

Original Research Article

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Limno-chemistry of Nellore Reservoir, SPSR Nellore District, Andhra Pradesh

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ABSTRACT

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Present investigation was carried out for a period of eight months analyzing selected parameters at fortnightly intervals. The results obtained were found to be within the prescribed limits set by standard recommended bodies namely WHO and BIS, except for BOD (WHO, 2004) and total hardness (WHO-1984, 2004; BIS-1991, 2012). The observed values were tested from fisheries point of view also with the standards proposed by renowned scientists of the field and found to be well within the limits. Hence, it can be said that, water from this reservoir is fit for irrigation, agriculture, pisciculture, industrial, domestic purposes and with little treatment with respect to BOD and total hardness can even fit for drinking also.

Introduction

Globally, fresh water has become the fastest depleting natural resource nowadays and only a small percentage of water exists as fresh water, and the portion accessible to human is again a negligible part of its global stock. Moreover, due to differences in geographical, geological, climatic and demographic reasons, even this available portion is also not equally accessible to all the people. The uneven distribution of water resources on the Earth makes some regions water scarce while others water rich and this is these spatial and

temporal variations in water quantity necessitated the storage of water to meet the water demands, and reservoirs are the resultant storage structures of surface waters. These man-made ecosystems serve as a basis for large-scale water management systems without parallel in nature. They are rarely and or never created for fishery purposes but are constructed for flood control, hydroelectric power generation, irrigation and navigation, however, especially in India, the secondary use of these impounded waters for fisheries is gaining much importance now-a-days in the wake of steadily declining trends in marine

capture fisheries from one side and the large expanse and vast untapped production potential of reservoirs on the other.

The Ministry of Agriculture, Government of India has classified reservoirs as small (<1000 ha), medium (1,000 to 5,000 ha) and large (>5000 ha) for the purpose of fisheries management (Srivastava *et al.*, 1985). There are varied opinions/criteria in the nomenclature of these anthropogenic lakes (David *et al.*, 1974; Bennet, 1970; Lu, 1986) in to small, medium and large reservoirs. Besides that, in case of small and medium sized reservoirs, still there are certain anomalies/ambiguities in the nomenclature adopted by different states. In Andhra Pradesh, Karnataka and Tamil Nadu, tanks refer to a section of irrigation reservoirs, including small and medium sized water bodies.

In India, reservoirs are recognized as sleeping giants for fisheries development, as is typified by a rapid increase in the gap between 'actual and potential production' from time to time. According to Sugunan (2011), an annual fish yield (Kg/ha) of only 49.94 (against 500.15) from small reservoirs, 12.81 (against 250.35) from medium-sized reservoirs and 11.2 (against 99.95) from large reservoirs, i.e., with a mean annual production of 29.71 Kg/ha against the mean estimated potential of 312.68 Kg/ha, have been realized from Indian reservoirs, thereby epitomized themselves as sleeping giants. This reveals that, Reservoir fisheries have not made significant progress in the country and did not contribute to the inland fish production of the country to the extent they can. One of the main factors responsible for these low yields is the unscientific management practices which stem from the inadequate knowledge on the ecology and production functions of these biotopes.

In Andhra Pradesh, the tanks and small reservoirs are segregated either arbitrarily or based on yardsticks that have no limnological relevance. For instance, all the small reservoirs in the state, created before independence and those without a masonry structure and spillway shutters are called tanks (Sugunan and Sinha, 2000).

In case of Andhra Pradesh, very little information is available on morphometry, hydrology, nutrient status and biological features of reservoirs besides their basic sediment characteristics. Long term monitoring and comprehensive analysis of the physico-chemical parameters is crucial to a holistic approach for proper utilization, management and conservation of reservoir for varied purposes they offer to the mankind.

There is an increasing interest in reservoir water quality, in view of multitude of benefits (water supply, flood control, hydropower generation, navigation, fish and wild life conservation, recreation etc.) they offer to the mankind. Of the various water uses, water supply, fish and wild life conservation, and recreation tend to have the greatest relationship with water quality. It is paramount that water quality in reservoirs should be assessed every so often to determine its suitability and safety for varied purposes.

Study area & sampling details

Nellore Reservoir is the terminal storage reservoir on right side of the river Pennar. It get supplies from sangam anicut, the longest anicut constructed in the pennar basin with a Length of 1242.4 m. in SPSR Nellore district of Andhra Pradesh. In addition to supplies from Sangam anicut, it gets supplies from its free catchment area of 26.75 Sq. Km and intercepted catchment of 23.75 Sq.Km.

Sampling (surface water) was carried out once in fifteen days from the two randomly selected sampling points (here after represented as N1 & N2) in the early hours of the day between 7.00 am and 9.00 am for a period of eight months covering, South-West monsoon (June to September) North-East monsoon (October to December), winter period/post-monsoon (January to February) and hot weather period/pre-monsoon/summer (March to May) on the basis of the local rainfall conditions (Fig. 1)

Materials and Methods

The quantum of rainfall received in the region during the study period was obtained from the Agricultural Research Station, Nellore. Air and water temperatures were recorded using a standard mercury centigrade thermometer to the nearest 0.1° and expressed in degree Celsius. Transparency of water was measured by using standard secchi disc of 20 cm diameter. pH of water samples was measured potentiometrically using digital pH meter (Digital pH Meter-111, EI). The samples fixed for dissolved oxygen were analyzed titrimetrically following modified Winkler-azide method and the results are expressed in mg/L. Free CO₂ content was estimated by the titrimetric method using phenolphthalein indicator and sodium hydroxide. Chloride content was estimated by titrating the water sample with silver nitrate using potassium chromate as indicator and expressed in terms of mg/L. The salinity of water samples was analyzed by following Mohr's method (Strickland and Parsons, 1972) and expressed as ppt. Total suspended solid content of water samples was analyzed by using Millipore filtration assemblage by employing method described in APHA (2005) and expressed as mg/L. Gravimetric estimation of TDS was carried out by following the method described in APHA (2005) and the results were expressed in mg/L. Gravimetric analysis of

total solids was carried out by employing standard method mentioned in APHA (2005) and expressed in the units of mg/L. Total alkalinity was estimated by titrating the water with sulphuric acid using phenolphthalein and methyl orange as indicators and the results are expressed in mg/L. Total hardness of water was estimated by titrating the water samples with standard EDTA, using ammonia buffer and Erichrome Black-T indicator and the results are expressed in mg/L.

Water samples for BOD measurement were incubated at 27°C for 3 days, and then samples were analyzed for the dissolved oxygen content following the Winkler's method. The difference in dissolved oxygen content between initial and after incubation period i.e. the amount of oxygen reduced represents BOD and is expressed as mg/L. Standard spectrophotometric procedure was followed to estimate the concentration of ammonia. (Strickland and Parsons, 1972). UV-Visible Spectrophotometer (T 60 LABINDIA) was used to measure the absorbance and the concentration is expressed in mg/L.

Results obtained were assessed to test the degree of interrelationship that exists between the selected physico-chemical parameters of water under study using SPSS.

Results and Discussion

Rain fall

Highest rainfall was observed during the month of November. No rainfall was observed in four months i.e., from February to May against eight (08) months of the present study. During the present investigation, the area experienced higher rainfall during N-E monsoon compared to S-W monsoon, which is in accordance with the observation made by Perumal (1993).

Air temperature

A significant variation in the value of air temperature has been observed due to the influence of climatological parameters. In general, the lower values of air temperature were observed in monsoon and post-monsoon, in comparison to pre-monsoon season. During the study period air temperature varied from 25.30°C to 31.70°C with a Mean \pm SD of 28.95 \pm 2.01°C (Table-1). Similar trend in air temperature was observed by Lubal *et al.*, (2012) in case of Mhaswad reservoir (24.7 °C to 38.3 °C).

Water temperature

Water temperature is of enormous significance as it regulates the biological activities and governs the solubility of gases in water. Temperature of water depends upon time of collection, water depth besides solar radiation, climate and topography. During the study period, it varied between 24.8°C and 31.0°C (Mean \pm SD of 28.23 \pm 1.65°C) (Table-2). Similar type of observations were made by Mathavan and Nambirajan (2012) while investigating on Grand anicut (25°C to 32.7°C), Thirupathaiah *et al.*, (2012) in case of Lower Manair reservoir (24°C to 30.0°C), Basavaraja *et al.*, (2014) in Anjanapura reservoir (25.25°C to 30.25°C).

Transparency

Transparent waters allow more light penetration which has far reaching effects on all aquatic organisms, including their development, distribution, behavior etc. During the present study, it varied between 38.5cm and 129cm (Mean \pm SD of 72.5 \pm 27.53cm) (Table-3). Higher values of transparency observed during pre-monsoon (summer) season compared to monsoon and post-monsoon seasons could be due to higher light intensity and more or less complete

settlement of allochthonous substances that find their ways in to the reservoir through runoff during monsoon and started settling to the bottom based on their specific gravity during the subsequent post-monsoon season after the cessation of rainfall. Similar type of observations were made by Hussain *et al.*, (2013) in case of a flood plain reservoir on river Ravi (30.48 cm to 150 cm), Idowu *et al.*, (2013) in case of Ado-Ekiti reservoir, Nigeria (51 cm to 154 cm), Muralidharan and Waghode (2014) in case of Tawa and Halali reservoirs as 20 to 153 cm and 20 to 154 cm respectively.

Total Suspended Solids (TSS)

High concentration of total suspended solids increases turbidity, there by restricts light penetration and hinders photosynthetic activity. It heightens the severity of light limitation. During the study period, TSS content varied from 16 mg/L to 34 mg/L (Mean \pm SD of 24.41 \pm 5.97 mg/L) (Table-4). Higher TSS values were observed during December (N-E monsoon), January (post-monsoon) and July (S-W monsoon) months can be attributed to the rainfall and associated turbulent conditions, and to certain extent entry of dislocated fine earth materials from the catchment area through runoff in to the reservoir, whereas lower values noticed in the pre-monsoon might be due to facilitation of the settlement of suspended particles due to stagnant conditions existing in the reservoirs during that period. Similar type of observation was made by Meshram (2013) in case of Tandula dam stating total suspended solids in the range of 25 to 91 mg/L.

Total Dissolved Solids (TDS)

Total dissolved solids fluctuated between 149 mg/L and 241 mg/L (Mean \pm SD of 198.16 \pm 22.26 mg/L) (Table-5). Based on the observed TDS values it can be considered as medium to

high productive reservoir. The observations on TDS clearly indicate that, TDS values were high in summer (pre-monsoon) months followed by winter (post-monsoon) and monsoon months. The highest values observed during summer season can be attributed to the intense solar radiation and associated high rate of evaporation in comparison to cooler periods during monsoon, which might have diluted the water to certain extent. Similar type of observations were made by Simpji *et al.*, (2011) in case of Hosahalli tank waters (120 to 256.4 mg/L), Lubal *et al.*, (2012) in case of Mhaswad reservoir (178 to 290 mg/L).

Total Solids (TS)

Total solids of a water sample represent both dissolved and particulate organic matter dissolved inorganic substances excepting dissolved gases and suspended inorganic substances.

During the present study TS content fluctuated between 181.5 mg/L and 258 mg/L (Mean \pm SD of 222.56 ± 18.93 mg/L) (Table-6). Total solids exhibited higher concentrations in pre-monsoon, compared to monsoon and post-monsoon seasons. This is due to the higher concentrations of TDS during this season, as they were the major contributors to the total hardness of the reservoir.

pH

pH of water is a master variable because many reactions that control water quality are pH dependent. pH of any aqueous system is suggestive of its acid-base equilibrium achieved by various dissolved compounds in it. During the present study it fluctuated between 7.75 and 8.55 (Mean \pm SD of 8.13 ± 0.2 mg/L) (Table-7). Though water was alkaline throughout the study period, slightly

higher values were noticed during pre-monsoon season compared to monsoon and post-monsoon seasons. Maximum values observed during pre-monsoon (summer) might be due to increased photosynthetic activity. The decrease in pH during monsoon may be due to greater inflow of water, while during post-monsoon (winter) could be due to decreased photosynthetic activity. Moreover, this low value of pH observed during monsoon and post-monsoon seasons might be due to decomposition of organic matter, which on biological oxidation gives up 'carbon dioxide'. Similar types of observations were made by Meshram (2013) in case of Tandula dam (7.95 to 8.51), Muralidharan and Waghode (2014) in case of Tawa and Halali reservoirs (7.4 to 9.1 and 6.9 to 9.0 respectively).

Dissolved Oxygen (D.O)

Dissolved oxygen (D.O) is the prime important critical factor in natural waters both as regulator of metabolic processes of plant and animal community and as a vital indicator of water quality, ecological & trophic status and productivity of a reservoir. During the present study, it varied between 5.2 and 8.35 mg/L (Mean \pm SD of 6.63 ± 0.93 mg/L) (Table-8). Highest dissolved oxygen concentrations were observed during pre-monsoon, whereas the lowest concentrations were noticed during post-monsoon season. These highest values can be attributed to high rate of photosynthetic activity that might have resulted in the liberation of oxygen as a by-product. Comparatively more or less higher values observed during monsoon season might be due to cumulative effect of wind generated turbulence, resultant mixing coupled with rainfall during this period. Post-monsoon lower values can be attributed to the aerobic decomposition of organic matter that might have entered in to the reservoir through runoff during precipitation. Similar type of

observations were made by Mathavan and Nambirajan (2012) in case of Grand anicut (4.7 to 5.8 mg/L), Bhadja and Vaghela (2013)

in case of Aji, Nyari and Lalpari reservoirs of Sourashtra (6.12 to 7.05 mg/L, 5.99 to 6.26 mg/L and 6.62 to 7.09 mg/L respectively).

Table.1

Air temperature (°C)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	28.3	28.3	27.3	31.7	31.2	31.6	25.2	27.2
	2 nd F	28.1	27.9	28.0	31.2	31.1	31.5	26.5	28.1
N2	1 st F	28.5	28.1	27.4	31.0	31.2	31.8	25.4	27.4
	2 nd F	28.2	27.6	28.0	31.2	31.3	31.6	26.4	28.2

Table.2

Water temperature (°C)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	28.4	27.8	27.2	31.2	28.6	30.9	24.8	27.0
	2 nd F	28.3	27.8	27.9	29.1	29.8	30.6	26.4	26.4
N2	1 st F	28.4	27.6	27.3	30.8	28.4	30.8	24.8	27.0
	2 nd F	28.2	27.6	28.0	31.2	31.3	31.6	26.4	28.2

Table.3

Transparency (cm)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	41	54	61	76	91	126	37	49
	2 nd F	49	61	72	82	112	112	54	54
N2	1 st F	40	62	64	82	98	132	40	51
	2 nd F	46	59	78	86	115	126	54	56

Table.4

Total Suspended Solids(TSS) (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	34	32	28	21	20	16	36	26
	2 nd F	36	28	26	20	16	19	30	26
N2	1 st F	31	28	28	18	12	16	28	24
	2 nd F	32	26	24	18	18	17	26	21

Table.5

Total Dissolved Solids (TDS) (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	190	202	220	210	234	244	176	164
	2 nd F	200	208	196	226	202	240	202	210
N2	1 st F	108	172	184	148	182	198	220	208
	2 nd F	180	186	152	185	280	232	172	210

Table.6

Total Solids (TS) (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	224	234	248	231	254	260	212	190
	2 nd F	236	236	222	246	218	259	232	236
N2	1 st F	139	200	212	166	194	214	248	232
	2 nd F	212	212	176	203	298	249	198	231

Table.7

pH									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	8.1	7.7	8.1	8.1	8.6	8.6	8.1	8.3
	2 nd F	8	8	8.6	8.2	8.3	8.5	7.8	8.1
N2	1 st F	7.9	7.8	7.9	8.1	8.3	8.5	8.2	8.2
	2 nd F	8	7.8	8	8.2	8.1	8.1	8	8.1

Table.8

Dissolved Oxygen (D.O) (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	6.8	5.3	6.6	5.6	7.6	7.8	7.4	5.1
	2 nd F	5.1	4.9	5	7	7.2	7.4	5.8	6.8
N2	1 st F	7.2	5.6	6.8	6.4	7.9	8.2	7.2	6.3
	2 nd F	6.1	5.4	6.9	5.8	7.9	7.7	7	5.6

Table.9

Carbon dioxide(CO ₂) (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	4	6	2	2	0	2	0	0
	2 nd F	8	4	0	0	0	1	3	0
N2	1 st F	4	6	2	2	0	0	0	0
	2 nd F	6	4	0	0	0	0	1	0

Table.10

Chlorides (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	134	92	78	100	132	128	128	86
	2 nd F	98	88	96	118	136	122	98	72
N2	1 st F	118	90	72	92	130	132	106	68
	2 nd F	86	82	80	116	122	108	88	58

Table.11

Salinity (ppt)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	0.27	0.2	0.17	0.21	0.27	0.26	0.26	0.19
	2 nd F	0.21	0.19	0.2	0.24	0.28	0.25	0.21	0.16
N2	1 st F	0.24	0.19	0.16	0.2	0.26	0.27	0.22	0.15
	2 nd F	0.19	0.18	0.17	0.24	0.25	0.22	0.19	0.13

Table.12

Biochemical Oxygen Demand (BOD) (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	7.2	6.8	6.4	5.2	4.8	4.2	6.6	6.4
	2 nd F	7.1	7.2	7.2	5.6	4.4	5.1	5.2	5.8
N2	1 st F	6.6	5.6	5.9	5	4.4	4.1	6.1	5.9
	2 nd F	6.9	5.1	6.8	5.6	3.8	5	4.7	5.6

Table.13

Total ammonia (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	0.26	0.16	0.08	0.03	0.02	0.05	0.26	0.03
	2 nd F	0.24	0.12	0.06	0.05	0.04	0.08	0.16	0.3
N2	1 st F	0.24	0.16	0.12	0.02	0.03	0.06	0.24	0.02
	2 nd F	0.18	0.1	0.05	0.04	0.04	0.08	0.18	0.01

Table.14

Total alkalinity (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	160	166	188	180	194	192	148	154
	2 nd F	140	176	192	198	248	194	136	148
N2	1 st F	152	144	164	174	168	182	140	148
	2 nd F	155	162	178	180	224	178	142	164

Table.15

Total hardness (mg/L)									
Month Station		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
N1	1 st F	244	260	210	210	198	180	288	268
	2 nd F	258	240	268	186	184	198	244	272
N2	1 st F	216	244	192	186	210	160	264	232
	2 nd F	232	220	210	196	184	176	210	240

Table.16

Sl. No.	Parameter	Observed value (Mean ± SD)	Supporting remarks
1	pH	8.13 ± 0.2 mg/L	Boyd and Lichtkoppler (1979) reported pH range of 6.09 to 8.45 as being ideal for supporting aquatic life including fish.
2	TDS	198.16 ± 22.26 mg/L	Jhingran and Sugunan (1990) noticed a total TDS content of up to 200 mg/L in case of medium productive reservoirs and more than 200 mg/L in case of high productive reservoirs.
3	D.O	6.63 ± 0.93 mg/L	Boyd (1979) reported that D.O concentration of 3 mg/L to 12 mg/L will promote the growth and survival of fish in reservoirs. D.O concentration more than 5 mg/L favours good growth of flora and fauna (Das, 2000).
4	CO ₂	1.78 ± 2.23 mg/L	Free CO ₂ concentration of more than 15 mg/L is detrimental to fish (Swingle, 1967).
5	Chlorides	101.69 ± 21.06 mg/L	Unni (1983) have designated moderate domestic pollution with chlorides from 50.9 to 129.9 mg/L.
6	BOD	5.7 ± 0.92 mg/L	Water bodies with BOD of 225 to 323 mg/L are called septic and anaerobic systems (Chandrasekhar <i>et al.</i> , 2003).
7	Total ammonia	0.11 ± 0.08 mg/L	The Water Encyclopedia, page 472 “Guidelines for Evaluating Quality for aquatic life” recommends that free NH ₃ should not exceed 0.5 mg/L (Van der Leeden <i>et al.</i> , 1990).
8	Total alkalinity	170.91 ± 23.45 mg/L	Phillipose (1960) suggested that a water body with total alkalinity greater than 100 mg/L is nutritionally rich. Alkalinity values above 300 mg/L have been reported to adversely affect the spawning and hatching of fresh water fish (Gupta and Gupta, 2006).
9	Total hardness	221.25 ± 29.99 mg/L	Sawyer (1960) categorized waters as hard waters with hardness of 151 to 300 mg/L. High hardness of aquatic ecosystem points out towards eutrophication (Rai, 1971).

Table.17 Correlation Co-efficient values observed between different physico-chemical parameters of water at Station N1

Parameters	Air temp.	Water temp.	Transparency	Turbidity	TSS	TDS	TS	pH	DO	CO ₂	Chlorides	Salinity	BOD	NH ₃	Total Alkalinity	Total Hardness
Air Temp.	1	.923*	.843**	-.773**	-.842**	.721**	.551*	.520*	.413	-.192	.455	.450	-.683**	-.597*	.691**	-.845**
Water Temp.		1	.784**	-.685**	-.716**	.621*	.477	.437	.212	.031	.393	.388	-.534*	-.579*	.616*	-.782**
Transparency			1	-.949**	-.909**	.746**	.555*	.671**	.521*	-.339	.478	.476	-.789**	-.658**	.784**	-.840**
Turbidity				1	.935**	-.655**	-.437	-.718**	-.465	.525*	-.350	-.343	.781**	.702**	-.808**	.755**
TSS					1	-.633**	-.388	-.655**	-.450	.566*	-.314	-.311	.814**	.758**	-.777**	.810**
TDS						1	.959**	.391	.516*	-.063	.229	.210	-.593*	-.359	.453	-.773**
TS							1	.226	.450	.133	.157	.136	-.407	-.150	.255	-.624**
pH								1	.453	-.605*	.435	.415	-.413	-.541*	.545*	-.427
DO									1	-.483	.673**	.658**	-.642**	-.036	.387	-.537*
CO ₂										1	-.204	-.185	.446	.397	-.424	.207
Chlorides											1	.998**	-.435	-.160	.446	-.478
Salinity												1	-.447	-.165	.442	-.474
BOD													1	.489	-.501*	.739**
NH ₃														1	-.686**	.661**
Total Alkalinity															1	-.753**
Total Hardness																1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

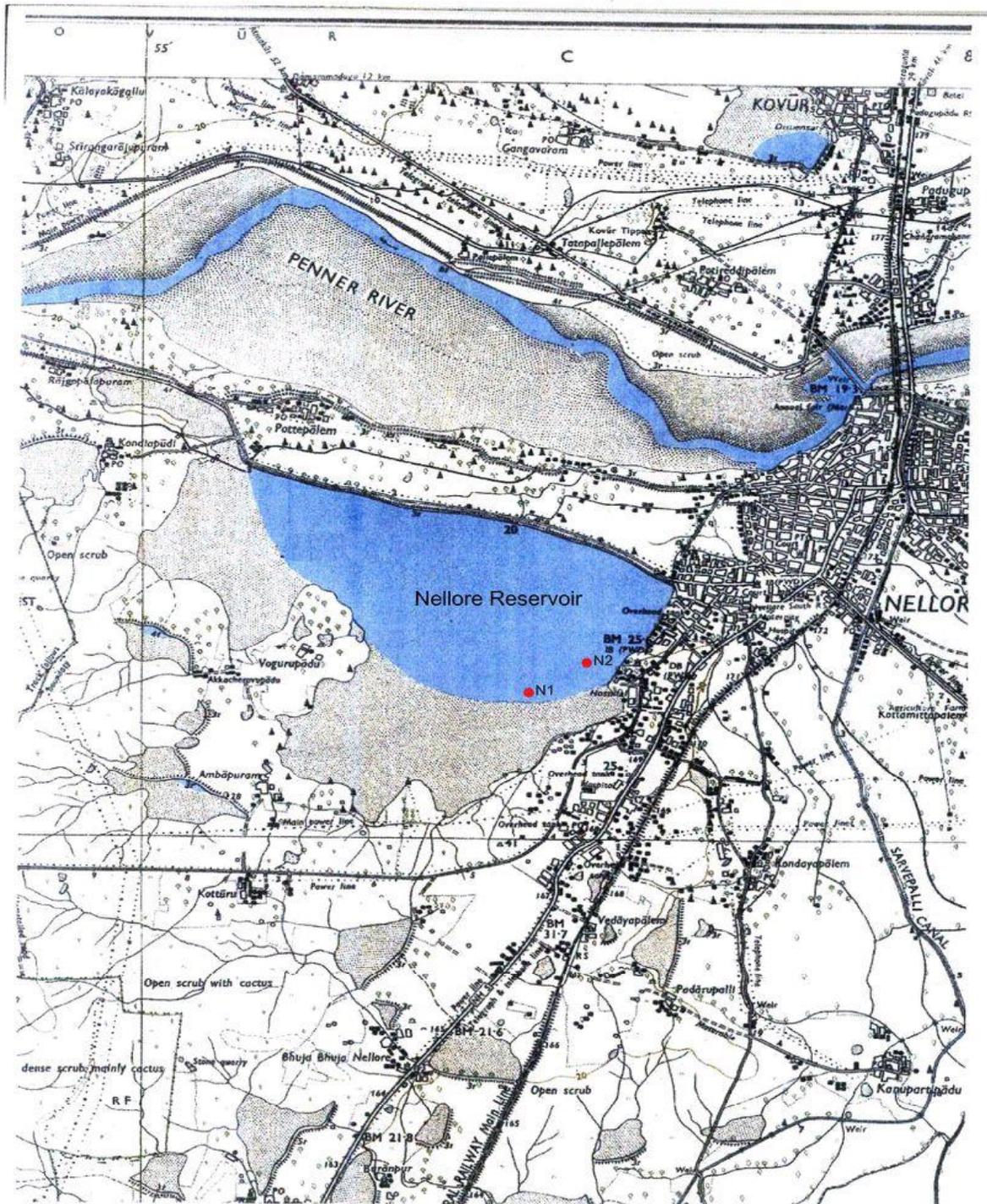
Table.18 Correlation Co-efficient values observed between different physico-chemical parameters of water at Station N2

Parameters	Air temp.	Water temp.	Transparency	Turbidity	TSS	TDS	TS	pH	DO	CO ₂	Chlorides	Salinity	BOD	NH ₃	Total Alkalinity	Total Hardness
Air Temp.	1	.927**	.863**	-.788**	-.802**	.199	.080	.490	.629**	-.270	.627**	.625**	-.569*	-.587*	.741**	-.767**
Water Temp.		1	.770**	-.650**	-.599*	.027	-.068	.320	.433	-.064	.510*	.526*	-.441	-.492	.701**	-.827**
Transparency			1	-.871**	-.823**	.438	.328	.544*	.589*	-.471	.584*	.576*	-.703**	-.562*	.768**	-.821**
Turbidity				1	.874**	-.371	-.249	-.481	-.442	.569*	-.381	-.367	.564*	.763**	-.779**	.704**
TSS					1	-.373	-.231	-.686**	-.560*	.673**	-.475	-.457	.731**	.771**	-.621*	.595*
TDS						1	.989**	.338	.434	-.459	.102	.094	-.507*	-.316	.490	-.107
TS							1	.245	.365	-.373	.031	.026	-.414	-.208	.415	-.016
pH								1	.697**	-.696**	.502*	.497	-.426	-.420	.295	-.346
DO									1	-.488	.695**	.684**	-.435	-.151	.479	-.468
CO ₂										1	-.194	-.163	.396	.535*	-.402	.322
Chlorides											1	.997**	-.479	.081	.408	-.456
Salinity												1	-.484	.093	.408	-.469
BOD													1	.430	-.523*	.562*
NH ₃														1	-.594*	.439
Total Alkalinity															1	-.695**
Total Hardness																1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Fig.1



N1 Nellore Reservoir Station-1
N2- Nellore Reservoir Station-2

Carbon dioxide (CO₂)

Organic decomposition, respiration, photosynthesis, diffusion and run-off etc. brings about changes in the carbon dioxide concentrations of water. During the present study, it ranged between 0 mg/L to 7 mg/L (Mean \pm SD of 1.78 ± 2.23 mg/L) (Table-9). Its absence or low concentrations recorded in most of the times may be due to the alkaline nature of the water. More or less higher values observed during monsoon and post-monsoon seasons can be attributed to decomposition of allochthonous organic matter that has entered in to the reservoir through runoff. Similar type of observations were made by Saxena and Saksena (2012) in case of Raipur reservoir (0 to 9.3 mg/L), Lianthuamluaia *et al.*, (2013) in case of Savitri reservoir (0 to 8.93 mg/L).

Chlorides

Chlorides occur naturally in waters. Discharge of sewage contributes to chlorides there by their concentration serves as an indicator of pollution by sewage. During the present study, chlorides varied between 65 mg/L and 131 mg/L (Mean \pm SD of 101.69 ± 21.06 mg/L) (Table-10). Higher values of chlorides were observed during pre-monsoon and monsoon samplings compared to post-monsoon. Higher values of pre-monsoon could be attributed to high rate of evaporation, which might have resulted an increase in their concentration, monsoonal high values might be due to the entry of runoff from the catchment area. Mohammad *et al.*, (2015) also recorded chlorides in the range of 80 to 240 mg/L in case of Wyrá reservoir.

Salinity

Salinity refers to the total concentration of all ions in water, and it usually is approximately

equal to the total concentration of major inorganic constituents. During the present study, it fluctuated between 0.14 and 0.27 ppt (Mean \pm SD of 0.21 ± 0.04 ppt) (Table-11). Comparatively high values of salinity were noticed during pre-monsoon followed by N-E monsoon seasons. Summer high values could be attributed to evaporative water loss, which might have increased the concentration of ions, while the entry of inorganic constituents in to the reservoir through runoff from the catchment area might be the reason for high values observed during N-E monsoon, which constituted major fraction of the total precipitation received in the study area. Bhadja and Vaghela (2013) also documented salinity values in the range of 0.357 to 0.399 ppt in case of Lalpari reservoir

Biochemical Oxygen Demand (BOD)

It gives a quantitative measure of biodegradable carbonaceous organic matter present in the water. During the present study, it ranged between 4.10 mg/L and 7.00 mg/L (Mean \pm SD of 5.7 ± 0.92 mg/L) (Table-12). More or less higher BOD values were observed in monsoon and post-monsoon seasons compared to summer season. This might be due to entry of allochthonous organic matter through runoff during rainy season, which up on being subjected to aerobic degradation might have resulted in high BOD values. Muralidharan and Waghode (2014) also documented BOD values in the range of 2.65 to 6.94 mg/L and 3.2 to 6.8 mg/L in case of Tawa and Halali reservoirs respectively.

Total ammonia

The toxicity of ammonia increases with increase in pH, as at higher pH, most of the ammonia remains in its gaseous (unionized) form. During the present study, it ranged between 0.03 mg/L and 0.25 mg/L (Mean \pm

SD of 0.11 ± 0.08 mg/L) (Table 13). In most of the instances, higher ammonia content observed during monsoon and subsequent post-monsoon seasons could be due to the decomposition of organic matter that has entered into the reservoir during monsoon season from the catchment area. Lianthuamluaia *et al.*, (2013) also reported ammonia ranging from 0.026 to 0.18 mg/L in case of Savitri reservoir.

Total alkalinity

Alkalinity imparts buffering capacity to water, there by helps in stabilizing the pH of water. During the present study, it varied between 139 mg/L and 236 mg/L (Mean \pm SD of 170.91 ± 23.45 mg/L) (Table-14). From the observed alkalinity values, these waters can be considered as moderate alkalinity waters. The observed pre-monsoon (summer) higher values compared to monsoon and post-monsoon seasons might have resulted from the effect of pH on the relative proportions of different forms (CO_2 , HCO_3^- and CO_3^{2-}) of inorganic carbon. Slightly higher values of alkalinity were observed during summer as was observed in case of pH. Similar type of observations were made by Manjare *et al.*, (2010) in case of Tamdalg tank waters (121.25 to 200 mg/L), Simpi *et al.*, (2011) from Hosahalli tank waters (110 to 165 mg/L), Lubal *et al.*, (2012) in case of Mhaswad reservoir (182 to 270 mg/L).

Total hardness

The principle ions causing hardness in water are the divalent cations, especially calcium and magnesium in case of surface waters. During the present investigation, hardness values fluctuated between 170 mg/L & 276 mg/L (Mean \pm SD of 221.25 ± 29.99 mg/L) (Table-15). Higher values of hardness observed during monsoon and post-monsoon seasons are probably due to the addition of

dissolved minerals from sedimentary rocks, large quantities of sewage and detergents in to the reservoir through surface runoff from surrounding watershed area that might have received them from nearby residential areas. Mohammad *et al.*, (2015) also observed hardness values in the range of 180 to 240 mg/L in case of Wyra reservoir (Table 16–18).

From the present study it can be concluded from fisheries point of view that, the reservoir can support good fish production with respect to many observed parameters as mentioned in table 16.

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