Journal of Environmental Science and Pollution Research 2(3) (2016) 103–106

ISSN: 2455-0272

Contents List available at JACS Directory

Journal of Environmental Science and Pollution Research

journal homepage: http://www.jacsdirectory.com/jespr

Assessment of Water Quality in Relation to Health Hazards in The Holy Ponds of Puri Town, Odisha, India

S. Satapathy, S.D. Sharma*, C.R. Panda

CSIR-Institute of Minerals and Materials Technology (IMMT), Council of Scientific and Industrial Research, Bhubaneswar – 751 013, Odisha, India.

ARTICLE DETAILS

Article history:
Received 02 August 2016
Accepted 17 August 2016
Available online 10 September 2016

Keywords:
Holy Ponds
Physicochemical Parameter
Bacteriological Analysis
Environmental Threats
Health Hazard

ABSTRACT

This study was intended to assess the water quality and level of sewage pollution indicator bacteria and their discrepancy in the holy ponds of Puri. For experimental point of view, five different ponds were taken during year 2015, in order to assess the pollution load and its effect to human health. The hydrobiological parameters like water temperature (WT) conductivity, pH, chemical oxygen demand (COD), biological oxygen demand (BOD) and dissolved oxygen (DO), nitrite, nitrate, ammonia, chloride, sodium were taken. The bacteriological parameters such as *Total Coliform* (TC), *Fecal streptococci* (FS) and *Fecal Coliform* (FC) were analysed for the suitability of the water for different uses like drinking and other domestic applications. It is revealed that all the five holy ponds i.e. Narendra Pond, Indradyumna Pond, Swetaganga, ParvatiPond and Markandeswar pond are being polluted day by day and totally unfit for both drinking and bathing purpose under BIS standard. Among the ponds; Swetaganga is found to be most polluted followed by Parvati Pond and others. The objective of the present study is to review the current status of pond ecosystem of the holy land Puri and to present a possible indication for threats against these ecosystems.

1. Introduction

Water is a chief source for domestic, industrial and agricultural use as well as providing food. Ponds are habitats of human importance. In spite of their fundamental importance to humans, freshwater pond ecosystems have been rigorously affected by a massive amount of anthropogenic disturbances, which have led to serious negative effects on the structure and function of these ecosystems. Water availability is a basis for human civilization but increasing human populations have resulted in rising burden on water supplies for drinking, hygiene, industrial processes and agriculture (irrigation). Analysis of water availability and human use imply that human extraction of the total available freshwater resource currently amounts around 50 % [1]. The expected population will significantly raise the demand for freshwater resources, and without ambiguity, the availability of fresh water for human consumption will be one of the great issues for humankind in the 21st century [2]. In spite of the significant importance of fresh water of high quality to humans, it has been misused from time immemorial.

The healthy aquatic ecosystem depends on the biological diversity and Physico-chemical property. Microorganisms are usually dispersed in nature and diversity of microorganisms is used as an indicator for organic pollution [3]. Bacteriological assessment of drinking water usually represents concentration of particular species of bacteria and their amount [4]. Higher level of indicator bacteria (Fecal coli and Total coliform) is directly proportional to fecal contamination and greater the risk of water-borne diseases [5]. Cryptosporidiosis, typhoid fever, Cholera, dysentery, hepatitis is a few waterborne diseases that spread through polluted water. Human fecal material is in general caused greater risk to human health because it contains human enteric pathogens [6].

Discharge of organic wastes human excreta, sewage waste, polythenes, municipal garbage and wastes of temples increasing bacterial pollution in the holy ponds of Puri and subsequently posing a serious threat to the water ecology, animals and human. Fecal polluted water may cause health hazard for users due to the presence of several microbial pathogens, including bacteria, viruses, fungi and protozoa [7]. As millions of pilgrims come to Puri from all over the world every year and consume the water of this holy pond thinking it to be pious. Hence, the aim of the study is to disclose the pollution status of the holy ponds of Puri in terms of Physicochemical and bacteriological characteristics. The problem of water pollution is more complex than other pollution due to its slower rate of regeneration, self-purification and easy spreading of disease.

Fresh water is essential for agriculture, industry and human existence; it is a finite resource of earth. Without adequate quantity and quality of fresh water sustainable development will not be possible [8]. Fresh water resource are becoming deteriorate day-by-day at the very faster rate. Now water quality is a global problem [9]. The healthy aquatic ecosystem is depended on the biological diversity and Physico-chemical characteristics [10]. Microorganisms are widely distributed in nature and diversity of microorganisms may be used as an indicator for organic pollution [3]. Bacteriological quality of drinking water usually shows concentration of particular species of bacteria and their occurrence [4]. High levels of fecal-indicator bacteria can be indicated by presence of pathogenic microorganisms present in water body. Higher the level of indicator bacteria is directly propositional to fecal contamination and greater the risk of water-borne diseases [5]. Cryptosporidiosis, typhoid fever, Cholera, dysentery and hepatitis is some of the common waterborne diseases that spread through contaminated water.

Human fecal material is generally caused greater risk to human health because it contains human enteric pathogens [6]. *Fecal coliform* and *Fecal streptococci* are most widely used indicator bacteria [11-13]. Bacteria concentration in a sample of water means the number of bacteria colonies present in per 100 millilitres (col/100 mL) of water sample. Discharge of organic wastes human excreta, sewage waste, polythenes, municipal garbage and toxic discharge from the factories increasing bacterial pollution in the Puri city. This waste flows into the drains, mixing with common water and subsequently posing a serious threat to the water ecology, animals and human. Fecal polluted water may cause health hazard for people due to the presence of several microbial pathogens, including bacteria, viruses, fungi and protozoa [7].

Thus, the objective of the present study is to assess the current status of five pond ecosystem of the holy land of Puri and to present a possible indication for threats against these ecosystems. We have mainly focussed on the effects of anthropogenic disturbances on fresh water ecosystems in the holy places of Puri, especially with regards to how the physico-chemical parameters and Bacteriological parameters of these systems are being affected by human disturbances.

*Corresponding Author
Email Address: sbdsharma1984@gmail.com (Satyabrata Das Sharma)

Cite this Article as: S. Satapathy, S.D. Sharma, C. R. Panda, Assessment of water quality in relation to health hazards in the holy ponds of Puri town, Odisha, India, J. Env. Sci. Pollut. Res. 2(3) (2016) 103–106.

2. Experimental Methods

2.1 Sampling Location

The study area lies between 19.47' to 19.50'N latitude and 85.48' to 85.52'E longitude .The elevation varies from mean sea level longitude covering the area of 16 km^2. The Puri town boasts of famous temple of world famous lord Jagarnath, magnificent, idyllic beach and religious temples. Though the ponds in Puri town are used for bathing purpose by local people, the temple ponds occupy a special status as it caters to other needs such as the rituals associated with the deities. The water of the 5 holy ponds of Puri are being used for various purposes from drinking to irrigation, bathing and various house hold uses including various seasonal rituals of lord Jagannath. Very often the temple wastes are thrown into the ponds, which add to its pollution level. The consideration of physicochemical factor is basic in understanding the tropic dynamics of water body. Each factor does play its individual role. Being lotic and stagnant, there is very less scope of the flow of fresh water into these ponds. Hence the pollutant level including bacteriological fauna creates unhealthy situation to which local people are exposed, leading to various health hazards. As there is perennial flow of people into Puri throughout the year and the temple ponds are the integral part of its tradition and ritual. Samples of ponds water have been analyzed to find out their water quality index.

Puri occupies a distinct and unique place in the tourist map of India. The city is also popular for its mythological ponds such as Narendra pond, Markandeswar pond, Indrawimna Pond, Parvati Pond and Sweta Ganga are the five holy ponds of Puri. These ponds are used by people for daily ablution and seasonal rituals. But due to urbanization and development activity the ponds of this city is struggling for its existence. In spite of the global alarm for restoration of water bodies, the ponds of this city are facing negligence. So it is the high time to access the quality of water and ascertain its usability. Considering the above fact the present investigation was undertaken. As part of the investigation some holy ponds are selected for detailed physicochemical analysis of water with different parameters. The water of the 5 holy ponds of Puri is being used for various purposes from drinking to irrigation, bathing and various house hold uses and most importantly in many rituals of the deity lord Jagarnath. But changes in its physical, chemical and biological properties have made it unsuitable for human consumption. The various sources of pollution include municipal sewage, drainage from various villages nearby; agriculture waste like insecticide; pesticide and inorganic fertilizer are continuously flowing in to these water banks. Around 30 villages surrounding the Jagarnath temple depends on these ponds for their daily house hold work including drinking purpose. Its play a significant role to the pilgrims who are coming from all over world to visit this holy place and take a holy deep in these ponds .That's why it is inevitable to study its physical, chemical as well as bacteriological parameters and record its pollution level and recommend the remediation.

In order to know the pollution potential of these pond parameter like pH, DO, BOD, COD, conductivity, Nitrate, Alkalinity, Total Hardness, *Fecal coliform*, *Total coliform* are analyzed and compared with the BIS standard.

2.2 Sampling Site and Description

2.2.1 Indradwimna Pond

It is located on the north western side of the Gundicha temple, being one among the 5 sacred Ponds of Puri, a vast no of piligrims come here to take holy deep due to its religious importance. Being 396 feet wide and 485 feet long and covers an area of 4.5 acre of land. As its embankments are closed at four sides its water can never be recirculated and remain constant. Adding to it more and more house hold garbage are dumped every day. During festive season the holy water is being taken by the people and also used to Lord Jagganath. Also 3 nearby villages totally depend upon this pond. But gradually its water is getting so polluted that it has reached the tolerance limit of unusable water parameter according to the state pollution control board, BBSR.

2.2.2 Narendra Pond

It is the largest Pond of Orissa and is also another worst polluted Pond of Orissa. It is built in the 15th century and is 10 feet below the road level. Its water is used for drinking purpose by the people of nearby villages, and also used.

2.2.3 Markandeswar Pond

Pond is an open structure and it is enclosed .rectangular in shape, 8.50 meters below the present road level. Its size varies from 350 feet northern, 508 feet eastern, 385 feet on the southern and 542 feet on the west side. It is existed beside the temple.

2.2.4 Sweta Ganga

It is a small sacred Pond situated to the west of Jagarnath temple. It is believed there is an underground connection between Sweta Ganga and river Ganga. It is one of the pancha tirthas of Puri. But as it is the 5 holy ponds of Puri, it is always over crowded with tourists. In addition to 5 sewage Ponds other sewages of Puri town is being poured into the water body. So it remains polluted throughout the year.

2.2.5 Parvati Pond

It is located inside the Lokanath temple another famous tourist place of Orissa. Lakhs of pilgrims come to this place in the month of Shrabana.

2.3 Physico-Chemical Analysis

The temperatures of the samples were noted at the sampling time in the sampling point. The samples were taken during the year of 2015 and examined in the laboratory of state pollution control board (SPCB), Orissa to analyze the physico-chemical parameters. Analysis was carried out for various water quality parameters such as Temperature of Water, pH, Conductivity, nitrite, Nitrate, Ammonia, Total Hardness (TH), Alkalinity Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), and Dissolved Oxygen (DO) using standard method of APHA, 2005 [14]. The reagents used for the analysis were of analytical grade and double distilled water was used for preparation of solutions.

2.4 Bacteriological Analysis

The bacterial indicators of sewage pollution i.e. *Total Coli* (TC), *Fecal Coli* (FC), and *Fecal Streptococcus* (FS) were assessed together by MPN method [14] and the ratio of FC/FS were calculated. The analysis was carried out in the laboratory of state pollution control board, Orissa.

2.5 Statistical Analysis

All the statistical analysis was performed and graphs are plotted on STATISTICA (version 7.0).

3. Results and Discussion

To assess the pollution and contamination level in the holy ponds of Puri, five different ponds such as Narendra, Indradyumna, Swetaganga, Parvati and Markandeswar pond were taken for experiment. The physico-chemical and biological parameter like pH, DO, BOD, COD, Conductivity, nitrate, Ammonia, nitrite, Alkalinity, Chloride, Total hardness, Total and *fecal coliform* were analyzed. The values of different parameters are shown in Tables 1 and 2, and compared with BIS standard (Table 3) regarding its classification. Furthermore, for better understanding statistical analysis was made among physic-chemical and bacteriological parameters (Table 4). It was observed that pH values of all these ponds are in arrange of 8.5 which are just same to the maximum range of standard i.e. 6.5-8.5. The dissolved oxygen content varied from 6.4 to 23.1 mg/L. BOD values ranged from 2.2 mg/L to 12 mg/L when comparison was made among the five ponds. During the present observation, COD value was found between 19.7 mg/L to 57.6 mg/L. The conductivity of the five ponds was in range of 571 ms/cm to 2770 ms/cm. The value of nitrate was found to be 1.1 to 3.1 mg/L and ammonia in water varied from 0.336 to 0.78 mg/L. Similarly alkalinity in the holy ponds of Puri were encountered in range of 84 to 232 mg/L. Likewise, hardness of pond water varied from 52 to 236 mg/L and chloride was ranged from 90-159 mg/L, which was on the higher side of the range of chloride. The ratio of FC and FS ratio of Narendra Pond, Markandeswar Pond, Indradwimna Pond, Swetaganga and Parvati Pond were such as 1.83, 1.83, 2.09, 1.088 and 2.18 respectively.

Table 1 Physico-chemical analysis of five holy Ponds of Puri

Location	Narendra Pond	Markandes-war Pond	Indradwim-na Pond	Swetaganga Pond	Parvati Pond
pH	8.5	8.5	8.5	8.5	8.4
DO (mg/L)	23.1	8.5	11.5	6.4	6.6
BOD (mg/L)	6.7	2.7	2.2	12	4
COD (mg/L)	52.1	19.7	28	57.4	28
Conductivity (ms/cm)	1443	1244	1047	2770	571
Nitrate (mg/L)	2.85	7.1	1.1	3.1	1.3
NH_4^+(mg/L)	0.67	0.56	0.56	0.336	0.78
Nitrite (mg/L)	0.0013	0.0011	0.0014	0.0091	0.0001
Alkalinity (mg/L)	232	204	84	218	136
TH (mg/L)	220	224	52	236	132
Cl (mg/L)	140	100	110	159	90
Sodium (mg/L)	91.3	65.8	79.5	100.2	52.6

Cite this Article as: S. Satapathy, S.D. Sharma, C. R. Panda, Assessment of water quality in relation to health hazards in the holy ponds of Puri town, Odisha, India, J. Env. Sci. Pollut. Res. 2(3) (2016) 103–106.

Table 2 Bacteriological analysis of five holy Ponds of Puri

Location	Narendra Pond	Markandeswar Pond	Indradwimna Pond	Swetaganga Pond	Parvati Pond
TC (MPN/100 mL)	480	340	840	1100	1500
FC (MPN/100 mL)	220	220	460	490	700
FS (MPN/100 mL)	120	120	220	450	320
(FC/ FS)	1.83	1.83	2.09	1.08	2.18

TC = Total Coliform, FC = Fecal Coliform, FS = Fecal streptococci

Table 3 Tolerance limits for inland surface Water (BIS: 2296:-1982)

S. No	Parameter	Class A	Class B	Class C	Class D	Class E
1	PH					
2	DO(mgμ),min	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
3	BOD(5 days at 200C(mgμ)	6	5	4	4	-
4	*Total Coliform* (MPN/100 mL),max	50	500	5000	-	-
5	TDS(mg/L),Max	500		1500		2100
6	Total hardness as mgμ of $CaCo_3$,Max	300	-	-	-	-
7	Chloride(mg/L),Max	400		400		1000

Classification of water on the basis of usage

Class A - Drinking water source without conventional treatment but after disinfection

Class B - Outdoor Bathing

Class C - Drinking water source with conventional treatment but after disinfection

Class D - Fish culture and wild life propagation

Class E - Irrigation, Industrial cooling, Controlled water disposal.

Source: BIS (Bureau of Indian Standard)

The Narendra pond, Markandeswar pond, Indradyumna Pond, Swetaganga and Parvati Pond are the holy ponds of Puri, the temple city of Lord Jaggannath. These ponds are used by the local people as well as pilgrims for bathing and drinking purpose since decades. Neither the temple authorities nor the civic administration has taken adequate steps to manage these sacred water bodies. Therefore, it was necessary to access the quality of water and about its usability. In order to ascertain the pollution potential of these ponds, different physic-chemical and bacteriological parameters has been analysed.

The high pH value in the pond water is due to saline contamination with Bay of Bengal. The pH showed a positive correlation with Sodium, NH_4^+ TC, FC, Cl and conductance. The maximum and minimum DO was observed at Narendra pond and Swetaganga pond respectively as compared to standard for class A&B. Dissolved oxygen (DO) level in the rest of ponds were within the standard limit. However the high DO at Narendra Pond i.e. 23 mg/L is mainly due to the algal blooms in the pond. DO showed a positively correlation with TC and FC whereas no significant relation were found with other parameters. It was observed that BOD showed a positive correlation with COD, conductance, nitrite, alkalinity, Cl and Sodium and negatively correlated with Ammonia. From the statistical analysis, it was found that the COD value showed a positive correlation with BOD, conductance, nitrite, alkalinity, Cl and Sodium. The increasing levels of conductivity and cations are the products of decomposition and mineralization of organic materials [15]. Conductivity showed significant positive correlation with all the parameters except DO, Nitrate, NH_4, TC and FC. Conductivity of water is mainly due to the presence of cations and anions. High values of conductivity indicate the presence of high amount of ions. While the total dissolved solid, which is directly proportional to conductivity having the standard under class A i.e. 500 mg/L max, in the present study the conductivity was recorded minimum at Parvati Pond and Maximum at Swetaganga. From these results it was revealed that except Parvati Pond no pond could satisfy class A and B category with respect to conductivity. The ponds are usually being used by the devotees for their bathing purpose still the value of nitrate in the ponds was well within the standard limit. The value of nitrate indicates that all ponds are mostly free from sewerage contamination. It showed a significant negative correlation with TC and FC and positive with alkalinity and hardness. Ammonia occurs naturally in the water bodies or is generated by nitrifying bacteria in water. The minimum concentration was found at Swetaganga and maximum at Parvati Pond. No limit for Class A and B is prescribed by BIS. Ammonia showed a negative correlation with BOD and conductance whereas positive with pH, Nitrite, Cl and Sodium. Alkalinity in water is mainly due to carbonate, bicarbonate and hydroxide ion. Water having the high pH values generally posses' high alkalinity values which vary from 84 to 232 mg/L. No standard has been prescribed for class A and class B category, hence no comparison was made. Alkalinity showed correlation with BOD, COD, conductance, Nitrate, TH and chloride and negative with FC. Hardness in water is mainly due to calcium and magnesium. There are two types of hardness (a) permanent hardness and (b) temporary hardness. Hard water causes problem while washing and boiling. The minimum hardness was at Indradwimna Pond maximum was reported at Swetaganga. But all the other ponds showed values well within the prescribed limit i.e., 300 mg/L for class A category. During the present observation it was found that total hardness had positive correlation BOD, conductance, nitrate, alkalinity and Chloride. The chloride content of water on higher side may be due to saline water contamination from the sea flowing nearby. However, the values of chloride were well within the prescribed limit for class A category i.e. 400 mg/L. Chloride showed a positive significant correlation with all most all physicochemical parameters except DO, nitrate and bacteriological parameters. Sodium value has no standard under class A and class B category but the level of sodium in pond water was high, ranging from 52.6 to 100.2 mg/L It is mainly due to mixing effect of sea water.

The Bacteriological quality of these ponds was too higher in comparison to the standard limit of BSI. *Total Coli* (TC) values were higher in Parvati Pond followed by Swetaganga, Indradwimna Pond, Markandeswar Pond and Narendra Pond. Continuously growing pilgrims of Puri are mainly responsible amplified level of pollution. More than 50% of drain water of the city are being drained to these ponds which bring pathogen and organic matters like faeces, food, waste paper, dead plant, and humus. Rather than, poor people living nearby villages, discard their shit at river bank. The bacteriological parameters showed negative correlation with alkalinity and nitrate and positive with pH, DO, TH, Cl while the others were not so much significant. The result revealed that except *Total Coli* (TC), *Fecal Coli* (FC), *Fecal Streptocoli* (FS) and FC/FS were found to be higher in all the ponds. To see the results, it is clear that at all the sampling locations; *Total Coli, Fecal coli* and *Fecal Streptocoli* of all the ponds were beyond the permissible limit. They come under class B category according to BIS and were not suitable for drinking purpose without pretreatment.

Table 4 Correlation coefficients between the Physico-chemical parameters and bacteriological parameters in the ponds of Puri

	pH	DO	BOD	COD	Cond.	NO_3	NH_4	NO_2	Alk.	TC	FC	TH	Cl	Na
pH	1													
DO	0.37	1												
BOD	0.21	0.03	1											
COD	0.3	0.36	0.91	1										
Cond	0.57	0.08	0.89	0.77	1									
NO_3	0.41	0.09	-0.06	-0.24	0.2	1								
NH_4	0.67	0.3	-0.63	-0.45	-0.9	-0.27	1							
NO_2	0.38	0.31	0.89	0.71	0.96	0.03	0.89	1						
Alk	0.35	0.31	0.62	0.58	0.59	0.58	0.29	0.4	1					
TC	0.77	0.55	0.22	0.08	-0.08	-0.68	0.15	0.18	-0.42	1				
FC	0.78	0.61	0.07	-0.07	-0.19	-0.68	0.18	0.09	-0.56	0.98	1			
TH	0.29	0.12	0.62	0.49	0.6	0.66	0.34	0.45	0.98	0.36	0.49	1		
Cl	0.58	0.3	0.89	0.94	0.9	-0.04	0.69	0.81	0.6	0.13	0.26	0.53	1	
Na	0.74	0.38	0.74	0.85	0.85	-0.05	0.72	0.74	0.46	0.27	0.37	0.37	0.96	1

4. Conclusion

On the basis of the experimental data obtained, it is revealed that all the ponds in Puri i.e. Narendra pond, Indradyumna Pond, Swetaganga, Parvati pond and Markandeswar pond are increasingly getting polluted day by day. Now it is totally unfit for both drinking and bathing purpose under BIS standard. Among the ponds Swetaganga is severely polluted, and the next is Parvati pond. Therefore, it is necessary to take necessary steps to reduce pollution load on the ponds otherwise in future these are going to be dead ponds. In order to make them pollution free at present and in future, the above mentioned recommendation may be strictly adhered to. In addition there should be sustained effort by administration and the public in general to create environmental awareness. It is recommended that dumping of all kinds of waste materials into the pond should be stopped immediately to allow the self-purification process of an aquatic system to regain its original condition. It will be better if the ponds are given some purification treatment and renovation including providing fencing around the periphery of the ponds.

Recommendation and Suggestions

- Complete check of municipal sewerage entry into the ponds.
- Complete flushing of the present water from the ponds and cleaning of the bottom sediments and fill up the pond with fresh water. The cleaning procedure should be carried out monthly once.
- There should be restriction for using pond water for bathing/washing purpose.
- Strict control on water throwing of ritual offerings which include rice, milk, sugar, candy flowers etc. into the ponds.

Cite this Article as: S. Satapathy, S.D. Sharma, C. R. Panda, Assessment of water quality in relation to health hazards in the holy ponds of Puri town, Odisha, India, J. Env. Sci. Pollut. Res. 2(3) (2016) 103–106.

- Attempt should be made to clear the algal blooms by mechanical means or by the use of suitable algaecides or by introducing suitable fish varieties which are capable of scavenging biological, organic and inorganic load of the ponds.
- Public awareness should be created about the potential source of pollution in the pond, so that in future people will use the pond in a proper way so that pollution problem will be minimized.

Acknowledgement

The authors wish to thank state pollution control board, Orissa for their kind encouragement and their laboratory facilities. The author thanks to Dr. CR Panda, Scientist F, Institute of Minerals and Materials Technology, CSIR for revising the manuscript and for the excellent suggestion to improve the quality of the manuscript.

References

[1] A. Szollosi-Nagy, P. Najilis, G. Bjorklund, Assessing the world's freshwater resources, Nat. Res. 34 (1998) 8-18.
[2] T.J. Johnson Pieter, H. Paull Sara, The ecology and emergence of diseases in fresh waters, Freshwater Bio. 56 (2011) 638-657.
[3] G.C. Okpokwasili, T.C. Akujobi, Bacteriological indicators of tropical water quality, Environ. Toxicol. Water Qual. 11 (1996) 77-81.
[4] C. Sandy, F. Richard, Quality and standard for drinking water: Chapter 3 Environmental health engineering in the tropics: An Introductory Textbook, 2nd Ed., Wiley Inter Science, New York, USA 1995, pp. 294 -295.
[5] W.O. Pipes, Bacterial indicators of pollution, CRC Press Inc., Boca Raton, Florida 1981, pp. 242-243.
[6] T.M. Scott, P. Salina, K.M. Portier, J.B. Rose, M.L. Tamplin, et al, Geographical variation in ribotype profiles of *Escherichia coli* isolates from human, swim, poultry, beef and dairy cattle in Florida, Appl. Environ. Microbiol. 69 (2003) 1089-1092.
[7] M. Hatha, A. chandran, S. Varghese, increased prevalence of indicator and pathogenic bacteria in the Kumarankom Lake: A function of salt water regulator in Vembandu Lake, A Ramsar site, along west coast of India, 12th World Lake Conference, The 12th World Lake Conference, Ministry of Environment and Forests, Government of India, Jaipur, 2008, pp. 250-256.
[8] N. Kumar, A view on freshwater environment, Eco. Environ. Conserv. 3 (1997) 3-4.
[9] H.B. Mahananda, M.R. Mahananda, B.P. Mohanty, Studies on the physico-chemical and biological parameters of a freshwater pond ecosystem as an indicator of water pollution, Eco. Environ. Conserv. 11 (2005) 537-541.
[10] K. Venkatesharaju, P. Ravikumar, R.K. Somashekar, K.L. Prakash, Physico chemical and bacteriological investigation on the river Cauvery of Kollegal stretch in Karnataka, J. Sci. Engg. Technol. 6 (2010) 50-59.
[11] T. Kistemann, T. Claben, C. Koch, F. Dangendorf, R. Fischeder, et al, Microbial load of drinking water reservoir tributaries during extreme rainfall and runoff, Appl. Environ. Microbiol. 68 (2002) 2188-2197.
[12] S.P. Pathak, K. Gopal, Rapid detection of *Escherichia coli* as an indicator of fecal pollution in water, Ind. J. Microbiol. 41 (2001) 139-151.
[13] V.J. Harwood, M. Brownell, W. Perusek, J.E. Whitelock, Vancomycin resistant *Enterococcus sp*. isolated from waste water and chicken feces in the United States, Appl. Environ. Microbiol. 67 (2001) 4930-4933.
[14] APHA, Standard methods for the examination of water and waste water, 21st Ed., American Public Health Association, Washington D.C., 2005.
[15] B. Abida, Harikrishna, Study on the quality of water in some streams of Cauvery River, J. Chem. 5 (2008) 377-384.