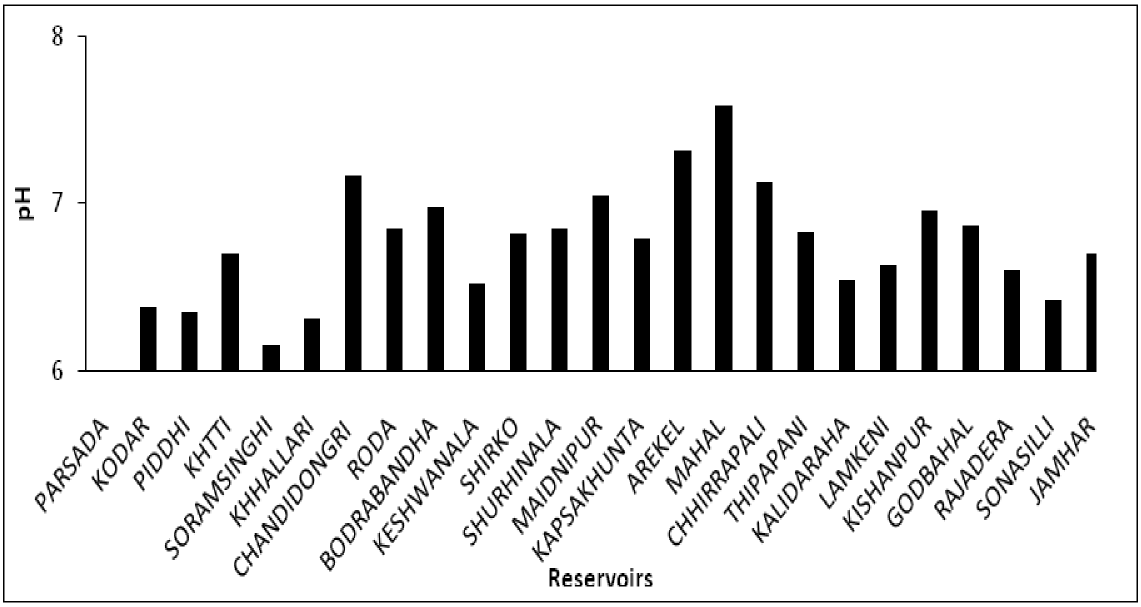

Fig 7: pH of sediment.

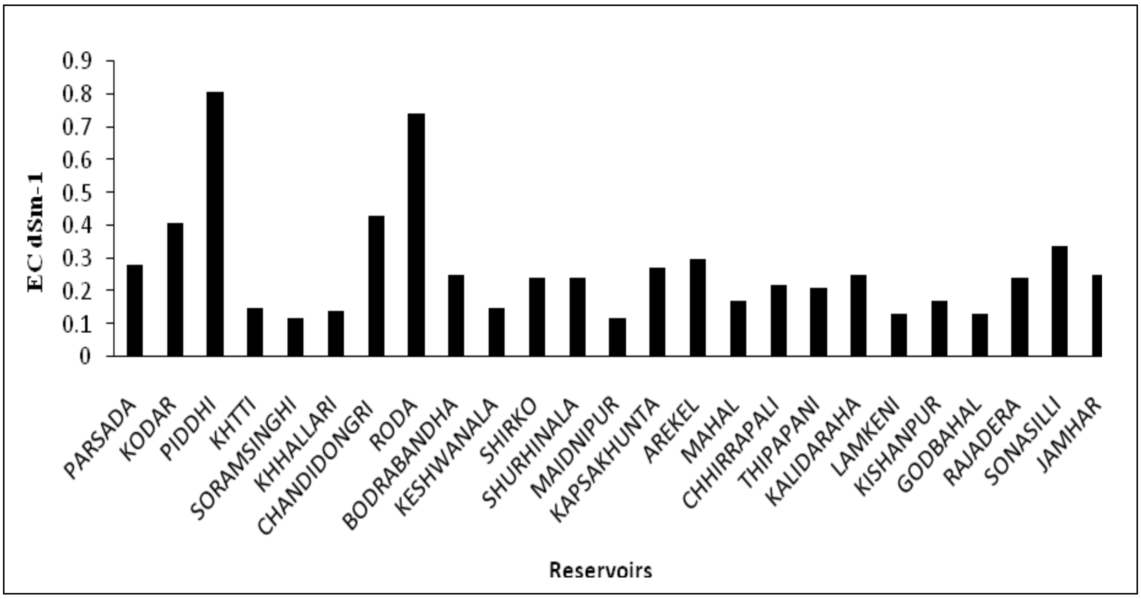

Fig 8: Specific conductivity of sediment.

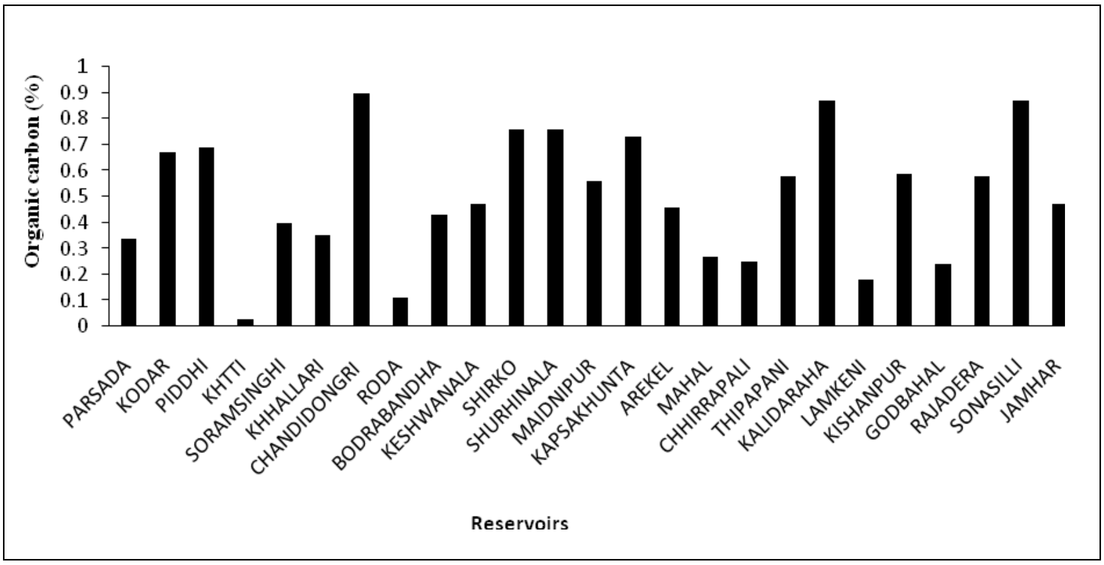

Fig 9: Organic carbon of sediment.

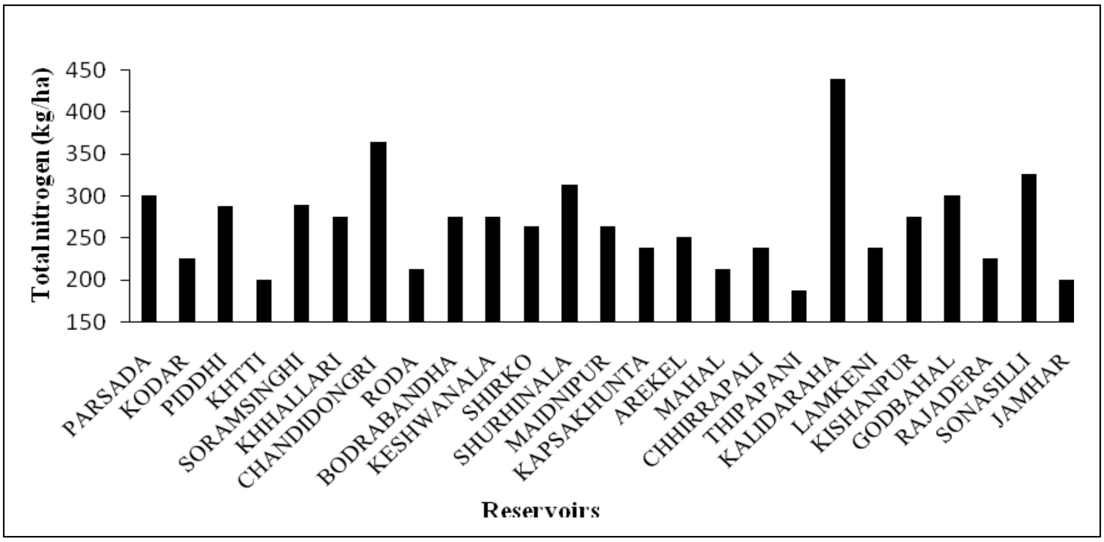

Fig 10: Total nitrogen of sediment.

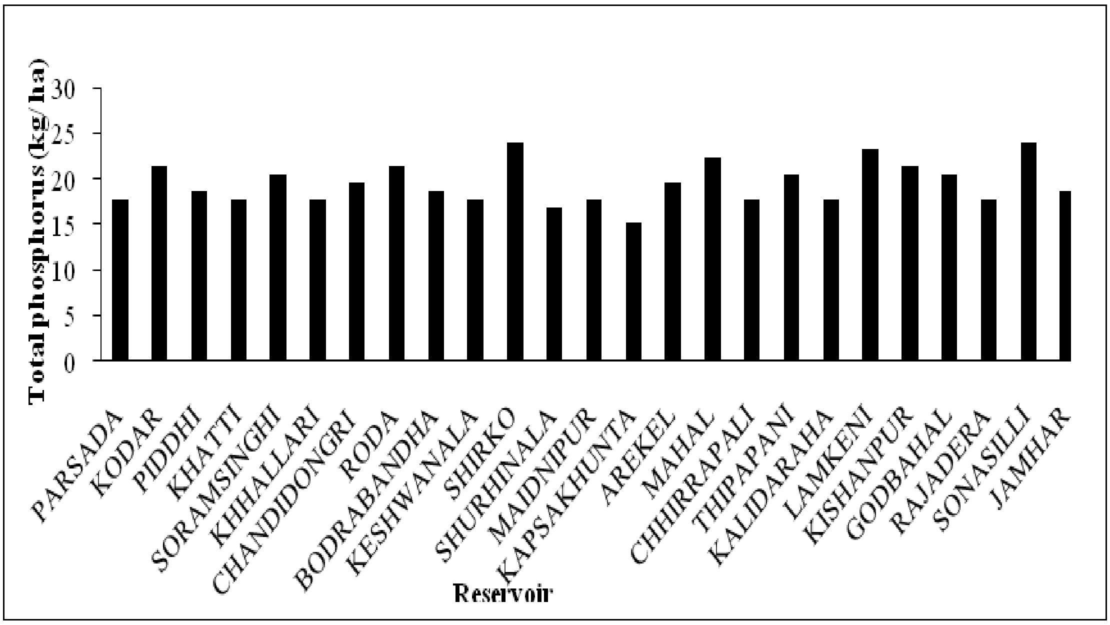

Fig 11: Total phosphorus of sediment.

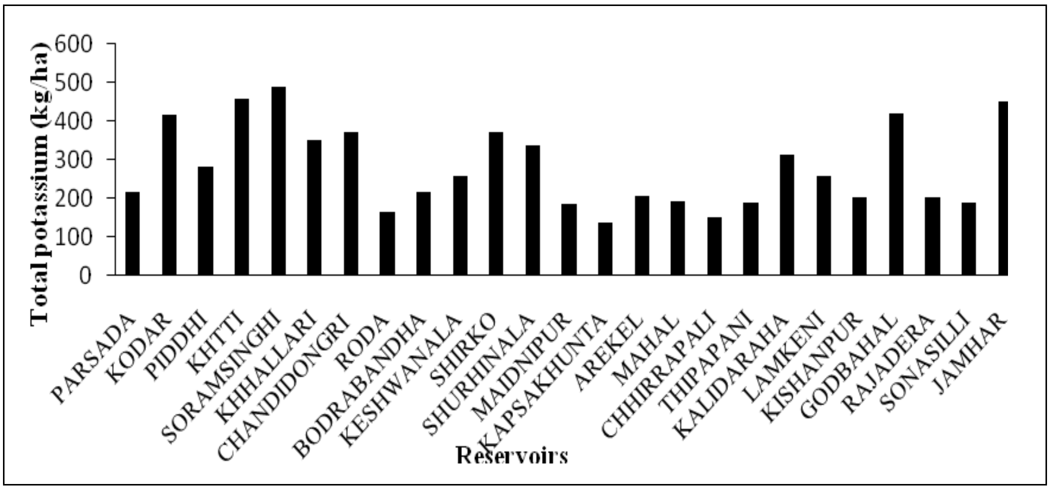

Fig 12: Total potassium of sediment.

3.4. Macrophytic abundance: All the reservoirs were heavily infested with macrophytes. Submerged macrophytes principally dominated by *Hydrilla* sp. and emergent macrophytes dominated by *Nelumbo* sp. were encountered in 64% of the reservoirs investigated. Emergent macrophyte *Vallisnaria* sp. was encountered in 72% of the reservoirs (Table 2) whereas, marginal macrophyte *Ipomoea* sp. was prevalent in all the reservoirs. *Marselia* sp. and *Chara* sp. was encountered respectively in 48% and 76% of the reservoirs. Regarding filamentous algae, 80% of the reservoirs were infested primarily with *Spirogyra* sp.

Table 2: Distribution of macrophytes in all investigated reservoirs.

Reservoir	*Hydrilla*	*Nymphoides*	*Vallisnaria*	*Ipomoea*	*Marselia*	*Chara*	Filamentous
Parsada	√	√	√	√	√	√	√
Kodar	√	√	√	√	√	√	√
Piddhi	√	√	√	√	√	√	√
Khatti	√	√	√	√	√	√	√
Soramsinghi	√	√	√	√	√	√	√
Khhallari	√	√	√	√	√	√	√
Chandidongri	√	√	√	√	√	√	√
Roda	√	√	√	√	√	√	√
Bodrabandha	√	√	√	√	√	√	√
Keshwanala	√	√	√	√	√	√	√
Shirko	√	√	√	√	√	√	√
Shurhinala	√	√	√	√	√	√	√
Maidnipur	√	√	√	√	√	√	√
Kapsakhunta	√	√	√	√	√	√	√
Arekel	√	√	√	√	√	√	√
Mahal	√	√	√	√	√	√	√
Chhirrapali	√	√	√	√	√	√	√
Thipapani	√	√	√	√	√	√	√
Kalidaraha	√	√	√	√	√	√	√
Lamkeni	√	√	√	√	√	√	√
Kishanpur	√	√	√	√	√	√	√
Godbahal	√	√	√	√	√	√	√
Rajadera	√	√	√	√	√	√	√
Sonasilli	√	√	√	√	√	√	√
Jamhar	√	√	√	√	√	√	√

4. Discussion

The results of the indicated that the small reservoirs were better managed with resultant planktonic turbidity which was manifested in low transparency compared to the large reservoirs. In a similar study in Kadgoan reservoir (Maharashtra), [17] observed that the level of transparency ranged from 24±1.63 to 68.66±2.49 cm with an average of 47.45±2.10 cm. As most of the reservoirs have suitable range of specific conductivity and more than half of them recorded the value above 200 µScm^{-1}; it might be concluded that the reservoirs have strong aquaculture potential as specific conductivity and productivity have a direct relationship as reported in earlier studies [4]. Low values of total alkalinity in most of the reservoirs were because of the fact that they were unmanaged with no lime applications. Moreover, many of the reservoirs were situated in the areas with acidic soils. However, as the total alkalinity was recorded low in contrast to the total hardness of water, it indicated that the hardness has been contributed by other than Ca^{++}. Therefore, in spite of high values, there is scope of amelioration in the values of calcium hardness through lime application particularly in the small reservoirs towards enhancing productivity. Seasonal variations of total hardness in the reservoir water of Chhattisgarh were recorded earlier [21]. As 50% of the reservoirs encountered soil pH values well below 7, it indicated that those reservoirs were inherent with low mineralization potentials. Soil with near neutral to slightly alkaline was considered to be ideal for fish production [1]. Earlier observation in soil pH in Yerrakalva reservoir was having pH near neutral during monsoon (6.94 to 7.03) but slightly increased in post monsoon season [7]. The soil pH of Sandynulla reservoir in Nilgris (Tamil Nadu) ranged between 5.7 and 7.0 [15]. As the sediment of the reservoir beds were low in organic matter content; it indicated that they are composed primarily of mineral soils not suitable for aquaculture. So, there is scope of organic enrichment with organic manure particularly in the small reservoirs. This is because sediment with less than 1% organic carbon as mineral soils which are not congenial for aquaculture practice [5]. As in general, potassium requirement in aquaculture is low, productivity status with regards to potassium in the reservoirs studied remained congenial. However, in reservoirs with acidic soil base the availability of potassium might be limited towards productivity [10]. This is in conformity with earlier studies where macrophytic abundance in unmanaged reservoirs was reported [19].

5. Conclusion

The results of the study indicated strong aquaculture potential of the small reservoirs of the Mahasamund District of Chhattisgarh with management intervention particularly with respect to weed management and enhancing total alkalinity and calcium hardness through application of lime. [17] Found TDS values ranged from 68 mg L^{-1} 248 mg L^{-1} in Western Maharastra.

6. Acknowledgement

The first author (SC) acknowledges the fishermen for their generous help and cooperation during collection of sample. The logistic and administrative support from the Department of Aquaculture, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences is gratefully acknowledged by all the authors.

6. References

1. Adhikari S. Soil and water quality management in aquaculture. Handbook of Fisheries and Aquaculture. Indian Council of Agricultural research, New Delhi. 2006, 1-30.
2. Anon. Water Resources Department, Government of Chhattisgarh. http://www.cgwrd.in/r-data.html, 2010.
3. APHA. Standard Methods for the Examination of Water and Wastewater (20th edn.). American Public Health Association, Washington, D.C, 1998.
4. Bhadja P, Vaghela A. Status of river water quality of Saurashtra, Gujarat, India. International Journal of Advanced Biological Research. 2013; 3(2):276-280.
5. Boyd CE, Wood CW, Thunjai T. Aquaculture pond bottom soil quality management. Pond Dynamics/Aquaculture Collaborative Research Support Program. Oregon State University. Oregon, USA, 2002, 1-48.
6. Chapman DV. Water quality assessments, a guide to the use of biota, sediments and water in environmental monitoring". 2nd Ed. Spon Press, Abingdon, 1996.
7. Das AK. Evaluation of production potential in a peninsular reservoir (Yerrakalva). Journal of the Inland Fisheries Society of India. 2002; 34(2):51-58.
8. Department of Animal Husbandry Diary and Fisheries (DAHDF). Ministry of Agriculture. In: Hand Book of Fisheries Statistics. Government of India, 2017, 81.
9. Food and Agriculture Organization (FAO). The State of World Fisheries and Aquaculture. Contributing to food security and nutrition for all. Rome. Annual Report, 2015-16, 200.
10. Fonseca RM, Barriga FJ, Fyfe WS. Dam reservoir sediments as fertilizers and artificial soils: case studies from Portugal and Brazil. 2013, 1-8.
11. Golterman HL, Clymo RS, Onhstad Mam. Methods for physical and chemical analysis of freshwaters. 2nd ed. Oxford: Blackwell Scientific Publications. IBP Handbook. 1978; 8:213.
12. Heck S, Bene C, Reyes-Gaskin R. Investing in African fisheries: building links to the millennium development Goals. Fish and Fisheries. 2007; 8(3):211-226.
13. Jackson ML. Soil Chemical Analysis Advanced Course (2nd edn.) Madison, West Indies. 1974, 895.
14. Jain SM, Sharma M, Thakur R. Seasonal variations in physico-chemical parameters of Halai reservoir of Vidisha district, India. Indian Journal of Ecobiology. 1996; 8(3):181-188.
15. Palaniswamy R, Murugswan, Manoharan S. Limnology and fisheries of an upland reservoir in Nilgiris. J Inland fish. Soc. India. 2006; 38(1):49-53.
16. Sarkar UK, Sharma J, Mahapatra BK. A review on the fish communities in the Indian reservoirs and enhancement of fisheries and aquatic environment. Journal of Aquaculture Research and Development. 2015; 6(1):1.
17. Sawant RS, Chavan NS. Morphometric features and hydrology of Kadgaon freshwater reservoir, (M.S.) India. European Academic Research. 2015; 3(4):3729-3739.
18. Srinivasa GS, Kotaiah B. Seasonal variation of water quality in a tropical Kalyani reservoirs, near Tirupati. Indian Journal of Environmental Protection. 2000; 20(6):452-455.
19. Sugunan VV. Reservoir fisheries of India. Daya Books. 1995, 345.
20. Tiwari AK, Dubey M, Ujjania NC, Manohar S. The study of physico- chemical properties of Kaliasote reservoir, Madhya Pradesh, (India). Proc. Nat. Sem. Emer. Tren. Chal. Aqua. Biotec. 2011, 30-35.
21. Upadhyay M, Gupta VL. Analysis of water quality using physico-chemical parameters of Khudia dam in Mungeli district, Chhattisgarh. Analysis. 2013; 3(1):42-45.