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STUDY ON PHYSIOCHEMICAL PARAMETERS AND BENTHIC MACRO-INVERTEBRATES OF KUNDA RIVER IN KHARGONE M.P., INDIA

Rajendra Kumar Chaurasia
Department of Zoology, G.C.M.D. College Maharajpur Dist. Chhatarpur M.P. India-471501

ABSTRACT: Physiochemical parameters and Benthic macro-invertebrates together can give better picture of any wetland ecosystem. The major objective of this study was to assess the water quality of River Kunda and its impact on structure and function of aquatic ecosystem. But this study was focused particularly on identification of the biological indicator of water pollution especially benthic macro-invertebrates along with physiochemical parameters. The water samples and bottom sediments were collected from upstream and downstream courses of Kunda River from in August 2010 to July 2012 and analyzed in the laboratory. Altogether 43 texa of invertebrates belonging to four phyla were recorded. The major groups identified were Oligochaetes, Diptera and Bivalvia. The values of physiochemical parameters were significantly different except temperature between upstream and downstream courses of river. The water was found more polluted at downstream course of Kunda River. Detailed study is essential to control the pollution in Kunda River. Immediate preventive measure for direct discharge of sewage and industrial effluents and disposal of solid waste should be taken along the river course.

KEYWORDS: Biological indicator, discharge; disposal, macro-invertebrates, Physiochemical parameters.

INTRODUCTION

Water quality monitoring is an important exercise, which helps in evaluating the nature and extent of pollution as well as effectiveness of pollution control measures. It also helps in determining the water quality trends and prioritizing pollution control effort. Water quality are those physical, chemical and biological factors that influence species composition, diversity, stability, production and physiological conditions of indigenous populations of a water body (Boyd 1982).

India is rich in water resources, being endowed with a network of rivers and blessed with snow cover in the Himalayan range that can meet a variety of water requirements of the country. However, with the rapid increase in the population of the country and the need to meet the increasing demands of irrigation, human and industrial consumption, the available water resources in many parts of the country are getting depleted and the water quality has deteriorated. Indian rivers are polluted due to the discharge of untreated sewage and industrial effluents (Bhardwaj 2005).

Water quality refers to the ability of our water resources to support human, animal, and plant life. Good water quality is necessary for providing us with drinking water that is safe and clean; for providing habitat for aquatic bugs, plants, and animals; for providing recreational opportunities like wading, swimming, and fishing; and for providing a place for us to connect with nature. The quality of water is of vital concern for mankind since it is directly linked with human welfare. In fact, pollution is the result of anthropogenic activities, which has adverse impact on mankind. Water is regarded as polluted when it is changed in its quality or composition, directly or indirectly as a result of human activities. Consequently, it becomes less suitable for human consumption.

Benthic "macro-invertebrates" are bottom-dwelling invertebrates large enough to be seen with the naked eye. They are usually greater than 1 mm or 1/32 inch long. They are aquatic insects and other aquatic invertebrates associated with the substrates of water bodies (including, but not limited to, streams and rivers).

MATERIALS AND METHODS

Study Area

The Kunda River is a Main river of Khargone district. It is a tributary river of Narmada river. It is originated from forest, Amba and Sirvel village. River Kunda has a length of approximately 169Kms. and its catchment area of 3825sq.km. This river is situated in the west directions of M.P. and it flows from South to North through four block of Khargone district Bhagwanpura, Goganwa, Khargone and Kasrawad. On the Kunda River there are two Dam constructed Dejla-Devada dam & Vanihar dam. It provides drinking water for the Khargone city. There is on a Shiv temple and Ahilyaghat before Siddhi vinayak ganesh temple at the bank of

Kunda River in Khargone. There are 7 stop dams is being constructed in last two years. These Stop dams provide drinking water & irrigation facility to Khargone District. Its water works water capacity is 20 crore litre. Its water holding capacity of 7 stop dams is 0.646 million cubic meters. Its capacity in stop water 1.5 million cubic meter and these stopdams are made in front of Kalika mata temple.

Latitude 21º49'16" (DMS) N and Longitude (DMS) 75º36'4"E.

Water analysis

The water samples were collected from the four selected sampling stations viz., Station I, Station II, Station III and Station IV in the Kunda River for the period of two year from August 2010 to July 2012. In the analysis of the physico- chemical properties of water, standard method prescribed in limnological literature were used. Temperature, pH, Transparency and Dissolved Oxygen were determined at the site while other parameters like Biochemical oxygen demand, Total Hardness, Alkanity, Chloride, Nitrate and Phosphate were determined in the laboratory. The Physico- Chemical parameters were determined by standard methods of Golterman (1978), Welch (1998), APHA (2005). To analyze other physiochemical parameters, water samples were collected in clean plastic bottles. Details including sampling site, date and time of sample collection were written in sampling bottles.

Biological indicator

Benthic macro invertebrates were collected using Grab sampler of area 0.02498 m2. For this firstly sampler was locked then subjected to the river bottom vertically with the help of nylon rope. When the sampler touched the bottom it automatically unlocked grabbing the sediments. Then the sampler pulled out from the river and sediments were transformed in buckets. Sediments were sieved putting on sieve of 0.4mm mesh size so that clay particles could remove. Macro-invertebrates retained on the sieve with some water were collected in labeled sample bags and carried to the laboratory for further processing. Sorting and identification of macro-invertebrates were done in next day referring Pennak, (1989), Needham and Needham (1996) and Enmondson (1959). Macro invertebrates were sorted and identified transferring samples into white enameled tray. Macro-invertebrates after identification were counted separately and stored in different bottles. 5% formalin was used as preservative to preserve macro-invertebrates except Mollusca. In case of Mollusca 70% alcohol was used as preservative agent.

RESULT AND DISCUSSION

Physiochemical Paramaters

Temperature

In the present study the water temperature varied between 16oC to 43oC. The minimum temperature of 16o C was recorded at Station-I in January 2012 and maximum temperature 43oC was recorded in station-IV in May 2011. Jain and Sharma (2001), Yogesh and Pendse (2001) also reported the same type of fluctuation in various freshwater bodies. Based on the results it was noted that Jayalakshmi et al., 2011 observe the temperature at Vijaywada Andhara padesh, fluctuated in between 220C to 340C. Pir et al., 2012 was obtained water temperature ranged from 20oC to 33oC on Narmada River. Efe Ogidiaka 2012 Temperature recorded of Ogunpa River at Bodija, Ibadan, Oyo state mean value 20.950C to 24.90C.

pH

pH is one of the most important factor in measuring water quality. Practically every aspect of water like acid and base neutralization, water softening, precipitation, coagulation and acidification is pH dependent. The alternation of pH of water is accompanied by changes in other physico-chemical aspects of the medium. In the present study pH showed variation between 7.2 to 9.4. The minimum pH of 7.2 was recorded at station-IV in August 2010 and maximum of 9.4 at station-IV in June 2011. The pH of Kunda River is in accordance with the findings of Ghose and Sharma (1988) and Singh and Ray (1995).

Sharma and Chowdhary (2011) observed pH variation between 6.8 to 9.4 mg/l in river Tawi of Jammu and Kashmir. Aweng et al., (2011) observed pH variation between 5.48 to 7.49 mg/l. in Madak river Kluang Johor, Malaysia. Balachandran et al., (2012) observed the value of pH ranged between 7.1 to to 9.05 in Banglore Lake at Karnataka. Efe Ogidiaka 2012 recorded pH of Ogunpa River at Bodija, Ibadan, Oyo state mean value 6.45 to 8.84. Aweng et al., (2012) observed the value of pH 6.94 to 7.18 on Sungai pichong at Gunung chamah, Kelantan, Malaysia. Mohan et al., 2013 observe the pH in River Tawi in vicinity of udhampur city (J & K) India fluctuated in between 8.2 to 8.5.

Transparency

Transparency is a characteristic of water that varies with the combined effect of colour and turbidity. It measures the depth to which light penetrates in the water body. Transparency of the surface water is often an important limiting factor in the development and distribution of plant and animal life in fresh waters. In the present study Transparency fluctuated from 10cm. to 60cm. The minimum transparency of 10cm. was recorded at station-I in August 2011 and maximum of 60cm. at station-IV in January 2011. Similar results show Sharma et al., 2008 in Ningland stream; Shittu et al., 2008 in Abeouta Nigeria; Kudthalang and Thanee (2010) in the upper part of the Chi Basin.

Sharma and Chowdhary (2011) observed transparency variation between 12.5 to 40.75 cm. in river Tawi of Jammu and Kashmir. Pal et al., 2012 studied A significant variation in water Transparency was found in the four ponds: Btg pond (182.5cm.), Krk pond (63.8cm.), Skd pond (52.67cm.), and Dgk pond (29.67cm.). Prabhakar et al., (2012) observed Transparency value between 7.30 to 20.89cm. in Palar River, Vellore district Tamilnadu. Mohan et al., 2013 observe the Transparency in River Tawi in vicinity of udhampur city (J & K) India fluctuated in between 45.0cm to 423cm.

Dissolved oxygen

Dissolved oxygen of water is an important test to study the quality of water. Its optimum value for good quality water has been 4 to 6 mg/l of DO which is able to maintain aquatic life in a water body. If DO values are somewhat lower than this value this indicates water pollution. Dissolved oxygen is an important parameter indicating all sorts of organic pollution and purity of water for intended use. In general, dissolved oxygen showed variation from 4.9 mg/l. to 9.8 mg/l. The minimum dissolved oxygen of 4.9 mg/l. was recorded at station-II in June 2011 and maximum of 9.8 mg/l. at station-II in October2010. The seasonal variation of DO in water depends upon the temperature of the water body which influences the oxygen solubility in water. This present result was in conformity with Mohan et al., 2013 in River Tawi in vicinity of udhampur city (J & K) India.

Biological Oxygen Demand

The biological oxygen demand, abbreviated as BOD, is a test for measuring the amount of biodegradable organic material present in a sample of water. Biological oxygen demand is the amount of oxygen utilized by microorganism in stabilizing the organic matter in aerobic condition. DO measurement forms the basis of BOD analysis. It gives an indication of load of biodegradable organic material present in the water body.

The level of BOD depends on temperature, during the present study Biological oxygen demand varied between 2.0 mg/l. to 6.3 mg/l. The minimum biological oxygen demand of 2.0 mg/l. was recorded at station-I in January 2012 and maximum of 6.3 mg/l. at station-II in March 2011. This present result was in conformity with Sisodiya and Moundiotiya (2006) in Kalakho Lake, Rajasthan; Balachandran et al., (2012) in Banglore Lake at Karnataka; Efe Ogidiaka 2012 recorded in Ogunpa River at Bodija, Ibadan, Oyo state and Prabhakar et al., (2012) in Palar River, Vellore district Tamilnadu.

Total Hardness:

Hardness is a natural characteristic of water which can enhance its palatability and consumer acceptability for drinking purposes. Health studies in several countries in recent years indicate that mortality rates from heart diseases are lower in areas with hard water. Total hardness is the parameter of water quality used to describe the effect of dissolved minerals (mostly Ca and Mg), determining suitability of water for domestic, industrial and drinking purposes. During the present study, Total hardness varied between 71 mg/l to 245 mg/l. The minimum Total hardness of 71 mg/l was recorded at station-I in November 2010 and maximum of 245 mg/l at station-III in May 2011. Bhatt et al., 2011was recorded the range of hardness 5-72 mg/l. as CaCO3 with Mean±SD 42.2±25.606 which showed that the hardness of the Bhotekoshi River reduced from upstream to the downstream. Same results were also reported by Sharma et al., 2012.

Alkalinity

Alkalinity of water is usually interpreted as the quality and kind of compounds (such as bicarbonate, carbonates and hydroxides present, which collectively shift the pH to the alkanlinic side of neutrality. In the present study the value of Alkalinity varied from 85 mg/l to 415 mg/l. The minimum alkalinity of 85 mg/l. was recorded at station-I in July 2012 and maximum of 415 mg/l. at station-II in September and November 2010. Sisodiya and Moundiotiya (2006) observed total alkalinity values fluctuated between 98 to 276 mg/l, indicating that the water is hard. The observed average values of total alkalinity ranged within 155.8 to 197.3 mg/l. during summer, 112.0 to 189.31 mg/l. during monsoon and

114.8 to 115.8 mg/l. during winter. Sharma et al., (2008) recorded total alkalinity between 68.4 to 91.4 mg/l in Ningland stream, India. Kudthalang and Thanee (2010) observed the mean of total alkalinity varied from 22.9±2.5 to 29.2±3.0 mg/l in the upper part of the Chi Basin. Balachandran et al., (2012) observed the value of total alkalinity fluctuated between 19.28 mg/l. to to 346.8 mg/l. in Banglore Lake at Karnataka.

Chloride

Chloride is one of the major inorganic anion in water and waste water. Chlorides occur naturally in all types of Natural freshwaters; however, their concentration remains quite low and generally less that of sulphate and bicarbonate. Higher concentration of chlorides is considered to be the indicator pollution due to higher organic waste of the animal origin or industrial effluents. The chloride reaches the river from different anthropogenic activities like septic tank effluents, animal feeds, use of bleaching agents by launderer and washing of cloths.

In the present study the value of Chloride varied from 18 mg/l. to 69 mg/l. The minimum chloride of 18 mg/l. was recorded at station-II in September 2010 and maximum of 69 mg/l. at station-IV in May 2011. Seasonally, the values were highest in summer and lower in winter and intermediate values were recorded in rainy season. Similar results have been observed by Tripathi (1982) and Ahmad (2004). Yogendra and Puttaiah (2008) observed value of Chloride ranged between156 mg/l. to 178 mg/l. in Shimoga Town of Karnataka. Shittu et al., (2008) observed Chloride value between 112 to 220 mg/l in Abeokuta, Nigeria. Sharma and Chowdhary (2011) observed value of Chloride ranged between 21.95 to 59.88 mg/l in river Tawi Jammu and Kashmir. Mohan et al., 2013 observe the Chloride in River Tawi in vicinity of udhampur city (J & K) India fluctuated in between 2.89mg/l to 22.09mg/l.

Nitrates:

Nitrates are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. In the present study, the Nitrate showed variation from 0.07 mg/l. to 4.250 mg/l. The minimum value of 0.07 mg/l. was obtained at station-III in March 2011 and maximum of 4.250 mg/l. at station-I in May 2012. Mohan et al., 2013 observe the Nitrate in River Tawi in vicinity of udhampur city (J & K) India fluctuated in between 0.109mg/l to 0.300mg/l. The most important source of nitrate is the biological oxidation of organic nitrogenous substances. Also nitrate in river Kunda may result from point and non-point sources such as sewage disposal systems, faulty septic tanks, soil erosion, livestock wading, bathing and washing clothes in river banks.

Phosphate

Phosphorus is one of the most important nutrients limiting the growth of autotrophs and biological productivity of the system. High Phosphorus content causes increased increased algal growth, often as blooms, till nitrogen becomes limiting. Phosphorus comes from several sources like human and animal wastes, industrial wastes, agricultural runoff, and exposed soil erosion. In the present study the value of Phosphate showed variation from 0.16 mg/l. to 3.58 mg/l. The minimum phosphate value of 0.16 mg/l. was recorded at station-I & II in November 2010 and maximum of 3.58 mg/l. at station-I in April 2012. Adeyemo et al., (2008) observed the value of Phosphate ranged between 0.35 mg/l. to to 16.2 mg/l. in Ibadan River at Ibadan city, Nigeria. Kudthalang and Thanee (2010) observed the mean of phosphate varied from 0.01±0.0 to 0.20±0.1 mg/l in the upper part of the Chi Basin. Efi Ogidiaka 2012 recorded Phosphate of Ogunpa River at Bodija, Ibadan, Oyo state mean value 0.28 to 1.32.

BENTHIC MACRO-INVERTEBRATES OF KUNDA RIVER

In the present study from August 2010 to July 2012, forty three (43) species comprising of three Phyla Annelida- 9 species of Oligocheates; Phyla- Arthropodes 8 species of Crustaceans and 10 species of Insects and Phyla- Mollusca 8 species of Gastropodes and 8 species of Pelecypodes were recorded. The present study reveals that the benthic fauna mainly dominates during winter at all the studied sites and lowest numbers were observed during the rainy season, due to influx of more water and high water velocity. Thus the forty three species belonging to five classes and four phyla of benthic macro invertebrates encountered in the study area. George et al., 2009 was Similar studied the benthic macro invertebrate fauna and physico-chemical parameters in Okpoka creek sediments and A total of nineteen (19) species recorded of benthic invertebrates' fauna belonging four (4) phyla- Annelida, Amphipoda, Arthropoda and Mollusca, six (6) classes Oligochaeta, Polychaeta, Crustacea, Insecta, Bivalvia and Gastropoda. Davis et al., (2003) the result obtained ephemeroptera, plecoptera and trichoptera (EPT), crustacea, and isopoda order were much higher at the reference site or unpolluted area. Meanwhile, this study was only recorded one taxa namely ephermeroptera instead of

three. Vesna et al., 2012 was recorded the Dominant in the composition of macrozoobenthos communities of the investigated Moravica River at South west Serbia were larvae of the insect groups Ephemeroptera, Trichoptera, Plecoptera, Chironomidae, Diptera, Coleoptera, and Heteroptera.

CONCLUSION

The impacts of anthropogenic activities on the water quality, biodiversity and distribution of benthic macro-invertebrates were clear. Compared to the I, II and IV Stations, resistant benthic macro-invertebrates could be found at the III stations of the Kunda River with poor and low water quality indices. Therefore, the collection of certain benthic macro-invertebrates species particularly in polluted and non polluted parts of a river indicated that they could be used as potential bio indicators for river pollution. These benthic macro-invertebrates species can be used to establish biological criteria to classify the river ecosystem as being healthy or polluted.

REFERENCES

1. Adeyemo O. K., Adedokun O.A., Yusuf R.K., Adeleye E.A. (2008): Seasonal changes in physico-chemical parameters and Nutrient load of River sediments in Ibadan city, Nigeria.Global nest journal, Vol 10, No 3.pp 326-336.
2. Ahmed A.M. (2004): Ecological studies of the river Padma at Mawa Ghat, Munshiganj Physico-chemical Properties. Pakistan Journal of Biological Sciences. 7(11) 1865-1869.
3. American Public Health Association (A.P.H.A.) (2005): American water works Association and Water pollution control federation standard methods for the examination of water and wastewater. 21 Edition American Public Health Association (A.P.H.A.) Washington D.C.
4. Aweng-Eh Rak, Ismid-Said, Maketab-Mohamed and Ahmad-Abas (2011): Effect of logging Activities on water quality and Benthic macroinvertebrates Assemblages of Madak River Basin, Kluang Johor, Malaysia. J. Appl. Sci. Environ. Manage. Vol. 15 (2) 337-340.
5. Balachandran C., Dinakaran S., Alkananda B., Boominathan M., and Ramchandra T.V. (2012): Monitoring aquatic macroinvertebrates as indicators for assessing the health of lakes in Bangalore Karnataka. Internatinal Journal of Advanced Life Sciences. Volume (5) 19-33.
6. Bhardwaj R.M. (2005): Water Quality Monitoring In India Achievements and Constraints. IWG- Env, International Work Session on Water Statistics, Vienna 1-11.
7. Bhatt R. P., Khanal S. N., Maskey R. K. (2011): Water quality impacts of hydropower project operation in Bhotekoshi river basin Sindhupal chowk district in Nepal. International Journal of Plant, Animal and Environmental Sciences Volume (1) 88-101.
8. Boyd C. E. (1982): Water quality in Warm fish ponds, Auburn University Agricultural Experiment Station. Auburn University Agricultural Experiment station. Auburn, Alabama United states of America. 9-44.
9. Davis S., Golladay S.W., Vellidis G., Pringle C.M. (2003): Macroinvertebrate Biomonitoring in Intermittent Coastal Plain Streams Impacted by Animal Agriculture, Institute of Ecology, Univ. of Georgia, Athens. J. Environ. Qual. 32:1036 – 1043.
10. Edmondson W.T. (1959): Fresh-water Biology, Second edition. John Wiley and Sons, Inc. New York.
11. Efe Ogidiaka (2012): Physico-chemical parameters and Benthic Macro-invertebrates of Ogunpa River at Bodija, Ibadan, Oyo State. European Journal of Scientific Research. Vol. 85(1) 89-97.
12. George A.D.I., Abowei J.F.N. and Daka E.R. (2009): Benthic Macro Invertebrate Fauna and Physico-chemical Parameters in Okpoka Creek Sediments, Niger Delta, Nigeria International Journal of Animal and Veterinary Advances, Vol. 1(2): 59-65.
13. Ghose N.C. and Sharma C.D. (1988): Effect of drain water on the physico-chemical and bacteriological characteristic of river Ganga at Patna, Bihar. In-'Ecology and pollution of Indian rivers' (Ed. Trivedy, R.K.) Asian publishing house, New Delhi, 255-269.
14. Golterman H. L. (1978): Method for physical and chemical analysis of fresh water IBP hand books no. 8 Black Well Scientific Publication Oxford pp. 213.
15. Jain R. and Sharma D. (2001): Water quality of Rampur reservoir of Guna District (M.P. India) Environ. Cons. J. 1(2) 99-102.
16. Jayalakshmi V., Lakshmi N. and Singara Charya M.A. (2011): Assessment of Physico-Chemical Parameters of Water and Waste Waters in and Around Vijayawada International Journal of Research in Pharmaceutical and Biomedical Sciences Vol. 2 (3) 1041-1045.
17. Kudthalang N. and Thanee N. (2010): The Assessment of water quality in the upper part of the Chi Basin using physico-chemical variables and Benthic Macro-invertebrates. Suranaree J. Sci. Technol. 17 (2): 165-176.

18. Mohan V.C., Sharma K.K., Sharma A. and Watts P. (2013): Biodiversity and abundance of benthic macro-invertebrates community of River Tawi in Vicinity of Udhampur city (J & K) India. Int. Res. J. Environment Sci. Vol. 2 (5) 17-24.
19. Needham J.G. and Needham P.R. (1996): A guide to the study of freshwater Biology Holden- day inc. Sanfranhisco, 108.
20. Pennak R.W. (1989): Freshwater invertebrates of the United States, 2nd Edn. John Wiley and Sons, New York. pp: 810.
21. Pir Z., Tali I., Mudgal L.K., Sharma S., Siddique A. (2012): Evaluation of water quality physicochemical characteristics of River Narmada at M.P., India. Researcher 4(5) 63-67.
22. Prabhakar C., Saleshrani K. and Tharmaraj K. (2012): Seasonal variation in Physico-chemical parameters of Palar River in and around Vaniyambadi segment, Vellore district Tamilnadu, India. International Journal of Pharmaceutical & Biological Archives 3(1): 99-104.
23. Sharma K.K. and Chowdhary S. (2011): Macro-invertebrates assemblages as biological indicators of pollution in a Central Himalayan River, Tawi (J & K) International Journal of Biodiversity and Conservation Vol. 3 (5). 167-174.
24. Sharma M. P., Sharma S., Goel V., Sharma P. and Kumar A. (2008): Water Quality Assessment of Ningland stream using benthic macro invertebrates. Life Sc. Journal, Vol. 5(3) 67-72.
25. Sharma S., Tali I., Pir Z., Siddique A., Mudgal L.K. (2012): Evaluation of Physico- chemical parameters of Narmada river, MP, India Researcher 4(5): 13-19.
26. Shittu O.B., Olaitan J.O., Amusa T.S. (2008): Physico-Chemical and Bacteriological Analyses of Water Used for Drinking and Swimming Purposes in Abeokuta, Nigeria, African Journal of Biomedical Research, Vol. 11 285-290.
27. Singh J. P. and Ray P. K. (1995): Limno Biotic Investigation of Kawar Lake, Begusarai, Bihar. (Environment and Ecology) 13(2): 330-335.
28. Sisodia R. and Moundiotiya C. (2006): Assessment of the water quality Index of wetland Kolakho Lake, Rajasthan, India. Journal of Environmental Hydrology Vol. (14) 1-11.
29. Tonapi G.T. (1980): Fresh water animals of India-an Ecological approach. Oxford and IBH Publishing Co. New Delhi; 341.
30. Tripathi C.K.M. (1982): Investigation on Ganga River to determine Biological indicators of water quality. Ph.D. thesis, BHU Varanasi.
31. Vesna V. Djikanovic, Gacic Z., Mickovic B., Jakovcev-Todorovic D., Cakic P. and Kracun M. (2012): Biological parameters of the Moravica River water quality (South-West Serbia)- composition of the aquatic macro-invertebrates and biological indices. Balwois 2012-Ohrid, Republic of Macedonia. 1-6.
32. Welch P.S. (1998): Liminological methods Mcgran Hill Book Co. New York.
33. Yogendra K. and Puttaiah E. T. (2008): Determination of water quality index and suitability of an urban water body in Shimoga Town, Karnataka. Sengupta, M. and Dalwani, R. (Editors), proceedings of tool 2007: The 12th world Lake conference: 342-346.
34. Yogesh S. and Pendse D.C. (2001): Hydrological study of Dahikhura reservoir. J. of Environmental Biology. 22(1) 67-70.