Water quality parameters as an indicator to determine pollution in Kuttanad, Kerala, India

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Abstract

The present study was conducted to determine the impact of agrochemical pollution in the rice bowl of Kerala-Kuttanad. The river Pamba, which is the third longest river, flows through Kuttanad, which splits it into upper and lower. Pamba River arises from Palanchi malai in the Western Ghats of Ranni Taluk of Pathanamthitta district, Kerala, India. The river is being utilized by local people for their daily needs. As it is getting polluted day by day, there is a need to determine the physical, chemical and biological characteristics of water resources. The increased demand for water as the consequence of population growth, agricultural and industrial development has been accompanied almost every day by researchers. The need for developing a uniform method for measuring the results of water pollution programs has long been recognized by environmentalists and expressed through their professional organizations. In the present study, the water quality parameters were assessed for both the upper and lower kuttanad areas. From the study, it can be concluded that, the temperature, pH and water turbidity were similar in both upper and lower kuttanad. On the other hand, dissolved oxygen was high in upper kuttanad. Whereas parameters like dissolved carbon dioxide, salinity, nitrate, and phosphates were high in lower kuttanad region.

Keywords: Water quality, Upper Kuttanad, Lower Kuttanad, Kerala

Introduction

Water, one of the most essential needs for the survival of life on earth. Water covers 71% of the Earth's surface and is vital for all known forms of life (UN, 2005). Only 2.5% of the Earth's water is fresh water, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products (Gleick, 1993). Water pollution is the loss of potency of water for beneficial uses due to addition of an excess of material that is harmful to humans, animals or aquatic life due to human activity. Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds. Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities. Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). The WHO states that one sixth of the world’s population, approximately 1.1 billion people do not have access to safe water and 2.4 billion lack basic sanitation (European Public Health Alliance, 2009). Polluted water consists of Industrial discharged effluents, sewage water, rain water pollution (Ashraf et al, 2010) and polluted by agriculture or households cause damage to human health or the environment (European Public Health Alliance, 2009). This water pollution affects the health and quality of
soils and vegetation (Carter, 1985). Some water pollution effects are recognized immediately, whereas others don’t show up for months or years (Ashraf et al, 2010).

The Kuttanad region is unique in Kerala with respect to its geographic and physiographic settings. This uniqueness is further emphasised by a less common reclamation process of impoldering whereby the region is carved out from backwaters. The geographic and physiographic peculiarities have their manifestations in the form of unusual natural environmental problems. Survival of life and sustenance of agriculture in this vulnerable ecosystem is possible only by mitigating the impacts of these problems through modification of the natural system. These modifications in the form of developmental projects, in turn, induced new sets of adverse environmental impacts. In lower Kuttanad, the agriculture is below the water level and there is a pumping out of water from paddy fields to river. Hence, the present study has been done with an aim to determine the water quality parameters in both upper and lower areas of Kuttanad, Kerala, India.

**Materials and Methods**

**Collection and preparation of water sample**

Fresh water were collected every second Saturdays in the months of July to December from upper and lower Kuttanad. It is known that the water is susceptible to changes in the chemical composition because of its powerful solvent properties. Many a times, number of samples we collect depends upon the homogeneity of water body or aquifer under consideration. The actual method of collection of samples was based on the depth of individual well. While collecting the samples following precautions were taken.

(1) Plastic containers of one litre capacity were used for the collection and storage of water samples as this material is resistant to solution action.

(2) The containers were thoroughly washed and rinsed before every collection. For each station, separate containers were used.

(3) The water samples collected were labelled properly and record was made for the following physico-chemical parameters.

   **i. pH**

   pH of water was determined at the site itself, with the help of a pH analyzer.

   **ii. Temperature**

   Temperature was determined in both upper and lower Kuttanad using a portable mercury thermometer in morning and evening and the average was taken and tabulated.

   **iii. Turbidity**

   This is a test to determine the amount of light penetration. Immersing a seechi disc was the methodology adopted to study turbidity. The disc was immersed when the water was calm and was observed during sunny days. The depth at which it disappeared was noted as A. Then, it was lifted slowly and the depth at which it reappeared was noted as B. Hence, the turbidity was calculated as;
iv. **Dissolved Oxygen**

Winkler's method described by Grasshoff et al. (1983) was applied for the determination of dissolved oxygen in seawater. The water samples were collected in BOD bottles. To this 1 ml of 40% of magnesium chloride and 1 ml of alkaline iodide were added to mix the dissolved oxygen in it. Fixing was done immediately after the collection. The precipitated manganese hydroxide was dispersed evenly throughout the glass bottle by shaking and allowed to settle. It was then acidified with 50% sulphuric acid. The oxidised manganese again reverted to the divalent state and iodine equivalent to the dissolved oxygen ill water was liberated. 50 ml of this solution was titrated against 0.01 N sodium thiosulphate using starch indicator. The end point is the disappearance of blue colour. Sodium thiosulphate solution was standardised using 0.01 N potassium dichromate solution. Dissolved oxygen was calculated using the equation,

\[
\text{Dissolved oxygen} = \frac{V}{V - 2} \times 0.698 \times N \times 8 \times 1000 \times 50 \times v
\]

V - Volume of the bottle (ml)

N - Strength of thiosulphate

v - Volume of thiosulphate consumed for 50 ml of acidified solution

v. **Dissolved carbon dioxide**

Here, the titration of water sample is based on acid-base theory. If excess carbon dioxide is dissolved in water, it gives a light acid status to water. It is then, titrated with sodium hydroxide against phenolphthalein as indicator which imparts a pink colour to water.

vi. **Salinity**

Following the procedure of Strickland and Parsons (1968), the salinity was estimated. Argenlometric titrations were carried out. 5 ml of water samples were titrated against 6% silver nitrate solution using 2 - 3 drops of potassium chromate indicator. The precipitate of silver halides has to be uniformly crushed using a magnetic stirrer. The end point is the appearance of permanent red colour. Similar titration using standard sea water of salinity 35 ppt was used to standardise the silver nitrate.

vii. **Phosphate content**

The determination of inorganic phosphate was done based on the reaction of phosphate ion with an acidified molybdate reagent to yield a phosphomolybdate complex, which is then, reduced to a highly coloured blue compound. About 20 ml of water sample is taken and added 2 ml of buffer solution. Optical Density at 880 nm was calculated using the formula;

\[
\text{Phosphate content} = \frac{OD \text{ of sample} \times \text{Control} \times 1000}{OD \text{ of standard} \times 20}
\]
Results and Discussion

The introduction of pollutants into an aquatic system can set off a complicated series of biological and chemical reactions. In order to understand how and why these reactions occur and to successfully manage any ecosystem, a sound knowledge of the structure and basic functioning of that system is vital. Various aspects of physicochemical characteristics and impact of pollution on river water quality have been reported by a number of workers in India and abroad. pH plays a critical role in the chemistry of rivers. The pH of water affects the solubility of many toxic and nutritive chemicals; therefore, the availability of these substances to aquatic organisms is affected. As acidity increases, most metals become more water soluble and more toxic. Toxicity of cyanides and sulfides also increases with a decrease in pH (increase in acidity). Ammonia, however, becomes more toxic with only a slight increase in pH. A decrease in pH would increase metal availability, lending itself to greater uptake by organisms and can cause physiological damage to aquatic life (Connell and Miller, 1984). Extremes of pH or rapid pH changes can exert stress conditions or kill aquatic life. Even moderate changes from acceptable criteria limits of pH are deleterious to some species. As pH is an important ecological factor controlling the life of animals and plants, an investigation to determine pH was conducted. The results revealed that, the pH was neutral in upper Kuttanad, whereas it was alkaline in lower Kuttanad.

Figure 1: pH of water at Upper and Lower Kuttanad

In the present study water temperature ranged between 19 to 23°C. The minimum temperature was recorded 19.6°C in November at lower Kuttanad whereas the maximum temperature recorded was 23.8°C in December at lower Kuttanad. Seasonal fluctuations in water temperature were recorded during the study period. The low water temperatures were recorded in winter seasons whereas high temperatures were recorded during the summer months at all the sites. Monthly variations of water temperature are shown in Table 2. Temperature is the important factor which influences the chemical, biochemical and biological characteristics of the aquatic system. The temperature of water is one of the most important characteristics
that determines, to a considerable extent, the trends and tendencies of changes in the river water quality. Temperature of water varies diurnally and seasonally parallel to the atmospheric temperature and influenced by the latter. Temperature fluctuations not attributed to these two factors, are usually due to waste of thermal industries and sometimes due to organic wastes discharges; where upon the microbial decomposition yields some heat to alleviate the temperature. Otherwise, water temperature is usually lower than that of the atmospheric temperature. Increased water temperature decreases the solubility of dissolved oxygen and water temperatures above 27°C are “unsuitable” for public use. At above 32°C it would be considered “unfit” for public use (Chapman, 1996).

Figure 2: Temperature of water at Upper and Lower Kuttanad

![Temperature of water at Upper and Lower Kuttanad](image)

Turbidity or light penetration depends on the intensity of sunlight, suspended soil particles, turbid water received from catchment area and density of plankton etc. (Kulshrestha and Sharma, 2006). Turbidity of river water is also affected due to total solids partly or fully decomposed organic matters, silts and turbulence caused by the currents, waves, human and cattle activities (Singh et al., 1999). Higher the turbidity value, lower the visible light will penetrate into water or clearer the water will be. Generally, turbidity values are highest in winter season and there is no natural disturbance in the water, while it is maximum in rainy season when rains and runoffs bring the small or large debris which floats in water at the surface or below due to disturbances. Turbidity values in summer months are generally intermediate between these two limits. In the present study, upper and lower Kuttanad was clear except in the monsoon season.

In the present study the DO values ranged between 8.8 to 11.2 mgl⁻¹. The minimum dissolved oxygen was recorded 8.8 mgl⁻¹ whereas the maximum of 11.2 mgl⁻¹. Considerable fluctuations were found throughout the study period. Monthly variations of dissolved Oxygen for all sites are shown in Table 3. Dissolved oxygen is one of the important parameters of water quality assessment. The maximum concentration of oxygen that can be dissolved in water is function of temperature and therefore DO content of water may vary from place to place and time to time (Prasad and Patil, 2008). Its presence is essential to maintain variety of forms of life in the water.
bodies. Similar trend has been shown by Fakayode, 2005 while studying the impact assessment of industrial effluent on water quality of the receiving Alaro River in Ibadan, Nigeria. In a system where rate of respiration and organic decomposition are high, the DO values remain lower than those of system where the rate of photosynthesis is high (Morrison et al., 2001).

Figure 3: Dissolved Oxygen at Upper and Lower Kuttanad

![Dissolved Oxygen at Upper and Lower Kuttanad](image)

In the present study the free carbon dioxide values ranged between 0.9 to 1.8 mg/l. The minimum carbon dioxide was recorded 0.9 mg/l whereas the maximum of 1.8 mg/l in lower Kuttanad. Monthly variations of water carbon dioxide for all sites are shown in Figure 4. Carbon dioxide (CO₂) enters in water from the atmosphere at the air-water interface and is naturally present in solution as a by-product of metabolism as mentioned by Shastri and Pendse (2001) during hydrobiological study of Dahikhuta reservoir. High concentration of free CO₂ may be attributed to the heavy inflow of organic waste. Increase in CO₂ indicates increase in pollution load (Koshy and Nayar, 1999). Similar finding were recorded by Singh et al. (2010).
In the present study, the phosphate value ranged between 0.08 to 1.46 mg/l. The minimum phosphate value was recorded at 0.08 mg/l to a maximum of 1.46 mg/l. Considerable fluctuations were found throughout the study period. Monthly variations of phosphate for all sites are shown in Figure 5. Phosphate is an important plant nutrient and plays a role of limiting factor among all other plant nutrients (Dugan, 1972; Hobbie, 1974; Reynolds, 1999) and therefore, its determination in natural water may yield significant conclusions regarding water quality. The excessive amounts of nitrates and phosphates are generally associated with phytoplankton blooms in natural water, provided other conditions are favourable and therefore increase the unpottability and unusability of such waters for various purposes.

Figure 5: Phosphate content at Upper and Lower Kuttanad
Water is least known universal solvent. It contains chlorides, sulphates, bicarbonates and bromides of sodium, potassium, magnesium and calcium. From the figure 4, it is clear that, there is a considerable variation in salinity in both upper and lower Kuttanad. In upper Kuttanad, the salinity is between 2.3 to 3.1% whereas in lower Kuttanad, it is between 4.9-5.9%. The lowest salinity in September may be due to monsoon floods and highest in December may be due to tidal sea water entry (Figure 6).

Figure 6: Salinity at Upper and Lower Kuttanad

![Salinity at Upper and Lower Kuttanad](image)

**Conclusion**

From the study, it can be concluded that, the water quality parameters have huge role in determining the pollution indices. It can also be seen from the results that, parameters like temperature, pH, and turbidity were same in both upper and lower Kuttanad. Whereas, upper Kuttanad showed more dissolved oxygen. In lower Kuttanad, dissolved carbon dioxide, salinity were high. Hence, this study can be considered as a preliminary tool in analysing the pollution level in Kuttanad, Kerala, India.

**References**


