The AJAS THE ASIAN JOURNAL OF ANIMAL SCIENCE
Volume 12 | Issue 1 | June, 2017 | 15-21
◆ e ISSN–0976–8963
DOI : 10.15740/HAS/TAJAS/12.1/15-21
Visit us | www.researchjournal.co.in

RESEARCH ARTICLE.....

Disposal, characteristics and impact of thermal power plant effluent along the coast of Jaigad, Ratnagiri, Maharashtra

ANKITA S. TEKADE, GIRISH N. KULKARNI **AND** RAHUL K. SADAWARTE

ABSTRACT..... The effluent discharge conspicuously affected the temperature, DO, salinity, pH of the bay water. It showed comparatively lower dissolved oxygen content and high nutrient content in effluent samples. Significant difference ($P<0.05$) was observed between the stations in the dissolved oxygen content and temperature. Samples were collected from three different sampling points at Jaigad coastal waters to study the physico-chemical characteristics. The physical and chemical parameters *viz.*, temperature, pH, salinity, alkalinity, DO, total suspended soilds, total dissolved solids, nitrate, phosphate, silicate and sulphate were studied using various standard analytical techniques. The study reveals that the physical and chemical composition of all the samples collected from the sites mainly depends on seasonal variations and discharge from the power plant.

KEY WORDS..... Effluent, Temperature, Salinity, pH, Dissolved oxygen, Nutrients, Jaigad

HOW TO CITE THIS ARTICLE - Tekade, Ankita S., Kulkarni, Girish N. and Sadawarte, Rahul K. (2017). Disposal, characteristics and impact of thermal power plant effluent along the coast of Jaigad, Ratnagiri, Maharashtra. *Asian J. Animal Sci.*,**12**(1): 15-21. **DOI : 10.15740/HAS/TAJAS/12.1/15-21.**

ARTICLE CHRONICLE - Received **:** *07.03.2017;* Revised **:** *03.05.2017;* Accepted **:** *17.05.2017*

Author for Corresponding -
ANKITA S. TEKADE
Department of Fisheries Hydrography, College of Fisheries, Shirgaon, RATNAGIRI (M.S.) INDIA
Email: ankicofsn@gmail.com

See end of the article for **Coopted authors'**

INTRODUCTION.....

The state of Maharashtra has a long coastline (~720 km) as its westernboundary. The coastal strip of about 500 km south of Mumbai, upto Goa is known as the 'Konkan coast', bordered with Western Ghats mountain range (Sahyadri range) along its eastern side and is blessed with extreme natural beauty and highly diverse biological diversity consisting of both natural as well as agricultural biodiversity.The present report attempts an environmental appraisal of a typical Konkan village, Jaigad (District, Ratnagiri) and its surroundings. In the context of the proposed coal-based mega Thermal power plant of 1200 MW located at Jaigad, the present study examines various aspects of the discharge with emphasis ecological consequences.

Jaigad is a major fishing village in the Ratnagiri Taluka of Maharashtra in the central Konkan region (17 17' 30" N and 73 o 12' 40" E), locatedon the edge of the conical land mass jutting into the Sashtri river mouth from the southern side. Topography of the Jaigad area comprises of slightly undulating plains at an elevation ranging between 30 – 60 m from the mean sea level. The area has relatively unpolluted natural resources, upon which the people are directly dependent for their livelihoods. The problem of the impact on the environment of thermal discharges from power stationsis certainly not a new and specific problem of power production by fission reactors. Every thermal power

station creates the problem of waste heat management and of possible impairment to man's environment. However, although the problem is not a newone, it has become particularly importance for two principal reasons: *viz.*, man's increasing awareness of the need to preserve or improve the quality of his environment and the very magnitude of the growth in electrical energy demand.

Thermal electric power plants use the steam-water energy cycle and the heated waters discharged into aquatic environment change physical-chemical properties of water. The influence of heating on aquatic ecosystems is ambiguous and at different levels of heating it may be both positive and negative (Kumar *et al.,* 2013). The most important ecological factor is the exclusion of excessive heat dumping exceeding the buffer (compensating) capabilities of the aquatic ecosystem. Thermal loads can cause negative processes in local areas of aquatic environment, such as overgrowth of blue-green algae deteriorating the water quality, changes in the composition of plankton and dynamics of its numbers, disruptions of the structure of fish communities and micro climatic changes (Yadav *et al*., 2010). A few attempts were made by researchers on the impact of coolant water discharge on hydro-biological characteristics. The study on coastal ecology in relation to thermal effluent has been carried out with special reference to the water quality, species diversity and biomass of plankton, nekton and benthos of Tuticorin, India (Selvin *et al.*, 2010 and Shelar, 2012). Detail studies were also done in order to understand the impact of heated effluents on benthic organisms by Suresh *et al.* (1993) along Kalpakkam coast and Kailasam and Sivakami (2004) at Tuticorin bay, South East coast of India. The impact of thermal discharge from coastal power plant on the distribution of physico-chemical parameter and phytoplankton in close proximity of MAPS and recovery potential of phytoplankton after entrainment in the cooling system of power plant was investigated by Poornima *et al.* (2005 and 2006). Manimaran *et al.* (2007) worked onecological problems associated with the disposal of coolant water and ash pond effluent in the coastal waters of Tuticorin. Effect of thermal power plant effluents on the hydrological conditionsin the Tuticorin Bay was also studied by Easterson *et al.* (2000).

RESEARCH METHODS.....

Three sampling stations established along the Jaigad coast E_1, E_2 and E_3. Where E_1 is effluent and E_2 and E_3 are other sampling stations. Every month, the effluent samples were collected during 2014 to 2015 from the outfall of thermal discharge before its confluence to sea (E_1) and the immediate receiving zone just below the confluence (E_2 and E_3) (Fig. A). The study was carried out for one year on monthly basis covering summer, monsoon, and winter seasons. Water samples were processed for their physico-chemical parameters to include. Temperature, pH, dissolved oxygen (DO), total dissolved solids (TDS), total suspended solids, total alkalinity (TA), nitrates (NO_3), phosphorus (P), silicate (Si) and sulphates (SO_4). These were analyzed according to standard methods (APHA, 2012) and results were analyzed statistically as per the procedures in Zhar (2004).

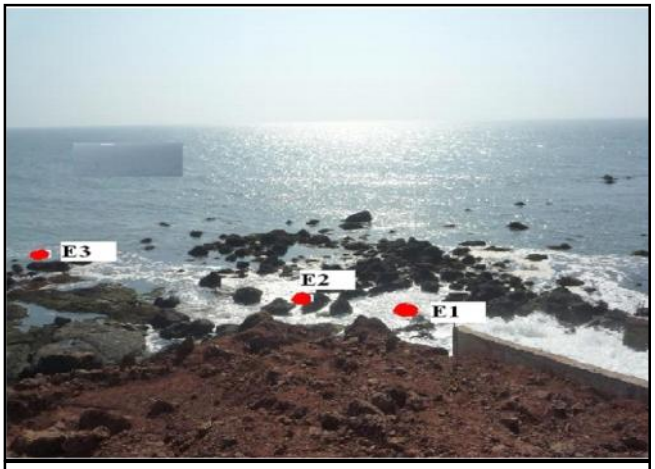

Fig. A : Disposal of effluent with sampling location

RESEARCH FINDINGS AND ANALYSIS.....

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads :

Disposal of effluent, water quality parameters studied at Jaigad coast sampling stations 2014-2015:

Disposal of effluent:

In JSW plant sea water is drawn from mouth of Damankul Bay. The water is cooled as it descents through the fill by gravity while in direct contact with air that passes over it. The cooled water is then collected in a cold-water basin below the fill from which it is pumped back through the process to absorb more heat. After

few cycles the water is pumped out through open drain to outfall point to the open sea on shore. Turbulence in the oceans leads to mixing. The ocean has stable stratification; vertical displacement must work against buoyancy force. Vertical mixing requires more energy than horizontal mixing. As a result, horizontal mixing along surfaces of constant density is much larger than vertical mixing across surfaces of constant density. The location of outfall points with confluence on coast of Jaigad (Dhamankul Bay) is shown in Fig A. Discharge volume of effluent per day from the thermal power plant was 17200 m^3/hr. The hot water from the outfall was discharged openly on rocky beach in to the sea. As per the environmental norms, the discharged water should not have temperatures in excess of 7ºC.

Table 1 : Discharge conditions of effluent from channel

Intake water temp	28 to 30°C
Intake/outfall velocity	0.5/2.0 m/s
Outfall temperature range	28 to 36^{0}C
Intake	Submerged
Outfall	Surface
Distance of channel	1 km
Pattern	Zigzag
Confluence of outfall	Open on rocky shore (Fig A)

Physico-chemical parameters:

Atmospheric and water temperatures :

Temperature is one of the most important factors that regulates distribution and life history of organisms. In tropical waters, the temperature directly influences all metabolic and physiological processes of organisms such as feeding, reproduction, movement and distribution of organisms (Swami and Udhayakumar, 2007). During the present investigation, atmospheric temperatures ranged from 27 to 32.1^{0}C. The observations indicated that throughout the study period the ambient temperatures during summer remained higher. It was also noted that the sampling station E_1 showed higher water effluent temperature than that of other sampling stations. Water temperature ranged between 28 to 36^{0}C. Maximum water temperature was observed at location E_1 in the month of May-15 while the minimum was observed in the month July-14. At E_1 minimum water temperature value of (31^{0}C) was found in the month of August while maximum value was recorded in the month of May (36 ^{0}C). In summer it showed increased values while in winter it showed declining values. At station E_2 the water temperature varied from 30.5^{0}C (August) to 35.8 ^{0}C (May). At E_3 the values of water temperature ranged between 28 ^{0}C (February) to 32.1^{0}C (May). It showed a decreasing trend from E_1 to E_3 in water temperature. The highest effluent temperature was found in May. Comparatively this change in water temperature was statistically significant at $P < 0.05$. This is due to release of water from cooling towers into Jaigad coastal waters. Low temperature was found may be due to rainfall effect resulting decrease the water temperature. Kailasam and Sivakami (1996) have reported the similar observations.

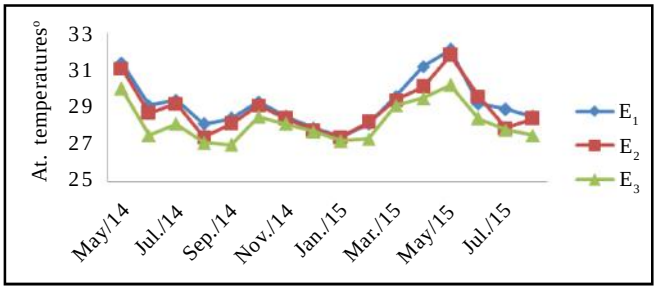

Fig. 1 : Monthly variations in atmospheric temperature (ºC) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

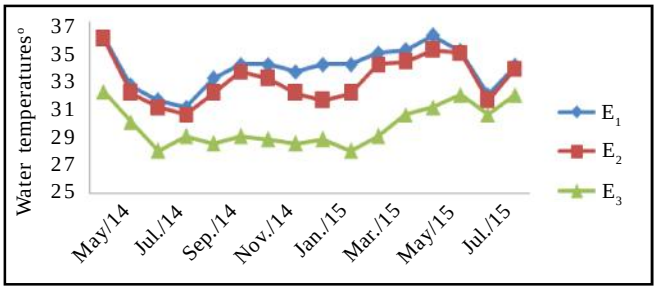

Fig. 2 : Monthly variations in water temperature (ºC) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

pH :

pH regulates the enzyme activities and other physiological processes in organisms (Odum, 1971). pH ranged between 7.4 to 8.3. Maximum pH was observed at E_3 in the month of February-15 and minimum was observed at E_1 in the month of May-14 and also in August. The pH is one of the most important abiotic factors that serve as an index for pollution. The pH values at E_3 sampling station were higher than that of other two stations. It showed a increasing trend from E_1 to E_3. ANOVA showed significant difference ($P<0.05$) in water pH between the stations. Increased pH was found may

due to temperature increases, as increased proportion of the water molecules dissociate to H+ and OHG, decreasing water pH (Julie *et al*., 2005).

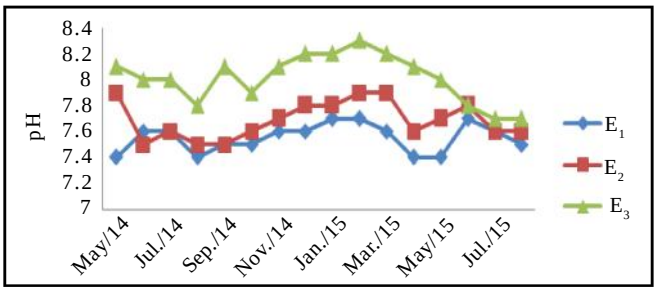

Fig. 3 : Monthly variations in pH at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

Dissolved oxygen:

The maximum dissolved oxygen 3.1 mg lit^{-1} was noted in E_3 in the month of February-15 and minimum of 2.1 mg lit^{-1} at E_1 in the month of May-15. DO is the fundamental fuel of life in aquatic ecosystem. DO in water is of great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity taking place in a water body and determines the biological changes which are brought about by the aerobic or anaerobic organisms (Dixit *et al.*, 2007). In the present investigation it was noted that there was inverse relationship between water temperature and DO. The DO values at E_1 sampling station were lower due to higher temperature that might be attributed to thermal discharge released from the power plant. DO was not statistically significant (P>0.05). Dissolved oxygen content of the study area have increased from station E_1 to station E_3 with increasing distance from discharge point, It is most likely that the temperature is affecting the dissolved oxygen

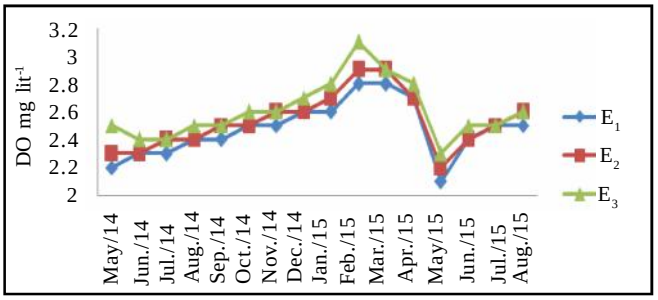

Fig. 4 : Monthly variations in dissolved oxygen (mg lit^{-1}) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

level in water (Theis, 1975; Guthrie *et al*., 1982 and Subramanian *et al*., 1990). Kailasam and Sivakami (1996) have reported the similar observations.

Salinity :

Salinity of different locations E_1 E_2 and E_3 ranged between 34.51 to 38.75 psu. Minimum salinity was observed at E_2 in the month of June-15 which can due to rainfall effect and maximum was recorded at E_1 in the month of May-15.The ANOVA showed no significant difference (P>0.05) in salinity between the stations.

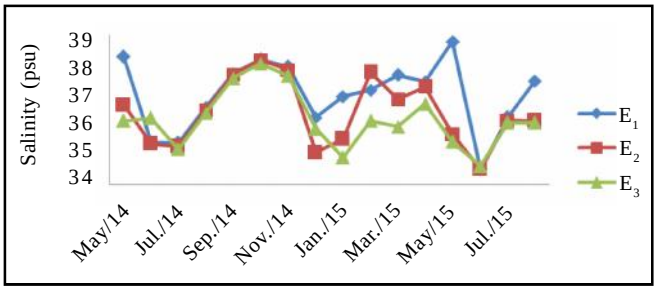

Fig. 5 : Monthly variations in salinity (psu) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

Total dissolved solids:

Total dissolved solids was minimum (26.33 mg lit^{-1}) in E_3 in May-15 and maximum was (39.12 mg lit^{-1}) at E_1 in April-15. TDS was statistically not differ significantly (P > 0.05) between the stations.

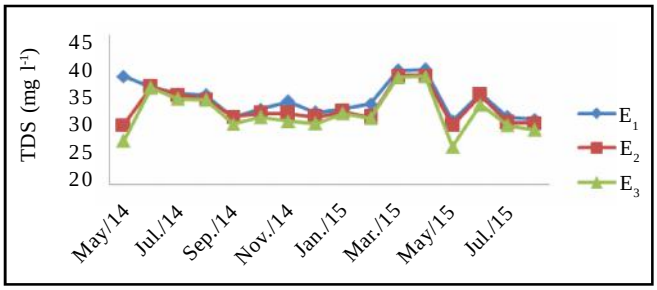

Fig. 6 : Monthly variations in total dissolved solids (mg lit^{-1}) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

Total suspended solid:

Suspended solid content was minimum (18.35 mg lit^{-1}) at E_3 in August-14 while the maximum (29.72mg lit^{-1}) was recorded at E_1 in May-15.The ANOVA showed no significant difference (P>0.05) in total suspended solids between the stations.

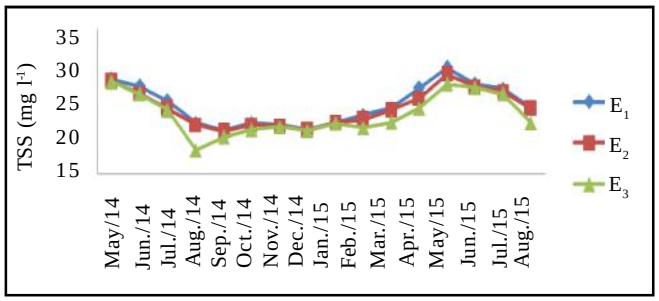

Fig. 7 : Monthly variations in total suspended solids (mg lit^{-1}) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

Total alkalinity :

The alkalinity values varied from 110 to 151 mg lit^{-1}. The minimum was observed in August-14 at E_2 and maximum was observed at E_3 in April-15. Total alkalinity was statistically not differ significantly ($P > 0.05$) between the stations.

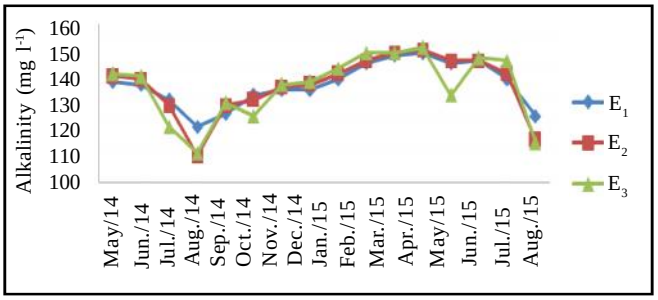

Fig. 8 : Monthly variations in alkalinity (mg lit^{-1})at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

Nutrients :

Nitrate content in effluent was fluctuated between 0.296 to 0.941 mg lit^{-1}. It was maximum at E_1 in May-15 and minimum in July-14 at E_3. Phosphate was ranged between 0.112 to 0.331 mg lit^{-1}. Maximum was observed at E_1 in May-15 and minimum was observed at E_3 in November-14. Level of silicate varied from 0.789 to 1.429 mg lit^{-1}. Maximum was observed in May-15 at E_1 against the minimum in December-14 at E_3. Nutrient was found higher in E_1 (effluent sample) as compared to E_2 and E_3. More amounts of nutrients have been recorded in station E_1 than other stations which can be due to the coolant water. Coolant water have more nutrients as observed Subramanian *et al*. (1990). This report was confirmed with present study also the nutrients of Nitrate-N, phosphate- P, silicate- silica was maximum in station E_1. Nutrients concentrations decrease with increasing the distance from the thermal power discharge.

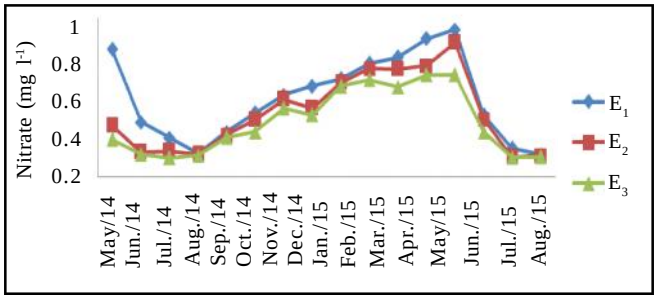

Fig. 9 : Monthly variations in nitrate-nitrogen (mg lit^{-1}) of effluent and effluent mixing zone of Jaigad coast during 2014-2015

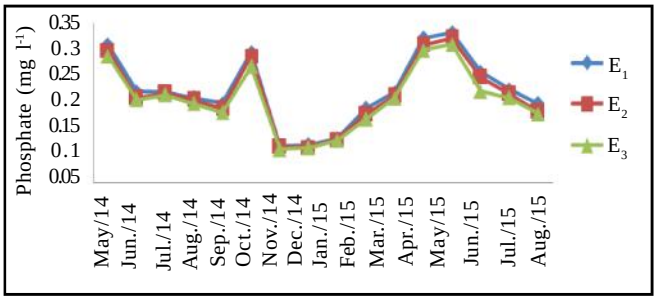

Fig. 10 : Monthly variations in phosphate - phosphorous (mg lit^{-1}) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

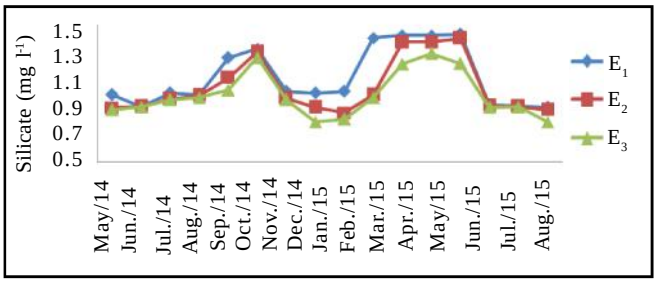

Fig. 11 : Monthly variations in Silicate - silicon (mg lit^{-1}) at different of effluent and effluent mixing zone of Jaigad coast during 2014-2015

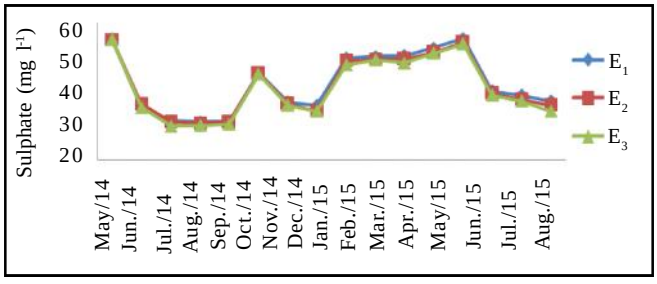

Fig. 12 : Monthly variations in sulphate (mg lit^{-1}) at different stations of effluent and effluent mixing zone of Jaigad coast during 2014-2015

The sulphate content varied from 29.74 to 55.25 mg lit^{-1}. Maximum was observed in May-15 at E_1 and the minimum was at E_3 in July-14. This might be attributed to discharge from thermal power plant into the coastal water of Jaigad. There were no considerable differences in the estimated values of sulphateat sampling stations throughout the course of study.

Conclusion :

– Monthly analysis of coastal water health through examination of water quality parameters for one year in Jaigad coastal waters indicated that all the parameters were within the normal values with few exceptions being Temperature and pH

– Important parameters like DO, Salinity, TDS, TSS, Nutrients were either comparable with the other coastal waters orwere well within the prescribed limits. Physico-chemical parameters of effluent and effluent mixing zone around Jaigad Thermal Power Station showed temporal and spatial variations.

– As a whole, the present study results indicate no gross changes in waterquality components.

Acknowledgement :

The authors would like to thank the Dean, College of Fishery Science, Ratnagiri for providing necessary Laboratory facilities and for the support to conduct this work.

COOPTED AUTHORS' –

GIRISH N. KULKARNI, Department of Fisheries Hydrography, College of Fisheries, Shirgaon, RATNAGIRI (M.S.) INDIA

RAHUL K. SADAWARTE, Department of Fisheries Engineering, College of Fisheries, Shirgaon, RATNAGIRI (M.S.) INDIA

LITERATURE CITED.....

APHA (2012). *Standard methods for the examination of water and waste water.* 21st Ed. American Public Health Association, American Water Works Association Environmental Federation, Washington DC, USA. 2605p.

Easterson, D.C.V., Asha, P.S. and Selvaraj, M. (2000). Effect of thermal power plant effluent on the hydrological condition of phytoplankton in the waters of tuticorin bay. *J. Mar. Boil. Ass. India*, **42** (1&2): 135-138.

Garg, S.K., Bhatnagar, A., Kalla, A. and Johal, M.S. (2002). *Experimental ichthyology,* CBS Publishers and Distributors, New Delhi, India, 171pp.

Guthrie, R.K., Davis, E.M., Cherry, D.S. and Walton, J.R. (1982). Impact of coal ash from electric power production on changes in water quality. *Water Resour. Bull.,* **18** (1) : 135-138.

Jeng Chang (2000). Precision of different methods used for estimating the abundance of the nitrogen-fixing marine cyanobacterium, *Trichodesmium Ehrenberg. J. Exp. Mar. Biol. Ecol.,* **245** (2) : 215-224.

Kailasam, M. and Sivakami (1996). The effect of thermal effluent discharge on benthic fauna of Tuticorin bay. *Indian J. Mar. Sci.*, **25**: 371-372.

Kailasam, M. and Sivakami, S. (2004). Effect of thermal effluent discharge on benthic fauna of Tuticorin Bay, South East coast of India. *Indian J. Marine Sci.*,**33** (2) : 194-201.

Kumar, Sameer, Dhruv, K. and Sehgal, D. (2013). Environment impact assessment of thermal power plantfor sustainable development. *Internat. J. Environ. Engg. & Mgmt.*, **4** (6): 567-572.

Manimaran, B., Srinivasan, A. and Selvin, P.J. (2007). Ecological problems associated with the disposal of coolant water and ash pond effluent in the coastal waters of Tuticorin. Abstracts - Phmfrm'07, pp. 96.

Odum, E.P. (1971). *Fundamentals of ecology*. W.B. Saunders Co. 3rd Ed., Philadelphia.

Poornima, E.H., Rajadurai, M., Rao, T.S., Anupkumar, B., Rajamohan, R., Narasimhan, S.V., Rao, V.N.R. and Venugopalan, V.P. (2005). Impact of thermal discharge from a tropical coastal power plant on phytoplankton. *J. Thermal Biol.*, **30** : 307–316.

Poornima, E.H., Rajaduraia, M., Rao, V.N.R., Narasimhan, S.V. and Venugopalan, V.P. (2006). Use of coastal waters as condenser coolant in electric power plants: Impaction on phytoplankton and primary productivity. *J. Thermal Biol.*, **31**(7) : 556–564.

Selvin, J. Pitchaikani, Ananthan, G. and Sudhakar, M. (2010). Studies on the effect of coolant water effluent of tuticorin thermal power station on hydro biological characteristics of tuticorin coastal waters, South East Coast of India. *J. Biological Sci.*, **2**(2):

118-123.

Shelar, P.S. (2012). Effect of thermal power plant effluent on the water and sediment quality characteristics of Thoothukudi coastal water. M.F.Sc. Thesis, Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Science University Thoothukudi.pp. 128.

Straughan, D. (1980). *Impact of Southern California Edison's operations on Intertidal Harbor*, Southern California Development Series, 80-RD-95.

Strickland, J.D.H. and Parsons, T.R. (1972). A practical Handbook of seawater analysis. *Fish. Res. Bd. Can. Bull.,* **167** : 311.

Subramanian, B., Prabu, S.K. and Mahadevan, A. (1990). Influence of thermal power station effluents on hydrobiology of seawater. *Water, Air, Soil & Pollut.*, **53**: 131-137.

Suresh, K., Ahamed, M .S., Durairaj, G. and Nair, K.V.K. (1993). Impact of power plant heated effluent on the abundance of sedimentary organisms, off Kalpakkam, East Coast India. *Hydrobiol.*, **268** : 109-114.

Swami, B.S. and Udhayakumar, M. (2007). Observation on seasonal variations in hydrographical characteristics recorded at Mumbai harbour. *Eco. Env. & Cons.,* **13**(2) : 383 – 394.

Theis, T.L. (1975). *The potential trace metal contamination of water resources through the disposal of fly ash*. Proceedings of the 2nd National Conference on Complete Water Reuse, Chicago Illinois, pp. 219-224.

Thorhaug, A. (1978). The effect of heated effluent from power plants on sea grass (Thalassia) communities quantitatively comparing estuaries in the subtropics to the tropics. *Mar. Pollut. Bull.,* **9**: 181-187.

Yadav, R., Sharma, S., Saini, S. and Kalla, S. (2010). Environmental assessment of underground water quality near Suratgarh Super Thermal Power Plant in Sriganganagar district, Rajasthan. *Internat. J. Environ. Sci*.,**4** (4) : 347-349.

Zar, J.H. (2004). *Biostatistical analysis*. 4th Ed. Tan prints (I) Pvt. Ltd., Delhi, India, pp.663.