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Research Article

NUTRIENT STATUS OF ARASALAR RIVER, A TRIBUTARY OF CAUVERY RIVER AT TANJORE DISTRICT OF TAMILNADU, INDIA

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ABSTRACT: Physico-chemical studies were conducted in river Arasalar situated in Kumbakonam, Tamilnadu, India. The study was conducted from January to December 2010. The present paper deals with nutrient status in Arasalar river, for this three stations were selected for the sampling methods i.e., S1, S2 and S3 the main aim of the study was to determine the nutrient status of Arasalar River and the suitability of the water for domestic and other purposes, in the light of water quality criteria prescribed by WHO standards. The parameters analyzed are water Temperature, pH, dissolved oxygen, Calcium, Magnesium, Chloride Sodium, potassium, Ammonia, Nitrite, Nitrate, Phosphate, Sulphate, Silicate and Iron. The results indicated that most of the Physico-chemical quality parameters of River Arasalar were within the WHO limits for drinking water and, therefore, may be suitable for domestic purpose. However, nutrients levels were high during the study period and did not give any clear seasonal variation. The results revealed that the values of Nitrite and Phosphate do not compile with WHO standards. Water quality assessment of delta regions of Arasalar River revealed strictly contamination from anthropogenic activities.
Key Words: Seasonal variations; Nutrients; River Cauvery; River Arasalar

INTRODUCTION

Rivers are the most important freshwater resource for man. Social, economic and political development has been largely related to the availability and distribution of freshwaters contained in riverine systems. River systems can be considered as arteries of the land supplying life giving water to an abundance of organisms whilst at the same time supporting modern civilizations [14]. The term water quality was coined with reference to the quality of water required for human use (i.e. drinking, agricultural and industrial purposes). This term entirely human prospective does not hold true for all aquatic organisms or ecosystems [7]. A more modern approach is to consider water quality as the combined effect of the physical attributes and chemical constituents not only in the water but upon all aspects of the aquatic environment [14].

A major threat to aquatic ecosystems which can be lead to severe pollution problem is nutrient enrichment. Nutrients are important building blocks for healthy aquatic ecosystems and are generally non – toxic even in high concentrations; however this can change with alterations in environmental parameters such as ph and temperature. Increased nutrient levels (especially nitrogen and phosphorus) can result in over stimulated growth of aquatic weeds and algae and can ultimately lead to oxygen depletion resulting in a eutrophic system. The occurrence of nutrients in aquatic ecosystems is closely linked to activities in the catchment, such as natural weathering, agricultural runoff and disposal of untreated or partially treated wastes [17, 21].

Nutrients are essential elements for the primary productivity of any aquatic ecosystem [36], and include nitrogen, phosphorus and silicon among others. The nutrient dynamics are influenced by different factors such as the weather, geology and soil type, drainage pattern and weathering processes. Nutrients occur in various sources and forms. Within the aquatic ecosystems, phosphorus and nitrogen roles can vary [16, 12]. Nitrogen occurs in numerous forms such as dissolved molecular nitrogen, a large number of organic compounds such as amino acids, amines, proteins, nitrates, nitrite and ammonium [34]. Sources of nitrogen include precipitation falling directly from onto the lake surface, nitrogen fixation in the water and sediments, input from the surface and ground water recharge. In marine ecosystems nitrogen is the liming nutrient for phytoplankton growth [27] while phosphorus frequently is a limiting nutrient in fresh water systems [12].

Water quality is at present a global issue, especially when considering its implications to humanity in terms of water borne diseases. The deterioration of water quality has led to the destruction of ecosystem balance, contamination and pollution of ground and surface water resources. Water quality degradation world-wide is due mainly anthropogenic activities which release pollutants into the environment thereby having an adverse effect upon aquatic ecosystems. Water quality can be regard as a net work of variables (pH, oxygen concentration, temperature etc.,) that are linked and co linked; any changes in these physical and chemical variables can affect aquatic biota in a variety of ways.

The research aim to be carried out during this two year study is to determine and integrate the physicochemical parameters and nutrient concentration, at river Arasalar thereby determining the quality of waters. This study will provide baseline information on the trophic status of the rivers for further studies in the Cauvery River and its tributaries Arasalar. The knowledge acquired will be useful in the management of these important ecosystem and natural resources of the river for the survival and continued economic benefits to the community. This study will cover a gap in knowledge of biotic (fauna and flora) and abiotic (water and sediment) components, with special regard to physical and chemical monitoring.

Study site

Kumbakonam in Tanjore district is located at 10º 59' north latitude and 79º 23' longitudes. India, along the certain holy river-edge settlements have grown into religious centers or holy cities. Kumbakonam is one such city in Tamilnadu, along the Cauvery River; located in the delta between the Cauvery and its tributary Arasalar. The city has developed in the delta between the Cauvery River to the north and the Arasalar River, to the south and has a gentle slope from north-west to south-east. Cauvery originates in Karnataka at Talakaveri, in Kodagu and flows down through Kushal Nagar, Srirangapatna, and Shivanasamudram before reaching Hogennikal and Srirangam in Tamilnadu. In Erode in Tamilnadu two more tributaries join it – Noyyal and Amaravathi. In Trichirapalli, it branches out in to Coleroon and Cauvery. Cauvery again divides in to Arasalar and Cauvery at Papanasam, near Kumbakonam.

The Arasalar is tributaries of the river Cauvery, having a total run of 24 km. It enters Karaikal region, a little east of Akalanganni. It forms the natural boundary line separating Niravi Commune from Tirunallar on the north-west and Karaikal on the north east. The Nattar, branching off from Arasalar at Sakkotai in Thanjavur District, runs a distance of 11.2km in a south-easterly direction across Nedungadu and Kottucheri Communes before emptying itself into the sea. The Vanjiar fed by the Arasalar, takes its course along the northern boundary of Tirunallar Commune, drops on a south-easterly curve towards Karaikal Commune and merges with the Arasalar, south-east of Karaikal town after covering a distance of about 9 km. The Nular, also fed by the Arasalar, runs a distance of 13.77 km. before it joins Vanjiar northeast of Karaikal town.

Sampling and analysis of water

In the present study, seasonal variations in physical and chemical parameters of river Cauvery were studied at Kumbakoam about 35 km from Thanjavur dt, Tamil Nadu. The sampling started on 10th January 2010 and continued up to December 12th 2010.The study period consists of 12 months. The river Cauvery there are three sampling station designated as station 1 (S1 - upstream of the river) station 2 (S2 - mid stream of the river) and station 3 (S3 - down steam of the river) were established for sampling purpose. Water samples were collected from three locations on monthly basis using a standard water sampler. At each station three samples were collected from 1/3, 1/2, and 2/3 width of the river along transect and mixed together to obtain a composite sample. All the samples were collected from the upper 15cm of the water surface and stored in polyethylene bottles fitted with screw caps. At the time of sampling, the air and water temperature were recorded by using alcoholic bulb and digital thermometer. Determination of pH and conductance were all so performed on site using portable meters (Henna pen type, Portugal) while all other parameters were analyzed by following standard methods given in [4, 31]. These parameters were compared with the water quality standards to indicators to indicate probable pollution in river.

RESULTS AND DISCUSSION

Presence of nutrients in water is judged on several factors among the various physicochemical, biological and biochemical factors are considered as most vital factor which indicates oxygen level, ionic status and biological activity in water respectively. Data of the mean and range values of nutrients of the river Arasalar for a period of one year (Jan to Dec 2010) are presented in the Table 1 while correlation matrix among various nutrients in river Arasalar at three stations has been shown in table 2, 3 and 4. Results of nutrient distribution in River Arasalar at three stations depicted in Fig 1.

Water temperature plays an important role in influencing the quality and ecology of streams and rivers. It affects not only the physical nature of water by changing the viscosity, density and surface tension but also the rate and types of chemical reactions that occur within. Water temperature is thus an important factor that influences that rate of all biological activities. Temperature can therefore be used as a first step in predicting the effects of mans activities on the aquatic ecosystem [23]. The water temperature was ranging from 26°C to 32°C during the study period. The minimum water temperature (26°C) was observed in December at S1 and maximum temperature (32°C) was observed in April at S3. The mean value of water temperature observed to be 29±1.58ºC, 28.84±1.62ºC and 29±1.47ºC for S1, S2, and S3 respectively. Water samples collected in the river Arasalar showed lower temperature in the monsoon season. In the summer season it was found to be highest. Similar seasonal variation in water temperature was recorded by [6] in river Cauvery.

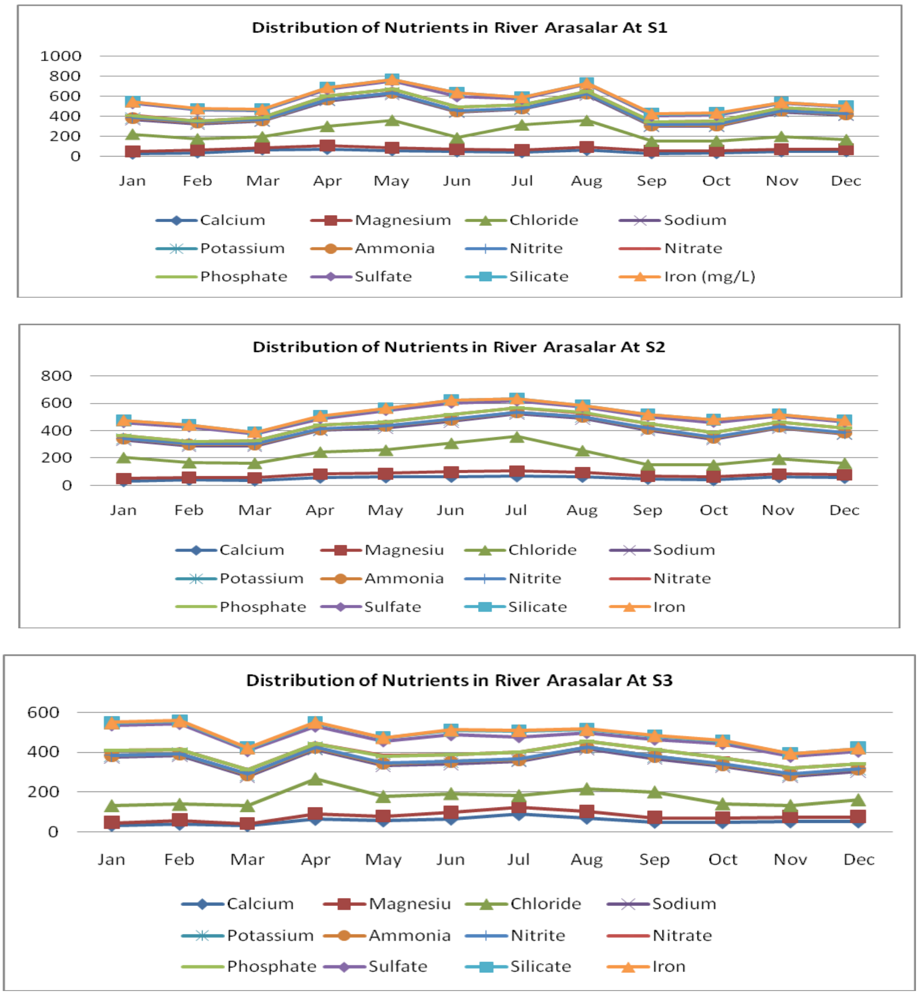

Fig1. Results of Nutrient Distribution in River Arasalar at Kumbakonam (Jan – Dec 2010)

Table 1 Range value Mean value and Standard Deviation of nutrient concentration of River Arasalar

Water quality Parameters	Range value			Mean value ± Standard Deviation			WHO Guide line
	S1	S2	S3	Station 1	Station 2	Station 3	
Water temperature(°C)	26-32	26-32	27-32	29 ± 1.58	28.84 ± 1.62	29 ± 1.47	40
pH	7.5-8.2	7.6-8.4	7.6-8.3	7.79 ± 0.21	7.93 ± 0.26	7.88 ± 0.26	6.5-8.5
Dissolved oxygen(mg/L)	5.4-7.4	5.1-7.5	5.2-7.7	6.46 ± 0.59	6.36 ± 0.76	6.42 ± 0.80	5.0-6.0
Calcium (mg/L)	26.66-72.14	32.06-67.33	33.66-88.77	47.616 ± 15.311	52.535±12.099	54.254±16.152	75
Magnesium (mg/L)	18.7-35.1	16.67-37.73	13.13-36.41	24.650 ± 4.717	24.964±6.172	24.271±7.843	50
Chloride (mg/L)	93.72-272.2	83.72-252.1	56.8-173.24	158.145±69.755	141.161±54.000	94.406±32.345	200
Sodium (mg/L)	145-260	118-249	142-245	200.583±53.615	175.583±44.914	175.333±36.824	200
Potassium (mg/L)	8.15-17.25	8.32-15.25	6.5-12.5	12.688± 2.717	12.013±2.355	8.85±1.819	10
Ammonia (mg/L)	0.26-0.82	0.16-0.73	0.06-0.6	0.455±0.163	0.319±0.166	0.29±0.179	-
Nitrite (mg/L)	2.2-4.9	2.3-4.7	2.2-4.8	3.75±0.799	3.366±0.806	3.6±0.737	3
Nitrate (mg/L)	13.91-40	12.61-32.84	15.82-34.2	30.746±7.651	26.413±6.375	25.979±6.707	50
Phosphate (mg/L)	0.85-1.9	0.9-1.8	0.9-1.96	1.267±0.314	1.259±0.277	1.521±0.381	0.1
Sulfate (mg/L)	33.93-114.4	42.52-109.1	42.9-132	67.174±25.377	66.492±22.913	82.730±27.850	200
Silicate (mg/L)	10.52-41.2	9.1-20.2	10.32-28.8	18.332±8.229	12.8116±3.2539	15.398±5.206	-
Iron (mg/L)	0.22-1.72	0.89-2.1	0.33-1.56	0.890±0.529	1.369±0.652	0.852±0.420	1

Table 2 Correlation matrix among various nutrients in river Arasalar at S1

S1	Calcium	Magnesium	Chloride	Sodium	Potassium	Ammonia	Nitrite	Nitrate	Phosphate	Sulphate	Silicate	Iron
Calcium	1											
Magnesium	0.449894	1										
Chloride	0.36143	0.405644	1									
Sodium	0.655671	0.496237	0.330423	1								
Potassium	-0.01756	0.11961	0.149453	-0.10724	1							
Ammonia	-0.8558	-0.38748	-0.32416	-0.62317	0.326841	1						
Nitrite	0.042007	-0.45673	0.000259	0.294709	-0.02607	-0.08895	1					
Nitrate	0.044951	0.281263	0.196991	0.293054	-0.74124	-0.18586	-0.11191	1				
Phosphate	0.425481	0.598965	0.260991	0.720424	0.186706	-0.48881	0.122179	-0.03837	1			
Sulfate	-0.22037	-0.17303	0.056162	-0.20139	0.587443	0.453495	0.226163	-0.35613	0.084301	1		
Silicate	-0.20481	0.096956	-0.17933	0.083661	-0.33555	0.122925	0.147315	0.525677	0.160656	0.414724	1	
Iron	0.169365	0.061178	0.214561	-0.04467	0.669808	0.132709	-0.09071	-0.35355	0.138303	0.729615	0.047308	1

Table 3 Correlation matrix among various nutrients in river Arasalar at S2

S2	Calcium	Magnesium	Chloride	Sodium	Potassium	Ammonia	Nitrite	Nitrate	Phosphate	Sulphate	Silicate	Iron
Calcium	1											
Magnesium	0.793389	1										
Chloride	0.563536	0.828312	1									
Sodium	0.448676	0.133548	-0.30341	1								
Potassium	0.008315	0.102038	0.315738	-0.29447	1							
Ammonia	-0.41176	-0.3657	-0.0604	-0.1966	-0.17006	1						
Nitrite	-0.07654	-0.22856	-0.18205	-0.09559	0.444397	-0.10547	1					
Nitrate	0.487565	0.473108	-0.00028	0.748241	-0.41417	-0.17272	-0.14029	1				
Phosphate	0.154591	0.037286	-0.30407	0.733865	0.254555	-0.20245	0.333345	0.583402	1			
Sulfate	-0.44075	-0.2541	0.09671	-0.66825	0.629098	0.380364	0.441189	-0.55251	-0.10656	1		
Silicate	0.129046	0.483846	0.477345	-0.32134	0.170903	-0.02577	0.419074	0.248504	0.033678	0.382299	1	
Iron	0.223419	0.253712	-0.04487	0.329834	-0.34234	-0.14581	-0.26986	0.554072	0.259395	-0.13869	0.182322	1

The pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent. Optimal pH range for sustainable aquatic life is pH 6.5 – 8.2. In the present study the mean values of pH at three sites of river ranged between 7.5 and 8.4 which are in accordance with the prescribed limit of 6.5-8.5 [33]. The minimum value (7.4) was recorded in November at S1 and maximum (8.4) in the month of November at S2. The mean value of pH recorded was 7.79±0.26, 7.93±0.26 and 7.88±0.26 for S1, S2, and S3 respectively. All these three stations showed alkaline condition throughout the study period. Alkaline pH was also observed by [24] in river Chambal during whole study period. However the alkaline pH formed throughout the year reveals that it is a potential for high production characteristic. According to [25] high pH was more productive than low pH.

Table 4 Correlation matrix among various nutrients in river Arasalar at S3

S3	Calcium	Magnesium	Chloride	Sodium	Potassium	Ammonia	Nitrite	Nitrate	Phosphate	Sulphate	Silicate	Iron
Calcium	1											
Magnesium	0.947262	1										
Chloride	0.069655	0.070069	1									
Sodium	-0.27846	-0.26433	-0.16741	1								
Potassium	0.005664	0.064033	-0.21521	-0.58047	1							
Ammonia	-0.02284	-0.11223	0.536669	0.108103	-0.66908	1						
Nitrite	-0.57311	-0.5417	-0.43611	0.008371	0.153796	-0.03306	1					
Nitrate	0.487182	0.486687	-0.26584	-0.26882	0.421259	-0.4828	-0.41129	1				
Phosphate	-0.30644	-0.37923	-0.18367	0.455129	-0.45764	0.503505	0.320282	-0.70562	1			
Sulfate	-0.43344	-0.47016	-0.1107	0.530728	-0.04033	0.140529	0.464739	-0.5339	0.594223	1		
Silicate	0.875216	0.776835	-0.00049	-0.27693	0.069843	0.158155	-0.40602	0.372392	-0.02007	-0.11147	1	
Iron	0.702665	0.606182	0.346312	-0.32465	0.15198	0.096271	-0.71742	0.322064	-0.14463	-0.18353	0.761124	1

Dissolved oxygen (DO) is very crucial for the survival of aquatic organisms and it is also used to evaluate the degree of freshness of a river [2]. Dissolved oxygen is the fundamental factor for the metabolism of the aerobic aquatic organisms and therefore its dynamic is important for the understanding of their distribution, behavior and growth. The distribution of dissolved oxygen affects the solubility of nutrient [35]. The solubility of dissolved oxygen is affected by temperature and its concentration varies with the dynamics of losses and productions mainly due to consumption by bacteria and other organisms through respiration, oxidizable organic matter and photosynthesis. During the present study, DO values were fluctuated between 5.1 to 7.7 mg/L in water samples collected from three sampling sites. DO values of water samples were found minimum (5.1 mg/L) in the month of June at S2 and maximum (7.7 mg/L) in the month of August at S3. The average value of dissolved oxygen was found to be 6.46±0.59, 6.36±0.76 and 6.42±0.80 for S1, S2, and S3 respectively. Dissolved oxygen showed maximum values in winter season. It may be due to temperature variations. Dissolved oxygen showed inverse relationship with water temperature [3]. Similar type of results was observed in present study as dissolved oxygen decreased with increase in temperature. This level of oxygen in the river should be able to support good fauna and flora.

Principal cat ions imparting hardness are calcium and magnesium. Calcium is an important micronutrient in an aquatic environment. Magnesium content of water is considered as one of the most important qualitative criteria in determining quality of water for irrigation. Generally, calcium and magnesium maintain a state of equilibrium in most waters. Generally, the calcium contents in the water is affected by the adsorption of the calcium ion on the metallic oxides in addition to, the effect of the microorganisms which play an important role in the calcium exchange between sediment and overlying water [10]. The Calcium content of water samples ranged between 26.66 and 88.77mg/L. The minimum value of calcium in the river was 26.66mgl/L at S1 in the month of January and maximum value was 88.77mg/L at Station 3 in the month of July. The mean calcium concentration in the study area varied from 47.616±15.311, 52.535±12.099 and 54.254±16.152 for S1, S2 and S3 respectively. Similarly the magnesium was ranging from 13.13mg/L to 37.73mg/L during the study period. The minimum magnesium (13.13mg/L) was observed in July at S2 and maximum (37.73mg/L) was observed in January at S3. The mean value of magnesium observed to be 24.650±4.717, 24.964±6.172 and 24.271±7.843mg/L for the S1, S2 and S3 respectively.

Cat ion of calcium and magnesium contribute to the hardness of water. Barrett (1953) has reported that the hard waters are more productive than the soft water from fisheries point of view. However, low values do not mean that it is not influenced by the pollutants but it might be due to the reverse cationic exchange with sodium i.e. sodium ions replace Ca and Mg ions there by reducing their concentration. In the present study, higher values of sodium are recorded, wherever there is low calcium and magnesium concentrations. The magnesium also follows the same trend as that of calcium. However magnesium content was less than that of calcium in natural bodies. The calcium and magnesium concentration in the present study was found to be well within the permissible limits of [33].
Chloride is a major anion of the element chlorine [33]. Chloride due to its high solubility is a common constituent of water after accumulating to values as high as a few hundred mg/L [8]. Chloride ions are important compounds of all living systems contributing to the osmotic, ionic as well as water regulation functions within organisms. The monthly variation in chloride ranged between 56.8mg/L and 272.2mg/L. The minimum value (56.8mg/L) was recorded in July at S3 and maximum (272.2mg/L) in the month of May at S1. The annual mean values were observed to be 93.72±272.2, 83.72±252.1 and 56.8±173.24mg/L for the S1, S2 and S3 respectively. Chloride ions exhibit no toxic effects upon living systems [7]. In the present study high values of chloride in summer months may be associated with high temperature which enhances the evaporation, reducing the volume of water thus resulting in the high concentration of salts. Chloride also gets added to waters from the discharge of industrial effluents or contamination with sewage [29]. High concentration of chloride is considered to be the indicators of pollution due to organic wastes of animal or industrial origin. High values of chloride are troublesome in irrigation water and also harmful to aquatic life [32].
Sodium and potassium are the most important minerals occurring naturally. The major source of both the cat ions may be weathering of rocks besides the sewage and industrial effluents. The sodium content of water samples ranged between 118 and 260mg/L. The minimum value of sodium in the river was 118mg/L at S2 in the month of February and maximum value was 260mg/L at S1 in the month of May. The mean Sodium concentration in the study area varied from 200200.583±53.615, 175.583±44.914 and 175.333±36.824mg/L for the S1, S2 and S3 respectively. Similarly, the Potassium was ranging from 6.5mg/L to 17.25mg/L during the study period. The minimum Potassium (6.5mg/L) was observed in February at S3 and maximum (17.25mg/L) was observed in February at S1. The mean value of Potassium observed to be 12.688±2.717, 12.013±2.355 and 8.85±1.819mg/L for the S1, S2 and S3 respectively. In the present study, high values of sodium and potassium are attributed to the possible contamination by domestic sewages and effluents. Soils retain sodium and potassium to a greater degree than chloride or nitrate. Therefore, sodium and potassium are not as useful as pollution indicators [37]. Increase in sodium and potassium values over time can mean there are long-term effects caused by pollution. Although not normally toxic themselves, these compounds strongly indicate possible contamination from more damaging compounds.
Ammonia in natural waters is the product of the breakdown of nitrogenous organic and inorganic matter in soil and water as well as excretion by biota and reduction of nitrogen gas by microbes [35]. Ammonia is a common pollutant that occurs in the free un-ionized form or as ammonium ions. Both are reduced forms of inorganic nitrogen derived from the decomposition of organic material. Ammonia is commonly associated with sewage and industrial effluents and forms part of many fertilizers [7, 8]. The toxicity of ammonia is directly related to concentration of the un-ionized form. The ammonium ions has very little or no toxicity [33]. Arasalar River had a range of ammonia concentration between 0.06mg/L and 0.82mg/L. It was minimum (0.06mg/L) in June at S3 and maximum (0.82mg/L) in the month of January at S1. Mean levels of ammonia were 0.455±0.163, 0.319±0.166 and 0.29±0.179mg/L for S1, S2 and S3, respectively. The concentrations of ammonia in the Arasalar River for the duration of the study were not alarming due to low anthropogenic activities reaching the river. Ammonia is naturally present in surface water and ground water and can be produced by the deamination of organic nitrogen containing compounds and by the hydrolysis of urea. The presence of ammonia is an evidence of sewage inflow to a water body. However, free ammonia serves as an indicator of aquatic pollution was generally absent or found in traces during most occasions in Narmada River [25]. Nitrite is the intermediate in the conversion of ammonia in to nitrates through the process of nitrification and denitrification by bacteria. The nitrite content of water samples ranged between 2.1 and 4.9 mg/L. In the present investigation nitrite level was minimum (2.1mg/L) in September at S1 while maximum (4.9 mg/L) in November at S1. The average nitrite levels were 3.75±0.799, 3.366±0.806 and 3.6±0.737mg/L for S1, S2 and S3, respectively. In the present study the nitrate content is found to be above the permissible limit (10 mg/l). It is widely assumed that nitrite concentrations in freshwaters are negligible [28], and the worldwide average concentration has been estimated to be 1 mg of nitrite/liter.

Nitrite levels were higher than 1 mg/L during the present study. This increase of nitrite indicates the river receives very rich amount of organic matter. The concentrations of nitrite in the Arasalar River for the duration of the study were alarming due to high anthropogenic activities reaching the river. Nitrites are toxic at certain concentrations and can cause damage to gills as well as diffusing in to red blood cells was it results in the formation of methhaemoglobin. Methhaemoglobin lacks the ability to bind with oxygen thereby resulting in retarded oxygen transport. During highly active periods death can result due to anoxia [7].

The nitrate is also one of the important factors of water quality. Nitrate is an essential nutrient but also a good indicator of contamination from natural and human activities. Sources include manures, inorganic fertilizer and on-site sewage disposal systems. Nitrates however were noted in higher concentrations throughout the sampling, values ranging from as low as 12.61mg/L to 40 mg/L. The minimum value (12.61mg/L) was observed in February at S2 and maximum value (40 mg/L) in the month of July at S1. Mean levels of nitrate were 30.746±7.651, 26.413±6.375 and 25.979±6.707mg/L for S1, S2 and S3, respectively. Levels above 5 mg/l are considered harmful to aquatic organisms. [29]. Nitrates can enter waters via fertilizers and agricultural runoff and are often found in high concentrations in ground water. Nitrates in high concentrations can be toxic to juveniles however generally nitrates are non-toxic [7]. The sampling sites investigated are all situated in agricultural and subsistence farming areas and thus higher nitrate levels were to be expected during the high flow due to an increase in runoff from the land. Phosphate is present in natural waters as soluble phosphates and organic phosphates. Phosphorus is an important macronutrient and plays a major role in the structure of nucleic acids and in molecules (e.g. ATP) that are involved in the storage and use of energy in cells. In surface waters it occurs most commonly either as orthophosphates or as polyphosphates. Orthophosphate is in a form that is immediately available to aquatic biota. Phosphorus is seldom found in high concentrations in non-polluted water due to the fact that it is utilized by plants and sequestered by cells [7]. During the present study, phosphate values were fluctuated between 0.85mg/L to 2.2mg/L in water samples collected from three sampling sites. Phosphate values of water samples were found minimum (0.85 mg/L) in the month of July at S1 and maximum (2.2 mg/L) in the month of February at S3. The average value of phosphate was found to be 1.267±0.314, 1.259±0.277 and 1.521±0.381mg/L for S1, S2 and S3 respectively. Major source of phosphate in water are domestic sewage, agriculture effluents and industrial waste waters. The high concentration of phosphate is, therefore, indicative of pollution [26] have reported higher phosphate content in lower stretch of Ganga River during monsoon season. Many researchers have observed an increase in phosphate concentration in such of the water bodies that receives domestic waste [21]. In the present investigation same thing was encountered.

Sulphur is an important building block of proteins and many other organic compounds. Within water it occurs mostly as the sulphate ion. Sulphate is the stable form of sulphur and is non-toxic, however occurring in excess sulphates form sulphuric acid (H_2So_4). This acid can have a devastating effect upon aquatic ecosystems [30, 22]. The mean concentration of sulphate was found in the range of 33.93 to 132 mg/l (Fig.2.10) which is within the range of prescribed drinking water standards (200 mg/l). In the present investigation sulfate level was minimum (33.93mg/L) in December at station S1 while maximum (132 mg/L) in February at S3. The average Sulphate levels were 167.174±25.377, 66.492±22.913 and 82.730±27.850mg/L for S1 and S2 and S3 respectively. The lower values of sulphate recorded could be because sulphate easily precipitates and settles to the bottom sediment of the river [1]. The sulfates are derived from discharge of domestic sewage, surface runoff and agricultural activity near by the water bodies, during rainy season all these wastes which seepage and bring sulfates to the river body. In the present study, the values of the sulphate in all the water samples were within the permissible limit. Similar report was recorded by the studies of [15].

Silica is quite abundant on the earth but silicates remain meager in water. The major source of dissolved silica in river is the weathering of rocks and mineral in the catchments area. Silicate is an essential nutrient for growth of diatoms that are important food to fishes [13]. The monthly variation in silicate ranged between 9.1mg/L and 41.2mg/L. The minimum value (9.1mg/L) was recorded in August at S2 and maximum (41.2 mg/L) in the month of June at S1. The annual mean values were observed to be 18.332±8.229, 12.811±3.253 and 15.398±5.206mg/L for the S1, S2 and S3 respectively. Silicates in river water exist mainly in the form of silicic acid and reactive polymer. The release of silicic acid depends on the availability of CO_2 or bicarbonates. The observed values are in agreement with the results recorded earlier by [18].

Iron is the fourth most abundant element found within the earth crust and can therefore occur in waters in varying degrees depending on the geology of the area [9]. It commonly occurs in two oxidative states, namely ferrous and ferric of which the later is essentially unavailable for uptake. The iron content of water samples ranged between 0.22 and 1.72 mg/L. In the present investigation nitrite level was minimum (0.22mg/L) in December at station S1 while maximum (1.72 mg/L) in May at S3. The average nitrite levels were 0.890±0.529, 1.369±0.652 and 0.852±0.420mg/L for S1, S2 and S3, respectively. Iron is regarded as an essential micronutrient and forms an important part of haeme-containing respiratory pigments. At high concentrations Fe becomes toxic, inhibiting various enzymes [7].

CONCLUSION

The results indicated that most of the physico-chemical quality parameters of River Arasalar were within the WHO limits for drinking water and, therefore, may be suitable for domestic purposes. In contrast, however, nutrient levels were high during the study period and did not give any clear seasonal variation. Water quality assessment of Arasalar River revealed strictly contamination from anthropogenic activities. During the period of monsoonal flow from contributories of Arasalar River, the sampling stations recorded comparatively higher pollutants such as phosphate and nitrite. Higher phosphate and Nitrite content recorded in water samples indicate pollution from fertilizer runoff from agricultural fields, sewage, and other non-point sources. In conclusion, surface water in the delta regions of Arasalar River showed contamination of phosphate and Nitrite if compared with WHO standards.

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