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Oil Pollution of the Black Sea, Turkish Straits System [IstanbulStrait (Bosphorus), Sea of Marmara, Çanakkale Strait, (Dardanelles)] and Golden Horn, in 1997 – 2003

Karadeniz, Türk Boğazları Sisteminde [IstanbulBoğazı, Marmara Denizi, Çanakkale Boğazı] ve Haliç'te 1997–2003 arasında Petrol Kirliliği

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Abstract

The Turkish Straits has been a tanker route for the Russian and Caspian oils from the Black Sea to the Mediterranean Sea.
In this work, the monitoring surveys were conducted on sea water during the years 1997-2003 in the Turkish Straits System (IstanbulStrait, northern part sea of Marmara and Dardanelles), Golden Horn, and vicinity of the Bosphorus entrance to the Black Sea, and additionally west part of the Black Sea in 2003 The oil pollution was determined monthly/seasonally. The highest oil amount in surface water of examined regions between 1997-2003 were ranked as:
for vicinity of Bosphorus entrance to the Black Sea:
2002>1999>2001>2003>1997>2000>1998,
for the IstanbulStrait:
2002>2001>2003>1999>1997>1998>2000,
for the Golden Horn:
2002>2003>2001>2000,
for the Sea of Marmara:
2003>2002>2000>1997>2001>1998>1999,
for the Dardanelles:
2002>2003>2001>1999>1998>1997>2000.

This investigation showed that the oil pollution had varied during the years. It is clear that Turkish Straits system is under the risk of oil pollution. This problem can be solved by the diminish of tanker traffic in the Turkish Straits system.

This monitoring plan was coordinated by İSKİ (The IstanbulWater and Sewerage Administration) and carried out by our Institute.

Keywords: Oil pollution 1997–2004, The Black Sea, IstanbulStrait, Marmara Sea, Dardanelles, Golden Horn.

Introduction

The Turkish Straits System is composed of the IstanbulStrait (Bosphorus), Sea of Marmara and Çanakkale Strait (Dardanelles), Golden Horn inclusive. It connects the Black Sea to the Mediterranean by way of the Aegean Sea.

A comprehensive accounts on oceanography of the Turkish Straits System are given in Memorandum (1941) as follows:

The IstanbulStrait lies between the latitudes of 41° 01' N and 41° 13' N and is about 31 km(17 nautical miles) in length, with an average width 1.4 km (8 cables). The narrowest part of the Strait is the Istinye-Kandilli area, lying almost at midway along the Strait, is merely 720 m. (0.4 nautical mile) wide.

The Marmara Sea is 11.500 km^2 with a volume of 3.378 km^3. Its maximum length (Gelibolu- Izmit) is 276 km and the maximum width is 76 km. The whole coastline extends 927 km-264 km of which lies in the European and 663 km in the Asian sides , the deepest point being 1.335 m.

The Golden Horn is an integral part of the Marmara Sea and separates the historical part of the city of Istanbulalmost into two equal parts. Golden Horn is 7 km long and 150-900 m wide, having depths ranging from 1m to 42m.

The Dardanelles (Çanakkale Strait) on the other hand, connects the Marmara Sea to the Aegean Sea and then to the Mediterranean Sea. It is 60 km long, 1.2 km at the narrowest and 6.5 km at the widest part, with depths varying between 60 and 100 m. Two layer-current exists in both straits. Water exchange between the Marmara Sea (the Black Sea water, upper layer) and the Aegean Sea(the Mediterranean water, lower layer) produces characteristic layeud water structure within the Straits. Speed of the upper-

layer current in southward direction is 0.5-4.8 knots in the IstanbulStrait and 1.6 knots in the Dardanelles; and whereas the rate of bottom current, towards the Black Sea, is 1.6 knots in the IstanbulStrait and 0.4 knot in the Dardanelles.

Number of vessels in dense shipping traffic reaches approximately 65.000 vessels in the IstanbulStrait and 35.000 in the Dardanelles almost every year. Number of tankers passes through the IstanbulStrait, up and down is 16 per day. Tanker traffic that the Strait witnessed by tanker types in 2002 was: petroleum 6022, LPG 545, chemical 860 (Akten, 2003; 2004).

Petroleum hydrocarbons are the important contaminants in seawater. There are several sources of petroleum hydrocarbons introduced to marine environment as spills - tanker accidents, tanker washings (gas-freeing operations),water ballasting, shipping transport, ship operations, storage,etc. All these processes in one way or other increase the oil pollution at sea water.

As indicated above the major problem in the Turkish Straits is especially the tanker traffic. Numerous tanker accidents have occurred in the Turkish Straits. The ship accidents in the IstanbulStrait amounted to 205 in total; 28 of which involved tankers in the period of 1982–1994 (Akten, 2003; 2004).

Many of the following incidents ended up with high or serious rate of oil spill:

- The major disaster was the collision accident between m.t Independenta (laden with 93.000 tons crude oil) with the dry cargo ship Evrialy, happened on 15 Nov. 1979, almost at the southern entrance to the IstanbulStrait, resulting in oil 70.000 tons crude spill and 20.000 tons oil burnt.
- The second major disaster was the Nassia case. It was again a collision accident between the m.t Nassia (with a dangerous cargo of 100.000 tons onboard) and MV Shipbroker occurred at the northern entrance to the IstanbulStrait in March 1994. Outcome of the accident was 2000 tons of crude oil spilled and more than 20.000 tons of oil burnt. Its pollution was investigated by Güven *et al.*(1995, 1996, 1998) and Okuş *et al.* (1996).
- Another serious casualty was the TPAO tanker fire occurred in Tuzla Bay on February 13, 1997 where 41.35 tons oil spilled (Ünlü *et al.*, 2000). The tanker had been taken to the yard for repair before

the fire broke out.

- The river tanker Volganeft 248 accident occurred in Dec. 29, 1999 at Florya, İstanbul, coast of Sea of Marmara. It was broken in two and sank with an oil cargo of 4365 tons, 3086 tons of which was spilled and leaked into the Sea of Marmara(Güven *et al*., unpublished data).
- M.V Gotia sank at 7 October 2002 in the IstanbulStrait, off the Emirgan quay, with 1082 tons of urea. After the incident 25 tons oil spilled and affected the IstanbulStrait (Güven *et al.*, 2004).

Primary factors responsible for oil pollution in the IstanbulStrait are not only the tanker traffic but also industrial pollution from the countries entouring the Black Sea, plus the city sewage.

The present problem of the Turkish Straits is the transportation of the the Russian and Caspian oils by tankers via the Turkish Straits. Sharp increase in tanker transportation in the Turkish Straits is a major problems for this area. Turkish authorities are committed to reduce the risk of serious oil spill in the high sensitive Turkish Straits (Anon. 1996a). According to papers published so far, oil discharge into the Black Sea is estimated as 410.000 t/a (Polikarpov *et al.,* 1991), however, other estimate an average of 80.000 t (Fashchuk, 1998).Shipping caused the input of 12.000 t/a oil into the Black Sea. Only 28% of the total amount of oil entered into the Black Sea is with river flow, 32–40% from shipping, and 5–10% as a result of oil spills caused by ships, accident and pipeline damage (Fashchuk and Shaporenko, 1995).In the most stable regions of oil film accumulation in the Black Sea in 1981-1990 in Novorossiisk to Tuapse and from Sochi to Batumi (Fashchuk *et al.*, 1996). In a recent paper on oil pollution with regard to Russian and Caspian coastal waters, stands out receives 86% of petroleum hydrocarbons (Shaporenko, 1997).Oil pollution in the region of İstanbul, Odessa and Sochi causes alarming, though 48% of approx. 110 thousand tons of petroleum is transported annually to the Black sea by the inflow of Danube waters (Anon.1996 b).

In the Sea of Marmara the oil pollution is mostly caused by the inflow from the Black Sea, as well as heavy shipping/tanker traffic and the Izmit refinery. The Dardanelles was also affected by the pollution carried from the Sea of Marmara and shipping/tanker traffic (Güven *et al.*, 2002).

The determination of oil pollution has some problems. These are extraction solvents and reference materials used for quantification. The determination of oil pollution in marine environment was made by various extraction of

solvents especially by methylene chloride (DCM) and hexane and others. UNESCO recommends DCM as extraction solvent (IOAC 1986).

The quantitative determination of oil in sea water is based on the measurement of total fluorescence of reference oil materials originated from different countries or chrysene which was proposed by UNEP (1984). The enormous number of compounds present in oil. But chrysene results do not reveal the definite level of oil pollution in sea water while chrysene is a minor component in oil and its fluorescence intensity being low (Domenico, 1994; Lara *et al.,* 1995; Ünlü and Güven, 2001).Oil contains many fluorescent subtances and their amounts depend on the crude oil origins. Ehrhard and Petrick (1989) suggested the usual reference material is the crude oil likely to be used or transported through the area under investigation. The present study, based on the Russian crude oil standard, the concentration of petroleum hydrocarbons in sea water examined.

On the other hand, some hydrocarbons found in sea water, are synthesized by living organisms (fish, algae, etc.) but these biogenic compounds are not particularly abundant and do not show the fluorescence. Especially flourescence PAH compounds are characteristic for the petroleum. These compounds are not synthesized by marine animals and plants .

Several papers have been published with regard to oil pollution in the IstanbulStrait (Baştürk *et al.,* 1988) and sediments in the Sea of Marmara (Shimkus *et al.,* 1993). The oil pollution in the Turkish Straits and also Golden Horn was systematically surveyed after the Nassia accident until 1996 (Güven *et al.,* 1995; 1998 a,b., Okuş *et al.*, 1996 and (afterwards since 2003 were planed by İSKİ.In the sea of Marmara, Izmit Bay (Güven *et al.*,1997), after the earth quake, 17 August 1999) (Güven and Ünlü., 2000, after TPAO accident Ünlü *et al.,* 2000, and in 2002 –2003 (Günday *et al.* unpublished data*).*The oil pollution of Dardanelles were first studied by our institute (Güven *et al.*, 2002 a,b, 2003). The oil pollution was also determined in the sewage of Çanakkale for 2001-2002 period (Güven and Ilgar., 2002 a,b) and (Güven *et al.*,2003*)*. IstanbulStrait oil pollution in sea water was determined after Gotia accident (Güven *et al.,* 2004).

In this paper, the oil pollution in the Black Sea, Turkish Straits and Golden Horn is reported for the period of 1997-2003.

Materials and Methods

The sampling was carried out during 1997–2003 at the following stations:
3 stations in vicinity of the Bosphorus entrance to the Black Sea, additionally
11 stations in west part of the Black Sea (28 August 2003),
7 stations in the IstanbulStrait (northern entrance and southern end),
11 stations in northern of the Sea of Marmara,
6 stations in Golden Horn ,
4 stations in the Dardanelles.

The investigation was made monthly at K2 station in the Black Sea and seasonally at K1, K3 stations, monthly in all stations of the IstanbulStrait and Golden Horn, seasonally in the Dardanelles as well as in the Sea of Marmara.

The sampling stations are shown in Figure 1 a ,b, c, d. The samples were taken by special bottle from the surface and by Niskin bottles at various dephts as 10 m, thermocline and deep water in IstanbulStrait and the Sea of Marmara, and in surface water and 10 m depth in the Dardanelles.

The sampling volume of seawater was 3L and 15 ml dichloromethane (DCM) was added for preservation of the samples. The oil concentration in sea water was determined in 2.8 L samples. It was divided into as 4x 700 ml and each portion was extracted with 50 ml DCM. The extracts were combined and dried over anhydrous sodium sulphate and distilled at 40 °C. The residue was dissolved in hexane and the volume adjusted to 10 ml with hexane. The petroleum hydrocarbon concentration in seawater was determined by UV spectrofluorophotometer (UVF) (Shimadzu RF-1501). Russian crude oil was used as reference material for plotting the calibration curve.

Fig 1a. Stations in west part of the Black Sea

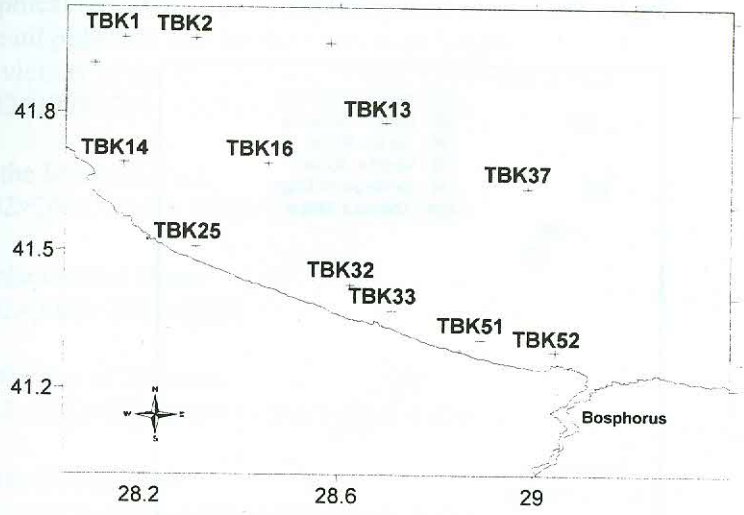


Fig 1b. Stations in vicinity of the Bosphorus entrance to the Black Sea, IstanbulStrait and northern part of the Marmara Sea

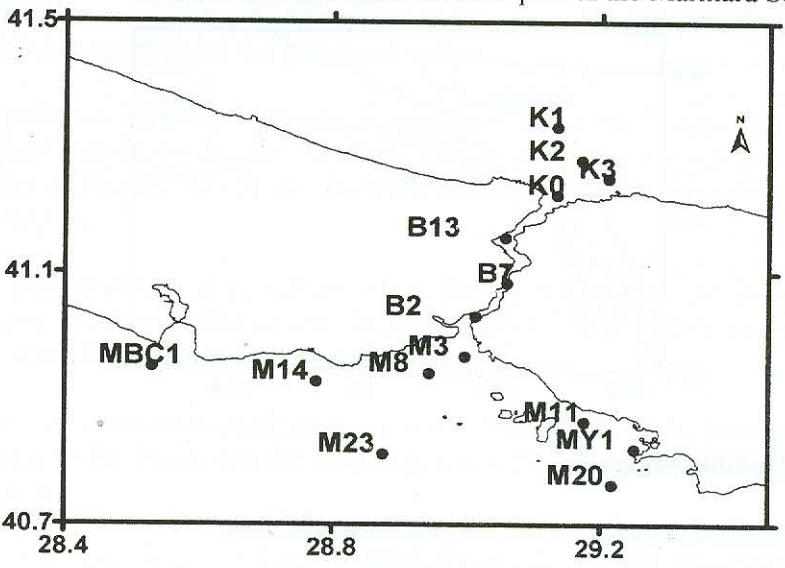


Fig1c. Stations in Goldern Horn

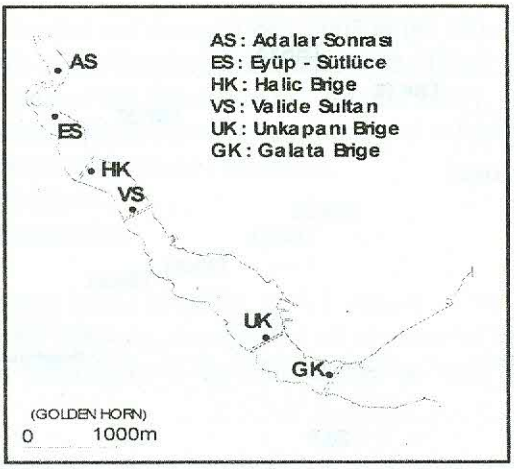
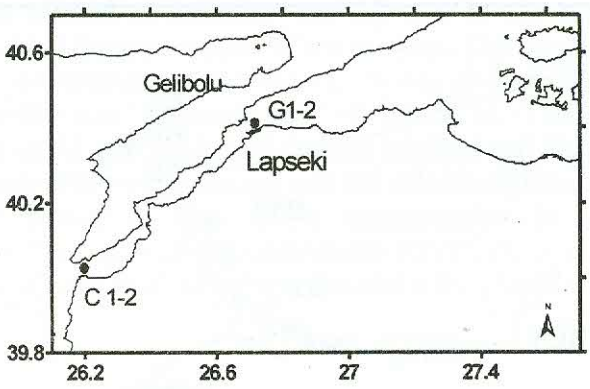


Fig 1d. Stations in Dardanelles



Results and Discussion

The standard equation of the reference material was:
$y= 552.67c+51.554$ $r^2= 0.98$
The oil level found in 1997–2003 at the vicinity of IstanbulStrait entrance to Black Sea, IstanbulStrait, Sea of Marmara, Dardanelles and Golden Horn are

shown in Tables 1-9. and the west part of the Black Sea in Table 10. The max. oil level in Turkish Strait Systems are shown in Table 11 and their graphical representation in Fig. 2 a-g.
The oil pollution rate for the years is as follows:
for vicinity of the Bosphorus entrance to the Black Sea,
2002>1999>2001>2003>1997>2000>1998

for the IstanbulStrait:
2002>2001>2003>1999>1997>1998>2000

for the Golden Horn:
2002>2003>2001>2000

for the Sea of Marmara:
2003>2002>2000>1997>2001>1998>1999

for the Dardanelles:
2002>2003>2001>1999>1998>1997>2000

Thus highest pollution was found during the years as:
In the year of 2002 in the vicinity of IstanbulStrait entrance to the Black Sea, Golden Horn and the Dardanelles,
In 2003 Sea of Marmara. According to these results, the pollution levels were independent in all the examined stations.

The pollution levels were found high in entrance of the IstanbulStraits and northern part of the Sea of Marmara. The oil concentration was low in the vicinity of Bosphorus entrance to the Black Sea and west part of the Black Sea stations.

The Turkish Straits were influenced by the oil pollution of the Black Sea. The causes of oil pollution are the discharge of tanker ballast in the open area of the Black Sea and in the Sea of Marmara

In 2003 oil concentration of surface water in the vicinity of the IstanbulStrait entrance to the Black Sea the level was lower than limit value (13 μg/L) of pollution.

As can be seen from the Tables 1-9 are not found a parallellism on the oil pollution level between the examined stations. Istanbul Strait like a funnel. The Black Sea water circulation is directed to the east and some of them

passes to IstanbulStrait as a transition through a funnel. The currents of water in and out of the IstanbulStrait are not similar. Along the of IstanbulStrait many reverse currents exist and those cause the different results on oil pollution. Thus several stations in the IstanbulStrait indicated different oil levels from one another.

On the other hand there are some anomolous value among the pollution level in the IstanbulStrait stations due to the heavy traffic.

An important result is that no paralelism found in this monitoring on the oil pollution level between the entrance and exit of the IstanbulStrait while in the former region exist many ships, boats traffic and ultimately the pollution is high.

Oil level was lower in the Dardanelles compared to that of Istanbul Strait. This result may be explained by the length of Dardanelles which is quite longer than the IstanbulStrait.The dilution of polluted water is expanded in a large area of the Marmara Sea before they reach to the Dardanelles. The other explanation of low oil level in the Dardanelles is the composition of the aromatic hydrocarbons in oil degrade during the sea water flux from the Black Sea to the Sea of Marmara. The time for surface water flux for the Istanbul Strait is in 10h wheras for the Sea of Marmara in 3 months. The degredation aromatic hydrocarbons especially, benzthiophenes derivatives and di/tri rings hydrocarbonsare high in short time. On the other hand, the variation of oil level in the examined area depends critically on the wind direction and is also certainly associated with increasing shipping activities.

The influence of meteorogical conditions and sampling time also played an important role in the oil pollution. Seasonal variations of oil pollution showed that in general the concentration of petroleum residue was found much higher in winter than in summer. It was due to the higher degradation and evaporation of oil compounds in summer than in winter.

The other sources in the Sea of Marmara are the industries which grow rapidly during the last 50 years in Izmit Bay and has enhanced the industrial pollution problems in Marmara Sea water. The important point of the pollution is the difference on the oil level on the surface and in deep water. It was found that the deep water was more polluted than the surface water.

Some part of oil is covered by a thin film on the surface water and evaporates but the remaining is deposited on plants or sediments. Our

observation revealed that the tar frequently seen in the coastal areas of Şile and Sinop was closely linked with irregular discharge of ballast water.

The highest pollution in the Dardanelles was observed in the surface water in 2002. The comparison of pollution at the entrance and exit of the Dardanelles showed that entrance (Gelibolu and Lapseki) was more polluted than the exit (Çanakkale) (Güven et al., 2003)

In Golden Horn the pollution decreased from the entrance (Adalar sonrası) to exit (Galata Bridge). The highest oil concentrations were found at station Eyüp-Sütlüce as 11 mg/L in 2002 and 592.2 μg/L in 2003. The pollution was high in 2002 and 2003. It was found an irregular pollution during the years of 2000–2003. In Golden Horn the oil level was found high due to the river of Alibeykoy and Halic.These rivers were more polluted by urban sewage.

In earlier studies made on the pollutions in this examined areas are summarized as follows. Baştürk et al. (1998) found DDPH level in Bosphorus-Marmara junction as 0.76μg/L in 1986 and 1.25 μg/L in 1987 (through chrysene equivalent). When compared this findings with our results the values given are very low. As indicated above the chrysene equivalent gave not true results and not corresponde the oil pollution in this area. The pollution level in the Turkish Straits after the Nassia accident in April 1994, in the Black Sea, at the station Karaburun at surface 12.1 μg/L, at thermocline as 56.5 μg/L; at Poyraz 24.9 μg/L, at Altınkum 18.6 μg/L, at Beykoz 12.3 μg/L (Güven *et al.*, 1996). In the Sea of Marmara the pollution level varied as 0.4-6.6 μg/L at surface water, 0.4-45.7 μg/L at thermocline and 0.1-64.5 μg/L at deep water (Okuş *et al.*, 1996).

Oil levels in the Black Sea, at surface water are 32.6 μg/L at K1 station, in the Istanbul Strait; northern entrance 27 μg/L, southern end 136.6 μg/L, in the Sea of Marmara as 103.7 μg/L at M2 station, in the Dardanelles northern entrance 43.5 μg/L, southern end 40.9 μg/L in 1996 (Güven *et al.,2002 b*).

After the TPAO tanker accident at 13 Feb. 1997 in Tuzla Bay, during 1997-1998, the highest pollution was determined as 32.2 mg/L (Ünlü *et al.*, 2000), in Izmit Bay during 1994–1995 as 12.74–383.4 μg/L at station 1 and 32.0-986.5 μg/L at station II (Güven *et al.*, 1997) and during 2002-2003 in these areas max. oil levels were 144.3 μg/L –549.2μg/L (Günday *et al.*, unpublished data).

After the earthquake of 17 August 1999 in Izmit Bay, the max. level was 179 mg/L (Güven and Ünlü., 2000)

After the Volganeft accident at 29 December1999 off Florya, the amount of the oil pollution was 14.05 g/L -2178.5µg/L at S3 and A5 stations respectively, (Güven *et al.*, Unpublished data).

In the Gotia accident at 7 Oct. 2002 (Emirgan, IstanbulStrait) 813.5 mg/L (max.) in Bebek Cove, 7.3 mg/L in Golden Horn and 27.4 mg/L in Yenikapı Sea of Marmara (Güven *et al.*, 2004).

In the Dardanelles in 2001-2002, the highest oil level in entrance (Gelibolu) was 148.3 µg/L in 2001 and 13.2 µg/L in 2002. In exit (Çanakkale), was 226.2 µg/L in 2001 and 6.6 µg/Lin 2002 (Güven *et al.*, 2002).

Unfortunately, there is not an available investigation on the Independenta accident.

In comparison the oil pollution in the other World Straits and tanker route with the Turkish Straits are as follows: in the Johor Strait (Malaysia) 0.085 – 2.79 µg/L (Abdullah *et al.*, 1996), in the Sao Sebatio Channel (Brazil) (Zanardi *et al.*, 1999a) 0.3 – 2.5 µg/L and after oil spill in accident point 49.6 µg/L (Zanardi *et al.*, 1999b), in the Shelikoff Strait 772-13049 µg/L (Page *et al.*, 1998), in tanker routes of the Arabian Gulf and the Gulf of Oman 128.6-207.7 µg/L (Shriadah, 1999).These results showed that Turkish Straits was more polluted (except the Shelikoff Strait).

Finally, the dilution and distribution of oil in Turkish Strait Systems will not be the same. The oil pollution problems in this area can be solved mostly by diminishing the tanker traffic and also to control the sewage of the surrounding countries of the Black Sea.

Regular measurement of the seas and straits of the world are not made. These are the first measurements made regularly on a monthly/seasonally basis in these straits.

In conclusion, the main affected area of the Turkish Strait Systems is IstanbulStrait. The oil pollution in the Turkish Strait has generally increased during the years.
Consequently, the oil pollution problem in Turkish Straits has continued and must be surveyed continuously on a daily /monthly basis.

Table 1: Oil Pollution in the Turkish Straits in 1997 (µg/L). S: Surface water, I:Interface layer, D:Deep water, Ç:Çanakkale, G:Gelibolu. The second value (max level) belongs to the month given in the same line.

Black Sea				İstanbul Strait				Sea of Marmara				Çanakkale Strait (Dardanelles)			
K1:	S.:	0.5-33.0	Feb.	K0:	S.:	2.8-43.1	Apr.	M3:	S.:	0.7-13.0	Feb.	Ç I:	S.:3.0-26.0		June
	10 m.:	5.1-10.0	Aug.		10 m.:	0.8-22.0	June		10 m.:	1.4-12.0	Aug.		10 m.: 1.8-29.2		June
	I:	2.8-17.0	Aug.		I:	0.9-26.0	June		I:	1.9-36.4	July				
	D:	3.5-28.1	Aug.		D:	2.4-34.5	July		D:	1.7-13.0	Nov.	Ç II:	S. :2.9-45.5		Dec.
													10 m.: 2.0-26.7		Dec.
K3:	S:	2.2-44.6	Nov.	B13:	S.:	1.9-44.0	Apr.	M8:	S.:	0.7-66.3	Feb.				
	10 m.:	5.4-12.2	Feb.		10 m.:	2.6-51.3	Feb.		10 m.:	1.5-32.2	Aug.	G I:	S.:1.9-23.9		Dec.
	I:	3.3-21.6	Feb.		I:	0.9-64.3	Feb.		I:	1.6-45.0	Dec.		10 m.: 2.4-34.7		May.
	D:	2.3-17.4	Aug		D:	2.8-22.3	June		D:	2.4-27.1	Feb.				
												G II:	S.:0.4-25.9		Dec.
				B7:	S.:	1.7-46.0	Ocl.	M11:	S.:	1.2-10.7	Feb.		10 m.: 2.4-28.3		Dec.
					10 m.:	1.4-48.0	Nov.		10 m.:	1.4-8.1	Feb.				
					I:	3.5-58.0	Nov.		I:	1.9-21.0	Aug.				
					D:	1.8-31.0	Mar.		D:	1.7-18.9	Aug.				
				B2:	S.:	5.3-66.8	Aug.	M14:	S.:	2.1-51.0	Jan.				
					10 m.:	1.9-46.1	Mar.		I:	1.6-60.0	Mar.				
					I:	0.8-29.0	July		D:	1.5-42.0	July				
					D:	2.1-47.0	July								
								M20:	S.:	2.0-6.5	Feb.				
									10 m.:	1.8-32.5	Aug.				
									I:	1.2-16.2	Aug.				
									D:	1.3-13.3	Aug.				
								M23:	S.:	1.5-5.0	Nov.				
									10 m.:	1.2-3.6	Nov.				
									I:	1.9-36.1	Aug.				
									D:	0.7-13.0	Aug.				

Table 2: Oil Pollution in the Turkish Straits in 1998 (μg/L). S: Surface water, I: Interface layer D:Deep water, Ç:Çanakkale, G:Gelibolu. The second value (max level) belongs to the month given in the same line.

Black Sea				**İstanbul Strait**				**Sea of Marmara**				**Çanakkale Strait (Dardanelles)**			
K1:	S.:	3.1-16.1	May	K0:	S.:	1.8-9.4	Nov.	M3:	S.:	1.1-6.7	May	Ç I:	S.:	0.7-27.3	Feb.
	10 m.:	2.1-5.6	Feb.		10 m.:	1.4-23.4	Jan.		10 m.:	1.1-4.8	May		10 m.:	1.4-12.8	Mar.
	I:	2.0-13.8	Dec.		I:	1.7-11.8	Apr.		I:	1.0-4.1	May				
	D:	1.3-3.3	Dec.		D:	1.9-8.5	May		D:	1.0-1.3	Nov.	Ç II:	S.:	1.0-45.9	
K3:	S:	1.7-1.9	May	B13:	S.:	1.6-18.2	Mar.	M8:	S.:	0.3-4.7	Aug.	Feb.			
	10 m.:	1.6-3.7	May		10 m.:	0.9-5.9	Mar.		10 m.:	0.6-9.5	Aug.		10 m.:	0.9-110.3	
	I:	0.5-2.6	May		I:	1.2-69.2	Mar.		I:	1.1-11.4	May	Feb.			
	D:	1.6-3.7	May		D:	3.7-56.7	Apr.		D:	1.4-5.1	May				
				B7:	S.:	0.8-9.8	May	M11:	S.:	1.3-26.7	Feb.	G I:	S.:	0.3-35.0	
					10 m.:	1.9-9.1	Feb.		10 m.:	0.8-8.5	May	Feb.			
					I:	0.3-44.0	Mar.		I:	0.9-7.5	May		10 m.:	0.6-9.2	
					D:	1.6-7.0	Ocl.		D:	1.2-8.1	May		July		
				B2:	S.:	1.9-45.3	Mar.	M14:	S.:	1.6-4.3	Nov.	G II:	S.:	1.2-40.3	Jan.
					10 m.:	1.5-7.0	June		10 m.:	1.6-6.5	May		10 m.:	2.0-15.2	June
					I:	1.8-42.0	Mar.		I:	0.6-8.8	May				
					D:	1.9-9.3	Apr.		D:	1.9-7.3	May				
								M20:	S.:	2.1-35.0	Aug.				
									10 m.:	0.5-11.0	May				
									I:	1.1-4.3	Aug.				
									D:	1.1-11.3	May				
								M23:	S.:	0.6-5.6	May				
									10 m.:	1.8-4.6	Feb.				
									I:	0.4-5.3	Feb.				
									D:	0.5-6.7	May				

Table 3: Oil Pollution in the Turkish Straits in 1999 (µg/L). S: Surface water, I:Interface layer, D:Deep water, Ç:Çanakkale, G:Gelibolu, L:Lapseki, K:Kilitbahir. The second value (max level) belongs to the month given in the same line.

Black Sea			**İstanbul Strait**			**Sea of Marmara**				**Çanakkale Strait (Dardanelles)**		
K1:	S.:	0.5-35.1 Mar.	K0:	S.:	2.0-13.4 July	MY1:	S.:	0.5-16.0	May	Ç I:	S.:	2.8-10.9Nov.
	10 m.:	0.6-27.9 Mar.		10 m.:	1.6-8.1 Sep.		10 m.:	0.9-13.4	May		10 m.:	2.9-8.8Nov.
	D:	0.8-29.8 Mar.		I:	2.3-7.0 July		I:	1.0-7.5	May			
				D:	1.7-10.1 Dec.		D:	0.9-37.3	Aug.	Ç II:	S.:	2.5-11.8May.
K2:	S.:	0.7-9.8 Dec.	K0(A):	S.:	1.6-253.1 Ocl.	MBC:	S.:	0.1-6.0	Aug.		10 m.:	3.4-13.5Nov.
	10 m.:	0.2-10.2 Apr.		10 m.:	1.9-8.5 Aug.		10 m.:	1.2-5.0	July			
	I:	1.2-13.8 Apr.					I:	0.5-4.5	July	G I:	S.:	2.5-12.1Nov.
	D:	1.1-16.5 Apr.	K0(B):	S.:	0.8-39.2 Ocl.		D:	1.3-7.0	Aug.		10 m.:	1.9-12.7Nov.
				10 m.:	1.1-37.9 Nov.	M3:	S.:	0.2-3.7	Dec.			
K3:	S:	0.9-126.9 Mar.					10 m.:	0.7-19.0	Mar.	G II:	S.:	1.5-15.8Nov.
	10 m.:	0.6-2.1 Mar.	B13:	S.:	2.8-52.8 Ocl.		I:	0.5-9.8	Aug.		10 m.:	1.3-7.5Nov.
	D:	2.6-3.1 Nov.		10 m.:	3.1-13.9 Sep.		D:	0.3-17.4	Mar.			
				I:	1.7-39.9 Sep.	M8:	S.:	0.2-2.9	Nov.	L:	S.:	0.3-61.6Feb.
				D:	1.9-25.9 Mar.		10 m.:	0.7-5.1	Nov.		10 m.:	0.7-57.5Feb.
							I:	1.5-30.2	Nov.			
			B2:	S.:	0.8-15.7 Nov.		D:	1.1-12.4	Nov.	K:	S.:	0.3-61.6Feb.
				10 m.:	5.0-13.3 Ocl.	M11:	S.:	1.2-3.7	Nov.			
				I:	1.3-24.7 July		10 m.:	0.5-3.8	Nov.			
				D:	2.2-25.2 Aug.		I:	1.0-3.7	Nov.			
							D:	0.3-.0	Nov.			
						M14:	S.:	1.1-4.2	May			
							10 m.:	0.8-4.7	May			
							I:	1.3-6.9	Aug.			
							D:	1.0-2.1	Nov.			
						M20:	S.:	0.9-4.2	Aug.			
							10 m.:	0.2-2.6	Nov.			
							I:	1.5-2.2	Nov.			
							D:	1.8-2.3	Mar.			
						M23:	S.:	0.5-5.7	Nov.			
							10 m.:	0.5-3.9	Nov.			
							I:	0.02-2.0	Nov.			
							D:	0.5-2.1	Nov			

Table 4: Oil Pollution in the Turkish Straits in 2000 (µg/L). S: Surface water, I: Interface layer, D:Deep water, Ç:Çanakkale, G:Gelibolu, L:Lapseki, K:Kilitbahir. The second value (max level) belongs to the month given in the same line.

Black Sea				**İstanbul Strait**				**Sea of Marmara**				**Çanakkale Strail (Dardanelles)**			
K1:	S.:	4.3-6.4	Nov.	K0:	S.:	1.9-10.2	Jan.	MY1:	S.:	2.7-141.5	Aug.	Ç I:	S.:	1.9-9.6	May.
	10 m.:	3.4-17.8	Feb.		10 m.:	2.9-10.4	Feb.		10 m.:	2.1-23.7	Jan.		10 m.:	1.3-23.2	May.
	I:	3.2-7.6	Nov.		I:	2.2-12.7	Feb.		I:	1 9-22.2	Mar.				
	D:	2.2-64.8	Feb.		D:	4.7-19.2	Jan.		D:	1.7-19.1	Mar.	Ç II:	S.:	1.3-13.6	May.
K2:	S.:	2.0-44.5	Ocl.	K0(A):	S.:	1.9-26.5	June	MBC:	S.:	1.9-16.9	Jan.		10 m.:	1.4-20.5	May.
	10 m.:	2.7-23.0	Apr.		10 m.:	2.2-26.9	Mar.		10 m.:	1.6-20.3	Mar.				
	I:	2.2-55.9	July						I:	2.1-16.5	Mar.	G I:	S.:	2.2-22.4	May.
	D:	2.8-22.0	Jan.	K0(B):	S.:	2.1-16.6	Jan.		D:	2.3-30.1	Mar.		10 m.:	1.0-22.3	May.
					10 m.:	2.2-110.6	Mar.	M3:	S.:	2.3-11.0	Nov.				
				B13:	S.:	1.8-10.0	Mar.		10 m.:	3.0-9.1	Nov.	G II:	S.:	0.7-41.1	May.
K3:	S:	2.8-15.7	Nov.		10 m.:	2.0-11.0	Mar.		I:	1.8-7.0	Nov.		10 m.:	1.6-23.5	May.
	10 m.:	2.7-9.5	Nov.		I:	2.1-17.0	Jan.		D:	1.5-31.7	May				
	D:	2.5-5.8	Nov		D:	1.6-35.7	July	M8:	S.:	1.7-21.9	May				
									10 m.:	1.2-15.0	Feb.				
				B2:	S.:	2.0-20.7	June		I:	1.6-6.0	Nov.				
					10 m.:	2.2-17.9	Jan.		D:	2.2-19.8	Feb.				
					I:	1.5-25.4	July	M11:	S.:	3.1-17.8	Feb.				
					D:	1.7-31.7	June		10 m.:	2.5-4.3	Feb.				
									I:	2.1-11.4	Feb.				
									D:	1.6-9.2	Feb.				
								M14:	S.:	1.5-26.07	Feb.				
									10 m.:	2.2-9.4	Nov.				
									I:	1.9-22.6	Feb.				
									D:	1.7-21.5	Feb.				
								M20:	S.:	2.1-7.3	May				
									10 m.:	1.7-9.6	May				
									I:	2.2-22.6	Feb.				
									D:	1.5-21.5	Feb.				
								M23:	S.:	1.4-23.7	Feb.				
									10 m.:	2.2-4.5	Feb.				
									I:	2.1-4.8	Nov.				
									D:	1.7-10.1	Feb				

Table 5: Oil Pollution in the Turkish Straits in 2001 (µg/L). S: Surface water, I: Interface layer, D:Deep water, Ç:Çanakkale, G:Gelibolu, K:Kilitbahir. The second value (max level) belongs to the month given in the same line.

Black Sea			**İstanbul Strait**			**Sea of Marmara**				**Çanakkale Strait (Dardanelles)**		
K1:	S.:	1.3-5.0 May	K0:	S.:	0.4-11.8 Jan.	MY1:	S.:	0.5-49.7	Ocl.	Ç I:	S.:	1.3-32.3Apr.
	10 m.:	2.0-2.6 May		10 m.:	0.4-10.2 Jan.		10 m.:	0.8-17.8	Nov.		10 m.:	1.0-38.4Apr.
	I:	2.0-3.9 May		I:	1.0-41.4 Ocl.		I:	0.7-66.3	Ocl.			
	D:	2.5-5.0 Aug.		D:	0.9-14.0 Jan.		D:	1.1-18.4	Ocl.	G I:	S.:	1.2-53.5Apr.
K2:	S.:	1.6-97.7 Feb.	K0(A):	S.:	1.7-72.0 May	MY2:	S.:	1.2-31.9	Dec.		10 m.:	1.6-27.3June
	10 m.:	1.2-14.1 Sep.		10 m.:	0.9-50.2 May		10 m.:	0.4-66.4	Ocl.			
	I:	1.3-67.8 Sep.					I:	0.6-44.8	Ocl.	G II:	S.:	1.2-39.0 Apr.
	D:	0.8-7.4 Feb.	K0(B:	S.:	0.2-32.7 Nov.		D:	0.8-33.0	Ocl.			
				10 m.:	1.5-49.9 May	MBC:	S.:	1.0-59.8	Nov.	K:	S.:	1.1-11.0June
K3:	S:	2.8-25.0 Aug.					10 m.:	0.6-89.5	Ocl.			
	10 m.:	3.0-6.3 Aug.	B13:	S.:	0.9-64.5 Ocl.		I:	0.2-61.8	Ocl.	Kanalizasyon: S.:		0.6-80.2 Apr.
	D:	2.5-5.8 Aug.		10 m.:	1.9-63.9 Dec.		D:	1.9-319.6	Feb.			
				I:	1.3-23.7 Ocl.	M3:	S.:	0.2-6.6	Feb.			
				D:	1.5-31.8 Ocl.		10 m.:	0.7-4.6	Feb.			
							I:	1.0-5.5	Feb.			
			B7:	S.:	0.9-68.7 Ocl.		D:	0.2-28.3	Feb.			
				10 m.:	0.4-46.5 Ocl.	M8:	S.:	0.4-17.0	Nov			
				I:	0.8-34.1 Ocl.		10 m.:	0.3-16.3	Nov.			
				D:	1.1-91.8 Ocl.		I:	1.3-5.5	Feb.			
							D:	0.8-4.5	Feb.			
			B2:	S.:	0.4-11.0 Jan.	M11:	S.:	1.0-7.5	Feb.			
				10 m.:	0.5-60.7 Ocl.		10 m.:	0.2-39.9	May			
				I:	0.2-14.5 Jan.		I:	0.1-25.5	May			
				D:	1.6-68.8 Ocl.		D:	1.1-32.7	May			
						M14:	S.:	1.3-8.7	May			
			Ki:	S.:	1.4-439.40Jan.		10 m.:	0.9-4.8	Feb.			
				10 m.:	1.0-50.7 July		I:	1.5-7.4	Feb.			
				D:	0.5-31.5 July		D:	0.7-5.0	Feb.			
						M20:	S.:	1.1-17.6	May			
							10 m.:	0.7-8.1	Feb.			
							I:	2.0-5.6	Feb.			
							D:	1.6-7.2	May			
						M23:	S.:	1.0-6.6	Feb.			
							10 m.:	1.2-5.8	Feb.			
							I:	1.1-7.4	May			
							D:	0.2-6.6	May			

Table 6:Oil Pollution in the Turkish Straits in 2002 (µg/L). S: Surface water, I: Interface layer, D:Deep water, Ç:Çanakkale, G:Gelibolu, K:Kilitbahir. The second value (max level) belongs to the month given in the same line

Black Sea			İstanbul Strait			Sea of Marmara				Çanakkale Strail (Dardanelles)	
K I:	S.:	2.0-28.5 Nov.	K0:	S.:	0,2-34.9 May	MY1:	S.:	1.1-74.2	Ocl.		
	10 m.:	2.6-17.3 Nov.		10 m.:	0,6-31.6 May		10 m.:	1.5-25.5	Dec.		
	D:	7.1-85.0 Aug.		I:	1,0-42,0 Ocl.		I:	0.9-66.3	Sep.	Ç I:	S.:1.3-61.8 July
				D:	0,5-10.7 Ocl.		D:	1.3-54.5	Sep.		10 m.: 1.0-56.5 July
K2:	S.:	1.5-209.2 July				MY2:	S.:	1.3-44.6	Dec.		
	10 m.:	1.8-284.2 Nov.	K0(A):	S.:	0,7-44.5 May		10 m.:	1.4-18.3	Sep.	Ç II:	S.:1.3-6.6 May.
	I:	1.5-33.7 June		10 m.:	0,6-69.3 May		I:	0.9-32.7	Sep.		10 m.: 1.4-10.5 Mar.
	D:	3.1-42.8 Aug.					D:	0.8-29.7	Dec.		
			K0(B):	S.:	0,4-45.5 Ocl.	MKC:	S.:	1.2-23.7	June	G I:	S.:2.2-4.2 July
K3:	S:	4.6-37.3 Aug.		10 m.:	0.9-47,9 May		10 m.:	1.0-31.2	Mar.		10 m.: 1.0-3.0 July
	10 m.:	3.8-37.7 Aug.					I:	1.9-20.2	Sep.		
	D:	2.6-7.7 May	B13:	S.:	0,9-48.9 Nov.		D:	2.1-50.8	Ocl.	L:	S.:0.3-105.8 May.
				10 m.:	1,9-163,8 Nov.	MBC:	S.:	0.9-42.6	Nov.		10 m.:0.7-44.9 May.
				I:	1,3-61,5 Ocl.		10 m.:	1.4-89.5	Nov.		
				D:	1,5-38.7 Ocl.		I:	2.1-61.8	Mar.	K	: S.:0.7-14.5 Mar.
							D:	1.3-319.0	Mar.		
			B7:	S.:	1.2-21,1 Nov.	MK:	S.:	2.7-198.6	June		
				10 m.:	0,8-39,3 Nov.		D.:	3.1-151.7	Nov.		
				I:	1.0-131,2 Ocl.	M3:	S.:	2.3-9.3	Aug.		
				D:	1,0-29,8 Sep.		10 m.:	3.0-117.5	Aug.		
							I:	1.8-592.7	Nov.		
			B2:	S.:	0,4-20.8 May		D:	1.5-318.9	Nov.		
				10 m.:	0,7-190.6 Ocl.	M8:	S.:	0.7-7.2	May		
				I:	0,8-37.0 Jan.		10 m.:	0.1-7.7	May		
				D:	1,2-73.7 Sep.		I:	0.9-7.8	May		
							D:	0.4-6.7	May		
			Kızkulesi:	S.:	1,2-752.9 Dec.	M11:	S.:	2.0-136.5	Nov.		
				10 m.:	0.8-495.1 Feb.		10 m.:	1.6-149.3	Nov.		
				D:	0,7-24.7 Feb.		I:	1.0-28.3	Nov.		
							D:	1.3-24.3	Nov.		
						M14:	S.:	0.5-18.9	May		
							10 m.:	0.2-7.4	May		
							I:	0.6-7.5	May		
							D:	1.4-8.8	May		
						M20:	S.:	1.4-33.5	Nov.		
							10 m.:	1.0-8.1	May		
							I:	1.9-44.6	Aug.		
							D:	1.0-7.2	May		
						M23:	S.:	0.4-12.9	Nov.		
							10 m.:	1.2-34.1	Nov.		
							I:	0.9-17.6	Nov.		
							D:	2.0-383.4	Nov.		

Table 7:Oil Pollution in the Turkish Straits in 2003 (µg/L). S: Surface water, I: Interface layer, D:Deep water, Ç:Çanakkale, G:Gelibolu, K:Kilitbahir. The second value (max level) belongs to the month given in the same line

Black Sea			İstanbul Strait			Sea of Marmara			Çanakkale Strait (Dardanelles)		
K1:	S.:	1.5-47.8 Nov.	K0:	S.:	0.1-255.2 Jan.	MY1:	S.:	1.3-490.3 Jan.	Ç I:	S.:	1.3-4.9 Mar.
	10 m.:	3.0-13.1 Feb.		10 m.:	0.1-116.2 Dec.		10 m.:	1.2-145.4 Nov.		10 m.:	1.0-3.7 Mar.
	I:	2.2-5.1 Nov.		I:	0.1-101.5 Dec.		I:	1.9-105.3 Dec.			
	D:	1.0-6.7 Nov.		D:	1.3-125.0 Dec.		D:	2.3-124. Dec.	G I:	S.:	2.2-11.7 Mar.
K2:	S.:	1.1-20.9 June	K0(A):	S.:	0.5-161.7 Dec.	MY2:	S.:	1.6-451.0 Jan.		10 m.:	1.0-1.7 Mar.
	10 m.:	1.6-41.8 June		10 m.:	0.5-148.5 Dec.		10 m.:	1.2-145.4 Dec.			
	I:	0.6-63.1 July	K0(B):	S.:	0.4-114.1 Dec.		I:	1.3-90.7 Dec.	G II:	S.:	0.7-102.3 July
	D:	2.6-53.0 Apr.		10 m.:	0.3-100.3 Dec.		D:	2.2-132.7 Dec.			
K3:	S:	1.8-6.6 Nov.	B13:	S.:	1.2-166.4 Feb.	MKC:	S.:	2.2-343.2 June	L:	S.:	0.3-1.9 July
	10 m.:	0.5-25.6 Nov.		10 m.:	0.5-136.2 Dec.		10 m.:	1.7-140.1 Dec.			
	D:	1.1-24.8 Feb.		I:	0.3-124.5 Dec.		I:	1.9-116.1 Dec.	K:	S.:	0.3-3.5 July
				D:	0.9-199.7 Dec.		D:	2.3-132.7 Dec.			
			B7:	S.:	0.3-210.1 Dec.	MBC:	S.:	1.9-120.0 Dec.			
				10 m.:	1.3-141.0 Dec.		10 m.:	1.1-239.3 Jan.			
				I:	0.7-21.9 Dec.		I:	2.3-126.9 Nov.			
				D:	0.3-160.5 Dec.		D:	1.3-133.2 Nov.			
			B2:	S.:	1.3-205.4 Dec.	MK:	S.:	3.7-142.3 Dec.			
				10 m.:	0.2-151.3 Dec.		D.:	1.1-146.1 Dec.			
				I:	0.3-248.1 June	M3:	S.:	0.3-5.9 Nov.			
				D:	2.3-152.3 Apr.		10 m.:	1.1-6.8 Nov.			
			Kızkulesi:	S.:	0.4-110.1 Dec.		I:	1.5-8.1 Nov.			
				10 m.:	2.0-114.1 Dec.		D:	1.6-5.4 Nov.			
				D:	1.7-105.6 Dec	M8:	S.:	0.7-2.9 Nov.			
							10 m.:	0.1-80.4 Feb.			
							I:	0.9-25.5 Feb.			
							D:	0.4-95.1 Nov.			
						M11:	S.:	1.2-16.7 Feb.			
							10 m.:	0.6-5.3 Nov.			
							I:	0.3-7.2 Nov.			
							D:	1.0-9.4 Nov.			
						M14:	S.:	0.3-18.8 May			
							10 m.:	0.8-8.1 Nov.			
							I:	1.2-10.9 Aug.			
							D:	0.4-26.3 May			
						M20:	S.:	1.2-3.2 Aug.			
							10 m.:	1.0-85.2 Feb.			
							I:	1.7-2.8 Nov.			
							D:	1.3-73.4 Feb.			
						M23:	S.:	0.6-6.6 Apr.			
							10 m.:	1.0-5.7 Nov.			
							I:	0.9-9.6 Nov.			
							D:	1.8-116.8 Apr.			

Table 8:Oil Pollution in the Turkish Straits in 2004 (µg/L). S: Surface water, I: Interface layer, D:Deep water, Ç:Çanakkale, G:Gelibolu, L:Lapseki, K:Kilitbahir. The second value (max level) belongs to the month given in the same line

Black Sea			İstanbul Strait			Sea of Marmara			Çanakkale Strait (Dardanelles)		
K1:	S.:	5.1-52.6 Feb.	K0:	S.:	2.5-108.3 Jan.	MY1:	S.:	1.3-300.9 Dec.			
	10 m.:	6.3-85.3 Aug.		10 m.:	1.6-103.9 Jan.		10 m.:	1.2-76.2 Dec.	Ç I:	S.:1.7-21.1	July
	I:	7.1-70.9 Aug.		I:	1.6-98.0 Jan.		I:	1.9-96.4 Jan.		10 m.: 1.2-21.1	July
	D:	4.0-108.9 May		D:	2.2-173.9 Apr.		D:	2.3-183.0 Jan.	Ç II:	S.:1.3-26.7	July
K2:	S.:	2.2-109. Jan.	K0(A):	S.:	0.9-84.9 Jan.	MY2:	S.:	1.2-99.2 June		10 m.: 1.7-22.4	July
	10 m.:	1.5-277.1 Dec.		10 m.:	1.2-401.8 Dec.		10 m.:	1.3-169.7 Jan.	G I:	S.:1.5-27.1	July
	I:	2.0-95.4 Jan.	K0(B):	S.:	1.5-87.0 Jan.		I:	1.3-180.3 Jan.	G II:	S.:1.7-32.1July	
	D:	2.7-140.7 May		10 m.:	1.0-84.0 Jan.		D:	1.8-325.3 Dec.		10 m.: 1.1-26.7	July
K3:	S:	3.7-33.7 Feb.	B13:	S.:	2.2-56.3 June	MKC:	S.:	2.2-189.9 Jan.	L:	S.:1.3-24.2	July
	10 m.:	3.0-49.7 Feb.		10 m.:	2.1-84.9 Jan.		10 m.:	1.7-113.8 Jan.	K:	S.:0.5-33.7	July
	D:	3.2-35.8 May		I:	1.5-176.0 Dec.		I:	1.9-253.1 Jan.			
				D:	1.9-382.5 Dec.		D:	2.3-216.0 Jan.			
			B7:	S.:	1.9-81.7 Jan.	MBC:	S.:	1.9-88.3 Feb			
				10 m.:	2.0-1512.0 Dec.		10 m.:	1.1-118.4 Feb			
				I:	2.3-406.0 Dec.		I:	2.3-450.2 Feb			
				D:	1.5-103.6 Feb.		D:	1.3-74.0 Feb			
			B2:	S.:	1.9-1223.0Dec.	MK.	S.:	2.4-209.6 Aug			
				10 m.:	2.2-304.7 Dec.		D.:	1.8-374.4 Aug			
				I:	2.5-121.3 Dec.	M3:	S.:	0.8-94.6 Feb			
				D:	2.3-84.2 Mar.		10 m.:	1.5-100.2 Feb			
			Kızkulesi:	S.:	2.2-1183.0Dec.		I:	1.0-105.8 May			
				10 m.:	2.5-89.1 Jan.		D:	1.9-113.7 Feb			
				D:	2.0-180.6 Feb.	M8:	S.:	0.7-321.3 Feb			
							10 m.:	0.1-57.5 Nov			
							I:	0.9-69.6 Nov			
							D:	0.4-86.8 Feb			
						M11:	S.:	0.2-32.9 May			
							10 m.:	1.6-39.6 May			
							I:	0.3-38.8 May			
							D:	1.1-88.1 Feb			
						M14:	S.:	0.3-150.1 Aug			
							10 m.:	0.8-67.6 Feb			
							I:	1.2-77.4 Feb			
							D:	0.4-150.1 Feb			
						M20:	S.:	1.4-66.8 Feb			
							10 m.:	0.3-160.0 May			
							I:	0.5-67.8 Feb.			
							D:	1.1-81.8 Feb.			
						M23:	S.:	0.3-61.6 Feb.			
							10 m.:	0.7-57.5 Feb.			
							I:	0.2-69.6 Feb.			
							D:	0.8-84.8 Feb.			

Table 9:Oil Pollution in the Golden Horn (µg/L). (S: Surface water, D:Deep water), The second value (max level) belongs to the month given in the same line1

2000:		
Eyüp-Sütlüce:	S:9.4-77.7	Dec.
	D:11.5-25.6	Dec.
Haliç Köprüsü:	S:6.8-46.5	Nov.
	D:6.9-39.8	Dec.
Valide S. Köprüsü:	S:8.4-48.5	Dec.
	D:15.2-24.8	Dec.
Unkapanı Köprüsü:	S:17.7-28.0	Oct.
	10 m.:5.1-17.3	Dec.
	20 m.:8.0-21.2	Oct.
	D:6.8-16.3	Oct
2001:		
Eyüp-Sütlüce:	S:2.9-31.8	Feb.
	D:4.1-41.3	June
Haliç Köprüsü:	S:3.0-44.6	Feb.
	D:3.7-21.9	Feb.
Valide S. Köprüsü:	S:1.7-607.6	Aug.
	D:3.3-21.6	Jan.
Unkapanı Köprüsü:	S: 5.0-18.7	Aug.
	10 m.: 2.8-8.4	Feb.
	20 m.:3.2-43.3	June
	D: 6.6-16.6	May
Galata Köprüsü:	S: 0.8-12.2	May
	10 m.: 1.2-6.3	May
	20 m.: 4.9-6.2	June
	D: 0.9-4.8	May

2002:		
Adalar sonrası:	S.:10.3-53.2	July
	D: 10.5-48.2	May
Eyüp-Sütlüce:	S: 2.7-11089	Oct.
	D: 1.7-434.1	Oct.
Haliç Köprüsü:	S: 7.3-89.6	July
	D: 0.9-41.0	Aug.
Valide S. Köprüsü:	S: 6.2-178.9	Dec.
	D:7.9-164.9	Dec.
Unkapanı Köprüsü:	S: 2.5-56.4	June
	10 m.:0.1-25.4	Nov.
	20 m.:2.2-43.3	Nov.
	D:4.3-69.8	Dec.
Galata Köprüsü:	S: 3.3-52.0	June
	10 m.: 4.0-63.5	July
	20 m.:1.8-50.9	Oct.
	D:6.3-166.4	Dec.
2003:		
Adalar sonrası:	S.:2.4-650.9	Feb.
	D: 2.8-208.7 Dec.	
Eyüp-Sütlüce:	S:1.5-592.2	Aug.
	D:4.1-100.2	Dec.
Haliç Köprüsü:	S:5.2-142.8	Dec.
	D:1.4-101.9	Dec.
Valide S. Köprüsü:	S:2.2-111.9	Dec.
	D:2.3-178.1	Dec

Unkapanı Köprüsü:	S:2.6-116.9	Dec.
	10 m.:1.2-94.2	Apr.
	20 m.: 0.5-79.0	Dec.
	D:1.9-78.4	Dec.
Galata Köprüsü:	S:0.7-122.8	Dec.
	10 m.:1.7-133.9	Dec.
	20 m.:0.1-142.9	May
	D:2.1-136.6	Dec.

Table 10. Oil pollution level in west Black Sea stations 28.08.02003

	BK1	BK2	BK13	BK14	BK16	BK25	BK32	BK33	BK37	BK51	BK52
Surface	8,91	4,40	9,10	10,9	6,47	5,70	9,59	7,63	4,50	4,25	1,05
10m	4,13	5,05	11,3	8,39	6,84	5,37	5,52	7,94	68,1	6,93	10,5
Term	24,7	1,41	5,40	5,86	7,13	4,10	19,9	5,64	5,68	5,44	8,99
30m	-	-	-	-	-	-	-	-	-	3,93	-
40m	-	-	-		-	-	-	-	-	-	8,29
50m	62,5	7,60	-	3,92	11,2	-	7,93	-	12,01	-	-
Depth	7,01	6,65	73,6	7,93	6,33	7,63	7,70	7,31	5,61	12,1	9,93

Table 11. Max. Oil pollution level in examined regions

Stations years	Black sea (Vicinity of Bhosphorus	İstanbul Strait Entrance	Exit	Golden horn	Sea of marmara	Dardanelles Entrance	Exit
1997	44,6	43,1	66,8	-	66,3	25,9	45,5
1998	16,1	9,4	45,3	-	35,0	40,3	45,9
1999	126,9	253,1	15,7	-	16,0	15,8	11,8
2000	44,5	26,5	20,7	77,7	141,5	41,1	13,6
2001	97,7	72,0	439,4	607,6	59,8	53,5	32,3
2002	209,2	45,5	752,2	1108,9	198,6	4,2	61,8
2003	47,8	255,2	205,4	650,9	490,3	102,3	4,9

Fig 3a-g Graphical representations of max. oil level in examined regions.

Fig. 3a

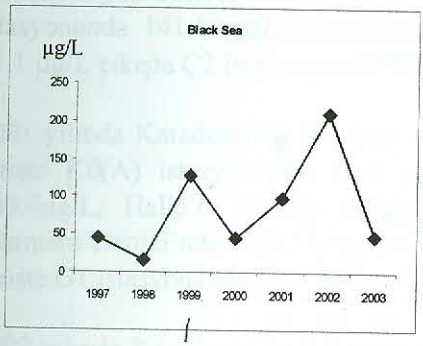


Fig. 3b

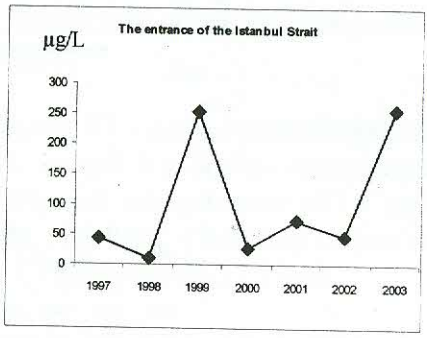


Fig. 3c

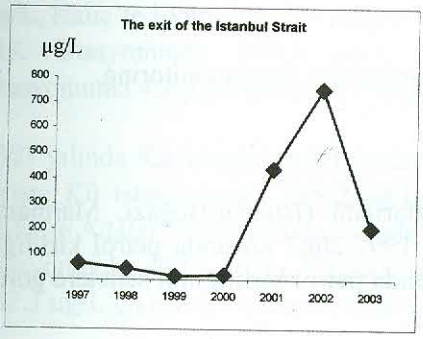


Fig. 3d

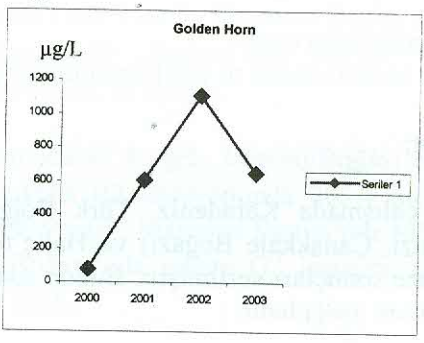


Fig 3e

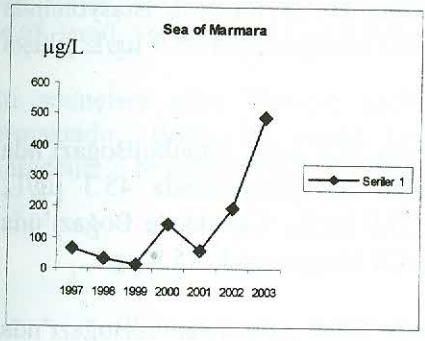


Fig 3f

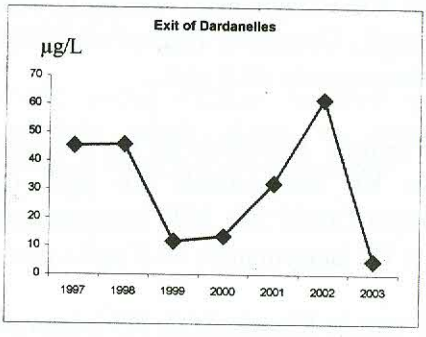
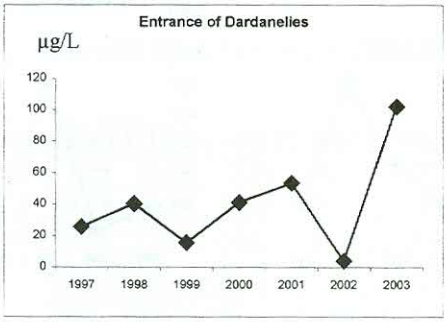


Fig 3g



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Özet:

Bu çalışmada Karadeniz, Türk Boğazlarında (IstanbulBoğazı, Marmara Denizi, Çanakkale Boğazı) ve Haliç'te 1997-2003 arasında petrol kirliliği izleme sonuçları verilmiştir. Bunun sonunda petrol kirliliğinin senelere göre dağılımı aşağıdadır.

1997 yılında Karadeniz'de K3 istasyonunda 44.6 µg/L, IstanbulBoğazı'nda girişte K0 istasyonunda 43.1µg/L, Marmara Denizi'nde M8 istasyonunda 66.3 µg/L, Çanakkale Boğazı'nda girişte G2 istasyonunda 25.9 µg/L çıkışta Ç2 istasyonunda 45.5 µg/L.

1998 yılında Karadeniz'de K1 istasyonunda 16.1 µg/L, IstanbulBoğazı'nda girişte K0 istasyonunda 9.4 µg/L çıkışta B2 istasyonunda 45.3 µg/L, Marmara Denizi'nde M20 istasyonunda 35.0 µg/L, Çanakkale Boğazı'nda girişte G2 istasyonunda 40.3 µg/L, çıkışta Ç2 istasyonunda 45.9 µg/L.

1999 yılında Karadeniz'de K3 istasyonunda 126.9 µg/L, IstanbulBoğazı'nda girişte K0(A) istasyonunda 253.1 µg/L çıkışta B2 istasyonunda 15.7 µg/L, Marmara Denizi'nde MY1 istasyonunda 16.0 µg/L, Çanakkale Boğazı'nda girişte G2 istasyonunda 15.8 µg/L çıkışta Ç2 istasyonunda 11.8 µg/L.

2000 yılında Karadeniz'de K2 istasyonunda 44.5 µg/L, IstanbulBoğazı'nda girişte K0(A) istasyonunda 26.5 µg/L çıkışta B2 istasyonunda 20.7 µg/L, Haliç'te Eyüp-Sütlüce istasyonunda 77.7 µg/L, Marmara Denizi'nde MY1 istasyonunda 141.5 µg/L, Çanakkale Boğazı'nda girişte G2 istasyonunda 41.1 µg/L çıkışta Ç2 istasyonunda 13.6 µg/L.

2001 yılında Karadeniz'de K2 istasyonunda 97.7 µg/L, IstanbulBoğazı'nda girişte K0(A) istasyonunda 72.0 µg/L çıkışta Kız Kulesi istasyonunda, 439.4µg/L, Haliç'te Valide Sultan Köprüsü istasyonunda 607.6 µg/L, Marmara Denizi'nde MBC istasyonunda 59.8 µg/L, Çanakkale Boğazı'nda girişte G1 istasyonunda 53.5 µg/L çıkış Ç1 istasyonunda 32.3 µg/L.

2002 yılında Karadeniz'de K2 istasyonunda 209.2µg/L, IstanbulBoğazı'nda girişte K0(B) istasyonunda 45.5 µg/L çıkışta Kız Kulesi istasyonunda 752.2 µg/L, Haliç'te Eyüp-Sütlüce istasyonunda 1108.9 µg/L, Marmara Denizi'nde MK istasyonunda 198.6 µg/L, Çanakkale Boğazı'nda girişte G1 istasyonunda 4.2 µg/L çıkışta Ç1 istasyonunda. 61.8µg/L.

2003 yılında Karadeniz'de K1 istasyonunda 47.8 µg/L, IstanbulBoğazı'nda girişte K0 istasyonunda 255.2 µg/L çıkışta B2 istasyonunda 205.4 µg/L, Haliç'te Adalar Sonrası istasyonunda 650.9 µg/L, Marmara Denizi'nde MY1 istasyonunda 490.3 µg/L, Çanakkale Boğazı'nda girişte G2 istasyonunda 102.3 µg/L çıkışta Ç1 istasyonunda 4.9 µg/L.

Batı Karadeniz' de 2003 yılında yapılan izlemede petrol kirliliği BK isyasyonlarında termoklinde 24.7 µg/L50 m'de 62.5 µg/L BK 37 'de 10m' de 68.1µg/L ve 50m'de 12 µg/Lbulunmuştur.

Bu sonuçlara göre Türkiye geçitlerinde petrol kirliliği senelere göre artmaktadır. Buna da petrol tankerlerinin gerek geçişi ve gerekse Karadeniz'e bıraktıkları balans sularının etkisi olduğu düşünülmektedir.

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