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# STUDIES ON THE PHYSICOCHEMICAL PARAMETERS OF STANLEY RESERVOIR (METTUR DAM) AT SALEM DISTRICT, TAMIL NADU, INDIA

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**ABSTRACT**

Water is important component of all living beings. It also performs unique and indispensible activities in earth ecosystem, biosphere and biogeochemical cycles. Physiochemical parameters were conducted to gain knowledge on the stanley reservoir and it was analyzed every month for a period of one year, from July-2010 to June-2011.Average rainfall at the reservoir were (75.6 mm). Atmospheric humidity fluctuated between 68.9 and 99 per cent. Water was least turbid in October – December (3.0 – 3.8 NTU).pH of the water varied between 6.5 and 7.9.Total alkalinity ranged from 108.2 mg/l in March 2011 at Stanley reservoir to 183.6 mg/l in December 2010.Carbonates varied from 7.00 to 9.96 mg/l. Nitrates were in the range: 0.42 – 0.95 mg/l. Calcium hardness of the reservoir varied between 45.6 and 58.77 mg/l for the entire study period. The dissolved oxygen concentrations in the water of the reservoir were in the range of 4.2 – 6.2 mg/l. Carbon dioxide levels were the reservoir and the levels varied between 0.00026 and 0.00059 ppm during the study period.

**Keywords**: Stanley Reservoir, Physio-chemical parameters.

## INTRODUCTION

Water resources play an essential role in both natural ecosystem and human development. It is vital sources for agriculture, industry and human existence. The healthy aquatic ecosystem is depended on the physico-chemical and biological characteristics [1]. The quality of water in any ecosystem provides significant information about the available resources for supporting life in that ecosystem. Good quality of water resources depends on a large number of physico-chemical parameters and biological characteristics.

To asses that monitoring of these parameters is essential to identify magnitude and source of any pollution load. Hydrological features of reservoirs are vital in the population growth and reproductive expansion of their living communities. However, these environmental factors tend towards large, rapid and erratic fluctuations and these result in biota fewer in variety and with broad physiological tolerances. Fish growth and production is highly variable in these constantly changing reservoirs [2]. Dams radically alter the hydrology of the river as well, both up and downstream [3]. Earliest reports on River Cauvery and its reservoirs concentrated mainly on the fishery and fish taxonomy [4].

Research on the hydrographical characteristics of several Indian rivers have been done under the auspices of All India Co-ordinated Research Project on Ecology and Fisheries of Freshwater Reservoirs [5] reviewed the ecological status of Indian river basins, including Cauvery basin, in the context of environmental water requirements. About two decades back, [6] analyzed the hydrological features of the Lower Anicut and tried to relate the factors with the fishery potential of the reservoir.

The aim of the study is to reveled out the pollution status of Reservoir in terms of physico-chemical characteristics of water. However, very little information is available in relation to physico-chemical characteristics of water in the stanley reservoir, (Mettur Dam) at Salem District, Tamil Nadu, India.. Hence, the preset study was conducted to study the physico-chemical properties of water in the stanley reservoir (Mettur Dam) at Salem District, for a period of one year from July-2010 to June-2011.

## MATERIAL AND METHODS

### Study Area

Stanley reservoir (Mettur dam) situated at 11°54 N, 77°50'E, is often described as an engineer's delight. A straight gravity structure, 1615 m long, rising 54 m above the Cauvery river bed, the dam was constructed across two hills of the Eastern Ghats. Stanley reservoir has a water spread of 15346 ha and capacity of 2646 million $m^2$ at FRL, the average area being 9324 ha. It receives water from the Cauvery river basin of 42217 $km^2$. Stanley reservoir is one of the largest fishing reservoirs in South India and fishing rights of this reservoir are under the preview of the Tamil Nadu State Fisheries Department.

### Sample collection

The water samples were collected from the surface layer (0.2 m depth) of reservoir once in a month as recommended [7] for the estimation of environmental variables. A precleaned and rinsed polythene water cans of 5 litre capacity and a 500 ml BOD bottles (which were used for the dissolved $O_2$ fixation) were used for collection of water samples for the analysis of physicochemical characteristics. Samples were protected from direct sun light and immediately transported to the laboratory for further analysis.

### Physico-chemical characters

### Rainfall, humidity and wind velocity

Rainfall, humidity and wind velocity data were collected from Meterological Department of Tamil Nadu Water Board, Thanjavur. Temperature, Turbidity, pH, Alkalinity (Total, Carbonate and Bicarbonate), Nitrite, Nitrate, Total phosphate, Hardness (Total, Calcium and Magnesium), Sulphate, Fluoride, Sodium and Potassium, Dissolved oxygen (DO), Dissolved $CO_2$, Salinity, was estimated in laboratory by adopting the standard procedures [8].

## RESULTS

### Rainfall and Humidity

Average rainfall at the reservoir were (75.6 mm). Maximum rainfall (273.5mm) was recorded in the month of December, 2010, while in the months February – May, there was no rainfall at all. Sporadic rains could be observed in June – August months (Table 1). Atmospheric humidity fluctuated between 68.9 and 99 per cent during the study period. Maximum humidity could be observed during September 2010 – January 2011 period, however, humidity was less during March – June 2011 (Table 1).

### Wind velocity and Water Temperature

Wind velocity at the reservoir was (Table 1). June, July and August were the windy months (Speed: 10.4 – 14.6 km/h), while rest of the year was relatively calm. Monthly variations in water temperature in the reservoir .However on the average water in Stanley reservoir was cooler (annual average: 29.38°C). In general, water was cooler in October 2010 – January 2011, however, the coolest water temperature (21.0°C) was observed in August 2010, at Stanley reservoir.

### Turbidity and pH

Turbidity represented as NTU showed identical pattern of variations in the reservoir .Water was least turbid in October – December (3.0 – 3.8 NTU), and high turbidity could be observed during summer months (March – June 2011). pH of the water varied between 6.5 and 8.8. Higher values of pH could be observed from December 2010 to June 2011, while near neutral values could be observed for the rest of the study period.

### Total Alkalinity, Carbonates and Bicarbonates

Total alkalinity ranged from 108.2 mg/l in March 2011 at Stanley reservoir to 183.6 mg/l in December 2010 .Alkalinity values were significantly higher during November 2010 – February 2011, in the reservoir, but the values were very low during March 2011 – June 2011. Carbonates varied from 7.00 to 9.96 mg/l during the study period .Stanley reservoir had the amount of carbonates (annual mean: 8.45 mg/l). Irrespective of the locations, carbonates were low during March – June 2011. Carbonate level was significantly high during November 2010 – February 2011 period. Compared to other months of the year, in August 2010, carbonate levels were very high in the reservoir (9.89 – 9.96 mg/l). Bicarbonate values varied between 108.0 mg/l (March 2011) and 171.55 mg/l (November 2010) .While observing the monthly variation of bicarbonates, it was obvious that March – June 2011period had the least levels of

bicarbonates, while November 2010 – January 2011 period had significantly higher amounts of bicarbonates.

**Nitrites and Nitrates**

Nitrites ranged between 0.05 and 0.23 mg/l during the study period .Although higher nitrite values were apparent during the non-rainy months of the year, the variations were not statistically significant. Nitrates were in the range: 0.42 – 0.95 mg/l .On a monthly basis, significantly higher nitrate values could be observed for November 2010 – February 2011; further it was noted that the nitrate level of February 2011 was exceptionally high (0.935 mg/l).

**Total Phosphates and Total hardness**

Total phosphates of the reservoir varied from 0.01 to 0.15 mg/l, during the entire study period .Among the months, July – October 2010 show the highest level of phosphates, while in the months of March and April 2011 the values were the lowest. Variations in the total hardness of the water of the reservoir are depicted and the values showed a range of 110.91 to 148.36 mg/l for the study period. July and August 2010 showed least water hardness, while December 2010 and January 2011, maximum hardness.

**Calcium hardness and Magnesium hardness**

Calcium hardness of the reservoir varied between 45.6 and 58.77 mg/l for the entire study period .although it could be observed that March and April 2011 were the months of highest hardness, and October 2010, the least. Magnesium hardness was in the range: 62.8 – 98.0 mg/l, during the study period Irrespective of the reservoirs, in July 2010 lowest level of magnesium hardness could be observed in the water, and the highest level, in January 2011.

**Sulphate and Fluoride**

Sulphates of the water showed remarkable variations in their concentration among the reservoir, and the annual range of sulphates was 13.6 – 19.98 mg/l. Among the months of November 2010 to February 2011 study period a significantly high concentrations of sulphate was recorded, while July to October 2010 show only very low concentrations. Annual variations of fluorides in the reservoir are presented in. Fluorides were of trace quantities and varied between zero and 0.0006 mg/l. Fluorides were totally absent in the reservoir during July 2010 – October 2010.

**Sodium and Potassium**

Sodium levels in the reservoir varied between 36.0 and 47.81 mg/l, during the study period. However, it could be observed that in January and February 2011, the concentrations were significantly the highest and the concentrations were very low during July – October 2010. Annual potassium variations were in the range, 4.66 – 7.54 mg/l .Monthly observations on the potassium levels of water showed that the values were noticeably more during July 2010 – February 2011.

**Dissolved Oxygen**

The dissolved oxygen concentrations in the water of the reservoir were in the range of 4.2– 6.2 mg/l .Monthly oxygen values, when compared, showed that November and December 2010 maintained highest dissolved oxygen, while February, March and May 2011, the lowest.

**Carbon dioxide and salinity**

Carbon dioxide levels were the reservoir and the levels varied between 0.00026 and 0.00059 ppm during the study period.Salinity levels were in the range: 0.007 – 0.193 ppt during the study period.

**DISCUSSION**

The total life of the world depends on water. hence the hydrological study is very much essential to understand the relationship between its different trophic levels and food webs. The environmental conditions such as topography, water movement and stratification, salinity, oxygen, temperature and nutrients characterizing particular water mass also determining the composition of its biota [9].

River Cauvery has many features common to tropical lotic water bodies, however, unlike River Ganges or River Brahmaputra, the major rivers of North India, this river is essentially rain fed, flowing for most part of the year with very little water. Hence the quality of water in its reservoir is also affected to a large extent by the seasonal fluctuations in the inflow and also to the extent of stagnation and evaporation prevailing particularly in the summer months.

Information gathered in the present study on the seasonal rainfall, atmospheric humidity and wind velocity (Table 1) revealed that the study period (July, 2010 – June, 2011) represented the typical climatic conditions of the region, primarily governed by the monsoon and the hot months of summer. Pre-monsoon period was comparatively windy. While rainfall in the upstream Karnataka also would have contributed to the water inflow, wind speed, summer heat and low humidity prevailing at the study zones might have increased the water evaporation of the reservoirs.

Temperature variations of the reservoir were about seven degree Celsius approximately, depending on the seasonal rains and the summer, and these fluctuations were of a lesser magnitude compared to the shallow lotic stretches of the river. [10] observed narrower fluctuation of water temperature in the reservoir zones of Cauvery



compared to the flowing water stretches, and he attributed this to the depth and turbidity of the standing water.

In a similar fashion, the turbidity of the reservoir varied according to the seasons. Water was least turbid during rainy season (3.0 – 3.8 NTU), while in summer months, the values varied between, 6.3 – 8.9 NTU. Higher turbidity of the reservoir-water during the summer months at present is definitely indicates the high plankton production in the water bodies due to the availability of abundant sunlight and nutrients.High turbidity may affect the production of fish and other aquatic organisms, mostly due to light obstruction [11] and prolonged conditions of very high turbidity can clog the gills of fishes.

Water pH varied between 6.5 and 9.2 with values more alkaline in the post-monsoon and summer months. Acidic and very high alkaline pH are deleterious to aquatic life, ie., pH below 4 and above 10 [12] and such variations may be due to industrial effluents mixing with river water [13]. Aquatic organisms, including many invertebrates, are known to be sensitive to acidic pH [14] have showed that pH and pH related variables can contribute significantly to the prediction of fish species richness. However, in the present study pH range fell well within the normal limits (annual average pH 8.1) ideal for better productivity.

Alkalinity values in the present study were in the range: 108.2 – 183.6 mg/l with an annual average of 155.5 mg/l .Alkalinity values were comparatively higher for Lower Anicut. For all the three reservoirs, alkalinity values were higher in November, 2010 to February, 2011. Water alkalinity is primarily governed by the concentrations of bicarbonates, and the present study on bicarbonate levels of the reservoirs revealed that the values closely conform to a trend identical to that of alkalinity variation. Similar to the bicarbonate levels, carbonate levels (7 – 9.96 mg/l) also varied between the reservoirs. Stanley reservoir had the least. Identical patterns of variations in carbonates and bicarbonates probably indicate the frequent inter-conversions of these radicals in the freshwater environment.

Dissolved oxygen levels of the reservoir varied between 4.6 and 6.2 mg/l, and this range falls within the range prescribed by WHO (1971) for the sustenance of fisheries and wildlife. However, this range was below the levels (7.0 – 8.3 mg/l) observed by [15] for the reservoirs of the Karnataka section of Cauvery. In the present study, higher level of dissolved oxygen was observed for Stanley reservoir might have been the reason for lower solubility of oxygen in the water. Further, in the warmer months (February – May) of the study period. These variations were not alarming, since the oxygen levels were maintained well above the prescribed limit. High level of wind action which leads to the dissolution of oxygen into the surface water and the photosynthetic activity of phytoplankton maintain an appreciable level of oxygen in reservoirs [16].

Nutrients play a vital role in the productivity of water bodies. Major nutrients analyzed in the present study included nitrates, sulphates and phosphates. Nitrates varied from 0.42 – 0.95 mg/l. In general, nitrates and sulphates were higher in post monsoon months, while phosphates were exceptionally high during monsoon months. Concentrations of nitrite a toxic intermediate radical of ammonia oxidation, were negligible in the present investigation. The concentrations of nitrates and sulphates were at an optimum level according to BSI (1982) for the promotion of fisheries and wild life. Nitrates (0.01 – 0.14 mg/l) and phosphates (0.01 – 0.03 mg/l) of Kabini, Harangi, Nugu and Hemavathy reservoirs were reported to be at a lower level[17], than those obtained in the present study. However, [18] reported comparable level of nitrates, phosphates and sulphates in Doyang reservoir, Nagaland, a water body with high fish production potential. High nutrient levels observed in the reservoir of the present study also underscore their greater production capacity.

Along with other anions like carbonates and bicarbonates, nitrates and sulphates also contribute to the hardness of water [19]although the hardness of water is chiefly determined by the concentrations of calcium and magnesium [20] Total hardness in the reservoir ranged from 110.91 to 148 mg/l.Monthly variations of total hardness were also significant. Magnesium hardness (62.8 – 98.0 mg/l) closely followed the trend of total hardness, location- wise as well as season-wise. However, such a definite trend akin to that of total hardness was not evident with regard to calcium hardness (45.6 – 58.7 mg/l). Their level was slightly more in early summer (March and April, 2011). The results show that hardness of the reservoir was primarily due to the magnesium content of the water and calcium remained relatively stable during the study period. Jayaram (2000) also opined that. Calcium is an essential component for the growth of both phytoplankton and zooplankton, and the heavy utilization of calcium was evident in the present study by its sudden decrease during late summer. Compared to the earlier study by Jerald (1994) in Lower Anicut, hardness of water was slightly less in the present study. The present study also showed that hardness of water was well within the permissible limits for maintaining a healthy fishery (WHO, 1971; BSI, 1982), but not so, at least during summer, with regard to potability of water.

Sodium levels (36.0 – 47.81 mg/l) in the present study were lower than those of calcium and magnesium, and potassium levels (4.66 – 7.54 mg/l) were very less. Similar values for sodium and potassium were observed in Lower Anicut by [21] have also observed such



phenomena with regard to sodium and potassium in natural freshwaters.

Fluorides were present only in trace quantities (maximum 0.0009 mg/l) and were undetectable during monsoon months. With regard to fluorides, Cauvery water is safe and well within the permissible limits as prescribed by WHO (1971) and BSI (1982). Carbon dioxide levels of the reservoir were negligible (0.00026 – 0.00061 ppm) and hence, a definite pattern was not discernible. Salinity also was meagre, but slightly higher in Lower anicut probably explaining its proximity to sea coast.

From the foregoing discussion, it is evident that the reservoirs of Cauvery maintain ideal levels of hydrological parameters to maintain a good fishery. Fisheries of a reservoir depend chiefly on its planktonic resources [8] decreased turbidity [11] calcium content [20-21]. The productive capacity of a body of water depends much on the quantity of available nutrients which form the basic material for structure and growth of living organisms, which in turn form the food for fishes [20] Hence, functioning of an aquatic ecosystem and its ability to support life-forms depend to a greater extent on the physico-chemical characters of its water [21]. In conclusion, the present study suggests that all the parameters dealt with are important for fishery management ventures to be taken up in reservoirs. Considering the growing anthropogenic influence on natural water bodies, monitoring of BOD, COD, insecticides and heavy metal levels are also to be considered, in addition. Such environmental surveys will help to maintain the quality of the water in reservoirs ideal for human utilization and fishery development.

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**CONFLICT OF INTEREST**

The authors declare that they have no conflict of interest.

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