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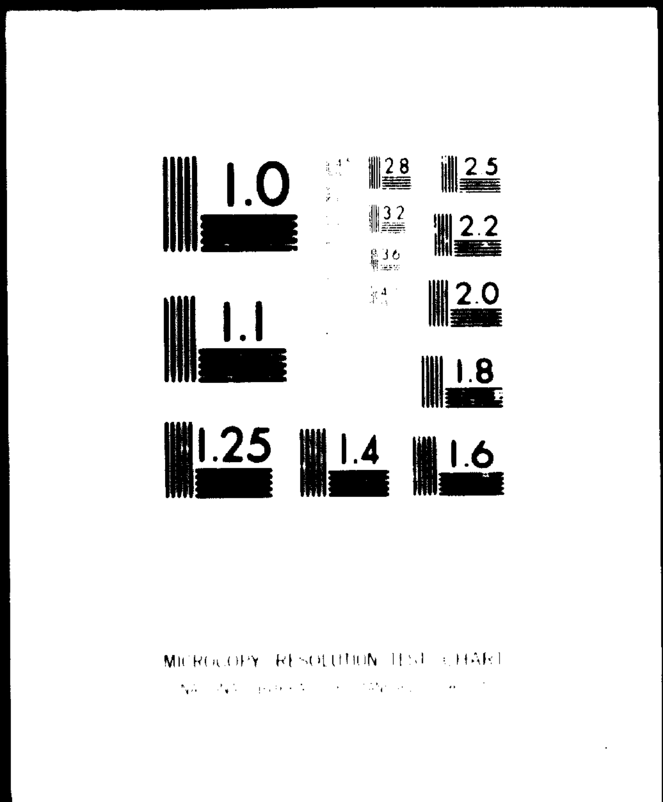

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UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

ENVIRONMENTAL ASPECTS OF INDUSTRIAL DEVELOPMENT IN DEVELOPING COUNTRIES

Case studies of the chemical industry in Turkey

Prepared under the joint UNIDO/UNEP
Environmental Programme

id.75-4627

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INTRODUCTION

The international community has been concerned in recent years about the mounting environmental pollution. Following the United Nations Conference on the Human Environment held at Stockholm in 1972, the General Assembly of the United Nations established the United Nations Environmental Programme (UNEP). A collaborative work programme has been developed by UNEP and UNIDO, of which this case study forms a component. Miss J. van Zuilichem (economist), Messrs. M. Geerling (chemist) and R. Kratel (ecologist) were engaged by UNIDO to undertake this case study.

On 9 June 1974, the group visited Ankara, Turkey to study the effects of industrial pollution on the environment in two of the country's most heavily industrialized areas: Ismit and Bandirma. In the course of the visit, which lasted some 13 days, the group held discussions with: P. Laming (Senior UNIDO Field Adviser in Turkey); S. Heppling (UNDP Resident Representative); Mustafa Bilginer (Ministry of Foreign Affairs); J. Onsan (State Planning Office); Adhim Osturk (Ministry of Agriculture); Dr. Kengel (Ministry of Health); M. Mirabaglu, A. Mussinoglu and U. Oysal (Tübitak Institute); and Professor Kor of the University of Istanbul. Umit Coskuner, Director of Research and Development, SEKA-Ismit, joined the UNIDO group in Ankara as adviser and interpreter and made a solid contribution to its work.

The municipal and regional authorities in both Ismit and Bandirma were extremely helpful in providing information regarding factories to be visited in their areas and in introducing the group to the appropriate managerial personnel. The factories in turn readily provided the data (mainly technological) requested of them. In the course of their discussions with the managements of individual factories, however, the group found that in many cases the managerial personnel were little aware of the negative effect that pollution from their concerns was having on the local environment. A visit to the Oceanographic Institute of Istanbul proved fruitless, but the National Fishing Research Institute provided some very valuable information.

The group found that Izmit Bay is being seriously polluted by effluents from local industries (particularly the pulp and paper mill at Seka) and that much of its marine life has already been destroyed. In the Bandirma area, the pollution being discharged into the atmosphere by heavy industry is seriously affecting crop yields.

Chapter I. ANTI-POLLUTION LEGISLATION IN TURKEY

At present, Turkey has only one law on pollution control and general hygiene, and amendments to it are still being considered in parliament. There does exist, however, a regulation which requires factories or other institutions to close down should they be causing harm to the environment.

A law on the protection and proper utilization of waters is currently being drafted. After certain regulations concerning water standards have been worked out, factories will be given two years to come into line with them. A factory failing to comply with the regulations, may be fined 5,000 Turkish lire (LT)[1/] or forced to close down. Under this law, also, municipalities will be required to install sewerage systems within five years. In addition, an inter-ministerial resolution on the protection of coastal zones has been put into effect. A clean-air law is being prepared and efforts being made to save heating fuel will help to decrease air pollution. However, for part of the Sea of Marmara these measures are too late: the waters of Ismit Bay are already dead.

Turkey's third Five-Year Plan features a land use policy; multi-functional land use plans are being prepared for urban centres and their surroundings. City plans are also taking into consideration urban expansion areas, agricultural areas, industrial location, recreation sites, protection of the natural environment, and environmental pollution.

Local governments invite small industries into their districts for tax purposes. At the moment there are two organised industrial sites, at Manisa and Bursa, and seven others are under construction. Small industries at these industrial sites are provided with infrastructure and low rents. Better management of the environment could result from such planning, but up till now, the Government has not offered the industries any assistance in installing anti-pollution equipment.

1/13.86 Turkish lire (LT) = $US1.00 (middle rate, January 1975)

A newly created committee, consisting of 63 local mayors, is planning to set up pollution monitoring stations around the Sea of Marmara. The Tübitak Research Institute (a State controlled organization that deals with industrial and engineering problems), private and State industries and various cities are represented on this committee.

A plan has been worked out to set up a treatment plant in the Izmit area which would absorb the solid waste of the city and control industrial pollution. Each industry must undertake the first stage of cleaning. According to the plan, industries may take anti-pollution measures on their own, use the treatment plant, or pay a fine of LT5,000 per day. The total cost of the plant will be LT1 billion. Sweco is making the feasibility study.

The Tübitak Institute

The aim of the Tübitak Institute is to assist industry by adapting existing technologies and developing new ones. The Institute is financed by the Government (and by industry for specific programmes). UNIDO recently provided it with $600,000 (including $300,000 for instruments) for a programme of research on construction materials.

In Ankara, Tübitak only has a section dealing with air pollution; a water pollution section will be added later. Other sections, dealing with electronics, construction materials research, food products and operational research are now functioning. Within the next three years, groups dealing with life science and environmental problems will be operational.

Tübitak carried out an air pollution study in Ankara on behalf of NATO in 1970-1972. Ankara is situated in an enclosed valley and prevailing winds are from the West. Air pollution is severe in winter time due to the use of lignite-type coal in often primitive household ovens; the contribution of industry is less. An SO_2 monitoring system comprising of 13 stations has been erected. The design is not very modern, but good results have been obtained. Concentrations of SO_2 as high as 2,000 mg/m^3 have been reported.

A chemical industries group has just begun activities; an investigation of pesticides in food products is under way. This group will also start an investigation on boron products as soon as the facilities are ready. In 1974, some $30,000 were available for these investigations. Within a year or two, pilot plant investigations on boron technology will start. The impetus for these investigations is provided by the heavy spillages and discharges of boron by the Bandirma boron industry. Each year, wastes containing as much as 7,000 tons of B_2O_3 are discharged into the Sea of Marmara.

Rasit Tolcn, head of the chemical technology section, described the heavy losses and discharges of mercury by the chlorine-alkali industries. He thought that the relatively low price of mercury was one of the reasons for the lack of concern at some factories with regard to mercury discharges. Turkey is a large producer of mercury.

Tübitak's future programme includes: processing waste pyrites-cinders from sulphuric acid production, and developing insecticides other than DDT for application to tobacco, fruit and other agricultural products.

Tübitak has started important activities in Gebze near Izmit at the Marmara Sea. A large institute is planned and under construction. Sections dealing with electronics, construction materials, food products and operation research are on stream. Within one to three years groups dealing with life science and environmental problems will be operational.

Tübitak has made a highly promising start toward becoming an institute that will provide much-needed assistance to Turkish industry.

Chapter II. PHYSICAL GEOGRAPHY OF THE MARMARA AND IZMIT REGIONS[2]

The areas of special concern to the study group were: the Sea of Marmara, the Golden Horn, the Bosporus and Izmit Bay.

Climate

The climate of these areas is derived from the Aegean and Mediterranean regions when the southerly (Lodos) wind is blowing, or from the Black Sea when the northerly to northeasterly winds are blowing. It is characterized by hot summers and mild winters.

The winds from the north are known as Etesian winds and they result from permanent low pressure area over the warm to hot Red Sea and a relatively high pressure area over the continent to the northwest. These dry winds are particularly pronounced in July and August when they blow about 80 per cent of the time. Occasional southerly winds bring warmer, more humid weather to the area and, when they are sufficiently strong, storm waves surge to the Marmara coastline and entrance to the Bosporus. These winds are particularly pronounced in winter.

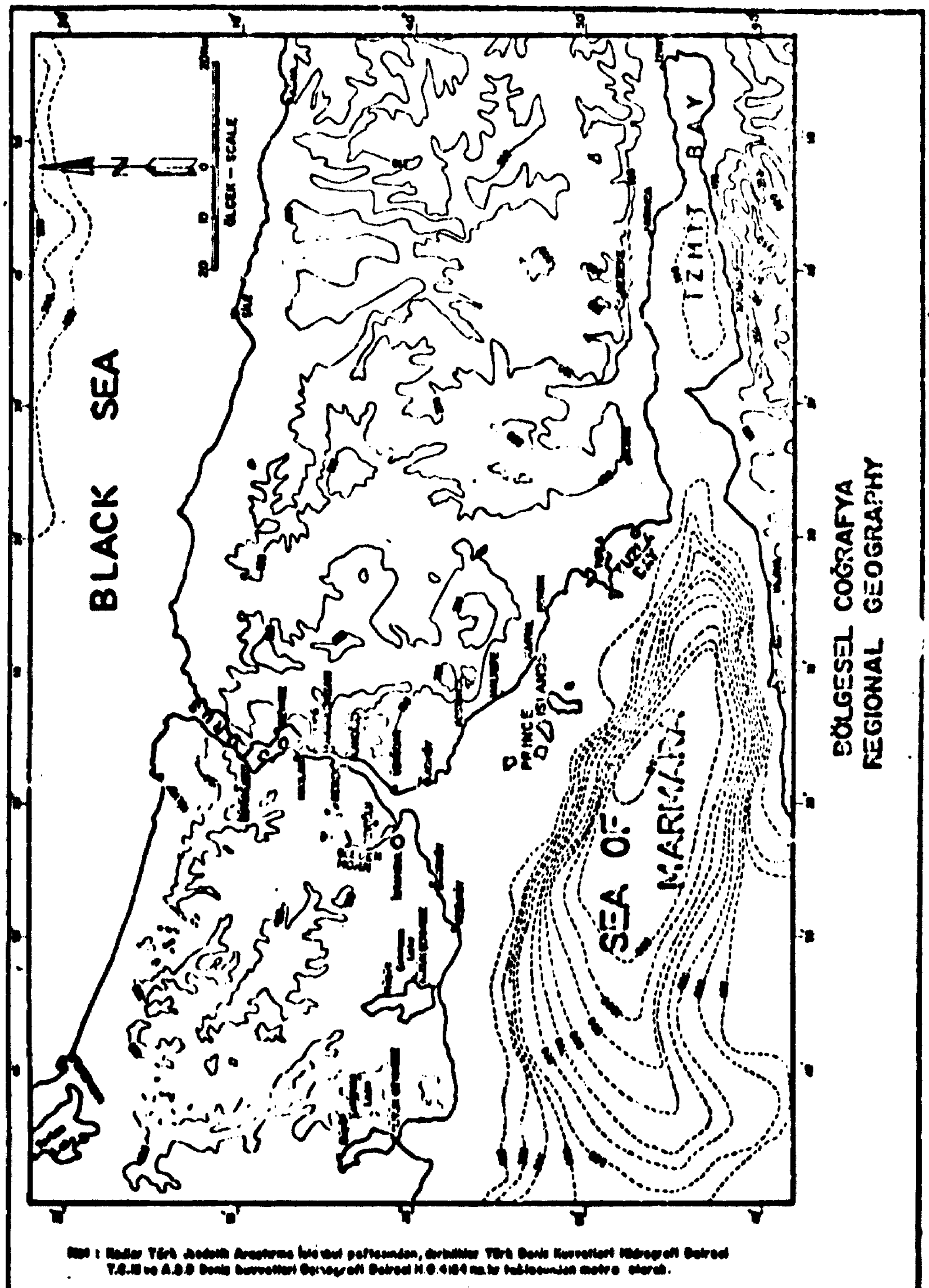
Most coastal areas experience a diurnal variation in wind direction because of the unequal rate of heating and cooling of land and sea. Sea breezes typically blow from a little before noon to about sunset, while land breezes begin during the evening and continue throughout the night.

A diurnal wind is an important consideration in marine disposal of wastes since it can move material floating on the sea surface shoreward during that part of the day when maximum recreational use is made of the water.

Water bodies

The Black Sea has become increasingly isolated from the Mediterranean Sea since late Tertiary time. There has also been a general decrease in salinity of the Sea's upper layer. Short-term variatione have been caused by repeated openings and closings of the connection with the Mediterranean and by the advances and retreats of continental ice sheets during the Pleistocene period.

2/Much of the material of this chapter has been adapted from the work of Professor Kor of the University of Istanbul.



Not : [illegible] Türk Jeodezi Araştırma İstanbul paftasından, derinlikler Türk Deniz Kuvvetleri Hidrografi Dairesi T.C.5 ve A.B.D Deniz Kuvvetleri Oşinografi Dairesi H.O.4184 no.lu tablosundan metre olarak.

Note: Elevations and depths in meters from Turkish Geodetical Survey Istanbul sheet, Turkish Navy Hydrographic Office chart T.C.5 and U.S.Navy Oceanographic Office chart H.O 4184

During the interglacial (high sea level) stage separating the Riss and Wurm glacial epochs, there was a connexion between the Sea of Marmara and the Black Sea (through the down faulted graben of Izmit Bay, Spanka lake and Adapazari). During the Wurm glaciation of Northern Europe, the Bosporus was a meandering valley which drained the area tributary to the Golden Horn and discharged into the Black Sea at a much lower level than that of the present sea. The present connexion between the Bosporus and the Sea of Marmara is associated with recent changes in sea level and local warping of the earth's surface. The sill or submarine bank which lies between Istanbul and Uskudar at an approximate depth of 32 metres is an important physical feature that determines present circulation and salinities.

The Bosporus

The Bosporus is a meandering strait about 31 kilometres long. The average depth is 35 metres. The bottom is characterized by potholes some of which have depths of up to 110 metres. A sill at 32 metres is located about two kilometres from the southerly entrance. There is a two-layer current system in which the upper layer of brackish Black Sea water flows south and the lower layer of saline Mediterranean water flows north.

The southerly flow of surface water from the Black Sea is caused by the decline in surface elevation between the north and south ends of the Bosporus (average decline of about 6 centimetres over this distance).

Variations in sea level are caused by tides, winds and changes in outflow from the Black Sea. For the Bosporus, there is a semidiurnal tide with a range of from 2 to about 10 centimetres and with a large diurnal inequality. The lunar fortnightly tide has an estimated range of about 5 to 20 centimetres. These tides are often obscured by wind set-up or storm tides.

The Golden Horn

The Golden Horn, so named in antiquity because of its shape, is an estuary into which Alibey and Kagithane creeks discharge an average of 100 x 10^6 m^3/year. The Golden Horn is approximately 7 kilometres long, with a surface area of about 2.5 x 10^6 square metres. Depths decrease from about 40 metres at the mouth to 1 metre at the upper end. The average width is approximately 370 metres.

The two-layer system of the Bosporus extends into the Golden Horn. Salinity data shows that the boundary between the two layers occurred at a depth of some 25 metres.

There is general local agreement, although available data is not sufficient for quantitative studies, that the Golden Horn is being filled with silt at an alarming rate. Comparisons of bathymetric cross-sections of the lower portion with a geologic section support this impression. In particular, the accumulation of bricks and other municipal fill which presumably began with the founding of Istanbul in 325 AD has reduced the width of the upper Golden Horn by some 400 metres.

The northeastern Sea of Marmara

The Sea of Marmara, together with the Bosporus and the Dardanelles, can be considered as a strait connecting the Aegean and Black Seas. There is a very stable two-layer system in which Mediterranean water flows toward the north, and Black Sea surface waters flow south. Surface currents are modified by winds and Coriolis force. Deep circulation shows the effects of Coriolis force.

The total travel distance from the Black Sea to the Aegean Sea is approximately 300 kilometres of which about 90 kilometres are occupied by the Bosporus and Dardanelles.

The characteristic bending of isopleths to the west along the northern coast indicates the movement of Black Sea water in that direction. In summer, this movement may be strengthened by the counter-clockwise circulation implied by the density distribution.

An intermediate temperature maximum of from 15.2 to 15.4 degrees C is found in the lower (Mediterranean) layer. There appears to be an annual variation of the depth to 15 degrees C, which varies from about 100 metres in summer to as much as 200 metres in early spring. The nature of this variation is probably related to the annual cycle of outflow of Black Sea water in the surface layer, which in turn affects the head of the lower water layer in the Bosporus and Dardanelles. Alternatively, the variation may imply that Mediterranean water moves through the Sea of Marmara to that section during an integral number of years (one or two for example).

Assume that estimated flow of Mediterranean water through the Bosporus of about 200 km^3/year displaces a layer between 15 metres depth (the lower limit of Black Sea water) and 150 metres depth (the average depth to 15 degrees C below the intermediate temperature maximum). The area of the Sea of Marmara at 100 metres depth is estimated at 10,000 square kilometres. The displacement volume is thus 0.135 kilometres x 10,000 square kilometres = 1,350 cubic kilometres, which equals approximately seven years' flow.

These calculations for flows in the Bosporus and Dardanelles indicate that about half the Mediterranean water which enters through the Dardanelles is entrained in the surface layers of the Sea of Marmara and returned directly to the Aegean Sea. The average residence time of the entrained water in the Sea of Marmara is accordingly less than that which goes on the Bosporus. This time is independent of the time for the water which flows on to the Black Sea, or the maximum seven-year value. The importance of a travel time measured in years is that it accounts for the reduced values of dissolved oxygen in the lower layers of the Sea of Marmara and the Bosporus.

Shoreward and easterly components found in surface current directions indicate a large clockwise eddy inshore from the main flow to the Bosporus along the northern Sea of Marmara coastline. Floating materials discharged offshore would consequently tend to be carried toward the shoreline. During periods of southerly winds, additional shoreward movement of surface waters will occur.

A shallow shelf extends from about 0.5 to 5 kilometres from shore at 20 to 30 metres depth, and a deeper shelf begins at about 3.5 and runs to 10 kilometres from shore at about 100 metres depth. The Eastern Marmara Basin has a maximum depth of about 1,200 metres. Maximum slopes just below the shallow and deep shelf breaks are about 120 m/kilometre and 300 m/kilometre (7 degrees and 16 degrees) respectively.

Izmit Bay

Izmit Bay, about 45 kilometres east of the Sea of Marmara, is divided into western, central and eastern portions. The bottom of the western portion slopes upward easterly from the 100m contour which bounds the Eastern Marmara Basin. Continuing in an easterly direction, a still exists at a depth of approximately 55 metres. The central portion deepens to about 180 metres.

The eastern portion of Izmit Bay is of special interest. It is small in area and relatively shallow, with depths of 30 and 40 metres at the centre. Sewage and industrial wastes from the city of Izmit are dumped into this part of the Bay.

Izmit Bay occupies a 45 kilometre fault-graben which extends from the northeastern Sea of Marmara. Its hydrography is established by the two-layer system of Black Sea and Mediterranean waters in the Sea of Marmara. The major streams entering the Bay are from the east and lie within the same graben.

The two layers are separated by an essentially horizontal transition or mixed layer which, in September 1973 increased from about 5 metres thickness at the entrance to 14 metres at the upper end, showing greater mixing in the shallower areas. In February 1973, the upper and transition layers were both about 20 metres thick, indicating uniform vertical mixing rates throughout the Bay and adjacent Sea of Marmara, possibly associated with winter storms. Salinities corresponded with those of the Sea of Marmara. The upper layer has concentrations of 22 to 23 per cent and the lower layer contains concentrations of as much as 33.5 per cent. Currents move to the west (velocities not known).

Oxygen concentrations vary from about 7 mg/litre in summer and 10 mg/litre in winter at the surface to about 2 mg/litre in the deepest areas. The last value is about half that for similar depths in the Bosporus because of longer residence time in the basin and possibly greater benthic oxygen demand in Izmit Bay.

Izmit Bay, which is developing as the most dense industry centre of Turkey, is being polluted at an increasing rate by domestic waste water, bilge water and greasy wastes from ships, industrial gaseous wastes and particle pollutants, eroded earth and organic pollutants introduced by streams. These pollutants have pronounced detrimental effects on the environmental health and marine life. A great water mass, some 15 km in length and with a surface area of 50 km^2, situated at the east of the Degirmendere-Yarimca line has become a dangerous medium for sea life and the shores bording it are quite unsuitable for camping and recreation purposes.

There is a possibility of future waste discharge to deep water in the central portion of Izmit Bay. Oxygen levels are depressed in these areas from natural causes. The larger volume of water here may permit assimilation of some wastes and movement of water from the central portion of the Bay may permit discharge of wastes to these areas.

Physical oceanography

The current system in the Bosporus is generally a two-layer one. Mediterranean water increases in density because of the excess of evaporation over precipitation during its circulation from the Strait of Gibraltar along the African and Levantine Coasts to the Aegean Sea. Here, the heavier, highly saline water seeks its own level and flows northerly through the Dardanelles, the Sea of Marmara and the Bosporus. Southward flowing brackish surface waters carry runoff from tributaries to the Black Sea drainage areas, the most notable of which are the Danube and Dneiper Rivers, of 840,000 and 502,000 square kilometres with average flows of 6,200 and 1,700 m^3/second respectively. The outflow from the Black Sea also includes the excess of precipitation over evaporation from the sea itself. The salt content of the outflow is obtained by vertical mixing within the Black Sea with the Bosporus undercurrent inflow.

Individual series of cross-sectional measurements and monthly average data indicate that flows in either direction vary between approximately 3,000 and 30,000 m^3/second.

Chemical oceanography

Some unpublished phosphate-phosphorus data on the Bosporus have been obtained by the Turkey Navy Hydrographic Office. A total of 97 samples were collected on 24 and 25 March 1965 from throughout the water column and along the entire length of the Bosporus. Although there was a large amount of scatter, median values of phosphate-phosphorus were 20 mg/litre at the surface, 15 mg/litre in the boundary layer, and 24 mg/litre at the bottom.

Values of pH vary from 6.9 to 7.05 at the bottom to from 7.1 to 7.5 at the surface, with the highest surface values in August and September. Replicate samples of surface bottom waters were obtained from the Bosporus near Cubuklu on 22 May 1967 and analysed for trace elements by means of an emission spectrograph. The results are listed in the Annex.

Ten elements were found in quantities which could be measured by the concentration techniques routinely used by the United States Federal Water Pollution Surveillance System Laboratories in Cincinnati.

Degrees of enrichment or depletion can be determined by normalising the results to the values reported by Goldberg for "average sea water". High enrichment factors were found for cadmium and for lead (lower layer only). Zinc, molybdenum, aluminium and copper exhibited moderate enrichment, particularly in Black Sea waters. A single sample showed moderate enrichment of nickel in bottom waters. Strontium was depleted, particularly in bottom waters.

Biological oceanography

The most valuable review of the biological oceanography of the area is that published by Gaspers. He summarizes the more important Phytoplankton, zooplankton and benthos species and their distributions, as well as those of the more important migratory fish. (These data are shown in the Annex to this report.)

Mackerel (Scomber scombus), important migratory fish, breed in spring in the Sea of Marmara, enter the Black Sea in summer and return to the Sea of Marmara, usually in January. Young bonito (Sarda sarda) about 25 centimetres long pass through Bosporus, Marmara and Dardanelles from late August to early October. The older fish return in May or June for spawning in the Black Sea. (These and further ecological data are also given in the Annex.)

Chapter III. THE TURKISH ECONOMY

Chemical and fertilizer sectors

During the period 1963-1971, the Turkish gross national product (GNP) increased by some 60 per cent, rising from LT 108.7 billion to LT 179.3 billion. The share of the agricultural sector in the GNP decreased from 41.2 per cent in 1963 to 28.1 per cent in 1972. During the same period, the share of industry increased from 16.3 per cent to 22.6 per cent and the per capita income of the 35 million population rose from LT 3,640 to LT 4,901. The average population growth rate was 2.7 per cent. During the period 1968-1973, some 25.7 per cent of the total fixed investment was invested in the manufacturing sector. In 1972, the shares of the chemical and fertilizer sectors in the manufacturing output were 15.5 per cent and 2.3 per cent respectively. For 1977 the planned shares are, respectively, 14.8 per cent and 3.9 per cent. During the period 1973-1977, some LT 3,850 million will be invested in the chemical sector and LT 4,670 million in the fertilizer sector.

In view of its decision to join the European Economic Community, and in order to bring its economic structure into line with its new role as a member of the Community, Turkey will establish basic intermediate and investment goods industries as soon as possible. Among the benefits expected to be gained by joining the Community is an increase in exports of industrial products. The share of the intermediate and investment goods industries in manufacturing output was 53.4 per cent in 1972 and will increase to 61.7 per cent in 1977. The share of the chemical sector (15.5 per cent in 1972) will decrease to 14.8 per cent whereas that of the fertilizer sector will increase to 3.9 per cent in 1977 (2.3 per cent in 1972). For the manufacturing sector as a whole there will be an average annual production growth of 11.7 per cent. The increase in the production of the intermediate goods industry will be 14.3 per cent.

The average annual production growth will be 13.3 per cent for the chemical sector and 28 per cent for the fertilizer sector. The growth of the chemical and fertilizer sectors is illustrated below.

	Production (tons)	
	1972	1977
Fertilizer (18 per cent P_2O_5)	827,000	2,618,000
Sodium Hydroxide	40,000	126,000
Chlorine	35,000	112,000
Borax	26,400	57,000
Boric acid	11,000	42,000
Hydrochloric acid	14,000	18,000
Phosphoric acid	61,000	345,000
Sulphuric acid	266,000	1,227,000

Agricultural sector

In 1972 the contribution of the agricultural sector to the GNP was 28.1 per cent. The targets and performance of this sector during the Second Five-Year Plan (1968-1973) and the targets for the third plan are as follows:

	Annual growth rates (per cent)		
	Target: 1968-1973	Realization	Target: 1973-1978
Crops	4.4	4.2	4.0
Livestock	4.8	3.2	5.0
Forestry	6.9	5.5	9.1
Fishery	9.1	5.2	8.4

In 1972 the consumption of nitrogen fertilizers (21 per cent N) was 1,700 tons. The demand is expected to rise to 286,000 by 1977. The consumption of phosphate fertilizers, which was 1,600,000 tons in 1972, will rise to 2,720,000 tons in 1977. The consumption of potassium fertilizers (50 per cent K_2O), 25,000 tons in 1972, is expected to rise to 33,000 tons by 1977.

The result of this trend is a growth in two kinds of pollution. First, there is a growth in the pollution caused by the factories where these products are produced. Secondly, there is a growth in indirect pollution, for example the transfer through the soil from target to non-target areas.

Fishery sector

At the end of the Second Five-Year Plan (1968-1973), the production of the fishery sector was far below the target of 9.1 per cent annual growth that had been set for the Plan period. The annual consumption of marine fish amounts to 32 kilograms per capita. The Government plans to increase this figure by one kilogram per capita during the Third Five-Year Plan. Most fishing is done in the coastal waters of the Black Sea, the Sea of Marmara and the Bosporus. The Mediterranean and the Aegean Sea supply less than 10 per cent of the total landings.

The largest part of the catch, namely 70.2 per cent, comes from the Black Sea. The Sea of Marmara delivers 23.2 per cent. Marine production far exceeds inland water production, as the following table shows.

Fish caught (tons)

	1972	1973 (estimates)
Marine	171,555	246,666
Inland water	16,605	19,540
	188,160	266,206

Chapter IV. SECTORAL STUDY : THE IZMIT AREA

Economics

The Izmit area covers some 3,513 km^2 and has a population density of 109 persons/km^2. There are 123,000 inhabitants in the central part of the city of Izmit; in the suburbs there are 25,000 inhabitants. The total population of the Izmit area is 400,000. In Izmit, the industries are divided as follows:

	Per cent
Investment goods	1.8
Consumption goods	68.49
Semi-finished goods	29.71

In the whole of Turkey the division is:

Investment goods	46.6
Consumption goods	39.4
Semi-finished goods	14.0

The fixed assets of the industries in Izmit were divided as follows in 1971 and 1972:

Fixed assets (LT)

Industry	1971	1972
Food	10,250,783	25,500,774
Textiles	5,176,597	12,702,220
Wood and cork	2,843,500	8,692,694
Furniture	1,985,064	3,158,265
Paper and related products	2,236,535,826	2,850,380,525
Printing	—	2,207,190
Rubber	201,878,977	380,047,494
Plastic	55,559,256	51,370,475
Chemical	856,410,722	2,100,945,652
Oil, coal	827,621,454	850,491,792
Oil products	94,727,001	137,418,437
Glass	761,292,459	827,076,764
Metallurgical	160,799,053	174,408,330
Metal	284,271,280	589,077,124
Machine	2,539,914	3,548,443
Electrical	265,691,520	372,791,059
Transport	109,146,961	115,051,755

Overall, the fixed assets increased by some 20-25 per cent over the two-year period. The chemical industries are the second most important in the Ismit area.

Investments in industry in the Izmit area in 1971 and 1972 were as follows:

Investments (LT)

Industry	1971	1972
Food	34,444	703,628
Textiles	1,136,578	2,188
Wood and cork	—	—
Furniture	325,000	5,000
Paper and related products	303,704,457	52,234,530
Printing	—	—
Rubber	13,950,000	36,236,653
Plastic	15,498,786	4,357,259
Chemical	36,972,248	353,054,954
Oil and coal	536,056,549	14,079,906
Oil products	9,904,938	20,066,744
Glass	60,379,995	94,636,445
Metallurgy	31,246,752	7,174,028
Metal	79,415,595	294,553,717
Machine	2,968,743	724,005
Electric	32,832,810	49,753,182
Transport	4,393,294	5,670,271

Investments in the chemical industry increased nearly ten-fold from 1971 to 1972.

Industrial production in the Ismit area in 1971 and 1972 was as follows:

Industry	Production (LT) 1971	1972
Food	56,416,057	89,902,895
Textile	48,290,625	47,975,398
Wood and cork	1,299,500	36,186,920
Furniture	2,364,419	3,412,214
Paper and related products	603,318,845	1,204,822,290
Printing	—	238,875
Rubber	468,069,114	596,294,396
Plastic	71,016,100	90,545,119
Chemical	817,518,548	824,339,996
Oil and coal	1,149,362,071	1,714,235,000
Oil products	130,007,301	157,334,901
Glass products	563,650,121	623,118,432
Metallurgical	117,103,763	171,358,907
Metal	745,398,483	997,396,470
Machine	3,097,470	4,738,037
Electrical	230,024,666	887,352,395
Transport	210,720,299	449,171,355

The production of the chemical industries remained nearly constant from 1971 to 1972.

In 1971, 26,132 persons were working in the industrial sector at Ismit. By 1972 this number had increased to 32,007. Wages in 1971 totalled LT 632,450,617 and in 1972 LT 879,497,452. Workers and wages are divided into industrial sectors as follows:

	Number of workers		Wages paid (LT)	
Industry	1971	1972	1971	1972
Food	217	740	3,036,708	13,030,153
Textiles	773	679	16,859,628	17,042,802
Wood and cork	42	179	292,960	2,909,811
Furniture	102	116	593,047	839,240
Paper and related products	5,718	10,225	120,716,347	210,802,835
Printing	-	30	—	233,399
Rubber	1,623	1,823	52,023,300	66,305,994
Plastic	415	408	8,846,191	10,952,955
Chemical	2,955	2,798	101,534,635	125,938,459
Oil and coal	547	555	25,646,895	36,591,000
Oil products	508	864	12,636,664	15,926,139
Glass	4,442	4,084	82,578,714	96,383,496
Metallurgical	962	1,069	9,248,396	23,816,501
Metal	3,070	3,199	62,012,874	87,454,884
Machine	75	118	910,200	2,358,125
Electric	3,159	3,694	95,561,540	110,790,682
Transport	1,224	1,346	39,201,719	48,101,556

Crop production

The yields of many crops in the Izmit area decreased over the period 1968-1971. However, this decrease was not the result of industrial pollution because industry in the Izmit area is restricted to one bank of the Bay and its wastes, consisting mostly of liquids, are discharged into the Bay.

The decreases in yields of some of the agricultural products during the past five years are shown in the following table:

	Yield (tons)	
	1968	1971
Beans	20.20	14.5
Tomatoes	19.9	16.7
Pepper	10	8.8
Peaches	10	4.8

Chemical industries

Seka pulp and paper mill

Seka is a State owned company with several factories all over Turkey.

The mill at Izmit produces daily 90-110 metric tons of pulp for bleached and unbleached papers, using the calcium sulphite process. The chips are fed to six stationary digesters - five of 130 m^3 capacity and one of 170 m^3 capacity. All have circulating pumps and indirect heaters. The five 130 m^3 digesters are lined with acid-resistant brick and have a recommended working pressure of 7 atm and a design of 8 atm. The other digester, which is comparatively new (8 years old), is of stainless steel and has a recommended working pressure of 8 atm and a design pressure of 9 atm.

Calcium base cooking liquor is made from iron pyrites and limestone. The pyrites are burned in a furnace. The flue gases pass through a cyclone, electrofilter, gas scrubber and cooler and are then blown to the acid towers filled with limestone where reaction forms the cooking liquor. The liquor is then pumped to storage tanks.

Digesters are initially pressurized to 4 - 5 atm with the liquor fill pump; pressure is then increased to 5.3 - 5.5 atm at a maximum temperature of 140°C.

The cooking cycle for the digesters is as follows:

	Hours
Chip filling	1
Liquor filling	½
Time to temperature (140°C max.)	5
Time at temperature	1-3
Time to relieve pressure	1
Blow	1
Wash cycle and dump	1½
Total	12-13

Each 130 m^3 digester is charged with 22,600 kg of chips (dry weight) and yields 9,880 kg of unbleached pulp (dry weight). The 170 m^3 digester is charged with 29,600 kg of chips (dry weight) and yields 12,900 kg of unbleached pulp (dry weight), a digester yield of 46 per cent. A subsequent 5 per cent washer, knot and screen loss reduces the unbleached pulp yield to 43.6 per cent.

An 8 per cent bleaching loss further reduces the bleach pulp yield to 40.2 per cent. The bleaching process includes the use of chlorine, 15 per cent caustic, hypochloride, SO_2 wash and water wash.

After the cooking, the pulp is complete. The digesters are vented to a 3 atm tank and the red liquor is drained to the sewer. Next, 60 m^3 of wash water are added through the digesters' base and allowed to soak for one hour without circulation. After the wash water is drained to the sewer, the contents of each digester are dumped into a separate chest with a perforated bottom. Wash water is again added. The pulp is then diluted and pumped to parallel drum washers, followed by knoters, vibrating screens, thickeners and chests.

The first stages of the production process are the same for both unbleached and bleached pulp. The bleached pulp is used for a complete line of high and medium grade papers at 85 GE brightness. Bleached pulp represents 75 per cent of total capacity.

Water pollutants. The condensate has a biochemical oxygen demand in the order of 4,600 ppm and a pH of 2.4.

Air pollutants. Ash particulates from the iron pyrites combustion total some 117 kg per metric ton of dry pulp. The total ash produced in one day, therefore, is 16.4 tons. Assuming an efficiency of 90 per cent for the electroprecipitator, the ash discharged from the stack to the atmosphere is 1.6 tons per day.

The discharge of SO_2 from the stack is about 11 tons per day, estimated on the basis of charging the digester with 125 kg of sulphur for each bone-dry ton of pulp.

Future developments. The pulp factory at Izmit will be closed in about five years time and its activities will be taken over by a new plant on the south coast of Turkey near Anstalya. There is plenty of wood and other raw materials in the Anstalya area. The new plant will be provided with a biological treatment plant. The treated effluent will be discharged into the sea.

Paper and chlorine production will remain at Izmit. There is a market for chlorine and caustic soda, apart from present-day activities. Paper production at Izmit is now 110,000 tons/year and will be expanded to 140,000 tons/year. Plans for a waste water treatment plant for the paper factories are under consideration.

Seka chlorine-caustic soda plant

The Seka chlorine-caustic soda plant started in [illegible] with diaphragm cells; in 1967 it was entirely rebuilt by Pintsch Bamag/Power Gas and mercury cells were installed. Investment costs were LT 18 million. The possibility of pollution by mercury discharges was not considered at all.

Yearly capacity of the factory is 4,000 tons of caustic soda, 3,500 tons of chlorine and 100 tons of hydrogen. Sea salt is used as a raw material. Purification is achieved by adding barium chloride, soda ash and caustic soda to precipitate sulphates, calcium and magnesium ions. The precipitated solids are separated in a Dorr clarifier. The wastes thus obtained are flushed into the Izmit Bay.

The cell house is well ventilated; only a weak smell of chlorine was detectable. No analysis of the air in the cell house (Cl_2 and Hg) was made.

Chlorine is liquefied. Part of it is sold and part is used in the factory for the manufacture of bleaching powder and hydrochloric acid.

There are two units for the production of hydrochloric acid. One is made of quartz and the other of karbate. Total production is 3,000 tons/year of 33 per cent HCl. Corrosion of the stack indicated that considerable HCl is not absorbed by water and passes into the atmosphere.

The bleaching powder is produced in batches in a rotating drum. Each batch produces six tons of bleaching powder in a reaction time of 10 hours. A small excess of chlorine escapes and is absorbed in a lime solution producing a solution of bleaching powder. This is used internally. The bleaching powder unit functions well and is in a good state of maintenance.

Sodium hydroxide. Sodium hydroxide is evaporated from the brine and is produced as a solid product. No mercury is separated before concentration. No analysis of the mercury content is made.

Chlorine is used in the manufacture of bleaching powder (1,800 tons/year) and hydrochloric acid 33 per cent (3,000 tons/year). The manufacture of hydrochloric acid consumes about one third of the hydrogen produced, the rest is vented into the air. The excess hydrogen was considered for use in the hardening of edible oils, but the mercury content of 30 mg Hg per m^3 hydrogen was prohibitive. No plan for separating the mercury from the hydrogen has been developed. Hydrogen is cooled to +30°C, which is far too high a temperature to arrive at low mercury levels; 5°C is the highest temperature admissable for this purpose. A total of 12 tons of mercury circulate in the cell house.

The laboratory facilities of the plant were not sufficient for analyses of the mercury levels in the other products and in the brine bleed. One ton of mercury, worth LT 200,000, is lost per year. The mercury losses are 250 gr per ton of caustic soda, which is high. Most of these losses are discharged into Ismit Bay.

Cost prices of products are:

	LT/ton
Caustic soda	1,600
Liquid chlorine	2,600
Bleaching powder	2,600
Hydrochloric acid (33 per cent)	1,000

The factory officials stated that no serious health effects had been observed, but a nearby hospital informed the group that many cases of both chronic and acute bronchitis have been observed among Seka's personnel. An average of 1-2 people are absent every day due to illness, at a cost of LT 36,500 to the plant. For undetermined reasons, liver diseases are frequent among personnel of the nearby Goodyear factory.

<u>Labour</u>. There are 110 persons working in the plant. Houses built nearby for them are pleasantly situated in a green area that includes sport facilities. Great importance is laid on personnel training.

Laboratories. There are five persons working in the laboratories. The total investment cost was LT 50,000. No equipment has been installed to analyse for pollutants.

Costs. The operating costs of the plant are divided as follows:

	Per cent			
	Sodium hydroxide	Chlorine (gas)	Liquid chlorine	Bleaching powder
Raw materials	27.05	24.76	77.62	55.82
Labour costs	9.0	9.69	5.45	21.35
Material	2.26	2.24	0.19	0.56
Amortization costs	0.37	0.38	0.06	1.27
Water, steam	53.02	54.49	4.12	0.51
Maintenance	3.16	3.23	7.03	7.62
Social costs	2.94	2.98	2.71	-
General management	1.83	1.85	2.10	6.32
Overhead costs	0.37	0.38	0.71	3.21

Koruma Tarim Ilâclari

Koruma is a privately owned company producing chlorine, caustic soda, DDT, benzene hexachloride, hydrochloric acid, sodium hypochloride and sulphuric acid.

Chlor-alkali unit. The chlor-alkali unit was designed by De Nora (Italy) and came into operation in 1964. It uses the mercury process. Daily capacities are 444 tons NaOH (100 per cent), 39.6 tons Cl_2 and 1.1 tons of hydrogen. There is enough space in the cell house for an 80 ton Cl_2 per day production but at present there are no plans for expansion.

Sea salt with low SO_4 content is used. Treatment to remove sulphate, magnesium and calcium is carried out by using barium chloride, caustic soda and soda ash. Precipitates are removed in a clarifier and discharged into the bay.

Some time ago the unit suspended sulphate removal, and it no longer uses barium salts. This has resulted in a longer life for the carbon electrodes (13 months instead of 9) and fewer polluting discharges (because of the absence of barium).

There are 22 cells, in which about 42 tons of mercury circulate. Mercury losses are 120 gr per ton of caustic produced, which amounts to one ton per year. This is rather a high figure. Some leakage of mercury pumps was observed. The NaOH is not treated before evaporation so as to reduce the mercury content.

Chlorine is liquefied and part of it is bottled in steel cylinders. In spite of the existence of an acoustic warning system, overfilling sometimes occurred. The installation of an automatic system that provides maximum safety is being considered, however.

Hydrogen is cooled to $-8^{o}C$ and therefore is free of mercury. About one third of the hydrogen is used for the production of hydrochloric acid. Some 35 - 40 tons of 33 per cent HCl are produced daily. The balance of the hydrogen is vented into the air. Plans exist to double the HCl production and to use the excess hydrogen as a fuel in the boiler house. Some technological problems have to be solved before proper combustion of the hydrogen can be assured, however.

Brine-bleed is currently discharged into Izmit Bay, but research aimed at reducing mercury compounds with hydrazine is under way. This should enable part of the mercury to be recycled.

Although Koruma's laboratory has a staff of 15 and is well equipped to do all kinds of mercury analysis, the facilities are hardly ever used and practically nobody shows any interest in the mercury contents of discharges and products.

Hydrochloric acid unit. The hydrochloric acid unit has a capacity of 35 tons per day. It was designed by Union Carbide and is built of karbate material. A small excess of hydrogen is used, so no chlorine can be emitted. Absorption is good and no HCl escapes. Plans are being made for double capacity. Most of the product is sold.

Sulphuric acid unit. The sulphuric acid unit, which was designed by Monsanto, uses sulphur as its raw material. Design capacity is 25 tons/day of monohydrate; actual production is 20.5 tons. Facilities for the production of oleum 25 per cent exist. Design is of the single contact/single absorption type and sulphur efficiency is 98 per cent; this means that 350 kg of SO_2 is emitted daily. Stack height is 18 m.

Sulphur prices are LT 1,100 per ton from the local refinery or LT 1,750 imported.

Oleum is produced if needed for DDT production. Most of the production from the sulphuric acid unit is sold.

DDT unit. The DDT unit was installed in 1964. Capacity is 2,400 tons per year, but no DDT has been produced for about 10 months and part of the unit has been dismantled for repairs. It is not sure whether production will start again. Tentative plans have been made to replace this unit with a phenol unit using chlorobenzene as an intermediate. A chlorobenzene unit currently exists as part of the DDT factory.

Each ton of DDT produced yields two tons of spent sulphuric acid of 78 per cent strength as a by-product. Attempts to sell this acid to a fertilizer plant have failed.

A spent acid recovery unit, designed and built by De Nora, was installed in 1965. In the beginning, heating with superheated steam was used for the decomposition of polluting by-products. However, this installation never worked properly and the designer himself did not succeed in bringing it on stream. In the end, the spent acid, containing chlorinated products, was discharged into the bay. This is causing rather serious pollution.

Benzene hexachloride (BHC) unit. The BHC unit was designed by Frazer Woodall Duckham. Its capacity is 5,400 tons/year and it will shortly be increased to 6,700 tons. BHC partly replaces DDT as an insecticide.

Production units are made out of quartz, which is transparent to the ultraviolet light necessary to maintain the photo-chemical reaction between benzene and chlorine. The ultraviolet light is produced by lamps positioned outside the reactor. The irradiation room is well sealed and no operators are allowed inside; work is remote-controlled from outside the room. There is no exposure to ultraviolet rays and therefore no hazards to the workmen.

Excess benzene is evaporated and recycled. BHC is flaked on a rotating cylinder that is completely enclosed, and remaining benzene vapours are evacuated, condensed and recycled. The layout of this unit is very good and maintenance is perfect. No discharges are produced.

At present, the active gamma-isomer of BHC (Lindane) is not isolated, but a plant for the production of pure Lindane is planned and will be operating by July 1975.

Sodium hypochlorite (NaOCl)unit. This unit was designed by De Nora and contains an absorption unit for the reaction of chlorine and the dilution of caustic soda.

Unit capacity is 1,000 tons/month. The product contains a minimum active chlorine content of 100 gr of chlorine per litre. No wastes are produced in this process.

Workshops and maintenance. The workshops at the Koruma plant are well equipped. There are facilities for rubber lining, for p.e. welding, for production of polyester-glassfibre vessels, and so on. Maintenance is on a high level and there is awareness of the importance of keeping it so. Flanges, valves and other details are kept in good order.

Discharges. Liquid effluents are discharged into Izmit Bay without treatment. Plans for treating brine bleed from the mercury cells are under investigation. The laboratory has the facilities to analyse the various pollutants, but up to now officials have shown little interest in the subject.

Labour. The total manpower is 378, including 82 in the production department and 29 in maintenance. The basic wage is LT 67.80/day; three different allowances bring it up to LT 84.30/day.

Superphosphate Gubre Fabrikasi

This privately owned fertiliser works is located at Yarimca, about 15 km north of Izmit and situated on the Bay. It was established in 1960 for the production of single superphosphate. The sulphuric acid used was bought elsewhere and phosphate rock was imported from Morocco and Jordan. Some years ago it was decided to change over to the production of triple superphosphate and a phosphoric acid plant was installed. Triple superphosphate is produced in the same unit that is used for single superphosphate.

The phosphoric acid plant was designed by St. Cobain (France) and was constructed on turn-key basis by Woodall-Duckham. It came into production in late 1973. Essentially, it is a single tank digester system using the dihydrate system. Plans for building a hemi-hydrate system, which results in a better quality gypsum, were considered but finally rejected because of higher investment cost and uncertainty about further use of the gypsum. Marketing of building materials made out of high-quality gypsum would have been too difficult, and transformation of spent gypsum into cement and sulphuric acid was considered not to be attractive from an economic point of view.

The plant has a capacity of 230 tons/day of P_2O_5. The single tank reactor has one central agitator and eight more near the periphery of the reactor. Ample ventilation of the fluorine-containing fumes formed in the reaction is provided for; a scrubber absorbs noxious fluorine compounds. Gypsum is filtered on a Useco rotating filter (without tilting pans), and a screw is utilized to discharge the filters. Some 1,400 tons of gypsum (containing 1 per cent P_2O_5) is produced daily. Fluorine content is not known.

The filter produces phosphoric acid of 28 per cent P_2O_5 strength. Concentration to 50 per cent P_2O_5 is performed in two vacuum distillation units. Fluorine containing gases from these units are scrubbed with water and discharged into the bay. The fluorine content of these discharges was not analysed. No plans for utilizing the discharges in the production of fluorine compounds exist.

Gypsum, at the time of the group's visit, was discharged into the bay at a short distance from the plant. Even though discharges had occurred only over a period of a few months, a rather large deposit of gypsum was visible. The company had decided, however, that in future it would load the spent gypsum into barges and dump it in a deep-water area of the Sea of Marmara. Barges had already been obtained, loading equipment was very near completion, and it was foreseen that in a few weeks the equipment could be used. Dumping gypsum in deep water is generally accepted as good practice, especially if an area with strong currents is selected. Due to its solubility of 2 grams/litre, gypsum dissolves easily if there is sufficient movement of the water.

Superphosphate unit. Single superphosphate (16-18 per cent P_2O_5) and triple superphosphate (42-44 per cent P_2O_5) are produced. Total capacity is 200,000 tons/year. For 1974, production of both types in equal amounts was planned; in 1975 only triple superphosphate will be produced.

Bradley mills (Raymond-type) are used in both phosphoric acid and superphosphate production.

The reaction needed to produce superphosphates is achieved in a Broadfield den of 30 tons/hour capacity. Two Broadfield dens are installed, one as a stand-by. Following the den operation, a granulating unit that contains a drum-granulator using water as a granulating acid is used. The product is subsequently dried in a standard co-current rotating drum-drier. The product is then sieved and fines as well as broken over-size are recycled to the granulator. Fineness is 30-40 per cent through 200 mesh (for single and triple superphosphates) and 30 per cent through 100 mesh for phosphoric acid.

The layout of the plant is good, although a certain amount of dust is produced by fast-moving transport belts. These belts have a speed of 1.8 m/sec and produce heavy clouds of dust at discharge ends. Plans to replace the belts by screw conveyors exist, but as a considerable height (12 m of height over 30 m of length) has to be covered, the screw system must have rather steep angle. This might cause trouble. The use of wide belts at low speeds (max 0.5 m/sec) and sufficient ventilation at discharge ends would be preferable. A rather small and inexpensive unit containing a small fan, a cyclone and a dust bag would be very satisfactory.

Noise from hammers on the drum drier is rather loud; a better arrangement could be made.

Bagging is done in open mouth polyethylene bags of 0.20 mm thickness which are then heat sealed. The capacity is 60 tons/hour in two bagging lines. Before bagging, dust is removed from the product by screening. The failure rate in heat sealing is 1-1.5 per cent.

Thirty-five people work in maintenance which is on a good level. Last year costs were LT 928,795. The factory is clean and apparently the floors are washed frequently. The equipment is in good condition. The only serious trouble, as mentioned before, was due to dust from the belts.

Labour. The plant has 224 workers. The minimum wage is LT 49; the maximum LT 83.25 per day. With the exception of three months of on-the-job training, the workers are given no special training. Forty-nine workers had accidents in 1973. The plant does not provide housing for its workers nor are there any plans to build a housing complex.

Laboratories. The plant has a laboratory for production control with a staff of five. The total investment was LT 500,000. Last year the operating costs were LT 14,034.

Costs. The operating costs of Gubre Fabrikasi for 1973 and 1974 are given below:

	Per cent	
	1973	1974
Raw materials	86.99	91.18
Labour	4.99	2.72
Energy	0.55	0.47
Others	7.47	5.63

Conclusions and recommendations. The plan for deep sea discharge of gypsum is an improvement over current practice. Fluorine discharge is uncontrolled; if the Izmit Bay is to return to good condition, discharge of fluorine compounds in large quantities must cease.

Within the factory, there are no serious health problems. However, the use of protective equipment in the dusty areas is recommended until a better technological solution can be found.

Chapter V. SECTORAL STUDY : THE BANDIRMA AREA

Fishing

The figures for fish caught in the Bandirma area during the period 1965-1973 are shown in the table below:

Year	Catch (kg)*
1965	111,565
1966	148,199
1967	215,060
1968	133,567
1969	135,030
1970	113,350
1971	103,075
1972	131,700
1973	111,200

*These figures do not include hauls of palamut, lobster or clams.

The figures indicate a relative constancy in catch over the period, even though a greater number of larger boats enabled the commercial fishermen to travel further from the coast in search of fish in 1973 than in 1965. It is suspected that pollution is the reason why the yields have not increased.

Agriculture

The land of the Bandirma area is divided as follows:

Agricultural use	Per cent	Hectares
Farming	78.08	3,315,117
Vineyard	2.30	9,803
Fruit	2.06	8,765
Vegetable	1.46	6,209
Mulberry	0.17	725
Olive	15.93	67,524
	100.00	3,408,144

In 1972, the numbers of families working different sizes of farms were as follows:

Families	Size of farms (1/10 x hect.)	Total area
81,893	1-50	1,956,404
14,761	51-100	1,024,986
3,633	101-200	520,880
1,745	201-500	446,964
227	501-1,000	145,520
44	1,001-2,000	64,100
17	2,001-3,000	43,900
2	3,001-4,000	7,900
2	4,001-5,000	10,000
2	5,000	24,804

While the yield per hectare of agricultural products is higher in Bandirma than it is in Izmit, some products have shown no significant growth during the past 12 years and others have shown no growth in yield per hectare.

Products that have shown growth are:

	Yield per hectare (tons)	
	1960	1972
Rye	1.1	1.3
Kaplica	1.1	1.4
Millet	0.8	1.0
Cotton	0.5	0.6
Oleaster	0.006	0.009
Vegetables	4.3	4.7

Products that have shown no growth, or even a reduction in growth, are:

	Yield per hectare (tons)	
	1950	1972
Liven	0.9	0.5
Sesame seed	0.6	0.5
Lentil	0.8	0.8
Linen	0.6	0.5
Sunflower	1.6	1.3
Garlic	7.3	5.1
Aspir	0.7	0.5
Mulberry	0.008	0.0007
Kizileik	0.01	0.007
Cherry	0.01	0.01
Wild apricot	0.01	0.01
Egg plant	19.6	19.4
Cauliflower	30.3	24.9
Cabbage	10.1	9.4
Carrots	7.6	5.8

Olive trees yielded the same amount in 1972 as they did in 1950, namely 0.01 ton per tree.

There appears to be no definite explanation as to why production of some crops did not increase and in many cases even decreased; in general, more fertilizers, pesticides and better agricultural techniques have been used over the past 12 years.

It is possible that pollution played a role; industries in Bandirma cause little air pollution but severe water pollution. At this time the effect of pollution on crop production cannot be directly traced; it has been ascertained, however, that the wild apricot that grows locally has suffered from pollution discharged by Bandirma's industry.

Chemical industries

Etibank Boraks ve Asitbarik Fabrikalari

This is a State owned factory producing boron compounds from locally mined boron minerals. Technology, factory layout and equipment were developed by Polymex on a turn-key basis.

The minerals used are colemanite and tinkal. Colemanite ($2CaO \cdot 3B_2O_5 \cdot 5H_2O$) in a pure state contains 50.8 per cent B_2O_3. The mineral used is 85-90 per cent pure, the balance is clay, calcium and magnesium carbonate, silica and traces of iron. Tinkal ($Na_2O \cdot 2B_2O_3 \cdot 10H_2O$) is essentially natural borax. Its purity is 85-90 per cent. Impurities are silica, clay, dolomite and calcium carbonate.

Colemanite is mined at Emit, tinkal at Kirka. Both sites are about 300 km from Bandirma. The minerals are transported by train and truck.

Colemanite can be a raw material for both borax and boric acid. First boric acid is produced. Any part of it can then be converted into borax by neutralizing with soda ash. In this case, borax is more cheaply prepared by directly purifying the tinkal ore by crystallisation.

Boric acid production. Colemanite ore is dried in a co-current rotating drum drier that uses fuel oil. The hot dried product is cooled and finely ground in ball mills. Noise level is 60 dB. Exhaust gases contain some ore dust and are washed with water; this water is discharged into the sewer. The discharge stack showed crust on the rim, so apparently droplets loaded with boron compounds are being discharged.

The product is further treated with sulphuric acid in a batch process at 90°C while being vigorously stirred. This prevents precipitation of gypsum on the unreacted ore. When the reaction is completed, the contents of the reactor are filtered, using old fashioned plate and frame filter presses. The filter is cleaned and prepared by hand. The filtrate is cooled in order to allow the boric acid to crystallise. The boric acid is then separated by centrifuging, dried on continuous tray driers, stored and bagged. Hot air is used for drying; it passes through a bag filter before discharge into the atmosphere. The filter unit discharges no particulates.

There are substantial problems connected with this production scheme. The most troublesome is the filtration unit. The relatively large amounts of clay-like substances in the colemanite give rise to the formation of gels which are difficult to filter. It is therefore impossible to arrive at dry filter cakes and filtration has to be stopped before the drying process is complete. Attempts to use filter aids to obtain better results were unsuccessful. The sludge from the filter presses contains 6-8 per cent of the input of raw material expressed as B_2O_3. Since 25,000 tons/year of boric acid are produced, there is a discharge of 2,000 tons of B_2O_3; this results almost entirely from inefficient filtering. Rotating pressure drum filters are now being installed which should result in greatly reduced losses of B_2O_3.

The centrifuges used for separating boric acid from its mother-liquor are old-fashioned and have a low production rate. They are batch-type centrifuges with a vertical axis fitted with a direct two-speed electrical drive. The management has decided to replace them by continuous centrifuges with horizontal axes of the "Bird" type. A more uniform product will be discharged from these new centrifuges and extensive losses of time due to cleaning will be avoided.

The present technology does not allow for the quality of the raw material and its impurities. The clay-like substances either have to be removed before acidification of the colemanite, or methods to prevent the formation of gels that hinder filtration will have to be developed. This is a programme that seems to be beyond the capabilities of the plant's laboratory. The Marmara Scientific and Industrial Research Institute at Gebze (a Tübitak branch) was asked to investigate the problem, but the Institute itself is still not fully operational. Plans do exist, however, to build a pilot plant at Gebze in order to develop technologies for the processing of the boron minerals which are so abundant in Turkey.

Borax production. Borax is made by purifying tinkal ore, which is essentially a natural borax. The purification process includes grinding the solution in hot water, filtering and crystallizing. The crystals are then centrifuged, dried, stored and bagged.

The problems are the same as those encountered in boric acid production. Impurities (clay, sand dolomite etc.) are filtered out of the hot solution in frame and plate press filters. Due to formation of clay-colloids, filtration is slow and a good filter cake cannot be obtained. Losses from borax left in the filter cake are extremely high; on a yearly basis of 32,000 tons of borax produced they amount to 5,000 tons of B_2O_3. As in the case of the colemanite ore, purification of the original ore to remove clay would improve processing. (The Institute at Gebze also plans to study the borax process.)

The plant laboratory is well equipped for analytical work. Modern equipment, such as an atomic absorption spectrometer, a visible light and ultraviolet spectrometer are available and are used. But the equipment needed to study process variations on a scale larger than bench-investigations is missing.

Twenty-two people are working in the laboratory. They include one chemical engineer, two technicians and four laboratory assistants. The budget for 1973 was LT 150,000; for 1974 it was LT 200,000. The investment cost of the laboratory was LT 2 million, of which LT 1.5 million was for building purposes.

Discharges. There are some discharges of boron compounds into the air from the colemanite drier system, as indicated by crust formations on the exhaust stack. The bag filters, examined after use in both the borax and boric acid driers, were in good shape; apparently no dust escapes. However, data are not available.

There have been no complaints from local farmers. Trace quantities of boron are beneficial to soil, although large doses of it can spoil a good soil for many years. Apparently there has been no problem of this nature.

Aqueous discharges are very heavy. Some 2,000 tons of B_2O_3 as boric acid, and 5,000 tons of B_2O_3 as borax, are discharged annually. These wastes, together with small quantities from cleaning, floor sweeping, spent sulphuric acid, gypsum (5,000 tons), silica, clay and other impurities from the ores are discharged through a 3 km pipeline into the Sea of Marmara. The 7,000 tons of B_2O_3 discharged into the sea is causing serious pollution. Professor Kor at the University of Istanbul is in charge of a special investigation of this problem.

Etibank sulphuric acid plant

This is a Russian designed factory with a capacity of 120,000 tons/year of H_2SO_4. Total investment was LT 140 million. Some of the pyrites used as raw material come from Turkish mines (Murgul and Cakmahkaya), the rest from Cyprus and Finland. The sulphur content is 45-48 per cent.

Process. The pyrites are dried in a co-current rotating drum drier with an air temperature of 250°C. Drier gases are discharged through a very low stack that does not even reach roof level. Some dust and water vapour are discharged. No analyses were carried out for SO_2.

The roaster section consists of three fluid bed roasters, each with a capacity of 100-120 tons/day. A roaster gas containing 14-15 per cent of SO_2 is produced. Roasting is followed by processing in a cyclone and a waste heat boiler, where steam of 35 atm is produced. (The steam is used to produce power.)

In addition, the roaster section contains two dry electrostatic filters (from which a gas containing 80-90 mg of dust/m^3 is emitted); two washing units in series; and two units in series of each 2 parallel wet electrostatic filters.

The gas from the three roasters passes through a drying tower, a mist-catcher of porous pumice stone, and a heat exchanger, before entering the contact section. The reaction vessel contains five layers of vanadium pentoxide catalyst. Coolers are of the heat exchange type.

The plant has a normal single contact/single absorption layout. Design capacity is 97 per cent conversion; actually 98.4 per cent is obtained. Absorption is carried out in two absorption towers in series; the second one acts also as a mist catcher. The acid coolers use sweet water from a nearby well. This water is recirculated through a forced-air water cooler. Sometimes small amounts of chlorine are added to prevent the growth of algae. In 1973, production was 120,000 tons of acid.

Discharges. The first washer, after the fluid bed roaster, removes some arsenic, depending on the nature of the pyrites used. The water is recirculated and the resulting weak sulphuric acid is later used in the boric acid factory. Arsenic contents are not analysed.

Small amounts of water solutions from the regeneration of ion-exchangers (for the preparation of boiler-feed) are discharged into the sea. Washing of the burner house floor produces large amounts of highly coloured water (due to iron oxides) which are also discharged into the sea.

Gaseous discharges are mainly stack gases emitted from absorption units. Design values are 0.3 mg of SO_3 and 0.5 mg of SO_2 per m^3 at S.T.P.; actually, 0.06 mg of $SO_2 + SO_3$ is discharged. Practically no mist is discharged; 50 kg of SO_2 is discharged per hour. The stack has a height of 50 metres.

About 75,000 tons of solid wastes (pyrite cinders) are produced annually. The average iron content is 56-60 per cent Fe. Murgul-cinders contain 1.4-1.5 per cent copper. The wastes in 1973 were: 5 per cent Murgul cinders; 15 per cent Cakmahkaya; 10 per cent Finnish and 70 per cent from Cyprus ore. The cinders are cooled with water upon leaving the roasters. The effluent water may contain arsenic compounds. No analysis was made.

Cinders are stored near the factory on two dumps. Since April 1972, no cinders have been sold; the dumps are therefore well filled. A third must be established shortly. Fine cinders used to be carried away by the wind and there were complaints from local farmers regarding the pollution. There have been no complaints within the past eight months however, ever since the practice was adopted of "wetting down" the cinders upon dumping. The wet cinders form a crust on top of the pile and prevent the wind from carrying away the dust.

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The plant is privately owned and produces only single superphosphate from imported phosphate rock (mainly Morocco Safi, 33.7 per cent P_2O_5) and sulphuric acid produced by the nearby Etibank sulphuric acid plant. The plant, which was built in 1972 as a grass roots project, was designed by Uhde (West Germany). The investment cost was LT 280 million.

The plant capacity is 600 tons/day, or 200,000 tons/year, of granulated, water-soluble single superphosphate of 18 per cent P_2O_5. The actual maximum production is only 550 tons/day, due to lack of well trained operators and to a shortage of water.

The phosphate rock is brought in by ship, but as there is no crane available, unloading has to be done on a moving belt. This results in high losses (estimated at 1.5-2.5 per cent). As the prevailing land winds blow the phosphate rock into the sea during the unloading operation, there are no complaints from farmers; however, these losses are too high and plans must be made to unload either with a good harbour crane fitted with an appropriate grab or with a pneumatic transport system.

The phosphate rock is ground in a Bradley mill (Raymond-type) with a 25 ton/hour capacity; it then passes over a 0.15 mm sieve.

As there is a shortage of fresh water (5-8 l/hour compared to a need for 40 l/hour), sea water is used for the absorption of fluorine compounds. The sodium chloride in the sea water reacts with fluosilic acid (H_2SiF_6) to form sodium silicofluoride (Na_2SiF_6), an insoluble product. Consequently, the washtower is frequently completely blocked and has to be cleaned. The sewer to the sea also became blocked and has since been replaced by an open canal. Apparently, as the problems arising from the use of sea water were not foreseen, a thorough hydrologic investigation of the site was not carried out before construction started.

The production unit is a Broadfield-den of 35 ton/hour capacity. The den is fed by a band-weigher (Kugler) coupled with an electromagnetic sulphuric acid dosing apparatus (Altometer). The product from the den is then granulated.

The granulator, a rotating drum with a length of 6 m and diameter of 2.5 m, makes a fixed number of 15 revolutions per minute. Its capacity is 35 tons/hour; water and steam are injected to control the granulation process. The power is 55 kW.

The granulation process is followed by drying in a co-current rotating drum. A sieve section separates the fines and oversize from good product. Broken oversize is recycled to the sieves; fines are recycled to the granulator. The recycling factor is 62 per cent.

The sieves are closed and ventilated and exhaust air passes over the cyclones before being vented. No excessive dust is emitted, but a fast-moving belt for the transfer of end products causes much dust formation. The speed is 1.3 m/hour; preferably this should be slowed down to about 0.5 m/hour. Emissions of fluorine compounds from the Broadfield den cause a bad atmosphere as operators frequently forget to close the inspection doors.

Ventilation on the Broadfield den is 25,000 m^3 per hour, which is sufficient if good operating practices are maintained. Except for the air pollution problem, plant maintenance is good.

Production. The product is stored for eight to fourteen days after preparation. Average analysis after eight days storage is:

			Per cent
Water soluble	P_2O_5	=	18.6
Total	P_2O_5	=	21.4
Free acid	P_2O_5	=	2.0
Humidity		=	4.9

This represents a good product.

Bagging. Bagging is done in polyethylene open mouth bags which are subsequently heat sealed, using Libra machinery. Capacity is 50 tons/hour.

Costs. The operating costs of the plant, expressed as percentages, are:

	Per cent
Raw materials	64.0
Fuel oil	6.2
Electricity	2.8
Labour	9.2
Depreciation	5.8
Maintenance	2.8
Interest	5.3

Some 1,250 kWh of electricity and 8.5 tons of oil per day are used.

Personnel. Personnel consists of 147 men. There are three shifts (19 each) for continuous production and two shifts (9 each) for bagging and transportation. Twelve men work in maintenance. Workers come from nearby city and villages.

Laboratory. The laboratory is equipped for production control. No emissions are analysed, however.

Chapter VI. POLLUTION OF THE SEA OF MARMARA

The area around the Sea of Marmara consists of the following districts: Balikesir; Bursa; Canahkale; Istanbul; Kocaeli; and Tekirdag. The populations of these districts in 1973 were as follows:

	Total Population	Population engaged in agriculture	Population engaged in fishing
Balikesir	749,669	569,305	18,880
Bursa	847,884	539,299	8,615
Canahkale	360,764	252,698	2,711
Istanbul	3,019,032	120,790	17,106
Kocaeli	385,408	258,005	1,876
Tekirdag	302,946	224,172	659

The total annual catch of fish during the years 1967-1969 is shown below:

	Total annual catch (kg)		
	1967	1968	1969
Balikesir	4,814,528	4,619,228	4,052,580
Bursa	2,309,230	1,796,337	3,036,643
Canahkale	1,571,201	1,560,673	1,542,447
Istanbul	28,575,594	19,347,470	32,178,131
Kocaeli	209,554	114,472	979,115
Tekirdag	1,372,085	832,663	1,267,858

Ismit lies in the Kocaeli district. It can be seen from the tables that although this district has a higher fishery population than the Tekirdag district, the amount of fish caught is much less.

An interview with fishermen revealed that the catch from Izmit Bay in 1972 was only 86 tons; the water there is almost void of life. A fisherman now needs to cast 15 nets to get the same quantity of fish that he would have caught in one net 25 years ago.

According to the Ministry of Agriculture, yields of fifteen types of fish caught in waters around Istanbul have decreased. The total value of the fish catch sold at the Istanbul fish market decreased from LT 157.5 million in 1969 to just under LT 14.6 million in 1973.

Economic losses were also experienced in the Sea of Marmara region due to the decreased catches.

The costs of installing the necessary anti-pollution equipment would be substantial; but they could be justified from the national viewpoint through the improved fish production that would result.

Annex. TRACE ELEMENTS AND PLANKTON LIFE OFF THE TURKISH COASTS *

Figure 1. Trace elements in Bosporus and Black Sea surface and Mediterranean bottom water averages

Elements	Sample No.							
	3	4	Mean	5	6	8	Mean	Ocean (27)
Concentrations (mg/litre)								
Salinity	-(1)	-	17,180	-	-	-	36,550	34,320
Zinc	36	28	32	50	40	45	45	10
Cadmium	<5	9	-	16	<5	<5	-	0.11
Boron	2,550	2,750	2,650	5,800	4,900	5,400	5,400	4,600
Iron	17	10	14	8	11	6	8	10
Molybdenum	81	64	72	147	129	134	137	10
Aluminium	133	44	88	10	95	11	~36	10
Copper	15	21	18	8	11	6	8	3
Nickel	<5	<5	-	8	<5	<5	-	2
Lead	<10	<10	-	21	<10	15	~15	0.03
Strontium	2,500	2,450	2,480	3,150	3,050	2,700	2,970	8,000
Ratios of Elemental Concentrations to Total Salts (salinity x 10^6)								
Zinc	2.1	1.6	1.9	1.4	1.1	1.2	1.2	0.29
Cadmium	-	0.52	-	0.44	-	-	-	0.0032
Boron	148	154	151	161	135	150	150	130
Iron	1.0	0.58	0.81	0.22	0.30	0.16	0.22	0.29
Molybdenum	4.8	3.7	4.2	4.1	3.5	3.7	3.8	0.29
Aluminium	7.7	2.6	5.1	-	2.6	0.30	~1.0	0.29
Copper	0.87	1.2	1.0	0.22	0.30	0.17	0.22	0.087
Nickel	-	-	-	0.22	-	-	-	0.058
Lead	-	-	-	0.58	-	0.41	~0.4	0.00087
Strontium	145	142	144	87	84	74	81	230

(1) Hyphen (-) indicates none detected.

NOTE: 8 elements not detected at sensitivity levels indicated

		Average Ocean Value
Arsenic	50 μg/litre	3 μg/litre
Barium	50 μg/litre	30 μg/litre
Vanadium	10 μg/litre	2 μg/litre
Manganese	5 μg/litre	2 μg/litre
Cobalt	5 μg/litre	0.1 μg/litre
Chromium	5 μg/litre	0.05 μg/litre
Beryllium	3 μg/litre	0.0006 μg/litre
Silver	1 μg/litre	0.04 μg/litre

* Adapted from data of Professor Kor of the University of Istanbul

Figure 2. Enrichment factors for trace elements in Bosporus waters

Element	Surface (Black Sea) Waters	Bottom (Mediterranean) Waters
Zinc	6.5	4.1
Cadmium	162	137
Boron	1.2	1.2
Iron	2.8	0.76
Molybdenum	14.5	13.1
Aluminium	17.6	3.4
Copper	11.5	2.5
Nickel	–	3.8
Lead	–	460
Strontium	0.62	0.35

Figure 3 (a). Plankton and transparency in Bosporus, Golden Horn and Sea of Marmara, October 16, 1957

Station Number	Sample taken at	Water colour	Transparency (seiche disc)	Bottom deposit (g.per 200 cm^3)	Results of Plankton Analysis
1 Dolmabahce (Bosporus)	Surface	Dark Blue	15 m	2.3	Algae-type planktons like Ceratium (C. Tripos) from Dinoflagels and Peridinium are predominant. Tintinnus (T. Inquilinus) Rabdus, Uronema are observed.
	5 m depth			3.2	Ceratium, Peridinium (P. Divergens) are found to be in majority. Tintira, Peritricha and Diatomaes are also observed.
2 Eyup (Golden Horn)	Surface	Dark Olive-Green	1.5 m	4.6	Highly polluted. Contains botanical residues and parasite eggs. The presence of Tintinus (T. Inquilinus), Ceratiums, Diatomaes and Copepodes was observed.
3 Kasimpasa (Golden Horn)	Surface	Dark Gray-Green		3.8	Infusorias, i.e. Ciliatas are predominant. Ceratium (C. Hirudinella), Peridinium (P. Divergens) and Chetopodes are also found.
	5 m depth			2.6	Infusorias, i.e. Ciliatas are predominant. Ceratium (C. Hirudinella), Peridinium (P. Divergens) and Chetopodes are also found.
4 Eminonu (Golden Horn)	Surface	Dark Blue-Green	8.5 m	2.3	Dinoflagelliates (Ceratium Tripos), Diatomaes and Peridiniums are found to be in majority. Companulina, Tintinus and Copepodes are also observed.
	5 m depth			1.8	The same as surface sample. Absence of Copopodes and the addition of Proto-ciliates.

Figure 3 (b). Plankton and Transparency in Bosporus, Golden Horn and Sea of Marmara, October [illegible]

Station Number	Sample taken at	Water colour	Trans-parency (secchi disc)	Bottom deposit (g per 200 cm^3)	Results of Plankton Analysis
5 Sirkeci (Bosporus)	Surface	Dark Greenish Blue	8.0 m	1.7	Copepodes (Calanus Finmarchicus), Amphipodes and Diatomeae are predominant. Infusoria, Radiolaria, and [illegible] are also observed.
	5 m depth			1.2	Dinoflagellates (Ceratium Tripos), Diatomeae and Ceratium Hirundinella are predominant. [illegible] Infusoria and Peridiniums are also observed.
6 Nearshore Sea of Marmara		Dark Bluish Green	7.0 m	2.4	Dinoflagellates, Copepodes and Amphipodes are predominant. [illegible], Tornarias and Trochophores are also found.
	5 m depth			0.8	Algaes, Copepodes and Diatomaes are in majority. Calanus Finmarchicus, Caligus Rapax and Siphonophores are also observed.
7 Offshore Sea of Marmara	Surface	Dark Blue	9.0 m	1.3	Campanulinas ([illegible]), Algaes, Copepodes and [illegible] are predominant. Ceratium Hirundinella, and Peridinium Divergens are also observed.
	5 m depth			1.2	Campanulinas, [illegible], Ceratiums and Algaes are predominant.

Figure 3 (c). Plankton and transparency in Bosporus, Golden Horn and Sea of Marmara, October 16, 1967

Station Number	Sample taken at	Water colour	Transparency (seiche disc)	Bottom deposit (g per 200 cm^3)	Results of Plankton Analysis
8 Princes' Islands	Surface	Blackish Dark Blue	8.0 m	1.2	Dinoflagellates (C. Tripos), free Copepodes and Leptostrucaes are predominant. Campanulinas, Ceratiums and Peridiniums are also observed.
	5 m depth			0.8	Ceratiums, Campanularias, Dinoflagellates are predominant. Diatomaes, Cumucaes (B. Scorpioidae) and Copepodes are also observed.
9 Princes' Islands	Surface	Dark Blue	8.80 m	0.6	Diatomaes, Infusorias and Campanulas are predominant. Amphipodes, Copepodes and Peritrichas are also observed.
	5 m depth			0.6	Dinoflagellates, Ceratiums and Copepodes are predominant. Diatomaes, Tornarias and Tintinus are also observed.
10 Offshore (Caddebostan) Marmara	Surface	Greyish Dark Blue	8.25	1.2	Dinoflagellates, Ceratiums and Trochophores are predominant. Tornarias, Diatomaes (B. Sinensis, C. Decipien) and Copepodes are observed.
	5 m depth			0.7	Dinoflagellates (C. Tripos), Diatomaes, Ceratiums and Chetopodes are predominant. Tintirnus, Peridinium, Leptostracae (Metalia Pipes) and Elitra are also observed.

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