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REVIEW ARTICLE

Physico - Chemical Parameters of River Water: A Review

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ABSTRACT

Rivers have been the most important freshwater resources and our ancient civilizations have flourished along the banks of rivers. River water finds multiple uses like agriculture, industry, transportation, aquaculture, public water supply and they have been used for cleaning and disposal purposes. Huge loads of waste from industries, domestic sewage and agricultural practices find their way into rivers resulting in large scale deterioration of the water quality. The growing problem of degradation of our river ecosystem has necessitated the monitoring of water pollution and water quality of various rivers all over the country to evaluate their production, capacity, utility potential and to plan restorative measures.

Key words: River, Physico – chemical parameters, Wastes, Flora and Fauna

PHYSICAL AND CHEMICAL PROPERTIES OF RIVER WATER

Hydrobiological investigations in the Bay of Bengal along the Tamilnadu Coast were made extensively by several earlier workers [1 – 10]. [11] studied the distribution and seasonal variation of temperature and salinity in Cochin back waters. [12] studied the physico-chemical characteristics in the coastal environment of visakhapattinam and form their study the concluded that the harbor water and polluted with nutrients and organic matter. [13] studied the diurnal variation in physico-chemical and primary production in Kakinada Coast of Andhra Pradesh. [14] studied the distribution of phytoplankton in relation to physico-chemical parameters in the west coast of India. Seasonal variation of certain hydrographical parameters like temperature, salinity, transparency and nutrients was studied in the Visakhapattinam Coast [15]. [16] made some observation on the seasonal variation of different physico-chemical parameters of the South East of India.

The environment conditions such as topography, water movement and stratification, salinity, oxygen, temperature and nutrients, with several rivers draining a total catchment of 3.02×10^6km and their estuarine, have water spread area of 2.7×10^4km with 80% of mangroves recorded on the east coast and 20% on the west coast [17]. Mangrove forests are considered to be highly productive tropical ecosystem [18]. It is a fact that the mangrove forests represent an important carbon and nutrient source to the adjacent lagoon and coastal systems [19-22].These mangroves have received considerable attention for floristic and faunal diversity [23]. [24] studied seasonal variation in physico chemical parameters of Kadalur coastal zone, Tamil Nadu. [25] worked on the physico-chemical characteristics of the fishing grounds on the West Coast of India. [26] studied the physico-chemical characteristics of the Vellore estuary, Southeast Coast of India.

Human activities have not only affected the exploitable living resources but have also caused a reduction in coastal biological diversity. These conditions imply, at present, that the coastal zone are either misused or overused. [27] they should however be managed on a sustainable – yield basis [28]. This requires a proper understanding of coastal process, biogeoresources and water quality [29].

Atmospheric and surface water temperatures are the important environmental factors. During summer, solar radiation and clear sky enhance the atmospheric temperature whereas in Monsoon, rainfall and cloudy sky reduced the atmospheric temperature and consequently the water temperature fall to the minimum [30]. Temperature is basically important for its effect on certain chemical and biological reactions taking place in water and in organisms and inhabiting aquatic media. It will depend upon season, time of sampling and ambient atmospheric temperature etc., [31].

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During the study period monsoon season got heavy rainfall, caused cloudy weather, heavy flood to decline the phytoplankton to density and physico-chemical parameters. Similar observations have been made by [32, 33].

LEC value at both the stations is high in Monsoon because rainfalls coupled with low intensity of solar radiation and higher concentration of dissolved organic matter and suspended sediments, which resulted in increased turbulence in the water [34]. Least amount of LEC was during the summer seasons at all the stations which might be due to the removal of suspended materials from the water column and cessation of freshwater flow there by reducing the abiogenic turbidity[35]. [36] analysed physico-chemical properties and heavy metal contents of the effluent discharged from Flash Light Ltd., and reported accumulation of heavy metals in *Raphamus sativus* and *Spinacia oleraea* when irrigated with industrial effluent. [37] studied the water quality conditions of Sylhet city of Bangladesh and its restaurants and their investigation was based on questionnaire survey of restaurants and laboratory tests on water samples like dissolved oxygen, electrical conductivity, total hardness, turbidity, temperature, suspended solid and coliforms bacteria. [38] studied the physico-chemical characteristics of water samples of Bantwal taluk in Karnataka and reported that it is suitable for irrigation and agricultural purposes. The quality of water in four streams of Cauvery River in Mandya, District analysed by taking into account the transparency, turbidity, depth, dissolved oxygen, colour, biochemical oxygen demand, nitrite, nitrate, total hydrocarbon and the overall density of rotifers to assess the impact of effluent on the water quality.

The temperature was basically important for its effects on the chemistry and biological activities of organisms in water. Temperature was known to influence in the determination of other factors like pH, conductivity, dissolved gases and various forms of alkalinity. Some of the factors that affect Palar river water temperature are heat exchange on the earth surface under controlled radiation in and out, ground water movement and chemical and thermonuclear processes occurring in aquifers, as suggested by [39].

The registered value of Turbidity is exceeded the highest desirable limit of [40] and [41] standard therefore not recommended for drinking purpose the desirable value of turbidity is 5 NTU and the permissible limit is 10 NTU. Generally, the maximum Salinity values was recorded during summer season and this could be described to the higher degree of evaporation in the study area and less tidal action. The low values were found during monsoon. The present findings are in affirmative with that of [42]. Minicoy Island. Salinity is one of the important factors which profoundly influence the abundance and distribution of the animals in estuarine environment and inshore waters. In the present study, the lower salinity was recorded during the months of October to December was due to heavy rainfall and large quantity of freshwater inflow. Water salinity positively correlated with temperature ($P>0.001$), pH ($P>0.01$) and negatively correlated with dissolved oxygen ($P>0.001$). Similar trend in the salinity values were also observed from various part of southeast coast of India [43-47].

pH is the measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions. The pH of the water samples varied from 5.40- 6.00 at different times, as indicated by the *in situ* readings. The result reveals that the pH value was not within the desirable limit of BIS and WHO standards [48] so that the river water cannot be used for drinking purpose. River waters with a pH of 5.5 and below are particularly at risk [49]. Basically, the pH was determined by the amount of dissolved carbon dioxide which forms carbonic acid in water [50, 51]. The pH of ground water can also be lowered by organic acids from decaying vegetation and the dissolution of sulfide minerals [52]. The pH was considerably lower in Palar river water which may be due to greater input of effluents from different types of industries.

Usually alkaline pH is considered to be good for promoting high primary productivity. However the present value shows more congenial conditions for primary production. Natural water has pH values between 6.5 – 8.5. These values are typical with slight seasonal variations, and a sudden change would indicate industrial pollution. Further, highly acidic or highly alkaline waters are undesirable because of corrosion hazards and possible difficulties in treatment.

The result revealed that pH value is within the desirable limit of BIS and WHO standards so that the water can be used for drinking purpose. A similar result was observed by [53]. The maximum pH may be due to the buffering capacity of water

and geology of catchments area [54]. The pH does not have any adverse health effect but it altars taste of water higher pH reduces the germicidal potentially of chloride and induces the formation of toxic trihalomethanes. Most of the natural waters are generally alkaline due to the presence of sufficient quantities of carbonate [55]. The influence of neritic waters was also there in the study area. The pH of waters gets drastic change with time due to exposure to biological activity and temperature.

Conductivity is the measure of capacity of a substance or solution to conduct electric current. Conductivity is reciprocal of the resistance. In this study, electrical conductivity values ranged from 11.90-13.15 µmhos/cm at different times, as indicated by the *in situ* readings. EC values indicate the presence of more salts in river water as suggested by [56]. EC values are a good measure of the relative difference in water quality between different aquifers [57]. It was related to TDS content and its value becomes higher with the increase of the degree of pollution.

Total hardness is defined as the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate in milligrams per litre. The hardness of water fluctuated from 152.20 – 231.19 mg L^{-1} and this value was within recommended BIS standards. A high concentration of hardness may be due to leaching from the soils or due to the high background concentration of the waters. WHO [58] permissible limit for total hardness of water is 150 mg L^{-1} and ISI [59] desirable limit was 300 mg L^{-1}. [60] suggested that the values between 150 and 300 mg L^{-1} of TH means the water was hard, and TH greater than 300 mg L^{-1} means the water is very hard. High concentration of hardness may cause the problem of heart disease and kidney stones [61]. According to the report of [62] fifty studies in nine countries have established a consistent statistical association between drinking water hardness and the incidence of cardiovascular problem. [63] suggested that water with a hardness of 50 ppm was considered to be soft; however a hardness of 300 ppm was permissible for domestic use, whereas it should be 2 to 80 ppm for boiler feeders, and an upper limit of 150 ppm was usually recommended for agriculture.

Alkalinity of a water is its acid – neutralizing capacity. Alkalinity is significant in many uses and because the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate and hydroxide content, it is taken as an indication of the concentration of these constituents. The total alkalinity of Palar river water at Vaniyambadi segment ranged from 23.5 – 28.73 mg L^{-1}. Alkalinity values serve as an index of productive potential of the water [64]. In this study, the recorded alkalinity values indicate a lower ability of the river water to support algal growth and other aquatic life.

Dissolved oxygen can be removed from the water by discharges of the oxygen demanding wastes other inorganic reductants like hydrogen sulphide, ammonia, ferrous, nitrate and other oxidable substances tends to decrease dissolved oxygen in water. The low dissolved oxygen concentration observed during summer could be ascribed to the higher salinity of the water and higher temperature. The trend noticed in the present study is in conformity with the findings of [65, 66]. Dissolved oxygen concentration varies according to many factors; the main factors are due to photosynthesis and respiration by organisms. BOD and COD values were similar to the dissolved oxygen concentration in the present study. Humidity influences the evaporation rate of salinity which in turn affects the salinity [67, 68] in Palk Bay. The water quality characteristics of aquatic environment arise from a multitude of physical chemical and biological interactions [69, 70].

EC value indicates the presence of more salts in river water as suggested by [71], EC value of is a good measure of the relative difference in water quality between different aquifers [72]. It is related to TDS content and its value becomes higher with the increase of the degree of pollution. The electrical conductivity, implying the impact of ionic composition of civic discharges. The conductivity values were above the permissible limits as per WHO. Recently in filtered ground water is chemically close to rainwater and has low electrical conductivity [73].

TDS indicates the total amount of inorganic chemicals dissolved in water samples. The TDS values were above the drinking water standards as Prescribed by WHO and BIS. The desirable and permissible value is 1500 – 2000 mg/l. [74] have found the TDS values are higher than that of permissible limit for drinking water. [75] reported that the desrable limit of total dissolved solids in drinking water.

Alkalinity of water is its acid neutralizing capacity. Alkalinity is significant in many uses

and because the alkalinity of may surface water is primarily a functional carbonate, bicarbonate and hydroxide content, it is taken as an indication of the concentration of these constituents, Alkalinity value reserve as an index of productive potential of water [76]. Anthropogenic activity leads to entry of more domestic wastes, washing, bathing etc., High value of alkalinity were also observed by [77].

A high concentration of Hardness may be due to leaching from the soils or due to high background concentration of the water WHO, permissible Limit for total hardness of water is 150 ml/l and [78] desirable limit is 300 mg/l. [79] has suggested that value of 50 ppm is considered to be soft and the value between 150 – 300 mg/l of total hardness means the water is hard and total hardness greater than 300 mg/l means the water is very hard, High concentration of hardness may cause the problem of heart diseases and kidney stones [80]. The hardness is measure of polyvalent cations in water. Hardness generally represents the concentration of calcium and magnesium ions, because these are the most common polyvalent cations. Hardness caused by the heat exchanged equipments, boilers and pipelines.

The concentration of Chloride was not within the prescribed standards of WHO [81]. The diserable and permissible values of chloride is 200-1000 mg/l. An excess of chloride beyond desirable limit in inland waters is considered as index of water pollution. The existence of considerable amount of chloride in river water may be due to discharge of industrial effluents into it. Sewage water and industrial effluents are rich in Chloride content and discharge of these waste waters result in greater chloride level in fresh waters [82]. However, excess of residual chlorine leads to the formation of potential carcinogenic chloro-organic compounds such as chloroform. [83] reported that the chloride content was high in the river water than other one. This is also one of the indications of organic pollution of animal human origin.

Fluorides enter into the water as a different fluoride bearing minerals like apatite and mica by industrial wastes, geological minings and agricultural runoff in big cities; it is an indication of water pollution. Dental, non skeletal, skeletal fluorosis is the general health effects of fluoride. The maximum permissible limit of fluoride in drinking water is recommended to be 1.5mg/l by WHO. Fluoride is critical factor, which determines the water quality, which is used for drinking.

Biological Oxygen demand is a measurement of the oxygen required for micro-organisms while breaking down organic matter to stable inorganic forms such as Co_2 NO_3 and H_2O ion and average basis, the demand for oxygen in proportional to the amount of organic waste to be degraded aerobically BOD is less in summer because due to zooplankton and phytoplankton population, temperature by sunlight and industrial wastes. It is more in monsoon because due to tidal flow and cool environment.

Chemical Oxygen Demand is the oxygen required by the organic substances in water to Oxidize then by a strong chemical oxidant. In the present investigation the recorded low value of DO and higher values of BOD and COD can be described to the discharge of effluents and non-point source of pollution in the coastal area and mangrove station.

Total Nitrogen exhibited higher value in monsoon season and very low in summer season the surface run of agricultural wastes fertilizers domestic wastes, house hold sewage and surface run off can also increases the concentration of total nitrogen and carbon in the study area. The TOC observed in high monsoonal season, phosphate value might be due to the regeneration and release of total phosphorus from bottom mud into the water column by turbulence and mixing [84]. The post monsoonal low value could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by phytoplankton [85].

Reactive Silicate content was higher than that of the other nutrients and the recorded high monsoon values could be due to large influx of fresh water derived from land drainage carrying silicate reached out from rocks and also from the bottom sediment [86, 87]. The observed low summer and post monsoonal values could be attributed to uptake of silicate by phytoplankton for their biological activity [88, 89].

The present study, it was been observed that the Nitrate value was within the WHO and BIS standards the desirable and permissible value is 45 – 100 mg/l. Algal growth and Blue Baby diseases in infants is the general and health effects of Nitrate. No chance for the occurrence of Blue Baby (Methaemoglobineamia) disease is found at the study area. High concentration of nitrate in the water may be due to local run off from the adjacent crop fields where the farmers have used nitrogen fertilizers. The high concentration may be due to the influenced

oxidation of the nitrogenous ammonia of nitrite to nitrate. The recorded highest monsoonal nitrate value could be mainly due to the organic materials received from the catchment area during the tidal flow [90].

In the present study, it was been observed that the Nitrite value was within the BIS and WHO standard. The desirable and permissible value is 0.2 - 15 mg/l the general and health effects of Nitrite is to form nitrosamines which are carcinogenic. This was due to the addition nitrogenous nutrients mainly terrestrial runoff like break down of vegetation, use of chemical fertilizers in agriculture and oxidation of ammonia from of nitrogen to nitrite [91]. Ammonia value was within the desirable limit of BIS and WHO standards the desirable limit is 0.2 – 15mg/l. Because the surface runs off wastes, agricultural wastes washed and show maximum value in pre-monsoon. Excess ammonia indicates polluted water and maximum algal growth.

Calcium value was not with the desirable limit of BIS and WHO standard. The desirable and permissible value of calcium 75-.200 mg/L. The calcium and magnesium contributes to the hardness of water as their carbonate magnesium is always considerably lower than of calcium component excessive concentration of magnesium is undesirable in domestic water because of the problems of scale formation of pitting [92, 93, 94]. The desirable and permissible value of Magnesium is 30-100 mg/l the general effect of magnesium poor lathering and deterioration of cloths. Iron value was not within the desirable value of BIS and WHO standards , the desirable and permissible limit of Iron in drinking water is 0.3 - 1.0 mg./l. The source of Iron is leaching of cost iron pipes in water distribution system and natural effects of iron are brackish color, iron bacteria and discolored beverages. Sulphate value was not within the desirable limit of BIS and WHO standard the desirable and permissible limit is 200-400 mg/l. Waste water for Tanneries, paper mill and textile mills contribute the sulphate in natural water along with some agricultural run-of containing residue of fertilizers. It can cause gastrointestinal irritation.

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