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The Effects of Sugozu Power Plant on Water Quality in the Iskenderun Bay, Eastern Mediterranean

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Abstract: To determine water quality of the impact area of Sugozu power plant, four samplings were carried out from 12 stations in May, August and October, 2009 and January, 2010. Water temperature, pH, salinity, dissolved oxygen, Secchi disc, nutrients (nitrate-nitrogen, ammonium-nitrogen, phosphate-phosphorus and silicate) and chlorophyll a were measured in the water column. Monitoring of water quality parameters showed that Sugozu power plant did not cause detectable changes in the water column. Variations in the investigated parameters were rather seasonal. These results are believed to be the outcome of environmental management system of the plant. By using high quality fuel and advanced burning technologies, treating flu gas and wastewater, it was possible to reduce its environmental effects.

Key words: Power plant, pollution, water quality, nutrients, Iskenderun bay, Turkey

INTRODUCTION

Electricity is an important commodity and as the world's population grows, the need for electricity will grow. In spite of the technological advances, a large proportion of power is still produced by old traditional methods with low efficiency 50-70% with coal this range begins at 30% where roughly one third of the calorific value of the fuel is lost (Ali *et al*., 2007). Modern day coal power plants pollute less than older designs due to new scrubber technologies that filter the exhaust air in smoke stacks however, emission levels of various pollutants are still on average several times greater than natural gas power plants. In these modern designs, pollution from coal-fired power plants comes from the emission of gases such as carbon dioxide, nitrogen oxides and sulfur dioxide into the air. All thermal power plants produce waste heat energy as a byproduct of the useful electrical energy produced (Anonymous, 2011). The primary effects of thermal pollution are direct thermal shock, changes in dissolved oxygen and the redistribution of organisms in the local community. In addition, to remove hardness, microorganisms and catalyze settling, chemicals added during cooling water treatment. The use of antifouling agents (usually chlorine or hypochlorite) deserves special attention. These chemicals discharge with cooling water to receiving medium and may cause environmental problems. Bacteria and phytoplankton appear to be resistant to thermal stress even at temperatures in excess of 30°C. Macrophytes are reported to be more sensitive to thermal stress and their threshold may be <25°C in temperate and up to 34°C in tropical waters. Zooplankton is not affected in discharges to temperate European waters where summer peaks rise to 30°C in the discharge. Most temperate fish species are able to tolerate a wide temperature range but few are resident in waters with temperatures >30°C (GESAMP, 1984). Acid rains as a result of waste gases from the power plant may change the pH of waters. Heavy metals like Fe, Mn, Co, Cu, Zn, Pb and U which include in coal ash may reach receiving environment through groundwater.

The aim of the present study was to investigate the probable effects of Sugozu thermal power plant on water quality. With this purpose impact area of the plant was monitored for 1 year period.

MATERIALS AND METHODS

Isken Sugozu power plant is a first coal fired power plant which is built and operated by private sector in Turkey. The plant has a net capacity of 1210 MW (605×2) and supplying a 6% of electrical energy need of the country and started to operate in 2003 in Yumurtalik-Adana. The plant uses hard coal with high quality as a fuel and advanced burning technologies (Anonymous, 2011).

To determine water quality of the impact area of Sugozu power plant, four seasonal samplings were made from 12 stations in May, August and October, 2009 and January, 2010 (Fig. 1).

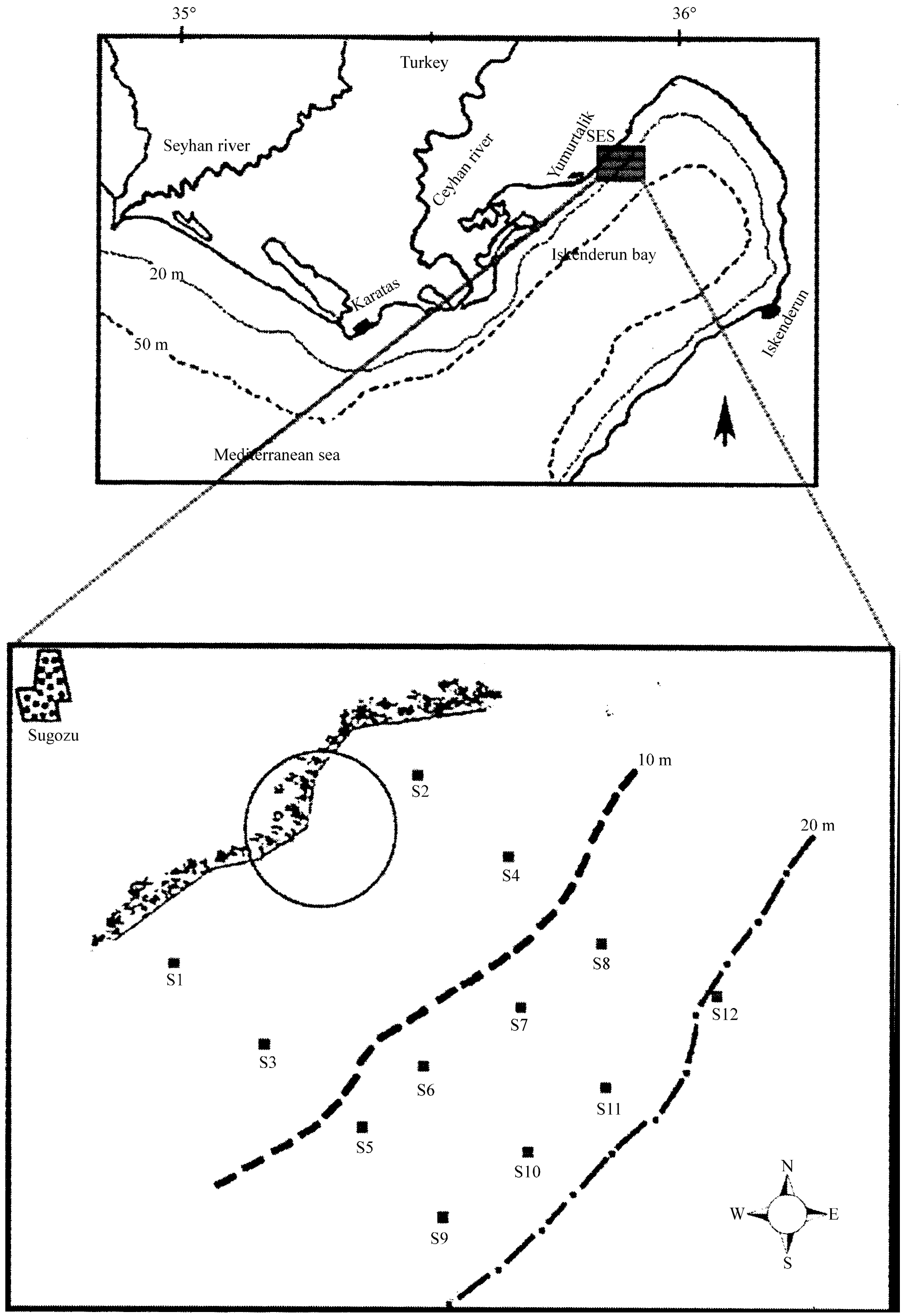

Fig. 1: Map of the study area

Surface and bottom water samples were collected by Nansen water sampler (HYDRO-BIOS). Water Temperature (T) and salinity were measured by SCT meter (YSI 30) whereas Dissolved Oxygen (DO) determined by oxygen meter (YSI 55) and pH determined using a handheld pH meter (YSI 100). Transparency was measured by lowering a Secchi disc from the boat. Chlorophyll a (chl a) values were measured *in vivo* using handheld Fluorometer (Turner Designs Aquaflour 8000-001). Collected water samples were transferred to the laboratory in a cool box for further analyses. Samples were kept in the refrigerator until analyses. Nutrients (nitrate-nitrogen, ammonium-nitrogen, phosphate-phosphorus and silicate) were determined spectrophotometrically (HACH DR 2000) according to Strickland and Parsons (1972).

Seasonal monitoring studies were carried out in 2005, 2007 and 2008 at the same sampling stations and depths and data from these surveys are available (Avsar, 2006, 2008, 2009). Same parameters were measured in these three surveys. Thus, we were able to compare the present data with the previous ones.

RESULTS AND DISCUSSION

Variations of some physico-chemical parameters measured during 1 year period in the impact area of Sugozu power plant are shown in Table 1.

During the monitoring period of May 2009 to January 2010 water temperature in the impact area of Sugozu power plant showed seasonal differences ($p<0.001$, Kruskal-Wallis) and ranged from 17.5-29.7°C. Annual mean value was 23.3°C. In the previous studies of 2005, 2007 and 2008 mean values were 22.0, 23.1 and 23.6°C, respectively (Avsar, 2006, 2008, 2009). It is possible to conclude that Sugozu power plant had no considerable effect on temperature of the receiving marine environment. Similarly, Koksal reported that power plant cooling water discharges did not elevate temperature of the creek of Ankara.

Salinity, pH and dissolved oxygen values also showed significant seasonal differences ($p>0.001$). Salinity ranged from 33.5-38.9% throughout the study. Heavy rains before the samplings of Spring and Winter caused low salinity readings. Highest values were observed in summer as expected.

The pH values of marine environment varies between 7.5 and 8.4 depending on biological activities and temperature. pH values stayed within this range during the sampling period and changed between 7.94 and 8.45. Annual mean value was calculated as 8.26. Annual mean values were 8.15, 8.10 and 8.35 in 2005, 2007 and 2008, respectively (Avsar, 2006, 2008, 2009).

Secchi Disc (SD) depths showed temporal variations and ranged from 1.2-9.0 m with annual mean of 3.65 m. Mean SD values were 4.64 m in 2005, 3.97 m in 2007 and 5.03 m in 2008. Lowest secchi disk readings were recorded in Spring and Winter due to rains observed in the area just before the samplings. Highest values measured in Autumn when the weather was fine and marine conditions were calm.

Dissolved oxygen concentrations indicated seasonal variations and ranged from 6.13-7.47 mg L^{-1} in the study area. Annual mean value is 6.8 mg L^{-1}. Lowest concentrations were measured in Summer and Autumn samplings due to elevated temperatures. Nevertheless, DO values never dropped below the limit of 5 mg L^{-1} which is essential for aquatic life. In the previous surveys annual mean values were 7.6, 6.7 and 6.1 mg L^{-1} in 2005, 2007 and 2008, respectively.

Table 1: Avarage, standard deviation and range of physico-chemical parameters in the water column

Stations	T (°C)	Salinity (%)	pH	DO (mg L^{-1})	Secchi (m)
S1					
Surface	23.6±5.20	36.0±2.40	8.32±0.09	6.61±0.28	1.8±0.4
Range	17.8-29.5	33.5-38.6	8.20-8.42	6.31-6.97	1.2-2.0
S2					
Surface	23.7±5.00	35.4±1.10	8.29±0.10	6.91±0.39	2.5±0.4
Range	18.4-29.1	34.6-37.1	8.20-8.42	6.41-7.24	2.0-3.0
S3					
Surface	23.3±5.30	36.8±2.20	8.25±0.16	6.85±0.45	2.2±0.2
5 m	23.3±5.30	36.4±2.00	8.26±0.16	6.71±0.47	2.0-2.5
Range	17.9-29.6	34.4-38.6	8.01-8.36	6.13-7.32	-
S4					
Surface	23.7±5.30	36.3±2.00	8.29±0.13	6.96±0.40	2.9±0.9
5 m	23.7±5.40	36.3±2.00	8.28±0.15	6.77±0.50	2.0-4.0
Range	17.9-29.7	34.5-38.7	8.05-8.41	6.40-7.47	-
S5					
Surface	23.3±5.20	36.3±2.20	8.30±0.11	6.81±0.44	-
5 m	23.3±5.40	36.4±2.00	8.30±0.14	6.61±0.43	3.1±0.9
10 m	23.2±5.30	36.5±2.00	8.31±0.12	6.72±0.47	2.0-4.0
Range	17.8-29.4	34.3-38.9	8.10-8.43	6.16-7.28	-
S6					
Surface	23.3±5.20	36.2±2.00	8.29±0.13	6.82±0.44	3.1±0.7
Range	17.8-29.3	34.5-38.4	8.12-8.43	6.27-7.29	2.0-3.5
S7					
Surface	23.5±5.30	36.3±1.70	8.29±0.14	6.73±0.36	3.7±1.7
Range	17.9-29.6	34.8-38.2	8.11-8.45	6.22-7.00	2.0-6.0
S8					
Surface	23.5±5.20	36.4±1.70	8.27±0.13	6.80±0.45	-
5 m	23.3±5.20	36.4±1.70	8.25±0.13	6.76±0.38	4.3±1.8
10 m	23.3±5.30	36.5±1.70	8.31±0.13	6.73±0.38	2.0-6.0
Range	17.8-29.4	34.9-38.3	8.06-8.42	6.18-7.15	-
S9					
Surface	23.2±5.50	36.2±1.90	8.26±0.13	6.83±0.45	-
5 m	23.2±5.40	36.5±1.70	8.22±0.20	6.78±0.42	5.5±2.6
10 m	23.2±5.40	36.5±1.80	8.23±0.19	6.77±0.41	3.0-9.0
15 m	23.0±5.10	36.6±1.80	8.25±0.16	6.63±0.47	-
Range	17.5-29.5	34.1-38.5	7.94-8.43	6.18-7.17	-
S10					
Surface	23.4±5.40	36.1±1.80	8.26±0.14	6.76±0.42	5.1±2.5
Range	17.7-29.5	34.2-37.8	8.11-8.44	6.19-7.13	2.0-8.0
S11					
Surface	23.3±5.40	36.3±1.60	8.25±0.14	6.73±0.43	5.5±2.9
Range	17.7-29.5	34.8-37.8	8.11-8.45	6.20-7.10	2.0-9.0
S12					
Surface	23.4±5.20	36.5±1.70	8.19±0.14	6.79±0.42	-
5 m	23.3±5.30	36.5±1.70	8.20±0.19	6.80±0.42	4.4±2.3
10 m	23.2±5.30	36.4±1.60	8.24±0.17	6.77±0.37	2.0-7.5
15 m	23.1±5.30	36.4±1.70	8.22±0.17	6.72±0.39	-
Range	17.8-29.4	34.8-38.1	7.96-8.45	6.16-7.15	-

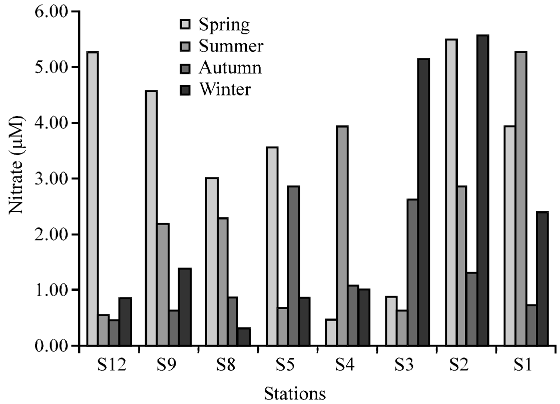

Fig. 2: Mean (all depths) nitrate-nitrogen variation during monitoring period

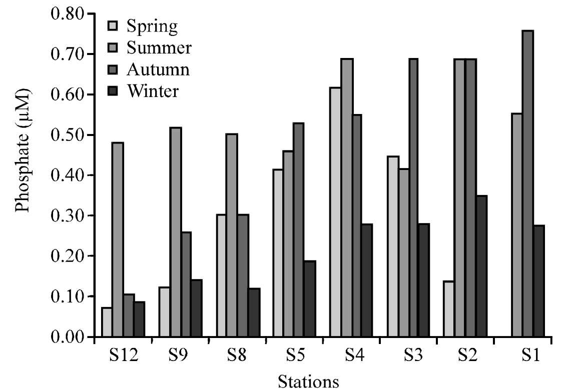

Fig. 4: Mean (all depths) phosphate-phosphorus variation during monitoring period

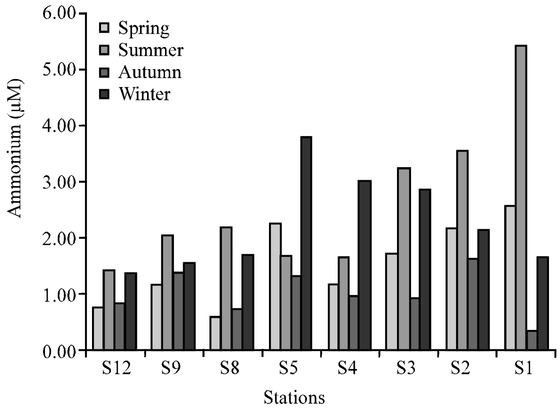

Fig. 3: Mean (all depths) ammonium-nitrogen variation during monitoring period

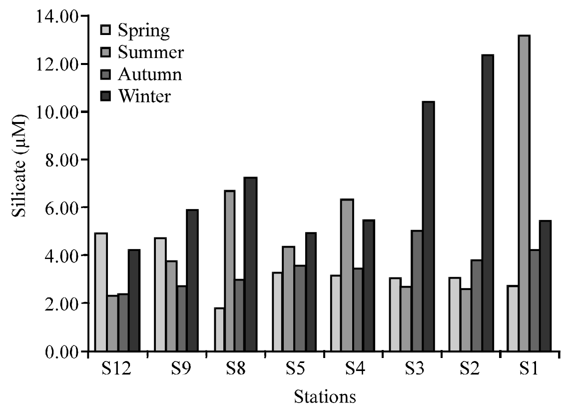

Fig. 5: Mean (all depths) silicate variation during monitoring period

No significant differences were detected between the sampling stations for temperature, pH, salinity, SD and dissolved oxygen ($p>0.05$). Vertical changes were also not important for all the parameters.

Nutrients: Nitrate-nitrogen levels ranged from non-detected (n.d.) to 9.29 µM in the area concerned (Fig. 2). Annual mean value was calculated as 2.1 µM. Annual mean values were 1.8, 1.9 and 1.4 µM in 2005, 2007 and 2008 sampling periods, respectively (Avsar, 2006, 2008, 2009). No significant differences were detected between the sampling stations ($p<0.05$) while differences were found to be significant between the seasons ($p>0.05$). Lower nitrate levels than those in the impact area of Sugozu power plant were reported by several studies: Nitrate concentrations ranged from 0.35-5.52 µM in a study conducted in the Eastern Mediterranean and ranged from 0.31-1.63 µM in the Iskenderun bay (Polat, 2002). Ammonium-nitrogen concentrations varied between nd and 5.42 µM during the study (Fig. 3). Annual mean value was 1.7 µM. This value was reported as 0.8, 1.3 and 0.8 µM in 2005, 2007 and 2008, respectively (Avsar, 2006, 2008, 2009). Differences between the sampling stations were not significant for ammonium ($p<0.05$). On the other hand seasonal variations were significant ($p>0.001$).

Phosphate-phosphorus values ranged from 0.41-0.96 µM throughout the sampling period (Fig. 4). During that period, annual mean value was 0.3 µM. In the previous ones, mean values were also 0.3 µM, hence there were no significant differences between them. Seasonal variations were significant as in nitrate and ammonium ($p<0.001$). Differences between the sampling stations were also found to be significant ($p<0.05$). Polat (2002) reported lower phosphate concentrations than those of the present study in the Iskenderun bay which was ranged from 0.08-0.60 µM. Silicate concentrations at the stations changed between 0.37 and 15.41 µM with the annual mean value of 4.4 µM (Fig. 5). Annual mean value was 3.6 µM in 2005, 3.1 µM in 2007 and 3.2 µM in 2008 (Avsar, 2006, 2008, 2009). Seasonal changes played an important role in the silicate concentration as in other

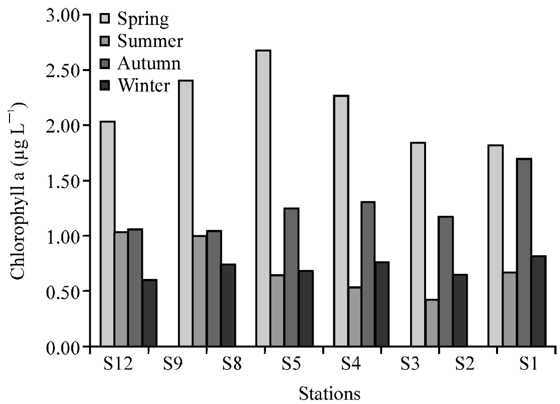

Fig. 6: Mean (all depths) chlorophyll a variation during monitoring period

nutrients ($p<0.05$). Silicate values did not show any significant differences between the sampling points ($p<0.05$). Similar results were reported in the eastern Mediterranean (ranging from 1.77-13.78 μM).

During the monitoring period highest nitrate concentrations were measured in Spring and Winter. It is believed that these readings were the result of agricultural runoff after the heavy rains. Similar results were obtained for the ammonium and silicate concentrations. Highest ammonium concentration of 5.26 μM was measured in Winter sampling. Likewise highest phosphate concentration was detected in Spring as 0.96 μM.

Chlorophyll a values indicated seasonal variations ($p<0.001$) ranging from 0.37-3.11 μg L^{-1} (Fig. 6). Yearly average value is calculated as 1.22 μg L^{-1}. In the previous studies, average values ranged from 0.6-0.8 μg L^{-1} at the same stations (Avsar, 2006, 2008, 2009). No significant differences were detected between the sampling stations ($p>0.05$).

In temperate zones like Mediterranean chlorophyll a values; a measure of phytoplankton growth, reach highest levels in Spring and Autumn months. In accordance, highest concentrations were measured in Spring and Autumn in the present study. It was reported that chl a concentrations varied between 0.42 and 2.78 μg L^{-1} in the Iskenderun bay (Polat, 2002). Metal concentrations in sediment were also measured in the study which was conducted at the same stations concurrently with the present one (Anonymous, 2010). It was reported that Cu, Cd, Zn and Fe concentrations in the surficial sediments were below the average shale values (commonly used as background values in sediment studies). According to the same report, variations in the plankton were common changes which take place in the Eastern Mediterranean. Poornima *et al.* (2005) who studied the impact of thermal discharge of power plant on phytoplankton concluded that the effect is localized and phytoplankton distribution and abundance in the coastal waters are not affected.

CONCLUSION

Monitoring of water quality parameters for 1 year period and comparison of the results with previous surveys which were carried out at the same stations revealed that activities of Sugozu power plant did not cause any significant effects in the marine impact area. Seasonal variations in the investigated parameters were more evident. One of the reasons of these results is believed to be the outcome of environmental management system of the plant. By using high quality fuel and advanced burning technologies, treating flu gas and wastewater, environmental effects are reduced.

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REFERENCES

Ali, M., M. Athar and A. Ehsan, 2007. The emissions and environmental impact of power plants operating on fossil fuel at Distt. Kasur, Pakistan. Ekoloji, 16: 74-80.

Anonymous, 2010. Marine ecology monitoring study of impact area of ISKEN-Sugozu power plant. Project No: 003.01.06. pp: 98.

Anonymous, 2011. Sugozu power plant. http://www.isken.com.tr/db/dosya/isken.ozet.brosur.ingilizce.2010.pdf.

Avsar, D., 2006. Marine ecology monitoring study project of impact area of ISKEN-Sugozu power plant. Final Report of 2005. Adana, Pages: 141 (In Turkish).

Avsar, D., 2008. Marine ecology monitoring study project of Impact area of ISKEN-Sugozu power plant. Final Report of 2007. Adana, Pages: 163 (In Turkish).

Avsar, D., 2009. Marine ecology monitoring study project of impact area of ISKEN-Sugozu power plant. Final Report of 2008. Adana (In Turkish).

GESAMP, 1984. Thermal discharges in the marine environment. UNEP Regional Seas Reports and Studies No. 45. Pages: 44.

Polat, S., 2002. Nutrients, chlorophyll a and phytoplankton in the Iskenderun Bay (Northeastern Mediterranean). Mar. Ecol., 23: 115-126.

Poornima, E.H., M. Rajadurai, T.S. Rao, B. Anupkumar and R. Rajamohan *et al.*, 2005. Impact of thermal discharge from a tropical coastal power plant on phytoplankton. J. Thermal Biol., 30: 307-316.

Strickland, J.D.H. and T.R. Parsons, 1972. A Practical Handbook of Sea Water Analysis. Fisheries Research Board of Canada, Ottowa, Canada, Pages: 310.